

Baseline Risk Assessment for 200-BP-5 Groundwater Operable Unit

Presented to: Performance
and Risk Assessment
Community of Practice
Annual Technical Exchange
December 16, 2015



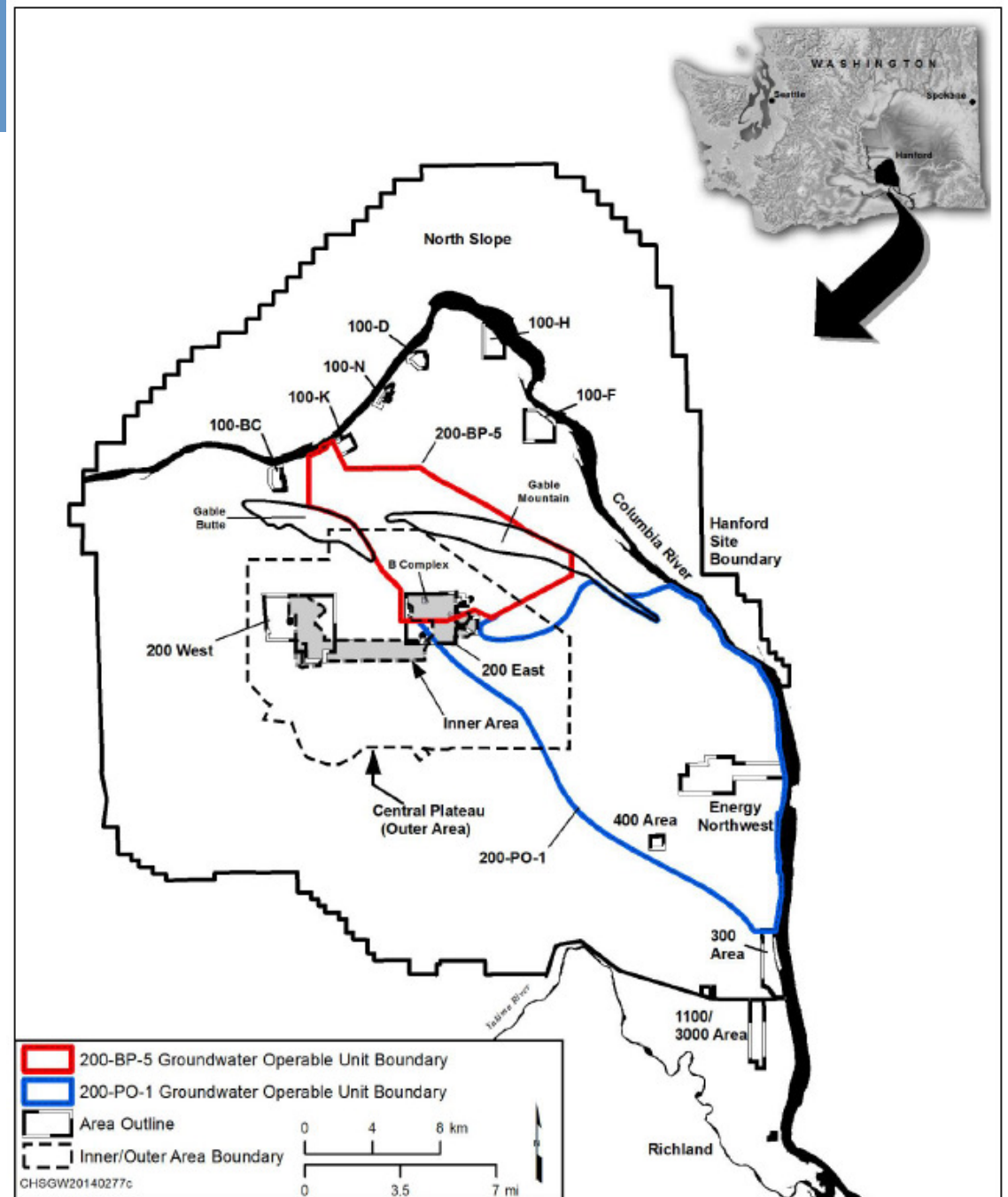
Presented by: Doug Hildebrand (DOE-RL); Donna Morgans and Alaa Aly (INTERA)

