ARTIFACT COLLECTION FROM WSDOT PARCEL W23A (SITE 45CL9225)

PRELIMINARY

Historic Catalog Form

3/10/2011

Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23A 001	45CL925	MT4 Fea. 1 (backdirt)	Activities	Painting	Container	Bottle, Paint	Colorless Glass	100%	embossed on base: (Hazel Atlas logo - H ove	Hazel Atlas Glass Co.	ca. 1923	1964	1	0
W23A 002	45CL925	MT4 Fea. 1 (backdirt)	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%	printed mark: [EDWIN M. K]NOWLES / [CHI	Edwin M. Knowles China	ca. 1900	1948	0	1
W23A 003	45CL925	MT4 Fea. 1 (backdirt)	Domestic	Food Prep/Consumption	Tableware	Indefinite	White Improved Earthenware	<25%	(white improved earthenware commercially i		ca. 1840s	-	0	1
W23A 004	45CL925	MT4 Fea. 1 (backdirt)	Structural	Electrical	-	Insulator	Composite	100%	(wire nail extending through center of insulat		ca. 1884	present	1	0
W23A 005	45CL925	MT4 Fea. 1 (backdirt)	Structural	Hardware	Fastener	Spike/Bolt	Ferrous	N/A					0	1
W23A 006	45CL925	MT4 Fea. 1 (backdirt)	Structural	Materials	-	Brick, Firebrick	Brick	<25%					0	1
W23A 007	45CL925	MT4 Fea. 1 (backdirt)	Structural	Materials	-	Brick, Common Red	Brick	>75%					0	1

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ARTIFACT COLLECTION FROM WSDOT PARCEL W23B (SITE 45CL926)

PRELIMINARY

Historic Catalog Form

3/10/2011

Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23B 001	45CL926	MT5 Fea. 1	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(same decorative pattern	French Chin	1916	1929	0	3
W23B 002	45CL926	MT5 Fea. 1	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%					0	3
W23B 003	45CL926	MT5 Fea. 1	Domestic	Food Prep/Consumption	Tableware	Bowl or Cup	Earthenware	<25%					0	1
W23B 004	45CL926	MT5 Fea. 1	Domestic	Furnishings	-	Flowerpot	Terra Cotta	<25%					0	1
W23B 005	45CL926	MT5 Fea. 1	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	1
W23B 006	45CL926	MT5 Fea. 1	Structural	Electrical	-	Insulator	Porcelain	100%	(electrical fence insulator		early 1900s	present	1	0
W23B 007	45CL926	MT5 Fea. 1	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(decolorized glass)		ca. 1870s	present	0	1
W23B 008	45CL926	MT5 Fea. 1	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	<25%					0	1
W23B 009	45CL926	MT5 Fea. 1	Domestic	Food Storage	Closure	Canning Jar Lid	Blue Glass	25-50%	(Lightning-type closure)		late 1870s	at least 1950s	0	1
W23B 010	45CL926	MT5 Fea. 1	Domestic	Indefinite	-	Plate	Carnival Glass	<25%	(Carnival Glass)		1907	1930*	0	3
W23B 011	45CL926	MT5 Fea. 1	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	1
W23B 012	45CL926	MT5 Fea. 1	Indefinite Use	Indefinite	-	Wire	Metal	N/A					0	2
W23B 013	45CL926	MT5 Fea. 1	Personal	Accoutrements	-	Purse Frame with Clasp	Metal	50-75%					0	
W23B 014	45CL926	MT5 Fea. 1	Structural	Hardware	Fastener	Nail, Wire	Ferrous	100%	(wire nails readily availab		ca. 1884	present	4	
W23B 015	45CL926	MT5 Fea. 1	Structural	Materials	-	Brick, Common Red	Brick	<25%					0	1
W23B 016	45CL926	MT5 Fea. 1	Structural	Electrical	-	Fuse	Composite	25-50%					0	1
W23B 017	45CL926	MT5, 6.6 m from W end, 45 cmbs (above Fea. 2)	Personal	Accoutrements	-	Bead	Blue Glass	100%					1	0
W23B 018	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	25-50%	printed mark: [LA FRA]N	French Chin	1916	1929	0	1
W23B 019	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	25-50%	(mends with cat. #210-W	French Chin	1916	1929	0	6
W23B 020	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	50-75%	printed mark: (inside pitc	Taylor, Smit	ca. 1925	present	0	6
W23B 021	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	25-50%	printed mark: DERW[OO	W.S. Georg	late 1930s	1940s	0	3
W23B 022	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	25-50%	(mends with cat. #212-W	Thompson	1868	1938	0	1
W23B 023	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%					0	1
W23B 024	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(mends with cat. #20-W2	Taylor, Smit	ca. 1925	present	0	1
W23B 025	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Cup	White Improved Earthenware	<25%	(white improved earthen		ca. 1840s	-	0	1
W23B 026	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	3
W23B 027	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Bowl	Porcelain	<25%	(decal decoration)		ca. 1900	present	0	1
W23B 028	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Saucer	Porcelain	25-50%	printed mark: MADE / IN		1921	1940	0	1
W23B 029	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Saucer	Porcelain	<25%	(mends with cat. #143-W		1921	1940	0	1
W23B 030	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Amber Glass	100%	embossed on base: (O in	Owens Bottl	1919	1929	1	0
W23B 031	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Amber Glass	100%	embossed on base: W /	Illinois Glas	1915	1929	1	0
W23B 032	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Amber Glass	<25%	embossed on base: (I ins	Illinois Glas	1915	1929	0	1
W23B 033	45CL926	MT5/MT7 Fea. 2	Personal	Health	Container	Bottle, Medicine	Cobalt Glass	100%	(external thread finish); e	Maryland Gl	1924	ca. 1970s*	1	0
W23B 034	45CL926	MT5/MT7 Fea. 2	Personal	Health	Container	Bottle, Medicine	Cobalt Glass	100%	embossed on base: M / 7	Maryland Gl	1907	ca. 1970s*	1	0
W23B 035	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Container	Canning Jar	Blue Glass	<25%	embossed on base: KER	Kerr Glass	1909	1912	0	1
W23B 036	45CL926	MT5/MT7 Fea. 2	Personal	Grooming/Health	Container	Cold Cream Jar	Milk Glass	100%	embossed on body: PON	Pond's Extr	ca. 1910	-	1	0
W23B 037	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid Liner	Milk Glass	>75%	embossed on liner: BOY		1869	at least 1950s	0	5
W23B 038	45CL926	MT5/MT7 Fea. 2	Domestic	Heating/Lighting	Lamp	Globe	Milk Glass	<25%					0	3
W23B 039	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	<25%	(Owens machine suction		1905*	1982*	0	1
W23B 040	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Container	Canning Jar	Aqua Glass	<25%	(ABM)		ca. 1905	present	0	1
W23B 041	45CL926	MT5/MT7 Fea. 2	Laundry	Clothing Maintenance	Container	Bottle, Bluing	Aqua Glass	<25%	embossed on shoulder: [		ca. 1920	ca. 1960s	0	
W23B 042	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Container	Canning Jar	Aqua Glass	<25%	(valve mark)		late 1910s	1940s	0	1
W23B 043	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Container	Canning Jar	Aqua Glass	<25%	embossed on body: [GE	Illinois Glas	ca. 1900	1920	0	1
W23B 044	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	100%	embossed on base: (I ins	Illinois Glas	1915	1929	1	0
W23B 045	45CL926	MT5/MT7 Fea. 2	Domestic	Food	Container	Bottle, Milk	Colorless Glass	100%	embossed on heel: 10 / (	Illinois Pacifi	ca. 1925	1930 or 1932	1	0
W23B 046	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Jar, Indefinite	Colorless Glass	100%	embossed on base: 5 (P	Pacific Coas	1919	1930	1	0
W23B 047	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	100%	embossed on base: (I ins	Illinois Glas	1915	1929	1	0
W23B 048	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	100%	(lug type external thread		ca. 1930	1982*	1	0
W23B 049	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	100%	(tooled finish; air venting		ca. 1900	early 1920s	1	0
W23B 050	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	100%	embossed on base: 7 / (	Hazel-Atlas	1923	1964	1	0
W23B 051	45CL926	MT5/MT7 Fea. 2	Domestic	Food	Container	Bottle, Milk	Colorless Glass	50-75%	embossed on body: ONE	Willsburg D	ca. 1900	1917?	0	4
W23B 052	45CL926	MT5/MT7 Fea. 2	Personal	Health	Container	Bottle, Medicine	Colorless Glass	25-50%	embossed on base: 6 (O	Owens Bottl	1925	1925	0	1
W23B 053	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	50-75%	embossed on body: PAT	Hygeia Bab	1916	-	0	1
W23B 054	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(decolorized glass)		ca. 1870s	present	0	1
W23B 055	45CL926	MT5/MT7 Fea. 2	Personal	Health	Container	Bottle, Medicine	Colorless Glass	<25%	(ABM; reinforced extract		post ca. 1906	1920s	0	1

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W23B 056	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Jar, Indefinite	Amethyst Glass	25-50%	(sun colored amethyst gl		1905	ca. 1920	0	3
W23B 057	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Jar, Indefinite	Colorless Glass	>75%	(interrupted external thre		1911	present	0	3
W23B 058	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle/Jar	Colorless Glass	25-50%	embossed on base: 8 / F	Owens Bottl	ca. 1916	1919	0	2
W23B 059	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(Owens machine suction		ca. 1915	ca. 1925	0	1
W23B 060	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Bowl, Serving?	Colorless Glass	<25%	embossed on base: (H o	Hazel-Atlas	1923	1964	0	2
W23B 061	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Jar, Indefinite	Colorless Glass	<25%					0	2
W23B 062	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%					0	1
W23B 063	45CL926	MT5/MT7 Fea. 2	Domestic	Indefinite	-	Indefinite	Amethyst Pressed Glass	<25%					0	1
W23B 064	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(decolorized glass)		ca. 1870s	present	0	3
W23B 065	45CL926	MT5/MT7 Fea. 2	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	100%	embossed on base: (cap	Capstan Gla	1918	1937	1	0
W23B 066	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Kitchen	Kettle	Enamelware	>75%	(enamelware)		ca. 1900	present	0	1
W23B 067	45CL926	MT5/MT7 Fea. 2	Faunal	Food	Animal	Bone	Bone	N/A					0	1
W23B 068	45CL926	MT5/MT7 Fea. 2	Faunal	Indefinite	Animal	Bone	Bone	N/A					0	1
W23B 069	45CL926	MT5/MT7 Fea. 2	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	[illegible]
W23B 070	45CL926	MT5/MT7 Fea. 2	Faunal	Food	Shellfish	Shell, Clam	Shell	N/A					0	[illegible]
W23B 071	45CL926	MT5/MT7 Fea. 2	Personal	Clothing	Fastener	Button	Shell	>75%					0	1
W23B 072	45CL926	MT5/MT7 Fea. 2	Structural	Electrical	-	Insulator	Porcelain	>75%	embossed: THOMAS	Thomas & S	1884	1957	0	1
W23B 073	45CL926	MT5/MT7 Fea. 2	Structural	Materials	-	Brick, Firebrick	Brick	25-50%	CLAY[BURN] / [MADE I	Clayburn Co	1905	1930	0	1
W23B 074	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Electrical	-	Battery Rod	Carbon	25-50%					0	2
W23B 075	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Flatwear	Spoon	Metal	100%	embossed on back of ha	Wm. A. Rog	1894	1929	1	0
W23B 076	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Tube	Metal	N/A					0	1
W23B 077	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Tube	Metal	N/A					0	1
W23B 078	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Handle	Metal	N/A					0	1
W23B 079	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Tube	Metal	N/A					0	1
W23B 080	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Wire	Metal	N/A					0	1
W23B 081	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Indefinite	Composite	N/A					0	1
W23B 082	45CL926	MT5/MT7 Fea. 2	Activities	Tools	-	File	Ferrous	100%					1	0
W23B 083	45CL926	MT5/MT7 Fea. 2	Structural	Materials	-	Pipe	Ferrous	100%					1	0
W23B 084	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid	Metal	>75%	stamped: KERR (in script		1901	1961	1	0
W23B 085	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid	Zinc	50-75%					0	1
W23B 086	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid and Liner	Composite	>75%	embossed on liner: GEN		1869	at least 1950s	0	1
W23B 087	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Closure	Can Lid	Ferrous	25-50%	(external friction lid)		1850s	present	0	1
W23B 088	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid?	Ferrous	<25%					0	13
W23B 089	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(sanitary can)		1904	present	0	7
W23B 090	45CL926	MT5/MT7 Fea. 2	Domestic	Food	Container	Can	Ferrous	<25%	(stamped end)		1849	-	0	11
W23B 091	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A					0	8
W23B 092	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(double/rolled seam)		1888	present	0	5
W23B 093	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A					0	78
W23B 094	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Indefinite	Wood	N/A					0	3
W23B 095	45CL926	MT5/MT7 Fea. 2	Indefinite Use	Indefinite	-	Indefinite	Fabric	N/A					0	4
W23B 096	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	>75%	printed mark: CANONSB	Canonsburg	1901	1920s	0	[illegible]
W23B 097	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Earthenware	<25%					0	[illegible]
W23B 098	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%					0	[illegible]
W23B 099	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Porcelain	<25%	(part of same vessel as c		ca. 1900	present	0	1
W23B 100	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	25-50%	(part of same "Phoenix B		1921	1940	0	5
W23B 101	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Structural	Electrical	-	Insulator	Porcelain	100%	embossed: THOMAS	Thomas & S	1884	1957	1	0
W23B 102	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Storage	Closure	Canning Jar Lid Liner	Milk Glass	25-50%	embossed on liner: BOY		1869	at least 1950s	0	1
W23B 103	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Amber Glass	<25%					0	3
W23B 104	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	100%	embossed on base: (cap	Capstan Gla	1918	1937	1	0
W23B 105	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food	Container	Bottle, Condiment	Colorless Glass	>75%	embossed: (IPGCO insid	Illinois Pacifi	1902	ca. 1925	0	7
W23B 106	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	50-75%	embossed on base: 50 (	Owens Bottl	1919	1929	0	11
W23B 107	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	25-50%					0	7
W23B 108	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Personal	Health	Container	Bottle, Medicine	Colorless Glass	<25%	(tooled reinforced extract		1890s	early 1920s	0	2
W23B 109	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	<25%	(part of same bottle as c	Owens Bottl	1925	1925	0	1
W23B 110	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	N/A	(decolorized glass)		ca. 1870s	present	0	6

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Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23B 111	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	N/A					0	1
W23B 112	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Furnishings	-	Flowerpot	Terra Cotta	50-75%					0	2
W23B 113	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Furnishings	-	Flowerpot	Terra Cotta	>75%					0	8
W23B 114	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Furnishings	-	Flowerpot	Terra Cotta	25-50%					0	7
W23B 115	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Faunal	Food	Shellfish	Shell, Indefinite	Shell	N/A					0	2
W23B 116	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Faunal	Indefinite	Animal	Bone	Bone	N/A					0	2
W23B 117	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Personal	Grooming/Health	Toiletry	Toothbrush Handle?	Bone	50-75%					0	2
W23B 118	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	-	Indefinite	Wood	N/A					0	2
W23B 119	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	-	Indefinite	Unidentified	N/A					0	1
W23B 120	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Waste	-	Clinker	Composite	N/A					0	2
W23B 121	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(stamped end)		1849	-	0	3
W23B 122	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(sanitary can)		1904	present	0	12
W23B 123	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(double/rolled seam)		1888	present	0	
W23B 124	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%					0	
W23B 125	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	100%	(wire nails readily availab		ca. 1884	present	1	0
W23B 126	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	N/A	(wire nails readily availab		ca. 1884	present	0	5
W23B 127	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Indefinite Use	Indefinite	-	Wire?	Metal	N/A					0	1
W23B 128	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Structural	Materials	-	Brick, Common Red	Brick	<25%					0	1
W23B 129	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Indefinite Use	Indefinite	-	Indefinite	Wood	N/A					0	2
W23B 130	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Structural	Hardware	-	Washer	Metal	100%					1	0
W23B 131	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A					0	59
W23B 132	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(double/rolled seam)		1888	present	0	1
W23B 133	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	100%	(wire nails readily availab		ca. 1884	present	1	0
W23B 134	45CL926	MT5/MT7 Fea. 2, mixed L1&2, 70-90 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	25-50%	(wire nails readily availab		ca. 1884	present	0	1
W23B 135	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	100%	printed mark: DERWOO	W.S. Georg	late 1930s	1940s	1	0
W23B 136	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(mends with cat. #18 and	French Chin	1916	1929	0	2
W23B 137	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	<25%	(associated with cat. #21	French Chin	1916	1929	0	2
W23B 138	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(same decorative pattern	French Chin	1916	1929	0	4
W23B 139	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	<25%	(part of same vessel as c	W.S. Georg	late 1930s	1940s	0	1
W23B 140	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%					0	1
W23B 141	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	White Improved Earthenware	<25%	(white improved earthen		ca. 1840s	-	0	1
W23B 142	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Butter Pat Dish	Porcelain	>75%	printed mark: KTK (embe	Knowles, Ta	1872	1931	0	3
W23B 143	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Porcelain	25-50%	printed mark: MADE / IN		1921	1940	0	6
W23B 144	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	25-50%	(part of same "Phoenix B		1921	1940	0	4
W23B 145	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Porcelain	25-50%	(decal decoration)		ca. 1900	present	0	6
W23B 146	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	1
W23B 147	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	3
W23B 148	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Furnishings	-	Flowerpot	Terra Cotta	25-50%					0	7
W23B 149	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Furnishings	-	Flowerpot	Terra Cotta	25-50%					0	10
W23B 150	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Personal	Social Drugs - Alcohol	Container	Bottle, Beer	Amber Glass	25-50%	(ABM)		ca. 1905	present	0	7
W23B 151	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Personal	Grooming/Health	Container and Closure	Cold Cream Jar and Lid	Composite	>75%	(circular paper label with	Armand Co	ca. 1916	see remarks	0	
W23B 152	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Jar, Indefinite	Milk Glass	<25%					0	2
W23B 153	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Storage	Container and Closure	Canning Jar, Lid and Liner	Composite	25-50%	embossed on body: [GE	Illinois Glas	ca. 1900	1920	0	9
W23B 154	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Storage	Container	Canning Jar	Colorless Glass	50-75%	embossed on base: KER	Kerr Glass	1915	1919	0	12
W23B 155	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Storage	Container	Canning Jar	Colorless Glass	25-50%	embossed on base: SCH	Schram Gla	ca. 1920	1925	0	9
W23B 156	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	100%	embossed on base: 6 (O	Owens Bottl	1925	1925	1	0
W23B 157	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	100%					0	5
W23B 158	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	25-50%					0	10
W23B 159	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	50-75%	(part of same bottle as c	Owens Bottl	1925	1925	0	5
W23B 160	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	<25%	(mends with cat. #106-W	Owens Bottl	1919	1929	0	1
W23B 161	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	<25%	(mends with cat. #53-W2	Hygeia Bab	1916	-	0	2
W23B 162	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl, Serving?	Colorless Glass	25-50%	(mends with cat. #60-W2	Hazel-Atlas	1923	1964	0	6
W23B 163	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Colorless Pressed Glass	25-50%					0	1
W23B 164	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Drinking Vessel	Tumbler	Colorless Glass	<25%					0	2
W23B 165	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Sugar Shaker	Aqua Glass	50-75%					0	5

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Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23B 166	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Sugar Shaker	Colorless Glass	<25%					0	2
W23B 167	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Container	Jar, Indefinite	Colorless Glass	50-75%	embossed on base: PAT		1903	ca. 1913	0	1
W23B 168	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Personal	Health	Container	Bottle, Medicine	Colorless Glass	25-50%	(mends with cat. #108-W		late 1890s	early 1920s	0	5
W23B 169	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(tooled patent/extract fini		ca. late 1870s	mid-1910s	0	1
W23B 170	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	("PRIOF"-type finish)		early 1920s	-	0	1
W23B 171	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(lug type external thread		ca. 1930	present	0	1
W23B 172	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Heating/Lighting	Lamp	Chimney	Colorless Glass	<25%					0	4
W23B 173	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	N/A	(decolorized glass)		ca. 1870s	present	0	8
W23B 174	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Laundry	Clothing Maintenance	Container	Bottle, Bluing	Aqua Glass	100%	embossed on base: (IPG	Illinois Pacifi	ca. 1925	1930 or 1932	1	0
W23B 175	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Furnishings	-	Mirror	Aqua Glass	N/A					0	11
W23B 176	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	4
W23B 177	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Faunal	Food	Shellfish	Shell, Clam	Shell	N/A					0	1
W23B 178	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Tube	Metal	N/A					0	1
W23B 179	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Wire	Metal	N/A					0	[illegible]
W23B 180	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Heating/Lighting	-	Light Bulb	Composite	25-50%	(Edison screw fitting)		1909*	present	0	[illegible]
W23B 181	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Rubber Band?	Rubber	N/A					0	6
W23B 182	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	-	Baby Bottle Nipple?	Rubber	25-50%					0	2
W23B 183	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Structural	Hardware	-	Washer	Metal	100%					1	0
W23B 184	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Cap?	Plastic	100%					1	0
W23B 185	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Activities	Firearms	Ammunition	Cartridge Case	Brass	50-75%					0	2
W23B 186	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Activities	Firearms	Ammunition	Cartridge (live)	Brass	100%	headstamp: U (underline	Union Metall	1892	1903	1	0
W23B 187	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Kitchen	Milk Pan	Zinc	>75%					0	19
W23B 188	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Mesh	Ferrous	N/A					0	1
W23B 189	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	100%	(wire nails readily availab		ca. 1884	present	7	0
W23B 190	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	N/A	(wire nails readily availab		ca. 1884	present	0	5
W23B 191	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Wire	Ferrous	N/A					0	1
W23B 192	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Spring	Ferrous	N/A					0	1
W23B 193	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Structural	Materials	-	Barbed Wire	Ferrous	N/A	(introduction of barbed wi		1876	present	0	3
W23B 194	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Flatwear	Spoon	Ferrous	100%					1	0
W23B 195	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(hole-in-cap can)		1823	ca. 1940s	0	1
W23B 196	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(stamped end)		1849	-	0	5
W23B 197	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(sanitary can)		1904	present	0	18
W23B 198	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(double/rolled seam)		1888	present	0	4
W23B 199	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Closure	Can Lid	Ferrous	50-75%	(external friction lid)		1850s	present	0	1
W23B 200	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Closure	Sprinkler Cap/Top	Ferrous	>75%					0	1
W23B 201	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food	Closure	Sprinkler Cap/Top?	Ferrous	100%					1	0
W23B 202	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Personal	Social Drugs - Tobacco	Container	Tobacco Tin	Ferrous	50-75%	(upright pocket tin)		early 1900s	-	0	13
W23B 203	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Indefinite	Ferrous	N/A					0	1
W23B 204	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Indefinite	Ferrous	N/A					0	1
W23B 205	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A					0	39
W23B 206	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Indefinite	-	Rack or Grill	Ferrous	50-75%					0	[illegible]
W23B 207	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(part of same "Phoenix B		1921	1940	0	[illegible]
W23B 208	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Porcelain	50-75%	(mends with cat. #28-W2		1921	1940	0	[illegible]
W23B 209	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(mends with cat. #273-W	French Chin	1916	1929	0	3
W23B 210	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	25-50%	printed mark: LA FRANC	French Chin	1916	1929	0	3
W23B 211	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	printed mark: (upper part	French Chin	1916	1929	0	3
W23B 212	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	25-50%	printed mark: T (extends	Thompson	1868	1938	0	1
W23B 213	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	<25%	(mends with cat. #277-W	W.S. Georg	late 1930s	1940s	0	1
W23B 214	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%					0	1
W23B 215	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%					0	2
W23B 216	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	25-50%	(peak popularity of Japan		1920s	1930s	0	7
W23B 217	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	50-75%	(peak popularity of Japan		1920s	1930s	0	16
W23B 218	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	1
W23B 219	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	1
W23B 220	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%					0	1

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Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23B 221	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Laundry	Clothing Maintenance	Container	Bottle, Bleach	Amber Glass	100%	embossed on base: CLO	Illinois Pacifi	1929	1930	1	0
W23B 222	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Health	Container	Bottle, Medicine	Cobalt Glass	100%	(external thread finish); e	Maryland Gl	1924	ca. 1970s*	1	0
W23B 223	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Health	Container	Bottle, Medicine	Composite	100%	(external thread finish); e	Maryland Gl	1924	ca. 1970s*	1	0
W23B 224	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	100%	embossed on base: (I ins	Illinois Glas	1915	1929	1	0
W23B 225	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container and Closure	Bottle, Indefinite and Screw Cap	Composite	100%	(lug type external thread		ca. 1930	1982*	1	0
W23B 226	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Heating/Lighting	-	Light Bulb	Composite	100%	stamped on top of bulb: (	General Ele	1914	1945	1	0
W23B 227	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Social Drugs - Alcohol	Container	Bottle, Beer	Amber Glass	<25%	(mends with cat. #150-W		1905*	1982*	0	9
W23B 228	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Jar, Indefinite	Milk Glass	<25%	(ABM)		ca. 1905	present	0	2
W23B 229	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Blue Glass	<25%					0	1
W23B 230	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Furnishings	-	Mirror	Aqua Glass	<25%					0	1
W23B 231	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Structural	Materials	-	Glass, Window	Aqua Glass	N/A					0	4
W23B 232	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	<25%	(mends with cat. #287-W	Illinois Pacifi	ca. 1925	1930 or 1932	0	3
W23B 233	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	<25%					0	[illegible]
W23B 234	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl, Serving?	Colorless Glass	<25%	(mends with cat. #60-W2	Hazel-Atlas	1923	1964	0	[illegible]
W23B 235	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Drinking Vessel	Tumbler	Colorless Glass	<25%					0	1
W23B 236	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Sugar Shaker	Colorless Glass	<25%					0	4
W23B 237	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food	Container	Jar, Indefinite	Colorless Glass	<25%	(mends with cat. #167-W		1903	ca. 1913	0	1
W23B 238	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	>75%					0	2
W23B 239	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Grooming	Container	Bottle, Perfume	Colorless Glass	>75%	embossed on base: (O in	Owens Bottl	1919	1929	0	1
W23B 240	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Container	Baby Bottle	Colorless Glass	<25%	embossed on base: 6 (O	Owens Bottl	1925	1925	0	1
W23B 241	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(interrupted external thre		1911	present	0	1
W23B 242	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Heating/Lighting	-	Indefinite	Colorless Glass	N/A					0	15
W23B 243	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(decolorized glass)		ca. 1870s	present	0	2
W23B 244	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(decolorized glass)		ca. 1870s	present	0	1
W23B 245	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	N/A	(decolorized glass)		ca. 1870s	present	0	25
W23B 246	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Faunal	Food	Shellfish	Shell, Clam	Shell	N/A					0	2
W23B 247	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	2
W23B 248	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Clothing	Fastener	Button	Shell	>75%					1	0
W23B 249	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Indefinite	Charcoal	N/A					0	1
W23B 250	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Tube	Metal	N/A					0	1
W23B 251	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Kitchen	Kettle	Enamelware	<25%	(enamelware)		ca. 1900	present	0	1
W23B 252	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Rubber Band?	Rubber	N/A					0	1
W23B 253	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Structural	Materials	-	Brick, Common Red	Brick	<25%					0	1
W23B 254	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Activities	Firearms	Ammunition	Cartridge Case	Brass	>75%	headstamp: REM-UMC /	Remington	1906	early 1900s	0	2
W23B 255	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Structural	Hardware	-	Washer	Metal	100%					1	0
W23B 256	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Structural	Hardware	-	Washer?	Ferrous	100%					1	0
W23B 257	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Fastener	Buckle	Ferrous	50-75%					0	1
W23B 258	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Handle	Ferrous	100%					1	0
W23B 259	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Mesh	Ferrous	N/A					0	2
W23B 260	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	100%	(wire nails readily availab		ca. 1884	present	9	0
W23B 261	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	N/A	(wire nails readily availab		ca. 1884	present	0	[illegible]
W23B 262	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Indefinite	Ferrous	N/A					0	3
W23B 263	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	-	Strap	Ferrous	N/A					0	1
W23B 264	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Social Drugs - Tobacco	Container	Tobacco Tin	Ferrous	50-75%	(upright pocket tin)		early 1900s	-	0	3
W23B 265	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(cone top)		1935	early 1970s	0	1
W23B 266	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Closure	Cap	Ferrous	50-75%					0	1
W23B 267	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A	(double/rolled seam)		1888	present	0	6
W23B 268	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(matchstick filler hole)		1900	mid-1980s	0	1
W23B 269	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food	Container	Can	Ferrous	N/A	(stamped end)		1849	-	0	8
W23B 270	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(sanitary can)		1904	present	0	10
W23B 271	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A					0	26
W23B 272	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Porcelain	<25%	(similar to other "Phoenix		1921	1940	0	2
W23B 273	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	50-75%	printed mark: LA FRANC	French Chin	1916	1929	0	4
W23B 274	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	<25%	(mends with cat. #210-W	French Chin	1916	1929	0	1
W23B 275	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	<25%	(mends with cat. #212-W	Thompson	1868	1938	0	1

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Historic Catalog Form

3/10/2011

Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23B 276	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(mends with cat. #20-W2	Taylor, Smit	ca. 1925	present	0	1
W23B 277	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	>75%	printed mark: DERWOO	W.S. Georg	late 1930s	1940s	0	4
W23B 278	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	<25%	(mends with cat. #96-W2	Canonsburg	1901	1920s	0	1
W23B 279	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Bowl	Earthenware	<25%	(mends with cat. #210-W	French Chin	1916	1929	0	1
W23B 280	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Earthenware	<25%	(gilding)		ca. 1880	present	0	1
W23B 281	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Porcelain	<25%					0	4
W23B 282	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	25-50%	(peak popularity of Japan		1920s	1930s	0	5
W23B 283	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	<25%	(peak popularity of Japan		1920s	1930s	0	2
W23B 284	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Personal	Health	Container	Bottle, Medicine	Cobalt Glass	100%	(external thread finish); e	Maryland Gl	1924	ca. 1970s*	1	0
W23B 285	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Storage	Closure	Canning Jar Lid	Blue Glass	100%	(Lightning-type closure)		late 1870s	at least 1950s	0	2
W23B 286	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Furnishings	-	Indefinite	Aqua Glass	<25%					0	1
W23B 287	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Aqua Glass	<25%	embossed on base: (I.P.	Illinois Pacifi	ca. 1925	1930 or 1932	0	1
W23B 288	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	100%	embossed on base: (I ins	Illinois Glas	1915	1929	1	0
W23B 289	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Personal	Health	Container	Bottle, Bitters	Colorless Glass	100%	embossed on base: A.D.	American Dr	ca. 1905	at least 1935	1	[illegible]
W23B 290	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Personal	Health	Container	Bottle, Medicine	Colorless Glass	100%	embossed on base: [6] (	Owens Bottl	1925	1925	1	[illegible]
W23B 291	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	>75%	embossed on base: (P C	Pacific Coas	1919	ca. 1930	0	5
W23B 292	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	embossed on base: (P C	Pacific Coas	1919	ca. 1930	0	1
W23B 293	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Jar, Indefinite	Colorless Glass	25-50%	embossed on base (reve		1903 or 1906	-	0	8
W23B 294	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food	Container	Jelly Tumbler	Colorless Glass	50-75%					0	4
W23B 295	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Drinking Vessel	Tumbler	Colorless Glass	25-50%					0	1
W23B 296	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Bottle/Jar	Colorless Glass	<25%	(interrupted external thre		1911	present	0	2
W23B 297	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Heating/Lighting	Lamp	Chimney	Colorless Glass	<25%					0	3
W23B 298	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Bottle, Indefinite	Colorless Glass	<25%	(decolorized glass)		ca. 1870s	present	0	1
W23B 299	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Faunal	Food	Shellfish	Shell, Clam	Shell	N/A					0	2
W23B 300	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	1
W23B 301	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Faunal	Indefinite	Animal	Bone	Bone	N/A					0	8
W23B 302	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Closure	Stopper	Cork?	100%					1	0
W23B 303	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Structural	Hardware	-	Washer	Metal	100%					1	0
W23B 304	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	-	Indefinite	Composite	25-50%					0	1
W23B 305	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	-	Indefinite	Metal	N/A					0	1
W23B 306	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	100%	(wire nails readily availab		ca. 1884	present	16	0
W23B 307	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Structural	Hardware	Fastener	Nail, Wire	Ferrous	N/A	(wire nails readily availab		ca. 1884	present	0	14
W23B 308	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	-	Mesh	Ferrous	N/A					0	1
W23B 309	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Activities	Painting	-	Paint Brush	Composite	25-50%					0	1
W23B 310	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	-	Wire	Metal	N/A					0	3
W23B 311	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	-	Indefinite	Composite	N/A					0	1
W23B 312	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	-	Tube	Metal	N/A					0	1
W23B 313	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Personal	Social Drugs - Tobacco	Container	Tobacco Tin	Ferrous	25-50%	(kidney-shaped upright p		ca. 1901	ca. 1905	0	1
W23B 314	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(matchstick filler hole)		1900	mid-1980s	0	1
W23B 315	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(hole-in-cap can)		1823	ca. 1940s	0	1
W23B 316	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Closure	Screw Cap	Ferrous	>75%					0	[illegible]
W23B 317	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Closure	Can Lid	Ferrous	>75%	(external friction lid)		1850s	present	0	[illegible]
W23B 318	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Closure	Lid	Ferrous	25-50%					0	[illegible]
W23B 319	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food	Container	Can	Ferrous	<25%	(stamped end)		1849	-	0	3
W23B 320	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	<25%	(double/rolled seam)		1888	present	0	3
W23B 321	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Indefinite Use	Indefinite	Container	Can	Ferrous	N/A					0	20
W23B 322	45CL926	MT5/MT7 Fea. 2, L4, 100-110 cmbs	Domestic	Food Prep/Consumption	Tableware	Indefinite	Porcelain	<25%	(part of same "Phoenix B		1921	1940	0	1
W23B 323	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Domestic	Food Prep/Consumption	Tableware	Saucer	Porcelain	<25%	(mends with cat. #143-W		1921	1940	0	1
W23B 324	45CL926	MT5/MT7 Fea. 2	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	2
W23B 325	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	3
W23B 326	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	3
W23B 327	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Faunal	Food	Shellfish	Shell, Clam	Shell	N/A					0	1
W23B 328	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Faunal	Food	Shellfish	Shell, Clam	Shell	N/A					0	8
W23B 329	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Faunal	Food	Shellfish	Shell, Oyster	Shell	N/A					0	1
W23B 330	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	25-50%	printed mark: LA FRA[N	French Chin	1916	1929	0	6

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Historic Catalog Form

3/10/2011

Catalog No.	Site Trinomial	Addt'l Prov Info	Artifact Group	Artifact Category	Artifact Type	Artifact Description	Material	% Complete	Mark	Maker	Begin Date	End Date	Whole Ct.	Frag Ct.
W23B 331	45CL926	MT5/MT7 Fea. 2	Domestic	Food Prep/Consumption	Tableware	Saucer	Earthenware	<25%	(same decorative pattern	Thompson	1868	1938	0	1
W23B 332	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Domestic	Food Prep/Consumption	Tableware	Cup	Porcelain	25-50%	(peak popularity of Japan		1920s	1930s	0	5
W23B 333	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid	Metal	>75%	stamped: KERR (in script		1901	1961	1	0
W23B 334	45CL926	MT5/MT7 Fea. 2	Domestic	Food Storage	Closure	Canning Jar Lid	Metal	>75%	stamped: KERR (in script		1901	1961	1	0
W23B 335	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Personal	Clothing	Fastener	Button	Shell	50-75%					0	2
W23B 336	45CL926	MT5/MT7 Fea. 2, L3, 90-100 cmbs	Indefinite Use	Heating/Lighting	-	Light Bulb	Composite	100%	stamped on top of bulb: (	General Ele	1914	1945	1	0
W23B 337	45CL926	MT5/MT7 Fea. 2, L2, 80-90 cmbs	Indefinite Use	Heating/Lighting	-	Light Bulb	Composite	25-50%	(Edison screw fitting)		1909*	present	0	1
W23B 338	45CL926	MT5/MT7 Fea. 2	Personal	Grooming/Health	Container	Cold Cream Jar	Milk Glass	100%	embossed on body: PON	Pond's Extr	ca. 1910	-	1	0
W23B 339	45CL926	MT5/MT7 Fea. 2	Personal	Grooming/Health	Container	Cold Cream Jar	Milk Glass	50-75%	embossed on body: PON	Pond's Extr	ca. 1910	-	0	2
W23B 340	45CL926	MT5 Fea. 1	Domestic	Food Prep/Consumption	Tableware	Plate	Earthenware	<25%	(mends with cat. #138-W	French Chin	1916	1929	0	1
W23B 341	45CL926	MT5/MT7 Fea. 2, L1, 70-80 cmbs	Domestic	Food	Container	Can	Ferrous	N/A	(stamped end; double/rol		1888	-	0	4

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INTERSTATE 5 COLUMBIA RIVER CROSSING SECTION 106 ARCHAEOLOGY TECHNICAL REPORT

Appendix 1B

Archaeological Discovery and Evaluation: ODOT Parcels

Rick Minor
Curt D. Peterson
Kendra R. Carlisle

Heritage Research Associates Report No. 344

INTERSTATE 5 COLUMBIA RIVER CROSSING
SECTION 106 ARCHAEOLOGY TECHNICAL REPORT

Appendix 1B

Archaeological Discovery and Evaluation: ODOT Parcels

Rick Minor
Curt D. Peterson
Kendra R. Carlisle

Report to
Washington State Department of Transportation
Oregon Department of Transportation

Submitted to David Evans and Associates, Inc.
Under Agreement No. Y-9245

Rick Minor
Principal Investigator
Heritage Research Associates, Inc.

December 2010

Heritage Research Associates Report No. 344

SHPO REPORTING DATA

Findings:	(-) Prehistoric _0_ Historic _0_ Isolate _0_
County:	Multnomah
Township/Range/Section:	T1N/R1E/Sections 3-4 T2N/R1E/Sections 33-34
USGS Quad:	Portland Oreg. 7.5′
Project Area:	225 acres (approximate)
Project Type:	Discovery and Evaluation
Archaeological Permit No.:	AP 1148
Field Notes Location:	Heritage Research Associates, Inc.
Report Title:	*Interstate 5 Columbia River Crossing Section 106 Archaeology Technical Report, Appendix 1B, Archaeological Discovery and Evaluation: ODOT*
Parcels:	
Authors:	Rick Minor, Curt D. Peterson, Kendra R. Carlisle
Contractor:	Heritage Research Associates, Inc., Eugene, Oregon
Client:	David Evans and Associates, Inc.
Date:	December 2010

MANAGEMENT SUMMARY

This volume describes the procedures and results of archaeological discovery investigations carried out on the Oregon shore of the Columbia River in connection with the Columbia River Crossing (CRC) project. The CRC project has the potential to impact archaeological resources extending back in time to 12,000 BP, when the last of the Missoula Floods swept down the Columbia River. The Pleistocene gravels deposited by these floods constitute a baseline for archaeology on the Columbia River floodplain where construction for the CRC project will be take place.

Over the millennia since the last of the Missoula Floods, the Columbia River has deposited substantial amounts of alluvial sands and silts along the Oregon shore that are generally in excess of 30 m thick. Archaeological remains may potentially be present at any depth within these alluvial deposits. Extending the search for archaeological evidence through the deep alluvium to the top of the Pleistocene gravels poses a significant methodological challenge for archaeology.

The CRC project is located along a section of the Columbia River floodplain between the Sandy and Willamette rivers referred to as the Columbia South Shore. Fifty-four radiocarbon dates have been reported from 16 archaeological sites along this section of the floodplain. The oldest archaeological sites date only to around 3,000 BP. The radiocarbon dates suggest that prehistoric occupation was episodic in nature. For the most part, prehistoric use of the floodplain involved villages and camps that were occupied for relatively short periods of time before abandonment.

The CRC APE on the Oregon shore consists of ODOT property along the I-5 corridor. From the Columbia River, the APE crosses Hayden Island, bridges Oregon Slough/North Portland Harbor, and extends southward for approximately three-quarters of a mile to Victory Blvd. Most of the APE is covered by the paved lanes of I-5 and associated interchanges. Few areas of exposed ground are available in which archaeological investigations may be conducted. Four previous archaeological surveys that included portions of the CRC APE did not identify any archaeological sites within the CRC APE.

The archaeological discovery investigations for the CRC project involved an unprecedented effort to identify evidence of past human occupation or activity in the deep alluvial deposits in the CRC APE. The effort to identify strata buried deep below the ground surface that may potentially contain archaeological remains dating back to 12,000 BP involved close collaboration between archaeologists and geologists, often referred to as the geoarchaeological approach, to a significantly greater extent than has been the case in previous archaeological research in the Lower Columbia Valley.

A review of information on the environmental setting of the CRC APE in the early historic period provides a baseline for interpretation of the geoarchaeological evidence. Ground-penetrating radar (GPR) surveys conducted to better understand the nature and thickness of artificial fill introduced during construction of I-5 established that conventional methods of archaeological site discovery, such as manual shovel/auger probe excavations and mechanical trenching, would not reach deep enough into native soils to verify the presence/absence of archaeological sites.

Probing for deeply buried archaeological remains was undertaken by means of continuous rotary-sonic coring to recover samples of sediments from the present ground surface down to the Pleistocene gravels. Sections from 14 boreholes (12 geoarchaeological and 2 geotechnical) were analyzed to establish (1) depth of artificial fill, (2) depth of the Holocene alluvium,

(3) stratigraphic ages of the alluvial deposits, (4) the sequence of landscape development, and (5) preservation potential for hosting archaeological remains.

The Pleistocene gravels were reached in 13 of the 14 boreholes. Depth to the gravels was greatest at 60.6 m on Hayden Island. Depths to gravels south of Oregon Slough ranged from 29.4 m to 46.1 m. The Holocene alluvium—the deposit in which archaeological remains might be found—was thickest at 54.8 m on Hayden Island. The thickness of the alluvium south of Oregon Slough ranged from 40.3 m to 25.5 m. Thickness of artificial fill in the boreholes along the I-5 corridor ranged from 5.8 m on Hayden Island, to 5.1 m on the south shore of Oregon Slough, to 3.0 m just north of Victory Boulevard.

Samples of organic material recovered from alluvium near the bottom of the boreholes submitted for radiocarbon dating provide dates for the initial deposition of the alluvial deposits. The oldest radiocarbon date obtained (10,740–11,190 cal BP) indicates that the alluvial deposits underlying Hayden Island span at least the last 11,000 years. The alluvial deposits elsewhere in the CRC APE span approximately the last 9,000 years, based on radiocarbon dates of roughly similar ages obtained from near the base of the alluvium in five different boreholes south of Oregon Slough.

Samples of organic material from near the top of the boreholes submitted for radiocarbon dating provide upper limiting ages for the alluvium. The latest date of 290–490 cal BP was obtained from wood fragments recovered from a context suggesting that a relatively stable vegetated levee/dune ridge had formed on Hayden Island by approximately 500 years ago. In contrast, samples at the artificial fill/alluvium contact in boreholes south of Oregon Slough produced earlier radiocarbon dates (in the 2,000 to 3,000 BP range), suggesting that the youngest prehistoric soils in this area are disturbed, and possibly missing altogether, as a result of past construction activity.

Within the alluvial deposits, tephras from at least two, and possibly three, volcanic eruptions are preserved. Tephra layers correlative with volcanic ash from the climactic eruption of Mount Mazama (at the present site of Crater Lake in the southern Oregon Cascade Range), which occurred at 7,700 cal BP, were present in 11 boreholes. A second tephra layer encountered in nine boreholes is tentatively correlated with the Mount St. Helens (MSH) Set-Y eruption that is radiocarbon dated to 3,900–3,300 cal BP. Lastly, weakly developed tephra layers observed near the top of three boreholes remain unidentified, but they may be related to the MSH Set-W eruption that occurred around 500 BP.

Much of the alluvium is occupied by two landscape features, floodplain channels and undifferentiated floodplains, that are characterized by sediments that are unlikely to have preserved archaeological remains. The other two landscape features represented in the alluvium, vegetated wetlands and vegetated levees/dune ridges, supported plant species or provided habitat for animals that were likely to have been exploited by native peoples. It is almost certain that sometime during the last 12,000 years native peoples exploited natural resources in the lakes, sloughs, and wetlands on the floodplain in the CRC APE.

No direct evidence of prehistoric occupation or activity was observed or recovered in any of the boreholes drilled on the Oregon shore in connection with the CRC project. However, the potential obviously exists that archaeological remains buried in the deep alluvium may be encountered during construction associated with the CRC project. In view of the dearth of evidence for human occupation on the floodplain before 3,000 BP, any archaeological evidence found is likely to be significant, in that it will contribute new information about prehistoric lifeways during earlier periods in Lower Columbia Valley prehistory about which very little is currently known.

PREFACE AND ACKNOWLEDGMENTS

Heritage Research Associates, Inc. (HERITAGE) carried out archaeological investigations on the Oregon shore for the Columbia River Crossing (CRC) project under the terms of a contract with David Evans and Associates, Inc. (DEA), a prime contractor on the CRC project. Rick Minor served as Principal Investigator for HERITAGE. Jenna Gaston and Tom Becker, were the Cultural Resource Coordinators for the CRC project. Archaeology is one aspect of the CRC's Environmental Program under the direction of Heather Wills (Environmental Manager).

The investigations for the CRC project on the Oregon shore were largely geoarchaeological in nature. The research design for these investigations was developed over the course of two years during discussions between Principal Investigator Rick Minor, Curt D. Peterson (Department of Geology, Portland State University), Mike Gallagher (Senior Planner/Northwest Cultural Resource Team Manager, Parametrix, Inc.), and Carolyn McAleer (Archaeology Program Manager, Oregon Department of Transportation [ODOT]).

Implementation of the research design was accomplished primarily under the direction of geomorphologist Curt D. Peterson and HERITAGE archaeologist Kendra R. Carlisle. Field investigations began in 2008 with a pedestrian archaeological survey, followed by ground-penetrating radar (GPR) surveys directed by Curt D. Peterson, assisted by HERITAGE personnel Galen Peterson and Sam Suárez. The main archaeological discovery effort involved the drilling of rotary-sonic boreholes for geoarchaeological purposes, undertaken between September and November 2009.

The borehole drilling was conducted under the terms of State of Oregon Archaeological Permit AP-1148. Drilling operations were coordinated by Mitchell F. Schaub of Foundation Engineering, Inc. (FEI). Boart Longyear provided the equipment and drill crews. Borehole locations and elevations were surveyed by DEA. While in the field, HERITAGE personnel Kendra R. Carlisle and Kennett Peterson recorded preliminary data for each core section.

Following completion of the borehole drilling, core boxes from the boreholes were stored at the Washington Department of Transportation (WSDOT) facility in Vancouver. The cores were analyzed for geological purposes by Curt D. Peterson, assisted by Kennett Peterson. The cores were examined for archaeological purposes at the HERITAGE home office in Eugene by Kendra R. Carlisle, assisted by Patrick Kolar.

Tephra samples from the cores were submitted for identification to Franklin F. Foit, Jr., at the School of Earth and Environmental Sciences, Washington State University. Radiocarbon samples were processed by Beta Analytic, Inc. Freshwater shellfish fragments were identified by Nancy Duncan, Pacific Northwest mollusk specialist, formerly with the USDI Bureau of Land Management/USDA Forest Service Special Status Species Program.

This volume was edited by Linda P. Hart and Kendra R. Carlisle. Graphics were prepared by Kevin C. McCornack. Final responsibility for preparation of this volume was assumed by Kathryn Anne Toepel.

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1. INTRODUCTION

The CRC project has the potential to impact archaeological resources associated with human occupation on the Oregon shore of the Columbia River extending back in time to 12,000 years Before Present (BP). This date is derived from the estimated age of the Pleistocene gravels underlying the deep alluvium on the Oregon shore that were deposited and/or reworked by the last of the Missoula Floods. These floods, which resulted from releases of glacially dammed Lake Missoula in present-day Montana, swept down the Columbia River, eroding earlier landforms and creating the modern landscape in the Lower Columbia River Valley (Baker and Bunker 1985; Benito and O'Connor 2003:624; O'Connor and Baker 1992; Waitt 1984, 1985).

The Missoula Floods cut into older Pleistocene gravels, represented today by the high gravel terraces that line the north and south banks of the Columbia River in Vancouver and northeast Portland. These terraces were deposited by a paleo-Columbia River with a much higher rate of flow than the modern Columbia River (Evarts et al. 2009; Peterson 2007). The Missoula Floods likely reworked these pre-existing gravels, truncating them at lower elevations and depositing sandy rythmites above them at the highest elevations. Ground-penetrating radar (GPR) surveys conducted for the CRC project in Vancouver show the shallow gravels to be cross-bedded in the lower terraces and plane bedded in the intermediate level terraces. The Missoula sandy rythmites are plane bedded in the highest terraces, reflecting sheet-flow deposition.

The Pleistocene gravels deposited and/or reworked by the Missoula Floods constitute a baseline for archaeology on the floodplain of the Lower Columbia River where the CRC project construction will take place. Over the millennia since the last of the Missoula Floods, the Columbia River has deposited substantial amounts of alluvial sands and silts along the Oregon shore. Archaeological remains may potentially be present at any depth within the alluvial sands and silts overlying the Pleistocene gravels. The archaeological discovery investigations for the CRC project involved an unprecedented effort to identify evidence of past human occupation or activity and paleolandscape conditions recorded in the deep alluvial deposits laid down along the Oregon shore over the last 12,000 years BP.

AGE AND DEPTH OF THE PLEISTOCENE GRAVELS

The age of the last Missoula Floods responsible for depositing and/or reworking the Pleistocene gravels has been estimated from the widespread occurrence of the Mount St. Helens set-S tephra and from radiocarbon dating (Mullineaux et al. 1978). Earlier studies led to the conclusion that the Mount St. Helens set-S tephra was erupted about 13,000 BP (Mullineaux 1996:31; U.S. Geological Survey [USGS] 2010). However, a number of earlier radiocarbon dates associated with set-S tephra have been reported (Benito and O'Connor 2003:633). A recent study suggests that a more reliable age for the last of the set-S tephras (layers Sg and So) is about 16,000 BP (Clynne et al. 2008:619).

A recent study correlating Missoula Flood stratigraphy, tephra, and radiocarbon dating undertaken along the Columbia River between the Pasco Basin in Washington and Portland, Oregon, found evidence that most, if not all, of the 25 major floods identified occurred after

19,000 BP (Benito and O'Connor 2003:624). In terms of radiocarbon dating, "the flooding apparently began sometime after 19,015 ± 165 14C yr BP and continued through 13,695 ± 95 14C yr BP, and perhaps substantially past 13,000 14C yr BP, depending on the age of the Mount St. Helens set-S tephra" (Benito and O'Connor 2003:637).

Radiocarbon dates obtained during studies of the Missoula Floods are almost all from locations upstream from the Columbia River Gorge. A single radiocarbon date useful in estimating the age of the last of the Missoula Floods has been reported downstream from the Gorge in proximity to the CRC project area. Peat from the bottom of a bog located on the north shore of the Columbia River "a short distance north of Vancouver, Washington," produced an age of 13,080 ± 300 BP (Mullineaux 1978:178). This bog, situated at an elevation of 60 m ASL, "appears to be high enough to have been above any flood later than the last scabland flood" (Mullineaux 1978:178).

PALEOLANDSCAPE

At the time of the last of the Missoula Floods, the landscape in the Lower Columbia Valley was quite different from the way it appears today. The Lower Columbia River is subject to tidal influence from the Pacific Ocean as far upstream as Bonneville Dam. As an incised river valley estuary, the Lower Columbia was dramatically affected by the rise in sea level at the end of the Pleistocene (Peterson et al. 2010). At its lowest dated submergence at 16,000 BP, sea level was approximately 360 feet below what it is today. At that time, the Lower Columbia River flowed through a deep canyon several hundred feet below the surrounding landscape.

As sea level rose, the valley floor was submerged. By 12,000 BP, sea level extended upslope (landward) in the valley to an elevation of -230 feet. At the time of the deposition of Mazama ash from the eruption of Mount Mazama at approximately 7,700 BP, sea level in the Lower Columbia Valley was approximately 41 feet below what it is today. The rate of sea level rise declined after 7,000 BP, and sea level approached its present elevation within the last several thousand years. Sea level and corresponding river level in the Portland–Vancouver Basin have risen only 9.8 feet (3.0 m) in the last 3,000 years, a rate of about 1.0 mm/year.

Over time, the Columbia River deposited substantial volumes of sands and silts on top of the Pleistocene gravels. The thickness of these alluvial deposits follows the contours of the underlying gravels. As a means of documenting the depths of the Pleistocene gravels below the modern surface, as well as the corresponding thickness of the alluvial deposits, borehole logs recorded during previous geotechnical investigations along the I-5 corridor were reviewed and compiled into a database (Peterson 2007). A stratigraphic profile derived from this database, extending north–south across the river valley, illustrates a significant difference in the near-surface geology on the two sides of the Columbia River (Figure 1-1). On the Washington shore, the Missoula gravels are very shallow, extending to within a few feet of the surface, if not covered by artificial fill. In contrast, on the Oregon shore, the Missoula gravels are deeply buried beneath alluvial deposits that are generally in excess of 30 m thick.

ARCHAEOLOGY ON THE COLUMBIA SOUTH SHORE

The CRC project is situated along a section of the Columbia River shoreline characterized by a relatively narrow floodplain that extends for approximately 30 km along the Oregon shore, from the confluence of the Sandy River with the Columbia (River Mile 120.3) downstream to the

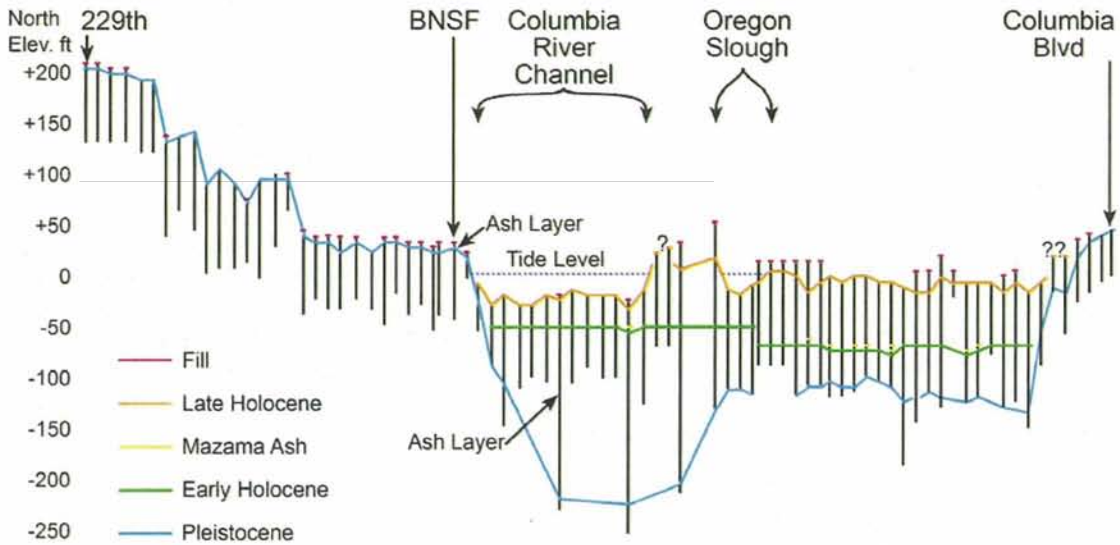

Figure 1-1. Stratigraphic cross-section showing the varying depths of the Pleistocene gravels across the Lower Columbia River Valley.

confluence of the Willamette River with the Columbia (River Mile 101.1). For most of its length, the narrow floodplain is bordered on the south by Columbia Slough. A remnant of the historic wetlands between the Sandy and Willamette Rivers, this stream flows roughly parallel to and about 0.6 to 2.7.km south of the Columbia River. The name "Columbia South Shore," previously used by the City of Portland to refer to a smaller section of shoreline east of I-205 (Minor et al. 1994), can be appropriately applied to this lengthier stretch of the Columbia River floodplain between these two tributary rivers.

The same subsistence resources available elsewhere in the Portland–Vancouver Basin were also accessible to prehistoric Native Americans living on the Columbia South Shore, only not in comparable quantities. Situated upstream from the Columbia–Willamette confluence, the Columbia South Shore was not nearly as rich an environment for Native Americans as the floodplain of the Columbia River below. Downstream from this confluence, the combined discharge of the Columbia and Willamette Rivers during the Missoula Floods doubled the width of the axial valley. The substantially wider floodplain provided a variety of riverine, lacustrine, and terrestrial environments that in combination were exponentially richer in terms of subsistence resources in comparison to the relatively narrow floodplain upstream.

Among the most important subsistence resources for Native Americans in the Portland–Vancouver Basin were anadromous fish, which included four species of salmon, as well as sturgeon and eulachon (Boyd and Hajda 1987). The single most productive Native American fishing site in the Portland-Vancouver Basin, referred to by early settlers as "the fishery," was just downstream from the Columbia–Willamette confluence (Tolmie 1885:32–33). The nearest Native American fishery of comparable note, the Cascade Rapids, was some 60 km upstream from the Columbia–Willamette confluence at the present site of Bonneville Dam (River Mile 145).

The significant difference between the density of subsistence resources downstream and upstream from the Columbia/Willamette confluence correlates closely with the frequency and distribution of recorded archaeological sites in the Portland-Vancouver Basin. A predictive model proposed for the "Wapato Valley" identified 276 previously recorded archaeological sites on the Columbia River floodplain in the Portland–Vancouver Basin (O'Rourke 2005:220). Of these, roughly 80 percent occur downstream, and only about 20 percent occur upstream, from the Columbia–Willamette confluence.

The first attempt to systematically review and assess the results of archaeological investigations on the Columbia South Shore was sponsored by the City of Portland and was undertaken by HERITAGE in 1994. Although the study was focused on a project area east of I-205, information from archaeological sites downstream on the Columbia River, as well as elsewhere in the Portland–Vancouver Basin, was incorporated. At that time, 26 radiocarbon dates from eight archaeological sites on the Columbia South Shore had been reported (Minor et al. 1994). Six of the eight sites, with 22 of the 26 radiocarbon dates, were located east of I-205.

The Columbia South Shore project involved extensive testing of previously recorded sites as well as surveys supplemented by auger testing in undeveloped tracts in the project area east of I-205. Only one previously unknown site was discovered. During the course of the project, five additional radiocarbon dates were obtained from four different archaeological sites. (Eight more radiocarbon dates were obtained from eight areas determined to be "non-sites," including two with Oregon State Historic Preservation Office (SHPO) sites numbers.)

Building on the results of the 1994 project, archaeological sites investigated since that time have been added to the tabular summary of investigations on the Columbia South Shore (Appendix 1B-I). Owing to the fact that the floodplain in that area has now been largely developed, few archaeological investigations have been conducted east of I-205 since 1994. Additional testing was conducted at previously recorded site 35MU26, which yielded one more radiocarbon date, and data recovery excavation undertaken at newly discovered site 35MU106 yielded four radiocarbon dates.

Most of the archaeological sites investigated since 1994 have been located on the floodplain west of I-205. And, with one exception (35MU105), these sites have been situated in the western portion of the Columbia South Shore, west of I-5 and the CRC project area. The ages of four newly discovered sites have been established from 9 radiocarbon dates. Further investigations at the previously identified St. Johns Site (35MU44/46) contributed another 14 radiocarbon dates.

Altogether then, 54 radiocarbon dates have been reported from 16 archaeological sites on the Columbia South Shore floodplain between the Sandy and Willamette rivers. Of the 16 sites, 11 are east of I-205, 1 is between I-205 and I-5, and 5 are west of I-5. In terms of the types of settlements represented, 5 have been interpreted as villages and 11 as temporary camps.

The oldest radiocarbon dates from an archaeological site on the Columbia South Shore are 2970 ± 80 BP , 2850 ± 30 BP, and 2800 ± 110 BP from 35MU117 on Columbia Slough northwest of Bybee Lake (Ellis 2000:55). These dates are in the same general time range as other "early" radiocarbon dates from prehistoric sites in the Portland–Vancouver Basin, which include 3510 ± 100 BP and 3360 ± 70 BP from 45CL31 on Vancouver Lake (Wessen 1983) and 2850 ± 95 BP and 2880 ± 155 BP from 35MU9 on Sauvie Island (Pettigrew 1981).

At the opposite end of the time scale, relatively little evidence of Native American activity dating to the historic period has been found on the Columbia South Shore. Limited testing suggests that the Nechacolee village observed by Lewis and Clark most likely corresponds to archaeological site 35MU70 (Minor et al. 1997). The St. Johns Site (35MU44/46) produced some copper artifacts, but the absence of glass trade beads and other trade items led to the conclusion that the settlement was abandoned by around AD 1800 (Pettigrew 2005:12.19).

The radiocarbon dates indicate that the archaeological sites on the floodplain do not represent continuous long-term occupation over the last 3,000 years. The St. Johns Site (35MU44/46), where occupation is thought to span the interval from AD 340 to AD 1800, is probably the longest-occupied settlement on the Columbia South Shore (Pettigrew 2005:12.22). Instead, the data suggest that prehistoric occupation in this area was episodic in nature. The radiocarbon dates are consistent with the information available from archaeological contexts, which indicates that, for the most part, prehistoric use of the floodplain involved villages and camps that were occupied for relatively short periods of time before abandonment.

NEW INFORMATION ON HISTORIC PERIOD NATIVE AMERICAN ACTIVITY

In 1805–1806, when Lewis and Clark passed through the Portland–Vancouver Basin, they identified 13 native groups living in villages along the Columbia River floodplain. Of these, 11 groups were downstream, and only two upstream, from the Columbia–Willamette confluence. Based on Lewis and Clark's population estimates, over 90 percent of the native population living in the Portland–Vancouver Basin in 1805–1806 resided in the 11 villages downstream from the Columbia–Willamette confluence (Moulton 1990:477-478).

The introduction of infectious diseases (malaria, smallpox, dysentery, and other maladies) decimated the native population. An estimated 15,545 Chinookans and Kalapuyans lived in the area in 1805; by 1840 the population had dropped to an estimated 1,932 individuals, an 88 percent decline (Boyd 1999:84).

Lewis and Clark refer to two Chinookan villages on the Columbia South Shore: (1) Neerchokioo, described as a few miles above the Multnomah [present-day Willamette] River, and (2) Nechacolee, described as a few miles below Sandy River and "back to the south" of "Dimond" [present-day Government] Island (Moulton 1991:57). Neerchokioo is thought to have been located in the vicinity of Portland International Airport (Strong 1959:34-35) and is not correlated with any known archaeological site. Nechacolee most likely corresponds to archaeological site 35MU70 (Minor et al. 1997).

Aside from Neerchokioo and Nechacolee, previous reviews of the ethnohistoric and historical literature did not identify references to other Native American settlements on the Columbia South Shore (Saleeby 1983; Hajda 1984). One account missed by previous reviews of the literature is a pioneer reminiscence by Mary Jane Hayden that mentions an Indian camp somewhere on Hayden Island (Hayden 1979:43).

Recent research by Robert Boyd in historical records that have been relatively inaccessible in the past has revealed new information about Native American camps on the Oregon shore in the historic period. The references found, which relate to Native Americans drawn to the Hudson's Bay Company Fort Vancouver across the river, date from the 1830s to the 1850s. Although details about the specific locations of these settlements are lacking, Boyd's report is significant in documenting the continued presence of Native Americans on the south shore of the Columbia River into the mid-nineteenth century (Appendix 1B-II).

THE CHALLENGE OF DEEP TESTING ON THE OREGON FLOODPLAIN

Extending the search for archaeological evidence of human occupation through the deep alluvial deposits to the top of the Pleistocene gravels on the Oregon shore poses a significant methodological challenge for archaeology. Most previous attempts to locate archaeological sites buried deeply in the alluvial sands and silts on the Oregon shore floodplain have been limited to depths within a few meters of the modern ground surface (exceptions noted below) and have met with mixed success.

The most thorough discussion of the issues and methods involved in identifying deeply buried archaeological sites is in a report entitled *Minnesota Deep Test Protocol Project* prepared for the Minnesota Department of Transportation by Commonwealth Cultural Resources Group, Inc. (Monaghan et al. 2006). As defined in that report, the term "deeply buried archaeological deposits" is used to refer to "cultural material that extends beyond the limits of hand excavated shovel tests" (Monaghan et al. 2006:1-3). The deep test process developed in Minnesota is directed toward "the discovery of any cultural material that occurs below the surface and cannot be discovered by methods ordinarily employed for site discovery and that has been buried by either natural or cultural processes" (Monaghan et al. 2006:1-3).

As discussed in the Minnesota deep test report, "deep testing usually focuses on alluvial, colluvial, or eolian landforms that have been active during the late Wisconsin and Holocene (i.e., post-12 thousand years before present" (Monaghan et al. 2006:1-3). As well, deep testing in landscapes buried within developing Holocene or late Wisconsin landforms "requires a multi-disciplinary approach that integrates earth and archaeological sciences" (Monaghan et al. 2006:1-3).

During the Deep Test Protocol Project studies were conducted to determine the efficacy of different methods in discovering deeply buried archaeological sites. The three primary site discovery methods evaluated were (1) geophysical (remote sensing) survey methods, (2) a combined coring and augering procedure, and (3) backhoe trenching. Each of these methods has its strengths and weaknesses, but based on an evaluation of these methods, the Deep Test Protocol Project concluded that:

> backhoe trenching is the best method for discovering buried archaeological sites and recommend that it be the preferred method for deep testing. If trenching is not possible, coring/augering should be employed. Additionally, this procedure may also be appropriate in other instances, such as where deposits with archaeological potential lie deeper than can be reached using a backhoe. When neither trenching nor coring/augering can be used, alternative methods, such as hand (bucket) augering or test pit excavation, may need to be employed as a last resort. (Monaghan et al. 2006:13-9)

The CRC project area on the Oregon shore, which contains thick alluvial deposits overlying Pleistocene gravels, represents a prime example of a landform developed during the Holocene that was a focus of investigation during the Minnesota project. To date, two of the three methods for discovering deeply buried sites tested during the Deep Test Protocol Project have been employed on the Oregon shore. The third method, geophysical (remote sensing) survey, has not been used in deep testing for buried archaeological sites on the Oregon shore floodplain.

The excavation of backhoe trenches has been a relatively common occurrence at archaeological sites on the Columbia South Shore. However, backhoe trenching has been most commonly employed after sites were already identified by other means. At these sites, backhoe trenches were used to remove overburden, expose sediment profiles, find cultural features, and establish the horizontal extent of the site's cultural deposits (Bland and Connolly 1989:14; Ellis and Fagan 1993). Use of backhoe trenching as a site discovery method, as recommended in the Deep Test Protocol Project report, has only rarely been employed (e.g., Chapman et al. 1998).

The use of augering/coring to search for buried archaeological sites on the Oregon shore floodplain has a relatively long history (e.g., Bland and Connolly 1989; Connolly and Bland 1991; Musil 1992; Musil and Toepel 1993). The instrument most commonly employed is a manual bucket auger with a diameter of 20 cm (which digs a hole 25 cm in diameter) that can reach maximum depths of 2.8 m below surface. An auger with a slightly smaller diameter (6 inches) also has been employed in searching for buried archaeological deposits on the Oregon shore floodplain (Ellis et al. 2001).

Mechanical augering has been used in several investigations to reach archaeological deposits on the Oregon shore floodplain buried under dredge deposits. A hollow-core auger with a split-spoon sampler was employed. Cultural deposits were identified below 3.0 to 3.7 m of dredge deposits at site 35MU105 (Ellis 1996), below 4.0 to 5.0 m of dredge deposits at site 35MU117 (Ellis 2000), and below 6.1 to 8.7 m of dredge deposits at site 35MU15 (Ellis et al. 2001).

In summary, backhoe trenching and both manual and mechanical augering/coring have been employed in attempts to identify evidence of human occupation on the Oregon shore floodplain not visible on the surface. All of these methods have been able to reach depths greater than those reachable in "hand excavated shovel tests," and therefore are forms of "deep testing" as defined in the Deep Test Protocol Project report. However, even at the sites where mechanical coring was employed, any archaeological remains encountered during deep testing on the Oregon shore floodplain were generally within approximately 2.0 to 3.0 m of the original ground surface.

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS IN THE CRC PROJECT VICINITY

In terms of legal description, the archaeological APE occupies approximately 225 acres in Multnomah County in T1N, R1E, Sections 3 and 4, and T2N, R1E, Sections 33 and 34. Research at the Oregon SHPO indicates that no archaeological resources have been previously recorded within the CRC APE on the Oregon shore. The earliest report on file at SHPO pertaining to cultural resources in the CRC APE addressed the I-5 Jantzen Beach–Delta Park Interchange on Hayden Island. It is stated in this report that "an archaeological reconnaissance survey" would not be required "prior to construction of the project" because "the potential for discovery of archeological sites in the project area has been eliminated by extensive development and construction" (Anonymous 1979).

Research at SHPO resulted in identification of four archaeological survey projects that have included portions of the CRC APE (Anonymous 1979; Connolly 1987; Chapman et al. 1998; Ellis and O'Brien 2003). None of these surveys resulted in the recording of archaeological sites within the CRC APE. The closest recorded archaeological site (35MU113), a small charcoal and fire-cracked rock feature evaluated as a non-significant resource, is about 0.4 mile west of the APE (Chapman et al. 1998).

In addition to these surveys within the CRC APE, previous surveys conducted on nearby portions of Tomahawk and Hayden Islands just outside the CRC APE have documented no archaeological sites (Ellis 1986; Follansbee and Frances 1980; Minor and Chappell 1994). Likewise, surveys conducted just outside the CRC APE on the south shore floodplain also have documented no archaeological sites (Bland and Connolly 2006; Durio 2005; Martin 1987; Musil et al. 1995).

RESEARCH APPROACH

Archaeological discovery investigations in the CRC APE on the south shore of the Columbia River were complicated by three factors: (1) the depth and nature of fill material introduced during construction of I-5, (2) the considerable depth of the alluvium deposited by the river over the last 12,000 years, and (3) the limited areas of exposed ground along the margins of I-5 in which discovery investigations can be conducted.

The section of I-5 that traverses the Oregon Shore floodplain was constructed across the top of an artificial berm built to raise the level of the travel lanes above the elevation of historic Columbia River floods. The fill material introduced to construct this berm was intentionally compacted to support the weight of vehicles on the interstate. This fill material, of unknown depth at the time the geoarchaeological investigations began, covers the original ground surface in the I-5 corridor.

The alluvium deposited by the Columbia River along the Oregon Shore is known from previous geological studies to extend to substantial depths below surface. Analysis of the logs from boreholes drilled in the vicinity of the existing I-5 bridges indicates that the alluvial deposits underlying the I-5 corridor are generally in excess of 30 m deep (Peterson 2007).

The CRC APE on the Oregon Shore consists of ODOT property along the I-5 corridor from the Columbia River south approximately to Victory Blvd. From the Columbia River shoreline, the APE crosses Hayden Island, bridges the Oregon Slough/North Portland Harbor, and extends southward for approximately three-quarters of a mile on the south shore floodplain. The major portion of the APE is covered by the paved travel lanes of I-5 and associated interchanges. Relatively few areas of exposed ground occur between the pavement edges and the ODOT property fences in which to conduct archaeological investigations.

Building upon the general discussion of potential methods of archaeological investigation outlined in the *Research Design for Archaeological Investigations, Columbia River Crossing (CRC) Project, Oregon and Washington* (Minor et al. 2008), a research strategy was developed to address the specific challenges posed by the particular nature of the CRC APE on the Oregon Shore. This strategy involved three avenues of investigation.

The investigations began with a review of information available on the environmental setting of the CRC APE in the early historic period to provide a baseline for interpretation of geoarchaeological evidence. Next, as proposed in *Archaeological Work Plan for Ground-Penetrating Radar (GPR) Exploration, Columbia River Crossing Project* (Minor and Peterson 2008), GPR surveys were undertaken to better understand the nature and depth of the artificial fill that mantles the CRC APE.

Finally, as outlined in the *Proposed Work Plan for Geoarchaeological Discovery Probing on the Oregon Shore for the CRC Project* (Minor et al. 2009), rotary-sonic boreholes were drilled in an effort to locate evidence of human occupation and to recover data that can be used in reconstructing the landscape on the south shore of the Columbia River inhabited by prehistoric Native Americans over the last 12,000 years. The borehole drilling, and more importantly the analyses of the sediments, tephra layers, and organic materials (for radiocarbon dating) recovered, provide a basis from which an assessment can be made of the potential for encountering archaeological remains during CRC project construction.

2. ENVIRONMENTAL SETTING

The earliest detailed descriptions of the Oregon Shore in the vicinity of the CRC project area are provided by historical maps and records dating from the mid to late 1800s. These depict an expansive floodplain bordered by the Columbia River (Oregon Slough) on the north and rolling hills on the south. The floodplain is covered by wet prairie and contains numerous lakes and waterways. As of 1852, four lakes (including what would later be called Force and Mud lakes) partially overlap the project area, which is bisected by two waterways—one connecting with a lake to the west (now Smith Lake) and the other with the Columbia Bayou (now Columbia Slough) to the south (Ives 1852) (Figure 2-1). Survey notes for a portion of the project area extending along the south bank of the river describe level land with "1st rate soil" and "balm, ash, willow, and oak" trees (Pownall 1854). An 1860 survey of Hayden Island (then Vancouver Island) describes level land with first-rate soil covered by prairie and timber (ash, cottonwood, and balm trees) as well as willow and briar undergrowth (Fitzhenry 1860).

This landscape continued relatively unchanged into the early 1900s. Maps from the late 1880s and 1890s show the same distribution of floodplain lakes and waterways in the project area as recorded in 1852 (U.S. Coast and Geodetic Survey [USCGS] 1888; USGS 1896). One of the lakes, overlapping the eastern extension of the project area south of the river, is depicted as a marsh—possibly reflecting seasonal or annual variation in water level (compare Figure 2-1 to Figures 2-2 and 2-3). The 1888 and 1896 maps also show a lake on the east end of Hayden Island within the project area (Figures 2-2 and 2-3).

The 1910s saw the beginning of substantial flood-control efforts on the south shore of the Columbia River. The early projects included filling around existing railroad trestles on the floodplain to form embankment levees (in 1909–1911 and 1918) (Sieke et al. 1957:Appendix A) and establishing local flood-control districts (in 1917) (Multnomah County Drainage District [MCDD] 2010a). The project area straddles Peninsula Drainage District Nos. 1 and 2 (Figure 2-4). In 1919 and 1921, the two districts began constructing levee systems; these were later improved and expanded starting in the 1930s (MCDD 2010b, 2010c). The districts also excavated drainage canals and installed pumping plants. These undertakings dramatically altered the topography of the floodplain by the 1940s, as evidenced by a map from 1940 that shows no lakes in or adjacent to the project area and diminished waterways (USGS 1940) (Figure 2-5). It is unclear to what extent similar flood-control measures were implemented on Hayden Island (although a dike was constructed on the east end by 1949) (USCGS 1949). The topography of the east end of the island changed significantly after the turn of the century with the disappearance of the lake in the project area by 1919 (City of Portland 1919) (Figure 2-4).

Prior to the reclamation efforts of the 20th century, the bottomland along the river was subject to regular flooding, prompting Euro-American settlers to utilize the area primarily for hay production and cattle grazing (Ellis and Zehendner 2002:5). This type of land use began as early as the 1820s, when the Hudson's Bay Company established a dairy on Hayden Island to supply nearby Ft. Vancouver (Carey 1971:245; Rockwood 1939:180), and continued with the influx of settlers following the opening of the Oregon Trail in 1843 and passage of the Donation Land Act in 1850. The first settlers to claim land in the project area were George W. Force and

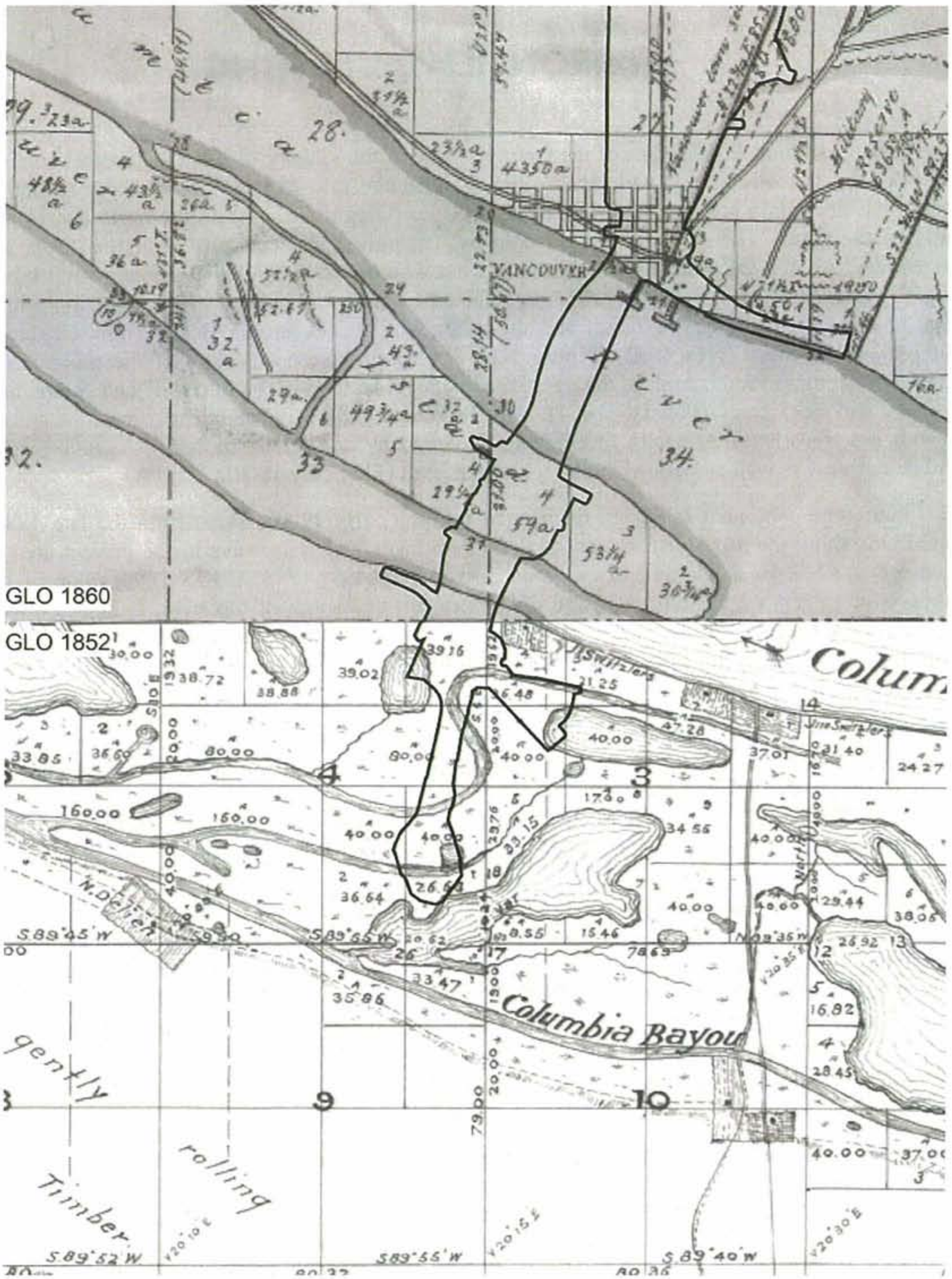

Figure 2-1. Overlay of the southern portion of the CRC project area (including the Oregon Shore and Hayden Island) on the 1852 plat of survey (below, Ives 1852) and 1860 master title plat (above, Government Land Office 1860).

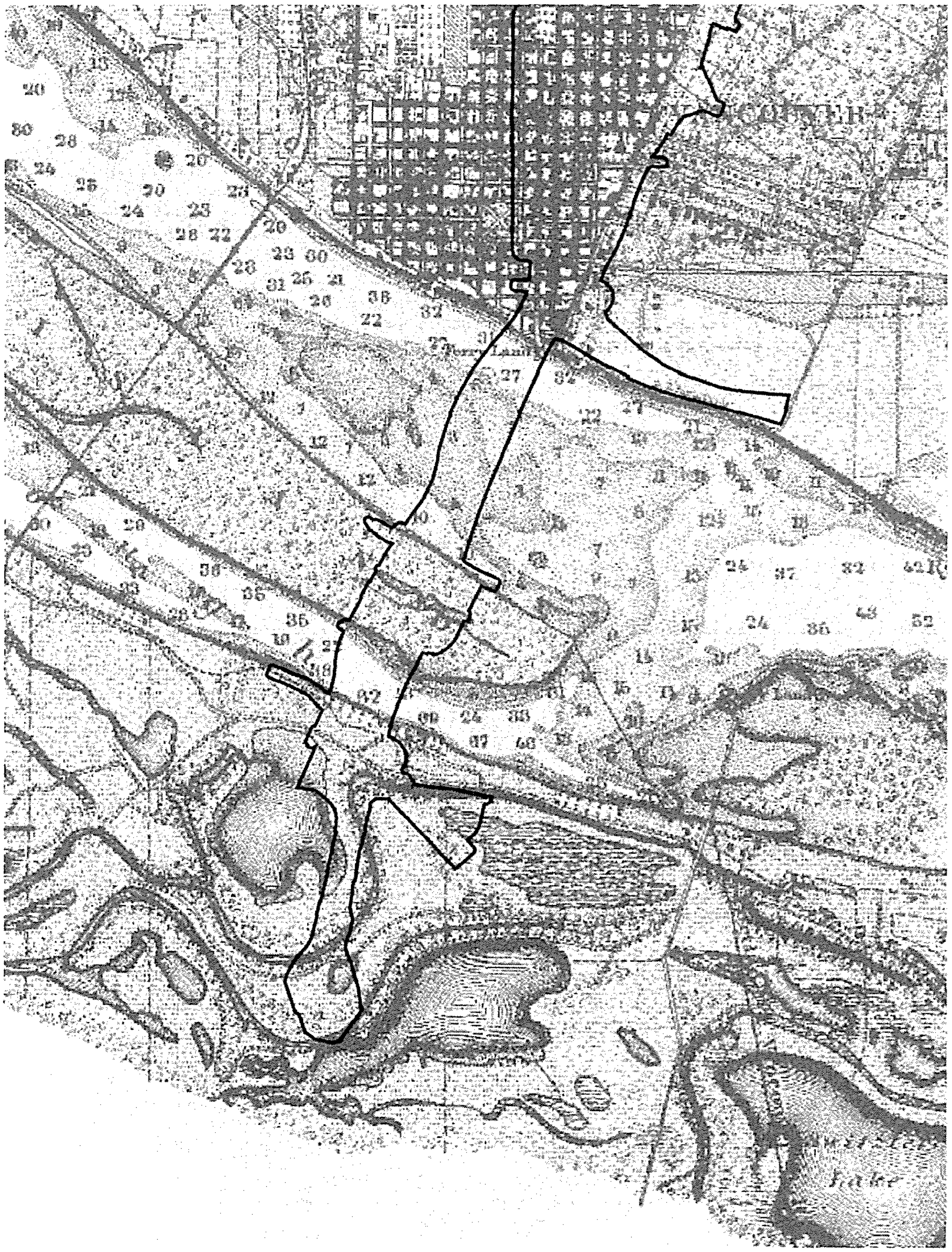

Figure 2-2. Overlay of the southern portion of the CRC project area (including the Oregon Shore and Hayden Island) on the 1888 U.S. Coast and Geodetic Survey map.

Figure 2-3. Overlay of the southern portion of the CRC project area (including the Oregon Shore and Hayden Island) on the 1896 Portland 15′ quadrangle.

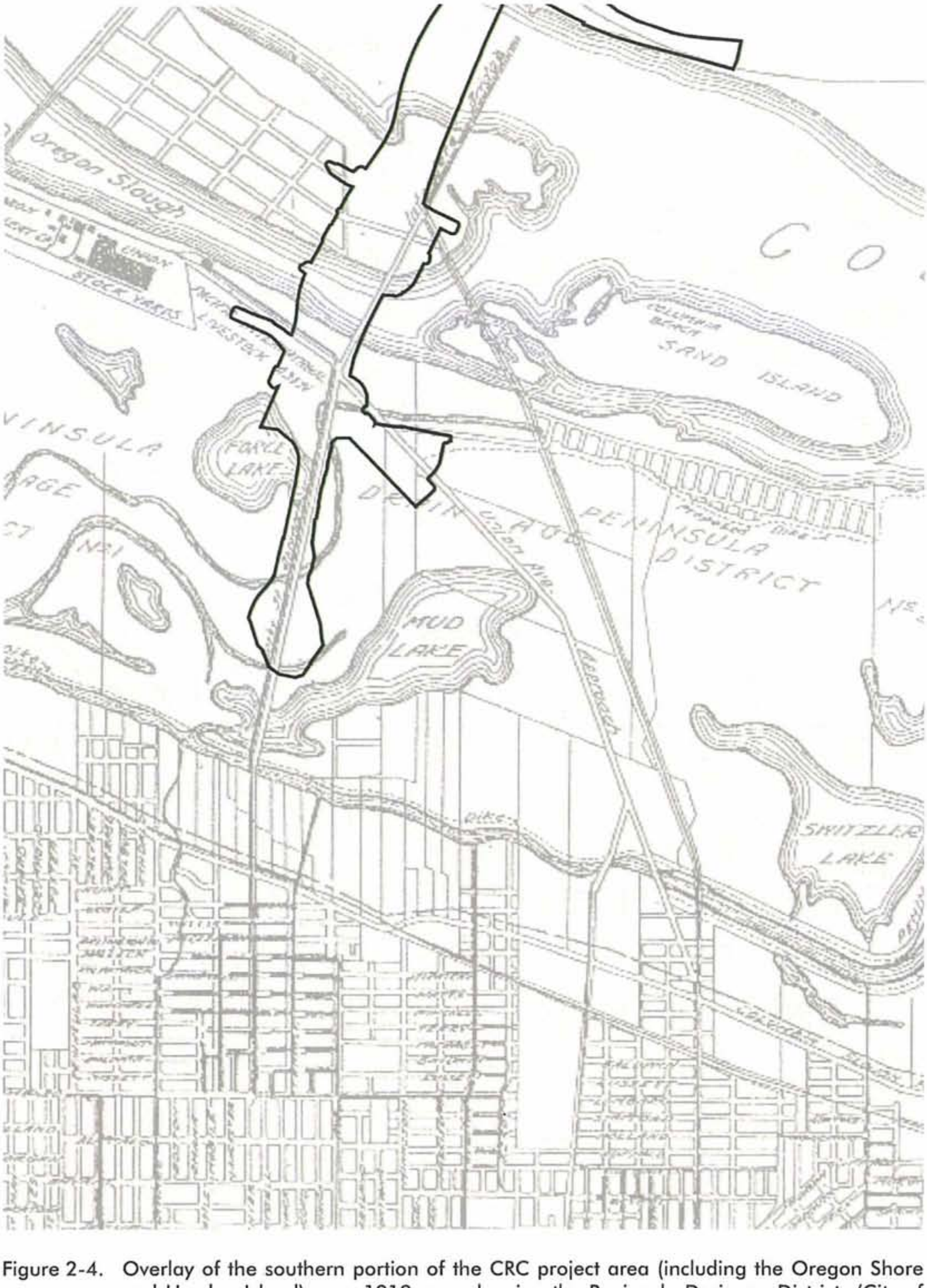

Figure 2-4. Overlay of the southern portion of the CRC project area (including the Oregon Shore and Hayden Island) on a 1919 map showing the Peninsula Drainage Districts (City of Portland 1919).

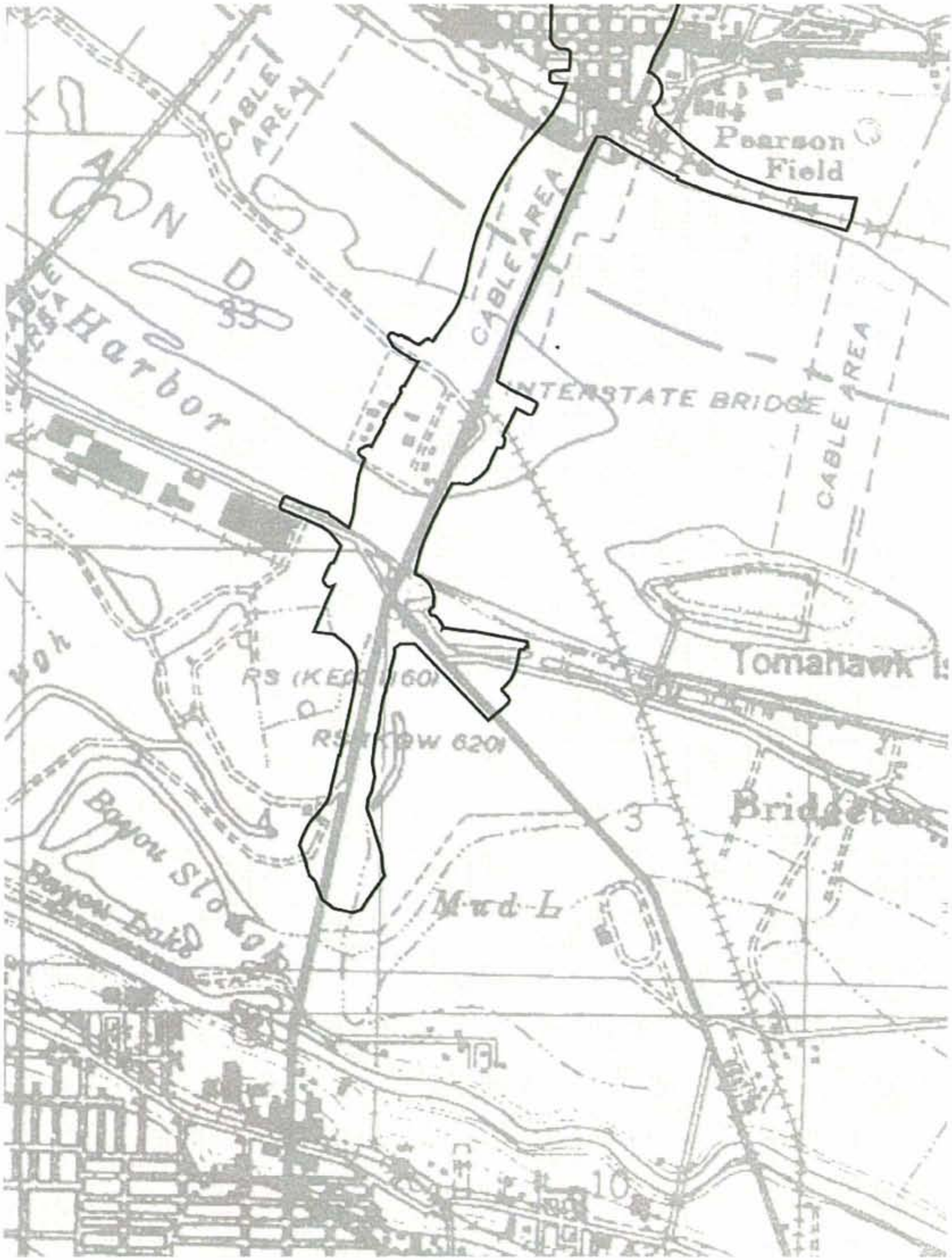

Figure 2-5. Overlay of the southern portion of the CRC project area (including the Oregon Shore and Hayden Island) on the 1940 USGS Portland 15′ quadrangle.

J. R. Switzler, who staked out adjacent properties (DLC 37 and DLC 38, respectively) on the south shore of the river by 1852 (Genealogical Forum of Portland 1957; Ives 1852). Both developed the portions of their claims closest to the river, where there was probably a natural levee offering higher ground. Force established what was possibly a house with outbuildings, an orchard, and fences (Musil et al. 1995:19; USCGS 1888) (Figure 2-2), while Switzler built structures in the middle of a cultivated field (later an orchard) just east of the project area (Ives 1852; USCGS 1888) (Figures 2-1 and 2-2).

The rural agricultural character of the south shore floodplain and Hayden Island in the vicinity of the project area persisted through the latter half of the 1800s. The only notable development was a network of unimproved roads that snaked across the floodplain. One road extended east–west through the project area, south of Force's and Switzler's improvements near the river (USCGS 1888) (Figure 2-2). The network connected to a more substantial road east of the project area that ran north through Portland to a ferry crossing on the bank of the Columbia, paralleling part of the Portland and Vancouver Railroad line (USGS 1896) (Figure 2-3).

In the second and third decades of the twentieth century, Hayden Island underwent a transformation from wetlands and agricultural use to transportation corridor and amusement park. As automobile travel increased, and the ferry crossing became strained, an interstate bridge was completed across the Columbia River in 1917. The new highway connection drew thousands of travelers, and in 1928 the Jantzen Beach Amusement Park opened on Hayden Island. During World War II, the city of Vanport emerged along the south shore of the Columbia River (west of present-day I-5) as housing for shipyard workers. On May 30, 1948, high flood waters on the Columbia broke through a dike and destroyed the city.

After World War II, Hayden Island underwent intense commercial development. In 1958 Oregon and Washington increased transportation services over the island with construction of a second I-5 bridge. The amusement park was razed in the 1970s to construct a shopping center, which in 1995 was reconfigured into a mall. Intensive developments during the twentieth century in transportation, commercial, and residential facilities have had major impacts on the natural landscape in the I-5 corridor and vicinity.

3. GROUND-PENETRATING RADAR SURVEYS

This chapter summarizes the results of ground-penetrating radar (GPR) surveys undertaken on Hayden Island and the adjacent floodplain on the Oregon shore in the CRC project area. The results summarized here contain GPR record interpretations that are developed in the context of survey area location, size, elevation, and ground-truthing. Representative boreholes completed by continuous rotary-sonic drilling provide ground-truthing for the continuous GPR profiles interpreted below.

The GPR profiles discussed here correspond to seven of the eight areas in which rotary-sonic boreholes were later excavated for geoarchaeological purposes (Figure 3-1). The eighth area, situated east of the I-5 corridor, was not surveyed by GPR because it was not identified as an area of interest at the time the GPR surveys were conducted. However, this eighth area was subsequently included in the areas sampled during the drilling of rotary-sonic boreholes to broaden the total area for which information on the subsurface environment on the Oregon shore was obtained.

The GPR profiling addressed in this report is based on low-frequency (50 or 100 MHz) antennae and a high-power transmitter (1000v). These systems were found to be optimal for surveying depth of fill in the Oregon shore floodplain settings. It should be noted that high-frequency GPR profiling (500 MHz antennae) was also performed in most of the survey areas. The high-frequency surveys did not penetrate through the highway construction fill that mantles the ground surface adjacent to I-5. Consequently, these surveys are not addressed in this report.

In this summary, GPR interpretations are presented for (1) extent of cut-and-fill and (2) depth to prehistoric soils. Details for each GPR survey line were recorded (and are available for review) in an Excel database entitled "GPRLineLogs." The database contains metadata for the GPR profiles. The GPRLineLogs database can be searched for (1) CRC line number (CRCLine1–244), (2) profile endpoint UTM coordinates, and (3) ground-truth profile number.

Ground-truthing of the GPR profiles was accomplished through comparison with soil profiles from shallow core logs (0–10 m deep) recorded for boreholes drilled by the rotary-sonic method as part of the geoarchaeological investigations for the CRC project. Profiles from boreholes that were closest to the GPR lines were used for this purpose.

The ranges and averages of the soil profile characteristics are presented, including measured depth of artificial fill as well as the compositions of the native prehistoric soils in the different survey areas. Details for each ground-truth borehole location were recorded (and are available for review) in an Excel database entitled "GroundtruthProfiles."

The ground-truth profiles can be searched for (1) CRC line number, (2) borehole site UTM coordinates, and (3) soil profile characteristics.

Details on GPR system testing on the Oregon shore floodplain are available in a separate report (Appendix 1B-III). These tests followed those performed for the terraced gravel plains of Vancouver, Washington (Appendix 1C-I). The preliminary GPR field tests for the Oregon shore

Figure 3-1. Locations of GPR survey areas, geoarchaeological boreholes, and selected geotechnical boreholes on Hayden Island and the Oregon shore floodplain. GPR surveys were conducted across nearly the full width (north to south) of Hayden Island, from the position of CRC-OB32-02 to the south underpass under I 5 at the south end of Hayden Island.

floodplain established the necessary use of high-power/low-frequency GPR systems (Bristow and Jol 2003) to penetrate artificial fill to the prehistoric floodplain soils.

Exposed shoulder and dike slopes in the Oregon shore survey areas demonstrated that the artificial fill is from dredged channel sand and construction gravel. Floodplain soils were expected to be topped by very conductive mud drapes and/or moderately conductive beds of muddy sand that would serve as basal conductive layers below the resistive artificial fill. Interpretations of the depth of fill above basal conductive layers were verified by comparison to core logs of the upper 10 m in geoarchaeological boreholes BH-1 through BH-8.

HAYDEN ISLAND

Hayden Island is bordered by the Columbia River on the north and by the Oregon Slough (Portland Harbor) on the south. The area in which GPR surveys were conducted extended along North Center Avenue, between North Hayden Island Drive and North Jantzen Beach Avenue, a distance of approximately 550 m. The south end of the profile turned southeast, where it formed a crossing profile that intersected I-5. The entire GPR line is taken to represent the 25–50 m wide corridor between North Center Avenue and I-5, encompassing an area of about 20,000 square meters. The current surface elevation in this area is ~10 m NAVD88.

Two GPR profiles were completed along a north–south transect, using a 1000v transmitter with 50 MHz antennae (CRC Line 160), and a 1000v transmitter with 100 MHz antennae (CRC Line 161). Both GPR lines were recorded under rapid data collection mode using an odometer trigger towed behind a vehicle. The 50 MHz antennae penetrated to 200 ns, or a depth of 10 m, using a default velocity of 0.1 m/ns^{-1} (Figure 3-2). The upper 125 ns depth section consists of resistive materials overlying more conductive materials from 150 to 200 ns. Resistive fill materials, extending to a depth of 5–6 m, occur along the full length (~500 m) of the profile along CRC Line 160.

The depth of the resistive materials corresponds to artificial fill depths (5–6 m subsurface) in CRC-RC-024A and BH-1. The fill consists of asphalt, gravel, dredged river sand, and silty sand, as shown in the borehole logs. The contacts with native soils occur at 3.1 m elevation NAVD88 and at 4.4 m elevation in boreholes CRC-RC-024A and BH-1, respectively. The uppermost native soil in the continuously cored and logged BH-1 is sandy mud from a vegetated wetland that mantled the sandy Hayden Island floodplain. The coincidence between GPR predicted fill depth and measured fill depth in the nearby boreholes confirms the assumed 0.1 m/ns^{-1} signal velocity for the unsaturated resistive fill materials that mantle Hayden Island.

A third CRC borehole, CRC-OB32-02, on the north bank of Hayden Island was not sufficiently sampled in the upper 10 m to establish the nature of fill materials. A wood sample (S-11) from 39 ft below surface, or −1.99 m elevation NAVD88, in CRC-OB32-02, yielded a radiocarbon date of 210 ± 40 BP (Beta-249922).

Using a verified GPR signal velocity of 0.1 m/ns^{-1}, the depth of fill in this area of Hayden Island ranges from 5 to 6 m, with an average fill thickness of 5.5 m. The preservation potential for native Holocene soils below the artificial fill is high. These soils, at a depth of 6–10 m, should include sandy floodplain silts grading downward into channel sands.

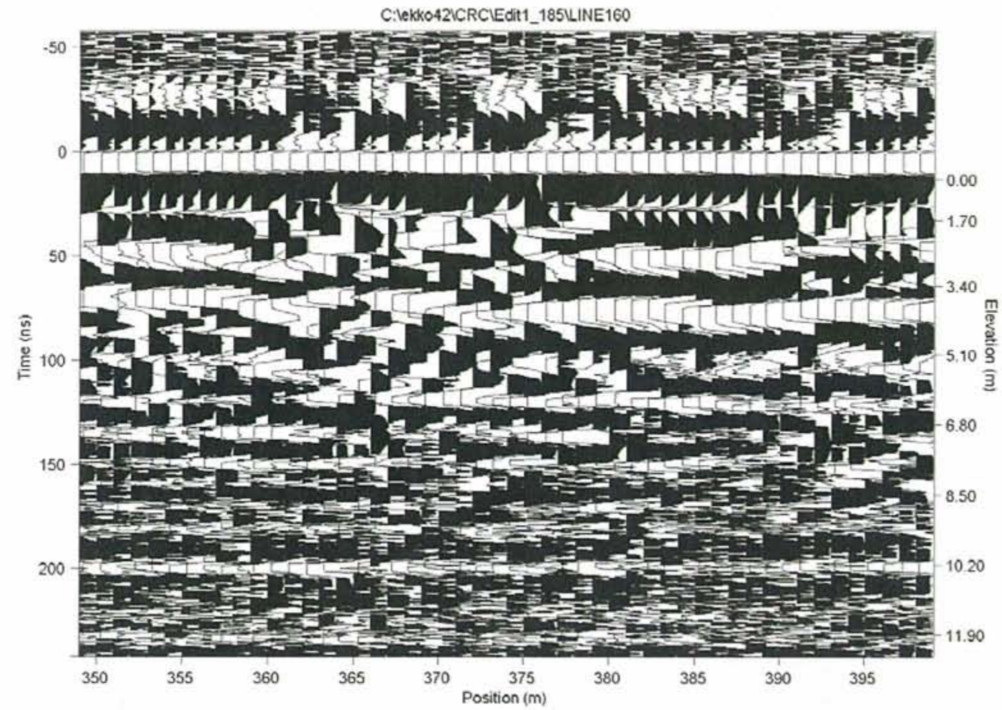

Figure 3-2. GPR profile segment (350–400 m distance) from CRC Line 160 using a 1000v transmitter and 50 MHz antennae. Resistive fill 0–125 ns (0–6 m deep) overlies more conductive materials 125–200 ns (6–10 m deep).

WEST OF I-5/MARINE DRIVE INTERCHANGE

Boreholes BH-2 and BH-4 were located adjacent to on- and off-ramps on the west side of the I-5/Marine Drive interchange. These boreholes were placed in highway fill with current surfaces at ~10 m elevation NAVD88. The two boreholes are 150 and 350 m south of the Oregon Slough and 150 m west of I-5. BH-2 is likely situated on the south bank or levee of the Oregon Slough. A natural levee may have existed on this bank since prehistoric times (Peterson 2007). BH-4 is located between the northeast shoreline of the remnant Force Lake and the Oregon Slough to the north.

A short GPR test line, 50 m in length, was collected with 100 MHz antennae in the Tri-Met parking lot at a distance of about 100 m due west of BH-2. Signal penetration reached a depth of 3–5 m, with a conductive layer recorded at a depth of 3–4 m. Permission was not obtained to complete a GPR survey on the TriMet or Expo properties.

BH-4 is represented by two orthogonal GPR profiles recorded in step mode, CRC Line 102 (61 m east–west) and CRC Line 103 (173 m north–south). Both profiles are located to the east, directly across I-5 at the northwest corner of the Delta Park East ball field and model aerodrome. These two profiles bound the northwest corner of an open field at an elevation of 7 m NAVD88, some 3 m lower than the surface elevations of BH-2 and BH-4.

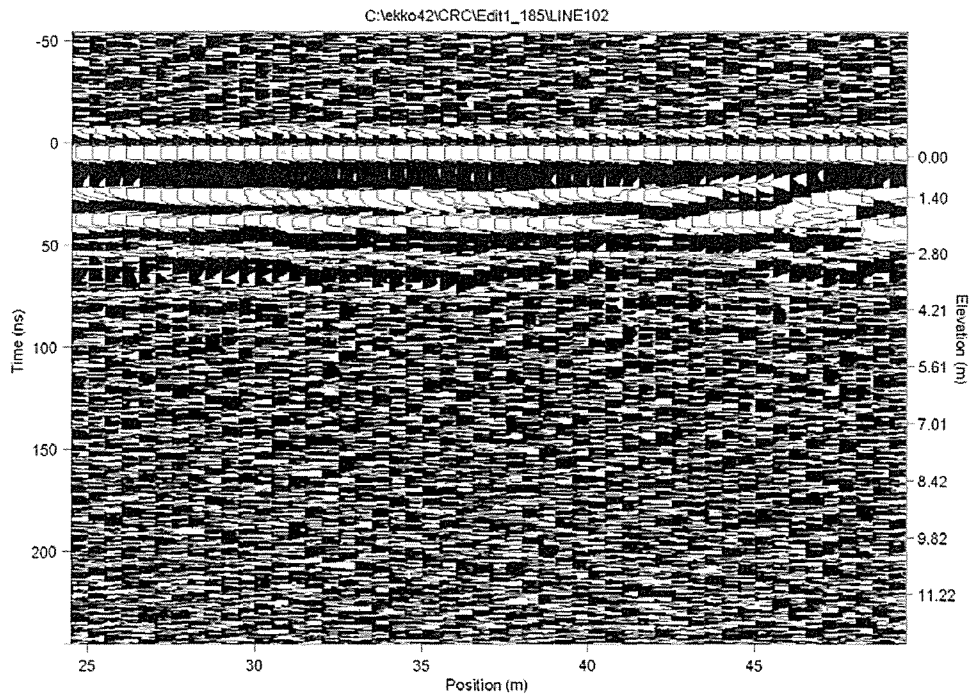

Figure 3-3. GPR profile segment (25–50 m distance) from CRC Line 102 using a 1000v transmitter and 100 MHz antennae. Resistive fill at 60 ns (3 m deep) overlies more conductive materials below 60 ns.

Resistive fill materials occur along the full lengths of profiles CRC Line 102 and CRC Line 103. The depth of resistive fill ranges from 55 ns (2.75 m deep) to 80 ns (4.0 m deep) (Figures 3-3, 3-4, and 3-5). The average of 10 fill contact depths from CRC Lines 102 and 103 is 70 ns (~3.5 m deep).

The elevations of contacts between artificial fill and native soils in BH-2 and BH-4 are 4.8 m NAVD88 and 3.45 m NAVD88, respectively. Fill materials include sand, gravel, asphalt tar, and concrete fragments, as documented in borehole logs. The uppermost native soil in the continuously cored and logged BH-2 is sandy mud that grades downward into a vegetated sand. The vegetated sand is interpreted to be an elevated levee and/or dune-ridge setting located on the south shoreline of the Oregon Slough. The uppermost native soils in BH-4 are vegetated wetland soils, apparently associated with back-levee swamp conditions. The contact elevations between resistive fill and native floodplain soils in CRC Lines 102 and 103 is estimated to be 3–4 m NAVD88, which is similar to the depth of fill logged in BH-4. The assumed GPR signal velocity of 0.1 m/ns^{-1} is verified by the depth of the fill materials in these boreholes.

The range of fill depths in BH-2 and BH-4 is 3–6 m, based on a GPR signal velocity of 0.1 m/ns^{-1} and/or representative borehole logs. The preservation potential for native Holocene soils below the artificial fill is high. The overlying fill contact is nearly horizontal, showing uniform burial of native soils. The native soils, at depths of 3–6 m subsurface, should include sandy levee deposits or vegetated mud from intact floodplain settings.

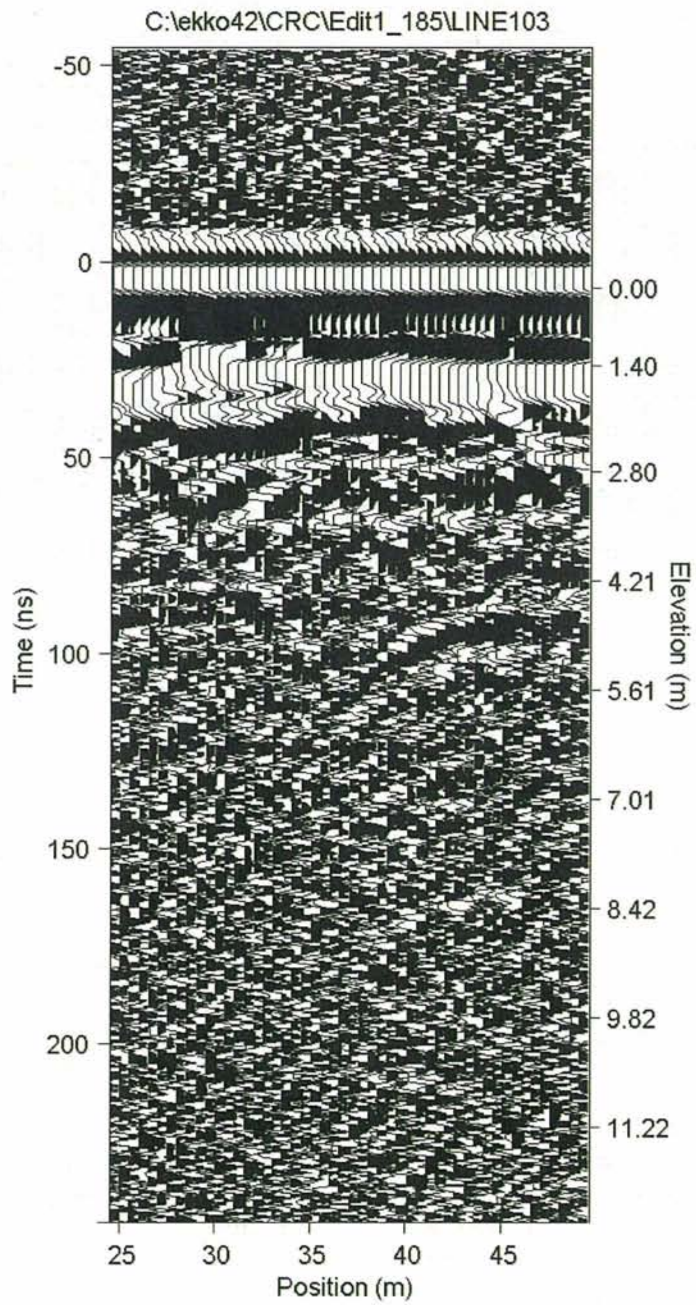

Figure 3-4. GPR profile segment (25–50 m distance) from CRC Line 103 using a 1000v transmitter and 100 MHz antennae. Resistive fill at 70 ns (3.5 m deep) overlies more conductive materials below 60 ns.

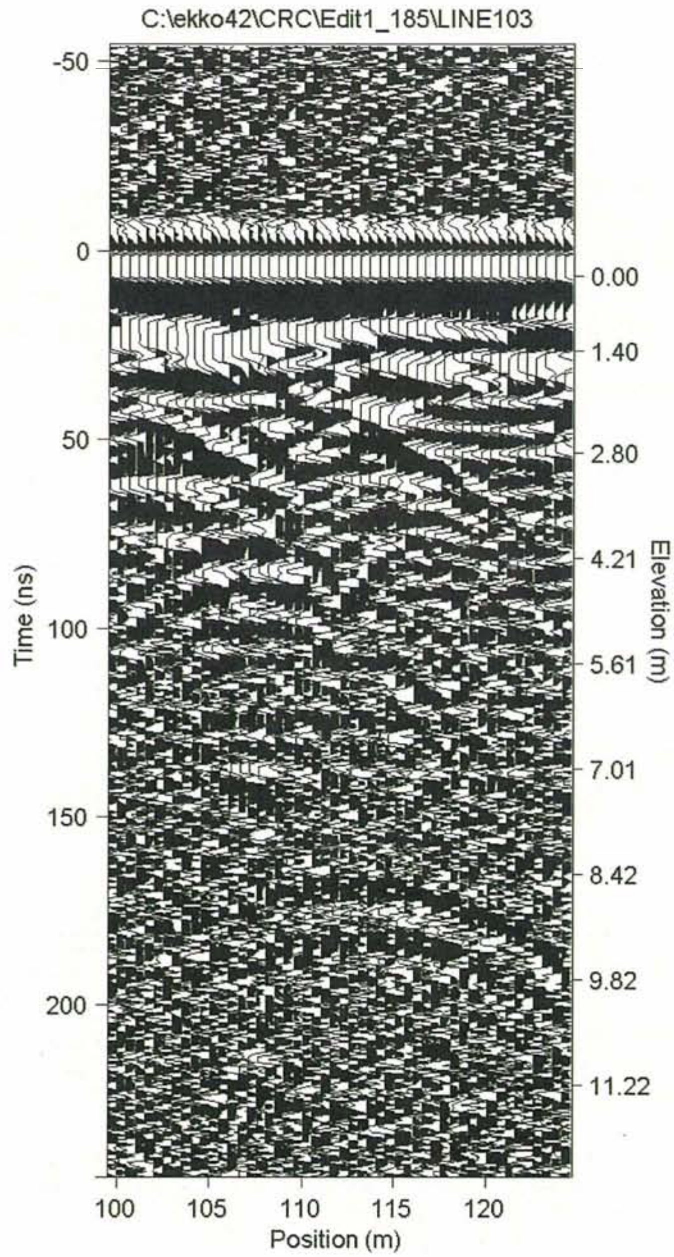

Figure 3-5. GPR profile segment (100–125 m distance) from CRC Line 103 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~80 ns (4 m deep) overlies more conductive materials below 80 ns. The contact between fill and native soils is gradational in the terminal segment of this GPR profile.

SOUTHEAST OF I-5/MARINE DRIVE INTERCHANGE

On the southeast side of the I-5/Marine Drive interchange, GPR surveys were undertaken along the off-ramp shoulder (7 m elevation NAVD88) and between the access shoulder and the Delta Park East ball field (6 m elevation). This area is situated 350 m south of the Oregon Slough. The GPR surveys covered an area of approximately 5,000 square meters.

This survey area is represented by GPR profiling in CRC Line 101, and CRC Lines 104–112, all located north of the northwest ball field in Delta Park East. These GPR lines were collected in step mode. All of the GPR profiles trend east to west, and are spaced 3 m apart, with line numbers increasing from north to south. CRC Line 101 was 150 m in length; the remaining lines decrease in length from CRC Line 104 (140 m long) to CRC Line 112 (50 m long). CRC Line 101 was laid out along the south margin of the access ramp shoulder, at 6–7 m elevation, rising slightly from east to west. The combined GPR line length in this survey area was 881 m.

CRC Line 101 provides a representative GPR profile in this survey area. Resistive fill extends to 50 ns (2.5 m deep) at 50–75 m distance (Figure 3-6) and to 75 ns (3.75 m deep) at 100–130 m distance along this line (Figure 3-7).

These GPR profiles can be compared to nearby borehole BH-3. The depth of artificial fill in BH-3 was 5.0 m. The borehole elevation is 7.46 m NAVD88. This fill depth corresponds to a fill-to-native-soil contact elevation of 2.4 m NAVD88. The GPR contact between resistive fill and the basal conductive layer in GPR profile CRC Line 101 at 75 m distance is 65 ns (3.2 m deep). Assuming a profile height of 6 m, the GPR contact elevation is 2.7 m NAVD88. The close agreement between resistive fill depths predicted by GPR and the fill depth observed in BH-3 confirms the assumed GPR signal velocity of 0.1 m ns^{-1}. Fill materials observed in BH-3 included sand and fine road-base gravel. The uppermost native soil in the continuous cored and logged BH-3 is rooted mud, reflecting a vegetated wetland in the back levee floodplain.

Although no GPR surveys were conducted in the vicinity, the fill and native-soil contacts in boreholes BH-6 and BH-6B, about 600 and 275 m southeast of BH-3, respectively, are worth noting. These boreholes are situated at elevations of 3.86 and 5.09 m NAVD88, respectively. The depth of fill at BH-6 is logged at 2.65 m or 1.21 m NAVD88. The depth of fill at BH-6B is logged at 3.5 m or 1.6 m NAVD88. The fill-to-native-soil contacts in these boreholes are about 1 m lower than in BH-3 and about 3 m lower than the native-soil contact at BH-2. The uppermost native soils in BH-6 and BH-6B contain rhizome-rooted mud, reflecting seasonally submerged swamps in back-levee settings of the intact floodplain.

Using a GPR signal velocity of 0.1 m ns^{-1}, the area around BH-3 is estimated to have an average fill depth of ~3 m. Similar fill depths of 2.6 m and 3.5 m were observed in BH-6 and BH-6B. The preservation potential for native Holocene soils below the artificial fill in these areas is high. These native soils, at a depth of ~3 m subsurface, should include rooted mud from vegetated wetlands in the back-levee floodplain.

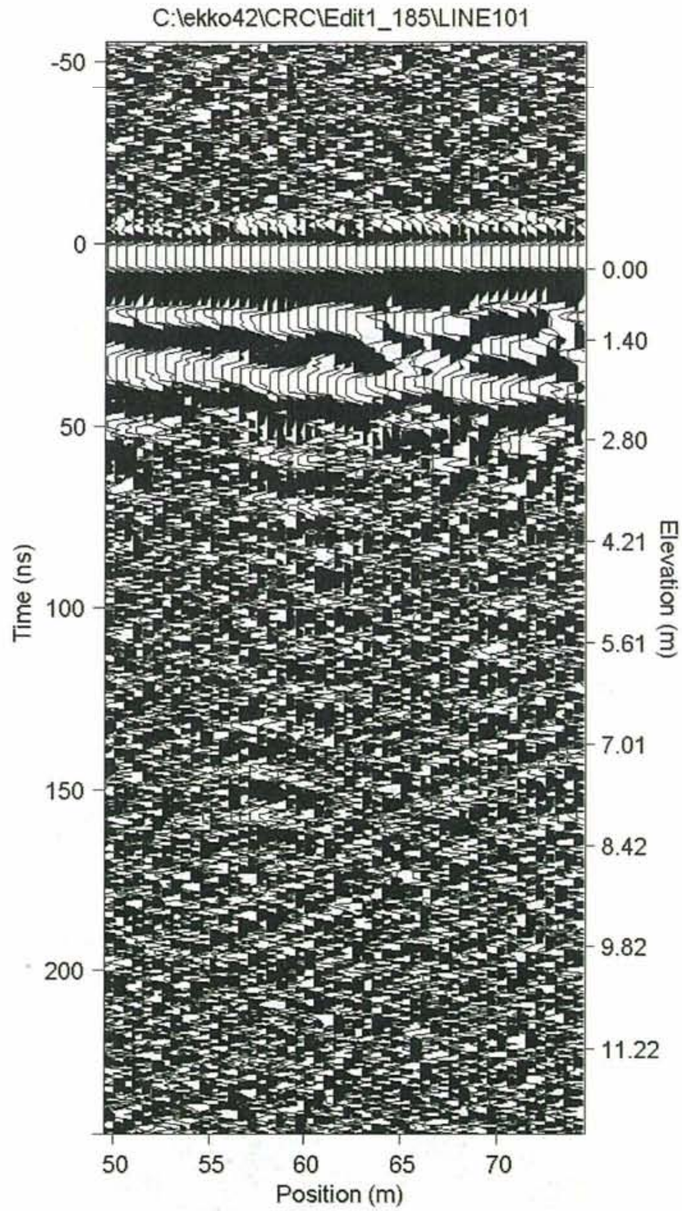

Figure 3-6. GPR profile segment (55–75 m distance) from CRC Line 101 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~50 ns (2.5 m deep) overlies conductive materials below 50 ns.

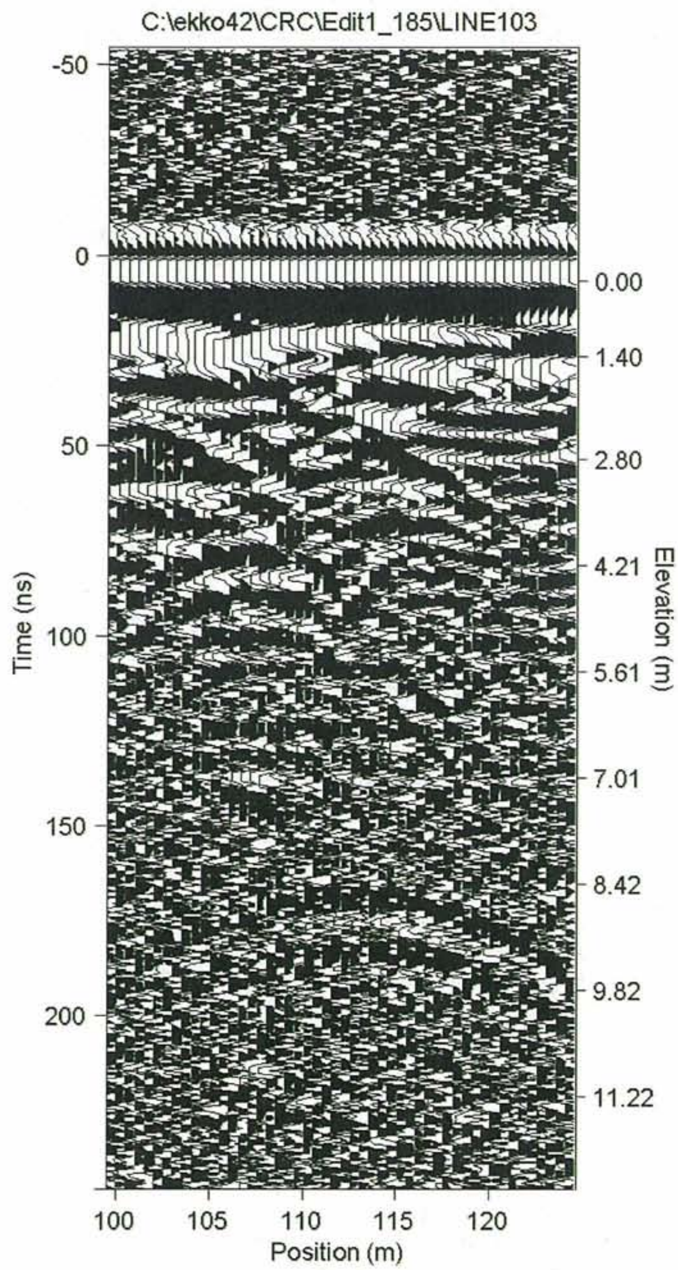

Figure 3-7. GPR profile segment (100–120 m distance) from CRC Line 101 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~75 ns (3.75 m deep) overlies conductive materials below 75 ns.

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SOUTH OF CITY OF PORTLAND FORESTRY CENTER

GPR surveys were undertaken on ODOT property consisting of a narrow strip of ground averaging about 10 m in width between I-5 and the City of Portland Forestry Center. Within this strip, the GPR surveys extended over a total distance of ~240 m. Overall, the GPR surveys were conducted within an area of approximately 2,400 square meters.

Located 700–800 m south of the Oregon Slough, the area surveyed is at an elevation of 6–7 m NAVD88. The ground subjected to GPR profiling is situated in a concave remnant of a meander loop shown on early historic maps (Peterson 2007). This area is positioned just south of a GPR test profile recorded in the Delta Park slough (Appendix 1B-III).

GPR profiling involved surveys of three GPR lines (1000v transmitter and 100 MHz antennae): CRC Line 175 (100 m), CRC Line 176 (100 m), and CRC Line 177 (44 m). The three GPR profiles were linked from north to south, and were recorded in step mode. CRC Line 175 demonstrates resistive fill to 100 ns (5.0 m deep), assuming 0.1 m ns^{-1} signal velocity (Figure 3-8).

Depth of fill in CRC Line 176 was obscured by strong EMA reflections from a rock wall encased in wire mesh on the west side of the profile. However, the south end of the profile extended beyond the rock wall. The line segment from 75 to 100 m distance showed resistive fill to 100 ns (5 m deep), assuming 0.1 m ns^{-1} signal velocity (Figure 3-9).

The GPR profile in CRC Line 177, at the south end of the series, demonstrates resistive fill to 80 ns (4 m deep), assuming 0.1 ns^{-1} signal velocity (Figure 3-10). This profile approaches the south end of a remnant meander cutoff (Peterson 2007).

Resistive fill to 4–5 m deep is established for the full lengths of CRC Line 175 and CRC Line 177, and for the last 25 m of CRC Line 176. The fill-to-native-soil contact for CRC Line 175 at 7.08 m surface elevation is estimated to be ~2 m NAVD88.

The depths of artificial fill in boreholes BH-7, BH-7C, and BH-7B were 5.7 m, 5.8 m, and 4.3 m, respectively. The borehole surface elevations are 6–7 m NAVD88. The borehole fill depths correspond to native-soil contact elevations of 1.3 m (BH-7), 1.7m (BH-7C), and 1.9 m (BH-7B), relative to the NAVD88 datum.

The estimated elevations for fill contact in the GPR profiles in CRC Line 175 and CRC Line 176 are about 0.5 m shallower, on average, than those established from the corresponding borehole logs. These differences are within the error range of 100 MHz wavelength depth discrimination. However, a slightly higher signal velocity (0.105 m ns^{-1}) could be applied to the fill in this area. Fill materials observed in BH-7, BH-7C, and BH-7B include sand, oxidized silt, and gravel. The uppermost native soil in all three boreholes was rooted mud, reflecting a vegetated wetland that was adjacent to an abandoned small channel in the floodplain.

Using a GPR signal velocity of 0.1 m ns^{-1}, this survey area contains fill depths in the ~4–5 m range. The tops of the native soils contained rooted mud, reflecting vegetated wetland settings in the floodplain.

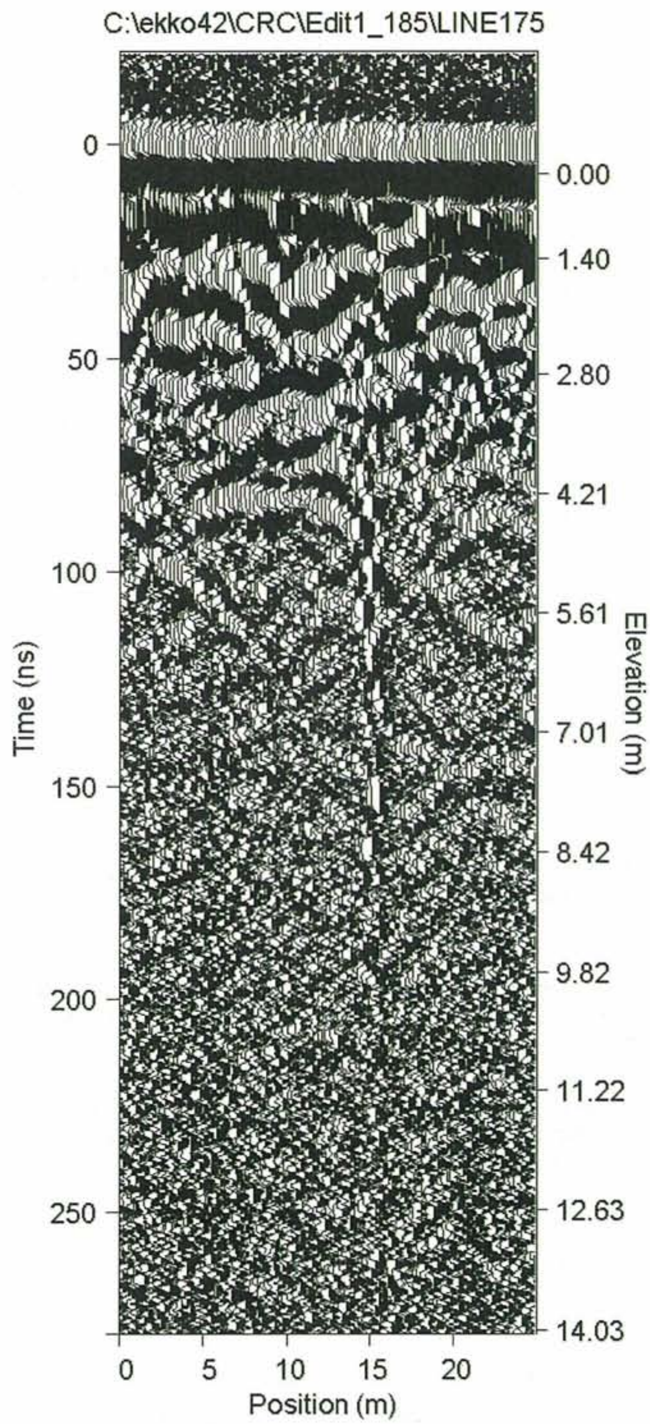

Figure 3-8. GPR profile segment (0–25 m distance) from CRC Line 175 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~100 ns (5.0 m deep) overlies conductive materials below 100 ns.

