To: John Jones and Stephanie Jennings, US Department of Energy (DOE)

From: David Collins, Mark Sherwin, Dixie Hambrick (MWH)

Cc: Dave Dassler (Boeing)

Date: September 29, 2014

Re: Rough Order of Magnitude Estimates for AOC Radiological Preliminary Remediation Volumes in Area IV and the Northern Buffer Zone, and Associated Truck Transport Estimates, based on DTSC Provisional Look-Up Table Values - DRAFT

I. Introduction

In October 2013, the United States Department of Energy (DOE) requested that MWH Americas, Inc. (MWH) use U.S. Environmental Protection Agency (EPA) radionuclide sampling data in Area IV and the Northern Buffer Zone and the Geographic Information System (GIS) to estimate rough-order-of-magnitude (ROM) soil remediation volumes based on Provisional Look-Up Table (LUT) values for radionuclides, and associated soil transport truckloads. This Technical Memorandum (TM) summarizes the evaluation process and presents the ROM radionuclide soil volume estimates and associated truckload results.

II. Radiological Remediation Volume Estimates

In January 2013, DTSC published Provisional LUT values for radionuclides for DOE's Agreement on Consent (AOC) soil remediation planning. The Provisional LUT values are based on EPA's radiological background threshold value (BTV) and method detection concentrations (MDCs) achieved by the two laboratories used during the EPA characterization program. Although DTSC provided two values for each radionuclide in the Provisional LUT table ('EPA Lab A' and 'EPA Lab B'), DTSC indicated that they would apply 'EPA Lab B' as the Provisional LUT value. The EPA Lab B values were the lower of the two published by DTSC in the Provisional LUT, and used in this evaluation to identify potential AOC radionuclide remediation volumes for DOE.

The EPA Lab B Provisional LUT values were compared to radionuclide data for display in GIS. Each individual radionuclide result was compared to its Provisional LUT value, and the ratio used to indicate the magnitude of the exceedance if the ratio was above 1. Sampling results were also screened to display the maximum ratio of all LUT comparisons for a location. The individual radionuclides listed in the DTSC Provisional LUT and evaluated for this TM are: Americium-241, Cobalt-60, Cesium-137, Europium-152, Europium-154, Europium-155, Nickel-59, Plutonium-238, Plutonium-239/240, Strontium-90, Thorium-228, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, and Uranium-238.

Soil volumes were estimated using the comparison of radionuclide data and Provisional LUT values according to the following criteria:

1. Radiological Preliminary Remediation Area (PRA) footprints were drawn using the DOE GIS to include all locations where radionuclide results exceeded the Provisional LUT values described above. Lateral extent was estimated based on exceedances and data below

screening criteria, as well as bedrock, site operational area extent, known release mechanisms and topography (as described further in items 4 and 5 below).

2. GIS data and analytical datasets were used to assess results at depth for each location. These data were used to estimate the average maximum depth of exceedance for each footprint area. Average depths were multiplied by respective footprint areas to calculate *in situ* (in place) volumes. A minimum depth of 2 feet was assumed.
3. *In situ* soil volumes were converted to *ex situ* soil volumes using a 30% swell factor to account for soil volume expansion following excavation. *Ex situ* soil volumes are presented in the summaries below.
4. In some cases features such as surface water drainage pathways or channels, ponds, fill soil or bedrock extent were used to estimate lateral and vertical extent of soil exceedances.
    a. Drainages and channels with multiple exceedances generally were considered as a single footprint rather than segregating short segments with single exceedances, assuming sediment transport within the drainage.
    b. Channel morphology (topography), bedrock outcrop or lateral bank data were used to define channel footprint width.
    c. Rock outcrop and refusal depth data (depth to bedrock) were used to define lateral and vertical extent of preliminary remediation soil volumes.
5. Historical site operations were also considered in defining lateral extent of exceedances. Where site operations included storage, intensive chemical use, known releases or where the preponderance of data indicates pervasive exceedances (e.g., SRE, RMHF, ESADA), larger areas were drawn between more widely spaced, interspersed exceedances.

