APPENDIX E

DEVELOPMENT AND SELECTION OF GROUNDWATER SCREENING LEVELS

DEVELOPMENT OF GROUNDWATER SCREENING LEVELS

To evaluate the leachate and groundwater sample analytical results from this investigation and from the 2008 investigation, SLR developed groundwater screening levels for the site. The shallow groundwater beneath the Yakima Landfill area does not meet the MTCA criteria for non-potable groundwater [WAC 173-340-720(2)] so state and federal maximum contaminant levels (MCLs) for drinking water were considered during the development of the groundwater screening levels. The Yakima River is the primary receptor of the shallow groundwater beneath the landfill property and beneficial uses of the river include domestic water, fish harvesting, and salmonid spawning/rearing (WAC 173-201A-600). Therefore, chronic state and federal water quality criteria (WQC) for protection of freshwater organisms and for protection of human health (consumption of both organisms and water) were also considered during the development of screening levels.

Based on the groundwater and leachate sample analytical results from this investigation and the groundwater sample analytical results from the 2008 investigation, except for the results from well MW-9A (not considered a background well in relation to the landfill; see Section 2.6 of the RI Report), groundwater screening levels were developed for the metals, conventional analytes, and organic chemicals that were detected in at least one sample. The selected screening levels were the lowest available MCL for protection of drinking water or the lowest available WQC for protection of surface water. The WQC for cadmium, chromium, copper, lead, nickel, and zinc were adjusted for hardness based on the average hardness concentration in wells MW-7 (161 mg/L $CaCO_3$) and MW-8 (153 mg/L $CaCO_3$), the two downgradient wells closest to the Yakima River. If an MCL or a WQC was not available, a screening level was obtained from the MTCA Method B equation for groundwater or surface water, respectively. The protectiveness of MCLs and WQC were assessed by using MTCA Method B equations. An MCL or a WQC was considered sufficiently protective if it was associated with a cancer risk less than or equal to $1x10^{-5}$, or a hazard quotient less than or equal to 1.0 [WAC 173-340-720(7)(b) and -730(5)(b)]. If an MCL or a WQC was not sufficiently protective, it was adjusted by using the applicable MTCA Method B equation to achieve a cancer risk of $1x10^{-5}$ or a hazard quotient of 1.0. The development and selection of the groundwater screening levels are presented in Tables E-1 through E-4.

Table E-1
Screening Levels for Protection of Drinking Water
Closed City of Yakima Municipal Landfill
Yakima, Washington

Analyte	WA State Drinking Water MCL	EPA Primary Drinking Water Standards		EPA Secondary Drinking Water Standards	Minimum MCL	MTCA Method B Groundwater Cleanup Level	Is MCL Sufficiently Protective?	Drinking Water Screening Level
		MCLG	MCL/TT					
Metals								
Arsenic	10	n/a	10	--	10	0.0058	No	0.058
Barium	2,000	2,000	2,000	--	2,000	3,200	Yes	2,000
Cadmium	5	5	5	--	5	8	Yes	5
Cobalt	--	--	--	--	--	--	n/a	--
Copper	1,300	1,300	1,300	1,000	1,000	590	No	590
Chromium VI	100	100	100	--	100	48	No	48
Iron	300	--	--	300	300	--	Yes	300
Lead	15	n/a	15	--	15	--	Yes	15
Magnesium	--	--	--		--	--	n/a	--
Manganese	50	--	--	50	50	2,200	Yes	50
Nickel	100	--	--	--	100	320	Yes	100
Potassium	--	--	--	--	--	--	n/a	--
Selenium	50	50	50	--	50	80	Yes	50
Sodium	20,000	--	--	--	20,000	--	Yes	20,000
Thallium	2	0.5	2	--	0.5	1.1	Yes	0.5
Zinc	5,000	--	--	5,000	5,000	4,800	No	4,800
Conventionals								
pH	--	--	--	6.5-8.5	6.5-8.5	--	Yes	6.5-8.5
Chloride	--	--	--	250,000	250,000	--	Yes	250,000
Fluoride	--	4,000	4,000	2,000	2,000	--	Yes	2,000
Nitrate	10,000	10,000	10,000	--	10,000	--	Yes	10,000
Nitrite	1,000	--	--	--	1,000	--	Yes	1,000
Sulfate	--	--	--	250,000	250,000	--	Yes	250,000
Organics								
1,1-Dichloroethane	--	--	--	--	--	1,600	n/a	1,600
N-Nitrosodiphenylamine	--	--	--	--	--	--	n/a	--
Vinyl Chloride	2	n/a	2	--	2	0.0029	No	0.029

