Sub-attachment A.5.1

Cell 1

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.1−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.1−2)
- LCS monthly accumulation volumes (refer to Figure A.5.1−1)
- LDS monthly accumulation volumes (refer to Figure A.5.1−2)
- OSDF horizontal till well 12338 water yield (refer to Figure A.5.1−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.1−4 and A.5.1−5)
- Plots of concentration versus time (refer to Figures A.5.1−6A to A.5.1−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.1−29)
- Control charts (refer to Figures A.5.1−30 to A.5.1−49)

A.5.1.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA Wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on revision 4 of the LMICP (DOE 2010b). Tritium results are for all cells are reported in Section A.5.5.

The LDS of Cell 1 was dry during the second, third, and fourth quarters of 2011. As shown in Table A.5.1–1, 6 of the 23 parameters sampled quarterly in the LCS, LDS, HTW, and GMA wells, (uranium, alkalinity, total organic carbon [TOC], arsenic, boron, and selenium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Horizontal Till Wells

The HTW is located beneath the liner penetration box of each cell by design. The liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, three (uranium, TOC, and alkalinity) are increasing in the HTW of Cell 1 (as indicated in the table below). The bivariate plot for the Cell 1 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.1−29. The plot shows that the chemical signature for uranium-sodium in the LCS

LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured in the HTW of Cell 1 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Uranium	Up	Up	Up
TOC[q]	Up		
Alkalinity	Up		
Arsenic			Up
Boron		Up	
Selenium			Up

[a]HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer,
GMA-D = downgradient Great Miami Aquifer; TOC = total organic carbon.
No entry indicates that the trend was not up.

The plot of concentrations versus time for uranium in the HTW of Cell 1 is presented in Figure A.5.1–6A. The data indicate that concentrations in the overall dataset (1997 to 2011) are increasing; however, when the data collected prior to the fourth quarter of 2006 are removed, the data become normally distributed with no Mann-Kendall trend. The same observation does not apply to the TOC and alkalinity data sets from Cell 1.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells, for uranium, arsenic, boron, and selenium, are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.1–1) measured in the LDS and GMA wells for parameters with increasing concentrations in the Cell 1 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
Uranium (µg/L)	**10.8**	3.08	5.12
Arsenic (mg/L)	**0.0125**[b]	0.00250	0.00150
Boron (mg/L)	**0.243**	0.112	0.060
Selenium (mg/L)	**0.00724**[c]	ND[d]	0.00165

Note: The highest averages are shown in bold.
[a] LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer,
GMA-D = downgradient Great Miami Aquifer.
[b] Arsenic has only been detected once in the LDS of Cell 1 (0.0125 mg/L).
[c] Selenium has only been detected once in the LDS of Cell 1 (second quarter 2009, 0.00724 mg/L).
[d] ND = not detected

A.5.1.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit. Usually, two parameters are used to compute standardized limits; the decision value (h) and the Shewart Control Limit (SCL).

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round," the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.1−1 in gray shading, fifteen parameters in the HTW and GMA wells of Cell 1 meet the criteria for control charts (i.e., more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 20 control charts.

These twenty control charts are presented in Figures A.5.1−30 to A.5.1−49. All of the control charts for Cell 1 indicate "in control" conditions. Past "out of control" conditions exist for total organic halogen (TOX) and cobalt, but as shown in the control charts, data collected since the out of control conditions indicate that the out of control conditions did not persist.

Parameter and Monitoring Point[a]	Assessment
Nitrate in the HTW	In Control
TDS in the GMA-U	In Control
TDS in the GMA-D	In Control
TOX in the HTW	In Control
Barium in the HTW	In Control
Calcium in the HTW	In Control
Cobalt in the HTW	In Control
Cobalt in the GMA-D	In Control
Copper in the HTW	In Control
Iron in the HTW	In Control
Iron in the GMA-U	In Control
Lithium in the GMA-U	In Control
Lithium in the GMA-D	In Control
Magnesium in the HTW	In Control
Manganese in the HTW	In Control
Manganese in the GMA-U	In Control
Nickel in the GMA-U	In Control
Potassium in the HTW	In Control
Sodium in the GMA-D	In Control
Zinc in the GMA-U	In Control

[a] HTW = horizontal till well; TDS = total dissolved solids; TOX = total organic halogens; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

A.5.1.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 1 are provided in Table A.5.1−2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 1 in 2011.

A.5.1.4 Summary and Conclusions

- Six parameters have an upward concentration trend in the HTW and/or GMA wells of Cell 1 (uranium, TOC, Alkalinity, arsenic, boron, and selenium).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 1 indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 1 are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Twenty control charts were constructed for Cell 1 parameters. All of the control charts exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 1 in 2011.

Table A.5.1−1. Summary Statistics for Cell 1

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
	LCS	12338C	53	54	98.1	ND	206	79.2	37.6	Normal	Up	Detected	
	LDS	12338D	37	37	100.0	1.5	37.0	10.8	6.8	Undefined	Up	Detected	
Total Uranium (µg/L)	HTW	12338	50	52	96.2	0.608	12.7	5.56	3.89	Undefined	Up	Detected	
	GMA-U	22201	55	59	93.2	ND	11.2	3.08	2.91	Undefined	Up	Detected	
	GMA-D	22198	59	59	100.0	0.574	15.2	5.12	2.98	Undefined	Up	Detected	
	LCS	12338C	23	23	100.0	227	721	422	151	Lognormal	Down	Not Detected	
	LDS	12338D	7	7	100.0	206	528	362	109	Normal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	HTW	12338	10	10	100.0	195	289	237	26	Normal	Up	Not Detected	
	GMA-U	22201	4	4	100.0	420	563	486	66	Normal	None	Insuff	
	GMA-D	22198	4	4	100.0	224	383	304	78	Normal	None	Insuff	
	LCS	12338C	23	23	100.0	21.8	55	38.7	7.0	Undefined	Up	Detected	
	LDS	12338D	7	7	100.0	87.1	202	128	39	Normal	None	Not Detected	
Chloride (mg/L)	HTW	12338	10	10	100.0	16.3	32	25.6	4.3	Normal	Down	Not Detected	
	GMA-U	22201	4	4	100.0	35.9	75	48.4	18.2	Normal	None	Insuff	
	GMA-D	22198	4	4	100.0	22.0	22.6	22.3	0.3	Normal	None	Insuff	
	LCS	12338C	22	34	64.7	ND	49	0.55	18	Undefined	None	Detected	
	LDS	12338D	5	10	50.0	ND	359	0.0536	113	Undefined	None	Not Detected	
Nitrate/Nitrite as Nitrogen (mg/L)	HTW	12338	4	10	40.0	ND	1.73	0.395	0.576	Lognormal	None	Not Detected	
	GMA-U	22201	1	4	25.0	ND	0.192	Insuff	Insuff	Lognormal	None	Insuff	
	GMA-D	22198	7	24	29.2	ND	0.55	0.169	0.227	Undefined	None	Detected	
	LCS	12338C	40	40	100.0	707	2510	1290	576	Undefined	Up	Detected	
	LDS	12338D	19	19	100.0	675	3500	1850	780	Lognormal	Up	Detected	
Sulfate (mg/L)	HTW	12338	32	32	100.0	549	907	705	98	Normal	Down	Detected	
	GMA-U	22201	35	35	100.0	91.8	1980	324	323	Lognormal	None	Detected	
	GMA-D	22198	35	35	100.0	101	506	224	107	Lognormal	Down	Not Detected	
	LCS	12338C	33	33	100.0	1790	5200	2420	900	Undefined	Up	Detected	
	LDS	12338D	6	6	100.0	2430	7540	5170	2000	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	HTW	12338	8	8	100.0	1190	1310	1260	40	Normal	None	Not Detected	
	GMA-U	22201	11	11	100.0	978	1260	1080	90	Normal	None	Not Detected	
	GMA-D	22198	11	11	100.0	577	805	687	81	Normal	None	Not Detected	
	LCS	12338C	52	54	96.3	9.99	51.8	19.6	8.9	Undefined	Down	Detected	123 (Q2-98) 0.9 (Q1-99) 0.85 (Q2-99)
	LDS	12338D	34	38	89.5	ND	15.7	6.51	2.96	Normal	None	Not Detected	80.9 (Q2-98)
Total Organic Carbon (mg/L)	HTW	12338	35	48	72.9	ND	7.24	1.73	1.02	Undefined	Up	Not Detected	
	GMA-U	22201	46	59	78.0	ND	17.6	2.49	3.55	Undefined	None	Not Detected	59.7 (Q2-98)
	GMA-D	22198	40	58	69.0	ND	15.8	1.39	2.78	Undefined	None	Not Detected	52.5 (Q2-98)
	LCS	12338C	50	55	90.9	ND	1.52	0.197	0.231	Undefined	None	Detected	
	LDS	12338D	28	38	73.7	ND	0.361	0.0527	0.0587	Lognormal	None	Not Detected	
Total Organic Halogens (mg/L)	HTW	12338	27	49	55.1	ND	0.063	0.00970	0.00960	Lognormal	None	Not Detected	
	GMA-U	22201	23	59	39.0	ND	0.078	0.00860	0.0116	Undefined	Down	Not Detected	0.308 (Q2-00)
	GMA-D	22198	10	58	17.2	ND	0.1	0.00386	0.0182	Undefined	Down	Detected	
	LCS	12338C	9	28	32.1	ND	0.0786	0.00736	0.0148	Normal	None	Not Detected	
	LDS	12338D	1	9	11.1	ND	0.0125	INSUFF	Insuff	Lognormal	None	Not Detected	
Arsenic (mg/L)	HTW	12338	3	20	15.0	ND	0.0607	0.00250	Insuff	Undefined	None	Not Detected	
	GMA-U	22201	3	11	27.3	ND	0.04	0.00250	Insuff	Undefined	None	Not Detected	
	GMA-D	22198	6	44	13.6	0.000113	0.0372	0.00150	0.00789	Undefined	Up	Detected	
	LCS	12338C	23	23	100.0	0.0241	0.205	0.0785	0.0497	Normal	Down	Detected	
	LDS	12338D	7	7	100.0	0.0146	0.0173	0.0156	0.001	Normal	None	Not Detected	
Barium (mg/L)	HTW	12338	10	10	100.0	0.0258	0.0764	0.0465	0.0149	Normal	None	Not Detected	
	GMA-U	22201	5	5	100.0	0.0399	0.124	0.0798	0.0325	Normal	Down	Insuff	
	GMA-D	22198	6	6	100.0	0.0562	0.138	0.0802	0.0292	Lognormal	None	Not Detected	

Table A.5.1−1 (continued). Summary Statistics for Cell 1

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12338C	54	55	98.2	0.0642	2.81	1.05	0.53	Undefined	None	Not Detected	
	LDS	12338D	37	38	97.4	0.169	0.345	0.243	0.043	Lognormal	None	Not Detected	0.0296 (Q1-98) 0.00100 (Q3-00)
	HTW	12338	46	49	93.9	ND	0.271	0.162	0.064	Undefined	None	Detected	
	GMA-U	22201	57	59	96.6	ND	0.158	0.112	0.028	Normal	Up	Detected	
	GMA-D	22198	54	58	93.1	0.0264	0.131	0.060	0.017	Undefined	None	Not Detected	
Calcium (mg/L)	LCS	12338C	23	23	100.0	377	939	548	146	Lognormal	None	Not Detected	1500 (Q3-05)
	LDS	12338D	7	7	100.0	324	553	396	78	Normal	Up	Not Detected	
	HTW	12338	10	10	100.0	230	349	273	37	Normal	None	Not Detected	
	GMA-U	22201	4	4	100.0	237	271	254	14	Normal	None	Insuff	
	GMA-D	22198	4	4	100.0	148	192	173	19	Normal	None	Insuff	
Cobalt (mg/L)	LCS	12338C	17	28	60.7	ND	0.0575	0.0029	0.0142	Undefined	Down	Detected	
	LDS	12338D	6	9	66.7	ND	0.0019	0.0011	0.0005	Normal	None	Not Detected	
	HTW	12338	10	17	58.8	ND	0.00349	0.00121	0.00079	Lognormal	None	Not Detected	0.0126 (Q3-09)
	GMA-U	22201	3	11	27.3	ND	0.00223	0.0005	Insuff	Undefined	None	Not Detected	
	GMA-D	22198	6	31	19.4	ND	0.0045	0.00078	0.00091	Lognormal	None	Not Detected	
Copper (mg/L)	LCS	12338C	20	24	83.3	0.00094	0.0285	0.0102	0.0073	Normal	None	Not Detected	
	LDS	12338D	6	8	75.0	ND	0.0231	0.0098	0.0070	Normal	None	Not Detected	
	HTW	12338	8	11	72.7	ND	0.0166	0.0095	0.0056	Normal	None	Not Detected	
	GMA-U	22201	4	4	100.0	0.00229	0.0105	0.0072	0.0035	Normal	None	Insuff	
	GMA-D	22198	4	5	80.0	ND	0.00888	0.00640	0.00355	Lognormal	None	Insuff	
Iron (mg/L)	LCS	12338C	25	28	89.3	ND	101	19.8	19.4	Lognormal	Down	Detected	
	LDS	12338D	7	9	77.8	ND	2.55	1.30	1.00	Normal	None	Detected	
	HTW	12338	17	17	100.0	0.271	13.9	5.26	3.82	Lognormal	None	Not Detected	
	GMA-U	22201	11	11	100.0	0.0479	4.42	2.73	1.78	Lognormal	None	Not Detected	
	GMA-D	22198	24	24	100.0	0.531	6.92	3.42	1.66	Normal	None	Detected	
Lithium (mg/L)	LCS	12338C	20	20	100.0	0.103	0.197	0.140	0.031	Lognormal	Up	Detected	
	LDS	12338D	9	9	100.0	0.0333	0.075	0.0561	0.0137	Normal	None	Not Detected	
	HTW	12338	13	17	76.5	ND	0.00943	0.00797	0.00149	Undefined	None	Not Detected	
	GMA-U	22201	11	11	100.0	0.00723	0.0153	0.0111	0.0027	Normal	None	Not Detected	
	GMA-D	22198	11	11	100.0	0.00799	0.0107	0.00934	0.00091	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12338C	23	23	100.0	71.4	482	169	137	Undefined	Up	Detected	
	LDS	12338D	7	7	100.0	120	326	179	69	Lognormal	None	Not Detected	
	HTW	12338	10	10	100.0	74.5	95.4	85.0	5.6	Normal	None	Not Detected	
	GMA-U	22201	4	4	100.0	44.6	54.7	48.8	4.5	Normal	None	Insuff	
	GMA-D	22198	4	4	100.0	39	47.8	44.6	4.0	Normal	None	Insuff	
Manganese (mg/L)	LCS	12338C	16	28	57.1	ND	7.7	0.249	1.81	Undefined	Down	Detected	
	LDS	12338D	8	9	88.9	0.00245	0.184	0.0275	0.0579	Lognormal	None	Not Detected	
	HTW	12338	16	17	94.1	ND	0.136	0.047	0.036	Normal	None	Not Detected	
	GMA-U	22201	13	13	100.0	0.0322	2.06	0.928	0.743	Normal	None	Not Detected	
	GMA-D	22198	43	44	97.7	0.178	1.09	0.512	0.210	Lognormal	None	Detected	
Nickel (mg/L)	LCS	12338C	25	28	89.3	ND	0.0535	0.0188	0.0167	Undefined	Down	Detected	
	LDS	12338D	9	9	100.0	0.00486	0.0353	0.0169	0.0082	Normal	None	Not Detected	
	HTW	12338	8	17	47.1	ND	0.0116	0.00439	0.00312	Normal	Down	Not Detected	
	GMA-U	22201	10	11	90.9	ND	0.0115	0.00519	0.00306	Normal	None	Not Detected	
	GMA-D	22198	17	44	38.6	ND	0.0100	0.0011	0.0025	Undefined	Down	Not Detected	0.13 (Q4-99)
Potassium (mg/L)	LCS	12338C	23	23	100.0	10.8	30	20.2	5.4	Normal	Up	Detected	
	LDS	12338D	7	7	100.0	13.2	35.4	19.8	7.4	Lognormal	None	Not Detected	
	HTW	12338	10	10	100.0	2.89	3.77	3.31	0.27	Normal	None	Not Detected	
	GMA-U	22201	4	4	100.0	2.28	3.97	3.35	0.78	Normal	None	Insuff	
	GMA-D	22198	4	4	100.0	1.89	2.07	2.00	0.08	Normal	None	Insuff	

Table A.5.1−1 (continued). Summary Statistics for Cell 1

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
	LCS	12338C	12	28	42.9	ND	0.0715	0.00981	0.0177	Lognormal	Up	Not Detected	
	LDS	12338D	1	9	11.1	ND	0.00724	Insuff	Insuff	Undefined	Up	Not Detected	0.076 (Q1-10)
Selenium (mg/L)	HTW	12338	0	17	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	0.025 (Q3-09)
	GMA-U	22201	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22198	3	31	9.7	ND	0.00364	0.00165	Insuff	Undefined	Up	Detected	
	LCS	12338C	28	28	100.0	11.7	29.3	17.9	3.8	Normal	Up	Detected	
	LDS	12338D	9	9	100.0	335	896	571	216	Normal	Up	Not Detected	
Sodium (mg/L)	HTW	12338	20	20	100.0	11.9	23.8	16.9	3.5	Normal	Down	Detected	
	GMA-U	22201	11	11	100.0	47.9	65.5	62.9	5.9	Undefined	Down	Detected	
	GMA-D	22198	11	11	100.0	14.1	17.1	15.3	1.0	Normal	None	Not Detected	
	LCS	12338C	18	28	64.3	ND	0.575	0.116	0.145	Lognormal	None	Not Detected	
	LDS	12338D	9	9	100.0	0.0557	0.671	0.239	0.190	Lognormal	None	Not Detected	
Zinc (mg/L)	HTW	12338	13	17	76.5	ND	0.618	0.0151	0.171	Undefined	None	Detected	
	GMA-U	22201	5	11	45.5	ND	0.0127	0.00589	0.00398	Normal	None	Not Detected	
	GMA-D	22198	15	44	34.1	ND	0.0474	0.00444	0.00709	Lognormal	None	Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires $n \geq 3$. In addition, Standard Deviation requires $n \geq 4$.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where $3 \leq n \leq 50$) or Shapiro Francia (where $n > 50$).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with $n \geq 4$.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with $n \geq 6$.

[h]Outliers determined by Rosner's (where $n > 25$) or Dixon procedure (where $4 \leq n \leq 25$).

[i]Q = quarterly

Table A.5.1−2. Cell 1 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER (UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (SAMPLES>GW BACKGROUND)	PW BACKGROUND[a,b,e] (SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	14	10	71.4	Yes	0.03	4.5	0.774	-	4.2 mg/L(1)	4.34 mg/L(1)	220 mg/L(0)
Inorganic											
Beryllium (mg/L)	14	2	14.3	No	0.0000674	0.00012	0.0001	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	14	4	28.6	Yes	0.00014	0.00084	0.0004	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	14	6	42.9	Yes	0.0012	0.00365	0.0023	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(0)	0.818 mg/L(0)
Lead (mg/L)	14	2	14.3	No	0.00066	0.0222	0.0114	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(1)	0.0114 mg/L(1)
Mercury (mg/L)	28	2	7.1	No	0.00000024	0.00047	0.0002	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Silver (mg/L)	14	1	7.1	No	0.00014	-	-	0.05 mg/L(0)	0.0117 mg/L(0)	0.0031 mg/L(0)	0.264 mg/L(0)
Thallium (mg/L)	14	2	14.3	No	0.0007	0.00756	0.0041	-	-	-	0.0028 mg/L(1)
Radionuclide											
Technetium-99 (pCi/L)	30	7	23.3	No	1.81	18.3	9.92	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organic											
4-Nitroaniline (ug/L)	27	1	3.7	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundw ater background, PW background, or PW maximum.

[a]If more than one sample is collected per w ell per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample w ith the maximum representative concentration is used for all the summary information.
[b]Rejected data qualified w ith an R or Z w ere not included.
[c]If the number of detected samples is equal to tw o, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.
[d]From Operable Unit 5 Record of Decision, Table 9-4.
[e]From the Characterization of Background Water Quality for Streams and Groundw ater w hich w as developed for Operable Unit 5 RI/FS documents.
[f]Max PW - maximum detected concentration in perched w ater as defined in the Remedial Investigation Report for Operable Unit 5.
[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

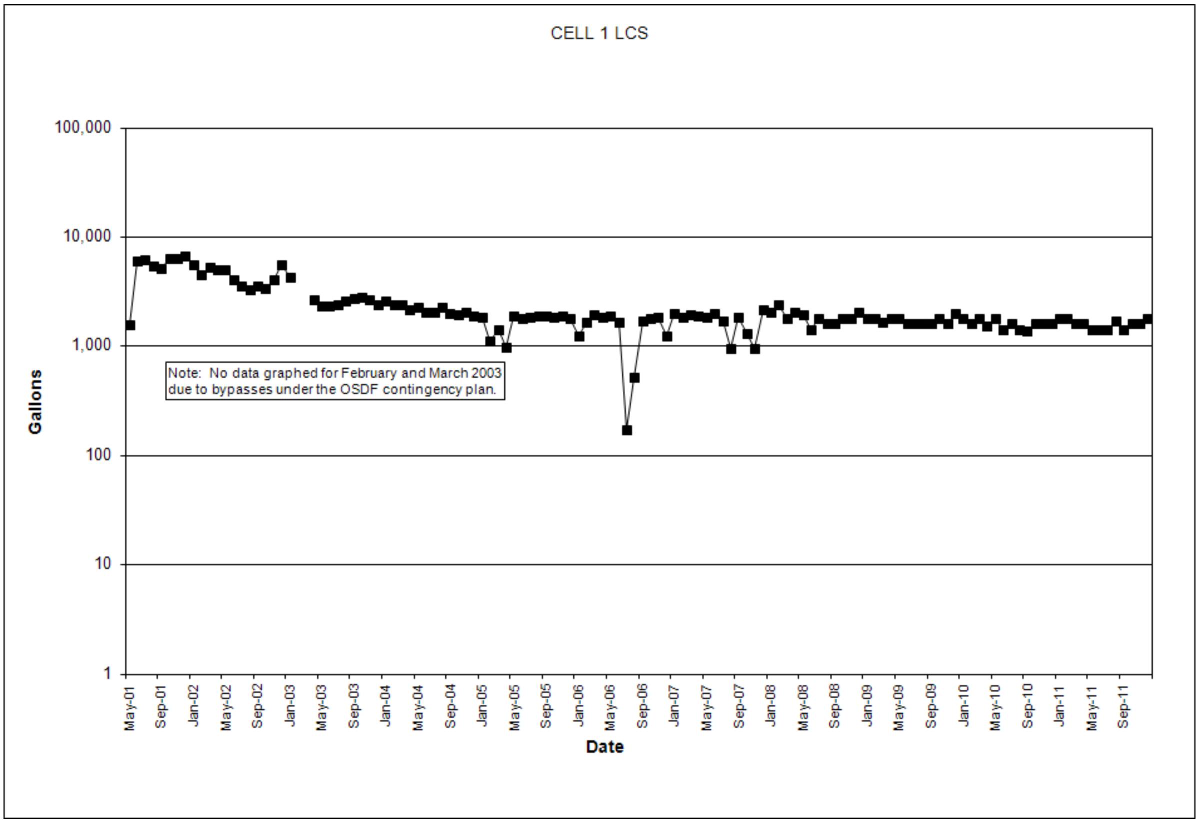


Figure A.5.1–1. Monthly Accumulation Volumes For Cell 1 LCS

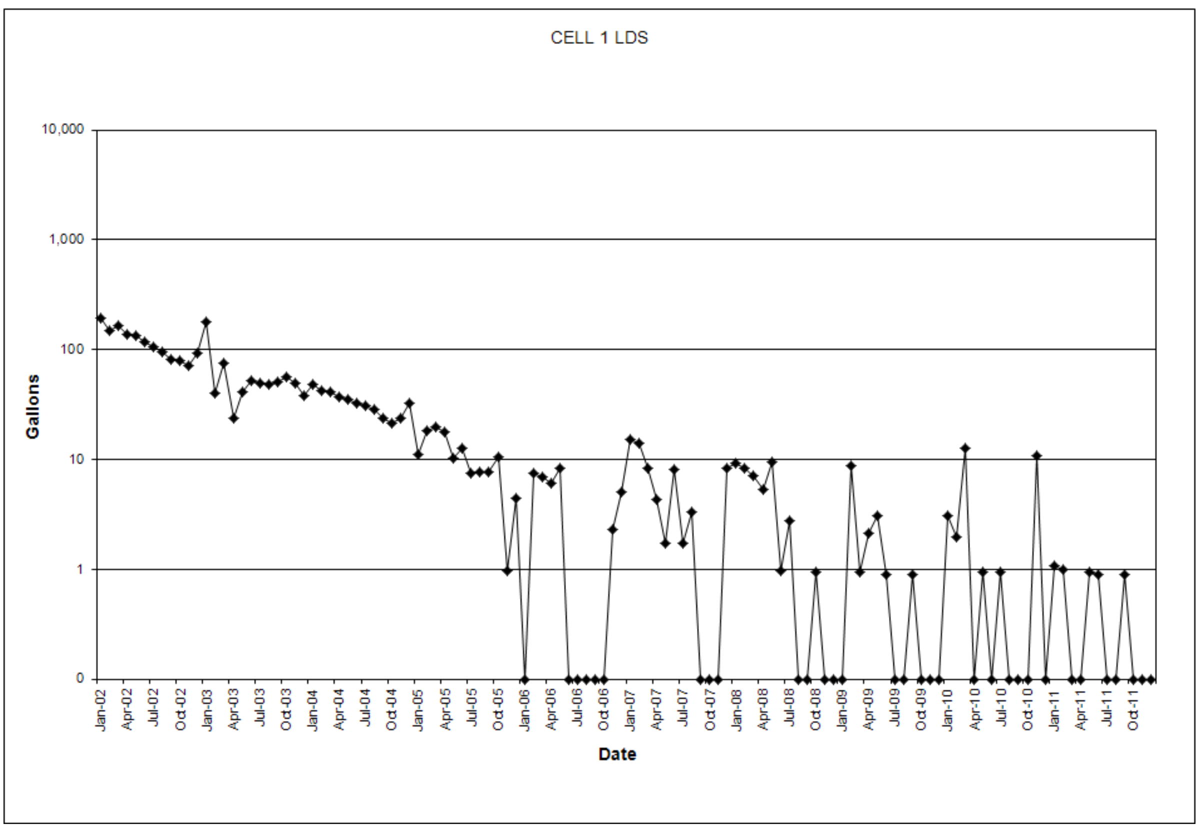
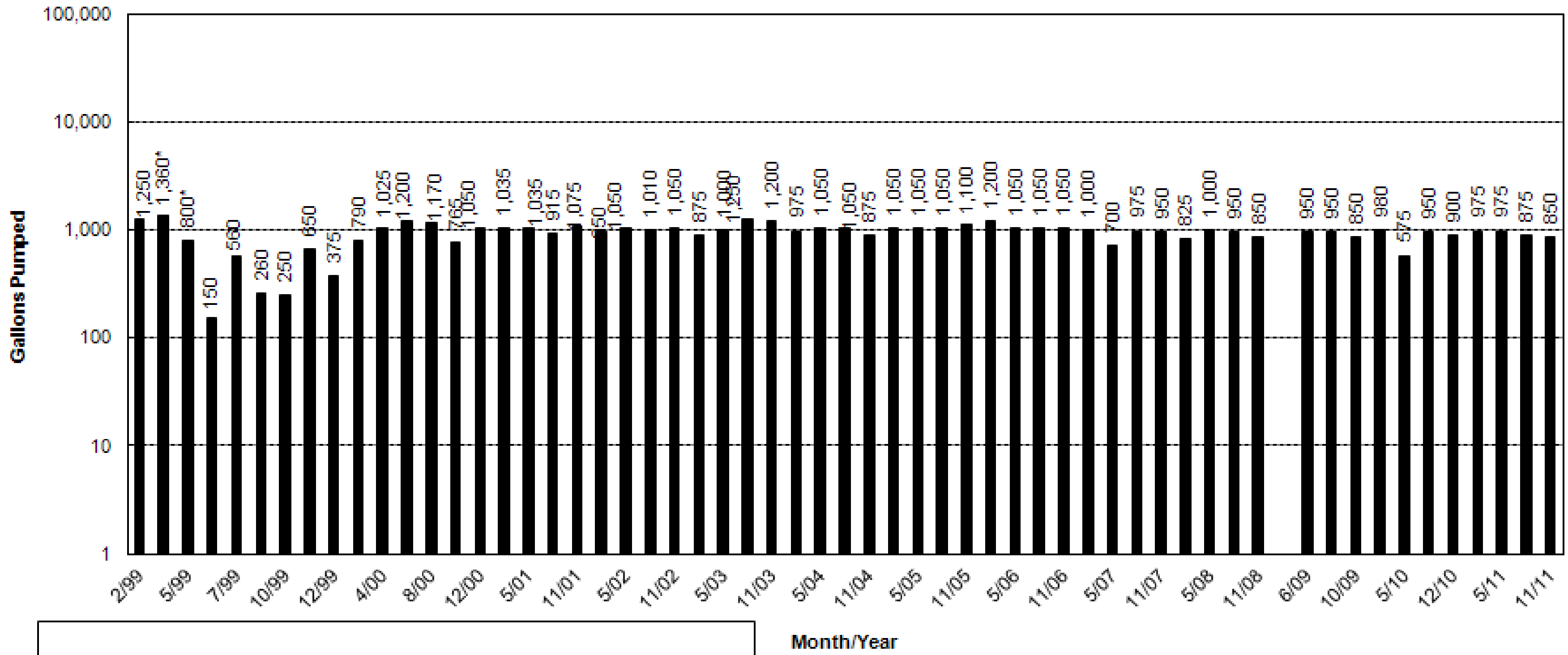


Figure A.5.1–2. Monthly Accumulation Volumes For Cell 1 LDS



12338 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	5655	n=9	628
2000:	6000	n=6	1000
2001:	4060	n=4	1015
2002:	4060	n=4	1015
2003:	4325	n=4	1081
2004:	3950	n=4	988
2005:	4250	n=4	1063
2006:	4350	n=4	1088
2007:	3625	n=4	906
2008:	3625	n=4	906
2009:	2750	n=3	917
2010:	3405	n=4	851
2011:	3675	n=4	919
Overall:			926

*More than one purge of the well was completed during these months to help evaluate well yield.

Figure A.5.1–3. OSDF Horizontal Till Well 12338 (Cell 1) Water Yield

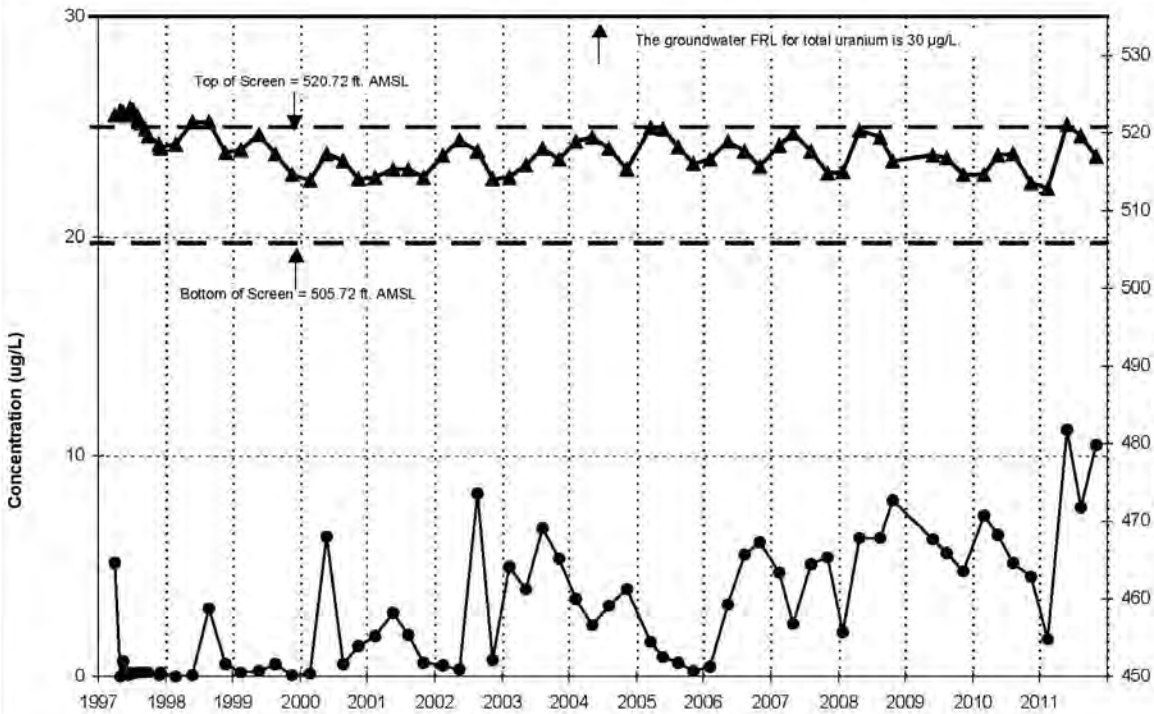


FIGURE A.5.1-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 1 Upgradient Monitoring Well 22201

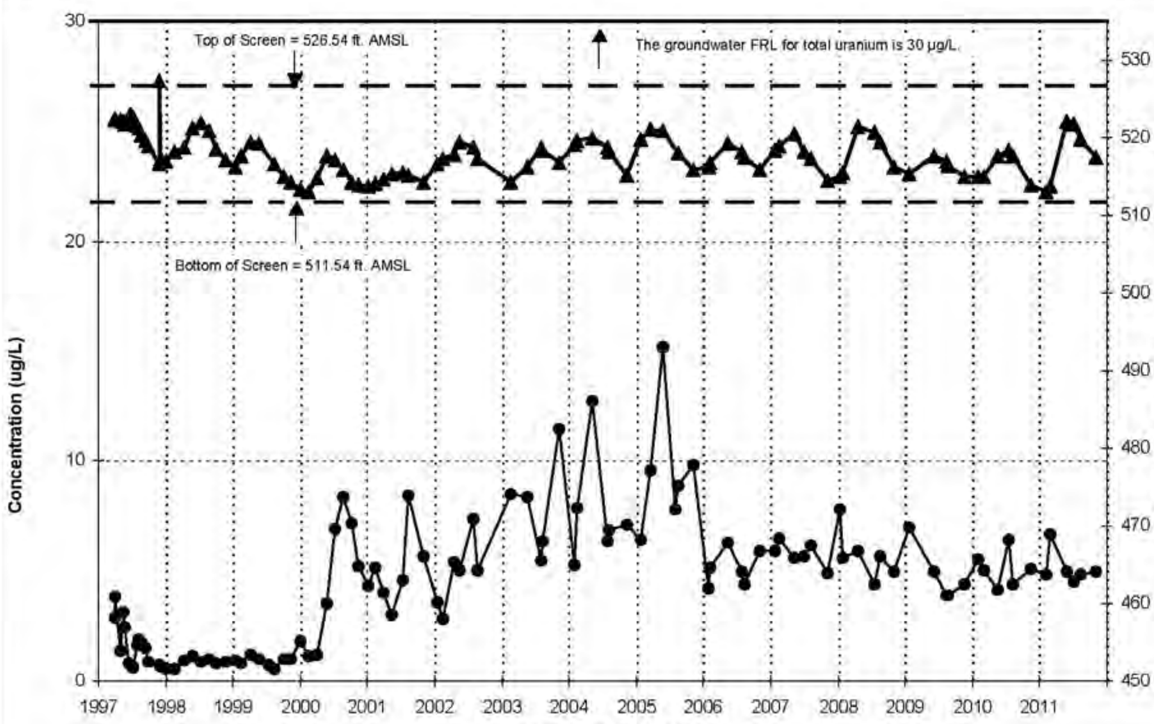


FIGURE A.5.1-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 1 Downgradient Monitoring Well 22198

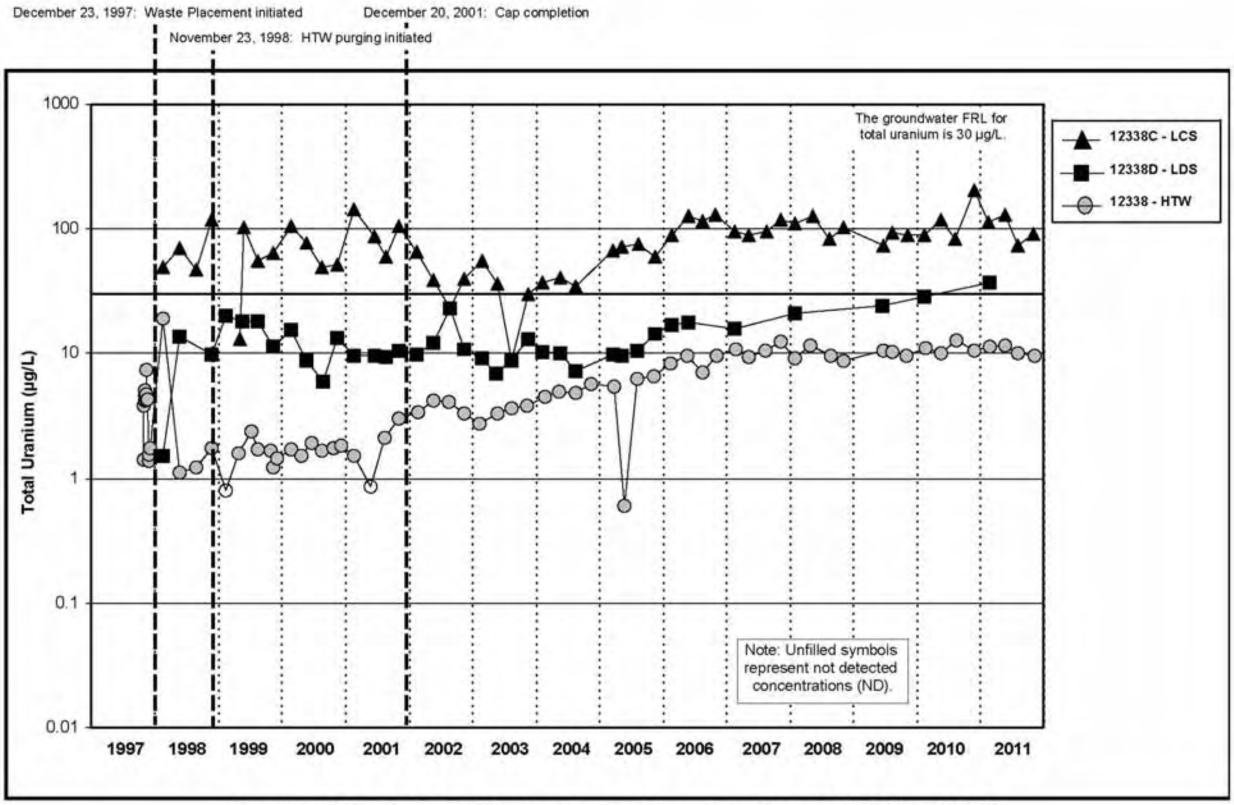


Figure A.5.1-6A. Cell 1 Total Uranium Concentration vs. Time Plot for LCS, LDS, and HTW