CH2MHILL
Plateau Remediation Company

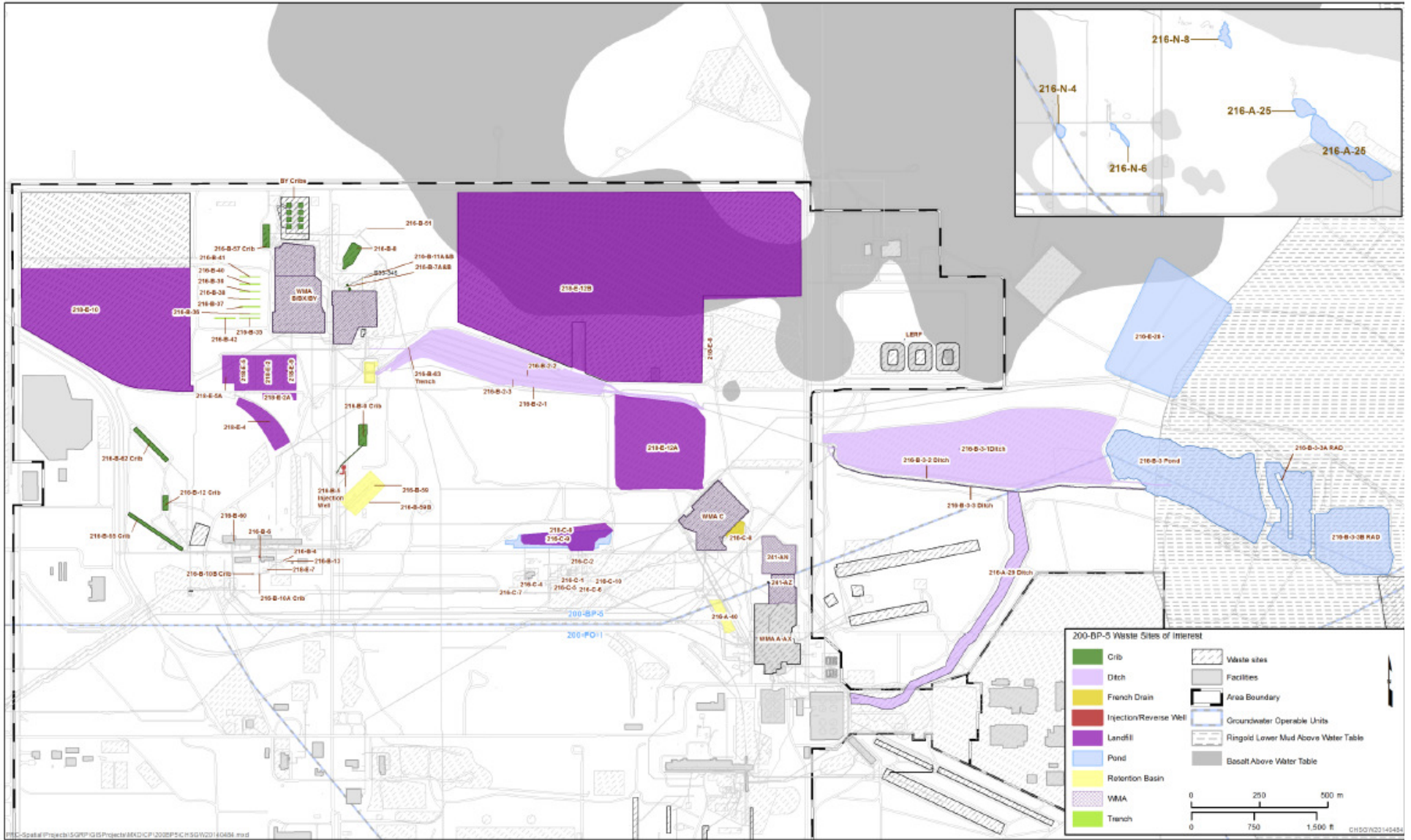


200-BP-5 OU

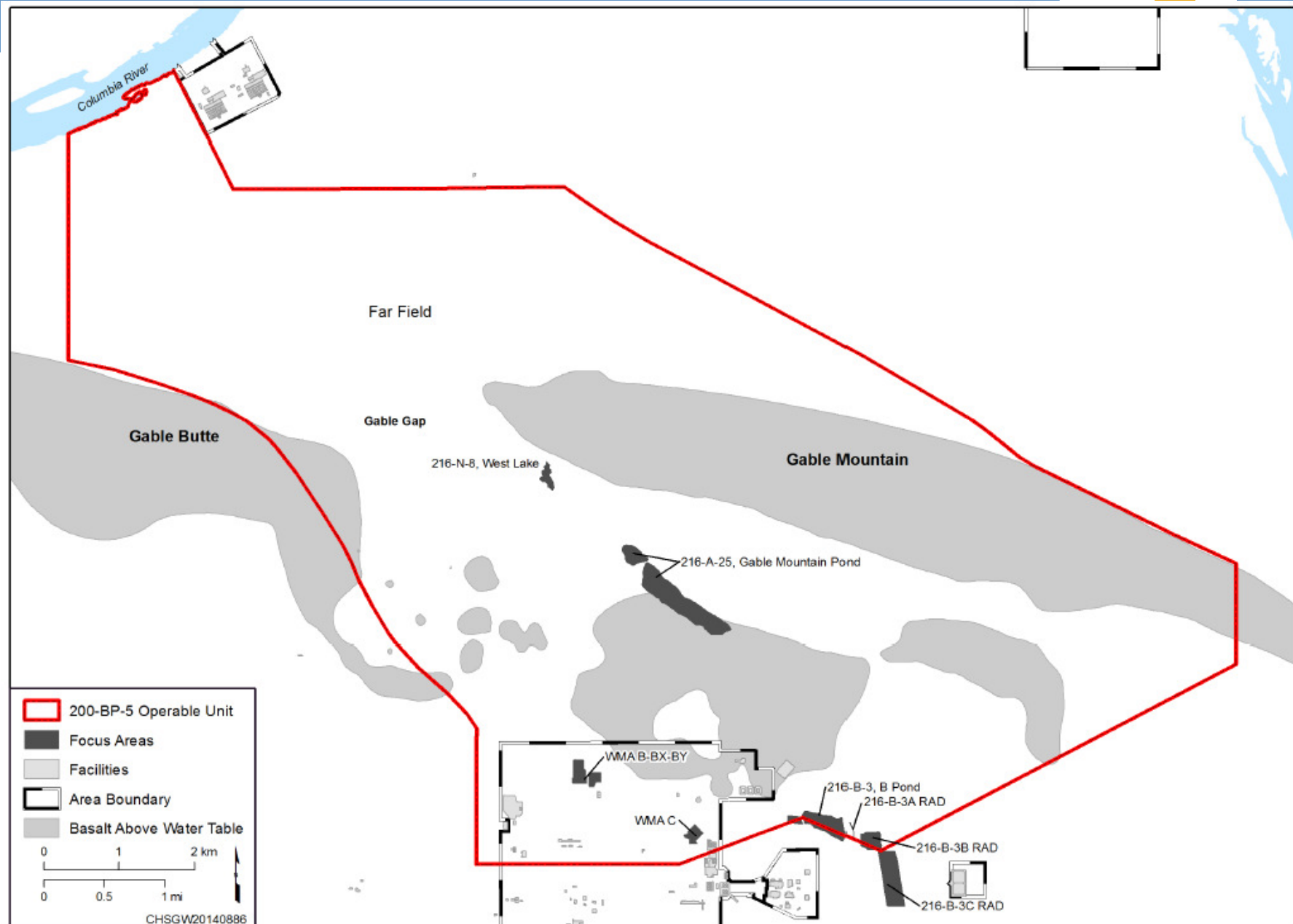
- Northeastern Central Plateau
- Remedial Investigation Report:
 - DOE/RL-2009-127; Draft A
- Under Ecology Review