Notes:
Values in micrograms per liter (µg/L).
MCL = Maximum contaminant level.
MCLG = Maximum contaminant level goal.
n/a = Not applicable (e.g., MCLGs of 0 for carcinogens are not applicable under MTCA).
TT = Treatment technology (i.e., for lead and copper).

Table E-2
Screening Levels for Protection of Surface Water
Closed City of Yakima Municipal Landfill
Yakima, Washington

Analyte	EPA WQC Criterion Continuous Concentration	EPA WQC Human Health Water+ Organism	State WQC Freshwater Chronic 173-201A WAC	National Toxics Rule	Minimum WQC	MTCA Method B Surface Water Cleanup Level	Is WQC Sufficiently Protective?	Surface Water Protection Screening Level
Metals								
Arsenic	150	0.018	190	190	0.018	0.0098	No	0.098
Barium	--	1,000	--	--	1,000	--	Yes	1,000
Cadmium	0.34	--	0.34	1	0.34	20	Yes	0.34
Cobalt	--	--	--	--	--	--	n/a	--
Copper	13	--	17	11	11	2,700	Yes	11
Chromium III	107	--	258	--	107	--	Yes	107
Chromium VI	11	--	10	10	10	490	Yes	10
Iron	--	--	--	--	--	--	n/a	--
Lead	4.1	--	4.1	2.5	2.5	--	Yes	2.5
Magnesium	--	--	--	--	--	--	n/a	--
Manganese	--	--	--	--	--	--	n/a	--
Nickel	76	--	230	160	76	1,100	Yes	76
Potassium	--	--	--	--	--	--	n/a	--
Selenium	5	--	5	5	5	2,700	Yes	5
Sodium	--	--	--	--	--	--	n/a	--
Thallium	--	0.24	--	--	0.24	1.6	Yes	0.24
Zinc	173	7,400	153	100	100	17,000	Yes	100
Conventionals								
pH	--	--	--	--	--	--	n/a	--
Chloride	230,000	--	--	--	230,000	--	Yes	230,000
Fluoride	--	--	--	--	--	--	Yes	--
Nitrate	--	10,000	--	--	10,000	--	Yes	10,000
Nitrite	--	--	--	--	--	--	Yes	--
Sulfate	--	--	--	--	--	--	n/a	--
Organics								
1,1-Dichloroethane	--	--	--	--	--	--	n/a	--
N-Nitrosodiphenylamine	--	3.3	--	--	3.3	9.7	Yes	3.3
Vinyl Chloride	--	0.025	--	--	0.025	3.7	Yes	0.025

Notes:
Values in micrograms per liter (µg/L).
n/a = Not applicable.
WQC = Water quality criterion.

Table E-3
Summary of Groundwater Screening Levels
Closed City of Yakima Municipal Landfill
Yakima, Washington