The radiological LUT evaluation resulted in 215 individual radiological exceedance areas comprising approximately 20 acres, and approximately 120,000 cubic yards of soil requiring remediation (ROM volume range of 80,000 to 180,000 cubic yards). Details regarding these areas are presented in Table 1 and shown on Figure 1.

III. Truckload and Transport Estimates

For truckload transport planning, an average volume of 16 cubic yards per truckload has been assumed based on previous soil removal actions at SSFL. This basis is consistent with Boeing remediation estimates since some waste will be hauled off in 10- to 15-cubic yard capacity roll-off bins, and some will be hauled off in 16- to 18-cubic yard end-dump trucks. Also it is worth noting for this evaluation that a 'truckload' is defined as a one-way transport estimate. The estimated duration needed for transport of these soil volumes has also been evaluated, assuming 35 truckloads per day and 5 days per week.

Based on these assumptions and a ROM estimate of 120,000 cubic yards of soil to be disposed of offsite, approximately 7,500 truckloads will be required with a hauling duration of 43 weeks. As noted above, the preliminary remediation volume for radiological exceedances is a ROM estimate, and as such, these truckload estimates may also vary accordingly.

IV. Additional Notes / Assumptions

1. The estimated soil volumes presented in this TM represent ROM engineering estimates within a tolerance factor of +50/-30%. These estimates should only be used for project planning purposes.
2. The evaluation and soil volume estimate were limited to locations within Area IV and the NBZ; locations outside of these areas (including Silvernale Pond and associated drainages) were not included in this evaluation. Also, the radiological data included in this evaluation was limited to EPA sampling results for the radionuclides listed in the DTSC Provisional LUT.
3. The swell factor is a function of various soil properties and can vary considerably depending on soil type. Many sources report swell factors for common materials, including state transportation agencies (Caltrans, Washington DOT, etc.), the Federal Highway Administration (FHWA) Geotechnical Technical Guidance Manual, and the Caterpillar Performance Handbook. According to the FHWA manual, dry earth has a swell factor of 50%, and dry sand 11% (with a 33% uncertainty). Based on silty sands, which are the most common soil type onsite, a range of 20% to 30% is appropriate for SSFL. The upper end of this range was used in this evaluation to be conservative.
4. Consideration of exclusion criteria as allowed by the AOC for federally protected species or cultural resources, or a 5% exclusion factor for yet-to-be-determined reasons, have not been applied to reduce the soil volume estimates presented in this TM.
5. The potential of naturally occurring radioactive material (NORM) exceedances was not evaluated for the information presented in this TM. Thus, NORM exceedances consistent with background may be included in the ROM soil volumes presented herein.

Table 1
Summary of Area IV Radiological
Preliminary Remediation Area Soil Volumes - Draft
Santa Susana Field Laboratory
Date Prepared - September 23, 2014