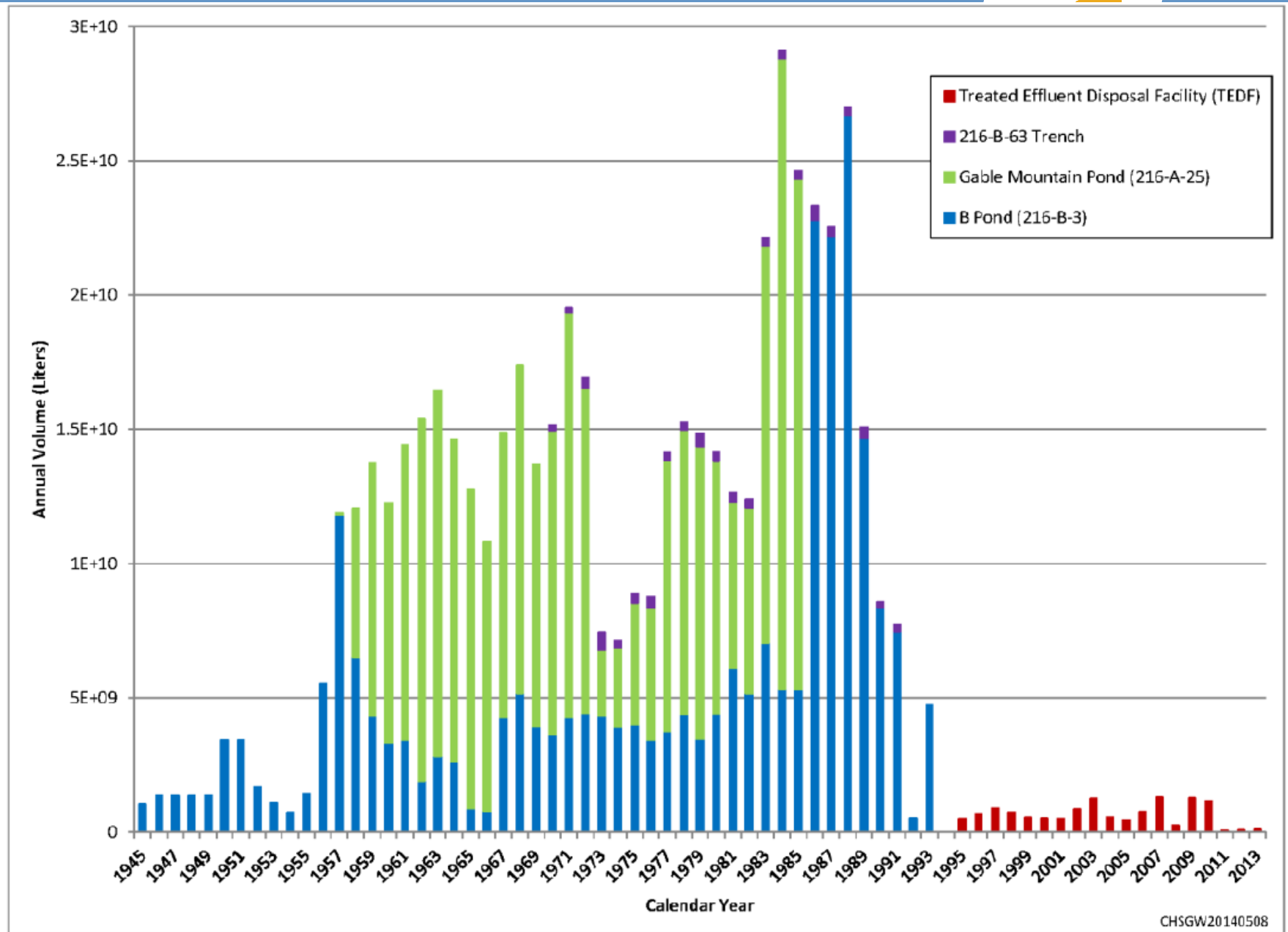
200-BP-5 Source Sites



200-BP-5 Major Facilities



200-BP-5 Water Discharges



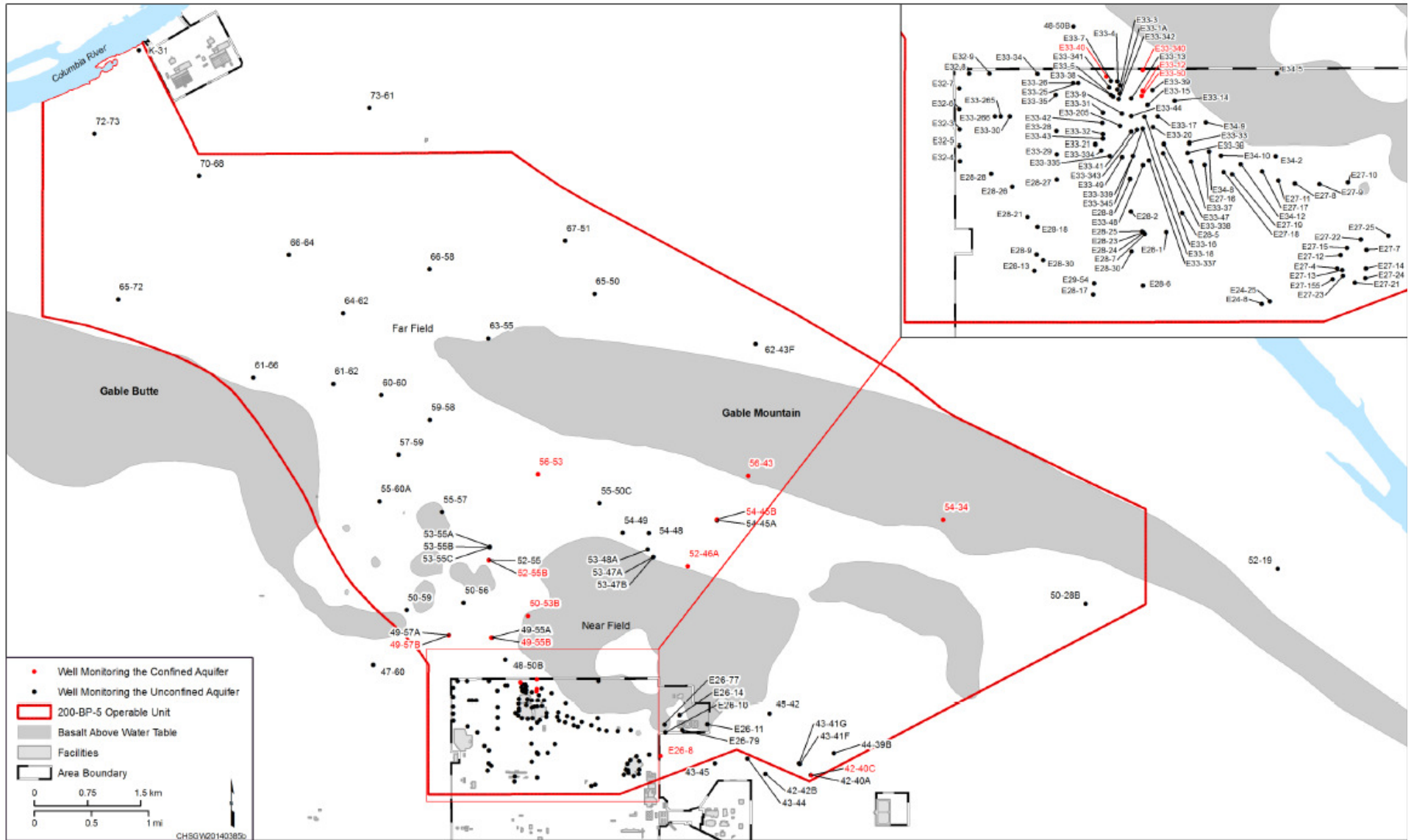
200-BP-5 Major Waste Discharges



Waste Sites	Contaminants	Derived Activity/ Concentration Released to Soil Column	Derived Liquid Release (L)
Highly Contaminated Waste Stream Sites within the B Complex			
UPR-200-E-131 (near 241-BX-102 SST)	Uranium	29,100 mg/L	346,750
	Technetium-99	6,560,400 pCi/L	
	Nitrate	11,000 mg/L	
	Tritium	11,089,100 pCi/L	
	Iodine-129	2,900 pCi/L	
Moderately Contaminated Waste Stream Sites within the B Complex			
BY Cribs	Technetium-99	3,798,800 pCi/L	33,810,000
	Nitrate	198,600 mg/L	
	Cyanide	Not provided	
	Cobalt-60	188,000 pCi/L	
	Iodine-129	4,870 pCi/L	
216-B-50 Crib	Tritium	2,307,00 pCi/L	54,739,900
216-B-57 Crib	Tritium	2,309,00 pCi/L	84,331,000
216-B-7 A&B Cribs	Technetium-99	35 to 420,800 pCi/L	44,617,500
	Nitrate	4,800 to 86,100 mg/L	
	Chromium	22 to 415 mg/L	
216-B-8 Crib	Technetium-99	3,400 pCi/L	35,269,100
	Nitrate	4,800 to 79,800 mg/L	
	Chromium	22 to 261 mg/L	
	Iodine-129	151 to 4,940 pCi/L	
Undocumented release near waste site 241-B-105	Tributyl phosphate waste that contains the same constituents as the BY Cribs	Not derived	280,090
Moderately Contaminated Waste Stream Sites near B Plant			
216-B-12 Crib	Uranium Nitrate Tritium	54.2 mg/L (insignificant) 0.5 to 8,280 mg/L 0.14 to 8,270,000 pCi/L	520,444,400

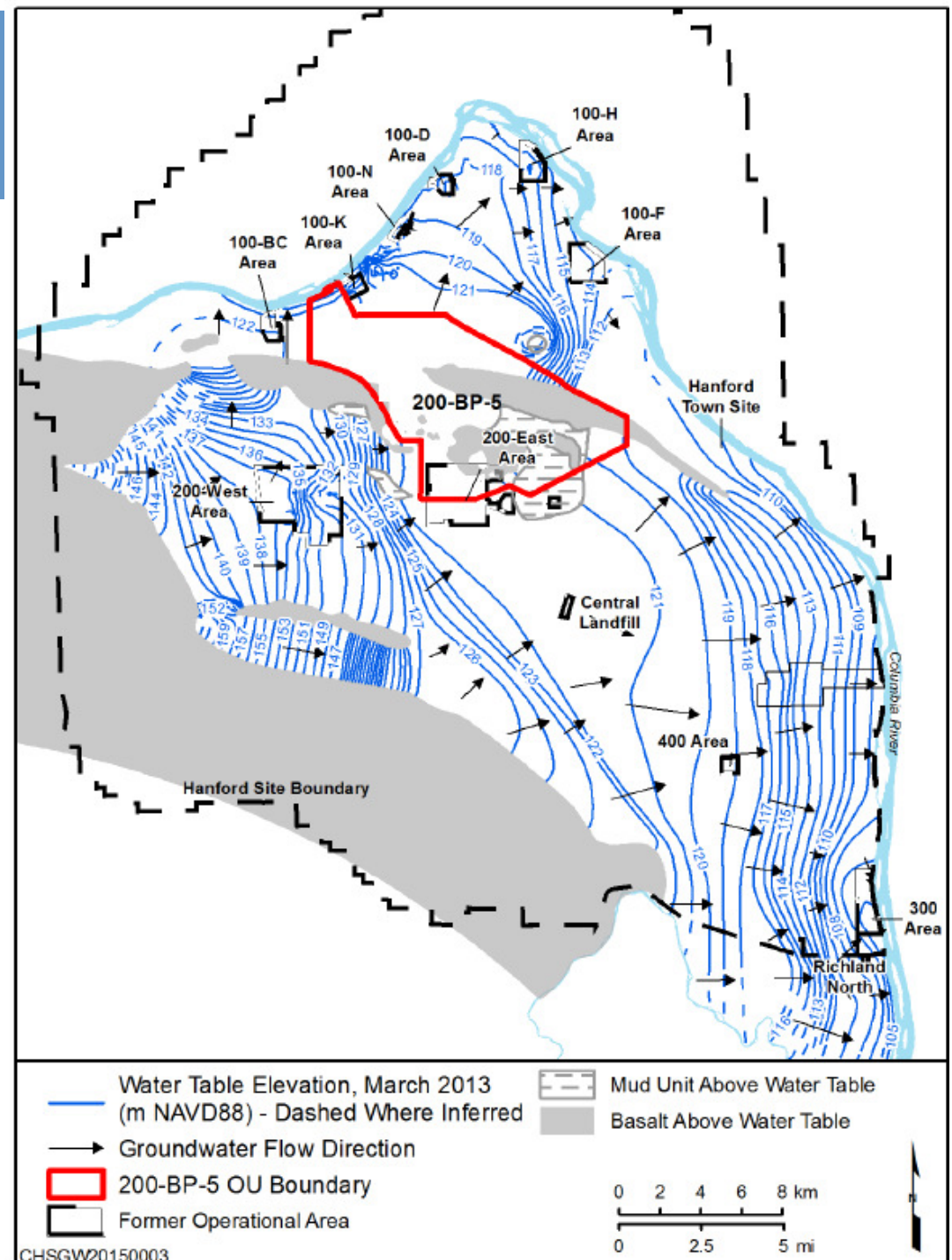
Waste Sites	Contaminants	Derived Activity/ Concentration Released to Soil Column	Derived Liquid Release (L)
216-B-5 injection well	Uranium	0.271 to 0.465 mg/L	32,090,000
	Nitrate	4,600 to 40,000 mg/L	
	Strontium-90	203,600 to 312,200 pCi/L	
	Cesium-137	234,000 to 358,500 pCi/L	
	Plutonium-239	177,400 to 2,383,500 pCi/L	
Sites Contaminated by UPRs and Other			
B Pond	Tritium Iodine-129	19 to 484,000 pCi/L <1 pCi/L (contribution from PUREX may not have been completed)	282,689,400,000
Gable Mountain Pond (216-A-25)	Nitrate Strontium-90	0.6 mg/L (undefined for UPR) 0.2 to 14,900 pCi/L	293,899,038,000
216-B-2-1 and -2 Ditches	Fractionation waste Nitrate	Not derived	Not derived
Highly Contaminated Waste Stream Sites at WMA C			
WMA C	PUREX (technetium-99 and nitrate) and scavenged waste (same contaminants as the BY Cribs) appear to have impacted groundwater, but sources have yet to be defined.	Because sources are undefined, concentrations are uncertain; however, current sites meeting the concentration requirements discussed above are provided for potential comparisons.	Not derived
UPR-200-E-81 east of Well 299-E27-23	Technetium-99 Nitrate	201,446 pCi/L 42,616 mg/L	136,260
UPR-200-E-82 north of Well 299-E27-4	Technetium-99 Nitrate	143,861,328 pCi/L 77,700 mg/L	9841
UPR-200-E-86 northwest of Well 299-E27-23	Technetium-99 Nitrate	70,276,528 pCi/L 19,224 mg/L	65,802
241-C-101	Technetium-99 Nitrate	59,375,377 pCi/L 13,284 mg/L	3,785
241-C-105	Technetium-99 Nitrate	59,815,087 pCi/L 30,210 mg/L	3,785
241-C-110	Technetium-99 Nitrate	3,212,828 pCi/L 171,069 mg/L	7,571