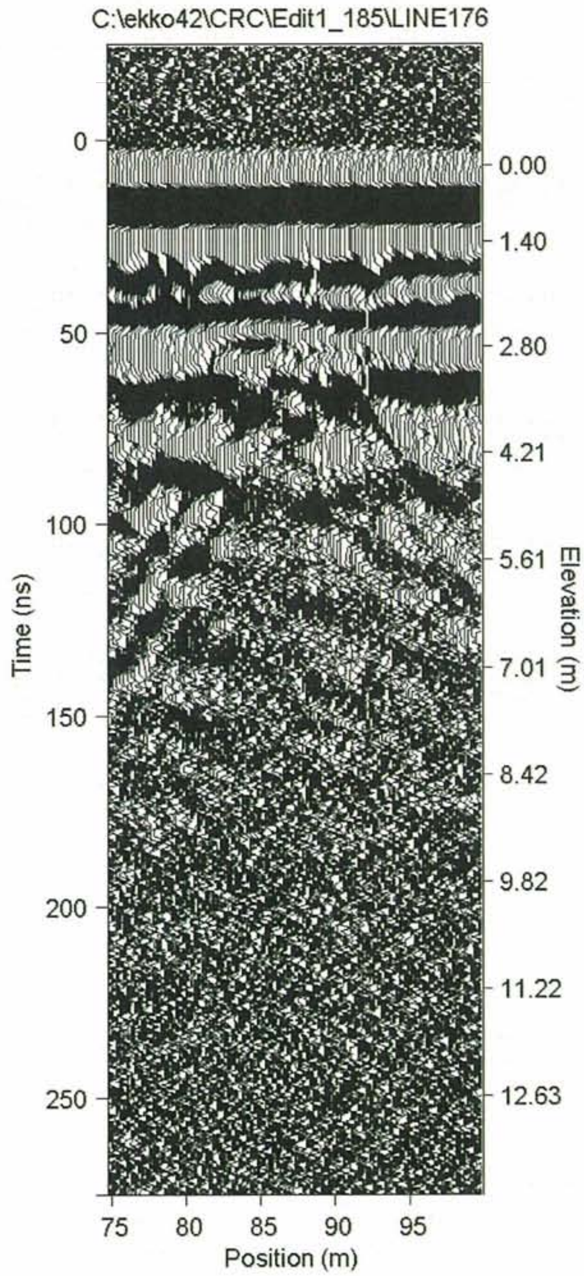

Figure 3-9. GPR profile segment (75–100 m distance) from CRC Line 176 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~100 ns (5.0 m deep) overlies conductive materials below 100 ns.

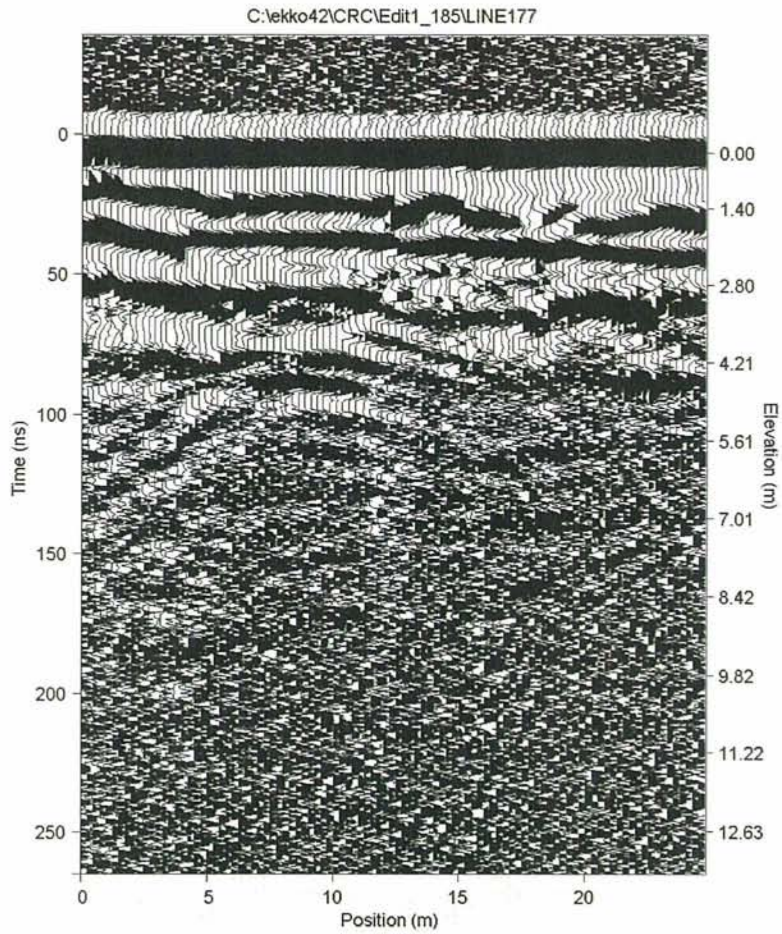

Figure 3-10. GPR profile segment (0–25 m distance) from CRC Line 177 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~80 ns (4.0 m deep) overlies conductive materials below 80 ns.

NORTH OF VICTORY BOULEVARD

GPR surveys were undertaken in two areas directly north of Victory Boulevard at the south end of the CRC project area. One area is a small triangle of land (50 × 30 m), at an elevation of 9.6 m NAVD88, bounded by I-5 southbound on the east and an on-ramp to I-5 northbound on the west. The other area, at an elevation of 6.5 m NAVD88, is on the east side of I-5, situated between an on-ramp to I-5 northbound on the west and an access road to Delta Park East on the east. Surface area in each of these small areas is about 750 square meters.

Low-frequency antennae (100 MHz) were used with a 1000v transmitter to penetrate potential fill depths of 4–5 m in these areas. Dense vegetation required GPR profiling on foot, using step mode, in the triangular area (Figure 3-11). The GPR profiles were compared to the results from the drilling of one rotary-sonic borehole (BH-5) in the triangular area, and two boreholes that contained intact sections from the upper 10 m (BH-8 and BH-8D) on the east side of I-5.

Figure 3-11. Collecting GPR profile data along a 50-m tape in the triangular area north of Victory Boulevard. Profile endpoints are georeferenced by GPS. A rotary-sonic borehole was drilled near the north end of the GPR profile.

GPR profiling in the triangular area was completed along one north–south line (CRC Line 166) with a 1000v transmitter and 100 MHz antennae. The 50 m profile demonstrates resistive fill to 125 ns (6.25 m deep) assuming 0.1 m ns-1 signal velocity (Figure 3-12).

GPR profiling in the area on the east side of I-5 utilized a segment of an 868 m long profile (CRC Line 162) that was collected along the Delta Park East access road. This access road runs north from Victory Boulevard to Marine Drive. The CRC Line 162 profile was collected with a 1000v transmitter and 100 MHz antennae. CRC Line 162 was recorded under rapid data collection mode using an odometer trigger towed behind a vehicle.

The profile segment extending from 550 to 600 m distance corresponds to the area in which the BH-8 series of boreholes was drilled. The 50 m profile segment demonstrates resistive fill to 75 ns (3.75 m deep) over conductive materials, assuming a signal velocity of 0.1 m ns^{-1} (Figure 3-13).

The depth of artificial fill in borehole BH-5 was 6.56 m. This observed fill-to-native-soil contact is similar to the GPR-predicted base-of-fill contact at 6.25 m below surface. The base of the fill corresponds to an elevation of 3.0 m NAVD88. The fill in BH-5 contains oxidized loam (dirt) and gravel. The fill overlies a rooted sandy mud that continues for another 3 m down the hole. The top of the native soil in this area is interpreted to be vegetated wetland.

Due to the difficulty of recovering soft mud at depth, four boreholes were cored by rotary-sonic drilling on the east side of I-5 north of Victory Blvd. Two boreholes that contained intact sections from the upper 10 m of the boreholes are used here to ground-truth the continuous GPR profile.

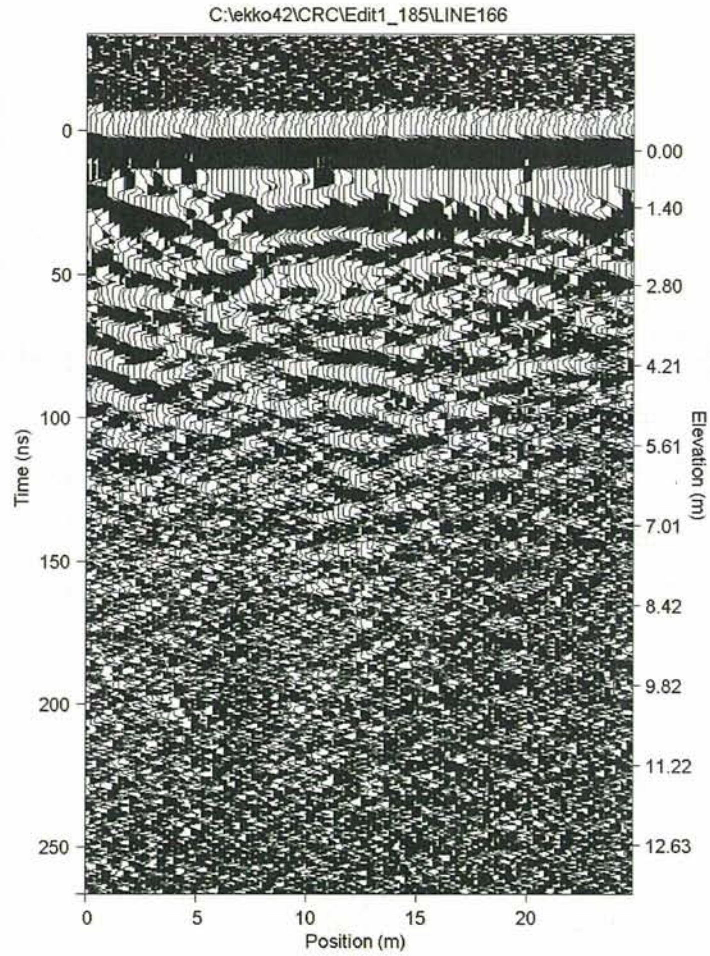

Figure 3-12. GPR profile segment (0–25 m distance) from CRC Line 166 using a 1000v transmitter and 100 MHz antennae. Resistive fill to ~125 ns (6.25 m deep) overlies conductive materials below 125 ns.

The depth of artificial fill in borehole BH-8 was 4.3 m; the depth of artificial fill in BH-8D was 3.0 m. The elevations of the top of muddy native soils in BH-8 and BH-8D were at 2.3 and 1.9 m NAVD88.

The surface at BH-8 is approximately level with the corresponding GPR profile surface. The GPR-predicted fill depth at BH-8 is 75 ns (3.75 m deep), assuming a 0.1 m ns-1 signal velocity. This close agreement verifies the assumed signal velocity of 0.1 m ns^{-1} in the fill. A 1.0 m offset between the base of fill found by GPR and by borehole logging at BH-8D is the result of a 1.0 m surface elevation difference between the GPR survey line and the borehole.

Using a GPR signal velocity of 0.1 m ns^{-1}, it was determined that the two GPR survey areas directly north of Victory Blvd. contain fill that ranges from ~3 to 6 m deep. Below the fill, the tops of the native soils contain rooted mud or rooted sandy mud, reflecting vegetated wetland settings in the floodplain.

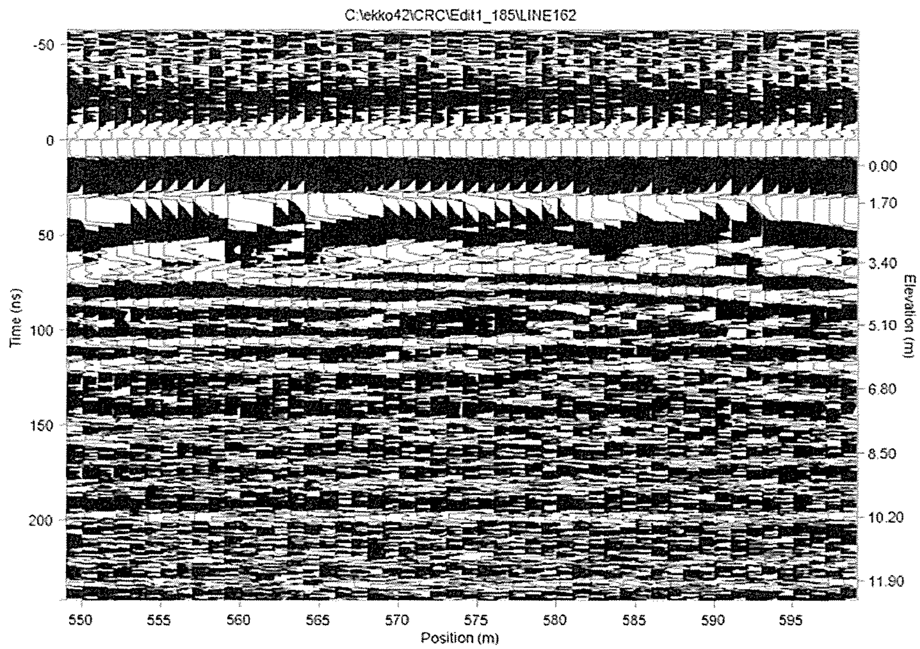

Figure 3-13. GPR profile segment (550–600 m distance) from CRC Line 162 using a 1000v transmitter and 100 MHz antennae. Resistive fill to 75 ns (3.75 m deep) overlies conductive materials below 75 ns.

CONCLUSIONS

1. GPR profiling indicates the existence of artificial fill deposits extending to substantial depths in all areas where the GPR surveys were conducted. The occurrence of these fill deposits over an even wider portion of the CRC project area was confirmed by the drilling of rotary-sonic boreholes for geoarchaeological investigations.

2. The correspondence between the GPR-predicted fill depths and measured fill depths from the borehole testing confirms the accuracy of a GPR signal velocity of 0.1 m ns^{-1} for the unsaturated resistive fill materials that cover Hayden Island and the Oregon shore in the CRC project area.

3. In view of the substantial depths of the artificial fill deposits on Hayden Island and the Oregon shore, manual shovel/auger probe excavations and even mechanical trenching would not provide an adequate means to ground-truth the GPR profiles.

4. Ground-truthing of the GPR profiles using information from the uppermost sections of the rotary-sonic boreholes established the contacts between the artificial fill and native soils. These boreholes provide the best information available about the native soils underlying the artificial fill and the potential of these soils to contain evidence of occupation or activity by prehistoric Native Americans on the Oregon shore floodplain.

4. GEOARCHAEOLOGICAL BOREHOLE INVESTIGATIONS

This chapter describes the procedures and results of the drilling of continuous rotary-sonic boreholes for geoarchaeological purposes in the CRC project area on the Oregon Shore. The boreholes were drilled through a cap of artificial fill into unconsolidated Holocene mud and sand alluvium that overlies Pleistocene gravels at depths of 30 m or more below surface.

Sections from 14 boreholes (12 geoarchaeological and 2 geotechnical) were subjected to geoarchaeological analyses to establish (1) depth of artificial fill, (2) depth of the Holocene alluvium (<12,000 BP), (3) stratigraphic ages of Holocene alluvium, (4) sequences of landscape development, and (5) preservation potential of hosting archaeological deposits and/or associated cultural materials.

The laboratory results summarized here establish the depth and age structure of the floodplain deposits, as well as the depositional settings that evolved in the ancestral Columbia River valley. This work builds upon previous reports that examined pre-existing borehole logs (Peterson 2007), entailed initial testing of ground-penetrating radar (GPR) on the Oregon shore (Appendix 1V-III), and conducted GPR surveys on ODOT parcels in the CRC APE on the Oregon shore (Chapter 3 of this report).

BOREHOLE LOCATION AND VERTICAL DATUM

Borehole site locations, obtained with a 12-channel WAAS-assisted GPS, are provided using UTM coordinates based on the WGS83 datum. Borehole site elevations, surveyed by David Evans and Associates (DEA) and tied to the nearest CRC control points, are based on the NAVD88 datum. Core sample depths, measured from the bottom of the source core section (marked in the field), are rounded to the nearest 0.1 m (and 0.1 ft).

FIELD METHODS

Exploratory geoarchaeological drilling was conducted on the Oregon shore for the CRC project over the course of almost three weeks between September 14 and October 12, 2009. A total of 14 boreholes (BH) were excavated to depths ranging from 3.0 m (10.0 ft) to 77.7 m (255.0 ft) below surface (Figure 4-1).

Two rotary-sonic drill rigs were utilized, a larger, truck-mounted SC300T (BH-1–6, 8) (Figure 4-2) and a smaller, track-mounted DB320 (BH-6B, 7–7C, 8B–8D) (Figure 4-3). The boreholes were drilled in increments (referred to as "runs") of 1.5 m (5.0 ft) to 6.1 m (20.0 ft). After each run, a 10 cm (4 in) diameter continuous core was extruded in 0.8 m (2.5 ft) to 3.1 m (10.0 ft) intervals into plastic bags (Figure 4-4) and secured in wooden core boxes (Figure 4-5). In many instances, the extruded core was divided into smaller sections to fit within the 1.5 m (5 ft) long core boxes. Great care was taken to ensure that the bags and boxes were appropriately labeled with location

Figure 4-1. Locations of all geoarchaeological and selected geotechnical boreholes excavated on the Oregon shore for the CRC project.

Figure 4-2. Truck-mounted SC300T drilling BH-2 (view to west with Expo Center in background).

Figure 4-3. Track-mounted DB320 drilling BH-7B (view to southeast).

Figure 4-4. Boart Longyear drill crew bags an interval of extruded core at BH-1.

Figure 4-5. Kendra Carlisle of HERITAGE (L) and Jeff Quinn of FEI (R) examine a core sample from BH-1. Wooden boxes in the foreground contain extruded core sections bagged in plastic.

and depth information. The core boxes were then stored at room temperature in a secured building at the WSDOT maintenance facility in Vancouver, Washington.

Foundation Engineering, Inc. (FEI) coordinated operations and logged geotechnical data for each borehole. Boart Longyear provided the equipment and drill crew. Geomorphologist Curt D. Peterson regularly visited to assess drilling progress and examine recovered cores. HERITAGE personnel Kendra Carlisle and Kennett Peterson recorded preliminary data for each core section, including depth (below surface), basic lithology, nature of the deposit (artificial fill or in situ sediment/soil), and presence/absence of cultural material (Figure 4-5). Radiocarbon samples (e.g., detrital wood, shell, rootlets) were collected where organic material was observed.

Following the completion of the geoarchaeological drilling, FEI oversaw the excavation of additional rotary-sonic boreholes in the project area as part of the geotechnical investigations on the Oregon shore. Kendra Carlisle of HERITAGE monitored the excavation of two of these boreholes (TB-5 and TB-7) in November 2009 (Figure 4-1). In general, the same field procedure was followed, including storage of the core boxes at the WSDOT facility in Vancouver. Additional tasks, such as SPT and Shelby tube sampling, were undertaken in some boreholes to address specific geotechnical questions.

LABORATORY METHODS

Core sections from 12 of the geoarchaeological boreholes and the 2 geotechnical boreholes were processed and analyzed by Curt D. Peterson and HERITAGE personnel under controlled laboratory conditions. Each section containing artificial fill and/or Holocene alluvium was split lengthwise (Figure 4-6); one half was described and (if alluvium) sub-sampled for geoarchaeological analyses (detailed below), while the other half was screened (through 1/8-inch mesh) for cultural materials. The Pleistocene gravel sections recovered from the bottom of the boreholes below the Holocene alluvium were not expected to contain (in situ) artifacts, so these were examined only for potentially dateable organics. Representative photos and descriptions of the basal gravels, which were relatively uniform in appearance, were recorded. All core log data were entered into an Excel database.

Figure 4-6. Core split S-22 from 17.9 m (58.8 ft) below surface in BH-8D. Contact between shallower tephra and deeper alluvial mud visible between 0.7 and 0.8 ft (split oriented downcore from left to right).

Each geoarchaeological core split was:

- photographed with a ruled scale using a tripod-mounted 15 megapixel digital SLR. All original photo (.jpg) files were retained with initial digital date stamps. Cropped and titled photo files were compiled in a digital photo database of all logged core sections.
- described with regard to lithology, grain size (sand and gravel), moist color, and presence/absence and type of organics. Lithology was characterized as gravel (>2.0 mm), sand (<2.0 mm), mud (smooth/non-gritty texture), and/or tephra listed in descending order of dominant to minor fractions. The mean particle size of the sand fraction (ranging from vcU at 1.4–2.0 mm to vfL at 0.062–0.088 mm) was assessed using calibrated grain-size cards; the maximum particle size of the gravel fraction was measured in millimeters. Colors were identified according to the Munsell system. Transported organics were designated as detrital. In situ organics (also known as macrofossils) were characterized as **peat** (>50% roots and rhizomes), **peaty to slightly peaty** (10-50% roots and rhizomes), and **rooted to slightly rooted** (<10% roots and rhizomes).
- sub-sampled at 0.5 to 0.75 m intervals (2 samples per 5 ft core section) for macrofossils and tephra, if present; core splits from selected boreholes (BH-1, 2, 3, 6, 7, and 8D) were also sub-sampled for microfossils (pollen), dry bulk density, and sand-fraction mineralogy. Only the Holocene alluvium was sub-sampled.

Selected organic samples were air dried and packaged in aluminum foil for submittal to Beta Analytic, Inc. for AMS dating. Calibrated radiocarbon ages are reported to 2 sigma analytical error in radiocarbon years before present (cal BP). Dated tephra layers are correlated to reported major volcanic eruptions.

Tephra samples were examined under (1) binocular microscope (lapilli) for evidence vesicles, or (2) petrographic microscope (ash mounted in plastic resin) with polarized light for glass shard isotropy. Samples with 5–10 percent isotropic (glass) ash shards in the light mineral fraction were considered sufficiently above background (<1 percent) to indicate a mixed sediment tephra layer. Selected tephra samples were packaged in aluminum foil for submittal for elemental analysis at the Microbeam Laboratory at Washington State University.

Bulk density samples were collected using ASTM 70 cm^3 bulk density rings and dried for 48 hours at room temperature prior to weighing (precision ± 0.01 g) on a digital scale. The component mud, sand, and gravel fractions were separated by wet sieving (using 2000 and 62 micron screens), then dried (48 hours at room temperature), and weighed to establish relative abundance.

Screening of the archaeological core splits did not result in recovery of any prehistoric or historical material from the Holocene alluvium samples. The only cultural objects recovered are a lead bullet, a possible chert heat spall, a tiny amber glass fragment, and a small, extremely rusted iron fragment. The bullet and chert spall were found in the artificial fill at the top of BH-7 and BH-8D, respectively. The glass fragment was recovered from the very top of the alluvium in BH-8D, 3.5 m (11.5 ft) below surface, and probably originated in the overlying fill. The iron fragment was found in floodplain channel deposits 24.8 m (81.3 ft) below surface in BH-1, and likely represents detrital material washed downstream. The discovery of these small items validates the screening methodology, demonstrating that small isolated archaeological artifacts would have been discovered if present. In addition, three anomalous rocks were discovered at 14.9 m (48.8 ft) and 15.8 m (51.7 ft) below surface in BH-2, and at 24.1 m (78.9 ft) below surface in BH-6B. These rocks do not exhibit any characteristics indicating human modification or use; it is possible that they were knocked into the boreholes during drilling.

DEFINITION OF PALEOLANDSCAPE FEATURES

Using the geoarchaeological data from the Holocene alluvium in each examined core, sedimentary facies were identified that represent past depositional environments within the floodplain landscape. A facies was assigned to a length of core spanning at least three consecutive core sample intervals (>1.5 m or 4.9 ft) exhibiting the same lithologic and organic characteristics. The type of facies differs according to these characteristics, which serve as proxy indicators of the conditions under which the deposit formed. Four facies, and corresponding depositional environments (floodplain landscape features), were distinguished (Table 4-1).

Table 4-1. Sedimentary Facies and Corresponding Floodplain Landscape Features.

Sedimentary Facies	Landscape Feature
rooted oxidized sand or muddy sand	channel levee or dune ridge
rooted or peaty mud	vegetated wetland
non-rooted sand or muddy sand	floodplain channel
non-rooted mud or sandy mud	undifferentiated floodplain

BOREHOLE SUMMARIES

Borehole summaries are presented in order of position from north to south across the CRC project area on the Oregon shore (see figure 4-1). The northernmost borehole, BH-1, was located on Hayden Island. BH-2 was located near the south shore of the Oregon Slough. Boreholes BH-4, BH-3, BH-6B, and BH-6 were located just south of the historic levee bordering the Delta Park floodplain. Boreholes BH-7, BH-7C, and BH-7B were located on the east side of I-5 in the central Delta Park floodplain. Boreholes TB-7 and TB-5 were located on the west side of I-5, adjacent to the east shoreline of the Vanport Wetlands. The southernmost boreholes, BH-5, BH-8D, and BH-8, were located on either side of northbound I-5 just north of the Victory Blvd. interchange.

In the following accounts, vertical positions within a core profile are described in meters and feet below surface; the corresponding elevations (in meters, based on NAVD88) are provided in Figure 4-7. Elevations are included in the text for samples warranting detailed contextual information (e.g., radiocarbon, tephra, and molluscan samples).

BH-1

BH-1 was located west of I-5 on Hayden Island (UTM 5051015N, 524952E). The surface elevation at the time of drilling was 10.9 m (35.9 ft) (NAVD88). Artificial fill comprised the upper 5.8 m (18.9 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 60.6 m (198.8 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 54.8 m (179.9 ft) thick.

A total of 66 sub-samples from BH-1 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. The bulk of the Holocene alluvium, from S-9 at 9.5 m (31.3 ft) to S-55 at 44.7 m (146.5 ft) below surface, consists of sand ranging in mean size from mL to cU. The sand grades up-section to rooted oxidized sand and silty sand (fL) in S-6 at 7.2 m (23.7 ft) below surface, which is capped by rooted sandy mud in S-5 at 6.5 m (21.3 ft) below surface. The sand grades down-section to mud and sandy mud in sample S-56 at 45.4 m (149.0 ft) below surface, which continues to S-70 at 59.8 m (196.3 ft) below surface.

Analysis of the sub-samples indicates that the Holocene alluvium in BH-1 consists predominantly of floodplain channel deposits overlying undifferentiated floodplain sediments (Figure 4-7). The channel deposits are capped by layers of vegetated wetland and vegetated levee/dune sediments.

A radiocarbon sample from S-67, near the base of the Holocene alluvium, yielded a date of 10,740–11,190 cal BP (Table 4-2). This date indicates that the Holocene alluvial deposits in BH-1 span at least the last 11,000 years. A radiocarbon sample from S-8 was dated to 290–490 cal BP, indicating that a relatively stable vegetated levee/dune ridge had formed in that location by approximately 500 years ago.

Table 4-2. Radiocarbon Dates from BH-1.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	2 Sigma Calibrated Results
S-8	C^{14}	8.7 m (28.6 ft)	2.2 m (7.3 ft)	290–490 cal BP
S-67	C^{14}	55.6 m (182.5 ft)	–44.7 m (–146.6 ft)	10,740–11,190 cal BP

BH-2

BH-2 was located adjacent to on- and off-ramps on the southwest side of the I-5/Marine Dr. interchange (UTM 5050297N, 524584E). The surface elevation at the time of drilling was 9.1 m (30.0 ft) (NAVD88). Artificial fill comprised the upper 5.0 m (16.3 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 36.2 m (118.8 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 31.3 m (102.5 ft) thick.

A total of 36 subsamples from BH-2 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Rooted oxidized sandy mud extends from the top of the Holocene alluvium, S-6 at 5.8 m (18.9 ft) below surface, to S-9 at 8.0 m (26.2 ft) below surface. Non-rooted muddy sand (fL) appears in S-10 at 8.8 m (28.9 ft) below surface and continues to S-12 at 10.2 m (33.4 ft) below surface. (The two facies represent an up-section accretionary bank-to-channel levee sequence.) Rooted mud extends from S-13 at 14.1 m (46.4 ft) to S-18 at 18.0 m (58.9 ft) below surface. Non-rooted mud and muddy sand (fL) alternate down-section to a basal rooted mud layer in S-39 at 34.0 m (111.5 ft) and S-40 at 34.7 m (113.8 ft) below surface. A distinctive paleosol occurs at the top of the Pleistocene gravel section in S-42 at 36.2 m (118.8 ft) below surface. The preservation of the paleosol demonstrates little to no re-working of the gravel during Holocene submergence and burial of the terrace by the Columbia River floodplain.

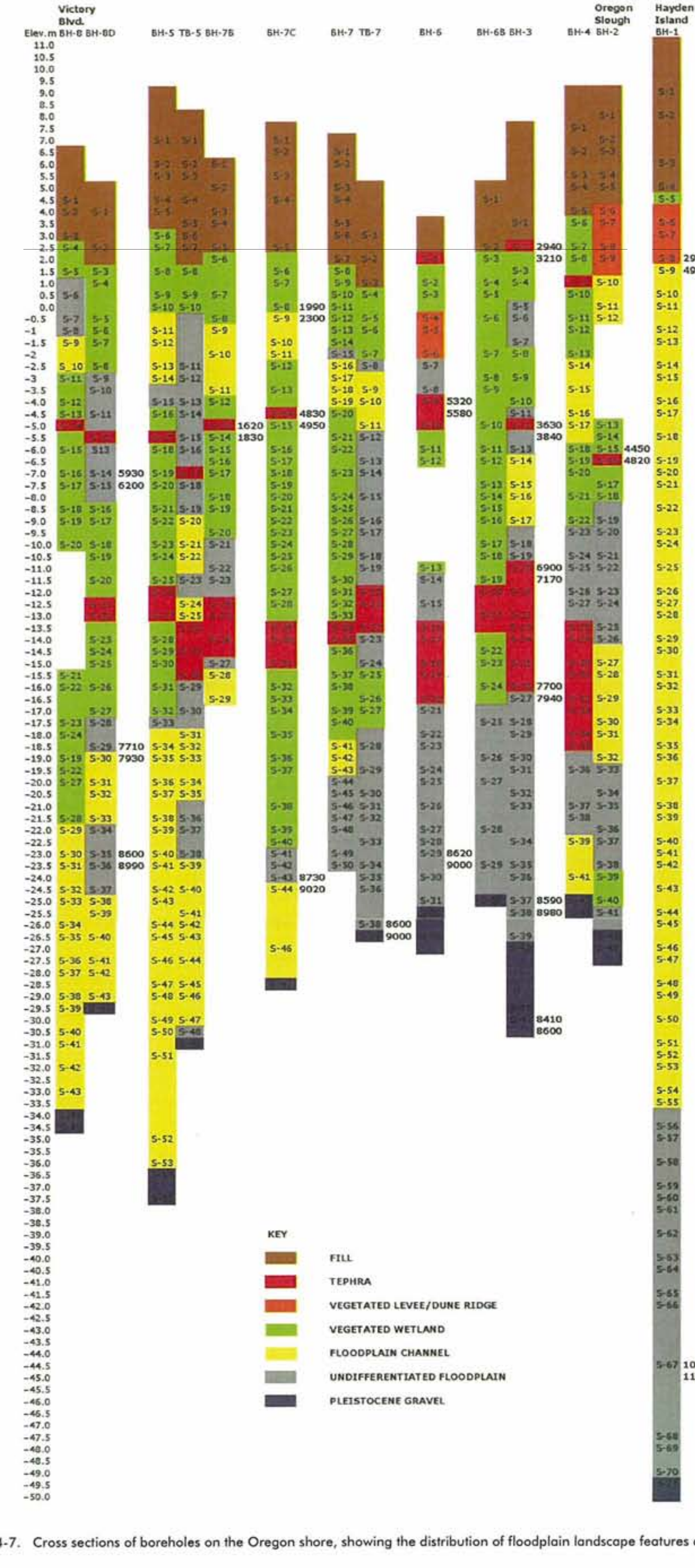

Figure 4-7. Cross sections of boreholes on the Oregon shore, showing the distribution of floodplain landscape features and tephra layers.

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The Holocene alluvium in BH-2 represents a variety of depositional environments (Figure 4-7). These include levee/dune at 5.8–8.0 m (18.9–26.2 ft) below surface, floodplain channel at 8.8–10.2 m and 24.8–28.7 m (28.9–33.4 ft and 81.3–94.0 ft) below surface, and vegetated wetland at 14.1–18.0 m and 34.0–34.7 m (46.4–58.9 ft and 111.5–113.8 ft) below surface, alternating with undifferentiated floodplain. Of the examined boreholes, BH-2 records the greatest change over time in the floodplain landscape on the Oregon shore.

One tephra layer was observed in BH-2 in sample S-16 (Table 4-3). A radiocarbon sample from immediately above the tephra in S-15 yielded three possible age ranges of 4,740–4,820 cal BP, 4,510–4,730 cal BP, and 4,450–4,470 cal BP. This tephra layer is tentatively correlated to the Mount St. Helens Set-Y eruption. Although radiocarbon dates associated with Set-Y tephra generally fall within the interval from 3,300 and 3,900 BP; based on mineralogical and chemical evidence an earlier layer of this tephra (Yn) has been identified in Canada (Mullineaux 1996:46). Correlation of the tephra in BH-2 with Mount St. Helens Set-Y is supported by the occurrence of a tephra layer (S-12) at a similar elevation in nearby BH-3. A radiocarbon sample from S-12 in BH-3 yielded a single age range of 3,630–3,840 cal BP.

Table 4-3. Tephra Correlations and Radiocarbon Date from BH-2.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-16	Tephra	16.4 m (53.9 ft)	–6.6 m (–21.8 ft)	MSH Set-Y (3,300–3,900 BP)[a]	
S-15	C^{14}	15.6 m (51.7 ft)	–6.0 m (–19.7 ft)		4,740–4,820 cal BP 4,510–4,730 cal BP 4,450–4,470 cal BP

[a] Clynne et al. (2008: 594)

BH-4

BH-4 was located south of BH-2 adjacent to on- and off-ramps on the southwest side of the I-5/Marine Dr. interchange (UTM 5050049N, 524566E). The surface elevation at the time of drilling was 9.2 m (30.1 ft) (NAVD88). Artificial fill comprised the upper 5.1 m (16.8 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 33.9 m (111.3 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 28.8 m (94.5 ft) thick.

A total of 36 sub-samples from BH-4 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. The upper portion of the Holocene alluvium, from S-6 at 5.7 m (18.8 ft) to S-22 at 17.9 m (58.8 ft) below surface, consists predominantly of rooted mud. Two non-rooted muddy sand (fL) intervals extend from S-14 at 11.9 m (39.0 ft) to S-17 at 14.4 m (46.4 ft) below surface, and from S-39 at 31.6 m (103.7 ft) to S-41 at 33.2 m (108.8 ft) below surface. The remainder of the Holocene alluvium, from S-23 at 18.7 m (61.4 ft) to S-38 at 30.9 m (101.3 ft) below surface, consists of non-rooted mud.

Analysis of the sub-samples indicates that the upper portion of the Holocene alluvium, 5.7–17.8 m (18.8–58.8 ft) below surface, is dominated by vegetated wetland sediments. The lower portion of the alluvium, 18.7–33.9 m (61.4–111.3 ft) below surface, contains primarily undifferentiated floodplain deposits (Figure 4-7). Based on the radiocarbon date obtained for a sample (S-36) from a similar elevation in nearby BH-3, the base of the Holocene alluvium in BH-4 is assumed to have been deposited between 8,500 and 9,000 BP.

Two tephra layers were observed in BH-4, one in sample S-9 and the other from S-28 to S-35 (Table 4-4). The tephra in S-9, which consists of white laminae and crushed lapilli, remains unidentified. The thick tephra layer extending from S-28 to S-35 contained substantial ash. Microscopic examination, under polarized light, revealed isotropic ash shards (>20 percent by volume). This tephra layer is correlated to the Mount Mazama eruption at approximately 7,700 BP (see Mazama tephra correlation and radiocarbon dates in BH-3).

Table 4-4. Tephra Correlations from BH-4.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation
S-9	Tephra	8.1 m (26.5 ft)	1.1 m (3.5 ft)	Unidentified
S-28 to S-35	Tephra	22.6 to 27.8 m (74.0 to 91.2 ft)	−13.4 to −18.7 m (−43.9 to −61.2 ft)	Mazama (~7,700 BP)[a]

[a] Zdanowicz et al. (1999)

BH-3

BH-3 was located in the southeast corner of the I-5/Marine Dr. interchange (UTM 5049944N, 524918E). The surface elevation at the time of drilling was 7.5 m (24.5 ft) (NAVD88). Artificial fill comprised the upper 4.3 m (14.2 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 34.7 m (113.9 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 30.4 m (99.7 ft) thick.

A total of 38 sub-samples from BH-3 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Intervals of rooted mud and rooted sandy mud comprise the upper portion of the alluvium from S-2 at 5.0 m (16.5 ft) to S-10 at 11.2 m (36.7 ft) below surface. The rooted mud is interrupted and underlain by non-rooted mud or sandy mud from S-5 at 7.3 m (24.0 ft) to S-7 at 8.8 m (29.0 ft) below surface, and from S-11 at 11.9 m (38.9 ft) to S-39 at 33.9 m (111.2 ft) below surface. A thin sand (mL) layer extends from S-14 at 14.2 m (46.5 ft) to S-17 at 16.4 m (53.9 ft) below surface. Analysis of the sub-samples indicates that the Holocene alluvium in BH-3 consists predominantly of undifferentiated floodplain deposits (Figure 4-7). Vegetated wetland sediment occurs between 5.0–6.5 and 9.6–11.2 m (16.5–21.4 and 31.4–36.7 ft) below surface, and channel deposits occur between 14.1 and 16.4 m (46.4 and 53.9 ft) below surface.

The base of the Holocene alluvium is well constrained temporally by the radiocarbon date of 8,590–8,980 cal BP obtained for S-37 at a depth of 32.4 m (106.3 ft) below surface. A second basal date of 8,410–8,600 cal BP was obtained for S-42 at 37.9 m (124.2 ft) below surface. Both samples consisted of wood in mud associated with gravels. In S-42, either the wood was pushed down into the gravels by overburden weight or during drilling. The top of the Holocene alluvium was dated to 2,940–3,210 cal BP using a radiocarbon sample taken from S-2 at 5.0 m (16.5 ft) below surface. A date of this considerable age obtained from a context so close to the contact with the artificial fill suggests that the youngest prehistoric soils at this location have been disturbed, or possibly even removed, probably as a result of past highway construction.

The Pleistocene deposits underlying the Holocene alluvium in BH-3 demonstrate the thickness of the relatively unweathered Missoula Flood gravels, which extend from S-40 at 34.7 m (113.8 ft) to S-58 at 56.8 m (186.5 ft) below surface. The Missoula gravels (predicted to date 12,000 BP) overlie older, weathered, weakly cemented gravels that rest largely in framework support. These older gravels are referred to here as the "Pleistocene Alluvium Gravel" (PAG).

A very prominent paleosol occurs in the PAG in S-61 at 61.4 m (201.5 ft) below surface, reflecting episodic aggradation of the Pleistocene Columbia River gravels. The PAG is thought to correlate to the weathered gravels that underlie Missoula Flood gravels in the Vancouver and northeast Portland terraces. The PAG in BH-3 extends to at least 75.6 m (248.0 ft) below surface. It is not known how much deeper the PAG extends before grading into the well-cemented Troutdale gravels.

Three tephra layers were observed in BH-3, in samples S-2, S-12, and from S-20 to S-26 (Table 4-5). The shallowest tephra sample in S-2 has yet to be verified for the presence of ash using petrographic microscopy and remains unidentified.

Table 4-5. Tephra Correlations and Radiocarbon Dates from BH-3.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-2	Tephra	5.0 m (16.5 ft)	2.4 m (8.0 ft)	Unidentified	
S-12	Tephra	12.6 m (41.3 ft)	–5.2 m (–16.9 ft)	MSH Set-Y (3,300–3,900 BP)[a]	
S-20 to S-26	Tephra	18.6 to 23.3 m (61.1 to 76.4 ft)	–11.2 to –15.8 m (–36.7 to –52.0 ft)	Mazama O (~7,700 BP)[b]	
S-2	C^{14}	5.0 m (16.5 ft)	2.4 m (8.0 ft)		2,940–3,210 cal BP
S-12	C^{14}	12.6 m (41.3 ft)	–5.2 m (–16.9 ft)		3,630–3,840 cal BP
S-20	C^{14}	18.6 m (61.1 ft)	–11.2 m (–36.7 ft)		6,900–7,170 cal BP
S-26	C^{14}	23.3 m (76.4 ft)	–15.8 m (–52.0 ft)		7,700–7,940 cal BP
S-37	C^{14}	32.4 m (106.3 ft)	–25.0 m (–81.9 ft)		8,590–8,980 cal BP
S-42	C^{14}	37.9 m (124.2 ft)	–30.4 m (–99.7 ft)		8,410–8,600 cal BP

[a] Clynne et al. (2008: 594)
b confirmed identification (Foit 2010); Zdanowicz et al. (1999)

The second tephra layer, in S-12, does contain 5–10 percent ash by volume. Based on an associated radiocarbon date of 3,630–3,840 cal BP from the same sample (S-12), the tephra layer in S-12 is correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP.

The third tephra layer, from S-20 to S-26, is quite thick (4.7 m, or 15.3 ft) and contains about 20 percent ash shards by point count volume in several samples. Based on glass microprobe geochemistry of the ash shards, this tephra layer correlates to the Mount Mazama eruption at approximately 7,700 BP (Foit 2010). The depositional period of the Mazama ash is well constrained in BH-3 by radiocarbon dates obtained for samples S-20 (6,900–7,170 cal BP) and S-26 (7,700–7,940 cal BP). The date range could indicate several hundred years of sedimentation for the ash deposit. The great thickness of the Mazama tephra in BH-3, as well as BH-4, likely reflects (1) proximity to a main channel sediment source, (2) large accommodation space in a sub-tidal environment, and (3) protection from subsequent scour, possibly by an intervening channel levee. By comparison, the Mazama tephra layer is not preserved in either BH-1 or BH-2 and thins dramatically in the Delta Park boreholes to the south of BH-3 and BH-4.

BH-6B

BH-6B was located southeast of BH-3, east of the I-5/Marine Dr. interchange, and south of Martin Luther King Jr. Blvd. (UTM 5049731N, 525184E). The surface elevation at the time of drilling was 5.1 m (16.7 ft) (NAVD88). Artificial fill comprised the upper 2.7 m (9.0 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 30.2 m (99.1 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 27.5 m (90.1 ft) thick.

A total of 27 sub-samples from BH-6B represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Rooted mud extends from S-3 at 3.5 m (11.5 ft) to S-24 at 20.9 m (68.7 ft) below surface. The rooted mud is underlain by a comparatively thin interval of non-rooted mud.

Analysis of the sub-samples indicates that the Holocene alluvium in BH-6B consists predominantly of vegetated wetland sediment overlying undifferentiated floodplain deposits (Figure 4-7).

One tephra layer was encountered in samples S-20 to S-21 (Table 4-6). This tephra is correlated to the Mount Mazama eruption at approximately 7,700 BP based on thickness and an elevation that is similar to that of the identified and dated Mazama tephra layer in BH-3.

Table 4-6. Tephra Correlation from BH-6B.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation
S-20 to S-21	Tephra	17.2 to 18.0 m (56.5 to 59.1 ft)	–12.1 to –12.9 m (–39.7 to –42.3 ft)	Mazama (~7,700 BP)[a]

[a] Zdanowicz et al. (1999)

BH-6

BH-6 was located southeast of BH-6B, on the east side of Delta Park and south of Martin Luther King Jr. Blvd. (UTM 5049432N, 525471E). The surface elevation at the time of drilling was 3.9 m (12.7 ft) (NAVD88). Artificial fill comprised the upper 1.9 m (6.2 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 29.4 m (96.3 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 26.4 m (86.5 ft) thick.

A total of 38 sub-samples from BH-6 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. The sedimentary facies comprising the alluvium are complicated, suggesting proximity to a channel margin environment, as observed in BH-2. Rooted sandy mud extends from S-1 at 1.9 m (6.3 ft) to S-3 at 3.6 m (11.7 ft) below surface, overlying rooted oxidized muddy sand (fU) from S-4 at 4.2 m (13.7 ft) to S-6 at 5.8 m (19.1 ft) below surface. Except for one additional rooted mud interval from S-11 at 9.6 m (31.5 ft) to S-13 at 15.0 m (49.1 ft) below surface, the remainder of the BH-6 Holocene alluvium is dominated by non-rooted mud.

Analysis of the sub-samples indicates that the Holocene alluvium in BH-6 consists of alternating facies representing vegetated wetland and undifferentiated floodplain, with one levee/dune interval 4.2–5.8 m (13.7–19.1 ft) below surface (Figure 4-7). A basal radiocarbon date of 8,620–9,000 cal BP was obtained for the Holocene alluvium from S-29 at 27.1 m (88.8 ft) below surface.

Three tephra layers were observed in BH-6 (Table 4-7). The uppermost tephra layer in S-1 remains unidentified. Sample S-9/S-10 is tentatively correlated with the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP. However, a radiocarbon sample associated with the tephra in S-9/S-10 yielded a date of 5,320–5,580 cal BP, which is considerably earlier than the time range of the MSH Set-Y eruption. Given that a radiocarbon date obtained from a tephra layer at a similar elevation in nearby BH-3 (S-12) falls within the known time range of the Set-Y tephra, the early date in BH-6 probably reflects the remobilization of old carbon. The tephra layer extending from S-16 to S-20 appears to correlate well with the Mount Mazama eruption at approximately 7,700 BP.

Table 4-7. Tephra Correlations and Radiocarbon Dates from BH-6.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-1	Tephra	1.9 m (6.2 ft)	2.0 m (6.4 ft)	Unidentified	
S-9 to S-10	Tephra	8.0 to 8.7 m (26.4 to 28.7 ft)	–4.2 to –4.9 m (–13.7 to –16.1 ft)	MSH Set-Y (3,300-3,900 BP)[a]	
S-16 to S-20	Tephra	17.2 to 20.3 m (56.5 to 66.5 ft)	–13.4 to –16.4 m (–43.8 to –53.9 ft)	Mazama (~7,700 BP)[b]	
S-9	C^{14}	8.0 m (26.4 ft)	–4.2 m (–13.7 ft)		5,320–5,580 cal BP
S-29	C^{14}	27.1 m (88.8 ft)	–23.2 m (–76.1 ft)		8,620–9,000 Cal BP

[a] Clynne et al. (2008: 594)

[b] Zdanowicz et al. (1999)

TB-7

TB-7 was located on the west side of I-5, adjacent to the east shore of the Vanport Wetlands (UTM 5049678N, 524596E). The surface elevation at the time of drilling was 5.4 m (17.7 ft) (NAVD88). Artificial fill comprised the upper 4.2 m (13.9 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 32.0 m (105.0 ft) below surface.

Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 27.8 m (91.1 ft) thick.

A total of 35 sub-samples from TB-7 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. The top of the alluvium consists of rooted mud from S-4 at 5.0 m (16.3 ft) to S-7 at 7.3 m (24.0 ft) below surface. A thin interval of non-rooted sand (fL) extends from S-9 at 8.8 m (29.0 ft) to S-11 at 10.4 m (34.0 ft) below surface. The remaining Holocene alluvium, from S-12 at 11.2 m (36.6 ft) to S-38 at 31.7 m (104.0 ft) below surface, is dominated by non-rooted mud. In-situ bivalve shells are present within the non-rooted mud at S-15, 13.4 m (44.0 ft) below surface. An interval of rooted mud interrupts the non-rooted mud from S-25 at 21.0 m (69.0 ft) to S-27 at 22.5 m (73.8 ft) below surface.

Analysis of the sub-samples indicates that the Holocene alluvium section in TB-7 is dominated by undifferentiated floodplain deposits with two intervals of vegetated wetland sediments at 5.0–7.3 m (16.3–24.0 ft) and 21.0–22.5 m (69.0–73.8 ft) below surface (Figure 4-7). The anomalous layer of sand from 8.8 to 10.4 m (29.0 to 34.0 ft) below surface can be traced in BH-7, BH-7C, BH-7B, and possibly in BH-5 and BH-8. The sand may correspond to remnant "abandoned" channel meanders that occur adjacent to the borehole sites (Peterson 2007). Tiny shell fragments recovered in S-15 at 8.0 m (26.3 ft) are too small for identification. As noted below, shell fragments from the freshwater genus *Anodonta* were recovered in BH-7. The absence of root or rhizome macrofossils in the undifferentiated floodplain sediments indicate a sub-tidal setting, possibly an abandoned lake or pond in the floodplain.

One tephra layer occurs in samples S-20 to S-22 (Table 4-8). Based on the thickness and elevation of this layer relative to the dated Mazama ash in nearby BH-3, this tephra is tentatively correlated with the Mount Mazama eruption at approximately 7,700 BP. The basal Holocene alluvium in TB-7 is very well constrained temporally by the radiocarbon date of 8,600–9,000 cal BP, obtained from S-38 at 31.7 m (104.0 ft) below surface. This is a very similar age to that obtained for the basal Holocene alluvium in nearby BH-3.

Table 4-8. Tephra Correlation and Radiocarbon Date from TB-7.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-20 to S-22	Tephra	17.2 to 18.8 m (56.5 to 61.7 ft)	–11.8 to –13.4 m (–38.8 to –44.0 ft)	Mazama (~7,700 BP)[a]	
S-38	C^{14}	31.7 m (104.0 ft)	–26.3 m (–86.3 ft)		8,600–9,000 cal BP

[a] Zdanowicz et al. (1999)

BH-7

BH-7 was located in a narrow strip of ODOT property bounded by I-5 on the west and the City of Portland Forestry Center on the east (UTM 5049663N, 524697E). The surface elevation at the time of drilling was 7.1 m (23.2 ft) (NAVD88). Artificial fill comprised the upper 5.0 m (16.4 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 30.5 m (100.0 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 25.5 m (83.6 ft) thick.

A total of 43 sub-samples from BH-7 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Rooted muddy sand and sandy mud extend from S-8 at 6.3 m (20.6 ft) to S-14 at 8.4 m (27.5 ft) below surface. A thin interval of non-rooted sand (fL) occurs in S-16 at 9.4 m (31.0 ft) to S-19 at 11.0 m (36.3 ft) below surface. This interval could stratigraphically correlate to similar intervals in nearby TB-7, BH-7C, and BH-7B. Rooted mud extends from S-20 at 11.9 m (38.8 ft) to S-40 at 24.8 m (81.2 ft) below surface. Another thin sand (fU) interval from S-44 at 26.8 m (87.9 ft) to S-50 at 30.5 m (100.0 ft) below surface separates the overlying rooted mud from underlying non-rooted mud.

Analysis of the sub-samples indicates that the Holocene alluvium in BH-7 consists predominantly of vegetated wetland sediments interrupted by floodplain channel deposits at 9.4-11.1 m (31.0-36.3 ft) and 25.5-26.5 m (83.7-87.0 ft) below surface (Figure 4-7). Shell fragments recovered from S-48 at 22.3 m (73.0 ft) and S-49 at 23.0 m (75.5 ft) below surface were identified as from the freshwater genus Anodonta. The absence of key features of the shell shape prevented identification to species (Nancy Duncan, personal communication 2010). Anodonta prefer mud sediments and are widely distributed in lakes and low-gradient stream habitats in western North America (Nedeau et al. 2009). These freshwater molluscan remains suggest a sub-tidal depositional environment for the basal undifferentiated floodplain sediments extending 26.8–30.5 m (87.9–100.0 ft) below surface.

One tephra layer was encountered in BH-7, in samples S-34 to S-35 (Table 4-9). This tephra is tentatively correlated with the Mount Mazama eruption at approximately 7,700 BP. The basal Holocene alluvium in BH-7 is assumed to date to roughly 8,700–9,000 BP, as it occupies an elevation similar to that of the dated basal layer (8,730–9,020 cal BP) in nearby BH-7C.

Table 4-9. Tephra Correlation from BH-7.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation
S-34 to S-35	Tephra	20.6 to 21.0 m (67.7 to 69.0 ft)	−13.6 to −14.0 m (−44.5 to −45.8 ft)	Mazama (~7,700 BP)[a]

[a] Zdanowicz et al. (1999)

BH-7C

BH-7C was located south of BH-7 in the same narrow strip of ODOT property between I-5 and the City of Portland Forestry Center (UTM 5049513N, 524676E). The surface elevation at the time of drilling was 7.5 m (24.7 ft) (NAVD88). Artificial fill comprised the upper 4.9 m (16.0 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 36.2 m (118.8 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 31.3 m (102.8 ft) thick.

A total of 40 sub-samples from BH-7C represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Rooted or peaty mud extends from S-6 at 5.8 m (19.1 ft) to S-40 at 30.0 m (98.5 ft) below surface, interrupted by a single interval of muddy sand between S-9 at 8.0 m (26.1 ft) and S-11 at 9.6 m (31.5 ft) below surface. Below the rooted mud, deposits of non-rooted mud and sand comprise the base of the Holocene alluvium.

Analysis of the sub-samples indicates that the Holocene alluvium in BH-7C consists predominantly of vegetated wetland sediments interspersed with a few intervals of undifferentiated floodplain sediments and floodplain channel deposits at 8.0–9.6 m (26.1–31.5 ft), 30.7–31.7 m (100.7–104.0 ft), and 32.5–34.7 m (106.5–113.9 ft) below surface (Figure 4-7).

Radiocarbon samples obtained from S-8 at 7.3 m (24.0 ft) below surface and S-43 at 31.7 m (104.0 ft) below surface yielded dates of 1,990–2,300 cal BP and 8,730–9,020 cal BP, respectively. This indicates that the Holocene alluvium section spans roughly the last 9,000 years and is missing the youngest prehistoric soils (at the top), likely due to past plowing or grading.

Two tephra layers were encountered in BH-7C, one in sample S-14 and the other from S-29 to S-31 (Table 4-10). Based on elevation, the S-14 tephra is tentatively correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP. However, a radiocarbon sample from the S-14 tephra yielded older date ranges of 4,830–4,880 and 4,940–4,950 cal BP. The S-29 to S-31 tephra layer is correlated, based on elevation and thickness, to the Mount Mazama eruption at approximately 7,700 BP.

Table 4-10. Tephra Correlations and Radiocarbon Dates from BH-7C.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-14	Tephra	11.9 m (39.1 ft)	–4.4 m (–14.5 ft)	MSH Set-Y (3,300-3,900 BP)[a]	
S-29 to S-31	Tephra	20.9 to 22.5 m (68.7 to 73.7 ft)	–13.4 to –15.0 m (–44.1 to –49.1 ft)	Mazama (~7,700 BP)[b]	
S-8	C^{14}	7.3 m (24.0 ft)	0.2 m (0.7 ft)		2,260–2,300 cal BP 1,990–2,160 cal BP
S-14	C^{14}	12.0 m (39.2 ft)	–4.4 m (–14.5 ft)		4,940–4,950 cal BP 4,830–4,880 cal BP
S-43	C^{14}	31.7 m (104.0 ft)	–24.2 m (–79.3 ft)		8,730–9,020 cal BP

[a] Clynne et al. (2008: 594)
[b] Zdanowicz et al. (1999)

BH-7B

BH-7B was located a short distance south of BH-7C between I-5 and the City of Portland Forestry Center (UTM 5049442N, 524669E). The surface elevation at the time of drilling was 6.2 m (20.4 ft) (NAVD88). Artificial fill comprised the upper 3.5 m (11.5 ft) of the core. Drilling was terminated after encountering a confined aquifer at a depth of 22.6 m (74.2 ft) below surface. The recovered Holocene alluvium measured 19.1 m (62.7 ft) thick. A core spanning the entire Holocene alluvium section was successfully obtained in borehole BH-7C (see above).

A total of 23 sub-samples from BH-7B represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the recovered Holocene alluvium. Rooted mud extends from S-6 at 4.3 m (14.2 ft) to S-8 at 6.6 m (21.5 ft) below surface. A thin non-rooted sand (fL) interval occurs from S-9 at 7.3 m (23.9 ft) to S-11 at 9.5 m (31.3 ft) below surface. This sand layer may stratigraphically correlate to a similar sand interval in BH-7C, BH-7, and TB-7. Rooted mud is found again from S-12 at 10.3 m (33.7 ft) to S-20 at 15.6 m (51.3 ft) below surface. Non-rooted mud extends from S-21 at 16.2 m (53.3 ft) to S-27 at 21.1 m (69.1 ft) below surface, overlying a second interval of sand.

Analysis of the sub-samples reveals that the upper portion of the Holocene alluvium, 4.3–15.6 m (14.2–51.3 ft) below surface, is dominated by vegetated wetland sediments with two intervals of floodplain channel deposits at 7.3–9.5 m (23.8–31.3 ft) and 21.7–22.6 m (71.2–74.2 ft) below surface (Figure 4-7). The lower portion of the alluvium is not well represented due to the lack of deeper core recovery (the deeper alluvium is better recorded in BH-7C).

Two tephra layers were encountered in BH-7B, one in sample S-13 and the other from S-24 to S-26 (Table 4-11). The S-13 tephra was at almost the same elevation as the S-14 tephra in nearby BH-7C that is tentatively correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP. However, in contrast to the radiocarbon sample from S-14 in BH-7C that produced older date ranges (4,830–4,880 and 4,940–4,950 cal BP), a radiocarbon sample from S-13 in BH-7B yielded younger age ranges of 1,620–1,670 cal BP and 1,680–1,830 cal BP. The S-24 to S-26 tephra is correlated, based on elevation and thickness, to the Mount Mazama eruption at approximately 7,700 BP.

Table 4-11. Tephra Correlations and Radiocarbon Date from BH-7B.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-13	Tephra	11.0 m (36.1 ft)	–4.8 m (–15.7 ft)	MSH Set-Y (3,300–3,900 BP)[a]	
S-24 to S-26	Tephra	18.7 to 20.3 m (61.3 to 66.5 ft)	–12.5 to –14.1 m (–40.9 to –46.1 ft)	Mazama (~7,700 BP)[b]	
S-13	C^{14}	11.0 m (36.1 ft)	–4.8 m (–15.7 ft)		1,680–1,830 cal BP 1,620–1,670 cal BP

[a] Clynne et al. (2008: 594)
[b] Zdanowicz et al. (1999)

TB-5

TB-5 was located south of TB-7 on the west side of I-5, adjacent to the east shore of the Vanport Wetlands (UTM 5049440N, 524549E). The surface elevation at the time of drilling was 8.1 m (26.5 ft) (NAVD88). Artificial fill comprised the upper 5.0 m (16.3 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 37.8 m (124.1 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 32.9 m (108.1 ft) thick.

A total of 39 sub-samples from TB-5 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. At the top of the alluvium, a thin interval of rooted mud extends from S-8 at 5.7 m (18.8 ft) to S-10 at 7.3 m (24.0 ft) below surface. Non-rooted mud and non-rooted sand (fU) alternate from S-11 at 9.6 m (31.5 ft) to S-48 at 37.8 m (124.1 ft) below surface.

The upper portion of the Holocene alluvium, 5.7–24.1 m (18.8–79.1 ft) below surface, is dominated by undifferentiated floodplain deposits with vegetated wetland sediments at 5.7–7.3 m (18.7–24.0 ft) and floodplain channel deposits at 16.5–18.0 m (54.0–59.0 ft) below surface. The lower portion of the alluvium, 25.0–37.8 m (81.8–124.1 ft) below surface, predominantly consists of floodplain channel deposits (Figure 4-7). The lack of roots and rhizomes throughout most of the Holocene alluvium in TB-5 suggests sub-tidal environments of deposition, such as lakes or channels in the floodplain setting. The sand sequence at the bottom of the Holocene alluvium likely correlates to similar basal sand sequences in BH-5, BH-8, and BH-8D.

Two tephra layers were observed in TB-5, one in sample S-17 and the other from S-26 to S-28 (Table 4-12). The S-17 tephra is tentatively correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP. The S-26 to S-28 tephra layer is much thicker and correlates to the Mount Mazama eruption at approximately 7,700 BP. The Mazama ash buried small bivalve shells recovered from S-28 at 22.6 m (74.0 ft) below surface. The presence of the shells is further evidence of a sub-tidal depositional environment for the undifferentiated floodplain sediments extending below the tephra to S-30 at 24.1 m (79.1 ft) below surface.

Table 4-12. Tephra Correlations from TB-5.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation
S-17	Tephra	14.0 m (46.0 ft)	–6.8 m (–22.3 ft)	MSH Set-Y (3,300–3,900 BP)[a]
S-26 to S-28	Tephra	21.0 to 22.6 m (69.0 to 74.0 ft)	–13.8 to –15.3 m (–45.3 to –50.3 ft)	Mazama (~7,700 BP)[b]

[a] Clynne et al. (2008: 594)
[b] Zdanowicz et al. (1999)

BH-5

BH-5 was located in a triangular area just north of Victory Blvd. between north- and southbound lanes of I-5 (UTM 5049221N, 524573E). The surface elevation at the time of drilling was 9.6 m (31.4 ft) (NAVD88). Artificial fill comprised the upper 5.8 m (19.0 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 46.1 m (151.3 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 40.3 m (132.3 ft) thick.

A total of 47 sub-samples from BH-5 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Depositional sequences in the Holocene alluvium vary widely down-core. Rooted mud occurs from S-6 at 6.6 m (21.5 ft) to S-10 at 9.6 m (31.5 ft) below surface. A thin interval of sand (fU) extends between S-11 at 10.3 m (33.9 ft) and S-14 at 12.6 m (41.4 ft) below surface. Rooted mud occurs again from S-16 at 14.1 m (46.3 ft) to S-32 at 26.4 m (86.5 ft) below surface. A very thick sand (fU) sequence extends from S-34 at 27.9 m (91.5 ft) to S-53 at 45.4 m (148.9 ft) below surface.

The upper portion of the Holocene alluvium, 6.6–26.4 m (21.5–86.5 ft) below surface, consists predominantly of vegetated wetland sediments with an interval of floodplain channel deposits at 10.3–12.6 m (33.9–41.4 ft) below surface. The lower portion of the alluvium, 27.9–45.4 m (91.5–148.9 ft) below surface, features floodplain channel deposits (Figure 4-7). It is not known whether the sand interval from 10.3 to 12.6 m (33.9 to 41.4 ft) below surface is continuous with sand intervals at similar depths in BH-7, BH-7B, BH-7C, and TB-7 to the north, and

BH-8 to the east. The sand interval could correlate with a more active period of floodplain channel migration, as suggested by abandoned channel meanders observed in historic photos of the Victory Blvd. area in the Delta Park floodplain (Peterson 2007). The thick sand sequence from 27.9 to 45.4 m (91.5 to 148.9 ft) below surface does not represent a main channel of the Columbia River, but rather a long-lived floodplain channel that occupied the central Delta Park floodplain during the early Holocene period. This basal sand sequence is also found in nearby boreholes TB-5, BH-8D, and BH-8.

Two tephra layers were observed in BH-5, one in sample S-17 and the other from S-26 to S-27 (Table 4-13). The two tephra layers in BH-5 occur in generally the same thickness and at the same elevations as the two tephra layers in nearby BH-8D and almost certainly relate to the same eruptive events. These two tephra layers are tentatively correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP and the Mount Mazama eruption at approximately 7,700 BP, respectively.

Table 4-13. Tephra Correlations from BH-5.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation
S-17	Tephra	14.9 m (48.9 ft)	–5.3 m (–17.5 ft)	MSH Set-Y (3,300–3,900 BP)[a]
S-26 to S-27	Tephra	21.8 to 22.6 m (71.5 to 74.0 ft)	–12.2 to –13.0 m (–40.1 to –42.6 ft)	Mazama (~7,700 BP)[b]

[a] Clynne et al. 2008: 594

[b] Zdanowicz et al. 1999

BH-8D

BH-8D was located just north of Victory Blvd. on the east side of the northbound on-ramp onto I-5 (UTM 5049221N, 524686E). The surface elevation at the time of drilling was 5.0 m (16.3 ft) (NAVD88). Artificial fill comprised the upper 3.0 m (10.0 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 34.6 m (113.5 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 31.5 m (103.5 ft) thick.

A total of 40 sub-samples from BH-8D represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Rooted mud extends from S-3 at 3.5 m (11.5 ft) to S-27 at 21.8 m (71.5 ft) below surface, with one interval of non-rooted mud from S-9 at 8.0 m (26.2 ft) to S-15 12.5 m (41.1 ft) below surface. An interval of sandy mud, from S-34 at 27.0 m (88.7 ft) to S-37 at 29.4 m (96.4 ft) below surface, separates deposits of sand (fU) extending to the base of the Holocene alluvium in S-43 at 34.0 m (111.4 ft) below surface.

The upper portion of the Holocene alluvium, 3.5–21.8 m (11.5–71.5 ft) below surface, consists predominantly of vegetated wetland sediments with an interval of undifferentiated floodplain deposits at 8.0–12.5 m (26.2–41.1 ft) below surface. The lower portion of the alluvium, 22.6–34.0 m (74.1–111.4 ft) below surface, is characterized by alternating floodplain channel and undifferentiated floodplain deposits (Figure 4-7).

Two tephra layers were observed in BH-8D, one in sample S-12 and the other from S-21 to S-22 (Table 4-14). These two tephra layers are tentatively correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP, and the Mount Mazama eruption at approximately 7,700 BP, respectively. Radiocarbon dates collected below each tephra layer antedate these eruptions, lending support to these tentative correlations. A radiocarbon sample from S-14 at 11.8 m (38.8 ft) below surface yielded a date of 5,930–6,200 cal BP. A radiocarbon sample from S-29 at 23.3 m (76.5 ft) below surface dated to 7,710–7,930 cal BP. A radiocarbon sample from S-35 at 27.0 m (91.6 ft) below surface dated to 8,600–8,990 cal BP, which is highly consistent with dates of similar age from undifferentiated floodplain deposits in BH-7C (8,730–9,020 cal BP) and BH-3 (8,590–8,980 cal BP).

Table 4-14. Tephra Correlations and Radiocarbon Dates from BH-8D.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation	2 Sigma Calibrated Results
S-12	Tephra	10.4 m (34.0 ft)	–5.4 m (–17.7 ft)	MSH Set-Y (3,300–3,900 BP)[a]	
S-21 to S-22	Tephra	17.3 to 17.9 m (56.7 to 58.8 ft)	–12.3 to –12.9 m (–40.3 to –42.4 ft)	Mazama (~7,700 BP)[b]	
S-14	C^{14}	11.8 m (38.8 ft)	–6.8 m (–22.4 ft)		5,930–6,200 cal BP
S-29	C^{14}	23.3 m (76.5 ft)	–18.4 m (–60.2 ft)		7,710–7,930 cal BP
S-35	C^{14}	27.9 m (91.6 ft)	–22.9 m (–75.3 ft)		8,600–8,990 cal BP

[a] Clynne et al. 2008: 594

[b] Zdanowicz et al. 1999

BH-8

BH-8 was located a short distance south of BH-8B, on the east side of the northbound on-ramp onto I-5, just north of Victory Blvd. (UTM5049107N, 524729E). The surface elevation at the time of drilling was 6.6 m (21.5 ft) (NAVD88). Artificial fill comprised the upper 3.5 m (11.5 ft) of the core. Below the fill, Holocene alluvium extended to the top of Pleistocene gravels at 40.0 m (132.6 ft) below surface. Bracketed by the artificial fill and Pleistocene gravels, the Holocene alluvium measured 36.9 m (121.1 ft) thick. Drilling operations failed to recover intact core sections between 16.8 and 21.6 m (55.0 and 71.0 ft) below surface, creating a significant data gap in that interval. Additional boreholes (BH-8B, BH-8C, and BH-8D) were drilled to recover the missing sections. Borehole BH-8D was successful in that regard.

A total of 43 sub-samples from BH-8 represent the lithology, sand size, moist color, and macrofossil (roots and rhizome) abundance and distribution in the Holocene alluvium. Rooted mud extends from S-4 at 4.3 m (14.1 ft) to S-28 at 28.0 m (92.0 ft) below surface with deposits of muddy sand (fL-mL) from S-6 at 5.9 m (19.2 ft) to S-10 at 8.9 m (29.1 ft) below surface. Sand extends from S-29 at 28.5 m (93.5 ft) to S-43 at 39.4 m (129.2 ft) below surface. This basal layer of sand varies in mean grain size from vfU to mL.

Analysis of the sub-samples indicates that the upper portion of the Holocene alluvium, 4.3–28.0 m (14.1–92.0 ft) below surface, is dominated by vegetated wetland sediments. The lower portion of the alluvium, 28.5–39.3 m (93.5–129.1 ft) below surface, consists of floodplain channel deposits (Figure 4-7).

One prominent tephra layer occurs in sample S-14 (Table 4-15). This tephra layer is tentatively correlated to the Mount St. Helens Set-Y eruption between 3,300 and 3,900 BP. As previously noted, drilling in BH-8 failed to recover the depth interval from 16.8 to 21.6 m (55.0 to 71.0 ft) below surface that was expected to host the Mazama ash (based on the depth of the ash in nearby BH-8D, BH-5 and TB-5).

Table 4-15. Tephra Correlation from BH-8.

Sample No.	Sample Type	Depth (Below Surface)	Elevation (NAVD88)	Tentative Correlation
S-14	Tephra	11.9 m (39.1 ft)	–5.3 m (–17.5 ft)	MSH Set-Y (3,300–3,900 BP)[a]

[a] Clynne et al. 2008: 594

SUMMARY

The basic data obtained from the geoarchaeological boreholes on thickness of fill, thickness of alluvium, and depth below surface to the top of the Pleistocene gravels is presented in Table 4-16. The target Pleistocene gravels were reached in 13 of the 14 boreholes. Depth to the gravels was greatest at 60.6 m (198.8 ft) in BH-1 on Hayden Island. Depths to gravels on the shore south of the Oregon Slough ranged from 29.4 m (96.4 ft) in BH-6 to 46.1 m (151.3 ft) in BH-5.

Thickness of fill in the boreholes along the I-5 corridor ranged from 5.8 m (19.0 ft) in BH-1 on Hayden Island, to 5.1 m (16.7 ft) in BH-4 on the south shore of Oregon Slough, to 3.0 m (10.0 ft) in BH-8D just north of Victory Blvd. near the southern boundary of the CRC APE. Fill thickness was shallower to the east of I-5, recorded as 1.9 m (6.2 ft) in BH-6 and 2.7 m (8.9 ft) in BH-6B near Martin Luther King Jr. Blvd.

The Holocene alluvium—the deposit in which archaeological remains might be found—was thickest at 54.8 m (179.7 ft) in BH-1 on Hayden Island. The thickness of the alluvium on the shore south of the Oregon Slough ranged from 40.3 m (132.2 ft) in BH-5 to 25.5 m (83.6 ft) in BH-7. Analyses of materials recovered from the Holocene alluvium, and the implications of these analyses for archaeology, are considered further in the next section of this report.

Table 4-16. Summary of Data on Thickness of Fill and Holocene Alluvium on the Oregon Shore.

Borehole No.	Total Depth	Fill Thickness	Holocene Alluvium Thickness	Depth of Pleistocene Gravel Contact
BH-1	76.1 m (220.0 ft)	5.8 m (18.9 ft)	54.8 m (179.9 ft)	60.6 m (198.8 ft)
BH-2	77.7 m (255.0 ft)	5.0 m (16.3 ft)	31.3 m (102.5 ft)	36.2 m (118.8 ft)
BH-4	36.6 m (120.0 ft)	5.1 m (16.8 ft)	28.8 m (94.5 ft)	33.9 m (111.3 ft)
BH-3	76.2 m (250.0 ft)	4.3 m (14.2 ft)	30.4 m (99.7 ft)	34.7 m (113.9 ft)
BH-6B	30.5 m (100.0 ft)	2.7 m (9.0 ft)	27.5 m (90.1 ft)	30.2 m (99.1 ft)
BH-6	35.1 m (115.0 ft)	1.9 m (6.2 ft)	26.4 m (86.5 ft)	29.4 m (96.3 ft)
TB-7	67.1 m (220.0 ft)	4.2 m (13.9 ft)	27.8 m (91.1 ft)	32.0 m (105.0 ft)
BH-7	32.9 m (108.0 ft)	5.0 m (16.4 ft)	25.5 m (83.6 ft)	30.5 m (100.0 ft)
BH-7C	36.6 m (120.0 ft)	4.9 m (16.0 ft)	31.3 m (102.8 ft)	36.2 m (118.8 ft)
BH-7B	22.9 m (75.0 ft)	3.5 m (11.5 ft)	N/A	N/A
TB-5	68.6 m (225.0 ft)	5.0 m (16.3 ft)	32.9 m (108.1 ft)	37.8 m (124.1 ft)
BH-5	47.2 m (155.0 ft)	5.8 m (19.0 ft)	40.3 m (132.3 ft)	46.1 m (151.3 ft)
BH-8D	36.6 m (120.0 ft)	3.0 m (10.0 ft)	31.5 m (103.5 ft)	34.6 m (113.5 ft)
BH-8	41.1 m (135.0 ft)	3.5 m (11.5 ft)	36.9 m (121.1 ft)	40.0 m (132.6 ft)

5. ANALYSES AND RESULTS

Examination and sub-sampling of the borehole core splits for geoarchaeological and archaeological purposes has been completed and the results of radiocarbon analyses and tephra identification have been obtained. These data contribute new information about the CRC project area in terms of alluvial chronology, tephra deposits, and landscape reconstruction.

ALLUVIAL CHRONOLOGY

To establish the ages of the alluvial deposits in the CRC project area, samples of organic material recovered from the rotary-sonic boreholes were submitted to Beta Analytic, Inc, for radiocarbon dating. Priority for dating was placed on samples collected under controlled laboratory conditions from the sediment cores subjected to geoarchaeological analyses. Nineteen radiocarbon dates were obtained from eight geoarchaeological boreholes (Table 5-1). One additional sample of organic material collected by the geotechnical investigators from a geotechnical borehole also submitted for radiocarbon dating is noted in the discussion below.

Top of Gravels

The top of the gravels in the samples recovered from the geoarchaeological boreholes were carefully examined for the presence of organic material suitable for radiocarbon dating. Sample S-42, recovered from the gravels at the bottom of BH-3, was submitted in the hope that it might shed light on the age of the gravels. The date of 8,410–8,600 cal BP obtained from this sample is too young, as it overlaps with a date of 8,590–8,980 cal BP from S-37, recovered from near the base of the alluvium in the same borehole. The S-42 sample probably reflects material pushed down into the gravels from the Holocene alluvium above. Another attempt to date the gravels, by submitting a sample of wood from –141 ft in geotechnical borehole TB-2, produced a date of 6290–6180 cal BP/6140–6120 cal BP, which is also much too young. This wood sample was not recovered in situ from a split spoon sample; instead, it was collected by the geotechnical crew from the "mud screen."

Base of Holocene Alluvial Deposits

Samples of organic material recovered from alluvium near the bottom of the boreholes provide dates for the initial deposition of alluvial deposits on the Oregon shore. The oldest radiocarbon date obtained, of 10,740–11,190 cal BP, from near the base of the alluvium (S-67) in BH-1, indicates that the Holocene alluvial deposits underlying Hayden Island span at least the last 11,000 years. The age of the alluvial deposits farther south on the mainland is indicated by a date of 8,600–9,000 cal BP, from S-38 just above the gravels in TB-7. This approximate age of 9,000 years for the base of the alluvial deposits on the mainland is corroborated by dates of roughly similar age obtained from samples slightly higher in the alluvium in BH-3 (S-37), BH-6 (S-29), BH-7C (S-43), and BH-8D (S-35).

Table 5-1. Radiocarbon Dates from Boreholes in the CRC APE on the Oregon Shore (in order of depth below surface)

Borehole No.	Sample No.	Depth (Below Surface)	Elevation (NAVD88)	Beta Analytic Lab No.	Conventional C^{14} Age	2 Sigma Calibrated Age
BH-3	S-2*	5.0 m (16.5 ft)	2.4 m (8.0 ft)	276962	2,910 ± 40 BP	2,940–3,210 cal BP
BH-1	S-8**	8.7 m (28.6 ft)	2.2 m (7.3 ft)	276961	310 ± 40 BP	290–490 cal BP
BH-7C	S-8*	7.3 m (24.0 ft)	0.2 m (0.7 ft)	276965	2,120 ± 40 BP	2,260–2,300 cal BP 1,990–2,160 cal BP
BH-6	S-9**	8.0 m (26.4 ft)	–4.2 m (–13.7 ft)	276963	4,710 ± 40 BP	5,320–5,580 cal BP
BH-7C	S-14**	12.0 m (39.2 ft)	–4.4 m (–14.5 ft)	276966	4,290 ± 40 BP	4,940–4,950 cal BP 4,830–4,880 cal BP
BH-7B	S-13*	11.0 m (36.1 ft)	–4.8 m (–15.7 ft)	271649	1,810 ± 40 BP	1,620–1,670 cal BP 1,680–1,830 cal BP
BH-3	S-12*	12.6 m (41.3 ft)	–5.2 m (–16.9 ft)	271644	3,460 ± 40 BP	3,630–3,840 cal BP
BH-2	S-15*	15.6 m (51.7 ft)	–6.0 m (–19.7 ft)	271643	4,100 ± 40 BP	4,740–4,820 cal BP 4,510–4,730 cal BP 4,450–4,470 cal BP
BH-8D	S-14**	11.8 m (38.8 ft)	–6.8 m (–22.4 ft)	276968	5,290 ± 50 BP	5,930–6,200 cal BP
BH-3	S-20*	18.6 m (61.1 ft)	–11.2 m (–36.7 ft)	271645	6,150 ± 50 BP	6,900–7,170 cal BP
BH-3	S-26*	23.3 m (76.4 ft)	–15.8 m (–52.0 ft)	271646	7,000 ± 50 BP	7,700–7,940 cal BP
BH-8D	S-29*	23.3 m (76.5 ft)	–18.4 m (–60.2 ft)	276969	6,990 ± 40 BP	7,710–7,930 cal BP
BH-8D	S-35*	27.9 m (91.6 ft)	–22.9 m (–75.3 ft)	276970	7,930 ± 50 BP	8,600–8,990 cal BP
BH-6	S-29*	27.1 m (88.8 ft)	–23.2 m (–76.1 ft)	276964	7,960 ± 50 BP	8,620–9,000 cal BP
BH-7C	S-43*	31.7 m (104.0 ft)	–24.2 m (–79.3 ft)	276967	8,030 ± 50 BP	8,730–9,020 cal BP
BH-3	S-37*	32.4 m (106.3 ft)	–25.0 m (–81.9 ft)	271647	7,900 ± 50 BP	8,590–8,980 cal BP
TB-7	S-38*	31.7 m (104.0 ft)	–26.3 m (–86.3 ft)	271641	7,940 ± 50 BP	8,600–9,000 cal BP
BH-3	S-42*	37.9 m (124.2 ft)	–30.4 m (–99.7 ft)	271648	7,720 ± 50 BP	8,410–8,600 cal BP
BH-1	S-67*	55.6 m (182.5 ft)	–44.7 m (–146.6 ft)	271642	9,620 ± 60 BP	10,740–11,190 cal BP

* Standard AMS ** Standard Radiocarbon

Top of Holocene Alluvial Deposits

Samples of organic material submitted for radiocarbon dating from near the top of the sediment columns recovered from the boreholes provide upper limiting ages for the Holocene alluvium. The latest date of 290–490 cal BP was obtained from BH-1 (S-8). The wood fragments on which this date is based were recovered from a context suggesting that a relatively stable vegetated levee/dune ridge had formed on Hayden Island by approximately 500 years ago.

However, similar late ages were not obtained from the top of the alluvium in boreholes on the mainland south of Oregon Slough. A sample at the artificial fill/alluvium contact in S-2 from BH-3 produced a much older date of 2,940–3,210 cal BP, and a similar (but slightly younger) date of 2,260–2,300 cal BP/1,990–2,160 cal BP was obtained from S-8 in BH-7C. Dates of this magnitude obtained from contexts so close to the contact with the artificial fill suggests that the youngest prehistoric soils at these locations are disturbed, and possibly missing altogether, as a result of past construction activity.

TEPHRA DEPOSITS

Within the alluvial deposits, tephras from at least two, and possibly three, volcanic eruptions are preserved (Table 5-2). Sediment samples from the boreholes were distinguished as tephra layers when they met one or more of the following criteria: (1) geochemical analysis of a sample identified an eruptive source, (2) the sample produced or was correlative with appropriate radiocarbon dates from a known eruptive event, (3) the sample occurred in a stratigraphic layer that exhibited continuity between boreholes, and (4) microscopic examination indicated isotropic ash and/or lapilli with vesicles.

Seven tephra samples recovered from boreholes were submitted for analysis to Franklin Foit, Jr., Director of the Microbeam Lab at the School of Earth and Environmental Sciences at Washington State University. Unfortunately, only one sample could be analyzed, as most of the samples contained glass particles that were either too sparse or too small to probe (Foit 2010).

The one sample successfully analyzed at the Microbeam Lab, from BH3 (S-20), matched Mazama O (similarity coefficient = 0.99). This is the first confirmed identification in the Lower Columbia Valley of tephra from the climactic eruption of Mount Mazama (at the present site of Crater Lake in the southern Oregon Cascade Range), which occurred at 7,700 cal BP (Zdanowicz et al. 1999; Bacon and Lanphere 2006).

This identification is supported by radiocarbon dates of 6,900–7,170 cal BP (S-20) and 7,700–7,940 cal BP (S-26) from BH-3. Tephra layers correlative with the Mazama tephra in BH-3 are present in most of the geoarchaeological boreholes, reflecting the widespread distribution of volcanic ash from the Mount Mazama eruption across the Oregon shore floodplain. It is noteworthy, however, that the Mazama tephra layer was not present in BH-1 on Hayden Island or in BH-2 on the south shore of Oregon Slough, apparently because these areas were within the active channel(s) at the time of the Mazama eruption.

A second, later, tephra layer encountered in the geoarchaeological boreholes is tentatively correlated with the Mount St. Helens (MSH) Set-Y eruption that is radiocarbon dated to 3,900–3,300 cal BP (Clynne et al. 2008:594; cf. Mullineaux 1996:45–46). In an effort to identify the eruptive event with which this tephra layer is associated, samples from two boreholes were submitted for microbeam analysis, but the glass shards in both samples were too sparse or too

Table 5-2. Tentative Correlation of Tephra Samples and Eruptive Events on the Oregon Shore Floodplain.

Borehole No.	Mount Mazama ~7,700 BP	Mount St Helens Set-Y 3,300–3,900 BP	Unidentified[a]
BH-1			
BH-2		S-16	
BH-4	S-28 to S-35		S-9
BH-3	S-20 to S-26[b]	S-12[c]	S-2
BH-6B	S-20 to S-21		
BH-6	S-16 to S-20	S-9 to S-10	S-1
TB-7	S-20 to S-22		
BH-7	S-34 to S-35		
BH-7C	S-29 to S-31	S-14	
BH-7B	S-24 to S-26	S-13	
TB-5	S-26 to S-28	S-17	
BH-5	S-26 to S-27	S-17	
BH-8D	S-21 to S-22	S-12	
BH-8		S-14	

[a] possibly Mount St Helens Set-W
[b] confirmed as Mazama O by Washington State University Microbeam Laboratory (Foit 2010)
[c] radiocarbon date falls within known time range for Mount St Helens Set-Y

small to probe. The BH-7B (S-13) sample was characterized as "mostly carbonate with 5–10% glass" (Foit 2010). The BH-2 (S-15) sample was characterized as "~5% glass mixed with carbonate and mineral detritus, the 6 shards analyzed were of extremely variable composition" (Foit 2010).

The tephra layer tentatively correlated with MSH Set-Y is represented at similar elevations in nine different geoarchaeological boreholes. A radiocarbon date of 3,630–3,840 cal BP from BH-3 (S-12) falls nicely within the known time range of 3,900–3,300 cal BP for the MSH Set-Y eruption. However, samples containing this tephra produced radiocarbon dates that were significantly older in three boreholes, BH-2 (S-15), BH-7C (S-14), and BH-6 (S-9), and significantly younger in one borehole BH-7B (S-13), than the known time range for the MSH Set-Y eruption.

Lastly, weakly developed tephra layers were observed near the tops of three geoarchaeological boreholes: BH-4 (S-9), BH-3 (S-2), and BH-6 (S-1). Samples of these tephra layers with sufficiently dense glass shards for microbeam analysis have not been recovered. A radiocarbon date of 2,940–3,210 cal BP was obtained from the BH-3 sample (S-2). At the present time, these highest tephra layers remain unidentified. In view of their proveniences near the tops of the boreholes, in proximity to the native surface/fill contact, these tephra layers may be related to the MSH Set-W eruption that occurred around 500 BP (Mullineaux 1996:69; Clynne et al. 2008:594). MSH Set-W tephra has been previously identified at site 35MU117 on Columbia Slough northwest of Bybee Lake (Ellis 2000:22; Hodges 2000:np).

The confirmed identification of Mazama O tephra, and the tentative identification of MSH Set-Y tephra, in the CRC project area are the first time these tephras have been documented in the

Lower Columbia River Valley. Tephra layers from these volcanic eruptions are important as time markers in the alluvium. It should be noted, however, that these particular tephra layers are difficult to see in the field and are most easily recognizable in a controlled laboratory setting. The presence of these tephra layers is also important as representing evidence of continuity in the distribution of sediment layers across the floodplain indicating that, to a considerable extent, the alluvial deposits on the Oregon shore accumulated over time without major interruptions by erosive events.

LANDSCAPE RECONSTRUCTION

Analysis of the sediment samples recovered from the geoarchaeological rotary-sonic boreholes indicates that the deep alluvium within the CRC project area on the Oregon shore contains evidence of four main landscape features characteristic of floodplain environments: (1) floodplain channels, (2) undifferentiated floodplains, (3) vegetated wetlands, and (4) vegetated levees/dune ridges (see Figure 4-7). The distribution and relative ranking of occurrence of these landscape features in each borehole is summarized in Table 5-3. These landscape features vary in their potential for containing evidence of prehistoric occupation or activity.

Floodplain channel features, not surprisingly, are prominently represented near the present channel of the Columbia River, particularly in the boreholes on Hayden Island and immediately south of Oregon Slough (BH-1, BH-2). Two other groupings of floodplain channel deposits are

Table 5-3. Distribution and Ranking of Landscape Features in Geoarchaeological Boreholes.

Borehole No.	Landscape Feature			
	Floodplain Channel	Undifferentiated Floodplain	Vegetated Wetland	Channel Levee or Dune Ridge
BH-1	1	2	4	3
BH-2	2	1	3	4
BH-4	3	2	1	N/A
BH-3	3	1	2	N/A
BH-6B	N/A	2	1	N/A
BH-6	N/A	1	2	3
TB-7	3	1	2	N/A
BH-7	3	2	1	N/A
BH-7C	2	3	1	N/A
BH-7B	2	3	1	N/A
TB-5	2	1	3	N/A
BH-5	1	3	2	N/A
BH-8D	3	2	1	N/A
BH-8	2	3	1	N/A

Landforms are ranked within each borehole according to total thickness of the corresponding facies (sedimentary deposits) as follows:
1 = primary landform (thickest combined facies)
2 = secondary landform
3 = tertiary landform
4 = minor landform (thinnest combined facies)

noteworthy. In pre-Mazama times (i.e., before 7,700 cal BP), a separate channel extended across the back edge of the floodplain in the southern portion of the CRC project area. This channel was much broader than Columbia Slough, which extends across the south edge of the floodplain today. A second grouping of shallow channel deposits is represented across much of the floodplain above the tephra layers tentatively identified as MSH Set-Y tephra (i.e., after 3,300 cal BP). These deposits are suspected to be remnants of abandoned channels, as they are in the vicinity of where abandoned channels are still in evidence on the floodplain today. Consisting of material reworked by the Columbia River, the floodplain channel features reflect intervals of channel migration and activity and, therefore, have a low potential for containing archaeological remains.

Undifferentiated floodplain features are characterized by mud or sandy mud that was probably seasonally submerged in some areas and covered by standing water in others. In some places, the undifferentiated floodplain was an intertidal habitat, as indicated by the recovery of bivalve fragments from sediments in three boreholes: BH-7 (S-48, S-49), TB-7 (S-15), and TB-5 (S-28). The sediments indicative of this landscape feature were non-rooted (lacking in peat rhizomes or macrofossils), meaning it was apparently not dry enough for the growth of vegetation. Undifferentiated floodplain features are strongly represented in the lower (older) portions of most boreholes, especially in those closest to the present channel of the Columbia River. Somewhat surprisingly, these landscape features continued to occur widely across the floodplain in post-Mazama times (i.e., after 7,700 cal BP), and persisted in the southern portion of the CRC project area (in TB-5, BH-5, BH-8B, BH-8) well after the time of the deposition of the tephra layers tentatively identified as MSH Set-Y tephra (i.e., after 3,300 cal BP). In view of their susceptibility to submergence, undifferentiated floodplain features have a low potential for containing archaeological remains.

Vegetated wetland landscape features are reflected by the presence in the sediment samples of plant macrofossils, which were identified as belonging to one of three types: (1) vertically descending rootlets (typically in the mm size range in thickness) and roots (1 cm to several cm in thickness) typical of annuals, shrubs, and trees; (2) rhizomes (similar to roots but different shapes, including tubular and cone-like) typically from rushes and sedges; and (3) peat, composed of roots, plant stems, rhizomes, and decayed leaves matted together. Vegetated wetland landscape features are most strongly represented in the boreholes to the south, away from the river, where they emerge before the Mazama ash fall (i.e., before 7,700 cal BP). In post-Mazama times, vegetated wetlands were the most widespread landscape features across the Oregon shore floodplain. Along with the margins of the floodplain channels, vegetated wetlands contained plant foods such as wapato and camas that were staple foods of native peoples in the Lower Columbia Valley (Boyd and Hajda 1987:315).

Vegetated levee/dune ridge landscape features are characterized by oxidized, presumably wind-blown, sand deposits and are high enough in elevation to support vegetation such as shrubs and trees characteristically found in upland floodplain environments. Of the four landscape features identified, vegetated levees/dune ridges have the most restricted distribution, mainly occurring on Hayden Island (BH-1) and the south bank of Oregon Slough (BH-2). This landscape feature was also in evidence in a separate area on the floodplain to the southeast of Oregon Slough (BH-6). These occurrences are all above the elevations of the tephra layers tentatively identified as MSH Set-Y tephra, indicating that vegetated levees/dune ridges emerged in the CRC project area relatively late in time, probably after 3,000 cal BP. In providing a setting high enough to be dry but with ready access to the river, vegetated levees/dune ridges have a high potential for containing evidence of occupation or activity in the prehistoric past.

6. SUMMARY AND CONCLUSIONS

On the Oregon shore, construction for the CRC project will take place on the floodplain of the Columbia River, where alluvial sediments have been deposited to considerable depths since the last of the Missoula Floods around 12,000 years ago. Archaeological evidence of human occupation on the Oregon shore floodplain may potentially be found at any depth within these thick alluvial deposits. Alluvial landforms active during the late Pleistocene and Holocene, like those on the Oregon shore floodplain, require that deep testing measures be undertaken to determine if buried archaeological resources are present (Monaghan et al. 2006:1–3).

Implementing a geoarchaeological approach, deep testing for archaeological remains on the Oregon shore involved a multi-stage effort. This process ranged from a review of historical documents to establish the nature of the floodplain environment in the early historic period, to GPR surveys to document the depth of artificial fill, to rotary-sonic drilling to sample the total thickness of the deep Holocene alluvial deposits down to the top of the underlying Pleistocene gravels. The measures taken during the geoarchaeological investigations for the CRC project represent an unprecedented effort to find archaeological resources deeply buried in the alluvial deposits on the Columbia River floodplain.

THE HISTORIC FLOODPLAIN SETTING

The earliest descriptions of the Oregon shore in the CRC project vicinity, dating from the mid- to late 1800s, show an expansive floodplain covered by wet prairie interrupted by numerous lakes and waterways. Maps dating to this period show as many as four lakes, one on Hayden Island and three on the mainland, partially overlapping the CRC project area. Vegetation noted by early surveyors on Hayden Island and along the south shore of the river included balm, ash, willow, and oak trees.

The landscape on the Oregon shore remained relatively unchanged into the 1910s, when substantial flood control efforts began. The excavation of drainage canals and construction of levees over the following decades drastically changed the topography of the floodplain, so much so that a 1940 map shows no lakes and greatly diminished waterways in the present project area. Even with the dike and levee construction, Hayden Island and the lowlands on the adjacent mainland were subject to inundation during high river stages. In 1948, the second highest flood in recorded Columbia River history broke through a railroad dike and destroyed the community of Vanport situated on the Oregon shore immediately west of present-day I-5.

GPR SURVEYS

Construction of I-5 across the Oregon shore floodplain and Hayden Island involved the introduction of substantial fill material along the interstate corridor to raise the roadway above the adjacent low ground surface. The fill deposited during earlier highway construction has made the original ground surface inaccessible for direct examination. As a means of assessing which deep archaeological testing methods might be most appropriate, GPR surveys were undertaken to establish the depth below the present-day ground surface of the contact between artificial fill and native soils at various locations within the CRC project area. The uppermost floodplain soils consisted of mud or muddy sand clearly identifiable as basal conductive layers below the resistive artificial fill.

Ground-truthing of the GPR profiles with data from nearby rotary-sonic boreholes established that the thickness of the fill in the I-5 corridor ranges from 5.8 m on Hayden Island to 3.0 m just north of Victory Blvd. near the south end of the CRC project area. In view of the substantial depth of the artificial fill, even very deep backhoe trenches might only expose the uppermost portions of the alluvial deposits. Mechanical augering/coring would be necessary to ensure that the full extent of the alluvial deposits, from the former ground surface down to the underlying Pleistocene gravels, was tested for the presence of archaeological remains.

BOREHOLE INVESTIGATIONS

Deep testing for buried archaeological remains in the CRC project area on the Oregon Shore was conducted by means of rotary-sonic drilling. In addition to the 12 boreholes drilled for geoarchaeological purposes, samples from two boreholes drilled as part of geotechnical investigations were recovered and analyzed in the same manner to expand the geographic area sampled. No evidence of prehistoric or historic occupation or activity was encountered in the sediment cores recovered from these 14 boreholes.

The target Pleistocene gravels were reached in 13 of the 14 boreholes. In most cases, the gravels reached corresponded to relatively unweathered Missoula Flood gravels. In BH-3, the rotary-sonic core extended deeper through these gravels into older, weathered, weakly cemented gravels. Referred to as the "Pleistocene Alluvium Gravel" (PAG) in this report, these older gravels are thought to correlate to the weathered gravels that underlie Missoula flood gravels in the river terraces in Vancouver and northeast Portland.

The sediment cores recovered from the 14 boreholes document the nature and thickness of the alluvium overlying the Pleistocene gravels on the Oregon Shore. The thicknesses of the alluvium ranges range from 54.8 m (179. ft) on Hayden Island (BH-1), to 31.5 m (103.5 ft) just north of Victory Blvd. (BH-8D), to 26.4 m (86.5 ft) to the east of I-5 near Martin Luther King Jr. Blvd. (BH-6). Within the deep alluvium, four main landscape features characteristic of floodplain environments are represented: (1) floodplain channels, (2) undifferentiated floodplains, (3) vegetated wetlands, and (4) vegetated levees/dune ridges.

Efforts to determine the age of the underlying Missoula Flood gravels were unsuccessful (two samples of organic material recovered from the gravels produced ages that are much too young). The time range of the Holocene alluvial deposits was established by means of 19 radiocarbon dates obtained from various depths. The earliest of these, from near the bottom of BH-1 on Hayden Island, dates to around 11,000 cal BP. The earliest dates from the Holocene alluvial deposits on the floodplain south of Oregon Slough are about 9,000 cal BP.

On the opposite end of the time scale, it is noteworthy that, with the exception of one late date from Hayden Island (290–490 cal BP), the latest dates from the floodplain south of Oregon Slough antedate 2,000 cal BP. This situation suggests that the uppermost and youngest alluvial deposits in this area are missing, likely removed during construction in the I-5 corridor.

Tephras from two major volcanic eruptions are preserved within the alluvium on the Oregon shore. The presence of Mazama O tephra from the climactic eruption of Mount Mazama at 7,700 cal BP was confirmed by microprobe analysis and supported by associated radiocarbon dates. The tentative identification of MSH Set-Y tephra from the eruption of Mount St. Helens between 3,300 and 3,900 cal BP is based on its elevation within the alluvium and associated radiocarbon dates. These are the first documented occurrences of these two tephras in the Lower Columbia River Valley.

IMPLICATIONS FOR ARCHAEOLOGY

The geoarchaeological investigations undertaken for the CRC project stand out as the first attempt to extend deep testing for buried archaeological remains through the entire thickness of the Holocene alluvium on the Oregon shore. Thirteen of the 14 boreholes reached the Pleistocene gravels that underlie the alluvium, sampling deep sands and silts deposited along the Oregon shore since the last of the Missoula Floods around 12,000 years ago. Previous archaeological investigations on the Oregon shore floodplain, even those that might qualify as "deep testing" under the Mn/DOT Deep Test Protocol (Monaghan et al. 2006), were limited to the uppermost two to three meters of the native soils, and were able to sample deposits spanning only the last 3,000 years.

No direct evidence of prehistoric occupation or activity was observed or recovered in any of the borehole core splits. This result is not surprising, however, as due to the small diameter of the cores (10 cm) and the low number of boreholes drilled (14), only a tiny fraction of the massive volume of sands and silts deposited over the last 12,000 years was actually sampled. One of the limitations inherent in deep excavations is that the sizes of samples generally decrease with increasing depth below surface (Brown 1975). Any deep testing to depths of 30 m (100 ft) or more, as was conducted for the CRC project, will necessarily involve sampling on a relatively small scale.

Although some variation is observed between boreholes, broad patterns are evident in the distribution of landscape features in the Holocene alluvium on the Oregon shore (see Figure 4-7). Much of the alluvium is occupied by landscape features, specifically floodplain channels and undifferentiated floodplain, characterized by sediments that are unlikely to have preserved archaeological remains. The other two landscape features represented in the alluvium, vegetated wetlands and vegetated levees/dune ridges, supported plant species or provided habitat for animals that were likely to have been exploited by native peoples.

To some extent, all of these land-use zones were probably present in the CRC project area at one time or other over the last 12,000 years. It is almost certain that sometime during this extremely lengthy period, native peoples exploited natural resources in the lakes, sloughs, and wetlands on the floodplain or in the adjacent Columbia River in the CRC project area. Some of this exploitation of resources presumably was undertaken from settlements of some kind, which may have ranged in terms of density of occupation from short-term campsites to long-term, village-level settlements. If one single landscape feature can be identified as the most likely to have been occupied, it would be the vegetated levees/dune ridges like those that lined the banks of Oregon Slough at the beginning of the historic era.

The deep alluvium that has accumulated on the Oregon shore has been shown to contain a detailed record of sediment regimes, landscape features, and volcanic eruptive events over roughly the last 11,000 years. It would not be surprising if evidence of prehistoric human occupation or activity has been preserved within these deep alluvial sediments as well. Although no archaeological resources have been identified to date, the potential obviously exists that archaeological remains buried in the deep alluvium may be encountered during construction associated with the CRC project. In view of the dearth of evidence for human occupation on the floodplain before 3,000 BP, any archaeological evidence found is likely to be significant, in that it will contribute new information about prehistoric lifeways during earlier periods in Lower Columbia Valley prehistory about which very little is currently known.

REFERENCES CITED

Anonymous
1979 Jantzen Beach–Delta Park Interchange: Cultural Resources. On file at the Oregon State Historic Preservation Office, Salem (SHPO Report No. 627).

Bacon, C. R., and M. A. Lanphere
2006 Eruptive History and Geochronology of Mount Mazama and the Crater Lake Region, Oregon. *Geological Society of America Bulletin* 118:1331–1359.

Baker, V. R., and R. C. Bunker
1985 Cataclysmic Late Pleistocene Flooding from Glacial Lake Missoula: A Review. *Quaternary Science Reviews* 4:1–41.

Benito, Gerardo, and Jim E. O'Connor
2003 Number and Size of Last-Glacial Missoula Floods in the Columbia River Valley Between the Pasco Basin, Washington, and Portland, Oregon. *Geological Society of America Bulletin* 115(5):624–638.

Bland, Richard L. and Thomas J. Connolly
2006 *Report of Exploratory Archaeological Survey at the Victory Boulevard–Lombard (Delta Park) Project, Multnomah County*. Museum of Natural & Cultural History Report No. 2006-50. Eugene.

Boyd, Robert
1999 *The Coming of the Spirit of Pestilence: Introduced Infectious Diseases and Population Decline Among Northwest Coast Indians, 1774–1874*. University of Washington Press, Seattle.

Boyd, Robert T., and Yvonne P. Hajda
1987 Seasonal Population Movement along the Lower Columbia River: The Social and Ecological Context. *American Ethnologist* 14(2):309–326.

Bristow, C. W., and H. M. Jol
2003 *Ground Penetrating Radar in Sediments*. Geologic Society Special Publication No. 211. London.

Brown, James A.
1975 Deep-Site Excavation Strategy as a Sampling Problem. In *Sampling in Archaeology*, edited by James W. Mueller, pp.155–169. The University of Arizona Press, Tucson.

Carey, Charles H.
1971 *General History of Oregon Through Early Statehood,* Vol. 1. Binfords and Mort, Portland.

Chapman, Judith S., D. V. Ellis, G. Evans-Hatch

1998 *Cultural Resource Investigations for a Proposed New Multnomah County Correctional Facility, Portland, Oregon.* AINW Report No. 155. Archaeological Investigations Northwest, Inc., Portland, Oregon

Connolly, Thomas J.

1987 Archaeological Survey of North Marine Drive, I-5 to Rivergate Industrial District, Multnomah County. Letter of June 16 to Pieter Dykman, Environmental Section, ODOT. Eugene.

City of Portland

1919 Map showing peninsula drainage districts and local features. Department of Public Works, Office of the City Engineer, Portland, Oregon.

Clynne, M. A., A. T. Calvert, E. W. Wolfe, R. C. Evarts, R. J. Fleck, and M. A. Lanphere

2008 The Pleistocene Eruptive History of Mount St. Helens, Washington, from 300,000 to 12,800 Years Before Present. In *A Volcano Rekindled: The Renewed Eruption of Mount St. Helens*, edited by D. E. Sherrod, W. E. Scott, and P. H. Stauffer, pp. 593–606. U.S. Geological Survey Professional Paper 1750.

Durio, Laurie

2005 *I-5: Delta Park (Victory Boulevard to Lombard Section), Multnomah County, Oregon.* Cultural Resources Technical Report. Report by CH2M Hill to the Oregon Department of Transportation.

Ellis, David V.

1986 *A Cultural Resources Study of the Proposed Hayden Island Marine Industrial Park, Multnomah County, Oregon.* Willamette Associates CRC Report No. 14. Portland.

1996 *Data Recovery Excavation at the Columbia Slough Site (35MU105), Multnomah County, Oregon.* Archaeological Investigations Northwest Report, Inc., No. 121. Portland.

1999 *Multnomah County Corrections Facility at Leadbetter Peninsula: Cultural Resources Survey, Evaluation, and Data Recovery Plan.* Archaeological Investigations Northwest Report, Inc., Letter Report No. 324. Portland.

2000 *Cultural Resource Survey for the Proposed Wapato Corrections Facility and Data Recovery Excavations at 35MU117, Portland, Oregon.* Archaeological Investigations Northwest Report, Inc., No. 205. Portland.

Ellis, David V., and Elizabeth J. O'Brien

2003 *A Cultural Resources Overview of the Multnomah County Drainage District #1, The Sandy Drainage Improvement Company, The Peninsula Drainage District #1, and the Peninsula Drainage District #2, Multnomah County, Oregon.* AINW. Archaeological Investigations Northwest, Inc., Report No. 1166. Portland.

Ellis, David, and Maureen Zehendner
2002 *Archaeological Excavations at 35MU119, Portland, Oregon.* Archaeological Investigations Northwest, Inc., Report No. 243. Portland.

Evarts, Russell C., Jim E. O'Connor, Ray E. Wells, and Ian P. Madin
2009 The Portland Basin: A (Big) River Runs Through It. *GSA Today* 19(9):4–10.

Fitzhenry, E.
1860 Field Notes of Vancouver Island, T2N, R1E, Willamette Meridian. On file at the Bureau of Land Management Archives, Portland, Oregon.

Follansbee, Julia A. and Ellen E. Frances
1980 *A Cultural Resources Survey of Tomahawk Island, Portland, Oregon.* On file at Oregon SHPO, Salem.

Foit, Franklin F., Jr.
2010 Letter of February 11 to Rick Minor reporting results of microbeam analysis of tephra samples from CRC project. On file, Heritage Research Associates, Inc., Eugene, Oregon.

Genealogical Forum of Portland
1957 *Genealogical Material in Oregon Donation Land Claims,* Vol. 1. Genealogical Forum of Portland, Portland, Oregon.

General Land Office
1860 Master Title Plat, T1N, R1E, Willamette Meridian. On file at the Bureau of Land Management Archives, Portland, Oregon.

Hajda, Yvonne P.
1984 Regional Social Organization in the Greater Lower Columbia, 1792–1830. Unpublished Ph.D. dissertation, Department of Anthropology, University of Washington, Seattle.

Hayden, Mary Jane
1979 *Pioneer Days.* Reprinted. Ye Galleon Press, Fairfield, Washington. Originally published 1915, Murgotten Press, San Jose, California.

Hodges, Charles
2000 *Geoarchaeological Investigations at 35MU117, Bybee Lake, Wapato Corrections Facility, Multnomah County, Oregon.* Edaphos Research, Portland.

Ives, Butler
1852 Plat of Survey, T1N, R1E, Willamette Meridian. On file at the Bureau of Land Management Archives, Portland, Oregon.

Martin, Michael
1987 *Columbia River Slough, Cultural Resource Field Investigation.* Memo to the files from U.S. Army Corps of Engineers, Portland District. On file, Oregon State Historic Preservation Office, Salem.

Minor, Rick and Jill A. Chappel
1994 *Archaeological and Historical Assessment of West Hayden Island, Multnomah County, Oregon.* Heritage Research Associates Report No. 161. Eugene.

Minor, Rick, Robert R. Musil, and Kathryn Anne Toepel
1994 *An Inventory and Assessment of Archaeological Resources in the Columbia South Shore for the City of Portland, Oregon.* Heritage Research Associates Report No. 165. Eugene, Oregon.

1997 The Search for the Nechacolee Village: Investigations at 35MU70 on the Columbia South Shore. In *Contributions to the Archaeology of Oregon, 1995–1997,* edited by Albert C. Oetting, pp. 223–248. Association of Oregon Archaeologists Occasional Papers No. 6. Eugene.

Minor, Rick, and Curt D. Peterson
2008 *Archaeological Work Plan for Ground-Penetrating Radar (GPR) Exploration, Columbia River Crossing Project.* Heritage Research Associates, Inc. Submitted to Columbia River Crossing Project, Vancouver, Washington.

Minor, Rick, Curt D. Peterson, and Mike Gallagher
2009 *Proposed Work Plan for Geoarchaeological Discovery Probing on the Oregon Shore for the CRC Project.* Heritage Research Associates, Inc. Submitted to Columbia River Crossing Project, Vancouver, Washington.

Minor, Rick, Kathryn A. Toepel, and Mike Gallagher
2008 *Research Design for Archaeological Discovery Field Investigations, Columbia River Cross (CRC) Project, Oregon and Washington.* Submitted to Columbia River Crossing Project, Vancouver, Washington.

Monaghan, G. William, Kathryn C. Egan, Michael J. Hambacher, Daniel R. Hayes, Steve R. Kuehn, Staffan Peterson, James A. Robertson, and Nelson R. Shaffer
2006 *Minnesota Deep Test Protocol Project.* Commonwealth Cultural Resources Group, Inc. Jackson, Michigan.

Moulton, Gary E. (editor)
1990 *The Journals of the Lewis and Clark Expedition, November 2, 1805–March 22, 1806,* Vol. 6. University of Nebraska Press, Lincoln.

1991 *The Journals of the Lewis and Clark Expedition, March 23–June 9, 1806,* Vol. 7. University of Nebraska Press, Lincoln.

Mullineaux, Donal
1996 *Pre-1980 Tephra-Fall Deposits Erupted from Mount St. Helens, Washington.* U.S. Geological Survey Professional Paper 1563.

Mullineaux, Donal R., Ray E. Wilcox, Walter F. Ebaugh, Roald Fryxell, and Meyer Rubin
1978 Age of the last Major Scabland Flood of the Columbia Plateau in Eastern Washington. *Quaternary Research* 10:171–180.

Multnomah County Drainage District (MCDD)
2010a Drainage District History. Electronic document, http://www.mcdd.org/History.html, accessed February 10, 2010.

2010b Peninsula Drainage District No.1. Electronic document, http://www.mcdd.org/PEN1history.html, accessed February 10, 2010.

2010c Peninsula Drainage District No.2. Electronic document, http://www.mcdd.org/PEN2history.html, accessed February 10, 2010.

Musil, Robert, Jill Chappel, and Kathryn Toepel
1995 *A Cultural Resource Assessment of Peninsula Drainage District No. 1, Portland, Multnomah County, Oregon*. Heritage Report No. 180. Heritage Research Associates, Inc., Eugene, Oregon.

Nedeau, Ethan J., Allan K. Smith, Jen Stone, and Sarina Jepsen
2009 *Freshwater Mussels of the Pacific Northwest*. 2nd ed. The Xwerces Society, Portland, Oregon.

O'Connor, J. E., and V. R. Baker
1992 Magnitudes and Implications of Peak Discharges from Glacial Lake Missoula. *Geological Society of America Bulletin* 104:267–279.

O'Rourke, Leslie M.
2005 The Wapato Valley Predictive Model: Prehistoric Archaeological Site Location on the Floodplain of the Columbia River in the Portland Basin. Unpublished M.A. thesis in Anthropology, Portland State University, Portland.

Peterson, Curt D.
2007 Appendix A: Geology and Geomorphology. In *Interstate 5 Columbia River Crossing—Archaeology Technical Report*, by Rick Minor and Kathryn Anne Toepel. Heritage Research Associates, Inc. Report to Columbia River Crossing Project, Vancouver, Washington.

Peterson, Curt D., Sandy Vanderburgh, Michael C. Roberts, Harry M. Jol, Jim Phipps, and David C. Twichell
2010 Composition, Age, and Depositional Rates of Holocene Shoreface Deposits under Barriers and Beach Plains of the Columbia River Littoral Cell, USA. *Marine Geology* 273(1-4):62–82.

Pettigrew, Richard M.
1981 *A Prehistoric Culture Sequence in the Portland Basin of the Lower Columbia Valley*. University of Oregon Anthropological Papers No. 22. Eugene.

2005 Archaeological Excavations at the St. Johns Site (35MU44/46), Portland, Oregon. On file, Oregon State Historic Preservation Office, Salem.

Pownall, J.

1854 Field Notes of Claim No. 39, T2N, R1E, Willamette Meridian. On file at the Bureau of Land Management Archives, Portland, Oregon.

Rockwood, E. Ruth (editor)

1939 Diary of Rev. George H. Atkinson, D.D. *Oregon Historical Quarterly* 40(2):168–187.

Saleeby, Becky M.

1983 Prehistoric Settlement Patterns in the Portland Basin of the Lower Columbia River: Ethnohistoric, Archaeological, and Biogeographic Perspectives. Unpublished Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.

Sieke, Kurtichanof, Dorner, Cochran Engineers and Architects

1957 Design Memorandum, Peninsula Drainage District No. 1, Lower Columbia River, Improvement to Existing Works, Oregon and Washington. Prepared for U.S. Army Corps of Engineers.

Strong, Emory.

1959 *Stone Age on the Columbia River*. Binfords & Mort, Portland, Oregon.

Tolmie, William

1885 Letter. In *Transactions of the Oregon Pioneer Association for 1884*, pp. 24–37. E. M. Waite, Salem.

U.S. Coast and Geodetic Survey (USCGS)

1888 Columbia River—Fales Landing to Portland. Map Sheet No. 6. U.S. Coast and Geodetic Survey, Washington, D.C.

1949 Columbia River—Fales Landing to Portland. Map Sheet No. 6. U.S. Coast and Geodetic Survey, Washington, D.C.

U.S. Geological Survey (USGS)

1896 Portland 15′ quadrangle. On file at the University of Oregon Map Library, Eugene.

1940 Portland 15′ quadrangle. On file at the University of Oregon Map Library, Eugene.

2010 Mount St. Helens, Washington, Summary of Eruptive Stages and Tephra Deposits. Electronic document, http://vulcan.wr.usgs.gov/Volcanoes/MSH/EruptiveHistory/summary_msh_eruptive_stage, accessed February 24, 2010.

Waitt, R. B.

1984 Periodic Jökuhlaups from Pleistocene Glacial Lake Missoula: New Evidence from Varved Sediment in Northern Idaho and Washington. *Quaternary Research* 22:46–58.

1985 Case for Periodic, Colossal Jökuhlaups from Pleistocene Glacial Lake Missoula. *Geological Society of America Bulletin* 96:1271–1286.

Wessen, Gary
1983 *Archaeological Investigations at Vancouver Lake, Washington*. Report to Cooper and Associates, Portland, Oregon. Western Heritage, Inc., Olympia, Washington.

Zdanowicz, C. M., G. A. Zielinski, and M. S. Germani
1999 Mount Mazama Eruption: Calendrical Age Verified and Atmospheric Impact Assessed. *Geology* 27(7):621–624.

APPENDIX 1B-I:

SUMMARY OF RADIOCARBON DATES AND CALIBRATED AGES FROM ARCHAEOLOGICAL SITES ON THE COLUMBIA SOUTH SHORE

Table 1. Summary of Radiocarbon Dates and Calibrated Ages from Archaeological Sites on the Columbia South Shore.

Site	Site Type	Laboratory No.	^{14}C Age (RCBYP)	Calibration Range (68% confidence) (BC/AD)	Depth Below Surface (cm)/ Elevation (m)	Association	Reference
35MU24 Blue Lake Park	Village	Beta-12847	1030±60	Cal AD 980–1030[a]	Data not reported		Ellis and Horton 1985
		Beta-12846	1210±60	Cal AD 690–900[a] Cal AD 910–960[a]	Data not reported		Ellis and Horton 1985
35MU26	Camp	Beta-71616	1310±90	Cal AD 650–790[a]	30–50 cm	Lens of charcoal and FCR in Probe A	Minor et al. 1994
		Beta-184109	1670±80	Cal AD 260–440[b]	40 cm	Campfire or hearth	Becker and Roulette 2003
35MU29/32	Camp	Beta-46184	540±60	Cal AD 1330–1330[a] Cal AD 1400–1440[a]	25–30 cm	Lens of charcoal and FCR (Feature 1)	Ellis and Fagan 1991:33
		Beta-51950	300±60	Cal AD 1510–1600[a] Cal AD 1620–1660[a]	25 cm	Small cluster of FCR and charcoal (Feature 2)	Ellis 1992a:31
		Beta-51951	1430±80	Cal AD 560–590[a] Cal AD 590–670[a]	42 cm	Small cluster of FCR and charcoal (Feature 3)	Ellis 1992a:33
35MU30	Non-Site	Beta-71617	310±60	Cal AD 1490–1610[a] Cal AD 1610–1660[a]	130–170 cm	No apparent cultural association, Auger Holes 15 and 16, Parcel 9	Minor et al. 1994:99
35MU44/46 St. Johns	Village	Beta-38884	250±50	Cal AD 1522–1571[c] Cal AD 1627–1676[c] Cal AD 1764–1768[c] Cal AD 1775–1802[c] Cal AD 1939–1946[c]	Data not reported	Pit 3, cedar post	Woodward 1990; Ellis 2000:12
		Beta-38966	330±50	Cal AD 1494–1533[c] Cal AD 1540–1601[c] Cal AD 1613–1636[c]	Data not reported	Pit 5, burn zone	Woodward 1990; Ellis 2000:12
		Beta-38885	390±50	Cal AD 1442–1520[c] Cal AD 1591–1623[c]	Data not reported	Pit 4, house floor?	Woodward 1990; Ellis 2000:12
		A-13543	1035±115	Cal AD 890–1071[c] Cal AD 1078–1130[c] Cal AD 1136–1158[c]	4.95–4.78 m	Feature 40	Pettigrew 2005:11.4, J.2
		A-13589	370±120	Cal AD 1437–1644[c]	Above 5.01–4.84 m	Above Feature 33	Pettigrew 2005:11.3, J.2
		A-13590	360±80	Cal AD 1455–1528[c] Cal AD 1552–1633[c]	4.77–4.59 m	Feature 20	Pettigrew 2005:11.3, J.2

Table 1. Summary of Radiocarbon Dates and Calibrated Ages from Archaeological Sites on the Columbia South Shore (cont.).

Site	Site Type	Laboratory No.	^{14}C Age (RCBYP)	Calibration Range (68% confidence) (BC/AD)	Depth Below Surface (cm)/ Elevation (m)	Association	Reference
		A-13591	370±70	Cal AD 1451–1523[c] Cal AD 1563–1628[c]	4.77–4.59 m	Feature 20	Pettigrew 2005:11.3, J.2
		A-13592	815+145/-140	Cal AD 1034–1104[c] Cal AD 1114–1142[c] Cal AD 1150–1294[c]	4.97–4.77 m	Feature 34	Pettigrew 2005:11.4, J.2
		A-13593	930±75	Cal AD 1025–1163[c] Cal AD 1172–1181[c]	4.97–4.88 m	Feature 38	Pettigrew 2005:11.4, J.2
		A-13594	515±110	Cal AD 1301–1372[c] Cal AD 1379–1480[c]	Above 5.07–5.02 m	Above Feature 42	Pettigrew 2005:11.4, J.2
		A-13596	275±40	Cal AD 1522–1577[c]	5.32–5.29 m	Feature 44	Pettigrew 2005:11.3, J.2
		A-13597	345±60	Cal AD 1483–1529[c] Cal AD 1548–1634[c]	4.95–4.65 m F5 4.97–4.87 m F51	Feature 5/51	Pettigrew 2005:11.3 J.2
		A-13636	1600±120	Cal AD 341–598[c]	4.77–4.52 m	Feature 48	Pettigrew 2005:11.4, J.3
		A-13637	103.2±1.2 pMC	Modern[c]	5.04–4.89 m	Feature 50	Pettigrew 2005:11.3, J.3
		A-13638	300±55	Cal AD 1495–1497[c] Cal AD 1514–1600[c] Cal AD 1615–1655[c]	4.97–4.42 m	Feature 1	Pettigrew 2005:11.3, J.3
		A-13639	395±45	Cal Ad 1442–1517[c] Cal AD 1597–1619[c]	5.07–4.87 m	Feature 3	Pettigrew 2005:11.3, J.3
		A-13640	280±45	Cal AD 1520–1589[c] Cal AD 1624–1661[c]	5.17–4.82 m	Feature 13	Pettigrew 2005:11.3, J.3
35MU47	Camp		530±50	AD 1400–1435[a]	Date not reported	Bulb cooking pit	Woodward 1983; Woodward and Associates 1990:14; Ellis 2000:12
35MU57 Broken Tops	Village	Beta-54904	180±60	Cal AD 1660–1700[a] Cal AD 1720–1820[a] Cal AD 1860–1860[a] Cal AD 1920–1950[a]	Data not reported	S5W16	Ellis and Fagan 1993:165
		Beta-54903	430±60	Cal AD 1430–1490[a] Cal AD 1610–1610[a]	3.84 m	Burnt post, House 1 (Feature 27)	Ellis and Fagan 1993:101

Table 1. Summary of Radiocarbon Dates and Calibrated Ages from Archaeological Sites on the Columbia South Shore (cont.).

Site	Site Type	Laboratory No.	^{14}C Age (RCBYP)	Calibration Range (68% confidence) (BC/AD)	Depth Below Surface (cm)/ Elevation (m)	Association	Reference
		Beta-54902	440±80	Cal AD 1420–1510° Cal AD 1600–1620°	Data not reported	Cluster of FCR in a charcoal-stained shallow pit in House 1 (Feature 16)	Ellis and Fagan 1993:95
		Beta-53634	490±70	Cal AD 1410–1450°	50 cm	Midden deposit in House 1 (Feature 2)	Ellis 1992b:44
		Beta-53635	1030±90	Cal AD 900–910° Cal AD 960–1050° Cal AD 1100–1120° Cal AD 1140–1150°	75–95 cm	Charcoal-stained soil layer with FCR (Feature 6)	Ellis 1992b:46
35MU58 Airport Way Upper	Camp	WSU-3472	1220±65	Cal AD 720–740° Cal AD 760–890°	100–110 cm	Concentration of FCR, charcoal, bisque, and charred camas (Feature 6).	Bland and Connolly 1989:14
		WSU-3471	1340±100	Cal AD l630–780°	130–164 cm	Concentration of FCR, charcoal, bisque, and charred camas (Feature 5)	Bland and Connolly 1989:14
		WSU-3467	1400±70	Cal AD 610–680°	120–130 cm	Concentration of FCR, charcoal, and bisque (Feature 2)	Bland and Connolly 1989:14
35MU58 Airport Way Lower		WSU-3469	1320±125	Cal AD 630–880°	220 cm	Extensive concentration of charcoal, and charred camas; intrusive from upper component (Feature 7)	Bland and Connolly 1989:14
		WSU-3468	1840±70	Cal AD 90–100° Cal AD 110–250°	194–200 cm	Small cluster of FCR, charcoal, bisque, and charred camas (Feature 4).	Bland and Connolly 1989:14
		WSU-3470	1910±60	Cal AD 60–150° Cal AD 170–200°	235 cm	Area of burnt earth and some FCR (Feature 8)	Bland and Connolly 1989:14
35MU70	Village	Beta-72049	150±60	Cal AD 1670–1790° Cal AD 1790–1900° Cal AD 1900–1950° Cal AD 1950–1960°	190–200 cm	Deep midden deposit in Auger Hole 1	Minor et al. 1994:100–103; Minor et al. 1997:237
		Beta-72048	390±70	Cal AD 1440–1530° Cal AD 1536–1635°	130–140 cm	Deep midden deposit in Auger Hole 1	Minor et al. 1994:100–103; Minor et al. 1997:237
35MU79	Camp	Beta-71618	1790±80	Cal AD 140–350° Cal AD 360–370°	30–50 cm	Rock and charcoal concentration in Auger Hole 4	Minor et al. 1994:103–104

Table 1. Summary of Radiocarbon Dates and Calibrated Ages from Archaeological Sites on the Columbia South Shore (cont.).

Site	Site Type	Laboratory No.	^{14}C Age (RCBYP)	Calibration Range (68% confidence) (BC/AD)	Depth Below Surface (cm)/ Elevation (m)	Association	Reference
35MU83	Non-Site	Beta-71619	1720±80	Cal AD 240–420[a]	220 cm	No apparent cultural association, Auger Hole 9, Parcel 17	Minor et al. 1994:106–107
35MU84 Hemlock	Camp	Beta-46485	2420±70	Cal AD 760–680[a] Cal AD 651–649[a] Cal AD 547–397[a]	110 cm	Circular rock oven or hearth in Test Pit 2.	Musil 1992a:24
35MU97	Camp	Beta-50268	1240±90	Cal AD 680–890[a]	160 cm	Lens of charcoal and FCR in Auger Hole 23	Musil 1992b
		Beta-57982	1150±60	Cal AD 820–840[a] Cal AD 860–980[a]	130–140 cm	Lens of charcoal and FCR in Trench 1	Musil 1992c:30
		Beta-57981	1430±90	Cal AD 550–670[a]	90–100 cm	Lens of charcoal and FCR in Trench 1	Musil 1992c:30
		Beta-57983	1460±80	Cal AD 540–660[a]	150–160 cm	Lens of charcoal and FCR in Trench 2	Musil 1992c:30
		Beta-57984	1540±90	Cal AD 420–630[a]	170–180 cm	Lens of charcoal and FCR in Trench 3	Musil 1992c:30
35MU103	Camp	Beta-73356	430±110	Cal AD 1410–1530[a] Cal AD 1540–1640[a]	160–170 cm	Charcoal , a biface, a flake, bone, and FCR in Auger Hole 25	Minor et al. 1994:115–116
35MU105	Camp	Beta-89811	270±70	Cal AD 1520–1570[b] Cal AD 1630–1670[b] Cal AD 1780–1795[b] Cal AD 1945–1950[b]	Data not reported	MA11, Substratum IIb3 (the second richest cultural substratum at site)	Ellis 1996:19
		Beta-89812	230±100	Cal AD 1525–1560[b] Cal AD 1630–1695[b] Cal AD 1725–1815[b] Cal AD 1920–1950[b]	Data not reported	MA15, Stratum IIa	Ellis 1996:18
35MU106	Camp	Beta-195355	320± 60	Cal AD 1480–1650[b]	50–60 cm	Charcoal from dark stratum in Shovel Probe A (1996)	Musil and Toepel 1996:10; Musil 2008
		Beta-241088	430±60	Cal AD 1430–1480[b]	55–65 cm	Midden	Musil 2008
		Beta-241089	300±40	Cal AD 1520–1590[b] Cal AD 1620–1650[b]	55–65 cm	Midden	Musil 2008

Table 1. Summary of Radiocarbon Dates and Calibrated Ages from Archaeological Sites on the Columbia South Shore (cont.).

Site	Site Type	Laboratory No.	^{14}C Age (RCBYP)	Calibration Range (68% confidence) (BC/AD)	Depth Below Surface (cm)/ Elevation (m)	Association	Reference
		Beta-195699	580±60	Cal AD 1300–1420[b]	120 cm	Thin charcoal lens in trench wall at Auger Hole 3; no apparent cultural association	Musil 2008
35MU113	Camp	Beta-115165	1260±120	Cal AD 660–895[b]	90 cm	Lens of charcoal with FCR	Chapman et al. 1998:13
35MU117	Camp	Beta-133677	2800±110	Cal BC 1105–825[b]	145–165 cm	MA28, Stratum IIa; from near the top of the artifact-bearing gravelly muds	Ellis 1999:4; 2000:55
		Beta-136885	2850±30	Cal BC 1030–975[b]	178–198 cm	MA46,Stratum IIc	Ellis 1999, 2000:55
		Beta-136886	2970±80	Cal BC 1305–1040[b]	200–220 cm	MA51, Stratum IIb	Ellis 1999, 2000:55
35MU119	Village	Beta-146373	1530±60	Cal AD 440–610[b]	65–70 cm	Feature 3, a line of charcoal resembling the end of a burned wood board or plank	Ellis and Zehendner 2002
		Beta-153849	1430±60	Cal AD 580–660[b]	70–80 cm	Feature 2, abrupt boundary between strata suggesting the edge of a prehistoric structure	Ellis and Zehendner 2003
		Beta-153850	1490±80	Cal AD 460–480[b] Cal AD 520–650[b]	60–70 cm	Feature 2, abrupt boundary between strata suggesting the edge of a prehistoric structure	Ellis and Zehendner 2003

[a] from Stuiver and Reimer (1993); dates and calibrations listed in Minor et al. (1994:141–143, and Appendix G)
[b] from Beta Analytic, Inc.
[c] from Stuiver and Reimer (1998); dates and calibrations listed in Pettigrew (2005:Appendix J)

REFERENCES CITED

Becker, Thomas E., and Bill R. Roulette

2003 *Report of Evaluative Testing at 35MU26, Columbia South Shore, Portland, Oregon.* Applied Archaeological Research Report No. 369. Portland.

Bland, Richard L., and Thomas J. Connolly

1989 *Archaeological Investigations at the Airport Way Site and Vicinity.* Oregon State Museum of Anthropology Report 89-2. Eugene.

Chapman, Judith S., David V. Ellis, and Gail Evans-Hatch

1998 *Cultural Resources Investigations for a Proposed New Multnomah County Correctional Facility, Portland, Oregon.* Archaeological Investigations Northwest Report No. 155. Portland.

Ellis, David V.

1992a *Data Recovery Excavations at 35MU29/32, Gresham, Oregon.* Archaeological Investigations Northwest Report No. 27. Portland.

1992b *Archaeological Investigations on the Winmar Pacific Portland Property: Final Report.* Archaeological Investigations Northwest Report No. 26. Portland.

1996 *Data Recovery Excavations at the Columbia Slough Site (35MU105), Multnomah County, Oregon.* Archaeological Investigations Northwest Report No. 121. Portland.

1999 *Multnomah County Corrections Facility at Leadbetter Peninsula: Cultural Resources Survey, Evaluation, and Data Recovery Plan.* Archaeological Investigations Northwest Letter Report No. 324. Portland.

2000 *Cultural Resource Survey for the Proposed Wapato Corrections Facility and Data Recovery Excavations at 35MU117, Portland, Oregon.* Archaeological Investigations Northwest Report No. 205. Portland.

Ellis, David V., and John L. Fagan

1991 *Archaeological Survey of the Safeco Gresham Property and Archaeological Testing of Prehistoric Sites 35MU29/32, Final Report.* Archaeological Investigations Northwest Report No. 16. Portland.

1993 *Data Recovery Excavations at Broken Tops Site (35MU57), Portland, Oregon.* Archaeological Investigations Northwest Report No. 31. Portland.

Ellis, David V., and Susan W. Horton

1985 Recent Research at the Blue Lake Park Site (35MU24). Paper presented at the First Annual Meeting of the Association of Oregon Archaeologists, Portland.

Minor, Rick, Robert R. Musil, and Kathryn Anne Toepel

1994 *An Inventory and Assessment of Archaeological Resources in the Columbia South Shore for the City of Portland, Oregon.* Heritage Research Associates Report No. 165. Eugene.

1997 The Search for Nechacolee Village: Investigations at 35MU70 on the Columbia South Shore, City of Portland. In *Contributions to the Archaeology of Oregon, 1995–1997,* edited by Albert C. Oetting, pp. 223–248. Association of Oregon Archaeologists Occasional Papers No. 6. Eugene.

Musil, Robert R.