Radiological PRA ID[1]	Subarea	Area[2] (ft^2)	Area[2] (acres)	Average Depth[3] (ft)	In Situ Volume[4] (cy)	Ex Situ Volume[4] (cy)	Radionuclide Exceedance[5]														
							Am-241	Co-60	Cs-137	Cm-243/ 244	Eu-152	Eu-155	Ni-59	Pu-238	Pu-239/ 240	Sr-90	Th-228	Th-230	Th-232	U-233/ 234	U-235/ 236	U-238
3	3-2	1006	0.02	5.0	186	242										X						
3	3-1	537	0.01	2.0	40	52									X							
5A-1	5A	746	0.02	2.0	55	72					X											
5A-2	5A	1222	0.03	2.0	91	118							X									
5A-3	5A	568	0.01	3.0	63	82										X						
5A-4	5A	1079	0.02	2.0	80	104										X						
5A-5	5A	612	0.01	5.0	113	147										X						
5A-6	5A	438	0.01	10.0	162	211	X															
5A-7	5A	940	0.02	2.0	70	91										X						
5A-8	5A	1030	0.02	2.0	76	99										X						
5A-9	5A	419	0.01	2.0	31	40										X						
5A-10	5A	1754	0.04	2.0	130	169										X						
5A-11	5A	825	0.02	2.0	61	79			X													
5A-12	5A	1271	0.03	5.0	235	306										X						
5A-13	5A	1271	0.03	2.0	94	122										X						
5B-1	5B	313	0.01	3.0	35	45										X						
5B-2	5B	192	0.00	2.0	14	18			X													
5B-3	5B	665	0.02	3.0	74	96										X						
5B-4	5B	20220	0.46	2.0	1498	1947			X													
5C-1	5C	1873	0.04	2.0	139	180			X						X							
5C-2	5C	526	0.01	40.0	779	1013										X						
5C-3	5C	274	0.01	2.0	20	26									X							
5DN-1	5DN	1004	0.02	2.0	74	97										X						
5DN-2	5DN	778	0.02	5.0	144	187										X						
5DN-3	5DN	9687	0.22	3.0	1076	1399										X						
5DN-4	5DN	3153	0.07	5.0	584	759										X						
5DN-5	5DN	7421	0.17	5.0	1374	1787										X						
5DN-6	5DN	232	0.01	2.0	17	22			X						X	X						
5DN-7	5DN	1451	0.03	5.0	269	349										X						
5DN-8	5DN	1763	0.04	5.0	326	424										X						
5DN-9	5DN	18883	0.43	4.0	2797	3637										X					X	
5DN-10	5DN	11098	0.25	3.0	1233	1603										X						
5DN-11	5DN	1806	0.04	2.0	134	174										X						
5DN-12	5DN	6867	0.16	2.0	509	661									X	X						
5DN-13	5DN	25842	0.59	5.0	4786	6221										X						
5DN-14	5DN	1708	0.04	5.0	316	411										X						
5DN-15	5DN	30799	0.71	3.0	3422	4449									X	X						
5DN-16	5DN	691	0.02	5.0	128	166										X						
5DN-17	5DN	927	0.02	5.0	172	223										X						
5DN-18	5DN	10878	0.25	5.0	2014	2619										X						
5DN-19	5DN	661	0.02	5.0	122	159								X		X						
5DN-20	5DN	178	0.00	5.0	33	43										X						
5DN-21	5DN	6417	0.15	5.0	1188	1545										X						
5DN-22	5DN	776	0.02	2.0	57	75										X						
5DN-23	5DN	358	0.01	5.0	66	86										X						
5DN-24	5DN	1755	0.04	2.0	130	169										X						
5DN-25	5DN	791	0.02	2.0	59	76										X						
5DN-26	5DN	14358	0.33	2.0	1064	1383										X						

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							Am-241	Co-60	Cs-137	Cm-243/ 244	Eu-152	Eu-155	Ni-59	Pu-238	Pu-239/ 240	Sr-90	Th-228	Th-230	Th-232	U-233/ 234	U-235/ 236	U-238
5DN-27	5DN	235	0.01	2.0	17	23									X							
5DN-28	5DN	14932	0.34	2.0	1106	1438										X						
5DN-29	5DN	502	0.01	2.0	37	48										X						
5DN-30	5DN	4604	0.11	3.0	512	665										X						
5DN-31	5DN	9419	0.22	2.0	698	907										X						
5DN-32	5DN	1926	0.04	2.0	143	185										X						
5DN-33	5DN	1892	0.04	5.0	350	455										X						
5DN-34	5DN	1854	0.04	5.0	343	446										X						
5DN-35	5DN	1950	0.04	2.0	144	188										X						
5DN-36	5DN	177	0.00	2.0	13	17										X						
5DN-37	5DN	188	0.00	5.0	35	45	X									X						
5DS-1	5DS	1925	0.04	4.0	285	371										X						
5DS-2	5DS	1925	0.04	5.0	356	463										X						
5DS-3	5DS	5227	0.12	2.0	387	503										X						
5DS-4	5DS	1968	0.05	3.0	219	284										X						
5DS-5	5DS	1924	0.04	2.0	143	185					X					X						
5DS-6	5DS	564	0.01	1.0	21	27			X													
5DS-7	5DS	5876	0.13	2.0	435	566										X						X
5DS-8	5DS	269	0.01	2.0	20	26									X							
5DS-9	5DS	673	0.02	3.0	75	97																X
5DS-10	5DS	575	0.01	3.0	64	83																X
5DS-11	5DS	9704	0.22	2.0	719	934										X						
6-1	6	5524	0.13	2.0	409	532			X							X						
6-2	6	829	0.02	5.0	154	200							X									
6-3	6	18839	0.43	2.0	1395	1814		X	X				X		X	X					X	
6-4	6	1872	0.04	5.0	347	451										X					X	
6-5	6	1573	0.04	25.0	1456	1893										X						
6-6	6	3475	0.08	3.0	386	502										X						
6-7	6	1275	0.03	2.0	94	123			X							X						
6-8	6	4966	0.11	3.0	552	717										X						
6-9	6	1907	0.04	2.0	141	184			X							X						
6-10	6	8868	0.20	5.0	1642	2135			X				X		X	X				X		X
6-12	6	900	0.02	2.0	67	87			X													
6-13	6	3698	0.08	3.0	411	534									X	X						
6-14	6	3672	0.08	1.0	136	177			X						X	X						
6-15	6	312	0.01	5.0	58	75										X						
6-16	6	613	0.01	2.0	45	59			X													
6-17	6	2460	0.06	2.0	182	237										X						
6-18	6	1049	0.02	1.0	39	51																
6-19	6	1935	0.04	3.0	215	280										X						
6-20	6	1440	0.03	5.0	267	347										X						
6-21	6	2407	0.06	5.0	446	579										X						
6-22	6	1358	0.03	2.0	101	131			X													
6-23	6	1577	0.04	5.0	292	380										X						
6-24	6	1738	0.04	2.0	129	167										X						
6-25	6	2702	0.06	2.0	200	260			X													
6-26	6	644	0.01	2.0	48	62									X							
6-27	6	852	0.02	2.0	63	82			X													
6-28	6	1815	0.04	2.0	134	175			X							X						