200-BP-5 Monitor Wells



200-BP-5 Water Table

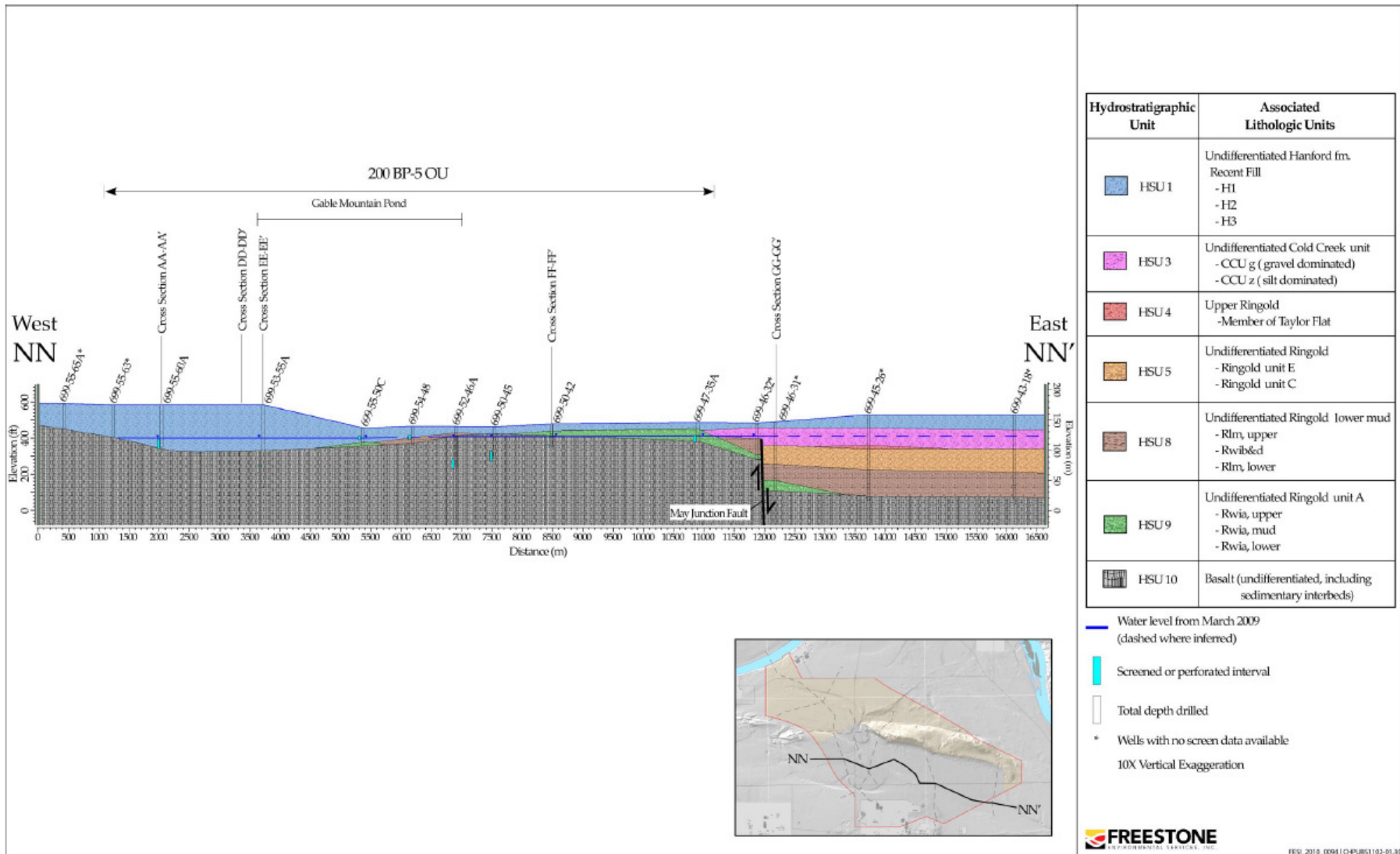
- Note the relatively flat water table covering about all the BP-5 OU and to the south.