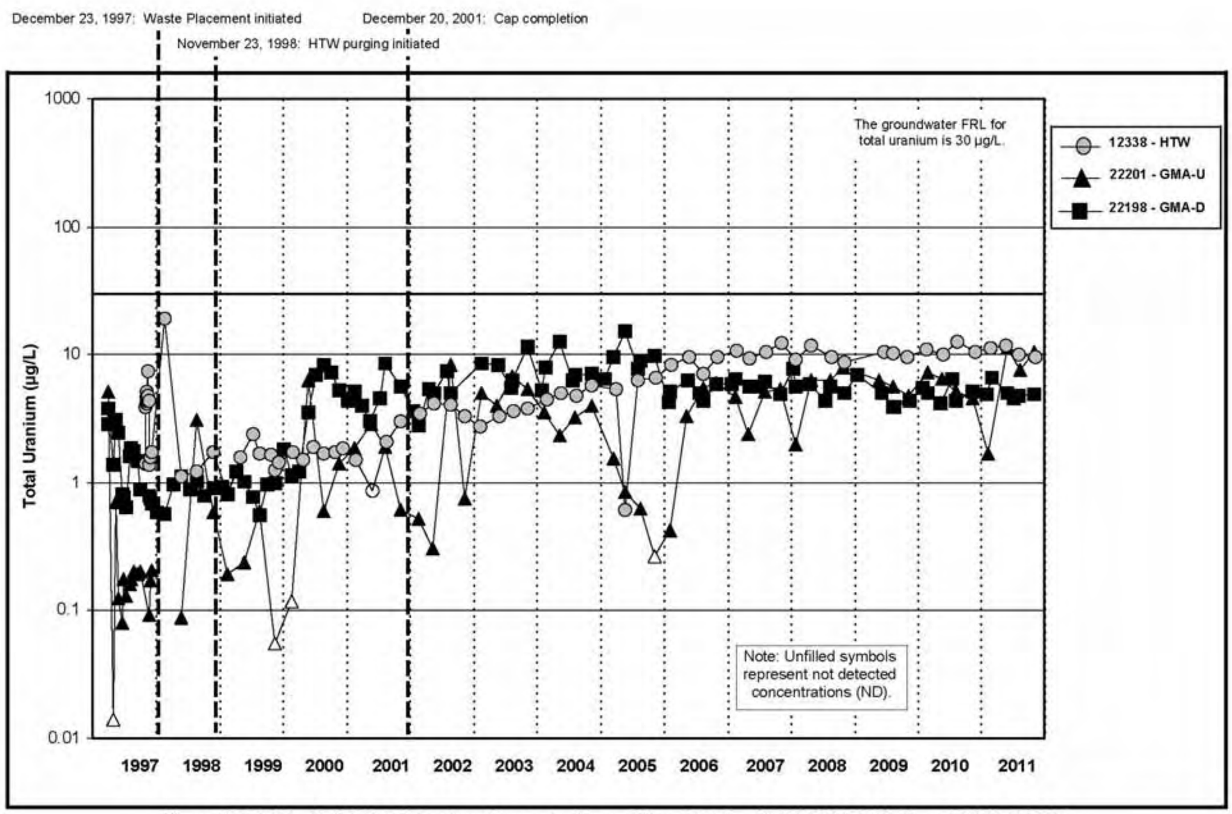


Figure A.5.1-6B. Cell 1 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

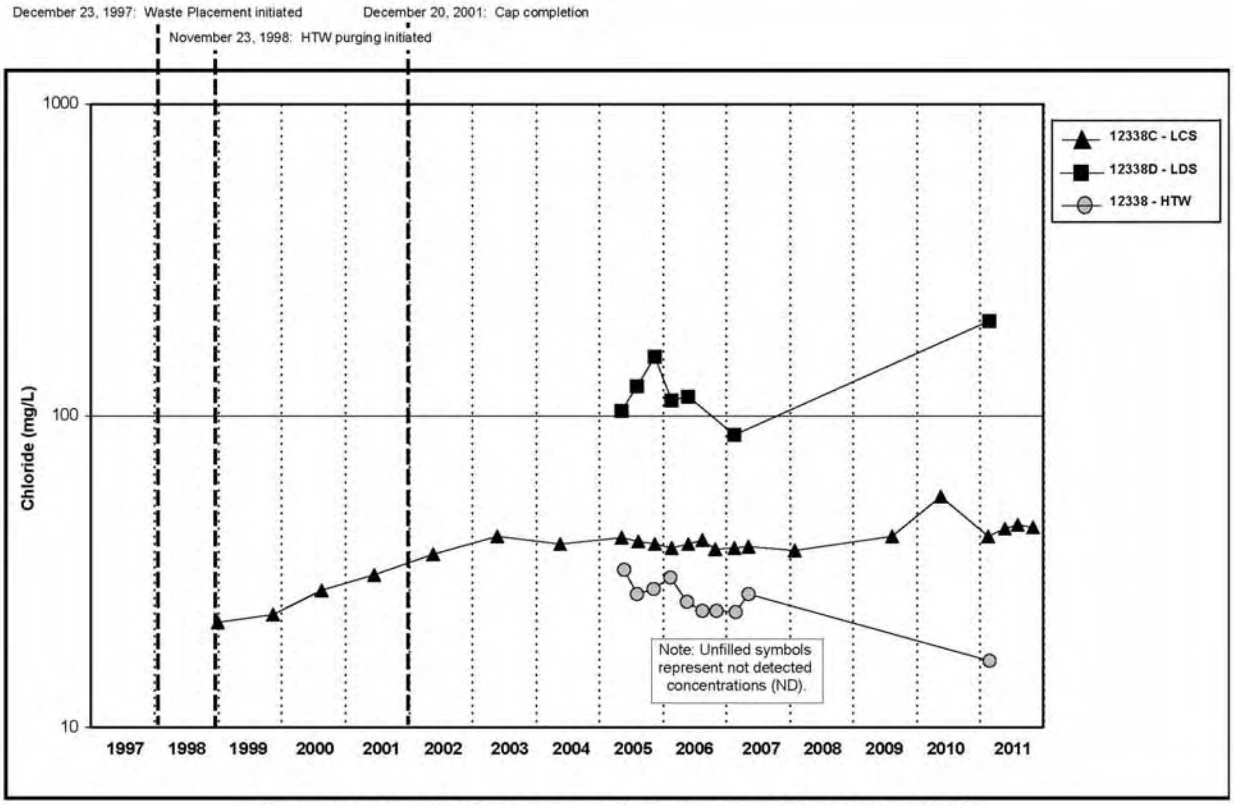


Figure A.5.1-7A. Cell 1 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

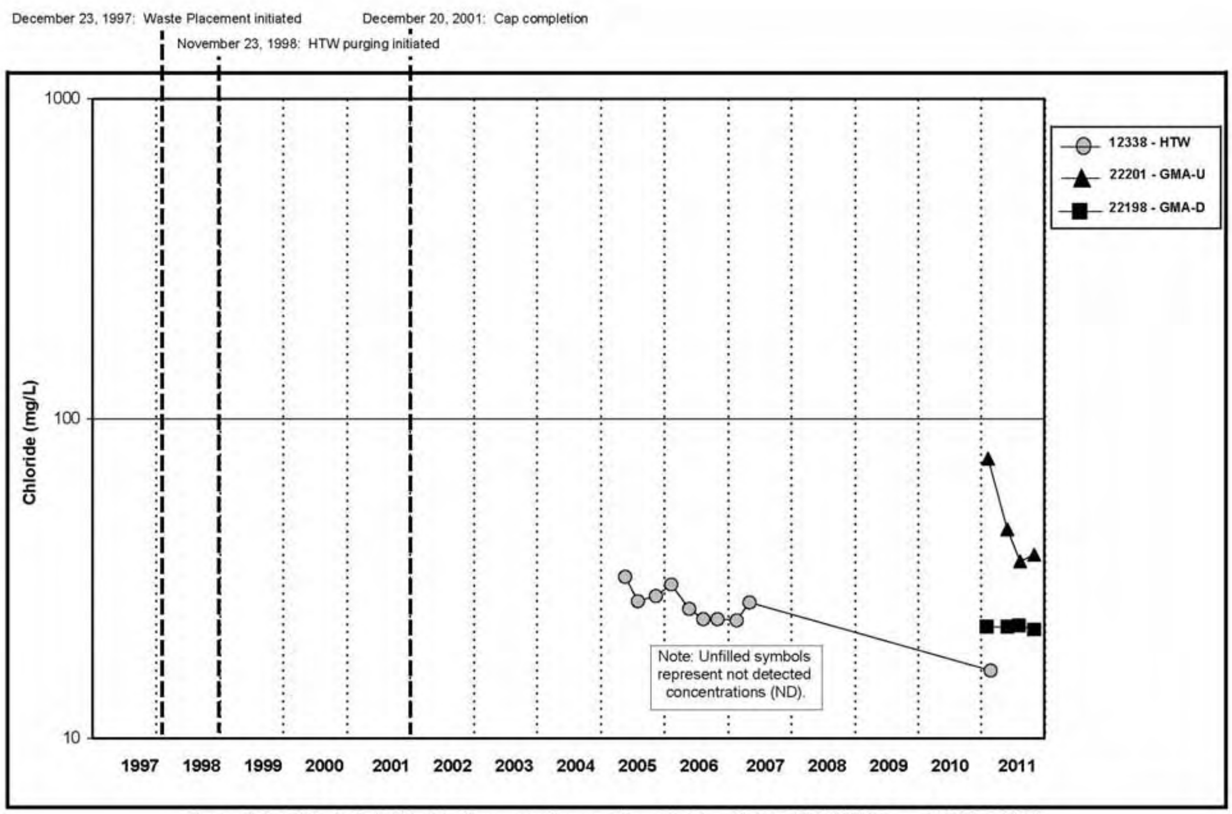


Figure A.5.1-7B. Cell 1 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

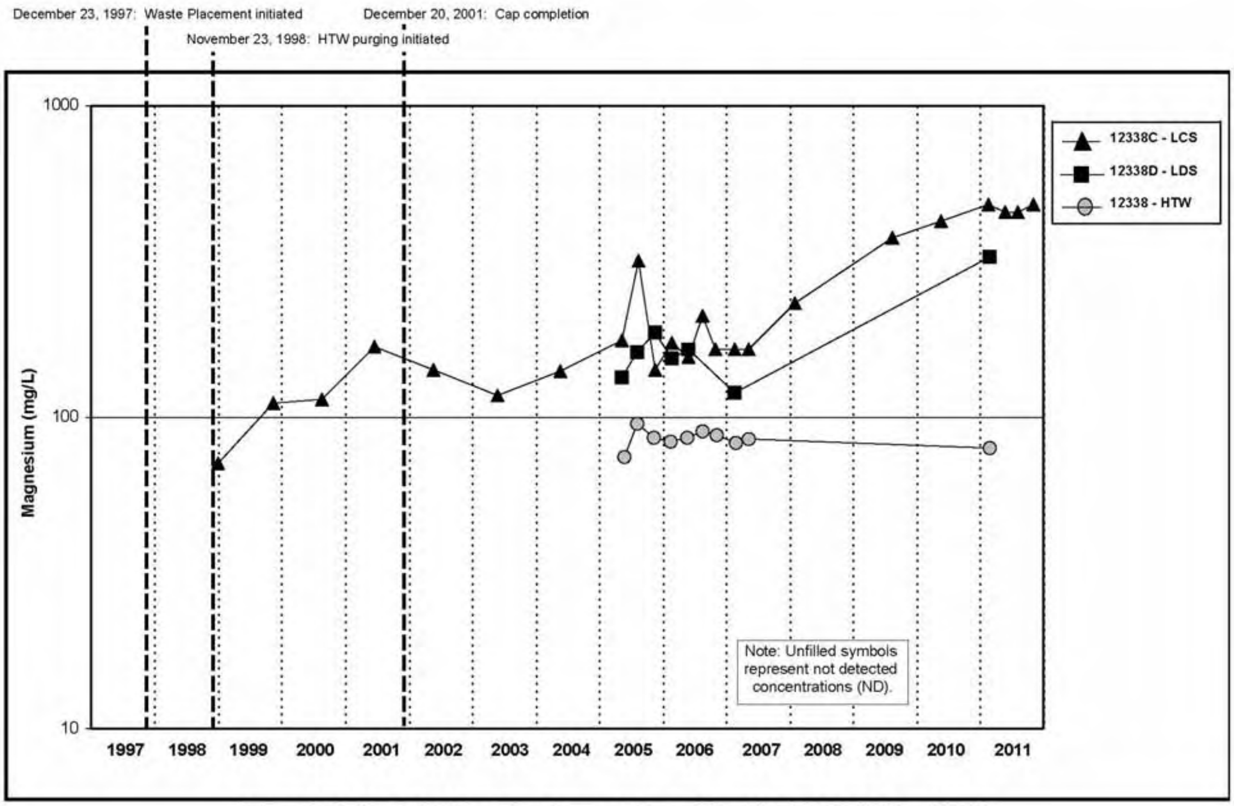


Figure A.5.1-8A. Cell 1 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

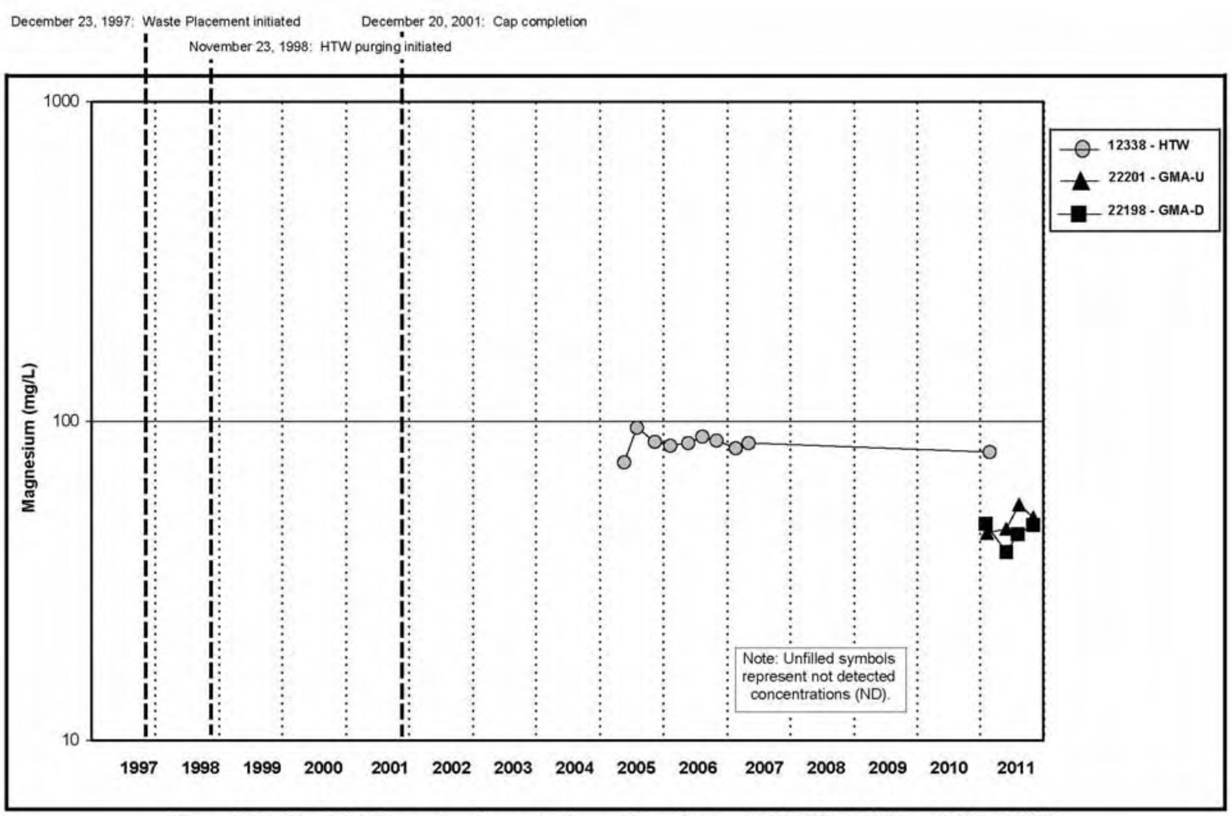


Figure A.5.1-8B. Cell 1 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

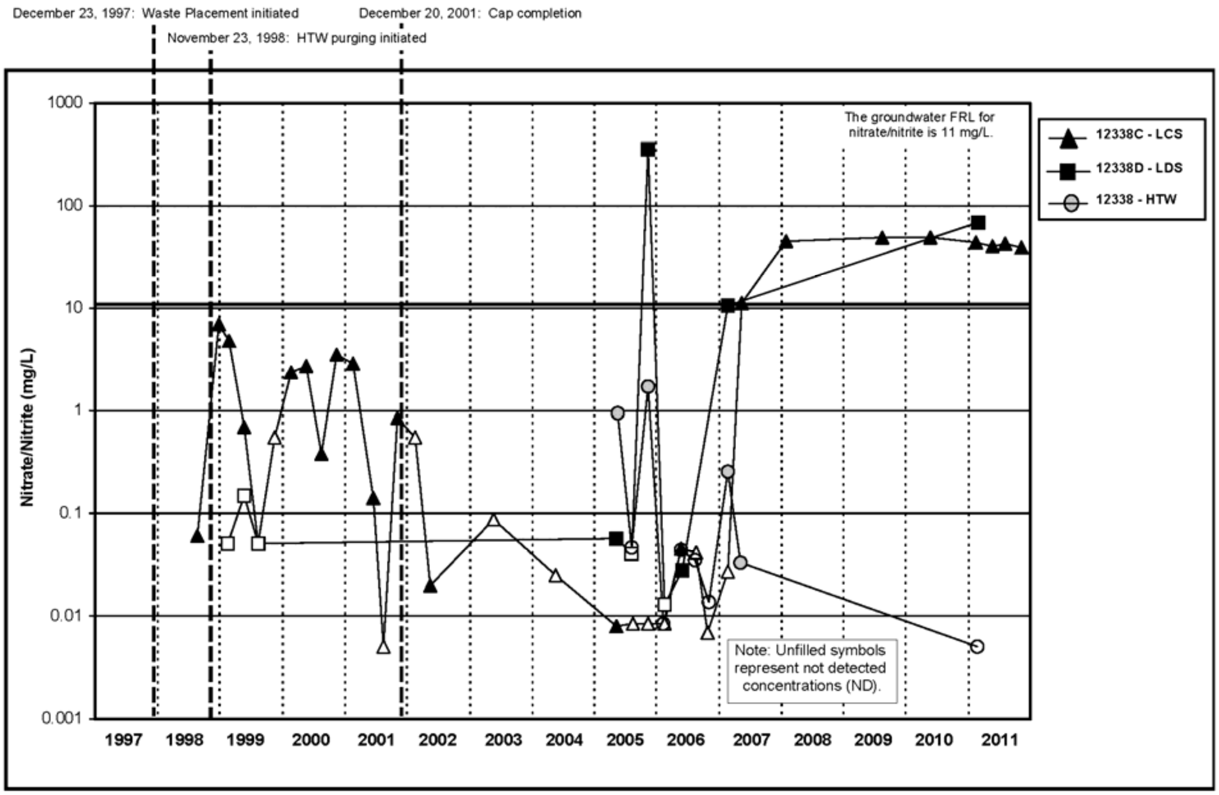


Figure A.5.1-9A. Cell 1 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

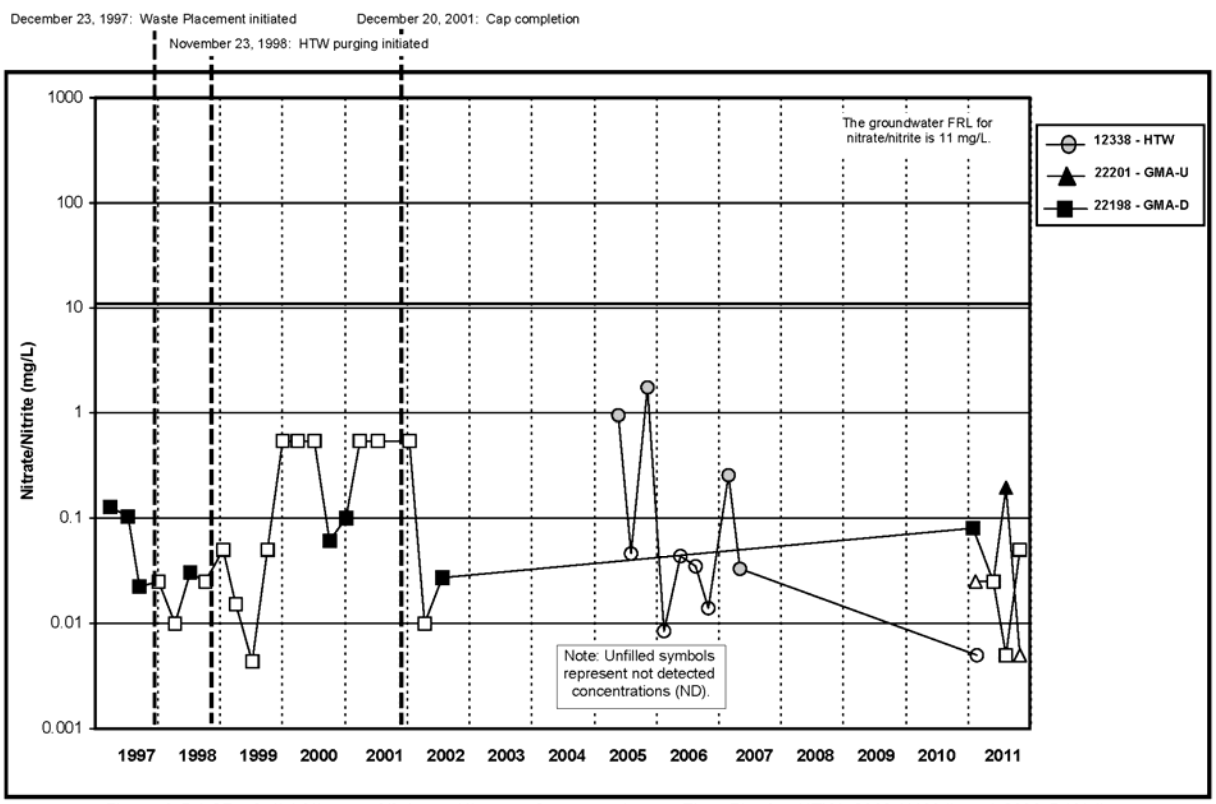


Figure A.5.1-9B. Cell 1 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

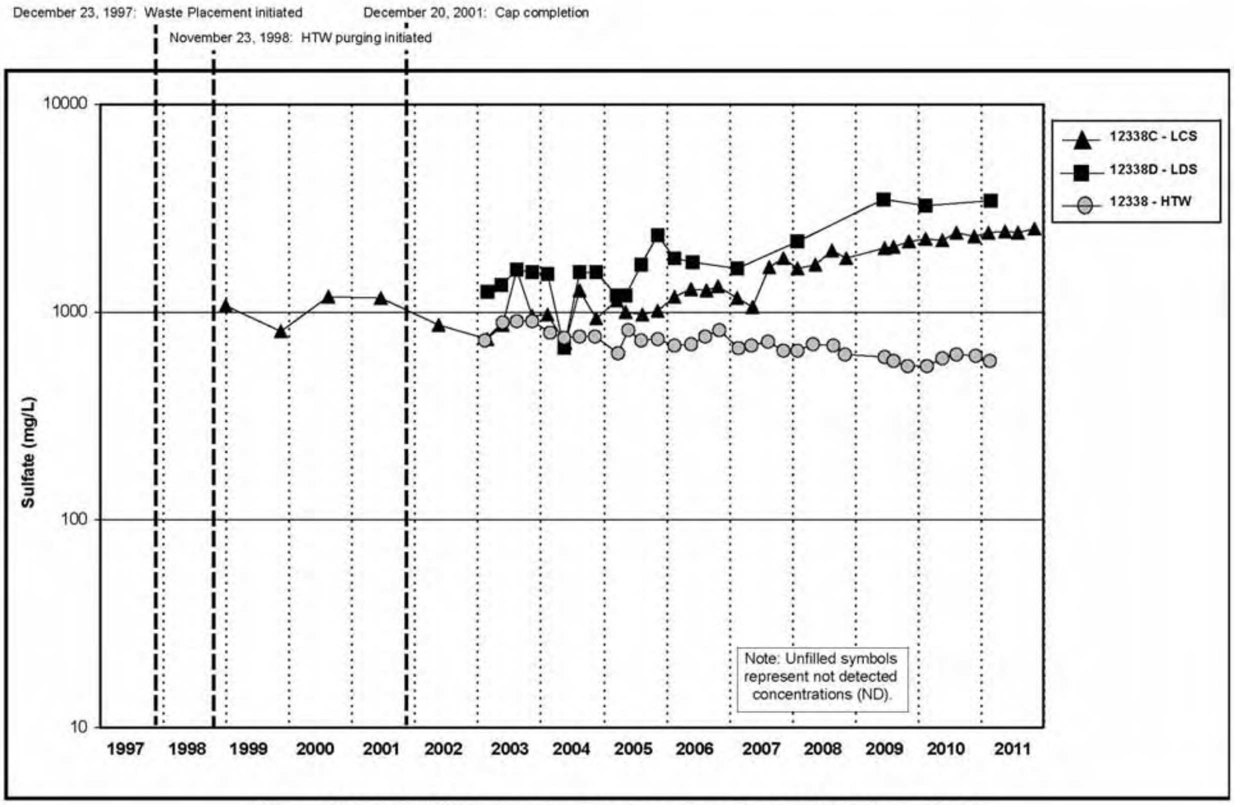


Figure A.5.1-10A. Cell 1 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

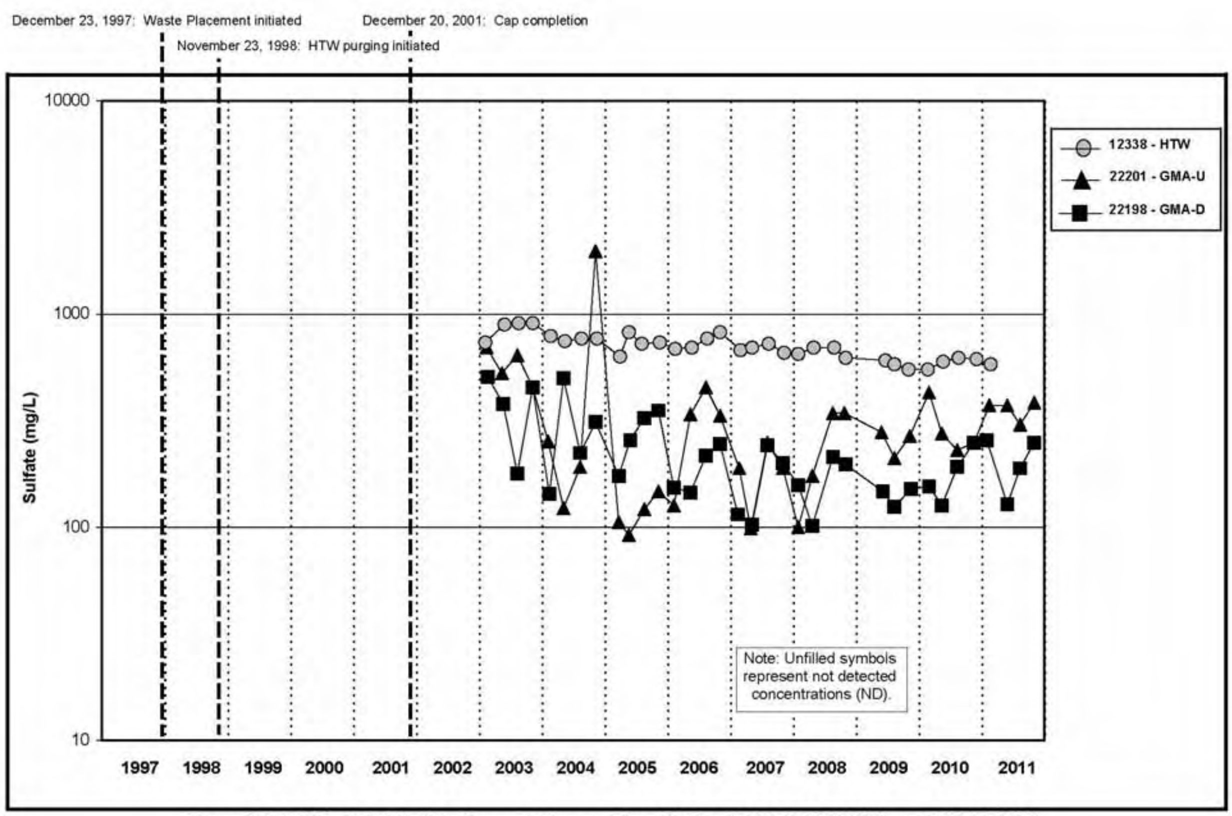


Figure A.5.1-10B. Cell 1 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

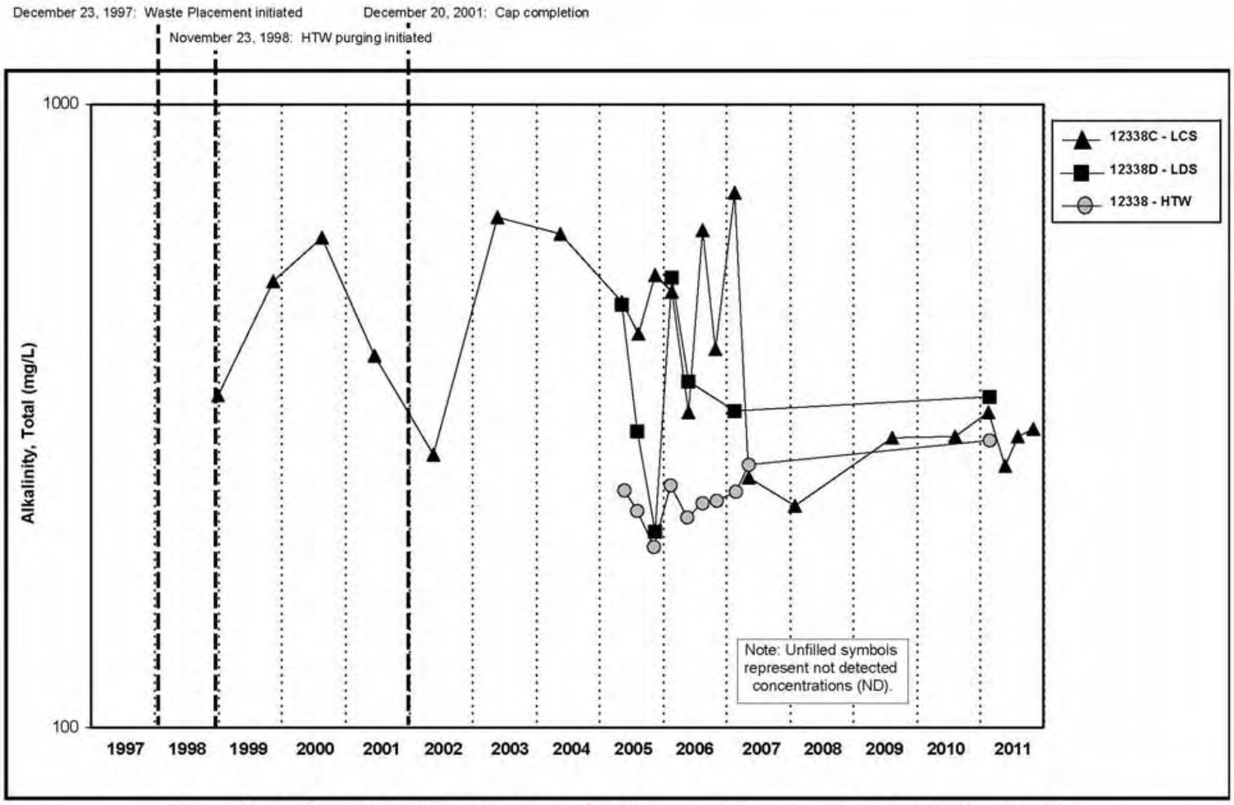


Figure A.5.1-11A. Cell 1 Alkalinity, Total (As CaCO3) Concentration vs. Time Plot for LCS, LDS, and HTW

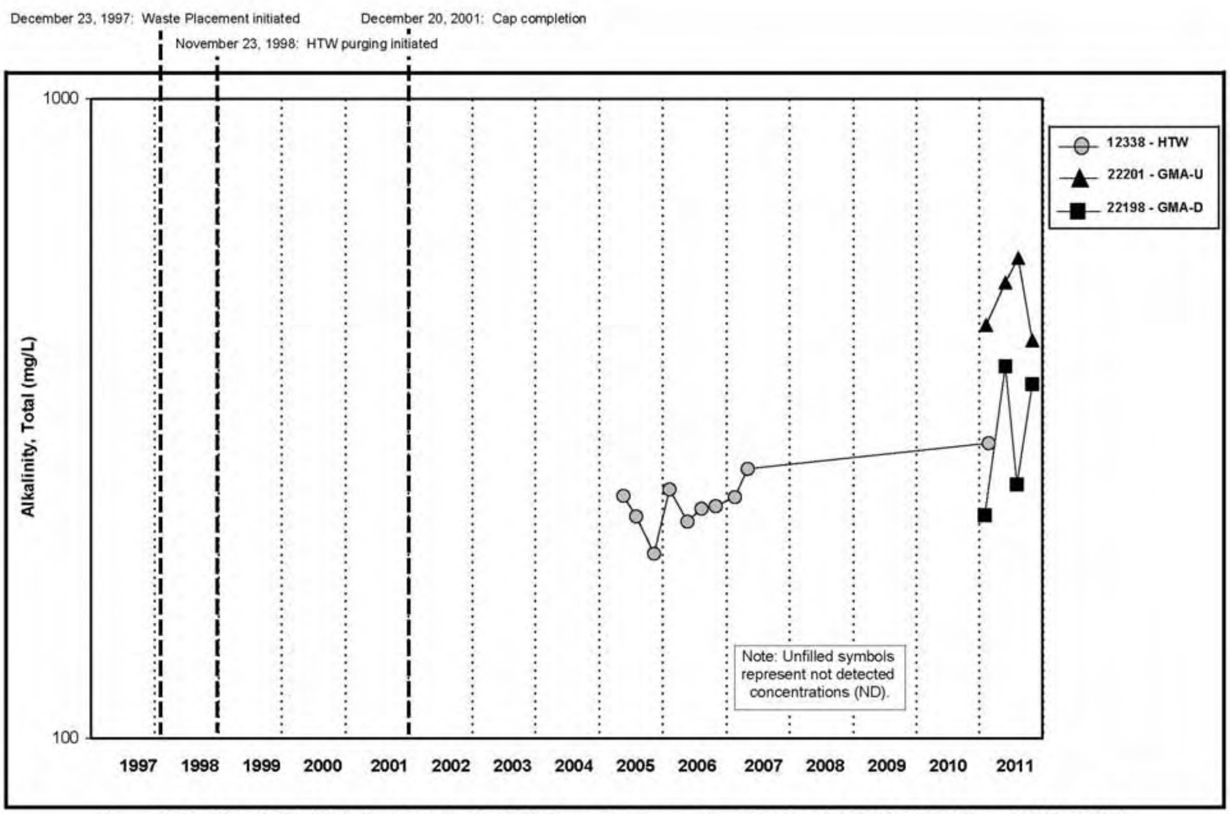


Figure A.5.1-11B. Cell 1 Alkalinity, Total (As CaCO3) Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