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							Am-241	Co-60	Cs-137	Cm-243/ 244	Eu-152	Eu-155	Ni-59	Pu-238	Pu-239/ 240	Sr-90	Th-228	Th-230	Th-232	U-233/ 234	U-235/ 236	U-238
6-29	6	2040	0.05	2.0	151	196			X							X						
6-30	6	1605	0.04	2.0	119	155			X							X						
6-32	6	474	0.01	2.0	35	46										X						
6-33	6	1364	0.03	2.0	101	131										X						
6-35	6	32069	0.74	2.0	2375	3088			X						X	X						
6-36	6	1028	0.02	2.0	76	99										X						
6-37	6	728	0.02	5.0	135	175										X						
6-38	6	616	0.01	2.0	46	59										X						
6-39	6	1725	0.04	2.0	128	166									X							
6-40	6	288	0.01	2.0	21	28			X													
7-1	7	10647	0.24	3.0	1183	1538										X						
7-2	7	206	0.00	2.5	19	25										X						
7-3	7	206	0.00	2.0	15	20										X						
7-4	7	603	0.01	4.0	89	116										X						
7-5	7	147	0.00	2.0	11	14			X		X											
7-6	7	179047	4.11	2.0	13263	17242			X					X	X	X				X	X	X
7-7	7	306	0.01	25.0	283	368									X	X				X	X	X
7-8	7	673	0.02	5.0	125	162										X						
7-9	7	205	0.00	2.0	15	20			X													
7-10	7	12314	0.28	2.0	912	1186			X							X				X	X	
7-11	7	4249	0.10	5.0	787	1023			X							X						
7-12	7	2080	0.05	3.0	231	300										X						
7-13	7	1739	0.04	3.0	193	251			X							X				X	X	X
7-14	7	8387	0.19	2.0	621	808			X					X	X	X						
7-15	7	653	0.01	5.0	121	157										X						
7-16	7	3488	0.08	2.0	258	336			X							X						
7-17	7	14088	0.32	2.0	1044	1357			X						X	X						
7-18	7	925	0.02	2.0	69	89														X		
7-19	7	909	0.02	2.0	67	88										X						
8N-1	8N	89	0.00	3.0	10	13	X						X									
8N-2	8N	1596	0.04	2.0	118	154							X			X						
8N-3	8N	966	0.02	2.0	72	93										X						
8N-4	8N	1332	0.03	5.0	247	321	X								X	X						
8N-5	8N	10883	0.25	5.0	2015	2620										X						
8N-6	8N	173	0.00	5.0	32	42										X						
8N-7	8N	2053	0.05	5.0	380	494									X	X						
8N-8	8N	199	0.00	5.0	37	48										X						
8N-9	8N	30386	0.70	5.0	5627	7315										X						
8N-10	8N	5729	0.13	3.0	637	828										X						
8N-11	8N	6364	0.15	3.0	707	919										X						
8N-12	8N	1921	0.04	5.0	356	462										X						
8N-13	8N	176	0.00	2.0	13	17										X						
8N-14	8N	183	0.00	5.0	34	44										X						
8N-15	8N	181	0.00	5.0	34	44										X						
8N-16	8N	180	0.00	2.0	13	17										X						
8N-17	8N	300	0.01	5.0	56	72										X						
8N-18	8N	515	0.01	5.0	95	124										X						
8N-19	8N	195	0.00	5.0	36	47										X						
8N-20	8N	175	0.00	2.0	13	17										X						