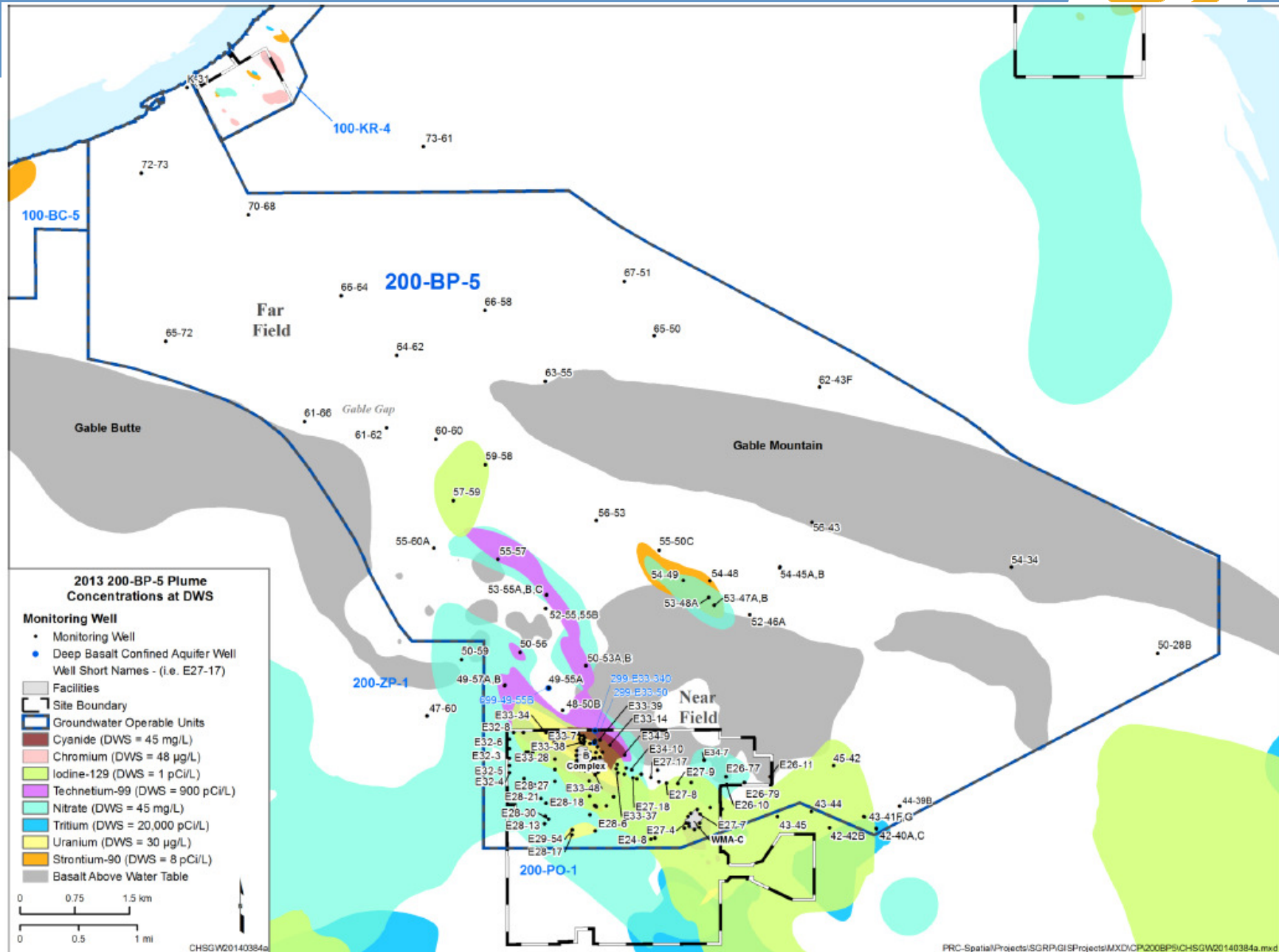
200-BP-5 Geology



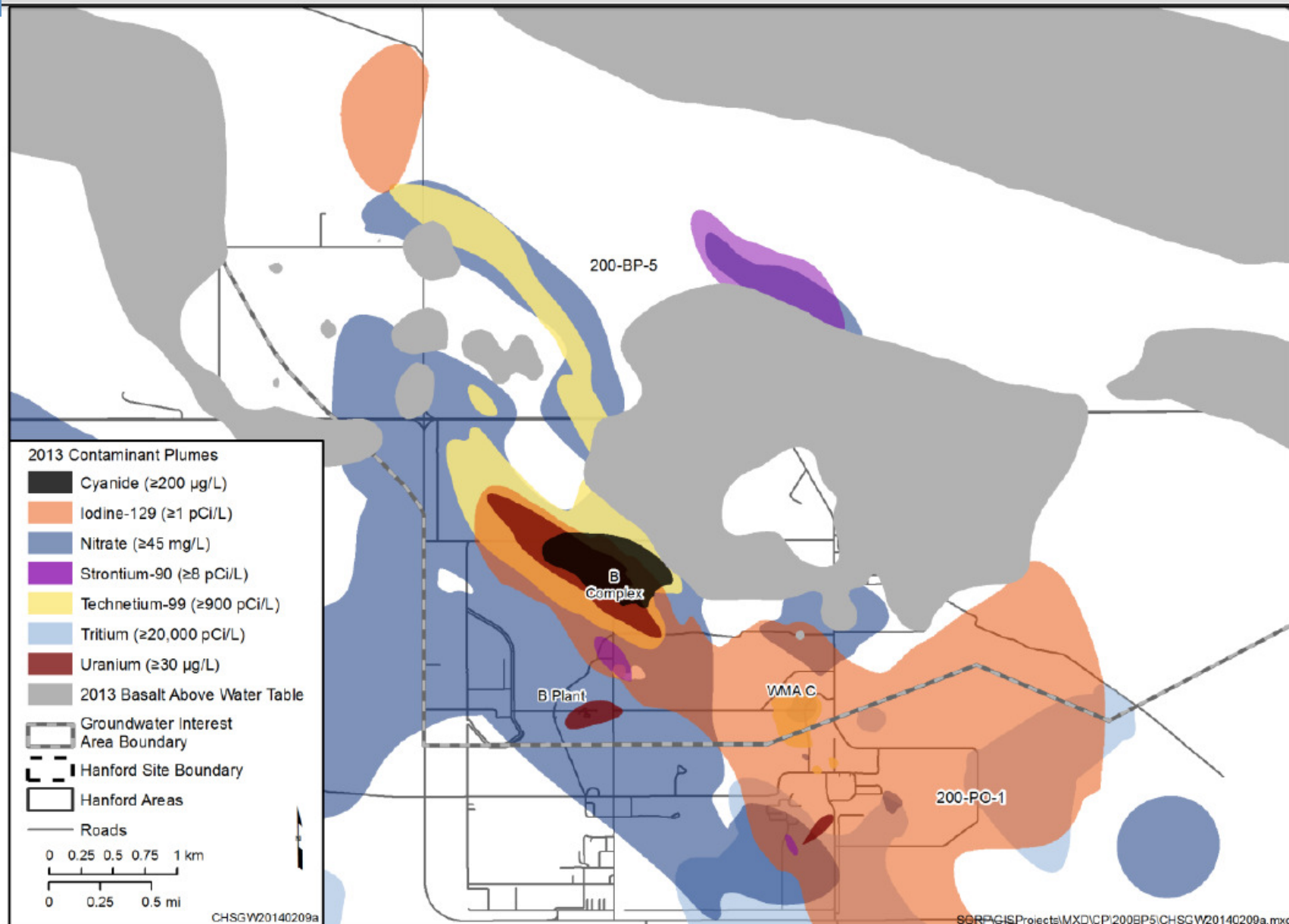
- Note the small saturated thickness.



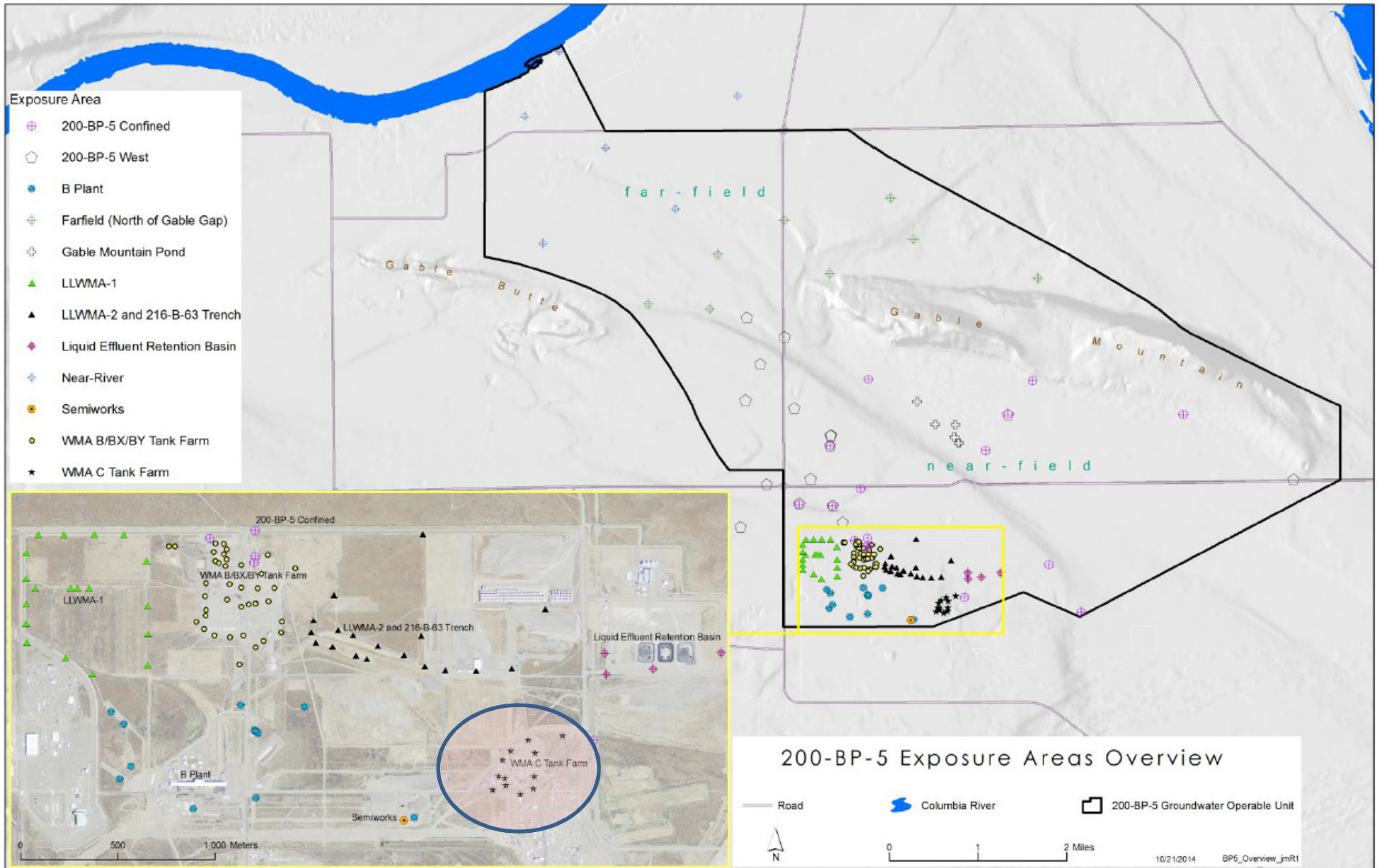
200-BP-5 GW Contamination



200-BP-5 OU High Concentration Area



200-BP-5 OU – Sub Areas



200-BP-5 OU – Evaluation of Measured Concentrations



- Simple comparison of six-year measurements (2008-2013) to drinking water standards (DWS):
 - MCLs and MCLGs: Federal and State
 - State of Washington Cleanup Values – MTCA Method B
 - Consideration of Background Concentrations