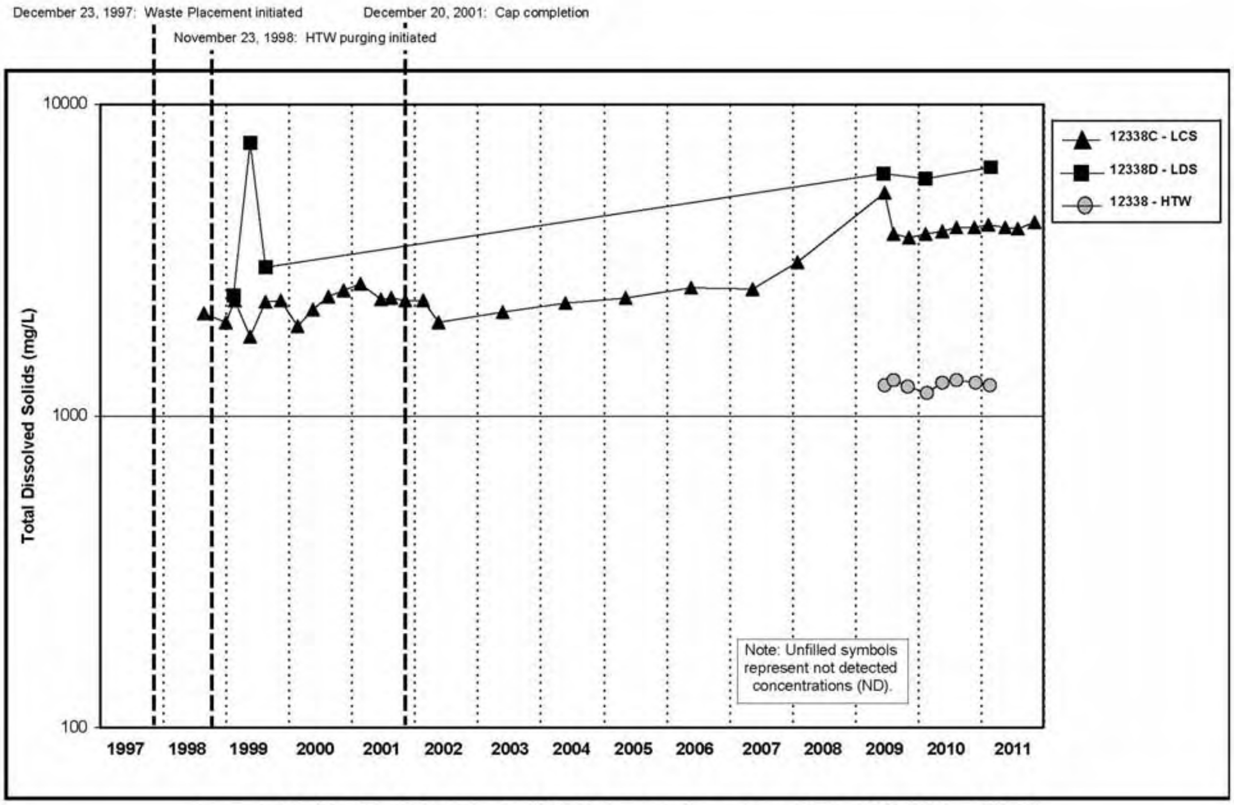


Figure A.5.1-12A. Cell 1 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

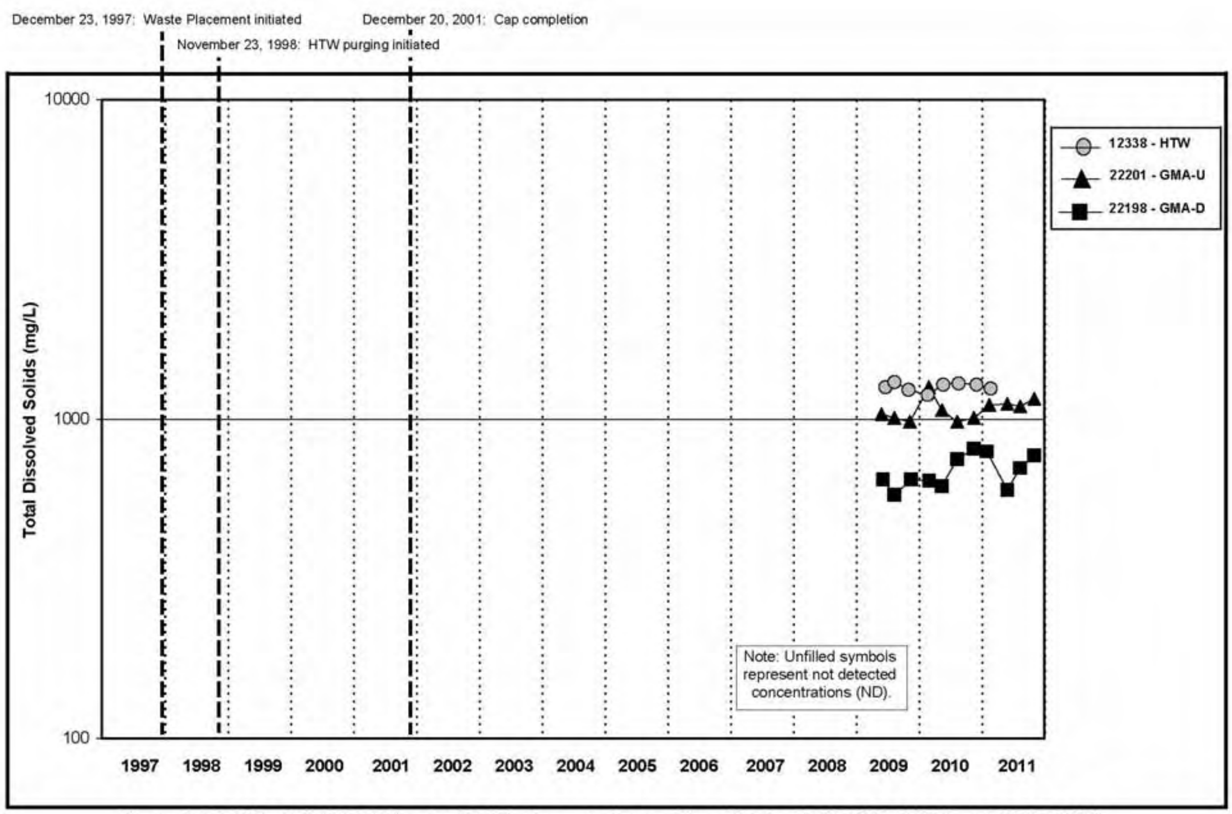


Figure A.5.1-12B. Cell 1 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

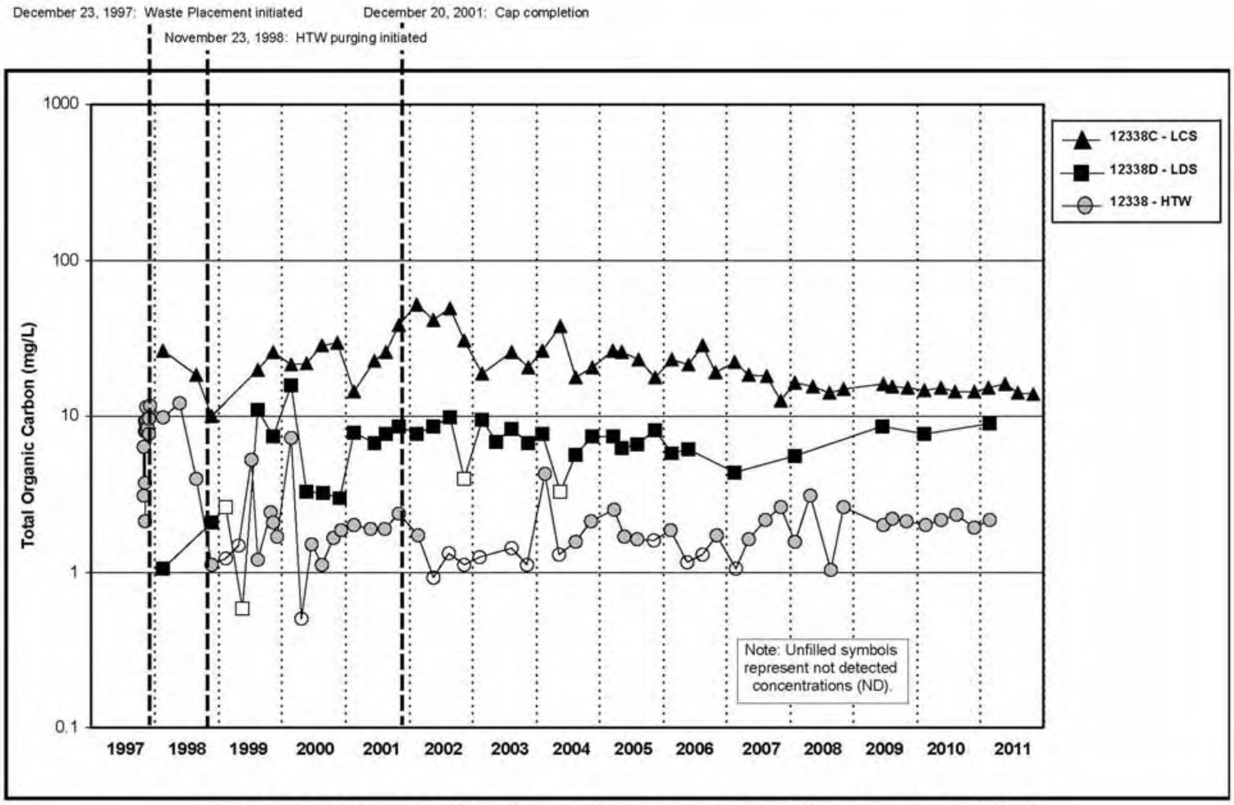


Figure A.5.1-13A. Cell 1 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

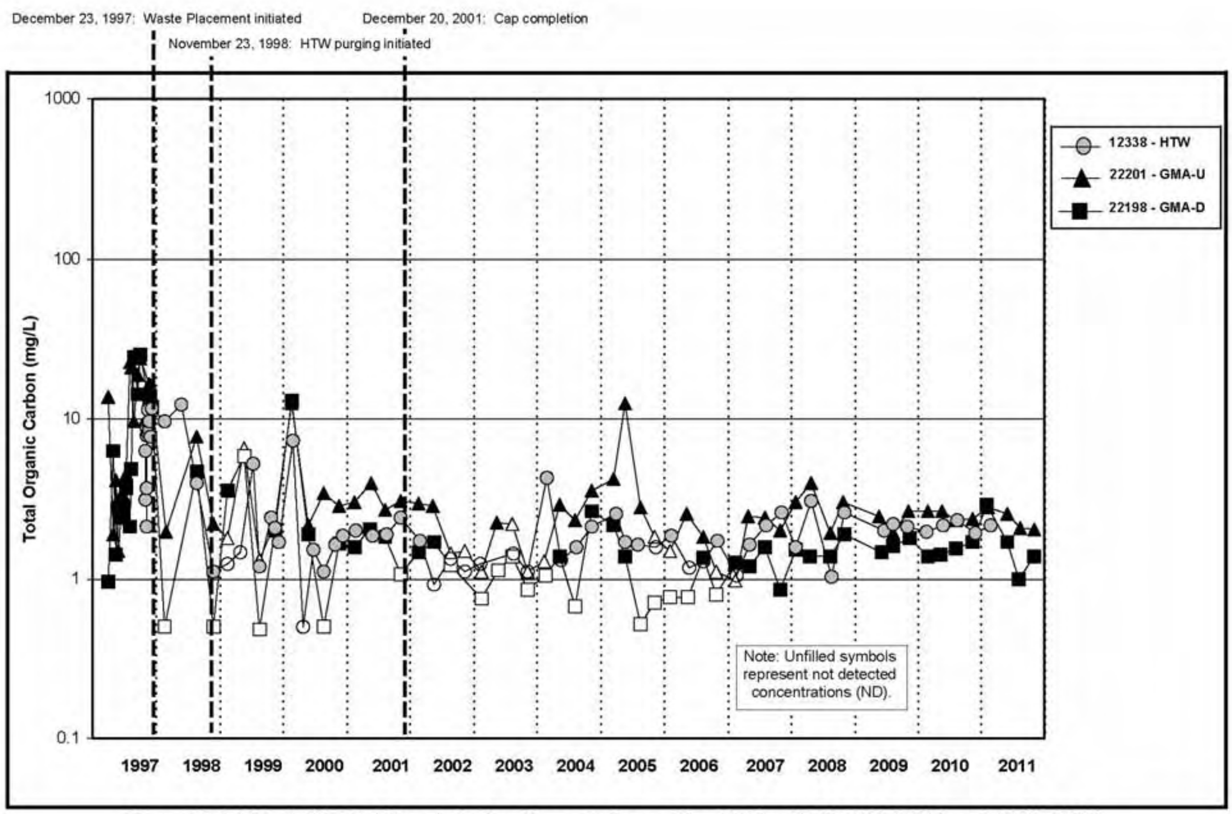


Figure A.5.1-13B. Cell 1 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

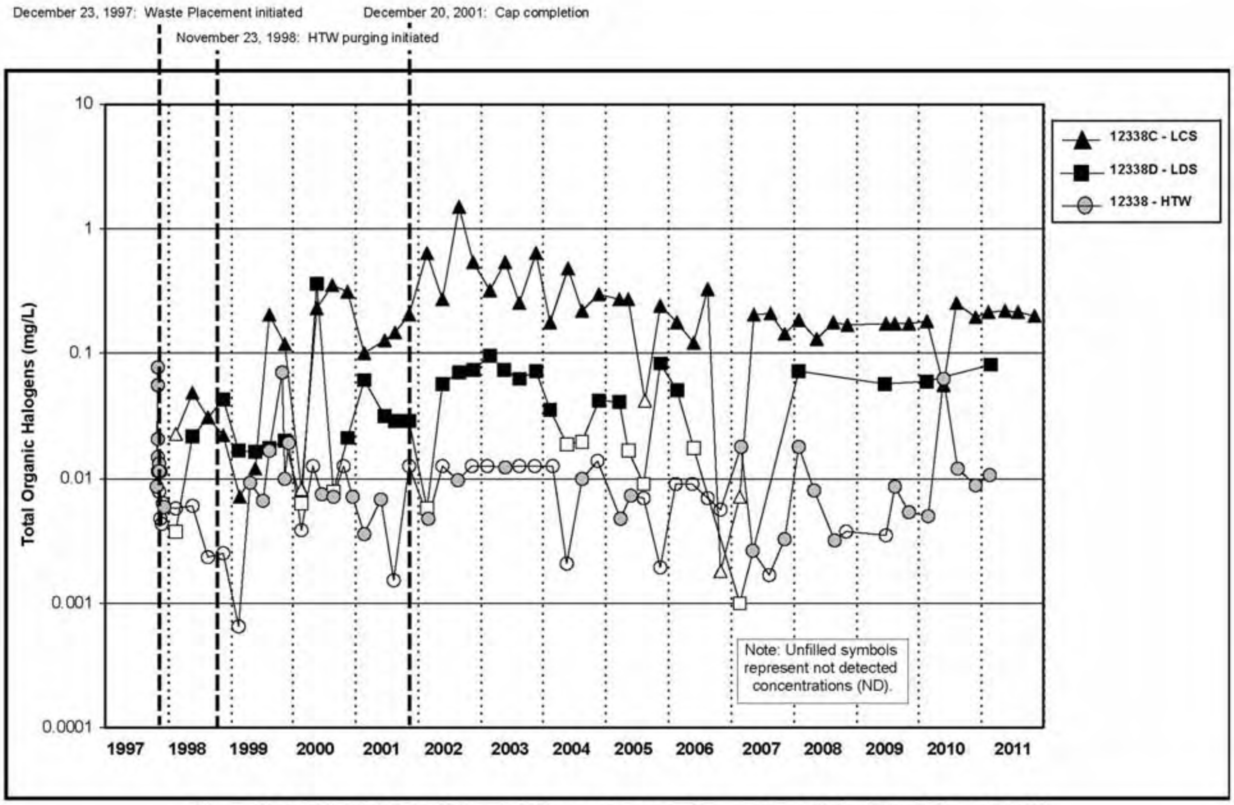


Figure A.5.1-14A. Cell 1 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

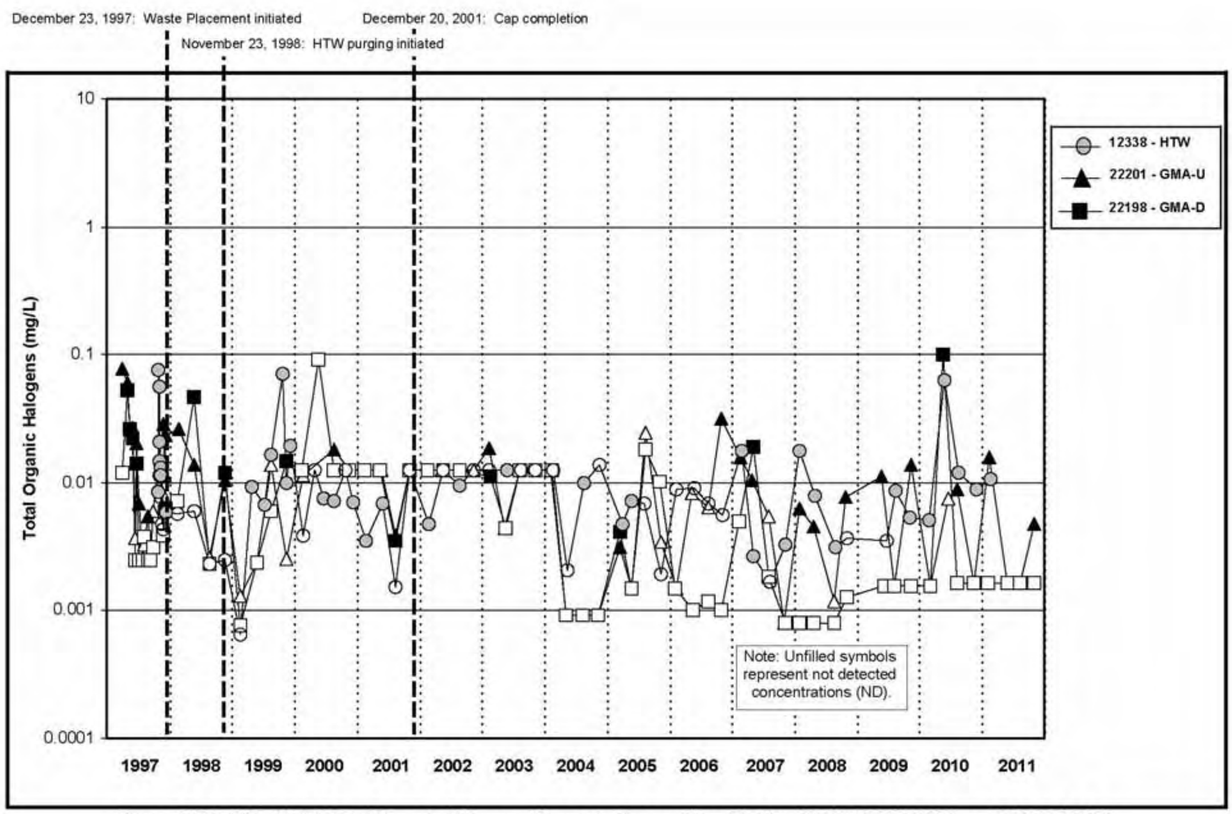


Figure A.5.1-14B. Cell 1 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

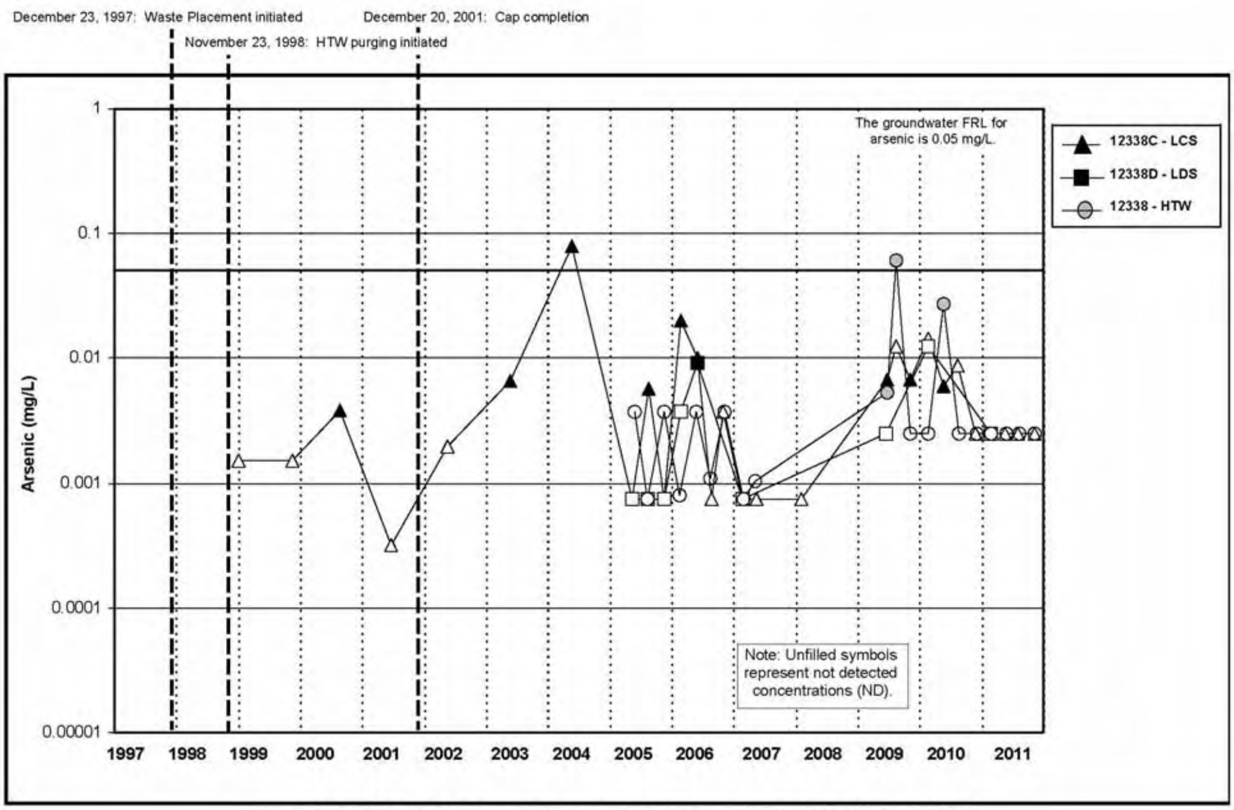


Figure A.5.1-15A. Cell 1 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

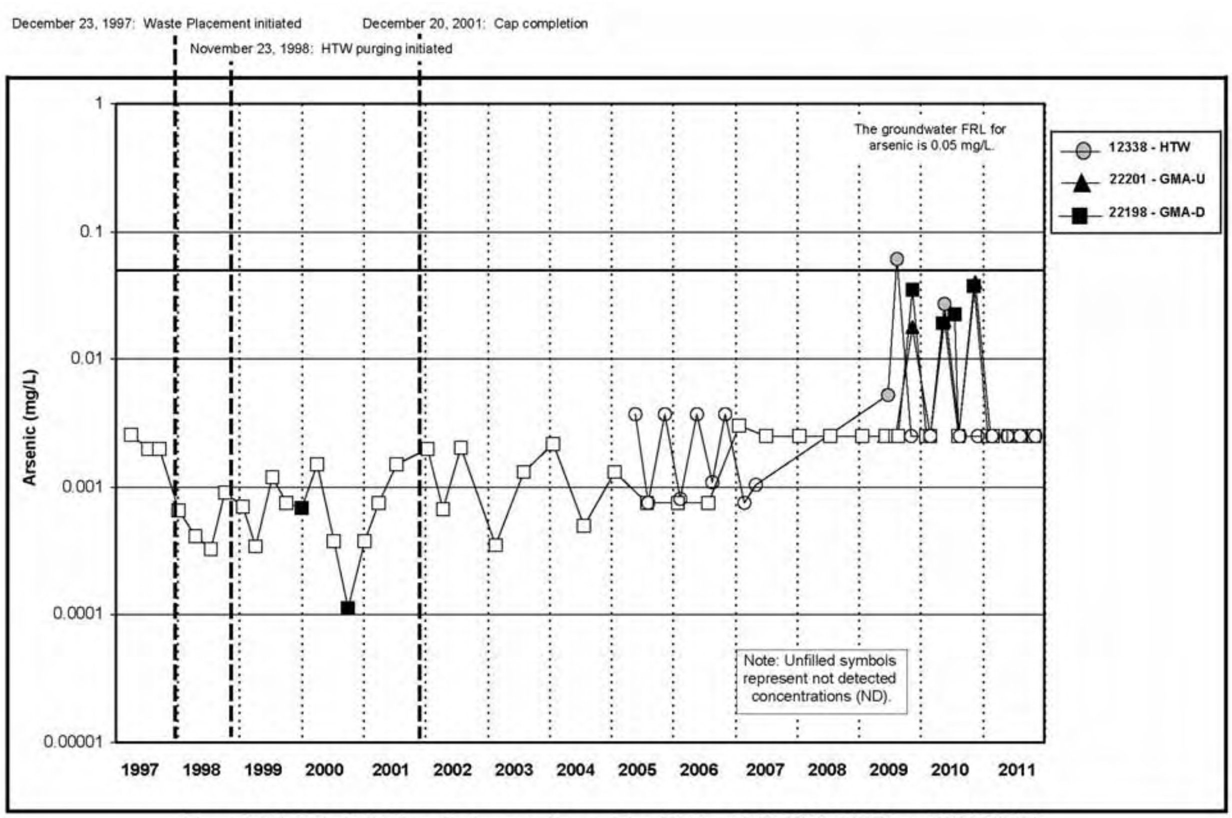


Figure A.5.1-15B. Cell 1 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

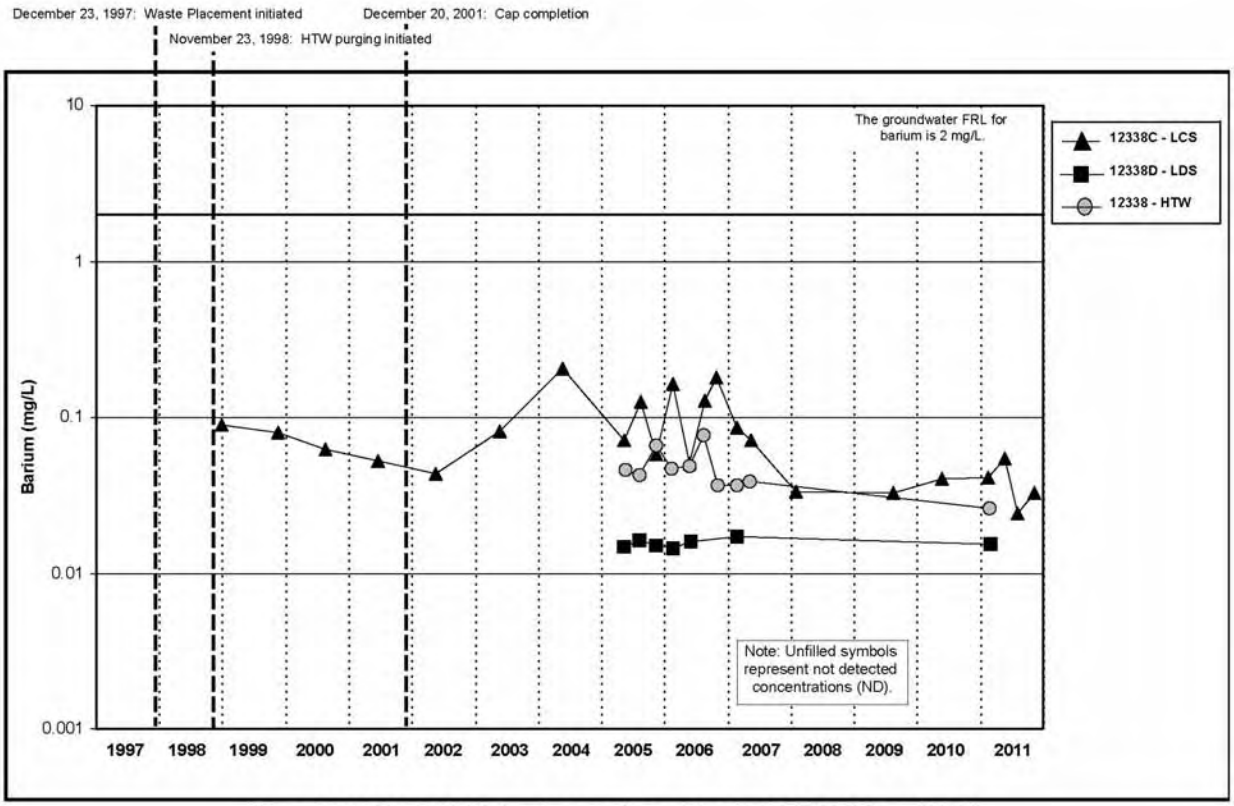


Figure A.5.1-16A. Cell 1 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

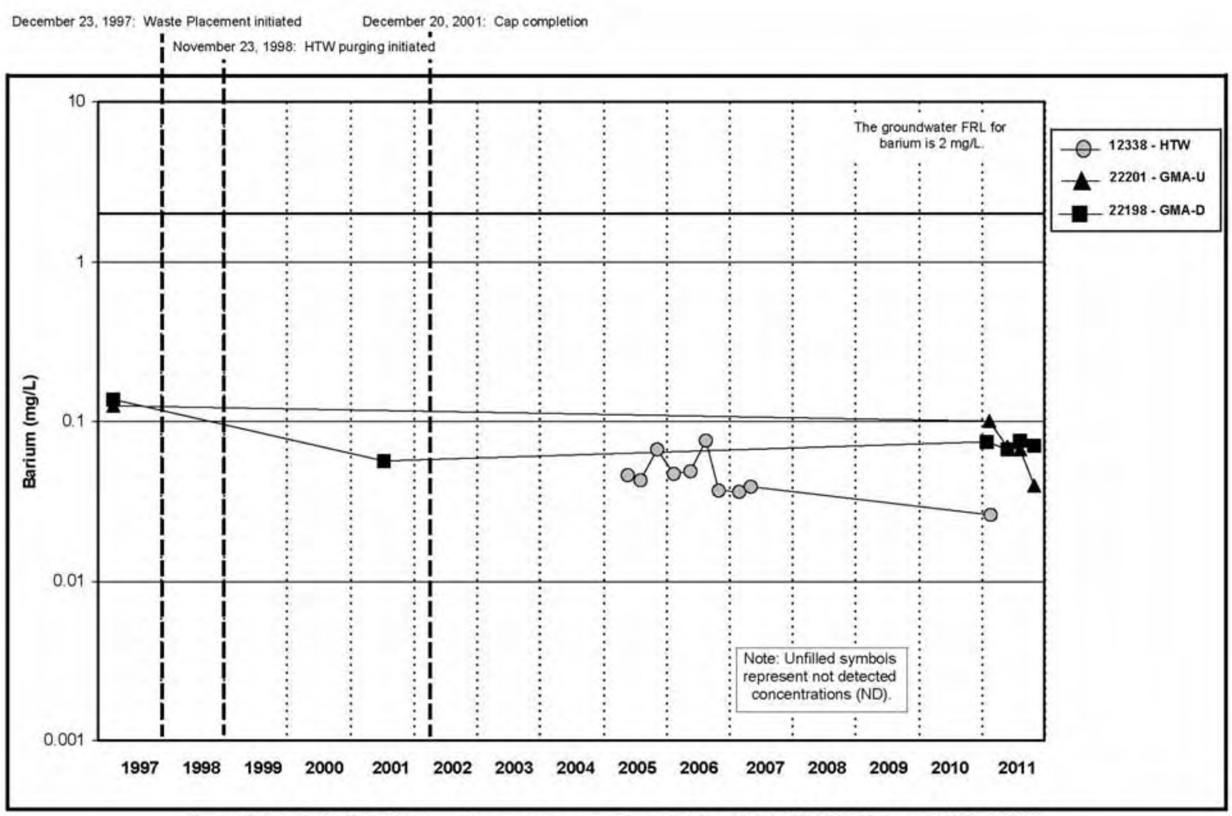


Figure A.5.1-16B. Cell 1 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

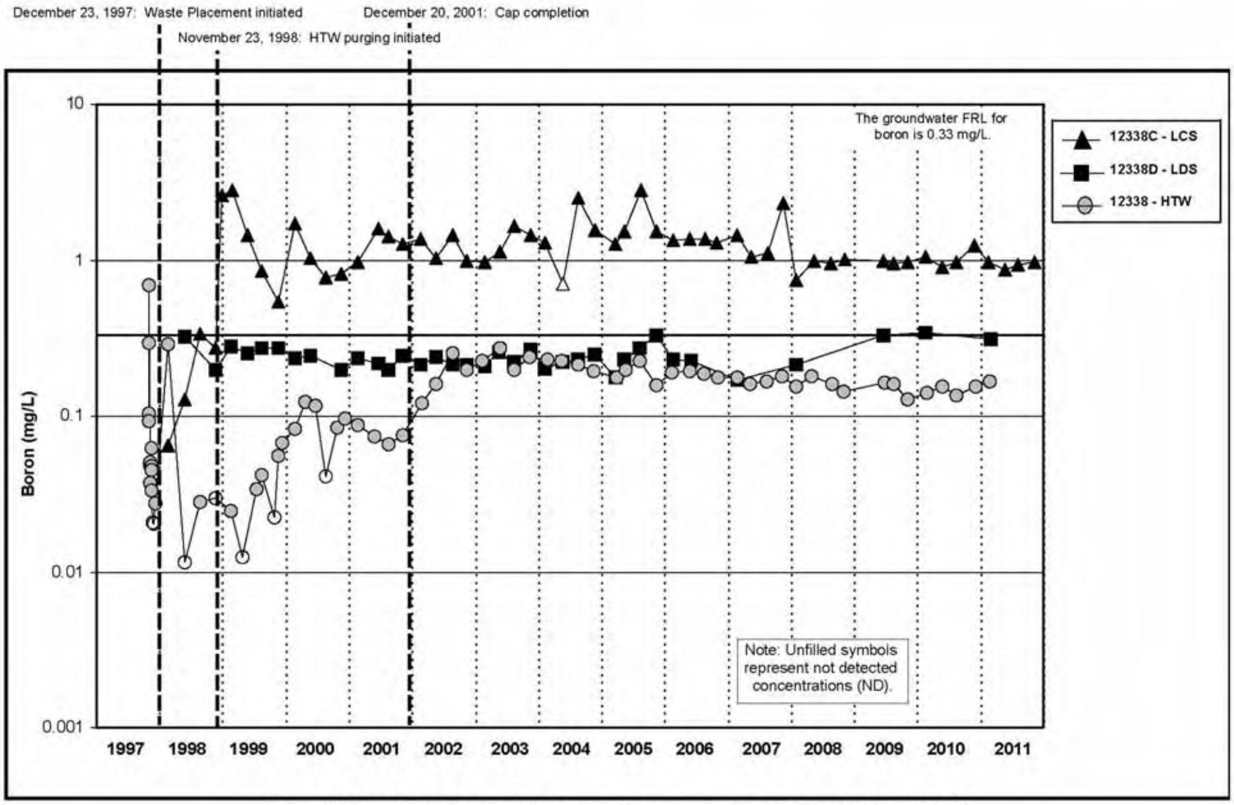


Figure A.5.1-17A. Cell 1 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

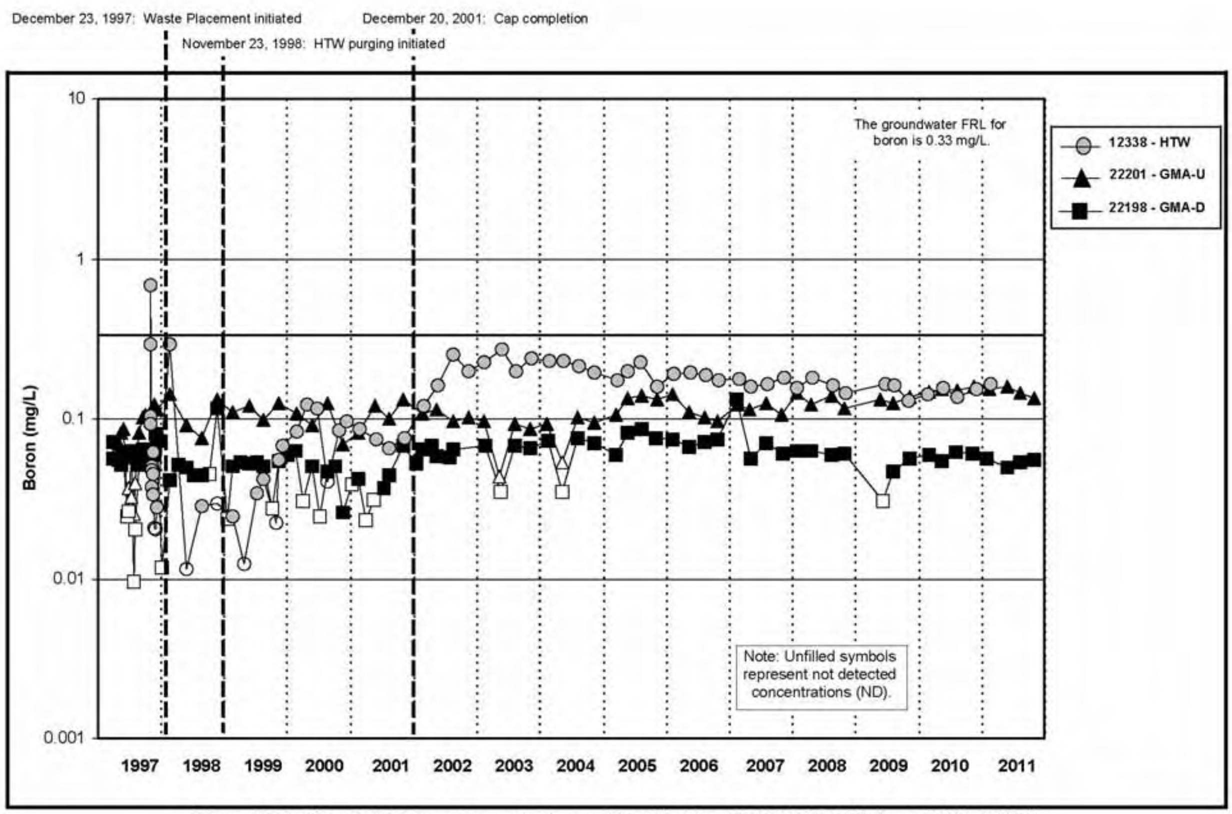


Figure A.5.1-17B. Cell 1 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

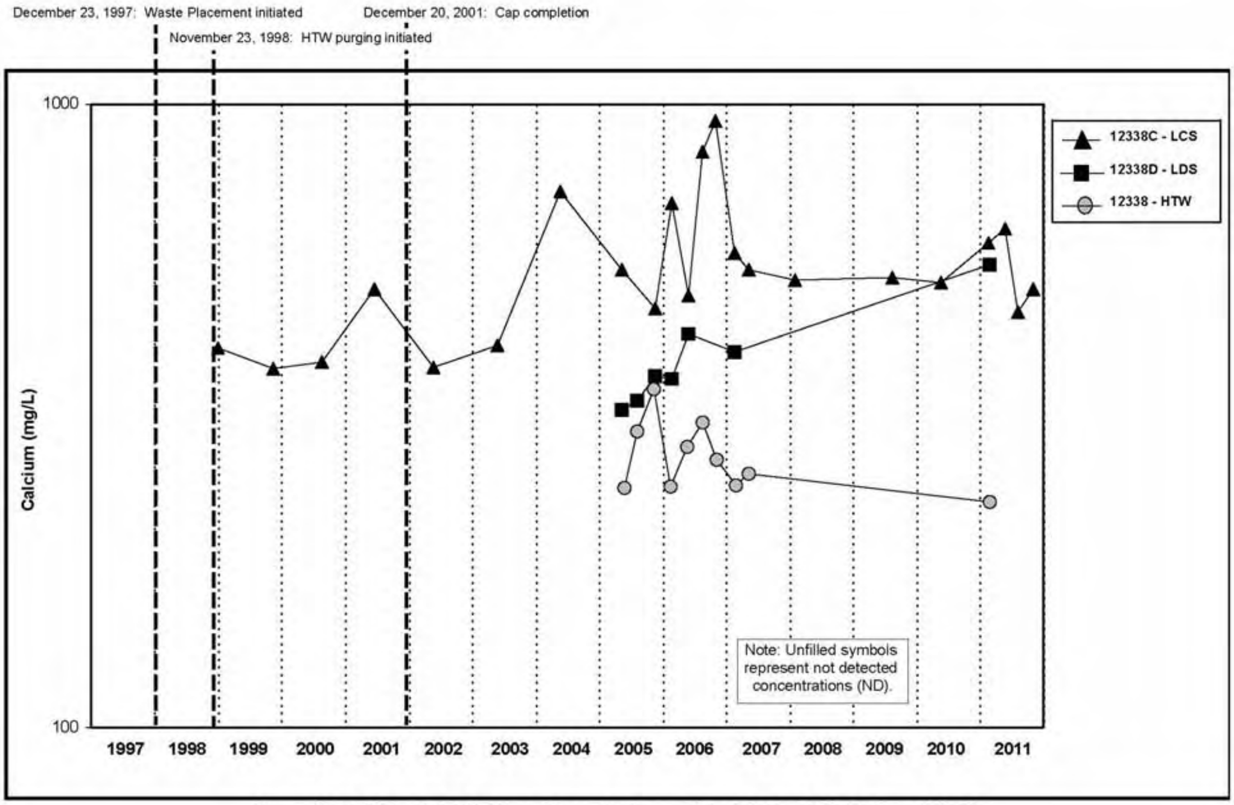


Figure A.5.1-18A. Cell 1 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

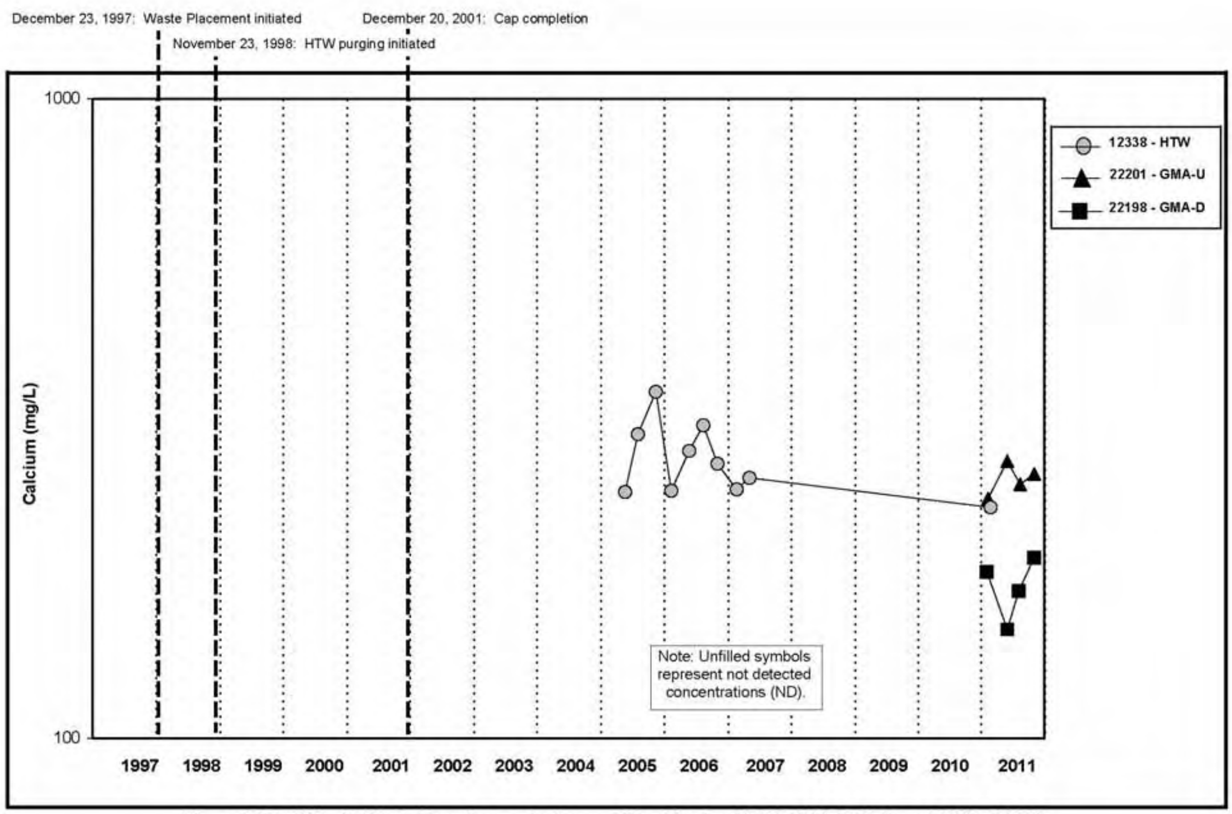


Figure A.5.1-18B. Cell 1 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

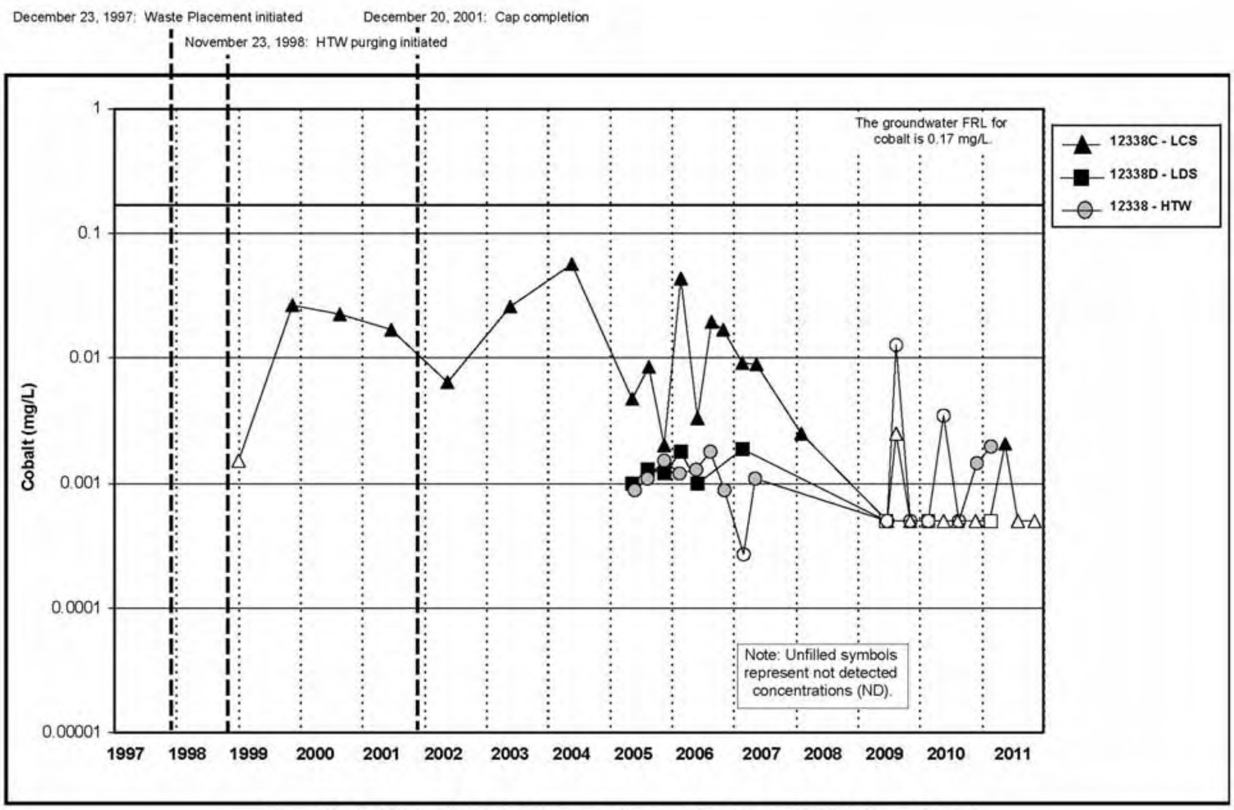


Figure A.5.1-19A. Cell 1 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

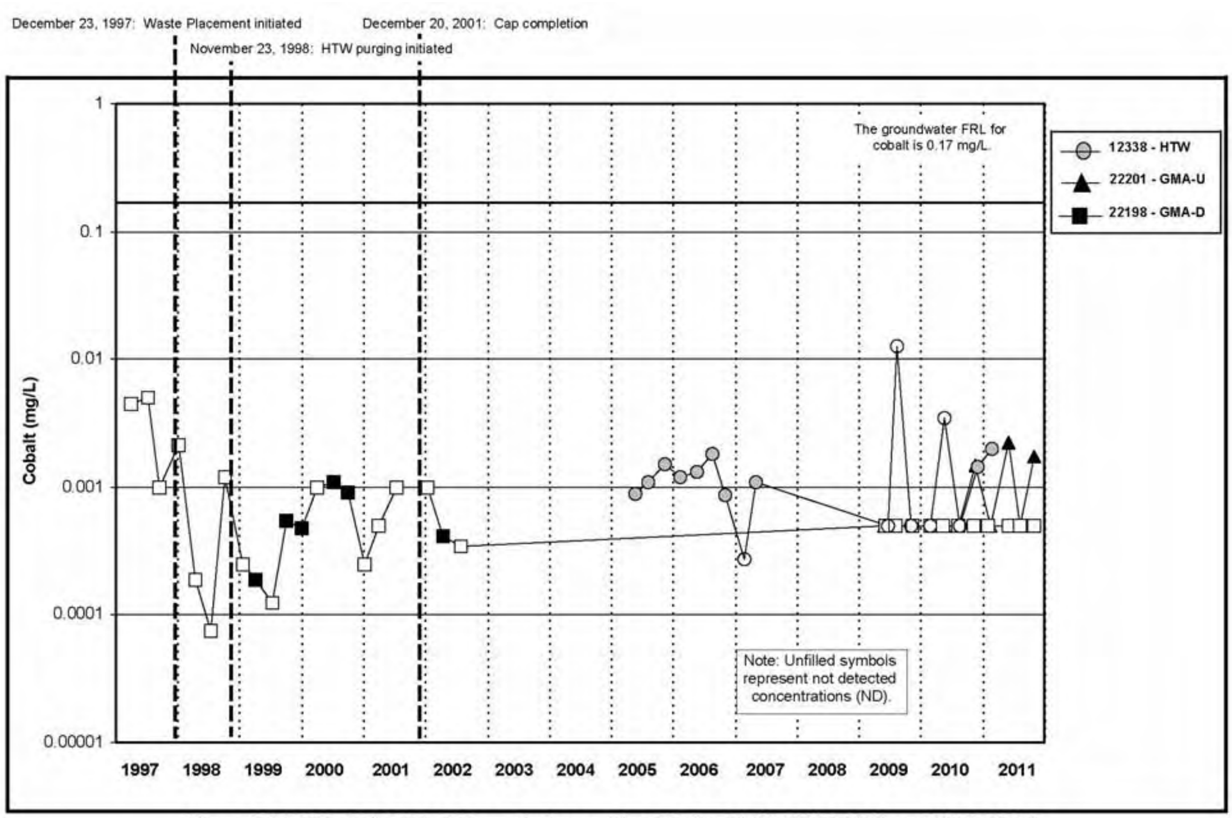


Figure A.5.1-19B. Cell 1 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

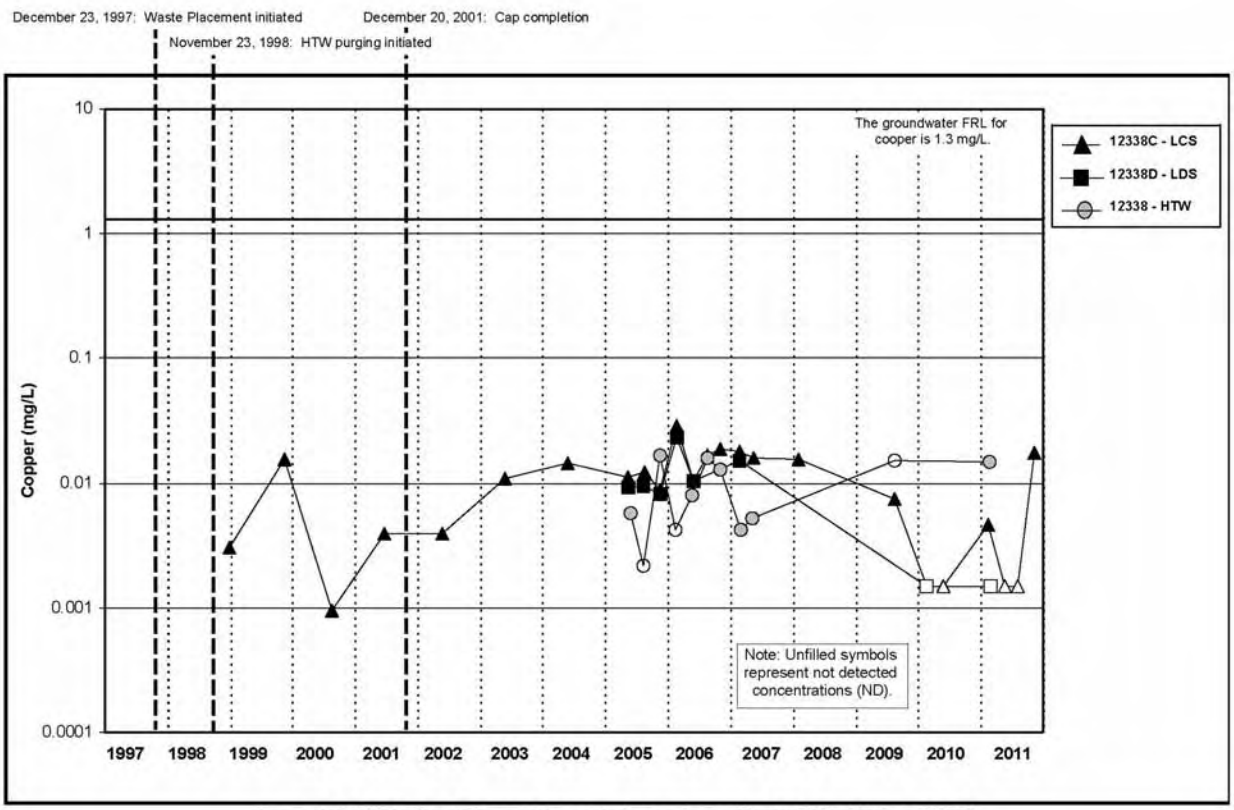


Figure A.5.1-20A. Cell 1 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

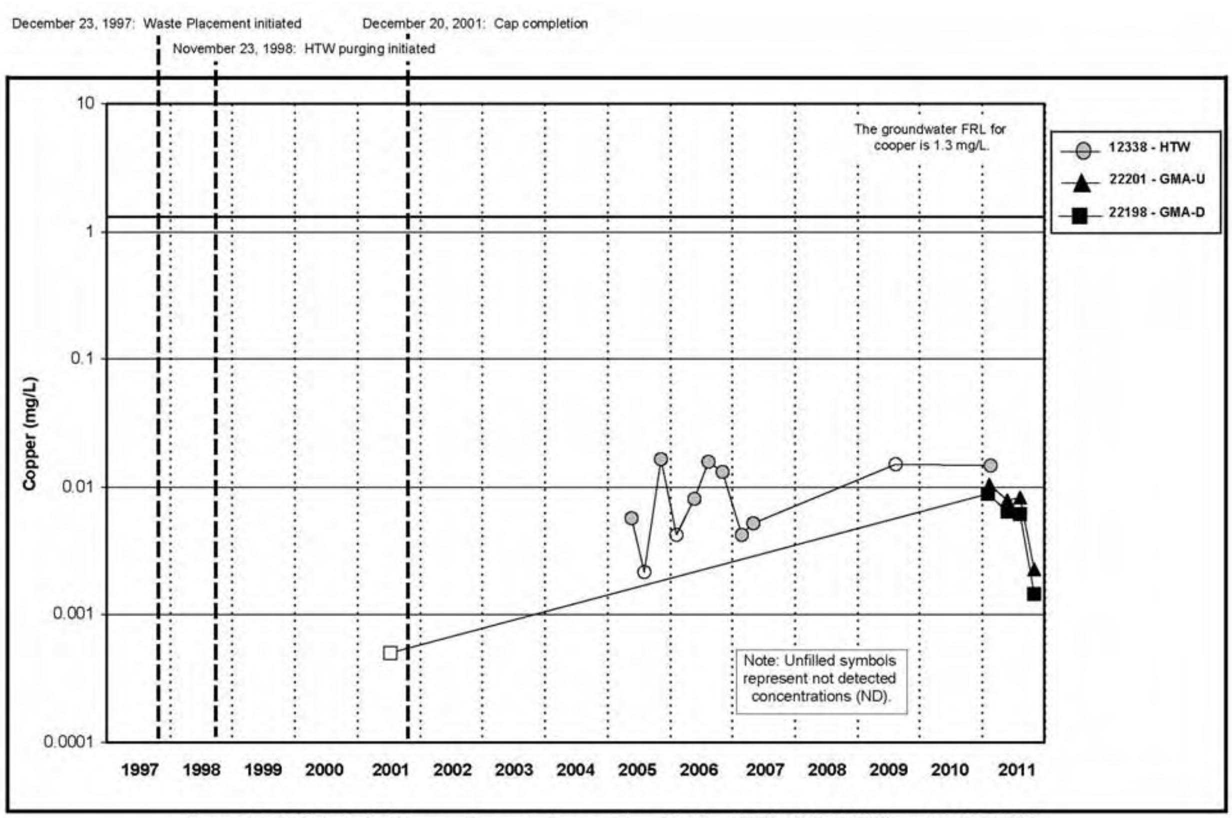


Figure A.5.1-20B. Cell 1 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

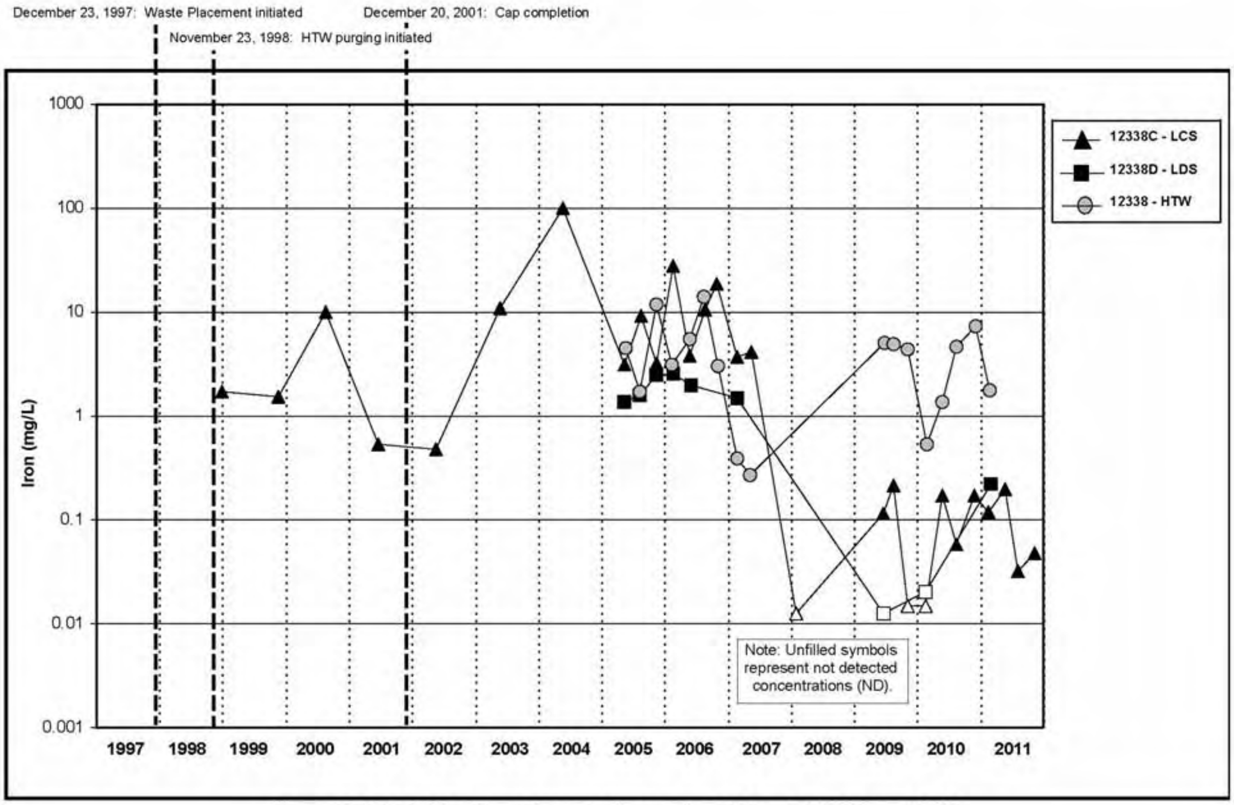


Figure A.5.1-21A. Cell 1 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

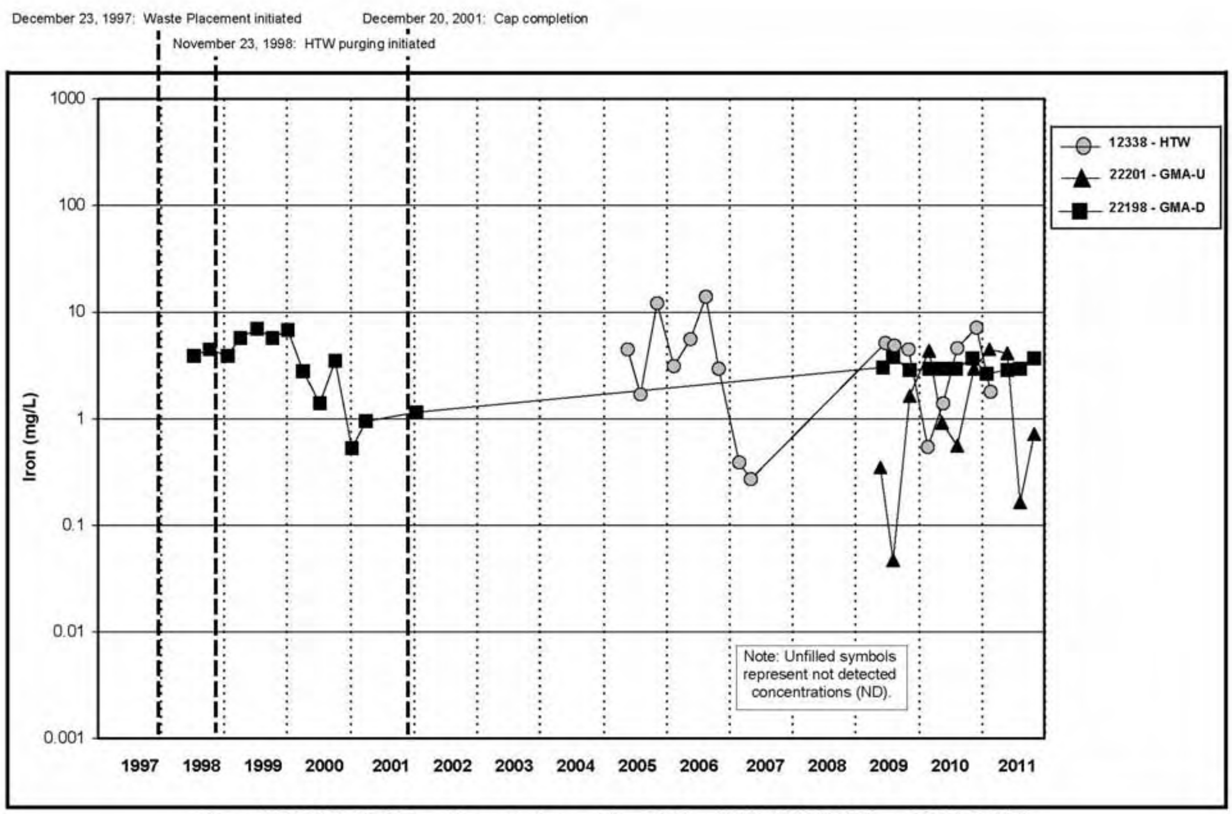


Figure A.5.1-21B. Cell 1 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

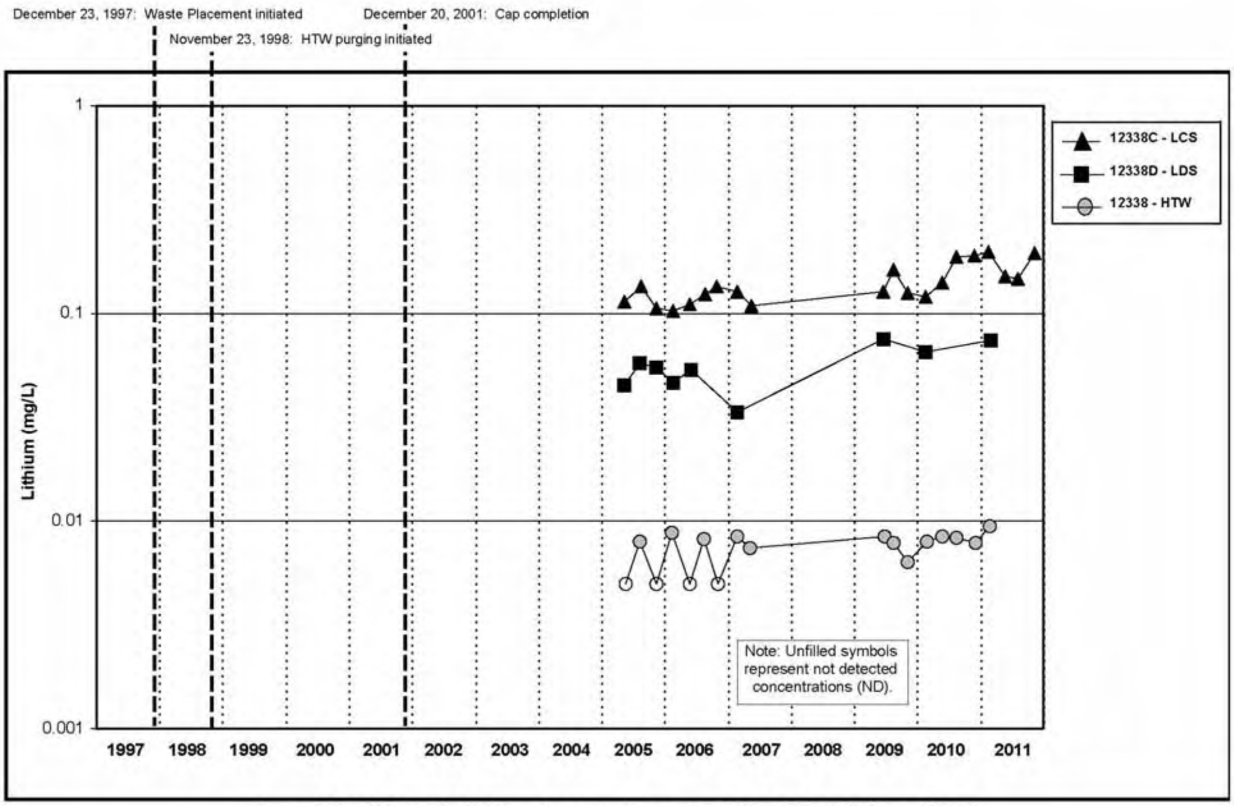


Figure A.5.1-22A. Cell 1 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

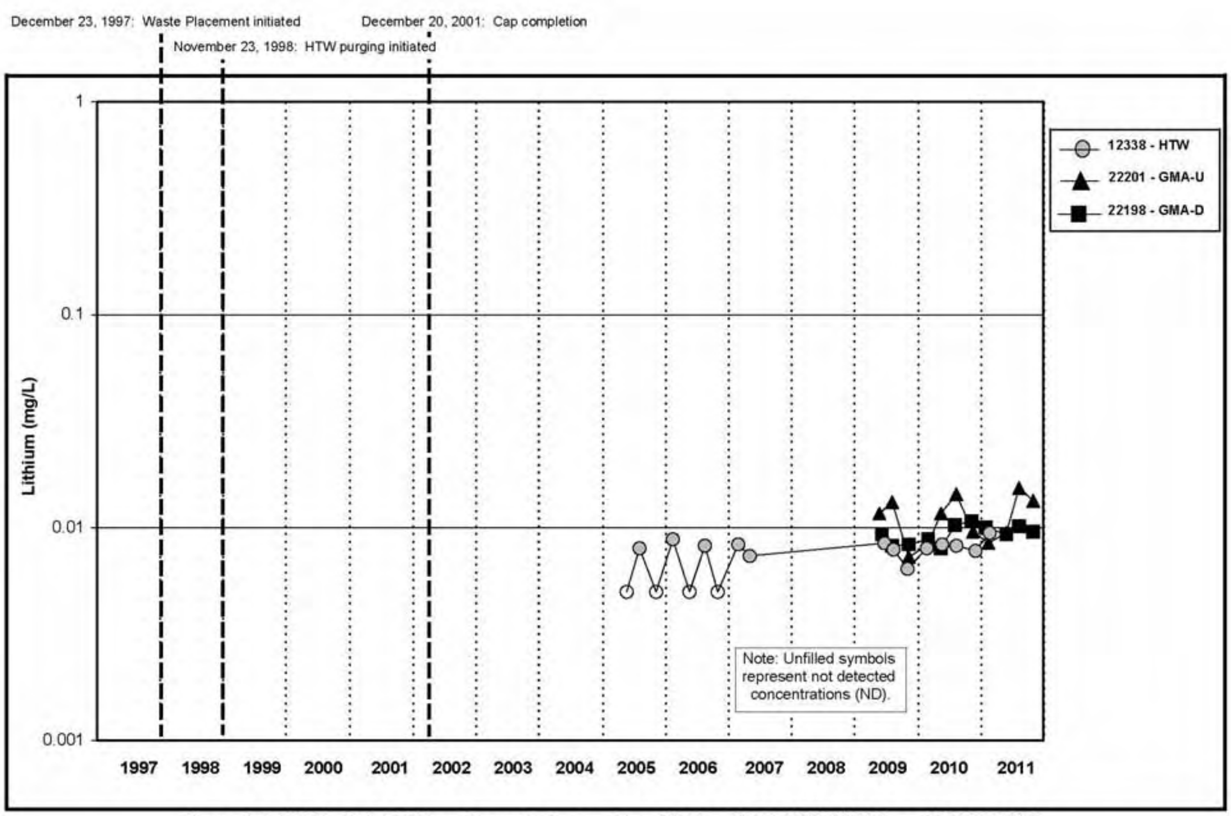


Figure A.5.1-22B. Cell 1 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

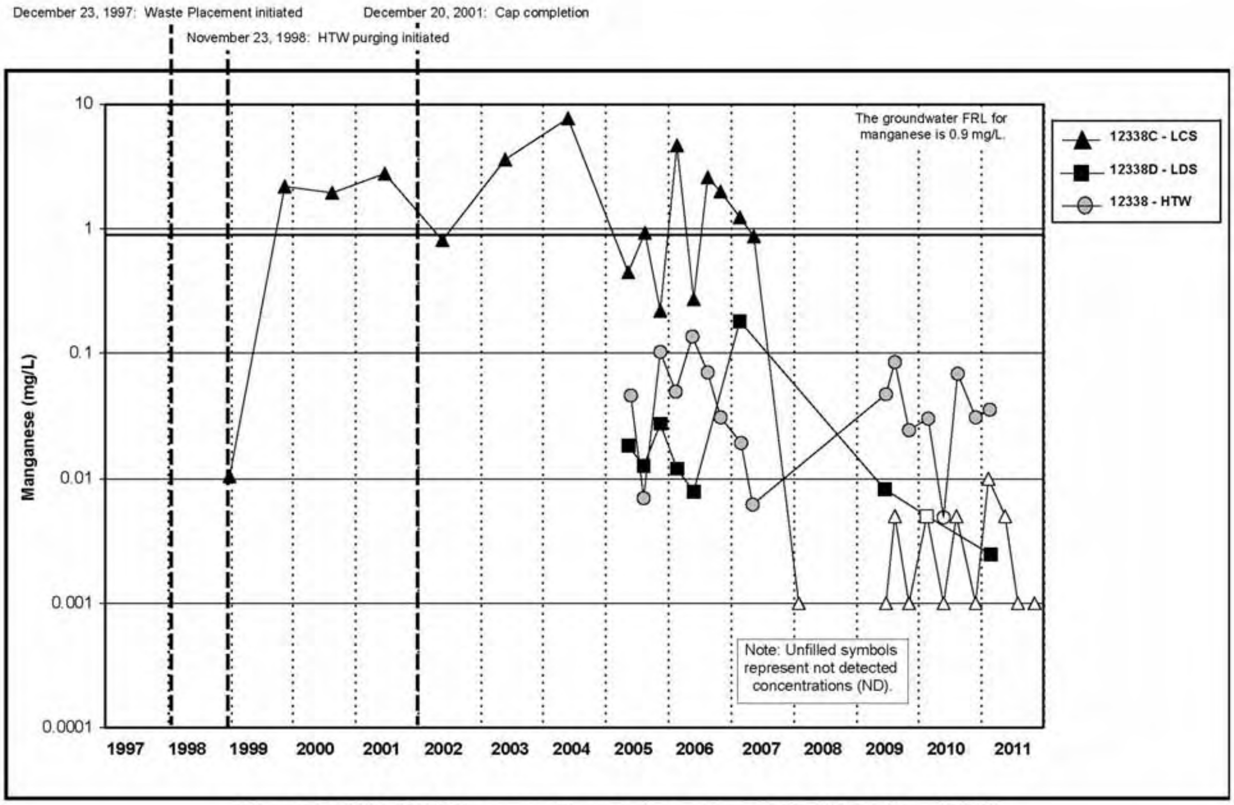


Figure A.5.1-23A. Cell 1 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