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							Am-241	Co-60	Cs-137	Cm-243/ 244	Eu-152	Eu-155	Ni-59	Pu-238	Pu-239/ 240	Sr-90	Th-228	Th-230	Th-232	U-233/ 234	U-235/ 236	U-238
8N-21	8N	4725	0.11	5.0	875	1138										X						
8N-22	8N	1077	0.02	2.0	80	104										X						
8N-23	8N	5172	0.12	2.0	383	498										X						
8N-24	8N	4195	0.10	2.0	311	404										X						
8N-25	8N	3218	0.07	0.0	0	0																
8N-26	8N	5821	0.13	2.0	431	561										X						
8N-27	8N	141	0.00	3.0	16	20										X						
8N-28	8N	1269	0.03	2.0	94	122										X						
8N-29	8N	765	0.02	4.0	113	147										X						
8N-30	8N	1807	0.04	5.0	335	435							X									
8N-31	8N	172	0.00	5.0	32	41										X						
8N-32	8N	173	0.00	5.0	32	42										X						
8N-33	8N	577	0.01	5.0	107	139										X						
8N-34	8N	3203	0.07	2.0	237	308										X						
8N-35	8N	5120	0.12	3.0	569	740										X						
8N-36	8N	1939	0.04	5.0	359	467			X							X						
8N-37	8N	197	0.00	5.0	36	47									X							
8N-38	8N	11843	0.27	2.0	877	1140										X						
8N-39	8N	6466	0.15	2.0	479	623														X		
8N-40	8N	1246	0.03	4.0	185	240										X						
8N-41	8N	4222	0.10	2.0	313	407										X						
8N-42	8N	2691	0.06	5.0	498	648								X		X						
8S-1	8S	1906	0.04	5.0	353	459										X						
8S-2	8S	3327	0.08	2.0	246	320									X	X						
8S-3	8S	686	0.02	5.0	127	165										X						
8S-4	8S	529	0.01	5.0	98	127			X													
8S-5	8S	1950	0.04	5.0	361	469										X						
8S-6	8S	643	0.01	3.0	71	93									X							
8S-7	8S	892	0.02	3.0	99	129			X							X						
8S-8	8S	2981	0.07	5.0	552	718										X						
8S-9	8S	538	0.01	5.0	100	130										X						
NBZ-1	NBZ	1874	0.04	2.0	139	180										X						
NBZ-2	NBZ	703	0.02	2.0	52	68										X						
NBZ-3	NBZ	706	0.02	2.0	52	68										X						
NBZ-4	NBZ	1880	0.04	2.0	139	181										X						
NBZ-5	NBZ	721	0.02	2.0	53	69										X						
NBZ-6	NBZ	1883	0.04	2.0	139	181										X						
NBZ-7	NBZ	1929	0.04	2.0	143	186										X						
NBZ-8	NBZ	683	0.02	2.0	51	66										X						
NBZ-9	NBZ	1925	0.04	2.0	143	185										X						
NBZ-10	NBZ	670	0.02	2.0	50	65										X						
NBZ-11	NBZ	2059	0.05	2.0	153	198										X						
NBZ-12	NBZ	628	0.01	2.0	47	60										X						
NBZ-13	NBZ	682	0.02	2.0	51	66										X						
NBZ-14	NBZ	1833	0.04	2.0	136	177									X							
NBZ-15	NBZ	14673	0.34	2.0	1087	1413										X						
NBZ-16	NBZ	450	0.01	2.0	33	43										X						
NBZ-17	NBZ	4942	0.11	3.0	549	714										X		X				
NBZ-18	NBZ	2814	0.06	4.0	417	542									X	X						

