8.0 GROUNDWATER EVALUATIONS

8.1 East Industrial Area Plume Investigation

The major groundwater evaluation that was conducted in 1999 was an investigation of the eastern edge of the Industrial Area VOC groundwater plume. The known extent of the plume, based on the existing wells in the area, appeared to coincide with a major north-south utility corridor that occurs to the east of Eighth Street in the Industrial Area (RMRS, 1999c). The utility corridor extends along most of the width of the IA in this area and is composed of numerous power and water lines. Because well coverage in this part of the IA is sparse, a project was designed to evaluate whether contaminated groundwater makes it past this corridor. Figure 8-1 presents the site area and existing monitoring wells. Figure 8-2 shows the potentiometric surface in this area.

The general approach for the groundwater investigation was to complete a line of wells in the UHSU along the utility corridor. The line extends from the northwest corner of Building 776 in the north to the northwest corner of Building 881 in the south. Wells 60099 through 61499 were installed except for well 60999 which could not be installed because of the density of utilities at the corner of Eighth and Central Avenues. Existing well 6186 was substituted for this well and is not far from the proposed location of 60999. Wells 60799 and 61399 were installed to investigate a known bedrock scour that occurs in a northeast direction and was thought to direct groundwater preferentially in this area. Existing well 37791 was also utilized for the southernmost well in the line near Building 881.

The wells were installed in September and October of 1999 and sampling was conducted in October and November. Wells were installed with a Geoprobe and were one inch in diameter. In many cases the alluvium was very thin but averaged eight to nine feet thick in most places. The bedrock was not extensively weathered in many of the boreholes. Table 8-1 shows the depth to bedrock and the saturated thickness of the alluvium, unless the water table elevation is below the level of the bedrock. Well development and sampling was difficult because of the limited saturated thickness that occurred in the alluvial materials and recharge from the bedrock materials was limited due to the lack of weathering. The lack of groundwater recharge due to both the nature of the lithology and the time of year, was responsible for the difference in sample collection dates in Table 8-1.

Table 8-1 Water Levels and Saturated Thickness for EIAP Line

Well	Date	Depth To Water	Units	Top of Casing Elevation	Water Table Elevation	Surface Elevation	Depth of Bedrock	Bedrock Elevation	Alluvial Saturated Thickness
Fourth Quarter 1999									
60099	11/5/99	9.18	ft	5982.75	5973.57	5983.30	9.00	5974.30	NA
60199	11/4/99	5.39	ft	5986.68	5981.29	5987.18	7.70	5979.48	1.81
60299	11/4/99	7.95	ft	5986.88	5978.93	5987.38	7.70	5979.68	NA
60399	11/4/99	9.20	ft	5986.23	5977.03	5986.70	6.70	5980.00	NA
60499	11/4/99	8.71	ft	5991.02	5982.31	5991.76	10.70	5981.06	1.25
60599	11/4/99	7.41	ft	5987.91	5980.50	5988.51	5.40	5983.11	NA
60699	11/4/99	Dry	ft	5986.92	NA	5987.42	2.30	5985.12	NA
60799	11/4/99	Dry	ft	5993.14	NA	5993.75	5.30	5988.45	NA
60899	10/11/99	8.10	ft	5995.67	5987.57	5996.09	10.20	5985.89	1.68
61099	10/11/99	9.42	ft	6001.81	5992.39	6002.29	13.60	5988.69	3.70
61199	10/11/99	9.51	ft	6002.80	5993.29	6003.31	17.00	5986.31	6.98
61299	10/11/99	7.51	ft	6003.48	5995.97	6003.88	9.80	5994.08	1.89
61399	11/4/99	5.00	ft	5983.89	5978.89	5984.47	1.50	5982.97	NA
61499	11/4/99	9.31	ft	5986.33	5977.02	5986.87	7.60	5979.27	NA
6186	11/9/99	10.31	ft	6000.60	5990.29	5999.5	11.50	5987.97	2.32
P313589	11/3/99	8.86	ft	6010.11	6001.25	6008.5	11.00	5997.50	3.75
P213689	11/9/99	10.10	ft	5996.04	5985.94	5994.3	13.00	5981.30	4.64
P317989	11/9/99	7.33	ft	5992.84	5985.51	5990.9	6.40	5984.50	1.01
P320089	11/8/99	15.02	ft	6011.87	5996.85	6009.9	18.80	5991.10	5.75
First Quarter 00									
60099	1/6/00	Dry	ft	5982.75	NA	5983.30	9.00	5974.30	NA
60199	1/6/00	6.09	ft	5986.68	5980.59	5987.18	7.70	5979.48	1.11
60299	1/6/00	8.69	ft	5986.88	5978.19	5987.38	7.70	5979.68	NA
60399	1/10/00	6.18	ft	5986.23	5980.05	5986.70	6.70	5980.00	0.05
60499	1/10/00	8.89	ft	5991.02	5982.13	5991.76	10.70	5981.06	1.07
60599	1/10/00	4.50	ft	5987.91	5983.41	5988.51	5.40	5983.11	0.30
60699	1/10/00	7.12	ft	5986.92	5979.80	5987.42	2.30	5985.12	NA
60799	1/10/00	6.92	ft	5993.14	5986.22	5993.75	5.30	5988.45	NA
60899	1/4/00	8.48	ft	5995.67	5987.19	5996.09	10.20	5985.89	1.30
61099	1/4/00	9.92	ft	6001.81	5991.89	6002.29	13.60	5988.69	3.20
61199	1/4/00	9.95	ft	6002.80	5992.85	6003.31	17.00	5986.31	6.54
61299	1/4/00	7.61	ft	6003.48	5995.87	6003.88	9.80	5994.08	1.79
61399	1/10/00	3.99	ft	5983.89	5979.90	5984.47	1.50	5982.97	NA
61499	1/6/00	8.51	ft	5986.33	5977.82	5986.87	7.60	5979.27	NA
6186	1/3/00	10.45	ft	6000.60	5990.15	5999.5	11.50	5987.97	2.18
P313589	1/3/00	9.60	ft	6010.11	6000.51	6008.5	11.00	5997.50	3.01
P317989	1/4/00	9.70	ft	5992.84	5983.14	5990.9	6.40	5984.50	NA

The wells were sampled for volatile organic compounds using EPA method 524.2. Table 8-2 shows the sampling results for detected VOCs along the east industrial area plume (EIAP) line.

Tetrachloroethene (PCE) was the only organic compound detected above action levels except for wells 60599 and 61199, which also detected trichloroethene. Wells 61099 and 61199 showed detections of PCE at 27 and 200 ug/L respectively. Farther north, well 60599 contained concentrations of PCE at 100 ug/L. Well 61499 showed PCE at the action level of 5 ug/L and well 60199 showed PCE at a concentration of 36 ug/L. Wells located between these wells showed either no detections of VOCs or the well was dry. Table 8-2 also shows historical results from other wells in the area.

Table 8-2 VOC Detections in Groundwater for EIAP Line

Location	Sample Date	TETRACHLOROETHENE (ug/L)	Lab Qual	TRICHLOROETHENE (ug/L)	Lab Qual	Type	Detect Limit	Validation
37791	10/31/96	0.4	J	1	U	REAL	1	Y
60199	3/2/00	36		0.4	J	REAL	2	V
60299	3/23/00	0.3	J	1		REAL	1	V
60499	1/26/00	0.3	J	0.8		REAL	1	V1
60599	2/24/00	100		5	U	REAL	5	V1
60699	5/10/00	1	U	1	U	REAL	1	V1
60799	5/10/00	0.4	J	1	U	REAL	1	V1
60899	12/13/99	1		0.2	J	REAL	1	V1
61099	12/14/99	27		1	J	REAL	2	V1
61199	12/9/99	220		12	J	DUP	20	V1
61199	12/9/99	200		12	J	REAL	20	V1
61299	12/13/99	2		0.1	J	REAL	1	V1
61399	2/24/00	1	U	0.3	J	REAL	1	V1
61499	5/10/00	5		0.1	J	REAL	1	V1
6186	1/31/00	0.5	J	1	U	REAL	1	V1
39691	8/22/94	0.2	U	0.2	U	REAL	0.2	V
P213689	8/8/95	0.7	J	0.4	J	REAL	1	V
P314089	8/21/95	1	U	1	U	REAL	1	V

The results suggest that contamination is moving across the utility corridor in three areas as evidenced by the detections in wells listed above. Contaminant concentrations are all below the Tier I action level, which helps define the high concentration portion of the IA plume better than was known previously. It is possible that the concentrations of contaminants in well 61499 are an extension of those seen in well 60599; however this is not certain. The detection of PCE in the southern portion of the EIAP line is consistent with high PCE contamination near well P320089. However wells 22696 and P114689 show high TCE which is not well represented in the wells in the northern portion of the EIAP line.

Analysis of the saturated thickness was also done for wells in the area to ascertain whether a drastic change in saturated thickness or water level would occur across the utility corridor. Given that the EAIP wells were sampled in the fall, during the dry part of the year, it is possible that water levels are not necessarily representative of the typical water levels that would be found during other times of the year. In general, saturated thickness in alluvial materials for the EIAP line are small, especially in the northern half of the line where water levels are near the bedrock contact or below it. The largest saturated thickness seen in wells east of the line occurs in wells P213689, 61099, 61199. Coincidentally, the latter two wells have significant detections of PCE. Taken as a whole, the wells east of the utility corridor tend to have an alluvial saturated thickness of 1- 2 feet. Comparison of this saturated thickness with wells to the west of the utility corridor suggests that changes may be normal for the area. Wells P313589 and P215789 have had a historic saturated thickness averaging approximately 4 feet. Farther west, wells P114689, P115689, P313489 and P320089 tend to have saturated thicknesses of 10-12 feet. The change in saturated thickness between these two sets of wells takes place over a distance of approximately 750 feet in an east-west direction in the IA. Changes from the 4 foot saturated thickness to wells with 1-2 feet occur over a similar distance. Therefore, there appears to be a natural gradient for water levels in the central Industrial Area for which strong evidence is lacking of an abrupt change at the utility corridor. Figure 8-2 presents the potentiometric surface for the EIAP area. The map reflects abrupt changes only in the area near buildings 883 and 881. This may be because of the foundation drains in the buildings.

Recommendations for additional work would involve collecting water levels and VOC samples from these wells during the spring so as to get a better picture of the amount of contamination that is moving across the utility corridor. In addition, wells may need to be installed farther east of the EIAP line near wells 61099 and 61199 to establish the extent of the IA plume in this area.

8.2 Groundwater ICP/MS Sampling Project

The Uranium ICP/MS project is a joint venture between CDPHE and RFETS to accurately determine the concentration of uranium isotopic species for areas with relatively high uranium at the Site. The project is an outgrowth of a smaller investigation done as part of the Solar Ponds Plume investigation, which was completed in 1998 (RMRS, 1999f). The ICP/MS analysis is more accurate in determining uranium species than the standard alpha spectrometry analysis done at RFETS. ICP/MS calculates an isotopic mass as opposed to an activity, which is measured by alpha spectrometry, and is therefore less influenced by count time and masking effects. The goal of the ICP/MS sampling is to determine where anthropogenic uranium contamination is occurring at RFETS as opposed to natural uranium.

Uranium samples were collected from July 1999 through August 2000. Table 8.3 lists the wells that were sampled and the concentration of isotope species. Sample locations were chosen based on the known areas with high uranium concentrations as plotted on plume maps in the 1996 RFCA Annual Groundwater Report (RMRS, 1997e). In addition, the Boundary wells near Indiana Street were also sampled along with seven upgradient background wells which were chosen south, west and north of the Industrial Area. In most cases four ICP/MS samples were collected

from the well so as to have a statistically qualified population for each location. Therefore, mean concentrations are listed in the table. In addition, QC samples were also collected at a frequency of one in twenty samples. Table 8.3 also includes the sample data from the Solar Ponds Plume investigation. Some of these wells were only sampled once and are listed with a 'Single Value' designation in the table. All samples were analyzed at the Los Alamos National Laboratory Isotope Lab (New Mexico), which has equipment capable of detecting small amounts of isotopes such as U236 with the required accuracy. Isotopic concentrations were established for U234, U235, U236 and U238. At this writing, a small percentage of samples had not been analyzed because of the recent fire near the lab. The data tables will be updated when this data is available.

From the isotopic data uranium ratios were determined. These ratios can be used to determine which locations show effects other than would be typical of natural uranium in the environment.

The ratio for U235/U238 in nature is .0072. A ratio higher than this would suggest that enriched uranium (i.e., U235) had been introduced to the environment. A ratio that is smaller than this number would suggest that depleted uranium (i.e., U238) had been added to the environment.

In addition, any detectable ratio for U236/U238 would suggest the introduction of anthropogenic uranium because U236 is a fission product and not found in nature. Table 8-3 shows the mean uranium ratios for wells in addition to those that were only sampled once.

Figure 8-3 is a plot of U235/2U38 vs. U236/U238. A horizontal line denotes the .0072 ratio point for U235/U238. The vertical line denotes the zero point for U236/U238. As can be seen from the Figure, most wells plot near the .0072 point and suggest that natural uranium is represented in the majority of wells sampled. The ratios that occur to the right of the zero point for U236/U238 suggest that some U236 may occur in these wells. Those wells that occur in the northeast or southeast quadrants of the Figure also show the effects of either enriched or depleted uranium.

Figure 8-4 shows the locations of the wells sampled along with the U235/U238 ratios. Figure 8-5 shows the U236/U238 ratio plot.

Table 8-3 Summary ICP/MS Isotope Data

Data Type	Locations	U 234	U 235	U236	U 238	U ug/l	234/238	235/238	236/238
Mean	1586	0.004028	0.440778	0.000313	62.517733	62.96	0.000066	0.007122	0.000004
Mean	3586	0.000654	0.062299	-0.000009	8.866486	8.93	0.000075	0.007144	0.000000
Mean	4087	0.003579	0.360437	0.000037	51.292162	51.66	0.000071	0.007087	0.000001
Mean	5387	0.001336	0.140144	0.000023	18.556238	18.70	0.000074	0.007656	0.000001
Mean	10294	0.002769	0.306654	-0.000054	42.715535	43.03	0.000067	0.007313	0.000000
Mean	10394	0.000477	0.038961	-0.000013	6.028885	6.07	0.000065	0.006556	0.000000
Mean	10592	0.002394	0.216995	-0.000036	30.041391	30.26	0.000081	0.007327	-0.000001
Mean	10594	0.009746	0.916240	-0.000179	129.325339	130.25	0.000086	0.007176	-0.000002
Mean	10694	0.001779	0.170900	0.000031	24.929110	25.10	0.000073	0.006812	0.000001
Mean	11294	0.000067	0.006677	-0.000012	1.002538	1.01	0.000069	0.006752	-0.000005
Mean	22996	0.000725	0.051193	0.000002	7.047342	7.10	0.000071	0.007293	0.000003
Mean	23296	0.002067	0.196020	0.000145	26.300772	26.50	0.000080	0.007407	0.000006
Mean	36391	0.002284	0.211320	-0.000041	29.462032	29.68	0.000080	0.007252	-0.000001
Mean	37791	0.001780	0.199289	-0.000031	27.581279	27.78	0.000067	0.007319	0.000000
Mean	37991	0.004748	0.366326	-0.000059	50.678761	51.05	0.000097	0.007330	-0.000001
Mean	41591	0.001470	0.168101	-0.000018	23.201038	23.37	0.000064	0.007318	-0.000001
Mean	41691	0.000207	0.020464	0.000041	3.252841	3.28	0.000067	0.006408	0.000012
Single Value	42993	0.242410	26.983200	0.187029	2960.249000	2987.70	0.000083	0.009230	0.000064
Mean	43993	0.003742	0.396439	0.001945	60.078093	60.47	0.000066	0.006782	0.000033
Mean	52894	0.003294	0.327952	-0.000048	46.659800	46.99	0.000073	0.007151	-0.000001
Mean	53194	0.002393	0.215764	-0.000004	29.310511	29.53	0.000061	0.007458	0.000001
Mean	59393	0.000925	0.090107	-0.000006	12.567129	12.66	0.000070	0.007267	0.000001
Mean	59793	0.004795	0.498053	-0.000070	68.992038	69.49	0.001583	0.007316	0.000000
Mean	61093	0.007431	1.413728	0.941030	600.071765	601.52	0.000032	0.002427	0.000042
Mean	75292	0.002514	0.220842	0.000130	30.279488	30.51	0.000082	0.007388	0.000004
Mean	75992	0.001645	0.159891	0.000300	23.797704	23.96	0.000069	0.006800	0.000013
Mean	00193	0.006032	0.576933	-0.000089	81.152072	81.74	0.000077	0.007195	-0.000001
Mean	00491	0.000959	0.090523	-0.000010	12.400294	12.49	0.000080	0.007395	-0.000001
Mean	00997	0.001045	0.091820	-0.000006	13.506709	13.60	0.000081	0.006947	0.000000
Mean	0386	0.001679	0.166965	-0.000029	23.437865	23.61	0.000074	0.007214	-0.000001
Mean	03991	0.000280	0.023597	-0.000003	3.457899	3.48	0.000084	0.006911	0.000000
Mean	0487	0.002307	0.229160	0.000039	32.136804	32.37	0.000073	0.007228	0.000001
Mean	04991	0.000889	0.064038	-0.000015	9.141401	9.21	0.000101	0.007109	-0.000001
Mean	06291	0.002267	0.131077	-0.000025	18.812863	18.95	0.000124	0.007057	-0.000001
Mean	06491	0.004060	0.365647	-0.000037	49.889794	50.26	0.000083	0.007432	0.000000
Mean	07391	0.004666	0.791799	0.010068	286.355557	287.16	0.000017	0.002806	0.000035
Mean	07991	0.001841	0.157668	0.000708	25.292882	25.45	0.000076	0.006328	0.000028
Mean	308-P-2	0.004325	0.374310	0.000038	51.934531	52.32	0.000087	0.007333	0.000001
Single Value	B102289	0.000030	0.003200	-0.000005	0.445000	0.40	0.000078	0.007360	-0.000012
Single Value	B201589	0.000120	0.014900	0.000000	2.062000	2.10	0.000061	0.007330	0.000000
Single Value	B203189	0.000370	0.027600	-0.000006	3.888000	3.90	0.000096	0.007190	-0.000001
Mean	B205589	0.023926	2.088546	-0.000125	286.951277	289.07	0.000057	0.007372	0.000000
Mean	B208689	0.012263	1.036906	-0.000099	142.741327	143.78	0.000089	0.007361	0.000000
Mean	B210489	0.004071	0.416713	0.000469	56.925560	57.35	0.000074	0.007402	0.000008
Mean	B302089	0.003974	0.318883	0.000038	43.340371	43.66	0.000088	0.007460	0.000001
Single Value	B302789	0.000170	0.020700	-0.000008	2.839000	2.90	0.000062	0.007380	-0.000003
Single Value	B305389	0.000560	0.061800	0.000002	8.590000	8.70	0.000066	0.007290	0.000000
Single Value	B405489	0.000300	0.017100	-0.000002	2.420000	2.40	0.000128	0.007170	-0.000001
Mean	P114389	0.000624	0.055216	0.000004	7.836517	7.90	0.000080	0.007135	0.000001
Mean	P207689	0.002197	0.221469	0.000032	30.780470	31.00	0.000075	0.007288	0.000001
Mean	P209189	0.000343	0.043935	0.000236	8.061863	8.11	0.000043	0.005478	0.000028
Mean	P209489	0.002230	0.248488	0.002235	38.496034	38.76	0.000062	0.006437	0.000059
Mean	P209589	0.035912	3.735736	0.018045	379.244690	383.04	0.000097	0.009934	0.000046
Mean	P209889	0.007202	0.674696	0.000106	94.217603	94.90	0.000079	0.007250	0.000001
					Mean		0.000103	0.007053	0.000007
Instument Detection Limits					Std Dev		0.000206	0.001060	0.000016
U234: 0.000015-0.000033				Mean Plus one Std Dev			0.000309	0.008114	0.000023
U235: 0.000030-0.000031				Mean Minus one Std Dev			-0.000103	0.005993	-0.000009
U236: 0.0000035-0.0000071				Mean Plus .5 Std Dev			0.000206	0.007584	0.000015
U238: 0.00095-0.00135				Mean Minus .5 Std Dev			0.000000	0.006523	-0.000001

Interpretation of these ICP/MS values is complicated by the fact that groundwater is the medium being investigated. Groundwater can encounter both natural uranium as well as anthropogenic uranium as it migrates through the subsurface. This potential mixing of sources complicates the determination of anthropogenic influence based strictly on the ratios observed. In addition, historic processes at RFETS involved both depleted and enriched uranium, which may hamper ratio determination if these wastes accumulated in the same area (e.g. Solar Ponds). As a first approach to data analysis the U235/U238 data was screened using the mean plus one standard deviation to identify those values that clearly fall outside the 70% area of the distribution (assuming normal distribution). To identify those wells where mixing of natural and anthropogenic sources may have occurred the mean plus 1/2 Standard Deviation was used. These estimations are coupled with known information on radionuclide spills at RFETS to evaluate the results of the ICP/MS sampling.