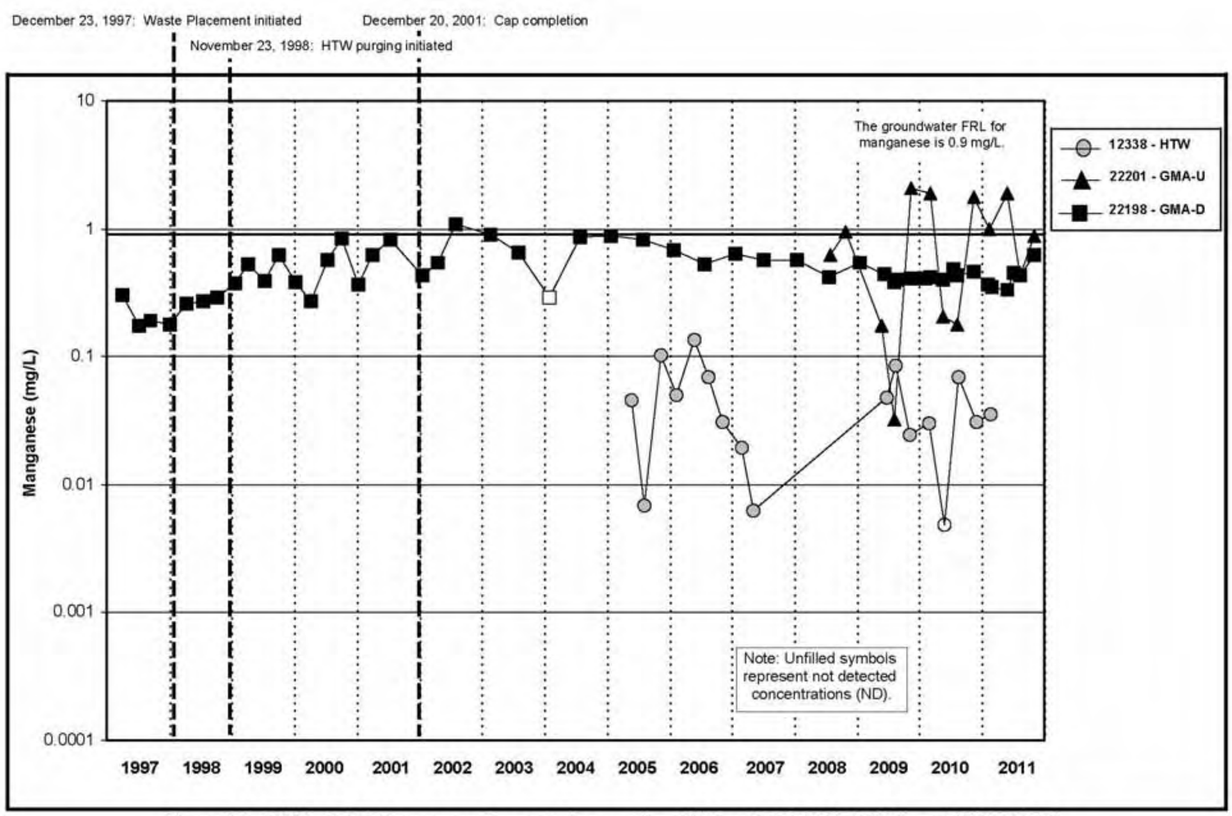


Figure A.5.1-23B. Cell 1 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

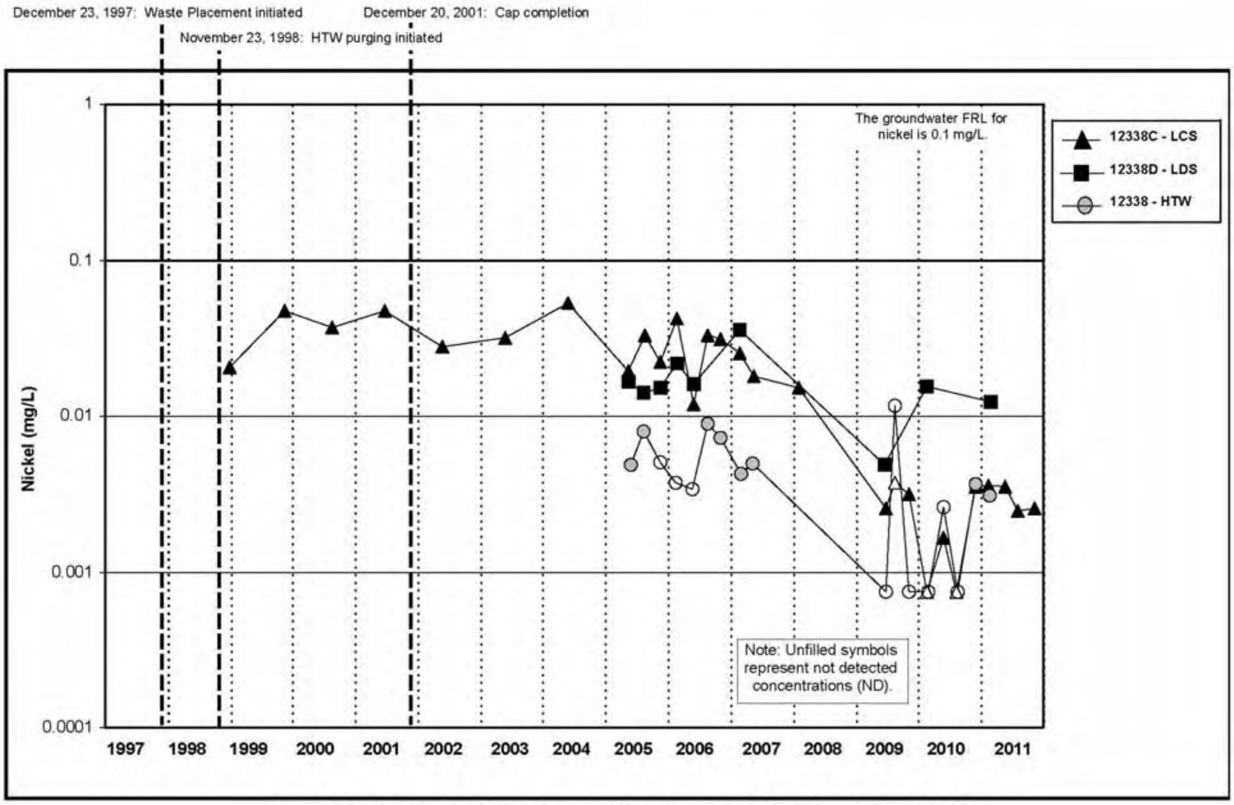


Figure A.5.1-24A. Cell 1 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

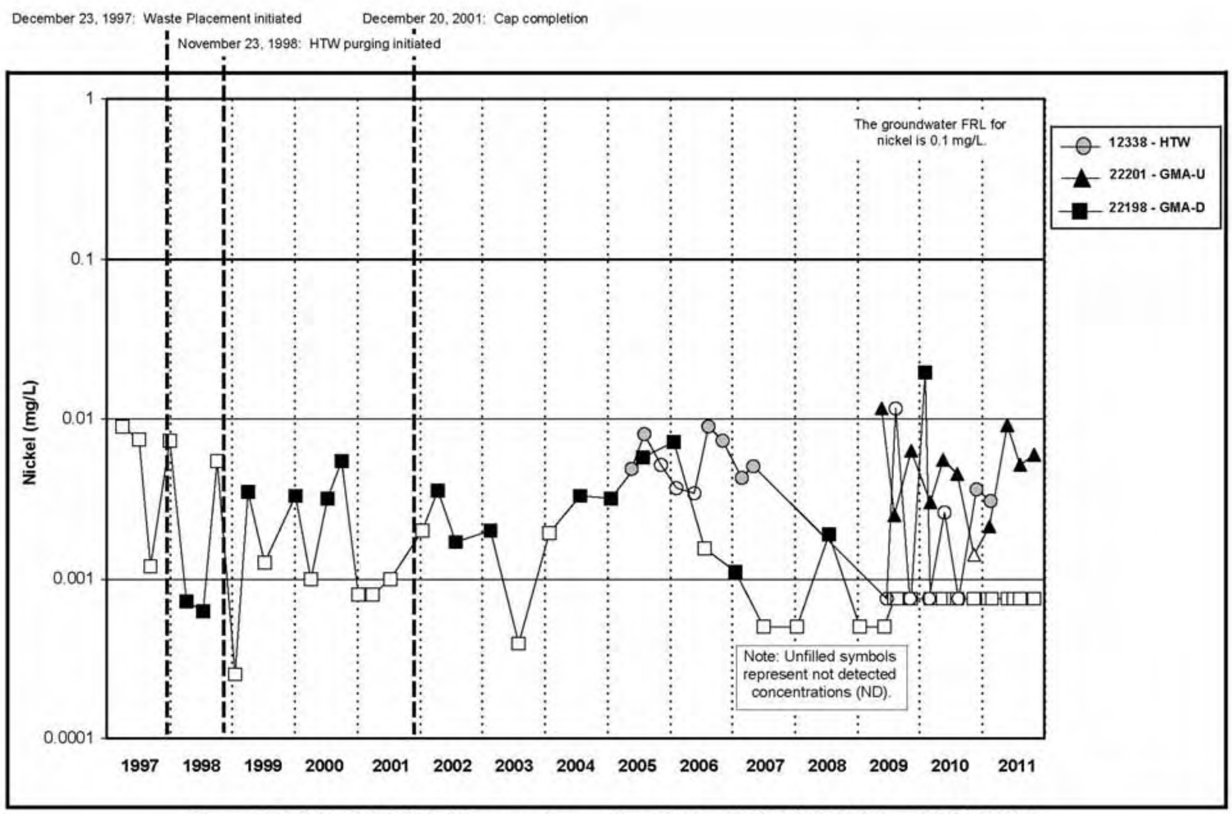


Figure A.5.1-24B. Cell 1 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

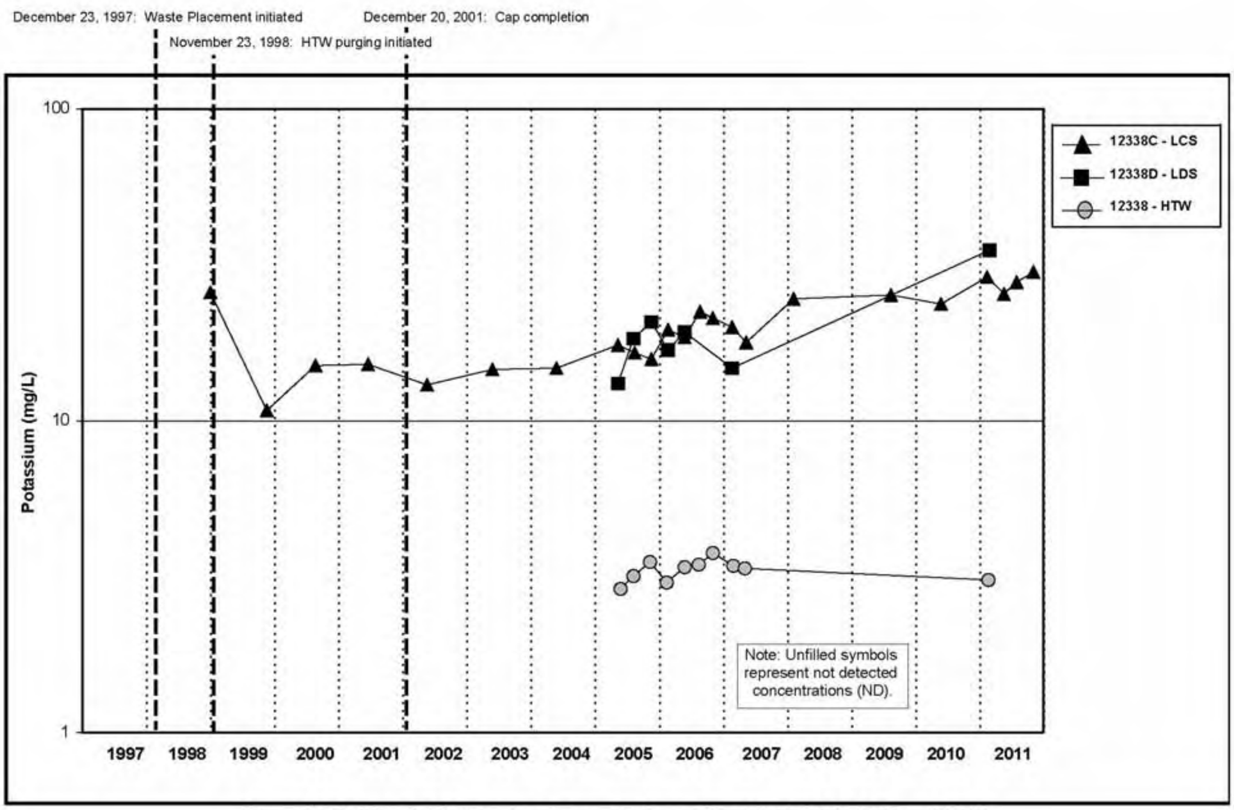


Figure A.5.1-25A. Cell 1 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

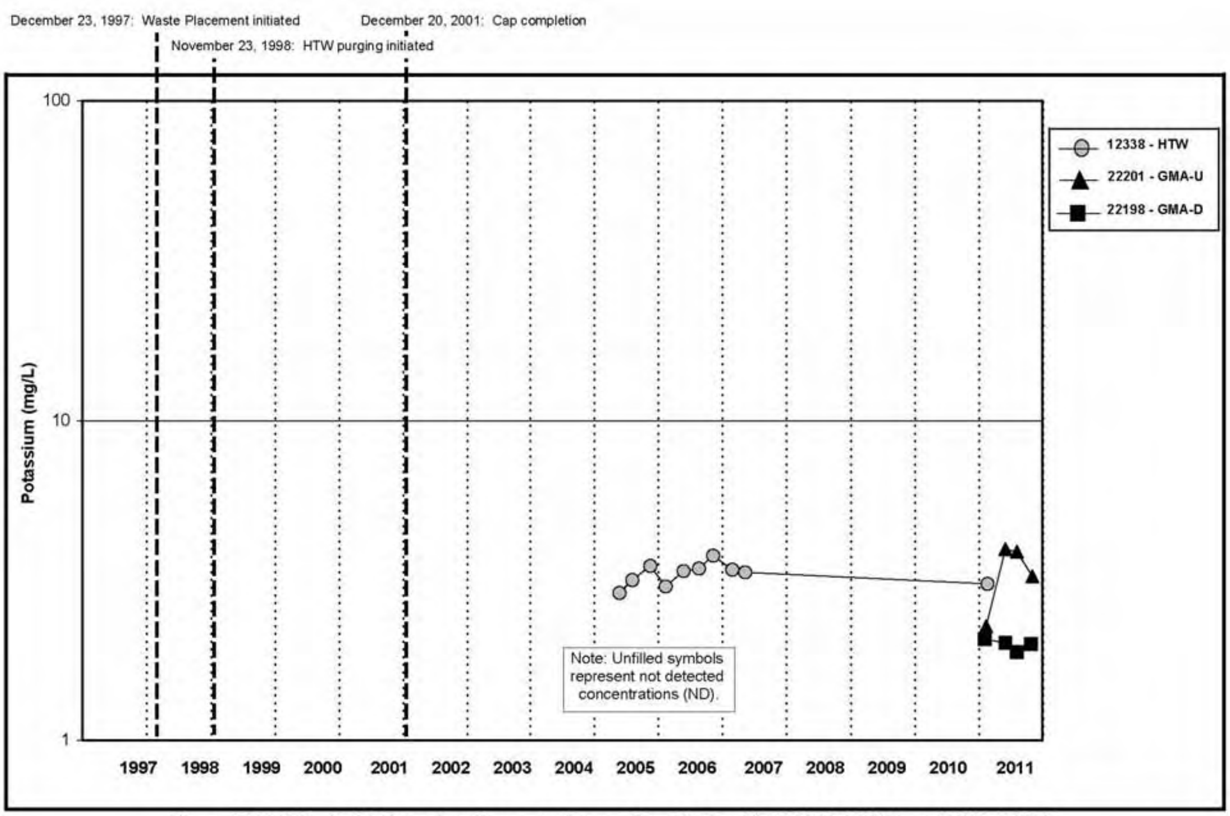


Figure A.5.1-25B. Cell 1 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

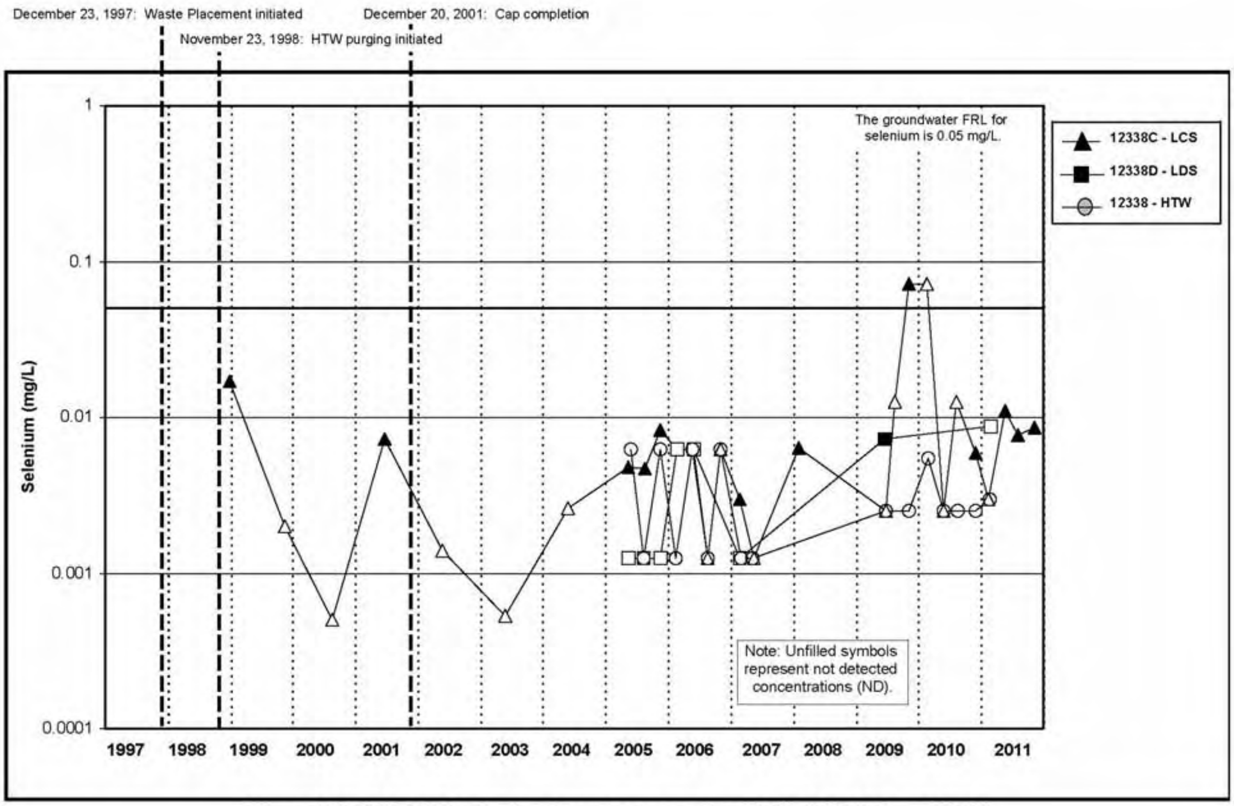


Figure A.5.1-26A. Cell 1 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

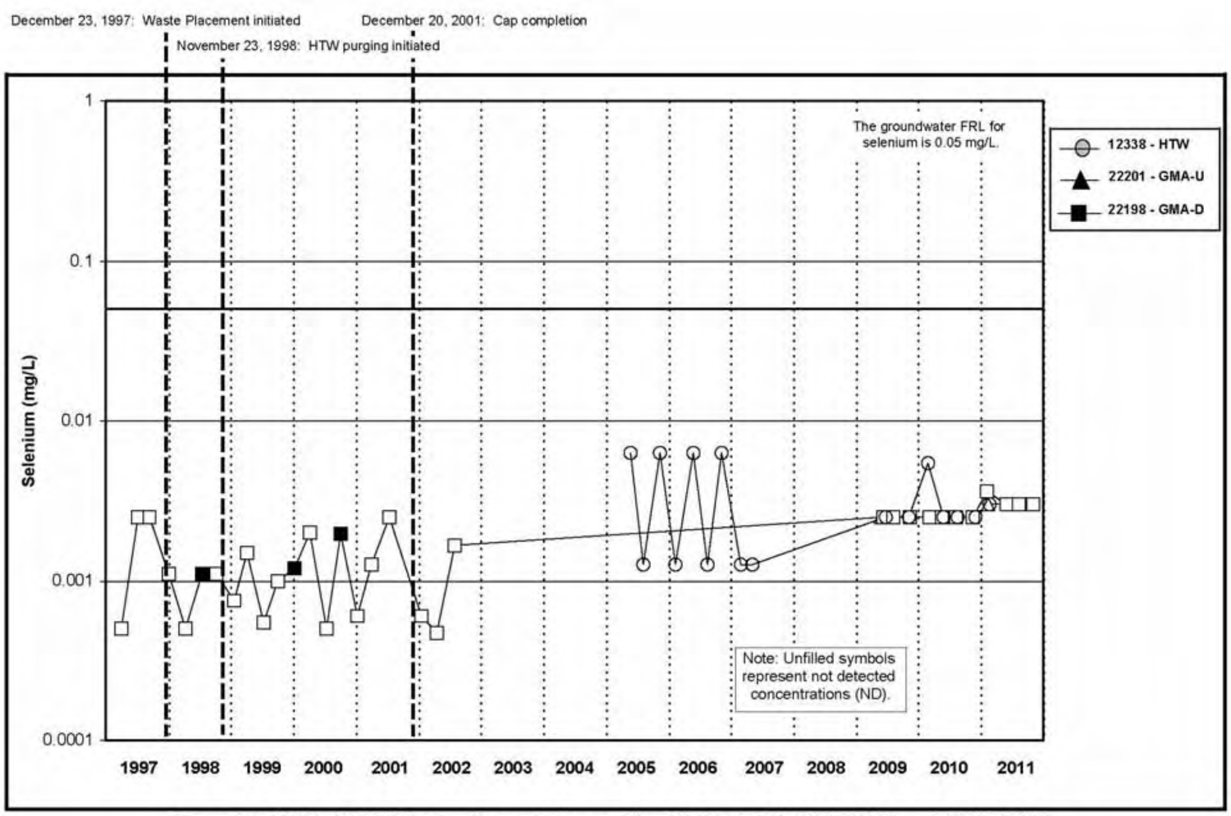


Figure A.5.1-26B. Cell 1 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

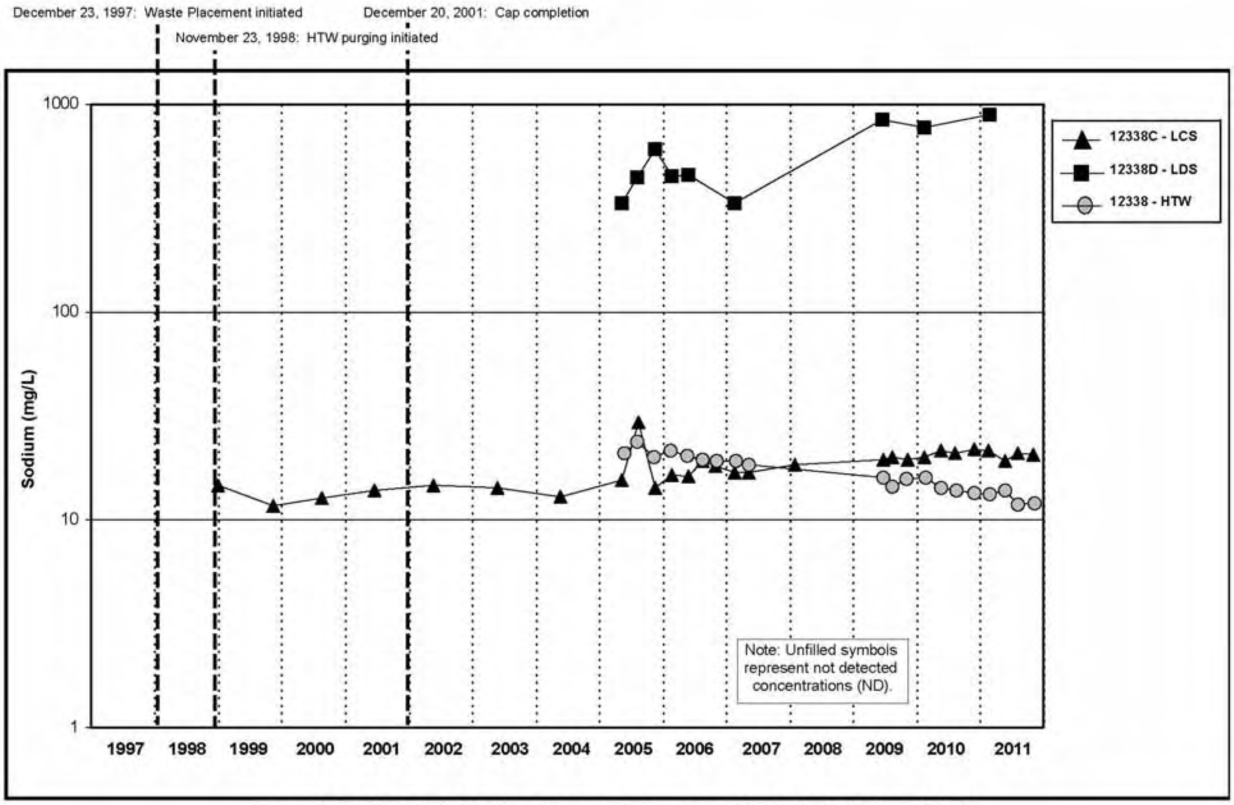


Figure A.5.1-27A. Cell 1 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

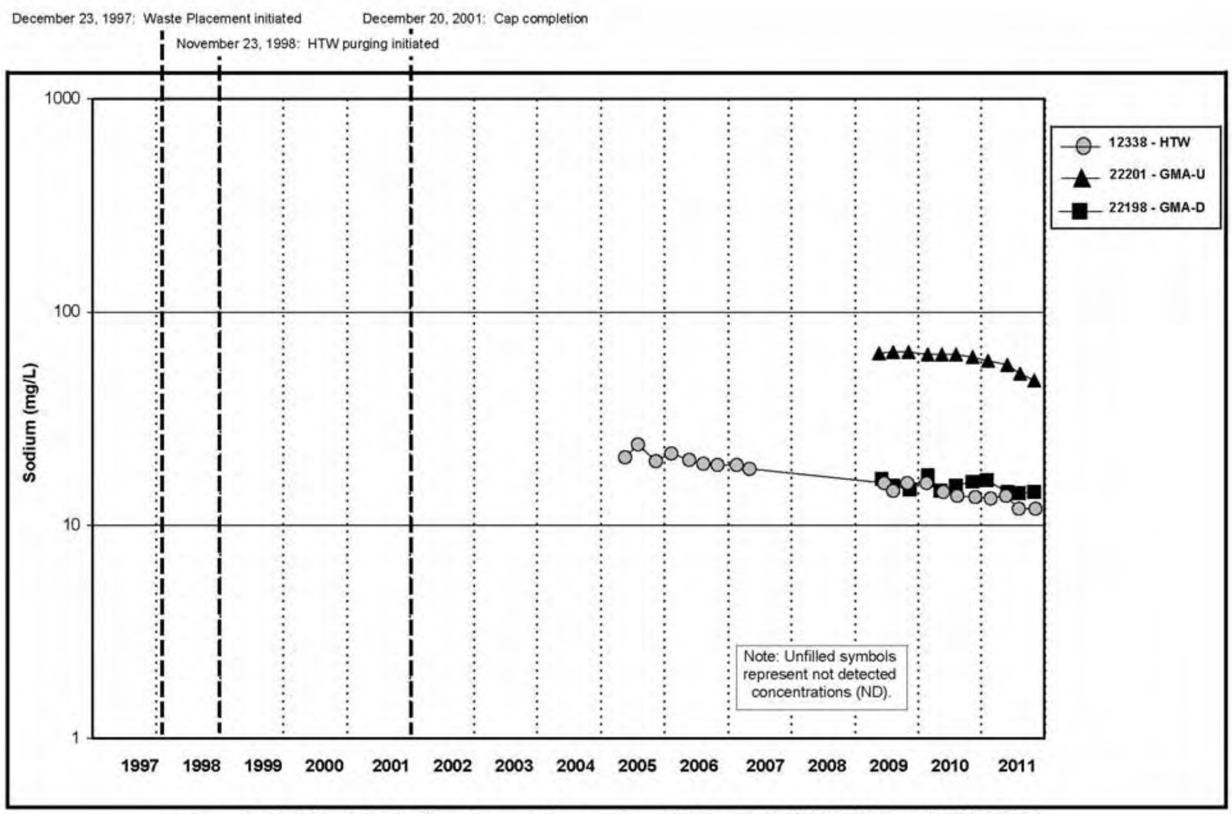


Figure A.5.1-27B. Cell 1 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

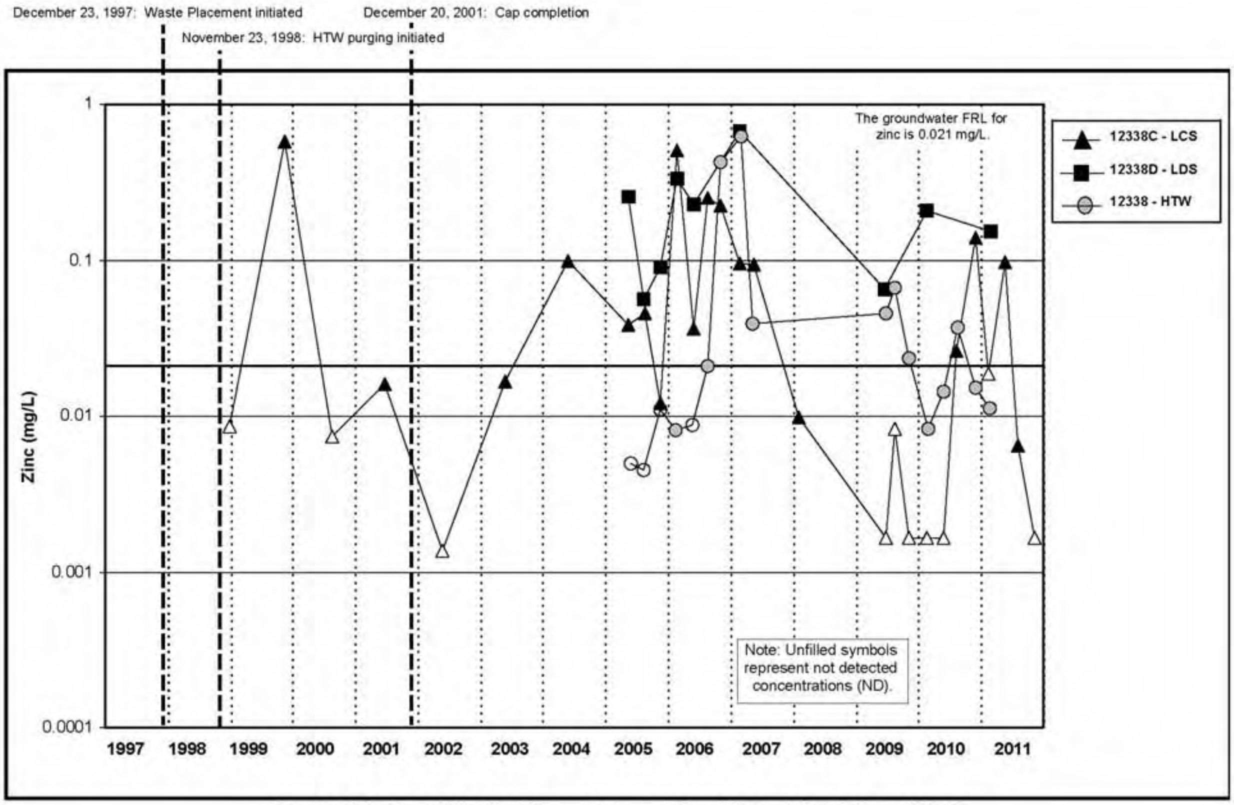


Figure A.5.1-28A. Cell 1 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

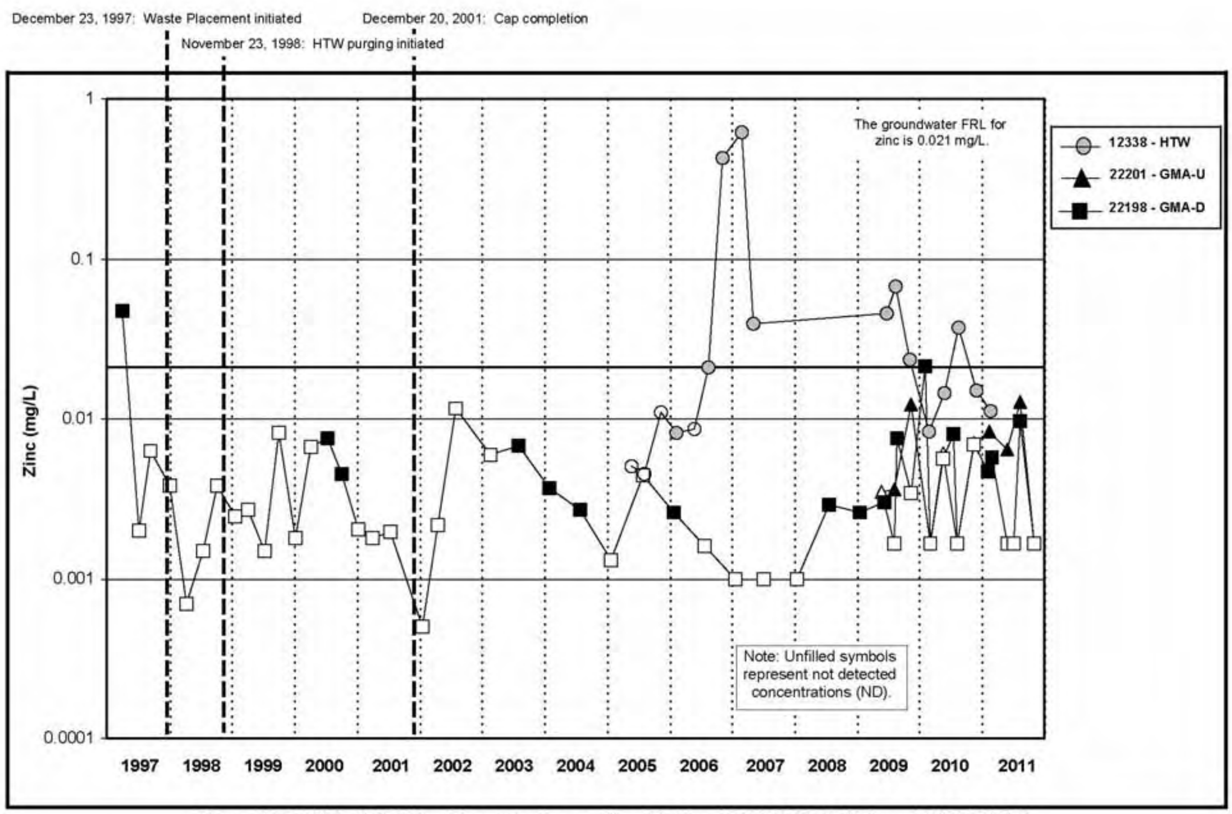


Figure A.5.1-28B. Cell 1 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

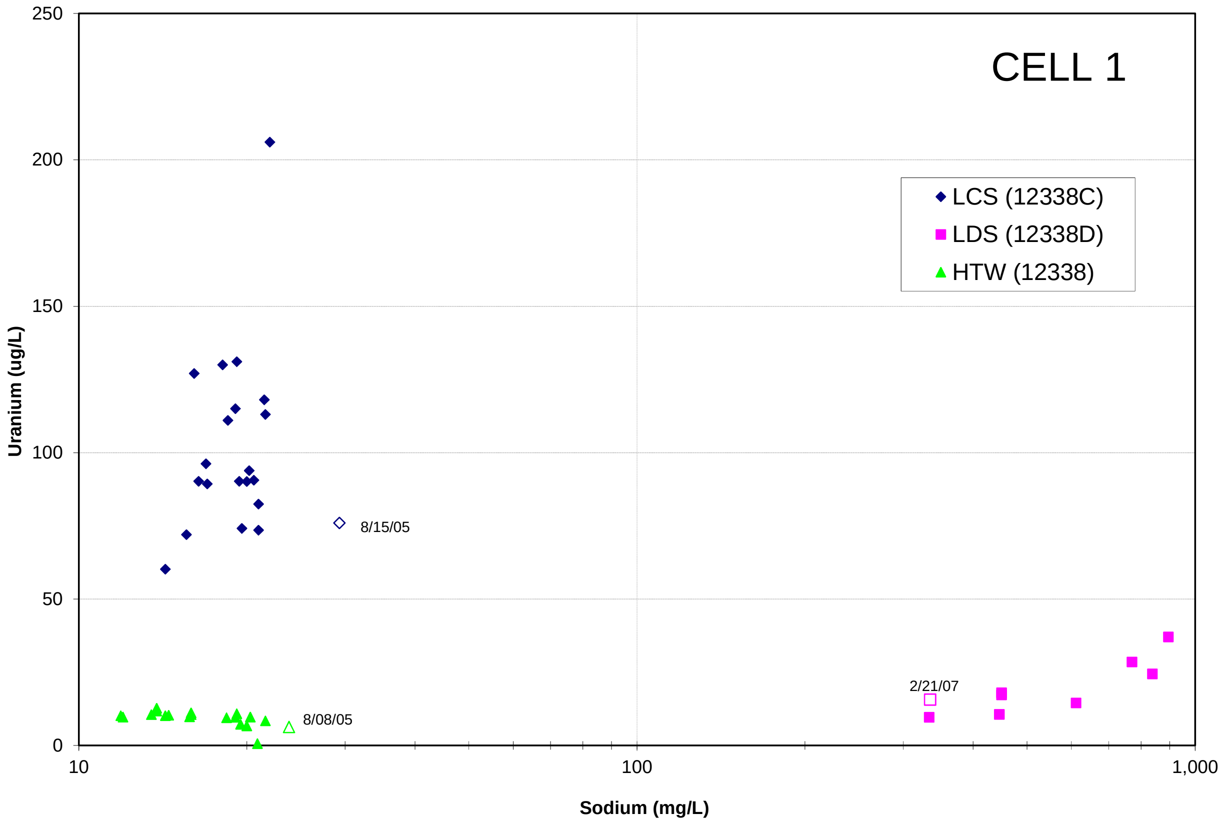


Figure A.5.1−29. Cell 1 Bivariate Plot for Uranium and Sodium

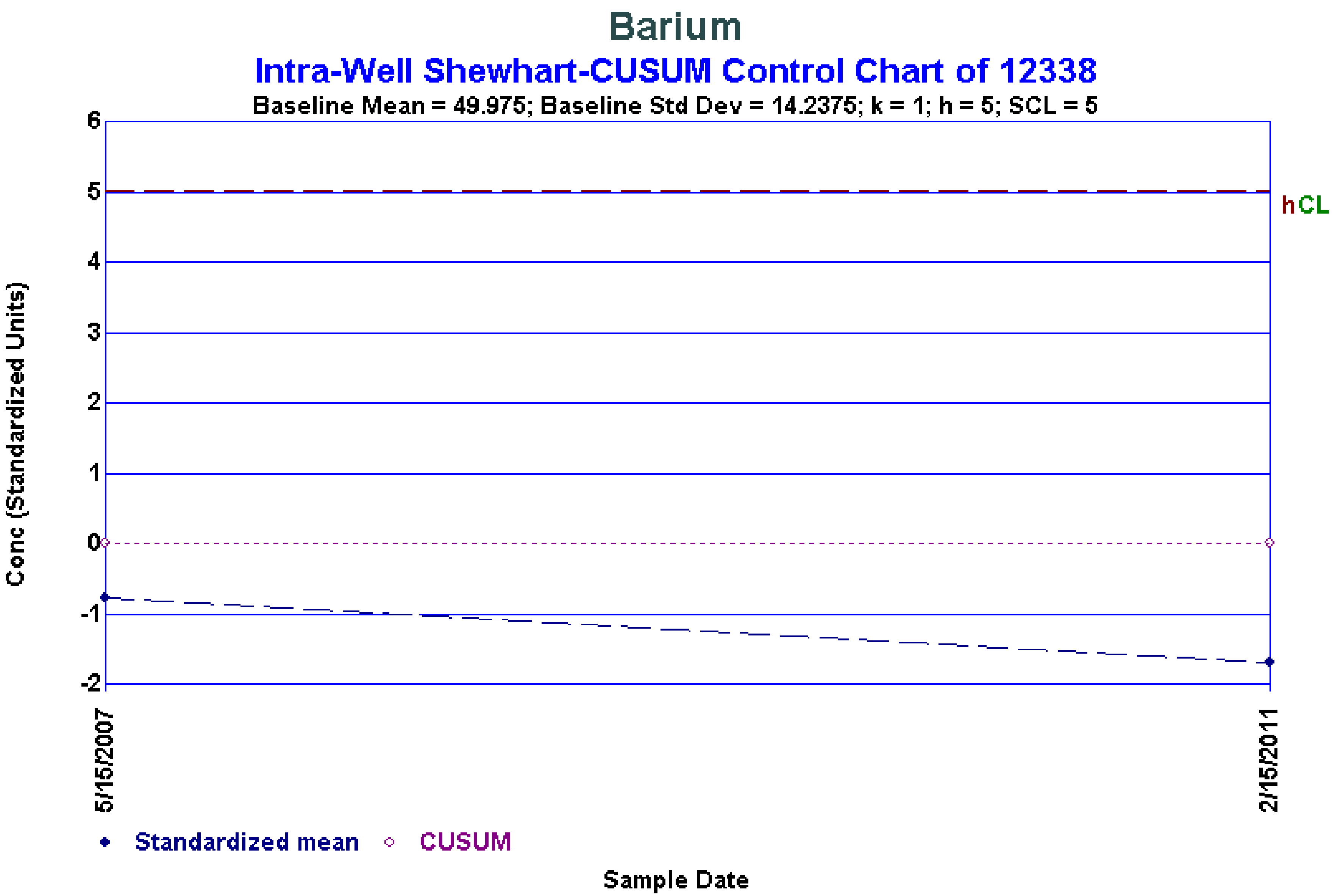


Figure A.5.1–30. Intra-Well Shewhart-CUSUM Control Chart (Barium 12338)

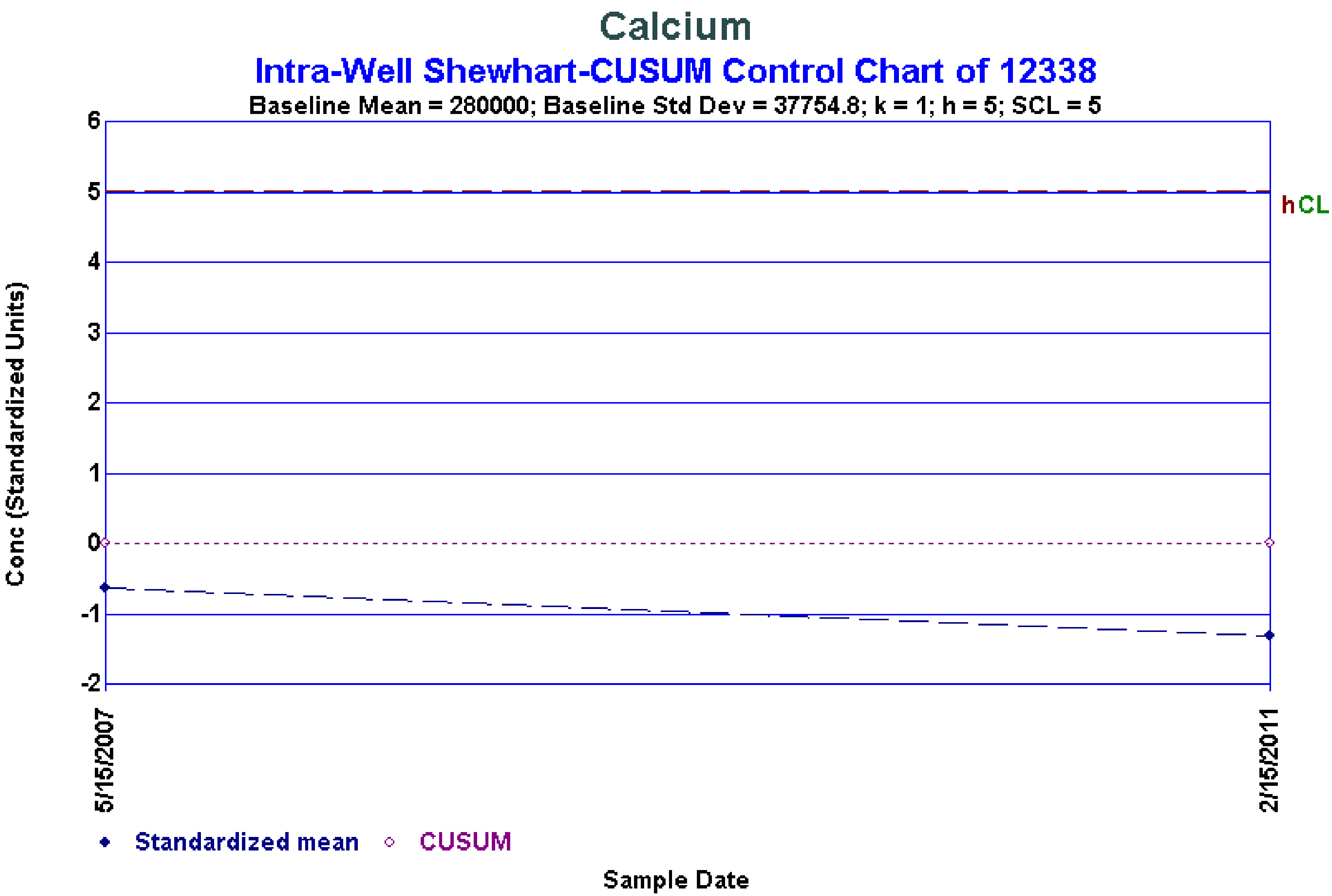


Figure A.5.1–31. Intra-Well Shewhart-CUSUM Control Chart (Calcium 12338)

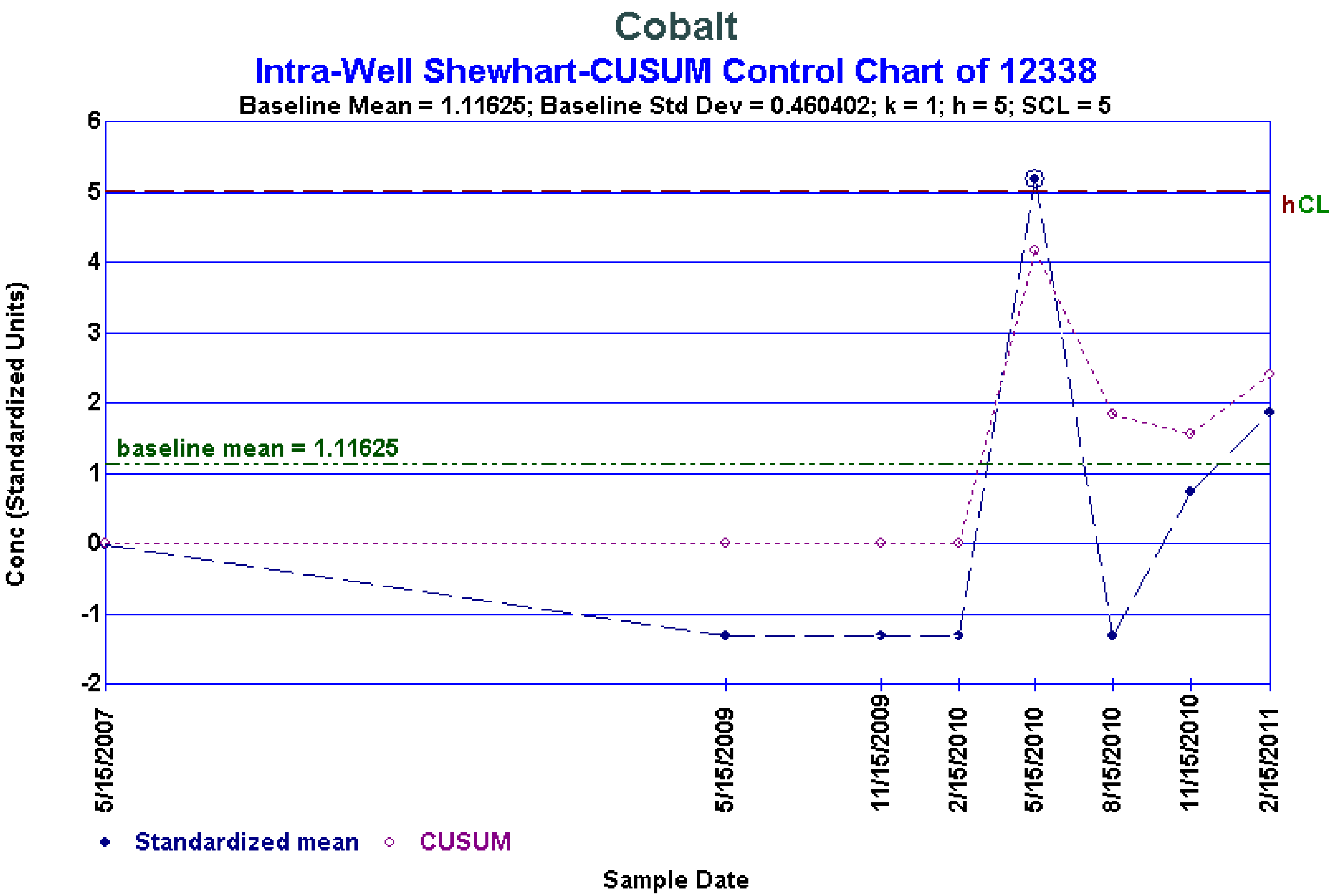


Figure A.5.1 –32. Intra-Well Shewhart-CUSUM Control Chart (Cobalt 12338)

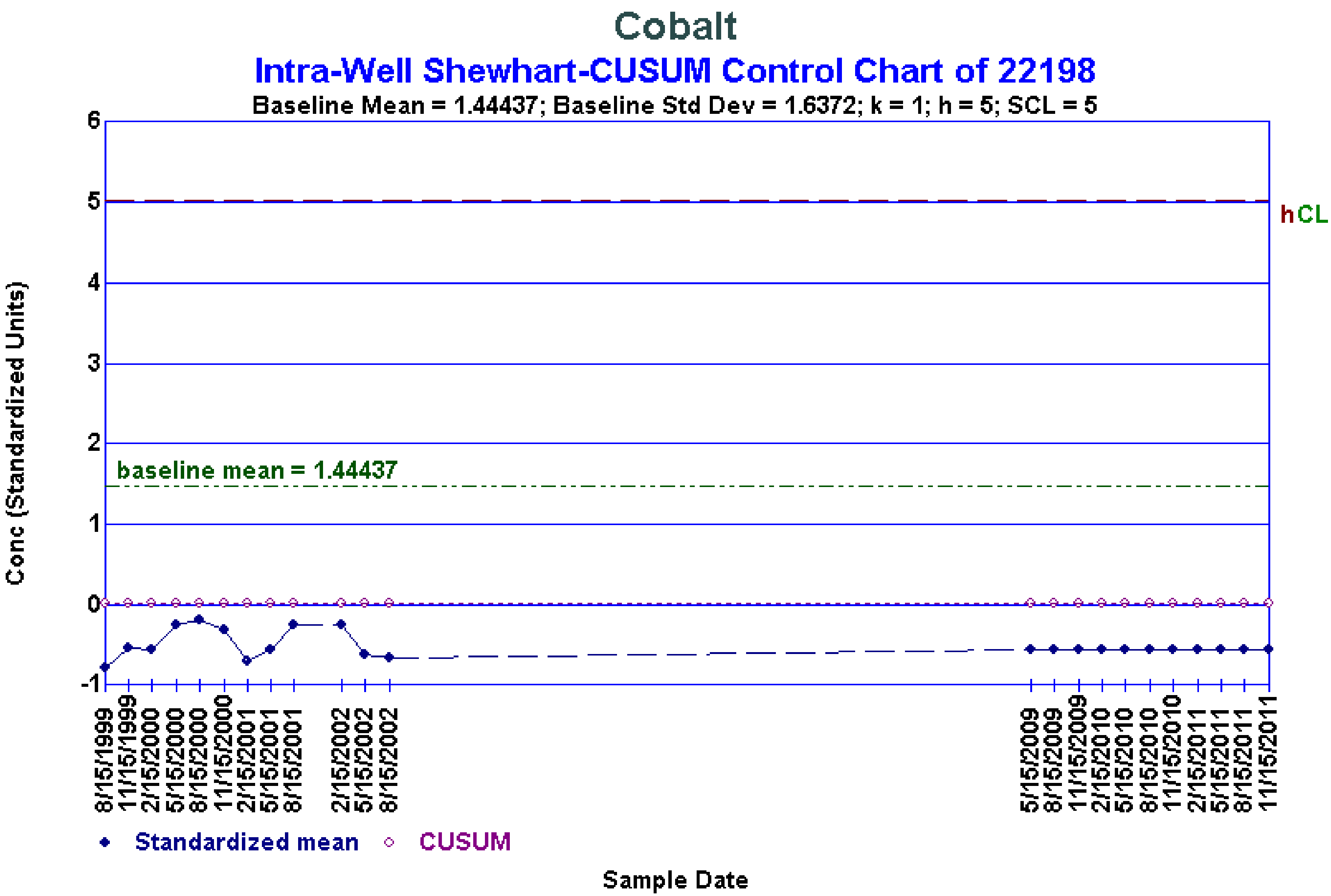


Figure A.5.1 –33. Intra-Well Shewhart-CUSUM Control Chart (Cobalt 22198)

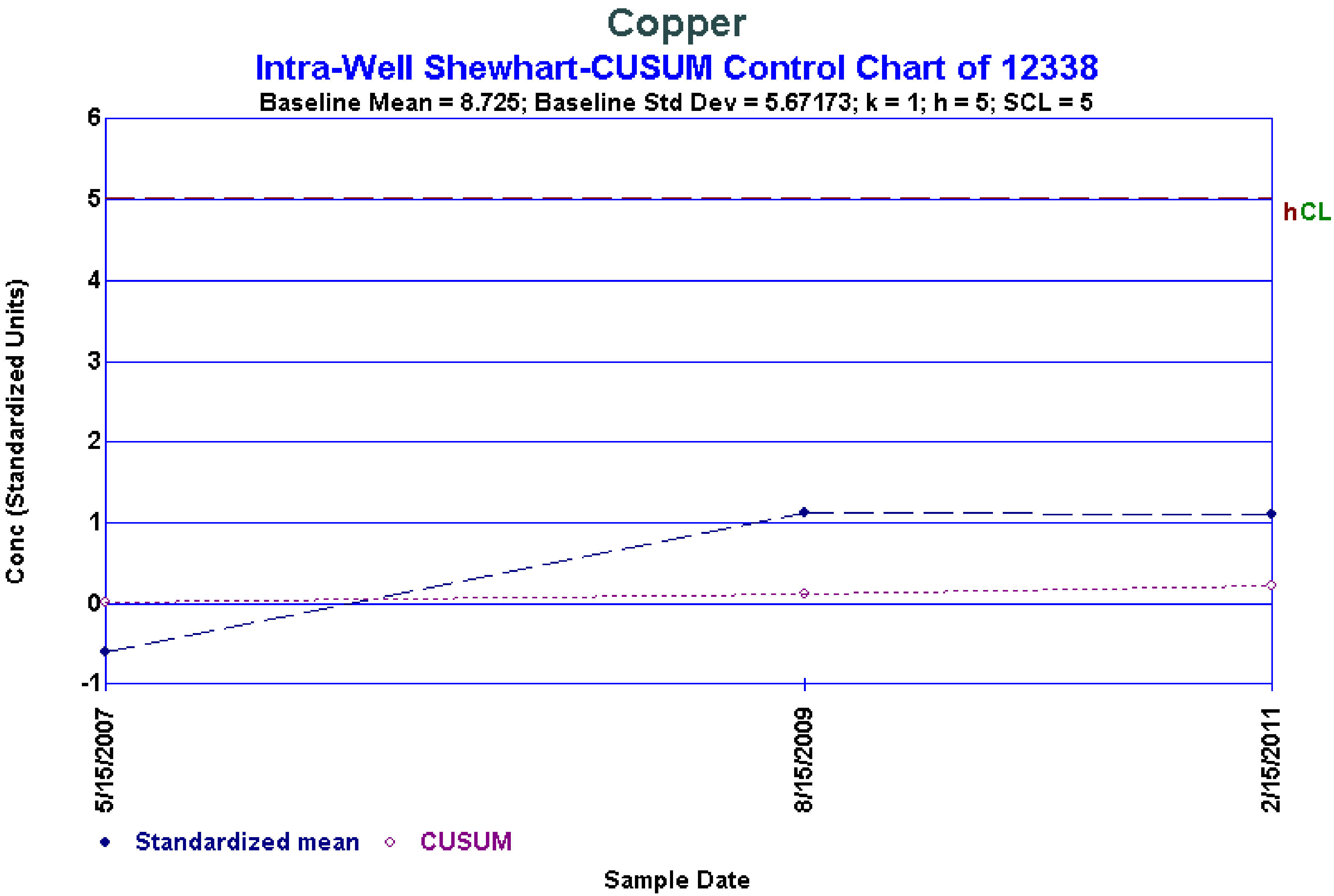


Figure A.5.1–34. Intra-Well Shewhart-CUSUM Control Chart (Copper 12338)

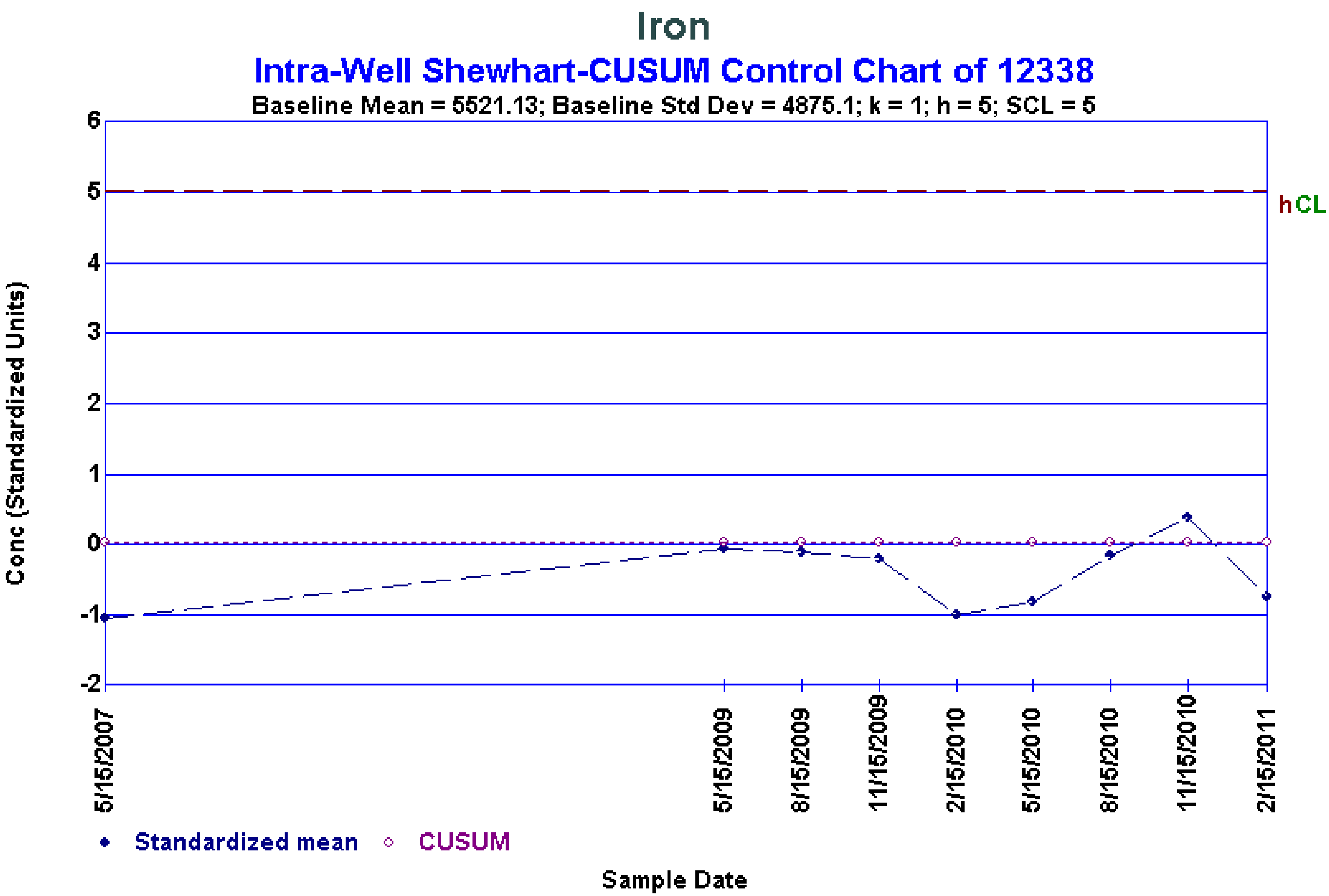


Figure A.5.1 –35. Intra-Well Shewhart-CUSUM Control Chart (Iron 12338)

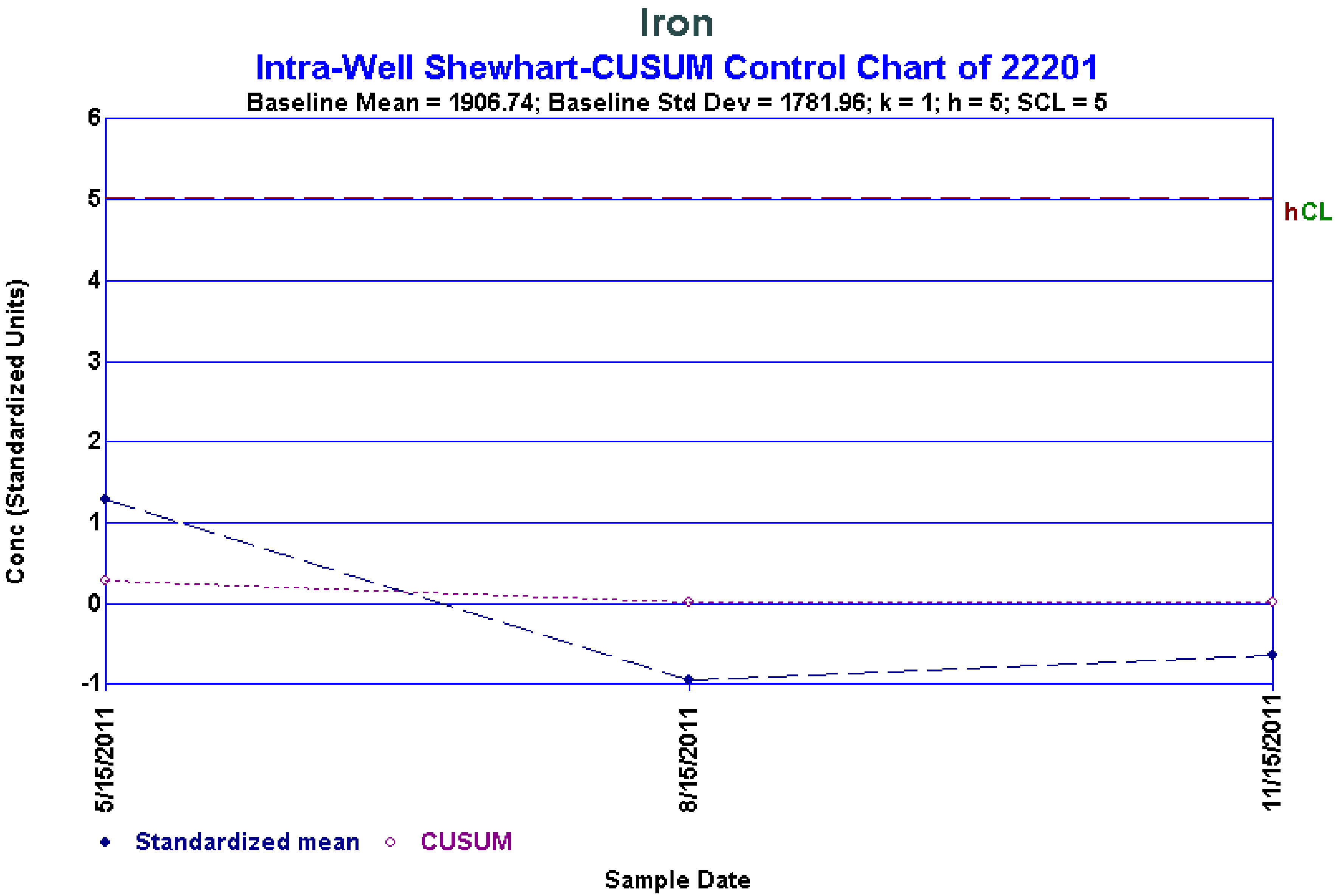


Figure A.5.1 –36. Intra-Well Shewhart-CUSUM Control Chart (Iron 22201)

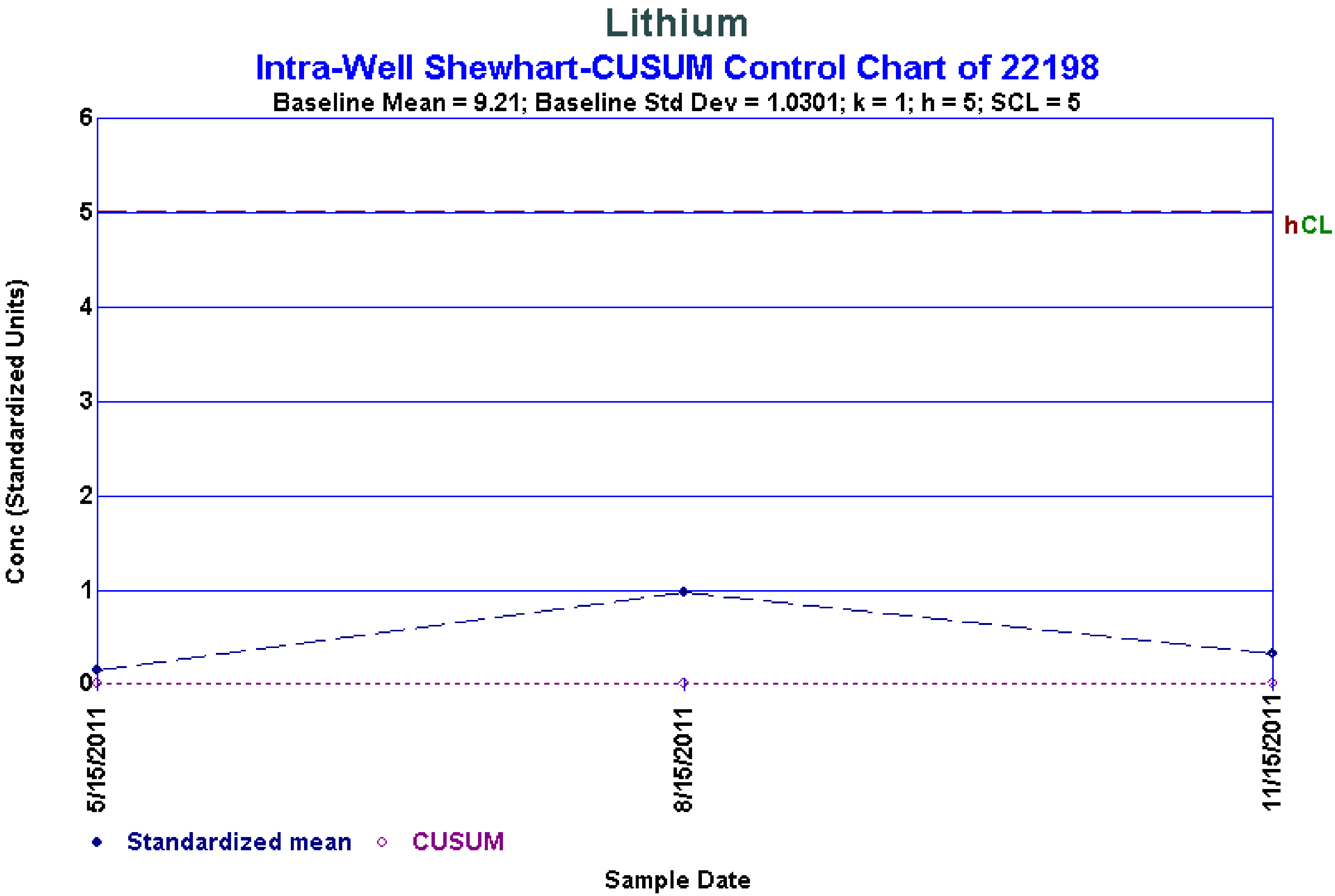


Figure A.5.1–37. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22198)

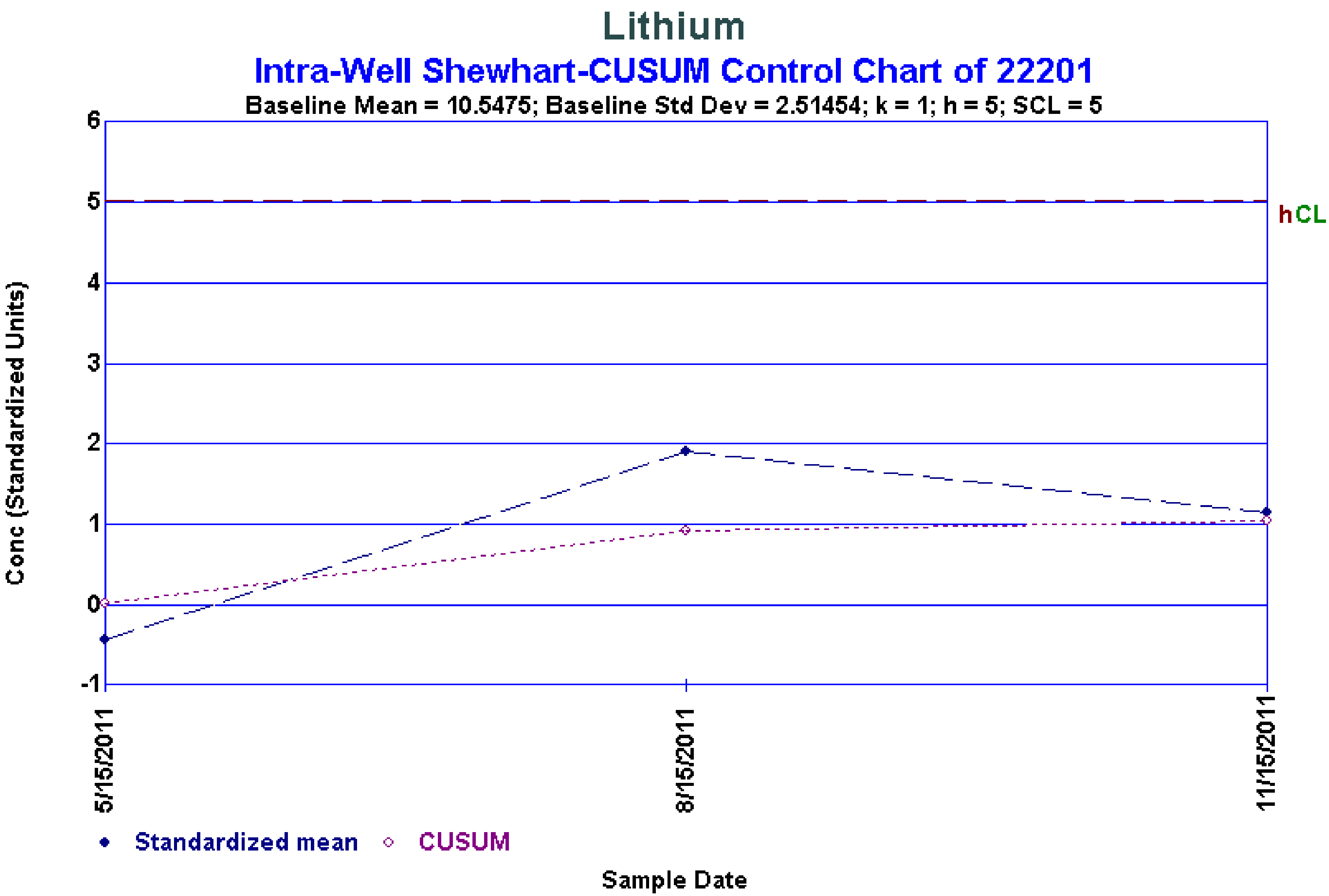


Figure A.5.1−38. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22201)

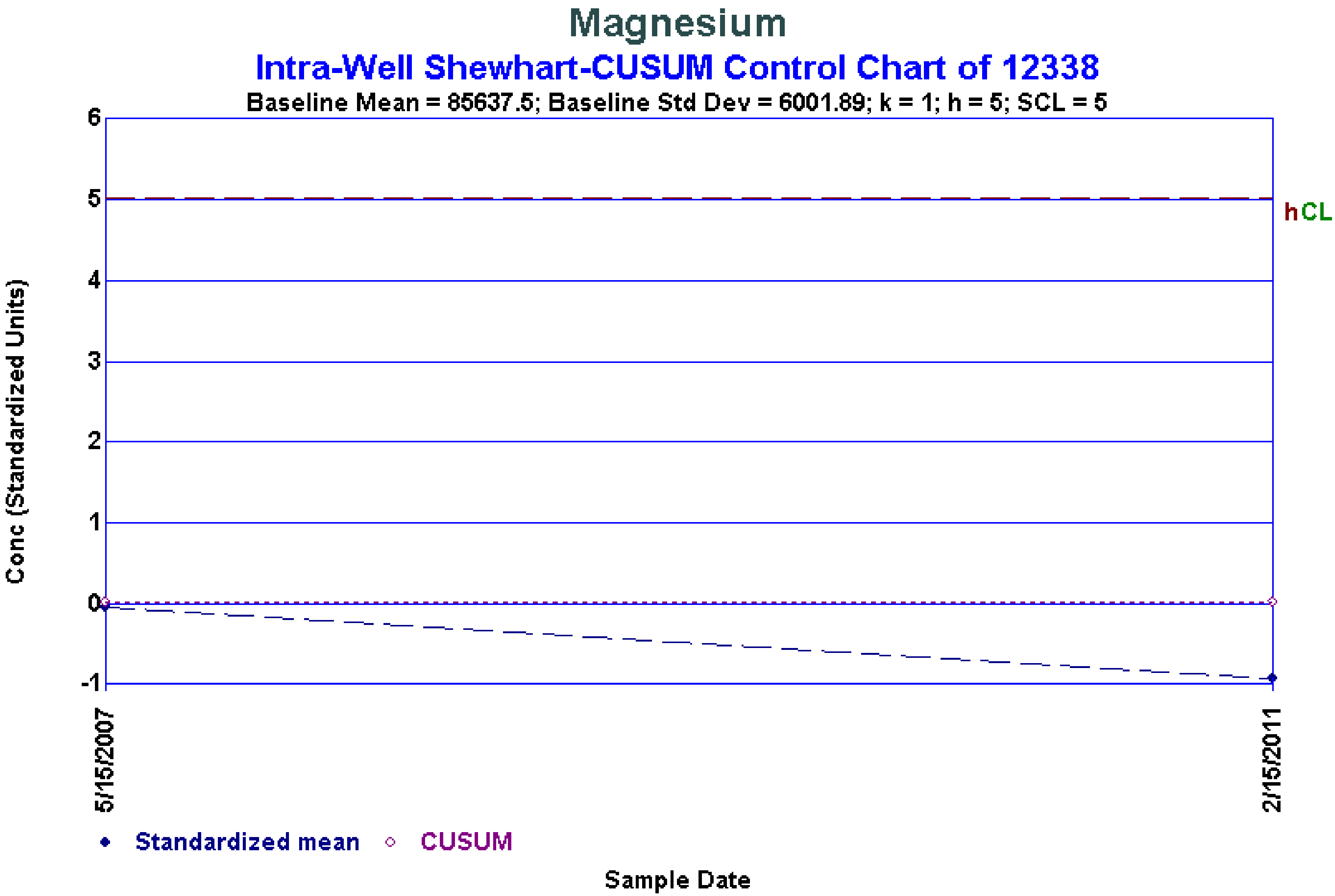


Figure A.5.1 –39. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 12338)

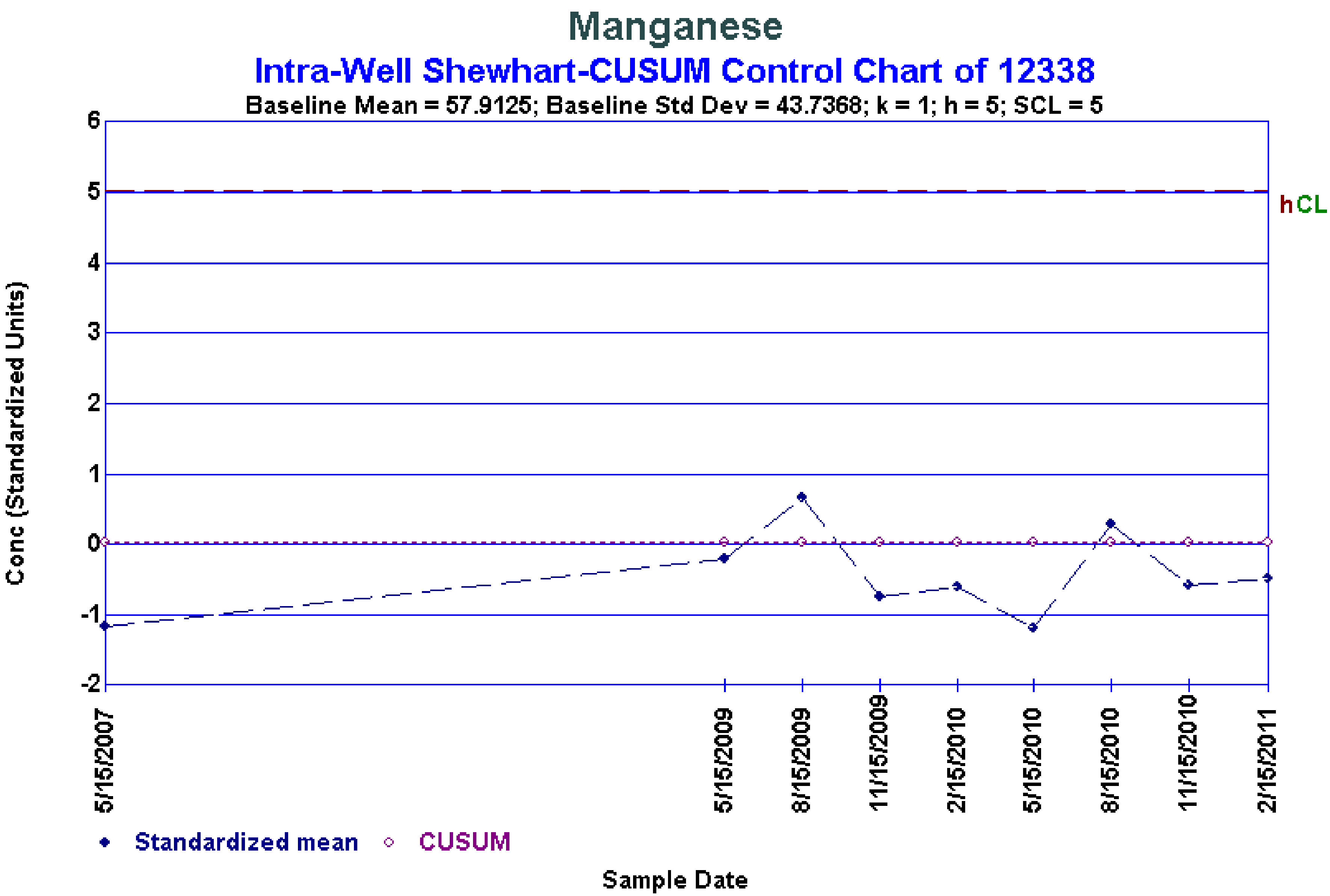


Figure A.5.1 –40. Intra-Well Shewhart-CUSUM Control Chart (Manganese 12338)