1992a *Archaeological Investigations at the Hemlock Site (35MU84), Multnomah County, Oregon.* Heritage Research Associates Report No. 112. Eugene.

1992b *Archaeological Testing in the Airport Way Wetland Mitigation Project Area, Multnomah County, Oregon.* Heritage Research Associates Report No. 115. Eugene.

1992c Arc*haeological Investigations at Site 35MU97, Multnomah County, Oregon.* Heritage Research Associates Report No. 136. Eugene.

2008 *Archaeological Investigations at 35MU106, Columbia South Shore, Multnomah County, Oregon.* Heritage Research Associates Report No. 318. Eugene.

Musil, Robert R., and Kathryn Anne Toepel

1996 *Archaeological Site Boundary Investigations at 35MU70 and 35MU106, Columbia South Shore, Portland, Oregon.* Heritage Research Associates Report No. 193. Eugene.

Stuiver, Minze, and Paula J. Reimer

1993 Extended ^{14}C Data Base and Revised Calib 3.0 ^{14}C Age Calibration program. *Radiocarbon* 35(1):215–230.

Stuiver, Minze, Paula J. Reimer, Edouard Bard, J. Warren Beck, G. S. Burr, Konrad A. Hughen, Bernd Kromer, Gerry McCormac, Johannes van der Plicht, and Marco Spurk

1998 INTCAL98 Radiocarbon Age Calibration, 24000-0 cal BP. *Radiocarbon* 40:1041–1083.

Woodward, John

1983 *Archaeological Assessment for the Port of Portland of a Proposed Columbia Slough Bridge Site: Phase 2 Report.* Submitted to the Port of Portland by John Woodward, Portland.

Woodward and Associates

1990 An *Archaeological Assessment of the St. Johns Site on the Columbia Slough With Primary Emphasis on Site 35MU46.* Submitted to the Port of Portland by Woodward and Associates, Portland.

APPENDIX 1B-II:

ETHNOHISTORICAL ACCOUNTS OF INDIAN SETTLEMENTS AND LAND USE IN THE VICINITY OF THE INTERSTATE 5 BRIDGE OVER THE COLUMBIA RIVER

Robert Boyd

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Robert Boyd

This report, a supplement to the ethnographic and ethnohistorical sections of the *Interstate 5 Columbia River Crossing—Archaeology Technical Report* (Minor et al. 2007), presents ethnohistorical information concerning Native American settlement and land use within the vicinity of the existing Interstate 5 bridges connecting the Portland and Vancouver metropolitan areas in Oregon and Washington. It is intended to identify potential culturally significant areas in which archaeological remains might be encountered during construction associated with the Columbia River Crossing (CRC) project.

For the purposes of this special report, the study area corresponds to the area within a two mile-radius of the existing I-5 bridges. This "two-mile radius" is an arbitrary designation intended simply to show proximity to the CRC project area. Until now, Indian settlements inhabited during the historic period in the study area have been poorly known and documented. A major reason for this lacuna has been the relative inaccessibility of significant historical records that could help pinpoint the location of historic Indian settlements. This is particularly so with the most important Indian settlement, the Cascades Indian winter encampment on the south shore across the Columbia River from Fort Vancouver, which is clearly documented only for the post-fever and pre-reservation period, a time span of about twenty years, from 1833 to 1853.

RECORDS FROM THE PRE-FEVER ERA, 1805-1830

Lewis and Clark, present in the Portland–Vancouver Basin in November 1805 and March–April 1806, have very little to say about the study area, though their journals contain a considerable amount of information on *Neerchokioo*, a village upstream on the south shore, and a lesser amount on *Nemalquinner*, a village downstream near the mouth of the Willamette River, as well as the "Shoto" villages across the river near Vancouver Lake. *Neerchokioo*, significantly, was documented as a seasonal (warm-season) settlement of the "Shahalas," the explorers' name for the Cascades Indians, whose winter villages were located on both sides of the river at the Cascades rapids some 40 river miles upstream in the area of present-day Bonneville Dam. *Nemalquinner*, by contrast, was said to be a warm-season campsite of the "Cushooks" people, who inhabited a village at present-day West Linn at Willamette Falls. Both home village areas were, perhaps significantly, along major salmon migration routes, and the Cascades and Willamette Falls Indians were said to move to the Vancouver area to take advantage of the resources abundant in that area, particularly wapato.

The Shoto villages were not visited by Lewis and Clark, and appear only in their population estimate and on their maps. The Vancouver area interior plains were neither visited nor mentioned, and another village on the north shore, *Wakanasisi* at Hewlett Point, and the Cascades winter encampment opposite Vancouver discussed later in this report are not noted at all, even though they were in the direct route of the explorers. This negative evidence implies that they were not at that time occupied.

Although the Astorian/Nor'wester period (1811–1821) on the Lower Columbia is copiously documented, particularly in its early years, there is practically no mention of the study area, and nothing on Indians in the area. The sole citation is from Alexander Henry, in February 1814, when he visited the vicinity of the future site of Fort Vancouver.

> Point Vancouver....The Land adjoining the River is low and most overflown at high water; it is a meadow extending about 3 miles in length and at the widest part about ¾ mile in breadth to the foot of a beautiful range of high Prairie ground rising about 30 feet. On the top of this Hill is a most delightful situation for a Fort on a Prairie of about 2 Miles long, and 2 miles broad, good Soil and excellent Pine [*sic:* fir] in abundance in the rear, in a word the most eligible situation I have yet seen on the Columbia, but the distance is too far from the sea and no Sturgeon Fishing so high up the River....Biche are apparently very numerous here, and Cheveril also [elk & deer]. Their tracks, dung &c are to be seen in every direction. The fire seems to have passed through the lower Prairie last Fall, and the green grass is already sprouted up about four inches in height, which gives the face of the country a pleasant appearance. (Henry 1992:674-75)

Though bereft of mention of Indians, this passage does contain interesting suggestions on resource availability and land use. Vancouver was beyond the sturgeon-fishing grounds, established elsewhere in the Astorian literature as from about Oak Point to the future site of *Wakanasisi*. Cervids were common on the Vancouver plains, and there is suggestive evidence of anthropogenic burning based on documentation in later years for the area.

In 1821 the Northwest Company merged with the Hudson's Bay Company (HBC), and the latter took over the former's posts in the Northwest. At that time, three years before he left the Northwest, long-time NWC employee Alexander Ross produced a map of the Columbia Basin showing prominent Indian settlements. Due to problems of scale, his map does not always depict villages exactly where they should be, and Ross amended the map in 1849 ("I have made some trifling altera[tions?]....Aug 1st 1849" (Ross 1974 [1821, 1849]), preparatory to possible publication in his book *Adventures of the First Settlers on the Oregon or Columbia River: Being a Narrative of the Expedition Fitted Out by John Jacob Astor, to Establish the "Pacific Fur Company;" with an Account of Some Indian Tribes on the coast of the Pacific.*[1] The map shows two settlements within the study area. On the north bank, at what appears to be the site of the first Fort Vancouver (1825–1829) are four structures; on the opposite (south) bank are four others with the legend "Namouite tribe."

Both these sitings need to be examined in the context of the peculiarities of the Ross map. First, the north bank fort area houses. Considering that no documentary sources for the area, either before (going back to Lewis and Clark), or in the four years up to the construction of the fort (1821–1825) mention a village here, plus the facts that the cluster is not named and Ross's own statement that he revised the map in 1849, the most likely explanation is that the structures are meant to represent the fort, and were added in 1849. But this does not solve the matter, and a

[1] The map was not included in the publication (Ross 1849) and now resides in the British Museum. In 1974 it was printed as a separate by the Friends of the Ellensburg Public Library (Ross 1974).

window of doubt remains. In *Wishram Ethnography*, Dalles-area informants said there was a village there, and named it */sketcu'txat/*, a term otherwise applied to the lower fort prairie (Spier and Sapir 1930:222). With this ambiguity introduced, archaeologists should be sensitive to the possibility of an Indian settlement at or below the site of the first fort.

Second, the south bank Namouite settlement. As noted above, problems of scale meant that some map sites/names are not exactly where they should be, so it is possible that Ross's Namouite" refers to *Neerchokioo*, a few miles upriver. But if the siting is as it appears to be, it would correspond to the post-fort (1825), post-fever (1830) Cascades Indian winter encampment. This could also be an 1849 addition, though the fact that it is named and numbered, unlike the north bank site, suggests that it dates to 1821. So the Cascades encampment may date to pre-fever times. Then there is the problem of the name. *Namouite* was not noted by Lewis and Clark. Ross names it in the text of *Adventures* twice, locating it upstream from Kiesno's *Cathlacamass* (St Helens) village, either on the Columbia below Bellevue Point (Sauvie Island, south-southeast bank) (Ross 1849:106) or up Multnomah Channel (Ross 1849:236). Alexander Kennedy's 1824–1825 Fort George report sites "Twatillacome & Namuit" on an "Island opposite the Willamett" (Kennedy 1824–1825). "Twatillacome" was a chief's name and may or may not refer to a settlement; "Willamett" in the early sources was the "lower mouth" of the present river, or the present entrance to Multnomah Channel. Thus, the "island" should be Sauvie, though if it is allowed that the "upper [true] mouth" of the Willamette was meant (following later usage), it could be one of the islands upstream. So the sources all place Namouite in a different spot. This could be the result of mistakes, seasonal movement, or both. For the purposes of this report, however, the name is less important than the Ross map location, at or close to the later Cascades winter encampment.

In 1824 Fort Vancouver was selected as the HBC's Pacific Northwest headquarters, and Fort Astor/George at the Columbia mouth became a secondary establishment. There are two passages from 1824 referring to "Jolie [beautiful] Prairie," at Fort Vancouver, and both mention Indians. From John Work's Lower Columbia salmon-trading journal, on May 24: "...encamped at Jolie Prairie....Indians come with 5 sturgeon to sell but wanted blankets for them" (Work 1824). And from George Simpson's 1824–1825 journal, on November 24:

> ...put ashore at Jolie Prairie. The country here is very pleasant well wooded & Hills plains and beautiful openings coming to the view at every reach. Several Indians came off from their Villages in Canoes bringing us a variety of excellent Fish, they appeared glad to see us and we received a hearty Welcome from two of their principal Men "Slyboots" & the "Little Chief" to each of whom we gave about 6 inches of Tobacco and to the others about a pipe each. (Simpson 1931:64)

Though neither passage specifically says so, the Indians were apparently not local. Work says they "come with" and Simpson "came off from their Villages in Canoes." Though Work says the Indians brought sturgeon, Henry earlier noted Vancouver was not in sturgeon-fishing territory, which was downstream from Hewlett Point. Henry's Indians "came...from their Villages in Canoes," verification that they did not live at the fort site. The chiefs' names, "Slyboots" and "Little Chief" are of no assistance in this study, as neither is mentioned in any other records, historical or ethnographic. Work's Indians must have come from the sturgeon area, downstream from the Willamette mouth, perhaps from one of the Multnomah villages on the Columbia bank of Sauvie Island, which were closest. Simpson's visitors could have come from any of the pre-fever settlements or even farther away. One thing abundantly clear in all the early records, especially the *Annals of Astoria* [Astoria Journal] (McDougall 1999), is that aboriginal river commerce was heavy, and distances traveled were great. Indians congregated wherever whites were, to trade for their new material goods.

Elsewhere in his journal, Simpson makes statements that refer to interior travel and resources:

> The place we have selected is beautiful as may be induced from its Name and the Country so open that from the Establishment there is good traveling on horse back to any part of the interior. (Simpson 1931:87)
>
> Deer are so numerous about the Jolie Prairie say the Stag or Red Deer [elk] and the Chevreuil or Roe [whitetail] that a good Cree Hunter could support a small Establishment." (Simpson 1931:111)

The reference to horses is important, as they were nowhere mentioned in Lewis and Clark's journals, and appear in the Astoria Journal (McDougall 1999) in 1811, when they were being traded from the interior to Indians farther down the Columbia. Sometime between 1805 and 1811 horses apparently were introduced over the Cascades passes to western Oregon and Washington, bringing with them better land transportation and access to more resources over wider areas than had been true at any time in the prehistoric era. Simpson's second passage affirms what Alexander Henry had said a decade prior about the abundance of cervids in the Vancouver high prairies.

Also in 1824–1825, two Scottish scientists, John Scouler and David Douglas, arrived at Fort Vancouver and began describing and inventorying species in the Fort Vancouver and Lower Columbia areas. Douglas gives the first of three complete descriptions of what was apparently the major wild plant resource of the low, wet prairies, specifically the "Vancouver Plains," which encompassed all the low-lying area starting at the west border of the present-day city of Vancouver/Vancouver Lake and extending to about Ridgefield. The following passages from Douglas cannot be sited exactly, but the observations almost certainly were made somewhere between Vancouver's west border and Hewlett Point.

> Phalangium Quamash [camas]; its roots form a great part of the natives' food; they are prepared as follows: a hole is scraped in the ground, in which are placed a number of flat stones on which the fire is placed and kept burning until sufficiently warm, when it is taken away. The cakes, which are formed by cutting or bruising the roots and then compressing into small bricks, are placed on the stones and covered with leaves, moss, or dry grass, with a layer of earth on the outside, and left until baked or roasted, which takes generally a night. They are moist when newly taken off the stones, and are hung up to dry. Then they are placed on shelves or boxes for winter use. When warm they taste much like a baked pear. (Douglas 1959:105)

Scouler, speaking of the same general area, adds that camas "grow abundantly in the moist prairies…& are collected by women & children," and that they were also boiled and eaten "cold" (Scouler 1905:174). Paul Kane's 1846 description adds: "camas…are found in immense quantities in the plains in the vicinity of Fort Vancouver…in the spring…the whole surface presenting an uninterrupted sheet of bright ultramarine blue" (Kane 1971:94). All three discuss camas ovens, which have been identified in archaeological sites.

Douglas is one of two observers who note a second potentially identifiable archaeological feature, sweatbaths, on the plains between the fort and Hewlett Point.

> May 1, 1825.…left the fort for the purpose of visiting an extensive plain seven miles below on the same side of the river. Passed several Indian steaming huts or vapour baths; a small hole is dug about 1 foot deep, in which hot stones are placed and water thrown on

> them so as to produce steam; the bather then goes in naked and remains until well steamed; he immediately plunges into some pool or river, which is chosen so as not to be far distant. They are formed of stick, mud, and turfs, with a small hole for means of entering. They are most frequently used when the natives come from their hunting parties after the fatigues of war, and also before they go on any expedition which requires bodily exertion. (Douglas 1959:115)

Though Douglas says "after" hunting or war, sweating usually preceded both, to remove body odor in the hunt, and to ceremoniously purify oneself before war. Sweatbathing accompanied other religious, especially life, rites, as the spirits were believed to not like contamination. Sweatbathing was also used for cleansing and curing. Interestingly, sweatbaths are rarely recorded in the ethnographic literature west of the Cascades, and not at all downstream from the Vancouver area. Like camas ovens, the shallow, rock-filled depressions of sweatbaths should be identifiable archaeologically, the differences being marked, in particular, by presence or absence of plant remains.

A final passage of note from the pre-fever era, though not indicative of a particular identifiable use area, is the first documentation of what was probably the "Klikitat Trail," an aboriginal trail connecting the Yakima Valley to the Portland-Vancouver Basin villages that apparently became heavily used after the introduction of horses. The passage is from a May 17 entry in the John Work journal of 1830:

> The road we were to pursue by the interior is said not to occupy more than four days.... I have heard it said that formerly some free men came from Vancouver to opposite the Dalles on horse by this route in three days. This used to be the grand war road of the Kyauses and Nezperces to go down to Kersinous. (Work 1909:305)

"Kyauses and Nezperces" should be qualified. The earliest documentation of Plateau Indians west of the Cascades, again from Henry in 1814, has a mixed group of mostly Sahaptin mounted hunters in the Willamette Valley (Henry 1992:672). "Kersinous" refers to Kiesno (Cassino, etc.) the chief, in the Astorian era, of *Cathlacamas* (St. Helens), and later, of *Wakanasisi*.

POST-FEVER (EARLY 1830s) DOCUMENTATION

The "fever and ague" (virgin soil malaria) epidemics of the 1830s claimed (in Dr. McLoughlin's words) nine out of ten Indians in the fort "vicinity." (McLoughlin 1941:88) These epidemics caused, in conjunction with the near-simultaneous appearance of white settlement, drastic changes in all aspects of Native American culture, notable for this report, in settlement and land use patterns. Survivors of depopulated villages congregated in smaller remnant settlements, and people moved closer to the fort where they had access to medicine, trade goods, and employment.

The most important document for the early post-fever (early 1830s) period in the study area is the journal kept by Doctor William Fraser Tolmie, a prominent HBC official and trader often stationed at Fort Vancouver (Tolmie 1963). On May 5 1833, Tolmie visited an Indian camp, apparently within two or three miles of the fort, where he witnessed what was probably a performance of what anthropologist Leslie Spier (1935) has called the "Christianized Prophet Dance," at that date mostly recorded from the Columbia Plateau to the east.

> ...Rode to see the farm which extends along bank of R to E. of fort—there several large fields of wheat & pease & one of barley—with rich & extensive natural meadows. Heard a loud howling & approaching a party of from 30 to 40 Indians, men, women & children

> performing their devotions. They formed a circle two deep & went round & round, moving their hands as is done in sculling [rowing], exerting themselves violently & simultaneously repeating a monotonous chaunt loudly. Two men were within the circle & kept moving rapidly from side to side making the same motion of arms, & were I told the directors or managers of the ceremony. Having continued this exercise for several minutes after we beheld them becoming more & more vehement & excited, they suddenly dropped on their knees & uttered a short prayer & having rested a short time resumed the circular motion. During the ceremony so intent were they that not an eye was once turned towards us, although we stood within a few yards. In an encampment close by, several persons were squatted round the fires—the dwellings, formed of poles covered with skins, looked very wretched. Felt a sensation of awe come over me when they knelt & prayed. The Govr. says that they have imitated the Europeans in observing the 7. as a day of rest. (Tolmie 1963:171-172)

Elsewhere and later in the post-fever years, Indians are noted to the east of the fort, in a few instances dancing, but in no other citation are they situated at this exact location, the fort farm. In all cases the east-of-the-fort Indians are Sahaptins, usually called "Klikitats," whose ethnic relations were all with the Columbia Plateau. And so it seems were the people who Tolmie describes here. The "Christianized Prophet Dance" was first described from Fort Nez Perces in 1831, and seems to be a reaction to the presence of the fever epidemics downriver. The "Prophet Dance" was ancient on the Plateau, and incorporating some Christian elements, its resurgence in the early 1830s has been hypothesized as ritual protection against the fever epidemics downriver (Boyd 1996:180). Besides the identity of ritual behaviors, note that Tolmie refers to "dwellings, formed of poles covered with skins," probably tipis, a definite Plateau-Plains trait not at all characteristic of coastal Indians. The camp of these people was apparently in the lowland along the Columbia just to the east of Fort Vancouver.

Tolmie wandered, exploring, in the low plains below and west of the fort and the high plains north and east of it. In the low plains west of the fort, like Douglas and Scouler, he noted camas (Tolmie 1963:171), and

> below fort...a broad belt of wood extending to river's edge....Many of the pines were strip't of their bark for a few feet above root....little underwood....What an excellent cricket field this part of the plain would make. (Tolmie 1963:176)

The "pines" (actually fir) "strip't of their bark" must be due to human agency, probably through fire, possibly white caused, but more probably the afore-mentioned Indian regular burning, practiced in the prairies to both stimulate the growth of root crops like camas and provide forage for cervids. This, with the passage from Henry, is the second that suggests that anthropogenic burning was practiced in the low plains below the fort.

On May 12, Tolmie returned to the camp where, the Sunday before, he had witnessed the Indian dances.

> ...reached to near the extremity of the farm entered the forest & visited the Indian encampment at which the religious ceremonies were performed last Sunday. Today the lodges were crowded with human beings of all sizes and sexes, squatted closely around the fires which burnt in the middle, notwithstanding their filthy abodes the inmates looked fresh & healthy, outside were several wolfdogs who retreated growling at our approach. Shook hands with a few of the principal men & by signs they gave us to understand on enquiry that about sunset the devotional ceremonies would commence. The camp seemed well supplied with food, for the central poles of the wigwam were hung with large pieces of salmon drying in the smoke. What externally appeared as

> several dwellings within was one apartment & contained at least 50 individuals. (Tolmie 1963:178)

Notable in this passage is reference to a structure that had 50 people inside and was composed of several sections. This recalls the well-known (and illustrated) description of the multi-"apartment" structure by Lewis and Clark in November 1805 at *Nechacolee*, several miles upriver from Tolmie's camp, on the south side of the Columbia.

Nechacolee has always been assumed, since Lewis and Clark's expedition, to be a Chinookan settlement, as that is the language they spoke. But if it is safe to equate house type with ethnicity, we then have Sahaptin tipis and Chinookan multifamily "apartments" in a single settlement. So perhaps it was mixed, or perhaps the dwellings were not indicative of, or limited to, a single ethnicity, but characteristic of a larger region, and used for different functions. The problem cannot be solved with the information that has come down to us. All we can be sure of for the purposes of this report is that, in May 1833, there was an Indian settlement east of the fort on the low plain along the river.

Although the place names collected by Lewis and Clark along the Columbia are all clearly Chinookan, in their narrative the explorers are not always clear about the language spoken by the people they encountered, and the word lists carefully collected by Lewis that could verify language use have been lost. But a second primary source from the area, published in 1835 but probably representing the situation before the fever years, seems to pin down clearly the common language of the area between the fort and the Cascades Indian villages. It was collected by the fort doctor from Michel LaFramboise, an HBC trader who in 1835 had been on the Columbia for over twenty years, had traveled widely, had wives in many tribes, and was familiar with several languages. LaFramboise called the people "from the Cascades to Vancouver, along the river" "Katlagakya" and said they spoke the "Saho Latak Language," also spoken by other downriver tribes (Gairdner 1841:255). The extent corresponds with what was later referred to by anthropologists as "Upper Chinookan," or the native term that has come down to us, "Kiksht" (Silverstein 1990:533). So with the exception of the Klikitat people, who were indubitably Sahaptin speakers, the peoples around the fort in both pre- and post-fever times appear to have been Chinookan speakers.

The presence of Sahaptins in the Vancouver area, however, never clear before Tolmie's 1833 passage, is abundantly evident after that date. And though the people Tolmie saw in May 1833 probably arrived there on their own, it appears that the doctor encouraged them and their compatriots to settle near the fort. This is documented in more than one source. Most clearly, in 1878, George Roberts, who arrived in Oregon at the same time as Tolmie, recalled:

> we employed a great many Indians at Vancouver often 8 to ten ploughs & as many harrows running with them—mostly of the Thlicatat tribe, those Indians were hunters and root diggers & were kept away from the Fort by the river Indians until Dr Tolmie was trader & took a kindly interest in them. The Doctor was proud of having so many Indians employed & always held out to the missionaries that that was the way to civilize them to teach them to work. (Roberts 1962:183)

This passage suggests that Klikitats were employed at the fort farm, in the general area where Tolmie observed Indians dancing in 1833.

What is *not* clear about the Vancouver area Klikitats, however, is where they settled. The Reverend Herbert Beaver, in June 1837, stated, "Nearly two hundred of the Klickatack Tribe of Indians have congregated, for agricultural purposes, on a large plain about fourteen miles distant from the Fort, during the last summer (Beaver 1959:58). This passage could be the first (1836) reference to the Lewis River Taidnapam, but Beaver frustratingly does not give directions, so it could be north or east. In spring 1838, a newly arrived Methodist missionary, Margaret Smith (later Bailey), said in her journal:

> Been to ride with Dr. Tolmie to see the Indians' gardens in the lower plains. These are the first attempts they have made at agriculture....they have been assisted and instructed by this gentleman....the small plantations were neatly fenced and planted with potatoes and peas. (Bailey 1986:120)

It doesn't seem likely that a lady would be riding 15 miles, so this passage may indicate somewhere closer, perhaps the bank meadows just to the east of the fort where Tolmie saw Sahaptins dancing in 1833. In October 1838, temporary chief factor James Douglas said that Tolmie's "Sunday School," taught at the fort, was "attended in great numbers," which also implies proximity. (Douglas in McLoughlin 1941: 239) Also in October, however, the Reverend Beaver reported, "The Klickatack tribe...have not congregated this year at any one spot in such large numbers as during the last, nor have they been so successful in their agricultural pursuits, owing principally to a bad choice of soil..." (Beaver 1959:131), which suggests an unsettled nature for this people. In their early years near the fort, the Klikitats may have moved from place to place. This supposition may be supported by the HBC's late 1838 census of the fort-area Indians, which counts Klikitats, but, unlike the other two communities it enumerates, does not give a location for them.

THE CASCADES INDIAN SOUTHBANK WINTER SETTLEMENT

Sometime during late 1838, the HBC conducted a census of several Indian communities on the Lower Columbia. A census of the river-mouth Chinooks has come down to us in two secondary sources, but the three censuses of the Vancouver area Indians exist only in the manuscript records of the Hudson's Bay Company Archives in Winnipeg (Hudson's Bay Company 1838). Never published, the censuses are located in the archives' seldom consulted "z" series (censuses). For the purposes of this study the censuses are very important, as they record in some detail the demographics of three communities: (1) *Wakanasisi*, six miles below the fort; (2) the Vancouver area Klikitat, said to be "at Vancouver;" and (3) the "Cath-lal-thlalah Tribe summer village Columbia Cascades winter village Banks of the Columbia opposite Vancouver Language a dialect of the Chinook." The latter were definitely within the study area, though exactly where is not clear since later historic sources are similarly vague and since no archaeological remains for the settlement are yet known. But there are enough historic citations from the next fifteen years to establish the Cascades Indians' winter settlement's certain existence.

The data from the first printed copy of the "Cath-lal-thlalah" census is provided in Table 1. Some notes on the census:

- There were 130 individuals, not 142, in the encampment. First, "Total Population" numbers in the original were not correctly added, and the column (as presented) should total 132. Second, Skanth's family had only 6 members despite an entry of 8. Therefore, using the correct figure, the "Total Population" column would add up to 130.
- There were two heads-of-family named Chechum nak.

Table 1. 1838 Cath-lal-thlalah Census.

No	Indian's Name	Wives	Sons	Daugh-ters	Followers	Total Population	Canoes	Guns	Horses
1	Sy la mish	3	3	2	2	11	2	1	
2	Sak wak	2	1	1		5	1		
3	Sak a mo why nak				2	3	5	2	
4	Poch poch	1		1		3	1	3	
5	Tamagun	1			3	5	1	1	
6	Yakit alp	1				2	1		
7	Uchatie was	1				2	1	1	
8	Che chum nak	1	1	3	3	9			
9	Swa kiiks	2		2	5	10	3	1	
10	Tzily choose	1	1	3	3	9	1		
11	Chechum nak	1	1		5	8	3	2	
12	Chow a pan	1				2	1		
13	Tash wick	1				2	1	1	
14	Ta walh	1				2		1	
15	Lama coti	1	1			3	2	2	
16	Tama wash	1				2		1	
17	Kikelic					1		1	
18	Skanth	1		1	3	8	1	2	
19	Towallak	1				2	2	1	
20	Wakalli	1				2	1	1	
21	Qualthanash	1				2	1	2	
22	Quaya					1			2
23	Sly ach	1				2		1	
24	Kay coo eech	1				2		1	
25	Quallaskin	2	1	2	7	13	2	1	
26	Kaiach un	1	1	1		4	1	1	
27	Mah wainah	1		3	4	9	1	1	
28	Palai palai				1	2			
29	Soo eiluch	2	1	1	1	6			
		31	11	20	39	142	32	28	2

- "Followers" was the HBC circumlocution for slaves.
- Following the column for horses there was a final column labeled "Remarks." Only two heads-of-family merited entries in this column: Che chumnak #2 was called "Beaver trapper" and Qualthanash "liberated Slave."
- Breaking down the numbers, of 130 total people, 91 were free and 39 slave, for a slave percentage of 30. Among the free population, 60 were adults and 31 children, or 34 percent, indicating a healthy population maintaining its numbers; in addition, there were 40 males and 51 females, an unbalanced sex ratio probably due more to adult male mortality than any other factor.
- Wealth is indicated by size of family, numbers of wives and offspring, and numbers of canoes and guns. Out of 29 households, 5 were polygynous, and they had 14 children amongst them, or an average of three each. Guns and canoes were surprisingly equably distributed, with only a few families having more than two of each. The canoes were family necessities, and the guns may have been purposively parceled out by the HBC so that each family had one.
- Only one man had a horse, consistent with the Cascades Indians being "river people" and starkly different from figures for the Klikitat census, which noted 67 horses for 81 families, but only 24 canoes.
- Of the 29 named Cascades family heads, eight appear in Catholic Mission records between March 8, 1841, and July 16, 1848. They are, chronologically, Yakitalp = Yakeltasp, Kikelic = Kayekele, Poch poch = Pohpoh, Tamagun = Tamakwen, Tzilychoose = Zelaikos Taya, Quallaskin = Taye Kwalaske, Swakooks = Swakux, and Kaiachun = Kaiakan.

The census is the first definite documentation of the Cascades Indians' winter village, as its title reads "opposite Vancouver." The closest geographic precedent in the historical record is Lewis and Clark's *Neerchokioo*, several miles upriver on the south bank, also a seasonal Cascades Indian settlement (though in Lewis and Clark's time, it was occupied during summer, not winter). It may be that the Cascades Indians, like the Klikitats, were encouraged by the HBC to settle closer to the fort. We know that the Klikitats were farming and trapping and that the *Wakanasisi* people were fishing for the HBC; the Cascades Indians may have been similarly employed, though clear documentation of employment for the Cascades Indians is lacking. It may also be that there was a more reliable access to a steady source of sustenance and medical care opposite the fort than there was in isolated villages several miles upriver.

The second historical citation documenting the Cascades Indian settlement comes from November 14, 1839, in the journal of the American Thomas Farnham, who was traveling from Willamette Falls to Fort Vancouver.

> Five miles below the [Willamette] Falls[2], Mr. Lee and myself left the canoe, and struck across about fourteen miles to an Indian village on the bank of the Columbia opposite Vancouver. It was a collection of mud and straw huts surrounded and filled with filth which might be smelt two hundred yards. We hired one of these cit[izen]s to take us across the river. (Farnham 1843(2):219)

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[2] Although it is over 6 miles from the falls, Farnham probably refers to the Milwaukie area, where Kellogg and Johnson Creeks enter the Willamette.

Farnham and the Reverend Lee were apparently traveling overland, and consulting a map, if they landed at the mouth of Johnson Creek. Going due north would take them along the Crystal Springs branch of the creek and the lowlands of Eastmoreland, through inner-east and northeast Portland, and to the Columbia at the east tip of Tomahawk Island, the later location being that of Switzler's Ferry, which was established in 1846 to take people between the south bank and the fort. This is indeed directly across (due south) from the fort. This, of course, is a reconstruction, based on clues in Farnham's account and from consulting a modern map. In fact, "opposite" could refer to a relatively wide expanse of shoreline, including, most notably, the north side of Tomahawk Island.

The passage is provocative in other ways. Did Farnham and Lee follow an Indian trail? The route is the shortest direct line between the Willamette Falls villages and the Columbia banks in the Vancouver area. Travel by canoe between these two places would involve a long jog around the North Portland peninsula. Canoes could carry more cargo, of course, but overland was certainly the faster route. Note also in Farnham's passage the reference to "straw huts." This description recalls the temporary structures described by Lewis and Clark at Neerchokioo, the south bank settlement's likely predecessor.

The south bank of the Columbia was not the only bank that had Indian visitors during the HBC era. An 1884 recollection by Dr. Tolmie, referring to the period about 1840, mentions Indians on the north bank of the Columbia near Vancouver:

> ...at Vancouver, in summer 1840, a young hunter from Kiesno's village, Wakanasissi, known to the whites as "the fishery," a few miles below Vancouver, was very early one morning paddling upstream in quest of deer, observed in a sleeping camp of Calapooyas on Vancouver beach, lying still, under a faded green blanket, a middle aged woman he was, under contract with the Tuality Indians, to kill on sight. He shot the woman, and cooly continued his hunt. The doctor [McLoughlin] got Kiesno to bring the murderer to the fort, and had him in irons; for it was considered an affront to the whites for Indians to fight or to kill each other near a company's post. (Tolmie 1885:32–33)

Incidents like this are common in the early contact literature, but what is important for this report is the mention of "a sleeping camp of Calapooyas on Vancouver beach." The importance of the passage is that there were outsiders in the form of Calapooya Indians from the Willamette Valley camped on "Vancouver beach," indicating occupation by Indian visitors on both the north and south banks during the HBC era.

WILKES EXPEDITION (1841) RECORDS

In 1841 the HBC's Northwest was visited by the "United States Exploring Expedition" under Commander Charles Wilkes. The members of the expedition spent much of their time around Fort Vancouver, and there are voluminous records of their travels and observations, in both the five-volume published narrative and several unpublished manuscript accounts by expedition members. The Wilkes party also surveyed the banks of the Columbia in the Vancouver area and produced maps showing contemporary shorelines, island outlines, and river depths. The expedition journals are very good on topography of the time, and all their information is exceedingly valuable in determining Native American settlement and land use in the pre-settlement era.

For instance, Wilkes himself describes the topography of the then Hayden and Pearcy Islands (the latter now part of the mainland). Going downriver:

> The Columbia at Vancouver makes a considerable angle, and is divided by two islands, which extend upwards [*sic:* north-northeast] about three miles, to where the upper branch of the Willamette [the contemporary Willamette mouth] joins it. The shores of these islands are covered with trees, consisting of ash, poplars, pines, and oaks while the centre is generally prairie, and lower than the banks: they are principally composed of sand. During the rise of the river in May and June, the islands are covered with water, that filters through the banks that are not overflowed. (Wilkes 1845:327–28)

This brief passage explains why there are no historic/ethnographic citations for Indian settlements on Hayden Island during the summer: it was overflowed. This is also a negative reason, perhaps, for the limitation of the Cascades settlement to winter over.

The highs and lows of the Columbia in 1841 were vastly different, both between seasons and compared to the relative stability they exhibit today. This also effected Indian settlement. From May 30, 1841:

> I witnessed the Columbia at its greatest and least heights and no idea can be formed of it unless seen at both these epochs. The flood is a very grand sight from the banks of the river at Vancouver as it passes swiftly by, bearing along the gigantic forest trees, whose immense trunks appear as mere chips. They frequently lodge for a time, in which case others are speedily caught by them, which obstructing the flow of water, form rapids, until by a sudden rush the whole is borne off to the ocean....Quantities of fine sand are borne along, and being deposited in the eddies, rapidly form banks, which alter the channel in places to a great degree. (Wilkes 1845:337)

This was a dynamic, always shifting environment.

One way of avoiding summer rapids such as Wilkes describes, would be for Native Americans to shift their focus to sheltered sloughs and backwaters. In the study area vicinity, this would probably have included the Columbia Slough and the calmer waters along the south side of Hayden Island. The following passage refers to Lake River, several miles downstream on the north shore. On August 1, 1841, George Emmons recorded in his journal:

> Upon this prairie farm there is a Lake or narrow sheet of still water [Vancouver Lake] that connects with the Columbia many miles below and during high water is generally ascended by the Indians in their canoes, to avoid the rapid current in the River. The portage at the head of this Lake being narrow, is easily overcome with light canoes. (Emmons 1841)

In other words, Indians canoed up placid Lake River from its mouth north of Ridgefield to Vancouver Lake to avoid the rapid summer flow of the Columbia, and then portaged the short distance between the south bank of Vancouver Lake and the Columbia near Vancouver. Emmons's is the only reference to such a portage[3], but his description makes eminent sense, given the contemporary hydrology. The exact location of the Vancouver Lake–Columbia portage is not known, but it was probably downstream from the study area.

The Emmons journal also describes Indian activity on the flat lands between the fort and *Wakanasisi*. This passage is from August 1, 1841, as well.

[3] Other than Wilkes' rewording in his diary (1925–1926:37).

> Saw several families of Indians encamped under the shade of large oaks in the Prairie. The boughs of the latter were their only covering. Miserably clad, ugly, and dirty in the extreme, they had some wild ducks, hazelnuts, & several kinds of berries some of their childrens heads were in the process of being flattened... (Emmons 1841)

This passage almost certainly describes Chinookans, as their heads were flattened and there is no mention of horses, hide clothing, or even temporary structures that might identify them as Sahaptins. Despite its clear ethnocentrism concerning cleanliness, the passage is valuable for what it says about summer subsistence activities: ducks, hazelnuts, and berries, and shelter under Oregon oaks. Similar summer scenes must have been duplicated in prairie areas throughout Chinookan lands and in the Kalapuyan Willamette Valley. Emmons could have seen these people anywhere within the study area.

Yet another Wilkes Expedition journal, that of William Hudson, may describe the seasonal arrival of Cascades Indians, and again seems to refer to the north bank. It is dated September 2, 1841.

> The number of Indians have very much increased at Vancouver since our arrival whole families living in tents (made of 4 sticks with a hide or old matting thrown over the top) on the beach—Those families are overrun with dogs—and live in the most filthy disgusting state. It is not a little singular that we have a concert from the canine tribe—or dogology—every evening...with the utmost regularity and generally lasts from 5 to 8 minutes. (Hudson 1841:373)

Again, note the temporary structures and unfortunate hygiene. Dogs were staples of most Indian settlements.

In late August and early September 1841, a small party of Wilkes's people under Edward deHaven surveyed the Columbia River in the vicinity of Fort Vancouver. DeHaven's notes are available on microfilm; however, the most important product of his survey is a series of maps, long available only in manuscript, but copied in 1970 by the National Ocean Survey, and available in a few libraries nationally (including the library of the Oregon Historical Society). The two maps from the Vancouver area show a riverine topography which is broadly similar, but different in details from that of today (Wilkes 1970 [1861]). Mainland banks both north and south appear much as they are now, but the configuration of Hayden and Tomahawk Islands is significantly different, as one might assume, considering Wilkes's own statements on the constantly shifting river features of the time.

Hayden and Tomahawk were then three islands named (west to east) McTavish, Joe, and Barclay Islands. Joe Island comprised the extreme northeast end of what is now Hayden Island, the area now spanned by the I-5 bridges. It was separated from Hayden Island by what was called "Division Creek," a sinuous stretch starting (on the north) to the west of the present-day bridges, assuming a north-south direction about mid-island, and exiting to the south about where the I-5 bridges now cross to the Oregon side. Barclay Island was roughly equivalent to modern Tomahawk Island, separated from Joe by a very narrow slough. For the purposes of this report, it is the north banks of Joe and Barclay Islands that are of interest. Both show a smooth shoreline in a gentle arc south-southwest of the fort, with Joe extending at its northernmost point a bit farther into the river than Hayden does today. Shallow river depths and a dotted line extending out from the eastern extremity of Barclay Island on the 1841 map indicate a bar or sandbank. Barclay Island's north bank shows none of the lagoons or indentations present today on Tomahawk Island, indicating that if the Cascades Indians' winter settlement was on the north bank of Barclay Island, much of it is now gone or has been altered significantly.

EARLY 1840S: CATHOLIC RECORDS AND THE BRITISH WARRE EXPEDITION JOURNALS

The next citation, from September 1841, comes from the Cascades rapids, but refers to the imminent departure of the people there to the area of Fort Vancouver. It is in the journal of Francis Norbert Blanchet, senior member of the first group of Catholic missionaries to the Northwest.

> I left on the 14th of September for the Cascades….The good Tamakoun came before me to clasp my hand; the rest imitated him….On the 20th the natives made preparations for departure; they leave the summer encampments and move to winter on the Vancouver islands, where the cold is less rigorous and hunting more abundant. (Landerholm 1956:88–89)

The timing of the move—September—is consistent with Hudson's passage, above, though a few weeks later. "Tamakoun" is the "Tamagun" of the 1838 census. He was a head chief of the Cascades Indians, and died in the measles epidemic of 1848. The mention of the "Vancouver Islands" in this passage is interesting in its vagueness. It suggests that the Cascades Indians camped on an island, possibly the islands referred to by Wilkes as Joe and Barclay Islands, not the south shore mainland. And since it is plural, it could also include the former Pearcy Island and maybe even the fever-abandoned Columbia shore of Sauvie Island.

A year later Blanchet again noted "the Cascade Indians…moving yearly in October, on the left shore of the Columbia, nearly opposite Vancouver, brought them near to the priest" (Blanchet 1983:111). Then from the second week of October 1842, he describes the Indian mission at Fort Vancouver. Though the passage from his journal is not specific as to location, entries from the Mission record book suggest it may have included the Cascades Indian settlement.

> I gave myself over to the instruction of the women and children of the native village, who did not understand French. After three or four weeks of repetition from morning to evening, about fifteen were capable of making the sign of the cross and reciting the first prayers of the Christian….The diversity of languages met with at Vancouver, the gathering place of several tribes, the difficulty of learning them, and above all the lack of time have induced me to use the jargon, which is understood and spoken almost every where….Not having any time to visit the lodges around about, two Christian women were charged with assembling the native children to present them at the baptism. At the close of the mission I counted seventy-six baptisms, of which fifty-five were of children of infidels, nine marriages and fifteen baptisms of children of the faithful. (Blanchet in Landerholm 1956:169–70)

From the Mission record book (Munnick 1972), November 21, 1842: "…baptized at the Village of Pohpoh on the left bank of the Columbia the following [10] children, namely…"[4] The "left bank" is the south shore. Whether it was on an island or the mainland is not clear. The name "Pohpoh" is interesting, because it appears both in the 1838 census and elsewhere in the contemporary Catholic records as the name of a chief at Willamette Falls (Blanchet in Landerholm 1956:79–86, 91–95). Perhaps these were two separate individuals, but the identity of names could also indicate the interesting possibility that Pohpoh was a prominent man in both places, with widespread family ties in the area, who moved with the seasons between Willamette Falls, Vancouver, and the villages at the Cascades Rapids. On November 26, the record book

[4] Parentage of each of the ten is given, and though none of the fathers' names is clearly from the 1838 census, the forepart of several appears close.

states: "baptized the [4] children following...at the camp of chief Tamakoun." There is no indication that a priest took a trip upriver to the Rapids, and since this passage was written only five days after the baptisms conducted at the Vancouver camp of the Cascades Indians, the baptisms on November 26 almost certainly took place there also.

The Catholic records from Fort Vancouver list "Cascades" vital events (baptisms, marriages, deaths) for 13 seasons (July to June, reflecting Indian seasonal movement patterns) between 1838 and 1852 (Munnick 1972). Not many of the citations contain information on *where* the events took place—at the fort, at the winter encampment, or at the Cascades rapids. Only a few entries refer specifically to either of the latter places. But by listing all entries relating to the Cascades Indians (54 by this writer's count), a pattern emerges. There are 11 entries concentrated between August and October 1844 (coincident with a dysentery epidemic) and 11 between November 1847 and February 1848 (during the time of the well-known Northwest measles epidemic). Dropping these 22 leaves a body of 32 entries. Of these, there are no entries relating to the Cascades Indians for April, two each for May through August and December-January, three each for September through November, and five apiece for February and March. The pattern, though not strong, exhibits enough clustering to suggest that most contact with "Cascades" occurred between September and March annually, the time when those people were in residence across from the fort. The low numbers (two each) for December and January may reflect winter weather, when the priests probably did not do much traveling. So it is this writer's hypothesis that most citations referring to Cascades Indians in the Catholic records from 1838 to 1852 do indeed refer to the winter encampment. If real, this represents a sizable body of citations.

The records for the 1844 dysentery epidemic, which began in July, indicate that Cascades Indians fled to the fort before the usual time (September) they would have left for the winter encampment. Jesuit Pierre de Smet, visiting the fort, said (August 5 or later)

> ...the Indians of the Cascades, large parties of whom encamped along the banks of the river, on their way to Vancouver, to obtain the aid of a physician. Those who could not proceed were abandoned by their friends; and it was truly painful to see these poor creatures stretched out, and expiring on the sand....more than a tenth of the Indians of the neighborhood had been swept off by a mortal disease; happily, they all had the consolation of receiving baptism before they expired. (de Smet 1906:167, 179)

Thomas Lowe's fort journal entry of August 16 says, "Many of the Cascade Indians have come down here in consequence of the prevalence of the Dysentery amongst their tribe" (Lowe 1843–1848). The HBC doctor at the time was Forbes Barclay, who treated the ill with calomel and castor oil, and reported that "Four hundred Indians died of the disease in the vicinity of the Fort" (Dunn 1846) What "vicinity" meant is not clear, but the Indians treated by Barclay almost certainly included some from the Cascades rapids, reflecting a probable decrease in their numbers that would be accelerated in the next decade by measles and smallpox epidemics.

During the winter of 1844–1845, a second exploring expedition, this time British, conducted by Henry Warre and Mervyn Vavasour, set up headquarters at Fort Vancouver. Labeled "secret," for many years Warre's lengthy journals were only accessible in Britain. They have never been published in their entirety, but examination of microfilm copies from the Public Archives of Canada reveals more information about the Cascades Indians' winter settlement. One of the earliest Warre citations, however, refers to Indians on what was apparently the north bank.

> The presence of the "Modeste" has attracted more than the usual Number of Indians to this neighbourhood & they are camped along the River bank and in the Woods. These Indians are miserable dirty specimens....Their houses are filthy and built of rough planks,

> some laid simply across a ridge pole, having an open space in the centre for a chimney. Others are roofed and made larger. Their sleeping boxes are ----lly raised a few feet above the ground & the fire is sunk in a square pit in the middle of the Chamber. They make nothing to attract the curious but their rush mats and a coarse rush Basket. (Warre 1845–1846:1284)

The *Modeste* was the ship that brought the British, and this passage reflects the ethnocentrism and culture shock that often accompanied initial impressions. The mention of two types of dwellings is interesting, though since it is not specific as to location, we cannot be sure what it means. The temporary structures were certainly located "along the River bank," but it is not clear that the more substantial ones were. There are, in fact, only a few historical citations that suggest that structures along the river bank may have included plank houses.

One of the most interesting descriptions in the Warre journals concerns "a little war" that occurred in the Vancouver vicinity, apparently in late January 1846. A chief player was "the Chief of the Village opposite the fort," so it is highly relevant to this study. Following is a reconstruction of the "war" that combines passages from Warre's two descriptions, the original (Warre 1845–1846:1478–81) and the more polished version (Warre 1845–1846:2031–41).

> The Indian population in the neighbourhood of Fort Vancouver have been in a most excited state for the last few days in consequence of a Tribe from the Interior having come down the River to avenge the death of a Comrade. It appears that the Chief of the Village opposite the fort on returning to his Lodge, discovered that one of his Wives had been seduced by a 'Brave' from the Village about 30 miles higher up the River. The chief very unceremoniously took the law into his own hands (the usual course, by the way, in this Country) and shot the offender. He being of some consequence & related to the chief of the village above, could not be overlooked without some reparation made to the relatives of the deceased. The chief refused to give the required number of Blankets &c, War was the consequence. About 70 warriors mustered on the Plain, near Fort Vancouver, painted & bedaubed most fiercely & armed with such weapons & implements of destruction as they could obtain. They…crossed the River…[and] landed near the devoted[?] village….They commenced firing very long shots, but lacking such very good care to conceal themselves that they could not see their enemies….near a hundred rounds of ammunition was expended and the Casualties were I believe, but one wounded….Their ammunition being exhausted, and not choosing to come to close quarters….It was some days before peace was made; and it was amusing to see the number of Indians scampering about, collecting their forces, in different parts of the Country: painted to the teeth & armed with such implements of death as they could get hold of. The most cruel part of the whole affair, was, the friends of the deceased Indian, murdering a poor woman related to the other party at the Indian village on the Clackamas River about 2 miles below the falls & 25 miles from the scene of action. The poor woman was asleep in her lodge, when some rascal shot her, the Ball entering the shoulder, broke her arm & leg; from the position in which she was sitting [sleeping?] the murders —— —— remained about the Falls, walked round the neighbourhood, for a week, and attended, on one Evening, a debating society. (Boyd 2008)

Geographically, the "war" was centered on the winter encampment, and involved people from the Cascades rapids ("thirty miles higher" should have been one of the Lower Cascades villages, Lewis and Clark's *Clahclellah*, *Wahclellah*, or */swapapani/*) and the Clackamas village at present-day Gladstone below Willamette Falls. All these were Chinookan settlements, and historical sources verify both seasonal movements and marital ties among those residing at all three locations. But in the polished version of Warre's "war," the upriver man is stated to have come from "a Tribe from the Interior," so he may have been Klikitat/Sahaptin. The "war" was a typical Lower Columbia affair, starting with an extra-marital relationship by a chief's wife, the murder of her paramour by her husband, the attempted resolution by the dead man's relatives with gifts, refused by the killer, escalation in the form of confrontation between two armed sides, much bluster and exchange of gunfire, only one wounded, and the later surprise murder by a relative of the killer which apparently settled scores (restored balance) with no other hostilities reported. Such "wars," really overgrown feuds, involving displays of fierceness and few casualties, are recorded elsewhere from the Lower Columbia (especially in the Astoria Journal [McDougall 1999]).

From 1846 to 1847, the best-known historical document from the Fort Vancouver area is Paul Kane's *Wanderings of an Artist Among the Indians of North America* (1859 [reprinted in Kane 1971]). Kane, however, was only in the area between December 8, 1846 and January 10, 1847; was an artist, not a writer; and his narrative is now known to have been written by someone else (who is not certain). Several of his paintings were most likely done within the study area, including IV-420, "Indian on a race course near Fort Vancouver with a head dress of beads;" IV-422, "Klikitat Indian;" IV-424, "...interior of a lodge at Fort Vancouver;" IV-426, "temporary lodge of the Chinook;" IV-428, "Klikitat lodge;" and IV-429, "Chinook traveling lodge with view of Mount Hood" (Kane 1971).

Other paintings were executed farther away from the fort, perhaps at *Wakanasisi* and certainly at Clackamas. *Wanderings* contains several passages that refer to Indians in this broader area. Some are more likely to describe Indians and customs adjacent to the fort than are others, though it is not possible to pin down which ones. The definitive *Paul Kane's Frontier* (which includes the text of *Wanderings* plus the largest printed selection of his paintings) contains relevant descriptions of slavery, camas, processed acorns, clothing, gambling, games, and structures (Kane 1971:92–95). Items that may have archaeological/land use significance include references to acorns, processed in pits near houses; a game similar to lacrosse, which was played in large open areas;[5] and structures, including plank houses and temporary dwellings. Kane describes Chinook "traveling lodges" thusly: "During the season the Chinooks are engaged in gathering camas and fishing, they live in lodges constructed by means of a few poles covered with rush mats" (Kane 1971:95). This description should be compared to Kane's painting IV-429 and the more cryptic passages describing temporary structures mentioned elsewhere in this report.

Between November 1847 and February 1848 the Catholic registers contain 11 references to Cascades Indians, mostly deaths, burials, and baptisms related to the 1847–1848 measles epidemic. An entry from December 16 specifically names the south bank winter camp: "baptized on the left bank of the Columbia, across from the fort, the 4 children of the Cascades..." (Munnick 1972). Each child (all girls) is named, as are her parents. One father, "Swakux," is clearly the same as "Swakooks" on the 1838 Cath-lal-thlalah census; the others are not so identifiable.

1848–1855: DENOUEMENT AND REMOVAL

References to the south bank winter camp after 1847 are brief and scattered, perhaps reflecting cumulative mortalities from the 1844 dysentery and 1847–1848 measles epidemics. For most of the following sources I am indebted to archaeologist David Ellis, who identified them in the course of his work at 35MU119 near the Portland Airport (Ellis 2002). The most important of

[5] Note painting IV-420, above, "on a race course near Fort Vancouver."

these sources is the set of 1851 General Land Office (GLO) survey notes compiled by Butler Ives. The GLO maps do not indicate structures, but Ives's survey notes site two camps in Section 1 of T1N, R1E, or in the general area of the Columbia South Shore between the tip of present-day Tomahawk Island and the west end of the Portland Airport. The relevant passages are: "To an Indian encampment there is several cabins huts &c being their winter quarters" and "To an Indian encampment with 3 or 4 cabins" (Ives 1851)

These brief passages are the only sources that actually site Indian structures, instead of saying merely "opposite Vancouver," or the like. Since they were stated to be "winter quarters," they almost certainly refer to the Cascades Indians' camp. Notably, the two sites are *not* directly across from the fort or on present-day Tomahawk Island, but a bit to the east (though still within the study area). This could mean several things: (1) that the early references saying "opposite" should not be taken as referring only to the area directly across the river from the fort itself, but across from the larger fort vicinity; (2) that the encampment was strung out over a long extent of river bank; or (3) that the encampment shifted slightly from year to year. Any one of these interpretations makes sense given historical, ethnographic, and hydrological patterns.

Another 1851 source suggests that there was a camp on present-day Hayden Island, as well. This is from a pioneer reminiscence from a Hayden family descendant. In 1916, Mary Jane Hayden recalled:

> In 1851 the Haydens moved to the island….Indians still lived in the vicinity, and Mrs. Hayden said her nearest neighbors were a camp of the Native Americans on the north bank. Other camps were not far away. Hayden Island was a hunting ground for Chief Tamitus, later killed in the 1855–56 war. (Hayden 1979:43)

During mid-July through mid-August 1853, a railroad survey party under George McClellan traversed what was then called the "Klikitat Trail," an aboriginal path connecting several plains and resource areas between Fort Vancouver and the Yakima Valley (McClellan 1853). This was apparently the "war road" of the Cayuse and Nez Perce mentioned by John Work in 1830. It has been hypothesized that, prior to the introduction of the horse to western Washington, the trail was a collection of short routes connecting interior resource areas accessible by foot, and that after the introduction of horses in the second decade of the nineteenth century it became a long-range transportation route connecting the Portland Basin and the Columbia Plateau. The beginnings of the trail were the plains on which the fort was sited, called by George Simpson "Jolie Prairie" (Simpson 1931:64); Paul Kane "Katchutequa, or 'the Plain'" (Kane 1971:91); and in Spier and Sapir's (1930:222) *Wishram Ethnography* transcribed as */sketcu'txat/*"[6], the Chinookan term. Tolmie (1885:31) added "Vancouver: named by the Tshinook Skit-so-to-ha, and by the Klikitat Ala-si-kas, or the place of mud turtles [Western Pond Turtle]." We already know from previous references that the lower plains were camas-gathering areas (Douglas 1959:105); were favored by deer and elk (Simpson 1931:111); and that Chinookans also took ducks and gathered berries and hazelnuts in the area (Emmons 1841).

From the fort plain the Klikitat Trail proceeded north-northeast through Clark county, connecting First through Fifth Plains (all with Indian names recorded by the McClellan party), to Yacolt and Chelatchie Prairies, to clearings along the upper Lewis River, and then into the mountain huckleberry areas of the high Cascades. Besides sketcu'txat/alasik'as, First Plain or "Wahwaikee"

[6] As there is no historical reference to an Indian settlement at this area, the earliest accounts (e.g., Lewis and Clark, Henry, above) note only landscape features, and (so far) no archaeological indication of a village, this writer believes that Emory Strong's (1959:34) "The Vancouver Shipyard at Vancouver is built on a large village site that was called Sketcu'txat" is a misinterpretation of Spier and Sapir (1930:222).

(/wawaci/ or "acorn" in Sahaptin) is close to the study area. Like almost all the other prairies along the Klikitat Trail, it was an important resource area, but apparently not an area of settlement, for the local native peoples. The McClellan journals mention salmonberry, wild rose, and Oregon grape (all foods) on the plain, and hazel along the trail. McClellan says "The 1st plain is a small prairie nearly circular and almost ¼ mile in diameter—the grass is good" (McClellan 1853) and another expedition journal calls it "nearly circular in form" with trees "which form a very sharply defined border around it" (Cooper 1853), clues that its shape and plant cover may have involved some sort of purposeful management. Many of the other prairies along the trail exhibit similar characteristics. The journals also note fireweed on /wawaci/, then in bloom (Norton et al. 1999). Borders of First Plain and the other lower trail plains are clearly depicted on George Goethals's (1883) *A Map of the Country in the Vicinity of Vancouver Barracks, Washington Territory.*

Sub-Indian Agent William Tappan's September 30, 1854 annual report is one of the most important contemporary documents on the Native peoples of Clark County. Since Tappan was sub-agent for Washington Territory, however, his report does not include any information on south bank settlements. There are descriptions of Taidnapams at Kalama and the Lewis River, of the Chinookan Wakanasisi village, and of Klikitat settlements east of the fort and at the Cascades rapids. However, a suggestive passage can be found in Tappan's description of Wakanasisi: "There is also a band who live at the fishery in summer, and on Columbia island in spring and winter" (Tappan 1854). "Columbia Island" most likely corresponds to Sauvie Island, directly across the river from Wakanasisi.

In autumn 1855, with the Yakama War threatening settlements in Clark County, Superintendent of Indian Affairs Joel Palmer instructed his local agent Lot Whitcomb to collect all Indians on the Oregon side of the Columbia and place them, for safety's sake, in temporary reservations. The following comments are found in communications between Palmer and Whitcomb in the microfilm Records of the Oregon Superintendency of Indian Affairs:

1) Palmer to Whitcomb, October 19, 1855: "You will proceed to the Indian Village on the bank of the Columbia river a few miles above Switzler's and direct those Indians to repair at once to the designated encampment..."

2) Whitcomb to Palmer, November 11, 1855: "I have collected all the Indians on the south side of the Columbia river between the mouth of the Sandy and Willamette Rivers, together. Encampment three miles above Mr. Switzers number near one hundred—all quiet and friendly—no fears of outbreak entertained on the part of the whites."

Both references are to a settlement near the present-day Portland Airport, but the wording suggests any additional Indians living on the south bank were also removed to the designated encampment.

In the last week of March 1856, the white settlement at the Cascades rapids was attacked, resulting in fatalities on both sides. As elsewhere in the Northwest, settlers fled to blockhouses and cities for safety. Another pioneer reminiscence, from Elizabeth Holtgrieve, mentions another south bank Indian camp apparently inhabited by Indians not yet removed to the temporary reservation:

> Indians had attacked the Cascades, and everyone on the Oregon side from Sandy River [was to] go to Portland....my husband...came on down to the Millard house and...went on down to the ferry. He...had to pass an Indian camp....When he came to the Indian

> camp he found several women and one man looking up the river. One woman said she was afraid her people were killed. (Atwell 1974:101)

Holtgrieve's reminiscence is the last known reference to an Indian winter encampment on the south bank. The reservations to which the various Cascades Indians were assigned were determined by where they were residing during the war years of 1855–1856. Some descendants are now enrolled at Grand Ronde, Oregon; others are enrolled at Yakama, Washington. In addition, because of the mixing of Clark County Indians (Taidnapam, Klikitat, Wakanasisi and Cascades) at the temporary Vancouver and White Salmon reserves between 1855 and 1857, there was intermarriage and Cascades blood is represented in the Cowlitz tribe. All these descendant groups have a historical interest in the Indian encampment "opposite Vancouver."

REFERENCES CITED

Atwell, Jim
1974 *Columbia Gorge History,* Vol. 1. Tahlkie Books, Stevenson, Washington.

Bailey, Margaret Smith
1986 *The Grains, or Passages in the Life of Ruth Rover.* Oregon State University Press, Corvallis.

Beaver, Herbert
1959 *Reports and Letters, 1836–1838, of Herbert Beaver*, edited by Thomas Jessett. Champoeg Press, Portland.

Blanchet, Francis Norbert

1983 *Historical Sketches of the Catholic Church in Oregon*, edited by Edward Kowrach. Ye Galleon, Fairfield, Washington.

Boyd, Robert
1996 *People of The Dalles: The Indians of Wascopam Mission.* University of Nebraska Press, Lincoln.

2008 Cathlapotle and its Inhabitants, 1792–1860. Draft report prepared for U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

Cooper, James
1853 *Notebook.* Smithsonian Institution Archives, Record Unit 7067. Washington, D. C.

Douglas, David
1959 *Journal Kept by David Douglas during His Travels in North America, 1823–1827.* Antiquarian Press, New York.

Dunn, J. R.
1846 *Journal on H. M. S. Fisgard.* Public Record Office, Adm. 101/100.r XC A/3930. Kew, Surrey, England.

Ellis, David V.
2008 *Archaeological Excavation at 35MU119, Portland, Oregon.* Archaeological Investigations Northwest Report No. 243. Portland.

Emmons, George F.
1841 Journal Kept While Attached to the South Sea Surveying & Exploring Expedition on Board the U.S. Sloop of War Peacock. W. L. Hudson Esqr. Commander, Vol. 3. Western Americana Collection, WA ms. 166. Beinecke Library, Yale University, New Haven, Connecticut.

Farnham, Thomas
1843 *Travels in the Great Western Prairies, the Anahuac and Rocky Mountains, and in the Oregon Territory.* R. Bentley, London.

Gairdner, Meredith
1841 Notes on the Geography of the Columbia River. *Journal of the Royal Geographic Society* 11:250–257.

Goethals, George
1883 A Map of the Country in the Vicinity of Vancouver Barracks, Washington Territory. On file, Clark County Historical Society, Vancouver, Washington.

Hayden, Mary Jane
1979 *Pioneer Days.* Reprinted. Ye Galleon Press, Fairfield, Washington. Originally published 1915, Murgotten Press, San Jose, California.

Henry, Alexander
1992 *The Journals of Alexander Henry the Younger,* Vol. 2, *The Saskatchewan and Columbia Rivers,* edited by Barry Gough. Champlain Society, Toronto.

Hudson, William
1841 Log 1840–42. Manuscript on file, University of North Carolina, Charlotte.

Hudson's Bay Company
1838 Census of Indian Population at Fort Vancouver: Klikitat Tribe, Cathlacanasese Tribe, Cath-lal-thlalah Tribe. MS B.223/z/1, fols. 26–28. Hudson's Bay Company Archives, Winnipeg.

Ives, Butler
1851 Field notes of the survey of the Subdivisional lines of township one north of range one East of the Willamette meridian. Microfiche, USDA Bureau of Land Management, Oregon State Office. Portland.

Kane, Paul
1859 *Wanderings of an Artist Among the Indians of North America, from Canada to Vancouver's Island and Oregon Through the Hudson's Bay Company's Territory and Back Again.* Longmans, Brown, Green, Longmans, and Roberts, London.

1971 *Paul Kane's Frontier, Including Wanderings of an Artist Among the Indians of North America*, edited by J. Russell Harper. University of Texas Press, Austin.

Kennedy, Alexander
1824–1825 Report, Fort George District, Columbia Department. MS B.76/e. Hudson's Bay Company Archives, Winnipeg.

Landerholm, Carl (translator, editor)
1956 *Notices and Voyages of the Famed Quebec Mission to the Pacific Northwest.* Oregon Historical Society, Portland.

Lowe, Thomas
1843–1848 Private Journal kept at Fort Vancouver. Mss E/A/1.95A. Royal British Columbia Archives, Victoria.

McClellan, George
1853 Journal [May 20–December 11]. Microfilm A228. University of Washington Libraries, Seattle.

McDougall, Duncan
1999 *Annals of Astoria: The Headquarters Log of the Pacific Fur Company on the Columbia River, 1811–1813*, edited by Robert F. Jones. Fordham University Press, New York.

McLoughlin, John
1941 *The Letters of John McLoughlin from Fort Vancouver to the Governor and Committee: First Series, 1825–38*, edited by E. E. Rich. Champlain Society. Toronto.

Minor, Rick, Kathryn Anne Toepel, and Stephen Dow Beckham
2007 *Interstate 5 Columbia River Crossing—Archaeology Technical Report.* Heritage Research Associates Report to Columbia River Crossing Project, Vancouver, Washington.

Munnick, Harriet (editor)
1972 *Catholic Church Records of the Pacific Northwest: Vancouver, Vols. 1–2, and Stellamaris Mission.* French Prairie Press, St. Paul, Oregon.

Norton, Helen, Robert Boyd, and Eugene Hunn
1999 The Klikitat Trail of South-central Washington: A Reconstruction of Seasonally Used Resource Sites. In *Indians, Fire, and the Land in the Pacific Northwest*, edited by Robert Boyd, pp. 65–93. Oregon State University Press, Corvallis.

Palmer, Joel
1855 Letter of October 19 to Lot Whitcomb. Records of the Oregon Superintendency of Indian Affairs, microfilm copy M2 Roll 5, p. 357. Portland State University Library. Portland, Oregon.

Roberts, George
1962 Letters to Mrs. F. F. Victor, 1878–83. *Oregon Historical Quarterly* 63(2):175–244.

Ross, Alexander
1849 *Adventures of the First Settlers on the Oregon or Columbia River: Being a Narrative of the Expedition Fitted Out by John Jacob Astor, to Establish the "Pacific Fur Company;" with an Account of Some Indian Tribes on the coast of the Pacific.* Smith, Elder, and Co., London.

1974 [1821, updated 1849] Map of the Columbia. Friends of the Ellensburg Public Library, Ellensburg, Washington.

Scouler, John
1905 Dr. John Scouler's Journal of a Voyage to N.W. America. *Oregon Historical Quarterly* 6:54–75, 159–205, 276–287.

Simpson, George
1931 *Fur Trade and Empire: George Simpson's Journal; Remarks Connected with the Fur Trade in the Course of a Voyage from York Factory to Fort George and back York Factory 1824–1825, Together with Accompanying Documents*, edited by Frederick Merk. Harvard University Press, Cambridge, Massachusetts.

De Smet, Pierre-Jean
1906 *De Smet's Oregon Missions and Travels over the Rocky Mountains, 1845–46*, edited by Reuben Thwaites. Early Western Travels, 1748–1846, Vol. 29. Reprinted. Arthur H. Clark Co., Cleveland. Originally published 1847, Edward Dunigan, New York.

Spier, Leslie
1935 The Prophet Dance of the Northwest and Its Derivatives: The Source of the Ghost Dance. *General Series in Anthropology* 1. George Banta, Menasha, Wisconsin.

Spier, Leslie, and Edward Sapir
1930 *Wishram Ethnography.* University of Washington Press, Seattle.

Strong, Emory
1959 *Stone Age on the Columbia River.* Binfords and Mort, Portland, Oregon.

Tappan, William
1854 Annual Report, Southern Indian District, Washington Territory. Cathlapootle, Wash Terr Sept 30, 1854. Microfilm copy of the Records of the Washington Superintendency of Indian Affairs, Washington D.C. University of Washington Library, Seattle.

Tolmie, William
1963 *The Journals of William Fraser Tolmie: Physician and Fur Trader.* Mitchell Press, Vancouver, Washington.

1885 Letter. In *Transactions of the Oregon Pioneer Association for 1884*, pp. 24–37. E. M. Waite, Salem.

Warre, Henry
1845–1846 Journal. MG 24, F71, Vols. I–III. Public Archives of Canada, Ottawa.

Whitcomb, Lot
1855 Letter of November 9 to Joel Palmer. Microfilm copy of the Records of the Oregon Superintendency of Indian Affairs, M2 Roll 5, p. 361. Portland State University Library, Portland, Oregon.

Wilkes, Charles
1845 *Narrative of the United States Exploring Expedition During the Years 1838, 1839, 1841, 1842*. Lea and Blanchard, Philadelphia.

1925 Diary of Wilkes in the Northwest. *Washington Historical Quarterly* 16:49–61, 137–145, 206–223, 290–301.

1926 Diary of Wilkes in the Northwest. *Washington Historical Quarterly* 17:43–65, 129–144, 223–229, 289–299.

1970 [1861] "Columbia River," sheets 5 and 6. In *Hydrography*, *Atlas of Charts*, Vol. 23. Reprinted. National Ocean Survey, Washington, D.C. Originally published by C. Sherman & Son, Philadelphia.

Work, John
1824 Journal. Ms. No. 219. Oregon Historical Society, Portland.

1909 Journal of John Work: April 30th to May 31st, 1830, edited by T. C. Elliott. *Oregon Historical Quarterly* 10:296–313.

APPENDIX 1B-III:

TESTING OF GROUND PENETRATING RADAR (GPR) IN COLUMBIA RIVER FLOODPLAIN SETTINGS ON THE OREGON SHORE

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Artificial fill is known to cover Hayden Island and to underlie the I-5 corridor extending across the Delta Park floodplain. However, no mention of fill was made in many of the logs recorded for the earlier geotechnical boreholes (1950s–1970s) drilled in this area (Peterson 2007). The lack of information about the depth of fill hindered the development of a research design for archaeological testing in advance of the CRC project. For this reason, GPR was proposed as a means to establish depth of fill in the CRC project area on the Oregon shore (Minor and Peterson 2008).

Based on historical aerial photographs, a geomorphic analysis of the CRC project area on the Oregon shore was conducted for the mid-historic period (1936), which antedated impoundments on the Columbia River and commercial development of the Delta Park floodplain (Figure 1). From the historical aerial photographs, channel levees were identified as having the highest potential as settings for archaeological sites (Peterson 2007). Intervening areas containing back-levee deposits presumably would have less potential for containing archaeological remains because of their susceptibility to seasonal inundation.

Floodplains like the south shore of the Columbia River in the CRC project area contain a wide variety of depositional settings, and corresponding lithologies and stratigraphic sequences. However the terminal deposit is typically a mud drape that accumulates in back-levee settings, following channel abandonment. The mud drape is frequently laminated, representing cyclic flooding, and it is often rooted by wetland vegetation. Deeper soils, between 15 and 50 feet deep, are described in borehole logs as mud and sandy mud (Peterson 2007). Such lithologies, if they exist, would likely serve as conductive layers in GPR profiling (Bristow and Jol 2003). Such conductive layers limit GPR signal penetration and prohibit signal reflection return.

MUD DRAPE AT 35MU106

The fine scale stratigraphy of the mud drape is well illustrated in a trench exposure at archaeological site 35MU106, a late prehistoric–early historic Native American settlement on the floodplain east of I-205 (Musil 2008). This site is located near the intersection of 185th and NE Marine Drive (UTM 5045005n, 541085e) in northeast Portland The site occurs in a minimally disturbed setting 200 to 300 m from the south shoreline of the McGuire Island South Channel. The current floodplain surface at this site is 7.0 m NAVD88. This test site should compare to natural floodplain soils located 200 to 500 m south of the Oregon Slough in the CRC project area.

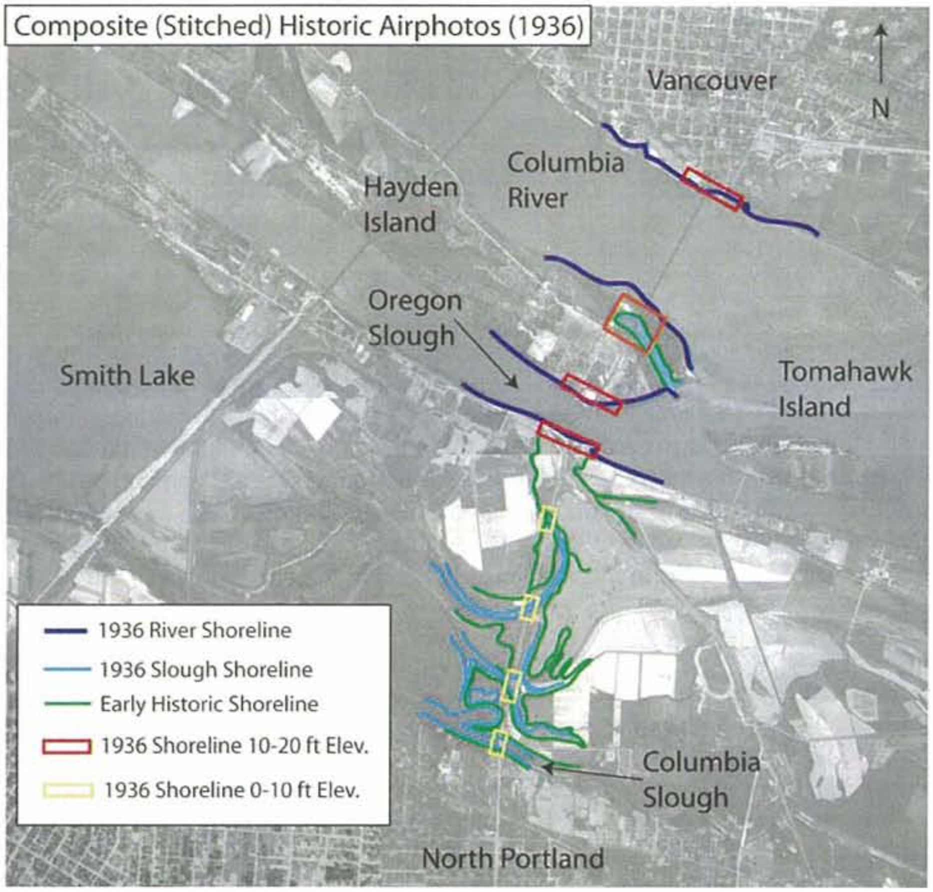

Figure 1. Composite image from 1936 aerial photographs with interpreted shorelines (colored lines) and adjacent 200-ft setbacks (colored boxes) at modern shorelines and abandoned floodplain channels (from Peterson 2007).

A back-levee floodplain soil was exposed in a backhoe trench excavated during the archaeological investigations (Figure 2).The widespread mud drape deposit visible in the trench profile represents the native topsoil that existed prior to burial by remobilized fill. The in-situ floodplain topsoil is characterized by (1) horizontal mud laminae, (2) enriched organics (dark), and (3) vertically descending roots or rhizomes (Figure 3). The remobilized fill at this site is about 1.0 m thick.

GPR EQUIPMENT AND TESTING METHODS

Two systems were used for the GPR testing on the Oregon shore floodplain. The two systems include a Sensors & Software pulseEkko 100Ka system (1000v transmitter) with 100 and 200 MHz unshielded antennae, and an Ekko Pro system (180v transmitter) with 250 and 500 MHz shielded antennae (http://www.sensoft.ca). The pulseEkko 100Ka system was used in profiling step mode with 16 or 32 digital stacking (Figure 4). The Ekko Pro system was tested in

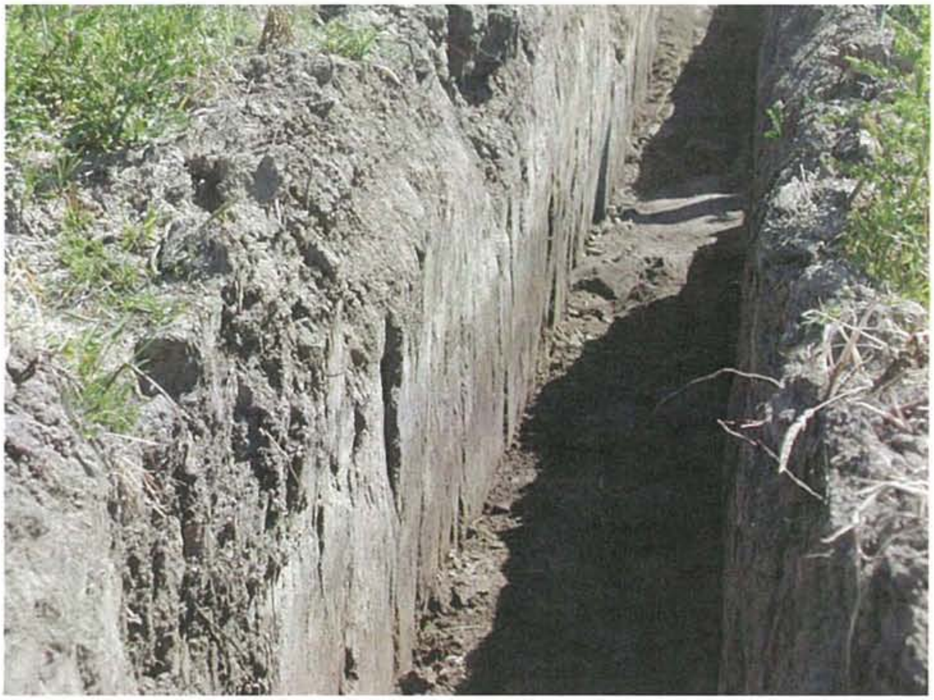

Figure 2. View of trench at 35MU107 located near the east end of the Oregon shore floodplain. The trench extends downward from disturbed surface deposits to in-situ mud drape sediments. Mud drape sediments are characteristically deposited in back-levee settings on the floodplain.

profile mode with odometer wheel triggering. Both methods permitted real-time profile display on field laptops or Digital Video Logger (DVL). GPR data was post-processed with Sensor & Software EkkoView Delux software (http://www.sensoft.ca).

GPR TEST IN CHANNEL BANK ACCRETIONARY DEPOSITS

GPR testing for characterization of shallow floodplain soils was conducted as part of a geoarchaeological study of the late prehistoric archaeological site known as Sunken Village (35MU4) (Croes et al. 2009). This site is located on the northeast bank of Multnomah Channel on Sauvie Island (UTM 505370n, 514075e). GPR profiling was performed in the channel bank accretionary deposits. Similar accretionary bank soils, including mud caps above sand layers, should occur on Hayden Island, and possibly in several remnant channel meanders on the Delta Park floodplain.

Both 100 MHz and 200 MHz unshielded antennae were tested with a 1000v transmitter in step mode (Waibel et al. 2007). The 100 MHz system demonstrated significant GPR signal impedance at a mud cap (25 ns depth) overlying a sandy point bar deposit (Figure 5). Gouge coring established the thickness of the mud cap at approximately 1.0 m, yielding a signal velocity of 0.08 m/ns^{-1}. Maximum penetration to 100 ns with 100 MHz antennae and a 1000v transmitter reached 100 ns (~4.0 m deep) in the channel bank deposits. Horizontal reflections in the sandy

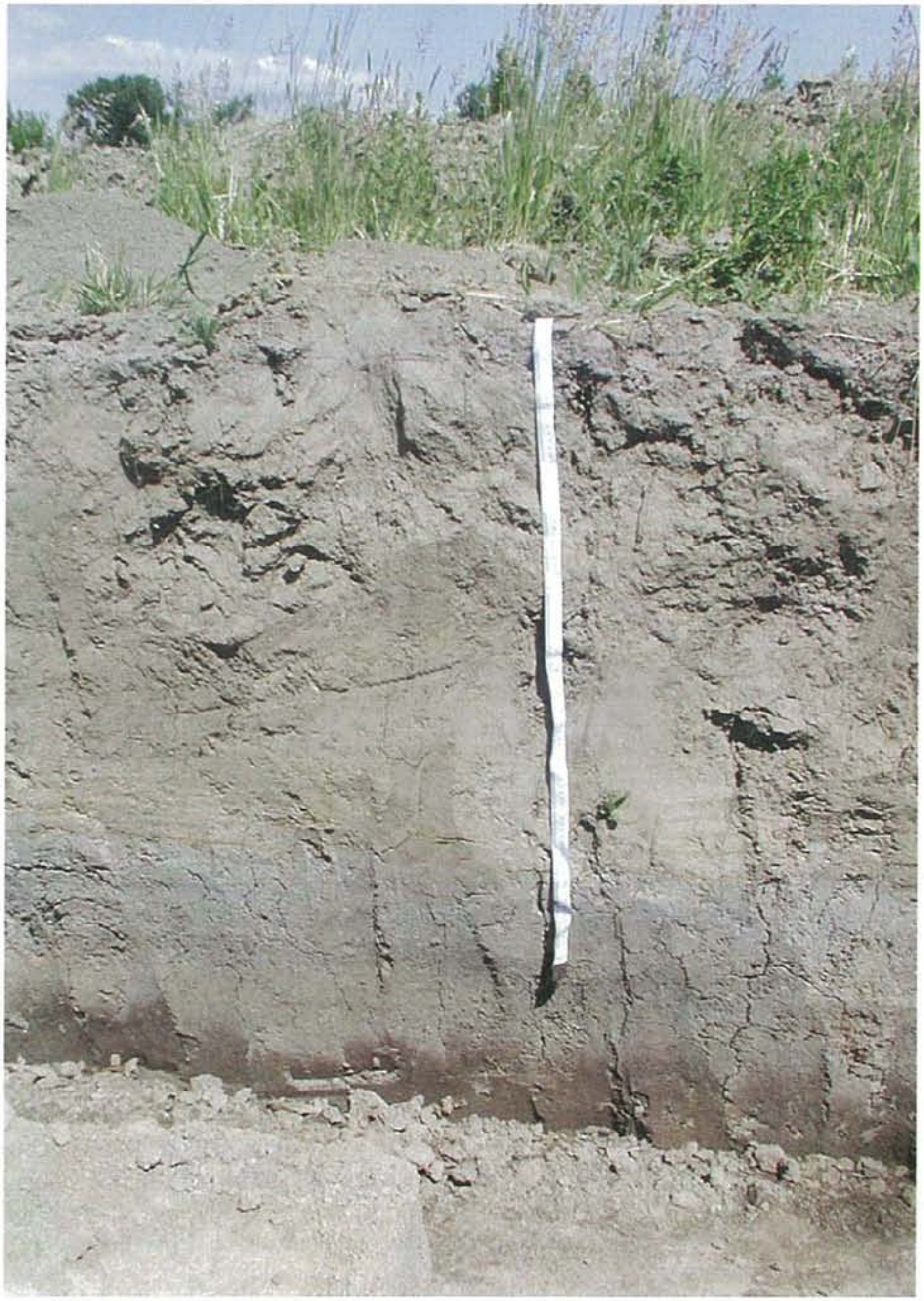

Figure 3. View of backhoe trench wall at 35MU107 showing remobilized sandy silt fill (light gray) over in-situ floodplain mud (dark gray). The mud layer overlies sand at depth, leading to the sedimentary sequence term of "mud drape." Laminae in the mud drape represent cyclic flooding in the back-levee setting of the stabilized floodplain.

Figure 4. GPR profiling in the CRC project area on the Oregon shore using pulseEkko 100a system with 200 MHz antennae and a 1000v transmitter in step mode. Crossing profiles are recorded using measuring tapes for step distances. Profile endpoints are georeferenced by GPS.

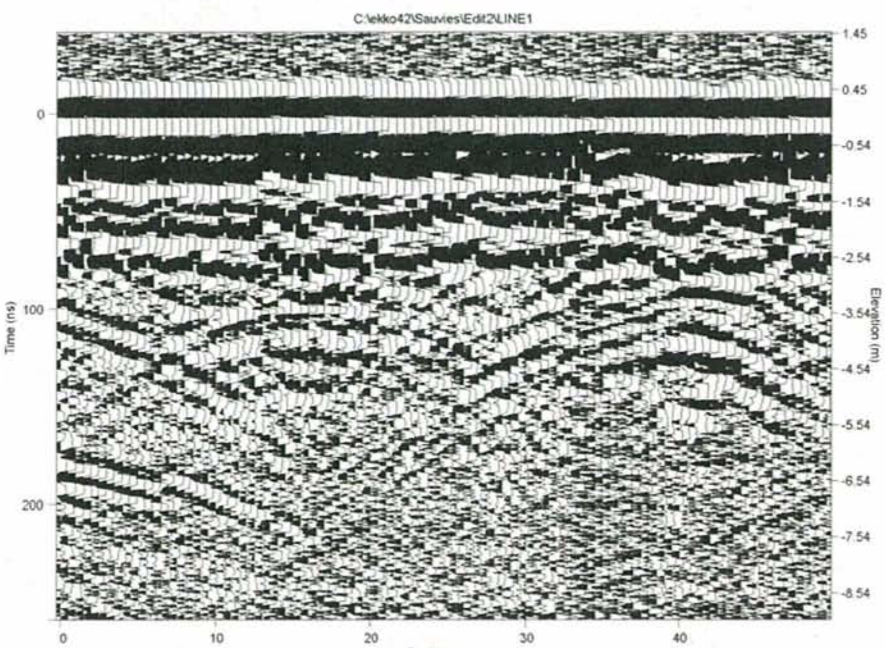

Figure 5. GPR penetration through accretionary channel bank deposits at Sunken Village with 100 MHz antennae and a 1000v transmitter. A mud cap to 25 ns (~1 m deep) is imaged above layered reflections in the underlying point bar sand to 80 ns (~4 m deep). Large parabolic reflections are electromagnetic artifacts (EMAs) produced by airwave reflections from metal/wood pilings along the channel bank.

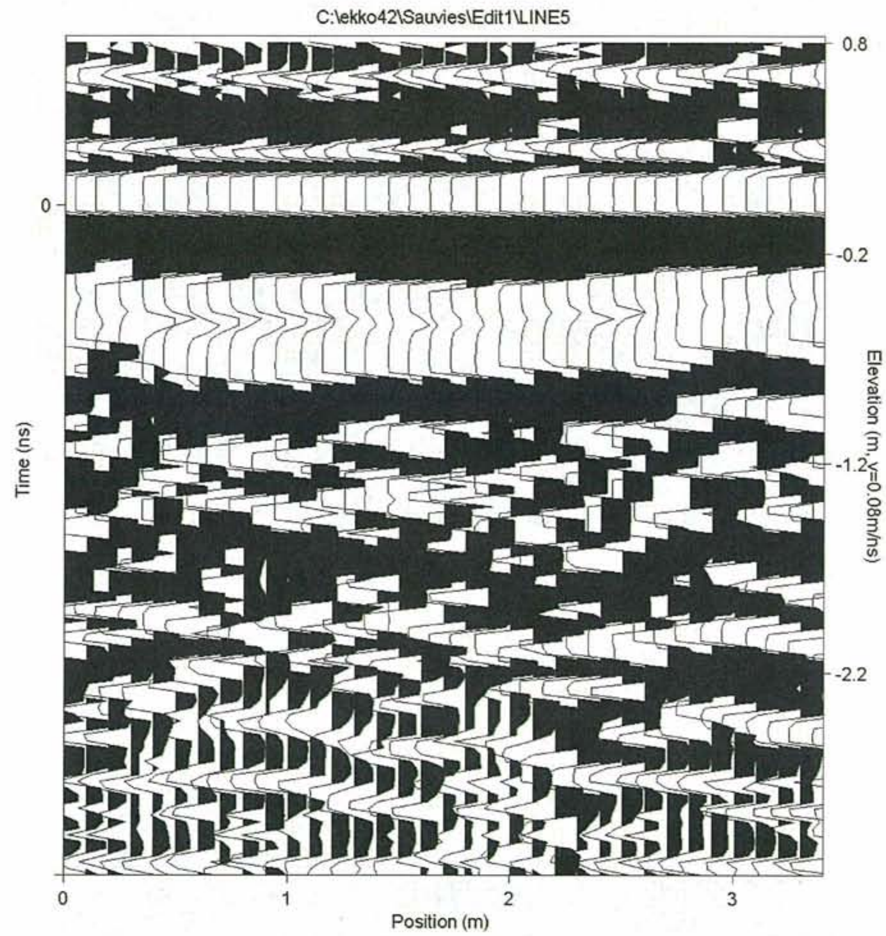

Figure 6. GPR record of accretionary channel bank deposit at Sunken Village using 200 MHz antennae with a 1000v transmitter. Signal penetration reached 40 ns (~2 m deep) using 0.08 m/ns^{-1} signal velocity in the saturated mud-sand deposit.

point bar deposit (25–100 ns depth) represent episodic accretionary events in the channel bank. The layered reflections are characteristic of channel bank sand deposition in the floodplain setting.

A GPR profile using 200 MHz antennae with a 1000v transmitter yielded only 40 ns depth of penetration, or 2.0 m depth (Figure 6). The laminated mud cap is characteristically massive (unlayered) to the 200 MHz antennae, but the underlying sand shows reflection layering. The disturbed layering of sand in this short profile is attributed to construction of acorn leaching pits by Native Americans (Croes et al. 2009).

GPR TEST IN ABANDONED CHANNEL MEANDER

GPR testing in shallow floodplain soils also was conducted next to an abandoned channel meander, or cut-off pond, immediately east of I-5 and north of the City of Portland's Forestry Center in Delta Park (UTM 5049750n, 524740e). GPR profiling was undertaken at this locality to (1) establish criteria for discrimination of fill from underlying floodplain deposits, (2) measure GPR signal velocity, and (3) estimate depth of return signal penetration, using several different GPR systems.

GPR signal velocity in artificial fill at this locality was established by calibration to a target horizon at 3.0–4.0 m deep. The vertical soil profile was exposed in a muddy bank of a cut-off meander that is preserved just north of the Forestry Center.

A test GPR profile was collected with the pulseEkko 100a system using 100 MHz antennae and a 1000v transmitter. A basal conductive layer is widespread at 80 ns (Figures 7–10). The fill surface drops about 1.0 m, based on hand level survey, to the west bank of the cut-off channel meander. The fill unit exposed in the cut-off meander bank contains sand, gravel, and oxidized silt (fill dirt). The basal conductive layer is a dark gray mud, which likely represents the top of the native (pre-fill) floodplain soils (Table 1). Summer water level in the cut-off pond occurs at 0.5–1.0 m below the native soil horizon.

We assume a ~4.0 m depth of the fill-to-native-soil contact under the GPR profile line, as projected from the cut-off meander west bank. The recorded 80 ns two-wave travel time to the fill-mud contact would correspond to an approximate signal velocity of ~0.1 m/ns^{-1}. The signal velocity in the conductive basal layer is not known, due to a lack of signal penetration or reflection in the native soil (mud).

Higher frequency shielded antennae were also tested in the Delta Park floodplains soils. A GPR profile using 250 MHz antennae with a 180v transmitter yielded penetration to 40–50 ns (~2.0–2.5 m deep) in the resistive fill (Figure 11). Small-scale concave reflections in the fill are apparent at 5–40 ns depth in the 250 MHz system profile. However, the 250 MHz system failed to penetrate through the fill to the underlying native floodplain deposits.

The highest frequency system tested in the Delta Park floodplain used 500 MHz shielded antennae with a 180v transmitter. The 500 MHz system penetrated to 20 ns (about 1.0 m deep), in the resistive fill materials (Figure 12). Neither the 250 MHz nor the 500 MHz low-power systems are considered suitable for establishing depth of fill, predicted to be at least 2.0 m thick, in the CRC project area of the Oregon shore.

Table 1. Soil Profile in West Bank of Abandoned Channel Meander.

Unit	Depth (m)	Elevation (m)	Soil Characteristics
Surface	0	5.0 NAVD88	Vegetated
Fill	0–3.5	5.0–2.5 NAVD88	Sand, Gravel, Silt
Native Soil	3.5–4.0	2.5–1.0 NAVD88	Rooted Mud
Water	4.0	1.0 NAVD88	

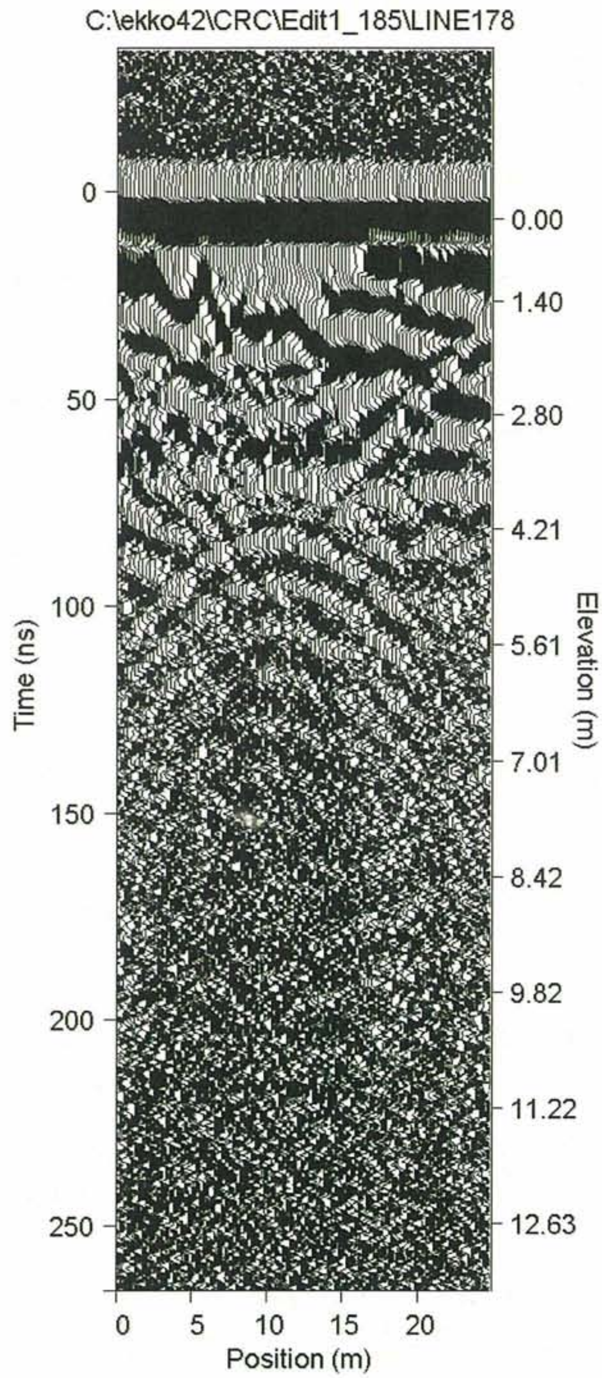

Figure 7. GPR profile segment (0–25 m distance) from abandoned channel meander, using 100 MHz antennae with a 1000v transmitter at 0.25-m steps. The record shows resistive fill materials over a basal conductive layer at 80 ns. The parabolic reflector near the top of the profile is an air wave reflection from a metal fence pole.

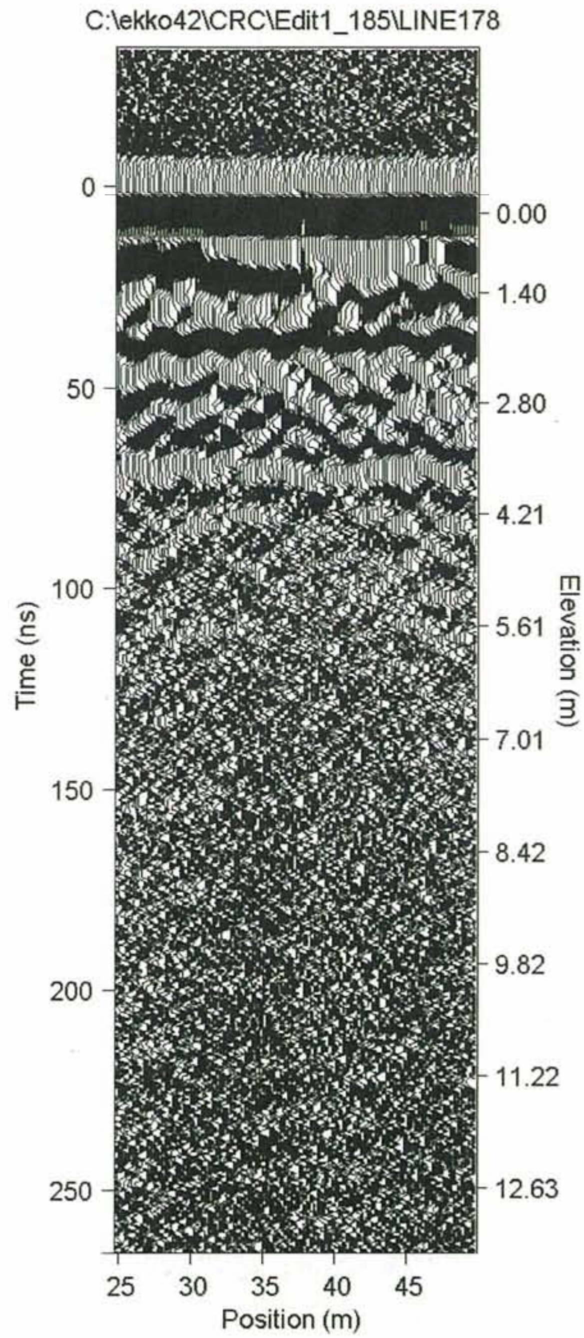

Figure 8. GPR profile segment (25–50 m distance) from abandoned channel meander, using 100 MHz antennae with a 1000v transmitter at 0.25-m steps. A basal conductive layer occurs at 60–70 ns, below which no further signal reflections are returned. The conductive layer is interpreted to be native floodplain soil, consisting of mud, as based on a nearby exposed stratigraphic section (Table 1). Small convex reflections occur in the upper 50 ns of the recorded section, which is representative of artificial fill.

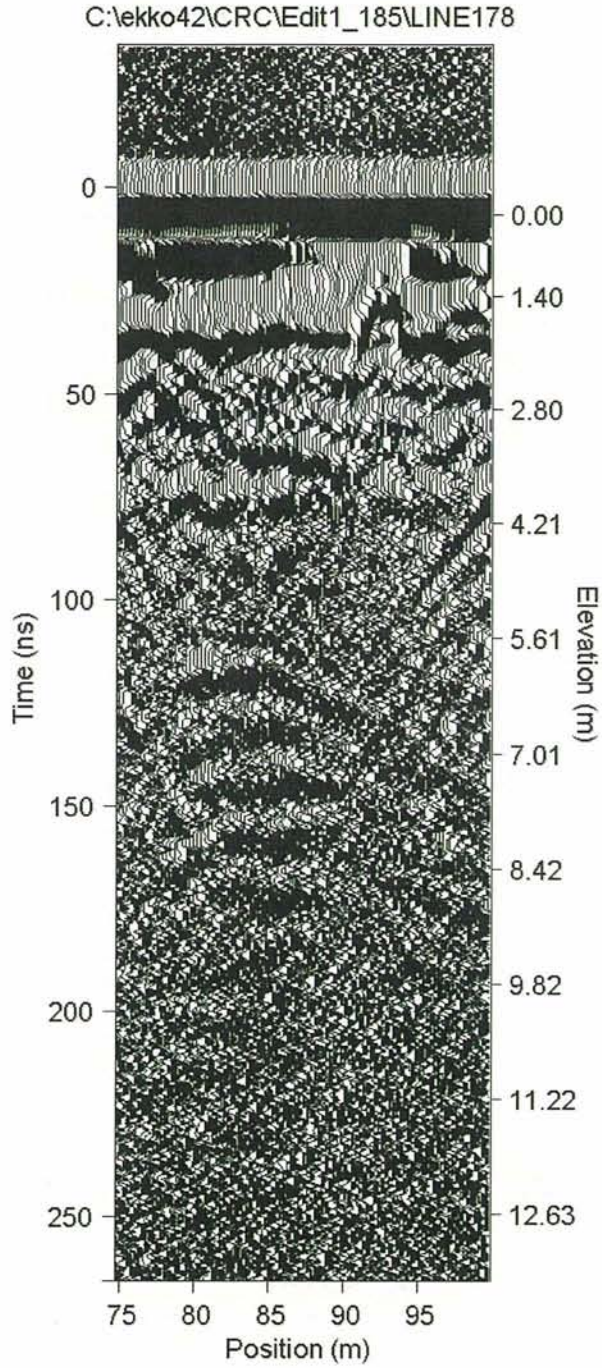

Figure 9. GPR profile segment (75–100 m distance) from abandoned channel meander, using 100 MHz antennae with a 1000v transmitter at 0.25-m steps. The profile shows resistive fill materials over a basal conductive layer at 80 ns. The depth of the fill-to-native-soil contact is projected from abandoned channel bank to be 4 m, thereby yielding a signal velocity of 0.1 m/ns^{-1} in the resistive fill.

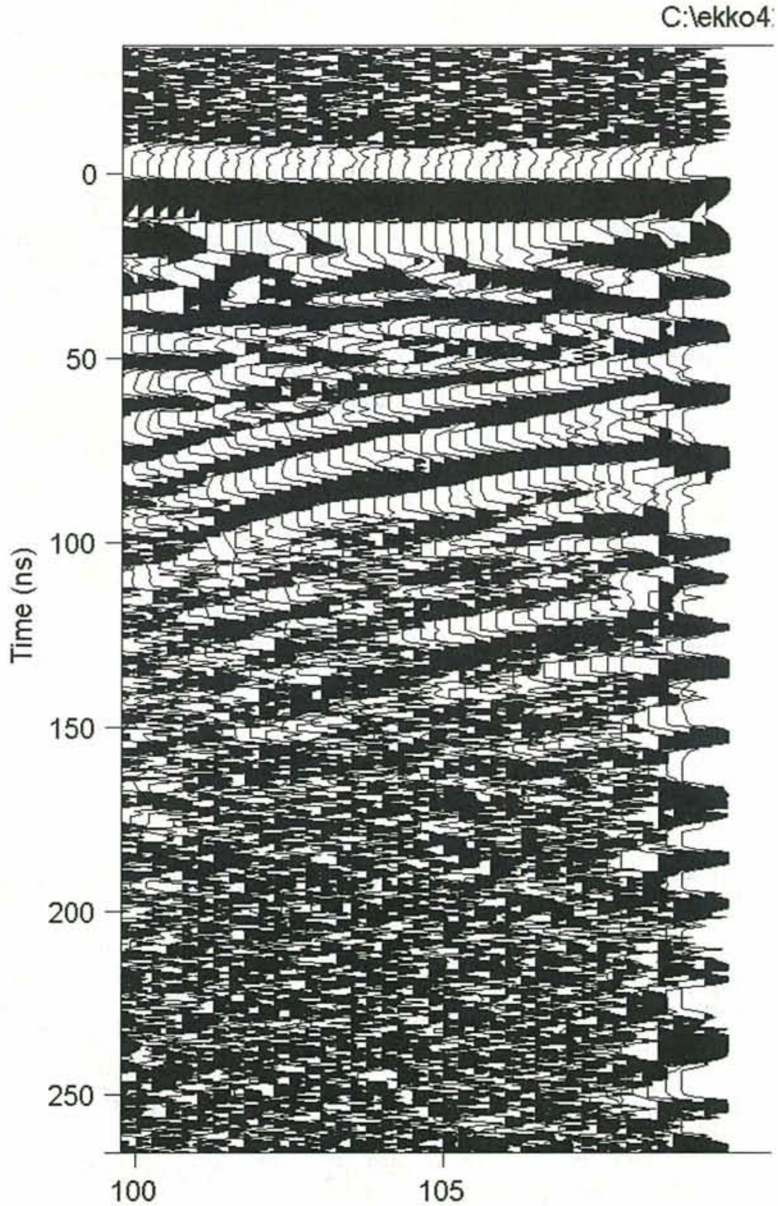

Figure 10. GPR profile segment (100–110 m distance) from abandoned channel meander, showing air wave reflection interference from the approach to a building, fence, and overhead power line at the terminal end of the profile.

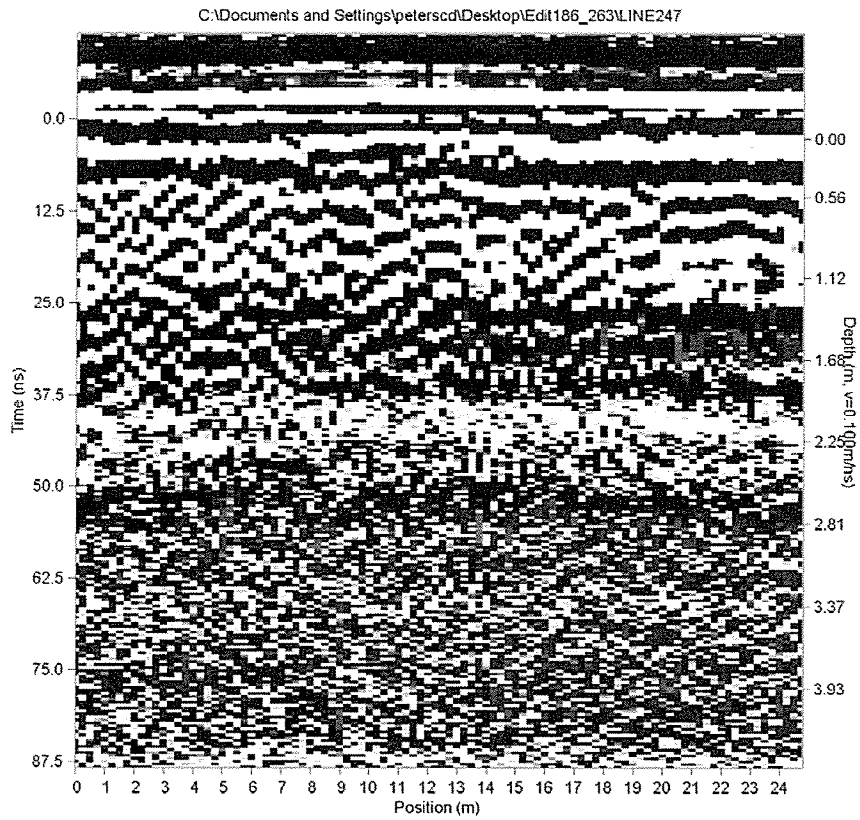

Figure 11. GPR profile in Delta Park showing signal penetration to 40–50 ns (~2.0–2.5 m deep) with 250 MHz antennae and a 180v transmitter.

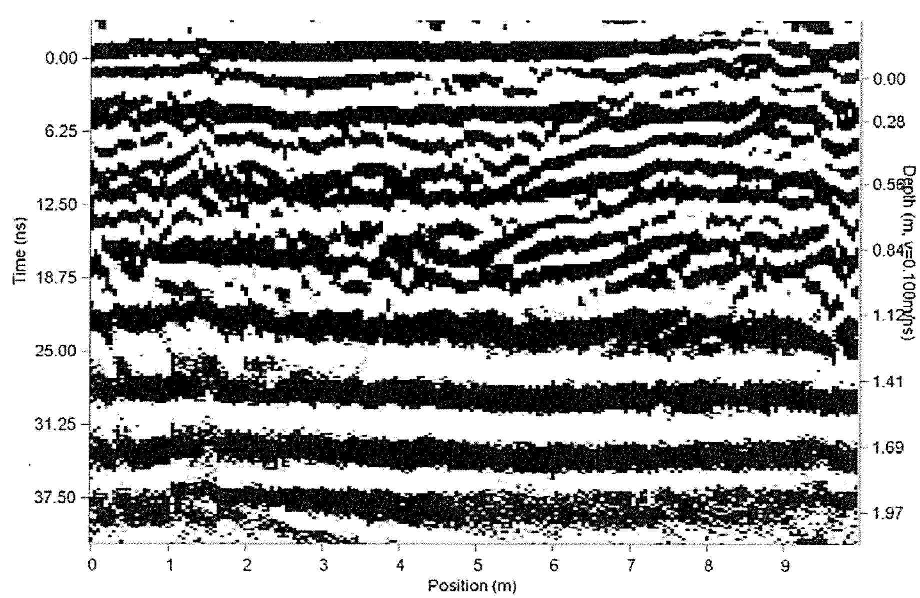

Figure 12. GPR profile in Delta Park showing signal penetration to 20 ns (1.0 m deep) with 500 MHz antennae and a 180v transmitter.

SUMMARY AND CONCLUSIONS

GPR testing on the Oregon shore floodplain demonstrates the applicability of using low-frequency and high-power systems to image the depth of resistive fill materials overlying the conductive native topsoils. The depth of signal penetration with 100 MHz antennae in the resistive fill is at least 4.0 m, assuming an estimated signal velocity of 0.1 m/ns^{-1}.

Characteristic GPR facies of the natural floodplain soils include (1) massive, high-impedance mud drapes in back-levee settings and (2) massive, high impedance mud caps over layered reflections in resistive channel sand deposits. In both cases the mud topsoil provides a widespread GPR facies that contrasts with overlying artificial fill.

Back-levee mud drapes at archaeological site 35MU106 reach at least 1.0 m thick, and contain laminated clayey silt with decomposed organics. These native topsoils of the vegetated floodplain are expected to be conductive to GPR electromagnetic signals.

Both 100 and 200 MHz antennae with a 1000v transmitter were used to image accretionary bank sediments of an active channel at the Sunken Village archaeological site on Sauvie Island. GPR testing of the active channel bank showed reduced penetration through a 1.0 m thick mud cap overlying layered sand deposits in the accretionary bank setting.

GPR signal penetration in resistive fill materials reached 80 ns in the abandoned channel meander test profile at the Forestry Center in Delta Park with 100 MHz antennae and a 1000v transmitter. An abrupt loss of signal penetration corresponds to a fill contact with a buried floodplain "mud" soil.

Abandoned channel meanders cross the CRC project area at several locations on the Oregon shore. Mud caps above abandoned channel levees and/or point bar deposits should be conductive to GPR electromagnetic signals. Deposits of channel levee sand and point bar sand under the mud caps should show layered GPR reflections.

Fill materials observed along the I-5 corridor in the CRC project area on the Oregon shore contain sand, gravel, silt, and concrete fragments. In the abandoned channel meander immediately east of I-5, these resistive materials demonstrate a shallow subsurface signal velocity of ~0.1 m/ns^{-1} in the unsaturated fill to 80 ns (~4.0 m deep). The seasonal (summer) groundwater surface (GWS) was measured at 1.0 m below the fill-native-soil contact in the cut-off meander pond in the abandoned channel. Soil lithology rather than GWS appears to limit signal penetration at this location.

High frequency shielded antennae (250 and 500 MHz with a 180v transmitter) failed to penetrate through the 3.0 to 4.0 m thick fill to image the basal conductive layer found in the abandoned channel meander at the Forestry Center. The relatively sharp transition of resistive fill over the basal conductive layer represents the contact of the fill over native floodplain soils in the Delta Park floodplain. The high-frequency antennae can be used to image concave and truncating reflections within the artificial fill, but not to reach the underlying native soil contacts.

Based on the preliminary GPR field-testing on the Oregon shore floodplain, it is recommended that 50–100 MHz antennae with a high power (1000v) transmitter be used to image the thickness of expected fill in the CRC project area. A predicted basal conductive layer, corresponding to mud drapes in the stable floodplain depositional sequence, should contrast with the overlying resistive fill, thereby establishing maximum fill depth in GPR profiles.

REFERENCES

Bristow, C. S., and H. M. Jol (editors)
2003 *Ground Penetrating Radar in Sediments*. Geologic Society Special Publication No. 211. London, England.

Croes, Dale R., John L. Fagan, and Maureen Newman Zehendner
2009 Sunken Village, Sauvie Island, Oregon, USA: A Report on the 2006–2007 Investigations of National Historic Landmark Wet Site 35MU4. *Journal of Wetland Archaeology* 9:1–216.

Minor, Rick, and Curt Peterson
2008 Archaeological Work Plan for Ground-Penetrating Radar (GPR) Exploration, Columbia River Crossing Project. Heritage Research Associates, Inc. Report to Columbia River Crossing Project, Vancouver, Washington.

Musil, Robert R.
2008 *Archaeological Investigations at 35MU106, Columbia South Shore, Multnomah County, Oregon*. Heritage Research Associates Report 318. Eugene, Oregon.

Peterson, Curt
2007 Appendix A: Geology and Geomorphology. In *Interstate 5 Columbia River Crossing—Archaeology Technical Report*, by Rick Minor and Kathryn Anne Toepel, pp. A-1–A-44. Heritage Research Associates, Eugene, Oregon. Report to Columbia River Crossing Project, Vancouver, Washington.

Waibel, M. S., D. Bida, T. Blazina, D. Boschmann, A., Bovero, C. Cannon, A. Donehey, E. Dunbar, K. Hauver, A. Jones, K. Olson, G. A. Ordway, C. D. Peterson, D. Sitts, T. J. Schepker, F. Seifert, S. Wilson
2007 Hydrogeoarchaeology Investigation of North American Acorn Leaching Pits at Sauvie Island, Oregon: Preliminary GPR Profiling of Shallow-Subsurface Stratigraphy and LIDAR Landform Analysis of the Multnomah–Sauvie Island Channel Bank at the Sunken Village Locality. Unpublished Field Report, Portland State University, Portland, Oregon.

PRELIMINARY

INTERSTATE 5 COLUMBIA RIVER CROSSING

Transit Technical Report for the Final Environmental Impact Statement

Columbia River CROSSING

December 2010

Columbia River CROSSING

Title VI

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Cover Sheet

Transit Technical Report

Columbia River Crossing

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Kelly Betteridge

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ACRONYMS

Acronym	Description
ADA	Americans with Disabilities Act
AOM	C-TRAN Administration, Operations, and Maintenance
API	Area of Potential Impact
BIA	Bridge Influence Area
BPA	Bonneville Power Administration
BRT	Bus Rapid Transit
CBD	Central Business District
CRC	Columbia River Crossing
C-TRAN	Clark County Public Transportation Benefit Area
DEIS	Draft Environmental Impact Statement
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HCT	High Capacity Transit
I-5 / I-205 / I-84	Interstate 5 / Interstate 205 / Interstate 84
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
LRV	Light Rail Vehicle
MOS	Minimum Operable Segment
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
NEPA	National Environmental Policy Act
NTD	National Transit Database
ODOT	Oregon Department of Transportation
OHSU	Oregon Health Sciences University
RTC	Southwest Washington Regional Transportation Council
RTP	Regional Transportation Plan
SR	State Route
TAZ	Transportation Analysis Zone
TriMet	Tri-County Metropolitan Transportation District of Oregon
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles Traveled
WSDOT	Washington State Department of Transportation

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1. Introduction

The Transit Technical Report addresses the effects on transit use and services that could occur with the multimodal Interstate 5 (I-5) Columbia River Crossing (CRC) Project. The CRC project is a bridge, transit, and highway improvement project to address the congestion and mobility problems on I-5 between State Route (SR) 500 in Vancouver, Washington, and approximately Columbia Boulevard in Portland, Oregon. The CRC Project includes a build highway and a build transit system, which combine to form a multimodal alternative needed to address the complex existing transportation problems.

The Transit Technical Report supports discussions provided in the I-5 Columbia River Crossing Project Final Environmental Impact Statement (FEIS).

The CRC project has evolved since the publication of the Draft Environmental Impact Statement (DEIS) to reflect new information and a greater depth of modeling, planning, and engineering efforts. In order to apply for transit funding through the Federal Transit Administration (FTA) Section 5309 New Starts program, comprehensive applications to enter preliminary engineering and to obtain a rating were submitted in September 2008. These applications required specific travel demand modeling to quantify mobility improvements, environmental benefits, operating efficiencies, cost effectiveness, and transit supportive land use policies and future patterns. These five components are judged by FTA and scored to reach a project justification rating.

The New Starts travel demand modeling was optimized to support the project purpose, which is to implement a transit investment that will:

- Improve connectivity, reliability, travel times, and operations of public transportation;
- Help reduce vehicular demand on the limited roadway capacity across the Columbia River;
- Respond to increasing population and employment;
- Improve transit access: 1) between the region's two largest Central Business Districts (CBDs) – the Vancouver Central City and the Portland Central City; 2) between the high-growth employment center of the Vancouver Central City and the established north Portland residential areas; and 3) between the high-growth residential areas in Clark County and the high-growth employment areas in the Portland Central City; and
- Support state, regional, and local land use plans and goals.

The transit networks modeled for the DEIS were changed for the subsequent New Starts application in order to satisfy the project purpose as stated above and to reflect the most current information available. Changes to travel demand forecasting modeling inputs that occurred between preparation of the DEIS and preparation of the FEIS are outlined in Section 1.3, "Alternatives Considered." In addition, further analysis of park-and-ride lot configurations was conducted to optimize the number, location, and size of park-and-ride lots for the different alternatives. Changes in park-and-ride lot configurations and sizes between the DEIS and FEIS are explained in Section 1.3.1 under "LPA Stations and Park-and-Rides" and "LPA Operating

Characteristics." The alternatives contained in this report are consistent with the LPA, with FTA direction on the Baseline Alternative, and with the further refinement through public involvement and more in-depth engineering that have occurred since then. The alternatives in the FEIS and the New Starts annual update submitted in Fall, 2010, are the same.

1.1 Background

This report has been prepared in support of the I-5 Columbia River Crossing Project FEIS, a combined transit, bridge, and highway improvement project to address congestion and mobility issues on I-5 between Vancouver, Washington, and Portland, Oregon. The FEIS has been prepared in compliance with the National Environmental Policy Act (NEPA). The FTA and the Federal Highway Administration (FHWA) are the lead federal agencies for the FEIS.

The CRC Project is a combined bridge, transit, and highway improvement project designed to address the congestion and mobility problems on I-5 between SR 500 in Vancouver, Washington, and approximately Columbia Boulevard in Portland, Oregon (this area is known as the Bridge Influence Area, or BIA). The CRC highway analysis focuses on the BIA, while the transit study area encompasses the greater region to include the major transit markets.

I-5 is the only continuous north-south interstate highway on the West Coast, linking the United States with Canada and Mexico. In the Vancouver/Portland region, I-5 is one of two major north-south highways that provide interstate connectivity and mobility. I-5 directly connects the central cities of Vancouver and Portland. The only transit connections between Vancouver and Clark County, Washington, and the Portland metropolitan area in Oregon are bus lines across the I-5 bridge and across the I-205 bridge, which is approximately 6½ miles to the east of I-5. There are no other crossings of the Columbia River for traffic or transit in the region; the next closest bridges are over 30 miles away outside the metropolitan area. Traffic conditions on the I-5 crossing over the Columbia River are influenced by the five-mile section of I-5 between SR 500 in Vancouver and approximately Columbia Boulevard in Portland. This section includes seven interchanges that connect four state highways and several major arterial roadways. These interchanges serve a variety of land uses and provide access to downtown Vancouver, two international marine ports, industrial centers, residential neighborhoods, retail centers, and recreational areas.

High-capacity transit applications in the I-5 corridor through north Portland and Vancouver have been studied periodically for over a decade. In 1993, the FTA, in cooperation with Metro, began studying high-capacity transit in the "South/North Corridor," which stretches from Milwaukie, Oregon to Vancouver, Washington. FTA and Metro published the South/North Corridor Project Draft Environmental Impact Statement in 1998. This study identified a variety of alignments and length options for a light rail corridor connecting Milwaukie, downtown Portland, North Portland, and downtown Vancouver. Subsequent funding challenges didn't allow construction of the entire corridor assessed in the South/North project, but did allow construction of the MAX Yellow Line through North Portland to the Expo Center in 2004. The newly-constructed light rail alignment along the downtown Portland transit mall accommodates Yellow Line light rail service and can accommodate an extension of light rail south to Milwaukie, Oregon; the Portland to Milwaukie light rail extension has received a Record of Decision from the Federal Transit Administration (FTA) on November 29, 2010, and is scheduled to open in late 2015.

1.1.1 CRC Transit Corridor – Study Area

The evaluation of transit uses four analysis areas to measure effects: the primary Area of Potential Impact (API), the secondary API, the study area, and the CRC Transit Corridor. The primary API addresses the area where direct construction effects would occur and the secondary API is where indirect effects would occur. These two areas are similar across technical disciplines. The study area broadly addresses areas where systemwide operational effects would occur. Figure 1-1 shows the primary API and secondary API as well as a general study area where systemwide operational effects would occur. Figure 1-2 shows the project study area with the transit corridor in regional context. Each of these analysis areas is described below.

1.1.2 Primary API

The primary API is the area that would experience direct impacts from construction and operation of the proposed project alternatives. Most physical project changes would occur in this area, although mitigation could still occur outside of it.

As defined, the primary API extends about five miles from north to south. It starts to the north of the I-5/Main Street interchange in Washington, and extends south to the I-5/Columbia Boulevard interchange in Oregon. North of the Columbia River, the primary API expands west into downtown Vancouver, and east near Clark College to include potential high-capacity transit (HCT) alignments and park-and-ride locations. Around the actual river crossing, the eastern and western sides each extend 0.25 mile from the I-5 right-of-way. South of the river crossing, the width narrows to 300 feet on each side.

1.1.3 Secondary API

The secondary API represents the area where indirect impacts (for example, traffic and development changes) would occur from the proposed project alternatives. For transit, some direct impacts could also occur in this area from the operations of the proposed project alternatives.

The secondary API, which is approximately 15 miles long, runs from a point approximately one mile north of the I-5/I-205 interchange all the way south to the I-5/I-84 interchange. It generally extends approximately one mile on both the east and west sides of the I-5 right-of-way. These boundaries, and the geographic extent of the potential indirect impacts, may change as traffic projections become available.

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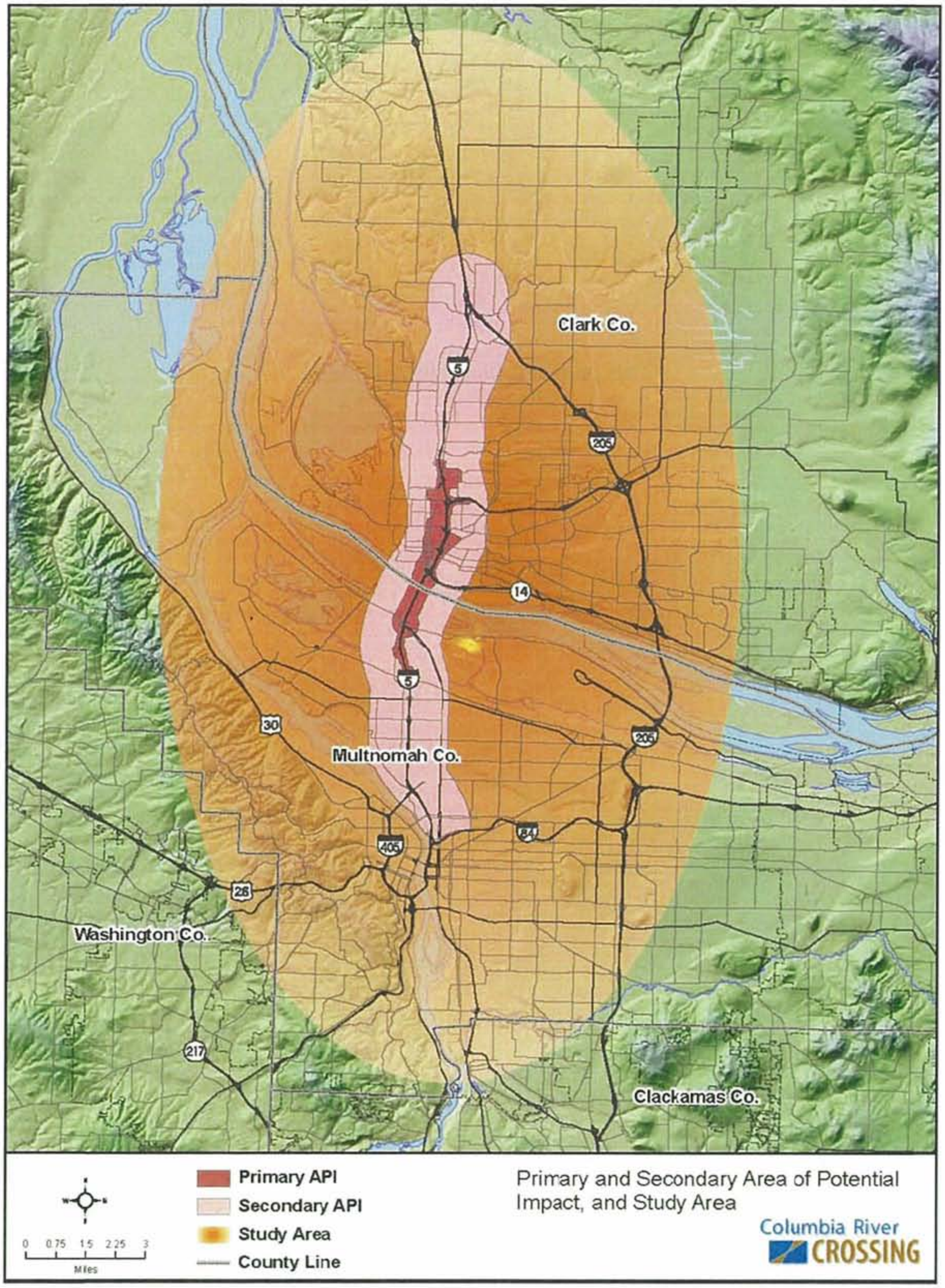
Figure 1-1. Primary and Secondary Area of Potential Impact, and Study Area



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1.1.4 Study Area

The study area is a sub-area of the four-county region (Multnomah, Clackamas, and Washington Counties in Oregon, and Clark County in Washington). The study area includes the area up to, and extending east of, Interstate 205 (I-205). It also extends north of the secondary API to include existing, planned, and programmed transit facilities in northern Clark County and south to include downtown Portland.

1.1.5 CRC Transit Corridor in Regional Setting

The CRC Transit Corridor includes part of the larger South/North Transit Corridor serving the Portland metropolitan area, comprising the urban portion of Clark County, Washington, and Multnomah, Clackamas, and Washington counties in Oregon. Portland is the largest city in the region and is located at its geographic center. The CRC Transit Corridor is generally defined as the transit "travel-shed" using the I-5 corridor for interstate travel between the urban portion of Clark County, City of Vancouver, north Portland, and the Portland Central City. (See Figure 1-2.)

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Figure 1-2. CRC Transit Corridor and Regional Setting

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1.2 Purpose and Need

The following is the I-5 CRC Project's Statement of Purpose and Need.

1.2.1 Project Purpose

The purpose of the proposed action is to improve I-5 corridor mobility by addressing present and future travel demand and mobility needs in the Columbia River Crossing Bridge Influence Area. The Bridge Influence Area extends from approximately SR 500 in the north to Columbia Boulevard in the south. (See Figure 1-3. Bridge Influence Area.)

The CRC Transit Corridor includes a wider area extending from the Portland central business district to northern Clark County. (See Figure 1-1.) The project would connect to an existing light rail system. (The existing and proposed regional high capacity transit for the region is shown in Figure 1-3.) Relative to the No-Build Alternative, the proposed action is intended to achieve the following objectives: a) improve travel safety and traffic operations on the I-5 crossing's bridges and associated interchanges; b) improve connectivity, reliability, travel times, and operations of public transportation modal alternatives in the Bridge Influence Area; c) improve highway freight mobility and address interstate travel and commerce needs in the Bridge Influence Area; and d) improve the I-5 river crossing's structural integrity.

1.2.2 Project Need

The specific needs to be addressed by the proposed action include:

- **Growing Travel Demand and Congestion:** Existing travel demand exceeds capacity in the I-5 Columbia River Crossing and associated interchanges. This corridor experiences heavy congestion and delay lasting two to five hours during both the morning and afternoon peak travel periods and when traffic accidents, vehicle breakdowns, or bridge-lifts occur. Due to excess travel demand and congestion in the I-5 bridge corridor, many trips take the longer alternative I-205 route across the river. Spillover traffic from I-5 onto parallel arterials such as Martin Luther King Boulevard and Interstate Avenue increases local congestion. The two crossings currently carry over 260,000 trips across the Columbia River daily. Daily traffic demand over the I-5 crossing is projected to increase by 40 percent during the next 20 years, with stop-and-go conditions increasing to at least 10 to 12 hours each day if no improvements are made.
- **Impaired Freight Movement:** I-5 is part of the National Truck Network, and the most important freight highway on the West Coast linking international, national, and regional markets in Canada, Mexico, and the Pacific Rim with destinations throughout the western United States. In the center of the project area, I-5 intersects with the Columbia River's deep water shipping and barging as well as two river-level, transcontinental rail lines. The I-5 crossing provides direct and important highway connection to the Port of Vancouver and Port of Portland facilities located on the Columbia River as well as the majority of the area's freight consolidation facilities and distribution terminals. Freight volumes moved by truck to and from the area are projected to more than double over the next 25 years. Vehicle-hours of delay on truck routes in the Portland-Vancouver area are projected to increase by more than 90 percent over the next 20 years. Growing demand

and congestion will result in increasing delay, costs, and uncertainty for all businesses that rely on this corridor for freight movement.

- **Limited Public Transportation Operation, Connectivity, and Reliability:** Due to limited public transportation options, a number of transportation markets are not well served. The key transit markets include trips between the Portland Central City and the City of Vancouver and Clark County, trips between North/Northeast Portland and the City of Vancouver and Clark County, and trips connecting the City of Vancouver and Clark County with the regional transit system in Oregon. Current congestion in the corridor adversely impacts public transportation service reliability and travel speed. Southbound bus travel times across the bridge are currently up to three times longer during parts of the AM peak compared to off-peak. Travel times for public transit using general purpose lanes on I-5 in the Bridge Influence Area are expected to increase substantially by 2030.
- **Safety and Vulnerability to Incidents:** The I-5 river crossing and its approach-sections experience crash rates nearly 2.5 times higher than statewide averages for comparable facilities. Incident evaluations generally attribute these crashes to traffic congestion and weaving movements associated with closely spaced interchanges. Without breakdown lanes or shoulders, even minor traffic accidents or stalls cause severe delay or more serious accidents.
- **Nonstandard Bicycle and Pedestrian Facilities:** The bike/pedestrian lanes on the I-5 Columbia River bridges are six to eight feet wide, narrower than the 10-foot standard, and are located extremely close to traffic lanes, thus impacting safety for pedestrians and bicyclists. Direct pedestrian and bicycle connectivity are poor in the Bridge Influence Area.
- **Seismic Vulnerability:** The existing I-5 bridges are located in a seismically active zone. They do not meet current seismic standards and are vulnerable to failure in an earthquake.

The transit portion of the Project implementing a transit investment will help meet the purpose and need by:

- Improving connectivity, reliability, travel times, and operations of public transportation;
- Helping reduce vehicular demand on the limited roadway capacity across the Columbia River;
- Responding to increasing population and employment;
- Improving transit access: 1) between the region's two largest CBDs – the Vancouver Central City and the Portland Central City; 2) between the high-growth employment center of the Vancouver Central City and the established north Portland residential areas; and 3) between the high-growth residential areas in Clark County and the high-growth employment areas in the Portland Central City; and
- Supporting state, regional, and local land use plans and goals.