Wells 61093, 07391 and P209189 show values less than the mean - 1Standard deviation point, which suggests the presence of a depleted uranium source. These three wells also show values for U236/U238 that are higher than the mean + 1 Standard deviation, which also suggests an anthropogenic uranium source. Well 61093 is located in the old landfill, which sits on the north bank of Woman Creek. Given that some radionuclide wastes are known to have been buried in this landfill, it seems realistic to conclude that there is a depleted uranium source influencing groundwater in this well. Wells, 59393 and 59793 which occur upgradient and downgradient of, well 61093, but not in the landfill, show normal values for U235/U236 and U236/U238. Well 07391 is used as a performance monitoring well for the Ryan's Pit source. The U235/U238 ratio is below the mean -1 Standard deviation point and the U236/U238 ratio is above the mean + 1 Standard Deviation point, suggesting that Ryan's Pit contained some depleted uranium waste. Ryan's Pit was excavated in 1996 and contaminated soil was removed. However, post remediation groundwater data show an increase of uranium and VOCs in this well. Well P209189 is located at the southwest corner of the westernmost Solar Pond (207C). The Solar Ponds were built to collect and consolidate radionuclide process wastes. The U235/U238 ratio is below the mean -1 Standard deviation point and the U236/U238 ratio is above the mean + 1Standard Deviation point, suggesting that depleted uranium waste was contained in this pond at some time. Well P209489 is located downgradient of well P209189 and downgradient of the Solar Ponds in general. This well shows a U235/U238 ratio that is below the mean -.5 Standard deviation point, which could suggest a mixed influence from a depleted uranium source.

The only other wells that suggest evidence of influence from a depleted uranium source are wells 41691, 07991, and P209489. Those wells show U235/U238 ratios that are below the mean -.5 Standard deviation point, which could suggest a mixed influence from a depleted uranium source. Wells 07991 and P209489 show U236/U238 ratios that suggest the presence of U236. Well 41691 is a boundary well located on the Woman Creek drainage at the eastern boundary of the Site. Historic data for this well has shown detections for plutonium and americium above action levels, but data from the last five years has shown no detections for these analytes. It is probable that any radionuclide contamination detected in this well is related to sediments in the Walnut Creek drainage, as this well is located very near the stream. Well 07991 is located in the former OU2 in the area of the East Trenches IHSSs. Well P209489 is located in the northwest corner of the Solar Ponds (207A).

Wells P209589 and 42993 are located near the Solar Ponds. Both wells show values greater than the mean + 1Standard deviation point, which suggests the presence of a enriched uranium source. These two wells also show values for U236/U238 that are higher than the mean + 1 Standard. Deviation, which also suggests an anthropogenic uranium source. Well P209589 is located downgradient of the northeasternmost Solar Pond, while well 42993 is located adjacent to the westernmost Solar Ponds. The Solar Ponds were created to consolidate radionuclide waste streams primarily from the uranium production buildings, so it seems plausible that water that leaked from these ponds would contribute to groundwater locally.

The only other well that suggests evidence of influence from an enriched uranium source is well 5387. Well 5387 shows a U235/U238 ratio that is above the mean +.5 Standard deviation point, which could suggest a mixed influence from an enriched uranium source. This well does not show a U236/U238 ratio that would suggest the presence of U236. Well 5387 is located on the 881 hillside due south of Building 881. This building historically processed enriched uranium in the 1950s. Wells 10592, 36391, 37991 and 0487 were also sampled from the 881 hillside and show ratios similar to that of natural uranium.

The ICP/MS data not only showed areas that may have depleted or enriched uranium affinities, but also qualified certain wells with historic high uranium values as having natural uranium affinities. Two of these wells are B205589 and 10294. Well B205589 is located in the northernmost part of the Site near a seep complex. This well has historically high uranium values relative to nearby wells. Well 10294 is a Boundary well located in the southeasternmost corner of the Buffer zone. It is a replacement well for B303089, which had high historic U238 values. Both of these wells have ratios in the natural range and suggest that the anomalous concentrations for uranium are also natural.

As a result of the ICP/MS project, recommendations can be made about monitoring uranium in the groundwater at RFETS. Currently uranium samples are analyzed for U233/234, U235 and U238 by alpha spectrometry. In light of the data received from the ICP/MS project, it seems prudent to discontinue monitoring for uranium species because it is unlikely that the ratios would change over time. It is therefore recommended that, in the future, groundwater be monitored for total uranium by alpha spectrometry only. Should total uranium values increase in some location with time, an ICP/MS sample would be collected to verify that the uranium seen is naturally occurring. This change would result in less costly sample analysis by eliminating uranium isotope data that is insufficient for isotopic ratio determinations. In addition, the ICP/MS data can be used to limit the need for radiologic screens in groundwater for most of the Site because the uranium found is natural except in a few small areas. This information may reduce remediation concerns related to the presence of uranium at levels exceeding current RFCA action levels.

8.3 Site Wide Water Balance

Closure activities and post closure conditions have the potential to alter groundwater and surface water flow at the RFETS. Because many Site closure decisions cannot be made without first considering quantified predictions of closure effects on groundwater and surface water flow, a Site water balance is necessary to assess current conditions

as well as various closure scenarios. The site wide water balance will address the problem of determining to what degree Site closure affects surface water and groundwater flow in the Woman Creek and Walnut Creek drainages. This information will be utilized to assess a number of Site closure issues including, but not limited to, compliance with surface water action levels, impacts to biological resources, and post closure land configuration design.

The site wide water balance will serve to quantify surface water and UHSU (tributary) groundwater flow and interactions occurring within the IA, in the drainage pathways immediately downstream, and within the eastern Buffer Zone. More specifically, modeling will focus on the Woman Creek and Walnut Creek drainages and associated upgradient groundwater source areas within the RFETS property boundary. The Rock Creek drainage and the underlying deep regional aquifer systems are excluded from consideration because of their hydrological isolation from potential IA sources and closure actions and their effects.

During 1999 the site wide water balance data quality objectives (DQOs) were identified. In the spring of 2000, thirteen (13) monitoring wells were installed with In-Situ Inc. Hermits® or Trolls® for continuous water level monitoring. In addition, 72 wells were activated for quarterly water level measurements. All of these measurements are in addition to the regularly scheduled groundwater monitoring specified in the IMP and measurements taken by the real time groundwater monitoring network described in Section 3.4.

8.4 Discussion of VOC and Nitrate Groundwater Plumes

The 1998 composite VOC (TCE, PCE, vinyl chloride, and carbon tetrachloride) and nitrate plume maps were combined into one map (Plate 11). The plumes were updated using the 1999 data for wells with at least one Tier I or Tier II VOC exceedance and at least one Tier II dissolved nitrate exceedance (Section 2.0 and Table 2-10). The 1999 groundwater chemistry data extracted from the SWD (Section 11.0 of this report) were used in constructing these maps. All monitoring wells with analytical results for the years 1991 through 1998, regardless of the number of samples collected during that time, were used to produce the 1998 plume maps (RMRS, 1999m). The 1998 composite VOC and dissolved nitrate plume maps consist of data compiled from approximately 600 wells. Plume boundaries, where drawn, represent the best estimates of the spatial distribution of concentrations of chemicals of concern in groundwater at RFETS.

8.4.1 Volatile Organic Compound Plumes

Plate 10 presents the 1998 composite of four common VOC contaminants – TCE, PCE, vinyl chloride and carbon tetrachloride and modified with 1999 data summarized in Table 2-10 and from plume maps generated in support of the *Sampling Analysis Plan for the D&D Groundwater Monitoring of Buildings 707, 776/777, 371/374, 865, and 883 (RMRS, 2000 RMRS-2000*. The VOC plume map has been updated from those published in previous Annual RFCA Groundwater Monitoring Reports (RMRS, 1997e and 1999m; and DOE, 1998a) to reflect new data collected in 1999, revised plume interpretations, and the locations of the Mound Plume, East Trenches, and Solar Ponds Groundwater Treatment Systems. Plume monitoring discussions and VOC trend evaluations are presented

elsewhere within this year's report. The main areas of change involved modifying the Tier I and Tier II plume boundaries as summarized below:

Refinements to the Tier I and Tier II boundary were made at the leading edge of the 903 Pad/Ryan's Pit plume near the South Interceptor Ditch at Pond C-1 as a result of the Tier I exceedance in well 90099 and Tier II exceedance in well 90399.

The leading edge of the Mound plume boundary was shortened slightly to account for the Mound Plume Treatment System and only Tier II action level exceedances for vinyl chloride in well 3586 and 1,1-dichloroethene in well 15699, downgradient of the treatment system.

Refinements to the Tier I and Tier II boundary were made at the leading edge of the East Trenches Plume based on construction and data from the East Trenches Groundwater Treatment System. The Tier I plume was redrawn to intercept the East Trenches Groundwater Treatment System based on the influent and effluent VOC concentrations and Tier II exceedance observed in well 95199 (previously a Tier I exceedance). The Tier II plume was redrawn to exclude well 95099 due to VOC concentrations below Tier II observed during 1999. The Tier I plume was adjusted based on VOC concentrations in well 12191, upgradient of Trench T-3, decreasing below the Tier I action levels. Well 23296 remained a Tier II exceedance and the results from this well do not change the VOC plume configuration.

The 881 Hillside/IHSS 119.1 plume was redrawn without the Tier I exceedance due to the decrease in VOC concentrations below Tier I observed in the collection well (COLWEL). The Tier II extent was reduced to reflect the location of the french drain and the decrease in VOC concentrations below Tier II observed in the collection gallery (COLGAL).

A small area of Tier I VOC contamination centered around D&D monitoring well 40099, east of Building 444, was added. The small area of Tier II VOC contamination centered around D&D monitoring well 10498, located downgradient of Building 123, was increased to encompass the Tier I VOC contamination in well 40099 and the Tier II VOC contamination observed in well 40299, south of Building 447, and well P416789, south of Building 439.

A small area of Tier II VOC contamination centered around SW13494, the footing drain outfall for Building 881, was added.

In 1999, an evaluation of the eastern boundary of the IA VOC plume was implemented to better define the extent of VOC contamination east of the Eighth Street utility corridor and upgradient of Buildings 707, 776, 778, 883, and 865. The eastern Tier II boundary was redrawn to reflect exceedances observed in wells 60199, 60599, 61099, 61199, and 61499. The northeastern Tier I boundary was redrawn to reflect the lack of Tier I exceedances in the wells along the Eighth Street utility corridor.

The northeast boundary of the North Industrial Area Plume, northeast of the former location of Building 779, was modified as a result of the historical Tier I VOC exceedances in well P210189 and Tier II VOC exceedances in wells 2286, 5687, and P209189.

The north boundary of the North Industrial Area Plume, north of Building 774, was extended due to the Tier II exceedances observed in Bowmans Pond (see Section 9.3). The Tier II extent was also modified to include well 20698 north of Building 779.

The western boundary of the Tier I carbon tetrachloride plume originating from IHSS 118.1 was extended to encompass well 21098.

A small area of Tier II VOC contamination centered around well 30595, north of the Solar Ponds, was added based on the 1997 Tier II TCE exceedance.

8.4.2 Nitrate Plumes

The 1999 nitrate plume map has been updated slightly from those published in previous Annual RFCA Groundwater Monitoring Reports (RMRS, 1997b, 1998 and 1999) to reflect new data collected in 1999. Plate 10 shows the estimated extent of Tier I (1,000 mg/L) and Tier II (10 mg/L) groundwater nitrate contamination based on data collected from the period 1991 to 1999. For reference, the background concentration for nitrate in groundwater at RFETS is 4.7 mg/L (DOE, 1993b).

Plate 10 illustrates one major nitrate plume (Solar Ponds Plume) and four areas of more minor nitrate contamination. The Solar Ponds Plume (SPP) is located in the northeast portion of the PA and extends from the Solar Evaporation Ponds to the northeast towards North Walnut Creek. All values of nitrate over the Tier I action level are associated with this plume. The four minor areas of nitrate concentration above the Tier II action level are associated with the area north of the Original Landfill (IHSS 115), the 903 and 904 Pads, IHSS 119.1 on the 881 Hillside, and an area west of the Present Sanitary Landfill Pond.

Isolated occurrences of nitrate above the Tier II action level were also observed at the following locations:

- well 41099 (47 mg/L), north of Building 886;
- well 22896 (12 and 15 mg/L) north of Building 559;
- well 2987 (13 mg/L) north of the South Interceptor Ditch and east of Pond C1;
- well 00597 (12 and 13 mg/L) at the south perimeter of the Present Sanitary Landfill;
- well 02197 (13 mg/L) southeast of the Present Sanitary Landfill (IHSS 114); and
- well 10994 (11 mg/L) downgradient of the Original Landfill.

No modifications of the plume boundaries were required based on the 1999 data. However, monitoring of the isolated occurrences, as summarized above, will be performed and additional wells may be added for nitrate analysis, if required.

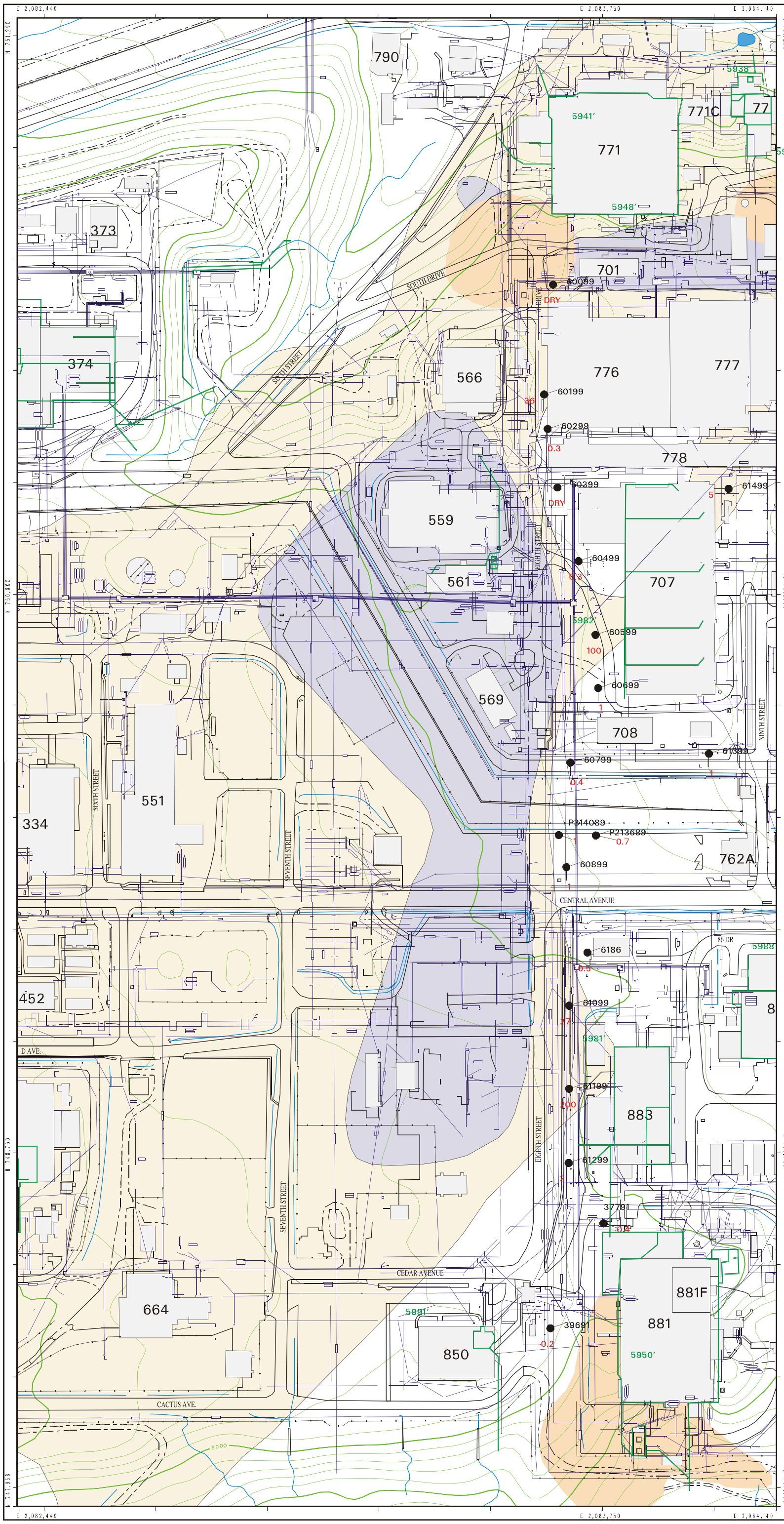

Figure 8-1

Monitoring Well Locations

East Industial Area VOC Plume

1999 Annual RFCA

Groundwater Monitoring Report

EXPLANATION

- Groundwater Monitoring Well (The red numbers indicate the 1999 Tetrachloroethene values.)
- Foundation Drain
- Composite VOC Groundwater Plume (concentration equal to MCL)
- Composite VOC Groundwater Plume (100 X MCL)
- Approximate extent of Unsaturated Area
- Utility Lines-- Process Waste, Sanitary Sewer, Electrical (above/below ground), Domestic Water (above/below ground), Steam (above/below ground), and Abandoned

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1804
1 inch represents approximately 150 feet