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Preliminary Remediation Area Soil Volumes - Draft
Santa Susana Field Laboratory
Date Prepared - September 23, 2014

Radiological PRA ID[1]	Subarea	Area[2] (ft^2)	Area[2] (acres)	Average Depth[3] (ft)	In Situ Volume[4] (cy)	Ex Situ Volume[4] (cy)	Radionuclide Exceedance[5]														
							Am-241	Co-60	Cs-137	Cm-243/ 244	Eu-152	Eu-155	Ni-59	Pu-238	Pu-239/ 240	Sr-90	Th-228	Th-230	Th-232	U-233/ 234	U-235/ 236	U-238
NBZ-19	NBZ	1059	0.02	5.0	196	255										X						
NBZ-20	NBZ	1427	0.03	2.0	106	137										X						
NBZ-21	NBZ	1030	0.02	2.0	76	99										X						
NBZ-22	NBZ	1954	0.04	2.0	145	188										X						
NBZ-23	NBZ	754	0.02	2.0	56	73										X						
NBZ-24	NBZ	2211	0.05	2.0	164	213												X				
NBZ-25	NBZ	1951	0.04	2.0	145	188										X						
NBZ-26	NBZ	634	0.01	2.0	47	61			X													
NBZ-27	NBZ	1871	0.04	2.0	139	180										X						
NBZ-28	NBZ	2822	0.06	2.0	209	272										X						
NBZ-29	NBZ	2375	0.05	2.0	176	229										X						
NBZ-30	NBZ	3686	0.08	2.0	273	355										X						
NBZ-31	NBZ	608	0.01	2.0	45	59										X						
NBZ-32	NBZ	4973	0.11	2.0	368	479										X						
NBZ-33	NBZ	1890	0.04	2.0	140	182														X		
NBZ-34	NBZ	511	0.01	2.0	38	49										X						
NBZ-35	NBZ	222	0.01	2.0	16	21										X						
NBZ-36	NBZ	6359	0.15	2.0	471	612										X				X	X	X
NBZ-37	NBZ	2159	0.05	2.0	160	208										X						
NBZ-38	NBZ	528	0.01	2.0	39	51								X								
Totals			**20**		**90,000**	**120,000**																

Notes

1. The lowest of the Provisional LUT values published by DTSC were compared to radionuclide data collected by EPA in Area IV and the NBZ since DTSC indicated they would apply the lowest value. Data were reviewed both as a composite of all radionuclide data and as individual isotopes.

2. An evaluation of potential NORM exceedances was not included in this analysis, and thus Provisional LUT exceedances consistent with background may be included in the exceedance extents and ROM soil volumes presented in this TM.

3. The estimated soil volumes presented in this TM represent ROM engineering estimates within a tolerance factor of +50/-30% and are based on the information available to MWH in May 2014. The total volumes have been rounded due to uncertainty. These estimates should only be used for project planning purposes.

3. The minimum remediation depth was assumed to be 2 feet.

4. *In situ* soil volumes were converted to *ex situ* soil volumes using a 30% swell factor to account for soil volume expansion following excavation.

5. Radionuclides indicated were exceeded in at least one sample collected within the identified preliminary remediation footprint boundary.

Area IV AOC Radiological Preliminary Remediation Areas

Base Map Legend

- Administrative Area Boundary
- Area IV Subareas
- Existing or Removed Structure
- Rock Outcrop
- Drainage
- Paved Road

Figure Legend

- Radiological Preliminary Remediation Areas for AOC Cleanup based on Provisional Look-Up Table Values

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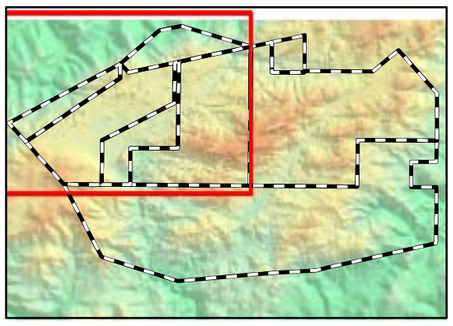
Date: September 17, 2014