Figure 1-3. Bridge Influence Area

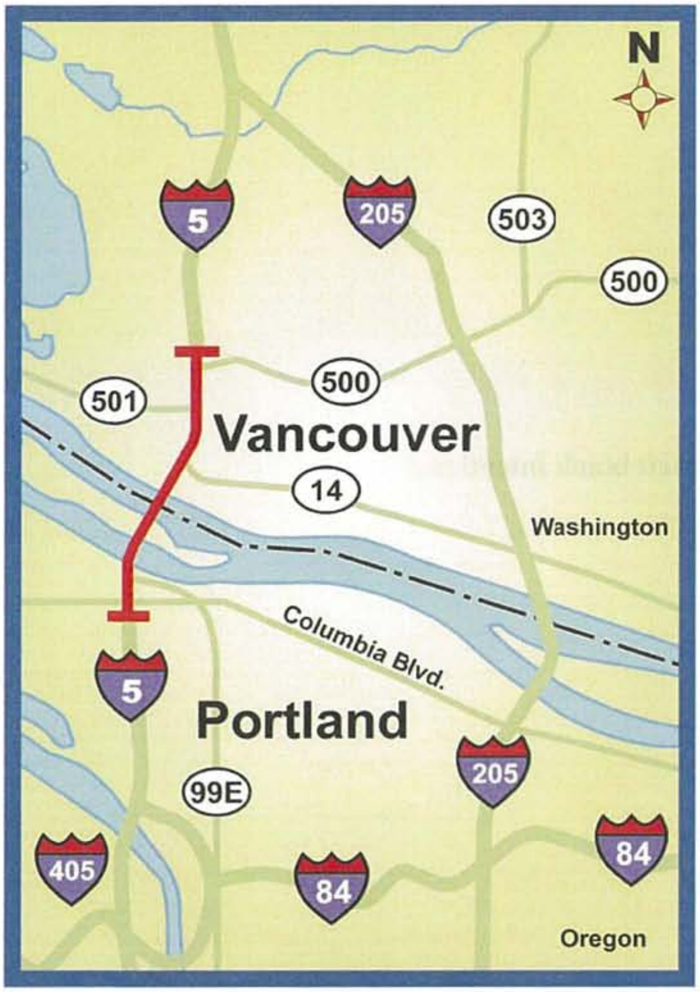

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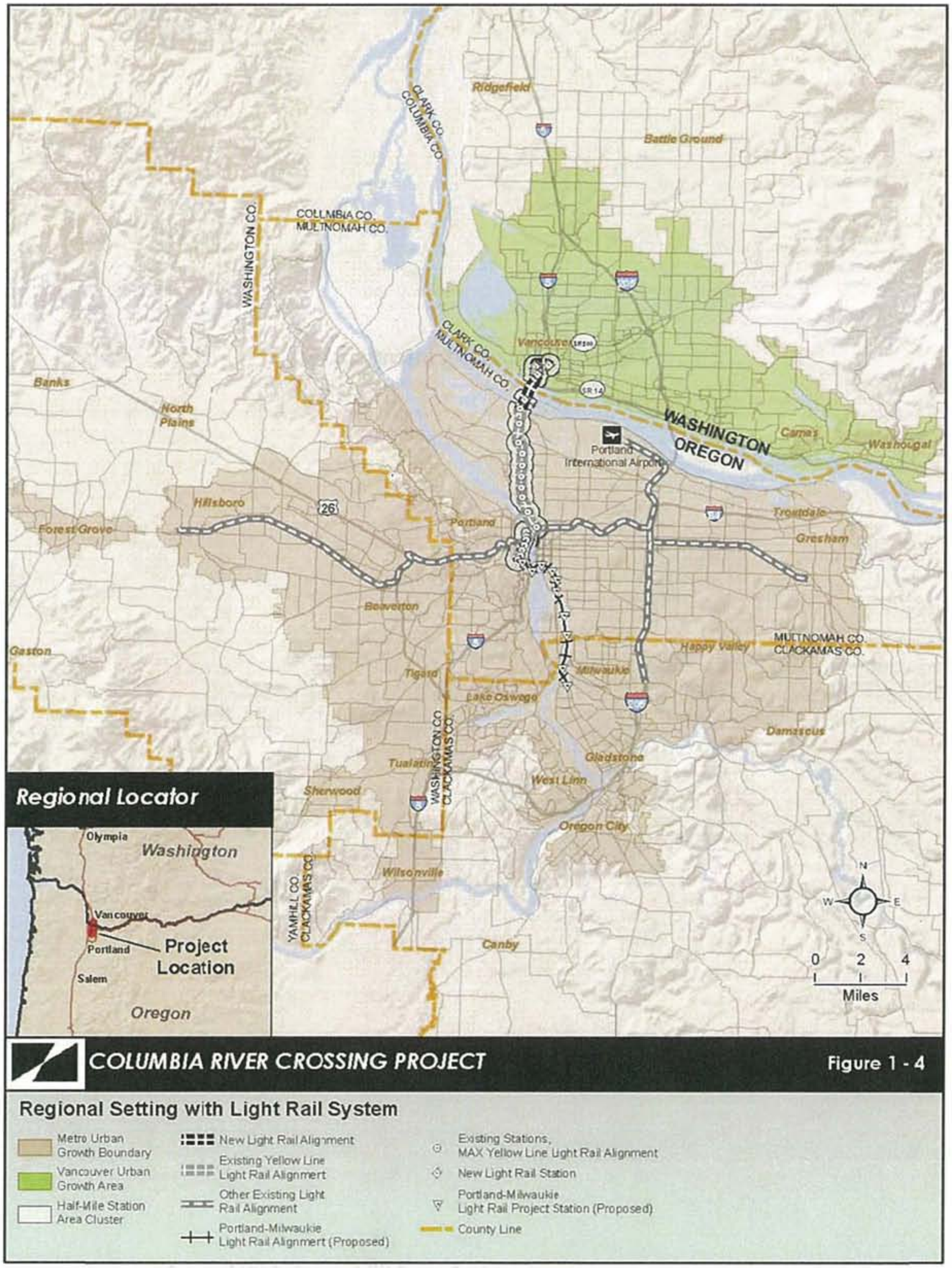
Figure 1-4. Regional Setting with Light Rail System



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1.3 Alternatives Considered

The FEIS examines six alternatives: the No Build Alternative, the Locally Preferred Alternative (LPA), and Alternatives 2, 3, 4, and 5 from the DEIS. This section briefly describes the six alternatives considered. The LPA has four options: LPA Option A, LPA Option B, LPA Option A with highway phasing, and LPA Option B with highway phasing. The transit element would not differ between LPA and LPA with highway phasing, nor would transit vary between Option A and Option B. Therefore, for purposes of this document, when the "LPA" is named, any of the four LPA options could be considered without significant differences in impacts due to transit.

Although the selection of an LPA means that the DEIS build alternatives (Alternatives 2 through 5) are not being carried forward, they are included in the FEIS. This section briefly describes all six alternatives. Tables comparing the LPA and the No Build Alternative to the DEIS build alternatives are included in Appendix A.

The No Build Alternative is required under NEPA and although it does not meet the project's Purpose and Need, it establishes a point of comparison with the LPA. The No Build Alternative is based on the same growth in population and employment through the year 2030 as the LPA, but would only include existing facilities and projects that anticipate funding and construction in the Metro and Southwest Washington regional financially constrained transportation plans, except the Milwaukie to Portland Light Rail Project.

The 2030 No Build highway system is similar to the existing I-5 highway system. It includes the existing lift span bridges, the existing mainline traffic capacity throughout the BIA, and the existing northbound managed lane from Going Street to Marine Drive. It also includes an added southbound lane planned from north of Victory Boulevard to south of Columbia Boulevard. All buses traveling on I-5 in the No Build Alternative would be subject to conditions on this highway system.

The 2030 No Build Alternative's capital improvements are based on a financially constrained network, including the projects in Metro's *2004 Regional Transportation Plan* (RTP) *Financially Constrained Project List* (with a 2030 horizon), and the Southwest Regional Transportation Council's (RTC's) *2007 Metropolitan Transportation Plan* (MTP) *Financially Constrained Project List*[1] (attached as Appendix B).

The four build alternatives from the DEIS include two bridge configurations, two types of high-capacity transit, and two levels of transit service. The main features of these alternatives are summarized in

[1] Amended July, 2008.

Table 1-1.

Table 1-1. Summary of DEIS Build Alternatives 2, 3, 4, and 5

Feature	Alternative 2	Alternative 3	Alternative 4	Alternative 5
High Capacity Transit System	BRT	LRT	BRT	LRT
Guideway Length[1]	2.06 to 4.22 miles	2.06 to 4.22 miles	2.06 to 4.22 miles	2.06 to 4.22 miles
New HCT Stations[1]	5 to 7	5 to 7	5 to 7	5 to 7
Terminus Options	Mill Plain MOS Clark College MOS Lincoln Kiggins Bowl	Mill Plain MOS Clark College MOS Lincoln Kiggins Bowl	Mill Plain MOS Clark College MOS Lincoln Kiggins Bowl	Mill Plain MOS Clark College MOS Lincoln Kiggins Bowl
Bridge	Replace Existing I-5 Bridges	Replace Existing I-5 Bridges	Supplemental Bridge to Existing I-5 Bridges	Supplemental Bridge to Existing I-5 Bridges
Transit Service	Efficient Level	Efficient Level	Increased Level	Increased Level

[1] Guideway length and number of stations varies depending on terminus and alignment.

Alternative 2: Replacement Crossing with Bus Rapid Transit replaces the existing I-5 bridge with a new tolled crossing. The new bridges would provide for automobile and truck traffic, bicycle and pedestrian crossings, and an exclusive guideway for Bus Rapid Transit (BRT). The BRT exclusive guideway extends between 2.07 and 4.22 miles north from the Expo Center through Vancouver to one of four possible terminus options (Mill Plain District, Clark College, Lincoln, or Kiggins Bowl). Alternative 2 includes between five and seven new transit stations and three to five park-and-ride lots with up to 2,410 spaces depending on the terminus. The BRT transit network would provide frequent service with BRT combined headways of 3.5 minutes peak and 15 minutes off-peak hours in downtown Vancouver. The BRT routes would cross the Columbia River in a new exclusive guideway and connect to the Tri-County Metropolitan Transportation District of Oregon (TriMet) light rail transit (LRT) at the Expo Center.

Alternative 3: Replacement Crossing with Light Rail is similar to Alternative 2 but includes LRT, rather than BRT. The LRT guideway would extend the existing Yellow Line LRT north from the Exposition Center through Vancouver to the same potential terminus options as Alternative 2. Alternative 3 would have the same park-and-ride and transit station sizes and locations as Alternative 2. The LRT line included in Alternative 3 would have slightly less frequent service than BRT service in Alternative 2, because LRT vehicles can carry more passengers per vehicle. Headways for the proposed LRT line in Alternative 3 would be 7.5 minutes in the peak and 15 minutes in the off-peak hours.

Alternative 4: Supplemental Crossing with Bus Rapid Transit would retain both existing I-5 bridges and add a new bridge. The existing bridges would be reconfigured to provide four northbound automobile lanes and a new wider bicycle/pedestrian path. The new bridge would carry four southbound automobile lanes and two BRT lanes (northbound and southbound). Under Alternative 4, automobiles would pay a slightly higher toll in the peak commute period than for Alternative 2 and 3. The guideway length, terminus options, station locations, and park-and-rides under Alternative 4 would be the same as for Alternative 2. However, transit service would be increased substantially in Alternative 4, compared to Alternative 2. The frequency of the BRT service would be increased substantially with headways of less than every two minutes in the peak hour in downtown Vancouver. In addition, the background bus network connecting to the exclusive guideway would increase with nearly twice as much service as under Alternative 2.

Alternative 5: Supplemental Crossing with Light Rail is similar to Alternative 4, but provides high-capacity transit via LRT. The LRT would have higher frequency of service than Alternative 3 with 6-minute peak and 10-minute off-peak headways. In addition, the background bus network providing connections to the LRT would have much more frequent service similar to Alternative 4 with a near doubling of Clark County Public Transportation Benefit Area Authority (C-TRAN) fixed-route platform hours.

The LPA includes a 2.9-mile light rail extension from Portland to Vancouver; highway, pedestrian, and bicycle improvements; and a new I-5 bridge. A more detailed description of the LPA is included in Section 1.3.1 below.

Model Network Changes between the DEIS and FEIS

This section describes the changes between the travel demand forecast models used for the DEIS analysis and the FEIS analysis.

Table 1-2 summarizes the differences in the travel demand forecast modeling inputs for the DEIS and the FEIS. These differences were a result of periodic updates to the regional model by Metro in accordance with the RTP in Oregon and the MTP in Clark County, Washington. In addition, the FEIS analysis used the Ivan version of the regional demand model rather than the Hugo version of the regional demand model, which was used for the DEIS, because the Ivan version is the most current version of the model available and is consistent with the model version used for the Portland-Milwaukie Light Rail Project.

Travel demand model input changes included:

- Using the most current regional model (Ivan rather than Hugo)
- An increase in the number of Transportation Analysis Zones to increase the level of sensitivity of the model
- An increase in the Value of Time model input to better model behavior responding to toll options on the bridge
- An increase in the posted speed on the I-5 bridge to match updated design speeds
- Some changes in the highway configuration in Vancouver to reflect recent improvements in design stemming from additional engineering and work with freight stakeholders and the community at large
- Parking at lots in Oregon was constrained to reflect the number of spaces provided
- Reallocation of some employment and households in Portland based on the most recent regional and local growth policies and analysis

Table 1-2. Travel Demand Model Input Changes from DEIS to FEIS (Excluding Changes to the Transit Network)

Data	DEIS Alternative 3	FEIS LPA
Regional Model	Hugo	Ivan
Number of Transportation Analysis Zones (TAZs[1])	2,029 (includes Columbia County and parts of Yamhill and Marion Counties)	2,041 (Clark, Washington, Multnomah, and Clackamas Counties only)
Value of Time[2]	$9.86 / hr in 1994$	$14.68 / hr in 1994$
Downtown Vancouver Circulation	Base	Some changes in highway configuration
Posted Speed On I-5 Bridge	50 miles per hour	55 miles per hour[3]
Highway Network Changes	Based on the financially constrained 2004[4] Regional Transportation Plan (RTP) and 2005[4] Metropolitan Transportation Plan of (MTP) plus project improvements.	Based on updated 2004 RTP and 2005 MTP plus project improvements. RTP has no ramps to SE McLoughlin Blvd in Portland from I-5 at the Marquam Bridge.
Park-and-Ride Demand Modeling	Unconstrained demand at all Oregon park-and-ride facilities; "shadow pricing" [5] only for Clark County lots	"Shadow pricing"[5] employed for all park-and-ride lots in the region
Land Use Changes	Base	South Waterfront, downtown Portland, and the Lloyd District changes in the form of employment and household reallocation to these areas from the rest of Portland

[1]TAZ= traffic analysis zone, which is a geographic area delineated by state and/or local transportation officials for tabulating traffic-related data—especially journey-to-work and place-of-work statistics. A TAZ usually consists of one or more census blocks, block groups, or census tracts.

[2] Value of time is generally defined as the amount a traveler is willing to pay in order to save time, or the amount they would accept as compensation for lost time.

[3]Posted speed on the bridge is increased to reflect safety improvements and widening of the facility.

[4]See Appendix B.

[5] Shadow pricing is a modeling technique used to constrain parking to the number of parking stalls available at a park-and-ride facility. It does not mean that parking at a facility will have a fee.

In addition to the non-network differences outlined in

Table 1-1, Appendix C lists the revisions to transit service frequencies that occurred between the CRC Project's DEIS and FEIS. The C-TRAN bus network changes resulted mainly from the direction provided by C-TRAN's recent service preservation plan, which shows a lower rate of growth over the next 20 years as currently approved by the C-TRAN Board of Directors.

Changes in park-and-ride configurations/sizes between the DEIS and FEIS are explained in Section 1.3 under "LPA Stations and Park-and-Rides" and "LPA Operating Characteristics."

1.3.1 Locally Preferred Alternative

The multimodal build alternative, which has been officially adopted as the LPA by the CRC Project partner agencies,[2] includes the construction of the proposed roadway, bicycle, and pedestrian improvements, and an approximately 2.9-mile extension of light rail facilities and services from the existing Expo Center Station in north Portland, across Hayden Island and through downtown Vancouver, terminating at the Clark Station. The extension of light rail would include construction of the light rail alignment, stations, park-and-ride lots, and other related facilities, the purchase and operation of additional light rail vehicles and the expansion of TriMet's existing Ruby Junction light rail maintenance facility.

Options A and B of the LPA and the LPA with highway phasing would not substantially change the light rail alignment or ridership. There would be no change between LPA options for transit, and therefore this document refers to only one "LPA" rather than distinguishing between the options. Figure 1-5 shows the locations of the new light rail alignment, park-and-rides, stations, and roadway improvements. The differences between Options A and B are only in local roadway configuration providing access to Hayden Island as explained below.

In addition to the transit improvements, the LPA includes highway improvements to the I-5 mainline and interchange improvements in the BIA. A replacement bridge would be constructed over the Columbia River. The highway lane configuration across the Columbia River would consist of three through lanes in each direction and two add-drop lanes, resulting in a five-lane configuration in each direction. The configuration would also consist of the planned added southbound lane from north of Victory Boulevard to south of Columbia Boulevard and retaining the existing northbound managed lane from Going Street to Marine Drive. LPA Option A includes local vehicular traffic between Hayden Island and Marine Drive on an arterial bridge west of the highway (which also carries light rail and a multi-use path). LPA Option B provides vehicular access between Hayden Island and Marine Drive via collector-distributor access lanes on the east and west sides of the I-5 highway. There is also a difference in the local street configuration between LPA Option A and LPA Option B. Please see Chapter 2 of the FEIS for maps of the LPA options and more information of the highway improvements. Under all LPA

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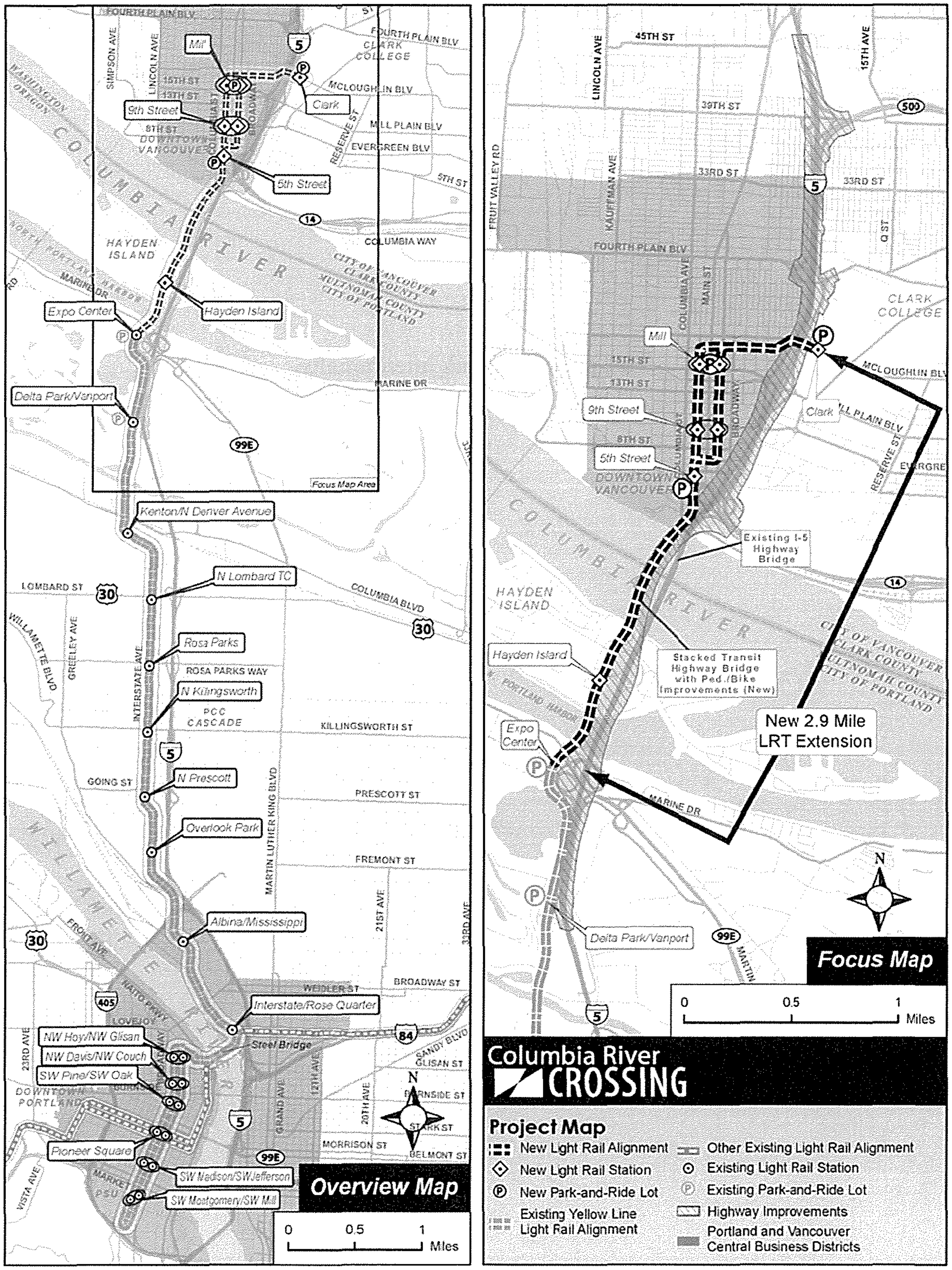
[2] CRC Project partner agencies are the Washington State Department of Transportation (WSDOT), Oregon Department of Transportation (ODOT), City of Vancouver, City of Portland, C-TRAN, TriMet, Metro, and Southwest Washington Regional [Note continued from previous page] Transportation Council (RTC). The LPA has been adopted into the financially-constrained regional transportation plans by both Metropolitan Planning Organizations (MPOs) in the region: Metro and RTC, on July 17, 2008 and July 22, 2008, respectively.

options, I-5 would be tolled in both the southbound and northbound directions. Suburban express buses on I-5 would benefit from the improvements to I-5 and the interchanges.

Figure 1-5. Project Map



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LPA Stations and Park-and-Rides

The LPA includes five new stations and three additional park-and-ride facilities north of the existing Expo Center Station. The stations, described in Table 1-3, would be located on Hayden Island in Portland, in downtown Vancouver, and just outside of downtown Vancouver near Clark College. Table 1-4 lists the park-and-ride lots used for bi-state travel between Clark County and Portland in the LPA, including the existing park-and-ride lots and the three proposed park-and-ride lots that would be constructed by the CRC Project: Columbia (approximately 570 spaces); Mill (approximately 420 spaces); and Clark (approximately 1,910 spaces).

Table 1-3. Columbia River Crossing Project Light Rail Stations

New Light Rail Station	Location
Hayden Island	Adjacent to I-5 on Hayden Island.
5th Street	Washington between 5th and 6th streets.
9th Street	Southbound platform on Washington between 9th and Evergreen Streets, Northbound platform on Broadway between 9th and Evergreen Streets.
Mill	Southbound platform on Washington between 15th and 16th Streets. Northbound platform on Broadway between 15th and 16th streets.
Clark	E. McLoughlin Street and E. K Street.

Table 1-4. Locally Preferred Alternative Park-and-Ride Lot Summary

	Park-and-Ride Facilities	Location	Parking Spaces Available 2030	New Parking Spaces
Clark County I-5 Corridor	Salmon Creek	Adjacent to I-5 at NE 139th Street	513	
	99th Street	Adjacent to I-5 at 99th Street	600	
	Bonneville Power Administration (BPA)/Ross	NE Ross and NE 15th Street	175	
	Clark *new**	E. McLoughlin Boulevard and K Street	***1,910***	***1,910***
	Mill *new* *	Between Washington and Main Street and between 15th and 16th	***420***	***420***
	Columbia *new* *	Between 4th and 5h and Columbia and Washington	***570***	***570***
		Total Spaces	**4,188**	**2,900**
Clark County I-205 Corridor	Fisher's Landing	SE 34th St and SE 164th Ave	836	
	18th Street	Adjacent to I-205 at 18th Street	500	
		Total Spaces	**1,336**	
Portland I-5 Corridor	Expo Center	2060 N Marine Drive	300	
	Delta Park/Vanport	1904 Victory Boulevard	304	
		Total Spaces	**604**	
		Total Spaces Used for Bi-State Travel	**6,128**	

*These park-and-ride facilities would be constructed as part of the Locally Preferred Alternative. The number of spaces in the new park-and-ride lots is approximate.

Source: Physical inventory of 2008 existing conditions.

The DEIS analysis of Alternative 3 evaluated a light rail extension with four different termini options, and each terminus option was paired with representative park-and-ride facilities (i.e., different lot locations and/or lot sizes). Chapter 2 of the DEIS noted that "all build alternatives include a representative combination of both physical and operational components" (page 2-2).

The four potential terminus options in the DEIS (Clark College Minimum Operable Segment (MOS), Mill Plain MOS, Kiggins Bowl Terminus, and Lincoln Terminus) were each analyzed with one representative park-and-ride lot configuration unique to its alignment and terminus. The costs, transit ridership estimates, cost-effectiveness, and environmental consequences documented in the DEIS for each terminus option were based on this representative example of how the terminus could be paired with a park-and-ride configuration.

Additional analysis has occurred since the publication of the DEIS resulting in a different park-and-ride configuration (location and size of lots) for the LPA than was documented in the DEIS for the Clark College terminus. (However, the configuration impacts were analyzed with various terminus options.) A version of Alternative 3 was selected by the local jurisdictions as the LPA. The LPA park-and-ride lot configuration was refined based on further analysis to determine the optimal combination/configuration of new park-and-ride facilities for Alternative 3, light rail transit with a new Columbia River bridge. An optimal configuration would maximize transit ridership while minimizing environmental effects.

To ascertain the optimum configuration of park-and-ride lots for each potential terminus of Alternative 3, each park-and-ride was evaluated individually. The memorandum *"Columbia River Crossing Project Costs, Ridership and Environmental Consequences of Potential Light Rail Park-and-Ride Lot Configurations (Using Alternative 3 as an illustration of the differences in configuration and impact),"* May 2008, included as Appendix D, documents much of that analysis. Individual ridership and environmental effects for the five park-and-ride lots considered were determined based on the lot size (number of stalls) and structure (surface or structured lot). The analysis showed that larger lots cost more to build; generally had more traffic, environmental, and land use impacts; and generated more transit ridership.

Different combinations of lots were paired with the four terminus options to determine potential configurations that could balance environmental effects while maintaining or increasing cost-effectiveness. An alternative park-and-ride lot configuration for the Clark terminus was crafted that improved cost-effectiveness based on ridership and cost when compared to the representative Clark College MOS park-and-ride configuration evaluated as Alternative 3. The characteristics of the DEIS version and the alternative version are listed in Table 1-5, below.

Table 1-5. Comparison of Alternative 3 DEIS Clark College MOS Representative Park-and-Ride Configuration and Alternative Park-and-Ride Configuration for Clark Terminus

Characteristics	DEIS Clark College MOS Representative Configuration	Alternative Clark Terminus Park-and-Ride Configuration
New Park-and-Ride Spaces	1,250 total	2,460 total
SR-14	*0*	*500*
Mill Plain	*0*	*560*
Clark College	*1,100*	*1,400*
Kiggins Bowl	*150*	*0*
Capital Costs (millions)[1]	$674.9	$723.3
Transit Ridership[2]	18,200[3]	21,350[4]
Annual Transit Ridership[5]	5,820,000	6,830,720
Cost Effectiveness[6]	$10.38	$9.44

[1] Capital costs are in millions of year-of-expenditure dollars and only reflect the cost of transit components of Alternative 3. Costs reflect a 60 percent confidence. See the *Cost Risk Assessment Final Report* for a detailed description of the methods used to prepare the capital costs estimates.
[2] Ridership is average weekday person trips across the Columbia River in the project area by transit on an average weekday.
[3] DEIS ridership was derived from the Metro travel demand model.
[4] Trips generated by additional park-and-ride spaces were estimated as a proportion of spaces (approximately 2.6 transit person trips per space). These additional trips were added to ridership from the Metro travel demand model.
[5] Annual transit trips are calculated by multiplying average weekday rides by 320, the factor used for annual ridership data in Exhibit 3.1-39 of the DEIS.
[6] Cost effectiveness was calculated by dividing annual (transit) ridership across the Columbia River in the I-5 corridor by the annualized capital and cost.

Further conceptual engineering of the Clark and SR-14 (Columbia) park-and-ride lots showed that 510 spaces could be added to the Clark lot and 70 spaces could be added to the SR-14 (Columbia) lot with minimal increases in environmental consequences. Therefore, the size of these facilities was increased to approximately 1,910 spaces and 570 spaces, respectively. This made it possible to reduce the number of spaces at the Mill lot to approximately 420 spaces. (Reducing parking at this downtown lot while providing more parking at Clark would respond to public input and balance traffic impacts with ridership.) The three new park-and-ride lots in the LPA provide approximately 2,900 parking spaces adjacent to three new light rail stations.

LPA Operating Characteristics

The LPA background transit network is very similar to the network serving downtown Vancouver and north Portland in 2008. The primary difference is a new, 2.9-mile LRT extension from the end of TriMet's LRT Yellow Line at Expo Center Station to the Clark terminus providing a one-seat ride between Vancouver and downtown Portland and truncation of duplicative bus service after the LRT extension is completed. The LRT would replace service provided by four C-TRAN buses that currently connect Clark County to the Delta Park/Vanport LRT Station in north Portland (lines 4, 41, 44, and 47). These C-TRAN transit lines would be truncated in downtown Vancouver instead of crossing the Columbia River as they do today. In addition, the C-TRAN 105 bus route, which currently runs from Salmon Creek Park-and-Ride to downtown Vancouver, and then to downtown Portland on I-5, would be truncated in downtown Vancouver.

The LRT extension would operate between the existing Expo Center Station, across the Columbia River, through downtown Vancouver on a Broadway/Washington couplet before heading east on 17th Street to the Clark Park-and-Ride terminus. The LRT would run in both directions everywhere except on the couplet where northbound trains would head east on 7th, then north on Broadway Street to 17th Street. Southbound trains would travel west on 17th past Broadway Street, turn south on Washington to 7th Street where two-way LRT traffic would resume. There would be one light rail station on Hayden Island, three new light rail stations in downtown Vancouver, and one near Clark College at the terminus. As discussed above, three new park-and-ride lots with approximately 2,900 spaces would provide access to the LRT line in Vancouver. By 2030, LRT headways would be 7.5 minutes in the peak and 15 minutes in the off-peak. (Appendix E: 2030 No Build and Locally Preferred Alternative Transit Network (T-Net) lists transit routes and headways for the No Build and LPA.)

C-TRAN would continue to use downtown Vancouver as the system's transit hub with its major routes (12 in total) converging there. The routes would follow roughly the same routing as today, with the exception of the four routes that would terminate in downtown rather than connect to the LRT Yellow Line at the Delta Park/Vanport Station (lines 4, 41, 44, and 47). See Appendix F: LPA Transit Routing Map.

The C-TRAN express bus system would continue to serve the I-5 corridor. Suburban express buses would continue to run from suburban park-and-ride locations non-stop to downtown Portland and Oregon Health Sciences University (OHSU) in the peak periods. These routes would originate at suburban park-and-ride lots (Salmon Creek, 99th Street, and BPA/Ross in the I-5 Corridor) and travel down I-5 with no intermediary stops before reaching their destinations. These buses would have headways ranging from 20 minutes to 240 minutes. Route 105 would terminate in downtown Vancouver no longer crossing the Columbia River.

1.3.2 Key Features of LPA and 2030 No Build Alternatives

The key characteristics of the LPA and the 2030 No Build Alternative are summarized in Table 1-6. A more comprehensive description of these alternatives and transportation analysis assumptions can be found in the *CRC Final Definition of Transit Alternatives Report* (CRC, 2009).

Table 1-6. Key Features of the LPA and 2030 No Build Alternatives

Alternative	Transit	Roadway
2030 No Build Alternative	Existing 2008 transit service and facilities. Some increases in route frequency and/or run times to avoid peak overloads and/or to maintain schedule reliability. Incremental increases in service hours and vehicle procurement consistent with both the MTP and RTP 2030 financially-constrained networks. Completion of the South Corridor light rail project on the Portland Mall and I-205. New 18th Street Park-and-Ride with 500 spaces off I-205 in Vancouver. Fishers Landing Park-and-Ride expanded by 250 spaces to 836 spaces. Articulated buses run on one new Express Route (#105S) running from downtown Vancouver to downtown Portland.	Roadway improvements are limited to those in the 2004 RTP and 2007 MTP financially-constrained highway network. See Appendix B for a detailed listing of the planned roadway and transit projects within the CRC project area.
LPA	All transit improvements included in the 2030 No Build Alternative.	Highway improvements to the I-5 mainline and interchange improvements in the BIA. A replacement bridge would be constructed over the Columbia River. The highway lane configuration across the Columbia River would consist of three through lanes in each direction and three add-drop lanes, resulting in a six-lane configuration in each direction. The configuration would also consist of the planned added southbound lane from north of Victory Boulevard to south of Columbia Boulevard and retaining the existing northbound managed lane from Going Street to Marine Drive. Under this system, I-5 would be tolled in both the southbound and northbound directions. Express buses on I-5 would benefit from the improvements to I-5 and the interchanges.
	2.9-mile extension of LRT tracks from the existing Expo Center Station in Portland to Clark Park-and-Ride in Vancouver with the rail guideway adjacent to the new southbound I-5 Bridge on Hayden Island, a one-way Broadway-Washington couplet in downtown Vancouver, and a two-way center running configuration on 17th Street. Three additional structured park-and-ride lots at: Columbia Park-and-Ride with approximately 570 spaces, Mill Park-and-Ride with approximately 420 spaces and Clark Park-and-Ride with approximately 1,910 spaces. Adjustments to 2030 No Build Alternative bus network to avoid duplication of light rail service: 1) eliminate C-TRAN routes crossing Columbia River to connect to the light rail line at Delta Park/Vanport MAX Station 2) eliminate C-TRAN express bus service from downtown Vancouver to downtown Portland on #105 and #105S. Expansion of the Ruby Junction Operations Facility to accommodate additional light rail vehicles. Nineteen additional light rail vehicles.	

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2. Affected Environment

2.1 Public Transportation

This section summarizes characteristics of the existing public transportation system and behavior within the region and corridor.

The existing transit network for the CRC Corridor includes fixed-route and express bus service to the transit markets within the corridor. (See Appendix G for a listing of 2005 bus routes and headways.) The existing transit conditions for this FEIS are derived from the base year of analysis (2005) for modeling outputs and more recent field-verified data, where appropriate. Although some of the transit conditions have changed since 2005, the modeled 2005 traffic and transit data provide a good comparison to the 2030 alternative outputs and are consistent with the 2030 Portland-Milwaukie Light Rail Project.

Transit service in the corridor is primarily provided by fixed-route, fixed-schedule buses operating in mixed traffic on freeways, highways, arterials, and local streets. Intra-suburban trips are served by local bus lines that connect suburban residential neighborhoods with transit centers in Vancouver and North Portland. The transit centers in Vancouver are linked to downtown Portland by express bus service running in general traffic on I-5 and I-205. The transit centers in north Portland are linked to downtown Portland with light rail service.

2.1.1 Public Transportation Providers

There are two public transit providers in the project study area: C-TRAN in Washington State and TriMet in Oregon.

C-TRAN is the mass transit agency serving the cities of Vancouver, Camas, Washougal, Ridgefield, La Center, Battle Ground, and Yacolt. It also serves the unincorporated areas surrounding Vancouver that are part of the Vancouver Urban Growth Area. Its operating area covers approximately 133 square miles with a population of approximately 350,000, with approximately 6 to 7 million passenger boardings per year.

TriMet (the Tri-County Metropolitan Transportation District of Oregon) is the mass transit operating agency for most of the Portland metropolitan region. It is the largest transit district in Oregon: operating in Multnomah, Clackamas, and Washington counties. Its operating area covers approximately 575 square miles and it serves a population of approximately 1.3 million, with approximately 100 million passenger boardings per year.

2.1.2 Transit Lines, Operations, and Facilities

As stated earlier, 2005 was the base year for modeled data in the TriMet and C-TRAN transit networks in prior phases of the CRC Project, including the DEIS. Since 2005, C-TRAN has implemented a significant service redesign. To reflect the changes to the C-TRAN system, this section reports the existing base network conditions (2005) and more recent conditions (2007) for that agency. The TriMet network (except for route 6) is very similar to 2005. (Route 6 used to serve downtown Vancouver, but now terminates on Hayden Island.) Therefore, this section only reports 2005 base year information for TriMet. For consistency with the DEIS, the FEIS continues to use the 2005 C-TRAN bus network as representative of existing conditions. However, this section describes both 2005 and 2007 conditions for the C-TRAN bus network.

In 2005, C-TRAN had 26 total bus routes (17 local routes and nine commuter/express routes). In the 2005 base year transit network, the bi-state service provided by C-TRAN consisted of six peak-period express routes (routes 105, 114, 134, 157, 173, and 190) in the I-5 corridor and two peak-period express routes in the I-205 corridor (routes 164, and 177). C-TRAN's express bus lines provide direct service from Vancouver to downtown Portland. C-TRAN also operated an all-day shuttle between the Fisher's Landing Transit Center and the Parkrose Transit Center in Portland (Route 165). (See Appendix G: 2005 TriMet and C-TRAN Transit Networks T-Net).

The current C-TRAN transit network is the result of the service redesign that was adopted by the C-TRAN Board of Directors in January of 2007 and fully implemented with minor modifications in November of 2007 and February of 2008. In downtown Vancouver, C-TRAN operates seven local bus routes. Generally, these bus routes operate at 15- to 60-minute headways in the peak and off-peak periods, on weekdays and weekends. See Appendix H for a complete list of the 2007 local bus routes and their headways. Of these, local bus routes 4 – Fourth Plain, 37 – Highway 99, and 37 – Mill Plain have the highest bi-state and local ridership. With C-TRAN's service redesign, Route 4 began extended service from downtown Vancouver to the light rail station at Delta Park/Vanport in north Portland. Route 4 also provides service to Hayden Island. Route 4 operates in general purpose lanes crossing the Columbia River and in mixed traffic on I-5 in order to serve Hayden Island and the Delta Park/Vanport LRT Station.

Within the project study area, C-TRAN also operates three limited bus routes (41 –Camas/ Washougal Limited, 44 – Fourth Plain Limited, and 47 – Battle Ground Limited). These limited stop routes operate only during the weekday peak periods. They have a stop spacing of every one-half to one mile, and therefore, do not meet the CRC definition of a point-to-point express bus. Route 44 is a limited stop version of the local bus Route 4, but offers additional coverage on Fourth Plain Boulevard approximately three miles east of Vancouver Mall, the Route 4 terminus. Route 44 operates during the peak periods only with a 30-minute headway. It crosses the Columbia River on I-5 general purpose lanes and provides a transfer opportunity to the light rail station at Delta Park, but does not stop on Hayden Island. Routes 41 and 47 also travel across the Columbia River and terminate at the light rail station at Delta Park/Vanport with peak period headways of 120 minutes.

As of 2007, C-TRAN operates a fleet of 109 fixed-route buses, with 26 routes (fifteen local, four limited stop, and seven commuter/express routes). C-TRAN fleet maintenance occurs at the Administration, Operations and Maintenance (AOM) building in Vancouver. According to data from the National Transit Database, in 2007 C-TRAN logged approximately 329,100 annual revenue hours (247,323 for fixed route bus, and 81,773 for demand response services for seniors and people with disabilities).

TriMet's rail network[3] consists of a 44-mile, 64-station, regional light-rail system with 105 light rail vehicles (LRVs). All LRV maintenance and repairs are carried out in two facilities — Ruby Junction on the east side of TriMet's service area and Elmonica on the west side. TriMet also operates 641 buses (including spares), grouped into 18 fleets on 93 bus lines, paratransit service for seniors and people with disabilities, and facilities with advanced amenities and passenger information. TriMet's buses are assigned to one of three garages—Center Street or Powell Garage on the east side or Merlo Garage on the west side—where they are serviced and receive maintenance. In 2005, TriMet operated one bi-state bus route (Route 6) to downtown Vancouver via North Portland and Hayden Island. However, since 2007, C-TRAN has provided all the bi-state bus service in the region. TriMet also owns and operates the 5.8-mile Interstate MAX Yellow Line, which operates through North Portland and includes 10 stations between the Rose Quarter and its terminus at the Expo Center light rail station, approximately two miles south of downtown Vancouver.

Table 2-1. Summary of Existing Transit Operating Characteristics

Characteristic		TriMet 2005	C-TRAN 2005	C-TRAN 2007
Vehicles	**Fixed Route Bus Active Fleet**	532	97[1]	95*
	Fixed Route Bus Spares	109	24	15
	Fixed Route Bus Contingency Vehicles	14	10	10
	LRV Active Fleet	105 LRVs	N/A	N/A
	LRV Spares	4 LRVs	N/A	N/A
Annual Revenue Hours	**Fixed Route Bus**	1,873,568*	231,191*	247,323*
	LRT	415,713*	N/A	N/A
Maintenance Facilities	**Buses**	3	1	1
	LRT	2	N/A	N/A

*Source: 2005 National Transit Database and 2007 National Transit Database.
Note: LRV = light rail vehicle.
[1] The 130 buses reported in the DEIS included active fleet, spare, and contingency vehicles. Spares are vehicles that are actively used as replacement vehicles; contingency vehicles are only moved into active fleet status under special conditions, such as where the number of spare vehicles is inadequate to meet the immediate need.

Table 2-2 lists the existing transit capital facilities within the CRC Study Area used for bi-state trips between Clark County and Portland in both 2005 and 2007. Within the CRC Study Area there are currently three transit centers in Clark County and four transit centers in the Portland area that are used by people traveling between Clark County and the Portland central city. The Seventh Street Transit Center in downtown Vancouver has been relocated to 99th Street west of I-5. With the relocation, bus service still continues throughout downtown Vancouver, but layovers and other operational functions have moved to the new transit center located at 99th Street. In North Portland, the Lombard Transit Center is located at the intersection of Lombard

[3] Year 2005 data.

Street and Interstate Avenue and is the main location for bus to light rail and bus to bus transfer activities.

Within the CRC Study Area, there are six existing park-and-ride lots in Clark County and two park-and-ride lots in Portland (within the I-5 corridor) that are used by people traveling between Clark County and Portland central city. With the addition of the 99th Street Park-and-Ride in 2007, the total number of parking spaces in the project area increased from 3,130 to 3,730.

Table 2-2. 2005 and 2007 Transit Capital Facilities used for Bi-State Travel between Clark County and Portland

			2005 Conditions		2007 Conditions	
State	Facility Name	Location	Transit Center	Parking Spaces	Transit Center	Parking Spaces
Washington	Downtown Vancouver Transit Center	7th Street between Washington and C Street	√	0		0
	Vancouver Mall Transit Center	NE Vancouver Mall Dr	√	0	√	0
	Fisher's Landing Transit Center	SE 34th St and SE 164th Ave	√	566	√	566
	Battle Ground Park-and-Ride	E Main St and NE Fairground Ave		20		20
	Salmon Creek Park-and-Ride	Adjacent to I-5 at NE 139th Street		493		493
	BPA/Ross Park-and-Ride	NE Ross and NE 15th Street		175		175
	K-Mart Park-and-Ride	Andresen and 25th St		100		100
	Evergreen Park-and-Ride	NE 138th Ave and NE 18th St		269		269
	Washougal Park-and-Ride	Second St and C St		20		20
	99th Street Transit Center	Adjacent to I-5 at 99th Street		0	√	600
Oregon	Expo Center Park-and-Ride	2060 N Marine Drive		300		300
	Delta Park/Vanport Park-and-Ride	1904 Victory Boulevard		304		304
	Lombard Transit Center	Lombard and Interstate Ave	√	0	√	0
	Rose Quarter Transit Center	Interstate and Holladay	√	0	√	0
	Parkrose Transit Center	NE Sandy Blvd and 95th	√	193	√	193
	Gateway Transit Center	NE 99th St and Pacific	√	690	√	690
	Total Spaces			**3,130**		**3,730**

2.1.3 Current Operating Revenue and Operating Expenses

In 2007, according to the National Transit Database, C-TRAN logged approximately 329,096 annual revenue hours (247,323 fixed route bus, and 81,773 paratransit). This is a slight increase from 2005, when C-TRAN logged 303,226 annual revenue hours (231,191 fixed route bus and 72,004 paratransit). Systemwide, farebox revenues were $5.6 million in 2007, and $4.8 million in 2005. Costs for operations and maintenance were $31.5 million in 2007, and $25.0 million in 2005.

In 2005, TriMet operated fixed route service for 2,208,586 annual revenue hours (1,516,296 fixed route bus, 487,966 paratransit and 204,324 light rail) according to TriMet's Service and Ridership Statistics Report. Systemwide, farebox revenues were $59.5 million. Costs for operations and maintenance were $237.6 million.

TriMet fare revenue as a percentage of the cost of operations and maintenance (O&M) were 25.0 percent systemwide (22.5 percent for fixed route bus, 41.8 percent for light rail, and 3.1 percent for paratransit). According to the National Transit Database (NTD), systemwide C-TRAN farebox revenue was 17.0 percent of the cost to operate and maintain their buses (22.5 percent for the fixed-route bus system and 3.0 percent for paratransit).

The O&M cost per boarding ride on TriMet for FY2005 was $1.74 for LRT and $2.47 for fixed route buses. According to the NTD, C-TRAN's O&M cost per boarding ride for FY2005 was $3.54 for fixed route bus and $26.07 for paratransit. For FY2007, C-TRAN's cost per boarding was $4.31 per ride for fixed-route buses and $33.68 per ride for paratransit.

Table 2-3. C-TRAN and TriMet Existing Operating Revenue and Operating Expenses

Agency - By Year		Annual Revenue Hours	Systemwide Farebox Revenues	Operations and Maintenance Costs	Costs Per Boarding
C-TRAN	2007	329,096 total - 247,323 fixed route bus - 81,773 paratransit	$5.6 million	$31.5 million	- $4.31 fixed route bus - $33.68 paratransit
	2005	303,226 -231,191 fixed route bus -72,000 paratransit	$4.8 million	$25.0 million	- $3.54 fixed route bus - $26.07 paratransit
TriMet	2005	2,208,586 total -1,516,296 fixed route bus -487,966 paratransit -204,324 light rail	$59.5 million	$237.6 million	-$2.47 fixed route bus -$1.75 light rail

Source: TriMet 2006 for TriMet data, National Transit Database (NTD) for C-TRAN data.
Note: 2005 C-TRAN data does not include vanpool.

2.2 Travel Behavior

The basic unit of measurement used in describing travel behavior is the "person trip," which is a trip made by one person from a point of origin to a destination, via any travel mode or combination of modes. It is also often referred to as an "unlinked trip" or an "originating trip."

In 2005 (the modeling base year for this FEIS), the transportation facilities in the CRC Corridor[4] were estimated to carry 536,000 person trips between the corridor and the Portland central city[5]

[4] See Figure 1-1 Regional Setting and Figure 3-1 Major Market Locations Map.

on an average weekday. Of these approximately 45,000 (8 percent) were on the transit system. Of 83,000 daily work person trips between the corridor and the Portland central city, 18,000 (22 percent) were on transit.[6]

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[5] Portland central city = Districts 1,2, and 3, CRC Corridor = Districts 1-6,12-18, and 21.

[6] Source: Metro's Travel Demand Model – 2009.

PRELIMINARY

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3. Environmental Consequences

3.1 District-to-District Travel Demand and Mode Choice

Travel demand (as measured in person trips) between districts (i.e., groupings of TAZs) help to discern travel markets and shifts in modes due to the differences between alternatives. The district-to-district travel demand totals are split into three groups: total person trips, transit to work trips, and total transit trips. The total person trip table is an output of the trip distribution model, whereas the transit work trip and total transit trip table are outputs of the mode choice model. Total transit trips include the work transit trips and non-work transit trips. Appendix I provides a reference map of the districts included in the regional travel demand model and transit trip tables for total person trip demand, transit work trip demand and total transit trip demand.

Improving transit connections (particularly during the commute (peak) hours) helps meet the CRC purpose and need by reducing vehicular demand on the roadway capacity across the river and improving connectivity, reliability, and travel times for public transportation. Commute trips comprise the majority of daily transit trips between the central cities (Portland and Vancouver) and the rest of the Project Corridor. Commute trips include all trips that are from a person's home to their place of work or college (home-based work trips and college trips).

There are three major markets for transit commute trips in the Project Corridor illustrated in Figure 3-1.

- Between the Portland central city and the Project Corridor residential areas,
- Between the Portland central city and the Washington residential area of the Project Corridor, and
- Between the Vancouver central city and the Portland residential areas of the Project Corridor.

The primary transit market in the CRC Transit Corridor is the commute trip between the residential areas north of the Portland central city and the Portland central city.

Table 3-1 compares the transit commute trips in 2005, the 2030 No Build Alternative and the LPA for the major transit markets. (Figure 3-1 shows the locations that make up the major transit markets in the Project Corridor.) The number of average daily transit commute trips would increase substantially for all three markets by 2030. With improvements to the Columbia River crossing in the LPA, the percent increase of transit commute trips grows substantially for the markets connecting Oregon and Washington commuters. Portland central city and Washington residential areas trips increase by 98 percent, and the Vancouver central city and Oregon part of the Project Corridor trips increase by 50 percent.

Table 3-1. Comparison of Average Daily Transit Commute Trips[1] in Key Markets in the Project Corridor (2030 Average Weekday Trips and Percent Increase)

Markets (Origin and Destination Pairs)		2005	2030 No Build		2030 LPA	
Between:	And:	Transit Commute Trips	Transit Commute Trips	Increase over 2005	Transit Commute Trips	Increase over 2030 NB
Portland Central City (1,2,3)[2]	Project Corridor Residential Area (4-6, 12-18, and 21)	10,000	16,000	60%	21,300	33%
Portland Central City (1,2,3)	WA part of Project Corridor Residential Area (13-18 and 21)	3,100	5,200	68%	10,300	98%
Vancouver Central City (13)	OR part of the Project Corridor (4-6 and 12)	200	600	200%	900	50%

[1]Commute trips include all trips from a person's home to work or college (home-based work and college).

[2]Parentheses () indicate Districts comprising a location. See Figure 3-1.

Note: Numbers and percentages are rounded.

Table 3-2 shows the transit mode share for commute trips on average weekday for 2005, the 2030 No Build Alternative and the 2030 LPA. The mode share reflects the percent of the total trips that are taken on transit. Transit mode share increases substantially by 2030 for both alternatives. In the LPA, trips between the key markets have a mode split that exceeds that in the 2030 No Build Alternative for all three markets. With the LPA, transit would account for 39 percent of trips between the Project Corridor and the Portland central city, 38 percent of the trips between the Portland central city and the Washington part of the CRC Project Transit Corridor, and 39 percent of the trips between the Vancouver central city and the Oregon part of the Project Corridor.

Table 3-2. Comparison of Average Daily Transit Mode Splits in Key Markets in the Project Corridor (2030 Average Weekday Trips and Percent Increase)

Markets (Origin and Destination Pairs)		2005	2030 No Build		2030 LPA	
Between:	And:	Transit Commute Trips	Transit Commute Trips	% Increase over 2005	Transit Commute Trips	% Increase over 2030 NB
Portland Central City (1,2,3)[2]	Project Corridor Residential Area (4-6, 12-18, and 21)	21%	31%	47%	39%	26%
Portland Central City (1,2,3)	WA part of Project Corridor Residential Area (13-18 and 21)	15%	22%	46%	38%	76%
Vancouver Central City (13)	OR part of the Project Corridor (4-6 and 12)	11%	26%	127%	39%	51%

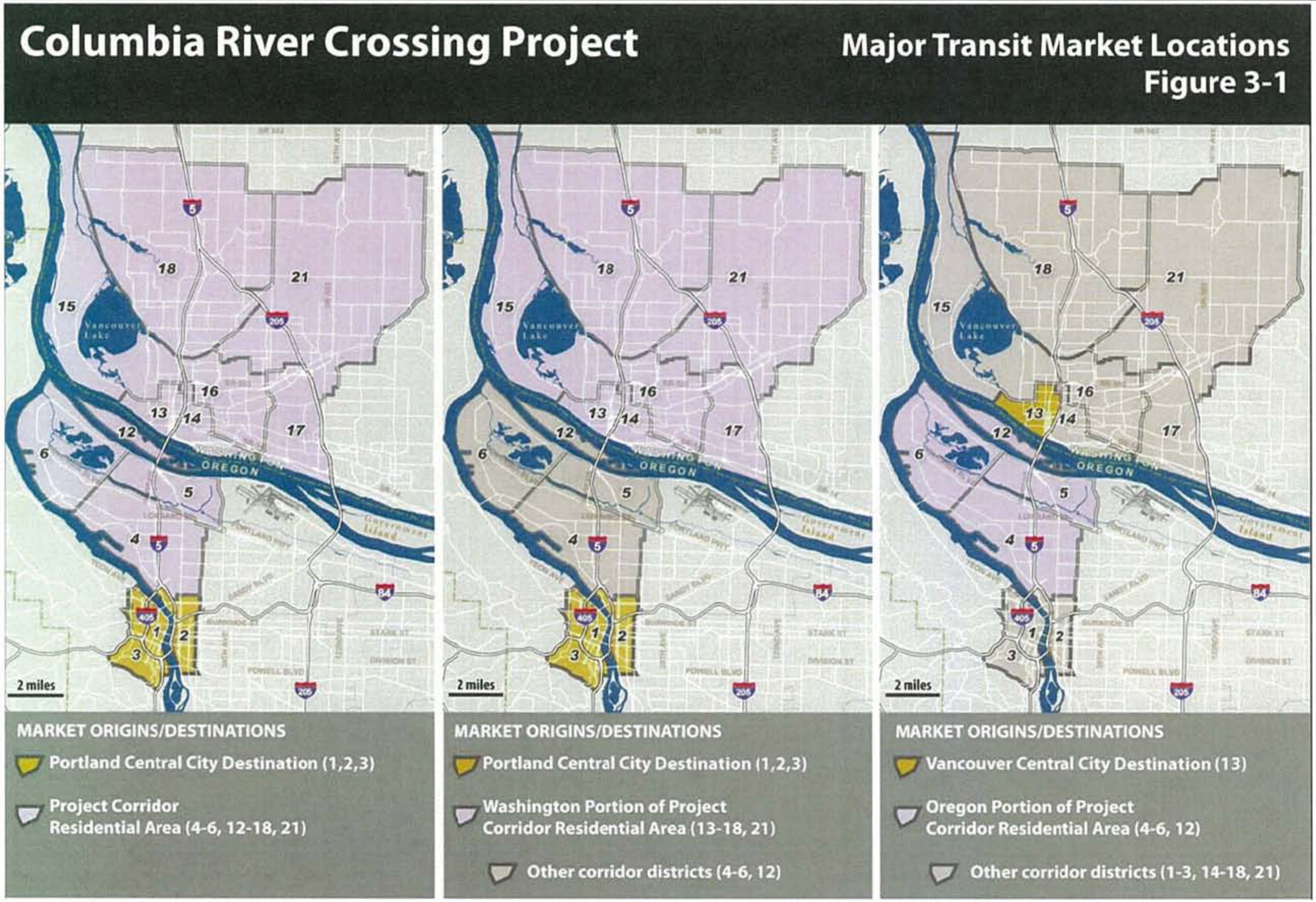
Note: NB = No Build Alternative.

[1]Commute trips include all trips from a person's home to work or college (home-based work and college).

[2]Parentheses () indicate Districts comprising a location. See Figure 3-1.

Note: Numbers and percentages are rounded.

Figure 3-1. Major Transit Market Locations



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3.2 Transit Impacts

3.2.1 Service Characteristics

The 2030 No Build Alternative is consistent with the service characteristics of the financially constrained transit networks associated with the *2004 Regional Transportation Plan* (Metro) and the *2007 Metropolitan Transportation Plan* (Southwest Washington Regional Transportation Council) *with July, 2008 amendments*. The LPA transit network is slightly different from the No Build; see Section 1 of this document.

Amount of Service

The amount of transit service provided is measured by daily vehicle hours traveled (VHT) in revenue service, daily vehicle miles traveled (VMT) in revenue service, and daily place-miles of service. Daily VHT are the cumulative time that transit vehicles are in service and daily VMT are the distance they travel, independent of the size of the vehicle. "Daily" is defined as an average weekday in year 2030. Place-miles refers to the total carrying capacity (seating and standing) of each bus or train and is calculated by multiplying the vehicle capacity of each bus or light rail vehicle by daily VMT. Place-miles highlight passenger capacity differences between alternatives caused by a different mix of vehicles and levels of service. Table 3-3 summarizes these transit service characteristics.

Service Growth

Service growth under the 2030 No Build Alternative would be constrained by available revenue sources, consistent with the financially constrained transit network in Metro's 2004 RTP. With the 2030 No Build Alternative, weekday corridor transit VMT and VHT would increase compared to existing levels by 25 and 28 percent, respectively. The greater percentage increase in VHT compared to VMT reflects that trips are anticipated to take longer in the forecast year due to more background congestion on roadways.

Table 3-3 shows that transit place miles are two percent greater with the LPA as compared to the 2030 No Build Alternative, with most of the increase attributed to light rail vehicles' greater capacity, even though VMT decreases by almost 20 percent. Place miles measure the transit capacity of the system.

The LPA includes an approximately 2.9-mile light rail extension between Expo Center Station in Portland and Clark College park-and-ride in Vancouver. In peak periods in 2030, two-car trains would operate every 7.5 minutes in the peak direction. The C-TRAN bus network would provide convenient bus connections to the light rail line in downtown Vancouver with 15 C-TRAN bus routes serving downtown Vancouver. In addition, express bus service would continue from the suburban park-and-ride lots in Clark County to downtown Portland. The local service buses that connect downtown Vancouver to the Delta Park/Vanport Station in North Portland would be truncated in downtown Vancouver because they would duplicate the new light rail extension service. The C-TRAN 105 route would also be truncated in downtown Vancouver. Three new park-and-ride lots would be constructed adjacent to the LRT stations in Vancouver.

Table 3-3. Average Weekday Corridor[1] Transit Service Characteristics, Year 2030

		Scenario	
Attribute	**Existing (2005)**	**2030 No Build**	**2030 LPA[2]**
Transit VMT (Weekday)			
Bus	28,500	36,000	33,600
LRT[3]	1,440	1,480	2,340
Total	29,940	37,480	35,940
% Change[4]	N/A	25.2%	-4.1%
Transit VHT (Weekday)[5]			
Bus	1,340	1,750	1,610
LRT	113	135	214
Total	1,453	1,885	1,824
% Change[4]	N/A	29.7%	- 3.2%
Place Miles (Weekday)[6]			
Bus	1,595,000	2,072,900	1,895,500
LRT	383,040	392,496	621,016
Total	1,978,040	2,465,396	2,516,516
% Change[4]	N/A	24.6%	2.1%

Source: Metro, 2009

Note: LPA = locally preferred alternative; LRT = light rail transit; VMT= vehicle miles traveled in revenue service; VHT = vehicle hours traveled in revenue service; N/A = not applicable.

1 Includes transit for all C-TRAN routes, TriMet North Portland routes, and the Yellow Line and the Columbia River Crossing extension.

2 LPA is based on a $2.00 peak and $1.00 off-peak, bi-directional toll on the I-5 Columbia River Crossing.

3 For LRT, *transit VMT* is measured in train miles, rather than in car miles.

4 For the 2030 No Build Alternative, the percent change is from the total for the 2005 existing conditions; for the LPA, the percent change is from the total for the 2030 No Build Alternative.

5 Vehicle Hours Traveled (Weekday) are based on revenue hours of service.

6 Place miles = transit vehicle capacity (seated and standing) for each vehicle type multiplied by VMT for each vehicle type. TriMet Bus capacity = 51, C-TRAN bus capacity = 61 (standard) and 91 (articulated), LRT capacity =266 (LRT consists of two-car trains; each car carries 133 people).

Note: Based on a $2.00 peak and $1.00 off-peak bi-directional toll.

Travel Time

Transit travel times are assessed using in-vehicle time and total travel time (in-vehicle plus wait time plus walk access times), as shown in Table 3-4. This table summarizes the change in AM peak-hour travel times and PM peak-hour travel times for the 2030 No Build Alternative and LPA. The first part of the table summarizes the in-vehicle travel times for transit. The second part of the table summarizes the total travel time, comprised of in-vehicle, wait and walk-access times. The travel time data shown are for trips between the Clark College terminus and downtown Portland, between downtown Vancouver and downtown Portland, and between downtown Vancouver and major employment centers in Portland.

Travel times were derived using travel demand forecasting model results and field-based data. Travel times for bus routes were derived from the Metro regional travel demand forecasting model (utilizing the software package for auto and transit assignments) for all bus routing not on

I-5 and outside of downtown Portland and downtown Vancouver. In downtown Vancouver, bus speeds were projected to be approximately eight miles per hour, based on a VISSIM microsimulation analysis.[7] In downtown Portland, bus speeds were projected to be approximately six miles per hour, based on observed travel speeds.[8] Where buses traveled on I-5, speeds were derived from the VISSIM microsimulation model. LRT travel times are derived from the LTK simulator modeled outputs.[9]

Travel times vary by time of day, direction of travel and travel mode. Travel times improve for transit in the LPA compared to the 2030 No Build Alternative. Table 3-4 shows three major impacts of the LPA on travel times within the project corridor compared to the 2030 No Build Alternative. The LPA:

- Improves transit travel times region-wide,
- Improves transit travel times relative to automobile travel times, and
- Improves reliability of transit travel times.

The in-vehicle and total transit travel times for all of the origin and destination pairs reported in Table 3-4 would improve with the LPA, compared to the 2030 No Build Alternative, with savings ranging between three and 28 minutes. For example, in the PM Peak northbound, total transit travel times from Pioneer Square to Clark College would drop from 72 minutes to 44 minutes (28 minutes faster) with the LPA. Similar improvements in travel time occur for other locations and for AM Peak southbound travel. In-vehicle time improvements with the LPA, range from three to 20 minutes of time savings.

Transit travel times would be more competitive with automobile travel times with the LPA, despite numerous highway improvements. In many cases, the travel times for transit are shorter than travel times for automobiles. (Trips where transit takes less time than automobile travel are shaded in Table 3-4.) It would take three fewer minutes (in-vehicle) during the AM Peak to travel from downtown Vancouver to Pioneer Square (32 minutes versus 35 minutes). The AM southbound automobile travel times during this time of day are longer than in the PM northbound, because of remaining I-5 bottlenecks south of the bridge influence area.

Transit reliability between major origins and destinations is higher due to the availability of LRT that travels in an exclusive guideway.

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[7] CRC VISSIM analysis 2007.

[8] In February 2007, the CRC project staff conducted a travel time survey of buses in downtown Portland. The average downtown Portland travel time was 5.4 miles per hour on the C-TRAN #105 and #134 lines based on 1,137 observations.

[9] LRT travel times were derived from the LTK travel time simulator.

Table 3-4. Transit Average Weekday Peak 4 Hour Travel Times to Selected Corridor Locations from Selected Portland CBD Locations, Year 2030

Origin/Destination	2030 No Build		2030 LPA	
	Transit AM Peak 4 Hour Southbound Direction	Transit PM Peak 4 Hour Northbound Direction	Transit[3] AM Peak 4 Hour Southbound Direction	Transit[3] PM Peak 4 Hour Northbound Direction
In-Vehicle Travel Time				
Between Downtown Vancouver and Rose Quarter	28[3]	27[3]	21	21
Between Downtown Vancouver and Pioneer Square	43[4]	47[4]	32	32
Between Downtown Vancouver and Hayden Island	5[5]	7[5]	2	2
Between Downtown Vancouver and Lombard Transit Center	13[3]	14[3]	8	8
Between Clark College and Pioneer Square	50[6]	55[6]	38	38
Total Travel Time[1]				
Between Downtown Vancouver and Rose Quarter	42[3]	41[3]	29	29
Between Downtown Vancouver and Pioneer Square	50[4]	55[4]	39	39
Between Downtown Vancouver and Hayden Island	16[5]	18[5]	10	10
Between Downtown Vancouver and Lombard Transit Center	27[3]	28[3]	16	16
Between Clark College and Pioneer Square	68[6]	72[6]	44	44

Notes: Shaded cells in Table 3-4 indicate transit travel times that would be faster than automobile travel times for the same trip and time period.

Sources: CRC VISSIM microsimulation, Metro Travel Demand Model and LTK runtime simulation model.

[1] Total transit travel times include 3.6 minutes of walk access (1.8 minutes at either trip end) in addition to initial and transfer wait time. Bus wait times are based on half the combined headway of the routes serving the origin-destination pair.

[2] LPA transit travel times are for the Yellow Line LRT including the new extension to Clark Station

[3] Transit travel times are for C-TRAN bus Route 44 (Fourth Plain Limited) to Delta Park/Vanport MAX Station, transfer to Yellow Line LRT.

[4] Transit travel times are for C-TRAN bus Route 105S (I-5 Express Shortline).

[5] Transit travel times are for C-TRAN bus Route 4 (Fourth Plain).

[6] Transit travel times are for C-TRAN bus Route 30 (Burton) to Vancouver CBD, transfer to bus Route 105 (I-5 Express).

Reliability

In the TriMet system, existing light rail lines, which generally use reserved or separated right-of-way, exhibit greater percentages of on-time arrivals than trunkline and local buses operating in mixed traffic. For FY 2007, on-time performance for the TriMet light rail system was 90 percent, while bus on-time performance was 78 percent. Transit service utilizing no or small amounts of exclusive right-of-way would operate in mixed traffic and would be subject to traffic congestion and delay. Although C-TRAN does not currently have exclusive right-of-way for transit service, we can assume that this reliability advantage for light rail will occur in the C-TRAN system when light rail is extended to Vancouver.

Table 3-5 summarizes three measures of transit reliability in the corridor: miles of LRT right-of-way, the number of passenger miles that would occur on that LRT right-of-way, and the percentage of passenger miles that would occur on the LRT right-of-way in the corridor. The 2030 No Build Alternative would not provide any LRT passenger miles north of Expo Center Station. The CRC Project would add 2.9 additional miles of LRT right-of-way, which would result in up to 160,000 additional average weekday passenger miles on LRT compared to the 2030 No Build Alternative. Of the average weekday passenger miles within the corridor in 2030, approximately 79 percent (approximately 206,000) would be on light rail with the LPA.

Table 3-5. Measures of Transit Reliability in Corridor[1]

Light Rail Right-of-Way Measure	Alternative	
	2030 No Build	LPA
Total Transit Passenger Miles in Corridor on Average Weekday	169,100	261,000
Transit Passenger Miles on Fixed Guideway on Average Weekday	46,800[2]	206,200
Percent of Total Corridor Passenger Miles on Fixed Guideway	28%	79%

Source: Metro, 2009.

1 LRT generally provides an exclusive grade and/or barrier-separated transit right-of-way.
2 Includes existing TriMet light rail Yellow Line.

Note: Numbers and percentages are rounded.

3.2.2 Transit Ridership

This section evaluates transit ridership: average weekday LRT ridership in 2030; 2030 corridor-wide transit trips, transit trips crossing the I-5 Columbia River crossing in 2030, transit trips crossing the I-205 Columbia River crossing in 2030, work and non-work transit trips and mode share, and station boardings.

Vancouver-Portland Light Rail Line and LRT System Ridership

Total transit ridership in the corridor would increase in the future as the population and employment increases and development becomes more compact. Transit trips would increase in both the 2030 No Build Alternative and the LPA, compared to existing conditions. Table 3-6 shows that under the LPA, average weekday transit trips on the Interstate MAX Yellow Line

LRT would increase by approximately 21,400 trips (150 percent), compared to the 2030 No Build Alternative.

Table 3-6. 2030 Average Weekday LRT Line Ridership and Peak-Hour, Peak Load Point Ridership

	Alternative	
	2030 No Build	**LPA**
Average Weekday Ridership[1]		
Interstate Max (Yellow Line)[2]	***14,300***	***35,700***
I-205 LRT (Green Line)	46,600	47,000
East-West Max (Blue Line)	106,600	105,800
Airport Max (Red Line)	31,800	32,600
Total LRT System[3]	199,300	221,100
PM 2-Hour Peak Direction Peak Load Point Ridership[2]		
Interstate Max (Yellow Line)[3]	***1,400***	***4,200***
I-205 LRT (Green Line)	3,900	3,800
East-West Max (Blue Line)	5,300	5,100
Airport Max (Red Line)	1,000	1,000

Source: Metro, 2009.

1 LRT ridership is boarding rides per line. Total does not include the downtown Portland mall mid-day tripper.

2 Peak load point ridership refers to the number of riders on the line at one time at the highest ridership location along the line. The peak load point on the Yellow Line would be just north of the Interstate/Rose Quarter Station under both the No Build Alternative and the LPA.

3 Interstate Max (Yellow Line) ridership includes the Columbia River Crossing Project that will extend the Interstate Max (Yellow Line) from Expo Center Station in North Portland to Clark College in Vancouver.

Note: Numbers may not total due to rounding.

CRC Transit Corridor and Total Systemwide Ridership

Table 3-7 shows that transit trip production in the CRC Transit Corridor would increase 150 percent compared to existing conditions and 15 percent compared to the 2030 No Build. Total systemwide transit trips would more than double from existing conditions.

Table 3-7. Average Weekday Total Systemwide and CRC Corridor Transit Trips[1], Year 2030

	Scenario		
	Existing (2005)[2]	**2030 No Build**	**LPA**
Total Corridor Transit Person Trips (originating rides)	59,700	127,800	146,400
Change from Existing	Not Applicable	68,100	86,800
Percent Change from Existing	Not Applicable	115%	145%
Change from No Build	Not Applicable	Not Applicable	18,600
Percent Change from No Build	Not Applicable	Not Applicable	15%
Total Systemwide Transit Person Trips	268,500	532,800	552,400

Source: Metro, 2009.

1 Transit trips are one-way linked trips from an origin (e.g., home) to a destination (e.g., place of work or school), independent of whether the trip requires transfer or not. A person traveling from home to work and back counts as two trips. Total corridor transit trips include all light rail, bus, and streetcar trips produced and/or attracted to the CRC corridor.

2 Existing conditions are based on 2005 base year modeled conditions.

Note: Numbers may not total due to rounding. Percentages may not calculate due to rounding.

Table 3-8 shows the 2030 average daily person trips on transit over the I-5 Columbia River bridge, and the number and percent of these trips on light rail and buses. Increasing the number of transit crossings would help meet the CRC Project purpose and need by helping to reduce vehicular demand on the roadway across the river and improving connectivity, reliability, and travel times for public transportation. The LPA would double the number of transit passenger trips over the I-5 Columbia River crossing, compared to the 2030 No Build Alternative. For weekdays, there would be 20,600 bridge crossings on transit, compared to 10,200 trips under the 2030 No Build Alternative. Of the transit passengers crossing the Columbia under the LPA, 18,700 would be on LRT (91 percent) and 1,900 would be on buses (9 percent).

Table 3-8. Average Weekday I-5 Columbia River Crossing Ridership by Transit Mode, Year 2030

Transit Ridership over Columbia River	2030 No Build Alternative	2030 LPA
Total Transit Passenger Crossings: I-5 Bridge	10,200	20,600
LRT	Not Applicable	18,700
LRT Percent of Total	Not Applicable	91%
Bus	10,200	1,900
Bus Percent of Total	100%	9%

Source: Metro, 2009.

Note: This table reports transit trips that cross the I-5 Bridge, not all transit trips on the proposed light rail extension or on bus lines. Trips that stay within Clark County are not counted. Therefore figures will not match Table 3-6 which counts all transit ridership.

Table 3-9 shows the number of average weekday transit passenger crossings over the Columbia River via I-205 for the 2030 No Build Alternative and the LPA. There would be approximately 300 additional average weekday transit trips across the Columbia River via I-205 under the LPA, compared to the 2030 No Build Alternative (all trips would be by bus). Compared to the I-5 bridge, there would be 9,300 and 19,500 fewer transit trips using the I-205 bridge under the 2030 No-Build Alternative and the LPA, respectively.

Table 3-9. Average Weekday I-205 Columbia River Crossing Ridership by Transit Mode, Year 2030

Ridership over Columbia River	2030 No Build Alternative	2030 LPA
Total Transit Passenger Crossings: I-205 Bridge	2,300	2,600
LRT	Not Applicable	Not Applicable
LRT Percent of Total	Not Applicable	Not Applicable
Bus	2,300	2,600
Bus Percent of Total	100%	100%

Source: Metro, 2009.

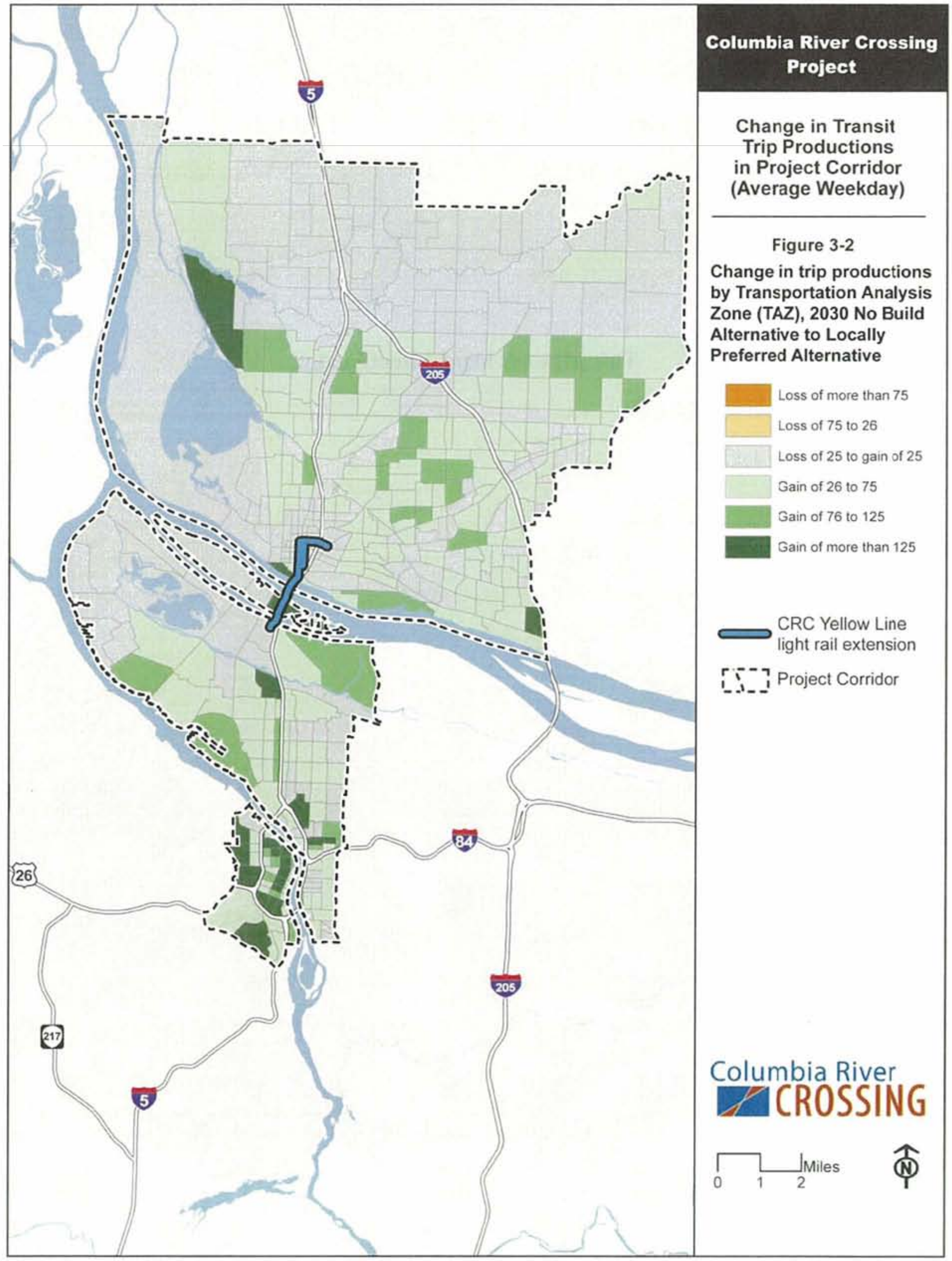
Note: This table reports transit trips that cross the I-205 Bridge, not all transit trips on the proposed light rail extension or on bus lines. Trips that stay within Clark County are not counted. Therefore figures will not match Table 3-6 which counts all transit ridership.

Transit Trip Productions

Figure 3-2 shows the change in transit trip productions (i.e., where trips would originate, typically a home) for the LPA, compared to the 2030 No Build Alternative. The map indicates which areas within the Columbia River Crossing Transit Corridor would benefit from the project, and conversely which areas would see a loss in transit ridership production compared to the 2030 No Build Alternative.

Compared to the 2030 No Build Alternative, none of the TAZs in the corridor would see a reduction in average weekday transit trip productions of more than 25. Just over half of the TAZs in the corridor would see an increase of 25 or more trips on an average weekday compared to the 2030 No Build Alternative. Of the 491 TAZs in the corridor, 24 would have a gain of more than 125 transit trip productions on an average weekday, 37 would have a gain of 76 to 125 trips and 192 would have a gain of 26 to 75 trips.

Figure 3-2. Change in Transit Trip Productions from 2030 No Build to LPA



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Work and Non-Work Transit Trips and Mode Share

Table 3-10 shows corridor transit trips and transit mode share for trips produced in the Columbia River Crossing Corridor that would be destined for the Portland central city for work and non-work purposes. Portland's central city is projected to have 264,000 jobs in 2030, accounting for 52.5 percent of the jobs in the corridor. The LPA would have greater transit mode shares for both home-based work and non-work trips destined to Portland's central city, compared to the 2030 No Build Alternative, with over a third of all work trips being on transit.

Table 3-10. Average Weekday Work and Non-Work Transit Trips and Transit Mode Share to Portland Central City[1] (2030) in Project Corridor

Attribute	Existing (2005)	2030 No Build Alternative	2030 LPA
Home-Based Work[2]			
Transit Trips	18,300	39,100	44,900
Total Person Trips	83,200	129,000	133,700
Mode Split	22%	30%	34%
Non-Work[3]			
Transit Trips	27,000	68,822	78,200
Total Person Trips	453,200	705,400	710,500
Mode Split	6%	10%	11%
Total[4]			
Transit Trips	45,300	107,900	123,100
Total Person Trips	536,300	834,500	844,200
Mode Split	8%	13%	15%

Source: Metro, 2009.
1 Portland central city is defined as Districts 1, 2, and 3.
2 Home-based work trips are defined as trips taken directly between one's home and one's place of work.
3 Non-work trips are defined as all trips that are not home-based work trips.
4 Total trips include all districts in the North Corridor (Districts 1-6, 12-18, and 21).
Note: Numbers and percentages are rounded.

Station Usage and Mode of Access and Egress

Table 3-11 summarizes individual station use and mode of access and egress to the new CRC Project light rail stations and the rest of the TriMet Yellow Line on an average weekday. The LPA would have a nearly 150 percent increase in ons (i.e., boardings) and offs (i.e., deboardings) at stations compared to the 2030 No Build Alternative. With the LPA, the Interstate/ Rose Quarter Station would still account for the highest number of ons and offs (19 percent of the total and 10,000 ons/offs), but the next two busiest stations would be in Vancouver. Clark Station would account for 6,700 ons/offs (13 percent of the total) and the northbound and southbound Mill Stations would account for 9,000 ons/offs (17 percent of the total).

The table shows that the LPA extension stations will account for 44 percent of all ons and offs on the Yellow Line. The LPA would result in a change to the mode of access. Although the number of riders accessing the train would increase for pedestrians, bus transfers, and park-and-ride users, the percent of the total ons/offs, for walk access trips would go down proportionately for the Yellow Line with the LPA (55 percent to 39 percent). This is because a large number of riders would access the LRT from the new park-and-ride lots. At the same time, the share of trips accessing the Yellow Line through transfers and park-and-rides would increase from 37 to 46 percent, and eight to 15 percent, respectively.

Table 3-11. Yellow Line MAX LRT Average Weekday Station Usage (Ons and Offs) by Mode of Access and Egress, Year 2030

		2030 No Build Alternative						2030 LPA					
	Station	**Station Ons/Offs**	**% of Total Ons/Offs**	**Station Ons/Offs by Mode of Access**		**% by Mode of Access**		**Station Ons/Offs**	**% of Total Ons/Offs**	**Station Ons/Offs by Mode of Access**		**% by Mode of Access**	
LPA Yellow MAX Extension	Clark (Vancouver)	0	0%	0	Walk[1]	-	Walk	6,750	13%	700	Walk	10%	Walk
				0	Transfer	-	Transfer			1,750	Transfer	26%	Transfer
				0	Park & Ride	-	Park & Ride			4,300	Park & Ride	64%	Park & Ride
	Mill SB (Vancouver)	0	0%	0	Walk	-	Walk	5,400	10%	400	Walk	7%	Walk
				0	Transfer	-	Transfer			4,350	Transfer	81%	Transfer
				0	Park & Ride	-	Park & Ride			650	Park & Ride	12%	Park & Ride
	Mill NB (Vancouver)	0	0%	0	Walk	-	Walk	3,700	7%	400	Walk	10%	Walk
				0	Transfer	-	Transfer			2,700	Transfer	74%	Transfer
				0	Park & Ride	-	Park & Ride			600	Park & Ride	16%	Park & Ride
	9th St SB (Vancouver)	0	0%	0	Walk	-	Walk	1,000	2%	500	Walk	49%	Walk
				0	Transfer	-	Transfer			500	Transfer	51%	Transfer
				0	Park & Ride	-	Park & Ride			0	Park & Ride	0%	Park & Ride
	9th St NB (Vancouver)	0	0%	0	Walk	-	Walk	1,100	2%	650	Walk	60%	Walk
				0	Transfer	-	Transfer			450	Transfer	40%	Transfer
				0	Park & Ride	-	Park & Ride			0	Park & Ride	0%	Park & Ride
	5th St (Vancouver)	0	0%	0	Walk	-	Walk	2,750	5%	800	Walk	29%	Walk
				0	Transfer	-	Transfer			550	Transfer	20%	Transfer
				0	Park & Ride	-	Park & Ride			1,400	Park & Ride	51%	Park & Ride
	Hayden Island	0	0%	0	Walk	-	Walk	2,450	5%	2,450	Walk	100%	Walk
				0	Transfer	-	Transfer			0	Transfer	0%	Transfer
				0	Park & Ride	-	Park & Ride			0	Park & Ride	0%	Park & Ride
Existing Yellow MAX	Expo Center	850	4%	550	Walk	65%	Walk	1,200	2%	750	Walk	63%	Walk
				150	Transfer	18%	Transfer			300	Transfer	23%	Transfer
				150	Park & Ride	17%	Park & Ride			150	Park & Ride	14%	Park & Ride
	Delta Park/Vanport	2,750	13%	850	Walk	32%	Walk	1,150	2%	1,150	Walk	100%	Walk
				1,200	Transfer	43%	Transfer			0	Transfer	0%	Transfer
				700	Park & Ride	25%	Park & Ride			0	Park & Ride	0%	Park & Ride
	Kenton – N Denver	1,550	7%	1,400	Walk	90%	Walk	1,950	4%	1,800	Walk	92%	Walk
				0	Transfer	0%	Transfer			0	Transfer	0%	Transfer
				150	Park & Ride	10%	Park & Ride			150	Park & Ride	8%	Park & Ride
	N Lombard Transit Center	1,700	8%	900	Walk	52%	Walk	3,250	6%	1,200	Walk	37%	Walk
				650	Transfer	39%	Transfer			1,900	Transfer	58%	Transfer
				150	Park & Ride	9%	Park & Ride			150	Park & Ride	5%	Park & Ride
	Rosa Parks	2,050	10%	1,650	Walk	81%	Walk	2,480	5%	1,950	Walk	78%	Walk
				250	Transfer	11%	Transfer			380	Transfer	15%	Transfer
				150	Park & Ride	7%	Park & Ride			150	Park & Ride	7%	Park & Ride
	N Killingsworth	2,550	12%	1,800	Walk	70%	Walk	3,450	7%	2,100	Walk	60%	Walk
				600	Transfer	23%	Transfer			1,200	Transfer	35%	Transfer
				150	Park & Ride	6%	Park & Ride			150	Park & Ride	5%	Park & Ride
	N Prescott	2,800	13%	2,650	Walk	94%	Walk	3,110	6%	2,960	Walk	95%	Walk
				0	Transfer	0%	Transfer			0	Transfer	0%	Transfer
				150	Park & Ride	6%	Park & Ride			150	Park & Ride	5%	Park & Ride
	Overlook Park	850	4%	800	Walk	96%	Walk	1,100	2%	1,050	Walk	96%	Walk
				0	Transfer	0%	Transfer			0	Transfer	0%	Transfer
				50	Park & Ride	4%	Park & Ride			50	Park & Ride	4%	Park & Ride
	Albina / Mississippi	900	4%	900	Walk	100%	Walk	1,300	3%	1,300	Walk	100%	Walk
				0	Transfer	0%	Transfer			0	Transfer	0%	Transfer
				0	Park & Ride	0%	Park & Ride			0	Park & Ride	0%	Park & Ride
	Interstate/ Rose Quarter	4,900	24%	100	Walk	2%	Walk	10,000	19%	200	Walk	2%	Walk
				4,800	Transfer	98%	Transfer			9,800	Transfer	98%	Transfer
				0	Park & Ride	0%	Park & Ride			0	Park & Ride	0%	Park & Ride

	Total Station Ons/Offs by MOA	**% of Total Ons/Offs by MOA**	**Total Station Ons/Offs by MOA**	**% of Total Ons/Offs by MOA**
Walk	11,550	55%	20,200	39%
Transfer	7,650	37%	23,800	46%
Park & Ride	1,650	8%	7,900	15%
Total Station Ons/Offs	20,850	100%	51,900	100%

[1] "Walk" mode of access includes access for all non-motorized modes (bicycle, skateboard, etc.).
*Numbers may be inconsistent due to rounding.
Source: Metro's Regional Travel Demand Model 2009.

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Appendices

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Appendix A

Comparisons of the LPA, 2030 No Build, and DEIS Alternatives

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Appendix A. Comparisons of the LPA, 2030 No Build, and DEIS Alternatives.

The following tables can be found in Chapter three of the FEIS and have been included in this appendix without any changes to format or content. DEIS and FEIS alternatives are not comparable on an item by item basis as many of the background assumptions have changed. For a list of changes between the DEIS and FEIS Model runs please refer to Appendix C.

Systemwide Transit Vehicles and Platform Hours of Service – Existing and Year 2030

Transit Characteristic	Existing Conditions	LPA	2030 No Build Alternative[1]	BRT[2]	Light Rail[2]
CTRAN Standard 40-foot Buses[3]	120	106	121	150	126
CTRAN Articulated 60-foot Buses[3]	0	0	12	24	0
TriMet Yellow Line LRVs[4]	18	37	18	16	30
Total Transit Vehicles	**138**	**143**	**151**	**166**	**156**
Weekday C-TRAN Bus Platform Hours[3, 5]	651	991	1,159	1,446	1,266
Weekday TriMet North Portland Bus Platform Hours[6]	1,110	1,120	1,120	1,238	1,238
Weekday TriMet LRT Platform Hours[4, 5]	113	214	135	135	208
Total Weekday Transit Platform Hours[5]	**1,874**	**2,325**	**2,414**	**2,819**	**2,712**
Total Annual Transit Platform Hours[5]	584,000	720,000	738,000	851,000	823,000

Source: CRC, 2009; CRC DEIS, May 2008.

1 The definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see Section 1.3 of the CRC Transit Technical Report for details).

2 Alternatives 2 (BRT) and 3 (LRT) were the Replacement Bridge with BRT and LRT in the DEIS, respectively (see Section 1.3 of the CRC Transit Technical Report for details).

3 Includes vehicles in service and spares. In general, the number of TriMet buses and platform hours would not change as a result of the alternatives under consideration.

4 Includes vehicles in service and spares.

5 Platform hours are the total scheduled time that a bus spends from pull out to pull in and includes dead head and layover times. Totals include only C-TRAN bus and TriMet LRT platform hours – TriMet bus platform hours would not change as a result of the alternatives under consideration. Platform hours for bus and light rail are annualized at different rates based on current annualization factors for the respective modes.

6 TriMet North Portland buses are lines: 4 – Fessenden, 6 – Martin Luther King Jr. Blvd, 8 – Middlefield/15th Avenue, 16 – Front Avenue/St. Johns, 33 – Fremont, 35 – Greeley, 44 – Mocks Crest, 72 – Killingsworth/82nd Avenue, and 75 – Lombard/39th Avenue

TriMet and C-TRAN Systemwide Numbers

TriMet 2005 systemwide busses	656
TriMet 2005 systemwide LRVs	115
C-TRAN 2007 systemwide buses	120
TriMet systemwide 2005 annual bus unlinked trips	68,764,800
TriMet systemwide 2005 annual LRT unlinked trips	34,755,100
C-TRAN systemwide 2005 annual bus unlinked trips	5,615,000
TriMet systemwide 2005 Annual Bus Revenue Hours	1,516,300
TriMet systemwide 2005 Annual LRT Revenue Hours	204,300
C-TRAN systemwide 2007 Annual Bus Platform Hours	247,300

Source: 2005 and 2007 National Transit Databases

Transit Average Weekday and Annual Transit Passenger Trips Crossing the I-5 Bridge – Year 2030

	LPA	2030 No Build Alternative[1]	BRT[2]	LRT[2]
Average Weekday Transit Passenger Trips Crossing the I-5 Bridge				
C-TRAN Express and Local Bus	1,900	10,200	11,300	2,200
High-Capacity Transit	18,700	0	5,400	18,600
Total	**20,600**	**10,200**	**16,800**	**20,800**
Annual Transit Passenger Trips Crossing the I-5 Bridge				
C-TRAN Express and Local Bus	479,000	3,043,000	3,227,300	552,000
High-Capacity Transit	6,133,000	0	1,600,800	6,121,000
Total	**6,612,000**	**3,043,000**	**4,828,100**	**6,673,000**

Source: CRC, 2009; CRC DEIS, May 2008.

[1] The definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see Section 1.3 for details).

[2] Alternatives 2 (BRT) and 3 (LRT) were the Replacement Bridge with BRT and LRT in the DEIS, respectively (see Section 1.3 for details).

[3] Passenger trips for bus and light rail are annualized at different rates based on current annualization factors for the respective modes.

P.M. Peak Direction Passenger Vehicle Mode Split[1] over the I-5 Bridge – Existing and Year 2030

	Existing Conditions	LPA	2030 No Build Alternative[2]	BRT[3]	LRT[3]
SOV	67%	58%	62%	53%	50%
HOV	27%	26%	28%	31%	30%
Transit	6%	17%	9%	17%	19%

Source: CRC, 2009; CRC DEIS, May 2008.

Note: SOV = single-occupancy vehicle, HOV = high-occupancy vehicle. Totals may not sum to 100 percent due to rounding.

1 Mode split is calculated as a percentage of total person trips over the I-5 Columbia River Crossing in the P.M. Peak direction.

2 The definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see Section 1.3 for details).

3 BRT and LRT were Alternative 2 (Replacement Bridge with BRT) and Alternative 3 (Replacement Bridge with LRT) in the DEIS, respectively (see Section 1.3 for details).

Average Weekday Transit Mode Split[1] for Home-Based Work Trips by Transit Market Area[2] – Year 2030

Transit Market[2]	Existing Conditions	LPA	2030 No Build Alternative[3]
Vancouver Central City to/from Oregon part of the Project Corridor	11%	39%	26%
Washington part of Project Corridor Residential Area to/from Portland Central City	15%	38%	22%
Portland Central City to/from Project Corridor Residential Area	21%	39%	31%

Source: CRC, 2009; CRC DEIS, May 2008.

1 Mode split is calculated as a percentage of total person trips over the I-5 Columbia River Crossing on an average weekday.

2 See Figure 3-1 in the CRC Transit Technical Report for an illustration of the transit market areas. The definition of these areas has changed since the DEIS, so the DEIS numbers are not comparable and therefore not reported here.

3 The definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see Section 1.3 for details).

4 BRT and LRT were Alternative 2 (Replacement Bridge with BRT) and Alternative 3 (Replacement Bridge with LRT) in the DEIS, respectively (see Section 1.3 for details).

Average Weekday P.M. Peak Average Transit Speeds in the CRC Area and Downtown Vancouver– Year 2030

	LPA	2030 No Build Alternative[2]	BRT[3]	LRT[3]
CRC Project Area	19 mph	10 mph	16mph	17mph
Downtown Vancouver	15 mph	8 mph	10 mph	13mph

Source: CRC, 2009; CRC DEIS, May 2008.

Note: mph = miles per hour.

[1] Average transit speeds are calculated by taking a representative transit line in the Metro travel demand model and averaging the link speeds and weighing them by the link lengths

[2] The definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see Section 1.3 for details).

[3] BRT and LRT were Alternative 2 (Replacement Bridge with BRT) and Alternative 3 (Replacement Bridge with LRT) in the DEIS, respectively (see Section 1.3 for details).

[4] See Exhibit 1.2-1 of the FEIS for an illustration of the CRC Project Area.

Average Weekday A.M. Peak Hour Transit Travel Time[1] between Select Locations – Year 2030 (minutes)

	LPA	2030 No Build Alternative[2]	BRT[3]	LRT[3]
Northern Terminus[4] to Expo Center	8	16	13	12
Northern Terminus[4] to Pioneer Square	38	50	43	40
Northern Terminus[4] to Lombard Transit Center	14	19	23	18
Downtown Vancouver (7th St. and Washington St.) to Pioneer Square	32	47	35	32
Pioneer Square to Salmon Creek (via Route 134)	32[5]	52[5]	32	32
Lombard Transit Center to Vancouver Mall (via Route 4L)	Not Applicable	Not Applicable	40	39
Hayden Island to 99th Street Transit Center (via 71L)	Not Applicable	Not Applicable	24	32
Salmon Creek to Pioneer Square (via Route 134)	53[5]	58[5]	51	51
Vancouver Mall to Lombard Transit Center (via Route 4L)	Not Applicable	Not Applicable	37	34
99th Street Transit Center to Hayden Island (via 71L)	Not Applicable	Not Applicable	24	19

Source: CRC, 2009; CRC DEIS, May 2008.

Note: SOV = single-occupancy vehicle, HOV = high-occupancy vehicle. Totals may not sum to 100 percent due to rounding.

[1] Transit travel time in this table includes in-vehicle time and wait time for transfers.

[2] The definition of the No-Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see see Section 1.3 for details).

[3] BRT and LRT were Alternative 2 (Replacement Bridge with BRT) and Alternative 3 (Replacement Bridge with LRT) in the DEIS, respectively (see Section 1.3 for details).

[4] The northern terminus would be located at proposed Clark College Station under the LPA and at the proposed Lincoln Station under the BRT and LRT alternatives (i.e., Alternatives 2 and 3).

[5] Travel time for LPA and 2030 No Build Alternative is from Pioneer Square to the 99th Street Transit Center via Route #199 – 99th Street Express

Transit Terminus Characteristics and Performance

Characteristic		FEIS	DEIS Alternative 3[1]			
		LPA	Kiggins Bowl terminus	Lincoln terminus	Clark College MOS	Mill Plain MOS
Average Weekday Transit Ridership over the I-5 Bridge		20,600	21,100	20,800	18,200	19,100
Annual Transit Ridership over the I-5 Bridge[2]		6,612,000	6,780,000	6,670,000	5,820,000	6,110,000
Peak/Peak Direction Vehicle Mode Split over the I-5 Bridge[3]	SOV	58%	50%	50%	52%	50%
	HOV	26%	29%	29%	29%	27%
	Transit	17%	21%	21%	19%	23%
Transit Accessibility	Clark County households within ½ mile of HCT station	4 %	5%	5%	4%	3%
	Clark County employment within ½ mile of HCT station	10 %	11%	11%	10%	9%
Increased Capital Cost[4]		**$931.7M**	**$1,068.8M**	**$879.3M**	**$674.9M**	**$615.8M**
Increase Annualized Capital Costs[4]		**$51.2M**	**$88.4M**	**$73.5M**	**$57.5M**	**$51.6M**
Increased Annual Operating Cost[5]		**$4,844,000**	**$4,240,000**	**$3,510,000**	**$2,950,000**	**$2,830,000**
Cost-Effectiveness[6]		**$8.47**	**$13.67**	**$11.55**	**$10.38**	**$8.91**

Source: CRC, 2009; CRC DEIS, May 2008.

Note: all data is based on 2030 operations and expressed in current dollars. HCT = high capacity transit; SOV = single-occupancy vehicle; HOV = high-occupancy vehicle. Totals may not sum to 100 percent due to rounding.

1 Alternative 3 from the DEIS is defined as the Replacement Bridge with LRT (see Chapter 2 of the DEIS) and was based on the Lincoln terminus.

2 Annual transit ridership is based on average weekday transit ridership multiplied by annualization factors for bus and high capacity transit based on current annualization for the respective modes.

3 Mode split is calculated as a percentage of total person trips over the I-5 Columbia River Crossing on an average weekday.

4 Capital costs are based on the transit fleet size in 2030 and do not include the cost of bicycle and pedestrian improvements that are included in the capital costs for the LPA reported in Chapter 4. Capital costs are annualized based on FTA's current guidance.

5 The increase in annual O&M costs for C-TRAN and TriMet compared to the 2030 No Build Alternative expressed in 2009 dollars for the DEIS alternatives and 2010 dollars for the LPA.

6 This cost-effectiveness measure is a local evaluation metric that differs from FTA's New Starts measure of cost effectiveness used to prepare a New Starts rating (see Chapter 4). Cost-effectiveness in this table is calculated as the change in annual O&M costs plus the change in annualized capital costs, divided by the change in annualized transit ridership across the I-5 bridge in 2030 (where the change is from the 2030 No Build Alternative). Note that the definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated for the LPA to reflect most current information (see Section 1.3 for details) – the changes in costs for the LPA are related to the current definition of the 2030 No Build Alternative; the changes in costs for the BRT and LRT alternatives from the DEIS are related to the definition of the 2030 No Build Alternative for the DEIS. Note that the cost effectiveness of the terminus options for Alternative 3 would be dependent on the configuration of park-and-ride lots and spaces (see Appendix D for details of how the Clark terminus was chosen for the LPA).

Average Weekday Transit Ridership and Transit Mode Split[1] for the LPA, 2030 No Build Alternative and Efficient and Increased Transit Operations Alternatives[2] – Year 2030

	LPA	2030 No Build Alternative	Efficient Operations[2]		Increased Operations[2]	
			BRT	LRT	BRT	LRT
Transit Ridership across the I-5 Bridge						
PM peak period[3]	6,850	3,800	4,900	6,100	5,600	6,700
Daily	20,600	10,200	16,800	20,800	19,800	23,100
Transit mode split across the I-5 Bridge						
PM peak period[3]	17%	9%	19%	21%	33%	37%
Daily	16%	12%	13%	15%	15%	16%

Source: CRC, 2009; CRC DEIS, May 2008.

1 Mode split is calculated as a percentage of total person trips over the I-5 Columbia River Crossing on an average weekday.

2 Efficient Operations were defined in the CRC DEIS as Alternative 2 (i.e., Replacement Bridge with BRT and transit service levels equilibrated to demand) and Alternative 3 (i.e. Replacement Bridge with LRT and transit service levels equilibrated to demand); Increased Operations were defined in the CRC DEIS as Alternative 4 (i.e., Supplemental Bridge with BRT and transit service levels increased by approximately 50 percent, compared to Alternative 2) and Alternative 3 (i.e. Supplemental Bridge with LRT and transit service levels increased by approximately 50 percent, compared to Alternative 3) – see Chapter 2 of the DEIS for details.

3 The PM peak period spans four hours for transit and autos. The mode split across the I-5 bridge does not include busses traveling on I-205.

Average Weekday P.M. Peak Average Transit Speeds[1] in the CRC Area and Downtown Vancouver for the LPA, 2030 No Build Alternative and Efficient and Increased Transit Operations Alternative – Year 2030

	LPA	2030 No Build Alternative[3]	Efficient Operations[2] BRT	Efficient Operations[2] LRT	Increased Operations[2] BRT	Increased Operations[2] LRT
Transit Speeds[1]						
CRC Project Area[4]	19 mph	10 mph	15 mph	17 mph	13 mph	17 mph
Downtown Vancouver	15 mph	8 mph	10 mph	13 mph	8 mph	13 mph
Travel time from Expo Center to Northern Terminus[4]	8 min.	16 min.	13 min.	12 min.	19 min.	12 min.

Source: CRC, 2009; CRC DEIS, May 2008. Note: mph = miles per hour.
Note: N/A = not applicable.

1 Average transit speeds are calculated by taking a representative transit line in the Metro travel demand model and averaging the link speeds and weighing them by the link lengths.

2 Efficient Operations were defined in the CRC DEIS as Alternative 2 (i.e., Replacement Bridge with BRT and transit service levels equilibrated to demand) and Alternative 3 (i.e. Replacement Bridge with LRT and transit service levels equilibrated to demand); Increased Operations were defined in the CRC DEIS as Alternative 4 (i.e., Supplemental Bridge with BRT and transit service levels increased by approximately 50 percent, compared to Alternative 2) and Alternative 3 (i.e. Supplemental Bridge with LRT and transit service levels increased by approximately 50 percent, compared to Alternative 3) – see Chapter 2 of the DEIS for details.

3 The definition of the 2030 No Build Alternative (Alternative 1 in the DEIS) was updated since the DEIS was published to reflect most current information (see Section 1.3 for details).

4 Transit travel time in this table includes in-vehicle time and wait time for transfers. The northern terminus would be located at proposed Clark College Station under the LPA and at the proposed Lincoln Station under the Efficient Operations and Increased Operations alternatives (i.e., Alternatives 2/4 and 3/5, respectively).

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Appendix B

Metro's 2004 Regional Transportation Plan (RTP) Financially Constrained Project List and RTC's 2007 Metropolitan Transportation Plan (MTP) Financially Constrained Project List (amended July, 2008)

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Appendix B: Financially-Constrained Project List from Metro's 2004 Regional Transportation Plan and RTC's 2007 Metropolitan Transportation Plan (amended July, 2008)

RTP #	2040 Link	Jurisdiction	Project Name (Facility)	Project Location	Project Description	2020 RTP Priority System	2030 RTP Illustrative System	2030 RTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	RTP Program Years	Primary Modal Type	Primary Mode	2040 Category
1025	Central City	ODOT	I-5/North Macadam Access Improvements	NB I-5 to NB Macadam Avenue	Construct new off-ramp	X	X	X	$ 20,000,000	2016-25	13	mv	1
1027	Central City	Portland/ODOT	South Portland Improvements	South Portland sub-area	Redesign Naito Pkwy as a neighborhood collector and reconnect east-west local streets. Rebuild Ross Island Bridge Ramps to separate regional traffic from neighborhood streets and improve access to I-405 and I-5	X	X	X	$ 28,293,000	2010-15	13	mv	1
1028	Central City	Portland/ODOT	Kerby Street Improvements	Kerby Street at I-5	Improve I-405/Kerby Street interchange to calm traffic and improve local access	X	X	X	$ 515,000	2004-09	1	mv	1
1029	Central City	Portland	SE Water Avenue Extension	SE Water Avenue	Extend SE Water Avenue from Caruthers to Division Place	X	X	X	$ 288,750	2004-09	1	mv	2
1030	Central City	ODOT	Ross Island Bridge Interchange	East approach to Ross Island Bridge	Interchange improvement	X	X	X	$ 5,082,000	2016-25	13	mv	2
1032	Central City	Portland	Southern Triangle Circulation Improvements	Between the Ross Island Bridge - Hawthorne Bridge/ Willamette River - SE Grand-MLK	Improve local street network and regional access routes in the area. Improve highway access route from CEID to I-5 SB via the Ross Island Bridge	X	X	X	$ 2,887,500	2016-25	1	mv	2
1035	Central City	Portland	SW Columbia Street Reconstruction	18th Avenue to Naito Parkway	Rebuild street	X	X	X	$ 924,000	2004-09	1	mv	1
1036	Central City	Portland	Broadway/Flint Arena Access	Broadway/Flint at Rose Quarter	Intersection realignment	X	X	X	$ 358,050	2004-09	1	mv	1
1037	Central City	Portland	Bybee Boulevard Overcrossing	Bybee Boulevard/McLoughlin Boulevard	Replace substandard 2-lane bridge with 2-lane bridge with standard clearance	X	X	X	$ 4,042,500	2010-15	1	mv	1
1039	Central City	Portland	SE Belmont Ramp	Belmont ramp of Morrison Bridge, eastside	Reconstruction of the ramp to provide better access to the Central Eastside	X	X	X	$ 1,732,500	2010-15	1	mv	1
1047	Central City	Portland	SE Seventh-Eighth Avenue Connection	Central Eastside Industrial District	Construct new street connection from SE Seventh to Eighth Avenue at Division Street	X	X	X	$577,500	2010-15	1	mv	2
1051	Central City	Portland	W. Burnside Street Improvements	W 15th to NW 23rd	Boulevard design improvements including pavement reconstruction, wider sidewalks, curb extensions, safer crossings, traffic signals at W 20th Pl and W 22nd, and traffic management to limit motorist delays	X	X	X	$10,000,000	2004-09	4	blvd	1
1052	Central City	Portland	North Macadam Street Improvements	South Waterfront District of the central city	Implement street improvements identified in the South Waterfront Framework Plan, including Bancroft, Bond, Curry, River Parkway, Harrison connector, key access intersections and other street improvements	X	X	X	$20,501,250	2004-09	1	mv	1

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RTP #	2040 Link	Jurisdiction	Project Name (Facility)	Project Location	Project Description	2020 RTP Priority System	2030 RTP Illustrative System	2030 RTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	RTP Program Years	Primary Modal Type	Primary Mode	2040 Category
1053	Central City	Portland	Naito Parkway Improvements	NW Davis to SW Market	Complete boulevard design improvements, including bike lanes, pedestrian crossings and pavement reconstruction	X	X	X	$ 7,400,000	2004-09	4	blvd	1
1054	Central City	Portland	Broadway/Weidler Improvements, Phase II and III	At Arena and 15th Avenue to 24th Avenue	Complete boulevard design improvements and ITS	X	X	X	$ 6,456,450	2004-09	4	blvd	1
1055	Central City	Portland/ODOT	MLK/Grand Improvements	Central Eastside and Lloyd districts	Complete boulevard design improvements	X	X	X	$ 3,465,000	2016-25	4	blvd	1
1082	Central City	Portland	SE Grand Avenue Bridgehead Improvements	Central Eastside Industrial District	Reconstruct west edge of SE Grand at bridgehead to provide sidewalks and urban standard turn lanes for vehicles and truck safety and access	X	X	X	$ 1,600,000	2004-09	6	ped	1
1084	Central City	Portland	Clay/Second Pedestrian/Vehicle Signal	SW Clay Street and SW Second Avenue	New signal installation	X	X	X	$ 115,500	2004-09	6	ped	1
1089	Central City	Portland	East Burnside/NE Couch Couplet and Street Improvements	East 12th Avenue to Burnside Bridge	Implement a one-couplet design including new traffic signals, widened sidewalks, curb extension, bike lanes, on-street parking and street trees	X	X	X	$ 7,500,000	2010-15	4	blvd	1
1090	Central City	Portland	W Burnside/NW Couch Couplet and Street Improvements	Burnside Bridge to West 15th Avenue	Implement a one-couplet design including new traffic signals, widened sidewalks, curb extension, bike lanes, on-street parking and street trees	X	X	X	$ 7,500,000	2010-15	4	blvd	1
1096	Central City	Portland	Barbur/I-5 Corridor Study	I-405 to Highway 217	Assess corridor improvement options	X	X	X	$ 1,732,500	2004-09	2	mmstudy	3
2109	Fairview/WV Transit Center (TC)	Multnomah Co.	Glisan Street Improvements	202nd Avenue to 207th Avenue	Complete reconstruction of Glisan Street to five lanes	X	X	X	$ 1,800,000	2004-09	1	mv	3
2110	Fairview/WV TC	Multnomah Co.	MKC Collector	Halsey Street to Arata Road	Construct new collector of regional significance	X	X	X	$ 1,100,000	2016-25	1	mv	3
1266	Gateway RC	Portland	NE/SE 99th Avenue Phases II and III	NE Glisan Street to SE Washington Street and SE Washington Street to SE Market Street	Reconstruct primary local main street in Gateway regional center	X	X	X	$ 4,042,500	2010-15	1	mv	1
2008	Gateway RC	Portland	102nd Avenue Boulevard and ITS/Safety Improvements, Phase 1	NE Weidler to NE Glisan Street	Implement Gateway regional center plan with boulevard design retrofit, new traffic signals, improved pedestrian facilities and crossings, street lighting, bicycle lanes and multimodal safety improvements	X	X	X	$ 3,234,000	2004-09	4	blvd	1
2010	Gateway RC	Portland	Halsey/Weidler Boulevard and ITS	within regional center between I-205 and NE 114th Avenue	Implement Gateway regional center plan with boulevard design retrofit, new traffic signals, improved pedestrian facilities and crossings, street lighting and new bicycle facilities	X	X	X	$ 12,127,500	2016-25	4	blvd	1
2011	Gateway RC	Portland	Glisan Street Boulevard and ITS	within regional center between I-205 and NE 106th Avenue	Implement Gateway regional center plan with boulevard design retrofit, new traffic signals, improved pedestrian facilities and crossings, street lighting and new bicycle facilities	X	X	X	$ 2,310,000	2010-15	4	blvd	1

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2012	Gateway RC	Portland	SE Stark/Washington Boulevard and ITS/Safety Improvements	92nd Avenue to 111th Avenue	Implement Gateway regional center plan with boulevard design retrofit, new traffic signals, improved pedestrian facilities and crossings, street lighting, bicycle lanes and multimodal safety improvements	X	X	X	$ 4,389,000	2010-15	4	blvd	1
2015	Gateway RC	Portland	102nd Avenue Boulevard and ITS/Safety Improvements, Phase II	NE Glisan Street to SE Market Street	Implement Gateway regional center plan with boulevard design retrofit, new traffic signals, improved pedestrian facilities and crossings, street lighting, bicycle lanes and multimodal safety improvements	X	X	X	$ 7,091,700	2010-15	4	blvd	1
2029	Gresham RC	Multnomah Co.	242nd Avenue Reconstruction	Powell Boulevard to Burnside Road	Reconstruct 242nd Avenue to five lanes	X	X	X	$2,400,000	2016-25	1	mv	1
2032	Gresham RC	Multnomah Co.	Burnside/Hogan Intersection Improvement	Intersection of 242nd/Burnside Street	Improve intersection by adding a southbound through lane	X	X	X	$ 546,000	2016-25	1	mv	1
2041	Gresham RC	Multnomah Co.	257th Avenue Corridor Improvements	Division Street to Powell Valley Road	Reconstruct street to arterials standards, including bike lanes, sidewalks, drainage, lighting and traffic signals	X	X	X	$ 4,800,000	2004-09	1	mv	2
2044	Gresham RC	Multnomah Co.	Orient Drive Improvements	282nd Avenue to 257th Avenue	Improve Orient Drive	X	X	X	$4,158,000	2016-25	1	mv	2
2045	Gresham RC	Multnomah Co.	190th Avenue Improvements	Butler Road to Highland Drive and Powell Boulevard to 190th Avenue	Reconstruct and widen street to five lanes with sidewalks and bike lanes. Widen and determine the appropriate cross section for Highland Drive and Pleasant View Drive from Powell Boulevard to 190th Avenue based on the recommendations from Phase 2 of the Powell Boulevard/Foster Road Corridor Study	X	X	X	$ 12,500,000	2010-15	1	mv	3
2048	Gresham RC	Multnomah Co.	Burnside Street Improvements	NE Wallula Street to Hogan Road	Complete boulevard design improvements	X	X	X	$7,484,400	2004-09	4	blvd	1
1119	Hollywood TC	Portland	Sandy Boulevard/Burnside/12th Avenue Intersection	Sandy Boulevard/Burnside/12th Avenue Intersection	Redesign intersection	X	X	X	$ 4,620,000	2004-09	1	mv	3
1120	Hollywood TC	Portland	Sandy Boulevard Multimodal Improvements, Phase I	12th Avenue to 47th Avenue	Retrofit existing street with multimodal boulevard improvements including redesign of selected intersections to add turn lanes and improve pedestrian crossings, bike lanes, on-street parking, and safety improvements	X	X	X	$ 17,325,000	2004-09	4	blvd	3
1122	Hollywood TC	Portland	Sandy Boulevard Multimodal Improvements, Phase II	47th Avenue to 99th Avenue	Retrofit existing street with multimodal boulevard improvements including redesign of selected intersections to add turn lanes and improve pedestrian crossings, bike lanes, on-street parking, and safety improvements	X	X	X	$ 4,620,000	2010-15	4	blvd	3
1226	Interstate SC	Portland	Killingsworth Bridge Improvements	Killingsworth at I-5	Improvements to bridge to create a safe and pleasant crossing for pedestrians and bicyclists over I-5	X	X	X	$2,700,000	2016-25	15	bike/ped	3

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1160	Lents TC	Portland	Foster-Woodstock, Phase I	87th-94th Avenues and 92nd Avenue within the Foster-Woodstock couplet	Implement Lent Town Center Business District Plan with new traffic signals, pedestrian amenities, wider sidewalks, pedestrian crossings, street lighting, increased on-street parking	X	X	X	$6,930,000	2004-09	6	ped	3
1161	Lents TC	Portland	Foster-Woodstock, Phase II	87th-94th Avenues and 92nd Avenue within the Foster-Woodstock couplet	Implement Lent Town Center Business District Plan with new traffic signals, pedestrian amenities, wider sidewalks, pedestrian crossings, street lighting	X	X	X	$5,775,000	2010-15	6	ped	3
1162	Lents TC	Portland	Foster Road Improvements	79th to 87th Avenues	Implement Lent Town Center Business District Plan with new traffic signals, pedestrian amenities, wider sidewalks, pedestrian crossings, street lighting, increased on-street parking, as appropriate	X	X	X	$ 2,310,000	2016-25	6	ped	3
2069	PDX IA	ODOT	I-205 Interchange Improvement	I-205 NB/Airport Way Interchange	New I-205 NB on-ramp at I-205/Airport Way interchange (Phase 1 in FC: modify signing, striping channelization and signal timing for NB on-ramp)	X	X	X	$23,100,000	2004-09	13	mv	2
2070	PDX IA	ODOT	I-205 Interchange Improvement	I-205 SB/Airport Way Interchange	Widen I-205 SB on-ramp at Airport Way; modify signing, striping channelization and/or signal timing for the I-205 NB on-ramp at Airport Way	X	X	X	$650,000	2004-09	13	mv	2
4017	PDX IA	Port	SW Quad Access	33rd Avenue	Provide street access from 33rd Avenue into SW Quad	X	X	X	$ 1,732,500	2004-09	1	mv	2
4021	PDX IA	Port	Airport Way Improvements, West	82nd Avenue to PDX terminal	Widen to three lanes in both directions	X	X	X	$11,550,000	2010-15	1	mv	2
4022	PDX IA	Portland/Port	East Columbia/Lombard Street Connector	Columbia/US 30 Bypass: NE 82nd Avenue to I-205	Provide free-flow connection from Columbia Boulevard/82nd Avenue to US 30 Bypass/I-205 interchange	X	X	X	$28,865,250	2004-09	1	mv	2
4026	PDX IA	Port/Portland	Cascades Parkway Connection	Cascades Parkway to Alderwood Road	Construct two-lane extension	X	X	X	$1,732,500	2004-09	1	mv	2
4028	PDX IA	Port	Airport Way/82nd grade separation	82nd Avenue/Airport Way	Construct grade separated overcrossing	X	X	X	$ 12,705,000	2010-15	1	mv	2
4031	PDX IA	Port	Airport Way return and Exit Roadways	Airport Way	Relocate Airport Way exit roadway and construct new return roadway	X	X	X	$16,170,000	2010-15	1	mv	2
4032	PDX IA	Port	Airport Way terminal entrance roadway relocation	PDX terminal	Relocate and widen Airport Way northerly at terminal entrance to maintain access and circulation	X	X	X	$4,620,000	2004-09	1	mv	2
4033	PDX IA	Port	Airport Way east terminal access roadway	PDX east terminal	Construct Airport Way east terminal access roadway	X	X	X	$9,240,000	2010-15	1	mv	2
4038	PDX IA	Port	82nd Avenue/Alderwood Road Improvement	82nd Avenue/Alderwood Road intersection	Construct new turn lanes, restripe and modify traffic signal	X	X	X	$ 790,000	2004-09	1	mv	2
4039	PDX IA	Port	NE 92nd Avenue	NE 92nd/Columbia Boulevard/Alderwood	Improvement to be defined	X	X	X	$ 1,732,500	2016-25	1	mv	2
4040	PDX IA	Portland	47th Avenue Intersection and Roadway Improvements	at Columbia Boulevard	Widen and channelize NE Columbia Boulevard to facilitate truck turning movements; add sidewalks and bike facilities	X	X	X	$ 2,800,000	2004-09	1	mv	2
4041	PDX IA	Portland	Columbia Boulevard/Alderwood Improvements	at Alderwood Road intersection	Widen and signalize intersection	X	X	X	$ 1,460,000	2004-09	1	mv	2

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4042	PDX IA	Port	Cornfoot Road Intersection Improvement	Alderwood/Cornfoot intersection	Add signal, improve turn lanes at intersection	X	X	X	$ 730,000	2004-09	1	mv	2
4043	PDX IA	Portland	33rd/Marine Drive Intersection Improvement	NE 33rd and Marine Drive	Signalize 33rd/Marine Drive intersection for freight movement	X	X	X	$ 288,750	2010-15	1	mv	2
4044	PDX IA	Port/Portland	Columbia/82nd Avenue Improvements	Columbia Boulevard at 82nd Avenue southbound ramps	Add through lanes on Columbia Boulevard, a SB right turn lane and signalize	X	X	X	$ 1,130,000	2004-09	1	mv	2
4045	PDX IA	Port/Portland	Airport Way/122nd Avenue Improvements	Airport Way at 122nd Avenue	Add NB left-turn lane, modify traffic signal and reconstruct island	X	X	X	$ 490,000	2004-09	1	mv	2
7006	Pleasant Valley TC	Portland	SE Foster Improvements	SE 122nd Avenue to Jenne Road	Widen Foster Road to four lanes from SE 122nd to SE Barbara Welch Road. Widen and determine the appropriate cross section of Foster Road from SE Barbara Welch Road to Jenne Road by completing Phase 2 of the Powell Boulevard/Foster Road Corridor Study in order to meet roadway, transit, pedestrian and bike needs	X	X	X	$14,000,000	2010-15	1	mv	3
7007	Pleasant Valley TC	Portland/Gresham	SE 174th North/South Improvements	SE Foster to Powell Boulevard	Based on the recommendations from the Powell Boulevard/Foster Road Corridor Study (#1228), construct a new north-south capacity improvement project in the vicinity of SE 174th Avenue/Jenne Road between SE Powell Boulevard and Giese Road in Pleasant Valley. This replaces former project 7007 which widened Jenne Road to three lanes from Powell Boulevard to Foster Road	X	X	X	$ 13,000,000	2010-15	1	mv	3
1271	Portland Corridor	ODOT	Linnton Community Bike and Pedestrian Improvements	Harbor Avenue to 112th Avenue	Replace 2 traffic signals @ 105th & 107th Ave., curb bulb-outs, sidewalks, and possibly adding pedestrian crossings	X	X	X	$550,000	2016-25	15	ped/bike	4
1209	Portland Mainstreet	Portland	NW 23rd Avenue Reconstruction	Burnside Street to Lovejoy Street	Rebuild street	X	X	X	$ 1,810,000	2004-09	1	mv	3
1012	Region	Multnomah Co.	Sellwood Bridge Replacement	Multnomah County	Implement recommendations from South Willamette Study	X	X	X	$ 90,000,000	2004-09	10	mv	3
1163	Region	ODOT	I-205/Powell Boulevard/Division interchanges	I-205 and Powell Boulevard and Division Street	Construct improvements to allow full turning movements	X	X	X	$12,000,000	2016-25	1	mv	4
1164	Region	ODOT	I-205 Ramp Study - PE/EA	I-205/Powell to Division	Perform a design study to evaluate modifications to the existing overpass at I-205 and Powell Boulevard, including full access ramps to and from I-205. The study should also address impacts to the interchange influence area along Powell Boulevard, Division Street, and SE 92nd Avenue.	X	X	X	$1,000,000	2004-09	2	mv	4
1165	Region	ODOT	I-205 Ramp Right-of-way Acquisition	I-205/Powell to Division	Acquire ROW	X	X	X	$2,000,000	2004-09	2	mv	4
2000	Region	Multnomah Co.	Hogan Corridor Improvements	Stark Street to Palmquist (Stark to Powell in FC)	Interim capacity improvements and access controls	X	X	X	$ 13,860,000	2004-09	13	mv	1

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RTP #	2040 Link	Jurisdiction	Project Name (Facility)	Project Location	Project Description	2020 RTP Priority System	2030 RTP Illustrative System	2030 RTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	RTP Program Years	Primary Modal Type	Primary Mode	2040 Category
3006	Region	ODOT	US 26 Improvements	US 26 between Sylvan and Highway 217	Complete interchange improvements by adding third through-lane and collector distributor system from Camelot Court to Sylvan Road (Phase 3)	X	X	X	$ 25,410,000	2004-09	13	mv	2
4004	Region	ODOT	Greeley Street Ramp Improvements	Greeley Street/I-5 ramps	Modernize Greeley Street ramps	X	X	X		2004-09	13	mv	1
4005	Region	ODOT	I-5 North Improvements	Lombard Street to Expo Center/Delta Park	Widen to six lanes	X	X	X	$ 41,000,000	2004-09	13	mv	1
4006	Region	ODOT	I-5/Columbia Boulevard Improvement	I-5/Columbia Boulevard interchange	Construct full direction access interchange based on recommendations from I-5 North Trade Corridor Study	X	X	X	$56,000,000	2010-15	13	mv	2
4009	Region	ODOT	I-5 Trade Corridor Study and Tier 1 DEIS	I-405 (OR) to I-205 (WA)	Plan improvements to I-5 to benefit freight traffic	X	X	X	$ 15,000,000	2004-09	2	mm study	2
5016	Region	ODOT	Highway 213 Grade Separation	Washington Street at Highway 213	Grade separate southbound Highway 213 at Washington Street and add a northbound lane to Highway 213 from just south of Washington Street to the I-205 on-ramp.	X	X	X	$ 10,395,000	2010-15	13	mv	1
5017	Region	ODOT	Highway 213 Intersection Improvements	Abernethy at Highway 213	Intersection improvements	X	X	X	$ 3,465,000	2010-15	13	mv	1
5021	Region	ODOT	Highway 224 Extension	I-205 to Highway 212/122nd Avenue	Construct new four-lane highway and reconstruct Highway 212/122nd Avenue interchange	X	X	X	$84,315,000	2010-15	13	mv	2
5023	Region	ODOT	I-205/Highway 213 Interchange Improvement	I-205 at Highway 213	Reconstruct I-205 southbound off-ramp to Highway 213 to provide more storage and enhance highway operations and safety	X	X	X	$1,155,000	2010-15	13	mv	1
5199	Region	ODOT	I-205 Auxiliary Lanes	I-5 to Stafford Road	Add auxiliary lanes as part of pavement preservation project	X	X	X	$ 8,000,000	2004-09	13	mv	1
4063	Rivergate IA	ODOT/Portland	N. Lombard Improvements	Lombard Street from Rivergate Boulevard (Purdy) to south of Columbia Slough bridge	Widen street to three lanes	X	X	X	$ 3,610,000	2004-09	1	mv	2
4065	Rivergate IA	Port/Portland	North Lombard Overcrossing	South Rivergate	Construct overpass from Columbia/Lombard intersection into South Rivergate entrance to separate rail and vehicular traffic. Project includes motor vehicle lanes, bike lanes, and sidewalks.	X	X	X	$24,453,660	2004-09	1	mv	2
4087	Rivergate IA	Port	Leadbetter Street Extension and Grade Separation	to Marine Drive	Extend street and construct grade separation	X	X	X	$ 8,000,000	2004-09	1	mv	2
4088	Rivergate IA	Port/Portland	Terminal 4 Driveway Consolidation	Lombard Street at Terminal 4	Consolidate two signalized driveways at Terminal 4	X	X	X	$ 1,000,000	2004-09	1	mv	2
2074	South Shore IA	Multnomah Co.	Sandy Boulevard Widening	122nd Avenue to 238th Avenue	Widens street to five lanes with sidewalks and bike lanes	X	X	X	$ 11,800,000	2016-25	1	mv	2
2051	Springwater IA	ODOT	US 26/Springwater Interchange Improvement	US 26 at Springwater	New interchange on US 26 to serve industrial area		X	X	$ 25,000,000	2004-09	13	mv	2

RTC Metropolitan Transporta-tion Plan	Jurisdiction (Not provided in MTP)	Project Name (Facility)	Project Location	Project Description	2018 Opening Year System	2030 MTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	MTP Program Years	Primary Mode	2040 Category
MTP	WSDOT	I-5	Columbia River Crossing (CRC). SR-500 in Vancouver, Washington to Columbia Boulevard in Portland, Oregon	Replacement I-5 river crossing and reconstructed interchanges. Light Rail Transit with terminus in Clark College vicinity.	X	X	N/A	2017		N/A
MTP	WSDOT	I-5	Salmon Creek to I-205	3 lanes each direction	X	X	N/A	2006	mv	N/A
MTP	WSDOT	I-5	SR-502 Interchange	New Interchange	X	X	N/A	2008	mv	N/A
MTP	WSDOT	I-5	Pioneer Street (Ridgefield)/ SR-501 Interchange	Replace Interchange	X	X	N/A	2009	mv	N/A
MTP	WSDOT	I-5	The Salmon Creek Interchange Project (SCIP) at 134th/139th Street	Construct NE 139th St. from NE 20th Ave. to NE 10th Ave. Reconstruct interchange with ramps added at 139th St. NE 10th Ave. Improve NE 10th Ave. from 134th to 149th St. with turn lanes	X	X	N/A	2010-2013	mv	N/A
MTP	WSDOT	I-5/I-205	Salmon Creek Interchange Phase II	Improve access to I-205 with flyover from 134th St to I-205 southbound		X	N/A	2013-2020	mv	N/A
MTP	WSDOT	I-5	319th Street Interchange	Rebuild Interchange	X	X	N/A	2011-2015	mv	N/A
MTP	WSDOT	I-5	I-205 to 179th Street	Auxiliary lane in each direction	X	X	N/A	2012-2013	mv	N/A
MTP	WSDOT	I-5	179th Street to SR-502	Auxiliary lane in each direction		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-5	179th Street Interchange	Reconstruct Interchange		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-205	Mill Plain Exit (112th Avenue connector)	Build direct ramp to NE 112th Avenue	X	X	N/A	2007	mv	N/A
MTP	WSDOT	I-205	Mill Plain to NE 18th St - Stage I	Ramps/Frontage Road between Mill Plain and 18th Streets	X	X	N/A	2011	mv	N/A
MTP	WSDOT	I-205	Mill Plain to NE 18th St - Stage II	Ramps/Frontage Road between Mill Plain and 18th Streets	X	X	N/A	2016	mv	N/A
MTP	WSDOT	I-205	Mill Plain to 28th Street	Ramps/frontage road between Mill Plain and 28th Streets		X	N/A	2020-2030	mv	N/A
MTP	WSDOT	I-205	I-205/SR14 Interchange	Rebuild Interchange		X	N/A	2020-2030	mv	N/A
MTP	WSDOT	I-205	SR-14 to Mill Plain	Ramp Separation		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-205	28th St to SR 500	North ramps		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-205	SR-500	WB SR-500 to SB I-205 Flyover		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-205	Padden Parkway Interchange	Rebuild interchange		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-205	SR-500 to Padden Parkway	3 general purpose and 1 auxiliary lanes each direction		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	I-205	Padden Parkway to 134th Street	3 lanes each direction		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	SR-14	I-205 to 164th Avenue	3 lanes ea. direction		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	SR-14	NW 6th Av. to SR-500/Union	2 lanes ea. direction w. interchange	X	X	N/A	2012	mv	N/A
MTP	WSDOT	SR-14	SE Union Street to 32nd Street	Add lanes and construct interchanges (for safety and capacity)		X	N/A	2016-2025	mv	N/A

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RTC Metropolitan Transportation Plan	Jurisdiction (Not provided in MTP)	Project Name (Facility)	Project Location	Project Description	2018 Opening Year System	2030 MTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	MTP Program Years	Primary Mode	2040 Category
MTP	WSDOT	SR-500	at I-205	Extend westbound auxiliary lane	X	X	N/A	2009	mv	N/A
MTP	WSDOT	SR-500	St. Johns Interchange	New Interchange	X	X	N/A	2011	mv	N/A
MTP	WSDOT	SR-500	42nd Avenue	Grade Separation		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	SR-500	54th Avenue	Interchange with collector-distributor connecting to Andresen		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	SR-500	at SR-503/ Fourth Plain	Construct turn lanes	X	X	N/A	2011-2016	mv	N/A
MTP	Port of Ridgefield/ WSDOT	SR-501, Port of Ridgefield Rail Crossing, vicinity of Pioneer Street, Ridgefield	Extend Pioneer St to Port of Ridgefield Rail Overcrossing to Port of Ridgefield	Grade separated crossing of mainline railway. Feasibility study and environmental impacts review	X	X	N/A	2010-2013	mv	N/A
MTP	WSDOT	SR-502	NE 10th Avenue to Battle Ground	2 lanes each direction	X	X	N/A	2013	mv	N/A
MTP	WSDOT	SR-503	at SR-502	Intersection improvement	X	X	N/A	2011-2016	mv	N/A
MTP	Clark County/ WSDOT	SR-503	at Padden Parkway	Add Interchange		X	N/A	2016-2025	mv	N/A
MTP	WSDOT	SR-503	Padden to SR-502	Add Lanes, 3 lanes each direction			N/A	2025-2030	bus	N/A
MTP	WSDOT	SR-503	SR-502 to Gabriel Road	Add Lanes, 2 lanes each direction			N/A		bus	N/A
MTP	WSDOT	SR-503	East Fork Lewis River	Northbound and southbound climbing lane	X	X	N/A	2011	bus	N/A
MTP	WSDOT	Vancouver Rail and 39th Street	RR at 39th Street	Vancouver Rail Bypass and W. 39th Street	X	X	N/A	2010	bus	N/A
MTP	C-TRAN	Fleet Expansion and Replacement	System Wide	Fleet expansion and replacement for fixed route, demand response, and vanpool, including vehicles with alternative fuel technology	X	X	N/A	Ongoing	bus	N/A
MTP	C-TRAN	Transit Enhancements	System Wide	Improvements/amenities at bus stops, super stops, and transit centers - new and existing	X	X	N/A	Ongoing	bus	N/A
MTP	C-TRAN	Administration, Operations, and Maintenance Facility	65th Street & 18th Street	Expansion/redevelopment	X	X	N/A	2010-2015	bus	N/A
MTP	C-TRAN	7th Street Passenger Service	7th Street & Washington	Redevelopment of C-TRAN property at 7th Street		X	N/A		bus	N/A
MTP	C-TRAN	Central County Park & Ride	I-205 & Padden Parkway	Develop Park & Ride	X	X	N/A	2010-2015	bus	N/A
MTP	C-TRAN	Evergreen Park & Ride	18th Street & 136th Avenue	Replacement or expansion of existing facility		X	N/A	2014-2023	bus	N/A
MTP	C-TRAN	219th Street Park & Ride	I-5 & SR-502	Park & Ride facility at new interchange		X	N/A	2020-2030	bus	N/A
MTP	C-TRAN	Salmon Creek Park & Ride	I-5 & 134th/ 139th Streets	Relocate existing park & ride as part of interchange project	X	X	N/A	2008-2010	bus	N/A
MTP	C-TRAN	179th/ Fairgrounds Park & Ride	I-5 & NE 179th Street	Develop Park & Ride		X	N/A	2020-2030	bus	N/A
MTP	C-TRAN	Fisher's Landing Transit Center	SR-14 & 164th Avenue	Expansion of park & ride facility		X	N/A	2014-2023	bus	N/A
MTP	C-TRAN	Vancouver Mall Transit Center	SR-500 & Thurston Way	Upgrades/improvements to transit center	X	X	N/A	2008-2010	bus	N/A

RTC Metropolitan Transporta-tion Plan	Jurisdiction (Not provided in MTP)	Project Name (Facility)	Project Location	Project Description	2018 Opening Year System	2030 MTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	MTP Program Years	Primary Mode	2040 Category
MTP	C-TRAN	High Capacity Transit	TBD	Alternatives Analysis for recommended corridor(s) from HCT Study (New Starts and/or Small Starts)	X	X	N/A	2008-2009	bus	N/A
MTP	C-TRAN	ITS Deployment	System Wide	Deploy ITS Phase 2 and 3, including digital radio system	X	X	N/A	Ongoing	bus	N/A
MTP	Clark County	119th Street	72nd Avenue to SR-503 (117th Av.)	2 lanes ea. direction, w/turn lane	X	X	N/A	2012	mv	N/A
MTP	Clark County	119th Street	Salmon Creek Av. to 72nd Avenue	1 lane ea. direction, w/turn lane	X	X	N/A	2016	mv	N/A
MTP	Clark County	119th Street	NW 7th Av to NW 16th Av	1 lane ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	179th Street	NE 10th to NE 29th Avenue	2 lanes ea. direction, w/turn lane		X	N/A	2010-2013	mv	N/A
MTP	Clark County	179th Street	NE 29th Avenue to NE 72nd Av.	2 lanes ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	179th Street	NE 72nd Avenue to Cramer Road	1 lane ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	179th Street	Cramer Road to NE 112th Av.	1 lane ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	179th Street	I-5 to NW 11th Avenue	2 lanes ea. direction, w/turn lane		X	N/A	Completion will be by frontage improve-ments 2013 to 2030	mv	N/A
MTP	Clark County	72nd Avenue	N. of 88th Street to 110th St	2 lane ea. direction, w/turn lane	X	X	N/A	2008	mv	N/A
MTP	Clark County	Andresen	Padden Parkway	Add Interchange		X	N/A	2013-2030	mv	N/A
MTP	Clark County	Highway 99	NE 99th Street to NE 119th Street	2 lanes ea. direction, w/turn lane	X	X	N/A	2016	mv	N/A
MTP	Clark County	Highway 99	122nd to 129th Street	2 lanes each direction w/ turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	Highway 99	South RR Bridge (Ross Street) to NE 63rd Street	2 lane ea. direction, w/turn lane (rail bridge)		X	N/A	2013-2030	mv	N/A
MTP	Clark County	NE 119th Street	SR-503 to NE 172nd Avenue	1 lane ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	NE 182nd Avenue	NE 159th to NE 174th St	Intersection improvements		X	N/A	2013-2030	mv	N/A
MTP	Clark County	NE 72nd Avenue	119th to 133rd Street	2 lanes each direction w/ turn lane		X		2023	mv	N/A
MTP	Clark County	NE 72nd Avenue	NE 133rd to NE 219th St	2 lanes ea. direction, w/turn lane		X		2013-2030	mv	N/A
MTP	Clark County	NE Ward Rd.	NE 88th Street to NE 172nd Ave	2 lanes ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	NE Ward Rd.	NE 172nd Avenue to Davis Rd	2 lanes ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	NE Ward Rd.	NE Davis Rd to NE 182nd Avenue	2 lanes ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Clark County	Padden Parkway	SR-503	Add Interchange		X	N/A	2013-2030	mv	N/A
MTP	Clark County	St. John's Blvd.	NE 50th Avenue to 72nd Avenue	2 lanes ea. direction, w/turn lane	X	X	N/A	2008	mv	N/A
MTP	Clark County	St. John's Blvd.	NE 68th St to NE 50th Av.	2 lanes ea. direction, w/turn lane	X	X	N/A	2013-2020	mv	N/A

PRELIMINARY

RTC Metropolitan Transporta-tion Plan	Jurisdiction (Not provided in MTP)	Project Name (Facility)	Project Location	Project Description	2018 Opening Year System	2030 MTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	MTP Program Years	Primary Mode	2040 Category
MTP	Clark County	Ward/ 172nd Av.	S. 99th Street to 119th St.	Realignment	X	X	N/A	2009	mv	N/A
MTP	Clark County	Grace Avenue	Grace Av/ East Main St	Align S Grace and N Grace	X	X	N/A	2009	mv	N/A
MTP	Clark County	NE 199th Street	SE Grace to East City Limits	1 lane ea. direction, w/turn lane, bicycle and pedestrian facilities	X	X	N/A	2011-2015	mv	N/A
MTP	Clark County	SE Grace Avenue	East Main St to NE 199th St	1 lane ea. direction, w/turn lane, bicycle and pedestrian facilities	X	X	N/A	2007-2010	mv	N/A
MTP	Clark County	SR-502/ 12th Avenue	Reconfigure roadway system and signal removal	1 lane ea. direction, w bicycle and pedestrian facilities	X	X	N/A	2009	mv	N/A
MTP	Clark County	SR-503 and NE 199th St.		Improve intersection - add turn lanes	X	X	N/A	2011-2015	mv	N/A
MTP	Clark County	38th Avenue	Bybee Road to Astor	1 lane ea. direction, w/turn lane	X	X	N/A	2010-2016	mv	N/A
MTP	Clark County	NW 6th Av	Ivy to Division	1 lane ea. direction, w/turn lane	X	X	N/A	2010-2016	mv	N/A
MTP	Clark County	E 4th Street	Highland to E. City Limits	Urban upgrade	X	X	N/A	2007	mv	N/A
MTP	Clark County	E 4th Street		Culvert/bridge replacement	X	X	N/A	2010-2016	mv	N/A
MTP	Clark County	La Center Road	at Timmen Road	Construct left turn lanes	X	X	N/A	2010-2016	mv	N/A
MTP	Ridgefield	SR-501 Deceleration Lane	SR-501 and NW 26th Street	Add deceleration lane on north side of SR-501	X	X	N/A	2009	mv	N/A
MTP	Ridgefield	West Vancouver Freight Access	5 Schedules (stages) - Schedule 1 new access to BNSF mainline/spurs to LaFarge and Albina Fuel; Schedules 2 - 4 internal rail improvements; Schedule 5 new access to Columbia Gateway	Cost estimates are in the range of $77 million to $100 million	X	X	N/A	Phased, 2007-2020	mv	N/A
MTP	Ridgefield	Hillhurst Road	Royle to 229th extension	Upgrade to 5 lane principal arterial	X	X	N/A	2012	mv	N/A
MTP	Vancouver	Hillhurst Road	SR-501 to Royle Road	1 lane each direction w/ turn lane	X	X	N/A	2013	mv	N/A
MTP	Vancouver	Hillhurst Road	Realign and connect to 8th Ave.	Extend existing road	X	X	N/A	2015	mv	N/A
MTP	Vancouver	I-5	219th St. to SR-501	NB auxiliary lane along I-5		X	N/A		mv	N/A
MTP	Vancouver	I-5	SR-501 to 219th St.	SB auxiliary lane along I-5		X	N/A		mv	N/A
MTP	Vancouver	Pioneer Street Bridge	over Gee Creek	Bridge Replacement	X	X	N/A	2015	mv	N/A
MTP	Vancouver	Pioneer Street/ SR-501	I-5 NB Ramps to S 10th Street	2 lanes each direction w/ turn lane	X	X	N/A	2008	mv	N/A
MTP	Vancouver	Pioneer Street/ SR-501	.5 mile west of S 45th to I-5 NB ramps	2 lanes each direction w/ turn lane	X	X	N/A	2010	mv	N/A
MTP	Vancouver	Pioneer Street/ SR-501	.5 miles west of S 45th to W of Reiman Road	Widen, 1-2 lanes each direction	X	X	N/A	2015	mv	N/A
MTP	Vancouver	112th Avenue	Mill Plain to 49th Street	2 lanes ea. direction, w/turn lane		X	N/A	2016-2025	mv	N/A
MTP	Vancouver	137th Avenue	49th Street to Vancouver City Limits	2 lanes ea. direction, w/turn lane	X	X	N/A	2007-2012	mv	N/A
MTP	Vancouver	138th Avenue	28th Street to 39th Street	2 lanes ea. direction, w access management	X	X	N/A	2007-2012	mv	N/A
MTP	Vancouver	164th Avenue	SE 1st to SE 34th St	Reconstruct intersections to improve traffic flow	X	X	N/A	2007-2012	mv	N/A
MTP	Vancouver	18th Street	162nd Avenue to 192nd Avenue	2 lanes ea. direction, w/turn lane	X	X	N/A	2012	mv	N/A

PRELIMINARY

RTC Metropolitan Transportation Plan	Jurisdiction (Not provided in MTP)	Project Name (Facility)	Project Location	Project Description	2018 Opening Year System	2030 MTP Financially Constrained System	Est. Project Cost in 2003 dollars ("*" indicates phasing in financially constrained system)	MTP Program Years	Primary Mode	2040 Category
MTP	Vancouver	18th Street	97th Avenue to NE 138th Avenue	2 lanes ea. direction, w/turn lane	X	X	N/A	2007-2012	mv	N/A
MTP	Vancouver	18th Street	138th Avenue to 162nd Avenue	2 lanes ea. direction, w/turn lane	X	X	N/A	2007-2012	mv	N/A
MTP	Vancouver	18th Street	87th Avenue to 97th Avenue	Extend existing street 1 lane ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Vancouver	192nd Avenue	SE 1st Street to NE 18th Street	2 lanes ea. direction, w/turn pockets	X	X	N/A	2010	mv	N/A
MTP	Vancouver	49th Street	122nd to 137th Avenue	1 lane ea. direction, w/turn lane		X	N/A	2013-2030	mv	N/A
MTP	Vancouver	E. Mill Plain	136th Ave. Intersection	Intersection improvement	X	X	N/A	2010	mv	N/A
MTP	Vancouver	Fourth Plain	I-5 to Railroad Bridge	2 lanes each direction	X	X	N/A	2013-2030	mv	N/A
MTP	Vancouver	Fourth Plain Boulevard/ Andresen	Intersection Influence Area	Reconstruct Fourth Plain in vicinity of 65th/66th Avenue to Andresen	X	X	N/A	2007-2013	mv	N/A
MTP	Vancouver	Fruit Valley Rd	Whitney to 78th Street	1 lane ea. direction, w/turn lane		X	N/A	2013-2020	mv	N/A
MTP	Vancouver	Grand Blvd.	Columbia House Way Intersection	Intersection improvement	X	X	N/A	2008	mv	N/A
MTP	Vancouver	MacArthur Blvd.	Lieser Rd. Intersection	Intersection improvement	X	X	N/A	2012	mv	N/A
MTP	Vancouver	Main Street	5th Street to McLoughlin	Convert to two-way street	X	X	N/A	2008	mv	N/A
MTP	Vancouver	Main Street	5th Street to Columbia Way	Re-connect to waterfront S. of rail berm	X	X	N/A	2011	mv	N/A
MTP	Vancouver	NE 28th Street	142nd Avenue to 162nd Avenue	1 lane ea. direction, w/turn lane	X	X	N/A	2013-2030	mv	N/A
MTP	Vancouver	SE 15th Street	164th to 192nd Ave.	Upgrade to collector arterial	X	X	N/A	2013-2030	mv	N/A
MTP	Vancouver	SE 1st Street	164th Avenue to 192nd Ave.	2 lanes ea. direction, w/turn lane	X	X	N/A	2007-2012	mv	N/A
MTP	Vancouver	E Street/ D Street	West City Limits (Lechner/6th) to 32nd St	Boulevard Design Improvement (1 lane each direction with left turn, sidewalks and bikelanes)	X	X	N/A	2009	mv	N/A
MTP	Vancouver	County-wide	County Wide	Walkway & Bicycle Programs	X	X	N/A	Continuing	mv	N/A
MTP	Vancouver	County-wide	County Wide	Demand Management	X	X	N/A	Continuing	mv	N/A
MTP	Vancouver	Various	System Wide	Intelligent Transportation System (ITS) Additions	X	X	N/A	Continuing	mv	N/A

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Appendix C

Comparison of Transit Networks for DEIS Alternative 3 and the LPA

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List of changes from DEIS to FEIS No Build Alternative model runs

- DEIS used a 2,029 zone network including Columbia County, and parts of Yamhill and Marion Counties; FEIS is based on a 2,041 zone system in just Clark, Washington, Multnomah, and Clackamas Counties; The DEIS used the HUGO version of the demand model, whereas FEIS used the IVAN version. There are very slight differences between the two models, but nothing within the actual model code that would change the results of the model runs in any significant way. DEIS contained 599 more park-and-ride spaces in Clark County due to the presence of 219th and Central County facilities. Fewer park-and-ride spaces in the FEIS No-Build results in less park-and-ride transit users, and additional traffic.