50 0 100ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy

Rocky Flats Environmental Technology Site

MAP ID: rfca-rpt99

December 07, 2000

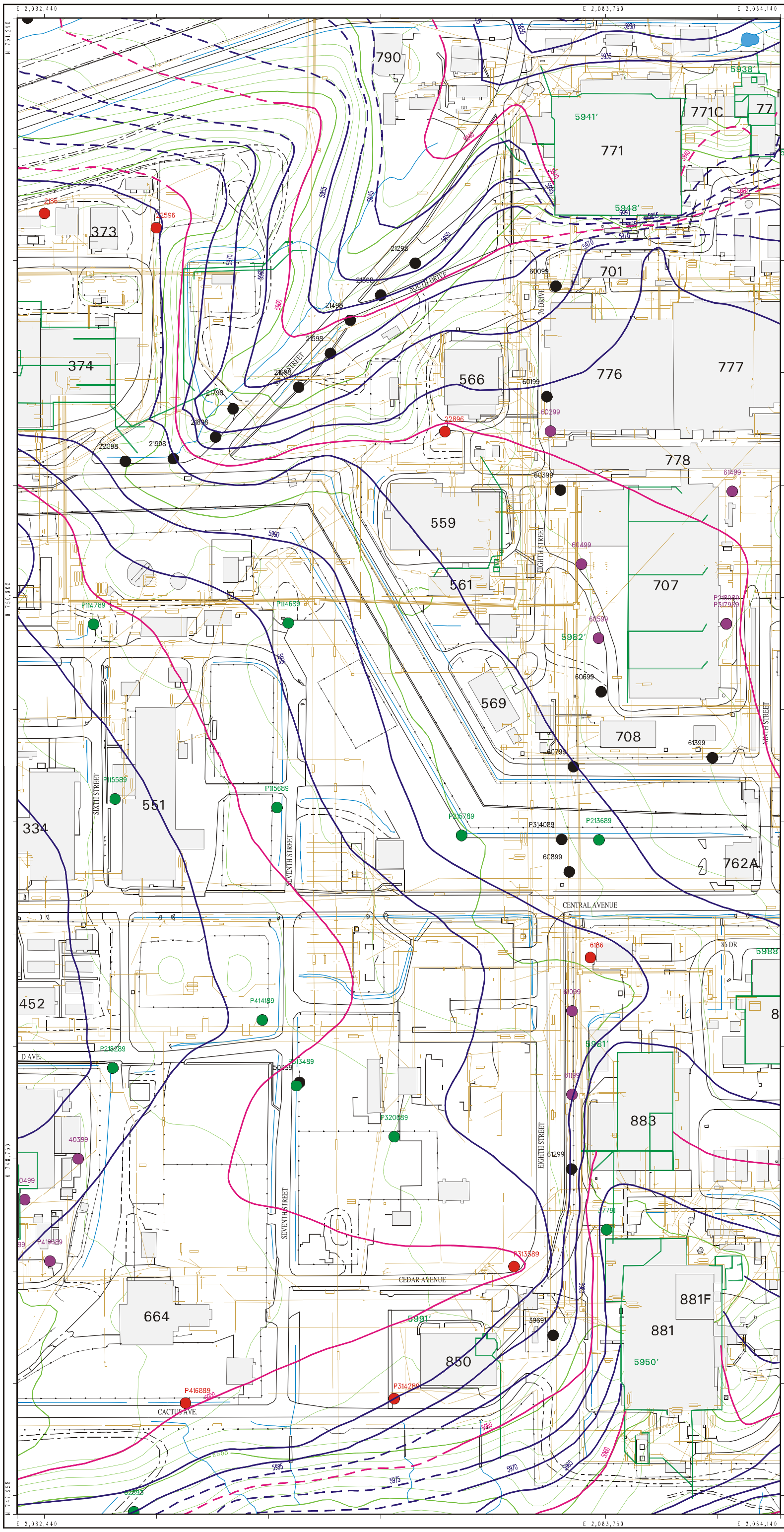

Figure 8-2

Potentiometric Surface
East Industial Area
Unconsolidated Surficial Deposits

1999 Annual RFCA
Groundwater Monitoring Report

EXPLANATION

IMP Well Type

- Water Quality Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- D&D Monitoring
- Non-IMP

5-Foot Water Level Contours
Second Quarter 1999

- 20-Foot Water Level Contour
- Dashed where Inferred
- 5-Foot Intermediate Water Level Contour
- Dashed where inferred
- Foundation Drain
- Approximate extent of Unsaturated Area
- Utility Lines-- Process Waste, Sanitary Sewer, Electrical (above/below ground), Domestic Water (above/below ground), Steam (above/below ground), and Abandoned

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
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DEM post-processing performed by MK, Winter 1997.

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Scale = 1 : 1804
1 inch represents approximately 150 feet

50 0 100ft

State Plane Coordinate Projection
Colorado Central Zone
Datum : NAD27

U.S. Department of Energy

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MAP ID: rfca-rpt99

December 07, 2000

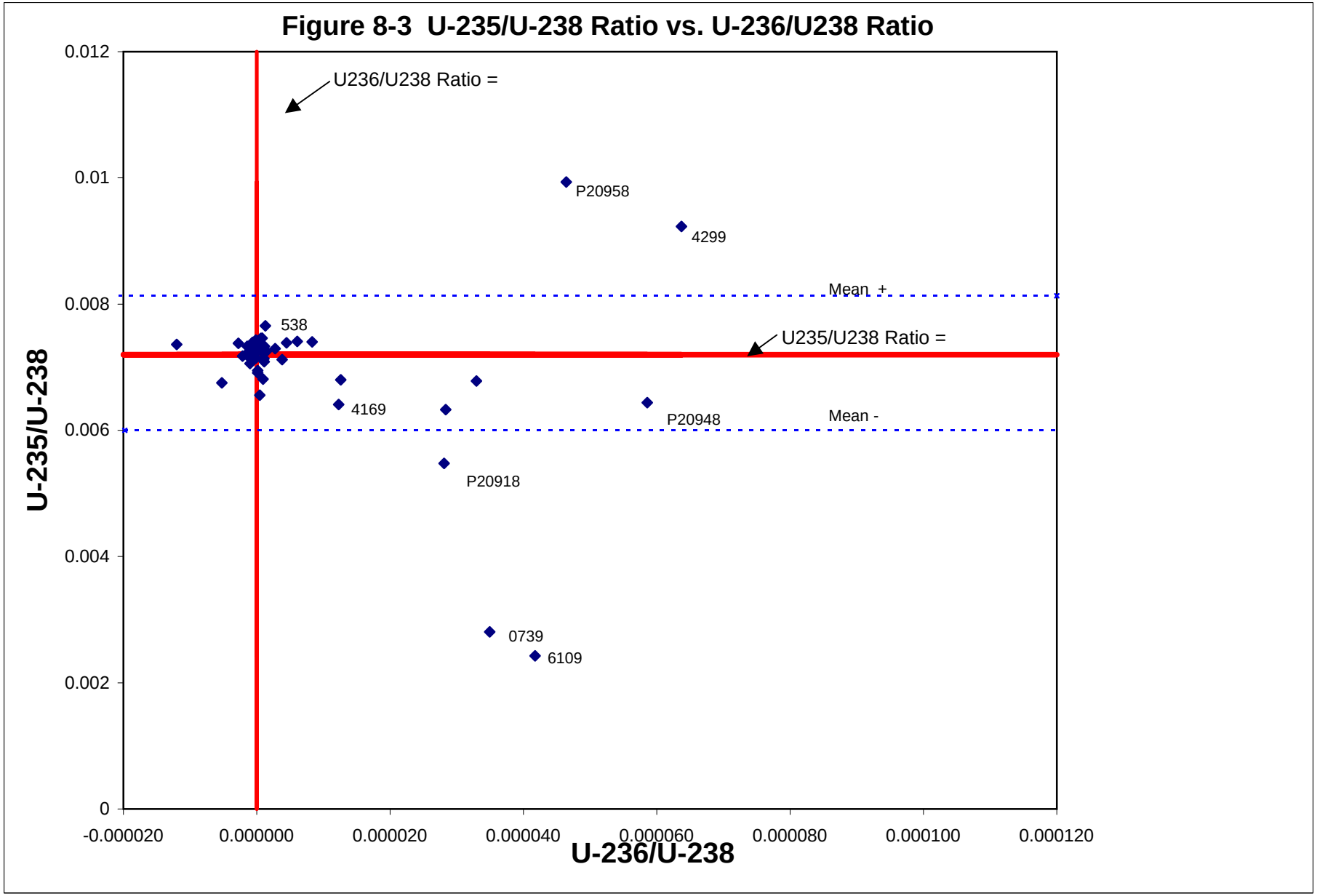
Figure 8-3 U-235/U-238 Ratio vs. U-236/U238 Ratio
U236/U238 Ratio =
U235/U238 Ratio =
Mean +
Mean -
P20958
4299
538
4169
P20948
P20918
0739
6109
0.012
0.01
0.008
0.006
0.004
0.002
0
-0.000020
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0.000080
0.000100
0.000120
U-235/U-238
U-236/U-238

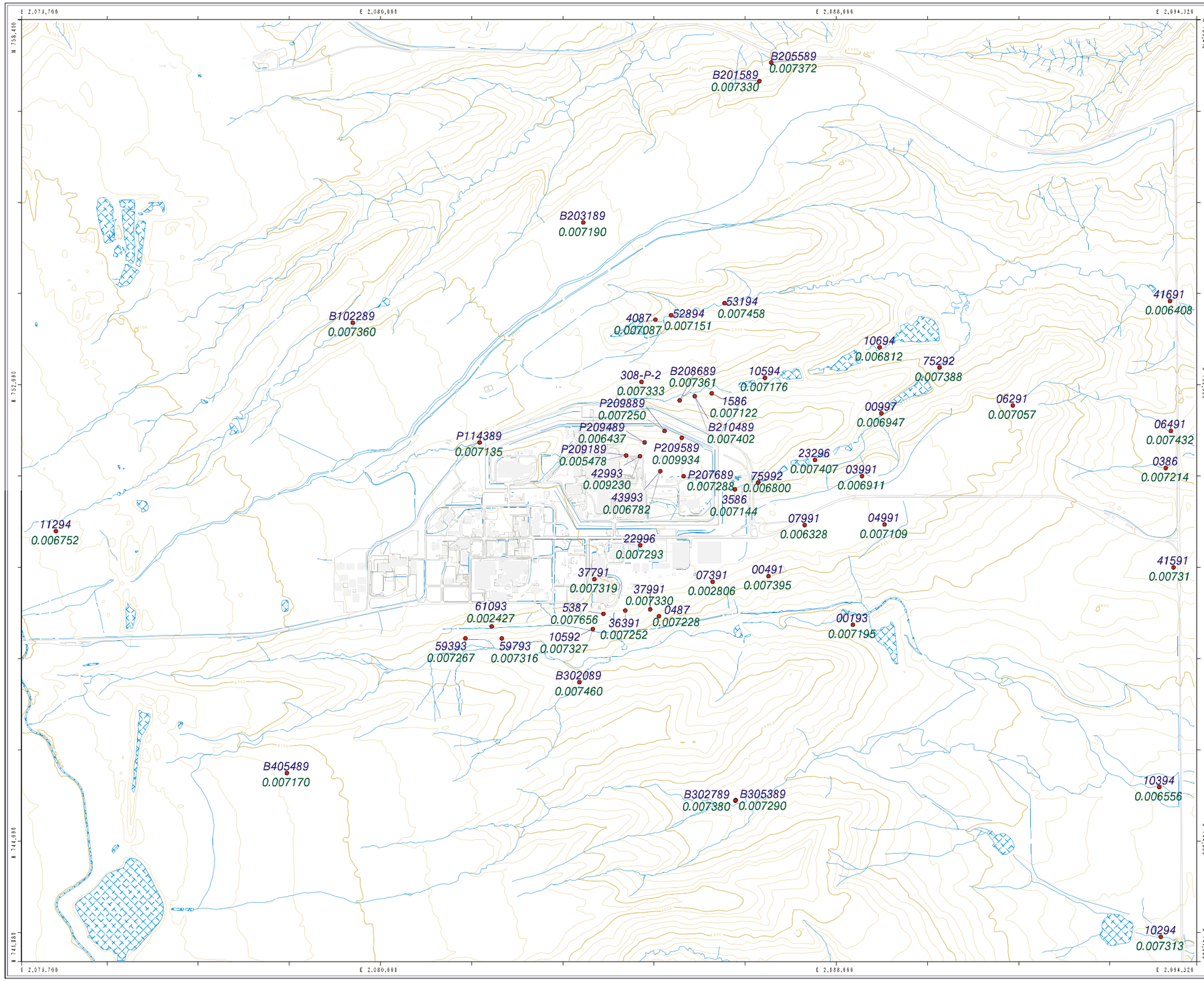

Figure 8-4

Selected Groundwater Wells and U235/U238 ICP/MS Ratios

1999 Annual RFCA Groundwater Monitoring Report

EXPLANATION

Location in Blue
Value in Green

Standard Map Features

Buildings and other structures

Lakes and ponds

Streams, ditches, or other drainage features

Contour (20-Foot)

Paved roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1:85

Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by:
DynCorp
THE ART OF TECHNOLOGY

Prepared for:
KAISER-HILL

MAP ID: rfca-rpt

November 14, 2000

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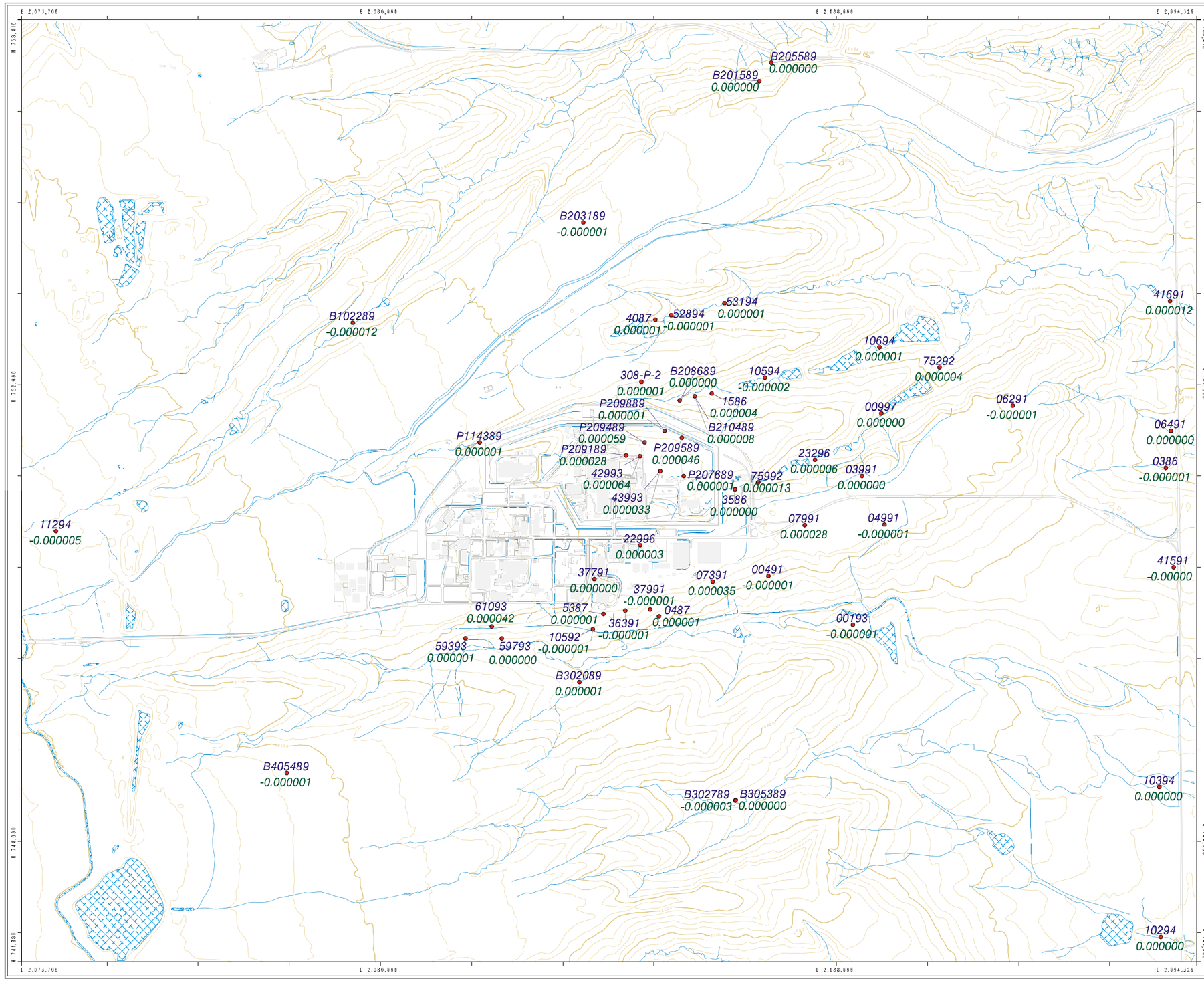

Figure 8-5

Selected Groundwater Wells and U236/U238 ICP/MS Ratios

1999 Annual RFCA Groundwater Monitoring Report

EXPLANATION

Location in Blue
Value in Green

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Contour (20-Foot)
- Paved roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1:85

Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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GIS Dept. 303-966-7707

Prepared by:
DynCorp
THE ART OF TECHNOLOGY

Prepared for:
KAISER-HILL

MAP ID: rfca-rpt

September 28, 2000

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9.0 GROUNDWATER CHARACTERIZATION ACTIVITIES

9.1 903 Pad VOC Investigation

As stated previously in Section 7.2, the 903 Pad was utilized as a drum storage area from the summer of 1958 to January 1967. The drums contained oils and VOCs contaminated with various radionuclides. Also stored in drums were hydraulic, vacuum pump, and silicone oils. Leaking drums were observed in 1964 during routine handling operations. When cleanup of the 903 Pad began in 1967, there were a total of 5,237 drums at the storage site, approximately 420 of which had leaked to some degree. It was estimated that approximately 5,000 gallons of contaminated liquid, containing about 86 grams of plutonium, had escaped to the subsurface. VOCs have impacted groundwater as a result of the leaking drums. Elevated concentrations of VOCs are present in groundwater beneath and downgradient of the site.

The Site Characterization of the 903 Drum Storage Area (Pad), 903 Lip Area, and Americium Zone, was completed in 1999. The investigation area is located in the Buffer Zone Operable Unit (OU). The purpose of the investigation was to estimate the volume of soil exceeding the RFCA action level Framework (ALF) Tier I soil action levels or other action levels identified as being protective of surface water for radionuclides in surface soils and VOCs in the subsurface (RMRS, 1999h). This discussion will focus on the portion of the investigation associated with the 903 Pad and the VOC contamination associated with the 903 Pad. The portion of the investigation which encompasses the 903 Lip Area and the Americium Zone deal with radiological contamination which spread from the 903 Pad to the 903 Lip Area by wind and rain and to the Americium Zone primarily by wind dispersion. The following Section 9.2 discusses the results of actinide transport and potential impacts to groundwater.

Work completed during 1999 on the 903 Pad VOC investigation, that are pertinent to this discussion, consisted of the drilling and sampling of nine soil boreholes. Boreholes were advanced using Geoprobe push drilling methodology and varied in depth from 16 to 24 feet below ground surface and were sampled every four feet or at indications of contamination. The sampling results are summarized in the *Characterization Report for the 903 Drum Storage Area, 903 Lip Area, and Americium Zone* (RMRS, 1999n). Volatile organic compounds identified consisted of tetrachloroethene, trichloroethene, methylene chloride, and 1,2-Cis-Dichloroethylene. Location of the 903 Pad and a summary of VOC detections in groundwater are presented in Figure 9-1. No new monitoring wells were installed during the investigation of the 903 Pad.

9.2 Actinide Aseptic Drilling Project

Background

The potential migration of plutonium-239/240 (Pu-239/240) and americium-241 (Am-241) from surface soils to groundwater at RFETS is being considered as part of the long-term remedial strategy currently under evaluation for Site closure implementation by DOE, the Kaiser-Hill (K-H) Team, and the Actinide Migration Evaluation group. Existing data on actinide migration at RFETS was summarized for the development of a conceptual model designed to gain an understanding of actinide transport pathways active at the Site (DOE, 1997). Over 30 monitoring wells at RFETS were found to contain mean groundwater Pu-239/240 and Am-241 activity-concentrations that exceeded RFCA Tier II action levels (0.15 picocuries per liter [pCi/L] and 0.145 pCi/L, respectively) for these contaminants. Groundwater interactions with surface water are inevitable as virtually all shallow groundwater on Site flows toward the major stream drainages and is eventually discharged to surface water via streams or reservoirs. Consequently, groundwater was characterized as representing a potential long-term threat to surface water based on a preliminary review of the available data.

The presence of Pu-239/240 and Am-241 in groundwater samples at RFETS has been the subject of much speculation and study (DOE, 1997a; EG&G, 1995c; CDPHE, 1996; Harnish et. al., 1994 and 1996; and Litaor, et. al., 1996). These contaminants are usually considered to be relatively immobile in the soil and groundwater environment due to their low aqueous solubility and tendency to strongly sorb on soil media (Cleveland et. al., 1976 and Honeyman and Santschi, 1997). Most wells with exceedances are located near potential source areas, such as the 903 Pad, but some are located at great distances from sources, including monitoring wells located at the east Site boundary along Walnut Creek. Colloid facilitated-transport of radionuclides in groundwater has been reported in the literature as being a potentially important mechanism for increased radionuclide mobility in the subsurface. Alternatively, it has been speculated that well completion zones may have been cross-contaminated when drilling through radionuclide-bearing surface soils or sediments found near source areas.