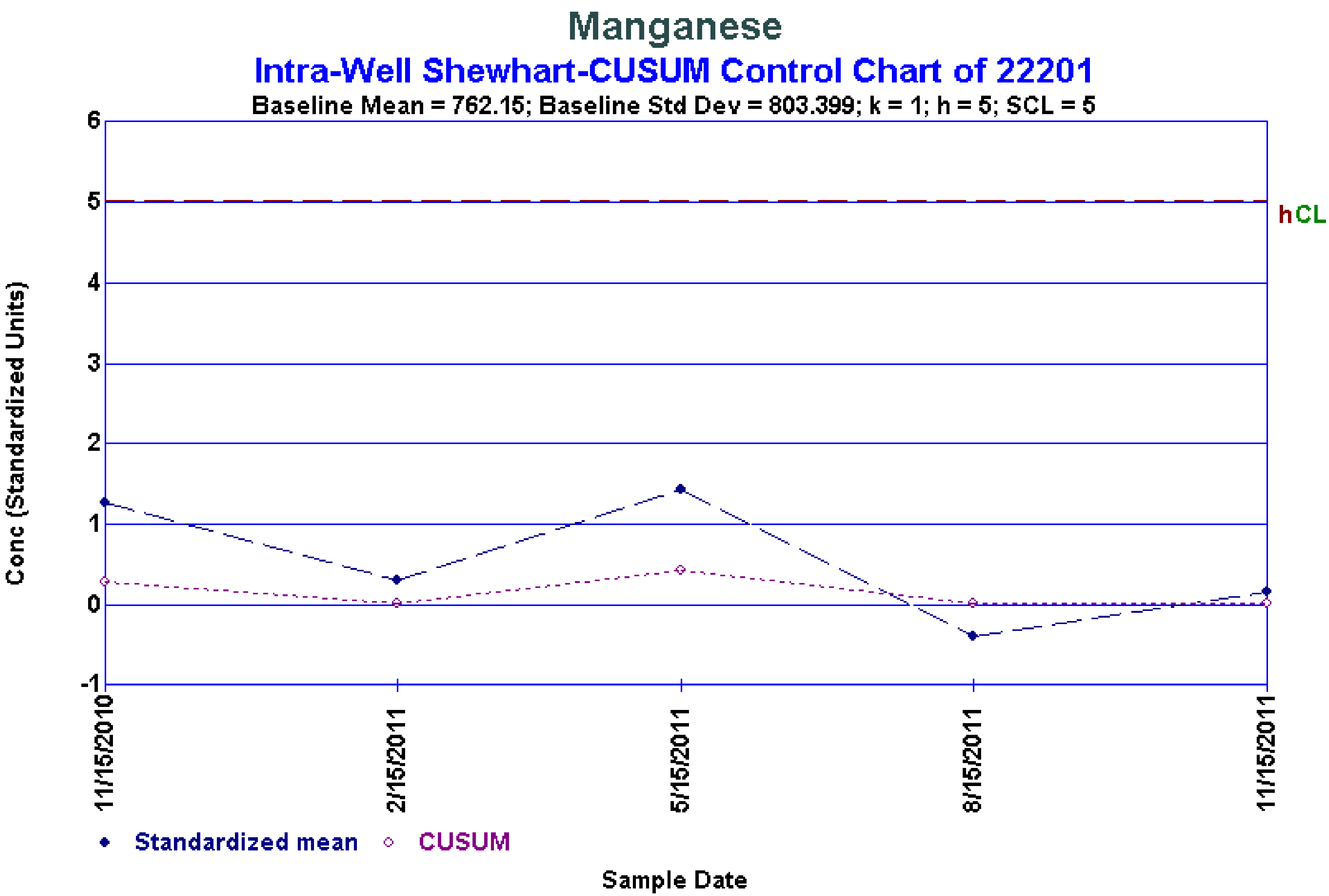


Figure A.5.1 –41. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22201)

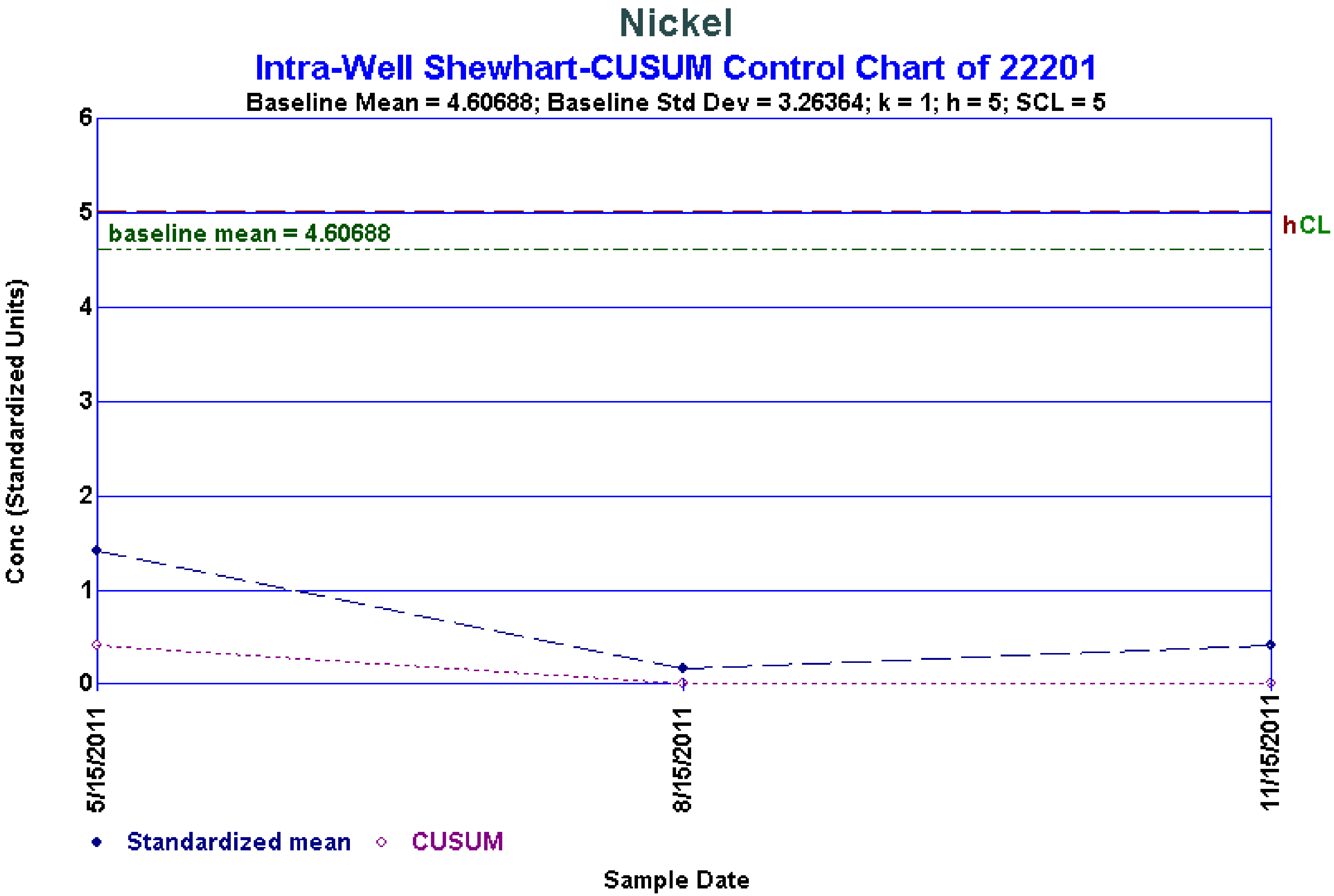


Figure A.5.1 –42. Intra-Well Shewhart-CUSUM Control Chart (Nickel 22201)

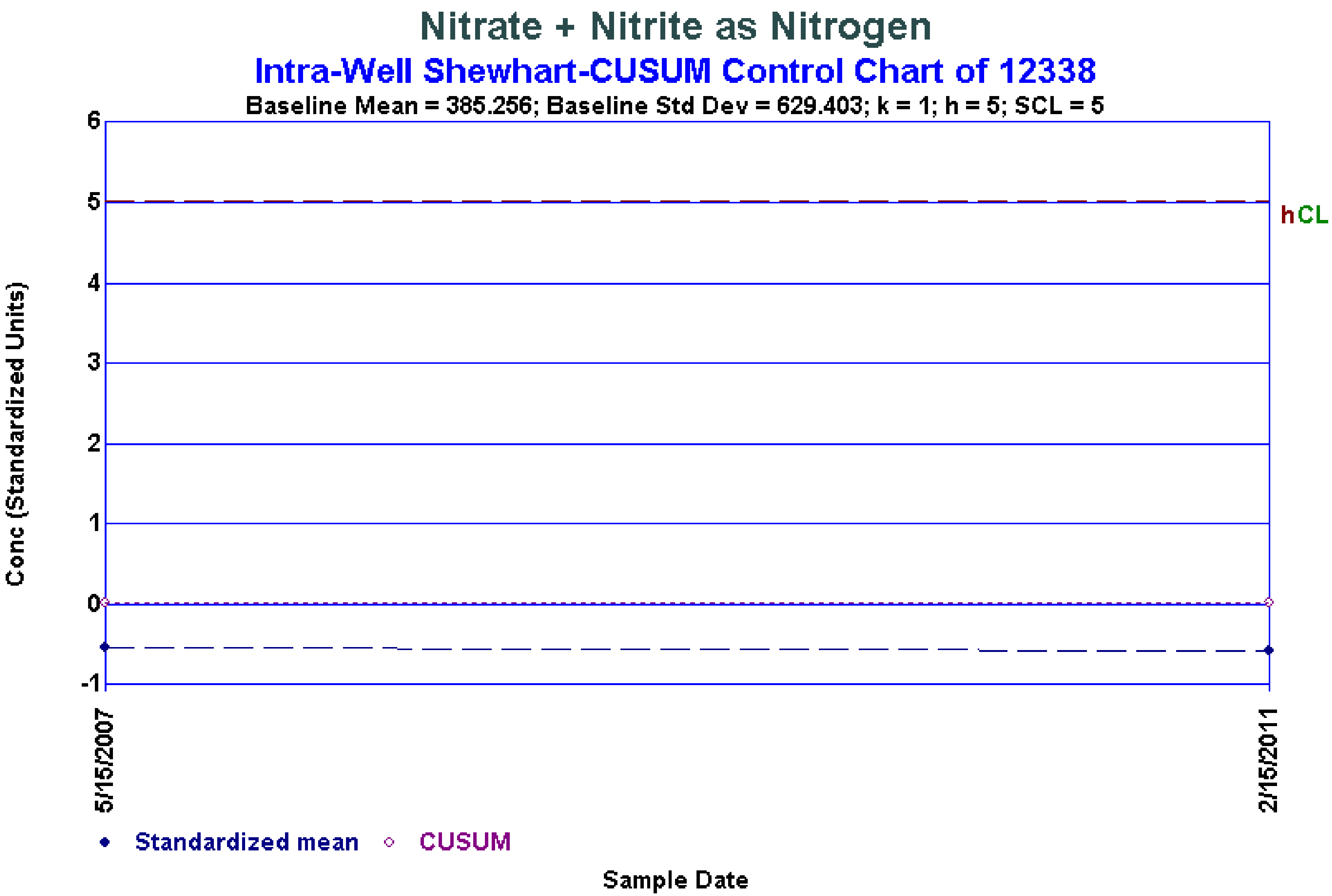


Figure A.5.1 –43. Intra-Well Shewhart-CUSUM Control Chart (Nitrate 12338)

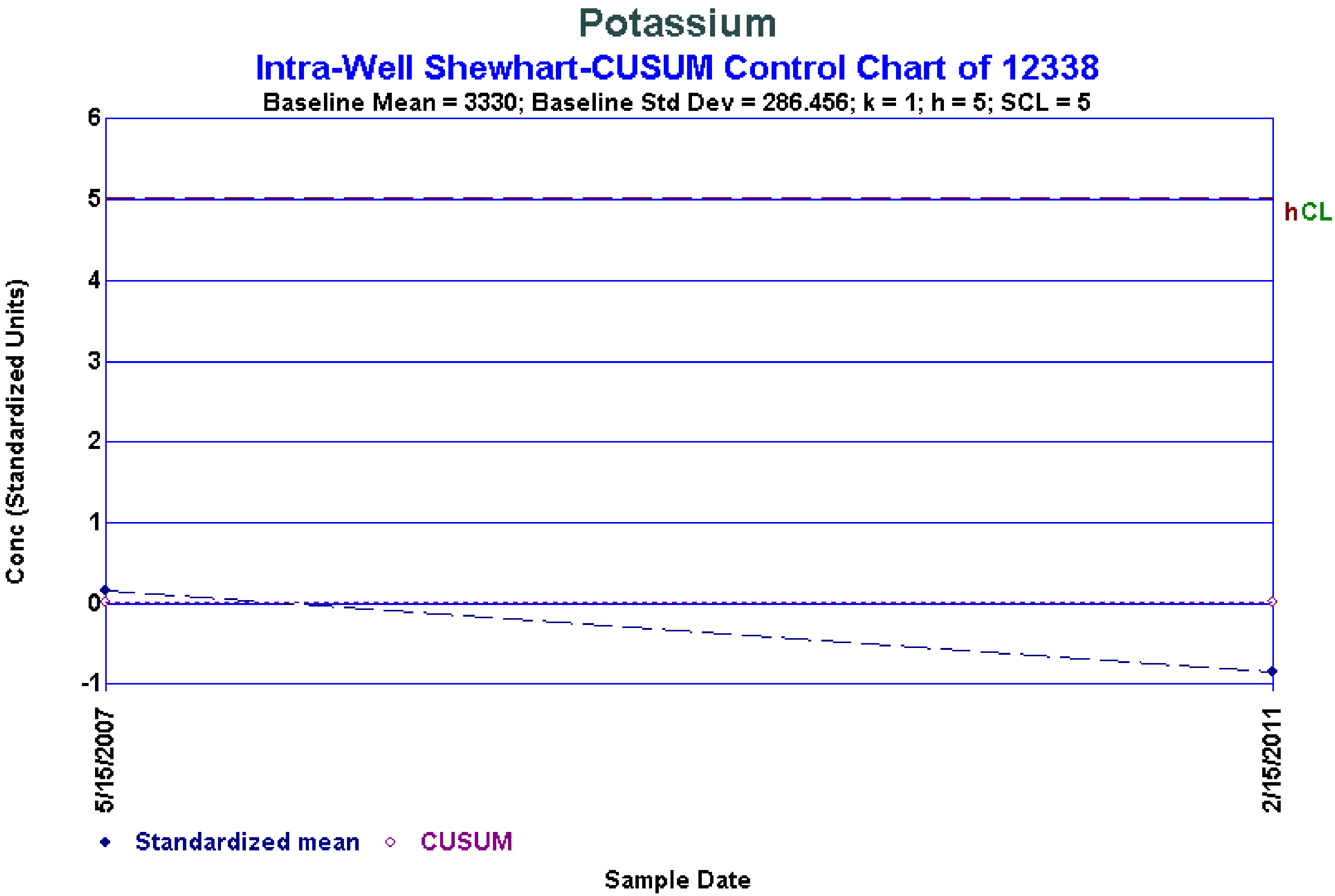


Figure A.5.1 –44. Intra-Well Shewhart-CUSUM Control Chart (Potassium 12338)

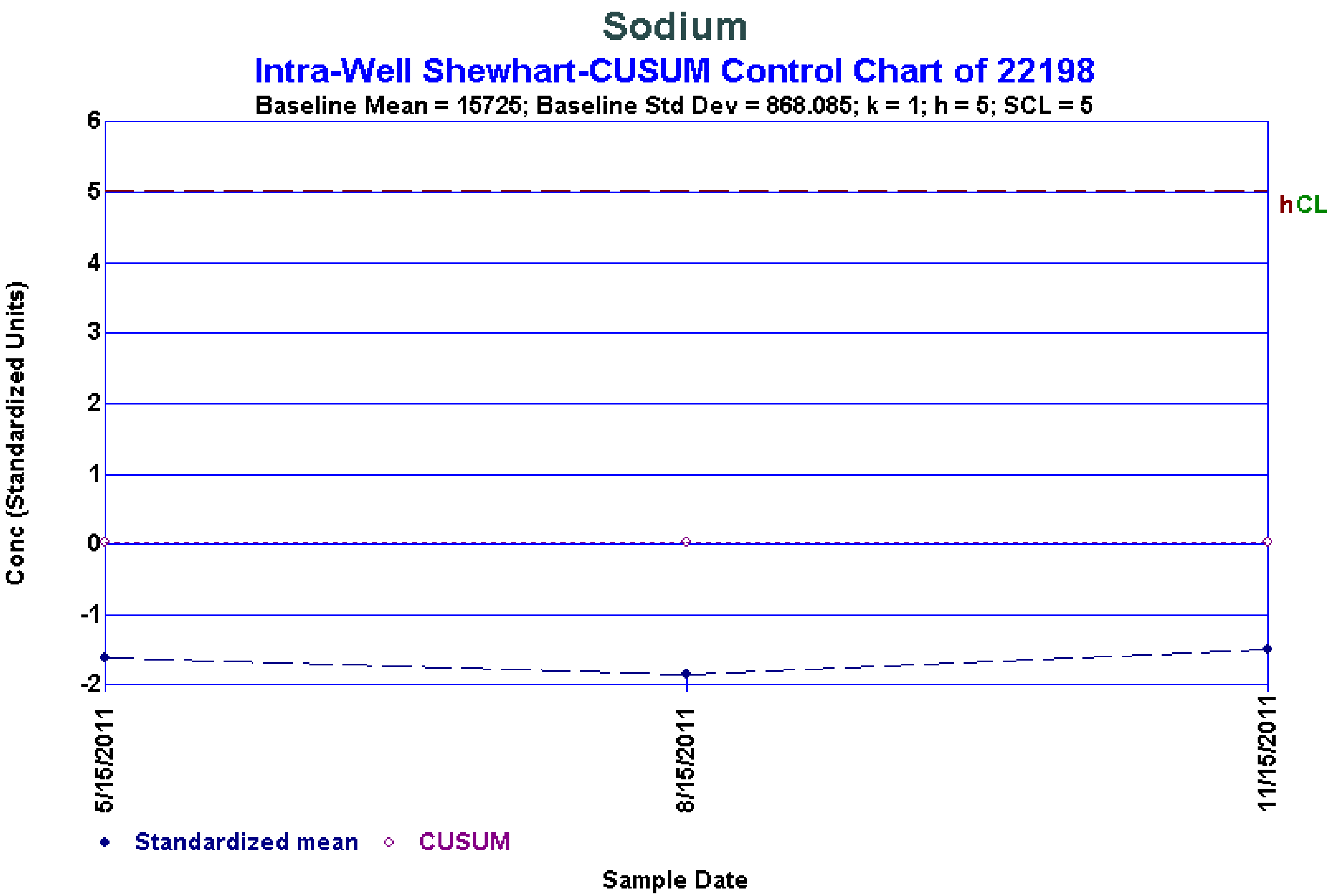


Figure A.5.1–45. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22198)

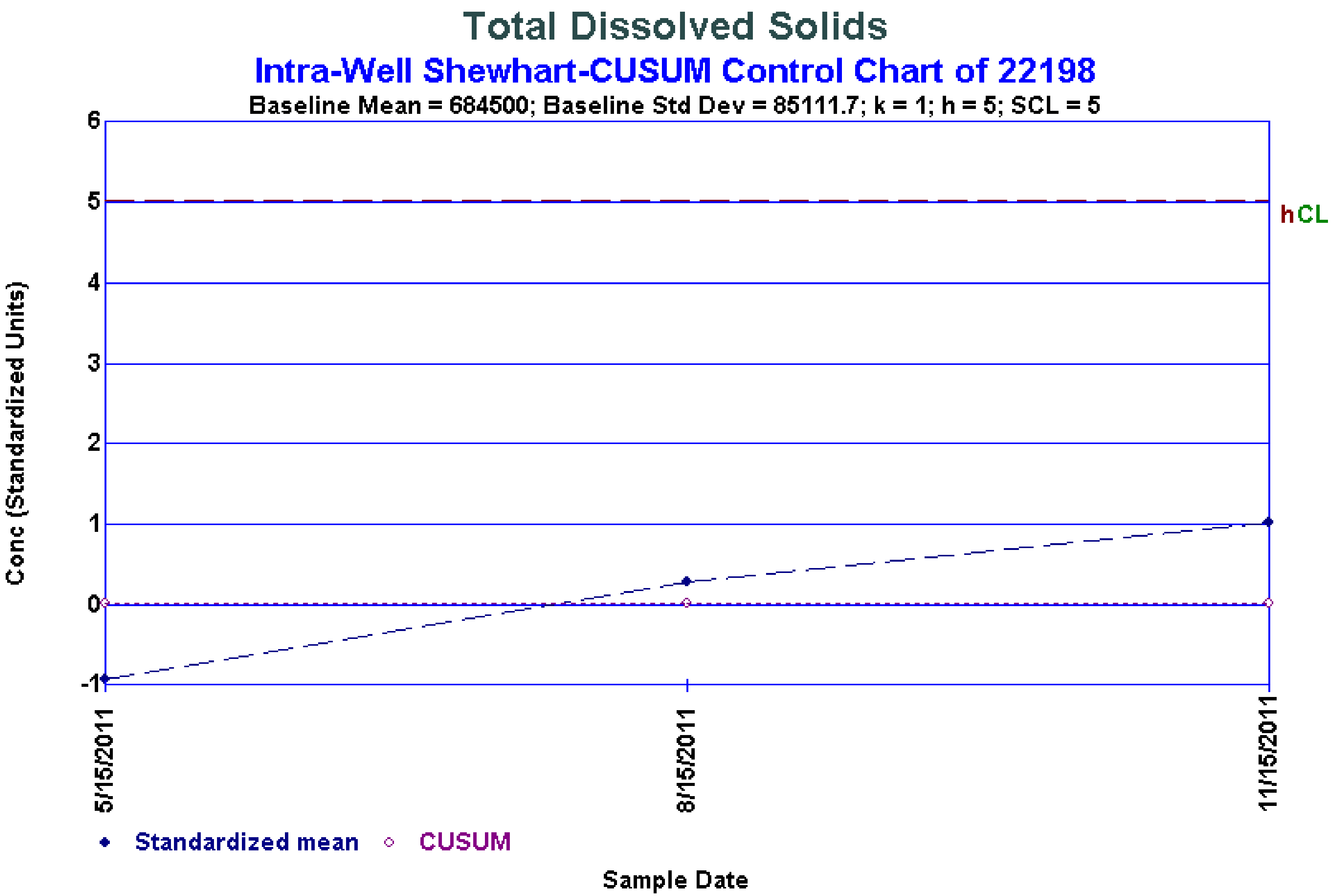


Figure A.5.1–46. Intra-Well Shewhart-CUSUM Control Chart (TDS 22198)

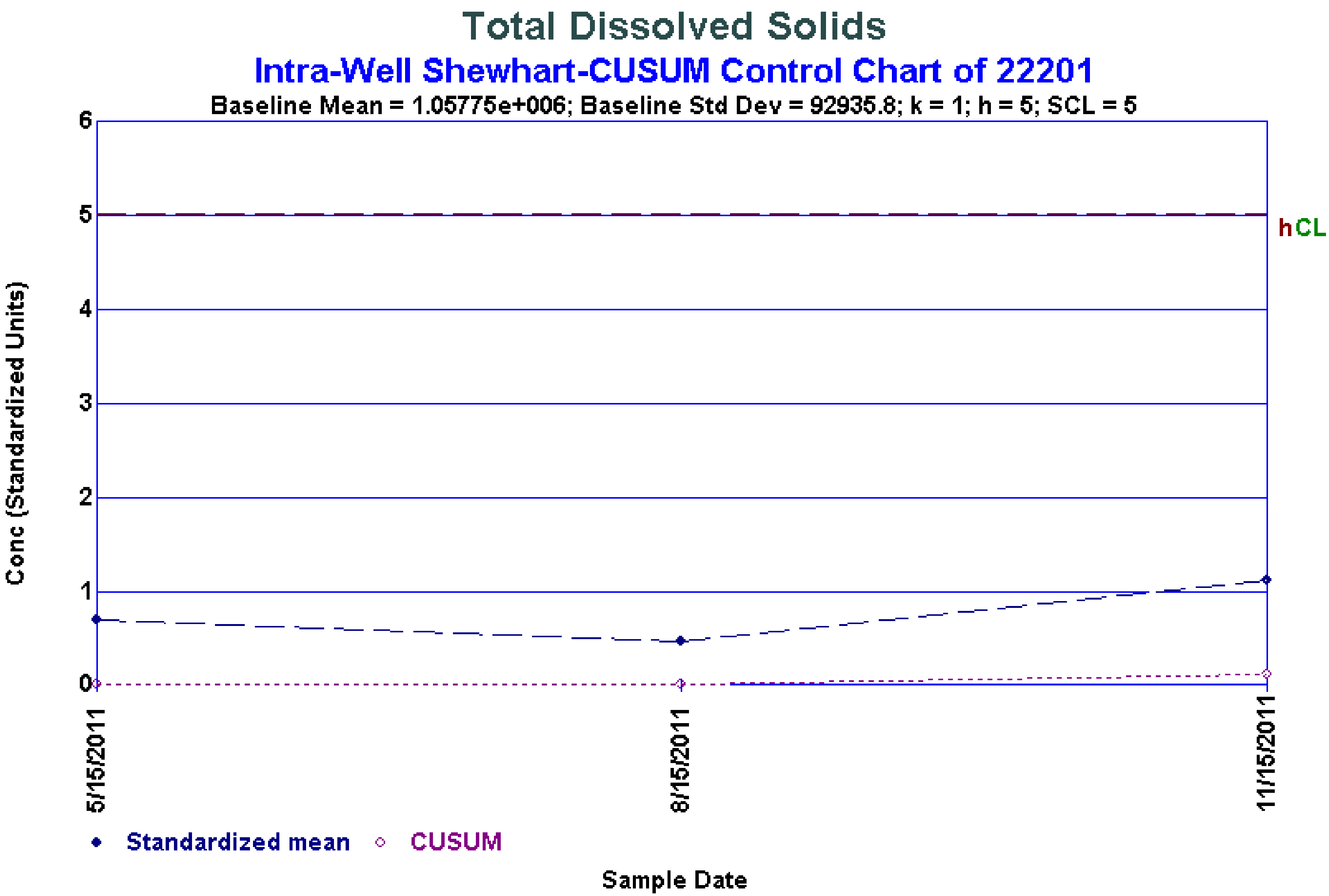


Figure A.5.1–47. Intra-Well Shewhart-CUSUM Control Chart (TDS 22201)

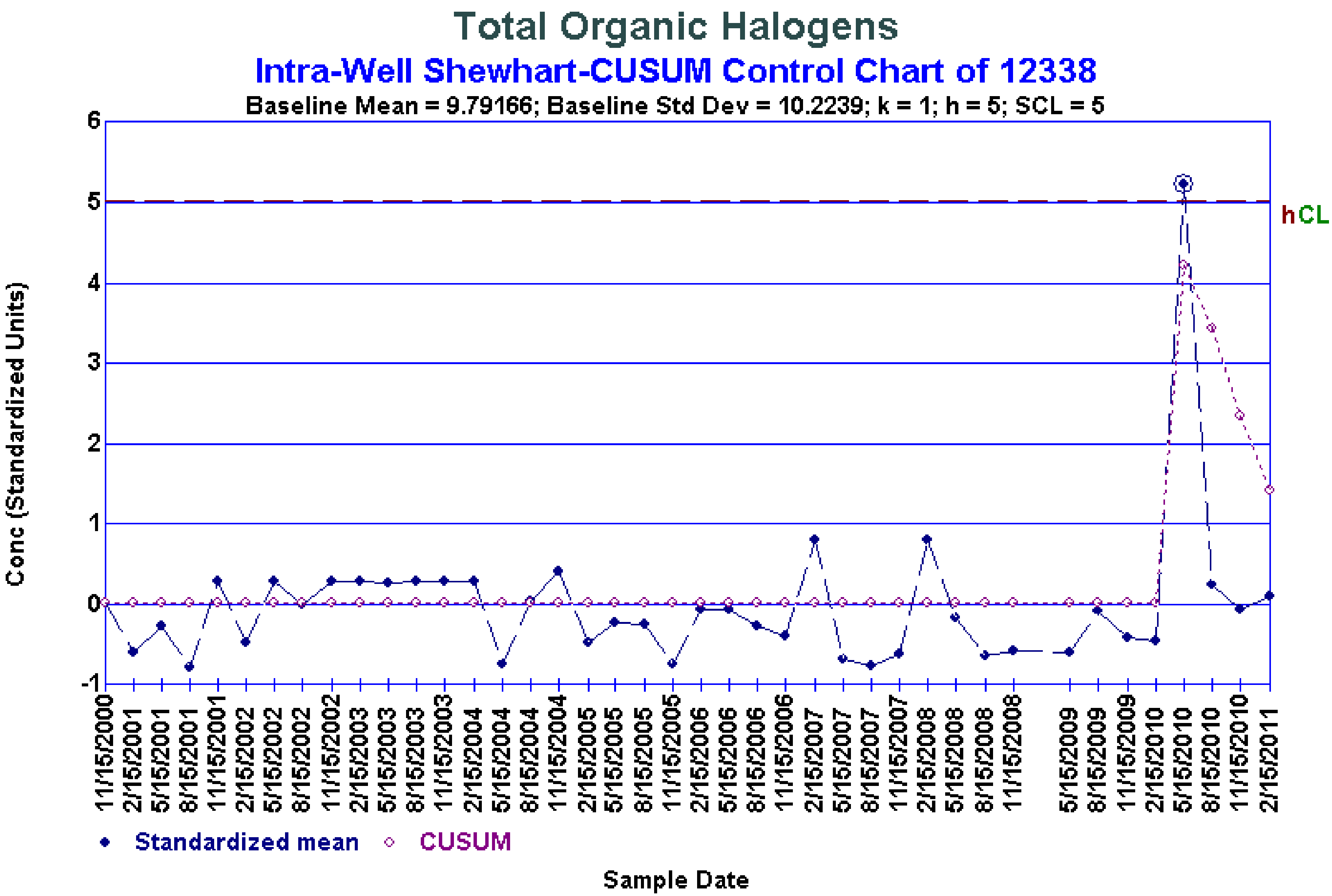


Figure A.5.1 –48. Intra-Well Shewhart-CUSUM Control Chart (TOX 12338)

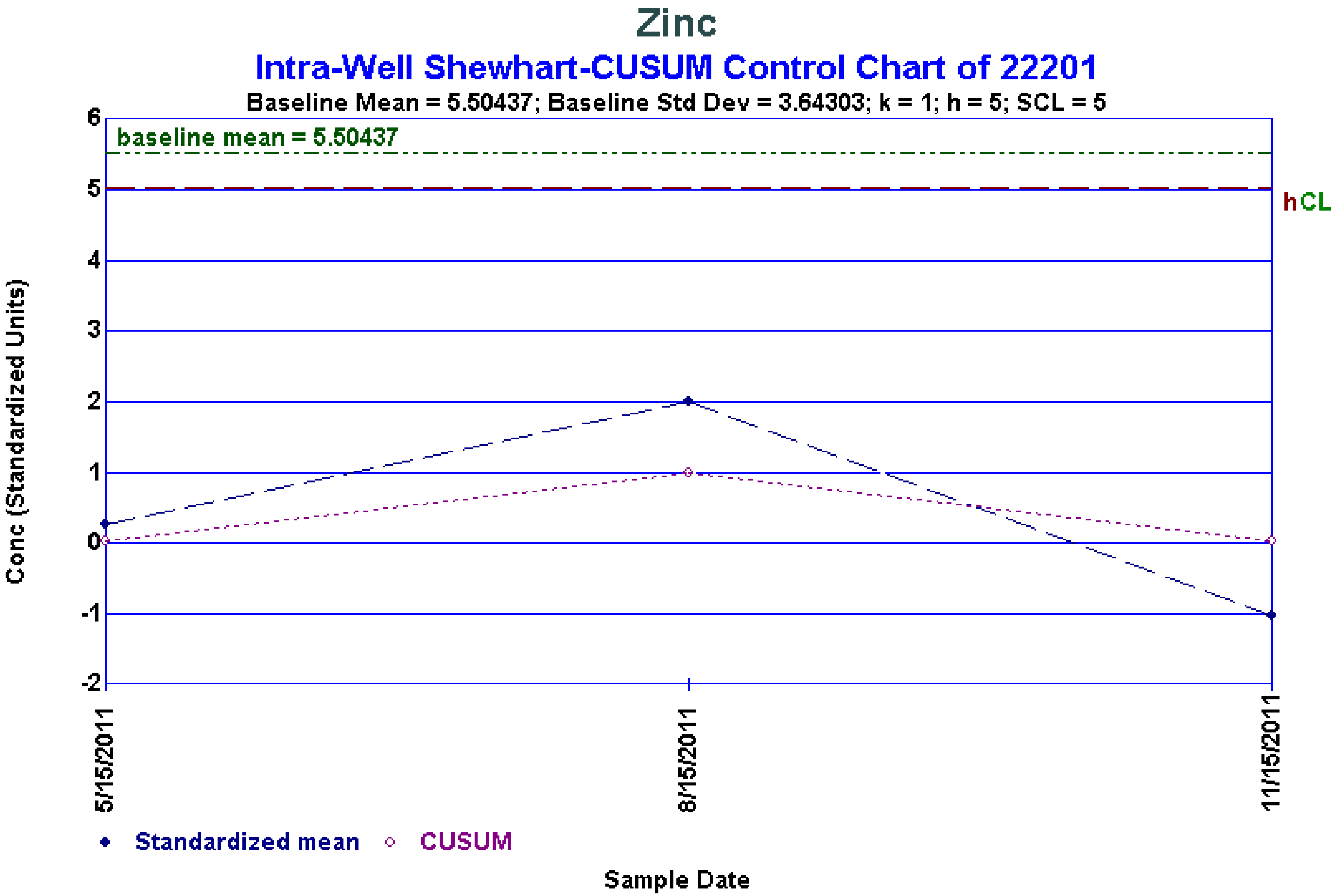


Figure A.5.1 –49. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22201)

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Sub-attachment A.5.2

Cell 2

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.2−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.2−2)
- LCS monthly accumulation volumes (refer to Figure A.5.2−1)
- LDS monthly accumulation volumes (refer to Figure A.5.2−2)
- OSDF horizontal till well 12339 water yield (refer to Figure A.5.2−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.2−4 and A.5.2−5)
- Plots of concentration versus time (refer to Figures A.5.2−6A to A.5.2−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.2−29)
- Control charts (refer to Figures A.5.2−30 to A.5.2−47)

A.5.2.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on revision 4 of the LMICP (DOE 2010b). Tritium results for all cells are reported in Section A.5.5.

The LDS of Cell 2 was dry during the first, second, and third quarters of 2011. As shown in Table A.5.2–1, 5 of the 23 parameters sampled quarterly in the LCS, LDS, HTW, and GMA wells (uranium, TOC, arsenic, boron, and sodium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Horizontal Till Wells

The HTW is located beneath the liner penetration box of each cell by design. The liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, uranium, TOC, and boron are increasing in the HTW of Cell 2 (as indicated in the table below). The bivariate plot for the Cell 2 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.2−29. There are only two data points for the HTW of Cell 2 shown in

Figure A.5.2–29 because the LDS has routinely been dry since the first quarter of 2006. A sample was collected during the fourth quarter of 2011. The plot shows that the chemical signature for uranium-sodium in the LCS, LDS, and the HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured in the HTW of Cell 2 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Uranium	Up	Up	
TOC	Up		
Arsenic			Up
Boron	Up	Up	Up
Sodium		Up	

[a]HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer,
GMA-D = downgradient Great Miami Aquifer.
No entry indicates that the trend was not up.

The plot of concentrations versus time for boron in the HTW is presented in Figure A.5.2–17A. If data prior to 2006 is removed from the dataset, the Mann-Kendall trend test indicates no statistical significant evidence for a trend.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells, for uranium, arsenic, boron, and selenium, are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.2–1) measured in the LDS and GMA wells for parameters with increasing concentrations in the Cell 2 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
Uranium (µg/L)	**19.2**	0.86	0.734
Arsenic (mg/L)	ND	**0.0025**	**0.0015**
Boron (mg/L)	**0.510**	0.0503	0.0501
Sodium (mg/L)	**826**[b]	26.8	17.0

Note: The highest averages are shown in bold
[a] LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer,
GMA-D = downgradient Great Miami Aquifer.
[b] Sodium has only been detected twice in the LDS of Cell 2 (fourth quarter 2005, 989 mg/L and fourth quarter 2011, 664 mg/L).
ND = not detected

As shown above, arsenic has never been detected in the LDS of Cell 2. It should be noted that the LDS of Cell 2 was dry between 2006 and the fourth quarter of 2011.

A.5.2.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared “out of control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit. Usually, two parameters are used to compute standardized limits; the decision value (h) and the Shewart Control Limit (SCL).

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limits on the charts. As a “work-a-round”, the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.2−1 in gray shading, 14 parameters in the HTW and/or GMA wells of Cell 2 meet the criteria for control charts (i.e., more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 18 control charts.

These 18 control charts are presented in Figures A.5.2−30 to A.5.2−47. All of the control charts for Cell 2 indicate “in control” conditions. Previous “out of control” conditions were no longer present in 2011.

Parameter and Monitoring Point[a]	Assessment
Alkalinity in the HTW	In Control
Nitrate in the HTW	In Control
TDS in the GMA-U	In Control
TDS in the GMA-D	In Control
TOC in the GMA-D	In Control
Barium in the HTW	In Control
Calcium in the HTW	In Control
Cobalt in the HTW	In Control
Copper in the HTW	In Control
Iron in the GMA-U	In Control
Iron in the GMA-D	In Control
Lithium in the GMA-U	In Control
Lithium in the GMA-D	In Control
Magnesium in the HTW	In Control
Manganese in the GMA-U	In Control
Potassium in the HTW	In Control
Zinc in the GMA-U	In Control
Zinc in the GMA-D	In Control

[a]HTW = horizontal till well; TDS = total dissolved solids; TOC = total organic carbon;
GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

A.5.2.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 2 are provided in Table A.5.2−2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 2 in 2011.

A.5.2.4 Summary and Conclusions

- Five parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 2 (uranium, TOC, arsenic, boron, and sodium).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 2 indicate that water is not mixing between the horizons. The LDS of Cell 2 has been dry between the first quarter of 2006 and the fourth quarter of 2011. Concentration increases in the HTW and GMA wells of Cell 2 are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Eighteen control charts were constructed for Cell 2 parameters. All of the control charts exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 2 in 2011.

Table A.5.2−1. Summary Statistics for Cell 2

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12339C	51	51	100.0	4.51	404	92.5	75.9	Lognormal	Up	Detected	
	LDS	12339D	27	27	100.0	4.08	71	19.2	14.9	Lognormal	None	Detected	
	HTW	12339	51	52	98.1	ND	36.9	7.80	5.71	Undefined	Up	Detected	
	GMA-U	22200	41	58	70.7	ND	1.11	0.286	0.250	Undefined	Up	Not Detected	
	GMA-D	22199	57	59	96.6	ND	12.1	0.734	2.58	Undefined	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12339C	23	23	100.0	60.5	683	552	180	Undefined	Up	Not Detected	
	LDS	12339D	2	2	100.0	131	198	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	10	100.0	199	278	245	23	Normal	None	Not Detected	
	GMA-U	22200	4	4	100.0	402	426	418	11	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	344	378	360	15	Normal	None	Insuff	
Chloride (mg/L)	LCS	12339C	23	23	100.0	3.95	41.2	13.3	6.5	Undefined	Up	Detected	
	LDS	12339D	2	2	100.0	44	112	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	10	100.0	128	252	196	43	Normal	Down	Detected	
	GMA-U	22200	4	4	100.0	31.5	41.4	36.6	4.3	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	23.2	25.3	23.8	1.0	Normal	None	Insuff	
Nitrate/Nitrite as N (mg/L)	LCS	12339C	22	33	66.7	ND	4.1	0.177	1.23	Undefined	Down	Detected	
	LDS	12339D	4	5	80.0	ND	5.4	2.75	2.10	Normal	None	Insuff	
	HTW	12339	2	10	20.0	ND	0.078	Insuff	Insuff	Lognormal	None	Not Detected	
	GMA-U	22200	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22199	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sulfate (mg/L)	LCS	12339C	40	40	100.0	155	1870	1550	370	Undefined	Up	Detected	
	LDS	12339D	10	10	100.0	2290	3420	2950	350	Normal	None	Not Detected	8110 (Q3-05)
	HTW	12339	32	32	100.0	489	850	637	88	Normal	Down	Detected	
	GMA-U	22200	35	35	100.0	61.1	434	192	102	Lognormal	Down	Not Detected	
	GMA-D	22199	35	35	100.0	101	540	170	105	Undefined	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12339C	32	32	100.0	557	3430	2790	988	Undefined	Up	Detected	
	LDS	12339D	4	4	100.0	1894	5780	3420	1670	Normal	None	Insuff	
	HTW	12339	8	8	100.0	1210	1480	1340	100	Normal	Down	Detected	
	GMA-U	22200	11	11	100.0	545	771	629	73	Normal	None	Not Detected	
	GMA-D	22199	11	11	100.0	576	818	651	74	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12339C	41	51	80.4	ND	6.6	2.86	1.40	Normal	Up	Detected	
	LDS	12339D	19	27	70.4	ND	26.1	4.20	4.98	Lognormal	Down	Detected	
	HTW	12339	34	47	72.3	ND	3.04	1.83	0.62	Normal	Up	Not Detected	11.1 (Q1-00)
	GMA-U	22200	46	58	79.3	ND	40.1	1.78	5.99	Undefined	None	Not Detected	
	GMA-D	22199	42	58	72.4	ND	3.7	1.54	0.62	Lognormal	None	Not Detected	16.5 (Q3-97) 10.5 (Q4-97) 48.1 (Q2-98) 9.68 (Q1-00)
Total Organic Halogens (mg/L)	LCS	12339C	24	52	46.2	ND	0.0826	0.0180	0.0203	Lognormal	None	Detected	
	LDS	12339D	9	28	32.1	ND	0.069	0.0122	0.0124	Undefined	None	Not Detected	
	HTW	12339	36	49	73.5	ND	0.0435	0.0210	0.0121	Undefined	None	Not Detected	0.78 (Q2-10)
	GMA-U	22200	17	58	29.3	ND	0.0138	0.00472	0.00468	Undefined	Down	Detected	0.124 (Q4-98) 0.177 (Q2-00) 0.073 (Q2-10)
	GMA-D	22199	12	58	20.7	ND	0.0272	0.00448	0.00595	Undefined	Down	Detected	0.0775 (Q2-00) 0.067 Q2-10)
Arsenic (mg/L)	LCS	12339C	17	28	60.7	ND	0.225	0.00931	0.0662	Undefined	Up	Detected	
	LDS	12339D	1	2	50.0	ND	0.00842	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	1	20	5.0	ND	0.025	Insuff	Insuff	Undefined	None	Not Detected	
	GMA-U	22200	3	11	27.3	ND	0.0355	0.0025	Insuff	Undefined	None	Not Detected	
	GMA-D	22199	6	24	25.0	ND	0.0429	0.0015	0.0113	Undefined	Up	Detected	
Barium (mg/L)	LCS	12339C	23	23	100.0	0.0362	0.283	0.0750	0.0745	Undefined	None	Detected	
	LDS	12339D	2	2	100.0	0.0167	0.0203	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	10	100.0	0.0203	0.13	0.0516	0.0333	Lognormal	None	Not Detected	
	GMA-U	22200	4	4	100.0	0.0866	0.156	0.119	0.029	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	0.0641	0.131	0.101	0.031	Normal	None	Insuff	

Table A.5.2−1 (continued). Summary Statistics for Cell 2

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12339C	52	52	100.0	0.207	4.78	1.93	1.05	Undefined	Up	Detected	
	LDS	12339D	27	27	100.0	0.289	2.22	0.510	0.380	Undefined	None	Not Detected	
	HTW	12339	46	49	93.9	ND	0.213	0.101	0.058	Undefined	Up	Detected	
	GMA-U	22200	46	58	79.3	ND	0.0888	0.0503	0.0166	Normal	Up	Detected	
	GMA-D	22199	49	58	84.5	ND	0.0775	0.0501	0.0159	Normal	Up	Detected	
Calcium (mg/L)	LCS	12339C	23	23	100.0	165	1320	607	256	Normal	Up	Detected	
	LDS	12339D	2	2	100.0	420	458	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	10	100.0	211	431	301	56	Normal	None	Not Detected	
	GMA-U	22200	4	4	100.0	130	161	148	14	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	132	193	154	28	Normal	None	Insuff	
Cobalt (mg/L)	LCS	12339C	24	28	85.7	ND	0.306	0.0192	0.0738	Undefined	None	Detected	
	LDS	12339D	1	2	50.0	ND	0.0035	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	17	58.8	ND	0.005	0.00125	0.00111	Lognormal	None	Not Detected	
	GMA-U	22200	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22199	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Copper (mg/L)	LCS	12339C	19	24	79.2	ND	0.0328	0.0058	0.0087	Undefined	None	Detected	
	LDS	12339D	2	2	100.0	0.0145	0.0221	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	8	11	72.7	ND	0.015	0.0077	0.0048	Normal	None	Not Detected	
	GMA-U	22200	4	4	100.0	0.00413	0.0144	0.00878	0.00428	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	0.000991	0.00794	0.00569	0.00324	Normal	None	Insuff	
Iron (mg/L)	LCS	12339C	27	28	96.4	ND	253	17.6	67.4	Undefined	Up	Detected	
	LDS	12339D	2	2	100.0	0.331	3.61	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	16	17	94.1	0.61	42.8	1.75	12.6	Undefined	None	Not Detected	
	GMA-U	22200	11	11	100.0	3.24	10	6.31	2.56	Normal	None	Not Detected	
	GMA-D	22199	11	11	100.0	3.46	5.82	4.34	0.61	Normal	None	Not Detected	
Lithium (mg/L)	LCS	12339C	20	20	100.0	0.377	0.967	0.564	0.170	Lognormal	Up	Detected	
	LDS	12339D	2	2	100.0	0.226	0.31	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	17	17	100.0	0.0132	0.0199	0.0163	0.0020	Normal	Down	Detected	
	GMA-U	22200	11	11	100.0	0.0039	0.00562	0.0045	0.0005	Normal	None	Not Detected	
	GMA-D	22199	11	11	100.0	0.0065	0.00878	0.0075	0.0007	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12339C	23	23	100.0	32.4	375	205	85	Normal	Up	Detected	
	LDS	12339D	2	2	100.0	393	468	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	10	100.0	79.7	133	98.4	14.4	Normal	None	Not Detected	
	GMA-U	22200	4	4	100.0	33.1	42.5	38.5	4.2	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	38	54.8	39.4	8.0	Undefined	None	Insuff	
Manganese (mg/L)	LCS	12339C	26	28	92.9	ND	12.7	2.06	3.94	Undefined	None	Detected	
	LDS	12339D	2	2	100.0	0.418	0.812	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	15	17	88.2	0.00414	0.364	0.0552	0.0848	Lognormal	Down	Detected	
	GMA-U	22200	13	13	100.0	0.204	0.507	0.328	0.088	Normal	None	Not Detected	
	GMA-D	22199	23	24	95.8	ND	0.791	0.319	0.160	Lognormal	Down	Not Detected	
Nickel (mg/L)	LCS	12339C	28	28	100.0	0.00495	0.421	0.0780	0.0930	Lognormal	None	Detected	
	LDS	12339D	2	2	100.0	0.00906	0.0215	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	8	17	47.1	ND	0.0111	0.00474	0.00375	Undefined	Down	Not Detected	
	GMA-U	22200	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22199	6	24	25.0	ND	0.0066	0.00152	0.00173	Undefined	None	Detected	
Potassium (mg/L)	LCS	12339C	23	23	100.0	3.93	49.7	20.4	13.2	Undefined	Up	Detected	
	LDS	12339D	2	2	100.0	29.8	38	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	10	10	100.0	3.27	5.05	3.77	0.53	Lognormal	None	Not Detected	
	GMA-U	22200	4	4	100.0	1.5	1.7	1.62	0.09	Normal	None	Insuff	
	GMA-D	22199	4	4	100.0	1.34	1.58	1.48	0.10	Normal	None	Insuff	

Table A.5.2−1 (continued). Summary Statistics for Cell 2

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12339C	10	28	35.7	ND	0.0522	0.00999	0.0134	Lognormal	None	Not Detected	
	LDS	12339D	1	2	50.0	ND	0.0191	insuff	insuff	Insuff	Insuff	Insuff	
	HTW	12339	1	17	5.9	ND	0.0367	Insuff	Insuff	Undefined	None	Not Detected	
	GMA-U	22200	0	11	0.0	ND	NA	insuff	insuff	Insuff	Insuff	Insuff	
	GMA-D	22199	0	11	0.0	ND	NA	insuff	insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12339C	28	28	100.0	3.32	26.7	17.4	5.6	Normal	Up	Detected	
	LDS	12339D	2	2	100.0	664	989	insuff	insuff	Insuff	Insuff	Insuff	
	HTW	12339	20	20	100.0	44.3	119	72.6	23.8	Lognormal	Down	Detected	
	GMA-U	22200	11	11	100.0	20.4	32.9	26.8	4.3	Normal	Up	Detected	
	GMA-D	22199	11	11	100.0	14.1	19.5	17.0	1.7	Normal	Down	Not Detected	
Zinc (mg/L)	LCS	12339C	19	28	67.9	ND	0.353	0.0594	0.0857	Lognormal	None	Detected	
	LDS	12339D	2	2	100.0	0.0747	0.284	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12339	9	17	52.9	ND	0.284	0.00512	0.0781	Undefined	None	Detected	
	GMA-U	22200	9	11	81.8	ND	0.0377	0.0164	0.0107	Normal	None	Not Detected	
	GMA-D	22199	15	24	62.5	ND	0.0255	0.00600	0.00488	Lognormal	None	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires $n \geq 3$. In addition, Standard Deviation requires $n \geq 4$.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where $3 \leq n \leq 50$) or Shapiro Francia (where $n > 50$).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with $n \geq 4$.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with $n \geq 6$.

[h]Outliers determined by Rosner's (where $n > 25$) or Dixon procedure (where $4 \leq n \leq 25$).