FEIS PnR Spaces	
99th St.	600
Salmon Creek	513
BPA	175
Fishers Landing	836
18th St.	500
Total PnR spaces	**2,624**

DEIS PnR Spaces	
99th	600
Salmon Creek	493
BPA	175
Fisher's Landing	586
Evergreen	269
Central County	480
219th	620
Total PnR spaces	**3,223**

- DEIS had unconstrained demand at all park-and-ride facilities in Oregon (this is not unusual for a study which focuses on a specific corridor). The result is that park-and-ride ridership was not limited by the number of available spaces in Oregon, and thus, regional MAX ridership was higher than it would otherwise be. This does not apply to the CRC corridor, where an effort to properly constrain demand at park-and-ride facilities was ubiquitous throughout the DEIS. The FEIS constrains all park-and-ride facilities throughout the region, and therefore regional park-and-ride demand (and MAX ridership) will be lower than in the DEIS.
- FEIS had some land use changes to South Waterfront, downtown Portland, and the Lloyd District in the form of employment and household reallocation to these areas from the rest of Portland. Portland land use control totals did not change from the DEIS to the FEIS.
- DEIS Yellow Line headways were 10 minutes peak / 15 minutes off-peak; FEIS headways are 12 min. / 15 min.

- TriMet North Portland routes had changes to numbering and/or headways for the lines listed in the table below:

TriMet N. Portland Routes with changes from DEIS to FEIS in the No-Build Alternative	DEIS (H0/T0) headways	FEIS (NB-30.1) headways
6 – MLK Jr. Blvd (06H in DEIS; 06M703 in FEIS)	7.5/12	20/20
6 – MLK Jr. Blvd (06M707 in FEIS)	N/A	20/30
16 – Front Avenue/ St. Johns/ Rivergate	30/0	30/120
2 – Greeley (35 – Greeley in FEIS)	7.5/30	10/30
40 – Mocks Crest (44 – Mocks Crest in FEIS)	12/15	15/15
Yellow Line MAX	10/15	12/15

- C-TRAN system-wide platform hours estimated for the DEIS at 358,400 and for the FEIS at 349,100
- C-TRAN route and/or headway changes are in the table below:

C-TRAN Routes with changes from DEIS to FEIS in the No-Build Alternative	DEIS (H0/T0) headways	FEIS (NB-30.1) headways
#1 – Fruit Valley (#25 – Fruit Valley in FEIS)	30/30	45/45
#2 - Lincoln	60/60	45/45
#3A – City Center Circulator	30/30	45/45
#3B – City Center Circulator	30/30	45/45
#4 – Fourth Plain (with Plomondon Loop)	15/15	N/A
#4 – Fourth Plain (no Plomondon Loop)	N/A	15/15
#4X (#44 in FEIS) – Fourth Plain Limited	30/0	20/0
#6 – Hazel Dell (#32 –Hazel Dell in FEIS)	30/30	45/45
#7 – Battle Ground via Van Mall Dr / Andresen Rd / 78th St / Central Co. P&R / 117th Ave (SR-503)	60/60	N/A
#7 – Battle Ground via 4th Plain Blvd / 102nd Ave / Covington / 76th St / 117th Ave (SR-503)	N/A	45/45
#9 – Salmon Creek Shuttle	N/A	30/60
#19A – Felida Loop	30/60	N/A
#19B – Felida Loop	30/60	N/A
#25 – St. Johns / Fruit Valley	30/30	25/25
#30 – Burton	30/30	20/20
#32 – Evergreen	30/60	45/45
#37 – Mill Plain via Clark College and Hudson Bay HS (Ft Vanc. Wy to McLoughlin Blvd to Reserve St)	15/15	N/A
#37 – Mill Plain with no service on McLoughlin Blvd	N/A	15/15
#37 – Highway 99 via 99th St TC (99TC), Salmon Cr P&R (SCPR), and WSUV	N/A	15/15
#71 – Highway 99 via 99TC and SCPR	15/15	N/A
#39 – Medical Center	N/A	60/60
#80 – Van Mall/Fishers via 18th Street P&R	N/A	60/60
#80 – Van Mall/Fishers via 28th Street and Evergreen P&R	60/60	N/A
#92 – Camas	30/30	60/60
#105 – I-5 Express via 99TC	30/60	N/A
#105 – I-5 Express via SCPR and 99TC	N/A	30/60
#105S – I-5 Express Shortline (VCBD to PCBD)	N/A	12/120
#118 – 18th Street P&R Express	N/A	30/0
#177 – Evergreen Express	60/0	N/A
#134 – Salmon Creek Express	12/0	25/0
#157 – Lloyd District Express via Van Mall/BPA	60/0	N/A
#157 – Lloyd District Express via 99TC	N/A	60/0
#165 – Parkrose Express (#65 in FEIS)	15/30	20/30

#173 – Battle Ground Limited via Kiggins Bowl P&R and Main Street	120/0	N/A
#47 – Battle Ground Limited via I-5 and Mill Plain	N/A	120/0
#183 – Central County Express	15/0	N/A
#190 – Marquam Hill Express via Central County P&R, Van Mall, and BPA/Ross P&R	60/0	N/A
#190 – Marquam Hill Express via BPA/Ross P&R	N/A	60/0
#199 – 99th Street Express	15/0	20/0
#219 – 219th Street Express	15/0	N/A
#301 – Ridgefield	60/0	120/0
#302 – La Center	90/0	120/0

Appendix D

Columbia River Crossing Project Costs, Ridership and Environmental Consequences of Potential Light Rail Park-and-Ride Lot Configurations (Using Alternative 3 as an illustration of the differences in configuration and impact)

May 2008

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Columbia River Crossing Project
Costs, Ridership and Environmental Consequences of Potential Light Rail Park-and-Ride Lot Configurations
(Using Alternative 3 as an illustration of the differences in configuration and impact)

This technical memorandum provides a summary of the costs, ridership and environmental consequences of potential light rail park-and-ride lot configurations for Alternative 3 for the Columbia River Crossing (CRC) Project. This memorandum illustrates, using Alternative 3 as an example (i.e., a replacement bridge with light rail), how various configurations of park-and-ride lots would affect the costs, ridership estimates and environmental consequences for Alternative 3 that are documented in the CRC Draft Environmental Impact Statement (DEIS – Washington State Department of Transportation: May 2008, FHWA-WA-EIS-08-01-D). Table 1 provides a summary of how capital costs, transit ridership and one measure of cost effectiveness would change as a result of differing configurations of park-and-ride lots for Alternative 3. This memorandum documents how those changes were calculated and how other environmental consequences would change as a result of changes in park-and-ride lot configurations.

Table 1
Summary of Capital Cost, Transit Ridership and Cost-Effectiveness Differences
Example Park-and-Ride Lot Configurations for Alternative 3

	Lincoln Terminus	Kiggins Bowl Terminus	Mill Plain MOS	Clark College MOS
Example A Configuration[1]				
Park-and-Ride Spaces	2,410	2,500	3,220	1,250
Capital Cost (millions)[2]	$879.3	$1,068.8	$615.8	$674.9
Transit Ridership[3]	20,800	21,100	19,100	18,200
Cost Effectiveness[4]	$11.55	$13.67	$8.91	$10.38
Example B Configuration[5]				
Park-and-Ride Spaces	1,960	3,560	1,060	2,460
Capital Cost[2]	$828.3	$1,115.2	$556.0	$723.3
Transit Ridership[3]	19,630	23,860	13,480	21,350
Cost Effectiveness[4]	$11.58	$12.64	$11.45	$9.44

Note: MOS = minimum operable segment. Table 5 provides information on how other environmental consequences would vary by park-and-ride lot configuration.

1 Example A is based on the park-and-ride lot configurations for Alternatives 3 as described in the CRC DEIS. See tables 3, 4 and 5 for a description of the DEIS park-and-ride lot configurations and the underlying data used to prepare the data within this table.

2 Capital costs are in millions of year-of-expenditure dollars and only reflect the cost of transit components of Alternative 3. Costs reflect a 60 percent confidence. See the *Cost Risk Assessment Final Report* for a detailed description of the methods used to prepare the capital cost estimates.

3 Transit ridership is the number of person trips (linked trips) passing over the Columbia River in the Bridge Influence Area on an average weekday in 2030 on light rail under Alternative 3.

4 Annualized cost divided by the annual transit guideway river crossings. See tables 4, 5 and 6 for annualized costs and annual transit ridership data.

5 See Table 6 for a description of the Example B configurations.

Alternative 3 is described in Chapter 2 of the DEIS, which also notes that "all build alternatives include a representative combination of both physical and operational components" (page 2-2) – park-and-ride lots and their capacities make up one aspect of the alternatives' physical components. Example A in Table 1 is based on one possible configuration of park-and-ride lots for the Alternative A terminus and minimum operable segment (MOS) options. Other combinations of park-and-ride lots are also feasible and reasonable; and those possible alternate configurations would measurably affect the performance of Alternative 3. This technical memorandum documents how alternate configurations would change the capital cost, transit ridership and other environmental consequences of the terminus and MOS options for Alternative 3, using Example B in Table 1 for illustrative purposes. This technical memorandum is based on data included in the DEIS and/or the DEIS's supporting documents listed in Appendix I of the DEIS.

Alternative 3, as with the other build alternatives, includes various terminus options for the proposed high capacity transit guideway. Alternative 3 in the DEIS includes two "full length" terminus options (i.e., Kiggins Bowl Terminus and Lincoln Terminus) and two shorter "minimum operable segment" (MOS) options (i.e., Clark College MOS and Mill Plain MOS). These four terminus options and the light rail alignments associated with them are illustrated in Figure 1.

For Alternative 3, the DEIS (i.e., Example A) includes five potential park-and-ride lot locations, which are also illustrated in Figure 1. Each park-and-ride lot location could be configured to provide alternate capacities, depending on how the lot would be designed and how it would function. Table 2 summarizes the various potential designs, capacities and functions of the five park-and-ride lots under consideration in the DEIS. In general, the design of a park-and-ride lot could be either a surface or structured lot; and in the case of the SR-14 Park-and-Ride Lot, it could be either a single structure or a combination of surface and structured sub-lots. Relative to the proposed light rail stations, the various park-and-ride lots could function either as a direct access lot (which would generally be within walking distance of a light rail station) or as a satellite lot (which would generally be greater than a half-mile from a light rail station, requiring a connecting bus trip between the lot and the station). How the lot would function would be dependant on the alignment and terminus options for the light rail facility. Further, for all of the alignment and terminus options under consideration, each park-and-ride facility could be omitted altogether. The result is that there are a wide number of combinations of park-and-ride lots, functions and capacities (or no lot at all) for each terminus and MOS option making up Alternative 3.

The CRC DEIS is based on a single configuration of the park-and-ride lots for each of the four terminus/MOS options for Alternative 3 (i.e., Example A). Those "representative" combinations and their resulting park-and-ride lot capacities and functions are summarized in Table 3. Again, the costs, transit ridership estimates and environmental consequences documented in the DEIS for the terminus and MOS options for Alternative 3 are all based on those representative park-and-ride lot configurations. Table 4 summarizes the capital costs and transit ridership of Alternative 3 based on the four terminus/MOS options and the park-and-ride lot configuration used the DEIS. The environmental consequences of Alternative 3 are documented in Chapter 3 of the DEIS and footnotes in Table 5 cite the location of the environmental consequences data in Chapter 3 for those environmental disciplines that could be noticeable affected by the various park-and-ride lot configurations.

Figure 1
Terminus and MOS Options and Potential Park-and-Ride Lot Locations
For Alternative 3 of the CRC DEIS

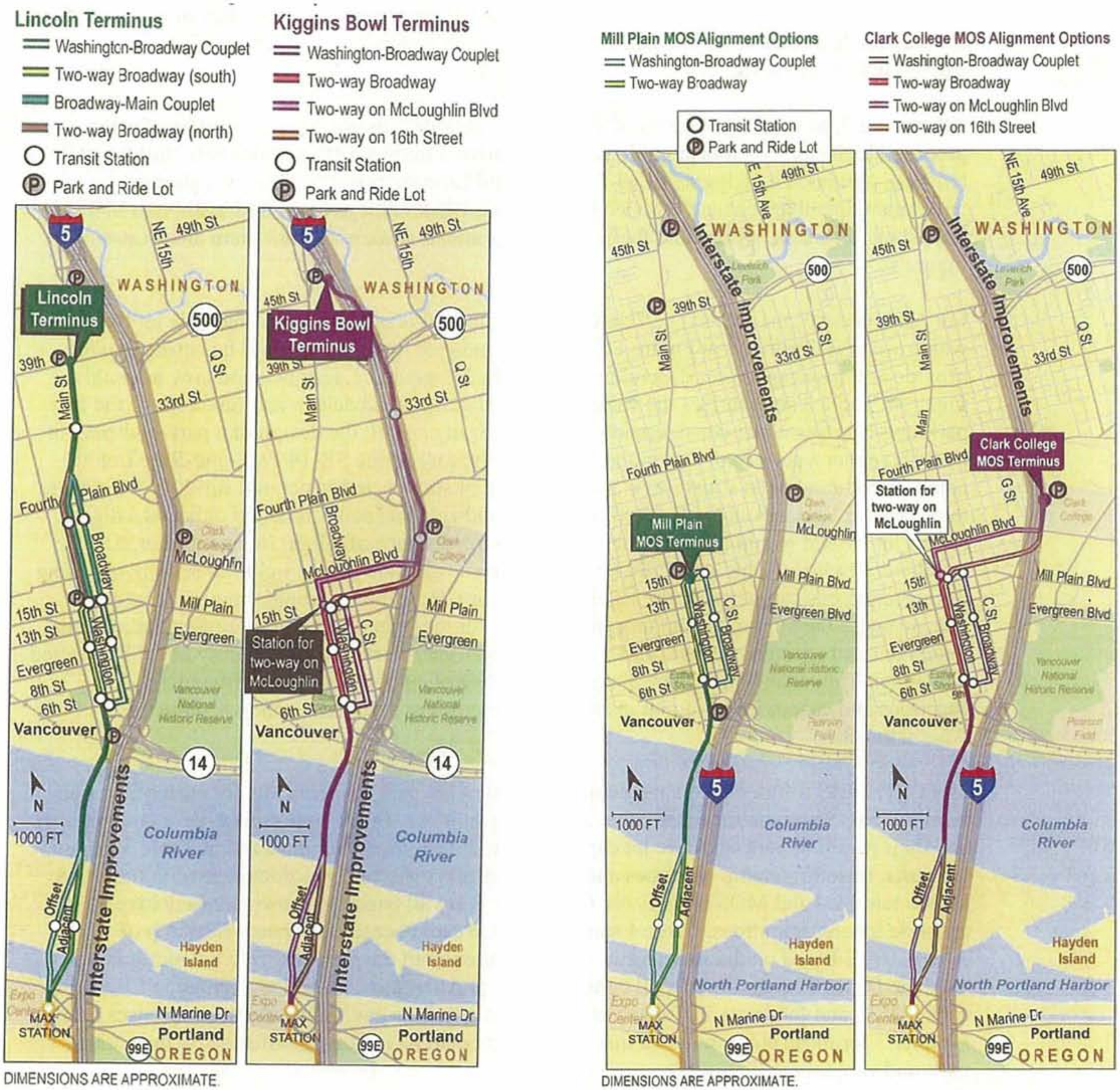

Table 2
Potential Size and Function (Direct Access or Satellite) of Park-and-ride Lots For Alternative A by DEIS Terminus and MOS Option

	Capacity (spaces)		Possible Access Function[1]	
	Surface	Structured	Termini/MOS with potential Direct Access[2]	Termini/MOS with potential Satellite[3] Access
SR 14	NA	500 1,150[4]	Lincoln Kiggins Bowl Clark College Mill Plain	NA
Mill Plain	NA	460 560	Lincoln Kiggins Bowl Clark College Mill Plain	NA
Clark College	460	1,100 1,400	Kiggins Bowl Clark College	Lincoln Mill Plain
Lincoln	900	1,800	Lincoln Mill Plain	Kiggins Bowl Clark College
Kiggins Bowl	150	1,400	Kiggins Bowl Clark College	Lincoln[5] Mill Plain

MOS = minimum operable segment.

1 Table shows the terminus and alignment options that could provide direct or satellite park-and-ride access. In general, direct access park-and-rides would be within a short walking distance of a HCT station; satellite park-and-rides would generally be more than ½-mile from a HCT station and access between the park-and-ride and HCT station would be via a local bus route.

2 A park-and-ride lot providing direct access to a light rail station could be either surface or structured. The lower number is for a single structured lot. The higher number is for a mix of structured and surface at three sub-lots within several hundred feet of each other.

3 A satellite park-and-ride lot would only be designed as a surface lot.

4 The SR 14 Park-and-Ride Lot could be located on one to three parcels using one or two structures, with varying capacities.

5 These spaces were modeled as direct access via a long walk link, but would not be "directly" served by a light rail station.

Table 5 illustrates how the cost, transit ridership and environmental consequences[10] would change for Alternative 3 if the park-and-ride lot configurations were to change. The table assesses the changes that would occur for each design (e.g., surface vs. structured) for each lot. If a particular park-and-ride lot's design and capacity is included as a part of the representative configuration of a terminus/MOS option described in Table 3, then the values for costs, transit ridership and environmental consequences in Table 5 would be deducted from the cumulative costs, transit ridership and environmental consequences for that terminus MOS option for Alternative 3 (Table 5 sites the references to those cumulative totals in the DEIS). Conversely, if a particular park-and-ride lot's design and capacity is not included as a part of the representative configuration of a terminus/MOS option described in Table 3, then the values for costs, transit ridership and environmental consequences in Table 5 would be added to the cumulative costs, transit ridership and environmental consequences for that terminus MOS option for Alternative 3.

10 Note that Table 5 only addresses environmental consequences that would measurably change as a result of a change in the park-and-ride lot configuration for Alternative 3. If an environmental discipline is omitted from Table 5 that means that there would be no measurable change for that discipline resulting from a change in the park-and-ride lot configuration for Alternative 3.

Table 3
Park-and-ride Configurations and Capacity
by Example A (DEIS) Terminus and Alignment Option

Park-and-Ride Facility	Lincoln Terminus		Kiggins Bowl Terminus		Mill Plain MOS		Clark College MOS	
	Direct	Satellite	Direct	Satellite	Direct	Satellite	Direct	Satellite
SR 14	0	0	0	0	1,150[1]	0	0	0
Mill Plain	0	0	0	0	560	0	0	0
Clark College	0	460	1,100	0	0	460[2]	1,100	0
Lincoln	1,800	0	0	0	0	900	0	0
Kiggins Bowl	0	150[2]	1,400	0	0	150	0	150
Total by Type	***1,800***	***610***	***2,500***	***0***	***1,710***	***1,510***	***1,100***	***150***
Total[3]	**2,410**		**2,500**		**3,220**		**1,250**	

1 Under the DEIS's configuration for the Mill Plain MOS, the design of the SR14 Park-and-Ride Lot would include the SR14 Loop and BNSF lots combined as one modeled lot.
2 These spaces were modeled as direct access via a long walk link, but would not be "directly" served by a light rail station.
3 Note that the park-and-ride lot totals for the Alternative 3 terminus and MOS options in Exhibit 22 of the CRC Project DEIS differ from the totals in Table 3 due to errors in Exhibit 22. In addition, Exhibit 22 of the DEIS mistakenly lists the Expo Center Park-and-Ride Lot (existing); while its spaces (300) were not included in the total spaces (Table 3 does not include the Expo Center Park-and-Ride Lot). Finally, the Mill Plain Park-and-Ride lot is mistakenly not listed in Exhibit 22 of the DEIS for the Mill Plain MOS option.

Table 4
Example A Transit Cost and Ridership For Alternative 3
Based on the Park-and-Ride Lot Configurations of the CRC Project DEIS

Measure	Lincoln Terminus	Kiggins Bowl Terminus	Mill Plain MOS	Clark College MOS
Capital Cost[1]	$879.3	$1,068.8	$615.8	$674.9
Annualize Capital Cost[2]	$73.51	$88.39	$51.54	$57.43
Annual Operating Cost[2]	$3.51	$4.24	$2.83	$2.95
Annualized Cost[2]	$77.02	$92.63	$54.37	$60.38
Transit Ridership[3]	20,800	21,100	19,100	18,200
Annualize Transit Ridership	6,670,000	6,780,000	6,110,000	5,820,000
Cost per Transit Ride[4]	$11.55	$13.67	$8.91	$10.38

1 Capital costs are in millions of year-of-expenditure dollars and only reflect the cost of transit components of Alternative 3. Costs reflect a 60 percent confidence. See the *Cost Risk Assessment Final Report* for a detailed description of the methods used to prepare the capital cost estimates.
2 See Exhibit 3.1-39 of the DEIS
3 Transit ridership is the number of person trips (linked trips) passing over the Columbia River in the Bridge Influence Area on an average weekday in 2030 on light rail under Alternative 3.
4 Annualized cost divided by the annual transit guideway river crossings.

Table 6 provides examples of how costs, transit ridership and cost effectiveness are calculated for other potential configurations of park-and-ride lots for Alternative 3, using Examples A and B for illustration. Following is a summary of the results of those calculations for the Example B configuration:

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Table 5
Cost, Transit Ridership and Environmental Effects by Park-and-Ride Lot – Surface and Structured (spaces)[1]

Measure	SR 14		Mill Plain[2]		Clark College			Lincoln		Kiggins	
	Structured 500	Structured 1,150	Structured 460	Structured 560	Surface 460	Structured 1,100	Structured 1,400	Surface 900	Structured 1,800	Surface 150	Structured 1,400
Capital Cost[3] (millions)											
60% Confidence YOE	$20.40	$29.50	$22.4	$26.00	$11.30	$67.90	$78.5	$30.80	$108.30	$8.60	$41.90
Transit Ridership[4]											
Average Weekday	1,300	2,990	1,196	1,456	1,196	2,860	3,640	2,340	4,680	390	3,640
Annual	416,000	956,800	382,720	465,920	382,720	915,200	1,164,800	748,800	1,497,600	124,800	1,164,800
Traffic[5]											
Auto Trips	275/250	635/575	255/230	310/280	255/230	725/715	925/910	600/590	1,200/1,200	85/75	925/850
Property Acquisition											
Residential	0	0	0	0	0	0	0	1	7	0	1
Commercial	0	3	1	1	0	0	0	0	2	0	2
Acres	0	1.23	0.92	0.92	5.48	5.48	5.48	12.20	17.00	2.81	3.15
Neighborhoods	0	0	1[6]	1[6]	0	0	0	0	0	0	0
Major Utility Relocate	0	0	0	0	0	0	0	1[7]	1[7]	0	0
Section 4(f) Uses	0	0	0	0	0	1[8]	1[8]	0	0	0	0
Visual	0	0	1[9]	1[9]	0	0	0	0	1[10]	0	0
Ecosystems	0	0	0	0	0	0	0	0	0	1[11]	1[11]
Wetlands	0	0	0	0	0	0	0	0	0	1[12]	1[12]
Hydrology	0	0	0	0	0	0	0	0	0	0	0
Impervious Acres[13]	1.2	6.2	0.9	0.9	5.1	5.4	5.4	9.1	12.9	2.2	2.7
HazMat	0	0	0	0	0	0		1[14]	1[14]	0	0

Note: YOE = year of expenditure; MOS = minimum operable segment.

1 This table summarizes how costs and environmental affects would change as a result of park-and-ride lots under consideration in the CRC DEIS for the range of LRT terminus and alignment options under consideration. If the park-and-ride is included in the DEIS terminus and alignment option (see Table 3), then the removal of the lot from that alternative would reduce the costs and impacts for that alternative by the amount indicated in this table; conversely, If the park-and-ride lot is not included in the DEIS terminus and alignment option (see Table 3), then the addition of the lot from that alternative would increase the costs and impacts for that alternative by the amount indicated in the table (see Table 4 for examples). There would be no noticeable consequences for those environmental disciplines not included in this table or upon operating costs.

2 A 650-space structured Mill Plain park-and-ride lot would: cost approximately $29.1 million: generate approximately 1,690 average weekday and 540,800 annual transit rides; and generate approximately 360 and 325 automobile trips in the a.m. and p.m. peak periods (see notes 4 and 5 on transit ridership and automobile trip generation rates) – all other factors in this table would be the same as for the 560-space lot).

3 In millions.

4 Trips generated are estimated as a proportion of spaces (approximately 2.6 transit person trips per space). Average weekday in 2030 that would cross the Columbia River in the project area by transit. Annual transit trips are calculated by multiplying average weekday rides by 320, the factor used for the annual ridership data in Exhibit 3.1-39 of the DEIS.

5 One-way and drop-off automobile trips generated in the a.m. and p.m. peak periods, entering and exiting the park-and-ride facilities, respectively.

6 Displacement of a US Bank branch office.

7 Potential need to relocate one water main.

8 Potential use of one public park resource (1.24 acres).

9 Five-story building would modify the aesthetics of the surrounding area.

10 Could add visual change for surrounding homes.

11 Less than 200 square feet of Burnt Bridge Creek buffer impacted; 0.2 acres WA Priority Habitat impacted; 0.4 acres Vancouver CAO impacted. I-5 lies between site and Burnt Bridge Creek.

12 Minor impact to Burnt Bridge Creek wetland and minor impact wetland at Kiggins Bowl.

13 New and reconstructed impervious surfaces.

14 WSDOT maintenance facility, which has the potential for discovery of contamination.

Table 6
Example B Park-and-Ride Lot Configurations for CRC Alternative 3 – Illustration of Calculations[1]

Clark College MOS	**DEIS**			**Add**			**Subtract**			**Result**		
Park-and-Ride Facility	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**
SR 14	0			500	$20.4	1,300				500		
Mill Plain	0			560	$26.0	1,456				560		
Clark College	1,100			1,400	$78.5	3,640	1,100	$67.9	2,860	1,400		
Lincoln	0									0		
Kiggins Bowl	150						150	$8.6	390	0		
Total	**1,250**	**$674.9**	**18,200**	**2,460**	**$124.9**	**6,396**	**1,250**	**$76.5**	**3,250**	**2,460**	**$723.3**	**21,346**
Annualized											$64.5	6,830,720
Mill Plain MOS	**DEIS**			**Add**			**Subtract**			**Result**		
Park-and-Ride Facility	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**
SR 14	1,150			500	$20.4	1,300	1,150	$29.5	2,990	500		
Mill Plain	560									560		
Clark College	460						460	$11.3	1,196	0		
Lincoln	900						900	$30.8	2,340	0		
Kiggins Bowl	150						150	$8.6	390	0		
Total	**3,220**	**$615.8**	**19,100**	**500**	**$20.4**	**1,300**	**2,660**	**$80.2**	**6,916**	**1,060**	**$556.0**	**13,484**
Annualized											$49.4	4,314,880
Lincoln Terminus	**DEIS**			**Add**			**Subtract**			**Result**		
Park-and-Ride Facility	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**
SR 14	0			500	$20.4	1,300				500		
Mill Plain	0			560	$26.0	1,456				560		
Clark College	460						460	$11.3	1,196	0		
Lincoln	1,800			900	$30.8	2,340	1,800	$108.3	4,680	900		
Kiggins Bowl	150						150	$8.6	390	0		
Total	**2,410**	**$879.3**	**20,800**	**1,960**	**$77.2**	**5,096**	**2,410**	**$128.2**	**6,266**	**1,960**	**$828.3**	**19,630**
Annualized											$72.8	6,281,600
Kiggins Bowl Terminus	**DEIS**			**Add**			**Subtract**			**Result**		
Park-and-Ride Facility	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**	**Spaces**	**Cost**	**Ridership**
SR 14	0			500	$20.4	1,300				500		
Mill Plain	0			560	$26.0	1,456				560		
Clark College	1,100									1,100		
Lincoln	0									0		
Kiggins Bowl	1,400									1,400		
Total	**2,500**	**$1,068.8**	**21,100**	**1,060**	**$46.4**	**2,756**	**0**	**$0.0**	**0**	**3,560**	**$1,115.2**	**23,856**
Annualized											$96.5	7,633,920

Note: DEIS = draft Environmental Impact Statement; MOS = minimum operable segment.

[1] See notes in Table 5 for a description of how costs and ridership differences are calculated. Costs are in millions of year-of-expenditure dollars. Ridership is average weekday person trips across the Columbia River on light rail in 2030. Annualized cost effectiveness is calculated by dividing annual (transit) ridership by the annualized cost: Lincoln Terminus = $11.58; Kiggins Terminus = $12.64; Mill Plain MOS = $11.45; Clark College MOS = $9.66. See Table 5 for how environmental consequences of Alternative 3 would change as a result of these example park-and-ride lot configurations.

- **Lincoln Terminus.** Based on the Example B configuration of park-and-ride lots in Table 6 for the Lincoln Terminus, there would be: a surface Lincoln Park-and-Ride Lot (900 spaces); a structured Mill Plain Park-and-Ride Lot (560 spaces); a single structured SR-14 Park-and-Ride Lot (500 spaces); and no satellite park-and-ride lot at Clark College. As a result, there would be a total of 1,960 direct-access park-and-ride spaces and no satellite park-and-ride spaces. Based on the alternate configuration for the Lincoln Terminus: capital costs would decrease by approximately $51.0 million; average weekday transit ridership in 2030 would decrease by approximately 1,170; and the annualized cost per annual new transit trip crossing the Columbia in the project area would increase from $11.55 to $11.58 (compared to the Lincoln Terminus option's results documented in the DEIS).

- **Kiggins Bowl Terminus.** Based on the Example B configuration of park-and-ride lots in Table 6 for the Lincoln Terminus, there would be: a structured Kiggins Bowl Park-and-Ride Lot (1,400 spaces); a structured lot at Clark College (1,100); a structured Mill Plain Park-and-Ride Lot (560 spaces); a single structured SR-14 Park-and-Ride Lot (500 spaces); and no satellite park-and-ride lot at Lincoln. As a result, there would be a total of 3,560 direct-access park-and-ride spaces and no satellite park-and-ride spaces. Based on the alternate configuration for the Kiggins Bowl Terminus: capital costs would increase by approximately $46.4 million; average weekday transit ridership in 2030 would increase by approximately 2,756; and the annualized cost per annual new transit trip crossing the Columbia in the project area would decrease from $13.67 to $12.64 (compared to the Kiggins Bowl Terminus option's results documented in the DEIS).

- **Clark College MOS.** Based on the Example B configuration of park-and-ride lots in Table 6 for the Clark College MOS, there would be: a structured Clark College Park-and-Ride Lot (1,400 spaces); a structured Mill Plain Park-and-Ride Lot (560 spaces); a single structured SR-14 Park-and-Ride Lot (500 spaces); and no satellite park-and-ride lot at Lincoln. As a result, there would be a total of 2,460 direct-access park-and-ride spaces and no satellite park-and-ride spaces. Based on the alternate configuration for the Clark College Terminus: capital costs would increase by approximately $48.4 million; average weekday transit ridership in 2030 would increase by approximately 3,150; and the annualized cost per annual new transit trip crossing the Columbia in the project area would decrease from $10.38 to $9.44 (compared to the Clark College MOS's results documented in the DEIS).

- **Mill Plain MOS.** Based on the Example B configuration of park-and-ride lots in Table 6 for the Mill Plain MOS, there would be: a structured Mill Plain Park-and-Ride Lot (560 spaces); a single structured SR-14 Park-and-Ride Lot (500 spaces); and no satellite park-and-ride lots at Lincoln, Clark College or Kiggins Bowl. As a result, there would be a total of 1,060 direct-access park-and-ride spaces and no satellite park-and-ride spaces. Based on the alternate configuration for the Clark College Terminus: capital costs would decrease by approximately $59.8 million; average weekday transit ridership in 2030 would decrease by approximately 5,620; and the annualized cost per annual new transit trip crossing the Columbia in the project area would increase from $8.91 to $11.45 (compared to the Mill Plain MOS's results documented in the DEIS).

In summary, there are a few items of note:

- First, the capital cost of a park-and-ride lot may include just the cost to construct that lot; or it may include additional costs needed to avoid or mitigate impacts. In particular, the structured Lincoln Park-and-Lot would include substantial roadway improvements needed to avoid or mitigate local congestion impacts to Main Street resulting from relatively high traffic volumes in the peak periods due to automobiles accessing the park-and-ride lot. Therefore, the per-space capital cost of the structured Lincoln Park-and-Lot would be greater than the per space cost for other structured lots under consideration.

- Second, for all alternatives and options under consideration, there would be a relatively high demand for park-and-ride trips in Clark County in 2030, which would not be fully met under any of the park-and-ride lot configurations under consideration. As a result, each park-and-ride lot would generally be full in 2030 and each park-and-ride space, regardless of its location, would generate approximately the same number of average weekday transit trips. Therefore, the total park-and-ride capacity and the capital cost to provide that capacity would be the most important factors affecting the cost effectiveness of a terminus/MOS option (as opposed to the differing locations of the park-and-ride lots). And as noted in the first bullet, the cost per space could be dependent upon the park-and-ride lot location.

- Third, a project's competiveness for Federal New Starts funding is affected by the cost effectiveness of the project, as defined by the FTA. While in the past, FTA used transit ridership as the measure of effectiveness, as was used in this DEIS, FTA now uses transit travel time savings (i.e. "user benefit" – relative to a baseline alternative) as the effectiveness measure. In general, the use of user benefits, especially in an environment where there would be a greater demand for park-and-ride spaced that would be supplied, accentuates the differences between alternatives, compared to using transit ridership. That is to say, that the general ranking of projects based on their cost effectiveness would tend to stay constant using either cost effectiveness measure, but the gaps in cost effectiveness between the alternatives tends to widen using a user benefit based cost effectiveness measure. Therefore, the use of a ridership-based cost-effectiveness measure is a general indicator of how well different alternatives would compete for Federal New Starts funds, especially in terms or ranking.

Appendix E

2030 No Build and LPA Transit Networks (T-Nets)

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Columbia River Crossing		2030 No Build		2030 LPA	
		2030 CRC NB-30.1		2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No-Build based on reduced C-TRAN Alt 2&3 w/ #44 at 20 min. peak only (349k network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
LIGHT RAIL		peak headway	off-peak headway	peak headway	off-peak headway
01HGAP - Blue Line	LRT - (Hillsboro-Gresham) via cross-mall	6	15	6	15
01PDXB - Red Line	LRT - (PIA-BTC) via cross-mall	15	15	15	15
01I205 - Green Line	LRT - (PCBD / PSU-CTC) via mall	7.5	15	7.5	15
01EXPO-Yellow MAX	LRT- (PCBD / PSU-Expo Center Station) via mall - no Milwaukie extension included	12	15	N/A	N/A
01MAIN-Yellow MAX	LRT- (PCBD / PSU-VANC Lincoln P&R via Main Street) via mall - no Milwaukie extension included	N/A	N/A	N/A	N/A
01VMOS-Yellow MAX	LRT- (PCBD / PSU-VANC Clark College P&R via Washington Street and McLoughlin Blvd) via mall - no Milwaukie extension included	N/A	N/A	7.5	15
01MALL	Off-peak circulator on downtown Portland transit mall	0	15	0	15
COMMUTER RAIL					
01COMR	Commuter Rail (BTC-Wilsonville)	30	N/A	30	N/A
STREETCAR					
01SCNW	Streetcar (NW 23rd-Gibbs / N. Macadam)	N/A	N/A	N/A	N/A
01SCLW	Streetcar (NW 23rd-Gibbs / N. Macadam)	10	10	10	10
01SCOM	Streetcar - Eastside with OMSI terminus	10	15	10	15
TRAM					
01TRAM	Tram (North Macadam-OHSU)	5	5	5	5
TRIMET BUSES					
02GREE	Greeley - (PCBD - UofP)	N/A	N/A	N/A	N/A
02V-PV	Vermont - (PCBD - Vermont / Shattuck)	N/A	N/A	N/A	N/A
02VCBD	Vermont - (PCBD - Vermont / Shattuck)	15	30	15	30
03I-205	I205 - (Gateway to CTC via I205)	N/A	N/A	N/A	N/A
04D-P148D	Division - (PCBD - 148th / Division)	N/A	N/A	N/A	N/A
04D148	Division - (PCBD - 148th / Division)	10	20	10	20
04D-PGL	Division Limited - (PCBD - Gresham TC)	N/A	N/A	N/A	N/A
04DGL	Division Limited - (PCBD - Gresham TC)	10	0	10	0
04D-PGTC	Division - (PCBD - Gresham TC) FB	N/A	N/A	N/A	N/A
04DGTC	Division - (PCBD - Gresham TC) FB	15	20	15	20
04F-PSTJ	Fessenden - (PCBD - St. Johns) FB	8	12	8	12
O6MLKH- Hayd Is via Steel Bridge/MLK	(Collins Cir / Mall / Steel Br. / RQ / MLK / Lombard /Denver / Hayd Isld) QJ Hayden SB to I-5 in Portland (PCBD-Hayden Island)	N/A	N/A	N/A	N/A
O6M703	(Collins Cir / Mall / Steel Br. / RQ / MLK / Lombard / Denver / Hayd Isld on I-5 in Portland (PCBD-Hayden Island)	20	20	20	20
O6M707	(Collins Cir / Mall / Steel Br. / RQ / MLK / Lombard / Denver / Hayd Isld on I-5 in Portland (PCBD-Hayden Island)	20	30	20	30

Columbia River Crossing		2030 No Build 2030 CRC NB-30.1		2030 LPA 2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No Build based on reduced C-TRAN Alt 2&3 w/ #44 at 20 min. peak only ([illegible] network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
07THES-OGCTC	Thiessen - (O.Grove / Concord-CTC)	N/A	N/A	N/A	N/A
08NE15-MID	NE 15th / MLK / Middlefield (PCBD - Middlefield) FB	N/A	N/A	N/A	N/A
08M15	NE 15th / MLK / Middlefield (PCBD - Middlefield) FB	10	12	10	12
08JPVA-PVA	Jackson Park / VA Hospital - (PCBD - VA Hospital) - Only with Tram, otherwise, go to 6/15 FB	N/A	N/A	N/A	N/A
08JVA	Jackson Park / VA Hospital - (PCBD - VA Hospital)	10	12	10	12
09B-P27TH	Broadway - (PCBD - 27th / Saratoga) - via Rose Quarter TC	N/A	N/A	N/A	N/A
09BWY	Broadway - (PCBD - 27th / Saratoga) - via Rose Quarter TC	10	15	10	15
09P98T-P98PWL	Powell/98th - (PCBD - 98th / Powell)	20	30	20	30
09PGL-PGR	Powell/Gresham Limited all the way to Gresham- (PCBD-GreshamTC)	30	0	30	0
09PGTC	Powell/Gresham TC - (PCBD - Gresham TC) FB	20	30	20	30
09PGX-PGR	Powell/Gresham Express - (PCBD - Gresham TC)	N/A	N/A	N/A	N/A
09PGX	Powell/Gresham Express - (PCBD - Gresham TC)	60	0	60	0
10H-P122FSTR	Harold - (PCBD - 122nd / Foster)	N/A	N/A	N/A	N/A
10H	Harold - (PCBD - 122nd / Foster)	12	15	12	15
10T-P33	NE 33rd - (PCBD - 33rd / Sutherland)	N/A	N/A	N/A	N/A
10T	NE 33rd - (PCBD - 33rd / Sutherland)	12	15	12	15
12BARB-PSWDX - Current Line 94(PSWDX (PCBD-	Barbur/Sherwood Express - (PCBD - Sherwood)	N/A	N/A	N/A	N/A
12BARB-PTI	Barbur/Tigard - (PCBD - Tigard TC) FB	N/A	N/A	N/A	N/A
12BARB	Barbur/Tigard - (PCBD - Tigard TC) FB	7.5	0	7.5	0
12BTIG	Barbur/Tigard - (PCBD - Tigard TC)	30	30	30	30
12BSHR	Barbur/Sherwood Local (PCBD - Sherwood)	30	30	30	30
12SG-Gresham	Sandy - (PCBD - Gresham) FB	30	30	30	30
12SP-Parkrose	Sandy - (PCBD - Parkrose)	15	15	15	15
14HS-P94F	Hawthorne Short - (PCBD - 94th / Foster) Not on 172nd FB	7.5	10	7.5	10
14HL - 14HX to Dam. (use route from P/F Study)	Hawthorne Long - (PCBD - Damascus) Not on 172nd	N/A	N/A	N/A	N/A
14HDX	Hawthorne Long - (PCBD - Damascus) Not on 172nd	20	30	20	30
154WILL-OC	Willamette - (Willamette / W. Linn - Oregon City)	N/A	N/A	N/A	N/A
154WLN	Willamette - (Willamette / W. Linn - Oregon City)	60	60	60	60
155S-OTCTC/DAM	Sunnyside/Damascus - (147th / Oregon Trail - CTC)	N/A	N/A	N/A	N/A
155S	Sunnyside/Damascus - (147th / Oregon Trail - CTC)	30	30	30	30
156MR-OTCTC	Mather Rd. - (147th / OregonTrail - CTC)	N/A	N/A	N/A	N/A
156MR	Mather Rd. - (147th / OregonTrail - CTC)	30	30	30	30
157HV-OTCTC	Happy Valley - (147th / Oregon Trail - CTC)	N/A	N/A	N/A	N/A
157HV	Happy Valley - (147th / Oregon Trail - CTC)	60	60	60	60
15MTAB-PRKRS	Belmont / Mt.Tabor / Parkrose via Adventist (PCBD - Parkrose TC) FB	N/A	N/A	N/A	N/A
15BELP	Belmont / Mt.Tabor / Parkrose via Adventist (PCBD - Parkrose TC) FB	4	10	4	10
15TMPK-P27MPK	NW 23rd / Montgomery Park - (PCBD - 27th / Mont. Park) FB	N/A	N/A	N/A	N/A
15TMPK	NW 23rd / Montgomery Park - (PCBD - 27th / Mont. Park) FB	8	10	8	10

Columbia River Crossing		2030 No Build		2030 LPA	
		2030 CRC NB-30.1		2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No Build based on reduced C-TRAN Alt 2&3 w/ #44 at 20 min, peak only ($48k network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
164MT-OHSUTI	Tigard / Marquam Hill - (OHSU - Tigard)	N/A	N/A	N/A	N/A
164MT	Tigard / Marquam Hill - (OHSU - Tigard)	15	N/A	15	N/A
166MH-OHSUHLYWD	Hollywood / Marquam Hill - (OHSU - Hollywood TC)	N/A	N/A	N/A	N/A
166MH	Hollywood / Marquam Hill - (OHSU - Hollywood TC)	15	N/A	15	N/A
16FMID Off-Mall JJ/RP	Front Ave / St. Johns / Marine Dr-(PCBD-Middlefield) via	N/A	N/A	N/A	N/A
16FHI Off-Mall JJ/RP	Front Ave / St. Johns / Hayden Island / Marine Dr - (PCBD-Middlefield) via Fess / Col / Hayden Is Off-Mall JJ/RP	N/A	N/A	N/A	N/A
16FASJ	Front Ave / St. Johns / Marine Dr-(PCBD-Middlefield) via Fess / Col Off-Mall JJ/RP	30	120	30	120
17H136-P136PWL	Holgate - (PCBD - 136th Powell)	10	15	10	15
1721SI-PSI (SLIN)	NW 21st / Sauvie Island - (PCBD - Sauvie Is.)	N/A	N/A	N/A	N/A
17SLIN	NW 21st / Sauvie Island - (PCBD - Sauvie Is.)	20	60	20	60
1721MP-PMPK (SMPK)	NW 21st / Montgomery Park - (PCBD - Montgomery Park)	N/A	N/A	N/A	N/A
17SMPK	NW 21st / Montgomery Park - (PCBD - Montgomery Park)	20	60	20	60
Mall	Hillside - (PCBD - Maclay / Burnside) Off-Mall	N/A	N/A	N/A	N/A
18HILL	Hillside - (PCBD - Maclay / Burnside) Off-Mall	60	N/A	60	N/A
19GLIS-PGT	Glisan - (PCBD - Gateway TC)	N/A	N/A	N/A	N/A
19G	Glisan - (PCBD - Gateway TC)	10	15	10	15
19WRHV	Woodstock/Rex - (PCBD - Rex / Extended to Happy Valley)	10	15	10	15
20BBTC-Gresham	Burnside / Beaverton TC - (BTC - Gresham)	N/A	N/A	N/A	N/A
20B STB	Burnside / Beaverton TC - (BTC - Gresham)	12	15	12	15
22ROSE-PRGT	Parkrose - (Parkrose - Gateway TC)	N/A	N/A	N/A	N/A
22ROSE	Parkrose - (Parkrose - Gateway TC)	45	45	45	45
23SR223-GTGR	San Rafael / 223rd - (Gateway TC - Gresham TC)	N/A	N/A	N/A	N/A
23S223	San Rafael / 223rd - (Gateway TC - Gresham TC)	60	60	60	60
25GLIS-GTRWD	Glisan / Rockwood - (Gateway TC - Rockwood TC)	N/A	N/A	N/A	N/A
25G	Glisan / Rockwood - (Gateway TC - Rockwood TC)	60	60	60	60
27MKTM-GTRWD	Market / Main - (Gateway TC - Rockwood TC)	N/A	N/A	N/A	N/A
27M	Market / Main - (Gateway TC - Rockwood TC)	60	60	60	60
2829LW	28 Linwood interline w/ 29Lake / Webster - (CTC - CTC)	20	30	20	30
30JC-MCTC	Johnson Creek - (MTC via 32nd - CTC)	N/A	N/A	N/A	N/A
30MJC	Johnson Creek - (MTC via 32nd - CTC)	60	60	60	60
30CTCO	Holcomb Rd - (CTC - OC) via Holcomb / Bradley / Gronlund / 212 / 224 / I-205	20	30	20	30
31DAM-MTC	Damascus - (DAM / CTC - MTC) via 212 / 224 / 82nd / King	20	30	N/A	N/A
31MDAM	Damascus - (DAM / CTC - MTC) via 212 / 224 / 82nd / King	N/A	N/A	20	30
31EST-MTC	Estacada - (EST / CTC / MTC) via 212 / 224 / 82nd / King Rd.	20	60	N/A	N/A
31MEST	Estacada - (EST / CTC / MTC) via 212 / 224 / 82nd / King Rd.	N/A	N/A	20	60
32OC-PCBD	Oatfield - (OC - PCBD)	N/A	N/A	N/A	N/A
32OCCC	Oatfield - (OC - PCBD)	20	0	20	0
32OC-MTC	Oatfield - (MTC - OC - Oatfield)	N/A	N/A	N/A	N/A
32OM	Oatfield - (MTC - OC - Oatfield)	0	30	0	30

Columbia River Crossing		2030 No Build		2030 LPA	
		2030 CRC NB-30.1		2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No-Build based on reduced C-TRAN Alt 2&3 w/ #44 at 20 min. peak only (3491 network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
33PM	McLoughlin - (PCBD - MTC)	N/A	N/A	N/A	N/A
33PMOC	McLoughlin - (PCBD - OC)	0	30	0	30
33PMCC	McLoughlin - (PCBD - CCC)	7.5	30	7.5	30
33F-PGTC	Fremont - (PCBD - GTC)	N/A	N/A	N/A	N/A
33FRE	Fremont - (PCBD - GTC)	12	15	12	15
34R152	34 River Rd. interline w/ 152 Milwaukie Shuttle - (OC - CTC)	20	30	20	30
35GREE	Greeley - (PCBD - U of Portland via Greeley)	10	30	10	30
35MAC-POC	Macadam - (PCBD - OC) FB (no service to Canby)	N/A	N/A	N/A	N/A
35MAC	Macadam - (PCBD - OC) FB (no service to Canby)	15	15	15	15
36SS-LOTU	South Shore - (LakeO - Tual - PCBD) to PCBD per JC Equil.	N/A	N/A	N/A	N/A
36TCBD	South Shore - (LakeO - Tual - PCBD) to PCBD	30	N/A	30	N/A
37NS-LBF - New Routing	North Shore - (LakeO - Tual PNR) via Cclub/LowerBoones	N/A	N/A	N/A	N/A
37NSHR	North Shore - (LakeO - Tual PNR) via Cclub/LowerBoones	45	45	45	45
38BOON-PTU (See Line 50TIGTUAL) Term. @ Tigard NOT Tual.	Boones Ferry - (PCBD - Tigard TC) via Kruse / 72nd / Hunziker / Hall	N/A	N/A	N/A	N/A
38BOON	Boones Ferry - (PCBD - Tigard TC) via Kruse / 72nd / Hunziker / Hall	20	30	20	30
39LNC-LCBU	Lewis and Clark - (L&C College - BurlingameTC)	N/A	N/A	N/A	N/A
39L	Lewis and Clark - (L&C College - BurlingameTC)	45	45	45	45
40MOCK-PSTJ	Mocks Crest - (PCBD - St Johns)	N/A	N/A	N/A	N/A
40TAC-PM Off-Mall stay on Macadam/ Moody	Tacoma - (PCBD - MTC) Off-Mall stay on Macadam/Moody	N/A	N/A	N/A	N/A
41TACS	Tacoma - (PCBD - MTC) Off-Mall stay on Macadam/Moody	30	45	30	45
42CMS	Cedar Mill Shuttle - (SunsetTC - CM) - Saltzman / Thompson / 143rd / 107th	N/A	N/A	N/A	N/A
43TFN-PWSQN	Taylors Ferry Nimbus - (PCBD - Wash Sq. / Nimbus)	N/A	N/A	N/A	N/A
43TFN	Taylors Ferry Nimbus - (PCBD - Wash Sq. / Nimbus)	60	N/A	60	N/A
43TF-PWSQ	Taylors Ferry - (PCBD - Wash Sq.)	N/A	N/A	N/A	N/A
43TF	Taylors Ferry - (PCBD - Wash Sq.)	60	30	60	30
44CHWY-PPCCC (formally known as 41CHWY)	Capital Hwy. - (PCBD - PCC Sylvania)	N/A	N/A	N/A	N/A
44CHWY	Capital Hwy. - (PCBD - PCC Sylvania)	10	15	10	15
44M	Mocks Crest - (PCBD - Williams - Willamette - Pier Park)	15	15	15	15

Columbia River Crossing		2030 No Build 2030 CRC NB-30.1		2030 LPA 2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No-Build based on reduced C-TRAN Alt 2&3 w/ #44 at 20 min. peak only (349k network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
45G-PTI	Garden Home - (PCBD - Tigard)	N/A	N/A	N/A	N/A
45G	Garden Home - (PCBD - Tigard)	15	30	15	30
46NH-FHI	North Hillsboro - (WashCo Fairgrounds - Hillsboro)	N/A	N/A	N/A	N/A
46NH	North Hillsboro - (WashCo Fairgrounds - Hillsboro)	45	45	45	45
47BLEV-WC185	Baseline/Evergreen - (Willow Crk / 185th - Hillsboro)	N/A	N/A	N/A	N/A
47BLEV	Baseline/Evergreen - (Willow Crk / 185th - Hillsboro)	30	30	30	30
48CORN-WC185	Cornell Rd. - (Willow Crk. / 185th - Hillsboro)	N/A	N/A	N/A	N/A
48CORN	Cornell Rd. - (Willow Crk. / 185th - Hillsboro)	30	30	30	30
50TIGTUAL (see map)	Tigard - Tualatin (Tig TC - Tual Mhwk) via Com Rail / Lboones / 72nd / Hwy 99W	N/A	N/A	N/A	N/A
51V-PCCPL	Vista - (PCBD - Council Crest - Patrick Place)	N/A	N/A	N/A	N/A
51CCPL	Vista - (PCBD - Council Crest - Patrick Place)	30	N/A	30	N/A
51V-PCCDSH	Vista - (PCBD - Council Crest - Dosch)	N/A	N/A	N/A	N/A
51CDSH	Vista - (PCBD - Council Crest - Dosch)	30	60	30	60
52FARM-F185	Farmington - 185th (BTC - PCC Rock Crk.)	N/A	N/A	N/A	N/A
52FARM	Farmington - 185th (BTC - PCC Rock Crk.)	15	15	15	15
52ORENCO	Orenco	N/A	N/A	N/A	N/A
53ALLN-BA	Artic / Allen - (BTC - Allen / Mercer Ind.)	30	N/A	30	N/A
54BH-PB	Beaverton - Hillsdale Hwy (PCBD - BTC) FB	N/A	N/A	N/A	N/A
54B	Beaverton - Hillsdale Hwy (PCBD - BTC) FB	15	15	15	15
55HAML-PRH	Hamilton - (PCBD - Scholls / Hamilton)	N/A	N/A	N/A	N/A
55HAML-PRH Off-Mall JJ/RP	Hamilton - (PCBD - Scholls / Hamilton) Off-Mall JJ/RP	N/A	N/A	N/A	N/A
55HAMJ	Hamilton - (PCBD - Scholls / Hamilton) Off-Mall JJ/RP	30	N/A	30	N/A
56SF-PWSQ	Scholls Ferry - (PCBD - WashSq.) FB	N/A	N/A	N/A	N/A
56S	Scholls Ferry - (PCBD - WashSq.) FB	20	30	20	30
57FFGV-BFG	Forest Grove - (BTC - Forest Gr.) FB	N/A	N/A	N/A	N/A
57FFGV	Forest Grove - (BTC - Forest Gr.) FB	10	15	10	15
58CANY-PB	Canyon Rd. - (PCBD - BTC)	15	30	15	30
59WPCH-WCSUN	Walker / Parkway / Cedar Hills - (Willow Crk. / 185th -	N/A	N/A	N/A	N/A
59WP	Walker / Parkway / Cedar Hills - (Willow Crk. / 185th -	60	60	60	60
60L	Leahy - (Cornell - SusetTC)	45	N/A	45	N/A
61XMAR-MHB	BTC - Beav. - Hillsdale Hwy - (Marquam Hill/OHSU-BTC)	N/A	N/A	N/A	N/A
61X	BTC - Beav. - Hillsdale Hwy - (Marquam Hill/OHSU-BTC)	30	N/A	30	N/A
62MRBV	Murray Blvd - (WashSq. - Sunset TC)	N/A	N/A	N/A	N/A
62MURR	Murray Blvd - (WashSq. - Sunset TC)	15	30	15	30
63ZOO	Washington Park (PCBD - Zoo)	60	60	60	60
67J158-BPCC	Jenkins / 158th - (BTC - PCC Rock Crk.)	N/A	N/A	N/A	N/A
67J158	Jenkins / 158th - (BTC - PCC Rock Crk.)	30	30	30	30
68CMH-POHSU Off-Mall	Collins Circle - (PCBD - OHSU / VA Hospital) Off-Mall	N/A	N/A	N/A	N/A
68CMH	Collins Circle - (PCBD - OHSU / VA Hospital) Off-Mall	10	N/A	10	N/A
70T13	12th Ave. - (Rose Qtr. - MTC) via 13th	N/A	N/A	N/A	N/A
70T17	12th Ave. - (Rose Qtr. - MTC) via 17th	N/A	N/A	N/A	N/A

Columbia River Crossing		2030 No Build		2030 LPA	
		2030 CRC NB-30.1		2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No Build based on reduced C-TRAN Alt 283 w/ #44 at 20 min. peak only (349k network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
71P122	60th / 122nd - (Woodstock / 94th - CTC) via Parkrose LRT	15	15	15	15
72K82	82nd / Killingsworth - (Swan Is. - CTC) FB	10	12	10	12
74X	SE Portland / Lloyd - (Lloyd Cntr / RoseQtr - Woodstock / 52nd)	30	N/A	30	N/A
75T MTC	39th / Lombard - (St. Johns - MTC) FB	15	15	15	15
76BVTU	Beaverton / Tualatin - (BTC - Tualatin TC) FB	12	15	12	15
77NTRDL	Broadway / Lovejoy - (Troutdale - Montgomery Park)	N/A	N/A	N/A	N/A
77BHTR	Broadway / Lovejoy - (Troutdale - Montgomery Park)	12	15	12	15
78LOTIG (same as today's 78 but terminates at Tigard	Tigard / LakeO - (Tigard TC - Lake Oswego)	N/A	N/A	N/A	N/A
78LOTG	Tigard / LakeO - (Tigard TC - Lake Oswego)	30	60	30	60
79OC (should be same route as today)	CTC / OC - (CTC - Or. City) via Gladstone - South End Loop FB	N/A	N/A	N/A	N/A
79C SOR	CTC / OC - (CTC - Or. City) via Gladstone - South End Loop FB	15	15	15	15
80TTRT	Kane Rd. - (Gresham TC - Troutdale) via Springwater	20	30	20	30
84BOR	Boring	60	N/A	60	N/A
84KEL	Kelso	N/A	N/A	N/A	N/A
84KBOR	Kelso	60	N/A	60	N/A
85SG	Swan Island from Rose Quarter via Interstate/Greeley	20	60	20	60
87R181 - New Routing	181st Ave. - (Alderwood / Damascus) via Airport / 181st /	N/A	N/A	N/A	N/A
87R182	181st / 182nd - (Sandy - Damascus)	30	120	30	120
88H198	198th / Hart - (Willow Crk. / 185th TC - BTC)	30	30	30	30
89RKN	Tanasbourne / North - (Tanasbourne - Sunset TC)	N/A	N/A	N/A	N/A
89TANB	Tanasbourne / North - (Tanasbourne - Sunset TC)	40	60	40	60
89RKS	Tanasbourne / South - (Tanasbourne - Sunset TC)	N/A	N/A	N/A	N/A
89TANC	Tanasbourne / South - (Tanasbourne - Sunset TC)	40	60	40	60
92X	South Beaverton Express - (Murray Hill - PCBD)	N/A	N/A	N/A	N/A
92XJC	South Beaverton Express - (Murray Hill - PCBD)	20	N/A	20	N/A
96TUAL	Tualatin / I-5 - (PCBD - Tualatin)	N/A	N/A	N/A	N/A
96TCOM	Tualatin / I-5 - (PCBD - Tualatin)	20	60	20	60
96WILS	N. Wilsonville / I-5 - (PCBD - N. Wilsonville)	N/A	N/A	N/A	N/A
96T MOH	N. Wilsonville / I-5 - (PCBD - N. Wilsonville)	20	60	20	60
99MX	McLoughlin Express - (PCBD - OC / CCC)	N/A	N/A	N/A	N/A
99PX	McLoughlin Express - (PCBD - OC / CCC)	12	0	12	0
201WILS	SMART / BARBUR	N/A	N/A	N/A	N/A
201WIL	SMART / BARBUR	30	60	30	60
202WIL	SMART / Oregon City	10	30	10	30
203WIL	SMART / Wilsnvle. Rd.	10	30	10	30

Columbia River Crossing		2030 No Build 2030 CRC NB-30.1		2030 LPA 2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No-Build based on reduced C-TRAN All 2&3 w/ #44 at 20 min. peak only (349k network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
204WIL	SMART / Wilsnvle. Rd.	N/A	N/A	N/A	N/A
204CRS	SMART / Wilsnvle. Rd.	10	30	10	30
205CAN	SMART / Canby	60	60	60	60
300 SES	Sandy - Estacada	120	120	120	120
300 SGR	Sandy - Gresham	30	60	30	60
300 SME	Sandy - Rhododendron	60	60	60	60
302MCC	Molalla / CCC	60	60	60	60
302MCN	Molalla / Canby	60	60	60	60
400CAN	Canby (Canby - OCTC)	30	30	30	30
C-TRAN Buses					
C002NS	Lincoln (99TC / 99th / 9th / 78th / Bernie / Lincoln / 39th / Columbia / 16th / Washington / 6th / Return to 99TC via Broadway in VCBD)	45	45	45	45
C003NSA	Clockwise Downtown Circulator (6th / Broadway / Evergreen / Columbia / 8th / Franklin / 11th / Jefferson / 13th / Kauffman / 33rd / Grand / Col House / Col Wy / Columbia / 6th)	45	45	45	45
C003NSB	Counterclockwise Downtown Circulator (Broadway / 6th / Columbia / Col Wy / Col House / Grand / 33rd / Kauffman / 11th / Franklin / 8th / Washington / Evergreen)	45	45	45	45
C004NS	Fourth Plain w/ no Plomondon Loop to Delta Park MAX (Van Mall / Fourth Plain / Main St / McLoughlin / Washington / I-5 / Hayden Is / Delta Park LRT Sta / return via Broadway in VCBD)	15	15	N/A	N/A
C004NSV	Fourth Plain w/ no Plomondon Loop to VCBD (Van Mall / Fourth Plain / Main St / McLoughlin / Washington / 8th / Broadway / return)	N/A	N/A	15	15
C006	Hazel Dell (99TC / Hazel Dell / KigPR / LincPR / Mill DistPR /	N/A	N/A	N/A	N/A
C007BG	Battleground (Van Mall / 4th Plain / 102nd / Covington / 76th / SR503 / 199th / 20th / Main / BGPR / BG Library)	45	45	45	45
C009NS	Felida (99TC / 7th / 101st / 9th / 105th / Hazel Dell / 99th / 21st / 119th / 36th / Seward / Bliss / Hathaway / 139th / Salmon Creek P&R / return via same route)	30	60	30	60
C025NS	St Johns / Fruit Valley (99TC / 99th / Hwy 99 / 88th / 25th / 99th / 50th / St Johns / Ft Vanc Wy / Evergreen / Broadway / 15th / Mill Plain / 4th Pl / Fruit Valley / 61st / return via Washington in VCBD)	25	25	25	25
C030NS	Burton (FLTC / 164th / Tech Ctr / Mill Plain / 192nd / Mill Plain / 172nd / 1st / 162nd / 39th / 138th / 28th / Burton / 25th / Andresen / 18th / Grand / McLoughlin / Washington / 8th / Broadway / return to FLTC)	20	20	20	20
C032NS	Evergreen / Andresen (Van Mall / Van Mall Dr / Andresen / Evergreen / Broadway / Main / Hazel Dell / 94th / 99TC / return via Washington in VCBD)	45	45	45	45

	Columbia River Crossing	2030 No Build 2030 CRC NB-30.1		2030 LPA 2030 CRC T-31.2	
Transit Line Listing		2030 CRC New Starts multimodal No Build based on reduced C-TRAN All 28.3 w/ #44 at 20 min. peak only (348k network)		2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1	
C037HWS	Highway 99 to Washington State U. Vancouver (Interlines w/ C037M) (8th / Broadway / Main / Highway 99 / 99th / 7th / 99TC / 7th / 99th / Hwy 99 / 139th / SCPR / 139th / 29th / Salmon Creek / WSUV / return via Washington in VCBD)	15	15	15	15
C037M	Mill Plain (Interlines w/ C037HWS or C037SC) (FLTC / 164th / Mill Plain / 15th / Washington / 8th / Broadway / return)	15	15	15	15
C039NS	Medical Center (VA Hospital / 4th Plain / Grand / 18th / Brandt / Mill Plain / MacArthur / Lieser / Mill Plain / 87th / 12th / Garrison / return)	60	60	60	60
C041NS	Camas / Washougal Limited to Delta Park MAX Station (Washougal / Camas / SR14 / FLTC / SR14 / 6th / Broadway / Evergreen / Washington / I5 / Delta Park LRT Station / return via I5 / 6th / Broadway / Evergreen / Washington / SR14)	120	0	N/A	N/A
C041NSV	Camas / Washougal Limited to VCBD (Washougal / Camas / SR14 / FLTC / SR14 / 6th / Broadway / Evergreen / Washington / return)	N/A	N/A	120	0
C044NS	Fourth Plain Limited to Delta Park MAX (Ward / 4th Pl / Van Mall / 4th Pl / Ft Vanc Wy / McLoughlin / Washington / I-5 / Delta Park LRT Station / I-5 / return via Broadway in VCBD)	20	0	N/A	N/A
C044NSV	Fourth Plain Limited to VCBD (Ward / 4th Pl / Van Mall / 4th Pl / Ft Vanc Wy / McLoughlin / Washington / 8th / Broadway / return)	N/A	N/A	20	0
C047NS	Battle Ground Limited to Delta Park MAX (Yacolt / BG / SR502 / I5 / Mill Plain / Washington / I5 / Delta Park LRT Station / return via Broadway in VCBD)	120	0	N/A	N/A
C047NSV	Battle Ground Limited to VCBD (Yacolt / BG / SR502 / I5 / Mill Plain / Washington / 8th / Broadway / return)	N/A	N/A	120	0
C065	Parkrose - Fisher's Limited (FLTC / SR-14 / I-205 / Parkrose TC / return)	20	30	20	30
C072E	Orchards (Van Mall / 4th Plain / Ward / Orchards Loop)	60	60	60	60
C078NN	78th St (99PR / Hwy 99 / 78th / Andresen / Van Mall)	60	60	60	60
C080NS	Van Mall to Fishers via 18th Street P&R (Van Mall / 4th Plain / 112th / 18th Street P&R / 18th / 136th / Mill Plain / Park Crest / Blairmont / McGillivary / Village Loop / FLTC)	60	60	60	60
C092	Camas/Washougal (FLTC / Camas / Washougal)	60	60	60	60
C105S	I-5 Express Shortline VCBD to PCBD using 60-ft articulated buses (SB: Evergreen / Washington / I-5 / I-405 / PCBD) (NB: PCBD / I-405 / I-5 / 6th / Broadway / Evergreen)	12	120	N/A	N/A
C105NS	I-5 Express (SB: SCPR / I-5 / 99TC / I-5 / Mill Plain / Washington / I-5 / I-405 / PCBD) (NB: PCBD / I-405 / I-5 / 6th / Broadway / Mill Plain / I-5 / 99TC / I-5 / SCPR)	30	60	N/A	N/A

Columbia River Crossing		2030 No Build 2030 CRC NB-30.1			2030 LPA 2030 CRC T-31.2		
Transit Line Listing		2030 CRC New Starts multimodal No-Build based on reduced C-TRAN All 2&3 w/ 044 at 20 min. peak only (349k network)			2030 CRC New Starts multimodal Build LRT to Clark College based on NB-30.1		
C105NSV	I-5 Express terminating in VCBD (SB: SCPR / I-5 / 99TC / I-5 / Mill Plain / 15th / Mill DistPR / Washington) (NB: 8th / Broadway / Mill Plain / I-5 / 99TC / I-5 / SCPR)	N/A		N/A	30		60
C118NS	18th Street Express (SB: 18th Street PR / I-205 / I-84 / Rose Quarter / PCBD) (NB: PCBD / I-5 / SR-14 / I-205 / 18th Street PR)	30		0	30		0
C134P	Salmon CreekExp PRM to PCBD	25		0	25		0
C157P	BPA to Lloyd Center PRM (Van Mall / BPA / Lloyd Ctr)	60		0	60		0
C164P	Fishers PR Exp PRM to PCBD (return via I-5)	15		0	15		0
C190BPA	Marquam Hill Exp from BPA P&R (BPA P&R / I-5 / Marquam Hill)	60		0	60		0
C199P	99th Express to PCBD	20		0	20		0
C219X	219th Express to PCBD	N/A		N/A	N/A		N/A
C265X	Fishers-Pk Rose Exp.	N/A		N/A	N/A		N/A
C301RQJ	Ridgefield - 99th Street P&R SHRL w/QJ (99PR / Ridgfld)	120		N/A	120		N/A
C302LCQ	La Center-99th PR SHTL w/ QJs (99PR / LaCenter)	120		N/A	120		N/A
C304RLQ	Ridgefield-99th P&R SHRL w/ QJ (99PR / Ridgfld)	N/A		120	N/A		120

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Appendix F

LPA Transit Routing Map

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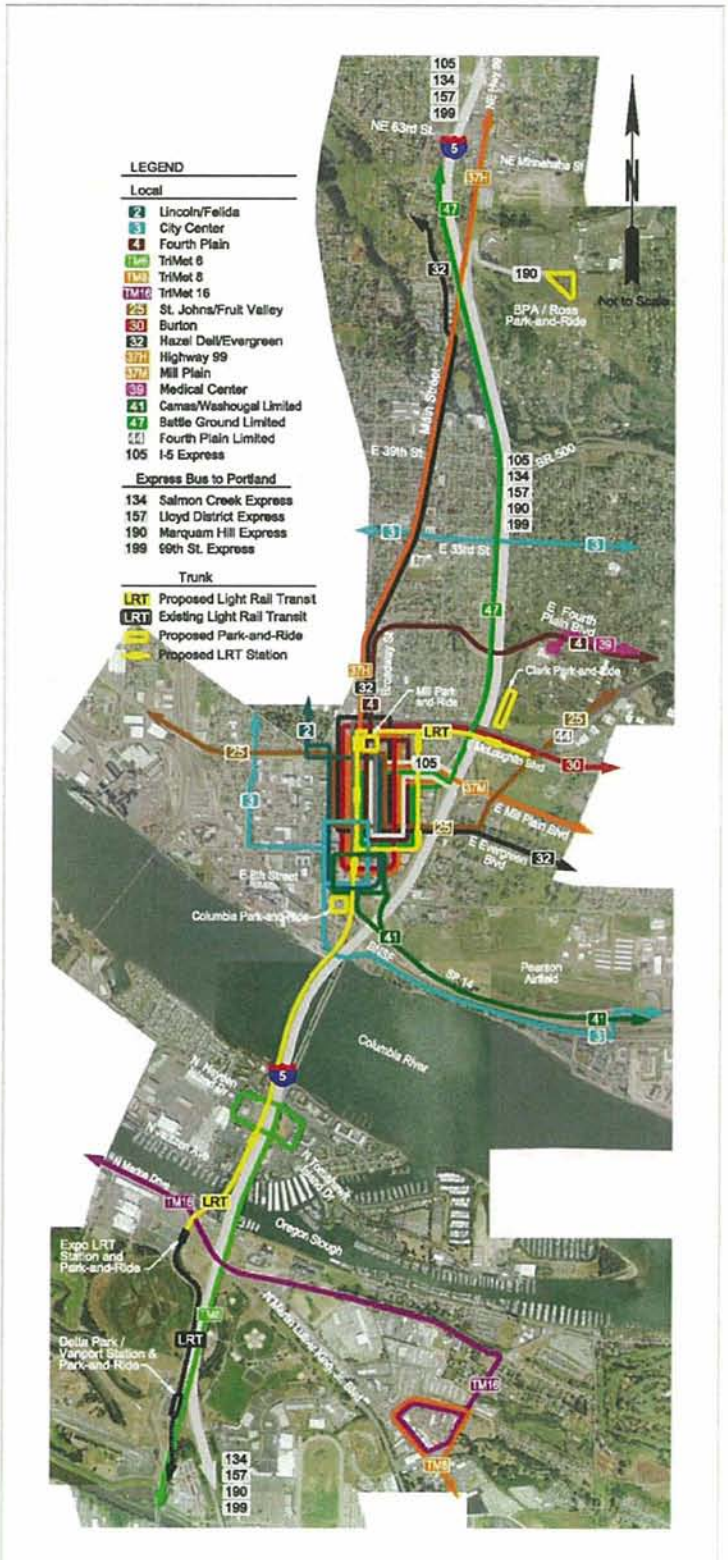
APPENDIX F: Locally Preferred Alternative Transit Routing Map



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Appendix G

2005 TriMet and C-TRAN Transit Networks (T-Net)

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PRELIMINARY

Transit Line	Route Description	Peak Headway	Off-Peak Headway	Line Group
01HGAP	LRT HILLS/GRESHAM	6.5	12	Blue MAX
01NRTH	RQ-EXPO LRT PIR	10	15	Yellow MAX
01PDXB	PDX/BEAVERTON LRT	15	15	Red MAX
01SCRP	SCAR RIVERPLACE-NW	13	13	Other Rail
02GREE	GREELEY	15	30	North Portland TM Bus
02VCBD	VERMONT (TO CBD)	20	30	Other TM Bus
04DGL	DIVISION-GRESHAM LTD	13	0	Other TM Bus
04DGTC	DIVISION	9	15	Other TM Bus
04F	FESSENDEN	13	15	North Portland TM Bus
06MLKV	MLK JR BLVD VANC	10	15	North Portland TM Bus
08JVA	JACKSON PARK/VA	7	15	Other TM Bus
08M15	NE 15TH MIDDLEFIELD	7	15	Other TM Bus
09BWY	BROADWAY	12	15	Other TM Bus
09P98T	POWELL 98TH	30	30	Other TM Bus
09PGL	POWELL GRESHAM LTD	20	0	Other TM Bus
09PGTC	POWELL GRESHAM	18	15	Other TM Bus
10H	HAROLD	11	30	Other TM Bus
10T	NE 33RD AVE.	15	30	Other TM Bus
12BKC	BARBUR/KC TC	30	30	Other TM Bus
12BSHR	BARBUR/SHERWOOD	30	30	Other TM Bus
12SG	SANDY BLVD-GRESHAM	22	30	Other TM Bus
12SP	SANDY BLVD-PARKROSE	17	30	Other TM Bus
14H	HAWTHORNE	5	12	Other TM Bus
14HX	HAWTHORNE EXP	30	0	Other TM Bus
152MCT	MILWSHTL(MTC/CTC)	30	60	Other TM Bus
154WLN	WILL/WLINN SHUTTLE	30	60	Other TM Bus
155S	SUNNYSIDE	60	60	Other TM Bus
156MR	MATHER RD.	60	60	Other TM Bus
157HV	HAPPY VALLEY	60	60	Other TM Bus
15B60	BELMONT TO 60TH AVE	30	0	Other TM Bus
15B92	BELMONT TO 92ND AVE	30	0	Other TM Bus
15BELP	BELMONT TO PARKROSE	6	15	Other TM Bus
15THUR	23RD THURMAN/GORDON	30	30	Other TM Bus
15TMPK	23RD AVE MONTG PARK	30	30	Other TM Bus
16FA	FRONT AVE.	30	0	North Portland TM Bus
17H136	HOLGATE	10	15	Other TM Bus
17S35Y	NW 21ST/35TH YEON	20	0	Other TM Bus
17SLIN	NW 21ST/LINNTON	30	30	Other TM Bus
17SMPK	NW 21ST/MONTG PARK	30	30	Other TM Bus
18HILL	HILLSIDE	60	0	Other TM Bus
19G	GLISAN GATEWAY	10	15	Other TM Bus
19W	WOODSTOCK	30	30	Other TM Bus
19WR	WOODSTOCK/REX	20	30	Other TM Bus
201BAR	SMART/WILS BARBUR	0	60	Other TM Bus
201BTC	WILS-COM-TUAL-BARBUR	30	0	Other TM Bus
203COM	SMART/WILS COMMERCE	30	0	Other TM Bus
204CRS	SMART/WILS CROSSTOWN	30	60	Other TM Bus
205CAN	SMART/WILS CANBY	60	60	Other TM Bus
20BSTB	BURNSIDE-STARK/BEAV	15	30	Other TM Bus
20BSTN	BURNSIDE-STARK/23RD	0	30	Other TM Bus

22ROSE	PARKROSE	30	30	Other TM Bus
23SRAF	SAN RAFAEL/148TH	60	60	Other TM Bus
25G	GLISAN-ROCKWOOD	60	60	Other TM Bus
27M	MARKET-MAIN	60	60	Other TM Bus
28LINW	LINWOOD	30	60	Other TM Bus
29LAKE	LAKE-WEBSTER	30	60	Other TM Bus
300SES	SANDY-ESTACADA	60	60	Other TM Bus
300SGR	SANDY-GRESHAM	30	60	Other TM Bus
300SME	SANDY-RHODODENDRON	60	60	Other TM Bus
301COC	CANBY/OREGON CITY	20	30	Other TM Bus
302MCC	MOLALLA/CCC	60	60	Other TM Bus
302MCN	MOLALLA/CANBY	60	60	Other TM Bus
31CM	MILW TC/CLACKTC	0	60	Other TM Bus
31CTC	CLACKAMAS TC	30	0	Other TM Bus
31E	ESTACADA LOCAL	60	0	Other TM Bus
31EL	ESTACADA LTD	60	0	Other TM Bus
31EM	MILW-ESTACADA LOCAL	0	60	Other TM Bus
31EX	ESTACADA EXP	60	0	Other TM Bus
32CCOC	CCC-OREGON CITY	0	60	Other TM Bus
32OCCC	OATFIELD/CCC	15	0	Other TM Bus
32OMIL	OATFIELD/CCC-MILW	0	60	Other TM Bus
33FRE	FREMONT/GATEWAY	15	30	North Portland TM Bus
33MCCC	MCLOUGHLIN CLACK CC	30	0	Other TM Bus
33MGCC	MCL-CCC VIA GLADSTN	30	30	Other TM Bus
33MGLD	MCLOUGH ORC-CBD-GLD	0	30	Other TM Bus
34CH	CLACKAMAS HEIGHTS	60	60	Other TM Bus
34RCBD	RIVER ROAD	60	60	Other TM Bus
35MAC	MACADAM/OREGON CITY	15	30	Other TM Bus
36TCBD	TUAL/PTLD CBD	30	0	Other TM Bus
36TULO	TUAL/LAKE OSWEGO	0	60	Other TM Bus
37NSHR	TUALATIN	45	45	Other TM Bus
38BK	BOONES FRY_KRUSE	30	0	Other TM Bus
39L	LEWIS & CLARK	30	30	Other TM Bus
40M	MOCKS CREST	15	30	North Portland TM Bus
41TACM	TACOMA/MCLOUGHLIN	30	45	Other TM Bus
43TFJL	TAYLOR FY/JOHNS LAND	30	30	Other TM Bus
43TFNM	TAYLOR FY/NIM-CBD-WS	30	0	Other TM Bus
43TFWS	TAYLOR FY/WS-CBD-WS	0	60	Other TM Bus
44CHWY	CAPITOL HWY	12	15	Other TM Bus
45G	GARDEN HOME	30	30	Other TM Bus
45GX	GARDEN HOME EXP	60	0	Other TM Bus
46NH	NORTH HILLSBORO	44	40	Other TM Bus
47BLEV	BASELINE /EVERGREEN	30	30	Other TM Bus
48CORN	CORNELL	30	30	Other TM Bus
51CCPL	COUNCIL CREST/PAT PL	0	60	Other TM Bus
51CDPD	COUNCIL CR/PAT-DOSCH	30	0	Other TM Bus
51CDSH	COUNCIL CREST/DOSCH	0	60	Other TM Bus
52O	FARMINGTON (185TH)	17	17	Other TM Bus
53ALLN	ARCTIC/ALLEN SHUTTLE	35	0	Other TM Bus
54B	B-H HWY	20	30	Other TM Bus
55HAML	HAML/78TH/BRENTWD	30	0	Other TM Bus
56S	SCHOLLS FERRY RD.	15	30	Other TM Bus

57FFGV	FOREST GROVE	15	15	Other TM Bus
58CANY	CANYON ROAD/BVTC	17	30	Other TM Bus
59WP	WALKER/PARK WAY	30	60	Other TM Bus
60L	LEAHY RD	30	0	Other TM Bus
61X	MH/BVTN	33	0	Other TM Bus
62MURR	MURRAY BLVD	20	30	Other TM Bus
63WSYL	CBD-WASH PARK-SYLVAN	60	60	Other TM Bus
64MT	MARQ HILL TIGARD	33	0	Other TM Bus
65MBAR	MARQ HILL BARBUR	30	0	Other TM Bus
66MH	MARQ HILL HOLLYWOOD	33	0	Other TM Bus
67J158	BVTC/JENKINS/PCC	30	30	Other TM Bus
68CMH	COLLINS CIR/MAR. HL	15	0	Other TM Bus
70T13	12TH AVE VIA 13TH	27	30	Other TM Bus
70T17	12TH AVE VIA 17TH	27	30	Other TM Bus
71T122	60TH-122ND	15	15	Other TM Bus
72K82	KILLINGSWORTH/82ND	8	10	North Portland TM Bus
74X	LLOYD/SE WOODSTK	30	0	Other TM Bus
75TMTC	39TH/LOMBARD (MTC)	11	14	North Portland TM Bus
76BVTU	BEAV/TUALATIN	30	30	Other TM Bus
77BHTR	BWAY/HALSEY TROUTDL	17	17	Other TM Bus
78BVLO	BEAV/LAKE OSWEGO	30	30	Other TM Bus
79CORC	CLACK TC-OREGON CITY	0	60	Other TM Bus
79CSOR	CLACK TC-SOUTH END	30	60	Other TM Bus
80TTRT	GRESHAM-TROUTDALE RD	60	60	Other TM Bus
81T257	TROUTDALE VIA 257TH	60	60	Other TM Bus
82E183	EASTMAN PKWY/182ND	60	60	Other TM Bus
83PARK	PARK BLOCKS	30	30	Other TM Bus
84BOR	BORING	60	0	Other TM Bus
84KEL	KELSO	60	0	Other TM Bus
85SG	SWANISL GREELEY/RQ	20	20	Other TM Bus
86ALD	ALDERWOOD	30	0	Other TM Bus
87A181	AIRPORT WAY/181ST	30	0	Other TM Bus
88H198	HART/198TH	30	30	Other TM Bus
89TANB	TANASBOURNE BRONSON	40	60	Other TM Bus
89TANC	TANASBOURNE CORNELL	40	60	Other TM Bus
92X	S BVTN EXP	24	0	Other TM Bus
94X	SHERWOOD PACIFIC EXP	10	0	Other TM Bus
95X	TIGARD EXP	25	0	Other TM Bus
96TCOM	TUAL/COMMERCE CIR	13	60	Other TM Bus
96TMOH	TUAL/MOHAWK	30	60	Other TM Bus
99PX	PCBD-MCLOUGHLIN EXP	12	0	Other TM Bus
C001	Fruit Valley	30	30	CTRAN Local
C002	Lincoln/Felida	45	45	CTRAN Local
C003A	Kauffman-Columbia	40	40	CTRAN Local
C003B	Columbia-Kauffman	40	40	CTRAN Local
C004	Fourth Plain	15	15	CTRAN Local
C006	Hazel Dell	35	35	CTRAN Local
C007	Battle Ground	45	45	CTRAN Local
C025	St. Johns	30	30	CTRAN Local
C030	Burton	30	30	CTRAN Local
C032	Evergreen	30	30	CTRAN Local
C037	Mill Plain	15	15	CTRAN Local

C039	Clark Col/Med Center	60	60	CTRAN Local
C071	Highway 99	15	15	CTRAN Local
C072	Orchards	48	48	CTRAN Local
C076	NE 63RD Eastridge	48	48	CTRAN Local
C078	78th St	60	60	CTRAN Local
C080	Van Mall/Fishers	38	38	CTRAN Local
C092	Camas/Washougal	30	30	CTRAN Local
C105X	I5 EXP	12	50	CTRAN I-5
C114X	Camas/Washougal Exp	60	0	CTRAN I-5
C134X	Salmon Creek Express	14	0	CTRAN I-5
C157L	BPA/Lloyd Cntr LTD	45	0	CTRAN I-5
C164X	Fishers Landing Exp	13	0	CTRAN I-205
C165X	Parkrose Exp	18	30	CTRAN I-205
C173L	Battle Ground LTD	60	0	CTRAN I-5
C177X	Evergreen Exp	25	0	CTRAN I-205
C190X	Marquam Hill Exp	60	0	CTRAN I-5

Appendix H

2008 C-TRAN Bus Network (T-Net)

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Columbia River Crossing Project — 2008 C-TRAN System

Transit Line Listing		Updated to match Feb. 2008 Service Change and No-Build Highway		
C-TRAN Buses				
C001LMI	Fruit Valley (Mill Dist / Fruit Vly Rd / Lakeside Mobile Estates) Interline w/ #25NN for NA-3 Only	30		30
C002NN	Lincoln (Columbia / 39th / Lincoln / Bernie / 78th / 9th / 99PR)	40		40
C003C	Kauffman-Columbia (Clockwise Grand / 33rd / Kauffman) No	40		40
C003CC	Columbia- Kauffman (Counterclockwise of C003C Route)	40		40
C004PIR	Fourth Plain Service Redesign (Van Mall / 4th Plain / Main/Broadway / Mill D/7th St / I-5 / Hayden Is. / PIR)	15		15
C004PIRX	Fourth Plain Ltd Service Redesign (Ward Rd / Van Mall / 4th Plain / Ft Vanc Wy / McLoughlin / WA / I-5 / PIR)	25		0
C006NN	Service Redesign: Hazel Dell to Evergreen (99TC / 94th / Hazel Dell / Main / Mill Dist / Broadway / Evergreen / Interline w/ #32 at Evergreen&C St)	30		30
C007LIB	Battleground (Van Mall / Central Co / SR503 / BGPR / BG Library)	45		45
C009BY	Felida Circulator	60		60
C019BY	99th Street - WSU	30		30
C025NN	St. Johns (Evergreen&Broadway / CCPR / St. Johns / 99PR) Interline w/ #1LMI in NA-3 Only	30		30
C030M	Burton (FLTC / 164th / Columbia Tech Ctr / 162nd / 39th / 28th / Burton / Andresen / 18th / McLoughlin / Clk Col PR / Mill Dist / Evergreen / Ft Vanc Wy)	30		30
C032	Evergreen/Andresen (Van Mall / Van CBD) Interline with #6	30		30
C037CC	Mill Plain (7th Street / Broadway / Mill Plain / CCPR / Hudson Bay HS / 164th / FLTC) Interline w/ #71NN	20		20
C039	Clark College / Medical Center (Evergreen / Washington / 8th / Broadway / Evergreen / Ft Vanc Wy / VA Hosp / 4th Plain / Grand / 18th / Brandt / Mill Plain / MacArthur / Lieser / Mill Plain / 87th / 12th / Garrison)	60		60
C071NN	Highway 99 (7th Street / Broadway / Main / Hwy 99 / KigPR / 99PR / SCPR) Interline w/ #37CC	20		20
C072E	Orchards (Van Mall / 4th Plain / Ward / Orchards Loop)	60		60
C078NN	w/ #80E	60		60
C080E	Van Mall to Fishers (VanMall / 4th Plain / 112th / 28th / Evgrn PR / Mt. View HS / FLTC) Interline w/ #78NN	30		30
C092	Camas/Washougal (FLTC / Camas / Washougal)	30		30

Columbia River Crossing Project

2008

C-TRAN System

Transit Line Listing		Updated to match Feb. 2008 Service Change and No-Build Highway		
C105CP	I-5 Express w/99th St QJ and DT couplet (SB: SCPR / I-5 / 99TC / I-5 / Mill Plain / Mill DistPR / Washington / I-5 / I-405 / PCBD) (NB: PCBD / I-405 / I-5 / 6th / Broadway / Mill DistPR / 16th / Main / Mill Plain / I-5 / 99TC / I-5 / SCPR)	15		45
C114PIR	Camas/Washougal LTD to PIR (SR14 / FLTC / 7th Street / PIR) QJ	120		0
C134P	Salmon CreekExp PRM to PCBD	10		0
C157P	BPA to Lloyd Center PRM (Van Mall / BPA / Lloyd Ctr)	60		0
C164P	Fishers PR Exp PRM to PCBD (return via I-5)	15		0
C173PIR	Battle Ground Express to PIR via VCBD (Yacolt / BG / 219PR / KigPR / Mill Dist / 7th Street / PIR)	120		0
C177P	Evergreen PR to PCBD (return via I-5, SR 14)	30		0
C190P	Marquam Hill Express PRM (Kmart / BPA / Marq Hill)	30		0
C199P	99th Express to PCBD	10		0
C265X	Fishers-Pk Rose Exp.	20		30
C301RDG	Ridgefield - 99th Street P&R SHRL (99PR / Ridgfld)	90		N/A
C302LC	La Center - 99th Street P&R SHTL (99PR / LaCenter)	90		N/A
C304RLC	Ridgefield - 99th Street P&R SHRL (99PR / Ridgfld)	N/A		240

Appendix I

District to District Travel Demand Reference Map and Travel Demand Tables for the 2030 No Build and the LPA

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Appendix I:
District to District Travel Demand Reference Map and Tables for the 2030 No Build and the 2030 LPA

The Metro travel demand model forecasts trips between the districts in the corridor to determine travel demand differences for different alternatives in the year 2030. On the following page, the CRC Project Corridor District Reference Map shows the districts analyzed.

The following six tables summarize the Metro travel demand model district to district travel for the 2030 No Build and the 2030 LPA. Table A-1 and Table A-2 show the total person trip demand for the two alternatives, Table A-3 and Table A-4 show the transit work trip demand, and Table A-5 and Table A-6 show the total transit trip demand.

Total Person Trip Demand

Total person trip demand indicates the total number of people wanting to travel by automobile, transit, bike and walk between two areas. The person trip demand Table A-1and Table A-2 compare the total demand for trips in 2030 with the No Build scenario versus if the LPA is implemented.

Transit Work Trip Demand

Transit work trips are those transit trips that begin or end at work. Table A-1 and Table A-2 show the trip tables for transit work trips by district for the 2030 No Build Alternative and the LPA.

Total Transit Trip Demand

Total transit trips included both work- and non-work trips using transit. Table A-5 and Table A-6 show total transit trips for the 2030 No Build Alternative and for the LPA.

CRC Project Corridor District Reference Map

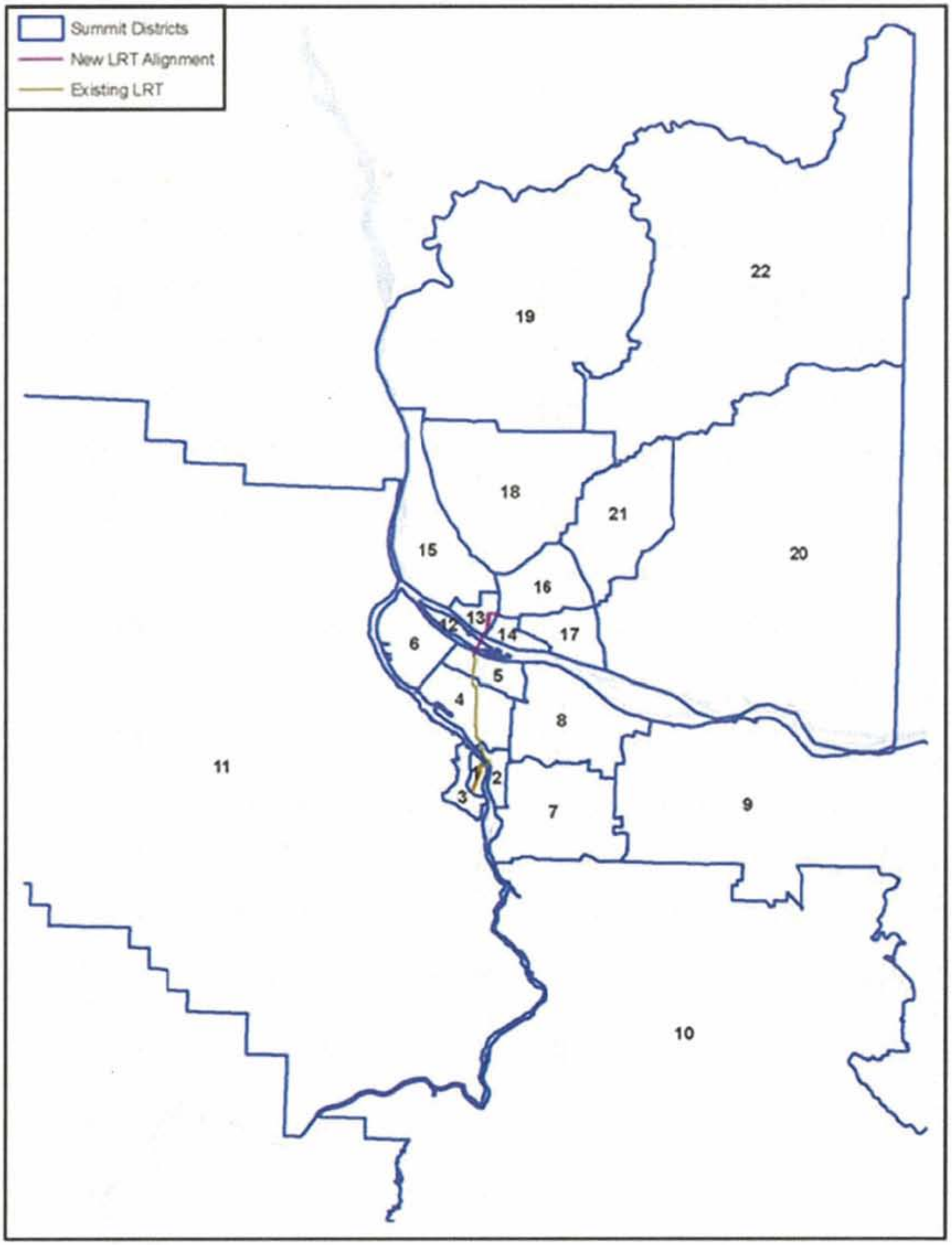

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Table A-1. No-Build Total Person Trip Demand by District, 2030 Average Weekday

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Sum
1	269626	36701	58713	10280	941	1147	23015	10579	3931	5695	51579	706	956	454	165	563	674	793	169	1203	642	157	478687
2	35240	59427	13500	9496	891	797	26427	12309	3905	5171	17918	710	627	310	116	418	480	559	118	913	471	114	189918
3	83702	17800	81908	6453	691	871	14934	6657	2644	4269	60576	604	660	331	133	462	567	680	144	914	540	134	285675
4	32878	35237	17824	76239	7042	8994	20873	25288	6476	5401	30260	4446	1830	913	399	1375	1403	1553	299	1772	1148	271	281972
5	1341	1993	1101	3397	2245	431	1708	2539	905	526	1996	690	569	265	105	408	476	477	80	515	344	78	22190
6	3339	4120	2858	10951	1203	12853	2981	3693	1414	963	7799	1279	797	400	161	593	601	710	145	817	539	138	58356
7	63460	68363	30164	18261	2897	2700	285767	69336	53341	83559	55022	1316	933	574	234	928	1938	1337	315	4153	1833	364	746801
8	34696	42450	17637	26395	4858	3365	72037	131369	42522	20100	28820	2131	1573	1029	360	1931	4099	2260	552	8564	3556	671	450986
9	23374	27044	13509	13405	3688	3223	95156	84571	673704	105471	24554	1447	1304	1103	353	1552	3367	2288	537	7354	3289	629	1090923
10	30831	30139	18476	10982	2470	2238	122207	44344	168221	1188308	136393	847	830	554	224	907	1878	1204	296	4144	1902	337	1767702
11	163353	57613	154919	34674	4173	9147	61021	28608	14797	94540	3876111	2305	2589	1345	642	1885	2397	2745	576	3998	2285	507	4520237
12	751	1420	852	2239	589	423	1012	1299	490	298	1426	5273	999	436	152	654	674	660	88	635	467	87	20924
13	831	738	562	1292	340	324	647	954	491	281	1073	1006	30590	6079	3583	6721	5487	6666	758	5336	3928	642	78390
14	544	552	397	887	218	242	492	774	425	233	784	482	7959	8606	1247	6336	4387	3804	528	4438	2921	443	46700
15	493	481	380	809	220	256	429	665	360	191	811	391	8336	2400	5438	3680	3129	7429	846	3119	3133	601	43599
16	1822	1568	1241	2751	723	878	1642	2835	1637	825	2642	1156	13440	10930	3404	43697	21977	13628	1782	14260	15211	1640	159689
17	1222	1156	930	1971	520	642	2090	3877	2443	1206	2022	669	7805	5564	1985	16752	61614	10066	1674	31772	18379	1762	176121
18	4520	3701	3186	5580	1776	2275	3895	6888	3969	1886	6666	2106	27985	10945	11085	20713	22856	212579	24545	29950	51929	19985	479021
19	1011	953	792	1471	492	614	1099	2188	1213	520	1476	545	7008	2929	2859	4757	6782	38973	118885	11495	14609	21940	242614
20	5697	5255	3811	7975	1934	2427	10397	20367	12213	5756	7615	1912	20946	18810	6107	25502	55184	35863	11247	502637	79960	25778	867391
21	2066	1923	1540	2892	887	1124	3234	6163	3880	1844	3215	984	12077	6913	4287	19041	37978	45643	7404	54325	138862	26746	383029
22	760	698	571	1043	365	460	1017	2162	1232	522	1064	352	4277	1885	1742	4026	6113	26432	17561	17806	32603	127780	250469
Sum	761557	399423	424871	249443	39170	55433	752080	467465	1000214	1527567	4319820	31359	154089	82776	44781	162901	244064	416349	188551	710119	378557	230805	**12641394**

Table A-2. LPA Total Person Trip Demand by District, 2030 Average Weekday

DISTRICT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Sum
1	274599	36567	57765	9975	908	1105	21882	10109	3722	5426	49801	895	1041	472	174	593	694	838	182	1127	645	165	478686
2	35217	60821	13331	9403	857	790	26065	12028	3755	4936	17751	708	663	321	121	433	486	590	126	869	461	118	189918
3	83451	17783	82489	6489	699	871	14724	6545	2565	4219	60483	687	676	338	138	479	580	726	157	872	559	144	285675
4	31568	35588	17900	77166	6927	9019	20197	25051	6310	5158	30525	4907	2120	1028	423	1420	1451	1700	316	1732	1184	283	281972
5	1309	1956	1107	3346	2282	428	1682	2513	894	503	2018	809	589	277	106	401	469	498	83	495	344	80	22190
6	3141	4075	2860	10687	1178	13515	2861	3599	1377	910	7929	1267	831	416	163	591	596	743	149	782	546	142	58356
7	60387	68126	29740	17947	2839	2685	290858	69149	53707	82401	54783	1493	988	632	245	937	1934	1359	309	4110	1816	355	746801
8	32721	42397	17146	26182	4866	3377	71460	135459	42450	19266	28459	2298	1677	1132	376	1958	4132	2314	539	8565	3550	663	450985
9	21235	25310	12760	12744	3620	3157	92855	83384	681744	106291	23929	1663	1405	1299	376	1571	3379	2404	523	7369	3284	620	1090923
10	28180	28841	17920	10498	2372	2153	118399	42977	168902	1200491	133979	941	857	586	231	892	1828	1181	281	4030	1840	321	1767702
11	155926	57350	152222	34874	4240	9270	59560	28081	14287	92736	3889581	2762	2658	1449	673	1933	2398	2957	629	3763	2347	540	4520236
12	1134	1262	949	2234	585	410	1020	1331	525	307	1606	5215	900	416	140	552	563	624	83	559	430	81	20924
13	914	848	595	1332	367	322	656	967	478	271	1126	913	29726	5996	3580	6787	5618	6972	787	5465	4008	664	78390
14	563	577	412	880	233	233	483	762	408	220	810	444	7420	8572	1265	6410	4519	3970	551	4519	2987	461	46700
15	636	589	432	964	259	266	469	712	361	194	898	418	7224	2451	5417	3941	3532	6899	805	3345	3184	604	43599
16	2201	1771	1358	3057	797	883	1655	2808	1531	766	2848	1073	12832	10782	3340	43629	22747	12590	1743	14398	15234	1646	159689
17	1646	1369	1019	2405	599	656	2144	3899	2363	1157	2138	719	6433	5654	1925	17139	62285	8880	1550	31879	18487	1773	176121
18	5102	4376	3663	6685	1967	2472	4038	6987	3766	1787	7778	2053	25457	11106	10745	20842	23156	210005	24418	29880	52437	20302	479021
19	1209	1158	951	1782	552	694	1098	2113	1103	468	1820	509	6633	2983	2761	4621	6442	37804	120195	11073	14463	22179	242613
20	5553	5088	3801	8308	1949	2464	9866	19474	11619	5319	7711	1686	20434	18421	6216	24883	54304	36610	11366	505042	81146	26130	867390
21	2723	2277	1791	3747	1044	1233	3270	6126	3695	1731	3711	1077	11785	6873	4032	19838	40098	40599	6933	54563	138831	27003	383028
22	912	820	681	1239	403	518	999	2108	1155	478	1302	323	4064	1875	1681	3878	5971	25779	17690	17680	32587	128323	250469
Sum	750326	398950	420892	251942	39545	56520	746243	466182	1006717	1535096	4330986	32863	146418	83081	44130	163729	247182	406039	189414	712116	380421	232599	**12641391**

Table A-3. No-Build Transit Work Trip Demand by District, 2030 Average Weekday

DISTRICT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Sum
1	8214	1049	2039	507	81	99	640	406	213	291	3246	18	19	7	3	6	7	5	1	9	4	0	16863
2	2342	1055	538	301	53	54	493	309	152	199	879	16	5	2	1	2	2	2	0	3	1	0	6409
3	5163	551	1278	242	40	48	315	212	106	136	2178	11	9	3	1	3	3	3	1	4	2	0	10310
4	5061	1237	988	827	127	166	466	441	198	218	1183	47	15	4	1	5	5	3	1	5	3	0	11001
5	109	23	21	14	6	4	8	8	5	5	22	1	1	0	0	0	0	0	0	0	0	0	229
6	554	133	117	90	14	56	40	43	17	18	122	6	2	0	0	0	1	0	0	0	0	0	1213
7	13037	3929	2768	915	165	160	3330	1751	1187	2055	3112	46	23	6	2	7	10	6	1	17	5	1	32533
8	6984	1962	1320	553	110	100	1020	1099	644	599	1484	27	11	3	1	3	5	3	1	11	2	0	15942
9	8030	2989	1761	478	104	90	1451	1446	2277	1076	1249	29	14	3	1	3	5	3	1	10	2	0	21022
10	8291	2287	1788	340	67	52	1508	864	609	2909	1815	16	11	2	1	2	3	2	0	7	1	0	20574
11	25330	2513	7454	607	95	102	946	556	252	563	24749	22	31	6	2	6	7	5	1	7	3	0	63257
12	100	29	20	14	3	3	8	8	4	4	20	2	1	0	0	0	0	0	0	0	0	0	218
13	319	74	63	36	7	8	22	20	10	12	56	8	31	24	11	29	38	27	5	30	14	2	846
14	206	45	39	21	4	5	14	13	6	8	34	4	56	28	6	18	23	13	3	22	8	1	578
15	176	34	37	12	3	3	9	7	3	4	24	3	54	11	9	13	16	19	4	13	6	1	461
16	742	173	166	85	18	18	53	47	21	28	125	20	261	70	25	97	114	61	13	82	49	7	2275
17	323	69	90	29	7	6	21	22	10	12	48	8	141	30	11	45	76	33	7	58	22	3	1074
18	1137	205	326	58	16	10	57	37	18	23	143	15	369	63	31	80	84	148	33	72	32	5	2962
19	266	55	104	12	4	2	14	9	4	5	29	4	127	19	9	25	23	50	13	19	9	1	803
20	1943	445	434	90	22	16	181	205	100	102	278	22	530	119	36	148	196	69	12	418	58	8	5434
21	496	97	159	33	9	6	24	19	8	12	60	8	166	29	13	47	51	38	12	34	47	12	1382
22	211	45	82	15	4	3	12	8	3	5	24	4	115	16	9	26	28	33	3	18	23	18	706
Sum	89035	18998	21592	5279	960	1009	10633	7529	5847	8282	40880	339	1994	447	173	566	701	522	112	840	292	62	216093

Table A-4. LPA Transit Work Trip Demand by District, 2030 Average Weekday

DISTRICT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Sum
1	8635	1026	1951	472	77	91	604	393	201	271	3054	28	29	10	4	9	10	7	2	9	5	1	16889
2	2431	1098	526	290	49	52	477	298	144	187	849	18	9	3	1	2	3	2	0	3	2	0	6445
3	5306	539	1261	236	40	47	309	208	101	131	2085	16	14	5	2	4	5	4	1	4	2	0	10317
4	5107	1282	1029	836	129	166	481	464	201	216	1229	69	41	9	3	9	11	8	1	8	4	1	11305
5	115	24	23	15	8	4	9	9	5	5	25	2	2	0	0	0	0	0	0	0	0	0	250
6	542	134	119	85	14	59	40	43	17	17	126	8	5	1	0	1	1	1	0	1	0	0	1213
7	12729	3865	2752	898	166	156	3357	1753	1183	1988	3075	70	43	11	4	10	15	9	2	20	7	1	32112
8	6797	1926	1308	542	110	99	1017	1127	635	575	1448	43	29	7	2	6	9	5	1	13	4	0	15703
9	7431	2794	1701	470	107	88	1433	1425	2285	1053	1196	49	33	6	2	6	8	5	1	12	3	0	20114
10	7702	2188	1754	332	68	50	1495	860	619	291	1784	28	23	4	1	4	5	3	0	8	2	0	19842
11	24481	2503	7353	601	99	103	937	557	246	552	24310	44	51	10	4	9	10	9	1	8	4	0	61892
12	159	34	32	21	4	5	13	11	6	6	32	3	2	0	0	1	1	0	0	1	0	0	332
13	398	126	92	72	16	15	39	35	16	17	90	13	31	29	13	34	45	35	7	37	17	3	1180
14	261	78	56	38	8	8	22	19	9	10	53	7	57	31	7	21	27	17	4	25	10	2	770
15	340	94	66	42	9	8	23	19	9	11	59	7	47	12	9	16	23	20	4	22	8	2	851
16	1247	360	262	180	39	37	97	80	37	48	241	31	288	73	28	102	122	67	15	94	54	9	3513
17	903	237	177	130	28	26	52	42	22	33	161	22	141	37	16	50	79	38	9	63	24	5	2297
18	1878	506	472	233	51	44	128	96	43	54	329	38	379	77	33	98	113	156	44	109	38	7	4928
19	265	62	114	24	6	4	13	9	3	4	30	5	83	13	6	16	15	34	13	12	6	1	737
20	2046	467	482	179	45	35	175	194	92	95	319	38	520	113	36	140	189	73	13	402	57	9	5719
21	1561	437	328	236	51	45	96	73	37	57	278	39	371	53	28	75	71	39	12	55	52	14	4007
22	236	61	95	29	8	5	13	10	4	5	29	6	85	13	7	21	24	23	2	15	22	18	732
Sum	90570	19841	21954	5962	1135	1147	10830	7729	5914	8252	40803	585	2281	517	206	635	786	553	133	922	321	72	221149

Table A-5. No-Build Total Transit Trip Demand by District, 2030 Average Weekday

DISTRICT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Sum
1	28795	4938	7730	1334	146	154	2325	1409	561	831	7660	51	72	15	6	24	29	24	2	32	8	1	56747
2	8066	4484	1677	838	102	86	2451	1265	480	616	2025	64	25	6	2	10	11	8	1	14	4	0	22294
3	16031	2003	5232	551	65	70	1194	640	257	327	5357	29	32	8	3	12	14	12	1	13	5	0	31857
4	10486	4410	2254	4847	369	530	1987	1964	531	555	2433	278	78	20	6	39	41	21	1	25	11	1	30887
5	288	130	67	132	35	11	63	69	23	20	74	15	14	3	1	7	8	4	0	4	2	0	968
6	1004	429	252	642	43	437	183	183	52	49	284	44	12	3	1	5	5	3	0	3	1	0	3637
7	24952	3985	5260	2102	242	214	18716	5492	3447	6569	5195	99	54	23	5	22	36	26	2	56	13	1	82508
8	13003	5400	2620	2003	200	162	4637	6069	2031	1692	2491	80	32	14	2	16	27	13	1	57	3	1	40620
9	11035	4744	2486	1059	131	106	4078	3269	3818	2272	1640	44	26	17	2	10	16	15	1	30	6	1	40805
10	10825	3511	2372	566	80	61	4122	1547	1449	14680	2674	24	22	6	1	7	12	8	1	18	4	0	41991
11	46064	5023	14307	1525	136	174	2494	1288	493	1263	75688	43	76	17	6	24	30	28	2	28	8	1	148723
12	169	126	47	115	17	10	49	44	14	12	44	45	31	8	2	20	23	11	0	9	3	0	798
13	409	117	87	91	14	10	44	39	18	19	75	49	175	144	64	300	344	269	9	214	64	7	2582
14	240	63	49	43	6	6	24	22	10	11	42	16	271	132	21	149	163	97	5	120	31	3	1524
15	190	42	43	25	4	3	13	11	5	5	27	9	213	62	35	71	75	165	6	46	21	3	1074
16	801	205	185	156	23	19	71	65	29	34	138	48	698	294	58	513	578	299	17	276	139	14	4663
17	343	78	98	57	9	6	30	32	14	15	52	16	346	195	26	240	501	181	9	305	81	8	2643
18	1159	217	336	78	19	11	65	43	21	25	150	26	754	197	82	226	213	1476	52	162	91	17	5419
19	267	55	105	13	4	2	15	9	4	5	29	5	148	26	12	32	30	193	153	26	13	12	1159
20	2035	467	456	153	23	16	206	240	112	109	286	28	771	667	49	313	512	271	16	1844	131	27	8733
21	504	101	163	48	9	7	27	22	9	13	61	11	242	111	20	115	160	177	14	98	228	44	2185
22	211	45	82	16	4	3	12	9	3	5	24	5	126	20	10	33	42	95	11	31	52	159	999
Sum	176878	46575	45906	16454	1682	2098	43405	23730	19445	29129	106449	1032	4219	1986	413	2189	2871	3415	304	3410	924	302	**532816**

Table A-6. LPA Total Transit Trip Demand by District, 2030 Average Weekday

DISTRICT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Sum
1	31959	5089	7930	1286	142	145	2731	1338	525	778	7298	123	173	35	11	46	53	40	3	37	13	1	59756
2	9222	4788	1748	886	97	84	2368	1217	446	578	1971	73	67	16	4	19	21	15	1	16	5	1	23644
3	17852	2051	5694	553	66	69	1162	622	244	320	5237	53	59	14	4	18	22	16	1	14	6	1	34079
4	11380	4723	2473	4974	383	539	1966	1979	525	540	2529	426	223	75	14	66	76	63	3	46	17	2	33020
5	352	144	80	138	40	12	66	73	25	21	82	30	31	9	2	9	13	9	0	7	2	0	1145
6	1061	446	274	631	43	462	175	178	50	47	292	56	35	10	2	10	10	9	0	7	2	0	3801
7	25594	10135	5416	2060	244	210	18810	5452	3414	6381	5147	147	105	59	8	34	51	42	2	59	15	1	83385
8	13248	5557	2671	1963	202	161	4593	6185	2045	1606	2423	123	92	55	6	29	42	33	2	61	12	1	41108
9	10402	4516	2430	1007	134	103	3959	3170	9870	2223	1569	77	66	71	4	17	25	34	1	32	8	1	39716
10	10336	3425	2382	551	81	59	4005	1505	1452	14734	2629	43	47	17	3	13	19	12	1	19	5	0	41341
11	46523	5122	14660	1536	143	176	2425	1260	480	1238	74902	98	139	37	9	36	44	38	2	30	11	1	148908
12	390	134	95	152	23	13	65	60	21	19	87	46	45	16	3	14	18	15	0	11	3	0	1231
13	593	214	142	194	30	21	78	74	31	29	128	68	166	173	72	336	393	341	11	251	73	8	3427
14	325	111	75	88	13	10	37	34	15	15	65	23	266	142	24	163	183	116	6	135	34	4	1883
15	386	116	78	85	12	10	31	28	12	13	66	18	182	77	37	90	104	157	6	67	25	4	1604
16	1386	422	300	334	48	40	125	112	48	56	263	60	745	302	62	543	628	297	13	304	143	17	6261
17	982	265	196	237	33	27	68	62	28	39	171	35	330	235	30	263	532	169	10	321	87	10	4131
18	1937	540	496	315	56	46	143	113	48	58	342	56	792	236	86	264	266	1541	64	211	101	20	7731
19	266	64	115	27	6	4	13	10	4	5	31	5	100	20	8	22	21	151	153	19	10	11	1065
20	2130	494	508	305	48	36	200	233	104	103	328	47	757	667	49	294	490	286	16	1791	130	27	9044
21	1605	452	339	295	53	46	104	82	40	60	283	46	495	139	35	177	226	164	14	134	243	47	5082
22	236	62	95	31	8	6	13	11	4	5	30	6	95	16	7	28	38	68	10	28	51	159	1007
Sum	188167	48869	48197	17648	1905	2279	43139	23797	19431	28870	105873	1658	5009	2421	480	2491	3275	3615	326	3599	1003	317	**552368**

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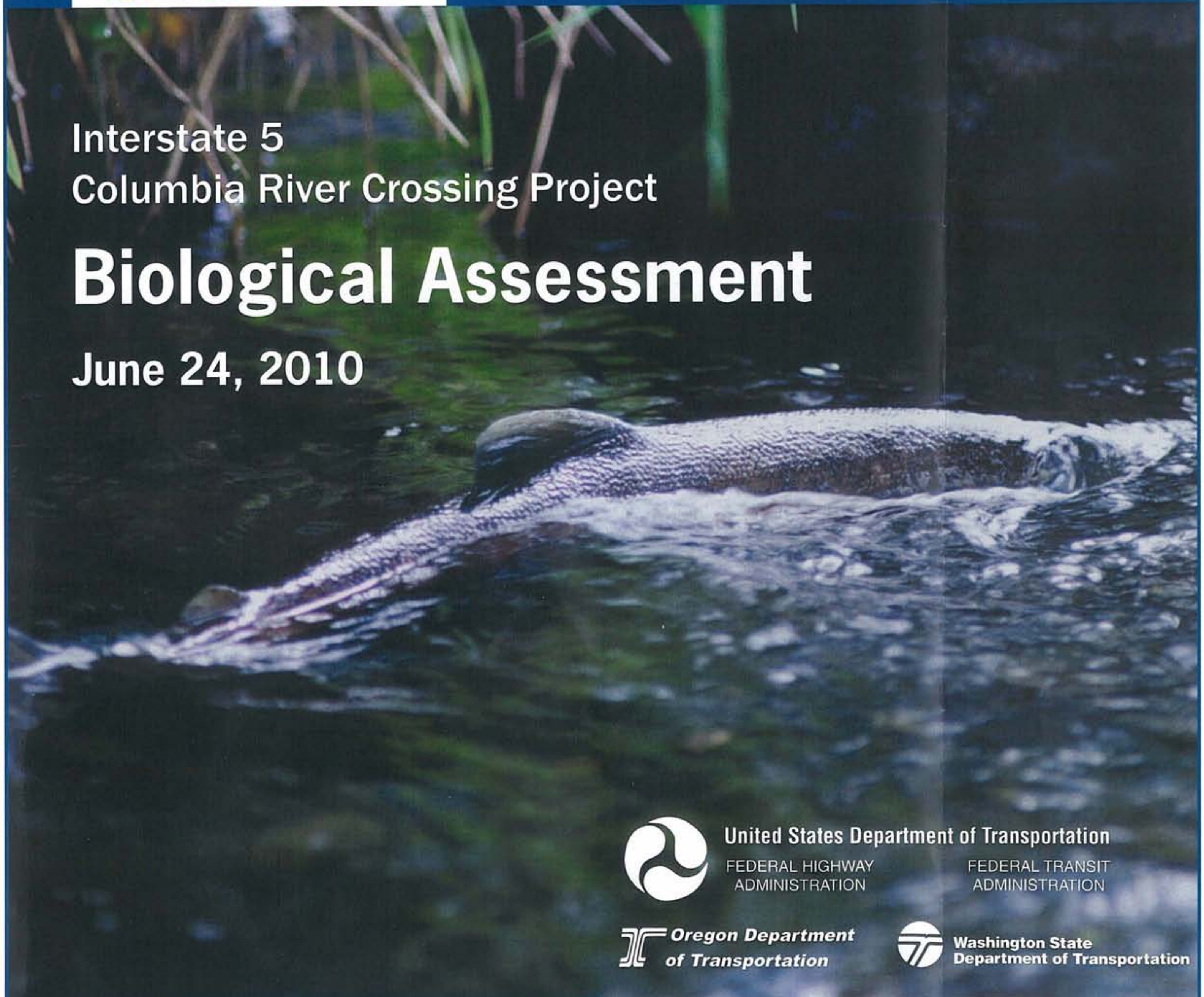
Columbia River CROSSING



Interstate 5
Columbia River Crossing Project

Biological Assessment

June 24, 2010

United States Department of Transportation
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL TRANSIT ADMINISTRATION

Oregon Department of Transportation

Washington State Department of Transportation

C-TRAN

TRIMET

8805

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON DIVISION
SUITE 501, EVERGREEN PLAZA
711 SOUTH CAPITOL WAY
OLYMPIA, WA 98501

FEDERAL TRANSIT ADMINISTRATION
915 SECOND AVENUE, SUITE 3142
SEATTLE, WA 98174

June 24, 2010

HEV-WA/CRC

Kim Kratz
NOAA National Marine Fisheries Service
Willamette Basin Habitat Branch
1201 NE Lloyd Blvd, Suite 100
Portland, OR 97232

Columbia River Crossing Request for Formal Consultation with NMFS

Dear Mr. Kratz:

As lead federal agencies, the Federal Transit Administration (FTA) and Federal Highway Administration (FHWA), are submitting this request for formal consultation with the National Marine Fisheries Service (NMFS), as required under Section 7(a)(2) of the Endangered Species Act (ESA) as amended. FTA and FHWA are providing the enclosed Biological Assessment (BA) for the above-referenced project.