Because a significant disparity exists between observed versus expected Pu-239/240 and Am-241 groundwater contaminant distributions, further evaluation of historical groundwater Pu-239/240 and Am-241 data and potential transport pathways was undertaken in 1998 to assess the significance of groundwater action level exceedances reported for RFETS monitoring wells (DOE, 1998c). This analysis concluded that much of the Pu-239/240 and Am-241 contamination detected in groundwater probably occurs from residual surface soil contamination introduced to the borehole during drilling and well installation operations (drilling-artifact contamination). Groundwater samples collected from these wells using historical RFETS sampling techniques (i.e., bailing) have the unavoidable effect of suspending contaminated drilling-artifact soil materials, thus creating artificially high contaminant levels. Under these circumstances, existing groundwater sampling results are unreliable indicators of groundwater contaminant concentration and transport.

Well drilling and installation using special surface-casing techniques offer a means to minimize or eliminate drilling-artifact contamination as a source for Pu-239/240 and Am-241 detections in groundwater samples. When

paired with existing monitoring wells containing Pu-239/240 and Am-241 contamination, monitoring wells installed with special surface-casing techniques can 1) provide a basis for assessing the effects, if any, of drilling-artifact contamination on groundwater sample quality, and 2) allow for the collection of groundwater samples that more accurately represent groundwater contaminant concentrations and transport conditions. Non-paired, specially-cased monitoring wells were installed in 1994 to evaluate elevated Pu-239/240 and Am-241 activity-concentrations in the lower Walnut Creek drainage and to upgrade boundary monitoring well integrity in other RFETS drainages (EG&G, 1995). No Pu-239/240 and Am-241 contamination above Tier II groundwater action levels was detected in any of the wells installed under this program. Until 1999, monitoring wells installed with special surface-casing techniques were not paired with existing monitoring wells to validate or invalidate radionuclide detections found in the original well.

9.2.1 Type and Extent of Contamination

Soils

Actinide transport to groundwater from contaminated surficial soils is a primary concern at RFETS. As shown in Figure 9-2, widespread areas of the Buffer Zone and localized areas in the IA have received windblown Pu-239/240 surface soil contamination. Vertical soil profiles of Pu-239/240 activity-concentrations for the uppermost 96 centimeters (cm) (3 feet) of RFETS soils presented in DOE (1998c) and Litaor et. al. (1994) indicate that plutonium movement is mainly restricted to the top 20 to 25 cm of soil. Pu-239/240 activity-concentrations exponentially decline below a depth of about 12 cm (Litaor et. al., 1994) to less than 1 pCi/g at 72 cm. Elevated plutonium activity-concentrations were detected in soil macropores (e.g., root channels) compared to the surrounding soil matrix, but extensive macropore development was not observed below a depth of 120 cm (3.9 feet) (Litaor et. al., 1994). This depth roughly corresponds with the average depth of most RFETS grass and forb root systems as reported in Weaver (1920). According to Weaver (1920), many grassland plants have root systems that can exceed a depth of 5 feet and some can attain maximum depths in excess of 10 feet. This information suggests that deep soil macropores may be present at RFETS, but these macropores should be relatively unimportant as a source medium for drilling-artifact contamination.

Groundwater

Figure 9-2 illustrates that wells containing unfiltered Pu-239/240 contamination (colored dots) are generally associated with surface soil contamination areas (color-shaded contours). The highest groundwater unfiltered Pu-239/240 activity-concentrations are found in alluvial wells at and east of the 903 Pad. Elevated unfiltered Pu-239/240 activity-concentrations are also found in certain bedrock wells in this area, including well 11791, as described in DOE (1998c).

Activity-concentration plots of unfiltered Pu-239/240 and Am-241 for wells 1587, 06991, 11791, and P313489 presented in DOE (1998) indicate that, with the exception of well 1587, Pu-239/240 and Am-241 activity-

concentrations have generally declined with time. The reason for this decline is thought to result from the flushing of contaminants in the borehole disturbed zone caused by routine sampling activities.

9.2.2 Project Approach

The following conditions were considered in the development of the sampling strategy for the Actinide Drilling-Artifact Contamination Project:

- The operating history of the former 903 Pad Drum Storage Area and other sites indicate that actinide contaminants, specifically Pu-239 and Am-241, have been released to the environment and transported by wind action to surface soils east and southeast of the pad.
- The physical and chemical properties of the contaminants, vertical soil actinide activity-concentration profiles, and drilling and well installation documentation indicate that cross-contamination from surface soil materials probably accounts for much, if not all, of the actinide contamination found in groundwater samples collected from 903 Pad and surrounding area wells.
- Existing groundwater analytical data indicate that actinide contamination occurs principally in the colloidal and particulate phase.
- Seasonally variable hydrologic conditions can affect well development effectiveness and sampling program success.

Additional details on project approach and sampling strategy are presented in the Actinide Drilling-Artifact Contamination Project sampling and analysis plan (SAP) (DOE, 1999a).

9.2.3 Monitoring Well Locations and Rationale

Four monitoring well locations (50099, 50199, 50299, and 50399) were chosen to evaluate actinide groundwater quality associated with Pu-239/240 and Am-241 surface soil contamination areas. These locations correspond to existing wells 1587, 06991, 11791, and P313489 respectively, all of which have a history of elevated groundwater Pu-239/240 and Am-241 activity-concentrations. Three of these wells, 1587, 06991, and 11791, are associated with wind-blown soil contamination from 903 Pad and Lip Area. The fourth well is associated with surface soil contamination in the IHSS 160 area (Building 444 parking lot). Figure 9-3 illustrates the location of these wells. The rationale for each monitoring well location is summarized in Table 9-1.

Table 9-1 Actinide Drilling-Artifact Contamination Monitoring Well Location Rationale

Well Number	Location	Rationale
50099	10 feet west of paired well 1587	Upgradient location from well 1587 for evaluating historical actinide groundwater contamination per DOE (1998). Groundwater at well 1587 has an apparent increasing Pu-239/240 trend; has a partially saturated screened interval; and was the focus of previous USGS research.
50199	10 feet west of paired well 06991	Upgradient location from well 06991 for evaluating historical actinide groundwater contamination per DOE (1998). Well 06991 has the highest average Pu-239/240 concentration of all wells not located on the 903 Pad and has a partially saturated screened interval.
50299	10 feet north of paired well 11791	Upgradient location from well 11791 for evaluating historical actinide groundwater contamination per DOE (1998). Well 11791 is completed in weathered bedrock materials in an area thought to be a bedrock groundwater discharge area. It has a fully saturated screened interval.
50399	10 feet northeast of paired well P313489	Cross gradient location from well P313489 for evaluating historical actinide groundwater contamination per DOE (1998). Well P313489 is located in the IA outside of the 903 Pad Soil Contamination Area and has a fully saturated screened interval.

9.2.4 Well Design and Installation

Well Design

Monitoring well designs selected for the program were consistent with the construction specifications prescribed in OPS GT.6, Rev. 2, *Monitoring Well and Piezometer Installation* . These wells were designed with screened intervals that closely approximate the paired well, except that the top of the screened or filter-packed interval for certain wells were set deeper than the original well to provide additional well intake zone protection. To ensure that these wells excluded drilling-artifact contamination, all wells were installed using dual ("aseptic") casing construction methods described in PRO.114, *Drilling and Sampling Using Hollow-Stem and Rotary Drilling and Rock Coring Techniques*, and as modified in the SAP.

The depth of actinide contamination in surface soils was an important consideration for well design. Surface casing must prevent contaminated soils from entering the borehole and contaminating deeper materials. As most Pu-239/240 is mainly limited to the top 40 to 60 cm of soil, a surface casing depth of 65 cm (2.1 feet) below original

grade was chosen to isolate the majority of contamination while permitting sufficient room for excess soil removal and casing cleaning. A target activity-concentration of below 1 pCi/g was adopted for determining whether the 65 cm isolation casing depth was adequate for excluding surface soil contamination from potentially entering the wellbore. Pu-239/240 or Am-241 activity-concentrations found to be higher than this criterion would result in analysis of deeper soil samples to document contamination conditions of the well intake zone and allow an assessment of cross-contamination potential for the well.

Typical well construction materials consisted of a 2.5 foot section of 16-inch inner diameter (ID) steel surface casing and concrete pad, and 2-inch ID, schedule 40 polyvinyl chloride (PVC) riser and factory cut (0.010-inch slot width) well screen with a 1 foot long PVC sump. Protective casing, consisting of a 6-inch ID or larger steel riser with locking cap and lock, was set in concrete to a depth of about 2 to 3 feet. Caution was exercised during each step of the well construction process to prevent surface contaminants from entering the borehole. All downhole equipment, including augers, rods, tools, and casing, were decontaminated and radiologically surveyed prior to advancing past the base of the isolation casing.

Borehole Drilling and Logging

Prior to drilling at each site, the uppermost 3 to 4 inches of soil was removed from a 3 x 3 foot square area surrounding the hole location. The excavated surface was then securely covered with plastic sheeting to prevent grossly contaminated soils from entering the immediate drill hole area. The work area immediately surrounding the excavation was also covered with plastic sheeting to suppress dust and minimize potential airborne contamination of the excavation soil surface. Surficial soil sampling and drilling was initiated through a pre-cut 16 to 20-inch hole cut in the plastic sheeting at the center of the square excavated area. This square area was later used for well pad construction in conjunction with cementing-in the surface isolation casing.

At each drill site, a 20-inch diameter hole was hand excavated to a depth of about 1.8 feet below the excavated soil surface in preparation for surface isolation casing installation. All soil cuttings were carefully removed in 4 to 6-inch lifts using freshly decontaminated tools in preparation for isolation casing installation. Steel surface casings were placed and seated in the boreholes to an approximate depth of 2.1 feet below original ground surface, with a 0.4 foot stick-up, to prevent potentially contaminated surface soil from entering the borehole. The plastic sheeting protecting the excavation surface was then cut at the borehole in preparation for cementing and pad construction. After sealing the top of the surface casing with plastic and duct tape, concrete was placed into the casing annulus, while causing as little disturbance to the borehole wall as possible. Once the annulus was filled, the remainder of the pad was poured to a finished dimension of 3 x 3 feet wide by 6-inches thick using a wooden frame.

After allowing for a 24 hour or longer cement set-up time, the plastic surface casing cover was removed for final clean out and sampling. The decontaminated auger string was then advanced to the estimated target total depth in the SAP based on drilling results obtained from the existing paired well. During drilling, continuous soil cores and subsurface samples from selected depths were obtained at two-foot increments using a split spoon sampler.

Well Installation

Groundwater monitoring wells were installed in accordance with GT.06, *Monitoring Wells and Piezometer Installation* and the project SAP (DOE, 1999). Generally, the wells were installed in accordance with the design specifications set forth in the SAP, although adjustments for screen depth (wells 50199 and 50299) and screen length (well 50199) were made to account for unexpected variations in bedrock depth. Table 9-2 contains the as-built specifications for the wells.

Table 9-2 Well Construction Specifications for Actinide Drilling-Artifact Contamination Wells

Well Number	Paired Well Number	Surface Isolation Casing Depth (ft)	Depth to Bedrock (ft)	Top of Well Intake (filter pack) (ft)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Total Depth (ft)
50099	1587	2.1	20.4	9.7	10.7	20.7	21.7
50199	06991	2.1	21.0	9.5	10.7	20.7	22.5
50299	11791	2.1	<2.4	9.1	8.3	14.3	14.6
50399	P313489	2.1	20.7	15.8	17.1	22.1	22.5

Note: All depths are reported from original ground surface

Well Development

Monitoring wells were developed prior to sampling using the procedures specified in PRO.106, *Well Development*, and as modified by the SAP. The main objectives of well development were to improve well yields and reduce turbidity levels, thus ensuring that any groundwater samples obtained were as representative as possible of undisturbed conditions. All water produced during well development was handled as uncharacterized development water in accordance with FO.05, *Handling Purge and Development Water*.

9.2.5 Sample Collection

Soil Samples

Soils samples collected at new drilling sites consisted of a set of five, depth-discrete surface and subsurface samples for documentation of Pu-239/249 and Am-241 contaminant conditions for drilling-artifact contamination evaluation. Surface soil samples were collected from each new well location site using the grab sampling method specified in GT.08, *Surface Soil Sampling*. After the uppermost 3 to 4-inch layer of soil was removed, a soil sample was collected from the borehole area to a depth of approximately 5 to 6-inches below the excavated soil surface. Following surface isolation casing installation and clean out, a subsurface soil sample was collected from the base of this casing to a depth approximately 1 to 2-inches below the casing point using hand tools, as specified in GT.08, *Surface Soil Sampling*. These samples were submitted for analysis to document the efficacy of the isolation casing

in excluding surface soil contamination. Additional subsurface soil samples were collected from the 4.0 to 5.0 foot depth interval, slough deposited at the top of the well intake zone, and from undisturbed soils in the upper 1-foot of the well intake zone. These samples were stored for possible future analysis pending the results of the uppermost soil and groundwater samples.

Groundwater Samples

Groundwater sampling began after the well fully recovered from the well development process. Pu-239/240, Am-241, and total suspended solids (TSS) samples were collected from each of the wells in well pairs 11791/50299, P313489/50399, 1587/50099, and 06991/50199 using the bailer method, as specified in PRO.108, Measurement of Groundwater Field Parameters, and PRO.113, Groundwater Sampling. Variability in operator bailing technique was minimized by having the same bailer operator collect samples from both wells in a pair. Well purging focused on turbidity monitoring to a greater degree than routine sampling because plutonium and americium are strongly particle-reactive and excessive turbidity levels might compromise paired comparisons. Turbidity levels in groundwater were monitored and allowed to stabilize prior to sampling. At the time of sampling, turbidity levels ranged from 2 to 149 NTUs (clear to cloudy) in the new wells and 0 to 239 NTUs in the existing wells. All wells yielded adequate sample volumes for collecting complete sample suites proposed in the SAP.

9.2.6 Sampling Results

Soils

Table 9-3 presents the results of Pu-239/240 and Am-241 analyses for the uppermost soil samples collected at each new well site. Samples collected at the excavated soil surface (3 to 4-inches below original grade) confirm that shallow soils were contaminated with actinides (2.8632 to 489.2946 pCi/g Pu-239/240 and 0.6885 to 104.5068 pCi/g Am-241) prior to surface isolation casing installation. Soil activity-concentrations at the base of the isolation casing were below the target activity-concentration of 1 pCi/g in wells 50199, 50299, and 50399, but exceeded the criteria at well 50099 (6.0409 pCi/g Pu-239/240 and 1.0666 pCi/g Am-241). The presence of above-target Pu-239/240 and Am-241 concentrations in this sample indicate that some shallow soil contamination was present when drilling was initiated through the isolation casing. For this reason, the deeper soil samples from this borehole were subsequently submitted for analysis to further examine the possibility that surface contamination may have been introduced to the well intake zone. These results will be reported in the Actinide Pathways report scheduled for completion in FY01.

Groundwater

The results of groundwater samples for all paired wells are contained in Table 9-4. Pu-239/240 activity-concentrations in groundwater ranged from below detection to 0.0601 pCi/L in the new wells and from below detection to 0.1067 pCi/L in the existing wells. Am-241 activity-concentrations were lower than Pu-239/240 in all

wells except well 06991. Generally, Pu-239/240 and Am-241 activity-concentrations were lower in the new wells compared to the existing wells, although further sampling will be required to verify these initial results. From these results, it is clear that actinide activity-concentrations at these locations are significantly lower than found in previous years, as reported in DOE (1997a). The results of verification sampling and significance of the data will be reported in the Actinide Pathways report scheduled for completion in FY01.

Table 9-3 Soil Sampling Results from New Actinide Drilling-Artifact Contamination Wells

Location	Sample Date	Depth Interval (ft)	Bottle #	Analyte	Result	Unit	Lab Qual	Valid	Detect Limit	2 Sigma	Lab
50099	10/20/99	0.0-0.5	00D0544-002.002	AMERICIUM-241	104.5068	pCi/g			0.0501	2.7246	GEL
50099	10/20/99	0.0-0.5	00D0544-002.002	PLUTONIUM-239/240	489.2946	pCi/g			0.2145	12.1989	GEL
50099	10/22/99	2.3-2.4	00D0544-003.002	AMERICIUM-241	1.0666	pCi/g			0.1031	0.3948	GEL
50099	10/22/99	2.3-2.4	00D0544-003.002	PLUTONIUM-239/240	6.0409	pCi/g			0.2041	0.6721	GEL
50199	10/21/99	0.3-0.5	00D0544-008.002	AMERICIUM-241	66.7397	pCi/g			0.1443	2.6733	GEL
50199	10/21/99	0.3-0.5	00D0544-008.002	PLUTONIUM-239/240	360.1567	pCi/g			0.2064	6.5475	GEL
50199	10/28/99	2.3-2.4	00D0544-009.002	AMERICIUM-241	0.0302	pCi/g	U		0.1851	0.0765	GEL
50199	10/28/99	2.3-2.4	00D0544-009.002	PLUTONIUM-239/240	0.189	pCi/g	U		0.2902	0.1903	GEL
50299	8/25/99	0.4-0.5	99D0069-002.002	AMERICIUM-241	26.4967	pCi/g		V1	0.0945	1.8839	GEL
50299	8/25/99	0.4-0.5	99D0069-002.002	PLUTONIUM-239/240	160.9394	pCi/g		V1	0.2471	3.794	GEL
50299	8/26/99	2.2-2.4	99D0069-003.002	AMERICIUM-241	0.0637	pCi/g	J	V1	0.0575	0.0721	GEL
50299	8/26/99	2.2-2.4	99D0069-003.002	PLUTONIUM-239/240	0.084	pCi/g	U	V1	0.2456	0.1304	GEL
50399	8/16/99	0.4-0.5	99D9513-001.002	AMERICIUM-241	0.6885	pCi/g		V1	0.0433	0.2056	GEL
50399	8/16/99	0.4-0.5	99D9513-001.002	PLUTONIUM-239/240	2.8632	pCi/g		V1	0.0725	0.5424	GEL
50399	8/17/99	2.2-2.8	99D9513-003.002	AMERICIUM-241	0.0477	pCi/g	U	V1	0.0646	0.0661	GEL
50399	8/17/99	2.2-2.8	99D9513-003.002	PLUTONIUM-239/240	0.1505	pCi/g	J	V1	0.0582	0.1115	GEL

Table 9-4 Groundwater Sampling Results from Actinide Drilling-Artifact Contamination Well Pairs

Location	Sample Date	Bottle#	Analyte	Result	Unit	Lab Qual	Detect Limit	Valid	2 Sigma Error	Lab
06991	11/29/99	00D0838-001.003	AMERICIUM-241	0.01837	pCi/L	J	0.0123	V	0.011796	GEL
50199	11/19/99	00D0822-001.003	AMERICIUM-241	0.00338	pCi/L	U	0.01243	V	0.006610	GEL
06991	11/29/99	00D0838-001.003	PLUTONIUM-239/240	0.00681	pCi/L	U	0.01836	V	0.010553	GEL
50199	11/19/99	00D0822-001.003	PLUTONIUM-239/240	0.03873	pCi/L		0.01297	V	0.016902	GEL
06991	11/29/99	00D0838-001.002	TOTAL SUSPENDED SOLIDS	13	mg/L		5	V		ACCU
50199	11/19/99	00D0822-001.002	TOTAL SUSPENDED SOLIDS	31	mg/L		5	V		ACCU
11791	9/21/99	99D0350-002.003	AMERICIUM-241	0.0709	pCi/L		0.0061	V	0.024900	GEL
50299	9/21/99	99D0350-001.003	AMERICIUM-241	0.0086	pCi/L	J	0.0058	V	0.008400	GEL
11791	9/21/99	99D0350-002.003	PLUTONIUM-239/240	0.0773	pCi/L		0.0269	V	0.029700	GEL
50299	9/21/99	99D0350-001.003	PLUTONIUM-239/240	0.0154	pCi/L	J	0.0069	V	0.012300	GEL
11791	9/21/99	99D0350-002.002	TOTAL SUSPENDED SOLIDS	27	mg/L		5	V		ACCU
50299	9/21/99	99D0350-001.002	TOTAL SUSPENDED SOLIDS	160	mg/L		5	V		ACCU
1587	11/10/99	00D0752-002.003	AMERICIUM-241	0.0465	pCi/L		0.0163	V	0.020800	GEL
50099	11/10/99	00D0752-001.003	AMERICIUM-241	0.0154	pCi/L	U	0.0162	V	0.012900	GEL
1587	11/10/99	00D0752-002.003	PLUTONIUM-239/240	0.1067	pCi/L		0.019	V	0.030100	GEL
50099	11/10/99	00D0752-001.003	PLUTONIUM-239/240	0.0601	pCi/L		0.0233	V	0.023700	GEL
1587	11/10/99	00D0752-002.002	TOTAL SUSPENDED SOLIDS	190	mg/L		5	V		ACCU
50099	11/10/99	00D0752-001.002	TOTAL SUSPENDED SOLIDS	5	mg/L	U	5	V		ACCU
P313489	9/10/99	99D0286-002.003	AMERICIUM-241	0.1321	pCi/L		0.017	V	0.034800	GEL
50399	9/10/99	99D0286-001.003	AMERICIUM-241	0.0097	pCi/L	U	0.0179	V	0.011700	GEL
P313489	9/10/99	99D0286-002.003	PLUTONIUM-239/240	0.042	pCi/L		0.0081	V	0.022000	GEL
50399	9/10/99	99D0286-001.003	PLUTONIUM-239/240	0.0021	pCi/L	U	0.0202	V	0.009500	GEL
P313489	9/10/99	99D0286-002.002	TOTAL SUSPENDED SOLIDS	150	mg/L		5	V		ACCU
50399	9/10/99	99D0286-001.002	TOTAL SUSPENDED SOLIDS	100	mg/L		5	V		ACCU

9.3 Bowman's Pond Site Characterization

The purpose of the Bowman's Pond Site Characterization was to investigate the potential nature and extent of contamination in surface soil, subsurface soil/sediment, and surface water for Bowman's Pond and surrounding depositional environments adjacent to Bowman's Pond including IHSS 139.1N (RMRS, 1999j). Bowman's Pond is referenced as a Potential Area of Concern (PAC) 700-1108 in the Historical Release Report (HRR) (DOE, 1992b). IHSS 139.1N consists of two empty, out of service, steam condensate tanks (T-107 and T-108) which are located immediately east of Bowman's Pond and within the ponds effluent drainage. Together, these Sites and the surrounding area comprise the depositional environment for the northern portion of the 700 Building area.