[i]Q = quarterly

Table A.5.2−2. Cell 2 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	14	6	42.9	Yes	0.076	0.2	0.13	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Antimony (mg/L)	14	3	21.4	Yes	0.00053	0.00629	0.0025	0.006 mg/L(1)	-	-	0.0987 mg/L(0)
Cadmium (mg/L)	14	5	35.7	Yes	0.000091	0.00128	0.0005	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	14	6	42.9	Yes	0.0009	0.0069	0.004	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(3)	0.818 mg/L(0)
Lead (mg/L)	14	4	28.6	Yes	0.0007	0.0275	0.0093	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(3)	0.0114 mg/L(1)
Thallium (mg/L)	14	4	28.6	Yes	0.00057	0.0107	0.0033	-	-	-	0.0028 mg/L(1)
Vanadium (mg/L)	14	3	21.4	Yes	0.00158	0.0116	0.0066	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(2)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	25	1	4.0	No	21.2	-	-	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organic											
Trichlorofluoromethane (ug/L)	11	1	9.1	No	0.27	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

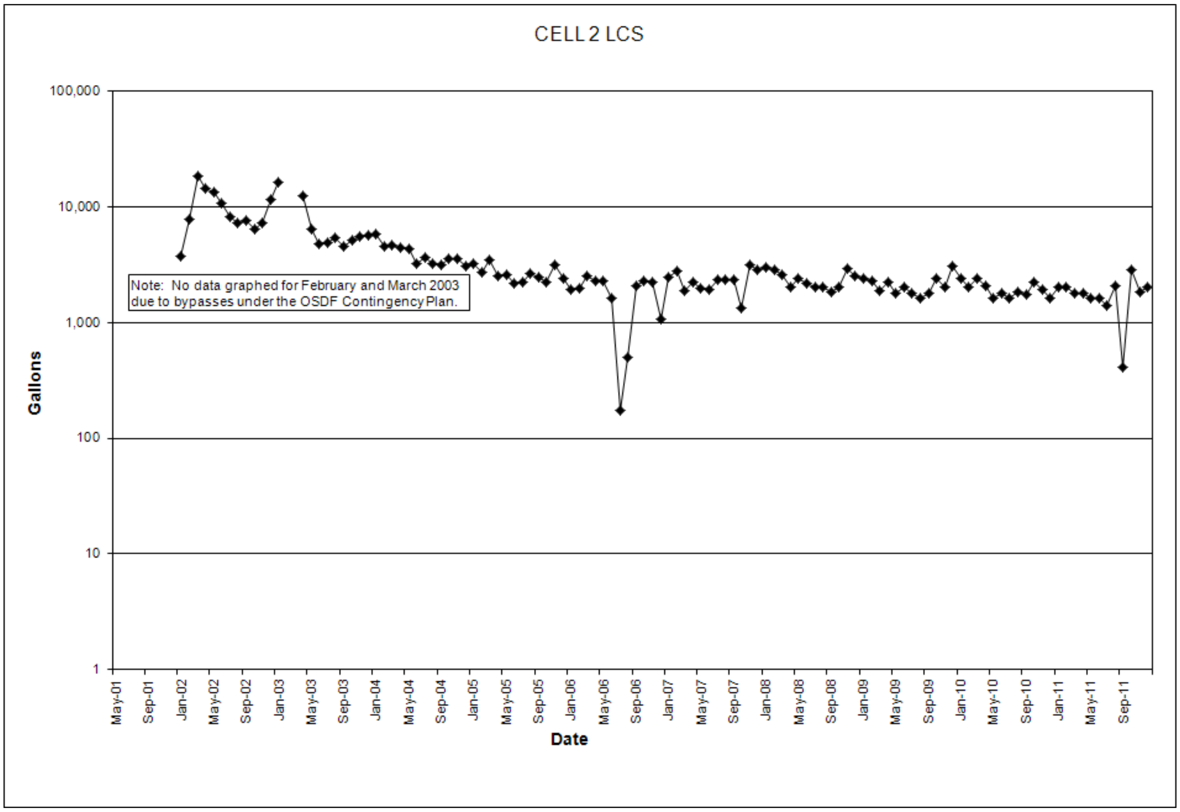


Figure A.5.2–1. Monthly Accumulation Volumes For Cell 2 LCS

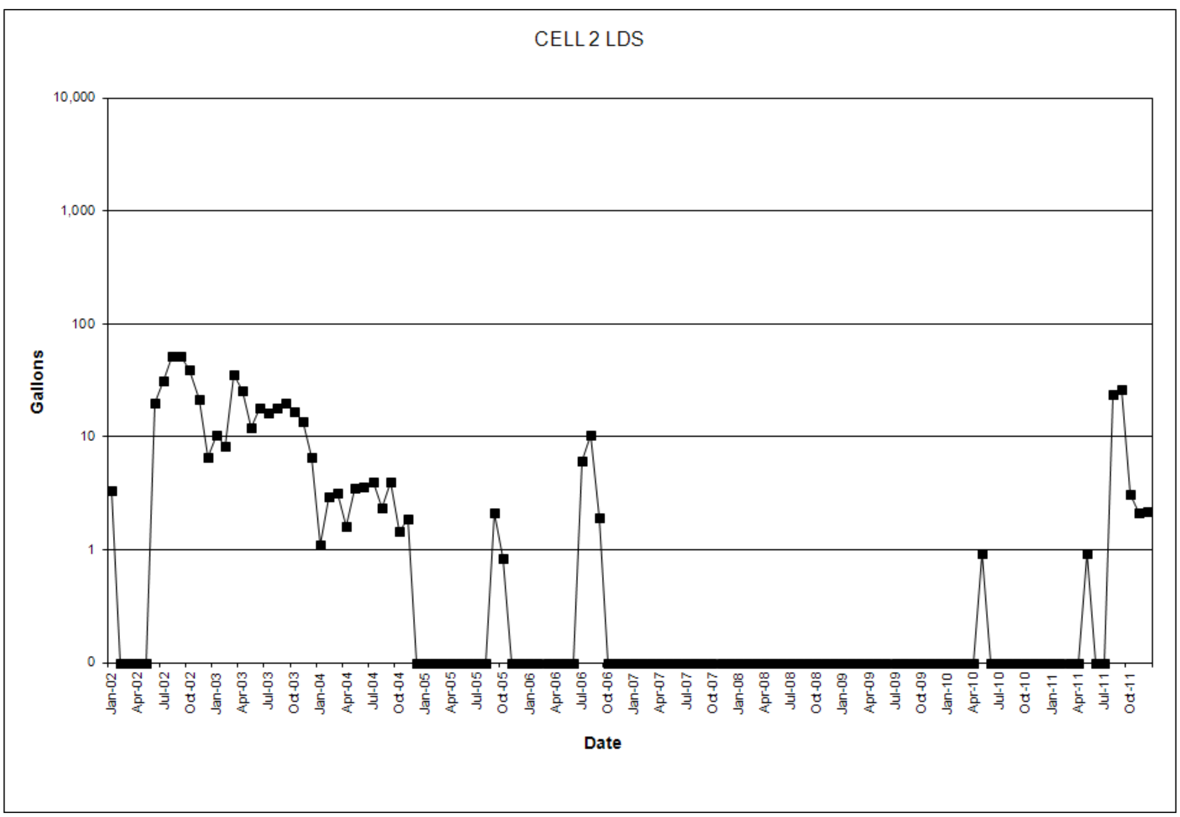
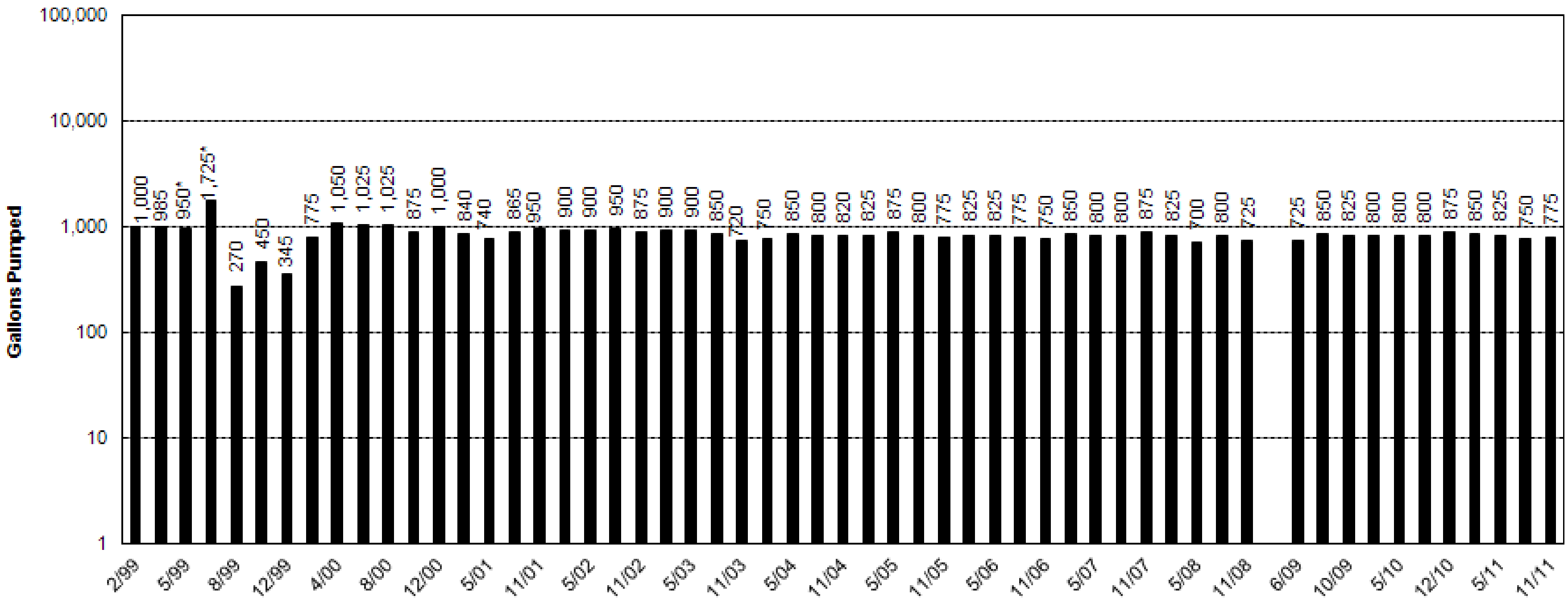


Figure A.5.2–2. Monthly Accumulation Volumes For Cell 2 LDS



12339 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	5725	n=7	818
2000:	5750	n=6	958
2001:	3395	n=4	849
2002:	3625	n=4	906
2003:	3370	n=4	843
2004:	3220	n=4	805
2005:	3275	n=4	819
2006:	3175	n=4	1088
2007:	3325	n=4	831
2008:	3050	n=4	763
2009:	2400	n=3	800
2010:	3275	n=4	819
2011:	3200	n=4	800
Overall:			835

*More than one purge of the well was completed during these months to help evaluate well yield.

Figure A.5.2–3. OSDF Horizontal Till Well 12339 (Cell 2) Water Yield

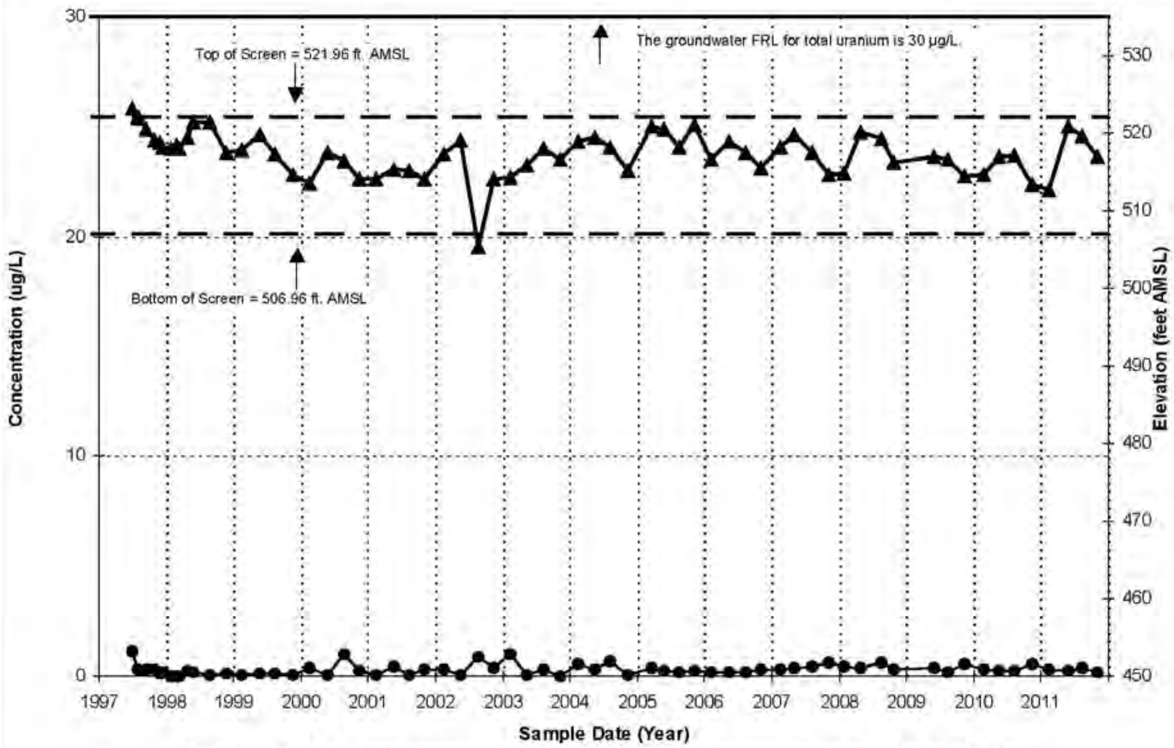


FIGURE A.5.2-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 2 Upgradient Monitoring Well 22200

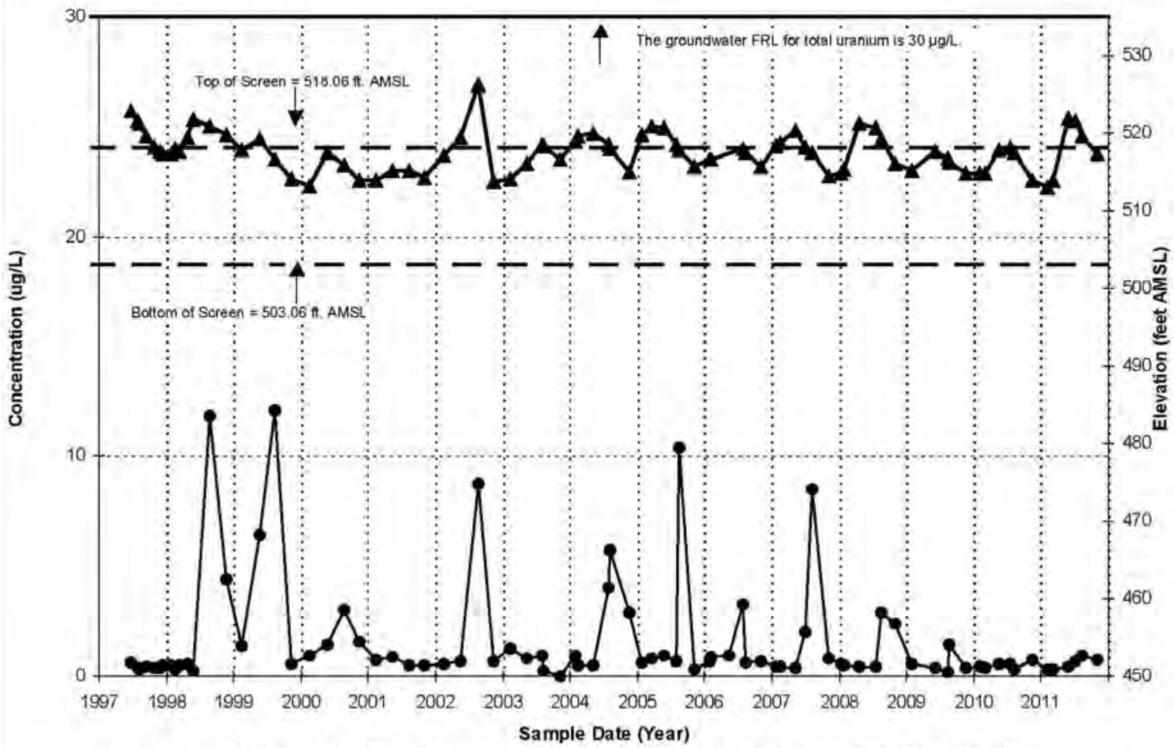


FIGURE A.5.2-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 2 Downgradient Monitoring Well 22199

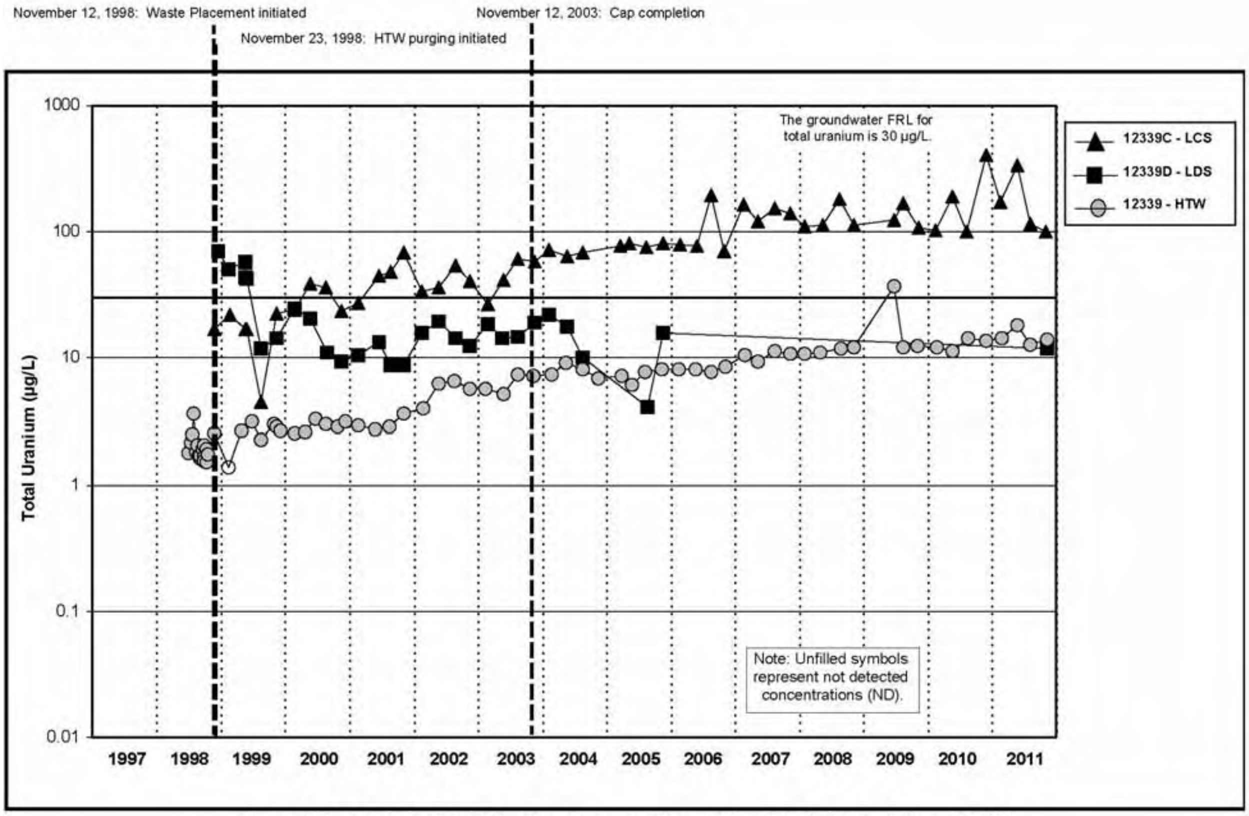


Figure A.5.2-6A. Cell 2 Total Uranium Concentration vs. Time Plot for LCS, LDS, and HTW

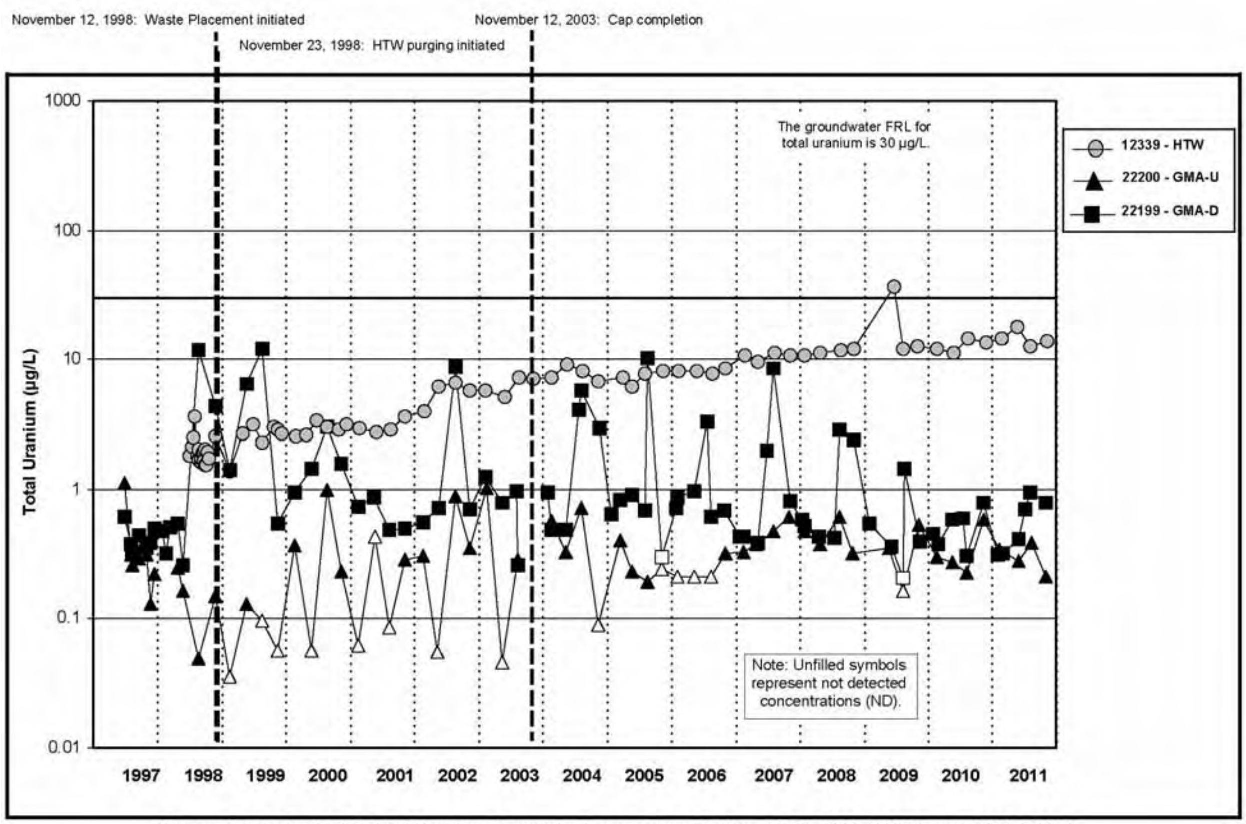


Figure A.5.2-6B. Cell 2 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

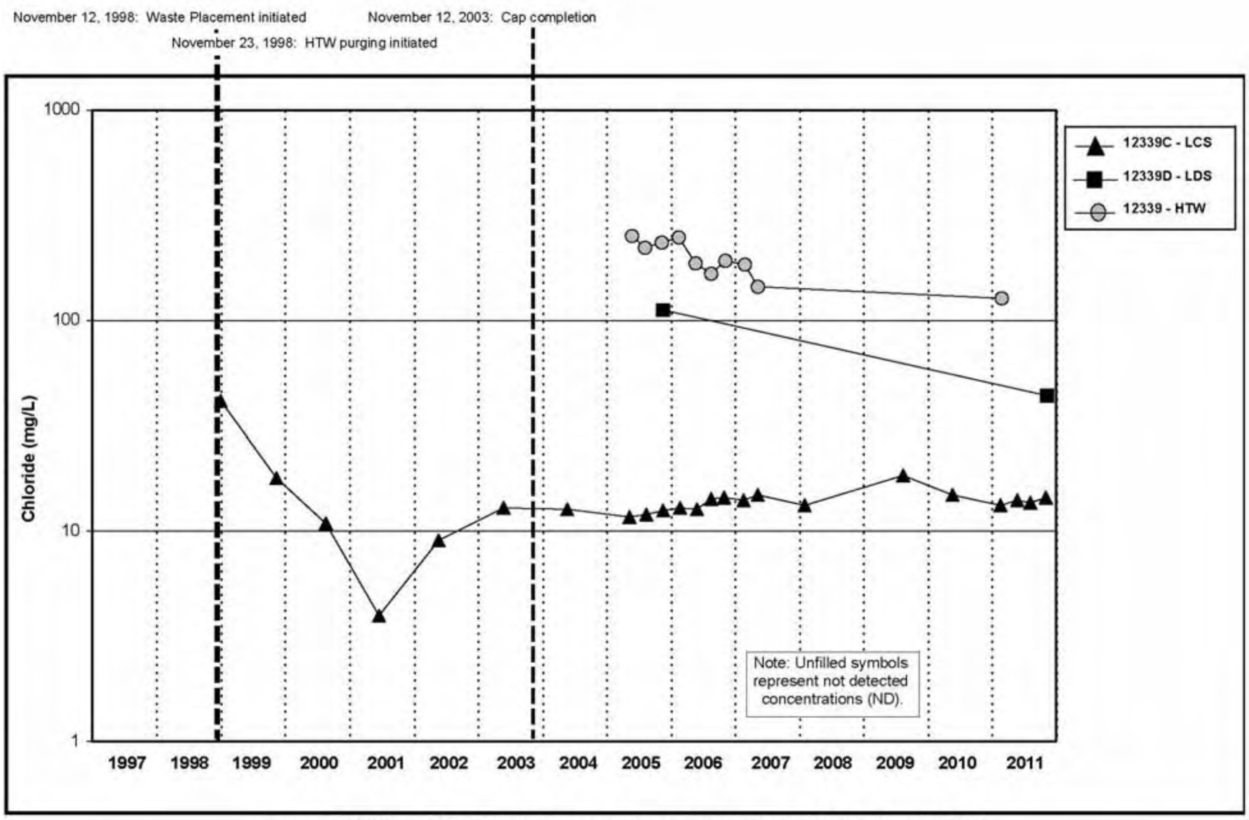


Figure A.5.2-7A. Cell 2 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

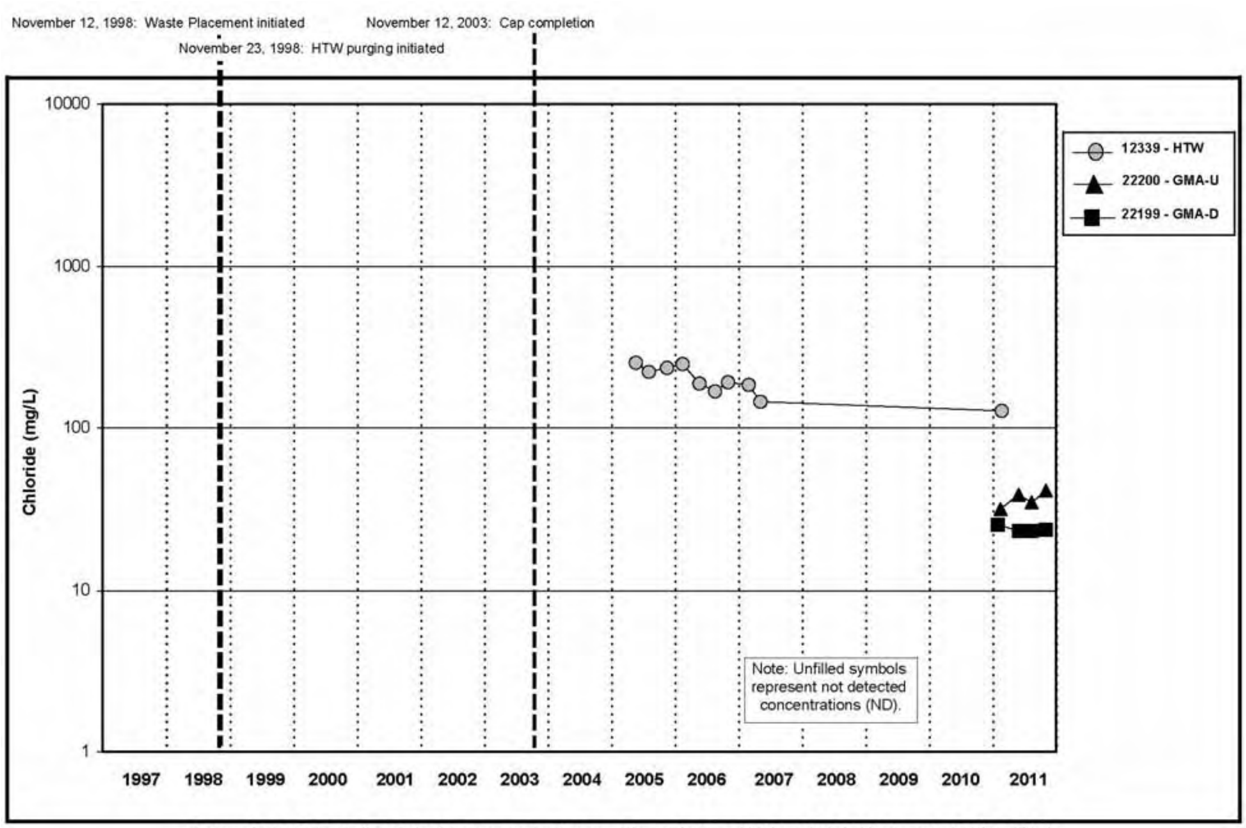


Figure A.5.2-7B. Cell 2 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

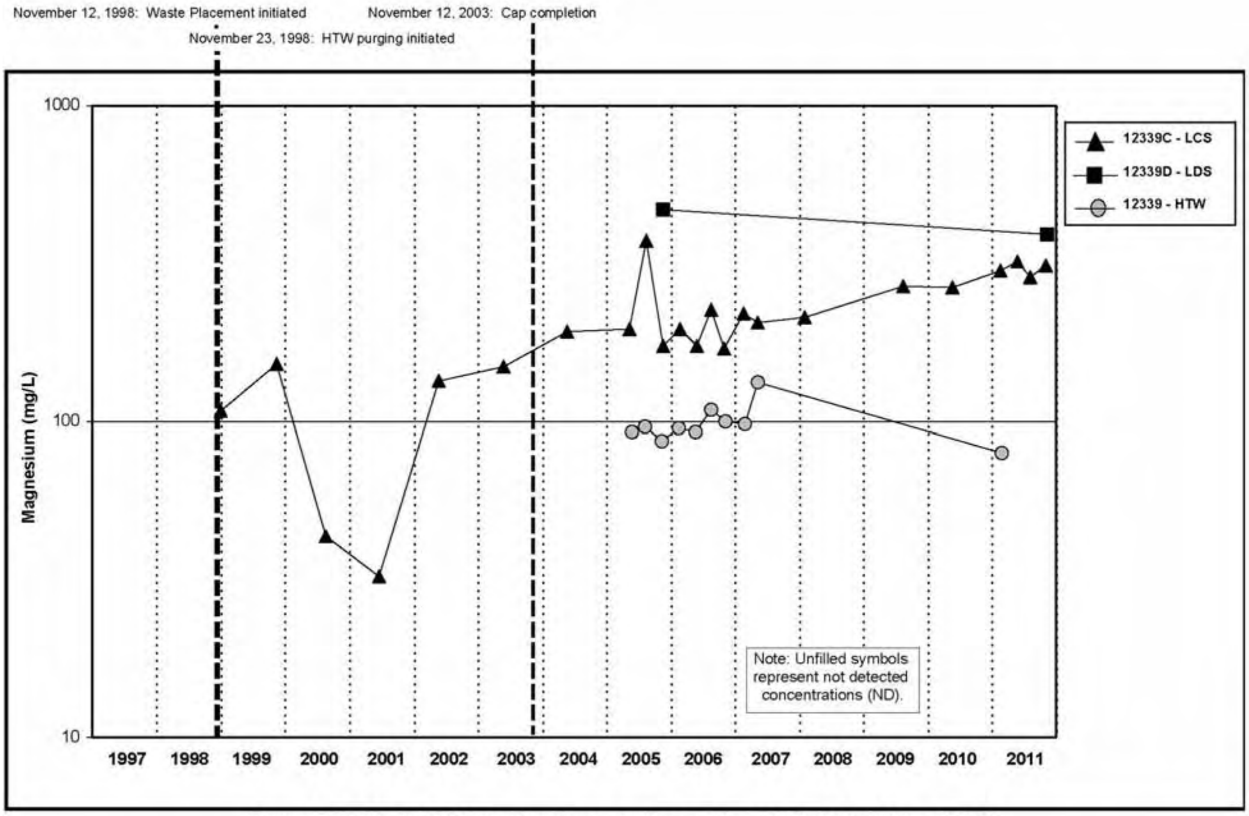


Figure A.5.2-8A. Cell 2 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

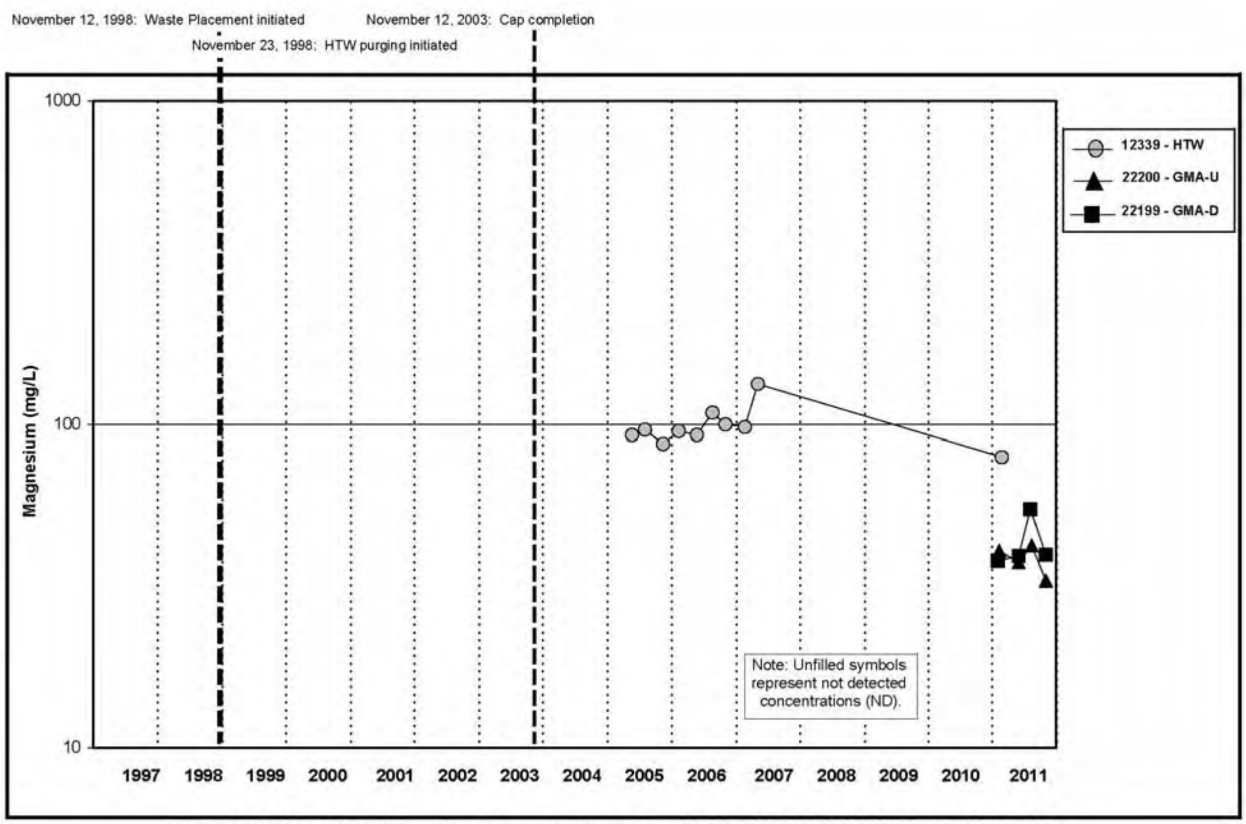


Figure A.5.2-8B. Cell 2 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

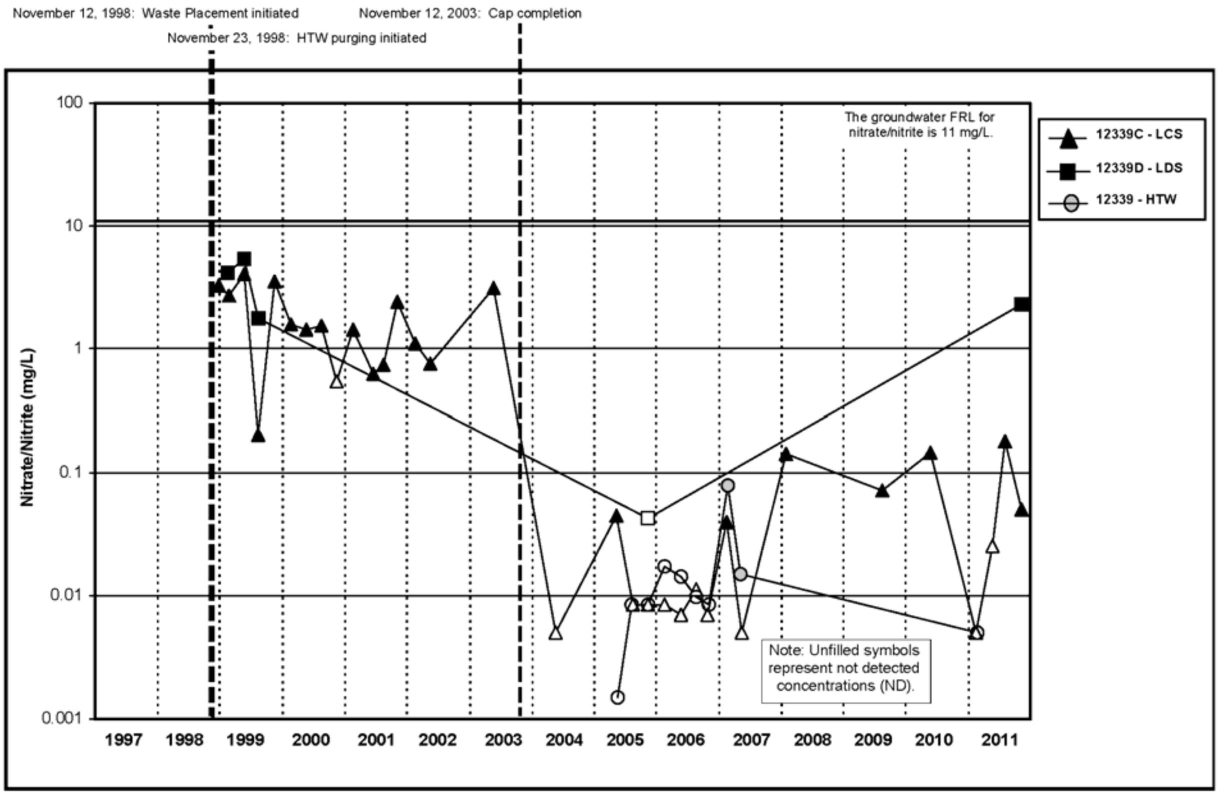


Figure A.5.2-9A. Cell 2 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

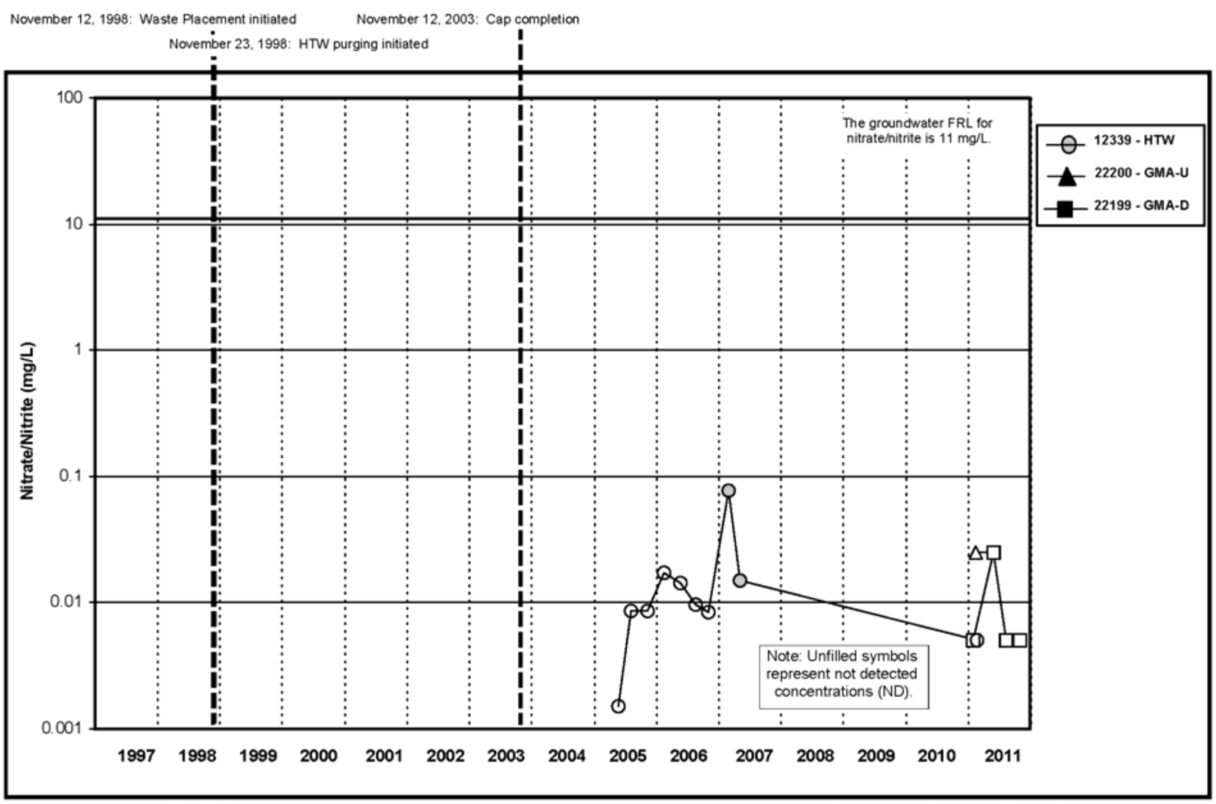


Figure A.5.2-9B. Cell 2 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

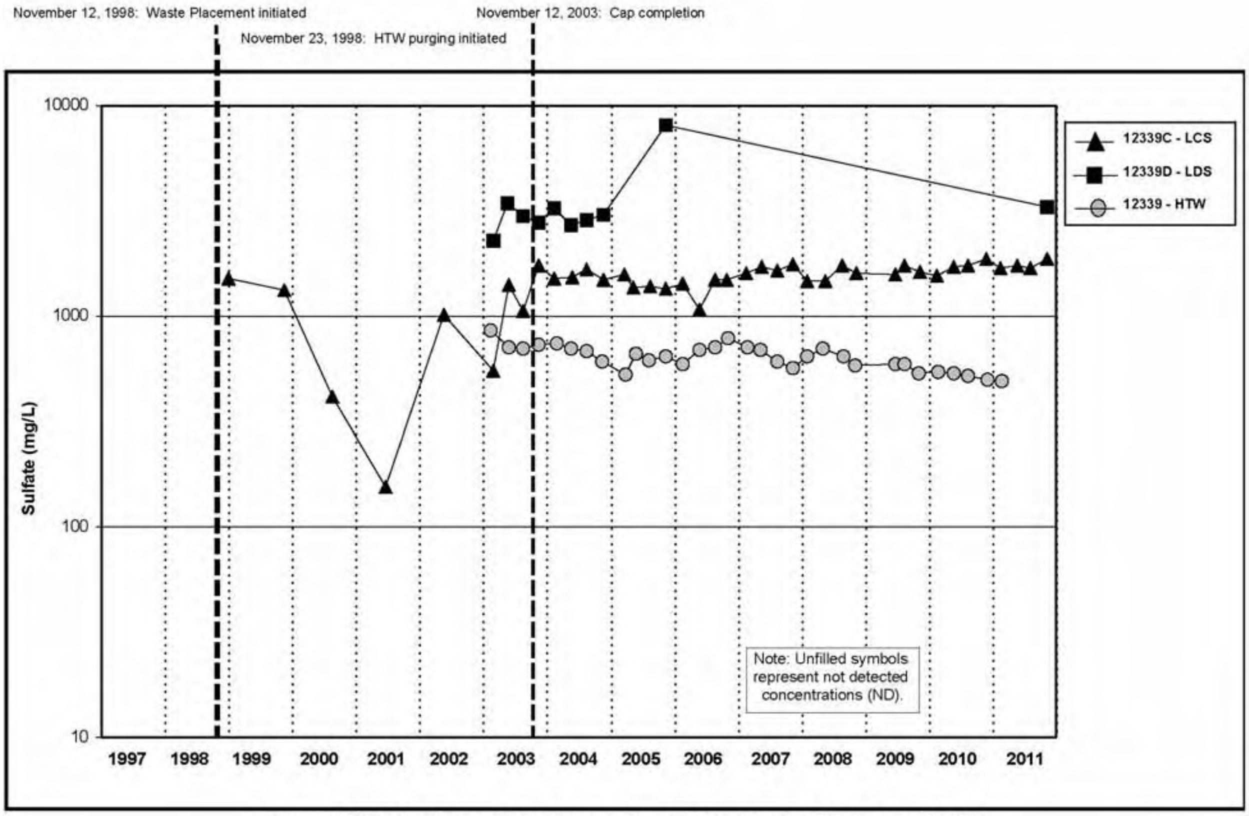


Figure A.5.2-10A. Cell 2 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

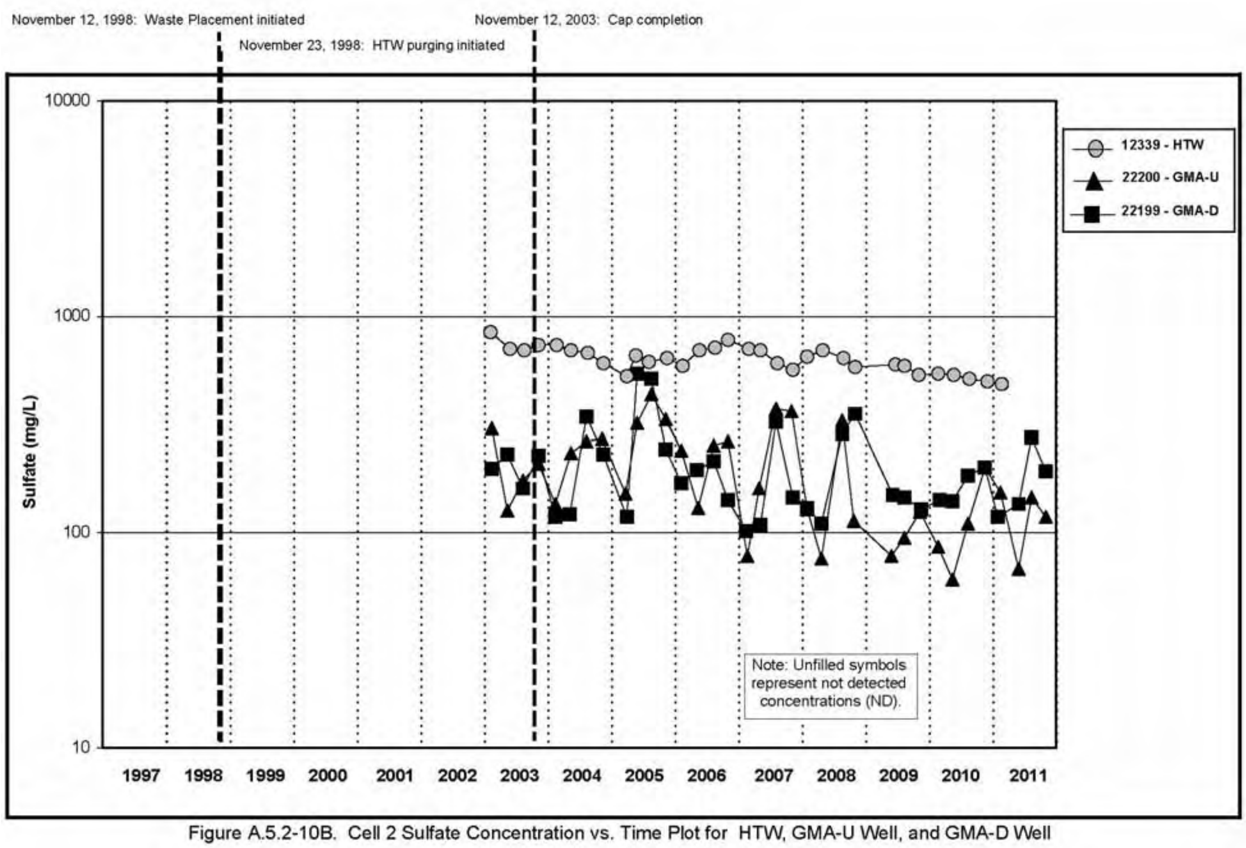


Figure A.5.2-10B. Cell 2 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

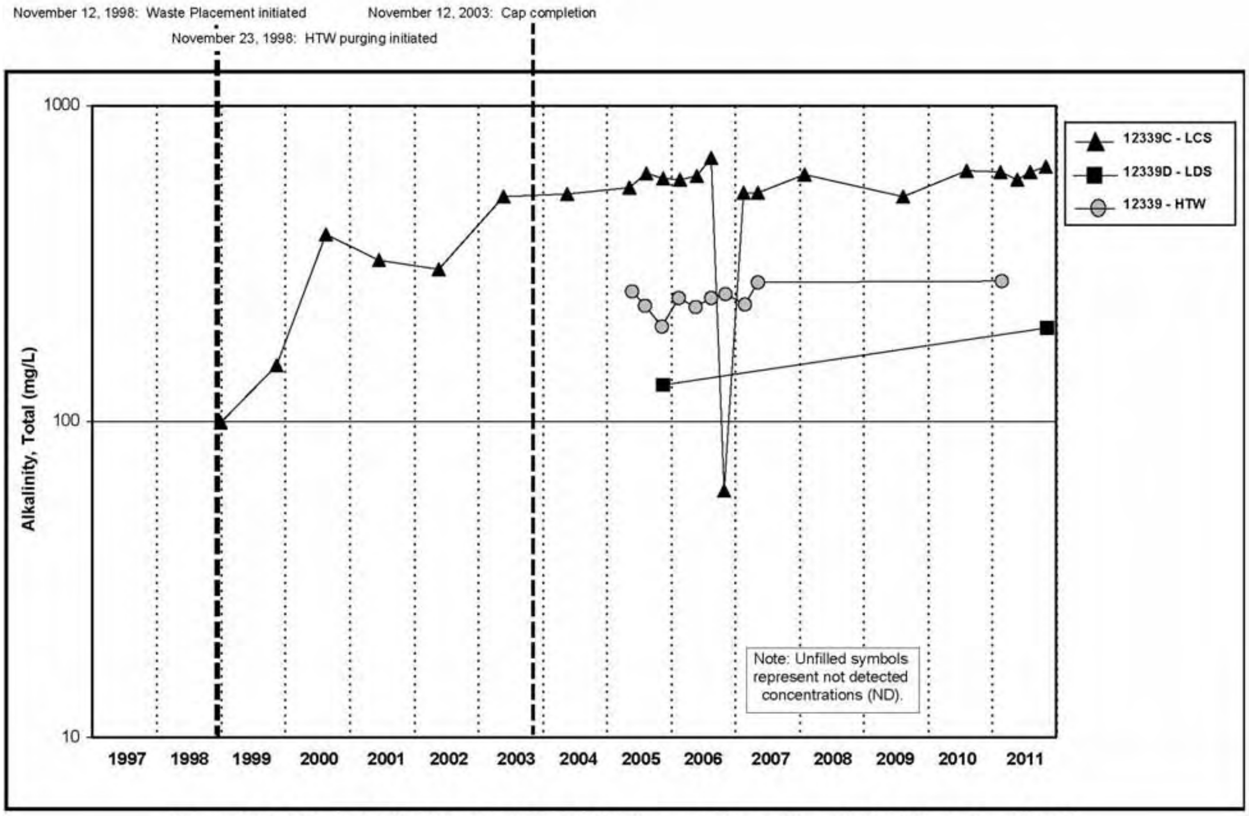


Figure A.5.2-11A. Cell 2 Alkalinity, Total (As CaCO3) Concentration vs. Time Plot for LCS, LDS, and HTW

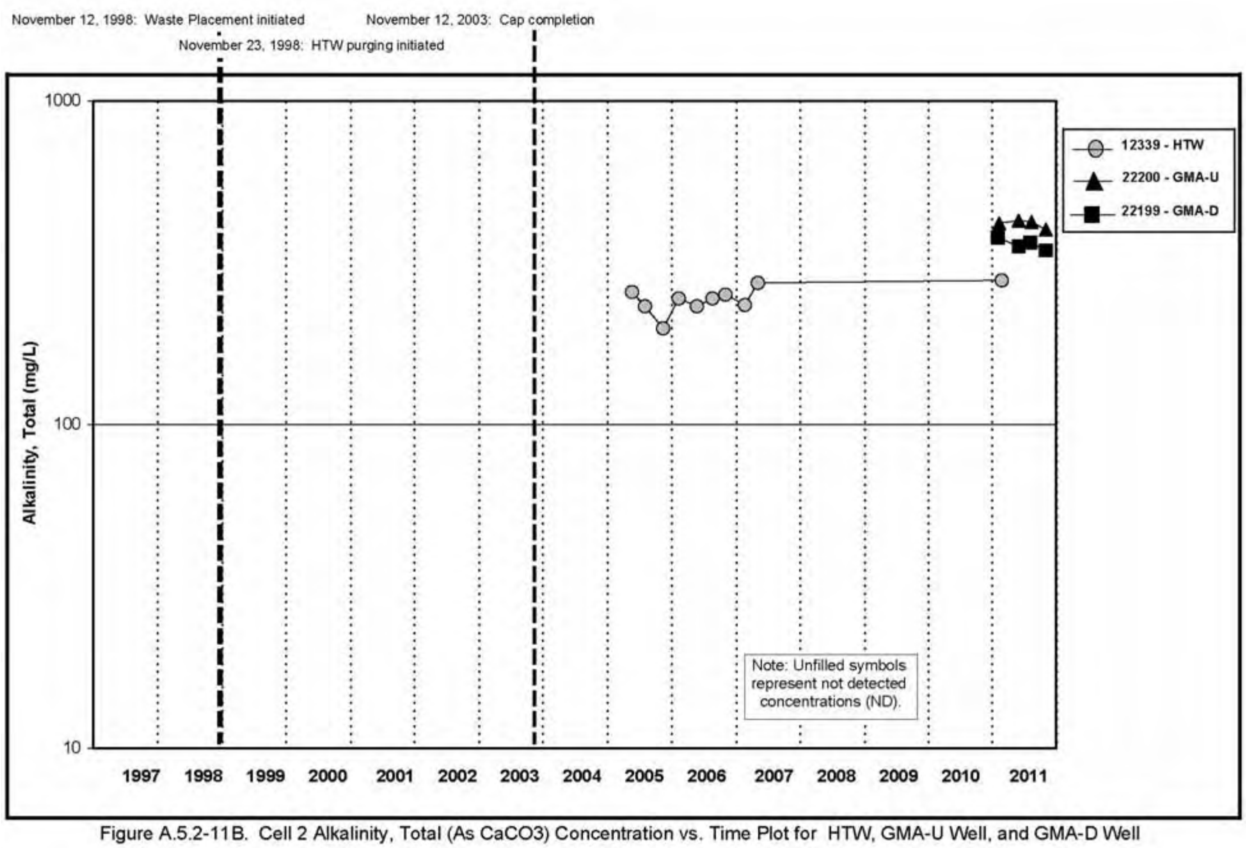


Figure A.5.2-11B. Cell 2 Alkalinity, Total (As CaCO3) Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