WMA C Contaminants (1)



Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	Groundwater Background 90 th Percentile	No. of Detects > Groundwater Background	Groundwater Background Level Basis	Action Level	No. of Detects > Action Level	Action Level Basis
Radionuclides																	
Americium-241	No	pCi/L	1/9/2008	12/10/2013	8	1	12.5	0.0096	0.058	0.14	0.14	7.70E-05	1	DOE/RL-96-61 Rev. 0, Table ES-1	15	0	40 CFR 141 – federal MCL
Gross alpha	No	pCi/L	1/9/2008	9/18/2013	75	17	22.67	-2.6	2.9	1.5	5.4	--	--	--	15	0	40 CFR 141 – federal MCL
Gross beta	No	pCi/L	1/9/2008	12/23/2013	243	242	99.59	8.2	8.2	8.4	16,000	3.1	242	DOE/RL-96-61 Rev. 0, Table ES-1	4 mrem/yr	--	40 CFR 141 – federal MCL
Iodine-129	No	pCi/L	1/9/2008	12/23/2013	92	92	100	--	--	1.3	7.5	9.00E-07	92	DOE/RL-96-61 Rev. 0, Table ES-1	1.0	92	40 CFR 141 – federal MCL
Plutonium-239/240	No	pCi/L	1/9/2008	12/10/2013	8	2	25	0.0091	0.045	0.055	0.11	--	--	--	15	0	40 CFR 141 – federal MCL
Technetium-99	No	pCi/L	1/9/2008	12/23/2013	259	245	94.59	-4.4	4.9	7.0	26,000	0.83	245	DOE/RL-96-61 Rev. 0, Table ES-1	900	152	40 CFR 141 – federal MCL
Tritium	No	pCi/L	1/9/2008	12/23/2013	80	78	97.5	210	250	370	2,900	119	78	DOE/RL-96-61 Rev. 0, Table ES-1	20,000	0	40 CFR 141 – federal MCL
Volatile Organic Compounds																	
2-Hexanone	No	µg/L	12/17/2009	9/6/2012	99	1	1.01	0.22	1.0	2.0	2.0	--	--	--	40	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Acetone	No	µg/L	1/9/2008	12/10/2013	112	3	2.68	0.34	5.0	0.94	5.6	--	--	--	7,200	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Carbon disulfide	No	µg/L	1/9/2008	12/10/2013	112	3	2.68	0.050	1.0	0.065	0.12	--	--	--	800	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Carbon tetrachloride	No	µg/L	1/9/2008	12/10/2013	112	3	2.68	0.063	1.0	0.22	1.3	--	--	--	0.63	1	WAC 173-340-720(4)(b)(iii)(A) and (B)
Chloroform	No	µg/L	1/9/2008	12/10/2013	112	20	17.86	0.10	1.0	0.11	0.27	--	--	--	1.4	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Semivolatile Organic Compounds																	
Methyl methacrylate	No	µg/L	3/26/2010	9/6/2012	95	1	1.05	0.26	0.26	1.4	1.4	--	--	--	11,200	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Tributyl phosphate	No	µg/L	1/9/2008	12/17/2010	28	1	3.57	0.47	1.0	1.0	1.0	--	--	--	9.7	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Metals																	
Aluminum	No	µg/L	1/9/2008	12/10/2013	9	3	33.33	5.0	20	12	26	7.1	3	DOE/RL-96-61 Rev. 0, Table ES-1	16,000	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Antimony	No	µg/L	3/13/2008	12/10/2013	48	8	16.67	0.60	4.0	3.6	74	55.1	3	DOE/RL-96-61 Rev. 0, Table ES-1	6.0	7	40 CFR 141 – federal MCL

WMA C Contaminants (2)



Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	Groundwater Background 99 th Percentile	No. of Detects > Groundwater Background	Groundwater Background Level Basis	Action Level	No. of Detects > Action Level	Action Level Basis
Arsenic	No	µg/L	1/9/2008	12/13/2013	62	61	98.39	5.0	5.0	4.1	16	7.9	7	DOE/RL-96-61 Rev. 0, Table ES-1	0.058	61	WAC 173-340-720(4)(b)(iii)(A) and (B)
Barium	No	µg/L	1/9/2008	12/23/2013	274	274	100	--	--	25	98	105	0	DOE/RL-96-61 Rev. 0, Table ES-1	2,000	0	40 CFR 141 – federal MCL
Boron	No	µg/L	12/10/2013	12/10/2013	1	1	100	--	--	23	23	36.0	0	DOE/RL-96-61 Rev. 0, Table ES-1	3,200	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Cadmium	No	µg/L	1/9/2008	12/23/2013	274	1	0.36	0.10	4.1	4.0	4.0	0.92	1	DOE/RL-96-61 Rev. 0, Table ES-1	5.0	0	40 CFR 141 – federal MCL
Chromium	No	µg/L	1/9/2008	12/23/2013	271	143	52.77	3.1	14	2.4	106	2.4	143	DOE/RL-96-61 Rev. 0, Table ES-1	100	1	40 CFR 141 – federal MCL
Chromium	Yes	µg/L	1/9/2008	12/23/2013	271	62	22.88	3.1	14	2.4	18	2.4	61	DOE/RL-96-61 Rev. 0, Table ES-1	48	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Cobalt	No	µg/L	1/9/2008	12/23/2013	268	2	0.75	0.10	4.1	1.8	4.0	0.92	2	DOE/RL-96-61 Rev. 0, Table ES-1	4.8	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Copper	No	µg/L	1/9/2008	12/23/2013	274	14	5.11	0.20	8.0	0.62	1,720	0.81	13	DOE/RL-96-61 Rev. 0, Table ES-1	640	1	WAC 173-340-720(4)(b)(iii)(A) and (B)
Hexavalent chromium	No	µg/L	1/9/2008	12/10/2013	10	10	100	--	--	2.4	6.9	--	--	--	48	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Iron	No	µg/L	1/9/2008	12/23/2013	272	178	65.44	9.0	80	18	603	570	1	DOE/RL-96-61 Rev. 0, Table ES-1	11,200	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Lead	No	µg/L	6/26/2008	12/10/2013	24	2	8.33	0.10	0.20	0.29	0.37	0.92	0	DOE/RL-96-61 Rev. 0, Table ES-1	15	0	40 CFR 141 – federal MCL
Manganese	No	µg/L	1/9/2008	12/23/2013	274	30	10.95	0.20	6.0	0.80	70	38.5	3	DOE/RL-96-61 Rev. 0, Table ES-1	384	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Mercury	No	µg/L	1/9/2008	12/10/2013	29	3	10.34	0.050	0.10	0.054	0.20	0.0030	3	DOE/RL-96-61 Rev. 0, Table ES-1	2.0	0	40 CFR 141 – federal MCL
Molybdenum	No	µg/L	12/17/2010	12/10/2013	2	2	100	--	--	1.2	2.9	3.2	0	DOE/RL-96-61 Rev. 0, Table ES-1	80	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Nickel	No	µg/L	1/9/2008	12/23/2013	274	121	44.16	1.5	13	0.23	293	1.6	119	DOE/RL-96-61 Rev. 0, Table ES-1	100	2	40 CFR 141 – federal MCL
Selenium	No	µg/L	12/3/2009	12/10/2013	45	45	100	--	--	3.4	17	10.5	18	DOE/RL-96-61 Rev. 0, Table ES-1	80	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Silver	No	µg/L	1/9/2008	12/23/2013	272	6	2.21	0.10	11	4.0	6.8	5.3	4	DOE/RL-96-61 Rev. 0, Table ES-1	80	0	WAC 173-340-720(4)(b)(iii)(A) and (B)