The project proposes the following activities:

- Replace the existing Columbia River bridges with new structures to convey larger volumes of traffic and meet current design standards for safety and seismic activity.
- Retrofit and widen the existing North Portland Harbor Bridge and add three new structures for auxiliary ramps and light rail transit.
- Improve seven interchanges and roadways along and adjacent to I-5 in Portland and Vancouver.
- Extend the Yellow Line Light Rail Transit (LRT) from north Portland through downtown Vancouver to Clark College.
- Add improved bicycle and pedestrian access on the new bridges and surrounding areas.
- Construct three new park and ride facilities in Vancouver.
- Expand the Ruby Junction Maintenance Facility to accommodate additional light rail transit vehicles.

- Construct stormwater best management practices (BMPs) and provide a high level of treatment of stormwater runoff from new and existing impervious surfaces.
- Demolish the existing Columbia River bridges.
- Fund compensatory mitigation activities that will contribute to the enhancement and recovery of salmon and steelhead near the mainstem lower Columbia River.

Construction is tentatively scheduled to begin in September 2012 and to be completed in December 2020, a total of approximately 100 months.

In regards to species under the jurisdiction of NMFS, FTA and FHWA have concluded that the proposed project **May Affect** and is **Likely to Adversely Affect** the following distinct population segments (DPSs) and evolutionarily significant units (ESUs): Lower Columbia River Chinook, Upper Columbia River spring-run Chinook, Snake River fall-run Chinook, Snake River spring/summer-run Chinook, Upper Willamette River Chinook, Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, Snake River Basin steelhead, Upper Willamette River steelhead, Snake River sockeye, Lower Columbia River coho, Columbia River chum, Southern DPS of eulachon, and the Eastern DPS of Steller sea lion.

FTA and FHWA have concluded that the proposed project **May Affect** and is **Not Likely to Adversely Affect** the Southern DPS of green sturgeon and the Southern Resident DPS of killer whale.

In regards to designated critical habitats under the jurisdiction of NMFS, FTA and FHWA have concluded that the proposed project **May Affect** and is **Likely to Adversely Affect** the following designated critical habitats: Lower Columbia River Chinook, Upper Columbia River Chinook, Snake River fall-run Chinook, Snake River spring/summer-run Chinook, Upper Willamette River Chinook, Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, Snake River Basin steelhead, Upper Willamette River steelhead, Snake River sockeye, and Columbia River chum.

FTA and FHWA are requesting formal consultation as allowed by 51 CFR 402.12(j). With submittal of this BA, FTA and FHWA have provided NMFS with the best scientific and commercial data available concerning the impact of the proposed project on listed and proposed species and designated critical habitats.

FTA and FHWA understand, as stipulated in ESA Section 7(b)(1)(A) and 50 CFR 402.14(c), formal consultation will be initiated by your receipt of this formal consultation request and will conclude within 90 days of that date. Additionally, we understand that a Biological Opinion will be prepared by NMFS within 45 days of completion of the consultation period. We also request copies of the draft Biological Opinion, incidental take statement, terms and conditions, and reasonable and prudent measures be sent to us for review prior to the finalization of the Biological Opinion.

Enclosed are both a hard copy and an electronic version of the BA.

If you have any questions about this project, or need additional clarification, please contact Steve Saxton, FTA Region 10 Transportation Program Specialist, at 206-220-4311 or John McAvoy, FHWA Major Projects Manager, at 360-619-7591.

Sincerely,

John McAvoy, P.E.
Major Projects Manager
Federal Highway Administration

Linda M. Gehrke
for
R.F.Krochalis
Regional Administrator
Federal Transit Administration

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON DIVISION
SUITE 501, EVERGREEN PLAZA
711 SOUTH CAPITOL WAY
OLYMPIA, WA 98501

FEDERAL TRANSIT ADMINISTRATION
915 SECOND AVENUE, SUITE 3142
SEATTLE, WA 98174

June 24, 2010

HEV-WA/CRC

Paul Henson
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
2600 SE 98th Street, Suite 100
Portland, OR 97266

Columbia River Crossing Request for Informal Consultation with USFWS

Dear Mr. Henson:

As lead federal agencies, Federal Transit Administration (FTA) and Federal Highway Administration (FHWA), are submitting this request for informal consultation with the U.S. Fish and Wildlife Service (USFWS), as required under Section 7(a)(2) of the Endangered Species Act (ESA) as amended. FTA and FHWA are providing the enclosed Biological Assessment (BA) for the above-referenced project.

The project proposes the following activities:

- Replace the existing Columbia River bridges with new structures to convey larger volumes of traffic and meet current design standards for safety and seismic activity.
- Retrofit and widen the existing North Portland Harbor Bridge and add three new structures for auxiliary ramps and light rail transit.
- Improve seven interchanges and roadways along and adjacent to I-5 in Portland and Vancouver.
- Extend the Yellow Line Light Rail Transit (LRT) from north Portland through downtown Vancouver to Clark College.
- Add improved bicycle and pedestrian access on the new bridges and surrounding areas.
- Construct three new park and ride facilities in Vancouver.
- Expand the Ruby Junction Maintenance Facility to accommodate additional light rail transit vehicles.

- Construct stormwater best management practices (BMPs) and provide a high level of treatment of stormwater runoff from new and existing impervious surfaces.
- Demolish the existing Columbia River bridges.
- Fund compensatory mitigation activities that will contribute to enhancement and recovery of salmon and steelhead near the mainstem lower Columbia River.

Construction is tentatively scheduled to begin in September 2012 and to be completed in December 2020, a total of approximately 100 months.

In regards to species under the jurisdiction of USFWS, FTA and FHWA have concluded that the proposed project **May Affect,** and is **Not Likely to Adversely Affect** the Columbia River distinct population segment of the conterminous U.S. bull trout (*Salvelinus confluentus*) and their designated critical habitat.

Critical habitat is proposed for listing in the Columbia River, Hood River, and Lewis River. FTA and FHWA have concluded that the project **Will Not Destroy or Adversely Modify** proposed critical habitat for bull trout and if the proposed critical habitat for bull trout is designated before completion of the project, we offer a provisional effect determination of **May Affect,** and is **Not Likely to Adversely Affect**.

FTA and FHWA request informal consultation as allowed by 51 CFR 402.12(j) for bull trout and designated critical habitat, and informal conferencing for bull trout proposed critical habitat. With submittal of this BA, FTA and FHWA have provided USFWS with the best scientific and commercial data available concerning the impact of the proposed project on listed species and designated and proposed critical habitat.

FTA and FHWA understand, as stipulated in ESA Section 7(b)(1)(A) and 50 CFR 402.14(e), informal consultation will be initiated by your receipt of this informal consultation request and will conclude within 30 days of that date. We look forward to receiving a letter from you in 30 days concurring with our effect determinations.

Enclosed are both a hard copy and an electronic version of the BA.

If you have any questions about this project, or need additional clarification, please contact Steve Saxton, FTA Region 10 Transportation Program Specialist, at 206-220-4311 or John McAvoy, FHWA Major Projects Manager, at 360-619-7591.

Sincerely,

John McAvoy, P.E.
Major Projects Manager
Federal Highway Administration

R.F. Krochalis
Regional Administrator
Federal Transit Administration

BIOLOGICAL ASSESSMENT

COLUMBIA RIVER CROSSING

Interstate 5

Multnomah County, Oregon
Clark County, Washington

170800030701 Columbia River, Hayden Island
170800010901 Salmon Creek, Vancouver
170900120301 Columbia Slough/Willamette River, Willamette River/Columbia River

Chinook salmon (*Oncorhynchus tshawytscha)*
Upper Columbia River Spring-Run ESU
Lower Columbia River ESU
Snake River Fall-Run ESU
Snake River Spring/Summer-Run ESU
Upper Willamette River ESU

Steelhead (*Oncorhynchus mykiss*)
Lower Columbia River DPS
Middle Columbia River DPS
Upper Columbia River DPS
Snake River DPS
Upper Willamette River DPS

Sockeye salmon (*Oncorhynchus nerka)*
Snake River ESU

Coho salmon (*Oncorhynchus kisutch)*
Lower Columbia River ESU

Chum salmon (*Oncorhynchus keta)*
Columbia River ESU

Bull trout (*Salvelinus confluentus)*
Columbia River DPS

Eulachon (*Thaleichthys pacificus*)
Southern DPS

Green sturgeon (*Acipenser medirostris)*
Southern DPS

Northern (Steller) sea lion (*Eumetopias jubatus)*
Eastern DPS

Killer Whale (*Orcinus orca)*
Southern DPS

United States Department of Transportation

FEDERAL HIGHWAY ADMINISTRATION

FEDERAL TRANSIT ADMINISTRATION

OREGON DEPARTMENT OF TRANSPORTATION

Washington State Department of Transportation

TRI MET

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Columbia River CROSSING

June 2010

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APPENDICES

All appendices are contained on a compact disc at the end of this report.

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ACRONYMS

µ	micro-; 10^{-6}
µPa	Micropascal
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADD	Acoustic Deterrent Devices
ADT	Average Daily Traffic
API	Area of Potential Impact
BA	Biological Assessment
BES	Bureau of Environmental Services, City of Portland
BIA	Bridge Influence Area
bike/ped	Bicycle/Pedestrian
BLM	Bureau of Land Management
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
BO	Biological Opinion
BRT	NMFS Biological Review Team
C	Celsius
Caltrans	California Department of Transportation
CAO	Clark County Critical Areas Ordinances
CBR	Columbia Basin Research
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfs	Cubic Feet per Second
CPUE	(Eulachon) Catch per Unit Effort
CR	Columbia River (ESU/DPS)
CRC	Columbia River Crossing
CRD	Columbia River Datum
CREDDP	Columbia River Estuary Data Development Program
C-TRAN	Clark County Public Transit Benefit Area Authority
CWA	Clean Water Act
CY	Cubic Yard
DAHP	Washington Department of Archaeological and Historical Properties
DART	Data Analysis in Real Time
dB	Decibel

dB_{peak}	Peak Injury Threshold (in decibels)
dB_{RMS}	Root Mean Square of Sound Pressure Levels (measured in decibels)
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
DEQ	Oregon Department of Environmental Quality
DLCD	Oregon Department of Land Conservation and Development
DOE	U.S. Department of Energy
DOT	Department of Transportation
DPS	Distinct Population Segment
DSL	Oregon Department of State Lands
DWR	Oregon Department of Water Resources
Ecology	Washington State Department of Ecology
ECSI	Environmental Cleanup Site Information
EFH	Essential Fish Habitat
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESC	Erosion And Spill Control
ESH	Essential Salmonid Habitat
ESU	Evolutionarily Significant Unit
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FHWG	Fisheries Hydroacoustic Working Group
FPAC	Fish Passage Advisory Committee
FPC	Fish Passage Center
fps	Feet per Second
FR	Federal Register
FTA	Federal Transit Administration
g	Gram
GIS	Geographical Information System
GMA	Growth Management Act

HAZMAT	Hazardous Materials
HIWWW	Hydroacoustic In-Water Work Window
HPA	Hydraulic Project Approval
HUC	Hydrologic Unit Code
I-5	Interstate 5
ICTRT	Interior Columbia Technical Recovery Team
InterCEP	Interstate Collaborative Environmental Process
ISAB	Independent Scientific Advisory Board
ITS	Intelligent Transportation System
IWWW	In-Water Work Window
JCRMS	Joint Columbia River Management Staff
JISAO	Joint Institute for the Study of Atmosphere and Ocean
km	Kilometer
LCFRB	Lower Columbia Fish Recovery Board
LCR	Lower Columbia River (ESU/DPS)
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
LUST	Leaking Underground Storage Tank
m	Meter
m/s	Meters per Second
Mm	Millimeter
MAX	Metropolitan Area Express
MCDD	Multnomah County Drainage District
MCR	Middle Columbia River (ESU/DPS)
MHRR	Mount Hood Railroad
MLK	Martin Luther King, Jr., Boulevard
MMPA	Marine Mammal Protection Act
MPG	Major Population Group
Mph	Miles per Hour
MS4	Municipal Separate Storm Sewer System
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MUP	Multi-Use Path
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act of 1969

NFH	USFWS National Fish Hatchery
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPH	North Portland Harbor
NRCS	Natural Resources Conservation Service
NRM	Northern Rocky Mountain
NTU	Nephelometric Turbidity Unit
NWFSC	Northwest Fisheries Science Center
OCS	Overhead Catenary System
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OHW	Ordinary High Water
ORNHIC	Oregon Natural Heritage Information Center
OSU	Oregon State University
PAH	Polycyclic Aromatic Hydrocarbon
Pa	Pascal
Pa-s	Pascal-seconds
PBAC	Pedestrian and Bicycle Advisory Committee
PBDE	Polybrominated Diphenyl Ether
PCB	Polychlorinated Biphenyl
PCE	Primary Constituent Element
PDX	Portland International Airport
PFMC	Pacific Fishery Management Council
PGIS	Pollution-Generating Impervious Surfaces
PIDP	San Francisco-Oakland Bay Bridge Pile Installation Demonstration Program
PIT	Passive Integrated Transponder
PL	Public Law
PTS	Permanent Threshold Shift
Q_P	Flow Rate of the Project Runoff, in cfs;
Q_R	Flow Rate of the Receiving Waterbody, in cfs
RKm	River Kilometer
RM	River Mile

RMS	Root Mean Square
RTC	Regional Transportation Council
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEPA	State Environmental Policy Act of 1971
SHPO	Oregon State Historic Preservation Office
σ	Sigma; Standard Deviation
SMA	Shoreline Management Act
SPCC	Spill Prevention, Control, and Countermeasures
SPL	Sound Pressure Level
SPUI	Single Point Urban Interchange
sq. ft.	Square Foot/Square Feet
SR	State Route or Snake River (ESU/DPS)
SWCD	East Multnomah Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
TDA	Threshold Discharge Area
TDM	Travel Demand Management
TES	Thermal Energy Storage
TESC	Temporary Erosion and Sediment Control
TMDL	Total Maximum Daily Load
TNAP	Temporary Noise-Attenuation Pile
TOD	Transit-Oriented Oriented Development
TriMet	Tri-County Metropolitan Transportation District of Oregon
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UCR	Upper Columbia River (ESU/DPS)
UGB	Urban Growth Boundary
URB	Upriver Bright (Chinook)
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UW	University of Washington

UWR	Upper Willamette River (ESU/DPS)
VCCV	Vancouver City Center Vision
VMC	Vancouver Municipal Code
WDFW	Washington Department of Fish and Wildlife
WDNR-NHP	Washington Department of Natural Resources, Natural Heritage Program
WLCTRT	Willamette/Lower Columbia Technical Recovery Team
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries

GLOSSARY

action – Any activity or program of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas. Examples include but are not limited to actions directly or indirectly causing modifications to the land, water, or air; actions intended to conserve listed species or their habitat; and the promulgation of regulations (50 CFR 402.02).

action agency – The federal agency proposing to undertake a major construction project (action).

action area – All areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02).

affect/effect – To *affect* (a verb) is to bring about a change. The *effect* (usually a noun) is the result.

ambient noise level – The background sound level, which is a composite of sound from all sources near and far.

attenuation – See *transmission loss.*

auxiliary lanes – Can improve safety reduce congestion by accommodating cars and trucks entering or exiting the highway or traveling short distances between adjacent interchanges, and reduce conflicting weaving and merging movements.

baseline – The starting point for analysis; ambient conditions from which to measure and compare potentially altered conditions caused by project activities.

best management practices (BMPs) – Methods, facilities, built elements, and techniques implemented or installed during project construction to reduce short- and long-term project impacts on listed and sensitive species and habitat. These measures are included as part of the federal agency's proposed action.

biofiltration – The process of filtering water through biological materials, such as vegetation.

biological assessment (BA) – The information prepared by or under the direction of an action agency to determine whether a proposed action (major construction activity) is likely to affect listed and proposed species and designated and proposed critical habitat that may be present in the project action area, including the evaluation of potential effects of the action on such species and habitat. The outcome of the BA determines whether formal consultation or a conference is necessary.

biological opinion (BO) – The document prepared by the U.S. Fish and Wildlife Service (USFWS) or National Oceanic and Atmospheric Administration (NOAA) Fisheries that states the opinion of the Service as to whether a federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

bioretention – The process of temporarily retaining water in a natural terrestrial community of plants, microbes, and soil.

bycatch – The unintentional harvest of a fish species while intending to catch another fish species.

candidate species – A species for which the Service has on file sufficient information on biological vulnerability and threats to support a proposal to list it as threatened or endangered.

coalescing plates – A device with parallel plates to separate oil from water by means of gravity.

cofferdam – An enclosure to isolate work activities from the active channel of a waterbody; it may be dewatered.

compost – Organic residue, or a mixture of organic residues and soil, that has undergone biological decomposition until it has become relatively stable humus.

congestion – For highways, congestion occurs when average speed is below 30 mph.

conservation measure – Activities or measures that help recover listed species.

couplet – A fixed method of routing two directions of travel on two adjacent, parallel streets, instead of placing both directions of travel on a single street.

critical habitat – Specific geographical areas that possess physical or biological features that are essential to the conservation of listed species. These designated areas may require special management consideration or protection.

cumulative effects – The effects of other, future state or private actions that are reasonably certain to occur within the federal project action area (50 CFR 402.02).

decibel (dB) – A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 micropascal (µPa) and air is 20 micropascals (the threshold of healthy human audibility).

delayed mortality – When a fish dies more than 1 hour and less than 48 hours after exposure to an effect.

demand – The total number of users attempting to access the transportation system, including those caught in congestion.

detention – The temporary storage of runoff, which is released at a slower rate than it was collected. Detention facilities are most commonly used for flow control.

direct effects – Impacts resulting from the proposed action.

distinct population segment (DPS) – A designation usually used by the USFWS for a discrete vertebrate stock that is treated as an individual species (e.g., a specified seasonal fish run in a particular river). This is equivalent to the NOAA Fisheries evolutionarily significant unit (ESU) classification.

drilled shaft – Constructed in diameters ranging from 18 inches to 12 feet or more to provide deep foundations for buildings, bridges, and retaining walls, and to stabilize landslides. Highly specialized construction techniques have been developed to install drilled shafts in conditions ranging from soft soils to hard rock.

drywell – A well completed above the water table so that its bottom and sides are typically dry except when receiving fluids. Drywells are designed to disperse water below the land surface.

effect/affect – See *affect/effect.*

effects of the action – The direct and indirect effects of a federal action on listed species or critical habitat, together with the effects of other interrelated and interdependent activities. Direct effects are those resulting from the proposed action. Indirect effects are those caused by the proposed action later in time, but still reasonably certain to occur. Interrelated actions are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

endangered species – A species that is in danger of extinction throughout all or a significant portion of its range.

estuary (the Columbia River) – The Columbia River estuary is considered to be that portion of the Columbia River extending from the mouth upstream to, and including, all tidally influenced areas (i.e., to Bonneville Dam).

evolutionarily significant unit (ESU) – A designation used by NOAA Fisheries for certain local salmon populations or runs that are treated as individual species. This is equivalent to the distinct population segment (DPS) classification.

federal action agency – The federal agency that proposes a specific action or triggers a federal nexus for a project (by providing permits, funding, etc.). This agency is responsible for formally submitting a biological assessment for the proposed action to the Services for review and informal or formal consultation.

federal nexus – A project with a federal nexus either has federal funding, requires federal permits, or takes place on federal lands.

filter strip – A grassy area with gentle slopes that treats stormwater runoff from adjacent paved areas before it can concentrate into a discrete channel.

formal consultation – The process between the Services and the action agency that commences with the action agency's written request for consultation under Section 7(a)(2) of the Endangered Species Act (ESA) and concludes with the Service's issuance of a biological opinion under Section 7(b)(3) of the ESA.

guideway – A transit right-of-way separated from general purpose vehicle transit. A guideway may have train tracks or separated bus lanes.

habitat conservation plan (HCP) – A planning document required under Section 10(a)(1)(b) of the federal ESA for non-federal entity actions with no federal nexus to conserve the ecosystems upon which listed species depend. An HCP is part of an application for incidental take for the non-federal entity.

hair cells – Cells within the inner ear of most vertebrates that contain cilliary bundles that respond to sound pressure and create the sensation of hearing.

harass – An intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying to such an extent as to significantly disrupt normal behavior patterns, which include but are not limited to breeding, feeding, and sheltering (50 CFR Part 17).

hard site conditions – Areas where there is no excess ground-effect noise attenuation, such as asphalt, concrete, hard-packed soils, and water surfaces.

harm – In the definition of *take* in the ESA. Harm is defined by the USFWS to include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, and sheltering (50 CFR 17.3). The National Marine Fisheries Service's (NMFS's) definition of harm includes significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, spawning, migrating, rearing, and sheltering (64 FR 60727, November 8, 1999).

hydrology – Refers to the flow of water—its volume, where it drains, and how quickly the flow rate changes in a storm.

hyporheic flow – Movement of water just below a stream bed, where groundwater and surface water may intermix.

impervious surface – A hard surface area that either prevents or retards the entry of water into the soil and from which water runs off at an increased rate of flow.

impulse – The time integral of the peak pressure, typically described in units of pounds per square inch per millisecond (psi/msec). It recognizes that a short pulse may do less damage than a longer duration pulse of the same pressure. Sound pressure is equivalent to kilowatts, while impulse is equivalent to kilowatt-hours.

incidental take – A *take* of listed species that results from an action but is not the direct purpose or intent of the action, as defined under the ESA. Incidental *take* can be authorized through Section 7 consultation or through Section 10 conservation planning, such as an HCP.

indirect effects – Effects caused by the proposed action later in time but still reasonably certain to occur.

infiltration – The downward movement of water from the surface to the subsoil.

infiltration pond – A facility that contains excess runoff then percolates that runoff into the surrounding soil.

interdependent action – An action having no independent utility apart from the proposed action.

interrelated action – An action that is part of a larger action and depends on the larger action for its justification.

is not likely to adversely affect – The appropriate finding in a biological assessment (or conclusion during informal consultation) when effects on listed species are expected to be discountable, insignificant, or completely beneficial.

jeopardize the continued existence of – To engage in an action that reasonably would be expected to directly or indirectly reduce the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

light rail transit (LRT) – A form of urban rail public transportation that generally has a lower capacity and lower speed than heavy rail and metro systems, but higher capacity and higher speed than traditional street-running tram systems.

listed species – Any species of wildlife, fish, or plant that has been listed as endangered or threatened under Section 4 of the ESA. Listed species are found in 50 CFR 17.11–17.12. Under the statute, the two types of species are treated in virtually the same way.

metapopulation – A metapopulation consists of a group of spatially separated populations of the same species which interact at some level. A metapopulation is generally considered to consist of several subpopulations together; each subpopulation may be separated by areas of suitable habitat which are currently unoccupied.

micropascal (μPa) – Most underwater acoustic sound pressure measurements are stated in terms of a pressure relative to 1 micropascal. One micropascal is equal one millionth of one newton per square meter.

minimization measure – Measures that reduce the impact of the project on listed species.

mode split – The percentage of travel by different forms of transportation, typically single-occupant vehicles, high-occupancy vehicles (two or more persons in a car), transit, walk, and bicycle.

mortality (fish) – Cessation of all activity including movements of the operculum, or when all respiration stops and the fish lies motionless.

National Pollutant Discharge Elimination System (NPDES) – The provision in the federal Clean Water Act that requires point source dischargers of pollutants to obtain permits, called NPDES permits. In Washington, NPDES permits are administered by the Washington Department of Ecology.

no effect – The appropriate conclusion when the proposed action will not affect a listed species or its critical habitat (i.e., will have no effect whatsoever—neither beneficial effects, nor highly improbable effects, nor insignificant effects).

outfall – The point of water discharge from a stormwater facility.

pascal (Pa) – A unit of pressure equal to 1 newton per square meter.

peak period – This is a more technically defined description of “rush hour”, when travel patterns generate the most traffic, especially in a certain direction.

performance measure – An observable or measurable benchmark for a particular performance objective against which a project can be compared. If the standards are met, the related performance objectives are considered to have been fully achieved. It is something quantifiable. Standards should be measures, not actions, and should be: 1) achievable, and 2) capable of being monitored.

piles – Steel, concrete, wood, or plastic cylinders or columns that may be hammered, vibrated, or drilled into the soil until they reach dense soil or bedrock. Load-bearing piles provide support to hold the weight of a structure and any traffic and equipment. Non-load-bearing piles may be used for mooring or support.

pool – A deep, slow moving area with smooth water surface.

predation – The act of preying on another animal.

proposed species – Any species of wildlife, fish, or plant that is proposed in the Federal Register to be listed under Section 4 of the ESA as threatened or endangered.

range (of a species) – The area or region over which an organism occurs.

rate – Percentage probability of an effect.

receiving water – A body of water or a surface water system to which surface runoff is discharged.

recovery – Action that is necessary to reduce or resolve the threats that caused a species to be listed as threatened or endangered.

riffle – A shallow, fast-moving stream section with water broken by rocks and boulders.

root mean square (RMS) – The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile-driving impulse, commonly used in repetitive or relatively continuous measurements such as in speech or highway noise. It is not applicable to transient signals such as explosions. It is used in calculating longer-duration sound pulses such as a pile-driving pulse of sound.

Services – An abbreviated term for the USFWS and NOAA Fisheries.

sound exposure level (SEL) – A common unit of sound energy used in airborne acoustics to describe short-duration events. The time integral of frequency-weighted squared instantaneous sound pressures. It is proportionally equivalent to the time integral of the pressure squared and can be described in terms of μ Pa^2/sec over the duration of the impulse Source: Fisheries and Hydroacoustic Monitoring Program Compliance Report, San Francisco-Oakland Bay Bridge East Span Seismic Safety Project 6-11.

sound pressure level (SPL) – Sound pressure is the sound force per unit area, usually expressed in micropascals (μPa) (or 20 micro newtons per square meter), where 1 pascal is the pressure resulting from a force of 1 newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure (e.g., 20 μPa).

species – Includes any subspecies of fish, wildlife, or plant, or any distinct population segment of any species of vertebrate fish or wildlife, which interbreeds when mature.

spherical spreading – Spreading of sound pressure in a dome or sphere shape from the source.

stormwater – A term used to describe water that originates during precipitation events. It may also be used to apply to water that originates with snowmelt or runoff water from overwatering that enters the stormwater system.

stormwater runoff – Occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces like driveways, sidewalks, and streets prevent stormwater runoff from naturally soaking into the ground.

suitable habitat – The area where an organism, including a plant, animal or fish, naturally or normally lives and grows.

strike interval – The length of time between strikes during pile driving.

swale – A natural depression or shallow drainage conveyance with relatively gentle side slopes, generally less than 1 foot, used to temporarily store, route, or filter runoff.

take (taking) – Defined under the ESA 16 USC 1532(19) as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

threshold discharge area (TDA) – An on-site area draining to a single natural discharge location or multiple natural discharge locations that combine within 0.25 mile downstream (as determined by the shortest flow path).

throughput – The number of users being served at any time by the transportation system.

transmission loss – The accumulated decrease in acoustic intensity as the acoustic pressure wave propagates outward from the source due to spreading.

trench – A long cut in the ground, i.e., a ditch or swale.

vault – An underground storage facility that collects runoff and either percolates that runoff into the surrounding soil at various rates or permanently pools the runoff.

water quality – Refers to the characteristics of the water—for example, its temperature and oxygen levels, how clear it is, and whether it contains pollutants.

wet pond – A facility that contains a permanent pool of water and removes pollutants from highway runoff through sedimentation, biological uptake, and plant filtration.

Section 1

SECTION 1

What does this section present?

Section 1 summarizes the purpose of the document as well as various project background information. The Endangered Species Act (ESA) requires preparation of a biological assessment (BA) for any major construction project with federal approval, funding, or permits. The purpose of the BA is to allow the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) to evaluate the potential effects of the proposed project on federally listed and proposed wildlife, fish, and plant species and designated and proposed critical habitats that are likely to occur in the vicinity of the project. Section 1 introduces the Columbia River Crossing (CRC) project and establishes why the project is necessary, the federal nexus to the project (Federal Transit Administration [FTA] and Federal Highway Administration [FHWA]), and the federally listed species and designated habitats assessed in this document.

What is the project's purpose and need?

The CRC project includes improvements to light rail transit (LRT), automobile, and bicycle and pedestrian (bike/ped) facilities. The project is designed to meet a specific purpose and need. The purpose of the project is to improve I-5 corridor mobility by addressing present and future travel demand and mobility needs in the CRC Bridge Influence Area (BIA). The needs addressed by the project include the following:

- Addressing growing travel demand and congestion, impaired freight movement,
- Impaired freight movement,
- Limited public transportation operation, connectivity, and reliability,
- Safety and vulnerability to incidents,
- Substandard bike/ped facilities, and
- Seismic vulnerability.

What coordination occurred between CRC and the regulatory agencies prior to BA submittal?

The BA was developed in collaboration with NMFS, USFWS, and representatives from federal and state environmental regulatory agencies collectively known as the Interstate Collaborative Environmental Process (InterCEP), a group formed in 2006 specifically to coordinate regulatory and permitting compliance for the project. A total of 16 pre-consultation meetings were held to cover specific issues: construction methods, hydroacoustics, fish run modeling, in-water work windows, stormwater, and indirect effects.

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1. INTRODUCTION

The Interstate 5 (I-5) Columbia River Crossing (CRC) project is a multimodal project focused on improving safety, reducing congestion, and increasing mobility of motorists, freight, bicyclists, and pedestrians along a 5-mile section of the I-5 corridor connecting Vancouver, Washington and Portland, Oregon, and extending the Yellow Line MAX from Delta Park in Portland to Clark College in Vancouver. The project area stretches from State Route 500 (SR 500) in northern Vancouver, south through downtown Vancouver, and over the I-5 bridges across the Columbia River and the North Portland Harbor to just north of Columbia Boulevard in north Portland (Figure 1-1). The project area also includes other elements as described below.

There are significant congestion, safety, and mobility problems in the 5-mile project area. The existing northbound bridge was built in 1917, and the southbound bridge was added in 1958. These bridges have been classified as functionally obsolete because they do not meet current or future demands for interstate service, resulting in long delays from congestion. If no changes are made, the daily congestion period is projected to grow from today's 6 hours to 15 hours by 2030 (CRC 2008a). In addition, this section of I-5 has an accident rate more than double that of similar urban highways. Narrow lanes, short on-ramps, and non-standard shoulders on the bridges contribute to accidents. Bridge lifts to allow passage of river traffic stop all traffic using I-5 over the mainstem Columbia River, resulting in delays on connecting roadways and adding to unsafe driving conditions.

Current transit service between Vancouver and Portland is limited to bus service and constrained by the limited capacity in the I-5 corridor and is subject to the same congestion as other vehicles, which affects transit reliability and operations. Bicycle and pedestrian (bike/ped) facilities are currently substandard in much of the project area.

Seismic safety is also an important issue. Recent geotechnical studies have shown that the sandy soil under the mainstem Columbia River bridges would likely liquefy to a depth of 85 feet during an earthquake greater than Magnitude 8. This could cause irreparable damage to the bridges and potential loss of human life.

To remedy these deficiencies, the CRC project proposes to:

- Replace the existing Columbia River bridges with new structures to eliminate the need for bridge lifts, convey larger volumes of traffic and meet current design standards for safety and seismic activity.
- Retrofit the existing North Portland Harbor Bridge, and add three new structures for auxiliary ramps and light rail transit (LRT).
- Improve seven interchanges along I-5 in Portland and Vancouver.
- Extend LRT from north Portland through downtown Vancouver.
- Add improved bike/ped access on the new bridges and surrounding areas.
- Construct three new park and ride facilities in Vancouver.
- Expand the Ruby Junction Maintenance Facility to accommodate additional LRT vehicles.

These project elements are discussed in more detail in Section 3.0, Project Description.

Figure 1-1. Project Area Map

Columbia River CROSSING

As required under Section 7 of the Endangered Species Act (ESA) of 1973, projects that use federal funding or require federal permits and may affect listed species must undergo consultation with U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). The CRC project is pursuing funding from two federal agencies: Federal Highway Administration (FHWA) and Federal Transit Administration (FTA). FHWA and FTA are the lead federal agencies, and this Biological Assessment (BA) has been prepared on their behalf. The purpose of this BA is to analyze the project's effects on: (1) species that are federally listed as threatened or endangered, (2) species that are proposed for listing, (3) designated and proposed critical habitat, and (4) essential fish habitat (EFH) in accordance with the Magnuson-Stevens Fishery Conservation Management Act (MSA).

1.1 PURPOSE AND NEED

The project Purpose and Need describes the parameters for project development and decision-making as based on defined problems and issues. It outlines the significance of the I-5 CRC corridor, the project purpose, and the need for the project and reviews the principles used to frame the physical limits and alternatives of the project. Defining the Purpose and Need for a project such as this one is a crucial step in designing and evaluating alternatives under the National Environmental Policy Act (NEPA). The Purpose and Need for this project was developed by relying on previous planning studies, solicitation of public input, and coordination with numerous stakeholder groups.

More than a decade of planning and multiple prior studies have evaluated transportation deficiencies in the I-5 CRC project area. These studies have identified a variety of transportation mobility and safety problems, many of which are being addressed through the I-5 CRC project. Beginning in early 2005 and concentrated in the fall of 2005, the CRC project worked with stakeholder groups and held public meetings to solicit feedback on how the overall goals and objectives of this project should be defined.

The CRC project worked with the community to form the CRC Task Force, a broad group of stakeholders representing the range of interests affected by the project. This group has met regularly with the CRC project team to provide advice and recommendations on all project milestones. In addition, a series of public open houses during the fall of 2005 provided more input from the public regarding how the project should define its goals and objectives.

The CRC project team also worked with many other local, state, and federal agencies to ensure that the purpose of this project would not conflict with other local and regional goals and would not predispose itself to an alternative that would be difficult for agencies to permit or approve. The federal co-lead agencies for this project, FTA and FHWA, were also instrumental in the development of the project's Purpose and Need.

Ultimately, transportation planning studies of the CRC project area provided the underlying scope of this project, while coordination with stakeholder groups, the public, and a variety of local, state, and federal agencies provided important input on how this project should be defined and what problems it seeks to address.

1.1.1 Project Purpose

The purpose of the proposed action is to improve I-5 corridor mobility by addressing present and future travel demand and mobility needs in the CRC Bridge Influence Area (BIA). The BIA extends from approximately Columbia Boulevard in the south to SR 500 in the north (Figure 1-1). Relative to the No-Build Alternative, the proposed action is intended to achieve the following objectives:

- Improve travel safety and traffic operations on the I-5 crossing's bridges and associated interchanges;
- Improve connectivity, reliability, travel times and operations of public transportation modal alternatives in the BIA;
- Improve highway freight mobility and address interstate travel and commerce needs in the BIA; and
- Improve the I-5 river crossing's structural integrity (seismic stability).

1.1.2 Project Need

The specific needs to be addressed by the proposed action include:

- **Growing travel demand and congestion:** Existing travel demand exceeds capacity in the I-5 crossing and associated interchanges. This corridor experiences heavy congestion and delay lasting 4 to 6 hours during the morning and afternoon peak travel periods and when traffic accidents, vehicle breakdowns, or bridge lifts occur. Due to excess travel demand and congestion in the I-5 bridge corridor, many trips take the longer, alternative I-205 route across the river. Spillover traffic from I-5 onto parallel arterials such as Martin Luther King Jr. Boulevard (MLK) and Interstate Avenue increases local congestion. The two crossings currently carry over 260,000 trips across the Columbia River daily. Daily traffic demand over the I-5 crossing is projected to increase by more than 35 percent during the next 20 years, with stop-and-go conditions increasing to approximately 15 hours each day if no improvements are made.
- **Impaired freight movement:** I-5 is part of the National Truck Network, and the most important freight highway on the West Coast, linking international, national, and regional markets in Canada, Mexico, and the Pacific Rim with destinations throughout the western United States. In the center of the project area, I-5 intersects with the Columbia River's deep water shipping and barging as well as two river-level, transcontinental rail lines. The I-5 crossing provides direct and important highway connections to the Port of Vancouver and Port of Portland facilities located on the Columbia River as well as the majority of the area's freight consolidation facilities and distribution terminals. Freight volumes moved by truck to and from the area are projected to more than double over the next 25 years. Vehicle-hours of delay on truck routes in the Portland-Vancouver metropolitan area are projected to increase by more than 90 percent over the next 20 years. Growing demand and congestion will result in increasing delay, costs, and uncertainty for all businesses that rely on this corridor for freight movement.

- **Limited public transportation operation, connectivity, and reliability:** Due to limited public transportation options, a number of transportation markets are not well served. The key transit markets include trips between central Portland and Vancouver and Clark County, trips between north/northeast Portland and Vancouver and Clark County, and trips connecting Vancouver and Clark County with the regional transit system in Oregon. Current congestion in the corridor adversely impacts public transportation service reliability and travel speed. Southbound bus travel times across the bridge are currently up to three times longer during parts of the a.m. peak compared to off-peak. Travel times for public transit using general purpose lanes on I-5 in the BIA are expected to increase substantially by 2030.
- **Safety and vulnerability to incidents:** The I-5 river crossing and its approach sections experience crash rates more than two times higher than statewide averages for comparable facilities. Incident evaluations generally attribute these crashes to traffic congestion and weaving movements associated with closely spaced interchanges. Without breakdown lanes or shoulders, even minor traffic accidents or stalls cause severe delay or more serious accidents. The number of cars using the I-5 crossing is predicted to increase by more than 35 percent by 2030. Accident rates in the CRC project area could double if nothing is done to improve existing conditions (see Figure 1-2).

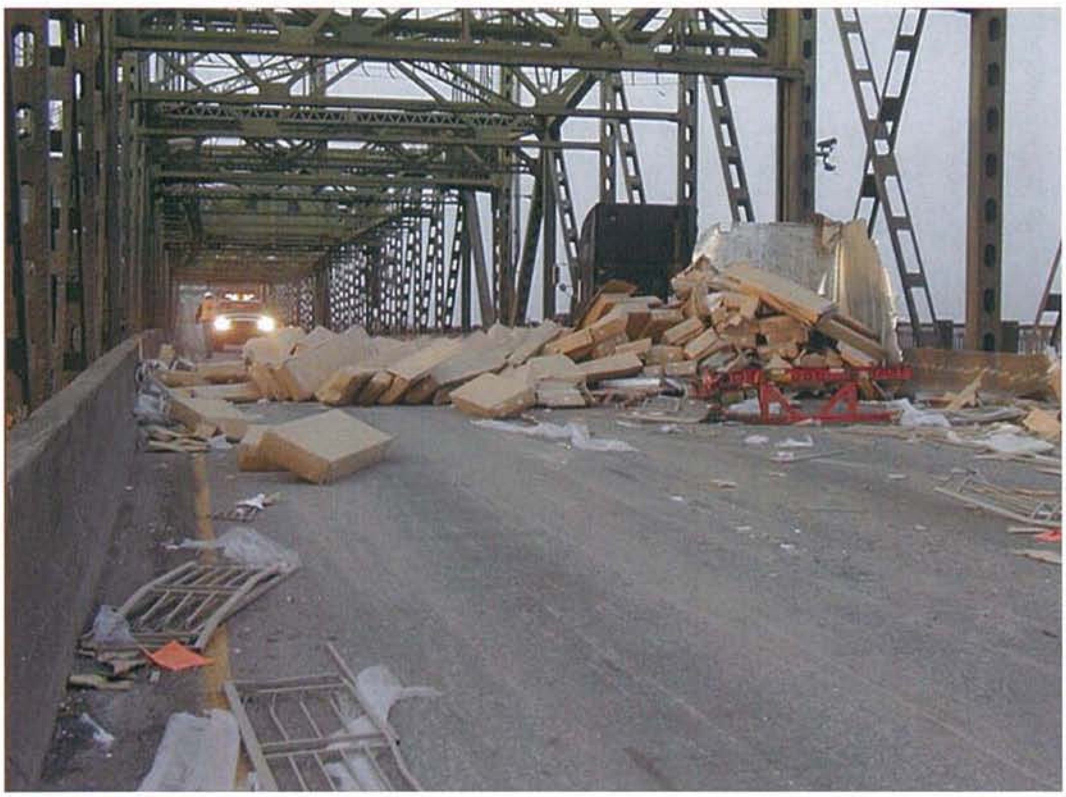

Figure 1-2. Accident Blocking the Existing I-5 Crossing

- **Substandard bike/ped facilities:** The bike/ped lanes on the existing I-5 bridges are about 3.5 to 4 feet wide, narrower than the 10-foot standard, and are located extremely close to traffic lanes, thus impacting safety for bicyclists and pedestrians (see Figure 1-3). Direct bike/ped connectivity is poor in the BIA.
- **Seismic vulnerability:** The existing I-5 bridges are located in a seismically active zone. They do not meet current seismic standards and are vulnerable to failure in an earthquake.

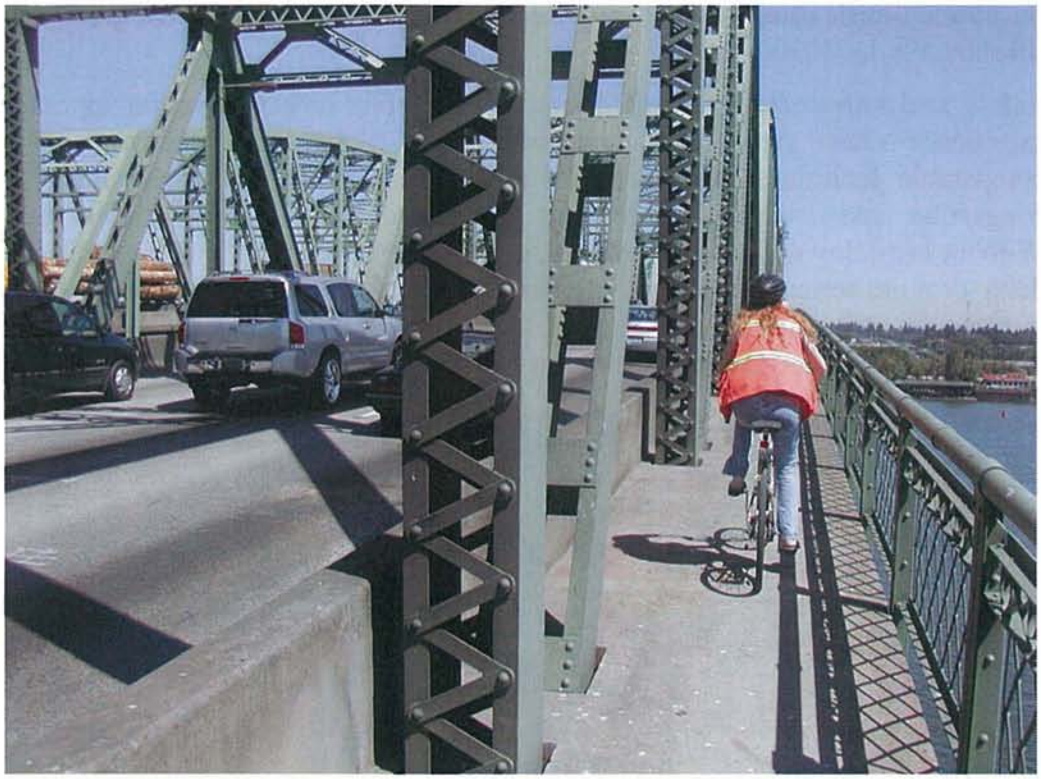

Figure 1-3. Existing I-5 Crossing Bike/Ped Path

1.2 BACKGROUND

The primary federal nexus for this project is federal funding from FHWA and FTA through the Oregon Department of Transportation (ODOT), Washington State Department of Transportation (WSDOT), Clark County Public Transit Benefit Area Authority (C-TRAN), and Tri-County Metropolitan Transportation District of Oregon (TriMet). The CRC office in Vancouver, Washington, was established by WSDOT and ODOT to coordinate project management and administration between the state agencies, and is therefore considered the project proponent. Table 1-1 provides a broad project summary.

Table 1-1. Project Summary

Project Name:	Columbia River Crossing
Location of Project:	I-5 from Oregon milepost (MP) 305.9 to Washington MP 3.1 2.5 mile extension of the existing MAX Yellow line from the Expo Center station across North Portland Harbor, over Hayden Island, across Columbia River, and through downtown Vancouver ending at Clark College.
Watershed and Hydrologic Unit Code (HUC) Field (5th and 6th):	Columbia Slough/Willamette River, Willamette River/Columbia River: 170900120301 Salmon Creek, Vancouver: 170800010901 Hayden Island/Government Island/Mainstem Columbia: 170800030701 Lower Hood River: 170701051202 (compensatory mitigation site) Mouth of Lewis River: 170800020605 (compensatory mitigation site)
Water Resource Inventory Area (WRIA):	Salmon/Washougal WRIA #28
USGS Quadrangle Map Location:	Portland Vancouver T2N R1E S34
Size of Action Area:	Approximately 8,214 acres near project site Approximately 22.2 million acres including killer whale distribution
City:	Portland, OR Vancouver, WA
County:	Multnomah, Oregon Clark, Washington Hood River, Oregon (compensatory mitigation site)
Project Staff:	Heather Wills – CRC Environmental Manager Sharon Rainsberry – CRC Environmental Team Steve Morrow – CRC Environmental Team Jeff Heilman – CRC Environmental Team Bill Hall, Jenny Lord, Michelle Guay, Mike Parton –BA Authors Tina Farrelly – Wetland Delineation and Botany Surveys
Site Visits:	Habitat Assessment: September 1–16, 2005 Rare Plant Survey: June 23, 2006; July 25–27, 2006; July 31, 2006; August 1, 2006; and August 17, 2006
Site Access Permission:	Generally not granted by landowners at this time if site extends past Department of Transportation (DOT) right-of-way; CRC staff retains information on rights of entry.
Current Land Uses:	Urban
Waterways:	Columbia River (includes North Portland Harbor) Columbia Slough Burnt Bridge Creek Lewis River and Hood River (compensatory mitigation sites)
River Mile (River Kilometer):	RM 106 (RKm 171) of the Columbia River RM 9 (RKm 15) of the Columbia Slough RM 2 (RKm 3) of Burnt Bridge Creek RM 1 (RKm 2) of Hood River (compensatory mitigation site) RM 0.2 (RKm 0.3 of Lewis River (compensatory mitigation site)

Prior Correspondence:	InterCEP was formed in 2005 to provide regular communication between project staff and federal, state, and local regulatory agencies. Approximately 40 meetings with the full InterCEP group or specialty subgroups were conducted. Further information on dates of those meetings, attendance, and topics discussed is included in Appendix G.

This BA was developed in collaboration with NMFS, USFWS, and representatives from federal and state environmental regulatory agencies collectively known as the Interstate Collaborative Environmental Process (InterCEP), a group formed specifically to coordinate regulatory and permitting compliance for this project. Members of this group include: FHWA, FTA, USFWS, NMFS, U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (EPA), ODOT, WSDOT, Oregon Department of Environmental Quality (DEQ), Washington State Department of Ecology (Ecology), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Oregon Department of Land Conservation and Development (DLCD), Oregon Department of State Lands (DSL), Washington State Department of Archaeology and Historical Preservation (DAHP), and Oregon State Historic Preservation Office (SHPO). A total of 40 InterCEP/pre-BA meetings were held between August 2005 and the submittal of this BA on June 24, 2010; most meetings were held at the CRC project office in Vancouver; other meetings were located at the WSDOT region office in Vancouver. See Appendix G for the meeting minutes and lists of meeting attendees. Coordination efforts between project proponents and InterCEP representatives were initiated in 2005 and are planned to continue through issuance of the Biological Opinion (BO).

The InterCEP group helped guide the CRC project team during development of this BA, as well as during development of the draft environmental impact statement (DEIS), released for public review in May 2008. After publication of the DEIS and consideration of public comments, the elected or appointed bodies of the project's six local partners (TriMet Board, C-TRAN Board, Portland City Council, Vancouver City Council, Metro Council, and Southwest Washington Regional Transportation Council [RTC] Board) selected a replacement I-5 bridge with light rail to Clark College as the project's locally preferred alternative (LPA). The LPA is the project proposed in this BA. The selection of one alternative for further analysis represents regional consensus on a comprehensive solution for the problems on I-5 between Vancouver and Portland. The CRC project team will continue working closely with the public and project partners to refine the LPA and to address additional board and council recommendations. The InterCEP group is continuing to help inform the project team in advance of the final EIS, which is expected to be released in summer 2010.

1.3 SPECIES AND CRITICAL HABITAT

Table 1-2 lists the species addressed in this consultation.

Table 1-2. Species Addressed

Common Name	Scientific Name	ESU or DPS (Federal ESA Status)[a]
Chinook salmon	*Oncorhynchus tshawytscha*	Lower Columbia River ESU (Threatened)
		Upper Columbia River Spring-Run ESU (Endangered)

Common Name	Scientific Name	ESU or DPS (Federal ESA Status)[a]
		Upper Willamette River (Threatened)
		Snake River Fall-Run ESU (Threatened)
		Snake River Spring/Summer-Run ESU (Threatened)
Steelhead	*O. mykiss*	Lower Columbia River DPS (Threatened)
		Middle Columbia River DPS (Threatened)
		Upper Columbia River DPS (Endangered)
		Upper Willamette River (Threatened)
		Snake River DPS (Threatened)
Sockeye salmon	*O. nerka*	Snake River ESU (Endangered)
Coho salmon	*O. kisutch*	Lower Columbia River ESU (Threatened)
Chum salmon	*O. keta*	Columbia River ESU (Threatened)
Bull trout	*Salvelinus confluentus*	Columbia River DPS of Conterminous U.S. (Threatened)
Northern (Steller) sea lion	*Eumetopias jubatus*	Eastern DPS (Threatened)
Green sturgeon	*Acipenser medirostris*	Southern DPS (Threatened)
Killer whale	*Orcinus orca*	Southern Resident Population (Endangered)
Eulachon	*Thaleichthys pacificus*	Southern DPS (Threatened)

[a] ESU = Evolutionarily Significant Unit; DPS = Distinct Population Segment.

Table 1-3 lists the designated and proposed critical habitats addressed in this consultation.

Table 1-3. Critical Habitats Addressed

Species	Waterway or Geographic Extent
Chinook salmon (runs listed above)	Lower Columbia River, North Portland Harbor, Columbia Slough[a], Lewis River, and Hood River within the action area
Steelhead (runs listed above)	Lower Columbia River, North Portland Harbor, Columbia Slough[a], Lewis River, and Hood River within the action area
Sockeye salmon(run listed above)	Lower Columbia River and North Portland Harbor within the action area
Chum salmon (run listed above)	Lower Columbia River, North Portland Harbor, and Lewis River within the action area
Bull trout (population listed above)	Proposed in the lower Columbia River, North Portland Harbor, Lewis River, and Hood River within the action area

[a] Critical habitat within the Columbia Slough is designated for Lower Columbia River Chinook salmon and steelhead ESUs.

1.3.1 Essential Fish Habitat

Essential fish habitat (EFH) for Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) (under the Pacific salmon EFH designation) is present within the action area. Designated EFH for Pacific Coast groundfish and Pacific Coast-Coastal Pelagic Species will not be affected by the proposed project. Effects to EFH are addressed in Section 9 of this BA.

1.3.2 Species Not Addressed in this Document

USFWS provides a regularly updated list of species that are listed under the ESA for each county in Oregon and Washington. The following species are included on the lists for Clark, Multnomah, and Hood River Counties, but are not addressed in this BA because no suitable habitat occurs within the action area:

- Columbian white-tailed deer (*Odocoileus virginianus leucurus*) Columbia River DPS
- Northern spotted owl (*Strix occidentalis caurina*)
- Gray wolf (*Canis lupus*)
- Golden paintbrush (*Castilleja levisecta*)
- Willamette daisy (*Erigeron decumbens* var. *decumbens*)
- Nelson's checkermallow (*Sidalcea nelsoniana*)
- Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*)
- Water howellia (*Howellia aquatilis*)
- Bradshaw's desert parsley (*Lomatium bradshawii*)
- Golden paintbrush (*Castilleja levisecta*)

Additionally, the plant species were not observed during surveys conducted in 2006. Appendix M outlines the rationale behind the No Effect determination for these species.

Section 2

Section 2

SECTION 2

What does this section present?

This section presents how CRC evaluated potential project effects on federally listed species and critical habitats. BAs must use the "best available scientific and commercial information" to analyze project effects. The project team gathered and analyzed information from a variety of sources, including previously prepared environmental reviews, biological assessments, biological opinions, peer-reviewed literature, field reconnaissance, and personal communication with local, state, and federal agency biologists and resource experts. CRC used an analytical framework to evaluate how habitat and species (individuals and populations) are exposed to project impacts. First, effect pathways were identified. Then, potential species exposure and response to the pathways were defined.

2. EVALUATION METHODS

2.1 ANALYTICAL FRAMEWORKS USED

The potential effects of the proposed action were evaluated by first defining the effects pathways from individual project elements and the elements of any interrelated and interdependent actions. These include project elements or actions with effects to habitat, individuals, and populations. Effect pathways include soil, air, water, vegetation, and river substrate.

Project impacts were further evaluated by considering the potential exposure of each species to an effect pathway and the species' expected response. Similarly, project impacts to critical habitat were evaluated by considering the potential exposure of each primary constituent element (PCE) to disturbance and the expected effect to habitat function. The analysis considered: proximity of each action to listed species and habitat; distribution of the species and habitat within the action area; timing and duration of the exposure; the nature of the effect (e.g., harassment, displacement, injury, mortality); and the disturbance frequency, intensity, and severity. Both short-term and long-term effects were considered. Finally, the analysis considered the resultant potential exposure to species and PCEs in the context of the limiting factors described within the recovery plans for each basin or the Technical Review Team reports.

Environmental performance measures were developed with the goal to avoid or minimize adverse effects to individuals and habitat. These best management practices (BMPs) and impact avoidance and minimization measures are included as a nondiscretionary part of the proposed action.

2.2 INFORMATION GATHERING

The project team conducted literature reviews and field reviews of listed species and aquatic, riparian, and terrestrial habitat features and conditions within the project area. Existing data, including previously prepared environmental reviews, biological assessments, biological opinions, and peer-reviewed literature, were also gathered and incorporated into the analysis.

The following process was used to collect fish, wildlife, and botanical resource data:

1. Collected a list of species and their habitats within the project area. These data were obtained from the Oregon Natural Heritage Information Center (ORNHIC); USFWS; NMFS; WDFW; the Washington Department of Natural Resources, Natural Heritage Program (WDNR-NHP); StreamNet; and WDFW's SalmonScape.
    - Procured species lists every 3 to 6 months from NMFS and USFWS (see Appendix L).
    - Contacted federal, state, and local agencies, and local biologists and experts. These communications are cited as personal communications in the occurrence and effects sections of this BA. Citations for these communications are provided in the reference section of the BA and include the date, name, and title of the contacted source.
    - Conducted a scientific literature review of studies, plans, and reports prepared by local, state, and federal agencies and private organizations for information on species and habitats that may occur within the project area.

2. Determined listed species habitat requirements.
   - Examined studies, plans, and reports and consulted with local biologists and federal, state, and local agencies.
   - Determined if critical habitat is designated or proposed for each listed species potentially occurring within the action area. Identified and evaluated PCEs potentially occurring in action area for species with designated or proposed critical habitat.
3. Determined existing habitat types and their associated species.
   - Obtained aerial photography to identify habitat types.
   - Obtained geographical information system (GIS) maps of habitats, documented species locations, locally protected zones, critical habitats, and other ecological features. Such resource classifications include EFH (NMFS), regionally significant habitat (Metro), ESH (DSL), priority habitats (WDFW), critical areas (City of Vancouver), and environmental zones (City of Portland).
4. Conducted field reconnaissance in the appropriate seasons to assess the presence of listed botanical species and all species' associated habitats within the project area and the role the habitats play in the species' life histories.
   - Conducted windshield surveys for habitats classified as non-urban, based on the Johnson and O'Neil (2001) species/habitat matrix.
   - Quantified habitat types and boundaries.
   - Used the Johnson and O'Neil (2001) species/habitat matrix to determine the species most likely to be present in these habitats.
   - Conducted rare plant surveys using the intuitive controlled method (BLM 1998).
5. Characterized aquatic and terrestrial habitats for features important to listed species.
   - Evaluated streams for their potential to support fish and other aquatic resources.
   - Aquatic characteristics of interest included water quality, substrate composition, bank stability, channel condition, fish passage, and riparian conditions. Surveyed riparian corridors for fish and wildlife habitat elements at the I-5 crossing of the Columbia River, North Portland Harbor, and Columbia Slough. Burnt Bridge Creek was surveyed where it runs parallel to I-5 at the northern boundary of the project area. Surveyed habitat elements include vegetation type and density; stream characteristics; and piers, footings, riprap, and other structures below the ordinary high water line (OHW).
6. Compiled lists and maps of observed listed species, habitats, protected habitats, and rare plants.

Section 3

Section 3

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SECTION 3

What does this section present?

Section 3 provides a thorough description of each project component, including the locations of secondary project features. Estimates are provided for various project elements such as the number of piles driven and assumed methods for activities such as pile installation are discussed. The impact of the various project elements and activities are considered in our analysis of direct and indirect effects in Section 6. An abbreviated summary of project element totals is provided below.

Summary of Major In-Water Construction Elements in the Columbia River and North Portland Harbor

Project Element	Columbia River Total	North Portland Harbor Total	Project Total
Permanent Impacts			
In-Water Piers or Bents (widened or new)	6	20	**26**
In-Water Piers Removed	11	0	**9**
Shafts	88	29	**117**
Shaft Caps	12	0	**12**
Net Change in Pollutant-Generating Impervious Surfaces	N/A	N/A	**Approx. +18 acres**
Net Change in Pollutant-Generating Surfaces Discharged Untreated	N/A	N/A	**Approx. -168 acres (168 acres newly treated)**
Temporary Impacts			
Cofferdams	11	0	**11**
Pipe Piles			
Load Bearing 18"-24"	600	225	**825**
Load Bearing 36"-48"	240	124	**364**
Non-Load Bearing 18"-24"	384	216	**600**
Total	**1,224**	**565**	**1,789**
Work Platforms, Bridges, and Support Structures	18	40	58
Barges	Up to 12 (at a single time)	Up to 9 (at a single time)	**Up to 21 (at a single time)**

Where is the project located and what are the key construction components?

The CRC project is a multimodal transportation project along a 5-mile section of the I-5 corridor connecting Vancouver, Washington, and Portland, Oregon. The project includes an extension of the Yellow LRT line from the Expo Center in Portland through downtown Vancouver to Clark College in Vancouver. The project area stretches from SR 500 in northern Vancouver, south through downtown Vancouver, and over the I-5 bridges across the Columbia River to just north of Columbia Boulevard in north Portland.

The project proposes to:

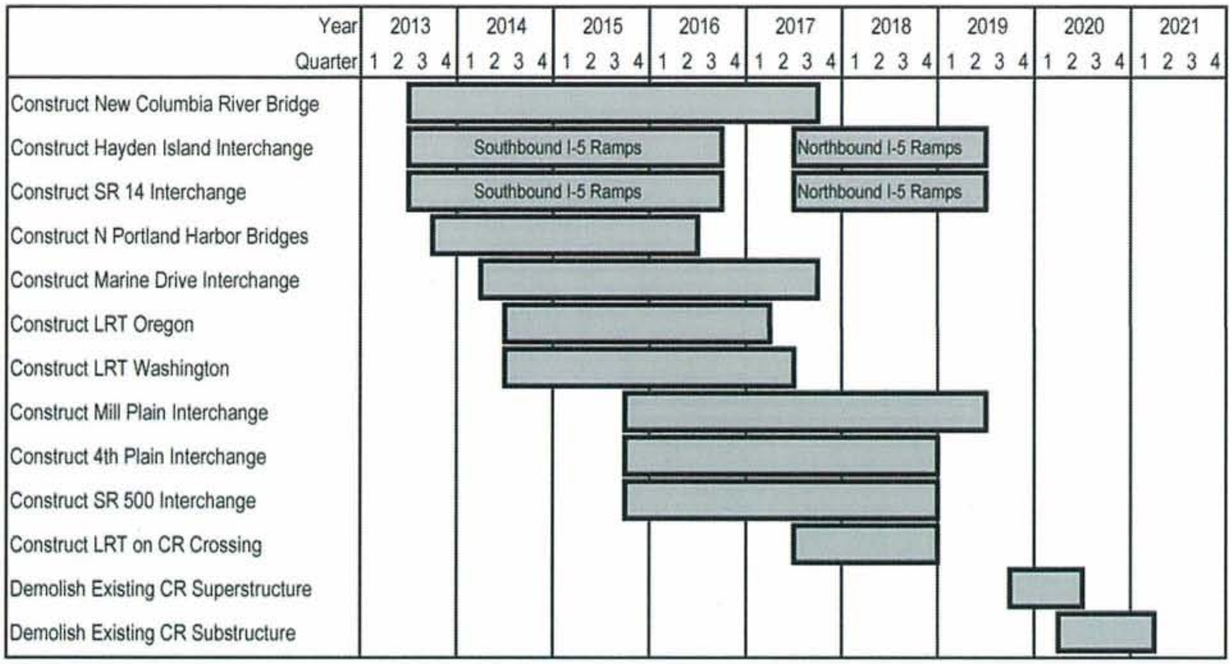
- Construct two new bridge structures over the Columbia River.
- Widen the existing North Portland Harbor bridge and construct three additional structures across the harbor.
- Improve seven interchanges along I-5 in Portland and Vancouver.
- Improve highway safety and mobility along I-5 in Portland and Vancouver.
- Extend LRT from north Portland to downtown Vancouver.
- Add improved bike/ped access on the new bridges and surrounding areas.
- Construct three new park and ride facilities in Vancouver.
- Expand the Ruby Junction Maintenance Facility to accommodate additional LRT vehicles.
- Demolish the existing Columbia River bridges.

Where will construction work occur?

Construction will occur in and over the Columbia River and North Portland Harbor in deep-water and nearshore areas. Three interchanges in Oregon and four interchanges in Washington will be rebuilt along a contiguous 5-mile corridor of I-5. Light rail infrastructure will be constructed from the Expo Center, across North Portland Harbor, Jantzen Beach (Hayden Island), and the Columbia River into Vancouver. LRT will be constructed through Vancouver to its terminus at Clark College. Stormwater treatment facilities will be built to manage and treat stormwater runoff from project elements. Stormwater treatment facilities will be located adjacent to the roadways and LRT guideways as appropriate. Additional construction activities will occur at the Ruby Junction Maintenance Facility in Gresham, Oregon. Habitat restoration activities will occur along the Lewis River near its ***confluence*** with the Columbia River and near river mile (RM) 1.5 of the Hood River.

When is construction planned?

Construction could start as early as fall 2012, but the sequencing of project elements allow for the project to begin any time after fall 2012. As shown in the figure below, construction of the Columbia River and North Portland Harbor bridges sets the sequencing for other project components. The Columbia River bridges and immediately adjacent highway improvements will require the longest construction timelines. Construction will begin with the Columbia River bridges, though other elements of the project will be started well before these bridges are finished.



CR = Columbia River; LRT = Light Rail Transit; N = North; SR = State Route

Representative Schedule of CRC Construction Activities

What defines this project's action area?

The action area consists of all areas to be affected directly and indirectly by the federal action. The CRC project action area includes different geographic extents for terrestrial and aquatic resources. The terrestrial portion of the action area includes those areas experiencing land use and traffic changes, and construction noise. The aquatic portion of the action area is composed of the farthest reaching extent of in-water noise from pile driving, stormwater runoff, and potential turbidity impacts. In addition, due to the potential impacts on Chinook salmon and the reliance by Southern Resident killer whales on Chinook as prey, the aquatic portion of the action area encompasses the overlap between Chinook and the Southern Resident killer whale population in the Pacific Ocean.

3. PROJECT DESCRIPTION

3.1 BACKGROUND

As described in Section 1, the I-5 CRC project is a multimodal transportation project focused on improving safety, reducing congestion, and increasing mobility of motorists, freight, bicyclists, and pedestrians along a 5-mile section of the I-5 corridor connecting Vancouver, Washington and Portland, Oregon, and extending the Yellow Line MAX from Delta Park in Portland to Clark College in Vancouver. The project area stretches from SR 500 in northern Vancouver, south through downtown Vancouver and over the I-5 bridges across the Columbia River to just north of Columbia Boulevard in north Portland (Figure 3-1).

The project proposes to:

- Replace the existing Columbia River bridges with two new structures.
- Widen the existing North Portland Harbor bridge and construct three additional structures across the harbor.
- Improve seven interchanges and roadways along and adjacent to I-5 in Portland and Vancouver.
- Improve highway safety and mobility along I-5 in Portland and Vancouver.
- Extend LRT from north Portland to downtown Vancouver.
- Add improved bike/ped access on the new bridges and surrounding areas.
- Construct three new park and ride facilities in Vancouver.
- Expand the Ruby Junction Maintenance Facility to accommodate additional LRT vehicles.
- Construct stormwater BMPs and provide a high level of stormwater runoff treatment.
- Demolish existing Columbia River bridges.

3.2 PROJECT AREA

The project area is defined as all areas that will be directly impacted by the project, including the footprint of the permanent and temporary structures, widened highway segments, new interchanges, city street realignments, associated road shoulder excavation and fill areas, stormwater facilities, areas contributing runoff to the stormwater facilities, wetland mitigation areas, and staging and access areas, including areas in the Columbia River and North Portland Harbor where work will occur from barges and temporary structures. The project area described is the immediate area involved in the action and is not equivalent to the "Action Area" defined in Section 3.15, a term required under the ESA to describe the area affected by the action.

Figure 3-1. Highway and Transit Elements Near the Columbia River

Columbia River CROSSING

Along the I-5 corridor, the project area extends 5 miles from north to south, beginning at the I-5/SR 500 interchange in Vancouver, Washington, and extending to the I-5/Victory Boulevard in Portland, Oregon (Figure 3-1). At its northern end, the project area extends west into downtown Vancouver and east to near Clark College to include high-capacity transit alignments, transit stations, park and ride locations, and city road improvements included as part of this project. Heading south along the existing over-water bridge alignments, the project area extends 0.25 mile on either side of the bridges to include the new Columbia River and North Portland Harbor bridges, as well as the adjacent areas where construction and demolition activities will occur. At its southern end, the project area extends east into Portland and includes city road improvements along Victory Boulevard.

The project area includes potential staging and casting yards at the Port of Vancouver, Alcoa/Evergreen, Sundial, Red Lion at the Quay, and Thunderbird Hotel staging sites (Figure 1-1). In Gresham, the project area includes a 10.5-acre expansion of the Ruby Junction Maintenance Facility. Along the Hood River in Oregon and along the Lewis River in Washington, the project area includes compensatory mitigation sites.

The project area described here includes all associated cut and fill slopes and stormwater treatment facilities.

3.3 PROJECT DESIGN HISTORY

The project presented in this BA is a result of a conscious effort by the design team to minimize impact to aquatic species and their habitats through multiple design refinements. The major design changes incorporated into the project description are listed in the items 1 through 3 below. In addition, the project has chosen a conservative treatment method for stormwater. This methodology is listed in item 4.

Throughout the development process, the project has made a number of major design changes to minimize impacts to the environmental baseline including the following:

1. The permanent in-water piers of the Columbia River and North Portland Harbor crossings will be constructed using drilled shafts, rather than with impact pile driving. Originally, the project proposed to drive numerous 96-inch steel piles, involving over 200 days of in-water impact pile driving and creating noise levels that will far exceed injury thresholds for listed fish throughout large portions of the Columbia River and North Portland Harbor within the action area. The current design significantly reduces the amount of impact pile driving, the size of the piles, and the amount of in-water noise. Drilled shafts have been minimized from 16 shafts per pier in the original design to a maximum of nine shafts per pier in the current design.

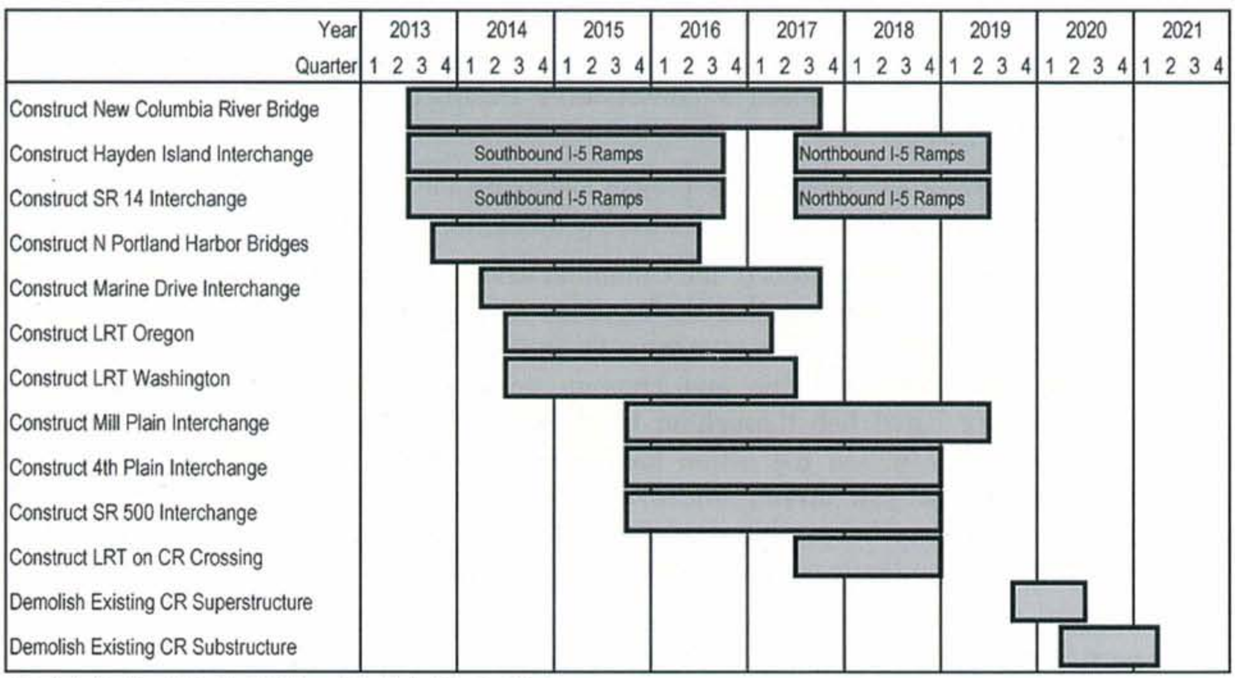
2. Earlier alternatives considered three bridges across the Columbia River: one for I-5 northbound traffic, one for I-5 southbound traffic, and one for LRT and bike/ped traffic. The current design proposes a stacked alignment, with LRT conveyed under the deck of the southbound structure and a bike/ped path beneath the northbound structure. This design reduces the number of in-water piers in the Columbia River by approximately one-third, and greatly reduces both the temporary construction impacts and the permanent effects of in-water piers.

3. The project proposes six in-water pier complexes for a total of 12 piers for the Columbia River bridges. Earlier designs considered up to 21 in-water piers, but the design has been refined to the minimum number necessary for a safe structure. Piers have been designed to withstand the design scour without armor-type scour protection (e.g., riprap).

4. The project provides a high level of stormwater treatment. The project area intersects several jurisdictions, each of which has different standards for stormwater treatment. The CRC project team will employ the most restrictive water quality requirements project-wide, meaning that in many cases, the level of stormwater treatment exceeds that of the local jurisdiction. In addition to treating the new impervious surfaces created by the project, the project has identified approximately 188 acres of existing impervious surfaces that will be retrofitted to meet current stormwater treatment standards. Together, these measures are expected to reduce impacts to the environmental baseline to a greater degree than by using the standards of the individual jurisdictions.

3.4 TIMELINE AND SEQUENCING

As shown in Figure 3-2, construction of the Columbia River and North Portland Harbor bridges sets the sequencing for other project components. The Columbia River bridges and immediately adjacent highway improvements will require the longest construction timelines. Construction will begin with the Columbia River bridges, though other elements of the project will be started well before these bridges are finished.



CR = Columbia River; LRT = Light Rail Transit; N = North; SR = State Route

Figure 3-2. Representative Schedule of CRC Construction Activities

The estimated start date for construction is 2013; the estimated end date is 2021. Funding will be a large factor in determining the overall sequencing and construction duration. Contractor schedules, weather, materials, and equipment could also influence construction duration.

Figure 3-2 provides an overview of the anticipated project timeline and sequencing of project elements. Table 3-1 summarizes the estimated interchange construction schedule timelines.

Table 3-1. Estimated Interchange Construction Schedule Timelines

Interchange	Partial Interchange Including Southbound Approaches (years)	Full Interchange (years)	Interchange Completion (total years)
SR 14	2.5	1.5	**4**
Hayden Island	1.5	2.5	**4**
Marine Drive and Victory Blvd	N/A	3	**3**
Mill Plain Blvd	N/A	3.5	**3.5**
Fourth Plain Blvd	N/A	2.7	**2.7**
SR 500/39th Street	N/A	4	**4**

The following provides a brief overview of the major construction sequencing issues. To the extent practicable, the timing of in-water work has been tailored to minimize impacts to aquatic species.

Columbia River Bridges Construction. The project will build two new spans over the Columbia River. The general sequence of bridge construction includes the following steps:

- **Initial preparation**: Mobilize construction materials, heavy equipment, and crews; prepare staging areas.
- **Installation of temporary in-water work structures**: Install temporary piles for work bridges and work platforms that will support construction equipment.
- **Installation of foundation shafts**: Drill and install shafts to support columns and superstructure.
- **Shaft caps**: Construct and anchor concrete foundations on top of the shafts to support pier columns.
- **Pier columns**: Construct or install pier columns on the shaft caps.
- **Bridge superstructure**: Build or install the horizontal structure of the bridge spans across the piers. The superstructure will be steel or reinforced concrete. Concrete will be cast-in-place or precast off site and assembled on site (Section 3.5).

North Portland Harbor Bridges Construction. The project will build three new spans and widen one existing span over North Portland Harbor. The general sequence of bridge construction includes the following steps:

- **Initial preparation**: Mobilize construction materials, heavy equipment, and crews; prepare staging areas.
- **Installation of temporary in-water work structures**: Install temporary piles for work bridges and work platforms that will support construction equipment.
- **Installation of foundation shafts**: Drill and install shafts to support structures.
- **Bent columns**: Construct or install bent columns on the drilled shafts.

- **Bridge superstructure**: Build or install the horizontal structure of the bridge spans across the bents. The superstructure will be steel or reinforced concrete. Concrete will be precast off site and assembled on site (Section 3.5).

SR 14 and Hayden Island Interchange Construction. Proper sequencing of interchange construction, particularly of construction of the SR 14 and Hayden Island interchanges, is critical to maintain traffic flow across the river during the entire project. Interchanges on each side of the bridge must be partially constructed before any traffic can be transferred onto the new structure. For the SR 14 interchange, it will take approximately 2.5 years to complete the southbound approaches and ramps and to allow traffic onto the new southbound Columbia River bridge (Table 3-1). Completion of the rest of the interchange will require approximately 1.5 additional years. For the Hayden Island interchange, it will require approximately 1.5 years to complete the southbound approaches needed to allow traffic onto the new southbound Columbia River bridge and approximately another 2.5 years to complete the full interchange. Both interchanges will need to be completed at the same time in order to move traffic onto the new southbound lanes and to allow construction of the remaining northbound lanes and ramps.

Marine Drive and Victory Boulevard Interchange Construction. Like the SR 14 and Hayden Island interchanges, construction of the Marine Drive interchange will require coordination with construction of the Columbia River bridge southbound lanes. Specifically, the use of the southbound collector-distributor (CD) system (Figure 3-13) requires the work to occur in the same period. Without construction of a new Marine Drive interchange, the light rail system cannot be completed as currently designed. The Marine Drive interchange is expected to take 3 years to construct, including work at the Victory Boulevard interchange.

Mill Plain Boulevard, Fourth Plain Boulevard, and SR 500/39th Street Interchange Construction. These three interchanges can be constructed independently. It will be most efficient to complete all highway construction north of SR 14 concurrently. Detours of I-5 around the SR 500/39th Street interchange will also facilitate efficient construction in this area. All three interchanges can be constructed in 4 years. More aggressive and costly staging could shorten this timeframe.

Demolition of Existing Bridges. Demolition of the existing river crossing structures is expected to take approximately 1.5 years. It can begin after traffic is rerouted to the new Columbia River bridges. However, work must be completed at the SR 14 and Hayden Island interchanges before the existing bridge can be demolished. The new northbound bridge and the northbound off-ramp to SR 14 must be completed and opened before traffic can be routed to the new bridges.

Ruby Junction Maintenance Facility Expansion. Expansion of the Ruby Junction Maintenance Facility is scheduled to begin in 2015.

Light Rail Construction. Light rail construction will require about 4 years for completion. LRT will use the southbound bridge across the Columbia River, and will be on a new, separate structure over North Portland Harbor. Any bridge structure work will be separate from the actual light rail construction activities and must be completed first. As noted, there are some staging considerations for the Marine Drive interchange construction. If not coordinated, design changes or temporary connections will be necessary to open the line.

3.5 IN-WATER AND OVER-WATER BRIDGE CONSTRUCTION

New bridges will be constructed over the Columbia River and North Portland Harbor, a side channel of the Columbia River. See Section 5.2 for a discussion of existing conditions.

3.5.1 Overview

3.5.1.1 Columbia River Bridges

The existing structures over the Columbia River consist of two separate bridges that are functionally obsolete (i.e., the existing configuration does not meet current bridge standards and traffic demand). The existing structures include lift spans that must be raised for certain river traffic, and that causes automobile traffic delays when lifted. Each has three lanes, substandard shoulders, and a bike/ped sidewalk that does not meet current Americans with Disabilities Act (ADA) accessibility standards.

The new Columbia River crossing will carry traffic on two separate bridges and include a new LRT line and improved bike/ped facilities. Each new bridge will carry three through-travel lanes and two to three auxiliary lanes for traffic entering and exiting the highway in each direction, as well as full standard safety shoulders. The eastern structure will carry northbound traffic on its upper deck, with bike/ped traffic below; the western structure will carry southbound traffic on its upper deck, with LRT below. Both existing bridges will be removed after the new bridges are constructed and related interchange work is completed.

The new bridges will be subject to multiple clearance constraints. Vertical clearances underneath the bridges must accommodate river traffic below. The project team, in consultation with the USCG and industry representatives, established a vertical minimum of 95 feet of clearance for the new bridges, so that the new structure could be built without a lift span. In addition, the bridges must not be so high as to interfere with flights from Portland International Airport (PDX) and Pearson Field, a historic airport just to the east of the project area. The top of deck of the new bridges will range in elevation from approximately 100 to 135 feet (North American Vertical Datum of 1988 [NAVD88]) over the Columbia River. Because of these elevation restrictions and the need to construct curved structures to match existing on-land infrastructure, suspension or cable-stay bridge designs are not practicable.

The new structures over the Columbia River will not include lift spans, allowing more free-flowing automobile and river traffic. In addition, grades on the proposed structure will meet current ADA standards for pedestrian accessibility.

3.5.1.2 North Portland Harbor Bridges

The project will widen the existing I-5 southbound bridge over North Portland Harbor and will add three new bridges adjacent to the existing bridges. Starting from the east, these structures will carry:

- A three-lane northbound CD ramp carrying local traffic from North Portland to Hayden Island.
- Northbound and southbound I-5 on the widened existing bridge across the North Portland Harbor with three through lanes and one auxiliary lane each.

- A southbound CD ramp with two through lanes and one merging lane. This structure will carry local traffic from Hayden Island to North Portland.
- LRT combined with a bike/ped path.

The bottom of the bridges over North Portland Harbor will be at approximately 40 to 45 feet elevation (NAVD88). The structures over North Portland Harbor do not and will not include lift spans.

3.5.1.3 Summary of Bridge Construction Timing

The ODFW- and WDFW-specified in-water work window for this portion of the Columbia River and North Portland Harbor is November 1 through February 28. Because of the large amount of in-water work involved, this project will not be able to complete the in-water work during this time period. Therefore, the project will request a variance to the published in-water work window. Some in-water construction activities are proposed to occur year-round, as shown in Table 3-2. Activities taking place outside of the normal in-water work will occur in coordination with ODFW, WDFW, NMFS, and USFWS and in compliance with the terms and conditions of all regulatory permits obtained for this project. Table 3-3 shows the proposed timing of activities that are *not* considered in-water work activities. Section 3.5.2 includes explanations of various structural terms such as shaft caps, etc.

Table 3-2. Proposed Timing of In-Water Work in the Columbia River and North Portland Harbor

Activity	Description	Activity Duration (2013-2021)	Timing
1. Install small-diameter piles (≤48") with impact methods.[a]	Small-diameter piles will be used in the construction of temporary work bridges/platforms, tower cranes, and oscillator support platforms.	Up to 1 hour/day (impact hammer operation). 138 days in CR, 134 days in NPH.	Only within approved extended in-water work window of September 15 through April 15 each year.
2. Install small-diameter piles (≤48") with non-impact methods.	Small-diameter piles will be used in the construction of temporary work bridges/platforms, barge moorings, tower cranes, and oscillator support platforms.	Length of work day is subject to local noise ordinances, however could be up to 24 hours/day. 138 days in CR, 134 days in NPH.	Year-round provided work does not violate water quality standards.
3. Extract small-diameter piles (≤48") (not including cofferdams).	Removal of small-diameter piles will be done using vibratory equipment or direct pull.	Length of work day is subject to local noise ordinances, however could be up to 24 hours/day.	Year-round provided work does not violate water quality standards.
4. Install/remove cofferdam for construction of Columbia River bridges.	Used to construct piers nearest to shore in the Columbia River (pier complexes 2 and 7). Steel sheet pile sections to be installed by non-impact means to form a cofferdam. Sheet pile removal can be direct pull or use a vibratory hammer.	Cofferdams could be in place for a maximum of 250 work days each. Installation and dewatering of each cofferdam will not take more than 65 workdays; cofferdam removal will not take more than 25 workdays. Length of work day is subject to local noise ordinances.	Year-round provided work does not violate water quality standards.
5a. Install large-diameter drilled shaft casings (≥72") using vibratory hammer, rotator, or oscillator outside of a cofferdam.	Used to construct piers and bents not immediately adjacent to shore in the Columbia River and North Portland Harbor.	CR: 110 – 120 days / pier complex NPH: ~8 days/shaft	Year-round provided work does not violate water quality standards.
5b. Install large-diameter drilled shaft casings (≥72") using vibratory hammer, rotator, or oscillator inside of a water- or sand-filled cofferdam.	Used to construct piers and bents nearest to shore in the Columbia River and North Portland Harbor.	CR PC 2 and PC 7: ~84 days each NPH: ~ 8 days/shaft	Year-round provided work does not violate water quality standards.
6. Clean out shafts and place reinforcing, concrete inside steel casings.	Applies to all piers and shafts. All activities/materials will be contained within the casings and have no contact with the water.	CR: 110 – 120 days / pier complex NPH: ~8 days/shaft	Year-round provided work does not violate water quality standards.

Activity	Description	Activity Duration (2013-2021)	Timing
7a. Perform placement of reinforcement and concrete for a cast-in-place pile cap.	Possible construction method for shaft cap at pier complexes 2 and 7. All activities and materials will be contained within forms and will have no contact with the water. The bottom of the pier caps may sit below the mud line.	Estimate 95 work days per pier.	Year-round. For pier caps nearest shore: year-round if work occurs within a dewatered cofferdam.
7b. Place a prefabricated pile cap, form, pile template, or similar element into the water.	At CR pier complexes 3 - 6. Potentially at pier complexes 2 and 7. Assume contact with the water surface, but not with the riverbed.	100 work days per pier.	For deep water piers: year-round provided work does not violate water quality standards. For piers nearest shore: year-round if work occurs within a dewatered cofferdam.
8. Install and remove cofferdam for demolition of existing Columbia River bridges.	Steel sheet pile sections will be driven, usually with a vibratory hammer, to form a cofferdam. Sheet pile removal can be direct pull or use a vibratory hammer. More than one cofferdam is to be in use at a time.	~ 370 days Installation: 10 work days per pier, Demolition: 20 work days per pier, Removal: 10 work days per pier.	Year-round provided work does not violate water quality standards.
9a. Perform wire saw/diamond wire cutting outside of a cofferdam at or below the water surface.	Used throughout for demolition of existing bridges to cut concrete piers into manageable pieces. These pieces could then be loaded onto barges and transported off site.	Pier cutting and removal to take approximately 7 work days per pier.	Year-round provided work does not violate water quality standards.
9b. Perform wire saw/diamond wire cutting or a hydraulic breaker inside of a cofferdam.	Used for demolition of the existing Columbia River bridges. Used in water to cut concrete piers into manageable pieces. Cofferdam may not be dewatered.	Pier cutting and removal to take approximately 7 work days per pier.	Year-round provided work does not violate water quality standards.
10. Remove material from river bed.	Old pier/bent foundations or riprap from North Portland Crossing may be removed. Will use bucket dredge.	Less than 7 work days during the published standard IWWW per pier.	No variance requested. 11/1 to 2/28.
10a. Spot remove debris and riprap from river bed	Guided removal (likely underwater diver assisted) of specific pieces of debris or large riprap only in the location where the shaft will be drilled. In North Portland Harbor only. Will use bucket dredge.	Up to 2 hrs/day. Less than 7 work days.	Year-round provided work does not violate water quality standards.

Note: Proposed timing is contingent upon obtaining an in-water work variance from all relevant regulatory agencies.

a As a minimization measure, temporary piles that are load-bearing will be vibrated to refusal, then driven and proofed with an impact hammer to confirm load-bearing capacity.

Table 3-3. Proposed Timing for Activities Not Considered In-Water Work (Columbia River and North Portland Harbor)

Activity	Description	Activity Duration (2013-2019)	Proposed Timing
1. Construction activity above the water surface (not superstructure).	Constructing the pier and pier table includes forming, reinforcing, and placing concrete above the water surface in the Columbia River and North Portland Harbor.	Constructing the pier, pier table, and cantilevers to take approximately 160 work days per pier complex in the Columbia River. In North Portland Harbor, ~57 to 142 days/bridge.	Year-round
2. Superstructure construction – form construction, placement of reinforcing, and concrete placement.	Concrete to be transported to the over-water work sites via barge or work bridges in the Columbia River and North Portland Harbor. Numerous barge trips may be required; alternatively, concrete could be pumped to the work site via temporary work/utility bridges.	In Columbia River: 750 work days. In North Portland Harbor: ~640 work days.	Year-round
3. Superstructure construction – precast or prefabricated element assembly.	In CR and NPH. Installation of bridge superstructure (pier tables, cantilevers, decking, etc.). Precast or prefabricated elements will be transported to the over-water work sites via barge or work platform. Numerous barge trips may be required.	CR: approximately 500 days per pier complex. NPH: 100 to 190 days per bridge.	Year-round
4. Use of equipment and facilities already installed in the water.	This will include use of in-water structures (work bridges/platforms, tower cranes, cofferdams, oscillator support platforms) previously installed in the water.	In Columbia River ~750 work days, In North Portland Harbor: ~ 640 work days.	Year-round
5. Work on the bridge over the water.	Work on the bridge will cover many activities, including striping, overlays, lighting systems, etc.	In Columbia River ~750 work days, In North Portland Harbor: ~ 640 work days.	Year-round
6. Demolition of concrete over water in the Columbia River.	After installation of containment measures, concrete sections (existing bridge deck or piers) will be cut and removed from the existing structures. Cut sections could be loaded onto barges and transported off-site or trucked off the bridge.	Demolition of concrete bridge deck and piers to take approximately 255 work days.	Year-round
7. Cut off/remove existing timber piles or concrete pier inside of a cofferdam.	Exposed piles will be cut off several feet below the mud line from beneath the existing Columbia River bridge piers.	If applicable, cutting and removal of pile to take approximately 7 work days per pier.	Year-round
8. Remove existing Columbia River superstructure over water.	Lifting partitioned truss sections off their piers and loading them onto barges for transport to a dismantling site.	Demolition of bridge deck, towers, and all 10 spans to take approximately 255 work days.	Year-round

Note: The determination of activities that are not considered in-water work was made in consultation with ODFW, WDFW, NMFS, and USFWS biologists. See Appendix G for Pre-BA meeting dates and discussion topics.

Note: The in-water work window is a regulatory guide established by ODFW. The guideline was created to assist the public in minimizing potential impacts to important fish, wildlife, and habitat resources. The guidelines are based on ODFW district fish biologist's recommendations. The IWWW can apply to any activity that is subject to the regulatory requirements of the Clean Water Act Section 404 and the State of Oregon's Removal-Fill Law. WDFW administers Chapter 77.55 RCW (Construction projects in state waters). Chapter 77.55 RCW requires anyone wishing to use, divert, obstruct, or change the natural flow or bed of any river or stream to first obtain a Hydraulic Project Approval (HPA) so that potential harm to fish and fish habitat can be avoided or corrected. WDFW has the "Gold and Fish" guide that was written as a guide when gold placer mining can occur during the calendar year, but it can be applied to other projects requiring an HPA. There are some circumstances where it may be appropriate to perform in-water work outside of the preferred work period indicated in the guidelines (i.e., an in-water work window variance). ODFW and WDFW may consider variations in climate, location, and category of work that will allow more specific in-water work timing recommendations on a project by project basis.

3.5.2 Columbia River Bridges

The project will construct two new bridges across the Columbia River downstream (to the west) of the existing interstate bridges. Each of the structures will range from approximately 91 to 136 feet wide, with a gap of approximately 15 feet between them. The over-water length of each new mainstem bridge will be approximately 2,700 feet (Table 3-4).

Table 3-4. Columbia River Bridges Over-Water Dimensions

Bridge	Approximate Length Over Water	Approximate Width
I-5 Northbound	2,700 feet	Varies: 91 to 130 feet
I-5 Southbound (with LRT)	2,650 feet	Varies: 91 to 136 feet

The Columbia River bridges will consist of six in-water pier complexes of two piers each, for a total of 12 in-water piers. Each pier will consist of up to nine 10-foot-diameter drilled shafts topped by a shaft cap. In-water pier complexes are labeled Pier 2 through Pier 7 (noted as P-2 through P-7 in Figure 3-3 and elsewhere in this document), beginning on the Oregon side. Pier complex 1 is on land in Oregon and pier complex 8 is on land in Washington. Portions of pier complex 7 occur in shallow water (less than 20 feet deep). Piers are designed to withstand the design scour without armor-type scour protection (e.g., riprap).

Figure 3-3 shows the basic configuration of these bridges, the span lengths, and the layout of the bridges relative to the Columbia River shoreline and navigation channels. More detailed information on pier size, depth, and other specifications appear in Section 3.5.2.1.

The USCG will require bridge lighting on the new bridges to be brighter than the background lighting. While there is likely to be a large amount of illumination on the bridge spans high above the water, permanent lighting at the water surface will likely be minimal, limited to navigation lights, which are typically small, dim, and not cast directly on the water surface.

Figure 3-3.
Proposed Layout of Columbia River Bridge Showing Piers and Existing Navigation Channels

Columbia River CROSSING

3.5.2.1 Columbia River Bridge Design

The proposed Columbia River mainstem crossing design uses dual stacked bridge structures. The western structure will carry southbound I-5 traffic on the top deck, with LRT on the lower deck. The eastern structure will carry northbound I-5 traffic on the top deck, with bike/ped traffic on the lower deck (Figure 3-4).

Each bridge will consist of a dual-level superstructure constructed on top of a series of six in-water piers. Each in-water pier will be constructed on a column, which will in turn be constructed on a shaft cap supported by up to nine 10-foot-diameter drilled shafts. The basic configuration of each pier is shown in Figure 3-5.

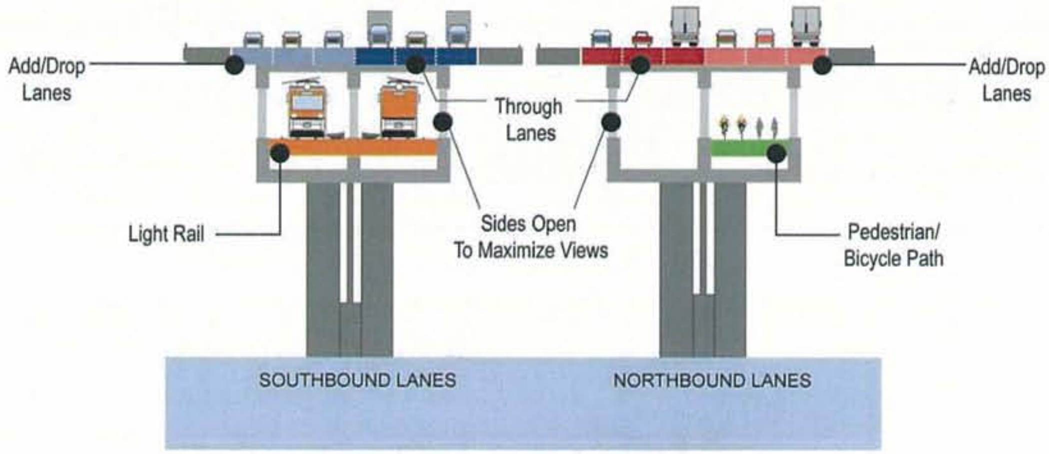
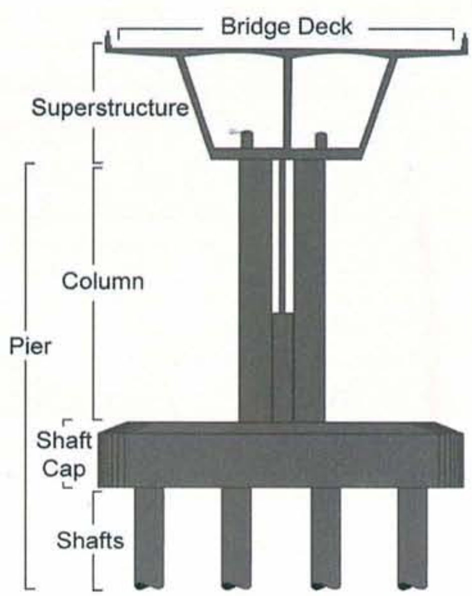


Figure 3-4. Schematic Representation of the Stacked Transit/Highway Bridge Configuration



NOTE: The bridge type shown is for display purposes only.

Figure 3-5. Schematic Representation of the Bridge Configuration

At each pier complex, sequencing will occur as listed below. Details of each activity are presented in the following sections.

- Install temporary cofferdam (applies to pier complexes 2 and 7 only).
- Install temporary piles to moor barges and to support temporary work platforms (at pier complex 3 through 6) and work bridges (at pier complex 2 and 7).
- Install drilled shafts for each pier complex.
- Remove work platform or work bridge and associated piles.
- Install shaft caps at the water level.
- Remove cofferdam (applies to pier complexes 2 and 7 only).
- Erect tower crane.
- Construct columns on the shaft caps.
- Build bridge superstructure spanning the columns.
- Remove tower crane.
- Connect superstructure spans with mid-span closures.
- Remove barge moorings.

All the activities listed above may occur at more than one pier complex at a time as shown in Appendix A and discussed in Section 3.5.2.2.

All activities will require the use of artificial lights for safety. Temporary over-water lighting sources will include the barges, work platforms/bridges, oscillator platforms, and tower cranes. The project will implement measures that minimize the effects of lighting on fish. Measures may include using directional lighting with shielded luminaries to control glare and direct light onto work areas, instead of surface waters.

3.5.2.2 Columbia River Bridge Construction Sequencing

A construction sequence was developed for building the new Columbia River bridges and demolishing the existing structures. The sequence was developed to prove constructibility of the proposed design and is a viable sequence for construction of the river bridges. Once a construction contract is awarded, the contractor may sequence the construction in a way that may not conform exactly to the proposed schedule but that best utilizes the materials, equipment, and personnel available to perform the work. However, the amount of in-water work that can be conducted at any one time is limited, and is based on three factors:

1. The amount of equipment available to build the project will likely be limited. Based on equipment availability, the CRC engineering team estimated that only two drilled shaft operations could occur at any time.
2. The physical space the equipment requires at each pier will be substantial. The estimated sizes of the work platforms/bridges and associated barges are shown in Appendix A. (This is a conceptual design developed by the CRC project team to provide a maximum area of impact. The actual work platforms will be designed by the contractor; therefore, actual sizes will be determined at a later date). The overlap of work platforms/bridges and

barge space limits the amount and type of equipment that can operate at a pier complex at one time.

3. The USCG has required that one navigation channel be open at all times during construction, to the extent feasible.

The 10-phase sequence is shown graphically in Appendix A.

3.5.2.3 Columbia River Bridge Construction Timeline

Construction is currently estimated to occur between 2013 and 2017.

3.5.2.4 Temporary Structures

Temporary Cofferdams

Pier complexes 2 and 7 will each require one temporary cofferdam. Cofferdams will consist of interlocking sections of sheet piles to be installed with a vibratory hammer or with press-in methods. Table 3-5 provides an estimate of the dimensions of the cofferdams and Table 3-6 estimates the duration that they will be present in the water. Cofferdams will be removed using a vibratory hammer or direct pull.

Table 3-5. Potential Dimensions of Temporary Cofferdams Used in Columbia River Bridge Construction

Length (ft)	Width (ft)	Height (ft)t	Area per Cofferdam (sq. ft.)	Total Cofferdams	Total Area of Cofferdams (sq. ft.)
105	75	30	7,875	2	15,750

Table 3-6. Construction Summary for Cofferdams in Columbia River

Location	Duration to Install (Days)	Duration of Construction (Days)	Duration to Remove (Days)
Pier Complex 2	70	330[a]	20
Pier complex 7	70	470[a]	20

a. Days represent approximate number of calendar days, cofferdam are in place. This duration represents approximately 240 to 300 working days.

Cofferdams will be installed in a manner that minimizes fish entrapment. Sheet piles will be installed from upstream to downstream, lowering the sheet piles slowly until contact with the substrate. When cofferdams are used, fish salvage must be conducted according to protocol approved by ODFW, WDFW, and NMFS (Appendix E). Cofferdams will not be dewatered.

Temporary In-Water Work Structures

The project will include numerous temporary in-water structures to support equipment during the course of construction. These structures will include work platforms, work bridges, and tower cranes. They will be designed by the contractor after a contract is awarded, but prior to construction.

Work platforms will be constructed at pier complexes 3 through 6. Figure 11 of Appendix A shows a conceptual design of a temporary in-water work platform. Work platforms are each estimated to be approximately 18,225 sq. ft. in area and will surround the future location of each shaft cap. Work bridges will be installed at pier complexes 2 and 7 so that equipment can access these pier complexes directly from land. Temporary work bridges will be placed only on the landward side of these pier complexes (Appendix A, Figures 1 and 4). The bottom of the temporary work platforms and bridges will be a few feet above the water surface. The decks of the temporary work structures will be constructed of large, untreated wood beams to accommodate large equipment, such as 250-ton cranes. After drilled shafts and shaft caps have been constructed, the temporary work platforms and their support piles will be removed.

After work platforms/bridges are removed at a given pier complex, one tower crane will be constructed between each pair of adjacent piers that makes up the pier complex. The crane will construct the bridge columns and the superstructure. Following construction of the columns and superstructure, the tower cranes and their support piles will be removed.

Both battered and vertical steel pipe piles will be used to support the structures. In addition, four temporary piles could surround each of the drilled shafts (see Appendix A, Figure 11). Due to the heavy equipment and stresses placed on the support structures, all of these temporary piles will need to be load-bearing. Load-bearing piles will be installed using a vibratory hammer and then proofed with an impact hammer to ensure that they meet project specifications demonstrating load-bearing capacity. The number and size of temporary piles for these structures is listed in Table 3-7.

Table 3-7. Summary of Steel Pipe Piles Required for Temporary Overwater Structures During Construction of Columbia River Bridges

Type of Structure	Number of Structures	Pile Diameter	Pile Length	Piles per Structure	Total Number of Piles
Work platforms/bridges	6	18"–24"	70'–90'	100	600
		42"–48"	120'	32	192
Tower cranes	6	42"–48"	120'	8	48
Barge moorings	N/A	18"–24"	70'–90'	Varies	80
Total	**12**	---	---	---	**920**

Not all of these structures will be in place at the same time. It is estimated that only 120 to 400 steel piles will be in the water at any one time.

Barges

Barges will be used as platforms to conduct work activities and to haul materials and equipment to and from the work site. Barges will be moored to non-load-bearing steel pipe piles and adjacent to temporary work structures (Appendix A, Figures 1-10). The approximate dimensions of mooring piles are listed in Table 3-7.

Several types and sizes of barges will be used for bridge construction. The type and size of a barge will depend on how the barge is used. No more than 12 barges are estimated to be moored or moving equipment for Columbia River bridge construction at any one time throughout the construction period (Appendix A, Figures 1-10). The number and the area of the barges are estimated in Table 3-8.

Area and Duration of Temporary Structures

Table 3-8 summarizes the area of temporary structures required for construction in the Columbia River as well as their duration in the water. The number of temporary platforms or bridges in the Columbia River will vary between zero and three during construction. Up to four work platforms and two work bridges will be required to install drilled shafts and construct shaft caps. Each work platform/bridge will require 22 to 25 work days to install. Each work platform/bridge will be in place for approximately 260 to 300 work days. Each tower crane will require approximately two work days to drive support piles and an additional 13 work days to construct the platform. Each tower crane will be in place for approximately 153 to 272 work days.

Barges will be moored around each pier complex. Approximately 80 mooring piles will be installed over the life of the project, each in place for approximately 120 work days. Up to 12 barges at one time would be on the site over the life of the project. Barges vary in size, but can be up to 30,000 sq. ft. in area. With several barges on the site, the over-water footprint could be up to 120,000 sq. ft. at any one time (estimate based on worst case scenario of 12 barges as shown in Appendix A, Figure 4).

Table 3-8. Summary of Temporary Structures Required for Construction in the Columbia River

Type of Structure	Structures	Total Piles (all sizes)	Total In-Water Area for Piles (sq. ft.)	Total Over-Water Area/ Footprint (sq. ft.)	Approx. Time to Install (Days/Platform)[a]	Duration Present in Water (Days - Each)
Work platforms/ bridges	6	792	3,393	148,000	22-25	260-315
Tower cranes	6	48	603	3,200	15	153-262
Barge moorings	N/A	80	251	N/A	N/A	120/mooring
Barges (cumulative, at a single time)	Up to 12	N/A	N/A	Up to 100,000[b]	N/A	Varies
Total	**18 to 30**	**920**	**6,844**	**Up to 251,200**	**---**	**---**

a Assumes two crews.

b Assumes more than one barge (see Appendix A, Figure 4).

Installation of Temporary Piles

Temporary piles will be used for mooring barges and to support in-water work structures. Mooring piles will be vibrated into the sediment until refusal. Vibratory installation will take between 5 and 30 minutes per pile.

Load-bearing piles (used for work platforms/bridges and tower cranes) will be vibrated to refusal (approximately 5 to 30 minutes per pile), then driven and proofed with an impact hammer to confirm load-bearing capacity. An average of six temporary piles could be installed per day using vibratory installation to set the piles, and up to two impact drivers to proof them. Rates of installation will be determined by the type of installation equipment, substrate, and required load-bearing capacity of each pile. Temporary piles will be installed and removed throughout the construction process. No more than two impact pile drivers will operate at one time. Generally, use of two impact pile drivers will occur at only one pier complex at a time.

In general, temporary piles will extend only into the alluvium to an approximate depth of 70 to 120 feet. Standard pipe lengths are 80 to 90 feet, so some piles may need to be spliced to achieve these depths.

Estimated pile installation specifications[1] are provided in Table 3-9. The number of pile strikes was estimated by WSDOT Geotechnical and CRC project engineers based on information from past projects and knowledge of site sediment conditions. The actual number of pile strikes will vary depending on the type of hammer, the hammer energy used, and substrate composition. The strike interval of 1.5 seconds (40 strikes per minute) is also estimated from past projects and is based on use of a diesel hammer. This estimate is within the typical range of 35–52 strikes per minute for diesel hammers (HammerSteel 2009). It is worth noting that for any one 12-hour daily pile driving period, less than one hour of impact driving will occur.

Table 3-9. Pile-Strike Summary for Construction in Columbia River

Pile Size	Estimated Piles Installed per Day	Estimated Strikes per Pile	Estimated Maximum Strikes per Day	Hours of Pile Driving/12-hr Work Day
18–24"	3	300	600	0.25
42–48"	3	300	1.200	0.50
Total	**6**	**--**	**1,800**	**0.75[a]**

a. This scenario assumes just one pile being driven at a time. During construction, up to two piles may be driven at the same time in the Columbia River. If this were to occur, the strike numbers would stay the same, but the actual driving time would decrease.

Figure 3-6 illustrates the schedule of impact and vibratory pile driving, based on the assumption that the first impact pile driving will start on September 15, 2013. The exact timing will vary as the start date varies (as early as September 2012), but will likely follow the general timeline as shown in Figure 3-6. Impact pile driving could potentially occur any day between September 15 and April 15; however, impact pile driving is more likely to occur in the first 18 months of construction as pier complexes are started. After the first 18 months, most of the pier complexes will be well underway, leaving only the work required to finish a couple of pier complexes and provide bases for superstructure construction.

[1] Number of piles driven per day, strikes per pile, total strikes per day, and duration of driving per day are estimates rather than maximums. The size and extent of this project requires contractor flexibility while minimizing effects to listed species. The CRC project is proposing performance measures that use these variables, in addition to the amount of attenuation, to calculate "exposure factors" on a weekly basis. The exposure factor uses the variables for daily piles strikes, timing and duration of piles strikes, days of pile driving within a week, size of pile (initial sound levels), fish speed, and fish mass to estimate the potential exposure to fish that are within or pass through the project area. Different combinations of any of these elements (such as pile strikes, duration or timing of pile strikes, and initial sound levels) will yield different exposure factors. For example, a higher number of pile strikes in a given time period may result in the same exposure factor as a lower number of pile strikes conducted on a pile that has higher initial sound levels. Section 3 of Appendix K provides detailed information on how typical and maximum exposure factors were calculated and provides details on how exposure factors will be calculated during construction activities. During construction, the contractor will calculate the weekly, maximum yearly, average yearly, and total project exposure factor to ensure that exposure to listed fish are not exceeded in accordance with Section 7 of this document.

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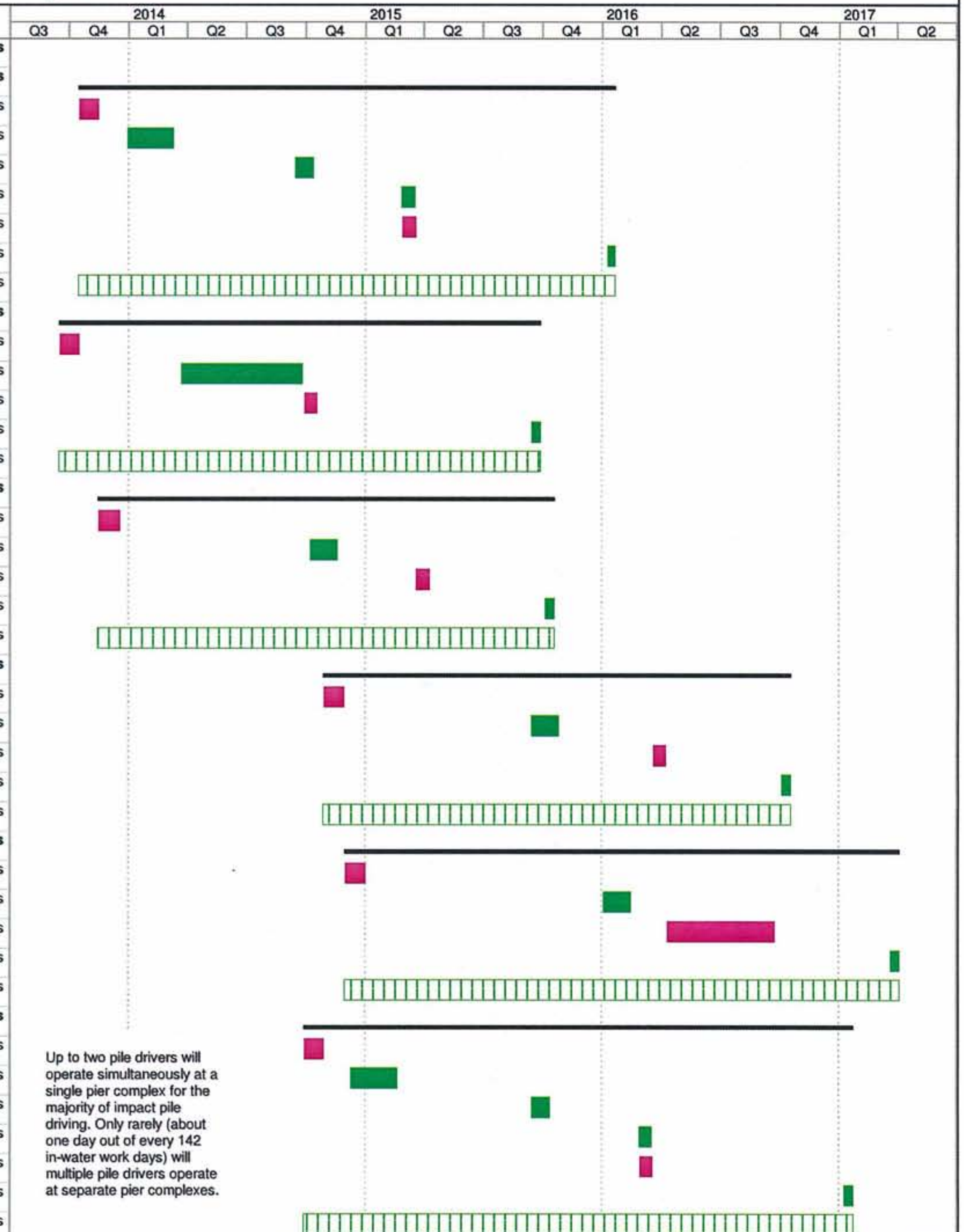
Figure 3-6. Sequencing of Pile Driving and Removal for Construction in the Columbia River

Task Name	Start	Finish	Duration
Bridge Construction Scenario 2/5/13	**9/16/13**	**4/5/17**	**928 days**
Pier 2	**10/16/13**	**1/22/16**	**593 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	10/16/13	11/14/13	22 days
Install Cofferdam (Vibratory Installation)	12/31/13	3/11/14	51 days
Remove Work Bridge & Piles (Vibratory Removal)	9/16/14	10/13/14	20 days
Remove Cofferdam (Vibratory Removal)	2/27/15	3/19/15	15 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	2/27/15	3/19/15	15 days
Remove Tower Crane (Vibratory Removal)	1/11/16	1/22/16	10 days
Barge Moorings (Vibratory Installation & Removal)	10/16/13	1/22/16	593 days
Pier 3	**9/16/13**	**9/29/15**	**532 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	9/16/13	10/15/13	22 days
Remove Work Platform & Piles (Vibratory Removal)	3/24/14	9/26/14	135 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	9/29/14	10/17/14	15 days
Remove Tower Crane (Vibratory Removal)	9/16/15	9/29/15	10 days
Barge Moorings (Vibratory Installation & Removal)	9/16/13	9/29/15	532 days
Pier 4	**11/15/13**	**10/20/15**	**503 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	11/15/13	12/17/13	23 days
Remove Work Platform & Piles (Vibratory Removal)	10/9/14	11/19/14	30 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	3/20/15	4/9/15	15 days
Remove Tower Crane (Vibratory Removal)	10/7/15	10/20/15	10 days
Barge Moorings (Vibratory Installation & Removal)	11/15/13	10/20/15	503 days
Pier 5	**10/29/14**	**10/19/16**	**516 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	10/29/14	11/28/14	23 days
Remove Work Platform & Piles (Vibratory Removal)	9/16/15	10/27/15	30 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	3/21/16	4/8/16	15 days
Remove Tower Crane (Vibratory Removal)	10/6/16	10/19/16	10 days
Barge Moorings (Vibratory Installation & Removal)	10/29/14	10/19/16	516 days
Pier 6	**12/1/14**	**4/5/17**	**613 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	12/1/14	12/31/14	23 days
Remove Work Platform & Piles (Vibratory Removal)	1/5/16	2/15/16	30 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	4/11/16	9/23/16	120 days
Remove Tower Crane (Vibratory Removal)	3/23/17	4/5/17	10 days
Barge Moorings (Vibratory Installation & Removal)	12/1/14	4/5/17	613 days
Pier 7	**9/29/14**	**1/23/17**	**606 days**
Install Work Bridge Piles (Vibratory & Impact Pile Driving)	9/29/14	10/28/14	22 days
Install Cofferdam (Vibratory Installation)	12/11/14	2/20/15	52 days
Remove Work Bridge & Piles (Vibratory Removal)	9/16/15	10/13/15	20 days
Remove Cofferdam (Vibratory Removal)	2/29/16	3/18/16	15 days
Erect Tower Crane (Vibratory & Impact Pile Driving)	2/29/16	3/18/16	15 days
Remove Tower Crane (Vibratory Removal)	1/10/17	1/23/17	10 days
Barge Moorings (Vibratory Installation & Removal)	9/29/14	1/23/17	606 days



Conceptual Schedule Only

Pier Activitiy Summary — Vibratory and Impact Activities

Vibratory Activities — Vibratory Activities (Intermittent)

Note: T... oposed schedule, so activity dates are likely to change. ...pril 2010

In accordance with an approved hydroacoustic monitoring plan (see Section 7.1.5) a noise attenuation device will be used during all impact pile driving, with the exception of during hydroacoustic monitoring when the noise attenuation device will be turned off to measure its effectiveness. A period of up to 7.5 minutes per week with no attenuation device has been allocated in the analyses and hydroacoustic minimization measure (see section 7.1.5) to allow for monitoring and for time to shut-down activities should an attenuation device fail. If the attenuation device fails, pile driving activities will cease as soon as practicable and resolution of the problem will occur. By incorporating this time into the analysis, the project may still proceed in event of an equipment failure without exceeding the thresholds listed in the hydroacoustic minimization measure. With the exception of hydroacoustic monitoring, intentional impact pile driving wihout a noise attenuation device is not proposed nor will it be allowed. In addition, to limit hydroacoustic effects, there will be a consecutive 12-hour period of no impact pile driving for every 24-hour day.

3.5.2.5 Construction of Permanent Piers

In-water drilled shaft construction consists of installing large diameter steel casing to a specified depth to the top of the competent geological layer known as the Troutdale Formation. The top layer of river substrate is composed of loose to very dense alluvium (primarily sand and some fines), beneath which is approximately 20 feet of dense gravel, underlain by the Troutdale Formation.

A vibratory hammer, oscillator, or rotator will be used to advance a casing (up to -270 feet NAVD88). If casing are installed by a vibratory hammer, installation is estimated to be one work day per casing. If casings need to be welded together, one work day is estimated for the weld. No more than two casings are estimated per shaft. Soil will be removed from inside the casing and transferred onto a barge as the casing is advanced. The soil will be deposited at an approved upland site. Drilling will continue below the casing approximately 30 feet into the Troutdale Formation to a specified tip elevation. After excavating soil from inside the casing, reinforcing steel will be installed into the shaft and then the shaft will be filled with concrete.

During construction of the drilled shafts, uncured concrete will be poured into water-filled steel casings, creating a mix of concrete and water. As the concrete is poured into the casing, it will displace this highly alkaline mixture. The project will implement BMPs to contain the mixture and ensure that it does not enter any surface water body. Once contained, the water will be treated to meet state water quality standards and either released to a wastewater treatment facility or discharged to a surface water body. The steel casing may or may not be removed, depending on the installation method. Figure 3-7 through Figure 3-10 depict typical drilled shaft operations and equipment.

No contaminated sediments have been documented within the installation areas. Adherence to the terms of water quality certifications and implementation of impact minimization measures will ensure that, should contaminated sediments be encountered, that they will be dealt with properly.

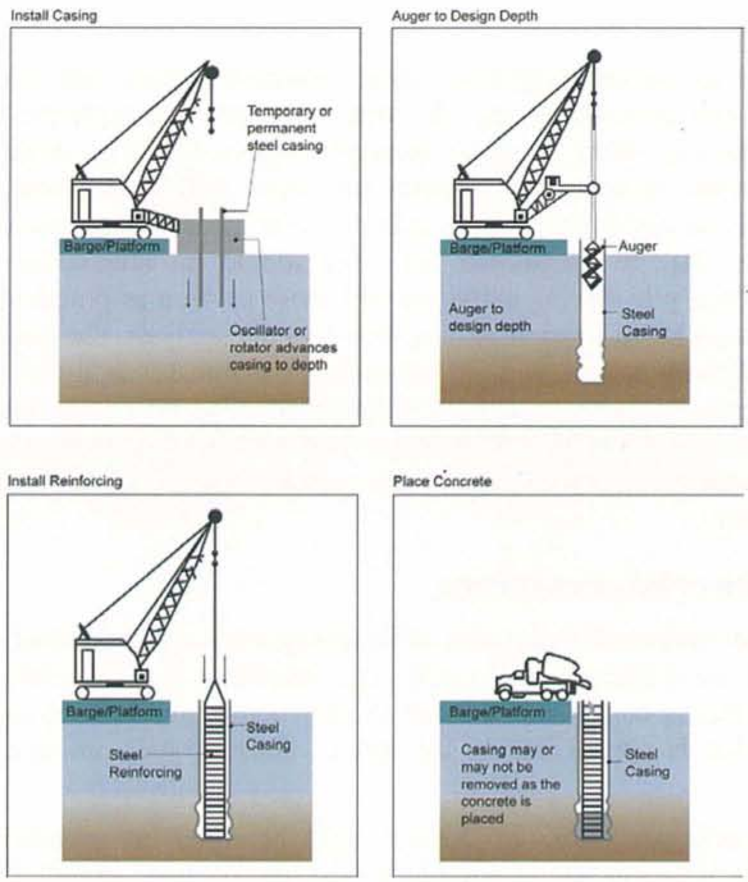


Figure 3-7. Typical Drilled Shaft Installation from Barge or Platform

Figure 3-8. Water-Based Drilled Shaft Installation

Figure 3-9. Clamshell Used for Removing Material from Drilled Shaft Casing

Figure 3-10. Preparation of a Steel Reinforcement Cage for a Drilled Shaft

Duration of Installation of Permanent Shafts

The total duration of the permanent shaft installation could vary considerably depending on the type of installation equipment used, the quantity of available installation equipment, and actual soil conditions. Installation of each drilled shaft is estimated to take approximately 10 days. With the limited in-water work window for impact pile driving and construction phasing constraints, the total duration of drilled shaft installation will be approximately 30 months. Phasing of construction is anticipated to follow the conceptual schedule shown in Figure 3-6.

Quantity of Permanent Shafts

Table 3-10 summarizes the permanent shafts to be constructed for each bridge over the Columbia River.

Table 3-10. Summary of Permanent Shafts in the Columbia River

Location	Shafts per Pier	Total Shafts	Total Plan Area of Shafts (sq. ft.)	Approx. Depth from Observed Lowest Water (0' CRD)
Piers 3–6 on northbound structure	Varies: 6 to 9	32	2,513	Varies: 24 to 32
Piers 3–6 on southbound structure	Varies: 6 to 9	32	2,513	Varies: 24 to 32
Pier complex 2	6	12	942	Varies: 21 to 25
Pier complex 7	6	12	942	Varies: 20 to 27
Total	**24 to 30**	**88**	**6,910**	**---**

Note: CRD = Columbia River datum.

Shaft Caps

Pre-cast shaft caps will be placed on top of the drilled shafts. The shaft caps will be fabricated off-site at a casting yard (Section 3.11) and then transported to the site. Installation of the shaft caps will require cranes, work barges, and material barges. Table 3-11 summarizes the dimensions of each shaft cap.

Table 3-11. Summary of Shaft Caps in the Columbia River

Type	Number	Width	Length	Total Area (sq. ft.)
Pier complexes 3–6	8	75	75	45,000
Pier complexes 2 & 7	4	75	45	13,500
Total	**12**	**---**	**---**	**58,500**

3.5.2.6 Column Construction

Columns will be constructed of cast-in-place reinforced concrete or precast concrete. Precast columns be fabricated at a casting yard (Section 3.11). Column construction is estimated to take 120 days for each pier complex. Construction columns will require cranes, work barges, and material barges in the river year-round (Figure 3-11).

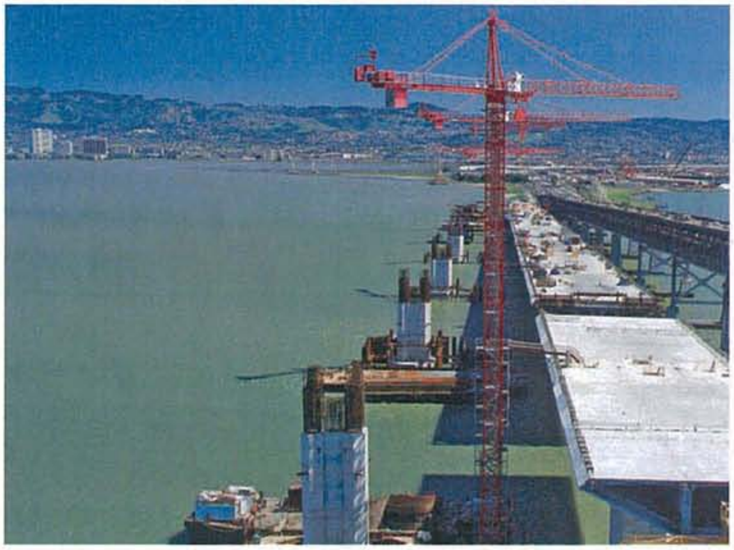


Figure 3-11. Typical Column and Superstructure Construction Using Barge-Mounted Cranes

3.5.2.7 Superstructure

The superstructure will be constructed of structural steel, cast-in-place concrete, or precast concrete. Precast elements will be fabricated at a casting yard (Section 3.11). Construction will require cranes, work barges, and material barges in the river year-round. Figure 3-11 and Figure 3-12 depict typical activities related to construction of the superstructure.

Figure 3-12. Platform-Mounted Crane Placing a Winch on a Superstructure Element

3.5.3 North Portland Harbor Bridge

The existing North Portland Harbor bridge will be upgraded to meet current seismic standards and widened to accommodate an additional southbound I-5 on-ramp. The seismic retrofit activities will consist solely of minor modifications to the bent caps and girders that will not require in-water work. Widening of the existing structure will require adding additional shafts adjacent to the existing bridge bents to support the additional structure width. In addition, three new bridges will be constructed across North Portland Harbor. Starting from the east, these structures will carry a CD ramp for northbound I-5, a CD ramp for southbound I-5, and LRT combined with a bike/ped path.

3.5.3.1 North Portland Harbor Bridge Design

The existing North Portland Harbor bridge was constructed in the early 1980s of pre-stressed concrete girders and reinforced concrete bents. The bents are supported by driven steel piling. Two previous bridges, constructed in 1917 and 1958, were built at the same location as the current bridge, but may not have been fully removed during subsequent replacement efforts. These bridges had reinforced concrete bents supported on timber piles. Some of this material may still be present, but this will not be confirmed until construction begins. Some removal of previous bridge elements is anticipated prior to installation of the new bridge shafts. Removal of remnant bridge elements will be with a clamshell dredge.

Table 3-12 gives the approximate dimensions of the new or improved bridges over the North Portland Harbor and the approximate water depth at each bent location. The existing bridge will be widened by up to 50 feet to accommodate new lanes. Bridge widths will vary due to merging of lanes on some structures. The three new bridge structures will consist of spans of varying lengths (Figure 3-13).

Table 3-12. Dimensions of North Portland Harbor Bridges

Bridge		LRT and Bike/Ped Path	I-5 Southbound Collector-Distributor	Widened Mainline	I-5 Northbound Collector-Distributor
Width Over Water		Varies 50-65 ft	Varies 50-82 ft	Varies 162-200 ft	Varies 57-82 ft
Length Over Water		Approx. 875 ft	Approx. 945 ft	Approx. 990 ft	Approx. 1,020 ft
Approximate Depth from Observed Lowest Water (0' CRD) (ft)	Bent 2	13	9	---	---
	Bent 3	15	13	---	---
	Bent 4	14	13	4	---
	Bent 5	20	14	12	---
	Bent 6	-4	---	13	13
	Bent 7	---	---	15	13
	Bent 8	---	---	16	17
	Bent 9	---	---	0	12

Note: CRD = Columbia River datum.