0 250 500 1,000 Feet



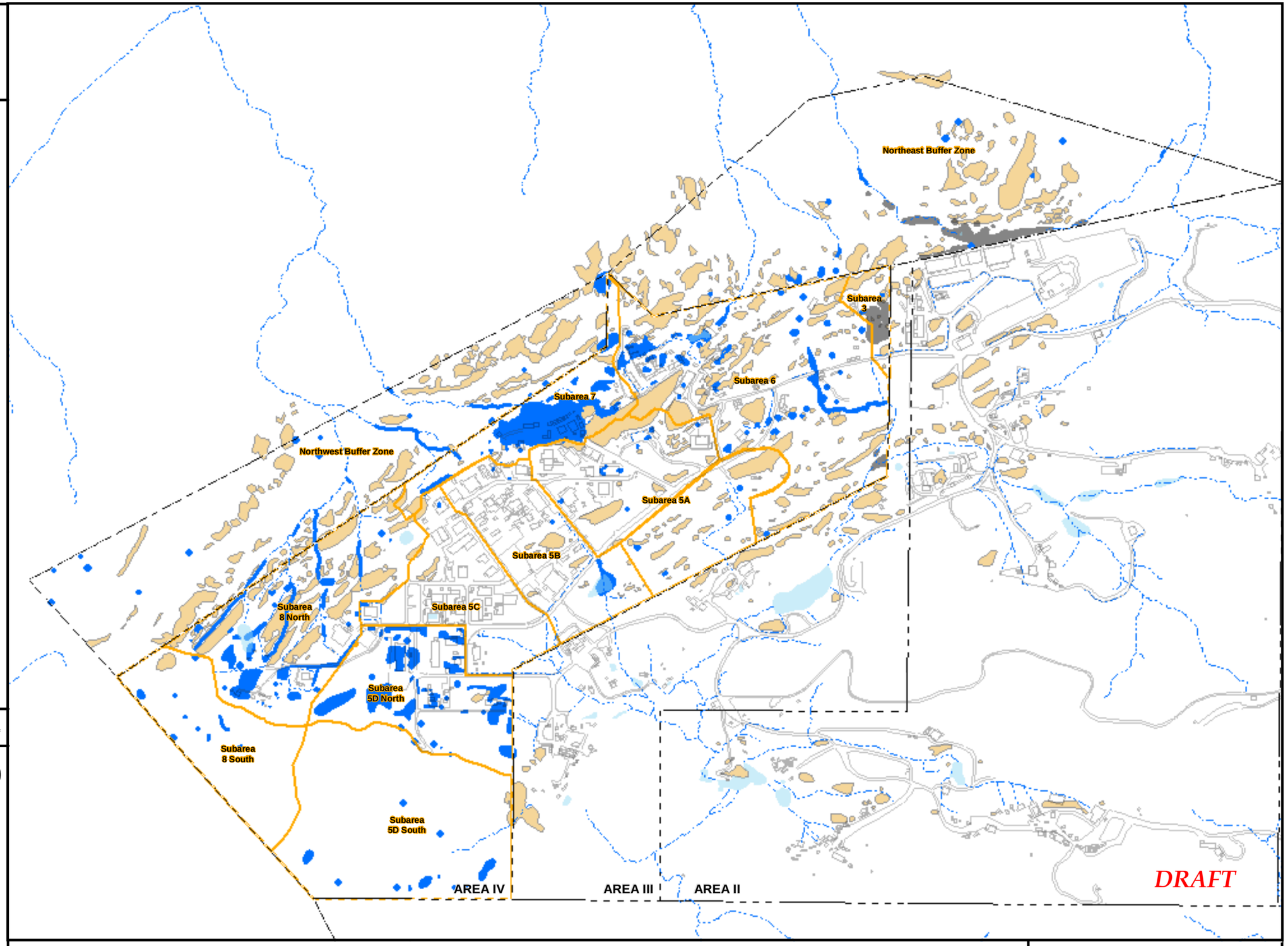


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FIGURE 1