WMA C Contaminants (3)



Analyte	Filtered?	Units	First Sample Date	Last Sample Date	No. of Results	No. of Detects	Frequency of Detects (%)	Minimum Nondetect	Maximum Nondetect	Minimum Detect	Maximum Detect	Groundwater Background 99 th Percentile	No. of Detects [^] Groundwater Background	Groundwater Background Level Basis	Action Level	No. of Detects [^] Action Level	Action Level Basis
Strontium	No	µg/L	1/9/2008	12/23/2013	274	274	100	0	0	113	739	323	186	DOE/RL-96-61 Rev. 0, Table ES-1	9,600	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Thallium	No	µg/L	1/9/2008	12/10/2013	29	2	6.9	0.050	0.10	0.30	0.32	1.7	0	DOE/RL-96-61 Rev. 0, Table ES-1	0.50	0	40 CFR 141 – federal MCLG
Tin	No	µg/L	12/3/2009	12/10/2013	23	4	17.39	0.10	0.10	0.14	0.42	21.6	0	DOE/RL-96-61 Rev. 0, Table ES-1	9,600	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Uranium	No	µg/L	1/9/2008	12/23/2013	239	237	99.16	0.10	0.10	0.51	38	9.9	3	DOE/RL-96-61 Rev. 0, Table ES-1	30	1	40 CFR 141 – federal MCL
Vanadium	No	µg/L	1/9/2008	12/23/2013	273	240	87.91	7.0	24	7.6	35	11.5	227	DOE/RL-96-61 Rev. 0, Table ES-1	80	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Zinc	No	µg/L	1/9/2008	12/23/2013	272	52	19.12	3.3	25	4.0	53	21.8	2	DOE/RL-96-61 Rev. 0, Table ES-1	4,800	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Anions																	
Chloride	No	µg/L	1/9/2008	12/23/2013	280	280	100	--	--	11,300	297,000	15,630	241	DOE/RL-96-61 Rev. 0, Table ES-1	250,000	1	40 CFR 141 – federal MCL
Cyanide	No	µg/L	1/9/2008	12/23/2013	269	89	33.09	1.7	4.0	3.3	41	8.4	46	DOE/RL-96-61 Rev. 0, Table ES-1	4.8	78	WAC 173-340-720(4)(b)(iii)(A) and (B)
Fluoride	No	µg/L	1/9/2008	12/23/2013	280	212	75.71	46	300	56	329	1,047	0	DOE/RL-96-61 Rev. 0, Table ES-1	960	0	WAC 173-340-720(4)(b)(iii)(A) and (B)
Nitrate	No	µg/L	1/9/2008	12/23/2013	280	280	100	--	--	8,280	118,000	26,871	201	DOE/RL-96-61 Rev. 0, Table ES-1	45,000	77	40 CFR 141 – federal MCL
Nitrite	No	µg/L	1/9/2008	12/23/2013	272	46	16.91	65	591	125	532	93.7	46	DOE/RL-96-61 Rev. 0, Table ES-1	3,300	0	40 CFR 141 – federal MCL
Sulfate	No	µg/L	1/9/2008	12/23/2013	280	280	100	--	--	51,800	333,000	47,014	280	DOE/RL-96-61 Rev. 0, Table ES-1	250,000	52	40 CFR 141 – secondary federal MCL

200-BP-5 OU – Risk Characterization



- Calculate Exposure Point Concentrations (EPCs):
 - By area
 - For selected wells
 - Six-year data sets
- Toxicity Information:
 - Radionuclides: EPA HEAST Tables (EPA 540-R-97-036)
 - Tier 1: EPA Integrated Risk Information System (IRIS)
 - Tier 2: EPA Provisional Peer-Reviewed Toxicity Values
 - Tier 3: Other Toxicity Values
- Tap Water Exposure Scenario:
 - EPA Regional Screening Tables
 - Consistent with a Residential Exposure Scenario
 - Use of GW as a tap Water Source – ingestion, inhalation, dermal

WMA C – Sample EPC Calculations



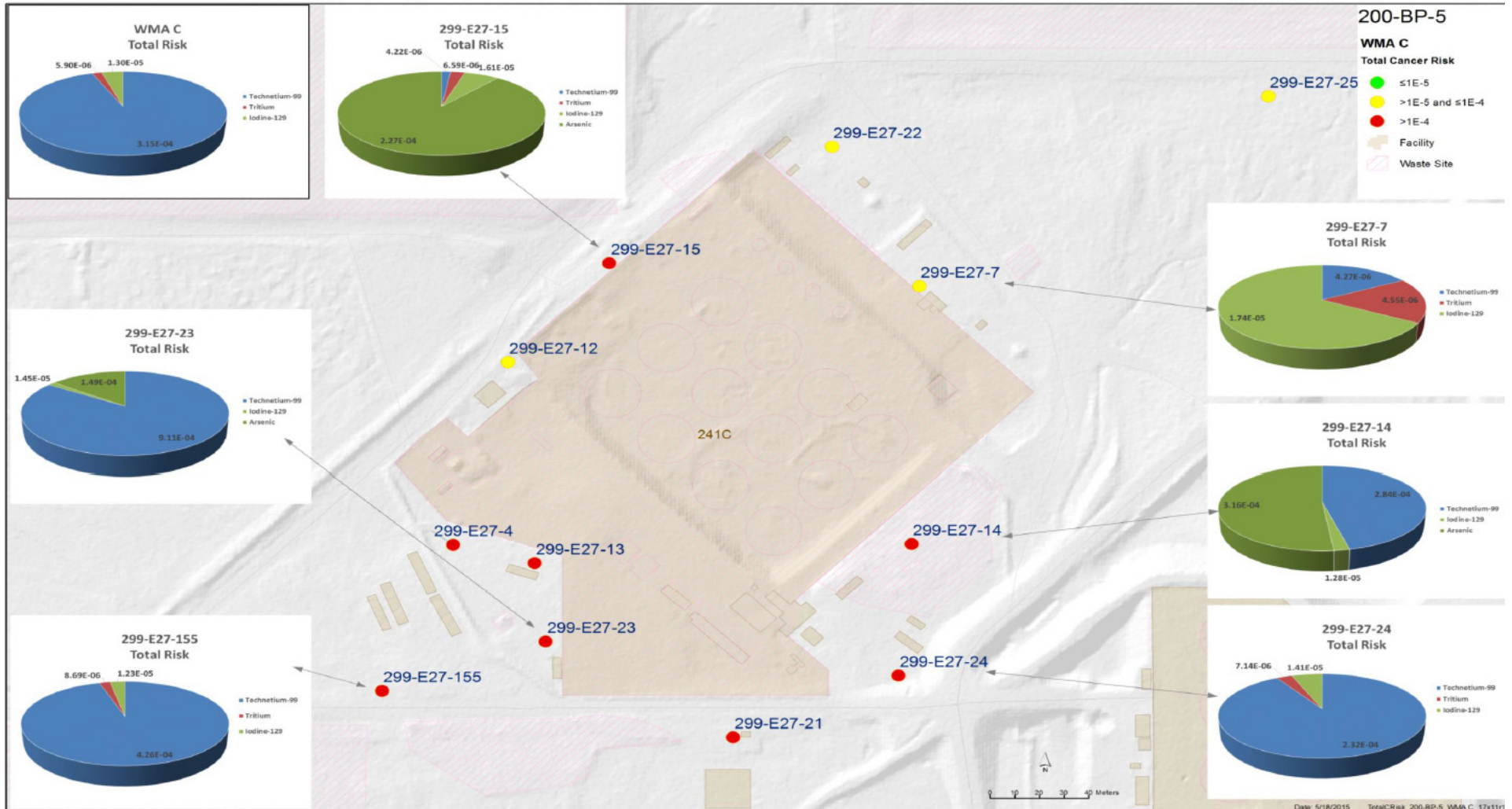
Exposure Area	Analyte Group	Analyte	CAS No.	Total Samples	Total Detects	Total Nondetects	Frequency of Detection (%)	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Coefficient of Variation	Exposure Point Concentration	Exposure Point Concentration Basis
WMA C Tank Farm	RAD	Plutonium-238	13981-16-3	8	0	8	0	pCi/L	-5.70E-02	0.087	—	—	—	—	—
WMA C Tank Farm	RAD	Plutonium-239/240	PU-239/240	8	2	6	25	pCi/L	0.0091	0.045	0.055	0.11	0.47	0.11	95% KM (% bootstrap) UCL
WMA C Tank Farm	RAD	Strontium-90	10098-97-2	8	0	8	0	pCi/L	-6.60E+00	0.10	—	—	—	—	—
WMA C Tank Farm	RAD	Technetium-99	14133-76-7	259	245	14	95	pCi/L	-4.40E+00	4.9	7.0	26,000	1.3	5,981	97.5% KM (Chebyshev) UCL
WMA C Tank Farm	RAD	Tritium	10028-17-8	80	78	2	98	pCi/L	210	250	370	2,900	0.34	1,074	95% KM (BCA) UCL