Bowman's Pond and the two steam condensate tanks are located within the PA immediately north of Building 774 and south of the North Patrol Road (Figure 9-4). Bowman's Pond consists of a small manmade depression approximately three to four feet (ft) deep with an areal extent of approximately 28 ft by 33 ft. Runoff water from the 700 Building Area enters the pond at several locations through culverts and from one polyvinyl chloride (PVC) pipe. Flow estimates range from 0 to 5 gallons per minute during normal weather conditions and increase to approximately 15 gallons per minute during precipitation events. The pond discharges to the east, saturating an area approximately 200 feet by 40 feet and resulting in a lush wetland depositional environment (including IHSS 139.1N).

Surface soil, subsurface soil/sediment, and surface water samples were collected from PAC 700-1108 and IHSS 139.1N in April 1999, to characterize the potentially contaminated media and provide the basis for future remedial decisions or a No Further Action (NFA) determination. Analytical data was evaluated with respect to the action levels and Standard Framework (ALF) for Surface Water, Groundwater, and Soils (Attachment 5) (RFCA, 1996) and Applicable or Relevant and Appropriate requirements (ARARS) established for the Industrial Area. In summary, there were no compounds identified from this investigation that exceeded (or approached) RFCA Tier I cleanup action levels. However, RFCA Tier II exceedances in soil and surface water were observed and are summarized herein.

9.3.1 Background

Based upon historical photographs and research identified in the HRR, Bowman's Pond was excavated in 1972 for the purpose of containing storm-water from storm and footing drains in the 700 Area. Previous investigations indicate that Bowman's Pond surface water and sediments may have been impacted by run off from upgradient storm and footing drains from Buildings 771 and 774. PCB contaminated soils were identified in and around Bowman's Pond during a sitewide sampling effort in 1991. Other possible releases to Bowman's Pond resulting from the adjacent steam condensate tanks (IHSS 139.1N) and from an Original Process Waste Line (OPWL) leak are documented in the HRR (DOE, 1992).

The steam condensate tanks (T-107 and T-108) are large aboveground tanks with a capacity of approximately 8,000-gallons each. The riveted steel tanks received steam condensate water from a nearby evaporative system and occasionally received liquid from a bermed area surrounding a sodium hydroxide product tank located immediately south and adjacent to Building 774 (Figure 9-4). The structural integrity of both tanks is noted as poor with holes present in the sides and badly corroded bottoms (DOE, 1992).

Bowman's Pond and the steam condensate tanks are located on a northward sloping colluvial surface consisting of approximately 10 to 11 ft of gravelly to sandy clay and silty clay. The top of bedrock is approximately 11 ft below ground surface and consists of Laramie Formation claystone. The depth to groundwater ranges between six to eight feet and the flow direction is north-northeast towards North Walnut Creek.

The maximum concentration of carbon tetrachloride detected in June 1998 from monitoring well P219189, which is located upgradient and west of Bowman's Pond, was 7 ug/L.

However, historically carbon tetrachloride is generally undetected in groundwater in well P219189. Consistent detections of 1,1-dichloroethene ranging from 17 up to 30 ug/L, above the Tier II action level of 7 ug/L, were observed in well P219189 during 1998 and 1999.

9.3.2 Scope of Investigation

Surface soil sampling (from 0.0 to 0.5 ft bgs) and subsurface soil sampling from 0.5 ft (at approximate 6 inch sample intervals) to the total achievable depth (total depth varied) was conducted at 11 locations within the investigation area (Figure 9-4). Sample intervals collected at the eleven locations consisted of grab samples for VOCs (non-composited) and composite samples for SVOCs, total metals, PCB/Pesticides, tritium, radionuclides, and radiological screens. For sample locations BH11099 and BH11199, soil pH composite samples were also collected.

Surface water samples from Bowman's Pond were collected to characterize variability in water chemistry throughout the pond and to compare current to previous water quality information. Two separate sampling events were conducted during which surface water sampling was performed.

The two sampling events are described as follows:

- A normal (or base level) sampling event during which runoff and flow conditions in the vicinity of the pond were considered to be at representative or average conditions occurred on April 20, 1999.
- A storm-sampling event took place on April 22, 1999 after a snowfall resulted in above average storm water runoff into the pond. Meteorological records indicate 1.28 inches of precipitation resulted from the snowfall.

For each sampling event, surface water samples were collected at the following locations: one sample from an inflow location at the southwest corner of the pond; one sample from the center of the pond; and one sample from an outflow location in the northeast corner of the pond (see Figure 9-4).

9.3.3 Soil Analytical Results

Five analytes were identified in surface and subsurface soils near or above RFCA Tier II action levels in the investigation area. They are; Benzo(a) Pyrene, Dibenzo(a,h)anthracene, Aroclor-1254, tritium and arsenic.

PCBs

Aroclor-1254 concentrations ranged from below detection to 68 mg/kg. This range of values is both well below and somewhat above the Tier II action level for surface soils of 2.86 mg/kg (industrial land use). The areas in which the levels of Aroclor-1254 exceed the Tier II levels are predominately within the soils/sediments upgradient of and within the influent, center, and south sediments of the pond. With the exception of the 0.5 to 1.5 ft interval from sample location BH11099, the sediments sampled in the effluent area and areas downgradient of the pond were all reported as being less than the Tier II threshold. The distribution of Aroclor-1254 within the surface and shallow subsurface intervals of the investigation area sediments reconfirms the same level of contamination initially identified in the 1991 sampling investigation.

Tritium

The reported values of tritium in soils range from 170 to 1300 pCi/L. There are no associated RFCA action levels for tritium in soils currently available to compare these values against however; PPRG values for an office worker exposure scenario are 44,700 pCi/g representing a 10^{-6} carcinogenic risk. Assuming a worst case scenario of 50% soil saturation, conversion calculations estimate that for this example, 1300 pCi/L is equivalent to 0.43 pCi/g. It should be noted that the laboratories are required by contract to report tritium values for soils in units of pCi/L (as opposed to pCi/g).

Semi-volatile Organics

Benzo(a)pyrene and Dibenzo(a,h)anthracene were the only reported semi-volatile organic compounds detected in the investigation area soil and sediments. The reported concentrations of benzo(a)pyrene and dibenzo(a,h)anthracene range from non-detection to 6400 µg/kg and non-detection to 1600 µg/kg, respectively. The sediments within seven of the eleven borehole locations exceeded the RFCA Tier II action level of 784 µg/kg for benzo(a)pyrene and sediments from two boreholes exceeded the respective RFCA Tier II action level for dibenzo(a,h)anthracene. Both compounds are well below the RFCA Tier I action level of 78,400 µg/kg for each compound.

Total Metals

The reported values for arsenic in soils range from 1.5 to 9.5 mg/kg. The Tier II action level for arsenic is 3.81 mg/kg (RFCA action levels for metals are the same for surface and subsurface soils). The Site-wide mean plus two

standard deviations background concentration of arsenic in surface soils is 10.09 mg/kg (EG&G, 1995b). All reported values for arsenic in soils fall below this value.

Radionuclides

The isotopes: U-233/234, U-235, U-238, Pu-239/240, and Am-241 were evaluated using the "Sum of Ratios" method to assess any potential for remedial actions (RFCA, 1996). For each sampled interval, the reported activities for each radionuclide were divided by their respective Tier II action levels and a sum of their ratios was calculated. The highest calculated sum of ratios for any sample was 0.07.

9.3.4 Surface Water Analytical Results

Volatile organic compound and radiological analytes detected in the three surface water locations at concentrations approaching or above their respective Tier II action levels include carbon tetrachloride and tritium. Although present in the surface water of Bowman's Pond, these contaminants are not identified above RFCA action levels in downgradient Point of Evaluation (POE) and Point of Compliance (POC) monitoring stations.

Volatile Organic Compounds

The concentrations of carbon tetrachloride detected from the two sampling events (normal and storm) for surface water range from 5 to 21 ug/L. These concentrations are at or above the respective RFCA Tier II action level of 5 ug/L. The reported values suggest a general decrease in concentrations from the inflow to the outflow areas of the pond as well as an overall decrease in concentrations during the normal event to the storm event conditions. The decrease in concentration is assumed to be due to a dilution effect of influent waters with the larger volume of water contained within the pond.

Tritium

The reported concentrations of tritium in the surface waters sampled from Bowman's Pond range from 180 to 510 pCi/L. The RFCA action level established for Woman Creek and Walnut Creek, the two main surficial watershed drainages from the Site, is 500 pCi/L. Reported values for tritium fall below this action level with the exception of one sample (the Eastern normal location duplicate sample) which was reported at 510 pCi/L with an estimated error of 180 pCi/L.

Radionuclides

For surface water, each radionuclide was analyzed separately and compared to its respective RFCA action level established for Woman and Walnut Creeks (RFCA, 1996). Total uranium concentrations (the sum of U-233/234, U-235, and U-238) reported for surface water range from 0 to 4.94 pCi/L. This range falls well below the action limit of 10 pCi/L established for Walnut Creek surface water. Concentrations for Pu-239/240 and Am-241 range from 0

to 0.184 and 0 to 0.098 pCi/L, respectively. A concentration of 0.184 pCi/L for Pu-239/240 was observed in one sample from the East (outflow) sampling location of the pond during the normal sampling event.

Normal event radionuclide activities were, in general, higher than activities during the storm event sampling. This suggests that surface runoff does not significantly contribute to radiological contamination in the pond water. An example of this is shown for the one exceeded value for Pu-239/240 of 0.184 pCi/L reported during normal sampling conditions and its corresponding storm event value reported at 0.093 pCi/L.

9.3.5 Conclusions

Prior to the investigation, data from previous investigations, and general process knowledge of the Bowman's Pond soil and sediment (and surrounding areas including IHSS 139.1N) indicated that the Sites were potentially contaminated. Broken OPWLs, Under Building Contamination (UBC) concerns and adjacent IHSSs within and surrounding Buildings 771 and 774 presented potential contaminant sources to the area. Further, the foundation and storm drains from the nearby buildings provide inflow to Bowman's Pond and may be a potential migration pathway for contaminants in the future.

Upon review of available information and data gathered from the investigation, several conclusions were made. These are as follows:

- The Bowman's Pond sediments and surrounding soils (including those associated with IHSS 139.1N) are not highly contaminated. There were no compounds identified at or above the RFCA Tier I surface and subsurface soil action levels.

- PCB contamination above Tier II surface and subsurface soil action levels (Aroclor-1254) is evident in the drainage upgradient of Bowman's Pond (SED 124 and BH10499) and within the sediments of the pond and depositional area at nearly identical concentrations (and locations) as observed in 1991.

- Radionuclide concentrations in soil and sediments are one to two orders of magnitude below the RFCA Tier II surface and subsurface soil action levels and using the Tier II sum of ratios methodology. Based upon this finding, no remedial actions are required for radionuclides.

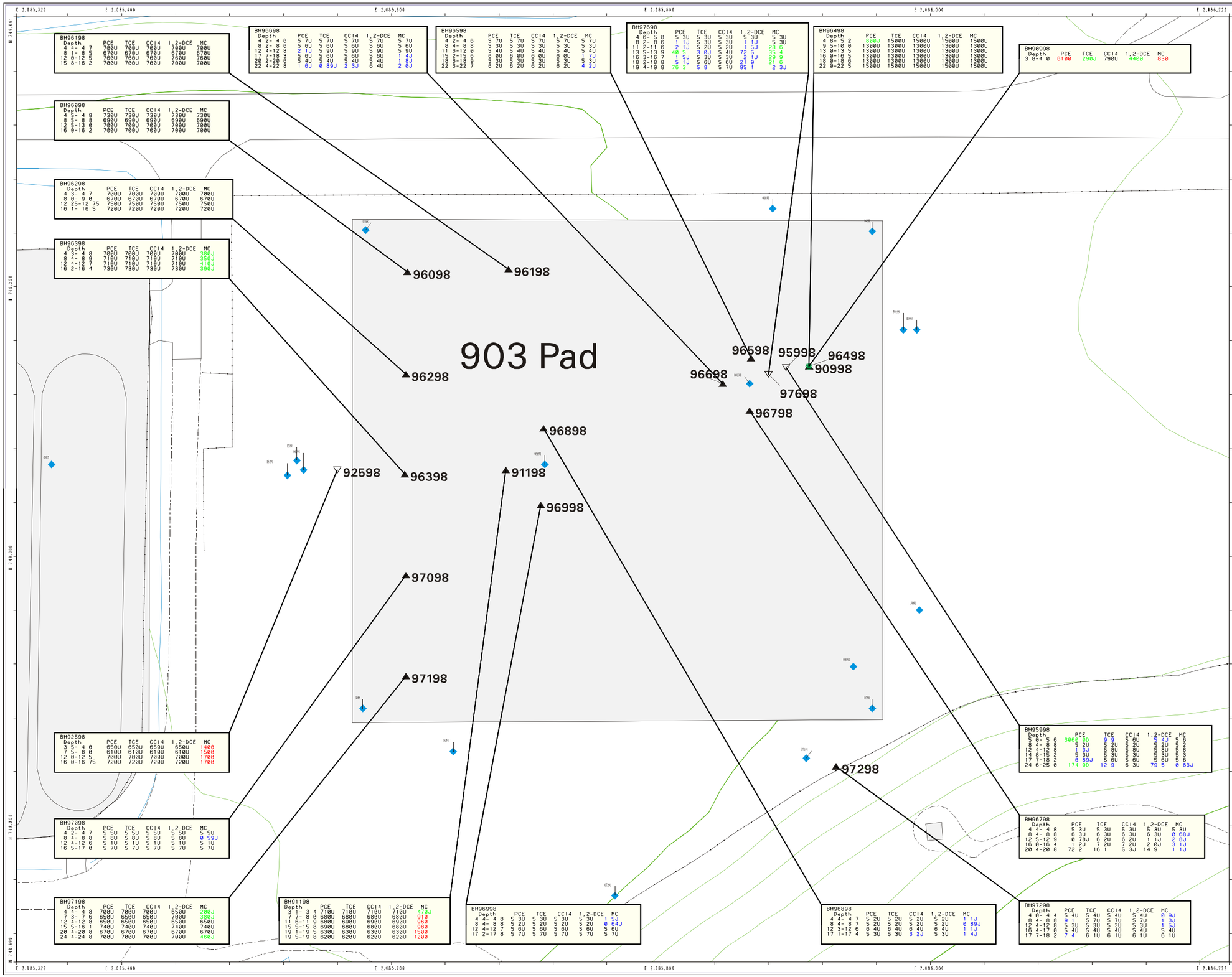
- Core logging of sediment from each of the eleven sampling locations reveals that Bowman's Pond sediments are approximately 4 feet thick near the center of the pond and between 1 and 2 feet thick at influent and effluent areas. The core logs show that sediments within the investigation area are composed of between 3 inches to 1.0 feet of organic matter over approximately one to two feet of gravelly silt and/or silty clay. Silty and highly plastic clays were predominantly observed from approximately 2 feet to the total depth of the boreholes. For boreholes completed in the wetlands outside of the pond, water levels ranged from 0 to 2 inches above ground

surface. Water depth at borehole locations along the edge of the pond ranged from 0 to 2 inches (above sediment) to 1.9 feet at the center of the pond.

- Soil and sediments within IHSS 139.1N are not contaminated with PCOCs identified from the Bowman's Pond surface water, contaminants associated with steam condensate water stored in Tanks T-107 and T-108, or from the bermed sodium hydroxide tank located immediately adjacent to Building 774.

- Concentrations of carbon tetrachloride in surface water from Bowman's Pond exceed the RFCA action level of 5 ug/L for surface water. Although a source has not been clearly identified, it appears that upgradient groundwater contaminated with carbon tetrachloride is entering the Building 771 and/or 774 footing drains (possibly from IHSS 118.1).

Given the findings presented above, it is recommended that the investigation area adjacent to and including Bowman's Pond be evaluated to determine if the levels of contamination identified are protective of surface water and ecological resources. Specifically, PCB contamination is localized within the study area at concentrations between RFCA Tier I and Tier II action levels. Carbon tetrachloride does not exceed RFCA action levels at downgradient surface water monitoring stations; therefore it is recommended that continued monitoring and evaluation be conducted to assess water quality at Bowman's Pond.