Analyte	Units	Protection of Drinking Water	Protection of Surface Water	Minimum Screening Level
Metals				
Arsenic	µg/L	0.058	0.098	0.058
Barium	µg/L	2,000	1,000	1,000
Cadmium	µg/L	5	0.34	0.34
Cobalt	µg/L	--	--	--
Copper	µg/L	590	17[a]	17
Chromium III	µg/L	--	258[a]	258
Chromium VI	µg/L	48	10	10
Iron	µg/L	300	--	300
Lead	µg/L	15	4.1[a]	4.1
Magnesium	µg/L	--	--	--
Manganese	µg/L	50	--	50
Nickel	µg/L	100	230[a]	100
Potassium	µg/L	--	--	--
Selenium	µg/L	50	5	5
Sodium	µg/L	20,000	--	20,000
Thallium	µg/L	0.5	0.24	0.24
Zinc	µg/L	4,800	153[a]	153
Conventionals				
pH	--	6.5-8.5	--	6.5-8.5
Chloride	mg/L	250	230	230
Fluoride	mg/L	2	--	2
Nitrate	mg/L	10	10	10
Nitrite	mg/L	1	--	1
Sulfate	mg/L	250	--	250
Organics				
1,1-Dichloroethane	µg/L	1,600	--	1,600
N-Nitrosodiphenylamine	µg/L	--	3	3
Vinyl Chloride	µg/L	0.029	0.025	0.025

Notes:
µg/L = micrograms per liter.
mg/L = milligrams per liter.
[a] Corrected for hardness (see Table F-4).

Table E-4
Hardness Dependent Water Quality Criteria
Closed City of Yakima Municipal Landfill
Yakima, Washington

Hardness Calculations

Well	Ion	MW (mg/mmol)	Groundwater Sample Concentration (mg/L)	|n|	Equiv. Weight	meq/L	Equivalent CaCO3 (mg/L)	Total Hardness (mg/L)	Avg. Hardness - All Wells (mg/L)	Avg. Hardness - MW-7 & MW-8 Only (mg/L)
	CaCo3	100.09	--	2	50.045	--	--	--	95.13	157.03
MW7	Ca++	40.078	39.9	2	20.039	1.991117321	99.64546634	161.4167068		
	Mg++	24.305	15.0	2	12.1525	1.234313927	61.77124049			
MW8	Ca++	40.078	35.4	2	20.039	1.766555217	88.40725585	152.649346		
	Mg++	24.305	15.6	2	12.1525	1.283686484	64.2420901			
MW9	Ca++	40.078	26.6	2	20.039	1.327411547	66.43031089	101.7222796		
	Mg++	24.305	8.57	2	12.1525	0.70520469	35.29196873			
MW11	Ca++	40.078	30.0	2	20.039	1.497080693	74.92140326	118.9848881		
	Mg++	24.305	10.7	2	12.1525	0.880477268	44.06348488			
MW12	Ca++	40.078	9.14	2	20.039	0.456110584	22.82605419	37.36288612		
	Mg++	24.305	3.53	2	12.1525	0.290475211	14.53683193			
MW13	Ca++	40.078	31.7	2	20.039	1.581915265	79.16694945	93.78614303		
	Mg++	24.305	3.55	2	12.1525	0.292120963	14.61919358			

Water Quality Calculations

Metal	mc	bc	State Factors	Avg. Hardness (mg/L)	CF	WQC	
						EPA Criterion Continuous Concentration (µg/L)	WA State FW Criteria (µg/L)
Cadmium	0.7409	-4.719	-4.719	157.03	0.89	0.34	0.34
Chromium III	0.819	0.6848	1.56	157.03	0.86	107	258
Copper	0.8545	-1.702	-1.464	157.03	0.96	13	17
Lead	1.273	-4.705	-4.705	157.03	0.73	4.1	4.1
Nickel	0.846	0.0584	1.1645	157.03	0.997	76	230
Zinc	0.8473	0.884	0.7614	157.03	0.986	173	153

Equations:

EPA WQC: WQC = exp[mc x ln(hardness) + bc] x CF

WA State WQC: WQC = exp[mc x ln(hardness) + state factor] x CF

Total hardness: (equivalent mg/L CaCO3 from C^{2+}) + (equivalent mg/L CaCO3 from Mg^{2+})

Notes:

mg/L = milligrams per liter.