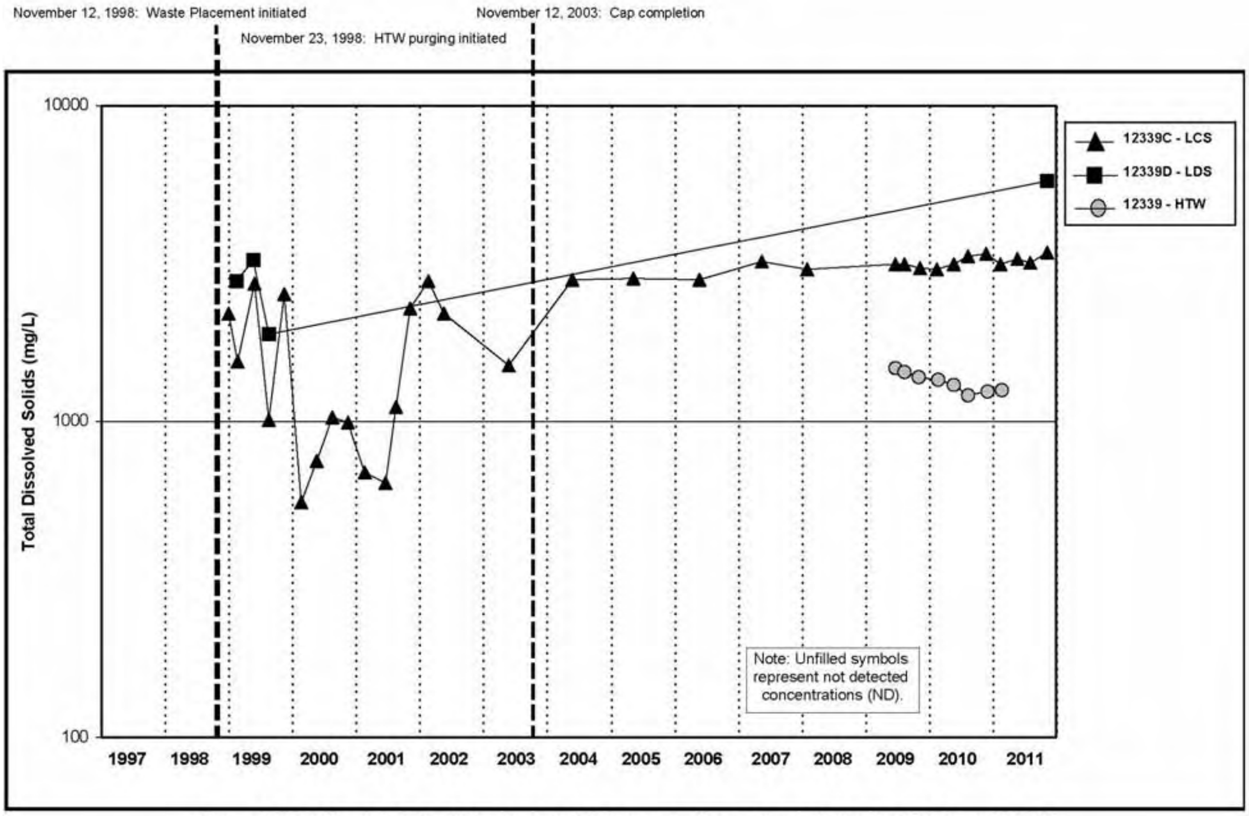


Figure A.5.2-12A. Cell 2 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

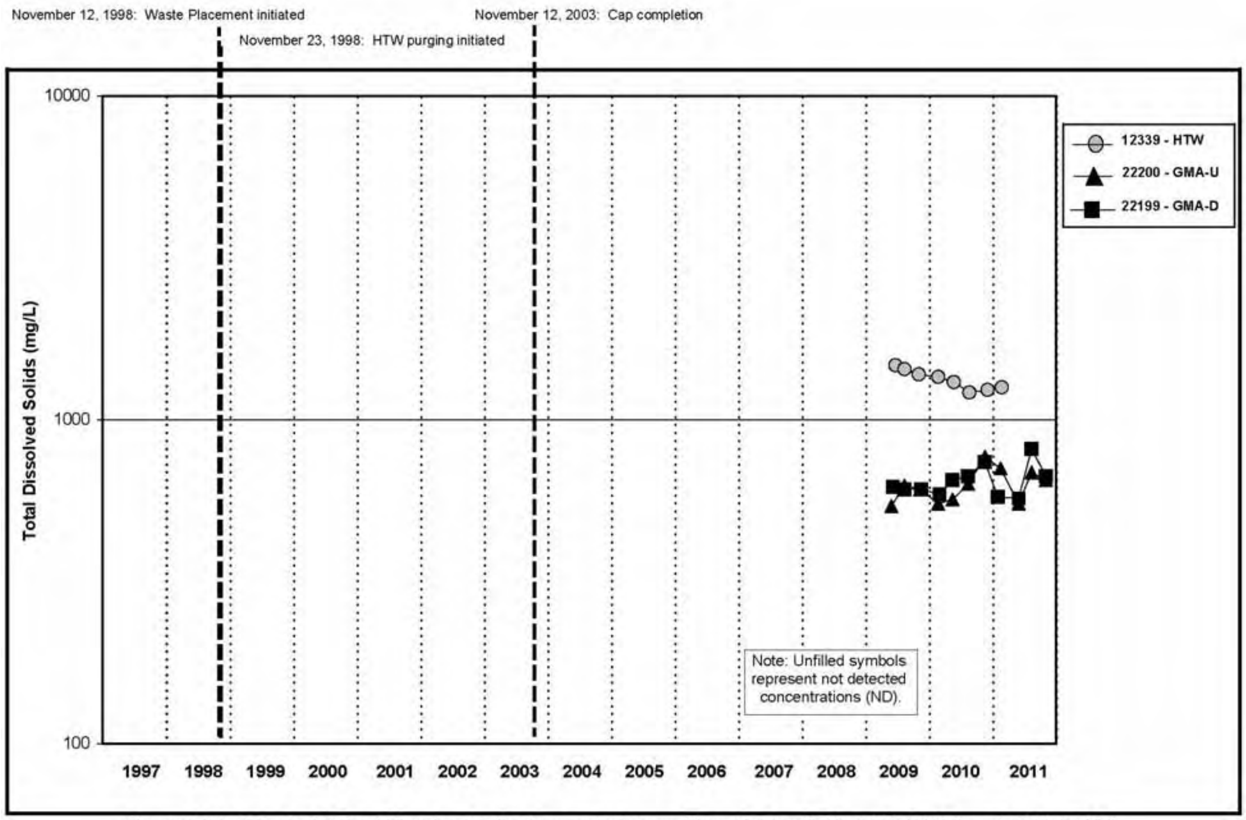


Figure A.5.2-12B. Cell 2 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

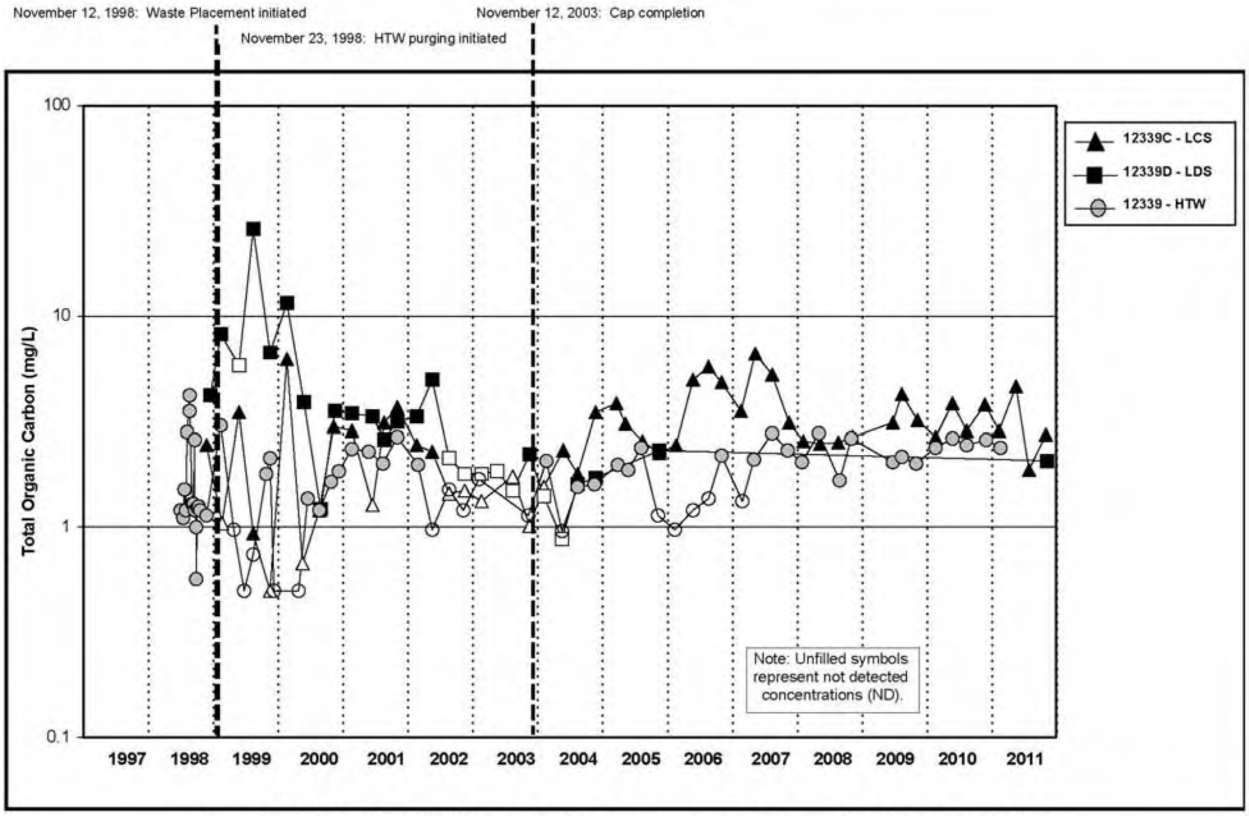


Figure A.5.2-13A. Cell 2 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

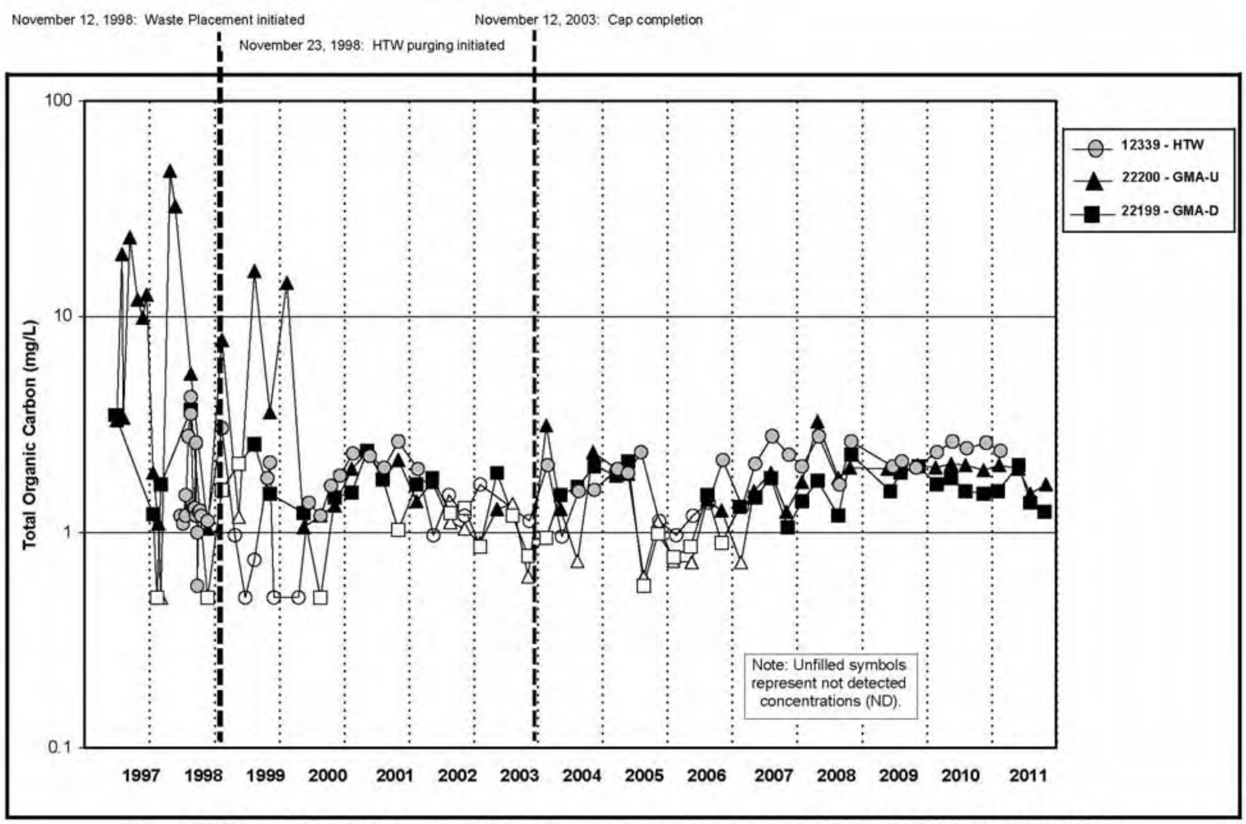


Figure A.5.2-13B. Cell 2 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

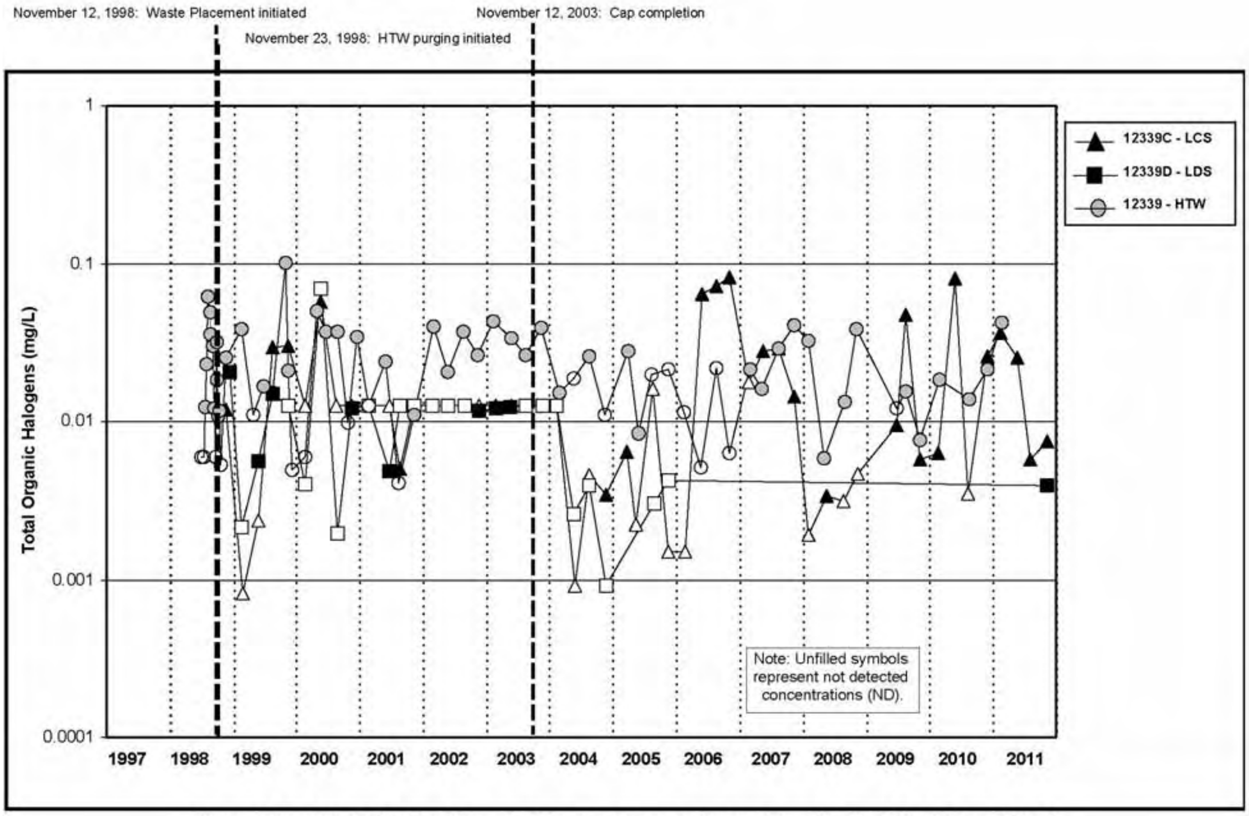


Figure A.5.2-14A. Cell 2 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

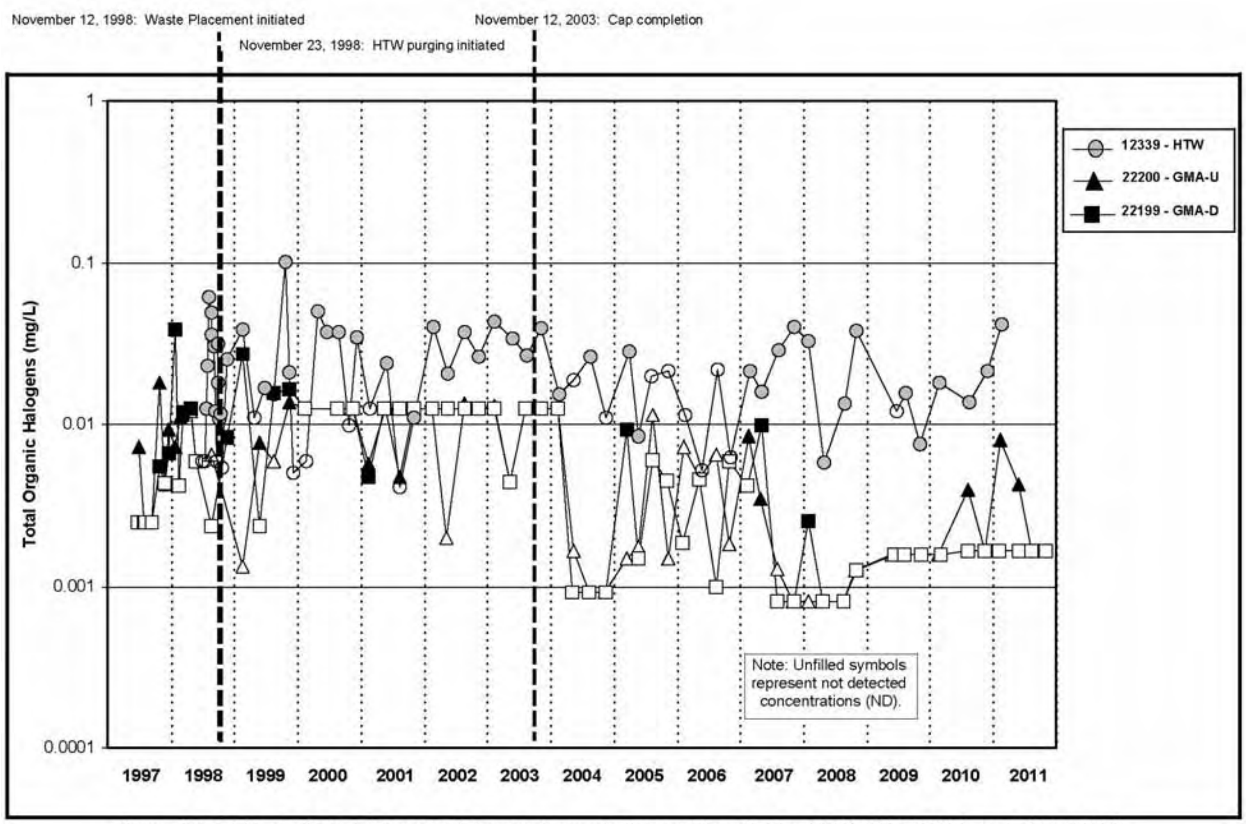


Figure A.5.2-14B. Cell 2 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

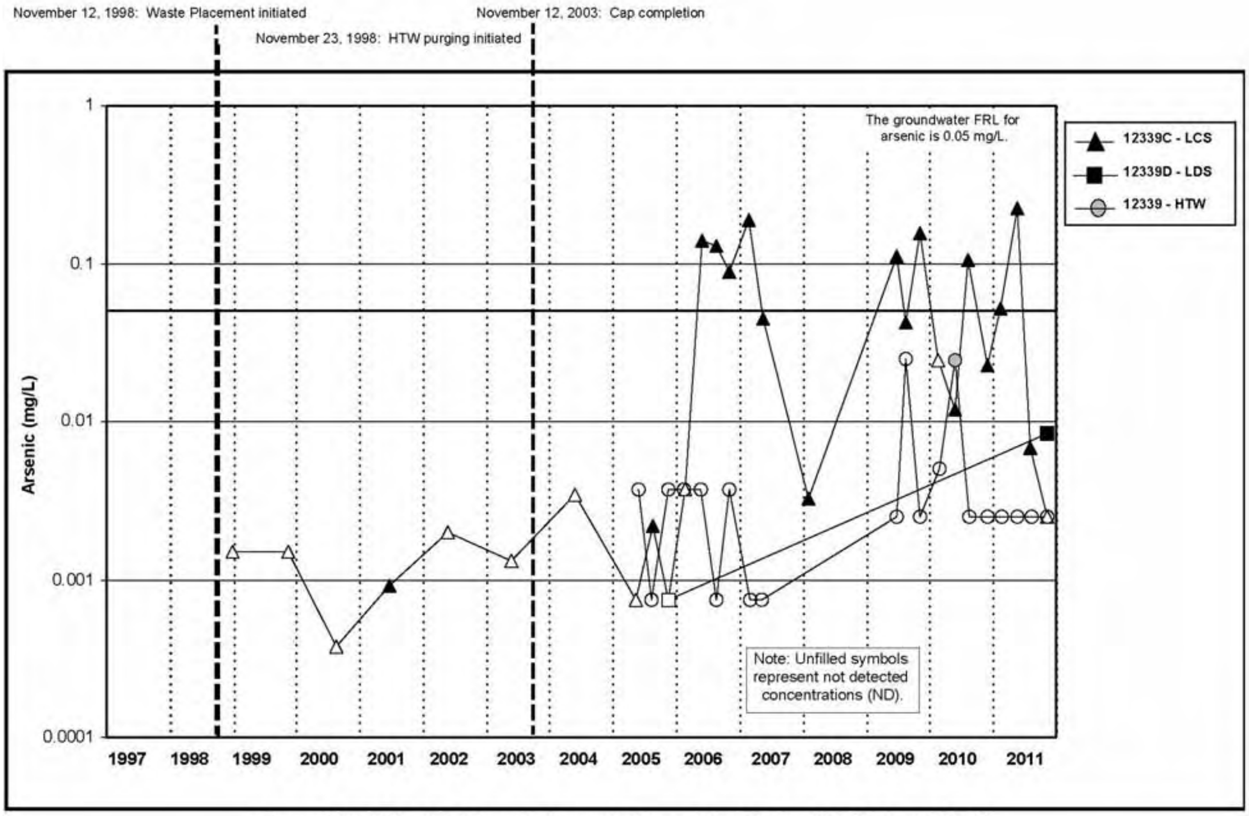


Figure A.5.2-15A. Cell 2 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

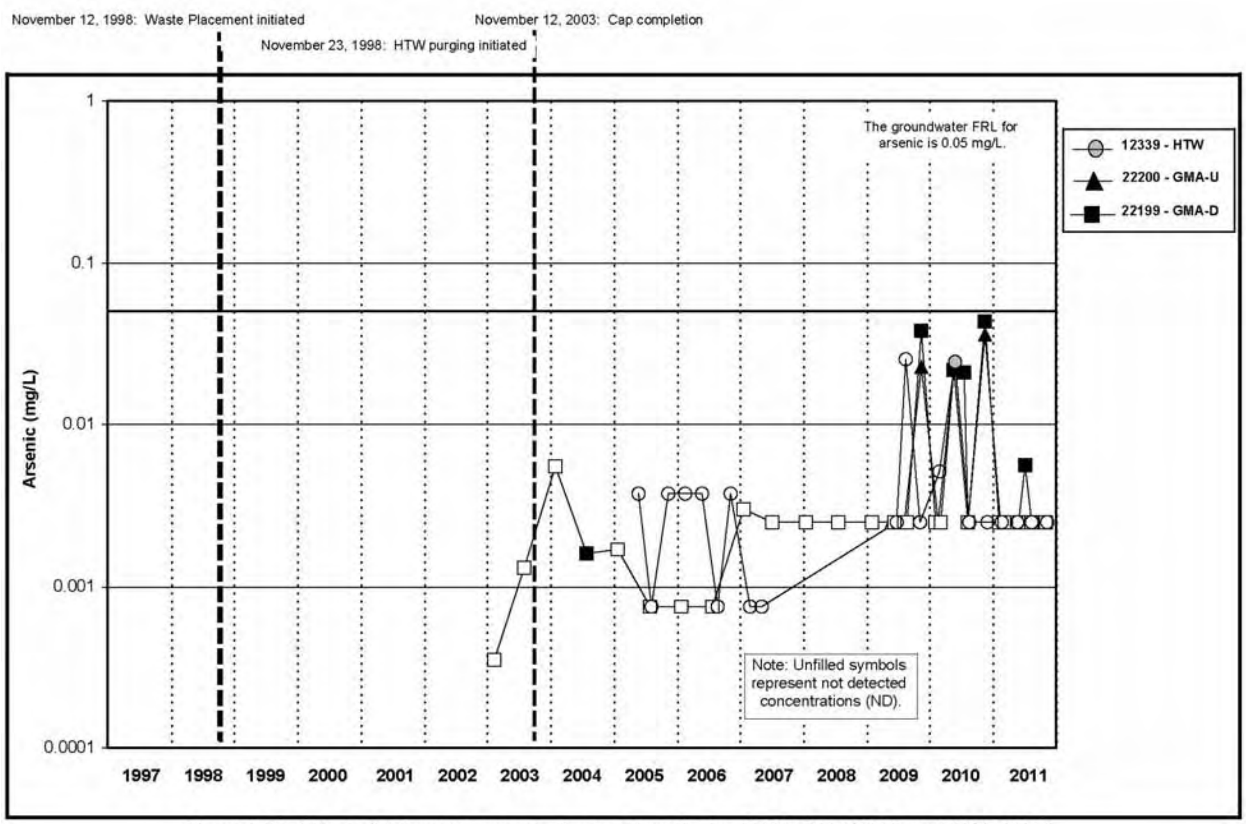


Figure A.5.2-15B. Cell 2 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

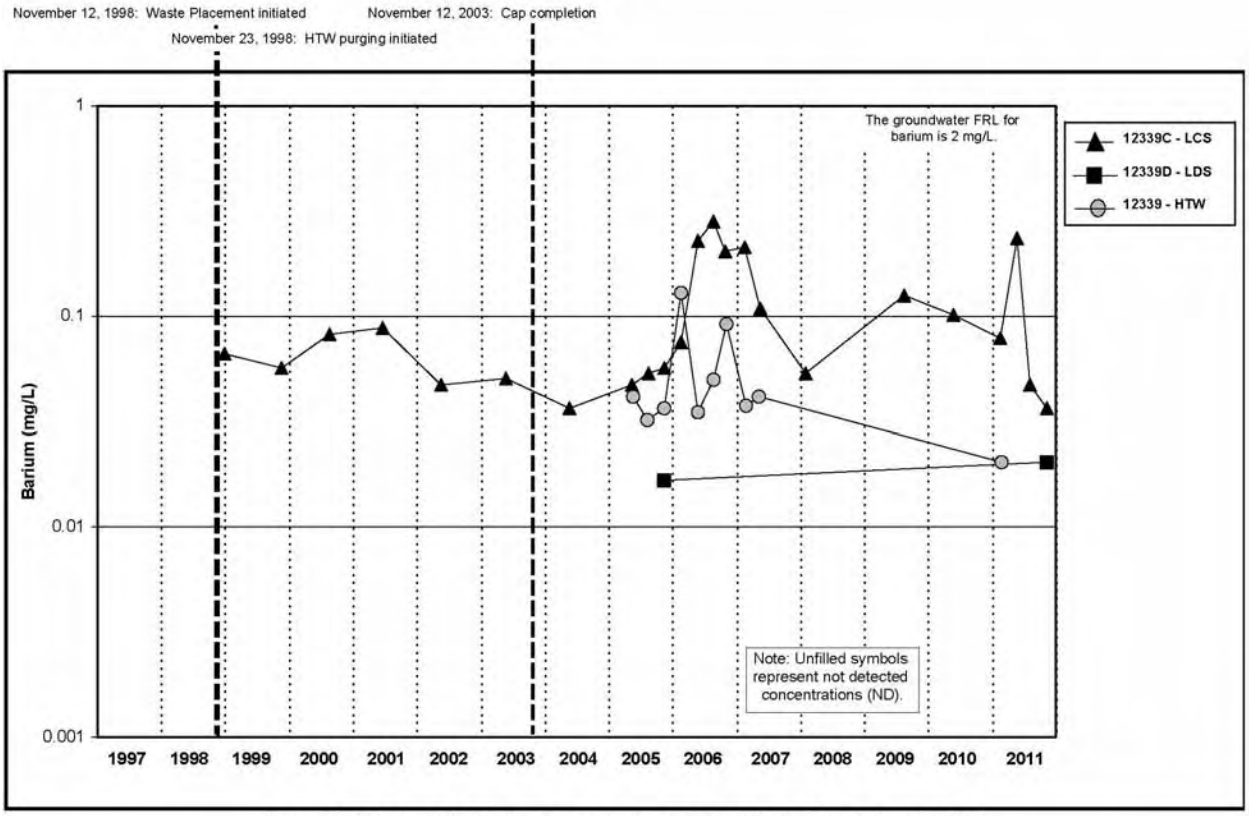


Figure A.5.2-16A. Cell 2 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

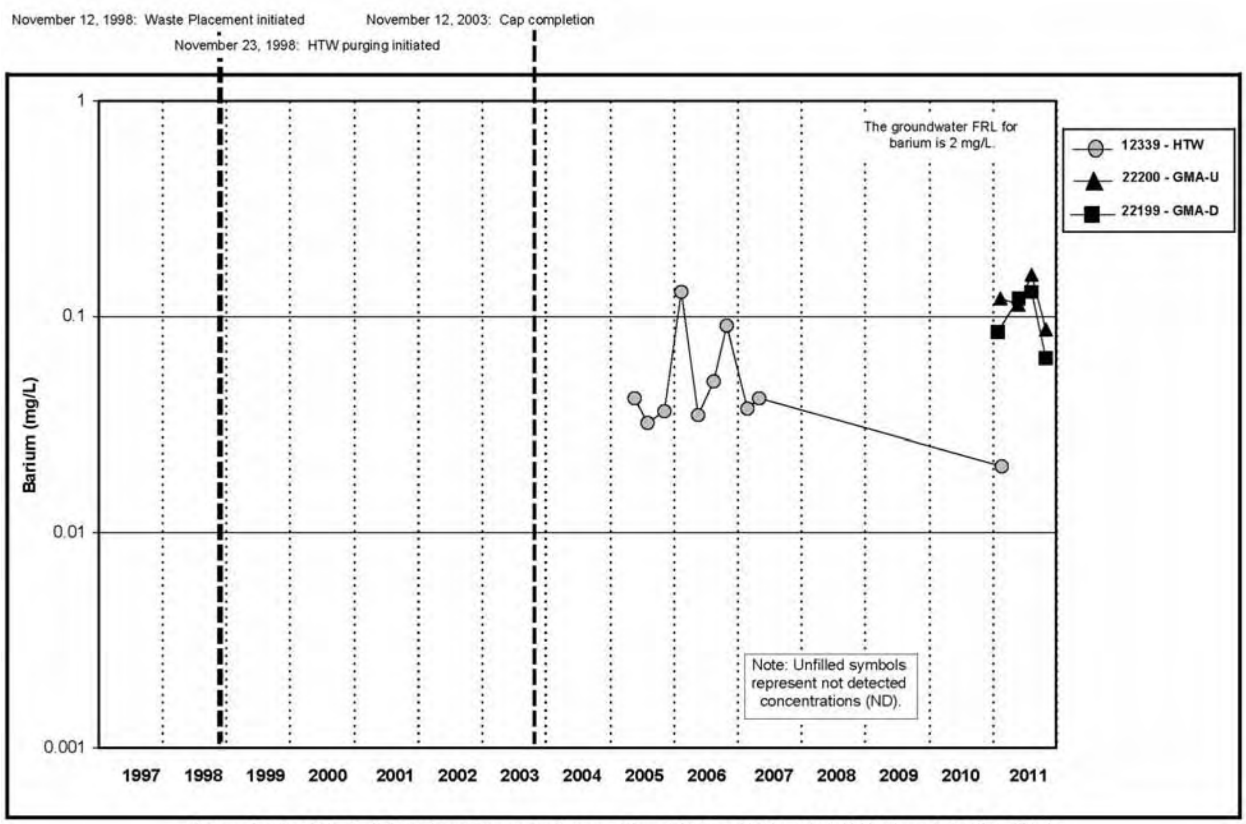


Figure A.5.2-16B. Cell 2 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

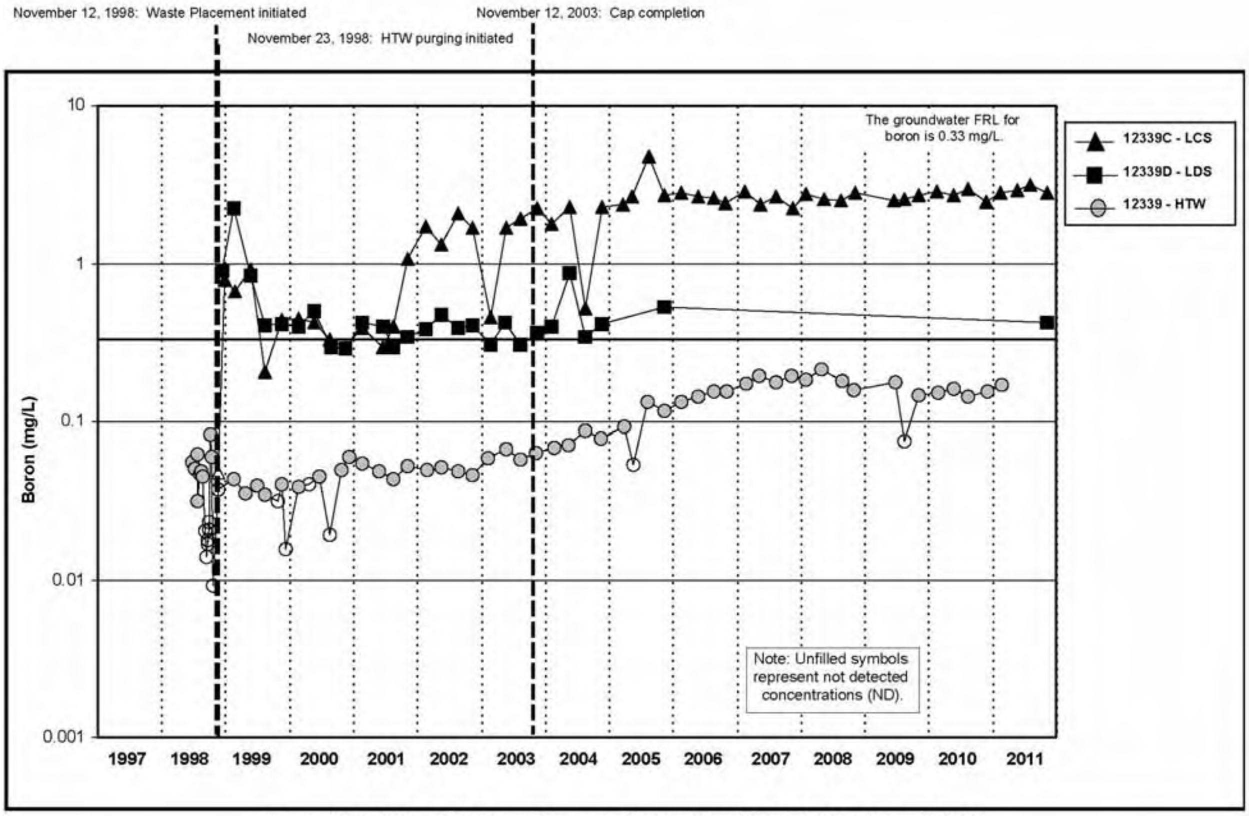


Figure A.5.2-17A. Cell 2 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

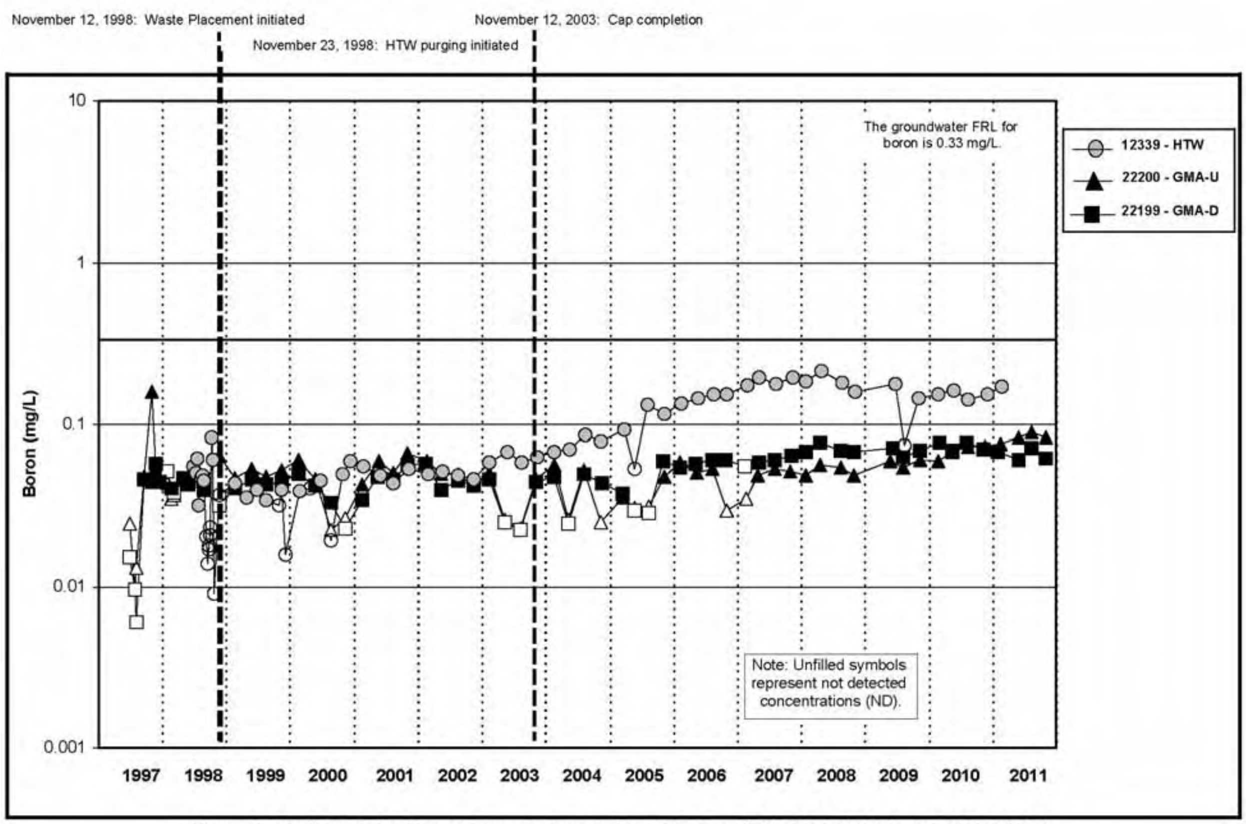


Figure A.5.2-17B. Cell 2 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

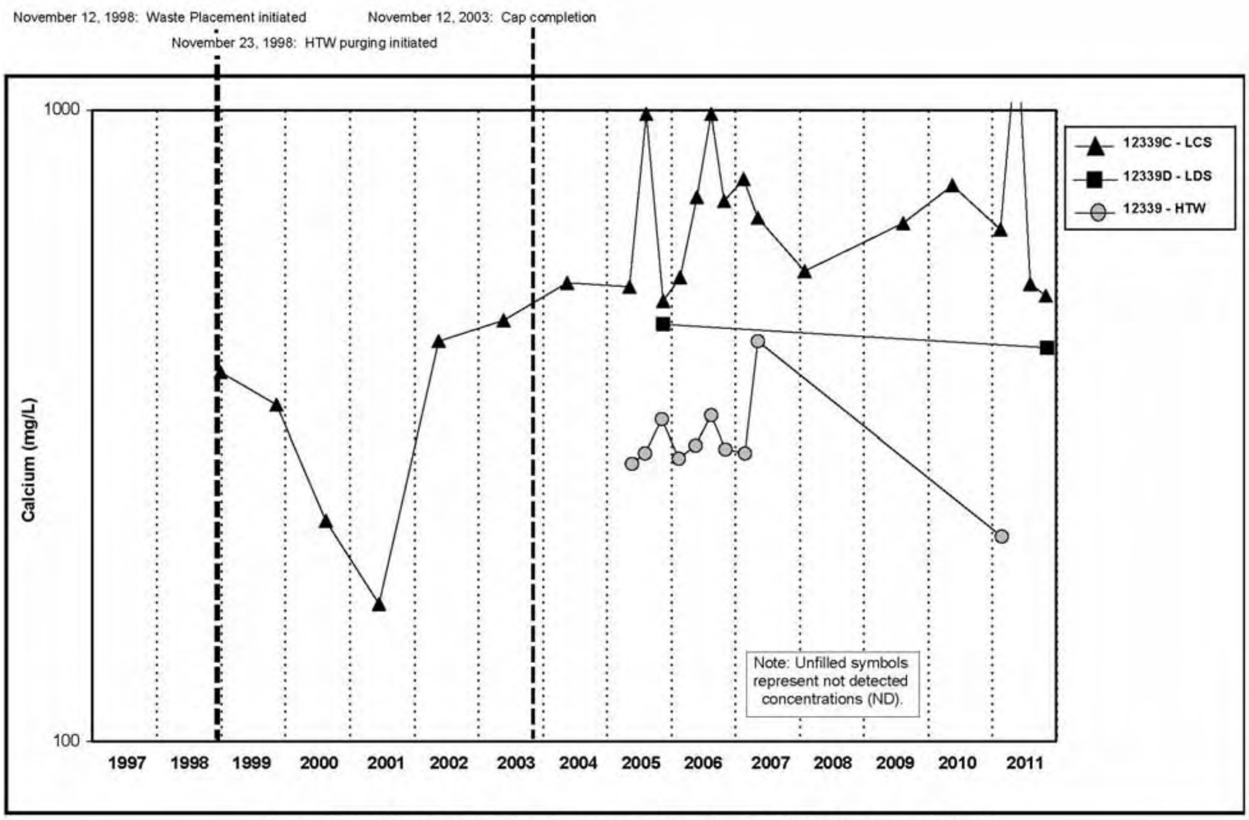


Figure A.5.2-18A. Cell 2 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

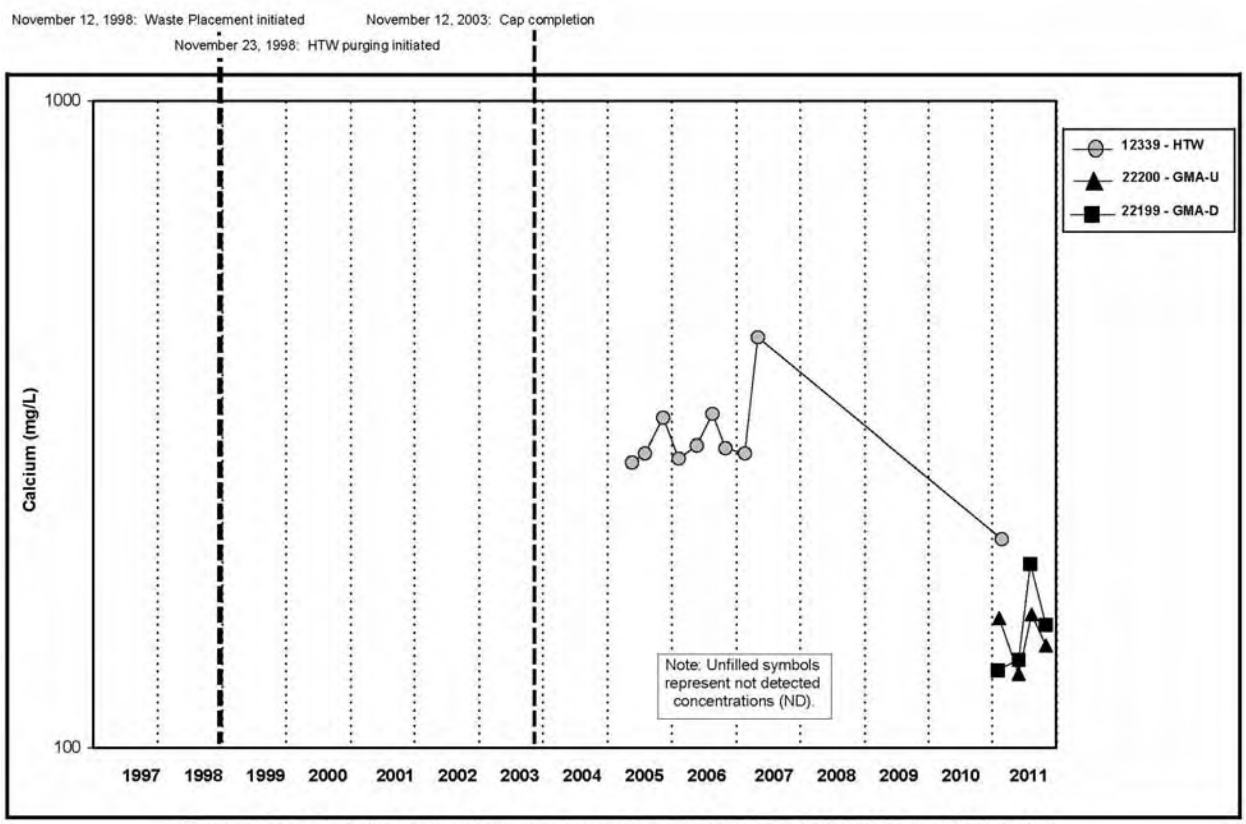


Figure A.5.2-18B. Cell 2 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

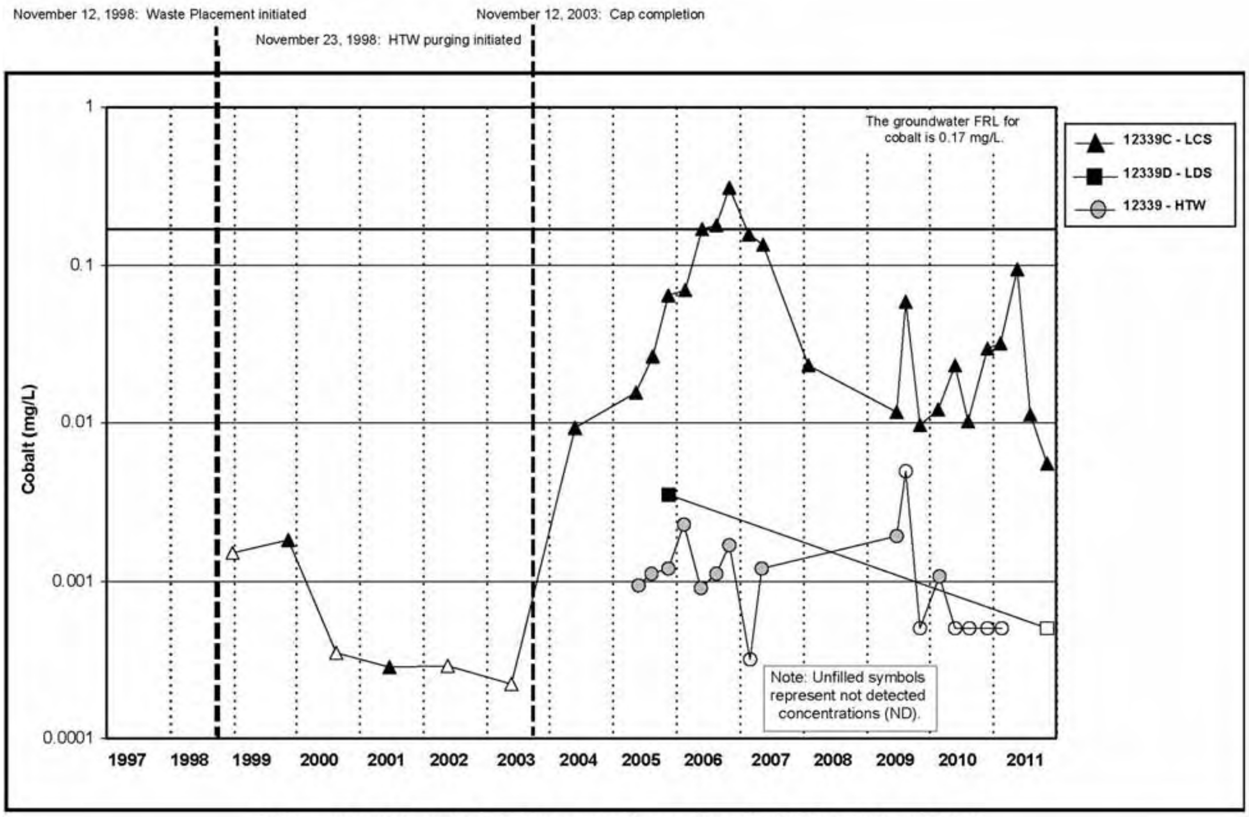


Figure A.5.2-19A. Cell 2 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

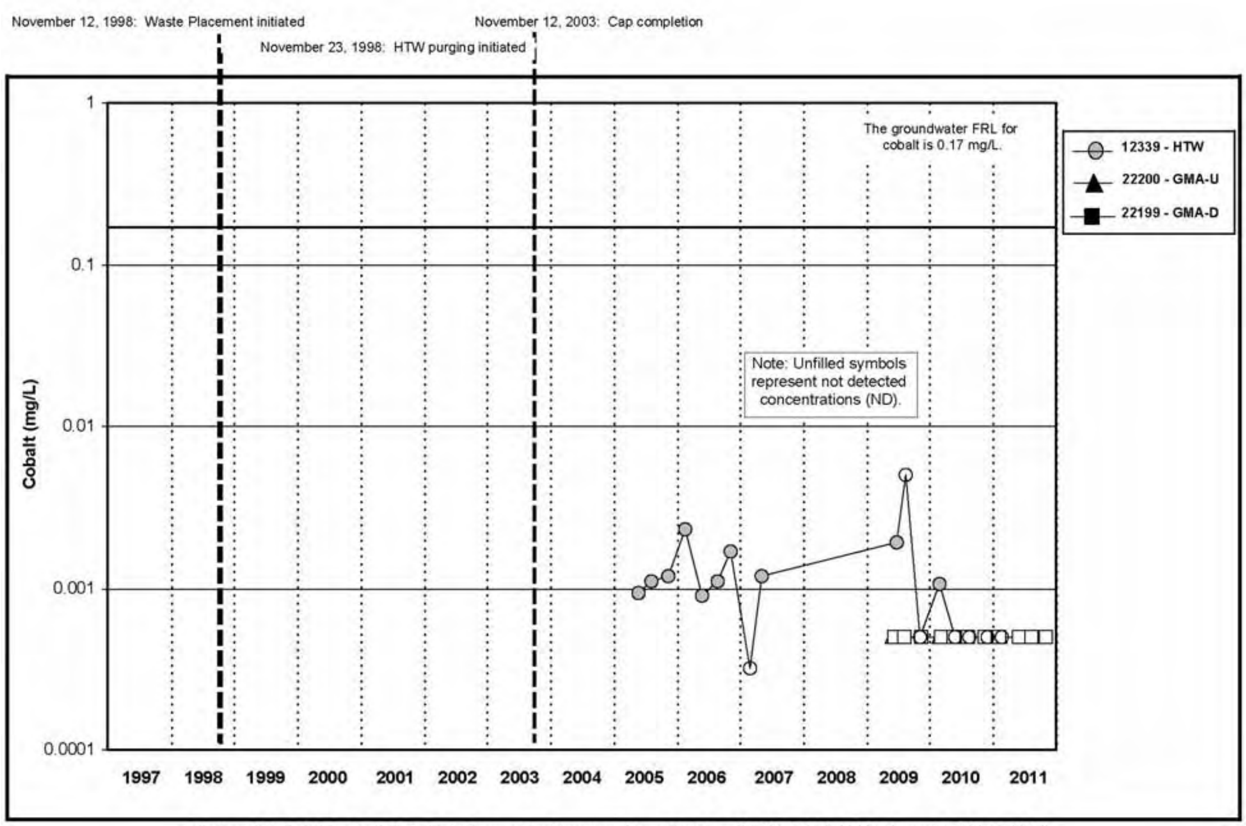


Figure A.5.2-19B. Cell 2 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

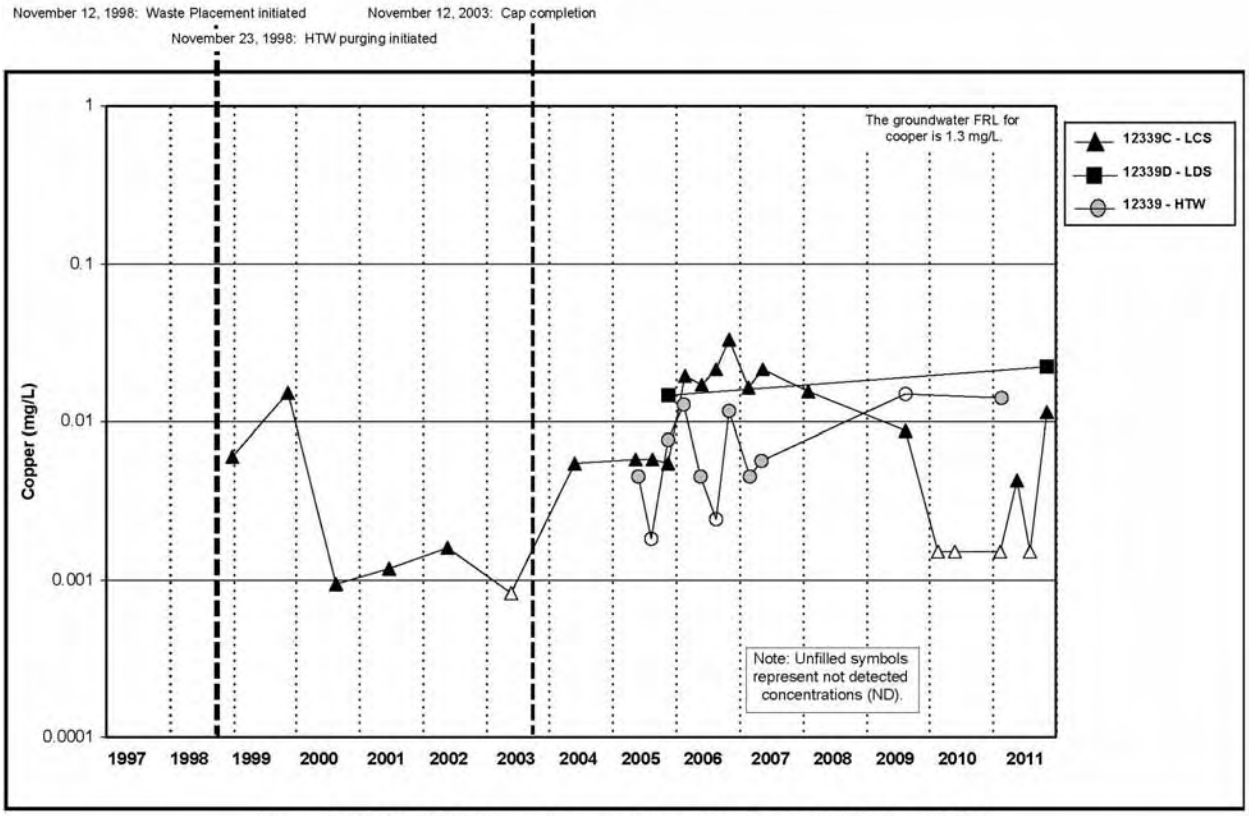


Figure A.5.2-20A. Cell 2 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

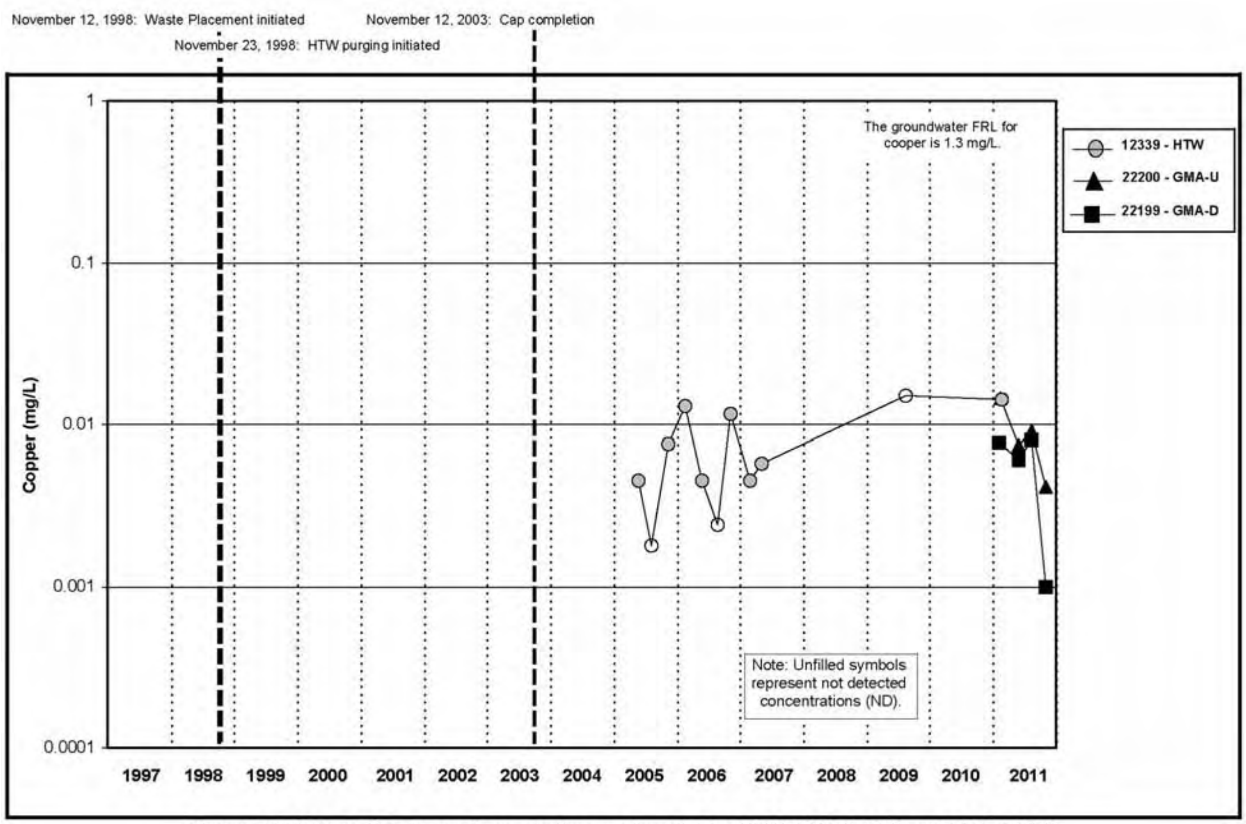


Figure A.5.2-20B. Cell 2 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