BH96198 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 4- 4 7	700U	700U	700U	700U	700U
8 1- 8 5	670U	670U	670U	670U	670U
12 0-12 5	760U	760U	760U	760U	760U
15 8-16 2	700U	700U	700U	700U	700U

BH96698 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 2- 4 6	5 7U	5 7U	5 7U	5 7U	5 7U
8 2- 8 6	5 6U	5 6U	5 6U	5 6U	5 6U
12 4-12 8	2 1J	5 9U	5 9U	5 9U	5 9U
17 7-18 3	5 6U	5 6U	5 6U	5 6U	1 4J
20 2-20 6	5 4U	5 4U	5 4U	5 4U	1 8J
22 4-22 8	1 6J	0 89J	2 3J	6 4U	2 0J

BH96598 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 2- 4 6	5 7U	5 7U	5 7U	5 7U	5 7U
8 4- 8 8	5 3U	5 3U	5 3U	5 3U	5 3U
11 6-12 0	5 4U	5 4U	5 4U	5 4U	5 4U
15 2-15 6	6 0U	6 0U	6 0U	6 0U	1 7J
18 6-18 9	5 3U	5 3U	5 3U	5 3U	5 3U
22 3-22 7	6 2U	6 2U	6 2U	6 2U	4 2J

BH97698 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 6- 5 8	5 3U	5 3U	5 3U	5 3U	5 3U
8 2- 8 6	1 1J	5 3U	5 3U	1 1J	5 3U
11 2-11 6	2 1J	5 2U	5 2U	1 5J	28 6
13 5-13 9	40 5	3 0J	5 4U	72 6	35 4
16 3-16 7	1 5J	5 3U	5 3U	2 1J	29 0
18 2-18 8	5 1J	5 6U	5 6U	21 9	21 6
19 4-19 8	76 3	5 8	5 7U	95 1	2 3J

BH96498 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 8- 5 2	550J	1500U	1500U	1500U	1500U
9 5-10 0	1300U	1300U	1300U	1300U	1300U
13 0-13 5	1300U	1300U	1300U	1300U	1300U
16 0-16 5	1300U	1300U	1300U	1300U	1300U
18 0-18 6	1300U	1300U	1300U	1300U	1300U
22 0-22 5	1500U	1500U	1500U	1500U	1500U

BH90998 Depth	PCE	TCE	CCl4	1,2-DCE	MC
3 8-4 0	6100	290J	790U	4400	830

BH96098 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 5- 4 8	730U	730U	730U	730U	730U
8 5- 8 8	690U	690U	690U	690U	690U
12 5-13 0	700U	700U	700U	700U	700U
16 0-16 2	700U	700U	700U	700U	700U

BH96298 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 3- 4 7	700U	700U	700U	700U	700U
8 0- 9 0	670U	670U	670U	670U	670U
12 25-12 75	750U	750U	750U	750U	750U
16 1- 16 5	720U	720U	720U	720U	720U

BH96398 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 3- 4 8	700U	700U	700U	700U	380J
8 4- 8 9	710U	710U	710U	710U	350J
12 4-12 7	710U	710U	710U	710U	410J
16 2-16 4	730U	730U	730U	730U	390J

BH92598 Depth	PCE	TCE	CCl4	1,2-DCE	MC
3 5- 4 0	650U	650U	650U	650U	1400
7 5- 8 0	610U	610U	610U	610U	1500
12 0-12 5	700U	700U	700U	700U	1700
16 0-16 75	720U	720U	720U	720U	1700

BH97098 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 2- 4 7	5 5U	5 5U	5 5U	5 5U	5 5U
8 4- 8 8	5 8U	5 8U	5 8U	5 8U	0 59J
12 4-12 6	5 1U	5 1U	5 1U	5 1U	5 1U
16 5-17 0	5 7U	5 7U	5 7U	5 7U	5 7U

BH97198 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 4- 4 8	700U	700U	700U	650U	200J
7 3- 7 6	650U	650U	650U	700U	380J
12 4-12 8	650U	650U	650U	650U	650U
15 5-16 1	740U	740U	740U	740U	740U
20 4-20 8	670U	670U	670U	670U	670U
24 4-24 8	700U	700U	700U	700U	460J

BH91198 Depth	PCE	TCE	CCl4	1,2-DCE	MC
3 1- 3 4	710U	710U	710U	710U	470J
7 7- 8 0	680U	680U	680U	680U	910
11 6-11 9	690U	690U	690U	690U	960
15 5-15 8	690U	690U	690U	690U	980
19 1-19 5	630U	630U	630U	630U	1500
19 5-19 8	620U	620U	620U	620U	1200

BH96998 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 4- 4 8	5 3U	5 3U	5 3U	5 3U	1 5J
8 4- 8 8	5 2U	5 2U	5 2U	5 2U	0 64J
12 4-12 7	5 6U	5 6U	5 6U	5 6U	5 6U
17 2-17 8	5 7U	5 7U	5 7U	5 7U	5 7U

BH96898 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 4- 4 7	5 2U	5 2U	5 2U	5 2U	1 1J
8 4- 8 7	5 2U	5 2U	5 2U	5 2U	0 89J
12 3-12 6	6 4U	6 4U	6 4U	6 4U	1 1J
17 1-17 4	5 3U	5 3U	3 2J	5 3U	1 4J

BH95998 Depth	PCE	TCE	CCl4	1,2-DCE	MC
5 0- 5 8	3000 50	9 0	5 6U	5 4J	5 6
8 4- 8 8	5 2U	5 2U	5 2U	5 2U	5 2
12 4-12 8	1 3J	5 8U	5 8U	5 8U	5 8
14 8-15 2	5 3U	5 3U	5 3U	5 3U	5 3
17 7-18 2	0 89J	5 6U	5 6U	5 6U	5 6
24 6-25 0	174 60	12 9	6 3U	79 5	0 83J

BH96798 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 4- 4 8	5 3U	5 3U	5 3U	5 3U	5 3U
8 4- 8 8	6 3U	6 3U	6 3U	6 3U	0 68J
12 5-12 9	0 78J	6 2U	6 2U	1 1J	2 8J
16 0-16 4	1 2J	7 2U	7 2U	2 0J	3 1J
20 4-20 8	72 2	16 1	5 3J	14 9	1 1J

BH97298 Depth	PCE	TCE	CCl4	1,2-DCE	MC
4 0- 4 4	5 4U	5 4U	5 4U	5 4U	0 9J
8 4- 8 8	9 1	5 7U	5 7U	5 7U	1 3J
12 4-12 8	5 3U	5 3U	5 3U	5 3U	1 5J
16 4-17 0	5 4U	5 4U	5 4U	5 4U	5 4U
17 7-18 2	7 4	6 1U	6 1U	6 1U	6 1U

Figure 9-1

903 Pad VOC Investigation and VOC Distribution in Soil

1999 Annual RFCA Groundwater Monitoring Report

EXPLANATION

- ▲ VOC Boreholes, Original
- ▽ VOC Boreholes, Stepout
- Radiological Borehole
- ● Borehole location
  BoreHole PCE TCE CCL4 1,2-DCE
  Sample Depth Results in Feet
  VOC Compound Results in ug/kg
- ◆ Groundwater Well

NOTE:
VOC detections in blue
Tier I Exceedance in red
Tier II Exceedance in green
PCE = Tetrachloroethene
TCE = Trichloroethene
CCL4 = Carbon Tetrachloride
1,2-DCE = 1,2-Cis-Dichloroethylene
MC = Methylene Chloride

U = Undetected, Contract Required Quantitative Limit
J = Associated Value is an Estimated Quantity
D = Dilution

Standard Map Features

- Buildings and other structures
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

*NOTE: Figure originally from the Characterization Report for the 903 Drum Storage Area, 903 Lip Area and Americium Zone (RMRS, 1999)

N

Scale = 1 : 840
1 inch represents 70 feet

25 0 50 100ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL

MAP ID: RFCA-RPT

December 07, 2000

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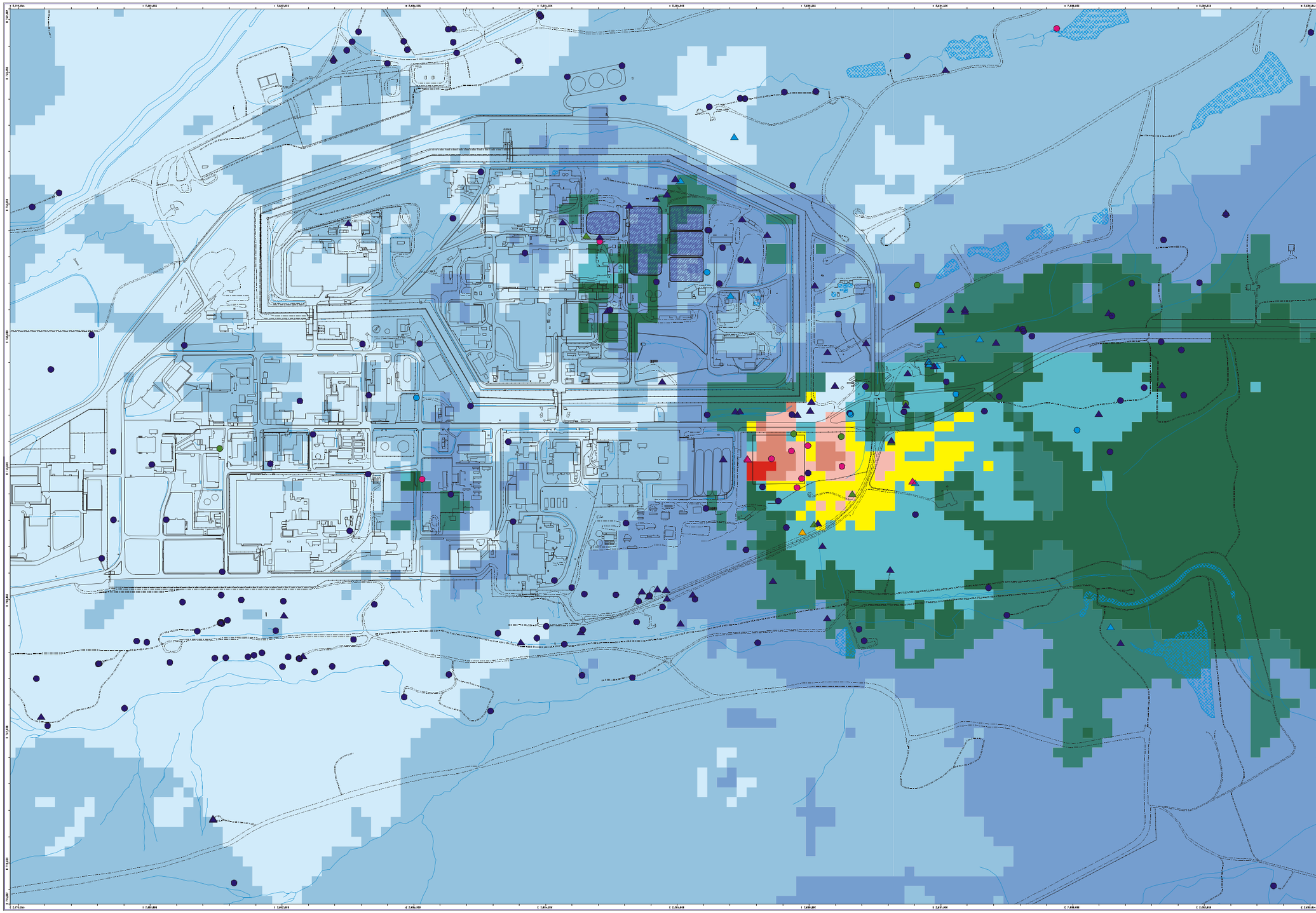

Figure 9-2

Unfiltered Plutonium 239/240 in UHSU Groundwater Superimposed on Surface Soil Plutonium 239/240 Concentrations 1991-1995

1999 Annual RFCA Groundwater Monitoring Report

EXPLANATION

Plutonium 239/240 Activity in Groundwater Wells (Units = pCi/L)

Alluvium Wells		Bedrock Wells
●	0.0 to 0.05	▲
●	0.05 to 0.15	▲
●	0.15 to 0.5	▲
●	0.5 to 1.0	▲
●	> 1.0	▲

Plutonium 239/240 Activity in Surface Soils Kriged Data (Units = pCi/g)

- < = 0.1 (2365.9 Acres)
- > 0.1 and < = 1.0 (2363.5 Acres)
- > 1.0 and < = 5.0 (945.7 Acres)
- > 5.0 and < = 10.0 (184.8 Acres)
- > 10.0 and < = 25.0 (272.3 Acres)
- > 25.0 and < = 100.0 (50.6 Acres)
- > 100.0 and < = 252.0 (11.4 Acres)
- > 252.0 and < = 1429.0 (4.9 Acres)
- > 1429.0 and < = 10000.0 (2.8 Acres)
- > 10000.0 (0.6 Acres)

Standard Map Features

- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Data Source:
Soil Pu concentrations from K-H, 2000, Report on Soil Erosion and Surface Water Sediment Transport, OU-RF-01823.

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N

Scale = 1 : 8770
1 inch represents approximately 731 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL

MAP ID: rfca-rpt/figures/unfiltered_pu/pu_poly.aml

November 16, 2000

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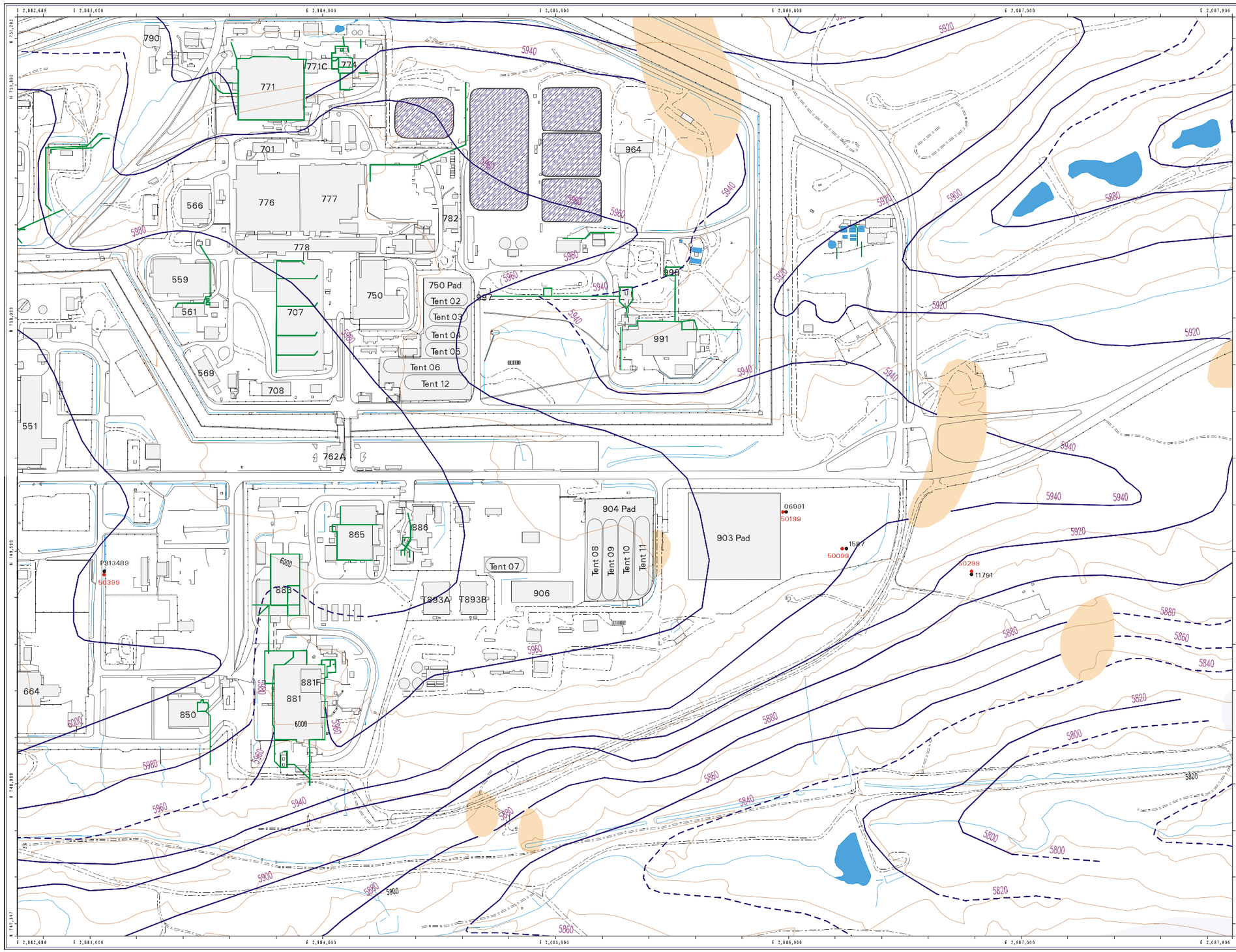

Figure 9-3

Monitoring Well Locations
Actinide Drilling Artifact Contamination Project

1999 Annual RFCA Groundwater Monitoring Report

- Actinide Monitoring Well Location
- Existing Groundwater Monitoring Well
- Water Level Contour -- 2nd Qtr. 1999
- Dashed where inferred
- Foundation Drain
- Approximate extent of Unsaturated Area

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads
- Contours (20' Intervals)

NOTE:
Contours Represent April 1999 Data

Scale = 1 : 5090
1 inch represents approximately 424 feet

100 0 200 400 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL

MAP ID: rfca-rpt/figures/act_drilling_artifact

November 14, 2000

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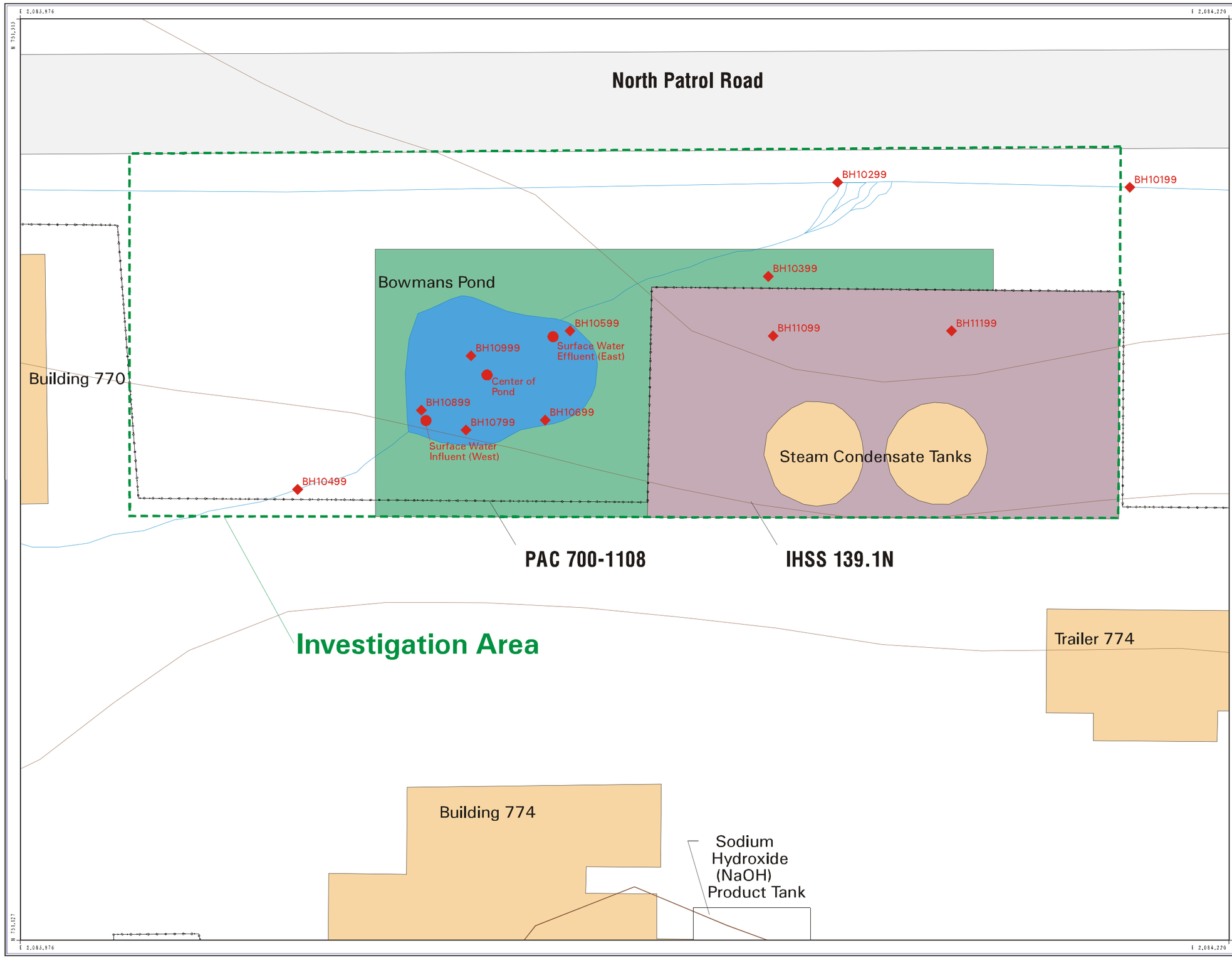

Figure 9-4

Bowmans Pond Investigation Location Map
Bowmans Pond (PAC 700-1108) and Steam Condensate Tanks (IHSS 139.1N)

1999 Annual RFCA Groundwater Monitoring Report

EXPLANATION

- 1999 Boreholes
- 1999 Surface Water Sampling Locations
- Investigation Area
- PAC 700-1108
- IHSS 139.1N
- North Patrol Road

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)

Scale = 1 : 230
1 inch represents approximately 19 feet

5 0 10 20ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL

MAP ID: 99-0384

September 28, 2000

Original map contents are preserved. Logo and date have changed.