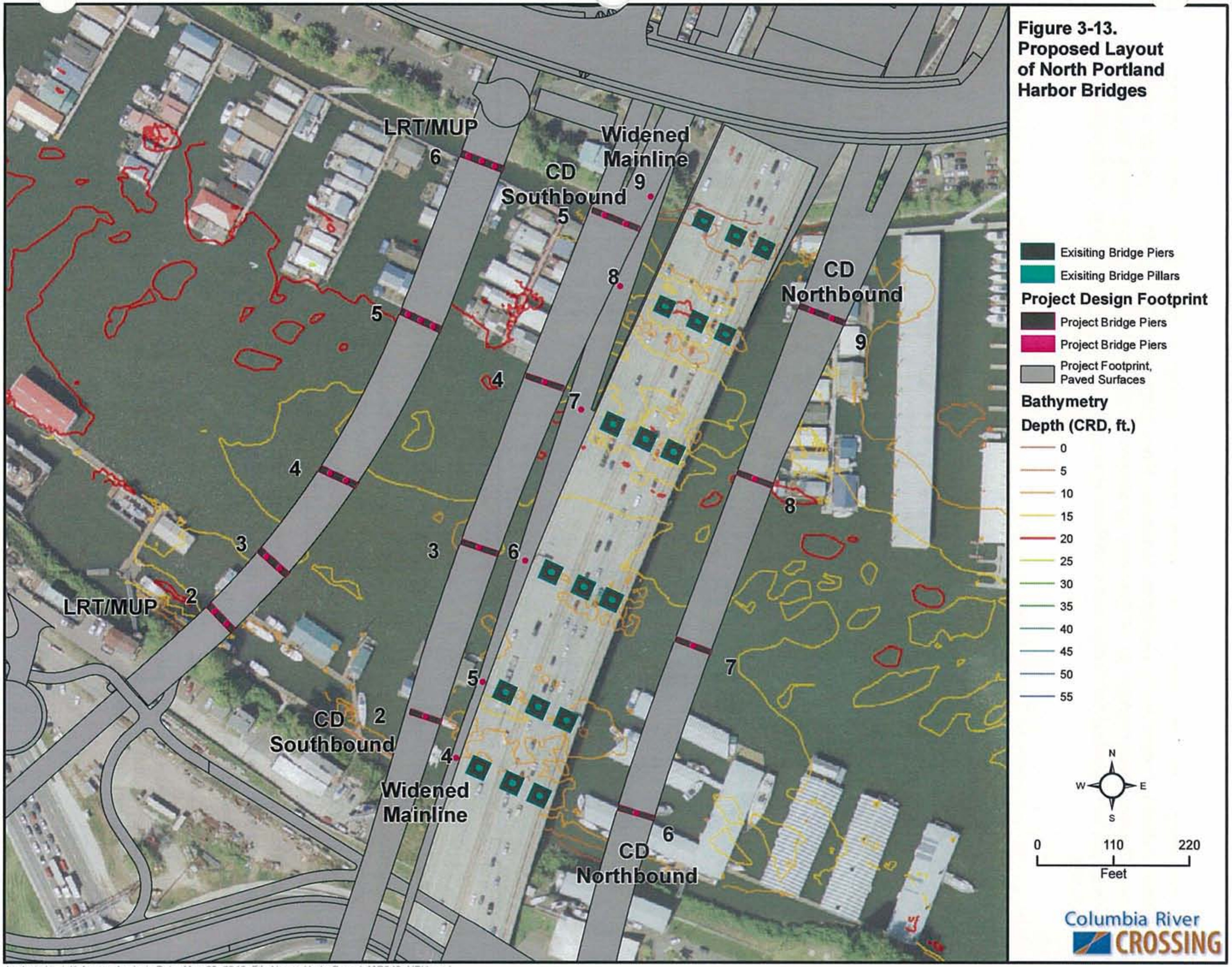


Figure 3-13. Proposed Layout of North Portland Harbor Bridges

Analysis by J. Koloszar; Analysis Date: Mar. 29, 2010. File Name: HydroSound_MG246_NPH.mxd

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Each bridge will have four to five in-water bents, consisting of one to three 10-foot-diameter drilled shafts (Figure 3-13). Unlike the Columbia River piers, shafts will not be topped by a shaft cap. Current designs place all of the bents in shallow water (less than 20 feet deep). Bents are designed to withstand the design scour without armor-type scour protection (e.g., riprap) (Figure 3-14).

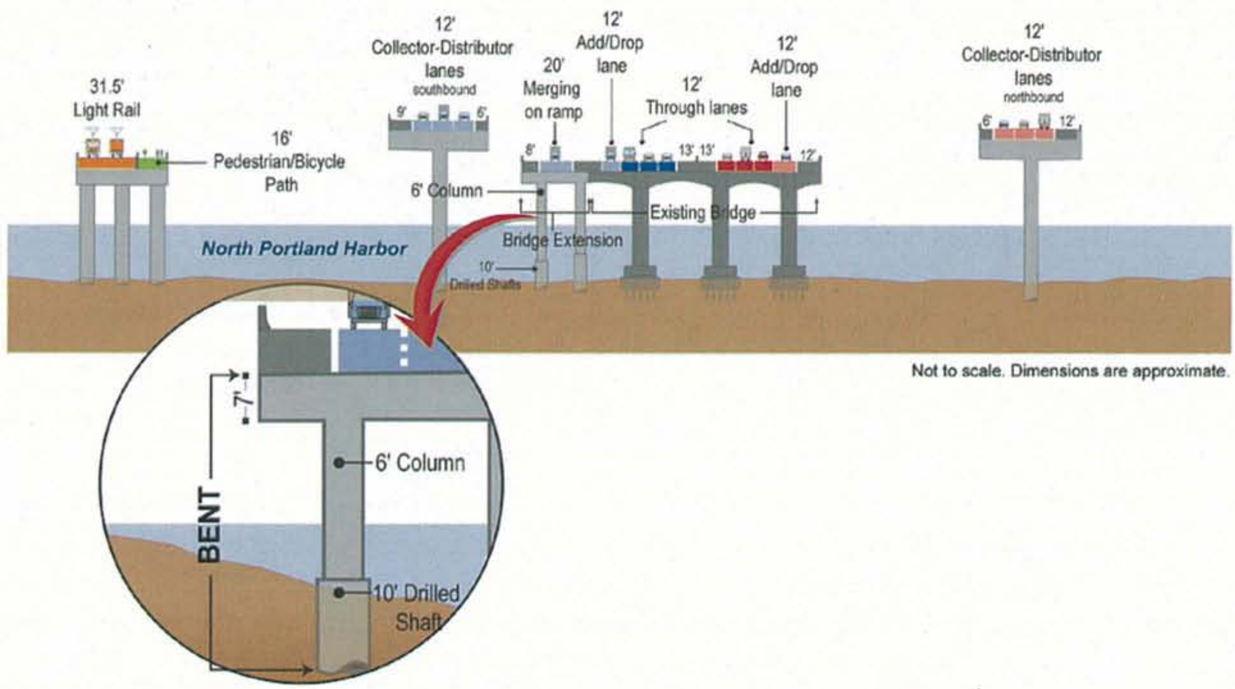

Figure 3-14. North Portland Harbor Mainline Bridge Cross-Section (Schematic)

3.5.3.2 North Portland Harbor Bridge Construction Sequencing

Construction is expected to be sequential, beginning with either of the most nearshore bents of a given bridge and proceeding to the adjacent bent. The actual sequencing will be determined by the contractor once a construction contract is awarded. No more than two of the four bridges are likely to have in-water work occurring simultaneously.

For the bents closest to shore, construction will occur from work bridges. At the other in-water bents, construction will likely occur from barges and oscillator support platforms[2]. Table 3-14 summarizes the areas of these structures located both in and over the water.

[2] Oscillator support platforms are used to support the oscillators used to install the steel casing for drilled shafts. Although this document uses the term oscillator support platform throughout, the platform may support equipment for vibratory or rotator installation of steel casings.

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General construction activities to build the bents and superstructure are similar to those for the Columbia River bridges, except that shaft caps will not be used and bridge decks will be placed on girders instead of balanced cantilevers (Figure 3-14). General sequencing of the construction of a single bridge appears below.

- Construct oscillator support platforms and work bridges using vibratory and impact pile drivers.
- Vibrate temporary piles to moor barges.
- Extract large pieces of debris as needed to allow casings to advance.
- Install drilled shafts at each bent.
- Construct columns on the drilled shafts.
- Construct a bent cap or crossbeam on top of the columns at a bent location.
- Erect bridge girders on the bent caps or crossbeams.
- Place the bridge deck on the girders.
- Remove temporary work bridges, oscillator support platforms, and supporting piles.

Some of these activities will occur simultaneously at separate bents.

3.5.3.3 North Portland Harbor Bridge Construction Timeline

Construction is currently estimated to occur between 2013 and 2020.

3.5.3.4 Temporary In-Water Work Structures

At the eight bents closest to shore, nine temporary work bridges will be constructed to support equipment for drilled shafts. In addition, at each of the 31 bent locations, one oscillator support platform will be constructed, each consisting of four load-bearing piles. The bridges and oscillator support platforms will be designed by the contractor after a contract is awarded, but prior to construction. The estimated size of the structures is summarized in Table 6-13 in Section 6 of this document. The bottom of the temporary work structures will be between 0 and 5 feet above the water line. Due to the heavy equipment and stresses placed on these structures, the supporting piles will need to be load bearing. All will be installed first with a vibratory hammer and then proofed with an impact hammer to ensure that they meet specifications for load-bearing capacity. The number and size of piles for temporary in-water work structures are listed in Table 3-13.

Table 3-13. Approximate Number of Steel Pipe Piles Required for Construction of North Portland Harbor Bridges

Type of Structure	Structures	Pile Diameter (inches)	Pile Length (feet)	Average Piles per Structures	Total Piles
Work bridges	9	18–24	70–120	25	225
Oscillator support platforms	31	36–48	120	4	124
Barge Moorings	N/A	36–48	120	N/A	216
Total	**40**	**–**	**–**	**29**	**565**

Following installation of the drilled shafts, the temporary work structures and their support piles will be removed through vibratory methods.

Other temporary piles will be installed to moor barges adjacent to the new bents (Table 3-13). These piles will not need to be load bearing, and therefore, they will be installed through vibratory methods only.

The need for steel pipe piles will be staged over the construction period. Steel piles will be installed and removed during the multi-year construction of the temporary support structures. Although the project will use over 500 piles in North Portland Harbor, only 100 to 200 piles are estimated to be in the water at any one time.

Barges

Barges will be used as platforms for conducting work activities and to haul materials and equipment to and from the work site. Barges will be moored with steel pipe piles adjacent to temporary work bridges or bents. The approximate number, size range, and length of mooring piles are listed in Table 3-13.

Several types and sizes of barges will be used according to specific function. No more than nine barges are estimated to be present in North Portland Harbor at any one time during the construction period.

Number, Area, and Duration of Temporary Structures

The number, area, and duration of temporary work platforms, support piles, mooring piles, and barges in water are summarized in Table 3-14.

Table 3-14. Summary of Temporary Overwater Structures in North Portland Harbor

Type of Structure	Structures	Total Area in Water (piles) (sq. ft.)	Total Area Over Water (sq. ft.)	Duration to Install (days/platform)[a]	Duration Present in Water (days)
Work bridges	9	2,790	29,640	12	20 - 42
Oscillator support platforms	31	900	27,900	2	10 - 34
Barge moorings	N/A	679	N/A	N/A	30
Barges (at one time)	Up to 9	N/A	105,000	N/A	10 - 34
Total	**Up to 49**	**4,369**	**162,540**	---	---

a Assumes one crew.

Installation of Temporary Piles

As with the mainstem Columbia River bridges, temporary piles will be required to support in-water work bridges or to moor barges during construction of the North Portland Harbor bridges. Unlike the Columbia River Bridges, cofferdams are not necessary.

Piles used for the temporary work bridges and the oscillator support platforms must be load bearing. They will first be vibrated to refusal, and then proofed with an impact hammer to confirm load-bearing capacity. An average of 3 load-bearing piles could be installed per day using vibratory installation to set the piles, with one impact driver to proof. Rates of installation will be determined by the type of installation equipment, substrate, and required load-bearing capacity of each pile.

Temporary mooring piles will be installed and removed throughout the construction process. Installation of these mooring piles could occur year-round and at any time of the day. These piles will be installed using vibratory methods only.

In general, temporary piles will extend only into the alluvium to an estimated depth of 70 to 120 feet. Standard pipe lengths are 80 to 90 feet, so some piles may need to be welded to achieve the lengths required to drive them to these depths.

Estimated pile installation specifications are provided in Table 3-15. Estimates of required number of strikes per pile and total strikes are the same as for the Columbia River (Section 3.5.2.4). However, only one impact driver will be used. Exposure factors based on daily pile strikes, timing, and duration of piles strike activities, days of pile driving within a week, and size of pile, among other factors were used to estimate the potential exposure to fish that are within or pass through the project area. Impact driving within North Portland Harbor is analyzed in conjunction with impact driving activities in the mainstem Columbia River to calculate the overall exposure factor for fish that occur in the project area.

Impact pile driving is proposed to occur only during a 31-week period from approximately September 15 to April 15 or other period approved by NMFS, ODFW, and WDFW. No impact pile driving will occur outside of the approved dates. Figure 6-20 provides an estimated pile installation schedule for North Portland Harbor.

Table 3-15. Pile-Strike Summary for Construction in North Portland Harbor

Pile Size	Estimated Piles Installed per Day	Estimated Strikes per Pile	Estimated Maximum Strikes per Day	Hours of Pile Driving/12-hr Daily Pile Driving Work Period
Temporary Work Bridge				
18"– 24"	3	300	900	0.165
Oscillator Support Platforms				
36" – 48"	3	300	900	0.165

As in the Columbia River mainstem, a noise attenuation device will be for all impact pile strikes, with the exception of a period of up to 2.5 to 5 minutes per week. This period allows time to test the effectiveness of the attenuation system and to shut down impact pile driving in the event of an attenuation device failure. Single strike and cumulative sound exposure levels will be monitored to ensure they do not exceed thresholds detailed in the hydroacoustic minimization measure (Section 7.1.5). In addition, each 24-hour day will include 12 consecutive hours of no impact pile driving to allow for migrating fish to pass through the area of effect (Section 6 and Appendix K) and to allow non-migrating fish time to recover from hydroacoustic impacts.

3.5.3.5 Bent Construction

In-water drilled shaft construction for the North Portland Harbor is described in Section 3.5.3.1.

3.5.3.6 Debris Removal

Debris from previous structures, including foundations from the 1917 and 1953 bridges, may be present at some locations where drilled shafts will be installed. This debris is likely to consist of large rock or old concrete. Because casings cannot advance through this type of material, it must be removed. Removal will consist of capturing the debris in a clamshell bucket. Capture of sediment will be limited. Debris will be placed in an upland location, and disposed of at a landfill if appropriate. Debris removal activities would be limited to the designated in-water work window of November 1 through February 28. Removal activities will take no more than 7 days over the course of construction.

Before debris removal begins, divers will pinpoint the location of the material. Debris removal will only occur in the precise locations where material overlaps with the footprint of the new shafts, greatly minimizing the areal extent of the activity. The amount of material in this location is unknown; however, assuming a worst-case scenario (that the area of the material is the same as the same as the footprint of the drilled shafts), the project will remove debris in no more than 31 locations over an area of roughly 2,433 sq. ft. No more than 90 cubic yards of material will be removed.

If any items are found during excavation that contain potential contaminants (e.g., buried drums, car bodies containing petroleum products, etc.) activities to control and clean up contaminants will be implemented in accordance with the Spill Prevention, Control and Countermeasures (SPCC) plan as described in Section 7.1.2.

Duration of Permanent Shaft Installation

Installation of each drilled shaft is estimated to take approximately 10 days. However, the total duration of this activity could vary considerably depending on the type of equipment used, the quantity of available equipment, and on-site soil conditions. The total duration of drilled shaft installation will be approximately 18 months.

Quantity of Permanent Shafts

The number and area of permanent shafts are summarized in Table 3-16 for bridges over North Portland Harbor. The approximate water depth at the location of each bent is also listed. Each bridge will have five to seven spans, each a maximum of 255 feet long.

Table 3-16. Number and Area of Permanent Shafts Required for North Portland Harbor Bridges

Bridge Type	Number of Bents	Number of Shafts/Bent	New Shafts /Bridge	Total Area of New Shafts (sq. ft.)[a]
Northbound CD	4	Varies 1-2	5	393
I-5 Widening	6	Varies 1-2	8	628
Southbound CD	4	Varies 1-2	5	393
LRT Bridge	5	Varies 2-3	12	942
Total	**20**	**--**	**30**	**2,356**

a 10-foot-diameter shafts.

Shaft Caps

No shaft caps are proposed for the North Portland Harbor bridges.

3.5.3.7 Column Construction

Columns will be constructed of cast-in-place reinforced concrete. Construction of cast-in-place columns is anticipated to occur from December 2013 through September 2015 and will require cranes, work barges, and material barges continuously throughout this period.

3.5.3.8 Superstructure

The superstructure will consist of girders and a deck. Girders will be constructed of structural steel, cast-in-place concrete, or precast concrete. Precast girders may be fabricated at a casting yard (Section 3.11). A cast-in-place concrete deck will be placed on the girders. This element of project construction will require cranes, work barges, and material barges in the river continuously from approximately December 2013 through September 2015.

3.6 DEMOLITION OF EXISTING COLUMBIA RIVER BRIDGES

The existing Columbia River bridges will be demolished after the new Columbia River bridges have been constructed and after associated interchanges are operating.

3.6.1 Proposed Bridge Demolition Methods

The existing Columbia River bridges will be demolished in two stages: 1) superstructure deconstruction and 2) substructure deconstruction.

3.6.1.1 Columbia River Bridges Superstructure Removal

Demolition of the superstructure will begin with removal of the counterweights. The lift span will be locked into place and the counterweights will be cut into pieces and transferred off-site via truck or barge. Next, the lift towers will be cut into manageable pieces and loaded onto barges by a crane. Prior to removal of the trusses, the deck will be removed by cutting it into manageable pieces; these pieces will be transported by barge or truck or by using a breaker, in which case debris will be caught on a barge or other containment system below the work area. After demolition of the concrete deck, trusses will be lifted off of their bearings and onto barges and transferred to a shoreline dismantling site.

The existing Columbia River bridge structures comprise 11 pairs of steel through-truss spans with reinforced concrete decks, including one pair of movable spans over the primary navigation channel and one pair of 531-foot long span trusses. The remaining nine pairs of trusses range from 265 feet to 275 feet in length. In addition to the trusses, there are reinforced concrete approach spans (over land) on either end of the bridges.

Table 3-17 describes the approximate area of the overwater portions of the existing bridges.

Table 3-17. Approximate Area of Existing Columbia River Bridges

	Northbound	Southbound
Steel Trusses	168,096 sq. ft.	176,943 sq. ft.
Reinforced Concrete Approach Structure	18,250 sq. ft.	18,950 sq. ft.
Total Structure Area	**186,346 sq. ft.**	**195,893 sq. ft.**

3.6.1.2 Columbia River Bridge Pier Removal

Nine sets of the 11 existing Columbia River bridge piers are below the OHW level and are supported on a total of approximately 1,800 driven timber piles. Demolition methods have not been finalized; however, the final design will consider factors such as pier depth, safety, phasing constraints, and impacts to aquatic species. Demolition of the concrete piers and timber piling foundations will be accomplished using one of two methods:

1. After removal of the trusses, a cofferdam will be installed at each of the nine in-water bridge piers to contain demolition activities. Cofferdams will not be dewatered. The piers and the piers will be broken up and removed from within the cofferdam. Timber piles that pose a navigation hazard will then be extracted or cut off below the mud line.
2. A diamond wire/wire saw (Figure 3-15) will be used to cut the piers into manageable chunks that will be transported offsite. Cofferdams will not be used. Timber piles will then be extracted or cut off below the mud line.

With either method, the pieces of the piers will be removed via barge.

Although ODOT maintenance personnel regularly inspect the existing bridge, the timber piles located underneath the existing piers are inaccessible and have not been inspected. Therefore, it is unknown whether these timber piles have been treated with creosote, but given their age and intended purpose, it is assumed that they have been so treated. Only piles that could pose a navigation hazard will be removed or cut off below mud line. These piles include those that are present in the proposed navigation channels and any that extend above the surface of the river bed. Piles will either be removed (using a vibratory extractor, direct pull, or clam shell dredge) or cut off below the mud line using an underwater saw. The exact number of piles to be removed is unknown.

Figure 3-15. Wire/Diamond Saw

3.6.1.3 Columbia River Bridge Demolition Sequencing

A conceptual demolition sequence was determined based on the amount of equipment likely available to build the project and the physical space the equipment requires at each pier. The sequence is provided in Appendix A, Figures 12 through 16. The actual construction sequence will be determined by the contractor once a construction contract is awarded.

3.6.1.4 Columbia River Bridge Demolition Timeline

Demolition will occur after the new Columbia River replacement bridges are built. Demolition activities will take approximately 18 months from approximately September 2018 through March 2020.

3.6.2 Use of Temporary Cofferdams and Piles During Bridge Demolition

Temporary cofferdams will be required to isolate work activities, and temporary piles will be installed to anchor work and material barges during demolition the spans and in-water piers.

3.6.2.1 Cofferdams

If the diamond wire/wire saw is not used, a temporary cofferdam consisting of interlocking sections of sheet piles will be used to isolate demolition activities at each of the nine in-water piers. Table 3-18 describes the estimated dimensions, area, and number of temporary cofferdams that will be used during bridge demolition.

Table 3-18. Approximate Cofferdam Specifications for Columbia River Bridge Demolition

Length	Width	Height	Area per Cofferdam (sq. ft.)	Number of Cofferdams	Total Area of Cofferdams (sq. ft.)
150	50	30	7,500	9	67,500

Sheet piles for cofferdams will be installed with a vibratory hammer or a press-in method. Table 3-19 describes the estimated number of sheet piles and duration for cofferdam installation as well as the total duration any one cofferdam will be present in-water. Up to three cofferdams will be in place at any given time. Sheet piles will be removed using a vibratory hammer or direct pull.

Cofferdams will be installed in a manner that minimizes fish entrapment. Sheet piles will be installed from upstream to downstream, lowering the sheet piles slowly until contact with the substrate. When cofferdams are used, fish salvage must be conducted according to protocol approved by ODFW, WDFW, and NMFS (see Appendix E).

Table 3-19. Demolition Summary for Cofferdams in the Columbia River

Number of Cofferdams	Number of Sheet Piles/ Cofferdam	Total Number Sheet Piles	Duration to Install Sheet Pile (#/Day)	Duration to Install One Cofferdam (days)	Duration Present in Water (days)	Duration to Remove One Cofferdam (days)
9	200	1,800	6	11	20	10

Barges

Barges will be used as platforms to perform the demolition and to haul materials and equipment to and from the work site (see Appendix A, Figures 8-10).

Several types and sizes of barges are anticipated to be used for bridge demolition. The type and size of each barge will depend on how the barge is used. Up to six stationary or moving barges are expected to be present at any one time during bridge demolition. Number of barges and barge area for each phase of demolition are summarized in Table 3-20.

3.6.2.2 Temporary Pipe Piles

Demolition is currently anticipated to occur from barges. Over 300 18- to 24-inch steel pipe piles (each approximately 70 feet long) will be used to anchor and support the work and material barges necessary for demolition. Table 3-20 summarizes temporary pile use during bridge demolition.

Table 3-20. Summary of Barges and Temporary Piles Used in Bridge Demolition

Application	Locations	Barges/ Location	Area of Barges[a] (sq. ft.)	Piles/ Barge	Piles	Area of Piles (sq. ft.)	Duration in Water (days/ location)
Span Removal	9	4-6	18,000	4	160	503	30
Pier Demolition	9	4	10,500	4	144	452	30
Total	---	---	**28,500**	---	**304**	**995**	---

a Cumulative at any one time.

Installation and Removal of Temporary Pipe Piles

All temporary piles will be installed using a vibratory hammer or push-in method. They will be extracted using vibratory methods or direct pull. Piles will be installed and removed continuously throughout the demolition process.

3.6.3 Equipment Necessary for Bridge Demolition

Equipment required for bridge demolition includes barge-mounted cranes/hammers or hydraulic rams. Vibratory hammers may be used to install and remove sheet piles for cofferdams and pipe piles for barge moorings. New permanent piles will not be required for demolition of the Columbia River bridges.

3.6.4 Proposed Bridge Construction and Demolition Minimization Measures

Throughout construction of the bridges over the Columbia River and North Portland Harbor and demolition of the existing Columbia River bridges, impact minimization measures will be used in accordance with regulations, permits, and state department of transportation specifications. These measures include methods to prevent pollutants from entering the water, salvage fish during isolation activities, utilize a noise attenuation device during impact pile driving, and monitor in-water noise, as well as monitoring and shutdown procedures to prevent injury to Steller sea lions during impact pile driving. Section 7 of this document presents detailed measures to avoid and/or minimize impacts from bridge construction and demolition activities.

3.7 ROADWAY IMPROVEMENTS

The proposed project includes improvements to seven interchanges along a 5-mile segment of I-5 between Victory Boulevard in Portland and SR 500 in Vancouver. These improvements include some reconfiguration of adjacent local streets to complement the new interchange designs, as well as new facilities for bicyclists and pedestrians.

In addition to interchange improvements, highway safety and mobility will be improved with a series of auxiliary (add/drop) lanes that will be sequentially added and then dropped at strategic locations through the corridor. The add/drop lanes will allow vehicles to travel between given points without merging into mainline interstate traffic, and will allow vehicles exiting or entering to minimize conflicts with through traffic. From the south end of the project area, I-5 northbound will add one auxiliary lane starting where the Victory Boulevard on-ramp enters I-5 (Figure 3-16). Another auxiliary lane will be added where the Marine Drive on-ramp enters I-5. An optional third auxiliary lane will be added where Hayden Island traffic enters I-5 over the river. One of these lanes will be dropped at the SR 14 off-ramp, and a second will be dropped at the Mill Plain off-ramp. North of the Mill Plain off-ramp, the number of auxiliary lanes will vary between one and two (or up to three with the Full Build option). Lanes will be added or dropped as the various on-ramps and off-ramps enter or exit I-5 at each subsequent interchange. Southbound I-5 and the associated interchanges and ramps will have a similar series of add/drop lanes (Figure 3-16).

Highway and surface roadway construction activities adjacent to each of the seven interchanges that will be rebuilt have been integrated into the construction design for each of these interchanges. Each interchange has a proposed construction description and sequence as described in more detail below; however, the general interchange and roadway construction activities are described here.

Typical reconstruction of roadway in the corridor involves a sequence of activities that will be repeated several times at any one particular interchange or roadway section depending on the amount of room a contractor has to work and where traffic must be accommodated.

In most cases, an area to detour mainline traffic will be constructed to clear the area for permanent work. Temporary earthwork, drainage, surfacing, and paving activities will take place to build these features. Prior to this, utilities may need to be relocated, drainage appurtenances put in place, and access to and from the freeway rerouted to accommodate the new mainline location. Once traffic is moved and an area is cleared, or in areas where it is already cleared, permanent work will proceed.

Earthwork equipment will build embankments or excavate earth to a subgrade elevation (the bottom of the eventual pavement section that traffic will drive on). Because of the tight areas, large earthmoving equipment is not envisioned for use in this work. Wheel loaders, back hoes, and similar equipment will be used. Dump trucks will be used to transport material to and from the project as the subgrades are constructed. Embankments must be built in layers with thorough compaction to ensure its stability. Large rollers will be used for this compaction. Once completed, rock will be placed on the subgrade with several lifts of asphalt or concrete pavement following. Rock will be placed by dump trucks and compacted with rollers. Asphalt will be placed with a paving machine that is fed by dump trucks then compacted by rollers. Final drainage fixtures will be placed either before or after the final surfacing operation. Illumination, Intelligent Transportation Systems (ITSs), and signal conduits will generally be placed prior to surfacing. Foundations and the appurtenances will precede or follow the surfacing work.

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Concrete barriers, guardrails, and other safety devices will follow the surfacing work, as will landscaping of the exposed earthen slopes. Temporary barriers may be used until roadways are fully completed. If deemed necessary through noise analyses, permanent stand-alone sound walls may be constructed before or after any of this work depending on available room and access to the work sites.

As the various stages are completed, the new roadways will be striped to accommodate the shifting of traffic to allow areas to be cleared for future stages of work. Once all traffic can be placed in its permanent position, a final level of asphalt will be placed and permanent striping and signing installed. This may be preceded by illumination and concrete median barrier being installed between adjacent roadways.

Victory Boulevard Interchange

The southern extent of the CRC highway improvements is the Victory Boulevard interchange. Improvements at this interchange will be limited to two of the ramps. The Marine Drive to I-5 southbound on-ramp will be braided over the I-5 southbound to Denver Avenue off-ramp. Braiding these two movements will eliminate the existing short (substandard) weave distance, improving traffic safety. Braiding the two movements will also eliminate direct access from the Marine Drive Interchange to the Victory Boulevard Interchange. Motorists will instead use local roads to travel from Marine Drive to Victory Boulevard. Local roads will also connect the Bridgeton Neighborhood to the Kenton Neighborhood.

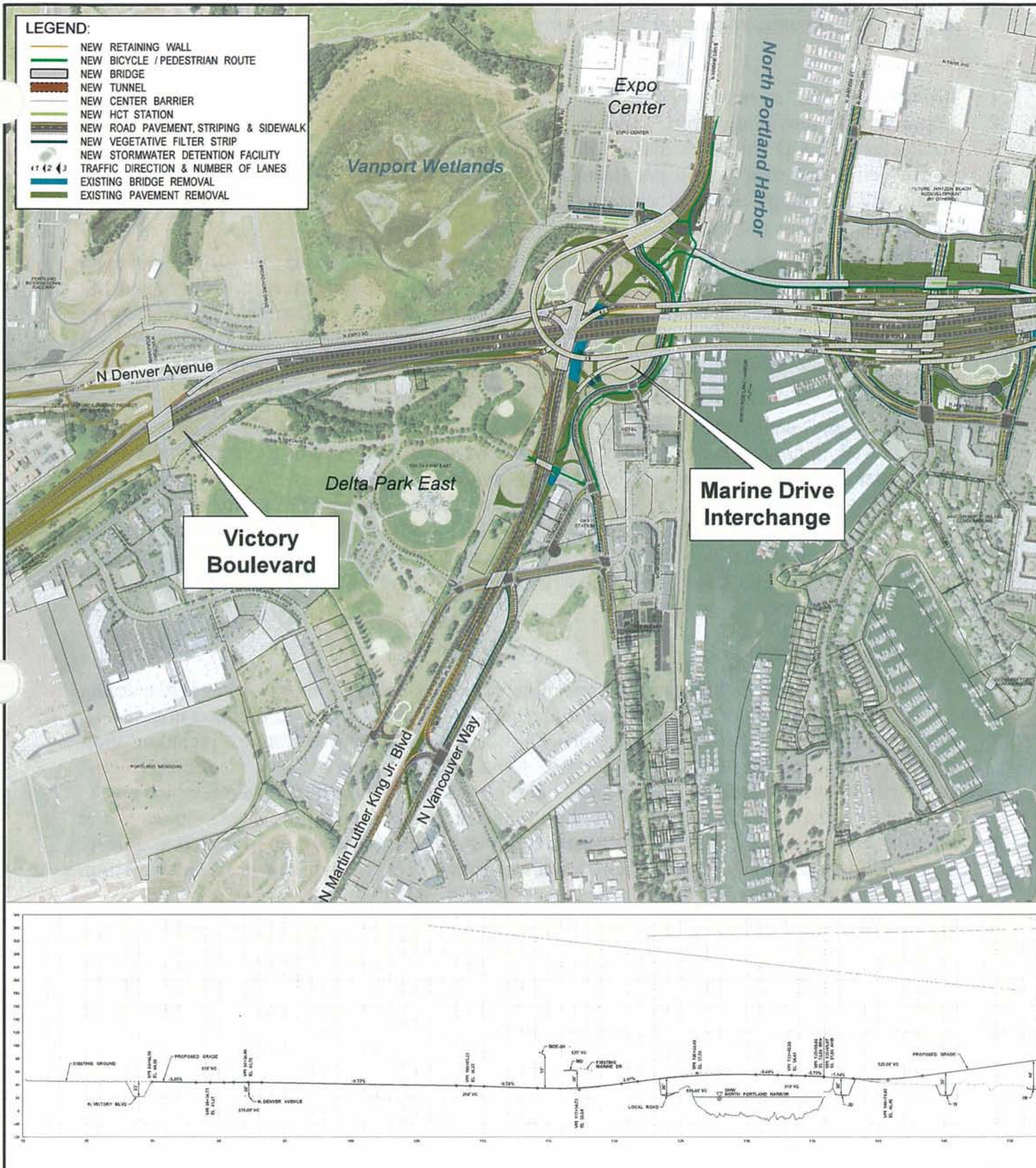
Currently, the existing Denver Avenue on-ramp merges with I-5 mainline northbound traffic; the proposed improvement will bring this ramp on as an add lane, acting as an auxiliary lane within the project limits to provide additional capacity and a safer roadway.

Marine Drive Interchange

All movements within this interchange will be reconfigured to reduce congestion and improve safety for trucks and other motorists entering and exiting I-5. On Marine Drive, trucks account for between 10 and 15 percent of the daily vehicle composition, which increases to between 20 and 30 percent during the peak periods (AM and PM). Trucks account for between 8 and 10 percent of the daily vehicle traffic across the I-5 bridges. Due to their size and maneuverability, within the Bridge Influence Area on I-5, large trucks, on average, operate equivalent to 2.5 passenger cars. Therefore, the proposed design for the Marine Drive interchange optimizes truck mobility. The proposed configuration is a single-point urban interchange (SPUI) with a flyover ramp serving the eastbound to northbound movement. With this configuration, three legs of the interchange will converge at a point on Marine Drive over the I-5 mainline. This configuration will allow the highest volume movements to move freely without being impeded by stop signs or traffic signals (Figure 3-16).

Specific changes to traffic movements at this interchange include:

- The northbound flyover ramp will allow motorists to travel from Marine Drive eastbound to I-5 northbound without stopping. Currently this movement is served by a double left turn at a signalized intersection.
- The Marine Drive eastbound to I-5 southbound ramp will also provide motorists access to I-5 southbound without stopping. This ramp will touch down south of Victory Boulevard.
- Motorists traveling on Martin Luther King Jr. Boulevard westbound to I-5 northbound will access I-5 without stopping at the intersection. Currently this is served by a loop that goes under the freeway. The new configuration will have less out of direction travel for this movement.



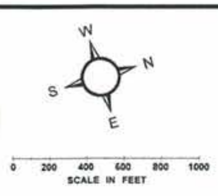


Figure 3-16

CRC Project Alignment

Victory Boulevard/Marine Drive Interchange

Columbia River CROSSING

Travel safety and mobility between the Marine Drive interchange and Hayden Island will be improved by providing direct connections separate from the I-5 mainline. The separate connections via CD will allow traffic entering and/or exiting the freeway at either Marine Drive or Hayden Island to travel on parallel structures over North Portland Harbor. Separating this traffic will prevent potential collisions and reduce congestion that can occur from a high number of conflicting traffic movements.

- The new interchange configuration changes the westbound Marine Drive and westbound Vancouver Way connections to Martin Luther King Jr. Boulevard and to northbound I-5. Rather than merging onto Martin Luther King Jr. Boulevard, which then loops to the west side and back to the east side of I-5 before entering northbound I-5, these two streets will instead access westbound Martin Luther King Jr. Boulevard farther east. Martin Luther King Jr. Boulevard will have a new direct connection to I-5 northbound.
- In the new configuration, the connections from Vancouver Way and Marine Drive will be served, improving the existing connection to Martin Luther King Jr. Boulevard east of the interchange. The improvements to this ramp will allow traffic to turn right from Vancouver Way, and the acceleration distance will be extended to allow for a safer merge. On the south side of Martin Luther King Jr. Boulevard, the existing loop connection will be replaced with a new connection farther east, touching down to Union Court near the entrance to Delta Park. A new undercrossing of Martin Luther King Jr. Boulevard will replace the existing one at Marine Way.

Hayden Island Interchange

The Hayden Island interchange will be reconfigured to lengthen the ramps and improve merging speeds by building longer ramps parallel to the highway rather than looped ramps (Figure 3-17). The current Hayden Island interchange off of I-5 contains substandard features, including short on- and off- ramps. The existing short ramps do not provide ample distance for some vehicles, especially trucks, to reach mainline speed before merging onto the mainline lanes, which results in a safety hazard. The combination of short ramps and lack of add/drop lanes requires traffic entering and exiting the highway to accelerate quickly when entering and decelerate quickly when exiting, or to back up along the ramps and mainline. These conditions result in congestion and higher crash rates on the highway and local streets (CRC 2008).

All movements for this interchange will be reconfigured. The new configuration will be a "Tight Diamond." Traffic exiting from the north (southbound traffic from Washington) and northbound traffic entering the highway would do so from the south end of the island. Likewise, traffic exiting from the south (northbound traffic from Oregon) and southbound traffic entering the highway would do so on the north end of the island.

Improvements to N Jantzen Drive and N Hayden Island Drive would include additional through, left-turn, and right-turn lanes. A new local road, N Tomahawk Drive, would travel east-west through the middle of Hayden Island and under the I-5 interchange, improving connectivity across I-5 on the island.

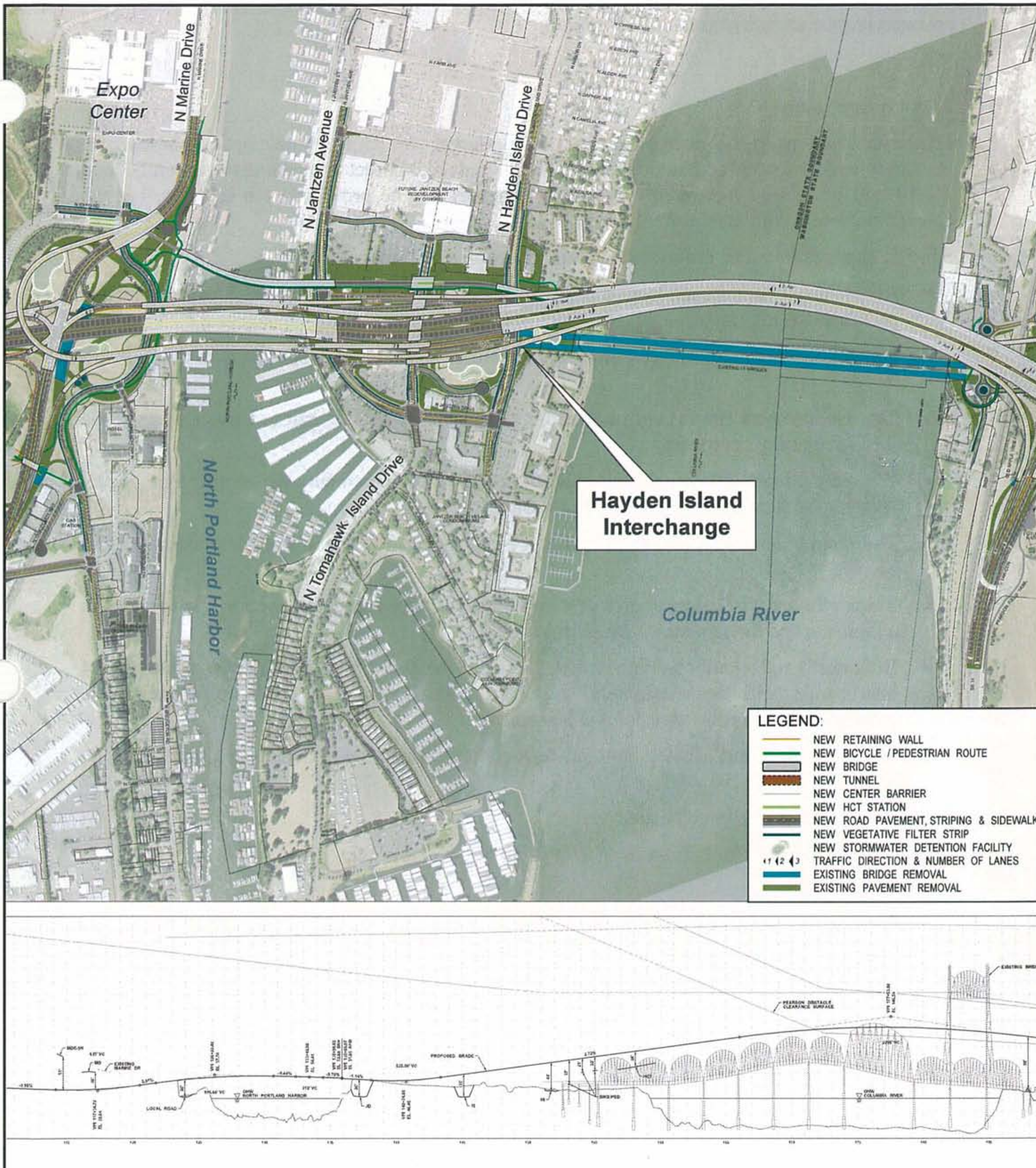


Figure 3-17
CRC Project Alignment
Hayden Island/Jantzen Beach Interchange

Columbia River CROSSING

SR 14 Interchange

The basic functions of this interchange will remain largely the same as the existing interchange, but safety will be improved and congestion will be reduced. Direct connections between I-5 and SR 14 will be rebuilt. Access to and from downtown will be provided as it is today, but the connection points will be relocated (Figure 3-18).

Specific changes to traffic movements at this interchange include:

- Access to I-5 southbound from downtown Vancouver will be made on C Street rather than on Washington Street.
- Downtown connections to and from SR 14 will be made by way of Columbia Street at 4th Street.
- The distance between the northbound I-5 exit to SR 14 and the exit to City Center will be increased to improve safety.
- With the reconfiguration of the SR 14 westbound movement, the merge that occurs between I-5 northbound and SR 14 to C Street will be eliminated.
- The southbound I-5 connection to SR 14 will be made with a structure under I-5 and SR 14.
- The northbound I-5 connection to SR 14 will be a flatter curve, allowing traffic to travel at a higher speed than on the existing ramp.
- Both north and southbound movements between the Mill Plain interchange and the SR 14 interchange will occur separate from the highway on CD roads, eliminating the substandard weave distances on the I-5 mainline.
- For all connections, acceleration and deceleration distances will adhere to highway design standards to improve safety.
- Raising I-5 at this interchange.
- Extending Main Street from 5th Street south to Columbia Way.

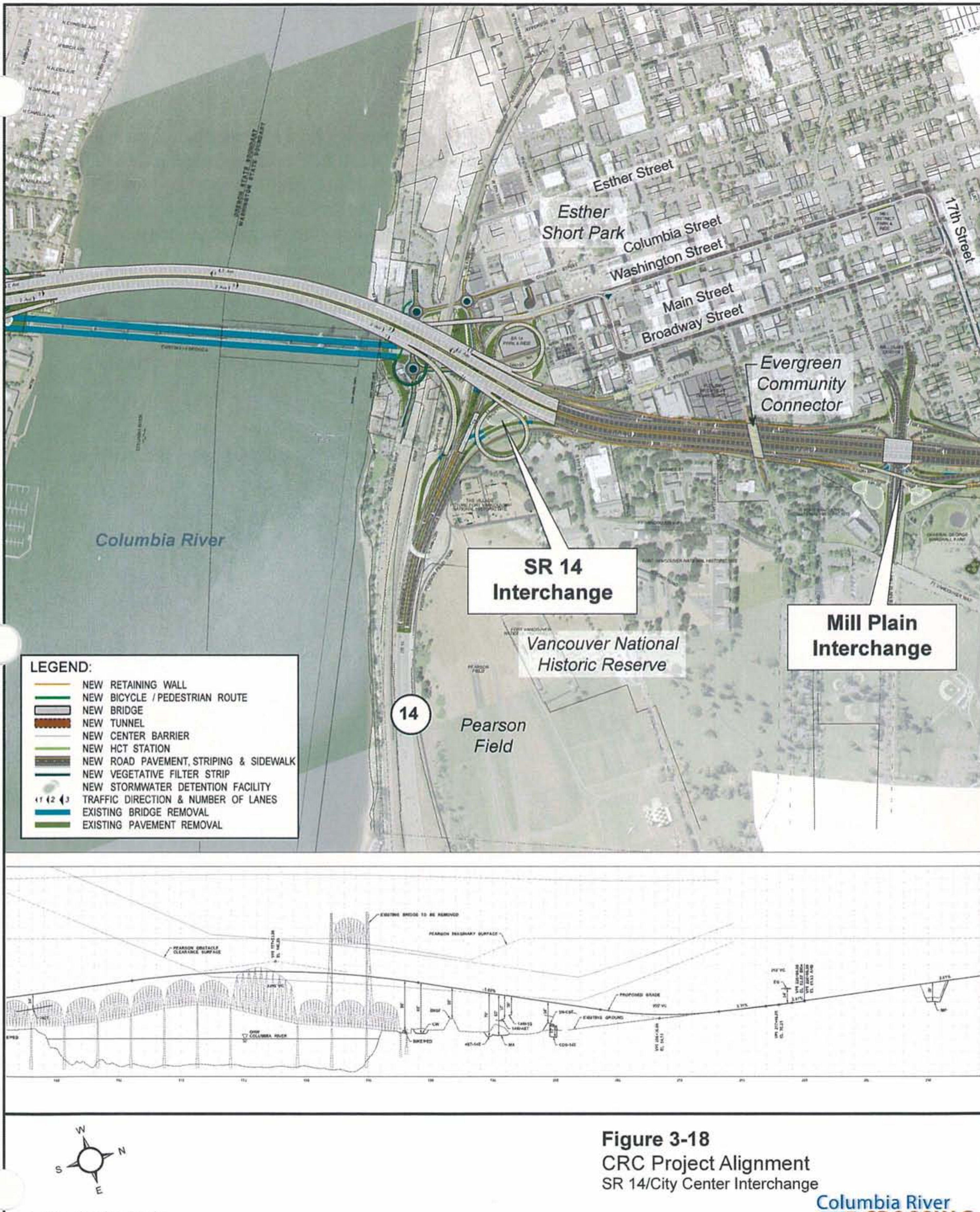


Figure 3-18
CRC Project Alignment
SR 14/City Center Interchange

Columbia River CROSSING

Mill Plain Interchange

This interchange will be reconfigured into a SPUI (Figure 3-19). The existing "diamond" configuration requires two traffic signals to move vehicles through the interchange. The SPUI will use one efficient intersection, allowing opposing left turns simultaneously. This will improve the capacity of the interchange by reducing delay for traffic entering or exiting the freeway. Highway exits to and from the north will be very similar to the interchange today.

Specific changes to traffic movements at this interchange include:

- Northbound I-5 traffic exiting at Mill Plain will travel on a CD ramp to Mill Plain. The CD will also accommodate the movement from SR 14 to I-5 northbound.
- Mill Plain traffic will enter southbound I-5 from a CD ramp that will also accommodate the movement from southbound I-5 to SR 14.
- Acceleration and deceleration distances will be lengthened.
- The right turns from I-5 south to downtown Vancouver will be accommodated with a double turn lane. All the other right turns will be single-lane.

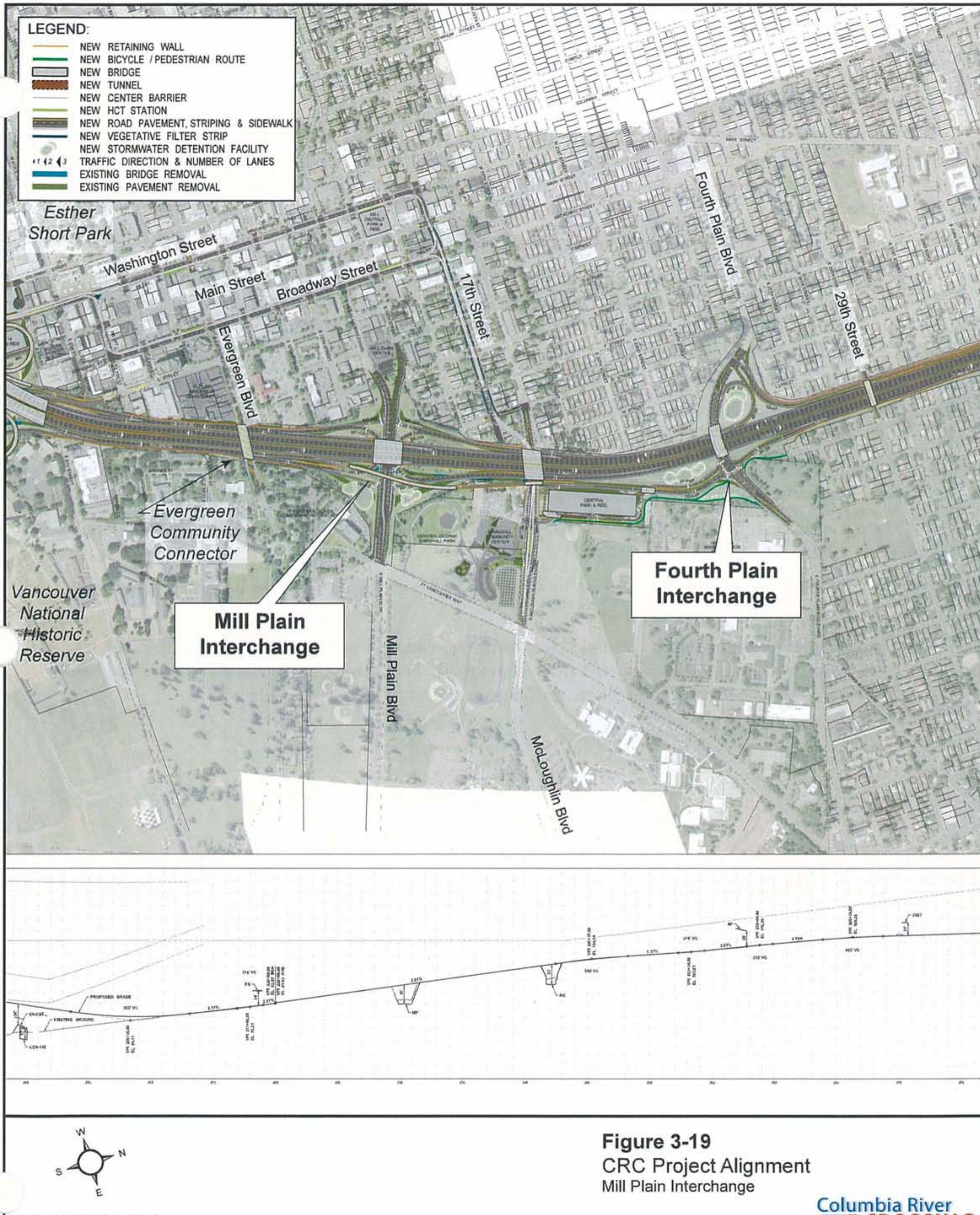


Figure 3-19
CRC Project Alignment
Mill Plain Interchange

Columbia River CROSSING

Fourth Plain Interchange

The improvements to this interchange will better accommodate freight mobility and improve access to the park and ride at Clark College. Northbound I-5 traffic exiting to Fourth Plain Boulevard will continue to use the off-ramp just north of the SR 14 interchange (Figure 3-20).

Specific changes to traffic movements at this interchange include:

- The southbound I-5 exit to Fourth Plain will be braided over/under the SR 500 connection to I-5, eliminating the substandard weave between the SR 500 connection and the off-ramp to Fourth Plain. This braided off-ramp will be in a tunnel between approximately 35th and 32nd Streets.
- This braided exit ramp will eliminate the direct connection between westbound SR 500 and Fourth Plain. This connection will still be possible by exiting SR 500 at St Johns Road and then crossing over I-5 on 39th, or by traveling south on I-5 and exiting at Mill Plain.
- A southbound road will be added to provide access to the Clark College park and ride from the north. This is for traffic exiting I-5 at Fourth Plain or already on Fourth Plain.
- The intersection at the entrance to I-5 south will be widened to better accommodate large trucks.
- The intersection at the entrance to I-5 north will also be designed to accommodate large trucks turning from Fourth Plain.
- Double left turns will be provided for the movements going east to north, south to east, and west to south into the park and ride access road. Two through lanes will be added for the northbound off-ramp to facilitate traffic coming from the park and ride.

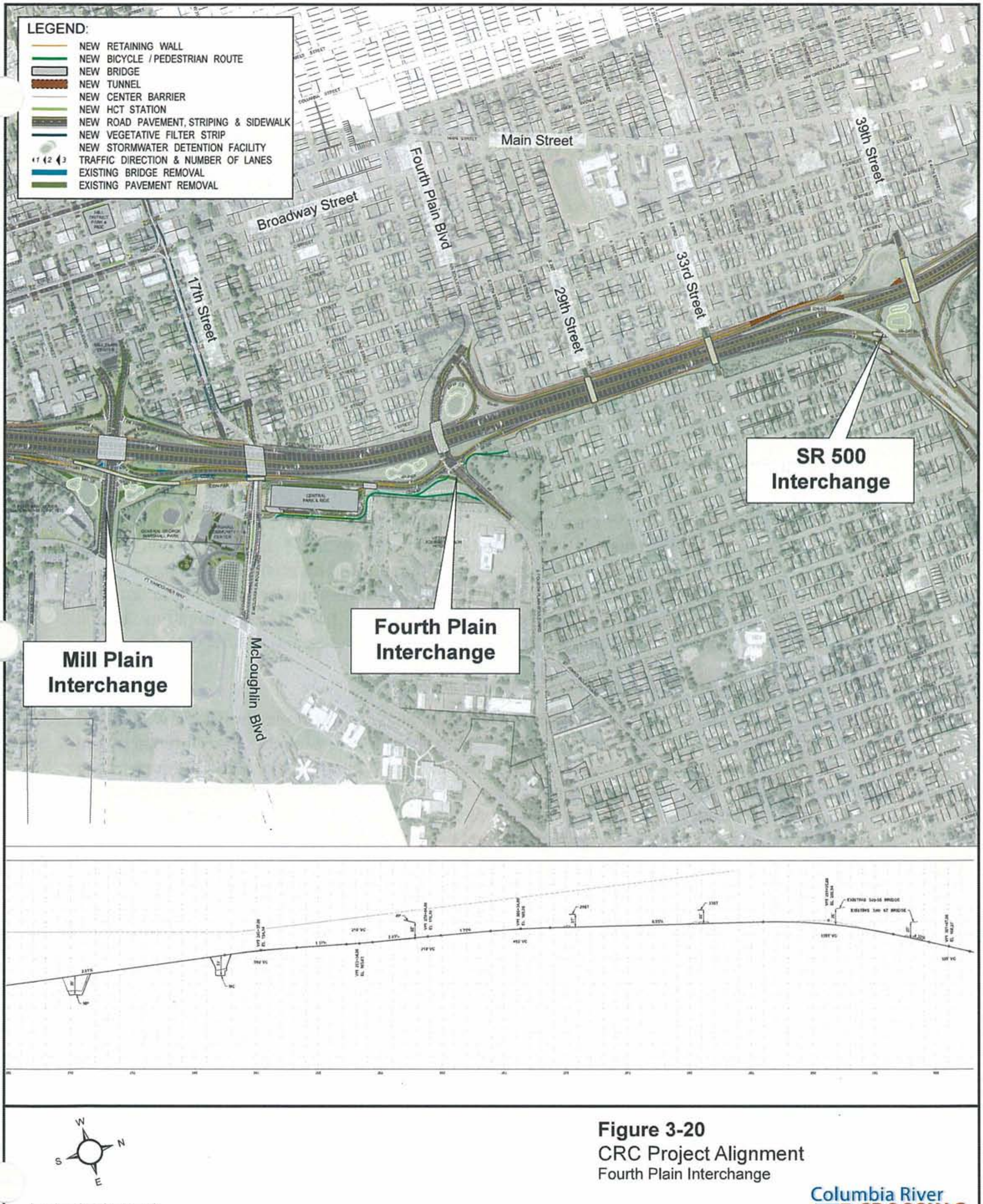


Figure 3-20
CRC Project Alignment
Fourth Plain Interchange

Columbia River CROSSING

SR 500 Interchange

Improvements to the SR 500 interchange will add direct connections to and from I-5. Currently, the connections between SR 500 and I-5 to and from the north require exiting the highway, traveling on a local street (39th Street), and then re-entering the highway. On- and off-ramps will be built to directly connect SR 500 and I-5 for both of these connections. I-5 southbound traffic is proposed to connect to SR 500 via a new structure underneath I-5. SR 500 westbound traffic will connect to I-5 northbound on a new ramp (Figure 3-21).

These improvements will eliminate the direct connections between 39th Street and I-5 to and from the north. These connections will instead be made through the I-5/Main Street interchange to the north.

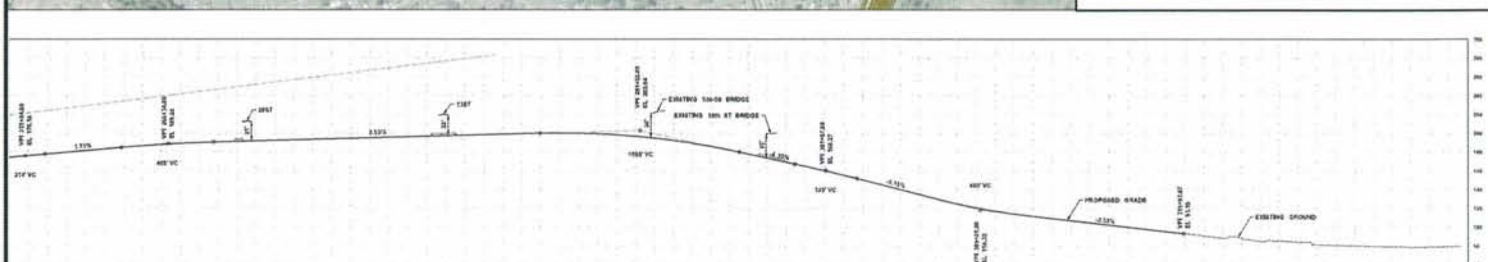
Burnt Bridge Creek runs adjacent to this interchange. Impacts are limited to ground and vegetation disturbance. These impacts are described in Section 3.7.1.4. No in-water work will occur in the creek.

3.7.1.2 Evergreen Boulevard Lid

A new community connector/overpass will be built considerably wider to the south than the current Evergreen overpass (approximately 300 to 400 feet wide) and will include landscaping, pathways, and other public space. It will function as a lid over I-5 and as a "community connection" between downtown Vancouver and the Vancouver National Historic Reserve. In addition to improved bike/ped connections, the facility will improve visual and cultural landscape connectivity. This new public space is proposed as part of the mitigation for the project's impacts to historic resources, parks and recreation resources, and aesthetic quality.

3.7.1.3 Temporary Traffic Changes

Widening I-5 and rebuilding interchanges will disrupt local and regional traffic flow. Typical construction methods will require narrowing lanes and shoulders to accommodate equipment and workers, shortening merge and exit distances, closing interchange ramps, and limiting some turning movements. For example, during construction of a new SR 14 interchange, connections between downtown Vancouver and SR 14 will be rerouted to Columbia Way, and I-5 traffic will use the Mill Plain Boulevard interchange and local streets to access SR 14.



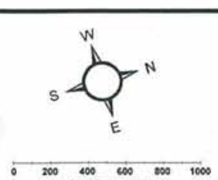


Figure 3-21
CRC Project Alignment
SR 500 Interchange

Columbia River CROSSING

3.7.1.4 Ground Disturbance, Vegetation, and Landscaping

The roadway improvements will described in this section will occur on land and above OHW. Retaining walls will be constructed; the number, height, location, and materials (concrete or steel) are still undetermined. The project will also require upland activities, including pile driving, installation of drilled shafts, seismic ground improvements, and staging. Other work items that will cause ground disturbance include relocation, removal, and replacement of utilities; lighting/illumination structures; signals; signing; and intelligent transportation system (ITS) improvements (e.g., installation of variable message signs, traffic sensors and cameras, radio and telecommunications).

In North Portland Harbor and the Columbia River, effects to riparian habitat will be negligible, as there is very little functioning riparian vegetation in the project area. Approximately 12 mature trees will be removed within the riparian zone of the Columbia River and North Portland Harbor. There will be no excavation or removal of trees from the Columbia Slough or Burnt Bridge Creek riparian area.

Ground disturbance, clearing, and grubbing related to roadway and transit improvements will permanently impact approximately 0.87 acres of existing vegetation in the Columbia River crossing area. The disturbed vegetation consists mainly of grasses and ground cover, with small portions of shrubs and trees. Activities at the Ruby Junction Maintenance Facility would disturb approximately 1.31 acres of grass lawns and trees associated with this residential and commercial site. In addition, approximately 415 acres of total ground disturbance is anticipated as part of the project. Table 3-21 provides a summary of these impacts by watershed.

Table 3-21. Summary of Ground Disturbance by Watershed

Watershed Name	Vegetated Acres	Vegetated and Non-Vegetated Acres
Burnt Bridge Creek	0.07	55
Columbia River	0.56	240
Columbia Slough	0.23	105
Fairview Creek	1.31	15
Total	**2.18**	**415**

Temporarily disturbed areas within DOT rights-of-way will be replanted according to the Roadside Classification Plan (WSDOT 2006) on WSDOT right-of-way, and according to the Roadside Development Design Manual (ODOT 2006) on ODOT right-of-way. Site-specific assessments may result in permanent replanting that differs from these roadside classifications plans; this will be determined by a landscape architect. Disturbed areas within transit or local rights-of-way would be replanted to local regulation standards.

3.8 PARK AND RIDE FACILITIES

Three new park and ride facilities are proposed as part of this project. They are identified by their general locations at the SR 14 interchange, the Mill District, and Clark College. The park and ride structures will be built of precast or cast-in-place concrete and will be constructed using nearby staging areas. Construction of the structures will generate concentrated truck traffic that may impact local traffic. These traffic issues will be addressed in the Traffic Management Plan.

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During excavation and foundation construction, dust and noise will be generated. These will be minimized through implementation of the Spill Prevention, Control, and Countermeasures (SPCC) plan. A Temporary Erosion and Sediment Control (TESC) plan will be implemented during construction to prevent turbid discharges to surface waters.

3.8.1 SR 14 Park and Ride

The proposed approximately 570-space SR 14 park and ride structure will be located within the curve of the SR 14 to southbound I-5 freeway ramp. The extension of Main Street will provide an eastern boundary and access to the structure. Four to five levels of parking are needed for the parking spaces. This sets the top parking level 5 to 9 feet above the road level of the roadway loop ramp. The surface footprint of the parking structure is approximately 43,700 sq. ft., or 1 acre.

The American Association of State Highway and Transportation Officials (AASHTO) suggests one entrance and exit for every 500 cars; thus, two entrances and exits are preferred to accommodate the 570 parking spaces. The main ingress/egress will be off the Main Street extension, which must be placed about halfway between 5th Street and the 4th Street/SR 14 connection to allow for proper traffic movements. Main Street is on a fairly steep grade in this area. A second entrance has been proposed off Washington Street, just south of 5th Street. It may also include an exit. The street on this block is planned as a one-way northbound street that will be a relief valve for the amount of traffic entering the downtown area from SR 14 onto Columbia Street. The existing site is undeveloped, and the structure will create new impervious surface area. A water treatment facility will be located within the interchange, and water collected from the parking structure will be routed to the facility (Section 3.12).

3.8.2 Mill District Park and Ride

The proposed current location for this approximately 420-space park and ride is an existing gravel lot bounded by 15th, 16th, Main, and Washington Streets in Vancouver's mid-town area. The right-of-way for the block is a rectangle with the south line on a skew that creates dimensions of approximately 201 feet along 15th and 16th Streets, 218 feet along Washington, and 207 feet along Main Street. The longer length along Washington makes it a good place for a light rail station because it will better accommodate ADA ramps at the ends of the platform. A ground-floor retail space will be included in the parking structure design and along both Main and Washington Streets. The parking structure will have one ingress/egress on 16th Street and one ingress on 15th Street.

This location will be the primary transfer site in the downtown area between buses and light rail, with 40 to 55 buses per hour stopping at this location. The current draft plan is to distribute bus stops on Main, 15th, and Broadway Streets in close relationship to the Mill District station. Coordination between bus stop layout design and retail accesses will need to occur.

The structure will include four to five full levels of structured parking above ground-floor retail space. The footprint of the structure is approximately 37,025 sq. ft., or 0.85 acre. The existing site is undeveloped and has been used as a graveled surface parking lot. Drainage for this site can be routed through cartridge filters and an oil separator into the existing storm sewer system (Section 3.12).

3.8.3 Clark College Park and Ride

The Clark College park and ride facility is slated to include approximately 1,910 parking spaces on five levels and will be readily accessible from I-5. This site is currently being used as overflow parking for the college's Physical Education Department offices. The Mill Plain/Fourth Plain CD and I-5 border this site to the west, the Veterans Administration hospital grounds are to the north, Clark College ball fields lie to the east, and McLoughlin Boulevard is to the south (Figure 3-22). Access will be from McLoughlin Boulevard and the CD road from I-5 south. The parking structure ingress/egress will be at the CD and McLoughlin Boulevard.

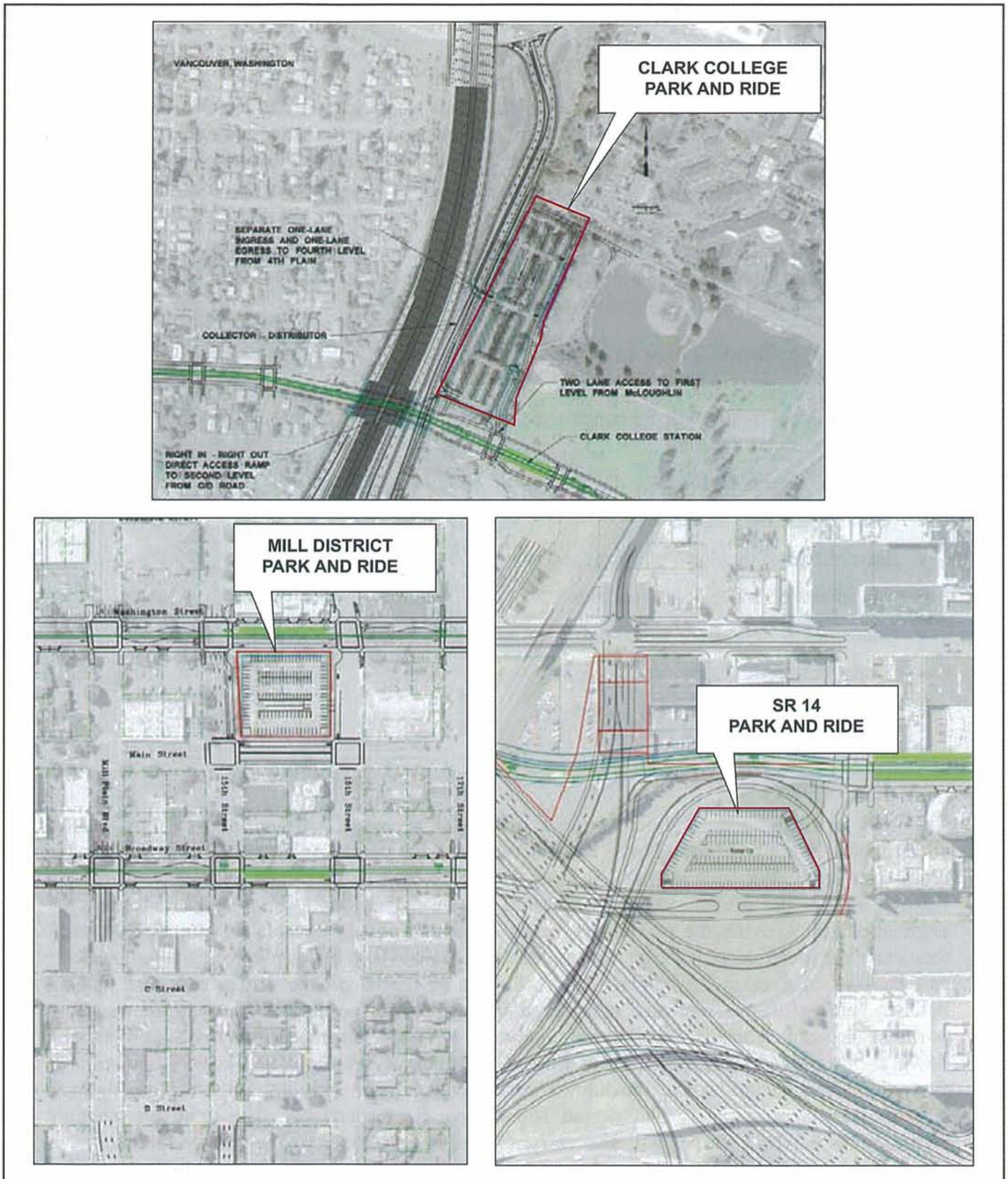
The footprint of the structure is approximately 178,425 sq. ft., or 4.1 acres. The site currently contains 93,940 sq. ft. (2.15 acres) of impervious surfaces, including an existing asphalt parking area and structures. As described in Section 3.12, stormwater will be drained from the park and ride roof into a swale on the site.

3.9 BUS IMPROVEMENTS

Bus improvements within the CRC alignment in Oregon will include bus pullouts on Marine Drive. In Washington, bus improvements within the CRC alignment will include the following:

- Provisions for bus operations at park and rides;
- Reconstructed bus stops on Broadway and Washington Streets due to construction of LRT alignment;
- Adding bus pullouts on McLoughlin Boulevard at the Central Park station; and
- Modifying routes through the Central Business District to better facilitate transfers between modes.

No bus infrastructure improvements outside of the immediate CRC alignment are anticipated as part of this project.



Columbia River CROSSING

Figure 3-22.
Park and Ride Facilities
Columbia River Crossing

3.10 LIGHT RAIL CONSTRUCTION AND OPERATION

LRT generally refers to electric-powered train systems operating on city streets or on separate rail systems. LRT differs from heavy rail in that it carries fewer passengers, operates at slower speeds, is more flexible, and is therefore better able to access more locations in urban centers. Conversely, in comparison to street cars or trams, LRT carries a higher number of passengers and operates at higher speeds.

The proposed project includes construction of LRT guideways, both at-grade and elevated, park and ride facilities, and transit stations; and expansion of TriMet's Ruby Junction Maintenance Facility in Gresham. These components are described below.

3.10.1 Portland Expo Center to Vancouver

The new high-capacity LRT project component will be an extension of the existing MAX Yellow Line. New tracks will be constructed starting just north of the existing platform at the Portland Expo Center Station.

Construction elements include:

- Grading and excavation
- Demolition of the north platform access
- Placement of underground utilities
- Placement and tie-in of signal and Thermal Energy Storage (TES) duct bank
- Construction of systems foundations
- Installation of overhead catenaries
- Concrete surface work
- Landscaping

The track from the Expo Center to north of Marine Drive will be pervious tie and ballast construction. North of Marine Drive, the trackway will be located on an impervious structure to cross over North Portland Harbor and onto Hayden Island as described in Section 3.5.3. On Hayden Island, the guideway will be located on an impervious surface and constructed on engineered fill. Leaving the island, the transit alignment will be located on structure and will then enter the lower deck of the stacked southbound replacement bridge over the Columbia River as described in Section 3.5.2. The track will then be placed on the bridge structure without ballast. These structures are also considered impervious surfaces. Upon leaving the northern portal of the stacked bridge, the light rail alignment will travel on impervious structure to a touch down at 5th Street in downtown Vancouver. Total trackway pervious and impervious surfaces from the Expo Center to the touchdown in Vancouver (not including the stacked highway structure) are approximately 25,000 and 160,000 sq. ft., respectively. The light rail structure across North Portland Harbor will also carry a bike/ped path facility. The area of this facility is not included in the estimates provided above. The construction of elevated guideways over existing streets may impact traffic because of temporary road closures. This and other traffic issues will be addressed in a traffic management plan prepared and approved by the project before construction begins. Clearing and grading activities and demolition of other structures for newly acquired right-of-way will occur where the elevated guideway transitions to at-grade track.

Elevated guideways and stations for light rail will be constructed of steel, reinforced concrete, or combinations of both. Construction will begin with preparation to build foundations that may consist of shallow spread footings, deep driven or augered piles, or drilled shafts. Once foundations are in place, concrete columns and crossbeams will be constructed.

The superstructure of each elevated structure may be built of steel, cast-in-place concrete, or precast concrete. If steel or precast concrete is used, sections can be transported to the site and lifted into place from the street. If cast-in-place concrete is used, then temporary structures will be required to support the superstructure until the cast concrete has gained enough strength (through curing) to support itself.

3.10.2 In-Street Construction in Vancouver

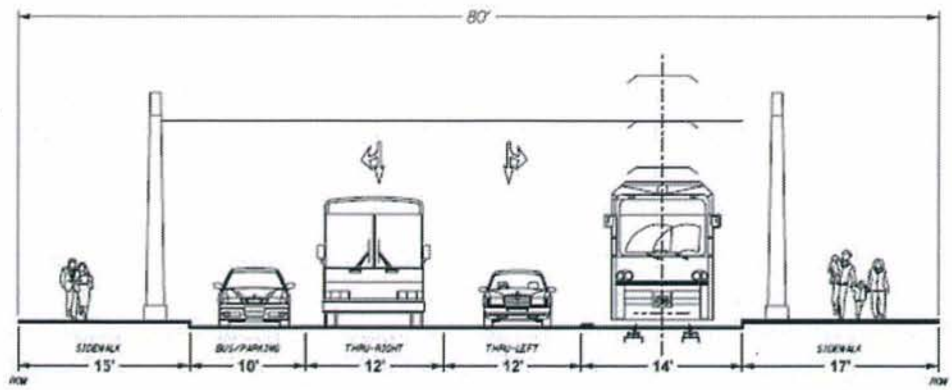
The new light rail guideway will be located within existing streets in Vancouver and will not contribute to a net increase in existing impervious surface. Final design of the LRT alignment and integration of automobile, pedestrian, and bicycle traffic facilities will occur in the future. Drawings showing proposed spacing of automobile, bus, and LRT on surface streets are presented in Figure 3-23.

Roadway construction for the light rail alignment will include restriping or rebuilding the road surface, rebuilding sidewalks, and constructing station platforms. Streetscape improvements will include removing, replacing, or adding vegetation, curb extensions, new signs and signals, and other measures to improve access to, and use of, the transit stations. Stations, park and rides, and new structures could require land-based pile driving and earthwork for clearing and grading these sites.

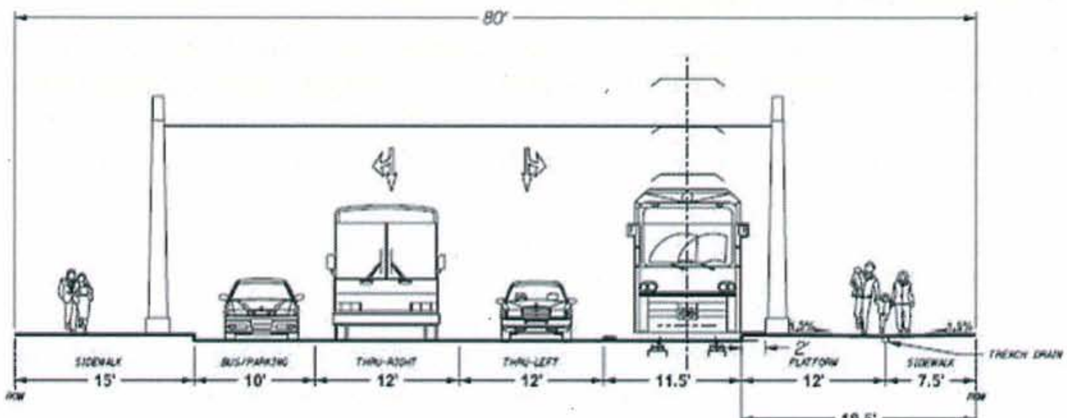
The roadway along the light rail alignment will need to be rebuilt to support the weight of a two-car train. This will generally require relocation of utilities. At-grade LRT tracks will require clearing, grading, and typically shallow excavations. Clearing may include demolition and removal of pavement, vegetation, and other surface features, and implementation of a TESC plan with BMPs, and a Pollution Control Plan. During the grading phase, the contractors will install culverts or other permanent drainage structures and below-grade light rail infrastructure. This may require temporary steel plates in the roadway and temporary lane closures. Where in-street track is proposed within existing or expanded street right-of-way, grading will generally be minimal, but extensive reconstruction of streets, sidewalks, and other facilities may occur. Shallow, near-surface excavations will be required to construct the subgrade and track and station platform slabs for at-grade segments.

Light rail will also require construction of an OCS over the guideway to provide electrical power to the trains. Additionally, it will be necessary to seek temporary construction easements or small permanent easements on some properties adjacent to the light rail alignment to allow construction workers to encroach on several feet of a property while rebuilding the sidewalk in front of the property or to place specific elements.

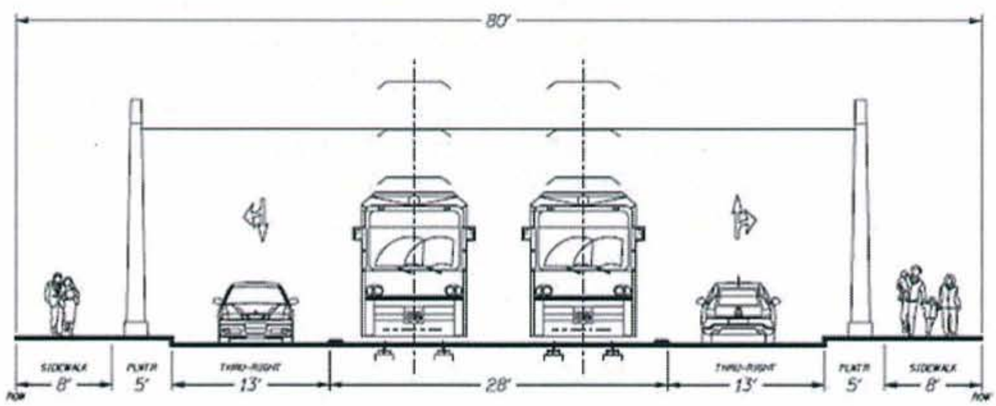
Transit construction will also require staging areas adjacent to or within the guideway to store construction equipment and materials. Many of the staging activities will take advantage of land that is already in the public right-of-way or in public ownership and that is not being used for other purposes, such as vacant lots.



SIDE RUNNING TRACK - 17/15 SIDEWALKS



SIDE RUNNING TRACK AT PLATFORM
17/15 SIDEWALKS



17TH CENTER RUNNING TRACKS

Figure 3-23. Designs for At-Grade LRT in Vancouver

3.10.3 Ruby Junction Maintenance Facility

The project includes an expansion of the TriMet's Ruby Junction Maintenance Facility on NW Eleven Mile Avenue in Gresham to accommodate the additional LRT vehicles included for the light rail component of this project (Figure 3-24). This expansion will include the need to acquire additional right-of-way and to build new storage tracks. This expansion of right-of-way will also provide enough land to accommodate LRT vehicles that might be added to TriMet's system by future projects, such as the planned Portland-Milwaukie LRT extension that is currently undergoing NEPA review and preliminary design.

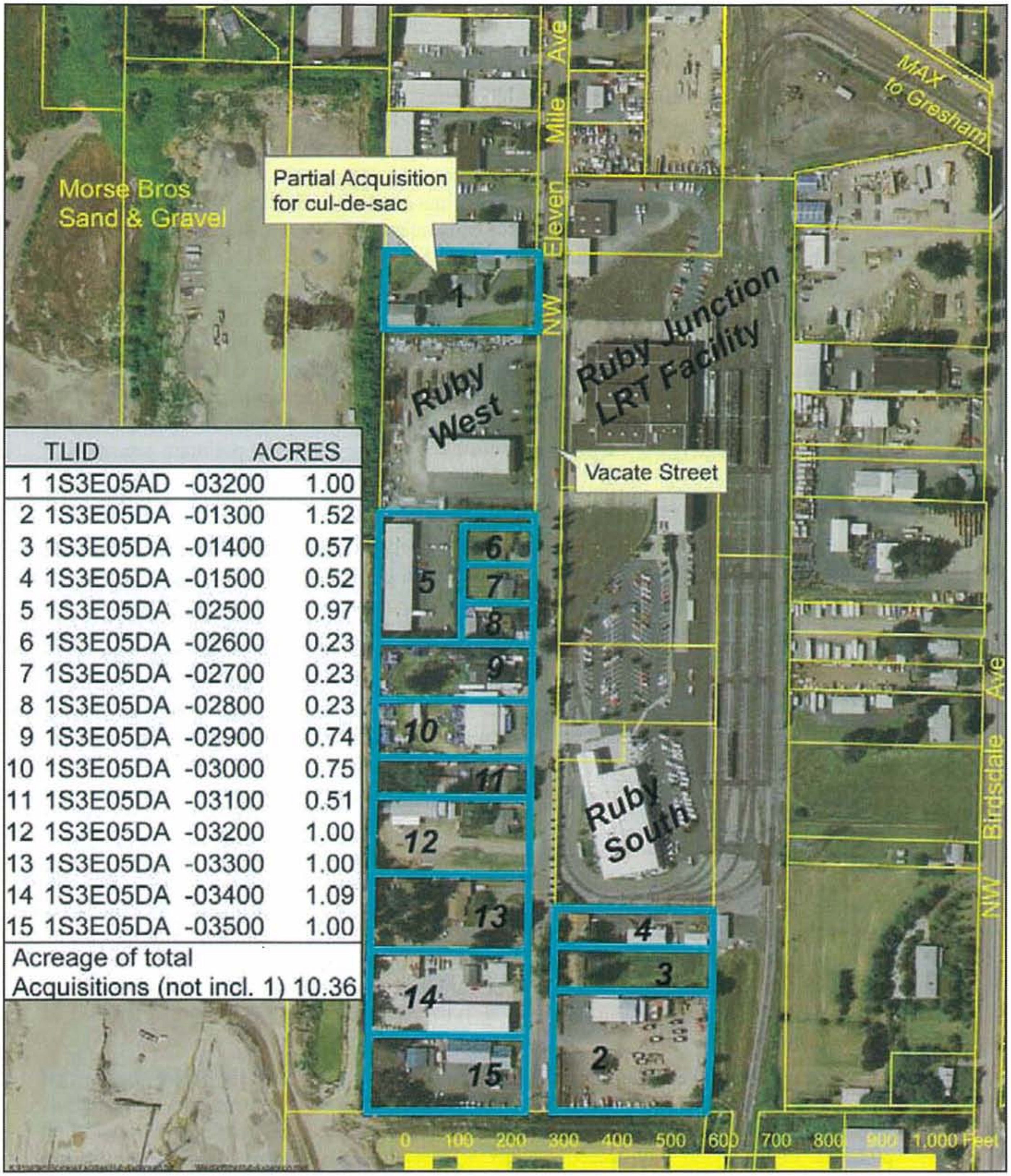
The expansion will convert some pervious surfaces to impervious surfaces; however, stormwater runoff from all new impervious surfaces will be infiltrated. Portions of three parcels, totaling approximately 2.0 acres, to be acquired as part of the facility expansion lie within the Federal Emergency Management Agency (FEMA) 100-year floodplain of Fairview Creek. Although no buildings will be constructed in the floodplain, portions of the floodplain may be developed for track and outside storage. Approximately 235,000 sq. ft. of impervious surface will be added at the facility, but approximately 60% will be used for LRT storage and is not pollutant-generating.

3.11 STAGING AND CASTING AREAS

Construction will require staging areas to store construction material, load and unload trucks, and conduct other construction support activities. Multiple staging areas will be needed, given the linear nature of the project and that much of it could be under construction at the same time. The existing I-5 right-of-way will accommodate most of the common construction staging requirements. Interchange areas at Marine Drive, SR 14, Mill Plain and Fourth Plain Boulevards, and 39th Street have enough room for staging most typical earthwork, drainage, utility, and structure activities. However, some construction staging may be needed outside the existing right-of-way, requiring temporary easements on nearby properties. The equipment will include, but may not be limited to paving equipment, hauling trucks, pile drivers, rotators/oscillators, concrete trucks, bulldozers, track excavators, backhoes, graders, scrapers, dump trucks, cranes, compactors, general use vehicles, and wheel loaders.

In addition, at least one large site will be required to stage larger equipment and materials such as rebar and aggregate, to accommodate construction offices, and to use as a casting yard for fabricating segments of the bridges. Suitable site characteristics for such a staging area include a large, previously developed site suitable for heavy machinery and material storage, proximity to the construction zone, roadway or rail access for landside transportation of materials, and waterfront access for barges (either an existing slip or dock capable of handling heavy equipment and material). The following three previously developed sites (Figure 3-25) are identified as possible major staging areas:

- The Port of Vancouver site: This 52-acre site is located along SR 501 near the Port of Vancouver's Terminal 3 North facility. This site is without river frontage, so materials would be transported over land to the construction site. Most of the property has an asphalt concrete surface, and any improvements will most likely be on top of this surface. Activities will consist of material storage, material fabrication (e.g., concrete and asphalt plants), equipment storage and repair, and temporary buildings. This site is currently used as a staging area for windmill components.



TLID		ACRES
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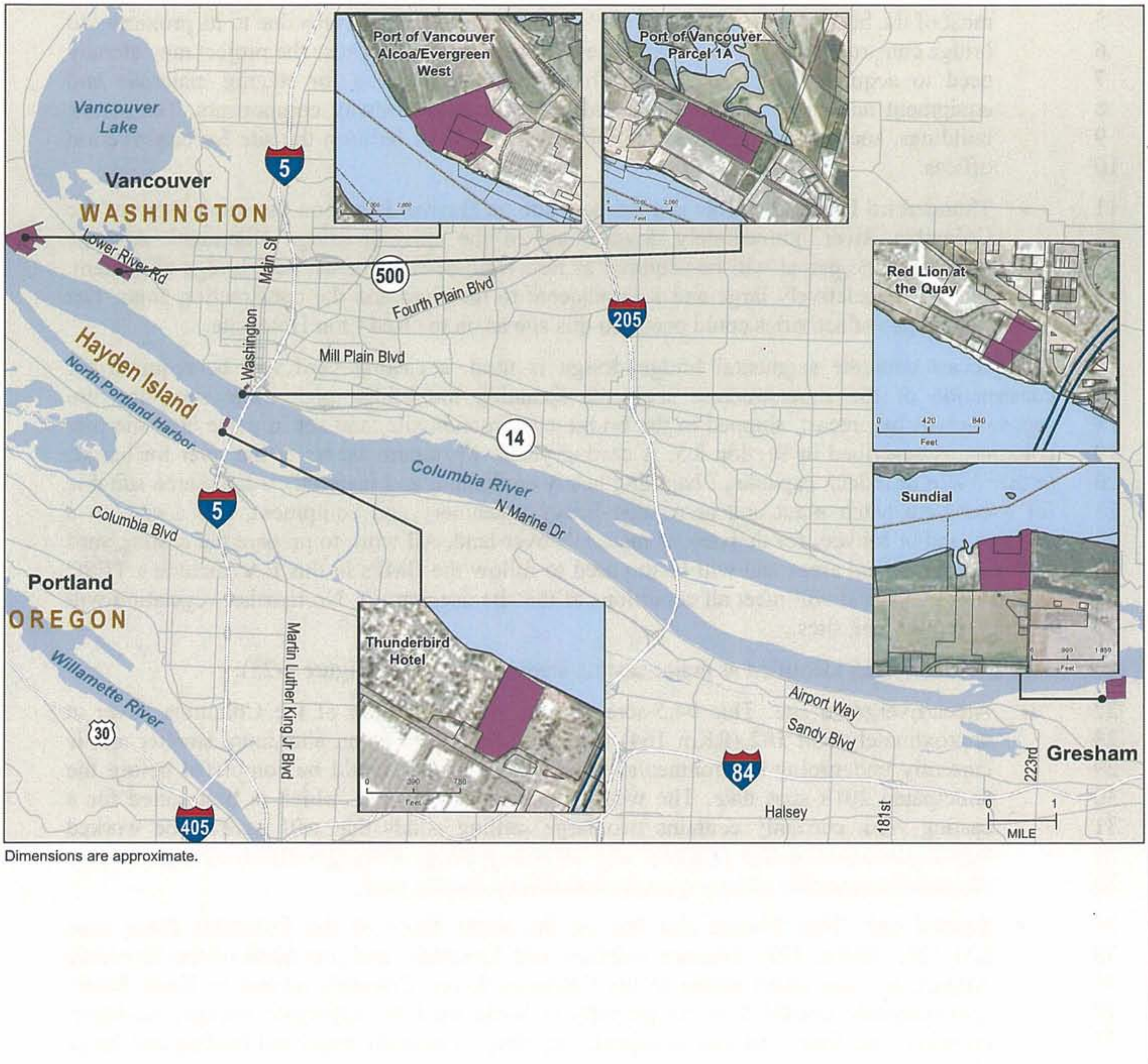
6	1S3E05DA -02600	0.23
7	1S3E05DA -02700	0.23
8	1S3E05DA -02800	0.23
9	1S3E05DA -02900	0.74
10	1S3E05DA -03000	0.75
11	1S3E05DA -03100	0.51
12	1S3E05DA -03200	1.00
13	1S3E05DA -03300	1.00
14	1S3E05DA -03400	1.09
15	1S3E05DA -03500	1.00
Acreage of total Acquisitions (not incl. 1)		10.36

Columbia River CROSSING

Figure 3-24.
Ruby Junction Maintenance Facility Expansion Area
Columbia River Crossing



Dimensions are approximate.

Figure 3-25.
Proposed Staging and Casting Areas

Columbia River CROSSING

- The Red Lion at the Quay Hotel: This is a 2.6-acre site on the north shore of the Columbia River, immediately downstream of the existing bridge alignment. A portion of this site will be acquired as right-of-way for the new bridge. Construction will require demolition of most of the buildings on the site. It could make an ideal staging area due to its proximity to bridge construction, large size, and access to the river, and because the project may already need to acquire the entire parcel. This site could be used for staging materials and equipment and for fabrication of smaller bridge and roadway components. Temporary buildings, such as trailers or other mobile units, will be built on the site for construction offices.
- Thunderbird Hotel Site: This is a 5.6-acre site on Hayden Island on the south shore of the Columbia River, immediately downstream of the existing bridge alignment. A large portion of the parcel will be acquired as new right-of-way for the new bridge alignment. The site is relatively large and it is adjacent to the river and the construction zone. The same types of activities could occur on this site as on the Red Lion Hotel site.

If a precast concrete segmental bridge design is used, a casting yard will be required for construction of the superstructure segments spanning the bridge piers. The superstructure segments will be precast, shipped to the bridge construction site, and set in place atop the pier columns, as described in Section 3.5. A casting yard will require access to the river for barges (either a slip or a dock capable of handling heavy equipment and material), a large area suitable for a concrete batch plant and associated heavy machinery and equipment, and access to a highway and/or railway for delivery of materials over land. All work to prepare the casting yard will occur in upland areas and will be required to follow the BMPs in this BA (include a TESC and SPCC plan), and will meet all conditions of the site use permits. No riparian vegetation will be impacted at these sites.

Two sites have been identified as major casting/staging yard areas (Figure 3-25):

- Alcoa/Evergreen site: This 94.5-acre site on the north shore of the Columbia River at approximately RM 102 (RKm 164) was previously used as an aluminum smelter and is currently undergoing environmental remediation, which should be completed before the anticipated 2013 start date. The western portion of this site, which is best suited for a casting yard, currently contains two large settling ponds that will have to be worked around. In addition, the property will require grading, drainage, and surfacing work to support the materials and equipment needed for a casting yard.
- Sundial site: This 56-acre site lies on the south shore of the Columbia River near RM 120.2 (RKm 193), between Fairview and Troutdale, and just north of the Troutdale Airport, and has direct access to the Columbia River. Currently owned by Knife River, approximately one-third of the property is being used for aggregate storage, stockpile, crushing, and sifting, as well as asphalt recycling. A recently improved landing and barge slip is located on the site.

3.12 STORMWATER RUNOFF TREATMENT

This section describes the stormwater management proposed for temporary construction activities and for increases in runoff from permanent new impervious surface areas constructed by the project. For the purposes of this section, the "project footprint" is defined as areas of new and rebuilt pavement, existing pavement that will be resurfaced and existing pavement that will be removed. It does not include existing pavement that will not be affected, even if runoff from that surface will be treated by the project. Stormwater treatment is not described for the Ruby Junction Maintenance Facilities elements of the project. For the Ruby Junction Maintenance Facility expansion, all new impervious surfaces will be infiltrated with no runoff anticipated to Fairview Creek or other surface waters.

3.12.1 Existing Conditions

Figure 3-26 through Figure 3-28 show existing drainage systems, watershed boundaries, and outfalls in the project corridor. Following is a brief description of these features based on the waterbody to which runoff is discharged. From south to north, these waterbodies are the Columbia Slough, Columbia River (including North Portland Harbor), and Burnt Bridge Creek. Table 3-22 shows the average monthly discharges for each watercourse, based on data available from U.S. Geological Survey (USGS) gauging stations (Figure 3-29 for locations). These data provide an indication of the relative size of each waterbody and permit a comparison of estimated project runoff with discharges in waterbodies receiving that runoff. For reasons discussed in Section 3.12.3, this section does not include Fairview Creek.[3]

Table 3-22. Mean Monthly Discharge

Month	Columbia Slough at Portland[a] (USGS 14211820)	Columbia River at Vancouver[a] (USGS 14144700)	Burnt Bridge Creek near Mouth[a] (USGS 14211902)
January	162	156,000	46
February	151	163,000	53
March	135	170,000	39
April	85	204,000	21
May	29[b]	286,000	19
June	65[c]	415,000	14
July	79	291,000	9.1
August	74	153,000	7.4
September	63	117,000	7.0
October	96	116,000	9.8
November	112	122,000	34
December	123	138,000	41

a Measured in cubic feet per second.

b Reverse flow from the Willamette River was recorded for mean monthly discharge in 1997, 2006, and 2008.

c Reverse flow from the Willamette was recorded for mean monthly discharge in 1990.

[3] Fairview Creek is the receiving waterbody for runoff from TriMet's Ruby Junction Maintenance Facility.

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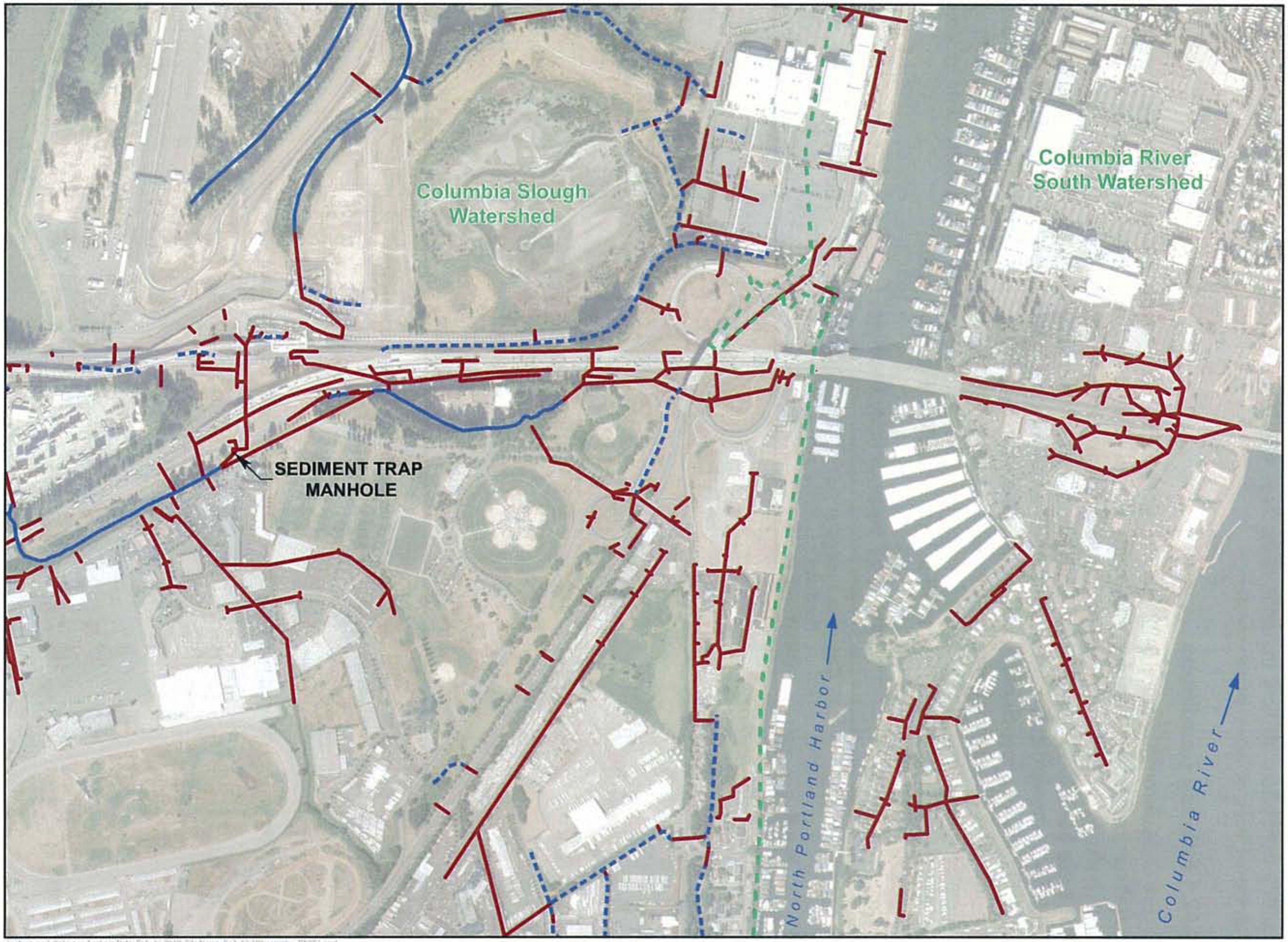

Figure 3-26.
Existing Conditions - Oregon

Figure 3-27. Existing Conditions - Washington State (Sheet 1 of 2)

8940

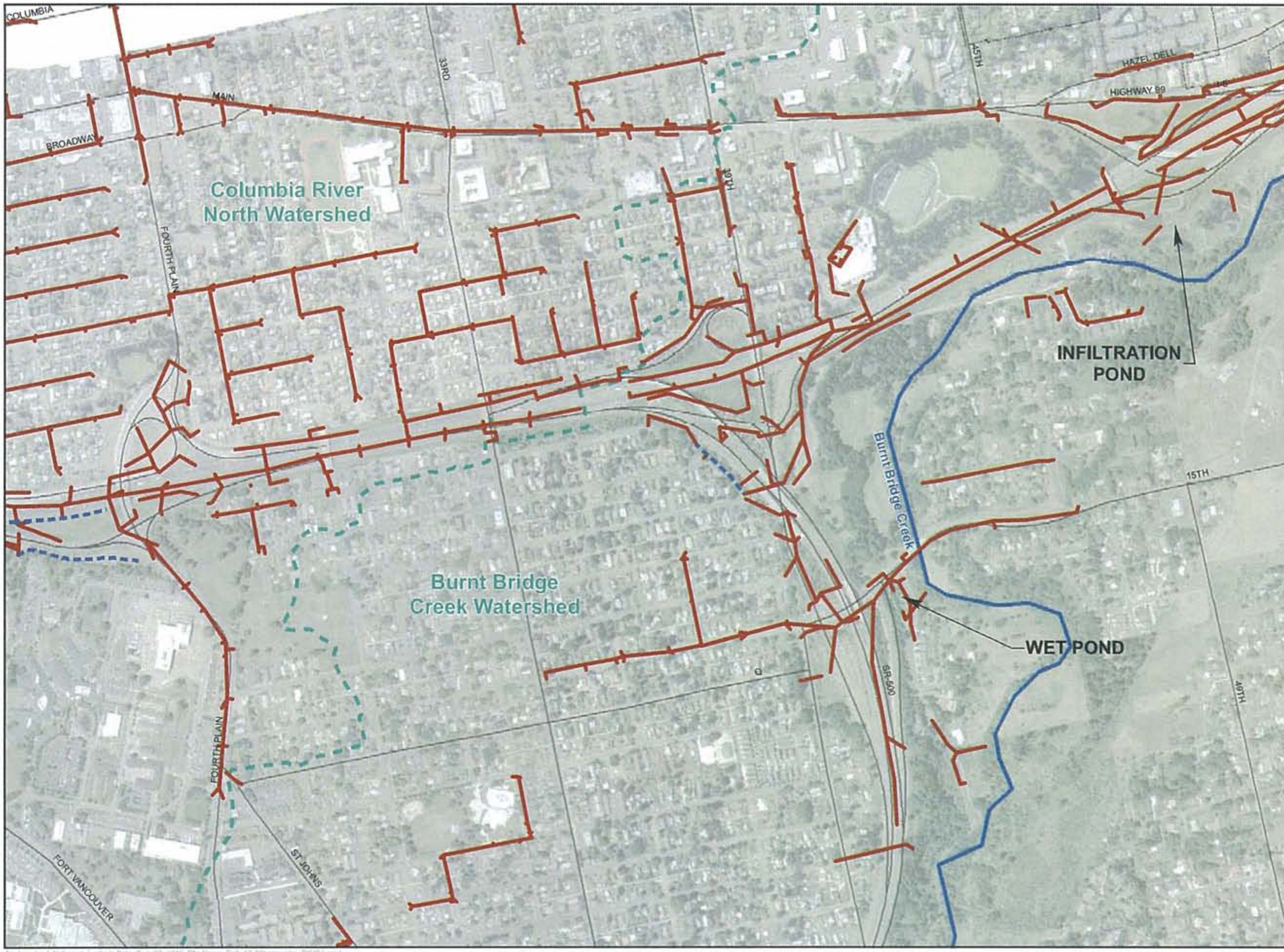

Figure 3-28. Existing Conditions - Washington State (Sheet 2 of 2)

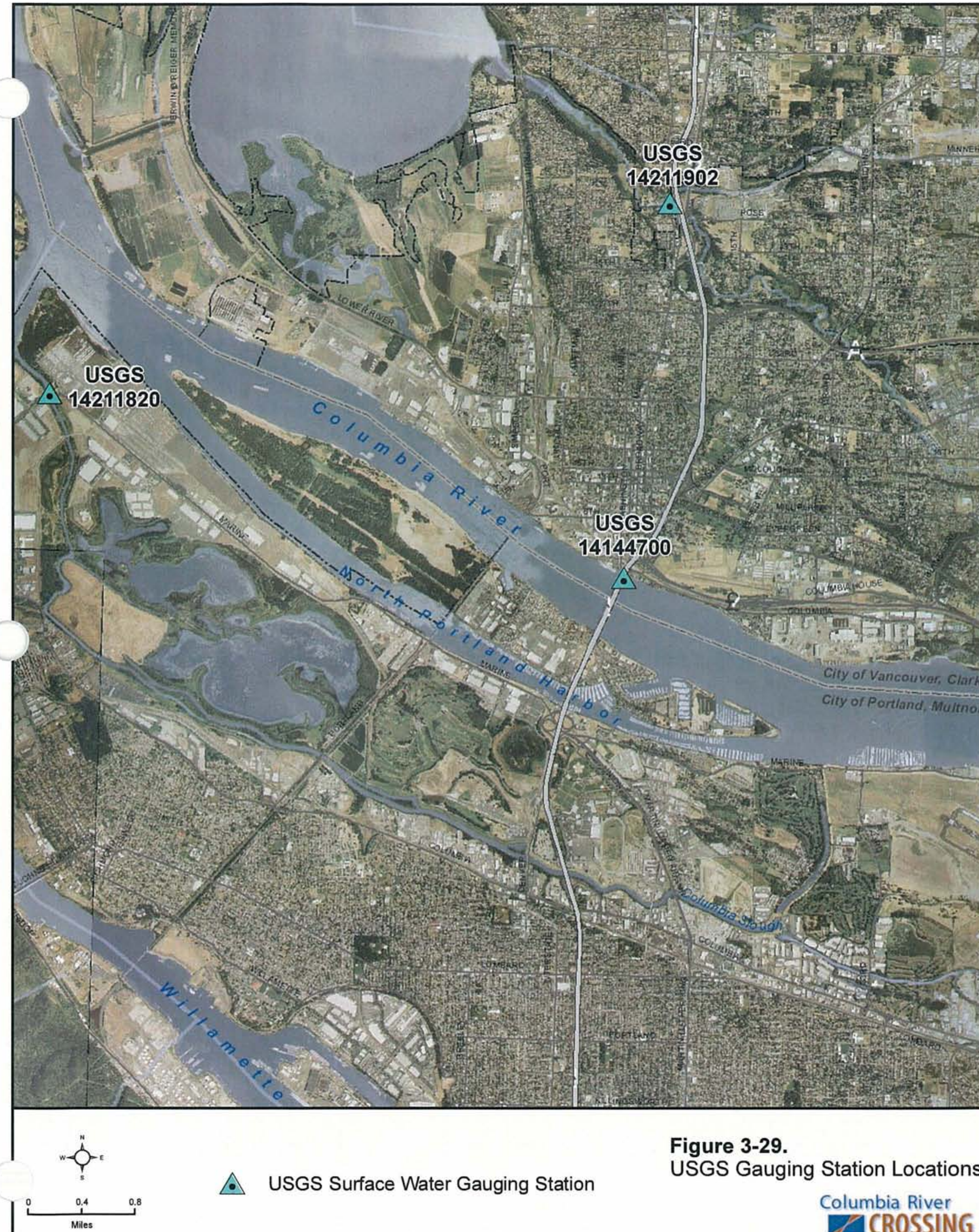

Figure 3-29.
USGS Gauging Station Locations

Analysis by J. Koloszar; Analysis Date: Feb 12, 2010, File Name: Ex_13-4Stormwater_RK251.mxd

3.12.1.1 Columbia Slough Watershed

Columbia Slough, located south of the CRC project, discharges to the Willamette River. Its watershed is a 51-square-mile area that extends from Kelley Point to the west to Fairview Lake and Fairview Creek to the east (COP 2005). This watershed includes portions of the former Columbia River floodplain and before the construction of a levee system and pump stations, would have been subjected to frequent inundation. Near I-5, the original ground surface is below the OHW for the Columbia River. There are two drainage districts within the project footprint: Peninsula Drainage Districts No. 1 and No. 2 (or Pen 1 and Pen 2, respectively). I-5 is the boundary between the two districts with No. 1 to the west and No. 2 to the east (Figure 3-30). Daily operations of both districts are managed by the Multnomah County Drainage District (MCDD).

Based on data available from the Natural Resources Conservation Service (NRCS) website, surficial soils in this area mainly comprise the Sauvie-Rafton-Urban land complex. These soils belong to Hydrologic Group D, and have a low infiltration rate and high runoff potential. A soil survey conducted in Multnomah County indicates that water tables in this area are at a depth of less than 1 foot (USDA 1983). While borehole logs available for the project area confirm the high groundwater table, they also indicate that the soils can be highly variable. Land west of I-5 generally has an Industrial zoning designation, while land to the east is generally designated as Open Space. The latter area includes sports facilities such as baseball diamonds.

I-5, Marine Drive, and Martin Luther King Jr. Boulevard are elevated on embankments or structures, and the drainage systems that serve these roads do not handle runoff from outside the right-of-way. These embankments are also part of the levee system. Surface runoff from I-5 and roads within the project footprint is generally confined to the roadway surface by continuous concrete barriers or curbs, and is collected almost entirely by closed gravity drainage systems with inlets and stormwater pipes, The one notable exception is Martin Luther King Jr. Boulevard east of I-5, where runoff is shed off the south shoulder. As shown on Figure 3-30, runoff from the project area drains to a system of sloughs before being discharged to the Columbia Slough via the Portland International Raceway, Schmeer Road, or Pen 2-NE 13th pump stations. These pump stations, which are sized to handle the 1-in-100-year runoff, have installed capacities of 19,700, 40,000, and 32,000 gallons per minute, respectively. Note that Marine Drive west of I-5, while within the confines of the levee system, drains to outfalls on North Portland Harbor and is included in the Columbia River South Watershed.

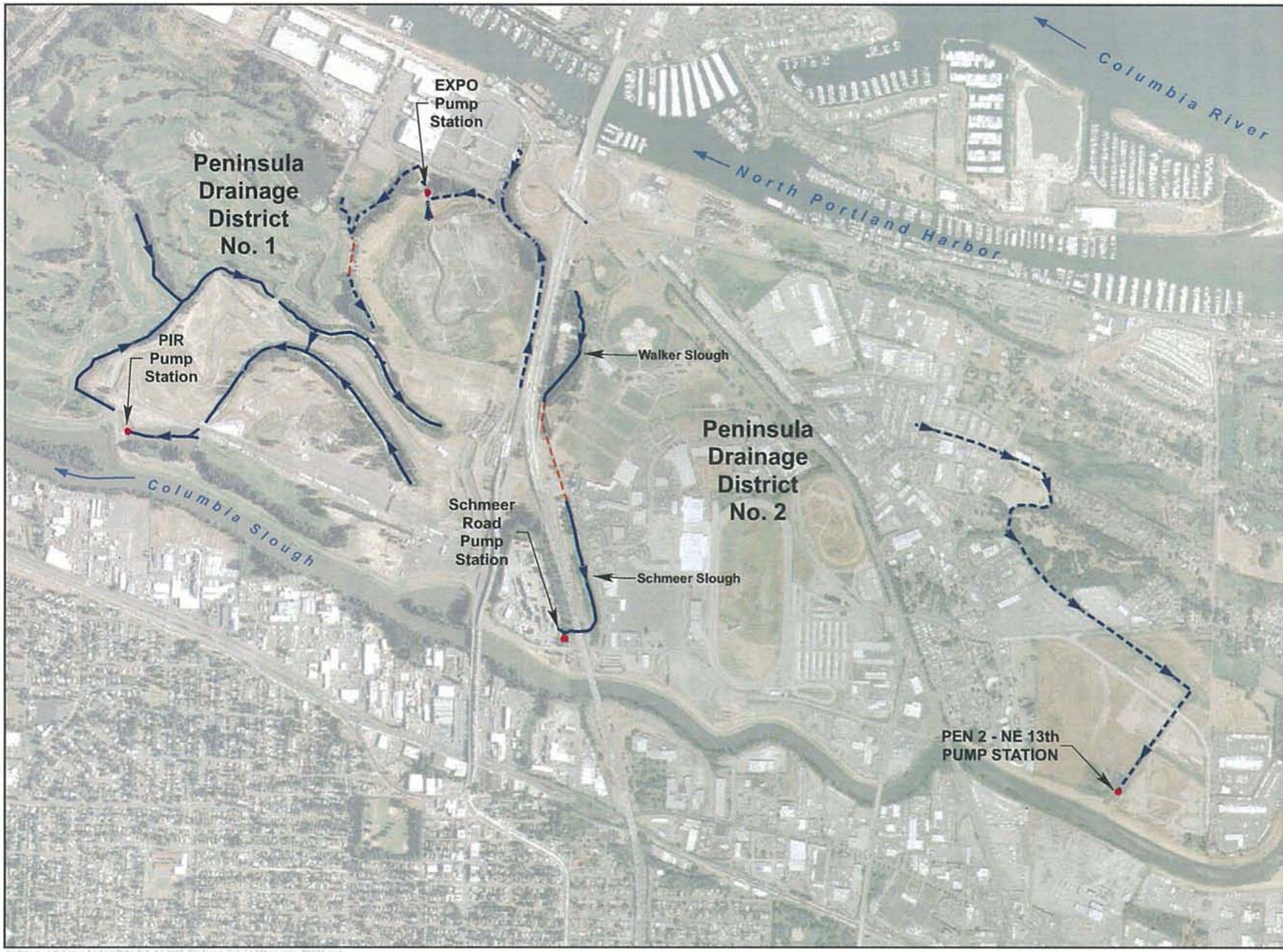

**Figure 3-30.
Surface Water Systems -
Peninsula Drainage Districts
No. 1 and No. 2**

Natural Watercourse
Drainage Ditch
Culvert
Pump Station

N
W E
S

0 600 1,200 1,800
Feet

Columbia River CROSSING

The existing pollutant-generating impervious surface (PGIS; see Section 3.12.3.1) within the project footprint in this watershed is approximately 46 acres. Runoff from about 3 acres (Martin Luther King Jr. Boulevard and Union Court) is dispersed and infiltrated. There are no flow control measures for runoff within the project footprint beyond the regulation of discharges to Columbia Slough provided by pump station operation. In addition, there are no engineered water quality facilities except for a manhole sediment trap located at the Victory Boulevard interchange (Figure 3-26) that treats runoff from approximately 6 acres of impervious surfaces at the interchange (not within the project footprint).

3.12.1.2 Columbia River South Watershed

For convenience, the areas draining to the Columbia River are divided into those within Oregon and those within Washington State. The Columbia River South Watershed includes the portion of the project area south of North Portland Harbor that drains to that waterbody, North Portland Harbor Bridge, Hayden Island, and the Columbia River bridges south of the state line.

Like the Columbia Slough Watershed, the project footprint within this watershed is located in what was part of the Columbia River floodplain. The portion south of North Portland Harbor is protected against flooding by a levee system, material dredged from the Columbia River has been used to raise the overall ground surface on Hayden Island east of the Burlington Northern Santa Fe (BNSF) railroad tracks above the 1-in-100-year flood elevation.

Surficial soils on Hayden Island comprise the Pilchuck-Urban land complex, based on available NRCS data. These are Hydrologic Group A soils that have a high infiltration rate and consist mainly of deep, well drained to excessively drained sands or gravelly sands. Available borehole information confirms this description. While limited piezometer data indicates that the groundwater table is about 15 feet below ground, the phreatic surface is expected to respond to changes in river level, given the highly permeable nature of the soils. The land either side of I-5 on Hayden Island is highly developed and comprises service-related businesses such as retail stores and restaurants, and their parking lots.

Like the Columbia Slough Watershed, I-5 is elevated on an embankment across Hayden Island. Surface runoff from I-5 and local roads within the project footprint is generally confined to the roadway surface by continuous concrete barriers or curbs. Except for the North Portland Harbor and Columbia River Bridges, runoff is collected entirely by closed gravity drainage systems with inlets and stormwater pipes that discharge directly to North Portland Harbor or the Columbia River. Runoff from the bridges is discharged through scuppers directly to the water surface below. The existing PGIS within the project footprint in this watershed is approximately 56 acres; there are no flow control measures or engineered water quality facilities.

3.12.1.3 Columbia River North Watershed

This watershed comprises the project footprint from the state line in the south to the SR 500 interchange in the north. It encompasses the current I-5 corridor as well as Vancouver city streets on which the LRT guideway will be located. The existing PGIS within the project footprint is approximately 97 acres; there are no flow control measures or engineered water quality facilities, with the exception of approximately 3 acres of SR 14 from which runoff is dispersed and infiltrated.

Within the project footprint, the land is formed of the gently-sloping Wind River and Lauren surficial soils. These soils belong to Hydrologic Group B and have a moderate infiltration rate. While depths to water table are not provided (USDA 1972), borehole logs available for the area indicate that groundwater levels are close to water levels in the Columbia River. In addition, piezometer readings taken by WSDOT in the SR 14 interchange area demonstrate that the water table, at least at that particular location, responds to changes in river level.

Land west of I-5 comprises downtown Vancouver and residential neighborhoods to the north. The area east of I-5 and south of Fourth Plain Boulevard contains the Pearson Airpark and Fort Vancouver Historic Park, both of which are low-density land uses. North of Fourth Plain Boulevard, land east of the highway comprises residential development.

Surface runoff from I-5 and local streets is generally confined to the roadway by continuous curbs and concrete barriers, and is collected almost entirely by closed drainage systems. The only exceptions are the Columbia River bridges and a few ditches adjacent to the highway. These closed systems discharge runoff directly to the Columbia River via outfalls in the vicinity of the existing highway bridges, while runoff from the bridges themselves drains through scuppers to the river below. A pump station located southeast of the SR 14 interchange (Figure 3-27) discharges runoff from lower lying portions of the interchange to the Columbia River during high river levels.

The vertical grade of I-5 is generally below the surrounding areas and as a result, the drainage system serving the highway also handles runoff from built-up areas outside the highway right-of-way, as shown on Figure 3-27 and Figure 3-28. These areas, which are extensive, are estimated to comprise over 50 percent of the total drainage area served by this system, and their contribution to flows was an important consideration when developing the approach to stormwater management in this watershed.

3.12.1.4 Burnt Bridge Creek Watershed

The project footprint within this watershed includes approximately 16 acres of existing PGIS, including the SR 500 interchange and portions of I-5 to the north and SR 500 to the east. Surficial soils in this area typically consist of Wind River loams. These soils belong to Hydrologic Group B and are considered to have a moderate infiltration rate. Residential developments are located south of the SR 500 interchange. There is a school to the northwest of the SR 500 interchange and a park to the northeast. Available information suggests that the groundwater table in this area is deep.

Typical of an urban environment, surface runoff from the highways and local streets is generally confined to the roadway by continuous curbs and concrete barriers, and is collected almost entirely by closed drainage systems. In contrast to the other watersheds, runoff from the entire PGIS within this portion of the project footprint currently contains some form of treatment. Runoff from about 15 acres within the project footprint is conveyed to an infiltration pond at the Main Street interchange, and the balance is conveyed to a wet pond north of SR 500 (Figure 3-28 for both locations).

The infiltration pond will prevent pollutants from entering the creek and will infiltrate flows; however, the primary water quality function of the wet pond is to reduce sediment. For this reason, runoff from the area served by this pond is not included in this report as receiving water quality treatment.

3.12.2 Temporary Construction Activities

Without proper management, construction activities could create temporary adverse effects on water quality in nearby water bodies, such as erosion or the accidental release of fuels and soluble or water-transportable construction materials.

Table 3-23 summarizes project-related areas of temporary disturbance by watershed and includes all areas within the proposed project footprint. It does not include potential staging areas on land outside the footprint, construction areas in or over water, or possible casting yard sites that may be required for fabricating segmental box bridge segments. Staging areas and casting yard sites are discussed in Section 3.11.

Table 3-23. Areas of Potential Disturbance During Construction

Watershed	Potential Area of Temporary Disturbance
Columbia Slough	105 acres
Columbia River – Oregon	70 acres
Columbia River – Washington	170 acres
Burnt Bridge Creek	55 acres
Fairview Creek	15 acres

Staging and casting yard sites will be required to local and state stormwater treatment requirements. Typical runoff from these sites could include oils, greases, metals, and high-pH water from concrete production. Stormwater treatment BMPs would be designed to treat specific areas of these sites. Site-specific BMPs could include pre-treatment facilities such as oil-water separators and sediment traps and standard facilities to meet water quality and water quantity issues, as appropriate. Appropriate BMPs for stormwater treatment are discussed further in Section 3.

National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Discharge Permits will regulate the discharge of stormwater from construction sites. These permits include discharge water quality standards, runoff monitoring requirements, and provision for preparing a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP contains all the elements of TESC and SPCC plans.

The SWPPP and its adoption by construction personnel are essential for ensuring water quality standards are met during construction, and a single, comprehensive plan will ensure project-wide consistency. Contractors will be required to have a certified Erosion and Sediment Control Lead on staff to ensure proper implementation of the SWPPP. In addition, the agency or agencies responsible for providing construction oversight will also have one or more staff assigned to monitor SWPPP implementation.

Typical elements of a SWPPP are listed in Section 7. Water quality standards, which include standards for turbidity and pH, are usually monitored at the point of discharge. There may also be special requirements, in addition to those for turbidity and pH, for discharges to the Columbia Slough and Burnt Bridge Creek, both of which are 303(d)-listed watercourses.

The selection of construction BMPs is dependent on the specific site layout and sequence of construction activities.

3.12.3 Permanent Water Quality and Flow Control Systems

The following sections describe the general approach to the management of runoff from impervious areas constructed by the project and from existing impervious areas within the project footprint that will remain after the project is completed. The project footprint is the area defined by the extent of property required for the completed project. It does not include areas that might be required to facilitate construction, such as temporary construction easements and staging areas.

The focus is on the potential effect of the project on runoff to receiving waterbodies in terms of pollutants and discharge. These waterbodies are the Columbia Slough, Columbia River (including North Portland Harbor), and Burnt Bridge Creek. Although there will be project-related construction in the Fairview Creek watershed,[4] the creek is not fish-bearing, the proposed impervious area will be less than currently exists, and runoff will be infiltrated. For these reasons, this watershed is not included in subsequent discussions.

3.12.3.1 Pollutant-Generating Surfaces

The intent of project stormwater management strategies is to reduce the potential impact on water quality and discharge from project-related changes in impervious area, especially PGIS. PGIS, defined as impervious surfaces considered to be significant sources of pollutants in stormwater runoff, provide a good indicator of the potential impact of the project on water quality in receiving waterbodies. For the permanent project facilities, these areas include:

- Highways and ramps, including non-vegetated shoulders
- LRT guideway subject to vehicular traffic (referred to as a semi-exclusive guideway where the tracks are subject to cross-traffic, or as non-exclusive where vehicles such as buses can travel along the guideway)
- Streets, alleys, and driveways
- Bus layover facilities, surface parking lots, and the top floor of parking structures

The following types of impervious area are considered non-PGIS:

- LRT guideway not subject to vehicular traffic except for occasional use by emergency or maintenance vehicles (often referred to as an exclusive guideway)
- LRT platforms
- Bike/ped paths and sidewalks

[4] Construction will comprise expansion of the TriMet LRT Maintenance Facility. The expansion would be a joint undertaking of the CRC and Portland-Milwaukie LRT Projects.

Exclusive LRT guideway is considered non-pollution-generating because the light rail vehicles are electric, and other potential sources of pollution such as bearings and gears are sealed to prevent the loss of lubricants. Light rail vehicle braking is almost exclusively accomplished via (power) regenerative braking, which avoids any friction or wear on the vehicle brake pads and, thus, releases very few pollutants. Sand, however, may need to be applied to the tracks to aid traction on steeper grades and this is taken into consideration when assessing water quality facility requirements.

Bus shelter roofs might be pollutant-generating if they are constructed from galvanized metal. Such areas will be very small in relation to the overall area of sidewalk and were not included in the calculation of PGIS area. In addition, these types of facility are not typically well-defined at this early stage of project development.

The focus on PGIS should not be taken to infer that only runoff from these areas will be treated. Runoff from contiguous non-PGIS sidewalks, for example, typically commingles with roadway drainage and, as such, would also be treated. As discussed in Section 3.12.5.5 the PGIS and non-PGIS within the project footprint together form most of the contributing impervious area for the project.

Table 3-24 provides the approximate areas of new and rebuilt impervious surfaces by project element and watershed. The acreages presented below include all impervious areas across the project corridor. The acreages presented later in this section, which are in relation to stormwater treatment design, include PGIS acreages only, a 10-acre allowance for post-project development on Hayden Island, and do not include Ruby Junction acreages since all new PGIS at that site will be infiltrated post-project. Therefore, the values in Table 3-24 are similar to values presented in further discussion, but cannot be compared directly.

Table 3-24. New and Rebuilt Impervious Surface Area in Acres by Project Element and Watershed

Element	Columbia Slough	Columbia River South	Columbia River North	Burnt Bridge Creek	Fairview Creek (Ruby Junction)	Total
Highway structures	12	20	20	1	0	**54**
Highway pavement (including tunnels)	27	22[a]	54	8	0	**111**
Transit guideway, platforms, and associated roadway	0	1	13	0	0	**14**
Transit maintenance facilities	0	0	0	0	5	**5**
Transit structures	0	3	1	0	0	**3**
Park and ride structures	0	0	5	0	0	**5**
Sidewalks and bike/ped paths (including those on transit structures)	4	6	13	1	0	**23**
Total	**43**	**52**	**105**	**10**	**5**	**215**

a This does not include 10 acres of post-project transit-oriented development assumed to be constructed adjacent to the Hayden Island LRT station.

Figure 3-31 through Figure 3-33 show the project footprint and those parts of the project that will be new or rebuilt versus those parts expected to be resurfaced. Within the project footprint, the project will increase the overall PGIS area by approximately 21 acres or approximately 10 percent over the existing 217 PGIS acres. New PGIS includes new and rebuilt pavement. The current design will result in approximately 191 acres of new PGIS and 43 acres of resurfaced pavement.

Project water management strategies will result in a reduction from current conditions of over 188 acres of PGIS from which runoff is discharged untreated. In addition, runoff from 183 of the 191 acres of PGIS created or rebuilt by the project (or over 95 percent) will be infiltrated (67 acres) or treated (116 acres), as well as 34 of the 43 acres of resurfaced roadway. In addition, runoff from about 4 acres on the existing North Portland Harbor Bridge and approximately 19 acres of existing PGIS that lie outside the project footprint (and will not be affected by the project) will be treated. These latter areas mainly comprise Vancouver streets from which runoff will naturally drain to proposed water quality facilities and other roadway surfaces that are considered to be "equivalent" areas for new project-related PGIS that will be difficult to treat.

The total Contributing Impervious Area (CIA) for the project, which includes PGIS and non-PGIS, is estimated to be approximately 291 acres. This area includes about 261 acres of new, rebuilt, and resurfaced impervious surface area created by the project and approximately 30 acres of existing impervious area that, while unaffected by the project, will contribute runoff to the area included in the project footprint. Runoff from approximately 262 acres or about 90 percent of the CIA will be treated or infiltrated.

3.12.3.2 Objectives

To minimize permanent stormwater-related impacts, the following stormwater management objectives were adopted for the project:

1. Provide flow control for new and rebuilt[5] impervious areas in accordance with state and local requirements. Note that flow control is only required for stormwater discharges to Burnt Bridge Creek. Discharges to the Columbia Slough, North Portland Harbor, and Columbia River are exempt.[6] Although Columbia Slough is exempt from flow control, the discharge of runoff from the project area to the waterbody is regulated by the operation of drainage district pump stations.
2. Select and provide water quality treatment for runoff from new and rebuilt PGIS in accordance with the most restrictive requirements of the agencies that have authority over the affected drainage areas.

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[5] Rebuilt impervious surfaces are existing impervious areas that are excavated to a depth at or below the top of the subgrade.

[6] Flow exemption is provided in the City of Portland's 2008 Stormwater Management Manual .