WMA C – Tap Water Exposure Scenario

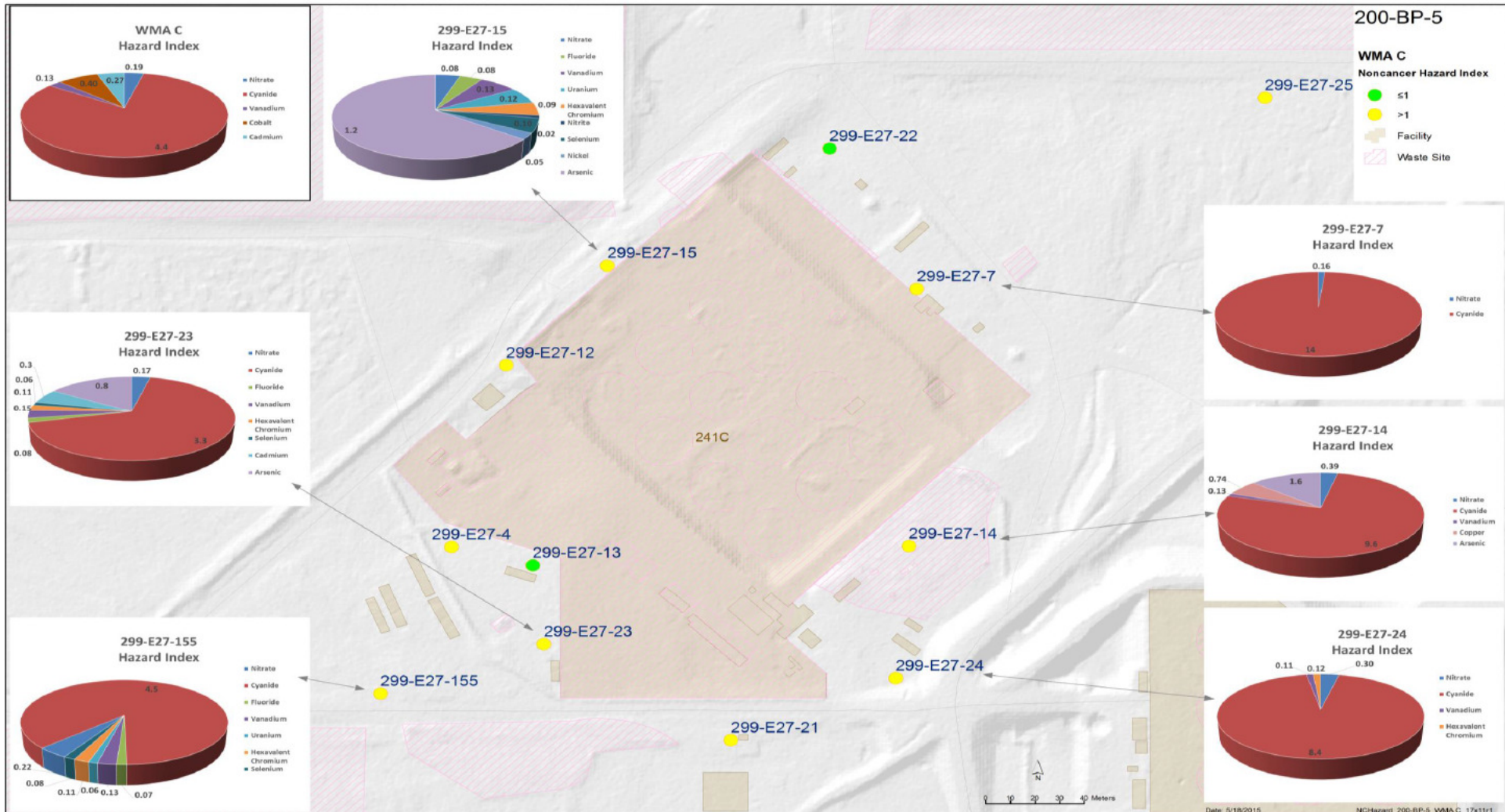


Analyte Group	Exposure Route	ELCR	% Risk Contribution	HI	% HI Contribution
Nonradionuclides	Ingestion	1.3×10^{-4}	Arsenic (ELCR = 1.3×10^{-4} ; 27%)	5.8	Antimony (HQ = 3.6; 36%)
	Dermal contact	1.0×10^{-6}	Carbon tetrachloride (ELCR = 2.9×10^{-6} ; <1%)	0.23	Arsenic (HQ = 0.66; 6.5%)
	Inhalation of volatiles	2.0×10^{-6}	Iodine-129 (ELCR = 1.3×10^{-5} ; 2.8%) Technetium-99 (ELCR = 3.1×10^{-4} ; 68%) Tritium (ELCR = 5.9×10^{-6} ; 1.3%)	4.1	Cadmium (HQ = 0.27; 2.6%) Cobalt (HQ = 0.40; 3.9%) Cyanide (HQ = 4.4; 43%) Fluoride (HQ = 0.068; <1%) Cr(VI) (HQ = 0.077; <1%) Nitrate (HQ = 0.19; 1.9%) Selenium (HQ = 0.065; <1%) Vanadium (HQ = 0.13; 1.2%)
	Total risk	1.3×10^{-4}		Total HI	10
Radionuclides	Ingestion	3.3×10^{-4}			
	Inhalation of volatiles	4.9×10^{-6}			
	Total risk	3.3×10^{-4}			
Total cumulative risk		4.6×10^{-4}			

WMA C – Risk Characterization for Selected Wells (ELCR)



WMA C – Risk Characterization for Selected Wells (HI)



WMA C – Native American Exposure Scenarios



Environmental Medium/ Exposure Pathway	CTUIR Total ELCR	CTUIR Risk Drivers (Contributes > 1 × 10 ⁻⁶)	CTUIR HI	CTUIR Hazard Drivers	Yakama Nation Total ELCR	Yakama Nation Risk Drivers (Contributes > 1 × 10 ⁻⁶)	Yakama Nation HI	Yakama Nation Hazard Drivers
WMA C Tank Farm								
Groundwater as a potential drinking water source	2.2 × 10 ⁻³	Iodine-129, technetium-99, tritium	16	Cyanide	2.3 × 10 ⁻³	Iodine-129, technetium-99, tritium	16	Cyanide
Groundwater as a potential source of steam from sweat lodge use (includes vaporized nonvolatiles)	4.6 × 10 ⁻³	Cr(VI), cobalt, cadmium, technetium-99	20	Cobalt, cadmium, vanadium	3.4 × 10 ⁻²	Cr(VI), cobalt, cadmium, technetium-99	142	Cobalt, cadmium, vanadium, nickel, barium, uranium, manganese, Cr(VI), cyanide
Groundwater as a potential source of steam from sweat lodge use (excludes vaporized nonvolatiles)	--	--	--	--	3.3 × 10 ⁻⁵	Carbon tetrachloride, chloroform, tributyl phosphate, tritium	6.6	Cyanide

WMA C – Risk Assessment Summary



Exposure Area	Individual Groundwater Evaluation Results (Comparison to DWS)	Tap Water Scenario Primary Contributors to Cancer Risk and Noncancer Hazards	Cumulative Annual Dose (4 mrem/yr)
WMA C Tank Farm	Cyanide Iodine-129 Nitrate Technetium-99 Sulfate*	Technetium-99 Cyanide	Iodine-129 Technetium-99

Conclusions



- Groundwater measurements are evaluated for each well within the 200-BP-5 OU
 - COPCs were identified for each sub area
- Risks are characterized for sub areas and selected individual wells
- Results for WMA C show consistent conclusions for risk and hazard drivers and identified COPCs
- Remedial Investigation results provide a basis for the Feasibility Study
- Note: document is currently being reviewed by the Washington State Department of Ecology. Some conclusions might change after the comment review process.