NT_Svr w:/projects/fy2k/rfca-rpt/figures/bowmans_pond/bowmans_pond.aml

10.0 OTHER GROUNDWATER PROGRAM ACTIVITIES

10.1 Well Control Program

The Well Control Program (WCP) establishes the administrative guidelines for the installation of all new monitoring wells and piezometers at RFETS. The procedures which comprise the WCP will be implemented through the Water Programs Division; more specifically Groundwater Operations. The WCP was integrally designed to assure compliance with the procedures for monitoring well installations at RFETS and the complete documentation of all pertinent data relative to all monitoring wells installed at RFETS. It also assures compliance with the regulations set forth by the State of Colorado, Office of the State Engineer, State Board of Examiners of Water Well Construction and Pump Installation Contractors, in 2 CCR 402-2, *Revised and Amended Rules and Regulations of the Board of Examiners of Water Well Construction and Pump Installation Contractors.* The WCP also provides guidance to the organization or individual responsible for installation of the monitoring well(s) or piezometer(s) regarding the interface between the WCP and applicable RFETS soil disturbance procedures.

A Well Control Program was originally placed in effect by EG&G on June 1, 1995. After one year the original WCP expired and was not reinstated. The new WCP described in this section was adopted in 1999. The new procedure document number is 1-K92-RFP-94-001, Revision 1.

The purpose of the WCP program is threefold. First, to protect groundwater at RFETS from improper drilling and well installation procedures, and to ensure that each installation receives a unique well name. Second, to ensure that all permitting activities required by the State of Colorado are complied with. Third, to create a central repository for data collection and management with respect to all data generated from the installation and sampling of new monitoring wells and piezometers.

10.2 Well Abandonment and Installation

During 1999 there were 69 monitoring wells or piezometers installed at RFETS. Table 10-1 summarizes the 1999 monitoring wells and piezometers and their purpose. Figure 10-1 presents the locations of the 1999 monitoring well installations and abandonments. Monitoring well logs and well construction diagrams for 1999 well installations found in appendix D. Three alluvial monitoring wells were destroyed in 1999 as a result of D&D, remediation, or other activities. These were well 2987, located above the SID and east of Pond C1, well 60295, located at south side of the East Trenches Groundwater Treatment System, and well 02297, located by Building 779. For the Solar Ponds Plume Groundwater Treatment System five monitoring wells were removed because they interfered with the collection trench at the east end. These were wells 44893, 44993, 45093, 45293, 45393.

Table 10-1 1999 Monitoring Well Installations

Well No.	Purpose of Well
15199	Monitoring for the Mound groundwater treatment system
15299	Monitoring for the Mound groundwater treatment system
15399	Monitoring for the Mound groundwater treatment system
15499	Monitoring for the Mound groundwater treatment system
15599	Performance Monitoring for the Mound groundwater treatment system
15699	Performance Monitoring for the Mound groundwater treatment system
15799	Performance Monitoring for the Mound groundwater treatment system
16199	Monitoring the Mound Plume Treatment System
16299	Monitoring the Mound Plume Treatment System
16399	Monitoring the Mound Plume Treatment System
16499	Monitoring the Mound Plume Treatment System
16599	Monitoring the Mound Plume Treatment System
18199	Plume Degredation well monitoring the IHSS 118.1 plume and Building D&D well monitoring Building 771
18299	Plume Degredation well monitoring the IHSS 118.1 plume
18399	Plume Degredation well monitoring the IHSS 118.1 plume
18499	Plume Degredation well monitoring the IHSS 118.1 plume
18599	Plume Degredation well monitoring the IHSS 118.1 plume
18699	Plume Degredation well monitoring the IHSS 118.1 plume
18799	Plume Degredation well monitoring the IHSS 118.1 plume
18899	Plume Degredation well monitoring the IHSS 118.1 plume
40099	D & D Monitoring for Building 444 Complex D&D
40199	D & D Monitoring for Building 444 Complex D&D
40299	D & D Monitoring for Building 444 Complex D&D
40399	D & D Monitoring for Building 444 Complex D&D
40499	D & D Monitoring for Building 444 Complex D&D
40599	D & D Monitoring for Building 771 Complex D&D
40699	D & D Monitoring for Building 771 Complex D&D
40799	D & D Monitoring for Building 771 Complex D&D
40899	D & D Monitoring for Building 771 Complex D&D
40999	D & D Monitoring for Buildings 865 and 886 D&D
41099	Building D&D well monitoring potential rad contamination near 886 lab
41199	Building D&D well monitoring potential rad contamination near 886 lab
41299	D & D Monitoring for Building 444 Complex D&D
41499	D & D Monitoring for Building 771 Complex D&D
41599	D & D Monitoring for Building 771 Complex D&D
50099	Actinide Migration Evaluation 903 Lip Area/Americium Zone
50199	Actinide Migration Evaluation 903 Lip Area/Americium Zone
50299	Actinide Migration Evaluation 903 Lip Area/Americium Zone
50399	Actinide Migration Evaluation 903 Lip Area/Americium Zone
60099	East Industrial Area Plume. NW corner B776
60199	East Industrial Area Plume West side B776
60299	D&D Monitoring for Building 776/777 Complex (EIAP Well Initially)

Table 10-1 1999 Monitoring Well Installations, continued

Well No.	Purpose of Well
60399	D & D Monitoring for Building 707 D&D (EIAP Well Initially)
60499	D & D Monitoring for Building 707 D&D (EIAP Well Initially)
60599	D & D Monitoring for Building 707 D&D (EIAP Well Initially)
60699	D & D Monitoring for Building 707 D&D (EIAP Well Initially)
60799	D & D Monitoring for Building 707 D&D (EIAP Well Initially)
60899	East Industrial Area Plume
61099	D & D Monitoring for Building 883 D&D (EIAP Well Initially)
61199	D & D Monitoring for Building 883 D&D (EIAP Well Initially)
61299	East Industrial Area Plume
61399	East Industrial Area Plume Perimeter Road
61499	D & D Monitoring for Building 707 D&D (EIAP Well Initially)
70099	Performance Monitoring of groundwater treatment system below Solar Ponds
70299	Performance Monitoring of groundwater treatment system below Solar Ponds
70799	Monitoring of groundwater treatment system below Solar Ponds
70899	Monitoring of groundwater treatment system below Solar Ponds
70999	Monitoring of groundwater treatment system below Solar Ponds
71099	Monitoring of groundwater treatment system below Solar Ponds
90099	Plume Definition well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90199	Plume Definition well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90299	Plume Definition well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90399	Plume Definition well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
95099	Performance Monitoring of groundwater treatment system below East Trenches
95199	Performance Monitoring of groundwater treatment system below East Trenches
95299	Performance Monitoring of groundwater treatment system below East Trenches
95699	Monitoring of groundwater treatment system below East Trenches
95799	Monitoring of groundwater treatment system below East Trenches
95899	Monitoring of groundwater treatment system below East Trenches

10.3 Groundwater Data Quality Review

The groundwater data cleanup task was started in calendar year 1999 and consisted of reviewing survey coordinates and providing areal descriptions of 1,285 well locations in support of the FY2000 Soil Water Database (SWD) Data Quality Review effort. The SWD Data Quality Review effort was initiated to address known data quality issues in SWD resulting primarily from legacy data, and to improve overall SWD data quality in support of the Site's accelerated Closure Mission. During the effort, deficiencies, missing information, incorrect information, and other

various data quality issues with SWD electronic data were identified and are in the process of being evaluated and addressed. Key activities include:

- Identifying and finding missing historical analytical data, and uploading data where possible.
- Adding missing electronic validation qualifiers to SWD data for samples collected prior to the completion of the SWD
- Modifying the electronic data systems to reduce redundant data entry and to provide more controlled data entry for environmental field results
- Formalizing data management procedures through development of an Environmental Data Management Procedure
- Reviewing and updating project codes and sample types
- Evaluating and repairing standard data links between location codes (Well No.) with electronic analytical data
- Developing a Master Location Table to synchronize sample geographic data between SWD and the Site's Geographic Information System (GIS), and
- Improving SWD data accessibility and usability through development of simplified user interfaces.

All of the data quality improvement activities are designed to improve the overall usability of SWD data and support increased data analysis and improved and more efficient data reporting. The SWD data quality review effort is ongoing and additional efforts are planned for FY01. The results of these efforts can be found in the Integrated Site-wide Environmental Data System (ISEDS), which provides environmental data to the Site regulators. Public stakeholders are able to access and download approved environmental reports through the Environmental Data Dynamic Information Exchange (EDDIE) web site. The EDDIE web site provides environmental monitoring information to Stakeholders on an ongoing basis. It is designed to allow easy electronic access to reports of routine and special monitoring projects at Rocky Flats Environmental Technology Site as the Site proceeds with its Closure Mission. The EDDIE web site can be accessed at http://www.RFETS.gov and select "environmental data" from the main menu.

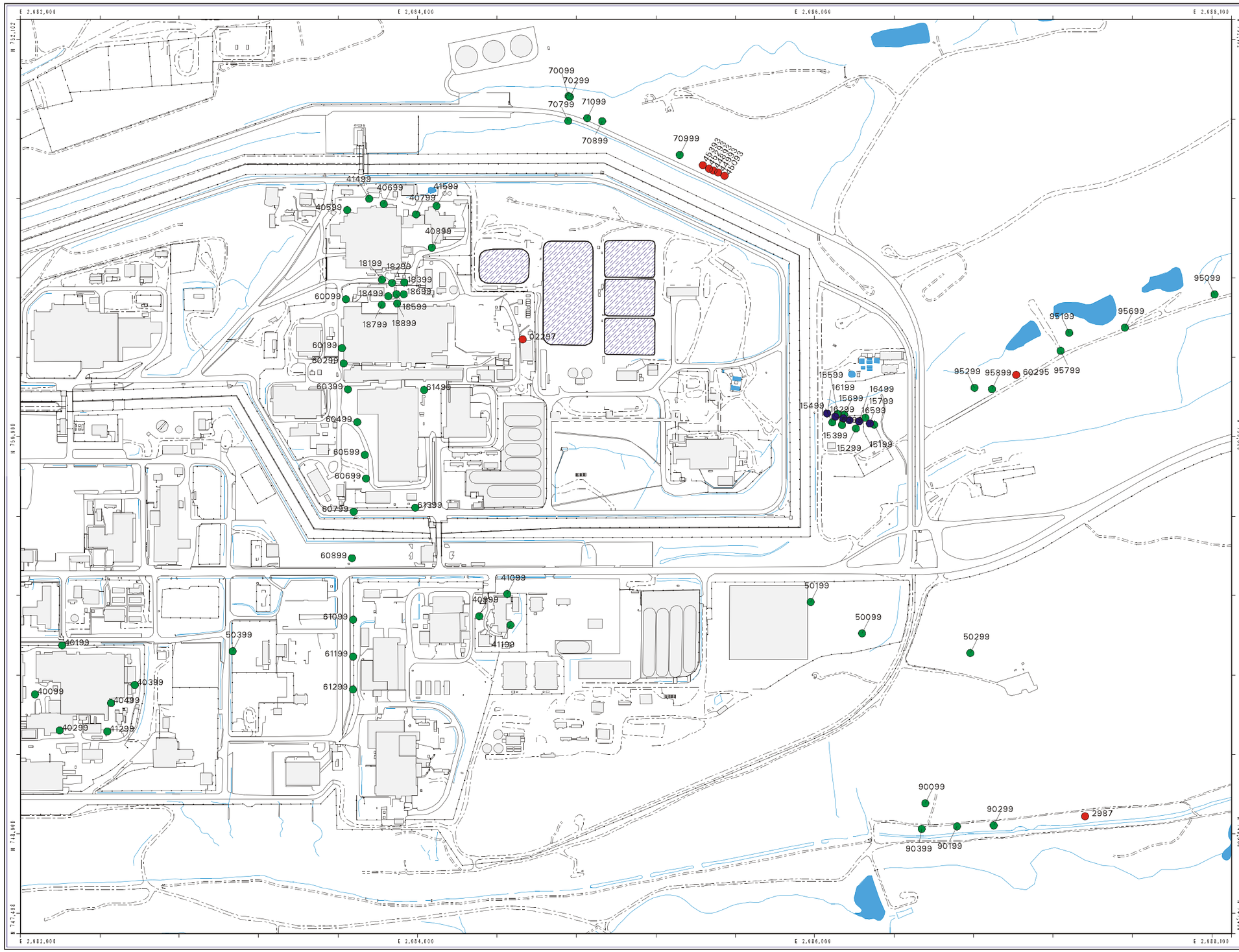

Figure 10-1
CY1999
Well Abandonments and Installations

1999 Annual RFCA Groundwater Monitoring Report

EXPLANATION

- 1999 Groundwater Monitoring Well Abandonments

  Note: Wells 02297, 60295, and 2987 were damaged or destroyed in 1999 and will be properly abandoned in the future.

- 1999 Groundwater Monitoring Well Completions

- 1999 Groundwater Monitoring Well Completions around the Mound Plume Nos. 16199 - 16599 (left to right)

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSI, Las Vegas.
Digitized from the orthophotographs, 1/95

Scale = 1 : 5940
1 inch represents 495 feet

200 0 400 800ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by:
DynCorp
THE ART OF TECHNOLOGY

Prepared for:
KAISER-HILL

MAP ID: rfca-rpt

November 14, 2000

NT_Svr w:/projects/fy2k/rfca-rpt/figures/well_abandonments/gw_aban-inst.aml

11.0 GROUNDWATER DATA QUALITY ASSESSMENT

All Section 11.0 Tables are found in Appendix E.

11.1 Methods

The quality of the analytical data is assessed in terms of five data-quality parameters: precision, accuracy, representativeness, completeness, and comparability, referred to as PARCC parameters (EPA, 1992a). This section summarizes the types of data available to assess the PARCC parameters.

The RFETS groundwater monitoring program, as established in the 2000 IMP, consists of 114 wells that are sampled at a quarterly or semi-annual frequency (K-H, 1999a). This report also contains data from 19 D&D wells installed in late 1999 (the 40099 and 90099 series wells) after publication of the IMP list, and three other existing wells that are being used for D&D at specific buildings (wells 20998, P317989 and P419689). A total of 287 well sampling visits were conducted during 1999. This represents all required visits and does not reflect multiple visits to wells that were dry or only provide water on a limited basis. Except in the case of one damaged (2987) well in the fourth quarter, all samples specified in the IMP were collected unless well disposition was prohibitive (i.e. dry, or went dry during sampling). For 1999, 2105 samples were to have been collected; the actual number collected was 1430 due to dry conditions, wells with insufficient water, or well damage. Table 2-1 presents a summary of sample collection and well disposition.

Quality Control (QC) samples consisting of real/duplicate pairs were collected from 15 locations and rinsate samples were collected from 10 locations. The frequency for field duplicate sampling of 1 in 9.07 locations exceeded the target rate of 1 location in 20 for the 1999 sampling program. Similarly, the frequency for field rinsate sampling of 1 location in 13.6 exceeded the target rate of 1 in 20 for 1999. PARCC analysis of the 1999 QC data is presented in the following sections. Data used to evaluate the PARCC parameters are summarized in this report, and are presented in full in the quarterly monitoring reports (RMRS 1999k; 1999l; 2000a and 2000b).

Precision

Precision is a measure of the reproducibility of analytical results. Precision is expressed quantitatively by the relative percent difference (RPD) between duplicate field samples for VOCs, metals, and water quality parameters as defined by the following equation:

$$RPD = \frac{|(S-D)|}{(S+D)/2} \times 100$$

where, S = Sample Result
D = Duplicate or Lab Replicate Result

With respect to Radionuclides the RFETS Groundwater Program uses the following “Duplicate Error Ratio” (DER) equation:

$$DER = \frac{|S-D|}{[(TPU_S^2 + TPU_D^2)]^{1/2}}$$

where,

TPUs = total propagated uncertainty of the Sample
TPU_D = total propagated uncertainty of the Duplicate or Lab Replicate
S = Sample Result
D = Duplicate or Lab Replicate Result

Because the laboratory hard copies and Electronic Data Deliverables (EDDs) rarely report TPU except for Tritium (H_3) analyses, the 2-Sigma Error has been substituted for TPU in the Uranium and Americium/Plutonium calculations made for this report. No tritium DERs were calculated because all of the tritium results were "U" qualified non-detections by the laboratories. (see below)

Between the First and Second Quarter 1999 Groundwater Reports (RMRS, 1999k and 1999l) several changes were made in the criteria that determine which real/duplicate pairs are selected for RPD/DER calculations. The RPD/DER calculation criteria are summarized in Table 11-2.

The QC criterion for RPDs is ≤30%, for DERs the criterion is ≤1.96. Tables 11-1a and 11-1b give a summary of the RPD and DER results for groundwater in 1999. Table 11-2 gives a brief summary of the overall precision compliance for RPDs and DERs from the major analytical groups. The overall precision compliance goal is 85%.

Accuracy

Accuracy is a measure of how closely an analytical result corresponds to the "true" concentration in a sample. Accuracy, as applied to groundwater analytical data from RFETS, is described in *Evaluation of Data for Usability in Final Reports* (RMRS, 1998e). This evaluation describes how to compare required analytical methods and detection limits with actual methods and detection limit for each analyte. Table 11-3 presents such a comparison between the Required and Actual Analytical Methods and Contract-Required Detection Limits (CRDLs) and Actual Detection Limits for the various analytes in 1999.

Additional information on the accuracy of laboratory analyses is given by matrix spike and laboratory control samples. Matrix spike recovery data for VOCs, metals, water quarterly parameters (WQPs) and PCBs are given in Table 11-4 and lab control sample recoveries for radionuclides are given in Table 11-5. These tables include all the matrix spike data for 1999 because these data were not included in the First and Second Quarter Groundwater Reports (RMRS, 1999k and 1999l). Acceptable criteria for matrix spike and lab control sample samples are between 80 and 120 percent recovery.

Representativeness

The discussion of representativeness in this section is limited to an evaluation of whether analytical results for field samples are truly representative of environmental concentrations or whether they may have been influenced by the introduction of contamination during their collection and handling. The potential introduction of contamination is evaluated by examination of the analytical results for equipment rinsates (Table 11-6). Equipment rinsates are used

to assess the efficacy of the decontamination process and possible cross-contamination between environmental samples. They are samples of volatile free "distilled" water that have been poured over or through decontaminated sampling equipment and subsequently handled in the same manner as environmental samples.

Although rinsates are used specifically as indicators of cross-contamination subsequent to decontamination of equipment, they are carried through the entire sampling, shipping, and laboratory process and are, consequently, also good indicators of potential contamination introduced during any of these steps.

Other aspects of representativeness such as numbers of samples and spatial distribution are fixed in the IMP (K-H, 1999a). All well visits that were required by the IMP were completed in 1999. Plate 1 presents the locations sampled for reference to the spatial distribution of the samples.