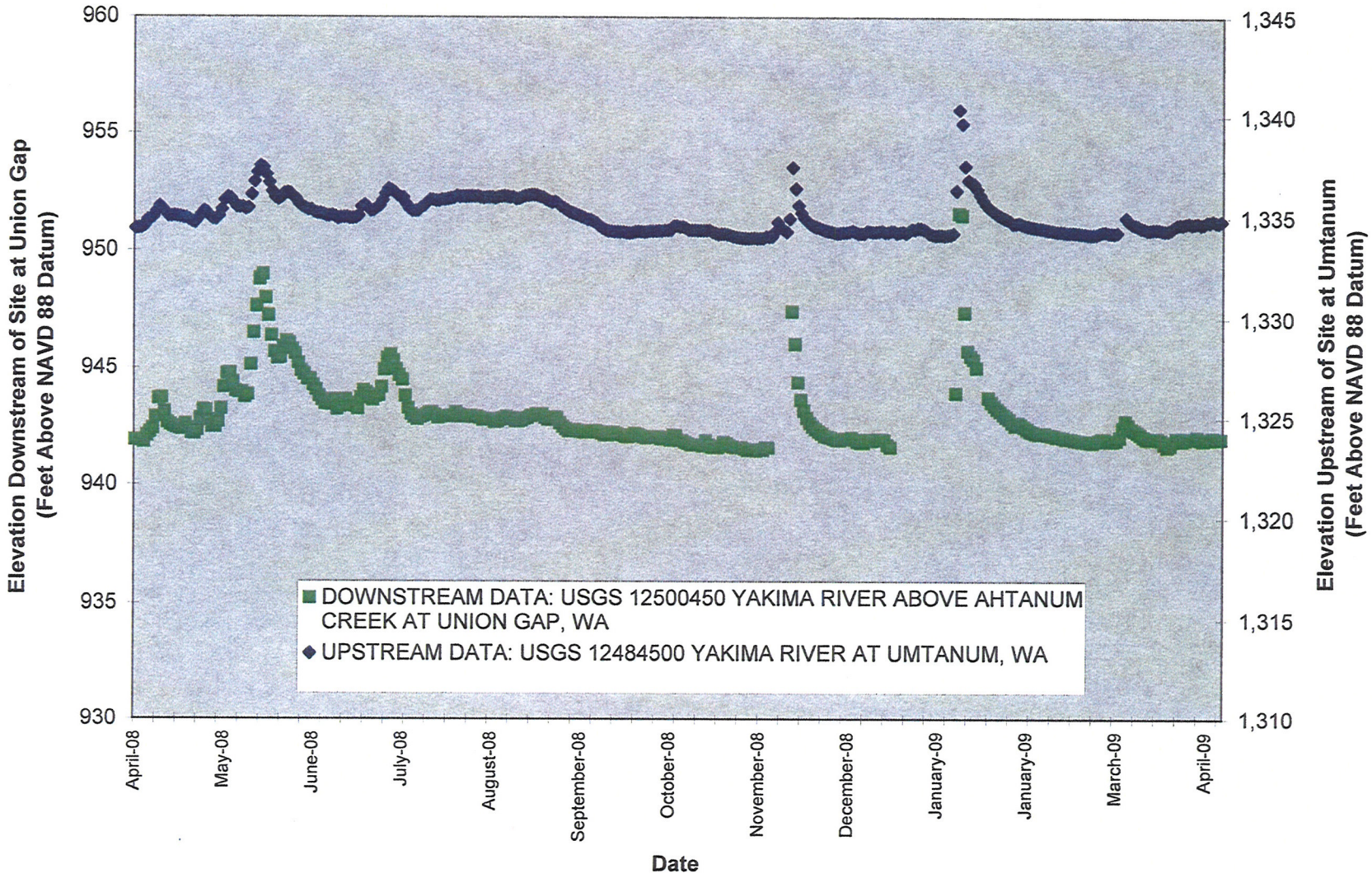
µg/L = micrograms per liter.

WQC = water quality criteria.

APPENDIX F

GRAPH OF YAKIMA RIVER ELEVATIONS

Water Elevation Data from Yakima River Gaging Stations



T:\1 PROJECTS\001.0221.00004 Yakima Landfill RI-FS\RI-FS Report\Yakima River Stage