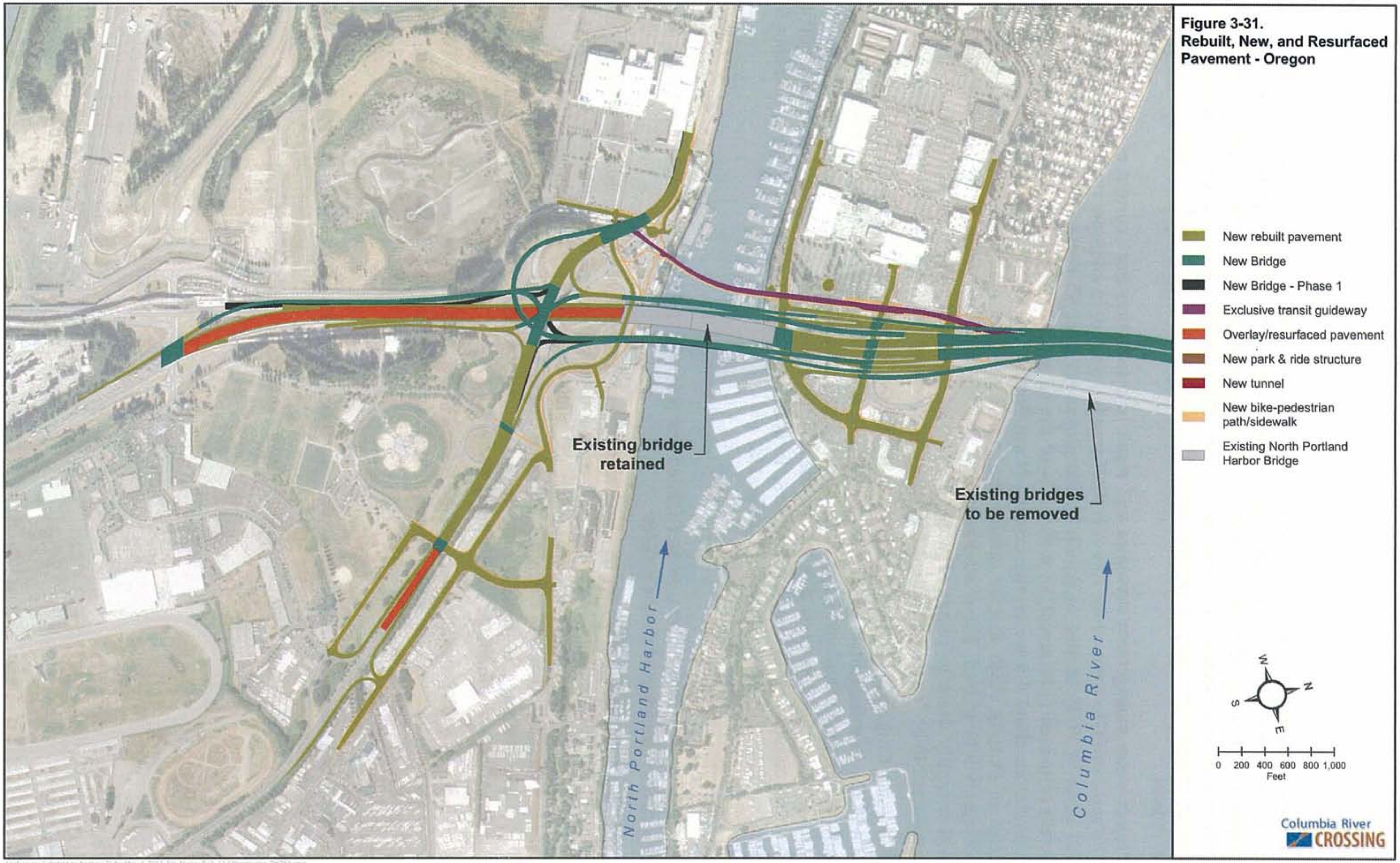
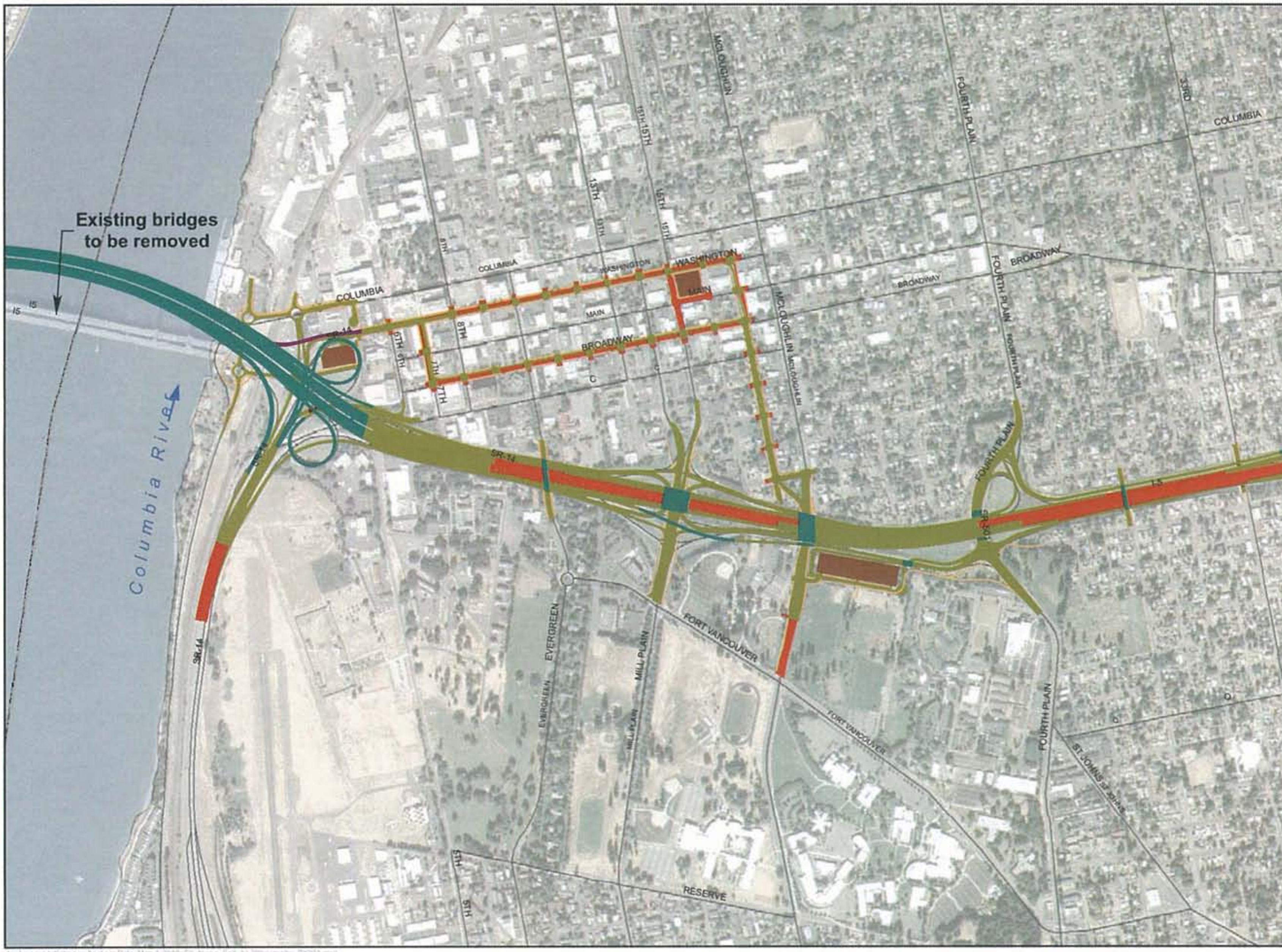


Figure 3-31.
Rebuilt, New, and Resurfaced Pavement - Oregon

Figure 3-32.
Rebuilt, New, and Resurfaced Pavement - Washington State (1 of 2)



New rebuilt pavement
New Bridge
Exclusive transit guideway
Overlay/resurfaced pavement
New park & ride structure
New tunnel
New bike-pedestrian path/sidewalk

W N S E

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

8951

8952

Figure 3-33.
Rebuilt, New, and Resurfaced Pavement - Washington State (2 of 2)

- New rebuilt pavement
- New Bridge
- Overlay/resurfaced pavement
- New park & ride structure
- New tunnel
- New bike-pedestrian path/sidewalk

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

3. Where practical and cost-effective,[7] provide additional water quality treatment for runoff from resurfaced (or overlaid),[8] and existing PGIS where none currently exists.
4. The different approach to new versus resurfaced pavement is consistent with the Standard Local Operating Procedures for Endangered Species (SLOPES IV) (NMFS 2008j), a programmatic biological opinion and incidental take statement for transportation projects undertaken in Oregon and on the north shore of the Columbia River and permitted by the USACE.

3.12.4 Water Quality Best Management Practices

The stormwater water quality management approach is to treat runoff to reduce the following pollutants that are typically associated with transportation projects:

- Debris and litter
- Suspended solids such as sand, silt and particulate metals
- Oil and grease
- Dissolved metals

Dissolved metals, especially dissolved copper, are of particular concern due to their potential impact on the olfactory systems of listed fish.

CRC adopted ODOT's recent technical memorandum on stormwater water quality on a project-wide basis to provide a standard approach to determining types of water quality facilities that will provide adequate protection to listed species (ODOT 2009). The memorandum is the result of a collaborative venture by ODOT, FHWA, and natural resource agencies (NOAA Fisheries, DEQ, USFWS, EPA, and ODFW). The decision to use this approach on the CRC project was endorsed by WSDOT and Ecology. For the project, the suite of BMPs resulting from the application of this technical bulletin was found to be comparable to or more restrictive than the results that would be obtained by using state and municipal agency requirements.

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[7] Based on the WSDOT Highway Runoff Manual guidelines: a) Treat runoff from existing PGIS (primarily in Vancouver) that would run on to new or rebuilt pavement, the runoff from which is proposed to be treated, and b) treat runoff from resurfaced PGIS (primarily on I-5) where it could be captured and conveyed to a proposed water quality facility without the need to excavate the resurfaced pavement to install new conveyance systems.

[8] Resurfaced impervious surfaces are those existing impervious surfaces where the asphalt or concrete is not removed down to or below the top of the subgrade.

Based on the ODOT memorandum, the following water quality BMPs are effective in reducing sediments, particulates, and dissolved metals, which are pollutants of concern for ESA-listed species observed in the waterbodies to which stormwater will be discharged:

- **Bioretention Ponds** are infiltration ponds that use an engineered (amended) soil mix to remove pollutants as runoff infiltrates through this zone to the underlying soils. The primary mechanisms for pollutant reduction are filtration, sorption, biological uptake, and microbial activity. While this BMP is best suited to sites with Hydrologic Group A and B soils, it may be used for Group C and D Hydrologic Group soils with the addition of an underdrain system to collect infiltration runoff and direct it to a stormwater conveyance system. An infiltration rate of 1 inch per hour was assumed when estimating the size of these facilities. If the soils cannot sustain this rate and there is insufficient space to increase the pond size to accommodate a lower value, underdrains will be installed.
- **Constructed Treatment Wetlands** are shallow, permanent, vegetated ponds that function like natural wetlands. They remove pollutants through sedimentation, sorption, biological uptake, and microbial activity.
- **Soil-Amended Biofiltration Swales** are trapezoidal channels with mild slopes and shallow depths of flow. The channels are dry between storm events and are typically vegetated. They treat runoff by filtration and sorption as runoff flows through the grass surface and amended soils. Amended soils, especially compost-amended, constitute an excellent filtration medium. Compost-amended soils have a high cation exchange capacity that will bind and trap dissolved metals. Similar to bioretention ponds, an underdrain system is recommended for sites with Group C and D Hydrologic Group soils.
- **Soil-Amended Filter Strips** are intended to treat sheet runoff from an adjacent roadway surface. Similar to grass swales, filter strips treat runoff by filtration and sorption as runoff flows through the vegetated surface and amended soils. In a confined urban setting such as the project corridor, opportunities to use this BMP are limited.
- **Bioslopes**, like filter strips, are intended to treat sheet runoff from an adjacent roadway surface. They comprise a vegetated filter strip, infiltration trench, and underdrain, and reduce pollutants through sorption and filtration. The percolating runoff flows through a special mixture of materials, including dolomite and gypsum, which promotes the adsorption of pollutants. Bioslopes are also known as media filter drains and ecology embankments.

Other water quality BMPs, including **dispersal**, **drywells** and **proprietary systems** (such as cartridge filters),[9] are considered on a case-by-case basis where the BMPs listed above are not practical or feasible.

Oil control pretreatment may be required at high-traffic intersections and park and ride facilities, where high concentrations of oil and grease are expected in stormwater runoff. Suitable types of treatment facilities include **baffle type oil-water separators** and **coalescing plate oil-water separators**.

[9] Cartridge filters are passive flow-through devices similar to the filters commonly available for household faucets. Media in the cartridges will trap or adsorb contaminants such as suspended particles and dissolved metals.

As the project design progresses, the team will continue to assess new technologies and whether they should be added to the suite of acceptable BMPs. For example, Ecology recently approved Americast's Filterra® system for reducing dissolved metals and other pollutants (Ecology 2006). This system uses engineered bioretention filtration incorporated into a planter box to treat runoff.

The sizing and detailed design of individual water quality facilities will be in accordance with the specific requirements of the state or local agency that has jurisdiction over that facility. For example, water quality facilities (or BMPs) within the WSDOT right-of-way will be sized and designed in accordance with the WSDOT Highway Runoff Manual. Runoff in excess of the flow needed to meet requirements for water quality treatment will be routed around such facilities to the maximum extent practical. This approach will reduce maintenance requirements and extend the life of the facility without compromising water quality objectives.

In Oregon, single rainfall events are typically used to size water quality facilities. ODOT uses rainfall events that will result in treatment of approximately 85 percent of the cumulative runoff, while the City of Gresham's and the City of Portland's design rainfall will result in treatment of approximately 80 and 90 percent of the average annual runoff, respectively.

In Washington, the types of water quality facility being proposed will be sized to treat at least 91 percent of the runoff volume, regardless of where the facility is located. Unlike in Oregon, design flows and volumes for water quality facilities in Washington are estimated using a continuous rainfall-runoff simulation model.

It should be noted that many of the proposed water quality facilities rely on infiltration as the primary mechanism for treatment and disposal. Depending on the infiltration rates available at a particular site, these facilities may be able provide an even higher percentage of runoff treatment. However, for purposes of describing and analyzing effects, the published state and local standards discussed above and in Section 3.12.5 will be used.

3.12.5 Stormwater Management Facilities

The following subsections describe the proposed stormwater water quality and flow control facilities on a watershed basis. As noted in the preceding section, water quality facilities were selected from the list of acceptable BMPs developed using the ODOT technical guidance memorandum cited in Section 2. The general approach is to provide centralized water quality facilities located in interchange areas, thereby minimizing the need for additional property acquisitions. Design development and refinements may necessitate considering BMPs other than those presented in this report, and stormwater conveyance system design may result in changes in areas draining to individual water quality facilities. The project will also identify and evaluate options as design progresses for low impact development and the use of more localized water quality facilities that treat runoff closer to its source, thereby reducing the size of the stormwater management facilities currently proposed. The ODOT technical memorandum will continue to be employed, ensuring that project objectives are not compromised and that water quality facilities will be provided for an equal or greater area of new and rebuilt PGIS.

In general, where feasible, water quality stormwater treatment facilities will be provided for new and rebuilt PGIS. Where this does not appear to be feasible, the treatment of the same or greater area of "equivalent" PGIS is proposed. In addition, water quality facilities are proposed for resurfaced and existing surfaces where practical and cost-effective.[10] As discussed in the preamble to Section 3.12.3, this approach is consistent with local and state jurisdictional agency requirements. The CRC design team has evaluated the need to resurface versus rebuilding existing I-5 pavement with the intention of reducing project cost and minimizing the use of non-renewable resources. This has resulted in the proposed mix of resurfaced and rebuilt pavement, a mix that will continue to be reviewed with a view to minimizing the extent of existing pavement that requires complete reconstruction. As a result of this stormwater treatment approach, the area of untreated PGIS is reduced from its existing condition in all watersheds.

Flow control is proposed only for discharges to Burnt Bridge Creek. As described in Section 3.12.3.2, the Columbia Slough and Columbia River are exempt from such requirements.

3.12.5.1 Columbia Slough Watershed

Overall, the project will increase the total PGIS in this watershed by approximately 10 acres. This increase may be attributed to new streets connecting areas on either side of the Marine Drive interchange, and the addition of runoff from the North Portland Harbor Bridge. As stated in Section 3.12.1, runoff from the existing structure currently discharges through scuppers to the water surface below. The project will create approximately 39 acres of new and rebuilt PGIS. While I-5 will generally follow its current alignment and grade, the Marine Drive interchange will be completely rebuilt and will differ significantly from its existing layout. In addition, about 11 acres of existing PGIS (primarily I-5 north of Victory Boulevard) will be resurfaced rather than rebuilt. The existing stormwater conveyance system will not be modified where highway resurfacing is proposed, and there does not appear to be adequate space between I-5 and Walker Slough to retrofit the existing stormwater conveyance system to treat runoff from approximately 3.7 acres of resurfaced and 2.1 acres of new I-5 pavement.

The existing LRT track will be extended north of the existing Expo Station, but since the guideway is ballasted track and considered non-polluting, it is not included in this summary. Table 3-25 summarizes project changes to PGIS and the areas from which runoff will be treated. The paragraphs following the table describe the individual water quality facilities, the locations of which are shown on Figure 3-34 through Figure 3-36.

Flow control is not required for runoff discharged to Columbia Slough, and no new outfalls are proposed. The stormwater management plan for this watershed reflects a request by the MCDD to minimize runoff from the project to the Peninsula Drainage District No. 2 surface water system, in order to provide greater flexibility for handling increased runoff from a potential redevelopment of the Hayden Meadows race track.

As described in Section 3.12.1, soils in this area are comprised of the Sauvie-Rafton-Urban land complex that belong to Hydrologic Soil Group D and are poorly drained. For this reason, the primary BMP proposed for water quality facilities in this watershed is a constructed treatment wetland. However, boreholes in the area show that the soils can be quite variable. As the project

[10] Based on the WSDOT Highway Runoff Manual guidelines; a) Treat runoff from existing PGIS (primarily in Vancouver) that would run on to new or rebuilt pavement the runoff from which is proposed to be treated, and b) treat runoff from resurfaced PGIS (primarily on I-5) where it could be captured an conveyed to a proposed water quality facility without the need to excavate the resurfaced pavement to install new conveyance systems.

design advances, site-specific geotechnical investigations may prove that one or more of the locations proposed for water quality facilities may be suitable for infiltration.

Table 3-25. Summary of Changes in PGIS – Columbia Slough Watershed

	Area (acres)			
	Infiltrated	**Treated**	**Untreated**	**Total**
Existing PGIS	2.7	0.0	39.0	**41.7**
Post-Project PGIS				
Existing PGIS retained as-is	0.0	1.9[a]	0.0	**1.9**
Existing PGIS resurfaced	0.0	6.3	4.7	**11.0**
Net change in existing PGIS	(2.7)	8.2	(34.3)	**(28.8)**
New and rebuilt PGIS	1.0	34.1	3.7	**38.8**
Net change in total PGIS	**(1.7)**	**42.3**	**(30.6)**	**10.0**

a The existing North Portland Harbor Bridge. This area is not currently in the watershed.

The following paragraphs describe individual proposed water quality facilities and the areas they serve.

Water Quality Facility CS-A

This facility, which comprises a biofiltration swale located south of Victory Boulevard and west of I-5, will be sized to handle runoff from about 1.7 acres of PGIS comprising the new bridge over Victory Boulevard and ramp from Marine Drive to southbound I-5 to the north of that bridge. Outflows from the swale will be discharged to Schmeer Slough at Outfall CS-01 via a stormwater pipe located on Victory Boulevard.

Runoff from a very short length of the Marine Drive to southbound I-5 (about 0.5 acre of PGIS) south of Victory Boulevard will be conveyed to a water quality swale constructed as part of the I-5 Delta Park project. This swale has adequate capacity to handle the additional runoff.

Water Quality Facility CS-B

This facility, a constructed treatment wetland located east of I-5 at the Marine Drive interchange, is sized to handle runoff from about 7.5 acres of PGIS comprising the interchange ramps on the east side of the highway. The grades are such that it would be difficult to convey runoff from about 1.0 acre of the ramp from northbound I-5 to Marine Drive to the wetland; therefore, a biofiltration swale is proposed (see Water Quality Facility CS-C). Outflows from the constructed wetland will be discharged to the upstream end of Walker Slough via Outfall CS-02.

Water Quality Facility CS-C

This is the biofiltration swale referred to under Water Quality Facility CS-B and, as mentioned in the preceding paragraph, it will treat runoff from approximately 1.0 acre of the south end of the new northbound I-5 to Marine Drive ramp. Like CS-B, treated runoff will be discharged to the upstream end of Walker Slough via Outfall CS-02.

Water Quality Facility CS-D

About 17.2 acres of PGIS comprising I-5 and the interchange ramps on the west side of the highway will be conveyed to a constructed treatment wetland located west of I-5 at the Marine Drive interchange. This drainage area includes approximately 4.6 acres of resurfaced PGIS and about 2.1 acres of PGIS on the existing North Portland Harbor Bridge that will be retrofitted with a stormwater collection and conveyance system.

Outflows from the constructed wetland will be released via outfall CS-03 to the drainage channel located immediately south of the Expo Center. The channel and associated pump stations may need to be enlarged to handle additional flows. Alternatively, the wetland could be enlarged to provide detention storage and reduce peak outflows. If necessary, an oil-water separation facility will be provided to pretreat runoff from the part of the Marine Drive bridge where traffic flow is controlled by traffic lights.

Water Quality Facility CS-E

Runoff from about 1.9 acres of new and rebuilt PGIS between Martin Luther King Jr. Boulevard and the new connection between Union Court and Martin Luther King Jr. Boulevard will be treated at a constructed treatment wetland located southwest of Martin Luther King Jr. Boulevard and northwest of the connection. The constructed wetland will handle runoff from Martin Luther King Jr. Boulevard and new ramp from Martin Luther King Jr. Boulevard to Union Court. Flows from the constructed wetland will be discharged to an existing stormwater pipe on Union Court at CS-04.

Runoff from the rebuilt Union Court west of the connection with Martin Luther King Jr. Boulevard (about 1.0 acre) will likely continue to be shed off the shoulders, dispersed and infiltrated, as presently occurs.

Water Quality Facility CS -F

A biofiltration swale is proposed adjacent to Vancouver Way and southeast of the new connection between Martin Luther King Jr. Boulevard and Vancouver Way. Flows from the swale would be discharged to an existing stormwater pipe on Vancouver Way at CS-05. The swale would treat runoff from about 3.6 acres of new and resurfaced westbound Martin Luther King Jr. Boulevard and the connection between Martin Luther King Jr. Boulevard and Vancouver Way.

Water Quality Facility CS -G

A biofiltration swale is proposed northeast of Vancouver Way and the new connection between Union Court, Vancouver Way, and Marine Drive. Flows from the swale will be discharged to an existing stormwater pipe on Vancouver Way at CS-06. The swale will treat runoff from about 2.4 acres of new and resurfaced pavement comprising the new connection between Union Court and Marine Drive and part of the rebuilt portion of Marine Drive.

Local Street Improvements

Approximately 6.1 acres of local streets will be constructed within this watershed in addition to those mentioned above, including portions of Vancouver Way and Marine Drive. Runoff from these streets would be treated in semi-continuous inflow biofiltration swales with the exception of about 0.9 acres of rebuilt pavement on Vancouver Way and about 0.7 acres on Marine Drive. The project team will continue to evaluate options to provide water quality facilities for the local streets the runoff from which not currently proposed to be treated.

3.12.5.2 Columbia River Watershed – Oregon

This watershed includes Hayden Island and a portion of Marine Drive, the runoff from which discharges to North Portland Harbor. The project will rebuild the Hayden Island interchange, retrofit the existing North Portland Harbor bridge with a stormwater collection and conveyance system, and demolish the existing the existing Columbia River bridges. The last two actions will result in eliminating runoff from approximately 8 acres of bridge deck that is presently discharged directly to the water surface below. The project will reduce the PGIS within this part of the Columbia River watershed by approximately 5 acres and create approximately 52 acres of new and rebuilt PGIS. Runoff from these areas and 2.3 acres of the existing North Portland Harbor Bridge will be treated prior to being released to North Portland Harbor or the Columbia River. Currently, there are no water quality facilities for runoff from the project footprint in this watershed.

Constructed treatment wetlands are proposed for the main water quality facilities on Hayden Island, rather than biofiltration ponds, even though the soils belong to the Pilchuck-Urban land complex and are classified as Hydrologic Group A. At locations where such facilities are being be considered, the depth to groundwater is only about 15 feet, and may be less depending on the influence of river levels on the phreatic surface. Considering the depth of the pond (approximately 8 feet), there may not be adequate separation between the invert and groundwater table for treating runoff. The EPA recommends a "significant separation distance (2 to 5 feet) between the bottom of an infiltration basin and seasonal high groundwater table." Again, no flow control facilities are required or proposed.

While the existing LRT track will be extended across the island, the guideway and adjacent bike/ped path are considered non-polluting and are not included in this summary. Proposed grades on the south end of the new transit bridge across North Portland Harbor are such that sand might be applied to the tracks to aid traction. For this reason, a manhole sediment trap or other sediment reducing BMP will be provided in the stormwater conveyance system at the south end of the structure.

Table 3-26 summarizes project changes to PGIS and the areas from which runoff will be treated. The paragraphs following the table describe the water quality facilities, the locations of which are shown on Figure 3-34, and the PGIS that will be treated by each. Flow control is not required or provided for runoff discharged to the Columbia River or North Portland Harbor, and only one new outfall is proposed: see Water Quality Facility NPH-B.

Table 3-26. Summary of Changes in PGIS – Columbia River South Watershed

	Area (acres)			
	Infiltrated	**Treated**	**Untreated**	**Total**
Existing PGIS	**0.0**	**0.0**	59.1	**59.1**
Post-Project PGIS				
Existing PGIS retained as-is	0.0	2.3[a]	0.0	2.3
Existing PGIS resurfaced	0.0	0.0	0.0	0.0
Net change in existing PGIS	0.0	2.3	(59.1)	(56.8)
New and rebuilt PGIS	0.0	52.3	0.7	52.3
Net change in total PGIS	**0.0**	**54.6**	**(59.1)**	**(4.5)**

a The existing North Portland Harbor Bridge.

The following paragraphs describe individual proposed water quality facilities and the areas they serve.

Water Quality Facility NPH-A

Grades are such that it would be difficult to convey runoff from Marine Drive west of the LRT track to the constructed treatment wetland CS-D described in Section 3.12.5.1. Instead, runoff from this area (approximately 3.3 acres of rebuilt and new PGIS) will be conveyed to a biofiltration swale located between Marine Drive and the flood control levee adjacent to North Portland Harbor. Flows from the swale will be discharged to an existing outfall (NPH-01) on North Portland Harbor via an existing City of Portland stormwater system. These actions will reduce the existing PGIS draining to this outfall by about 2 acres.

Water Quality Facility NPH-B

Runoff from about 4.3 acres of PGIS comprising the ramps to and from Jantzen Drive will be directed to a biofiltration swale located at the south end of the ramps; ramp grades are such that it would be difficult to convey runoff to water quality facility CR-A or CR-B. As noted in the preamble to this subsection, a new outfall may be required to convey outflows to North Portland Harbor (NPH-02) (Figure 3-34).

Water Quality Facility CR-A

A constructed treatment wetland is proposed east of I-5, between Tomahawk Island and Hayden Island Drives. The facility would treat runoff from approximately 22.0 acres of PGIS mainly comprising the new I-5 mainline. This area includes about 2.3 acres on the existing North Portland Harbor Bridge and approximately 1.6 acre of PGIS on the Tomahawk Drive extension under I-5 which will be pumped to this constructed wetland (proposed grades preclude gravity drainage). Flows from the wetland would be discharged to the Columbia River via one of the two ODOT outfalls located under the existing Columbia River Bridges (CR-01 and CR-02).

Water Quality Facility CR-B

About 7.7 acres on the lower portion of ramps to and from Hayden Island Drive will be directed to a constructed treatment wetland located underneath the south end of the existing Columbia

River bridges. Similar to facility CR-A, flows from this pond will be discharged to the Columbia River via one of the two ODOT outfalls located under the existing bridges.

Local Street Improvements

The project will rebuild or realign approximately 8.9 acres of local streets within this watershed. Except for about 1.6 acre of Tomahawk Island Drive (see Water Quality Facility CR-A), runoff from these roads will be treated in semi-continuous inflow biofiltration swales constructed on either side of the roadways, to the maximum feasible extent. Note that it may not be feasible to treat runoff from about 0.7 acre at the west end of proposed improvements to Hayden Island Drive. At this location, the proposed improvements tie back into existing pavement, and the proximity of businesses to the street limits options for installing swales.

Hayden Island Redevelopment

This watershed includes existing surface parking areas that may or may not remain after the project is complete depending on final designs for the post-project development of Hayden Island. Due to uncertainity at this stage in project design, the design team has made some assumptions in order to include this area in preliminary stormwater treatment designs. They have assumed that 10 acres (this value is included in Table 3-26) west of I-5 would be redeveloped for commercial use. This assumption is based on the fact that there would be an LRT station on the west side of the highway. The remaining area east of I-5 would be landscaped, which is a reasonable assumption since a large portion of this area would be occupied by a water quality facility. Regardless of alterations to this preliminary stormwater design, redevelopment of these areas will need to comply with the stormwater requirements of either ODOT or the City of Portland and runoff would either be infiltrated or treated before being released to the Columbia River or North Portland Harbor.

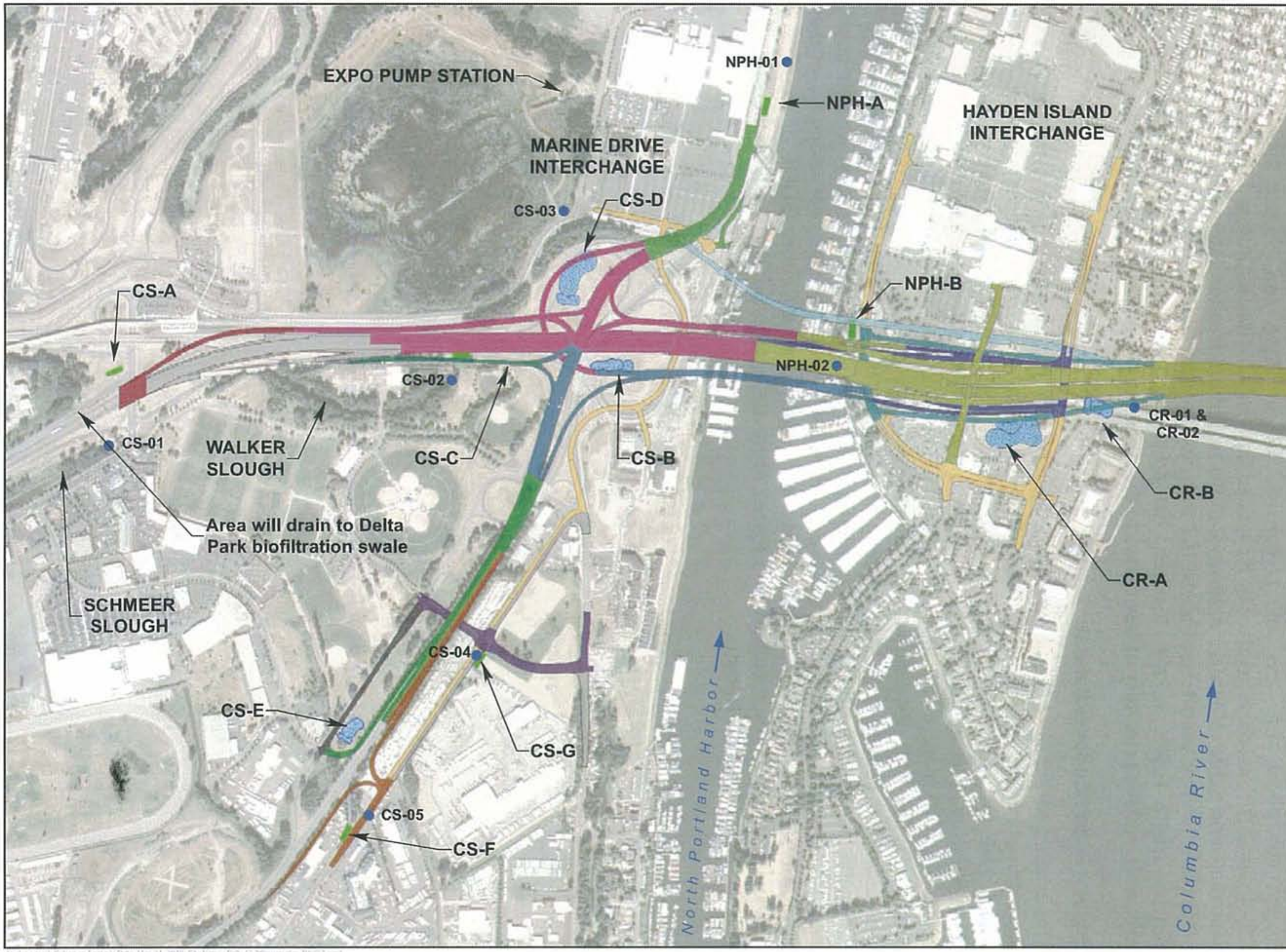

Figure 3-34.
Proposed Water Management Facilities - Oregon

Areas Draining to Water Quality Facilities

- CR-A
- CR-B
- CS-A
- CS-B
- CS-C
- CS-D
- CS-E
- CS-F
- CS-G
- NPH-A
- NPH-B
- Exclusive Guideway
- Streets with Semi-Continous Biofiltration Swales
- Shed and Dispersed
- Not Treated

Stormwater Facility Type

- Constructed Wetland
- Bioretention Pond
- Biofiltration Swale
- Proprietary Cartridge Vault
- Outfalls

N S E W

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

3.12.5.3 Columbia River North Watershed

The total PGIS in this watershed will be increased by approximately 13 acres, most of which may be attributed to the reconfigured interchanges and increased number and length of merge lanes for I-5. The project will create approximately 92 acres of new and rebuilt PGIS while reducing existing PGIS by about 79 acres. Approximately 21 acres of existing PGIS, mostly on I-5, will be resurfaced. Water quality facilities, shown on Figure 3-35 and Figure 3-36, are proposed for approximately 88 acres of new and replaced PGIS and about 19 acres of resurfaced and existing PGIS. In contrast, runoff from less than 3 acres of PGIS is currently treated. In addition, water quality facilities will be provided for approximately 17 acres of existing PGIS outside the project footprint. This includes: 1) streets outside the project footprint from which runoff will drain to water quality facilities proposed for the LRT guideway and at the Fourth Plain interchange; and 2) a portion of Fourth Plain Boulevard east of I-5 proposed as an "equivalent" area (see Water Quality Facility CR-M).

Flow control is not required for this watershed and none is proposed. In addition, no new outfalls are proposed.

Both the SR 14 and Mill Plain interchanges will be reconstructed and their footprints will be very different from what currently exists. From the SR 14 north, I-5 will be widened to accommodate additional merge lanes, and existing pavement will be replaced or resurfaced. Reconstructing the two interchanges, combined with the extent of pavement reconstruction between the SR 14 and Fourth Plain interchanges, provides an opportunity to install new conveyance systems. These new systems will allow runoff from I-5 to be separated from runoff from the urban areas to the west. Water quality facilities will be provided at the SR 14 and Mill Plain interchanges to handle runoff from the new, replaced, and resurfaced PGIS from Fourth Plain Boulevard south. The existing stormwater conveyance system under this portion of I-5 will continue to handle runoff from the urban areas to the west. North of the Fourth Plain interchange, the existing conveyance system is shallow enough to allow retrofitting with water quality facilities at the Fourth Plain interchange. Any discharge from water quality facilities will be released to the stormwater system that currently serves I-5.

The LRT guideway will be located on city streets, and existing grades will be generally maintained. Unlike in the Columbia Slough and Columbia River South Watersheds, the proposed LRT track will be located for the most part on Vancouver city streets. With the exception of the above-grade guideway between 6th Street and the new southbound Columbia River bridge, the LRT track could be subject to use by buses and would not be considered non-polluting. This is a conservative determination, one that could change should buses be excluded from the guideway. Although the above-grade guideway would be considered non-polluting, proposed grades are such that sand might be applied to the tracks to aid traction. Similar to the transit bridge across North Portland Harbor, a manhole sediment trap or other sediment reducting BMP will be provided in the stormwater conveyance system at the north end of the structure.

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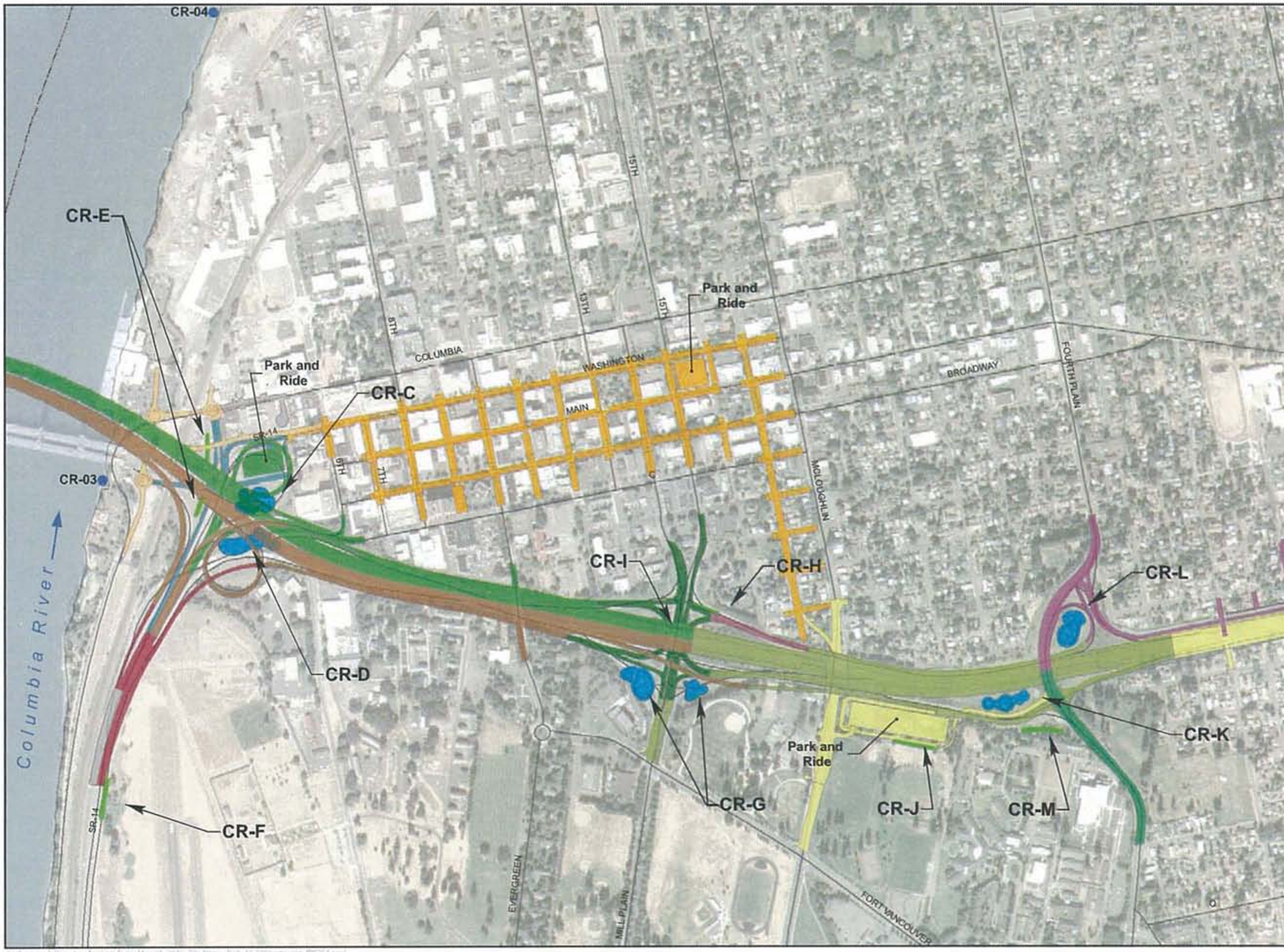

Figure 3-35. Proposed Water Management Facilities - Washington State (1 of 2)

Areas Draining to Water Quality Facilities
- CR-C
- CR-D
- CR-E
- CR-F
- CR-G
- CR-H
- CR-I
- CR-J & CR-M
- CR-K
- CR-L
- Exclusive Guideway
- Transit Treatment Facilities
- Not Treated

Stormwater Facility Type
- Constructed Wetland
- Bioretention Pond
- Biofiltration Swale
- Proprietary Cartridge Vault
- Outfalls

W N S E

0 200 400 600 800 1,000
Feet

Columbia River CROSSING

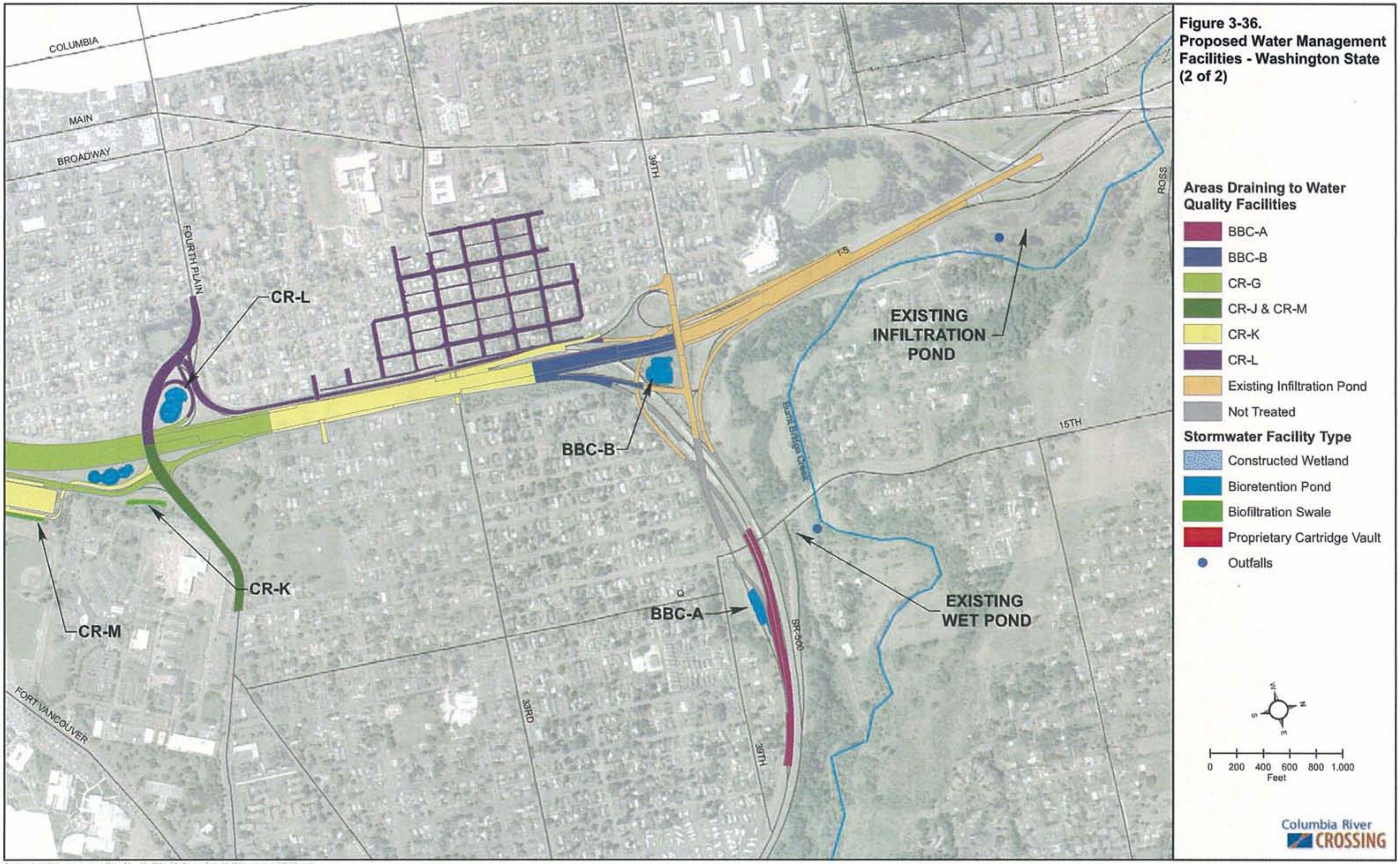

Figure 3-36. Proposed Water Management Facilities - Washington State (2 of 2)

As described in Section 3.12.1, soils in this area comprise the Wind River and Lauren Group. These soils belong to Hydrologic Group B and are considered suitable for infiltration. For this reason, the primary BMP proposed for water quality facilities in this watershed is a biofiltration pond. Bypasses will be provided to convey discharges in excess of the water quality design flow around each pond. Boreholes, to be drilled as the project design advances, will provide site-specific information on soil properties, infiltration rates, and depths to groundwater table (including seasonal variations and effect of river levels).

Table 3-27 summarizes project changes to PGIS and the areas from which runoff will be treated. The table includes areas of PGIS primarily in that are not within the project footprint but runoff from which would drain to proposed water quality facilities. Runoff from these areas is not currently treated. The paragraphs that follow describe the water quality facilities and the PGIS that will be treated by each. Any discharge from these facilities will be released to existing stormwater conveyance systems, the same systems that currently serve those areas. Flow control is not required or provided for runoff discharged to the Columbia River, and no new outfalls are proposed.

Table 3-27. Summary of Changes in PGIS – Columbia River North Watershed

	Area (acres)			
	Infiltrated	Treated	Untreated	Total
Existing PGIS	2.8	0.0	97.4	**100.2**
Post-Project PGIS				
Existing PGIS retained as-is	0.0	0.0	0.0	**0.0**
Existing PGIS resurfaced	13.1	5.6	2.6	**21.3**
Net change in existing PGIS	10.3	5.6	(94.8)	**(78.9)**
New and rebuilt PGIS	58.5	29.9	3.1	**91.5**
Net change in total PGIS	68.8	35.5	(91.7)	**12.6**
Existing PGIS not within footprint[a]	**9.0**	**8.3**	**0.0**	**17.3**

a These are areas from which runoff will drain to proposed water quality facilities or "equivalent" areas to compensate for new or rebuilt PGIS from which it may not be feasible to treat runoff.

The following sections describe individual proposed water quality facilities and the areas they serve. Since this watershed represents approximately 50 percent of the total project footprint, the water quality facilities proposed for the highway elements are grouped by interchange.

SR 14 Interchange

Runoff from PGIS at the SR 14 interchange, I-5 mainline, and CD roads between the SR 14 and Mill Plain interchanges, Evergreen Boulevard bridge over I-5, and park and ride structure at the SR 14 interchange will be conveyed to water quality facilities located within the SR 14 interchange footprint (Figure 3-35). An oil-water separator will be provided to pretreat runoff from the parking structure.

Water Quality Facility CR-C

A bioretention pond is proposed west of I-5, between the highway and Main Street extension, to treat runoff from about 18.7 acres of PGIS comprising southbound I-5 (including 1.8 acres of

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resurfaced pavement), ramps on the west side of the interchange, the SR 14 park and ride, and the west side of the Evergreen Boulevard bridge over I-5. Any overflow will be discharged to an existing stormwater conveyance system, the 60-inch diameter stormwater trunk currently serving I-5.

Water Quality Facility CR-D

Runoff from approximately 18.5 acres of northbound I-5 (including 2.0 acres of resurfaced pavement), ramps on the east side of the interchange, and east side of the Evergreen Boulevard bridge over I-5 will be conveyed to an bioretention pond located inside the loop ramp from northbound I-5 to C Street. Any overflow will be discharged to the existing 60-inch diameter stormwater trunk serving I-5.

Water Quality Facility CR-E

Two biofiltration swales are proposed adjacent to the intersection of Main Street and SR 14 to treat runoff from about 2.6 acres of new PGIS on SR 14 and Main Street. Outflow will be discharged to the Columbia River via one of the existing conveyance pipes in the vicinity.

Water Quality Facility CR-F

Runoff from approximately 3.0 acres of new and rebuilt pavement and from about 0.9 acres of resurfaced westbound lanes will be conveyed to a biofiltration swale located north of the highway. Flows from the swale will be discharged to the Columbia River (outfall CR-03) via an existing 6-foot-square culvert under I-5 and the BNSF railroad track. Runoff from the resurfaced eastbound lanes will be shed to the shoulder where it will be infiltrated, similar to what currently occurs.

Local Street Improvements

Continuous inflow biofiltration swales will be constructed on either side of approximately 1.6 acres of new streets. Based on the current layouts, runoff from approximately 0.8 acre of new construction on Columbia Street north of 4th Street will not be treated.

Mill Plain Interchange

Runoff from new ramps at this interchange, Mill Plain Boulevard, and the highway and CD road to the north will be conveyed to the following water quality facilities located within the interchange footprint. Overflows or outflows from these facilities will be discharged to the Columbia River (outfall CR-03) via the existing stormwater system serving I-5 (Figure 3-35).

Water Quality Facility CR-G

Two bioretention ponds are proposed on the east side of I-5. They will treat runoff from approximately 19.9 acres of PGIS comprising new ramps; new, replaced, and resurfaced highway; the new CD road to the north; and Mill Plain Boulevard. The area includes about 3.9 acres of resurfaced highway.

As design work progresses, the project team will evaluate options for diverting runoff into one of the proposed ponds from about 2.3 acres of PGIS served by an existing stormwater conveyance system on Mill Plain Boulevard east of the project footprint. The existing drainage system discharges into the WSDOT stormwater trunk under I-5.

Water Quality Facility CR-H

Runoff from approximately 0.8 acre of the ramp from southbound I-5 to Mill Plain Boulevard will be directed to a biofiltration swale west of the ramp. Outflows from the swale will be discharged to the existing stormwater conveyance system under I-5.

Water Quality Facility CR-I

Grades are such that it would be difficult to convey runoff from about 5.3 acres of Mill Plain Boulevard in the immediate vicinity of the interchange to the bioretention ponds described under CR-F. Instead, it is proposed that this runoff be conveyed to proprietary cartridge filters. Based on available data, there appears to be adequate vertical separation between the low point on Mill Plain Boulevard and invert of the existing stormwater conveyance system under I-5 to install this type of facility and permit gravity discharge to that system. If necessary, an oil-water separator pretreatment facility would be provided to pretreat flows to the cartridge filters.

Fourth Plain Interchange

The Fourth Plain interchange will be replaced, access will be provided from Fourth Plain Boulevard to the proposed Clark College park and ride structure, and existing pavement will be resurfaced between the Fourth Plain and SR 500 interchanges (Figure 3-36). The existing stormwater conveyance systems north of Fourth Plain would be retained by the project. Available data indicate that the main stormwater pipe under I-5 is shallow enough to permit flows to be redirected to water quality facilities located in the interchange.

Water Quality Facility CR-J

Drainage from the top surface of the Clark College park and ride (about 2.9 acres) will be conveyed to an oil-water separator and biofiltration swale located on the east side of the structure. An oil-water separator will be provided to pretreat the runoff.

Water Quality Facility CR-K

A bioretention pond is proposed southeast of the Fourth Plain interchange to handle runoff from about 10.9 acres of PGIS (including 5.6 acres of resurfaced highway) comprising I-5 mainline and access road to the Clark College park and ride.

Water Quality Facility CR-L

Runoff from approximately 3.6 acres of new and replaced pavement on Fourth Plain Boulevard and interchange ramps and tunnel northwest of the interchange, as well as runoff from about 9.0 acres of existing streets in the Shumway neighborhood to the north, will be conveyed to a bioretention pond located within the west interchange footprint.

It may be difficult to treat runoff from approximately 0.7 acre of rebuilt pavement on Fourth Plain west of the interchange. An "equivalent" area of PGIS will be treated in Water Quality Facility CR-M.

Water Quality Facility CR-M

A biofiltration swale is proposed in an existing drainage channel south of Fourth Plain Boulevard and east of the CD road. It will treat runoff from approximately 1.7 acres of new and rebuilt PGIS east of I-5 and about 0.8 acre of existing PGIS on Fourth Plain to compensate for the area west of the interchange that the project may not be able to convey to Water Quality Facility CR-L. Outflow from the biofiltration swales and any overflow from the bioretention ponds will be released to the Columbia River via the existing stormwater conveyance system under I-5.

LRT Guideway

The proposed approach to constructing the LRT guideway along Vancouver city streets is to excavate a slot within the existing pavement to facilitate single-track guideway construction. For single-track guideways, it was assumed that the remaining pavement will be resurfaced within each block. For double-track guideways, it is assumed that the entire street will need to be replaced. The pavement at intersections will need to be completely rebuilt, whether it is a single- or double-track guideway.

Runoff from about 12.0 acres of new guideway and replaced PGIS, the Mill Plain park and ride structure, and approximately 4.7 acres of resurfaced PGIS, will be directed to new catch basins located at replaced intersections along the at-grade guideway. With the exception of a portion of Washington Street between 10th Street and McLoughlin Boulevard, available data indicate that there is adequate vertical separation between existing grades and stormwater pipe inverts to install proprietary water quality systems such as cartridge filters. The new catchbasins will also intercept runoff from about 7.5 acres of existing street surface that slope towards the intersection but will not have any project-related improvements. Treating runoff from these streets would be considered a stormwater credit for the project. Based on available data, drainage to the sag curve on McLoughlin Boulevard under I-5 will need to be pumped to the existing WSDOT stormwater system under I-5.

The project area on Washington Street between 10th Street and McLoughlin Boulevard to the Columbia River drains to the Columbia River via outfall CR-04, located approximately 3,300 feet downstream from the existing I-5 bridges. Based on data provided by the City of Vancouver, there may not be adequate vertical separation between road and existing stormwater pipe inverts to permit the installation of proprietary filter cartridges. It is proposed that runoff from the guideway and roadway surface be discharged to the existing stormwater conveyance system untreated. Drainage from the top floor of the Mill Plain park and ride structure (about 1.0 acre) will be discharged to the adjacent City of Vancouver stormwater system via an oil-water separator and proprietary water quality facility. The 7.5 acres of existing street surfaces from which runoff will be treated (see the preceding paragraph) will more than compensate for the lack of treatment of 1.6 acres of new and rebuilt PGIS along this part of Washington Street.

The areas listed in Table 3-27 assume that buses will use the at-grade LRT guideway. Should buses vehicles be excluded, the area of new PGIS will decrease by about 3 acres.

It should be noted that the data provided by the City of Vancouver was provided on an as-is basis and will need to be verified by survey as design work progresses.

3.12.5.4 Burnt Bridge Creek Watershed

Project-related construction in the Burnt Bridge Creek watershed comprises the partial reconstruction of the SR 500 interchange to provide full connectivity between SR 500 and I-5 and associated improvements to both highways. The project will increase the total PGIS in the watershed by about 3 acre and will create approximately 9 acres of replaced and new PGIS, as shown on Table 3-28. About 10 acres of existing PGIS will be resurfaced. The table also includes areas of PGIS primarily in that area not within the project footprint but runoff from which would drain to proposed water quality facilities. Runoff from these areas is not currently treated. Unlike the other watersheds, runoff to Burnt Bridge Creek must be reduced to predevelopment (forested) conditions for peak discharges between 50 percent of the 2- and 50-year event.

An existing infiltration pond at the Main Street interchange will not be modified by the project. Rather, the project will significantly reduce the total PGIS draining to this facility, which includes approximately 5 acres of new and rebuilt PGIS, by about 4 acres. The infiltration pond was constructed as part of the I-5: Burnt Bridge Creek to NE 78th Street project, which was completed in 2003. Overflows from this pond during extreme runoff events are discharged to Burnt Bridge Creek via a spillway and open channel.

Table 3-28. Summary of Changes in PGIS – Burnt Bridge Creek Watershed

	Area (acres)			
	Infiltrated	Treated	Untreated	Total
Existing PGIS	14.5	0.0	1.7	16.2
Post-Project PGIS				
Existing PGIS retained as-is	0.0	0.0	0.0	0.0
Existing PGIS resurfaced	9.0	0.0	1.2	10.2
Net change in existing PGIS	(5.5)	0.0	(0.5)	(6.0)
New and rebuilt PGIS	7.8	0.0	1.3	9.1
Net change in total PGIS	2.3	0.0	(0.8)	3.1
Existing PGIS not within footprint[a]	**1.9**	**0.0**	**0.0**	**1.9**

a These are areas from which runoff will drain to proposed water quality facilities or "equivalent" areas to compensate for new or rebuilt PGIS from which it may not be feasible to treat runoff.

The following paragraphs describe the new water quality facilities proposed for this watershed and the areas it serves. Figure 3-36 shows the facilities and contributing drainage area.

Water Quality Facility BBC-A

To meet flow control and water quality treatment requirements, runoff from approximately 0.9 acre of new and about 1.9 acres of "equivalent" existing PGIS on SR 500 will be conveyed to a bioretention pond adjacent to the new ramp from 39th Street to eastbound SR 500. The "equivalent" existing PGIS currently drains to the existing wet pond east of 15th Avenue and north of SR 500 (outside the project footprint). The latter "equivalent" area is required to compensate for the approximately 1.3 acres of new PGIS which cannot be treated.

Data from boreholes in the vicinity of 15th Avenue and 39th Street indicate an infiltration rate of 1 inch/hour may be readily achieved and preliminary sizing indicates that inflows up to the

1 in 100 year event can be infiltrated. Regardless, an overflow will be provided to convey excess runoff to Burnt Bridge Creek via the existing wet pond located to the north and ultimately to Burnt Bridge Creek via an existing outfall (BBC-01).

Water Quality Facility BBC-B

Topography in the vicinity of the existing infiltration pond at the Main Street interchange will preclude expanding this facility to accommodate additional runoff from the CRC project. Instead, a new bioretention pond, BBC-B, will be constructed immediately east of I-5 at the SR 500 interchange. This effectively reduces the area draining to the Main Street interchange facility by approximately 3 acres even accounting for new PGIS. Runoff from about 1.3 acres of new and 2.3 acres of overlay PGIS on I-5 south of 39th Street will be redirected to the new pond.

Again, data from boreholes in the vicinity of 15th Avenue and 39th Street indicate an infiltration rate of 1 inch/hour may be readily achieved, and preliminary sizing indicates that inflows up to the 1 in 100 year event can be infiltrated. An overflow will be provided to convey excess runoff to Burnt Bridge Creek via the existing infiltration pond located at the Main Street interchange to the north, and ultimately to Burnt Bridge Creek via outfall BBC-02.

3.12.5.5 Project Summary

Table 3-29 presents an overall summary of the project changes to PGIS and the areas from which runoff will be treated or infiltrated. The table includes areas of PGIS that are not within the project footprint but runoff from which will drain to proposed water quality facilities. Runoff from these areas is not currently treated. The project area currently provides treatment or infiltration for 25 acres of PGIS. The completed project will add 18 acres of net new PGIS, and will provide treatment for all of the new PGIS and for 168 acres of existing untreated PGIS. This scenario represents additional treatment of more than 10 times the net new PGIS area.

As noted in the prior subsections, the areas do not include staging areas outside the project footprint or casting yards that might be required for fabricating bridge elements. All new impervious surfaces at the Ruby Junction Maintenance Facility expansion area are being infiltrated, with no runoff to Fairview Creek.

Table 3-29. Summary of Changes in Total PGIS

	Area (acres)			
	Infiltrated	**Treated**	**Untreated**	**Total**
Existing PGIS	20	0	197	217
Post-Project PGIS				
Existing PGIS retained as-is	0	4	0	4
Existing PGIS resurfaced	22	12	9	43
Net change in existing PGIS	2	16	(188)	(170)
New and rebuilt PGIS	67	116	8	191
Net change in total PGIS	69	132	(180)	21
Existing PGIS not within footprint[a]	**11**	**8**	**0**	**19**

a These are areas from which runoff will drain to proposed water quality facilities or "equivalent" areas to compensate for new or rebuilt PGIS from which it may not be feasible to treat runoff.

The CIA, which encompasses both PGIS and non-PGIS, includes new and rebuilt impervious surfaces within the project footprint and existing impervious areas outside the project footprint that drain to the project footprint via direct flow or discrete conveyance. The CIA does not include those impervious areas that are outside the project footprint and that flow through the project, but whose conveyance or outfalls will not be modified by the project.

The total CIA for the project is estimated to be 291 acres and comprises:

- Approximately 191 acres of new and rebuilt PGIS created by the project within the project footprint. Runoff from about 183 acres will be treated or infiltrated as shown in Table 3-29.
- About 42 acres of existing PGIS within the project footprint will be resurfaced. Runoff from approximately 34 acres will be treated or infiltrated as shown in Table 3-29.
- Runoff from approximately 4 acres comprising the existing North Portland Harbor Bridge will be directed to new water quality facilities at the adjacent interchanges.
- Runoff from about 21 acres of existing PGIS mainly in downtown Vancouver will contribute runoff to the project from outside the footprint primarily via gutter flow. Runoff from about 19 acres will be treated or infiltrated as shown in Table 3-29. The project may be able to treat runoff from an additional 2 acres on Mill Plain Boulevard east of I-5 as described in Section 3.12.5.3.
- About 28 acres of new non-PGIS exclusive LRT guideway, bike/ped paths, and sidewalks will be created within the project footprint and approximately 4 acres of existing non-PGIS outside the project footprint will contribute runoff to the project primarily via gutter flow. Runoff from about 22 acres of bike/ped paths and sidewalks will be treated, either because it will commingle with street runoff or be shed to adjacent vegetated areas. Over 60 percent of the non-PGIS area from which runoff would not be treated comprise the elevated LRT guideway and adjacent bike/ped facilities. While not included in the areas receiving water quality treatment, runoff from the steep grades at the south and north ends of the elevated LRT guideway may be routed through sediment traps if operational considerations indicate that sand will need to be applied to the tracks to aid in traction.

Table 3-30 compares estimated average peak monthly runoff from the three watersheds with average flows in the three receiving waterbodies: Columbia Slough, Columbia River, and Burnt Bridge Creek. Peak runoff is for the areas of resurfaced, new, and rebuilt PGIS within the project footprint for each watershed, and is based on the average 24-hour precipitation measured at PDX. Peak runoff rates were determined using a single-event rainfall-runoff model. The average discharge in each receiving waterbody is from available USGS data as described in Section 3.12.1. The comparison is conservative, since the table compares peak with average flow rates. This is especially true for the Columbia Slough watershed, where peak runoff from the project will be significantly attenuated as it flows through the surface water drainage systems and then pump operation before discharging to the Columbia Slough.

Table 3-30. Comparison of Project Runoff with Receiving Waterbody Discharge

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Columbia Slough												
Ave. Peak Project Runoff, Q_P cfs	1.4	1.0	0.8	0.4	0.4	0.4	0.2	0.5	0.8	1.0	1.6	1.8
Ave. Discharge in Waterbody, Q_R cfs	162	151	135	85	29	65	79	94	63	96	112	123
Ratio of Q_R to Q_P	120	150	180	220	70	170	400	200	80	90	70	70
Columbia River South												
Ave. Peak Project Runoff, Q_P cfs	1.0	0.7	0.6	0.3	0.3	0.3	0.1	0.3	0.6	0.7	1.1	1.3
Ave. Discharge in Waterbody, Q_R cfs	156,000	163,000	170,000	204,000	286,000	415,000	291,000	153,000	117,000	116,000	122,000	138,000
Ratio of Q_R to Q_P	160,000	220,000	310,000	730,000	1,000,000	1,500,000	2,100,000	460,000	210,000	160,000	110,000	110,000
Columbia River North (w/o infiltration)												
Ave. Peak Project Runoff, Q_P cfs	2.9	2.1	1.6	0.8	0.8	0.8	0.4	0.9	1.6	2.1	3.3	3.7
Ave. Discharge in Waterbody, Q_R cfs	156,000	163,000	170,000	204,000	286,000	415,000	291,000	153,000	117,000	116,000	122,000	138,000
Ratio of Q_R to Q_P	54,000	77,000	110,000	270,000	380,000	550,000	810,000	170,000	75,000	55,000	37,000	37,000
Columbia River North (w/infiltration)												
Ave. Peak Project Runoff, Q_P cfs	1.3	1.0	0.7	0.4	0.4	0.4	0.2	0.4	0.7	1.0	1.5	1.7
Ave. Discharge in Waterbody, Q_R cfs	156,000	163,000	170,000	204,000	286,000	415,000	291,000	153,000	117,000	116,000	122,000	138,000
Ratio of Q_R to Q_P	120,000	170,000	240,000	580,000	820,000	1,200,000	1,700,000	360,000	160,000	120,000	83,000	83,000
Burnt Bridge Creek (w/o infiltration)												
Ave. Peak Project Runoff, Q_P cfs	0.8	0.5	0.4	0.2	0.2	0.2	0.1	0.2	0.4	0.5	0.8	0.9
Ave. Discharge in Waterbody, Q_R cfs	46	53	39	21	19	14	9.1	7.4	7.0	9.8	34	41
Ratio of Q_R to Q_P	70	110	110	110	100	70	100	34	19	20	45	48
Burnt Bridge Creek (w/infiltration)												
Ave. Peak Project Runoff, Q_P cfs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ave. Discharge in Waterbody, Q_R cfs	46	53	39	21	19	14	9.1	7.4	7.0	9.8	34	41
Ratio of Q_R to Q_P	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: Q_P = flow rate of the project runoff in cfs; Q_R = flow rate of the receiving waterbody.

3.13 MITIGATION AND MONITORING

The project is anticipated to permanently impact approximately 0.55 acre and temporarily impact 1.18 acres of in-water habitat in the Columbia River and North Portland Harbor in Oregon. A mitigation site has been identified east of the project in the lower Hood River. Mitigation activities at this site are described in detail in Section 3.14.2. Mitigation will fulfill requirements determined by USACE and DSL during the course of the regulatory permitting process. No jurisdictional wetlands will be impacted in Oregon during construction or operation of the project, with the possible exception of impacts related to enhancement or restoration activities at the Hood River mitigation site. Additional required mitigation for these types of impacts is not anticipated.

The project is anticipated to permanently impact approximately 0.60 acre and temporarily impact 1.10 acres of the Columbia River in Washington. A mitigation site has been identified west of the project on the east bank of the Lewis River at the confluence with the Columbia River. Mitigation activities at this site are described in detail in Section 3.14.2. Mitigation will fulfill requirements determined by USACE, WDFW, and Ecology during the course of the regulatory permitting process. No jurisdictional wetlands will be impacted in Washington during construction or operation of the project, with the possible exception of impacts related to enhancement or restoration activities at the Lewis River mitigation site. Additional required mitigation for these types of impacts is not anticipated.

Mitigation activities will be funded by the CRC project and be permitted and constructed by third parties. Both mitigation sites will have a federal nexus through USACE permits and will need to undergo separate ESA Section 7 consultations to analyze their effects to listed species and critical habitat. Conditions of regulatory permits issued by USACE and the States of Oregon and Washington will require compliance monitoring for a minimum of 5 years after completion of the mitigation project.

3.14 INTERDEPENDENT AND INTERRELATED ACTIONS

An interrelated activity is an action that is part of a larger action and depends on the larger action for its justification. An interdependent activity is one that has no independent utility apart from the proposed action. To determine if an action is interrelated or interdependent, the "but-for" test can be applied. That is, the action is interrelated or interdependent if it would not occur "but for" the larger action.

3.14.1 Maintenance Activities

Among the interrelated or interdependent activities of this project are operation and maintenance activities in the long-term. WSDOT, ODOT, TriMet, C-TRAN, and the Cities of Vancouver and Portland all have established roadway maintenance and operations staff that will operate and maintain CRC after its construction in accordance with their standard operation procedures designed to meet operational and permitting needs, e.g., compliance with 4(d) and other programmatic approaches. Each agency will be responsible for maintaining elements of the roadway, guideway, trail, or other elements within their respective jurisdictions, unless inter-agency agreements between jurisdictions prevail. The majority of the maintenance and operations resources are already provided for, as the roadway facility already exists and CRC is replacing and updating the highway facility. Coordination will be done with the respective maintenance program managers to plan and program additional funding or reallocate resources that may necessary to maintain and operate new infrastructure features such as stormwater facilities, additional lane miles that result from widening, fewer personnel needed to operate the bridge, etc.

3.14.2 Compensatory Mitigation

To offset project impacts to aquatic habitat in the Columbia River and North Portland Harbor, CRC will provide compensatory mitigation at two sites (one in Oregon and one in Washington). The mitigation design has not yet been developed, but the mitigation sites will comply fully with all regulatory permit terms and conditions. In Oregon, the compensatory mitigation will comply with the Section 404 permit issued by the USACE, the Section 401 permit issued by DEQ, and the Removal-Fill permit issued by DSL and would compensate for the temporary impact to 1.18 acres of open water habitat and permanent loss of 0.55 acre of open water habitat of the Columbia River and North Portland Harbor. In Washington, the compensatory mitigation will comply with the Section 404 permit issued by USACE, the Section 401 permit issued by Ecology, and the Hydraulic Project Approval issued by WDFW and would compensate for the temporary impact to 1.10 acres of open water habitat and permanent loss of 0.60 acre of open water habitat of the Columbia River.

CRC created a Conservation Measures Working Group consisting of staff from ODFW, WDFW, NMFS, and USFWS to prepare a methodology identifying goals and project selection criteria to evaluate and prioritize potential measures. This effort was discontinued as the project was refined to further minimize potential impacts to listed species. However, the CRC team adapted and applied the goals and project selection criteria approved by the group as general guidance for the mitigation site selection process. Compensatory mitigation sites or actions can also be considered conservation measures under Section 7(a)(1) of the ESA, but conservation measures are not considered mitigation.

3.14.2.1 Goals and Project Selection Criteria

The goals and project selection criteria used for mitigation site selection are listed below.

Goals

- To restore habitat types or aspects that have been lost or greatly reduced over the last approximately 75 years.
- To restore access to historical habitats for anadromous and resident aquatic species.
- To provide "connectivity" and not be physically isolated from other habitat areas.
- To address impaired watershed processes that affect the aquatic system, water quality, and related ecosystem services.
- To preserve, enhance, and protect natural processes in order to maintain the habitat restored.
- To help implement adopted recovery plans or develop information to help advance the science.

Project Selection Criteria

- Sites shall address recovery measures or critical limiting factors such as those identified in the Basin Recovery Plan Module or the Watershed Assessment and Action Plan.
- Shall be large enough (size and shape) to provide for complexity (i.e., multiple niche habitats within overall habitat) and provide some measureable and demonstrable improvement in function of system (e.g., within a watershed or some defined area).
- Avoid sites where success is not achievable. Sites where the natural conditions or functions have been so altered as to be irreversible or where adjacent land use would limit or preclude project success.
- Avoid sites that would conflict with existing management plans or strategies.
- Conduct restoration measures that will have demonstrable, measurable results and have a high likelihood of achievement.
- Funding and scope to ensure long-term monitoring (a "feedback loop") and be able to implement adaptive management.
- Activity shall have defined and supported goals, objectives, and success criteria so success can clearly be demonstrated.
- Ground activities such as aquatic or riparian habitat restoration and enhancement must have a mechanism for long-term protection (e.g., conservation easement or public ownership).
- Site selection will avoid locations where restoration actions conflict with other ESA-protected species.

In Oregon, CRC selected the Hood River Off-Channel Reconnection because it is consistent with the six goals and all but one of the project selection criteria. In Washington, CRC selected the Lewis River confluence side channel restoration project because the restored shallow water off-channel habitats will provide high-value tidal rearing habitat for juvenile salmonids. This site is consistent with all of the Goals and project selection criteria. CRC will fund each site and private project proponents will construct and maintain them.

Because CRC is providing funding for the restoration sites, they are interrelated actions to the CRC project. The direct and indirect effects to listed species and designated critical habitats from these actions must be considered in this BA; however, a more detailed analysis of negative and beneficial effects from these projects will occur through separate Section 7 ESA consultations as requested by USACE. The private project proponents will initiate separate Section 7 ESA consultations for both restoration sites as actions requiring federal permits. Therefore, in order to identify the potential direct and indirect effects of the interrelated mitigation actions, the CRC project identified federally listed species potentially present in the vicinity of the mitigation sites, designated and proposed critical habitats and anticipated effects from mitigation activities on these species and critical habitats. To determine available habitats and anticipated impacts of project activities, site visits were made for both mitigation sites and information evaluated from each project's proponent.

3.14.2.2 Oregon Compensatory Mitigation: Lower Hood River Powerdale Corridor Off-Channel Wetland Reconnection

The Lower Hood River Powerdale Corridor Off-Channel Wetland Reconnection restoration site is located upriver and approximately 60 miles east of the CRC project in the Hood River watershed in Hood River County (Township 3N, Range 10E, Section 6; HUC 17070105). The restoration site is part of a 400-acre parcel owned by Columbia Land Trust. CRC is providing funding for the design and restoration of a historic side channel of the Hood River as compensation for the CRC project's waterway impacts. The Council will obtain permits from the USACE, creating the nexus for an independent Section 7 consultation. Columbia Land Trust/Hood River Watershed Council will prepare a separate BA for the restoration site.

The CRC project will temporarily impact 1.18 acres of open-water habitat over its construction period and cause permanent loss of 0.55 acre of open-water habitat in the Columbia River and North Portland Harbor (1.73 acres impact total). The proposed compensatory mitigation is located on the Hood River between RM 1.0 and 2.0 where the Mount Hood Railroad (MHRR) has cut off and isolated a historic side channel and an associated 21-acre wetland. The purpose of the mitigation project is to restore connectivity of the side channel and the wetland with the mainstem Hood River, greatly improving habitat complexity for migrating and rearing salmonids. The proposed mitigation project will install a bridge at the upstream end (RM 2.0) and an outlet bridge or trestle at the downstream end (RM 1.0) to reconnect 1 mile of side channel and the wetland. The bridge structures will pierce the 20-foot-high levee that has been a barrier to natural stream functions at this site for almost a century, while allowing the MHRR to continue its operations.

Oregon has not established mitigation ratios for impacts to jurisdictional waterways (such as the Columbia River). The proposed CRC mitigation will restore and enhance a side channel of the Hood River at a ratio of more than 10 times the area of the project impacts. Other proposed aquatic habitat improvements include:

- Addition of large wood in the side channel to form log jams for salmonid rearing habitat,
- Grading to improve side channel function,
- Removal of debris or spoils from past activities,
- Removal of decommissioned irrigation pipe, and
- Planting the enhanced wetland and riparian area with native vegetation.

The final design and construction sequence of the mitigation will be based upon construction and staging methods, site topography, groundwater levels, and stream flow. Construction methods will include the use of land-based heavy equipment, such as tracked excavators and dump trucks, to excavate the channel and haul off spoils material, as well as to breach the railroad embankment at the upstream and downstream ends of the project.

Prior to breaching the embankments, the project will likely install lateral cofferdams to isolate the work area and prevent fish or other aquatic life from moving into the in-water work area. The cofferdams will likely be comprised of steel sheeting forced into the stream bed by an excavator. Cofferdams will be installed starting at the upstream end and working downstream to decrease the potential for fish entrapment. Once construction work in the side channel is complete, the water will then be allowed to flow through the new stream bed. The restored channel will be re-watered slowly to limit the amount, duration, and extent of turbidity. Turbidity is not expected to extend more than 100 feet upstream and 300 feet downstream from the channel inlet and outlet. Some increase in sedimentation may also occur intermittently for weeks or months within the new channel and in the Hood River immediately downstream of the outlet until riparian and wetland vegetation is established.

Most of the construction will be performed below the OHW elevation of the Hood River, but will be isolated from the main river channel due to the presence of existing levees. The channel reconnection will occur during the designated in-water work window (July 15 to August 31). Standard minimization measures (MMs) and BMPs (such as site dewatering, fish exclusion, and TESC and SPCC plans) will be implemented to minimize potential impacts to listed species. Construction staging will occur on upland areas only.

A construction start date is not available, but construction is estimated to take up to two construction seasons, including site preparation, excavation, and planting. It is unknown at this time whether there will be funding for long-term monitoring and implementation of adaptive management.

3.14.2.3 Washington Compensatory Mitigation: Lewis River Confluence Side-Channel Restoration

The CRC project will temporarily impact 1.10 acres of open-water habitat and cause permanent loss of 0.60 acre of open-water habitat in the Columbia River (1.70 acres impact total). CRC is proposing off-site compensatory mitigation on the east bank of the Lewis River at its confluence with the Columbia River. This site is located downriver and approximately 10 miles northwest of the CRC project in the Lewis River watershed in Clark County (Township 4N, Range 1W, Section 2; HUC 170800020506). The restoration site is a 640-acre privately owned site managed by Wildlands of Washington, Inc. (Wildlands). The CRC project is providing funding for a conservation easement on approximately 80 acres of the property, of which 18.1 acres are proposed for restoration of historic side channels to mitigate for the CRC project's waterway impacts. In Washington, mitigation ratios for impacts to jurisdictional waterways such as the Columbia River are not established under regulatory law. The proposed mitigation will restore side channels of the Lewis River at a ratio of more than 10 times the area of the project impacts. Wildlands will be obtaining permits from USACE, providing a nexus for an independent Section 7 consultation. Wildlands will prepare a separate BA or use an existing programmatic BO for the mitigation site.

Historically the east bank of the Lewis River at the confluence of the Columbia River had multiple side channels with an open hydraulic connection to the Columbia River. Between the years 1965 to 1973, USACE filled the side channels through deposition of dredge spoils. Restoration will consist of removing the dredge spoils to reconnect the channels to the Lewis and Columbia Rivers. The mitigation project would restore over 21,100 linear feet of historic side channels of the Lewis River, totaling 18.1 acres. The intent of the restoration project is to provide high-value tidal rearing habitat for juvenile salmonids.

Construction methods will include the use of land based heavy equipment such as tracked excavators and dump trucks. Fill material will be removed from the side channels and hauled off site. The project will improve aquatic habitat and complexity in the side channels by adding large wood to form engineered log jams, removing invasive plant species, and planting native riparian vegetation.

When channel work is completed, the project will breach a levee at the upstream and downstream ends of the channel, restoring the surface-water connection between the Lewis and Columbia Rivers. Levee breaching will occur only during the designated in-water work window (August 1 to 15). The restored channels will be re-watered slowly to limit the amount, duration, and extent of turbidity. Turbidity from channel reconnection is not expected to extend more than 100 feet upstream and 300 feet downstream from the inlet and outlet. Some increase in sediment input may also occur in the new channel and mainstem river intermittently for weeks or months until riparian and wetland vegetation is established. The final design and construction sequence of the reconnected side channels will be based upon construction and staging methods, site topography, groundwater levels, and stream flow.

Most of the side-channel construction will be performed below the OHW elevation of the Lewis River, but will be isolated from the river due to existing levees. Standard BMPs (such as site isolation, fish exclusion, and TESC and SPCC plans) will be implemented to minimize the amount of sediment entering the Lewis or Columbia Rivers during earthwork.

Construction of the mitigation site is estimated to take up to 1.5 years, including site preparation, excavation, and planting. Monitoring of the mitigation site will occur for 10 years after construction to ensure the project has met performance standards for wetland enhancement and stream restoration.

3.14.3 Other Interrelated and Interdependent Actions

Additional interrelated and interdependent actions include the following:

- Utility relocation during construction of the project.
- Construction and operation of unanticipated staging and casting areas not covered by this BA.
- Acquisition and relocation of existing floating homes from moorages in North Portland Harbor will occur prior to construction of the North Portland Harbor Bridges. Up to 32 floating homes in the Portland Harbor will be displaced. Floating homes will be treated as real property unless it is determined there are sufficient replacement sites to which the floating homes can be economically relocated. If a sufficient number of replacement sites are not available, the floating homes will be purchased at fair market value and the occupants will be provided relocation assistance that may include payments, if necessary, to acquire decent, safe and sanitary replacement housing. The acquired floating homes will be sold on the condition that they are moved to other locations. The locations could be within North Portland Harbor, but may be in other portions of the lower Columbia River subbasin.
- Design and operation of a rebuilt pump station located at the downstream (west) end of an unnamed drainage channel between the Expo Center and Vanport Wetlands that flows west then south into the Columbia Slough. The pump station moves water from the

channel into the Columbia Slough. The MCDD operating as Peninsula Drainage District No. 1 plans to rebuild the pump station, but the design and construction is currently on hold until a determination of additional capacity needed to accommodate runoff from the CRC project is made (Section 3.12.1.1).

- Transit-oriented development on Hayden Island. The Hayden Island Plan outlines a vision for the future redevelopment of Hayden Island. The plan responds to the extension of light rail to Hayden Island by proposing transit-oriented development near the future location of the light-rail station. Under this plan, the 80-acre Jantzen Beach Super Center immediately west of I-5 will redevelop from "big box" regional commercial center into a medium-density mix of commercial and residential uses, with up to 2,000 new housing units centered on the new light rail station. The plan reduces industrially zoned lands by 81 acres, increases residentially zoned land by 69 acres, and increases commercially zoned land by 11 acres. (COP 2009a). This plan is based on the construction of transit and light rail stations, and is therefore interrelated.

Other projects in the action area are planned to occur regardless of the CRC project, and have independent justification and utility. Although they are not interrelated or interdependent actions, they are identified here to assist the reader in understanding the context of this BA. Of these projects, two listed below have no federal nexus and are described in Section 6.7. It should be noted that the *construction and operation* of these projects constitutes a cumulative effect, while the potential increased *rate* of development in these areas due to the CRC project is an indirect effect of the CRC project.

- **Redevelopment of downtown Vancouver along a transit corridor.** The VCCV plans for increased development in downtown Vancouver along a future high-capacity transit (bus or light rail) corridor. Future development along this corridor is likely to occur because downtown Vancouver is planning for and experiencing an overall growth trend that is expected to continue regardless of the project (approximately 16.5 acres have been identified as vacant and available for redevelopment). Because the development along a transit corridor is already planned independently in the VCCV plan, outside of the larger CRC action, and is not dependent on the CRC project's light rail for its implementation, it is not an interrelated or interdependent action. However, the construction of light rail along the corridor will potentially influence the rate of development. The potential indirect effects from the increased *rate* of development along the light rail corridor are discussed in Section 6.2.2.
- **Redevelopment of downtown Vancouver waterfront.** The City of Vancouver has approved a Master Plan for a 35-acre development along the Vancouver waterfront west of I-5. Development of this area is not tied to the project and will occur whether or not the project is constructed. However, the CRC project's extension of the Portland MAX light rail network and extension of Main Street will improve access to this area and potentially influence the rate of redevelopment. The potential indirect effects from the increased *rate* of redevelopment along the waterfront are discussed in Section 6.2.2.
- **WSDOT SR 500/St. John's Improvements, Vancouver.** This project is a federal action that involves road improvements and correction of a fish passage barrier east of the I-5 and SR 500 interchange. This project has completed a separate ESA Section 7 consultation and therefore will not be further discussed in this BA.

3.15 ACTION AREA

The action area is defined as: "all areas to be affected directly and indirectly by the federal action and not merely the immediate area involved in the action" (ESA, 50 CFR 17.11). The action area for the proposed action is defined by its direct and indirect effects including those from interrelated and interdependent actions or activities. The action area consists of the geographic extent of the physical, biological, and chemical impacts of the project. For our project, we have described the extent of the action area in terms of the terrestrial extent and the aquatic extent of all areas that could be potentially affected by the project (Figure 3-37).

3.15.1 Terrestrial Portion

In the terrestrial portion of the action area, the farthest reaching effects of the project were determined to be the extent of potential land use and traffic changes and, in areas where land use or traffic changes are not anticipated, the extent of construction noise. Potential effects from land use changes are defined by project land use planners to extend 0.50 mile from each of the transit stations in the project area (including the existing Expo Station, as the project will reconfigure the Marine Drive interchange and extend light rail to the north), in areas of Hayden Island included in the Hayden Island Plan, and in the area within the City of Vancouver included in the VCCV (see Figure 3-37 and Section 3.15 for details on extent).

In areas that are not anticipated to have potential land use and traffic changes, the extent of the action area is defined by the extent of construction noise. Noise is expected to be the project impact with the most far-reaching terrestrial environmental effects. Based on the types of construction equipment proposed for the project, noise levels associated with the majority of construction are not expected to exceed 90 A-weighted decibels (dBA) (WSDOT 2009). With multiple pieces of equipment operating with similar noise levels, using decibel addition, noise levels could reach as high as 93 dBA. Noise levels from general construction equipment would be expected to attenuate to ambient noise levels within 700 feet as it traveled over land.[11] However, peak noise levels will be generated by pile driving, which is one of the potential construction methods that may be used to construct bridge foundations, retaining walls, or tunnels. Pile driving could occur at any of the seven project interchanges and will occur in the Columbia River and North Portland Harbor. This activity, assuming use of an impact pile driver, would generate peak noise levels of approximately 110 dBA at 50 feet from the source, assuming use of an impact pile driver (WSDOT 2009). In-air noise levels from pile driving would be expected to attenuate to ambient noise levels within 3,200 feet (0.6 mile) as it traveled over land and by 9,000 feet (1.7 miles) as it traveled over water. Ambient noise levels in the action area are driven primarily by high traffic volumes on I-5. However, ambient noise levels in action area were determined from levels expected further from I-5 where I-5 noise is no longer dominating and pile driving noise would be. The ambient noise level is assumed to be 65 dBA, typical of an urban residential area (Cavananough and Tocci, 1998, as cited in WSDOT 2010).

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[11] Using the spherical spreading model where $D_1 = D_0 * 10^{(\text{initial SPL} - \text{ambient}/\alpha)}$, where D_1 is the distance from the equipment at which noise attenuates to ambient levels, D_0 is the distance from the equipment at which the initial sound level was measured, and α is the variable for soft- or hard-site conditions. For our analysis ambient = 65 dBA, the initial sound level is 93 dBA at 50 feet from the source, and α = 25 over land (soft site conditions) (WSDOT 2010).

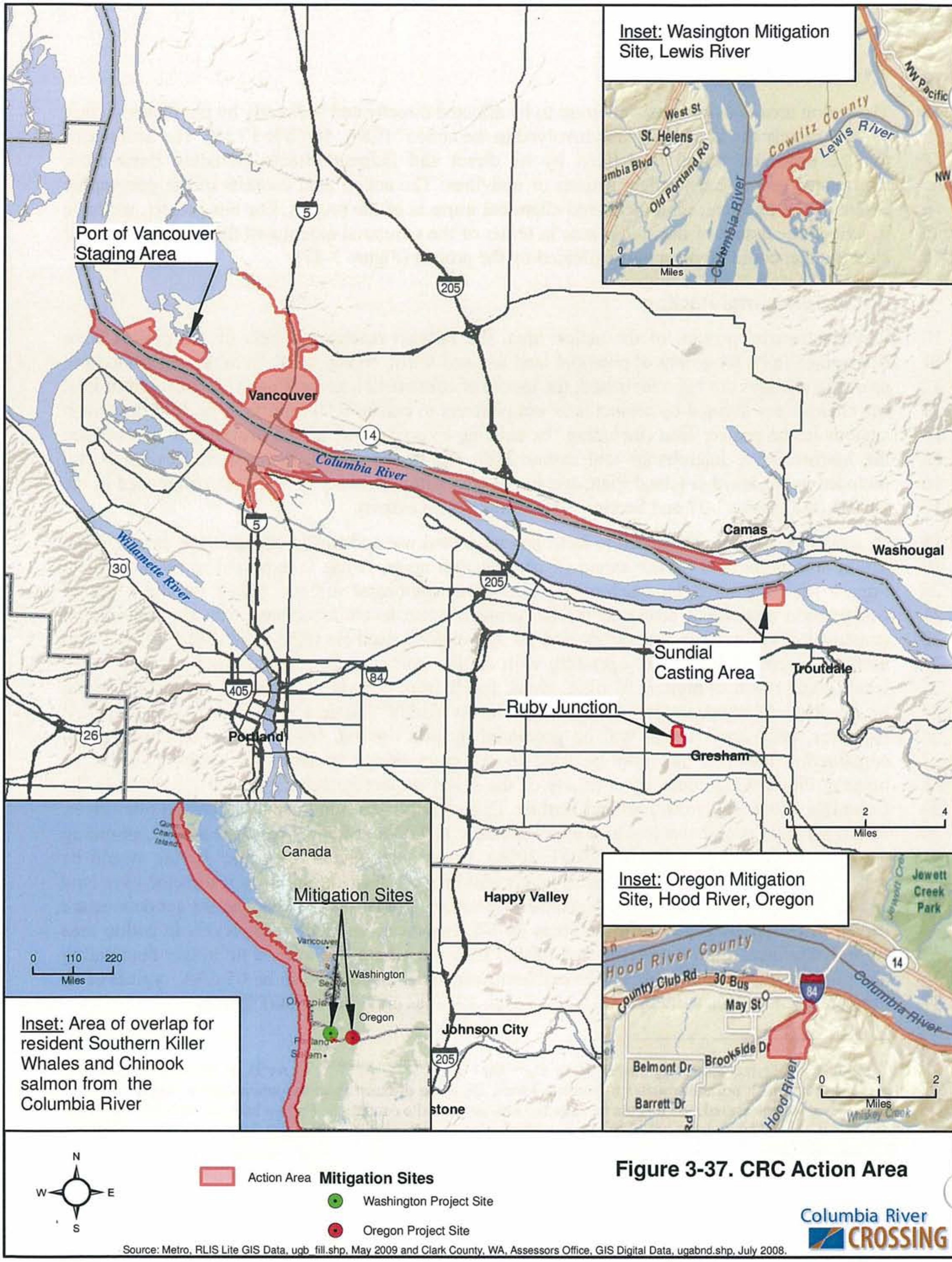

Figure 3-37. CRC Action Area

At the Alcoa, Port of Vancouver, Sundial, Red Lion, and Thunderbird staging/casting sites and at the Ruby Junction expansion site, general construction equipment has a maximum noise level is expected to attenuate to background within 700 feet of the project footprint (see Appendix A).

3.15.2 Aquatic Portion

Hydroacoustic impacts from impact pile driving are the farthest reaching extent of project aquatic impacts in the Columbia River and North Portland Harbor (see Section 6.1.1). Due to the curvature of the river and islands present, underwater noise from impact pile driving is expected to encounter land before it reaches ambient levels. Noise from impact pile driving is not expected to extend beyond Sauvie Island, approximately 5.5 miles downstream, and Lady Island, 12.5 miles upstream (see Appendix K).[12] This distance encompasses the Columbia River from approximately RM 101 to 118 (RKm 163 to 190). Within North Portland Harbor, underwater noise is expected to extend 3.5 miles downstream and 1.9 miles upstream.

The extent of the aquatic portion of the action area in Burnt Bridge Creek and the Columbia Slough is based on the distance to where stormwater pollutants are expected to dilute to background levels. In Burnt Bridge Creek, based on proposed treatment and infiltration methods, pollutant levels in stormwater runoff will outflow only in infrequent storm events. Therefore, any pollutants entering the creek are expected to dilute to background levels in close proximity to the outfall, and most definitely by the confluence with Vancouver Lake. In the Columbia Slough watershed, stormwater runoff from the project travels through open ditches before being pumped to the Columbia Slough. Based on the enhanced treatment proposed and some infiltration that will occur prior to the outfall to the Columbia Slough, pollutant levels are expected to dilute to background levels at or close to the Columbia Slough outfall, prior to reaching the salmon-bearing portion of the slough (see Section 5.2.2.2 for extent of salmon in Columbia Slough).

The action area encompasses portions of the Pacific Ocean because Chinook salmon from the Columbia River, which are affected by the CRC project, are available as prey for listed Southern Resident killer whales in areas off the Pacific coast. Therefore, NMFS has requested that the action area include the marine environment within 50 km of the Pacific coast from southern Oregon north to the Queen Charlotte Islands, where Southern Resident killer whales may overlap in distribution with Chinook from the Columbia River (Figure 3-37).

[12] No background noise levels for the project site are available. One measurement of 60 Pa or 136 dB peak has been reported for the lower Columbia River at RM 45 where the river is tidally influenced (Carlson et al. 2001). A crude approximation of the root mean square (RMS) values is approximately 121 dB RMS (subtracting 15 dB, Jim Laughlin 2009, personal communication).

The project action area also includes interrelated mitigation activities funded by the project in the Lewis and Hood Rivers (Figure 3-37). These sites will be consulted on as interrelated actions by their individual project proponents. The action area at these sites is defined by the immediate project footprint plus the extent of general construction noise for the terrestrial portion and the extent of turbidity from in-water work for the aquatic portion. The extent of general construction noise from construction equipment is estimated to extend less than 8,000 feet (0.7 mile) in all directions before it attenuates to ambient levels.[13] The extent of turbidity is expected to extend no more than 300 feet downstream and 100 feet upstream from in-water work.

The aquatic and terrestrial extent of the action area is shown in Figure 3-37. This action area encompasses all other project impacts including visual disturbance.

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[13] Using the spherical spreading model where $D_1 = D_0 * 10^{(\text{initial SPL} - \text{ambient}/\alpha)}$, where D_1 is the distance from the equipment at which noise attenuates to ambient levels, D_0 is the distance from the equipment at which the initial sound level was measured, and α is the variable for soft- or hard-site conditions. For our analysis ambient = 40 dBA for a rural area (EPA 1978, as cited in WSDOT 2010), the initial sound level is 87 dBA at 50 feet from the loudest equipment (a clam shovel), and $\alpha = 25$ over land (soft site conditions) (WSDOT 2010).

Section 4

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Section 4

SECTION 4

What does this section present?

Section 4 provides information on the listed fish species and designated habitats within the action area, especially for local populations. For each listed ESU/DPS in the action area, it provides the run timing, local status information, and presence or absence of suitable habitat. Current population estimates from recovery plans and other reliable sources are provided, and trends, conservation needs, and threats or limiting factors to recovery are addressed. The presence and characteristics of designated critical habitat within the project's action area are discussed.

How many species are listed in the action area?

The action area supports one or more life stages of 18 species listed under the ESA. These listed species consist of five ESUs of Chinook, five DPSs of steelhead, one ESU of sockeye, one ESU of coho, one ESU of chum, and one DPS each of bull trout, Steller sea lion, green sturgeon, killer whale, and eulachon. Additionally, 11 critical habitat units are present within the action area.

When are listed species present and what are they doing in the action area?

Species occurrence is the action area is complex due to the variety of life history strategies, species, and sizes of salmonids present in the lower Columbia River. General timing is estimated as follows:

- Adult and outmigrating and rearing juvenile salmonids: year-round.
- Adult Chinook, steelhead, and sockeye: between March and October.
- Adult coho and chum: between August and February.
- Chum salmon spawning: between November and January.
- Adult eulachon spawning: between February and July.
- Adult and subadult Steller sea lions: November and May.
- Juvenile Chinook, steelhead, sockeye, and coho outmigration: between March and October.
- Juvenile chum rearing: between December and March.
- Juvenile chum outmigration: between February and May.
- Juvenile eulachon rearing: between January and May.
- Juvenile eulachon outmigration: between February and August.

4. NATURAL HISTORY AND SPECIES OCCURRENCE

The action area supports one or more life stages of 18 species listed under the ESA (see Table 4-1). Additionally, 11 critical habitat units are present within the action area (see Table 4-1). The sections below describe the occurrence of species and critical habitat within the action area. Appendix C provides detailed natural history information about each species.

Table 4-1. ESA-Listed Species Likely to be Present in the Action Area

ESU/DPS **Species Common Name** ***Species Scientific Name***[a]	**Federal Status**[b]	**Critical Habitat Present**	**Presence Documented in Action Area**[c]	**Habitat Use within Action Area**[d]
LCR ESU **Chinook** *Oncorhynchus tshawytscha*	LT	Yes	Yes	M/H; S; R
UCR Spring-Run ESU **Chinook** *O. tshawytscha*	LE	Yes	Yes	M/H; R
SR Fall-Run ESU **Chinook** *O. tshawytscha*	LT	Yes	Yes	M/H
SR Spring/Summer-Run ESU **Chinook** *O. tshawytscha*	LT	Yes	Yes	M/H
UWR ESU **Chinook** *O. tshawytscha*	LT	Yes	Yes	M/H; R
LCR DPS **Steelhead** *O. mykiss*	LT	Yes	Yes	M/H; S; R
MCR DPS **Steelhead** *O. mykiss*	LT	Yes	Yes	M/H
UCR DPS **Steelhead** *O. mykiss*	LE	Yes	Yes	M/H
SR DPS **Steelhead** *O. mykiss*	LT	Yes	Yes	M/H
UWR DPS **Steelhead** *O. mykiss*	LT	Yes	Yes	M/H
SR ESU **Sockeye** *O. nerka*	LE	Yes	Yes	M/H
LCR ESU **Coho** *O. kisutch*	LT	None designated	Yes	M/H; S; R
CR ESU **Chum** *O. keta*	LT	Yes	Yes	M/H; S; R

ESU/DPS Species Common Name *Species Scientific Name*[a]	Federal Status[b]	Critical Habitat Present	Presence Documented in Action Area[c]	Habitat Use within Action Area[d]
CR DPS **Bull trout** *Salvelinus confluentus*	LT	Yes (Proposed)	Yes	M/H; F
Eastern DPS **Northern (Steller) sea lion** *Eumetopias jubatus*	LT	No	Yes	F, T
Southern DPS **Green sturgeon** *Acipenser medirostris*	LT	No	Yes	F, H
Southern Resident DPS **Killer whale** *Orcinus orca*	LE	No	See discussions regarding killer whale action area in Section 3 and Appendix H.	
Southern DPS **Eulachon** *Thaleichthys pacificus*	LT	N/A	Yes	M, S

Notes:

a LCR = Lower Columbia River; UCR = Upper Columbia River; SR = Snake River; UWR = Upper Willamette River; MCR = Middle Columbia River; CR = Columbia River

b Federal status: LT = Listed Threatened, LE = Listed Endangered, N/A = Not Applicable.

c Source: Columbia River Crossing Fish-Run Working Group 2009 (CRC 2009).

d Habitat uses: S = Spawning, R = Rearing (includes foraging behavior), M/H = Migration/Holding (holding includes resting behavior), F = Feeding, T = Transiting.

In general, all runs of listed salmonids are present in the lower Columbia River during at least a portion of the March through October window as migrating adults and outmigrating juveniles (see Figure 4-1 and Figure 4-2; note that timing represented in these figures is for the mainstem Columbia River and North Portland Harbor only, as comprehensive data on timing in the Columbia Slough and Burnt Bridge Creek are lacking. Also note that timing in these figures is for general illustrative purposes and may vary annually, depending on environmental conditions; for a detailed statistical analysis of abundance and timing by species and life stage, see Appendix K. Most juvenile outmigration between Bonneville and the mouth of the river occurs between March and October, with peaks at various times within this period, depending on species and run type (Carter et al. 2009). For seven of the stocks listed above, adult migration timing extends outside of the March-through-October window. Due to the variety of life history strategies, species, and sizes of salmonids present in the lower Columbia River, outmigrating and rearing juveniles are likely to be present in the action area year-round.

4.1 LOWER COLUMBIA RIVER CHINOOK

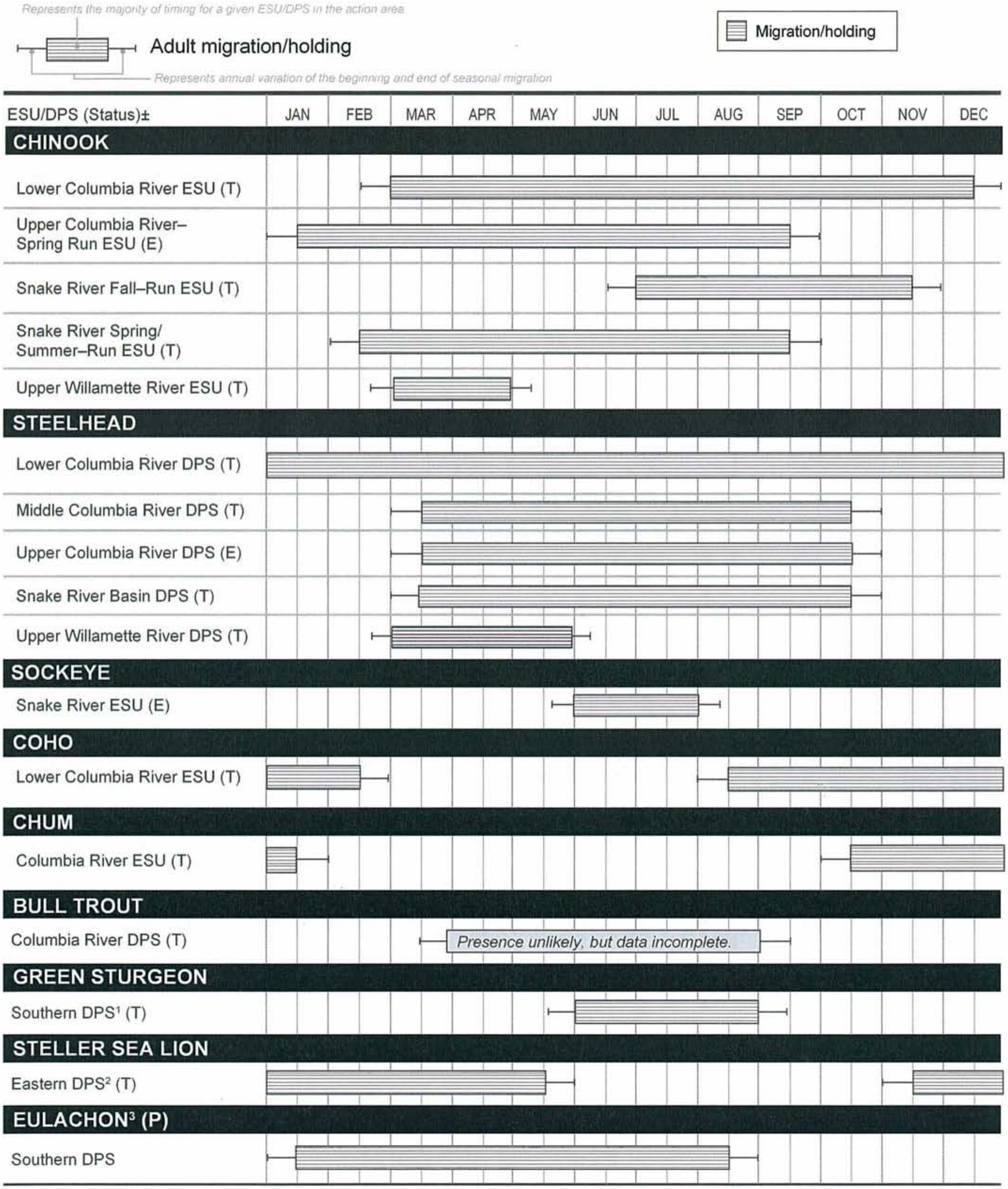
4.1.1 Status and Biological Context

The LCR Chinook ESU includes all naturally spawned populations of Chinook from the Columbia River and its tributaries that occur from the river's mouth at the Pacific Ocean, upstream to a transitional point between Washington and Oregon east of the Hood and White Salmon Rivers (70 FR 37160) (see Figure 4-3). This geographic extent of this ESU also includes the Willamette River to Willamette Falls, Oregon, with the exception of spring-run Chinook in the Clackamas River. There are 17 artificial propagation programs for Chinook in this ESU.

Figure 4-1

TYPICAL PRESENCE–ADULTS

ESA-Columbia River and North Portland Harbor Species Occurring in the Columbia River Crossing Action Area



Columbia River CROSSING

± Status abbreviations: (E) Endangered; (T) Threatened; (P) Proposed for Listing

FEBRUARY 24, 2010

[1] Olaf Langness, WDFW, personal communication 2008

[2] Federal Register (62 FR 24345)

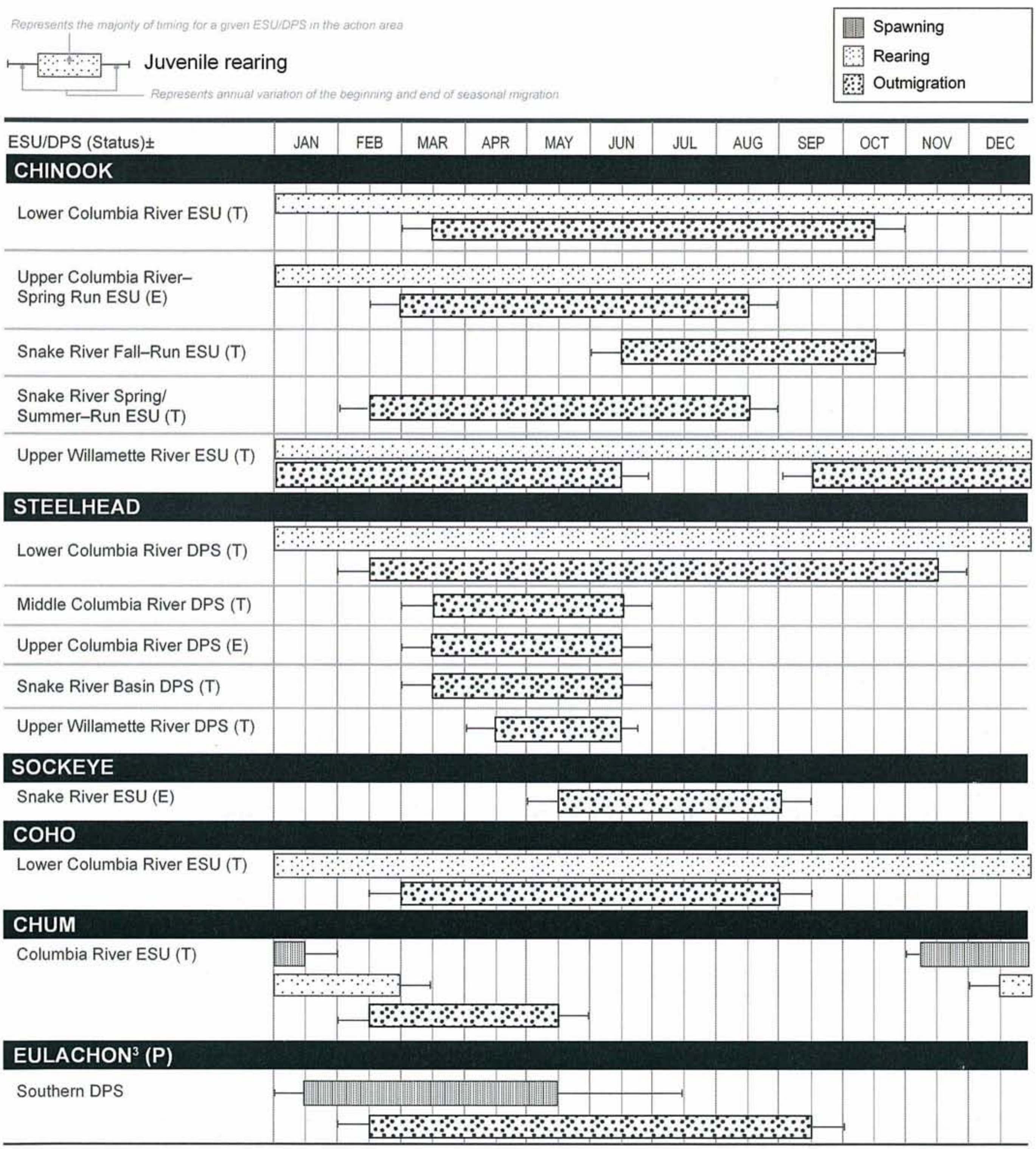
[3] WDFW & ODFW 2001: Washington and Oregon Eulachon Management Plan; Langness personal communication 2009

Sources: Information compiled from Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife and National Marine Fisheries Service species experts unless otherwise indicated.

Figure 4-2

TYPICAL PRESENCE–JUVENILES AND LARVAE

ESA-Columbia River and North Portland Harbor Species Occurring in the Columbia River Crossing Action Area



FEBRUARY 24, 2010

Columbia River CROSSING

± Status abbreviations: (E) Endangered; (T) Threatened; (P) Proposed for Listing

[1] Olaf Langness, WDFW, personal communication 2008

[2] Federal Register (62 FR 24345)

[3] WDFW & ODFW 2001: Washington and Oregon Eulachon Management Plan; Langness personal communication 2009

Sources: Information compiled from Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife and National Marine Fisheries Service species experts unless otherwise indicated.

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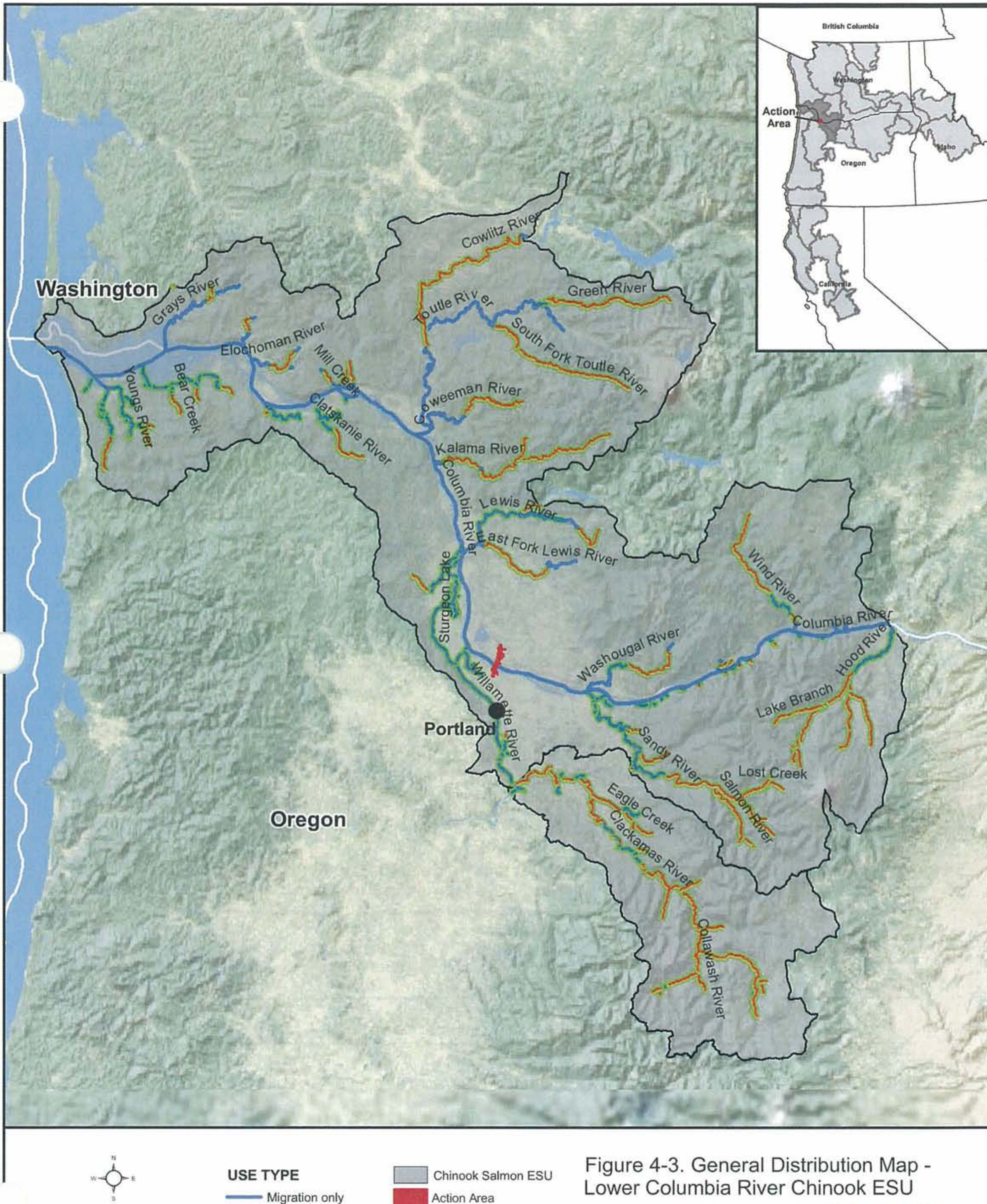


Figure 4-3. General Distribution Map - Lower Columbia River Chinook ESU

Map is intended to show distribution of the ESU, and not specific habitat use by life stage within the action area itself.

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: May 20, 2009; Plot Date: May 20, 2009; File Name: ESUDPS_JL194.mxd

LCR Chinook exhibit three life history types: early fall runs ("tules"); late fall runs ("brights"); and spring runs; Table 4-2 summarizes the characteristics of these life history types. Fall runs historically (e.g., pre-settlement) occurred throughout the entire range of the ESU, while spring runs historically occurred only in the upper portions of basins with snowmelt-driven flow regimes (e.g., western Cascade Crest and Columbia Gorge tributaries).

Table 4-2. Life History and Population Characteristics of LCR Chinook

Characteristic	Spring	Early Fall (Tule)	Late Fall (Bright)
Number of extant populations	9 (includes 4 potentially extinct)	20	2
Life history type	Stream	Ocean	Ocean
Adults present in action area	February-June	August-September	August-December
Emergence	December-January	January-April	March-May
Rearing duration in freshwater	12-14 months	1-4 months (up to 12 months in some cases)	1-4 months (up to 12 months in some cases)
Rearing habitat	Tributaries, mainstem	Tributaries, mainstem, sloughs, saltwater estuary	Tributaries, mainstem, sloughs, saltwater estuary
Age at return	4-5 years	3-5 years	3-5 years
Estimated historical abundance of spawning adults	125,000	140,000	19,000
Recent natural-origin spawning adults (~1997-2001)	800	6,500	9,000

Sources: NMFS 2008e; Columbia River Crossing Fish-Run Working Group 2009 (CRC 2009).

There are six major population groups in this ESU: Cascade spring, Gorge spring, Coastal fall, Cascade fall, Cascade late fall, and Gorge fall; the populations occurring within the action area are summarized in Table 4-3. These are further delineated according to tributary into 32 historical subpopulations, seven of which are extirpated or nearly so. Eleven subpopulations occur in the action area and are listed in Table 4-3.

Table 4-3. Summary of Status for LCR Chinook in the CRC Project Area (Subpopulations Occurring Within or Above the Action Area Only)

Subpopulation	Legacy[a,e]	Core[b,e]	Abundance Estimate (4-year Average of Natural-Origin Spawners)		Viable Abundance Goal[e]	Current Viability[e]	Extinction Risk[e,f]
			LCFRB 2004[c]	NMFS 2008e[d]			
			Cascade Fall				
Washougal	No	No	1,225	1,130	5,800	Low	High
Clackamas	No	Yes	56	40	1,400	Low	High
Sandy	No	No	208	183	1,400	Low	High

Subpopulation	Legacy[a,e]	Core[b,e]	Abundance Estimate (4-year Average of Natural-Origin Spawners)		Viable Abundance Goal[e]	Current Viability[e]	Extinction Risk[e,f]
			Gorge Fall				
Lower Gorge	No	No	Insufficient data		1,400	Low	High
Upper Gorge	No	Yes	138	109	1,400	Low	High
White Salmon	No	Yes	174	218	1,600	Low	High
Hood	No	No	N/A	36	1,400	Low	High
			Cascade Late Fall				
Sandy	Yes	Yes	445	2771	5,100	Low	High
			Cascade Spring				
Sandy	Yes	Yes	2,649	959	2,600	Medium	Moderate
			Gorge Spring				
White Salmon	No	No	Insufficient data		1,400	Very Low	Very High
Hood	No	Yes	0	51	1,400	Very Low	Very High
Estimated Total for These Populations			**4,895**	**5,497**	**24,900**		

Note: Abundance estimates indicate some measure of overall abundance for a specific and short time series, relative to recovery goals and to other subpopulations; however, estimates vary according to source and statistical methodology, and recent viability estimates (McElhany et al. 2007) indicate that reliable estimates are not available for many subpopulations in this ESU. Estimates here also do not reflect recent (mid-2000s) higher returns of some subpopulations attributed to improved ocean conditions.

a Genetic Legacy designation by the Technical Recovery Team. Genetic legacy populations represent unique life histories or are relatively unchanged by hatchery influences.

b Core population designation by Technical Recovery Team. Core populations were the largest historical populations and were key to metapopulation processes.

c Source: Lower Columbia Fish Recovery Board (LCFRB) 2004; 1997-2000 average natural spawning escapements (from Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan 2004, Appendix A: Focal Fish).

d Source: NMFS 2008e; abundance estimates are 5-year geometric means from approximately 1997-2001/1990-2004.

e Source: LCFRB 2004.

f Source: McElhany et al. 2007.

LCR Chinook use the Columbia River within the action area for migration, holding, and rearing. Rearing habitat is limited in the Columbia River portion of the action area, but is present in off-channel areas downstream of the existing I-5 bridge (e.g., accessible areas of small tributaries, backwater areas, and other low-velocity refugia).

Adults of the fall run migrate through the action area from August to December on their way to spawn in large mainstem tributaries. Upstream migrating adults of the spring run are present from February to June on their way to spawn in upstream and headwater tributaries (CRC 2009; NMFS 2005a).

Spawning habitat is not documented within the Columbia River portion of the action area; however, fall-run Chinook spawn upstream of the action area in the lower Columbia River near Ives Island and Hamilton Creek, at RM 143, 3 miles downstream from Bonneville Dam and 37 miles upstream from the I-5 bridge (FPC 2008).

Spawning occurs between late September and December, and eggs incubate over the fall and winter months. Timing of fry emergence is dependent on egg deposition time and water temperature. Downstream juvenile migration occurs 1 to 4 months after emergence (NMFS 2005a). Stream-type Chinook, which typically rear in higher elevation tributaries for a year before outmigrating, begin downstream migration as early as mid-February and continue through August; they are most abundant in the Columbia River estuary (generally defined as the lower Columbia River between Bonneville Dam and the mouth) between early April and early June (Carter et al. 2009). Spring-run Chinook juveniles outmigrate from freshwater as yearlings (stream-type).

The fall-run Chinook outmigration typically peaks between May and July, although juveniles are present through October (CRC 2009; Carter et al. 2009).

Information regarding Chinook use of Burnt Bridge Creek is limited. The abundance of Chinook is thought to be very low (PSMFC 2003); however, there is the potential for all freshwater life stages of fish in this ESU to occur in the lower reaches (Weinheimer 2007 personal communication; WDFW 2007b). Two juvenile fall-run Chinook were documented in April 2003 in the lower reaches of Burnt Bridge Creek, less than 0.50 mile downstream of I-5 (PSMFC 2003). No juvenile Chinook or redds were observed upstream of I-5 during surveys conducted in November and December 2002 and April and May 2003 (PSMFC 2003).

Within the action area, habitat in the creek between Vancouver Lake and I-5 is characterized by low-gradient pool and marsh habitat with moderate canopy cover, and was described in a 2007 survey as good salmonid rearing habitat (WDFW 2007a). Upstream of the action area between I-5 and Fourth Plain Boulevard, the survey noted increasing canopy cover, abundant beaver activity and pond habitat, and good rearing and spawning habitat in portions where the stream flows through a greenbelt with protected riparian areas (e.g., Leverich and Arnold Parks). Habitat upstream of these areas is degraded by urban development, non-native vegetation, channelization, and bank armoring, and provides much less habitat.

There are no complete passage barriers in Burnt Bridge Creek, although seasonal velocity and flow barriers exist. A 2007 WDFW fish passage inventory of the creek documented several culverts within the action area that function as partial barriers, including the I-5 culvert at MP 3.07 (RM 1.9/RKm 3). This culvert is an undersized box culvert with less than 1 percent slope, which causes high velocities through the culvert at certain flows (WDFW 2007a). Yearly stream flows vary, and the frequency with which the culvert is impassable is unknown; however, the presence of coho redds above the culvert in November and December 2002 (see Section 4.12.1) indicate that access to spawning habitat is possible (WDFW unpublished data).

Because potential spawning habitat occurs in the creek within the action area, there are no complete passage barriers, and there are documented detections in the lower watershed, it is possible that Chinook could use this portion of the action area for migration, rearing, or spawning.

LCR Chinook are known to use the Columbia Slough up to NE 18th Avenue, including the action area. Juvenile Chinook use the Columbia Slough for rearing and migration only, as spawning habitat is absent from the Slough (COP 2009a). Chinook are not likely to be present in the Slough during summer months (approximately June through September, depending on the year), as water temperatures are often too high to support juvenile salmonids (COP 2009a).

Quantitative data for abundance estimates are available for only about half of the populations in this ESU. Of those with available data, abundance estimates are low and many of the long- and short-term abundance trends are sharply negative (see Table 4-3). Natural production of Chinook in the Lower Columbia River basin is generally considered to be substantially reduced compared to historic levels (Myers et al. 1998), and in some cases, natural runs have been effectively replaced by hatchery production. The abundance of fall-run Chinook is currently much higher than that of spring-run Chinook in this ESU (NMFS 2008e). Accessible stream habitat has been significantly reduced from historical conditions by hydroelectric projects in some tributaries, leading to the extirpation of some populations. This ESU was determined to have a high to very high risk of extinction (McElhany et al. 2007) (see Figure 4-4).

LCR Chinook are likely to be present in the Columbia River and North Portland Harbor year-round within the action area and thus are likely to be present during in-water work.

4.1.2 Limiting Factors

Limiting factors for this ESU include habitat degradation (e.g., hydropower development), hatchery effects, fishery management and harvest decisions, and predation. LCR Chinook populations began declining in the early 1900s due to habitat changes and harvest rates. Populations above Bonneville Dam are affected by upstream and downstream passage barriers and by the degradation of spawning habitat in lower tributary reaches. For populations originating in tributaries below Bonneville Dam, migration and habitat conditions in the mainstem and estuary have been affected by hydrosystem flow operations. Tributary habitat degradation is pervasive due to development and other land uses, and hydroelectric projects have blocked some spawning areas. Hatchery production for this ESU has reduced the diversity and productivity of natural populations. Predation is a significant factor for juveniles and adults, particularly for spring-run populations. Key predators include piscivorous birds (e.g., Caspian terns and cormorants), piscivorous fish (e.g., pikeminnow), and marine mammals (e.g., seals and sea lions) (NMFS 2008e).

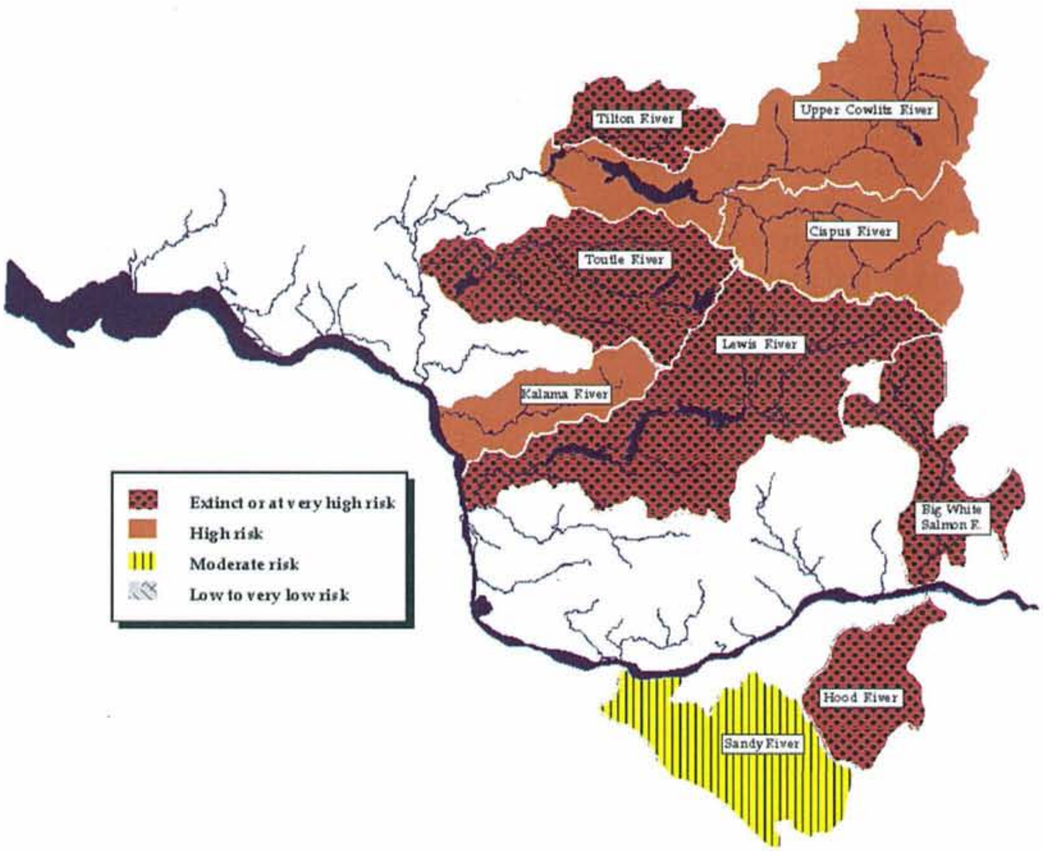
4.1.3 Designated Critical Habitat

Critical habitat was designated for LCR Chinook on September 2, 2005 (70 FR 52630), and includes the Columbia River from the mouth to the confluence with the Hood River, as well as stream reaches in tributary subbasins. Designated critical habitat is present in the action area in the Columbia River and North Portland Harbor. Designated critical habitat occurs in the Columbia Slough up to roughly 1.6 miles downstream of I-5, which is outside of the action area. Burnt Bridge Creek does not contain designated or proposed critical habitat for any of the species discussed in this BA.

Designated critical habitat and its primary constituent elements (PCEs) are discussed in detail in Section 5.4. Critical habitat and PCEs were designated simultaneously for LCR Chinook, UCR Chinook, the five steelhead DPSs addressed in this BA, and CR chum; therefore, the PCEs listed below also apply to these runs.

The following PCEs are present in the action area: freshwater spawning, freshwater rearing, freshwater migration, and estuarine areas.

In the action area, these PCEs are generally in poor condition due to altered channel morphology and stability, lost and/or degraded floodplain connectivity, loss of habitat diversity, excessive sediment, degraded water quality, increased stream temperatures, reduced stream flow, and reduced access to spawning and rearing areas (NMFS 2008e).



SOURCE: Lower Columbia River Fish Recovery Board 2004.
Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan

Figure 4-4.
Extinction Risk - Lower Columbia River
Chinook ESU

Columbia River CROSSING

4.2 UPPER COLUMBIA RIVER SPRING-RUN CHINOOK

4.2.1 Status and Biological Context

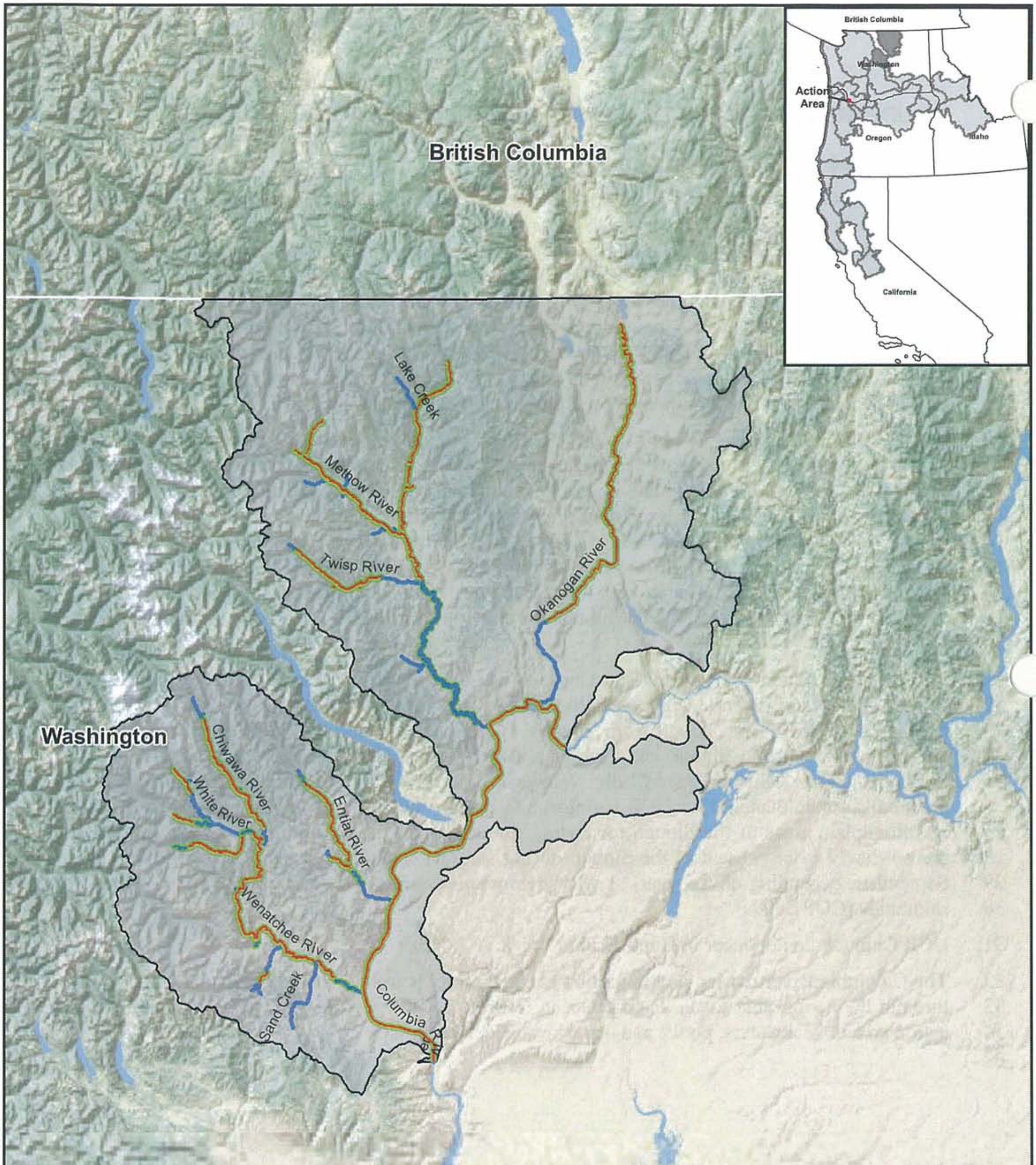
The Upper Columbia River (UCR) spring-run Chinook ESU includes all naturally spawned populations of Chinook in all accessible river reaches in the mainstem Columbia River and its tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River (70 FR 37160) (see Figure 4-5). The ESU consists of one major population group (MPG) composed of three existing subpopulations (the Entiat, Methow, and Wenatchee) and one extinct population (formerly distributed above Chief Joseph Dam). All of the existing three subpopulations migrate through the action area. Chief Joseph Dam was completed in 1961 and functions as a total passage barrier for further upstream migration of this ESU. There are six artificial propagation programs for Chinook in this ESU.

Within the action area, adult and juvenile UCR Chinook are present in the Columbia River and North Portland Harbor during upstream adult migration, downstream juvenile outmigration, holding, and rearing. Figure 4-1 and Figure 4-2 summarize the timing of Chinook presence in the action area. Upstream-migrating adults are present in the action area from approximately mid-January to mid-September (CRC 2009; NMFS 2005a). Juveniles outmigrating to the ocean are present in the action area from mid-February through August (CRC 2009). Rearing juveniles may be present in the action area year-round. Due to the potential presence of individuals from this ESU at any time of year, UCR Chinook are likely to be present in the action area during in-water work.

The extent to which UCR spring-run Chinook use the Columbia Slough is unknown. Recent genetic analyses of juvenile Chinook in the Slough show that juveniles originating from upriver ESUs are present in the Slough from January to June (Teel et al. 2009). These ESUs include UCR summer/fall-run Chinook and Deschutes River fall-run Chinook. The study did not detect UCR spring-run Chinook specifically. However, the Slough is accessible to and provides potentially suitable habitat for UCR spring-run Chinook. Juveniles would use seasonal wetlands and floodplain areas of the Slough for resting, foraging, and refuge from high flows. Juveniles are not likely to be present in the Slough during summer months (approximately June through September, depending on the year) as water temperatures are often too high to support juvenile salmonids (COP 2009a).

UCR Chinook do not occur in Burnt Bridge Creek.

The Columbia River rearing and migration corridor extends from Rock Island Dam downstream through the action area to the Pacific Ocean (NMFS 2005a). Holding habitat is present in the action area in backwaters, pools, and other low-velocity areas.



USE TYPE

Migration only

Rearing and migration

Spawning and rearing

Chinook Salmon ESU

Action Area

0 10 20

Miles

Figure 4-5. General Distribution Map - Upper Columbia River Spring-Run Chinook ESU

Map is intended to show distribution of the ESU, and not specific habitat use by life stage within the action area itself.

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: May 20, 2009; Plot Date: May 20, 2009; File Name: ESUDPS_JL194.mxd