Completeness

Table 11-7 compares the actual number of samples collected in 1999 to the required number of samples. As a result of dry wells or wells with such low productivity as to prohibit sample collection, the completeness goal of 90% was not met for any of the major analyte groups. (With respect to minor analyte groups, the six Total Recoverable Petroleum Hydrocarbon samples collected in the Fourth Quarter represent the only sampling suite that was completed.)

Completeness is also a quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system. Table 11-8 summarizes the validation completeness evaluation. Detailed validation and verification data for all analytes and samples are provided in the 1999 quarterly reports (RMRS 1999k, 1999l, 2000a, and 2000b). A completeness metric was calculated using the following formula:

Completeness = $Dp_u = \frac{DP_t - DP_n}{DP_t} \times 100$ (in percent) The completeness criterion is $\geq$ 90%.

Where:
Dp_u = Percentage of usable data points
DP_n = Non-usable data points
DP_t = Total number of data points

Comparability

During 1999 planned analytical methods for VOCs, metals, water quality parameters and radionuclides remained consistent over the entire year. Table 11-3 lists the required methods for the various analytes. Laboratory analyses were performed according to standard CLP protocols and results should be comparable to data produced by similar methods.

11.2 Discussion of Analyte Groups

11.2.1 Metals

Precision

There were 31 duplicate sample events paired with the 202 real sample events in the data set for metals in 1999 (1 in 6.5). For the 31-real/duplicate pairs there were 837 records for analyses. From these there were 400 instances of detections in which an RPD could be calculated (Table 11-1b). Three hundred twenty nine (329) of the calculated RPDs were within the QC criterion of $\leq$30% (Table 11-3). With 82.3% of the RPDs meeting the QC criterion, precision for dissolved metal analysis was below the acceptable goal of 85%.

The recommended frequency for duplicate samples is 1 in 20 on a per-well basis. In 1999, 12 of 136 wells sampled were analyzed for metals as real/duplicate pairs, a ratio of 1 in 11.3. Thus duplicate sample frequency was within the requirements on both a per-well and per-analysis basis.

Accuracy

All metal analyses were performed using contract-required methods during 1999. Contract- required methods stipulate the CLP-SOW method for analysis of dissolved metals. As shown on Table 11-3, analyses were run using this method for all dissolved metal samples. Additional analyses were run using CLP-SOW for total metals. The total metals analyses were run as necessary in support of various groundwater evaluations, and to analyze samples collected with dedicated pumps using the low-flow (micropurging) techniques. Based on the Table 11-4 summary, methods used during 1999 for analysis of metals meet or exceed the requirements described in *Evaluation of Data for Usability in Final Reports (RMRS,1998e).*

Table 11-3 also presents a summary of the comparison of required to actual detection limits for analyses of samples collected in 1999. Actual detection limits for 21 metals were at or below CRDLs for 100 percent of the analyses performed. Six analytes had actual detection limits for which some analyses were above CRDLs. The analytes were, antimony with acceptable actual detection limits in 95% of the analyses, arsenic (98%), lead (96%), selenium (54%), silver (15%), and thallium (15%). Discussion and data accuracy evaluations for specific samples and analyses are presented in the quarterly reports.

Representativeness

There were 432 rinsate records versus 5454 real sample records for metals in 1999 (1 in 12.6). Most metals rinsate results were either “U” (non-detection) or “B” (detection was less than the CRDL but greater than the IDL) qualified indicating that in general no metals contamination was introduced during sampling and/or shipping activities. As shown on Table 11-6, metals were detected in 16 rinsate analyses. All analyses yielded results below Tier II limits where a Tier II limit is defined.

Completeness

The Integrated Monitoring Plan (K-H, 1999a) requires that samples be analyzed for metals in 122 wells. Sampling for metals was attempted in all the required wells during 1999 (Table 11-7). Thirty-nine wells were dry or went dry during sampling; resulting in 55 metals samples that could not be collected. One sample could not be collected because of a damaged well casing (well 2987). Of the 258 metal sample events required by the IMP, 202 were successfully completed during 1999, a success rate of 78.3% (Table 11-7). The goal, which assumes adequate groundwater production from the monitoring wells, is at least 90% successfully sampled.

All metals sampling records were either validated or verified in 1999. Validation of metals records was performed on 44.6% (3024 of 6777 analyses), which is well above the 25% criterion defined in the IMP. Of the analyses that were validated or verified, 2 were rejected (R-validated), 6775 analyses were judged to be acceptable and valid. Because of the relatively low number of rejected analyses the metals results were found to be acceptable for 99.9% (6775 of 6777) of the analyses (Table 11-8).

Comparability

No changes were made to analytical procedures during 1999. Thus analyses from 1999 are comparable to previous analyses.

11.2.2 Radionuclides

Precision

The data set for radionuclides (americium-241, plutonium-239/240, uranium isotopes U-233/234, U-235, and U-238, tritium, and strontium-89/90) contains 65 duplicate sampling events versus 422 real events (1 in 6.5). A DER could be calculated for 59 of the 140 duplicate/real analytical pairs (Table 11-1a). All but two of the DER values (U-235 in well 70393 and U-238 in well 70193) were below the 1.96 precision limit. As shown on Table 11-2, the precision metric was met in 93.2% of radionuclide duplicate/real samples.

Accuracy

All radionuclide analyses were performed using the proper contract required methods during 1999 (Table 11-3). With respect to analytical methods, the 1999 results are accurate. Required detection limits for the radionuclide analyses performed during 1999 were met except for two analyses. The plutonium analyses in well 3586 (Dup) and well 02497 exceeded the CRDL. As such, the accuracy of radionuclide analyses is generally good.

Representativeness

There were 75 rinsate records from radionuclide radionuclides (americium-241, plutonium-239/240, uranium isotopes U-233/234, U-235, and U-238 and tritium) collected at 7 locations in 1999. Ten rinsate analyses yielded detectable values (Table 11-6). Two detectable results for uranium are recorded as negative but were not “U”

qualified by the laboratory. In any case, all detections were below Tier II Action Levels. Based on 67 of 75 (89.3%) of rinsate results being undetected, there is little indication of introduced contamination during sampling activities being a concern for 1999 radionuclide data.

Completeness

As shown on Table 11-7, 166 plutonium/americium, 263 uranium isotope, 96 tritium, 48 strontium-89/90, 12 cesium -137 and 8 neptunium-237 samples were to have been collected for analyses. All the required samples were collected or attempted. The success rate varied due to dry wells or wells that went dry during sampling. The percentages of successful sample collection were 69.9% for Pu/Am, 76.8% for U-isotopes, 69.8% for tritium, 66.7% for, strontium-89/90, 33.3% for cesium-137 and 12.5% for neptunium-237. The goal is 90%, groundwater conditions permitting.

All radionuclide results (1161) except for 8 cesium -137 and 1 neptunium-237 were either validated or verified (99.2%). Of the validated/verified results (a total of 1152) 7.7% (89) were validated and 92.3% (1063) were verified. The percentage for validation is well below the 25% criterion while the percentage for verification is well above the criterion. Only 3 uranium analyses (0.26%) of the validated/verified results were rejected. As shown in Table 11-8, 100% of the plutonium/americium, tritium, strontium-89/90, cesium-137 and neptunium-237 radionuclide analyses are usable. 99.6% of the uranium analyses are usable. In general the radionuclide analyses are thought to be complete.

Comparability

No changes were made to analytical procedures during 1999. Thus the radionuclide analyses presented here are assumed to be comparable to previous analyses.

11.2.3 Volatile Organic Compounds and Semi-Volatile Organic Compounds

Precision

There were 33 duplicate sampling events versus 231 real records for VOCs in 1999 representing a ratio of 1 in 7.0 events. RPDs were calculated for the 77 duplicate/real pairs that had detections (Table 11-1b). Sixty-eight RPD values were less than the QC criterion of 30%, which equates to 88.3% meeting the QC criterion during 1999 (Table 11-3). Table 11-1b does not suggest a common reason for duplicate/real pairs that exceed the 30% QC criterion. However, the analyses of VOCs for 1999 meet the overall precision compliance goal of 85% and are therefore adequately precise. (Note that this discussion combines VOCs analyzed by two different methods; EPA 524.2 comprising 32 events and SW-846 Method 8260 comprising 1 event.)

One duplicate sample for semi-volatile organic compounds (103 analytes) was collected versus seven real samples. One pair of the SVOC duplicate/real results could be used to calculate an RPD, hexachloroethane (Table 11-1b). This RPD was within the 30% precision criterion. Results are precise for the analysis of SVOCs in 1999.

Accuracy

All VOC and SVOC analyses performed in 1999 employed contract-required methods (Table 11-3). With respect to analytical methods, the results are accurate.

As shown on Table 11-3, the majority of the VOC analytes met CRDLs when EPA Method 524.2 was used. Fifty seven of the analytes ranged between 85% and 87% in meeting the CRDL criteria for this method given that approximately 264 analytical events were possible. Trichlorofluoromethane only met the CRDL criteria 68% of the time.

Table 11-3 shows that for the SW-846 Method 8260 technique that the range for meeting the CRDL criteria is between 12.5% and 25.0%. The CRDLs in this case were met in only 1 of 8 analyses because the sampled wells contained elevated amounts of carbon tetrachloride and chloroform and the laboratory chose not to process the samples at the CRDL.

The results from both VOC analytical methods mentioned above with detection limits higher than CRDLs come from wells that are known to contain significant concentrations of certain VOCs such as carbon tetrachloride and chloroform. The laboratories run preliminary dilution analyses for samples from those wells. To protect instrumentation, the laboratories do not run 1x dilutions on the samples from wells having significant VOC contamination. CRDLs were not met for any of the VOC analytes from samples collected at those wells. Further discussion and additional data are provided in the quarterly reports (RMRS 1999k, 1999l, 2000a, and 2000b).

All SVOC analyses met the CRDL limits. Results for nine SVOC compounds specified in the analytical statement of work were not returned in any of the analyses, see the end of the SVOC section of Table 11-3.

Representativeness

There were 19 rinsate-sampling events from ten wells for VOCs in 1999. All of these events were analyzed using EPA 524.2 method. Of the 1102 resulting records, 28 rinsate analyses contained VOCs at detectable concentrations (Table 11-6). Considering all rinsate analyses, 97.5% yielded non-detectable concentrations. Individual results are discussed in the quarterly reports (RMRS 1999a, 1999b, 2000a, and 2000b). Based on the high percentage of non-detections in the rinsate samples the VOC samples are judged to be representative.

No rinsate samples were collected for SVOCs because the wells of interest are sampled using submersible pumps that do not have equipment that can be used to collect a rinsate sample. (A pump installation has a 1-2 foot piece of tubing at the surface through which the sample is collected.)

Completeness

During 1999, the required 278 VOC and 8 SVOC sample sites were visited (Table 11-7). From these, 231 VOC and 7 SVOC samples were collected, yielding success rates of 83.1% and 87.5% respectively. In general dry well

conditions precluded collection of samples, the goal of 90.0% was not reached for VOCs and SVOCs in 1999. One damaged well (2987) could not be sampled for VOCs.

There were 16581 VOC analytical records returned in 1999. All VOC records were either validated or verified. Of these, 25.5% of the analyses (4233) were validated, and 74.5% (12348) were verified (Table 11-8). These percentages match the the 25% validation and 75% verification criteria. Of the analyses for which validation or verification was performed, 0.07% (11) were rejected and are considered unusable data. Overall, 99.9% of VOC analyses are usable.

Similarly, there were 824 SVOC analytical records returned in 1999. All (100%) were verified, and none were validated (0%). Eight of the 824 records were rejected and are unusable. Overall, 99.0% of the SVOC results are usable.

Comparability

As stated above, no changes were made to analytical procedures during 1999. Thus the VOC analyses presented here are assumed to be comparable to previous analyses. The VOC analyses done by the SW-846 Method 8260 and SVOC analyses were new analytical suites during 1999. They probably will not be continued in the CY2000 sampling events.

11.2.4 Water Quality Parameters

Precision

For the major water quality parameters: fluoride, total dissolved solids, and sulfate, there were 95 duplicate sample records versus 504 real sample records for collected water quality parameters during 1999 (1 in 5.3). Eighty-nine of the real/duplicate pairs could be used to calculate RPD values (Table 11-1b). As shown on Table 11-2, 87 of the RPD values (97.8%) were within the QC criterion of 30%. The two RPDs that were greater than the criterion were calculated for nitrate/nitrite-real/duplicate pairs wells 0386 and 41591. Overall, the data indicates good precision for water quality parameter analyses.

For total cyanide there were four duplicate analyses for which no RPD could be calculated. There were 15 real cyanide analyses. For the other five minor water quality parameters, chloride, nitrate, total organic carbon, dissolved organic carbon and sulfide there is one duplicate record for seven real records in 1999. All these pairs gave an RPD value (Table 11-1b). The sulfide results are the only ones where the RPD exceeded the $\leq$30% criterion.

Accuracy

All water quality parameter analyses were performed using the proper contract required analytical methods in 1999 (Table 11-3). Analytical data indicate that the contract-required detection limits were met for all water quality parameter analyses in 1999 (Table 11-3). With respect to methods, the results for 1999 are accurate.

Representativeness

There were 46 equipment rinsate analyses for water quality parameters in 1999 (total cyanide, fluoride, nitrate/nitrite, total dissolved solids and sulfate). Forty of the analyses (87.0%) were non-detects. As shown on Table 11-6, two nitrate/nitrite rinsate analyses, three TDS analyses and a sulfate had detectable concentrations. The results for these analyses are low and none of the results were above Tier II levels where such levels are defined. No significant introduced contamination is indicated.

Completeness

As shown in Table 11-7, 21 total cyanide, 79 fluoride, 246 nitrate/nitrite, 133 sulfate, 219 total dissolved solids, 8 total organic carbon, 8 dissolved organic carbon, 8 sulfide and 8 chloride samples were to have been collected for analysis. All of the required visits for sampling were made. The success rate varied because of dry wells or wells that went dry during sampling. One well was damaged (2987). The percentages of successful sample collection were 71.4% for total cyanide, 65.8% fluoride, 80.5% nitrate/nitrite, 69.9% sulfate, 73.5% total dissolved solids and 87.5% for total organic carbon, dissolved organic carbon, sulfide and chloride. The goal is 90%, groundwater conditions permitting.

All of the 701 water quality parameter analyses performed in 1999 were validated or verified (Table 11-8). Validation was done on 32.0% of the (224) results, verification was done on 68.0% (477). As shown on Table 11-8, all of the 1999-WQP analyses provided usable data points.

Comparability

As stated above no changes were made to analytical procedures during 1999. Thus the water quality parameter analyses presented here are assumed to be comparable to previous analyses. The chloride, total cyanide, nitrate, total and dissolved organic carbon and sulfide analyses were new for 1999, they will be continued in the future.

11.2.5 Polychlorinated Biphenyls (Pesticides-PCBs)

Precision

No duplicate samples for PCBs were collected in 1999. The laboratory qualified all 56 real-results from the 7 PCB samples as “U” non-detections at the detection limits.

Accuracy

Contract required detection limits were met for all PCB analyses in 1999 (Table 11-3). The EDD files show that all PCB analyses were performed using the SW-846 8080A/8081 method. However, the hard copy laboratory reports say that EPA SW-846 Third Edition, Method 8082, Revision III, June, 1997 was used. As shown in Table 11-3 the contract required detection limits are specified for SW-846 Method 8082.

Table 11-4 gives the two matrix spike results for PCBs for the fourth quarter of 1999. Both results are within the acceptable 80-120% recovery range. Only one of the RINs submitted for analysis had matrix spike quality control samples run. Accuracy quantification for PCBs could have been better. However, because all the results were non-detects analyses for polychlorinated biphenyls are judged to be accurate for 1999. Note that multiple matrix spikes (MS1) matrix spike duplicates (MD1) are listed in Table 11-4 with results given in µg/l. These results are probably a data entry error on the part of the laboratory and are reported here for completeness.

Representativeness

No rinsate samples were collected for PCBs. The lack of detections in the real samples implies that no PCBs were contributed by the sampling process and that the collected samples are representative.

Completeness

Due to lack of water only 8 of 15 wells could be sampled for PCBs (53.3%). All of the 56 results returned were classified as usable data points. Validations were made 62.5% of the time while verifications were made the remaining 37.5% of the time. Sampling was incomplete due to dry wells, however it was complete with respect to gathering usable data.

Comparability

These were the first PCB analyses performed in 1999.

11.2.6 Total Recoverable Petroleum Products (TRPHs)

Precision

No duplicate samples for Total Recoverable Petroleum Hydrocarbons were collected with the six real sampled wells in 1999. All six results were non-detections at the detection limit.

Accuracy

Contract required detection limits were met for all TRPH analyses (Table 11-3). EPA Method 418.1 was used for analyzing all the TRPH samples it is the required method. No matrix spike data were provided with either the EDD or hard copy TRPH files.

Representativeness

No rinsate samples for TRPH were collected. The lack of detections in the real analyses implies that samples were not contaminated by petroleum hydrocarbons during the sampling process and that the collected samples are representative.

Completeness

All six samples planned were successfully collected. Because TRPH analyses are done on a Task Order basis there is no validation or verification procedure established to classify the samples.

Comparability

Total Recoverable Petroleum Hydrocarbon samples were run for the first time in the fourth quarter 1999 by the Groundwater Program at RFETS.

12.0 CONCLUSIONS AND FUTURE ACTIVITIES

The groundwater program experienced a number of improvements during 1999 and set projects in motion which will be accomplished in 2000. The following conclusions can be made with respect to the groundwater program based on the detailed discussions found elsewhere in the report.

Data collection and data quality for groundwater samples collected in 1999 have improved in the areas of data validation and verification. Much of this information was readily available and could be included in the data quality assessment section. Though the validation and verification percentages are not at the required levels the results show that only a small percentage of the analytical data is rejected. In addition, procedural improvements have been made in 1999 that will help collect more samples from wells that have low recharge. This will be done by timing visits based on an approximate recharge rate rather than a set time period.

The expansion of the real time monitoring network will also improve the understanding of the nature of recharge at RFETS and will potentially shed light on discharge and flow rates.

With respect to groundwater reporting, changes have been made to this years Annual RFCA Groundwater Monitoring Report based on input from the regulatory community. This report tried to focus on data evaluation as opposed to data presentation. Individual wells have been discussed more completely and the results of groundwater evaluations have been expanded. The actual data used in the current annual report will be provided in the four RFCA Quarterly reports and not reproduced here. The RFCA Quarterly reports have stayed the same except for some changes in the format of the report.

The Building D&D monitoring program was expanded with the addition of the Building 123 monitoring network. D&D monitoring for Buildings 444, 886 and 771.

The largest programmatic improvement for groundwater has been in the characterization and quantification of groundwater plume nature and extent. Evaluation of the East Trenches Plume resulted in a remedial strategy involving the construction of a passive VOC treatment system which was completed in 1999. The Solar Ponds nitrate/uranium plume also received additional characterization and modeling of contaminant fluxes. This has also resulted in the construction of a groundwater treatment system during 1999.

Characterization activities were also initiated for the Ryan's Pit/903 Pad Plume with installation of four monitoring wells along the pathway to surface water. A natural attenuation sampling project was implemented in 1999 to determine whether contaminants are naturally degrading prior to impacting surface water.

Groundwater evaluation of the eastern end of the Industrial Area plume has revealed contamination crossing to the east of a large, north-south trending utility corridor in the IA.

A natural attenuation study was also implemented for the IHSS 118.1 source area. Future groundwater evaluations will involve establishing the eastern extent of the carbon tetrachloride plume and investigating natural attenuation at the PU&D Yard Plume.

Given the large amount of new data with respect to the nature and extent of groundwater contamination at RFETS, a review of the groundwater monitoring network will be done in FY01. It is anticipated that some minor changes will be made to the monitoring based on this evaluation. Specific areas of review would include the north IA, the Present Landfill, and the Ryan's Pit source area which have shown evidence of increased extent or concentrations of contaminants.

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