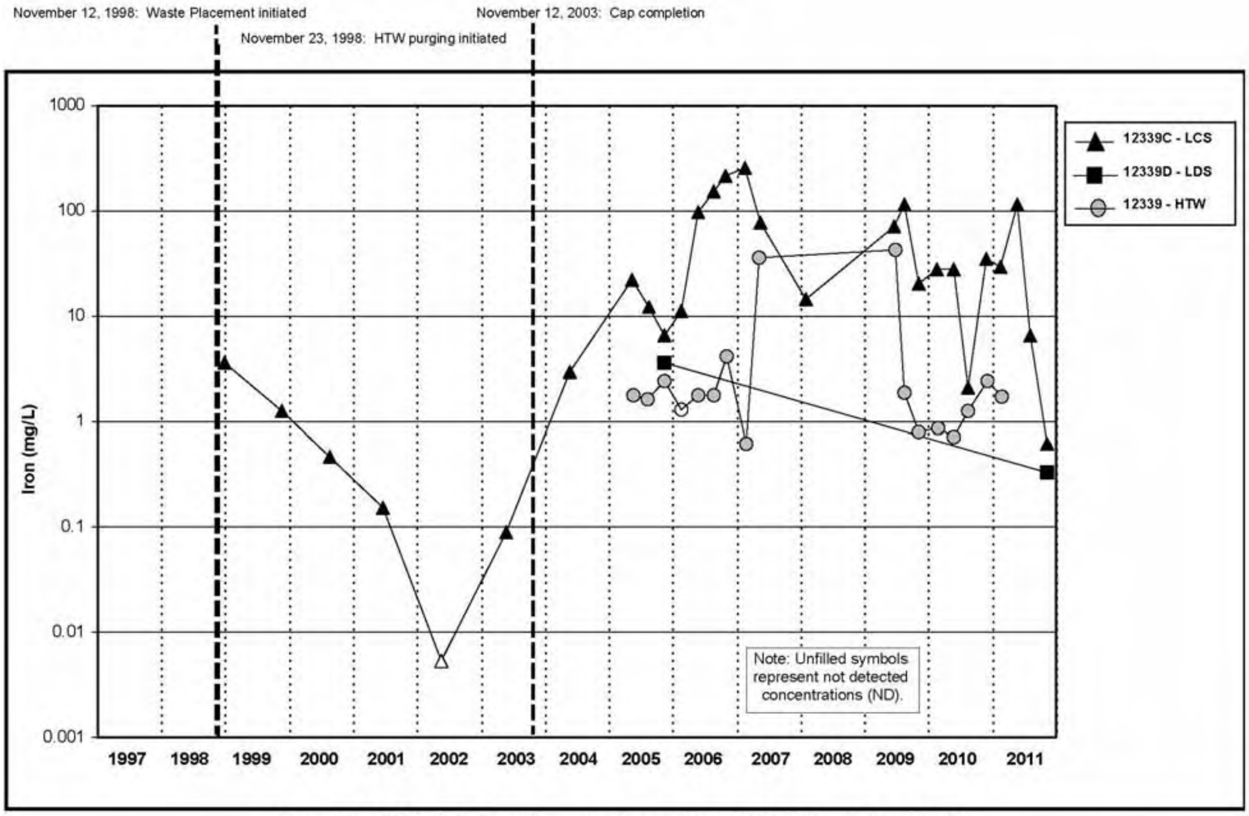


Figure A.5.2-21A. Cell 2 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

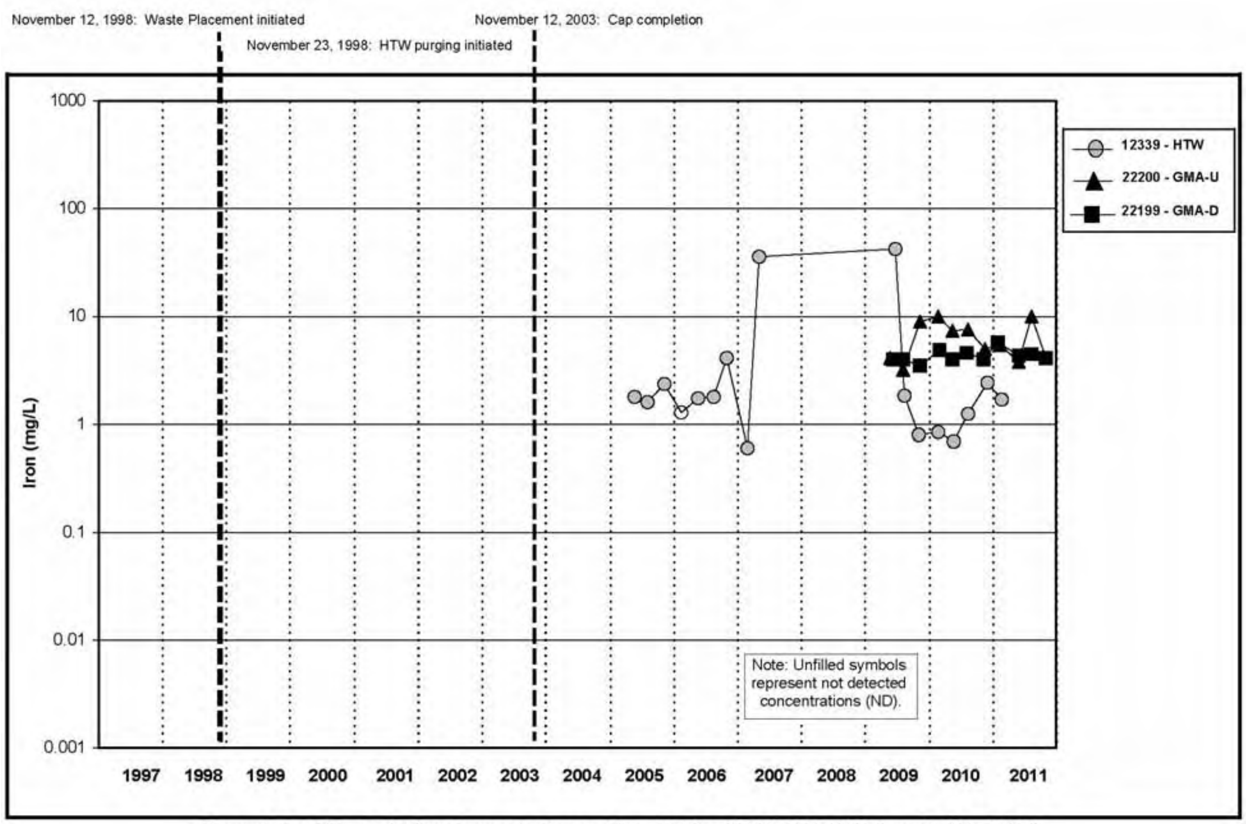


Figure A.5.2-21B. Cell 2 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

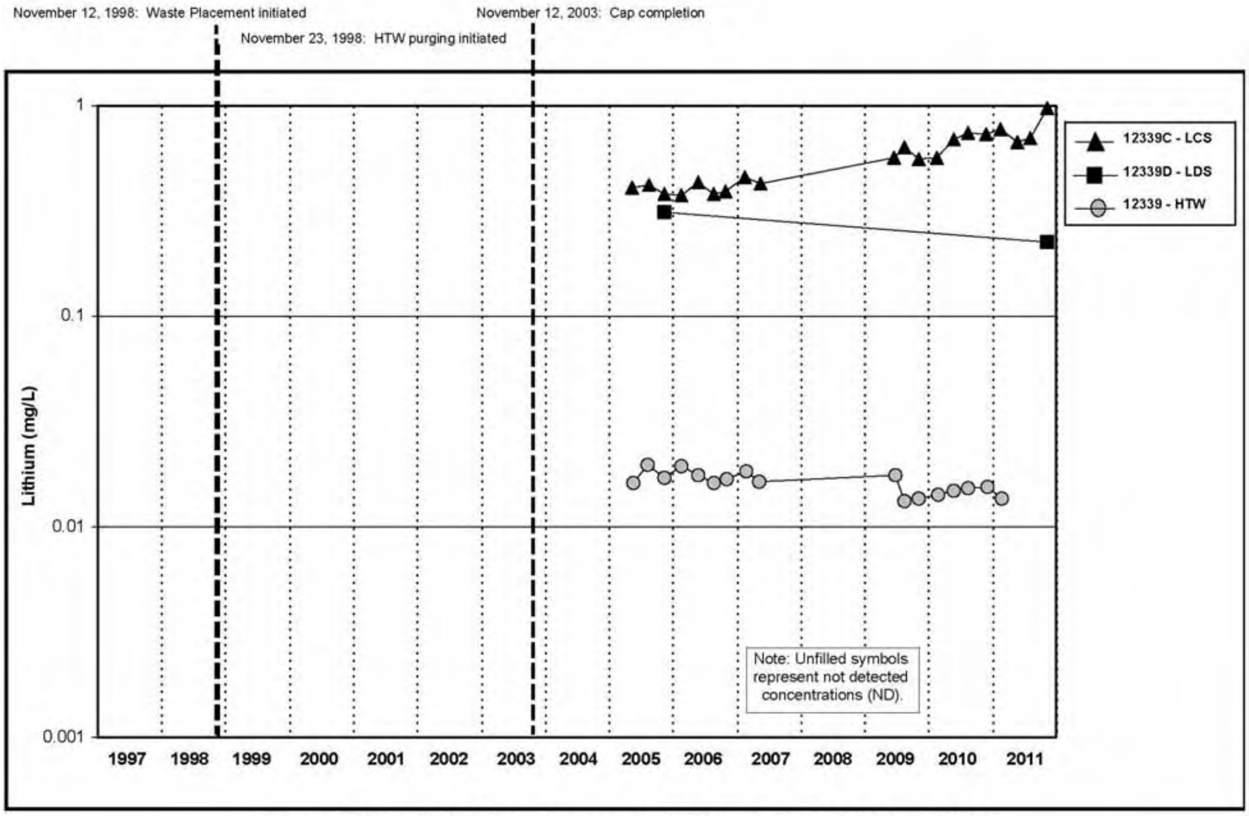


Figure A.5.2-22A. Cell 2 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

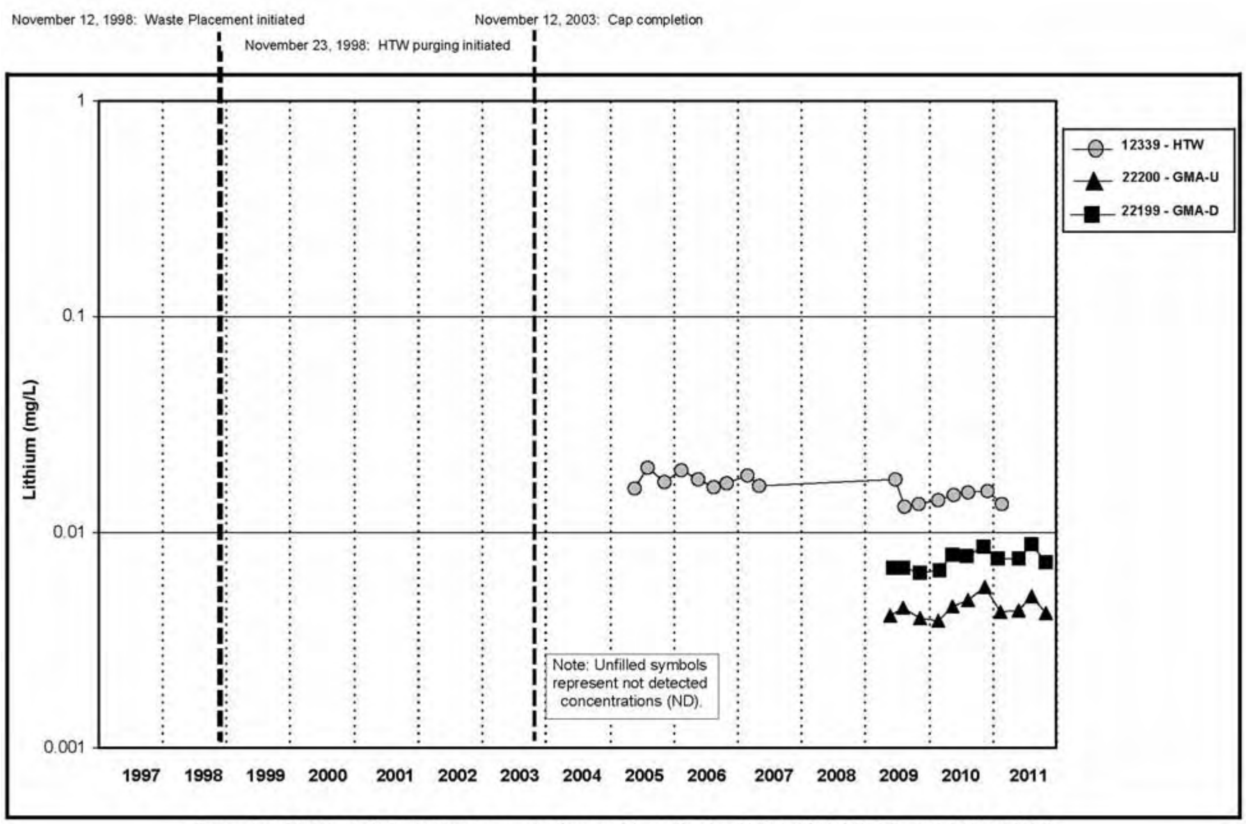


Figure A.5.2-22B. Cell 2 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

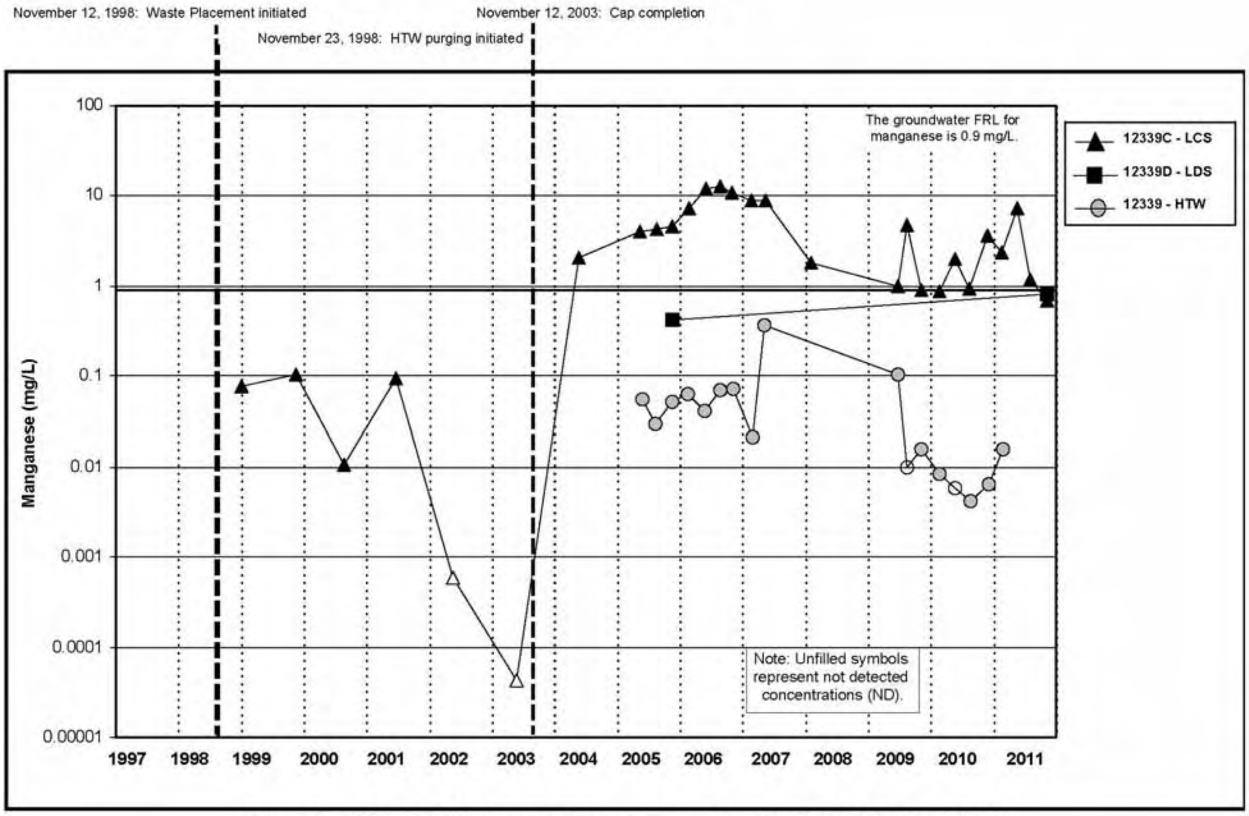


Figure A.5.2-23A. Cell 2 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

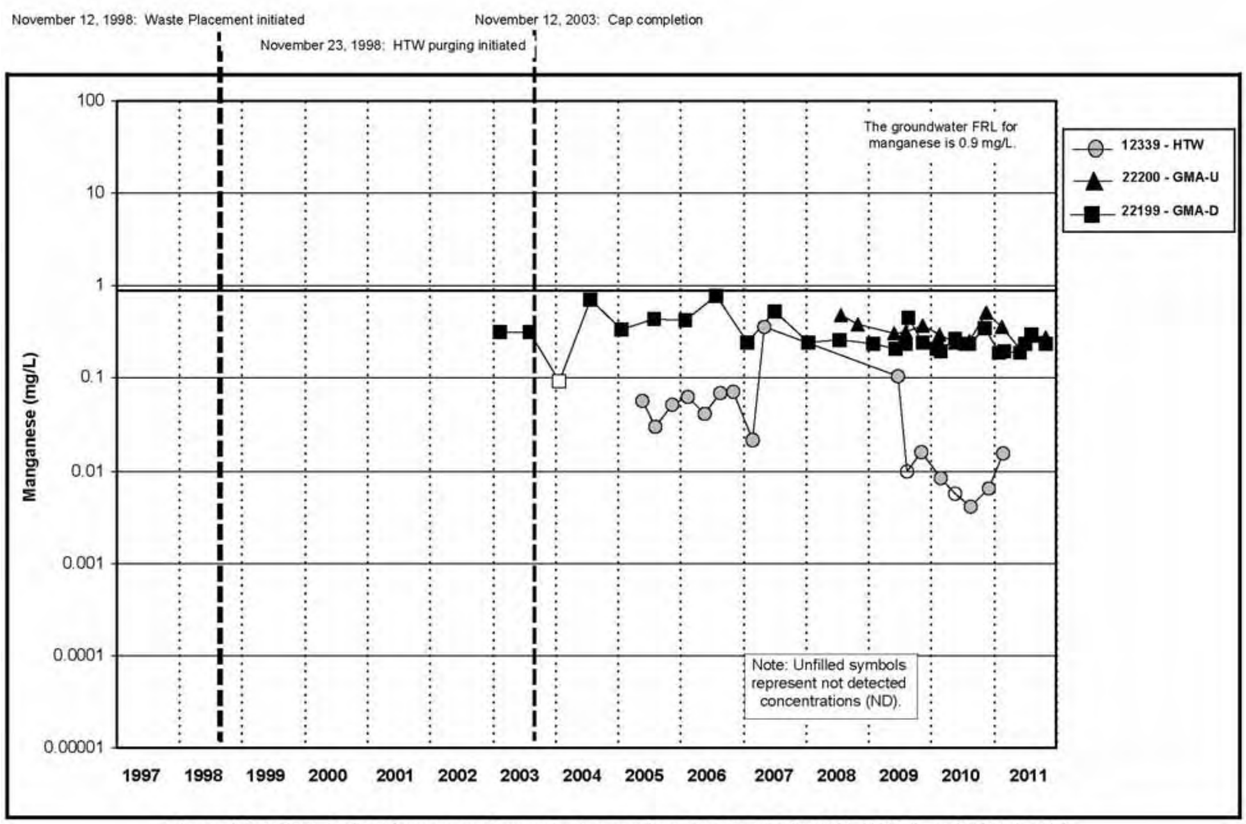


Figure A.5.2-23B. Cell 2 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

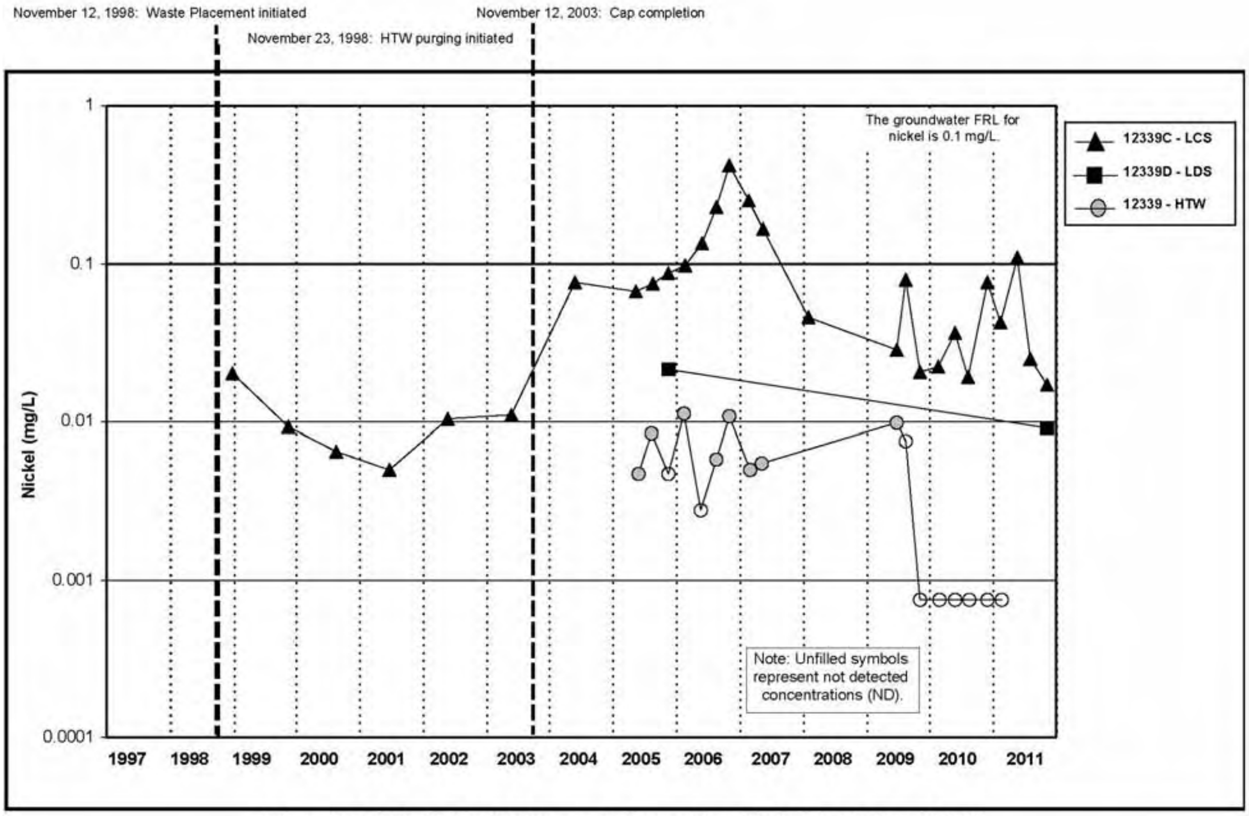


Figure A.5.2-24A. Cell 2 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

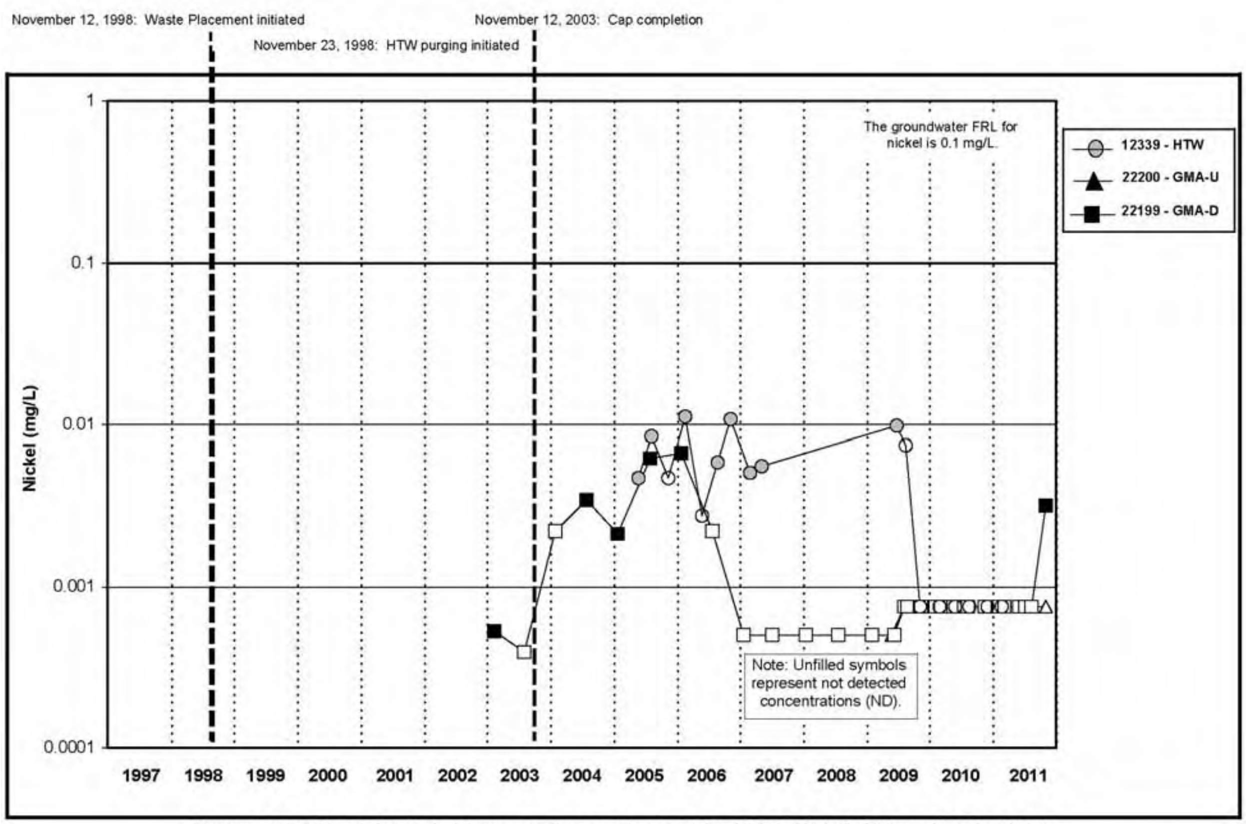


Figure A.5.2-24B. Cell 2 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

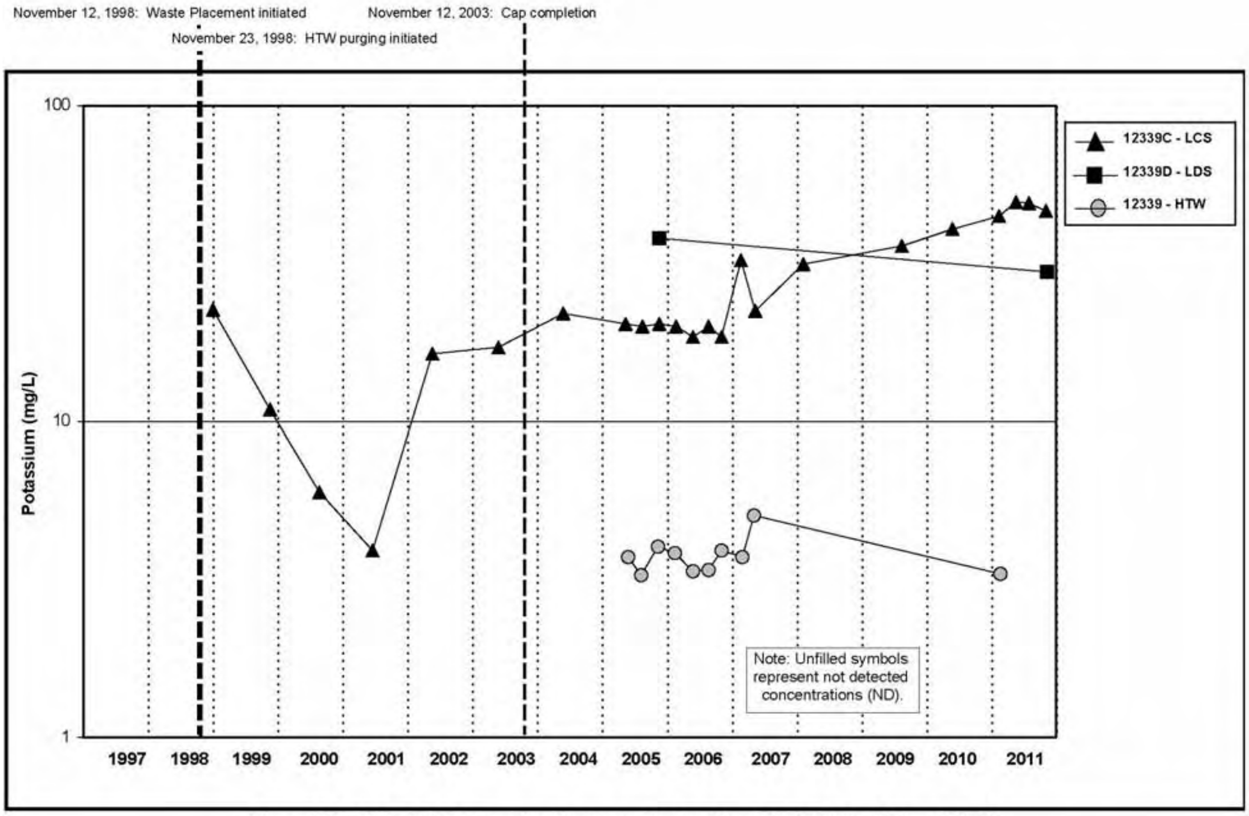


Figure A.5.2-25A. Cell 2 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

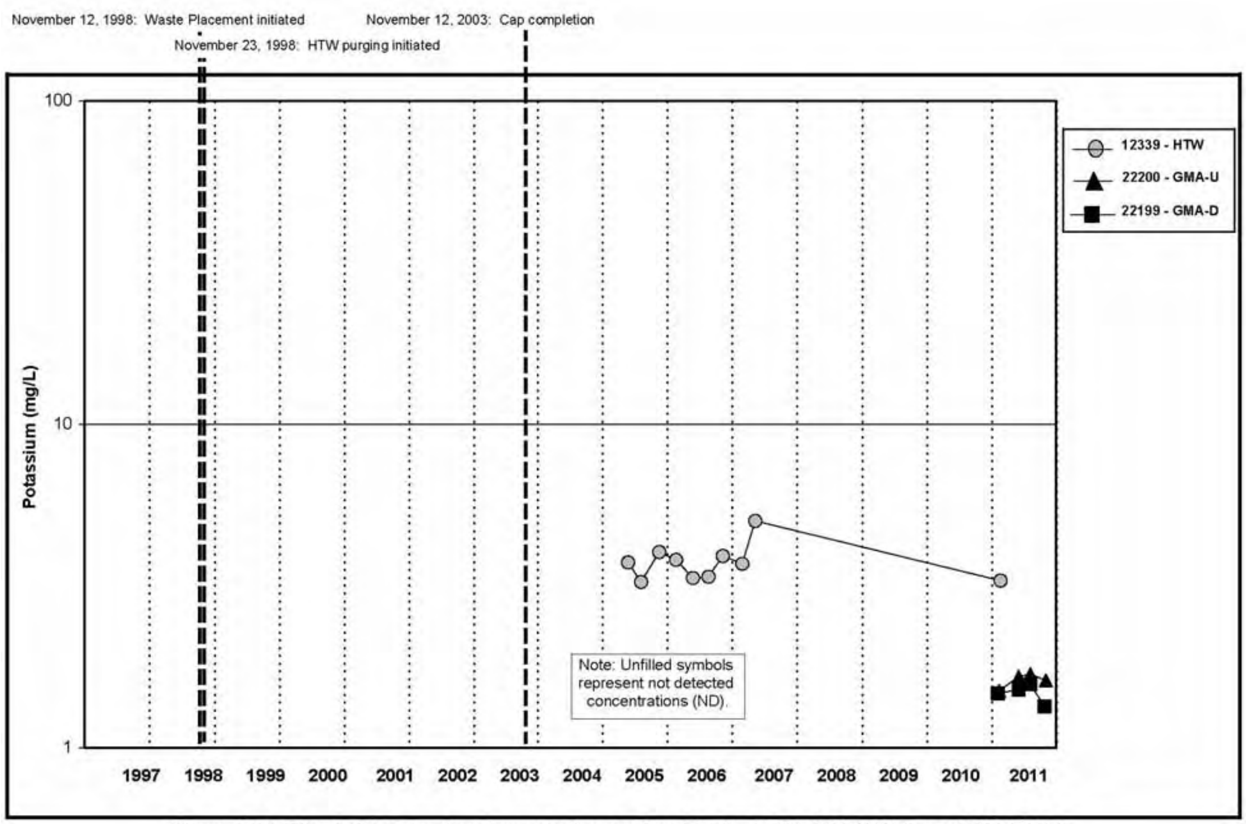


Figure A.5.2-25B. Cell 2 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

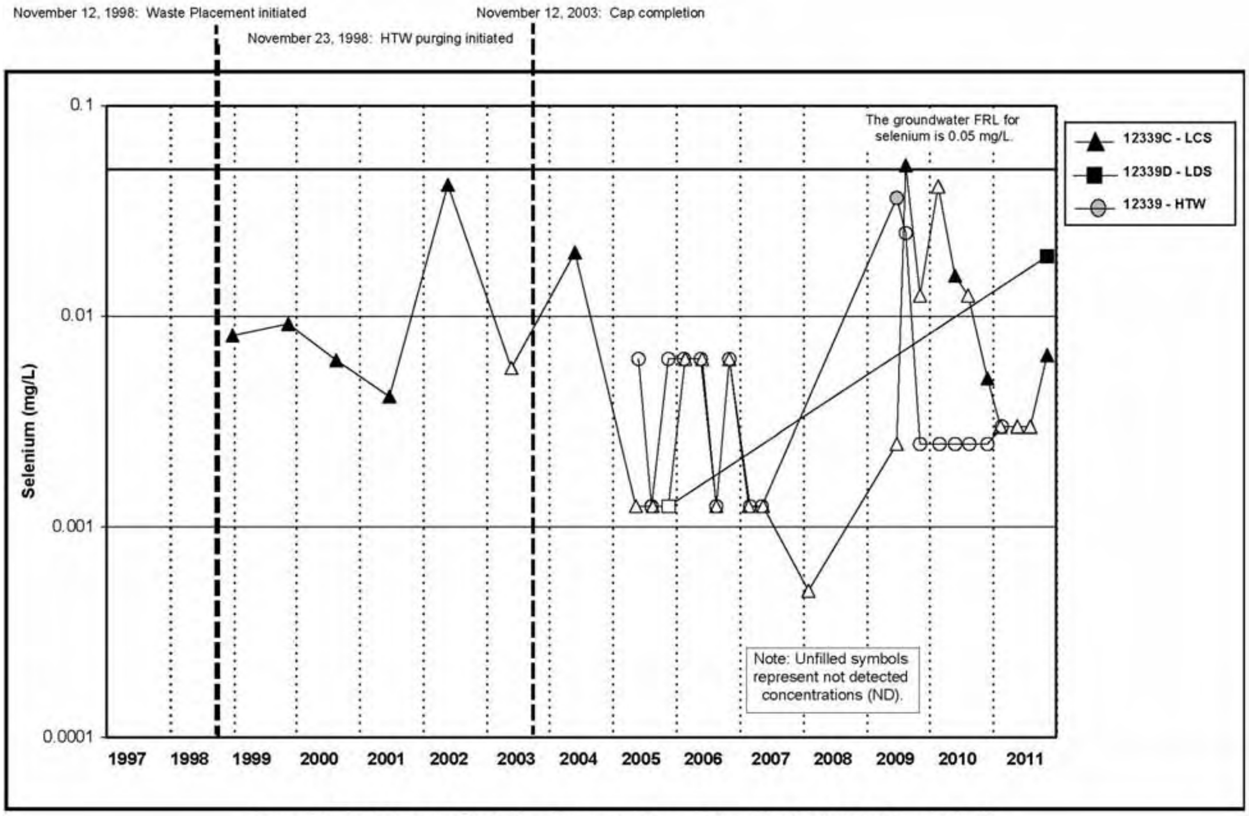


Figure A.5.2-26A. Cell 2 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

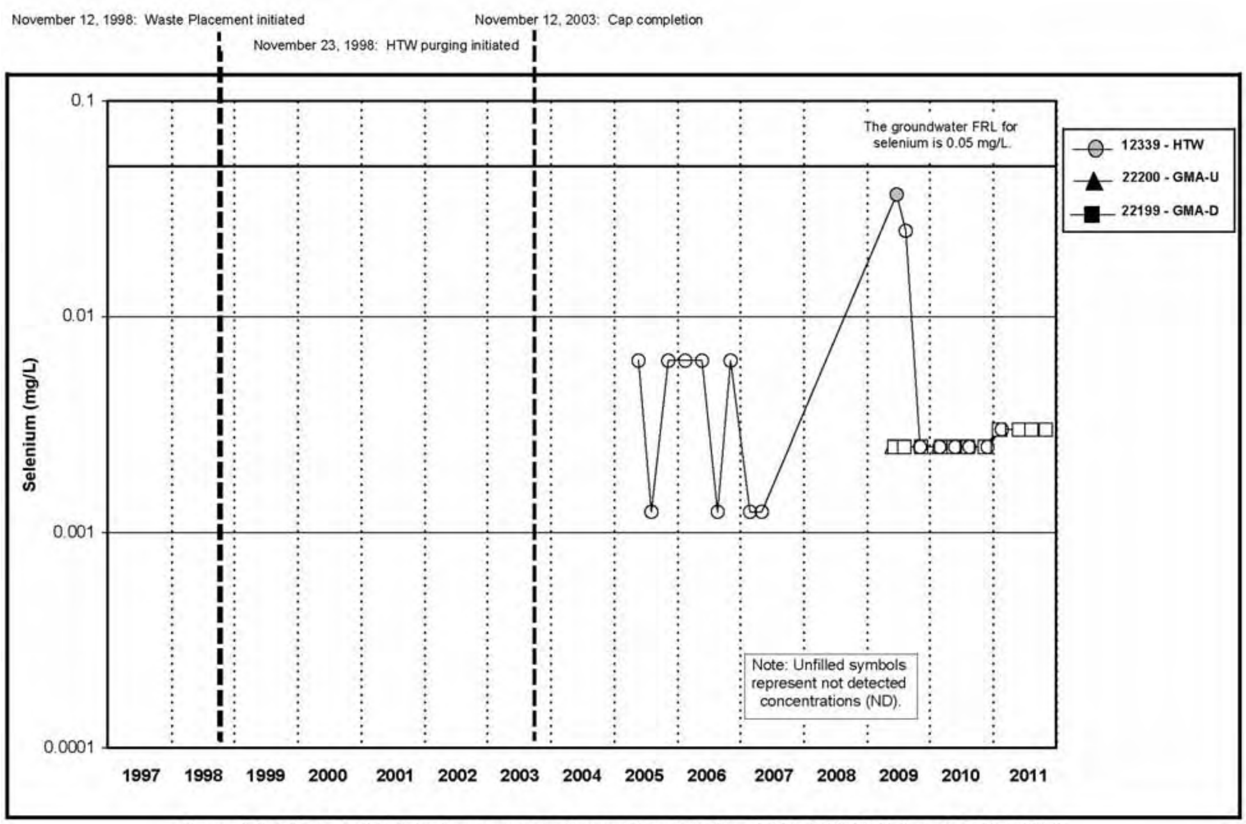


Figure A.5.2-26B. Cell 2 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

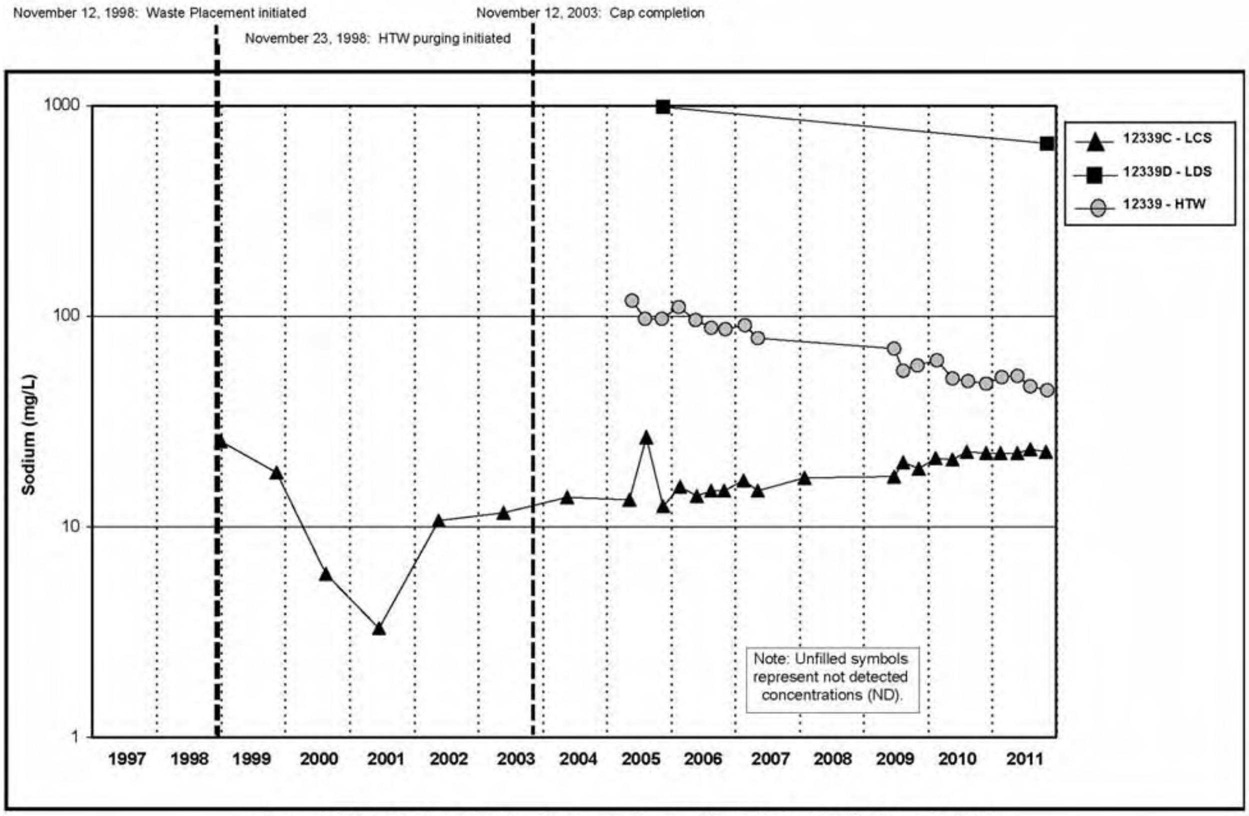


Figure A.5.2-27A. Cell 2 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

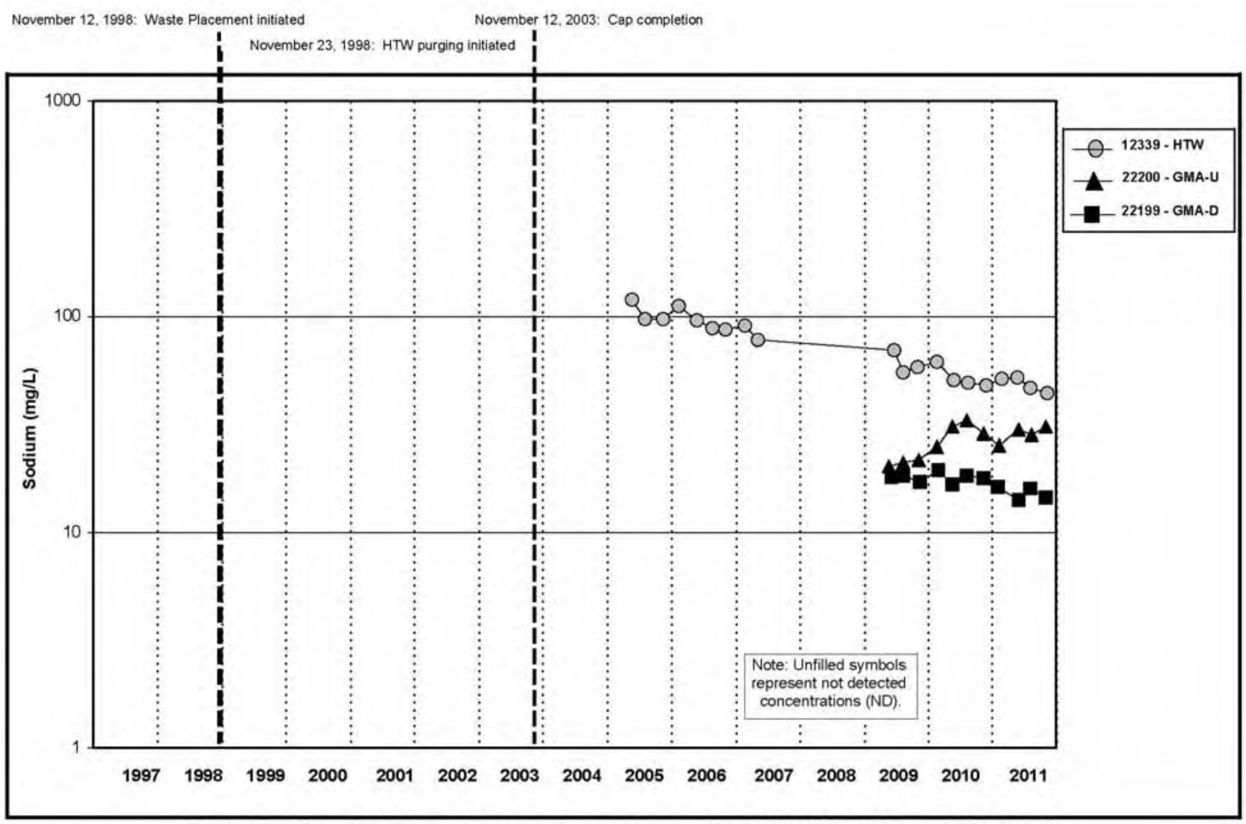


Figure A.5.2-27B. Cell 2 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

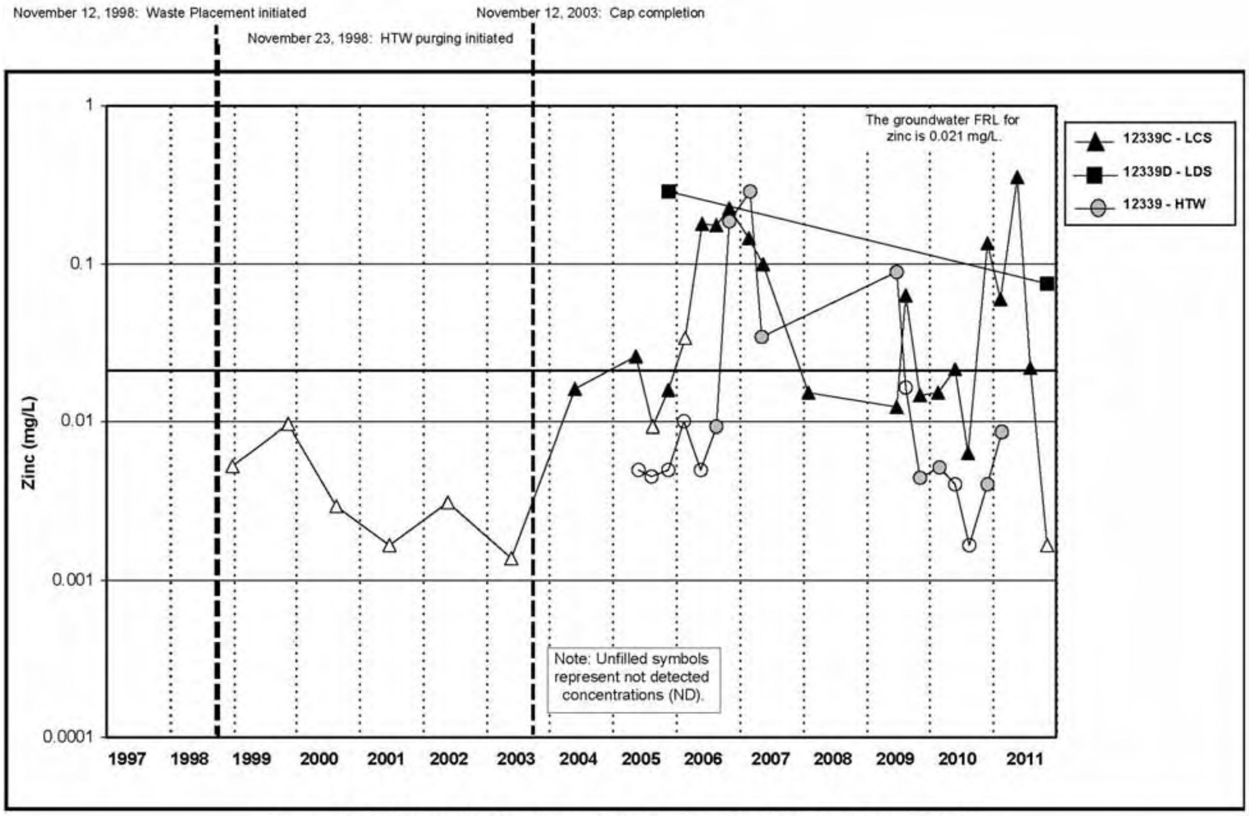


Figure A.5.2-28A. Cell 2 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

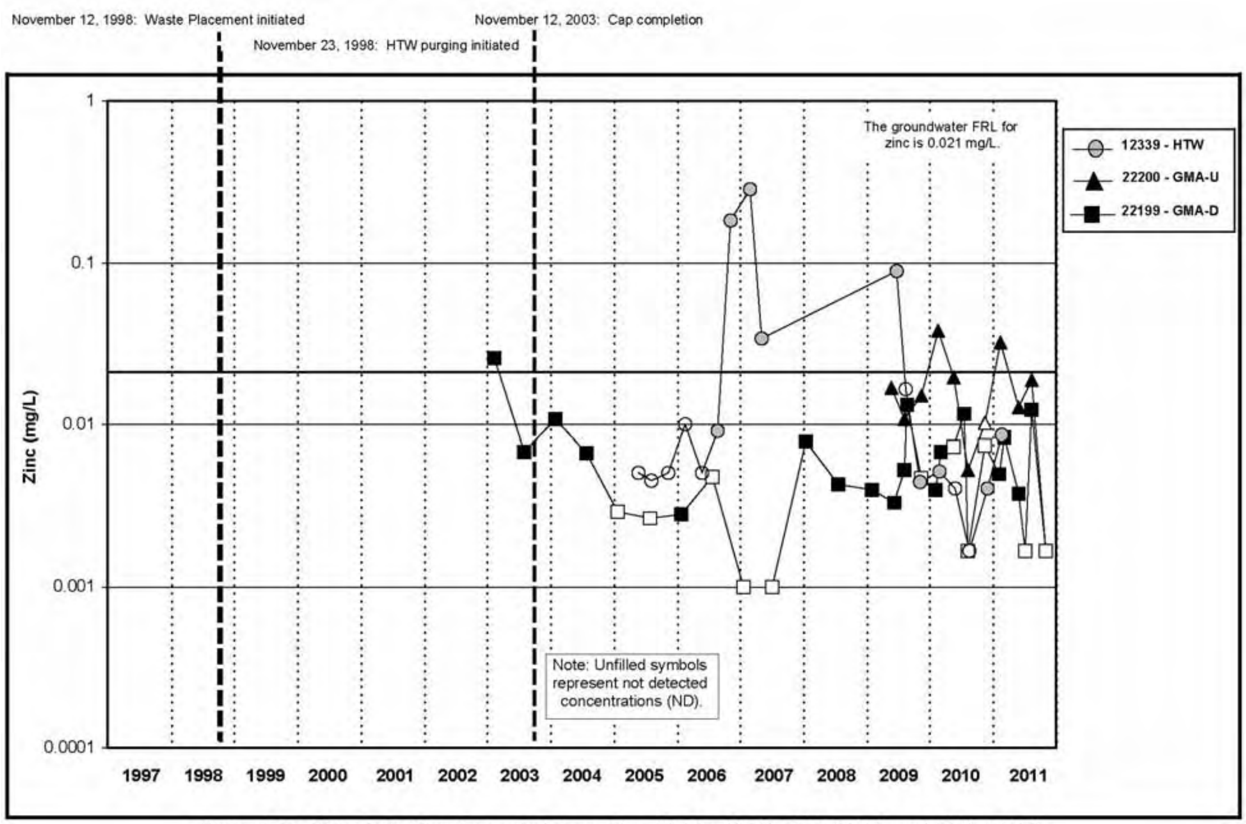


Figure A.5.2-28B. Cell 2 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

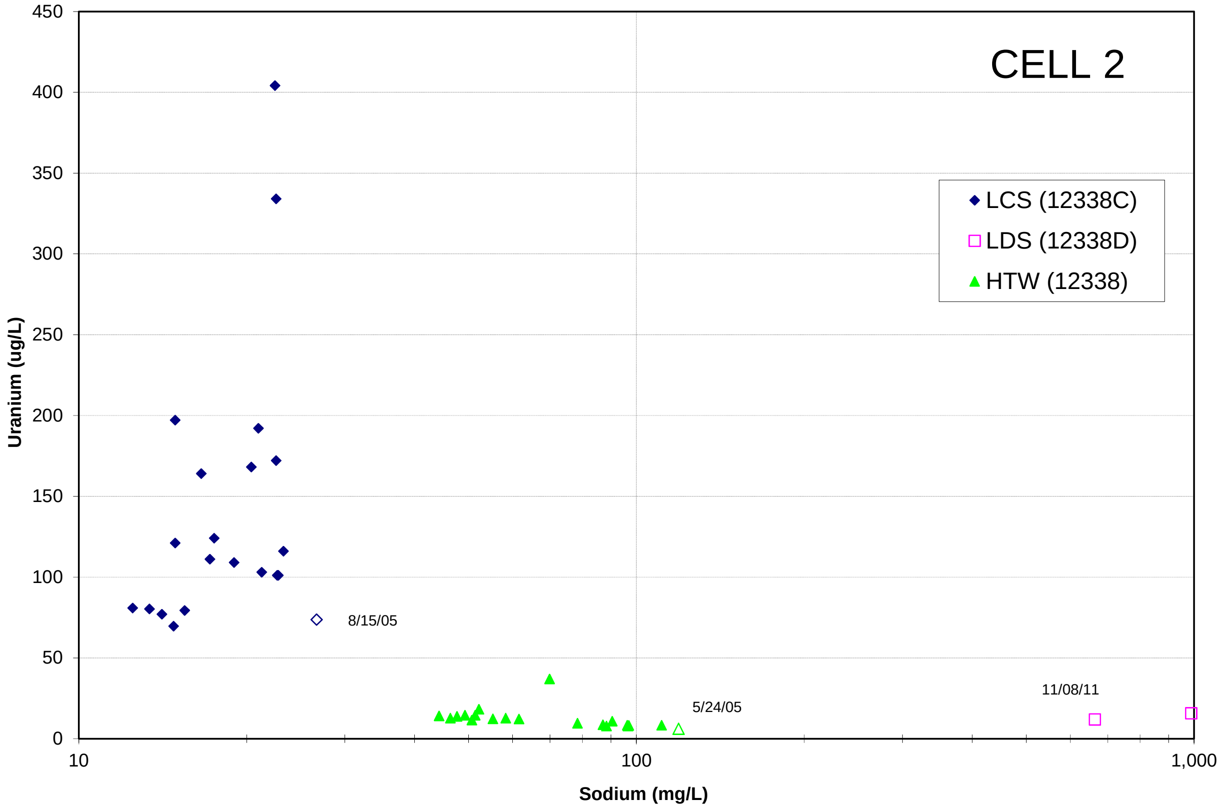


Figure A.5.2−29. Cell 2 Bivariate Plot for Uranium and Sodium

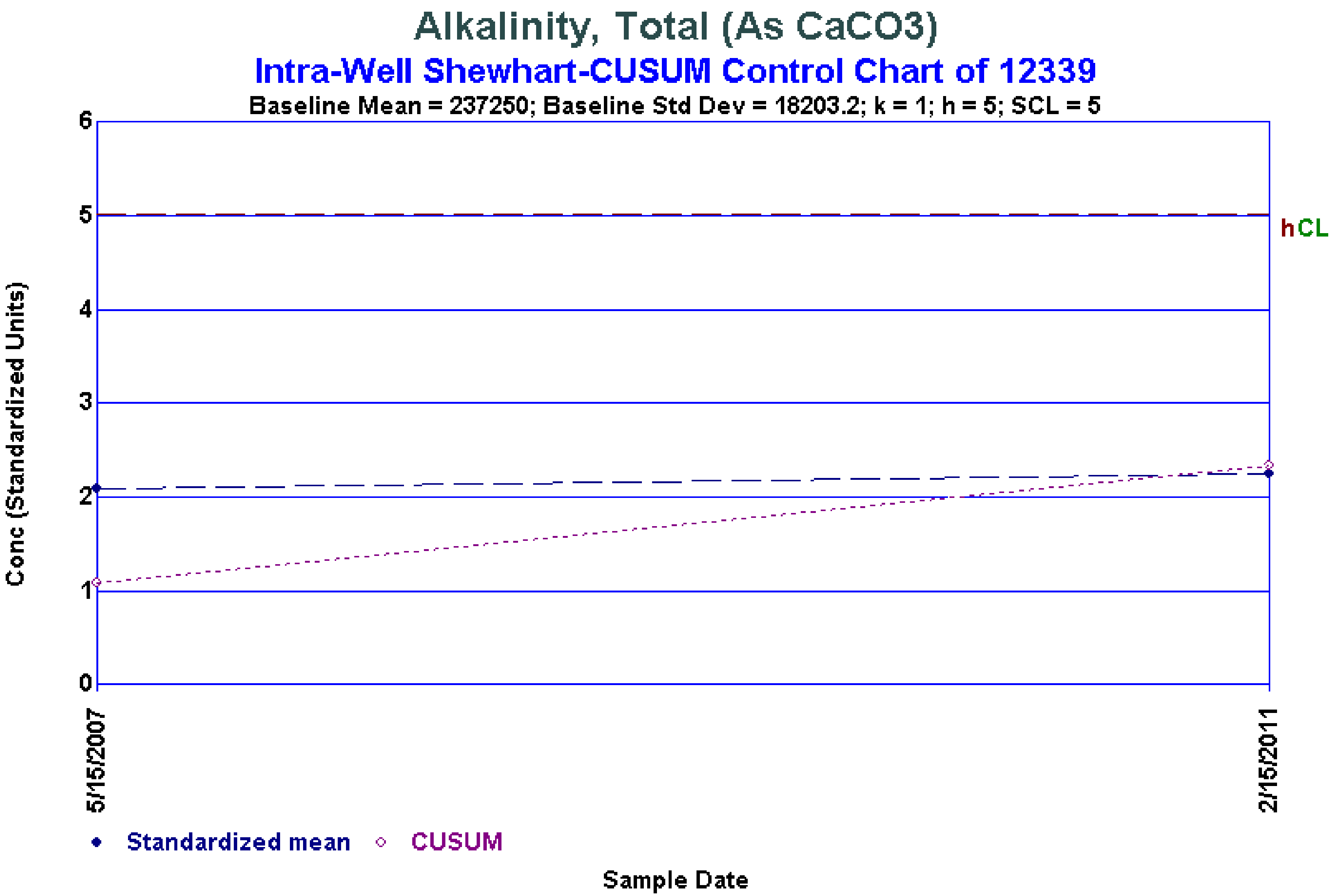


Figure A.5.2−30. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 12339)

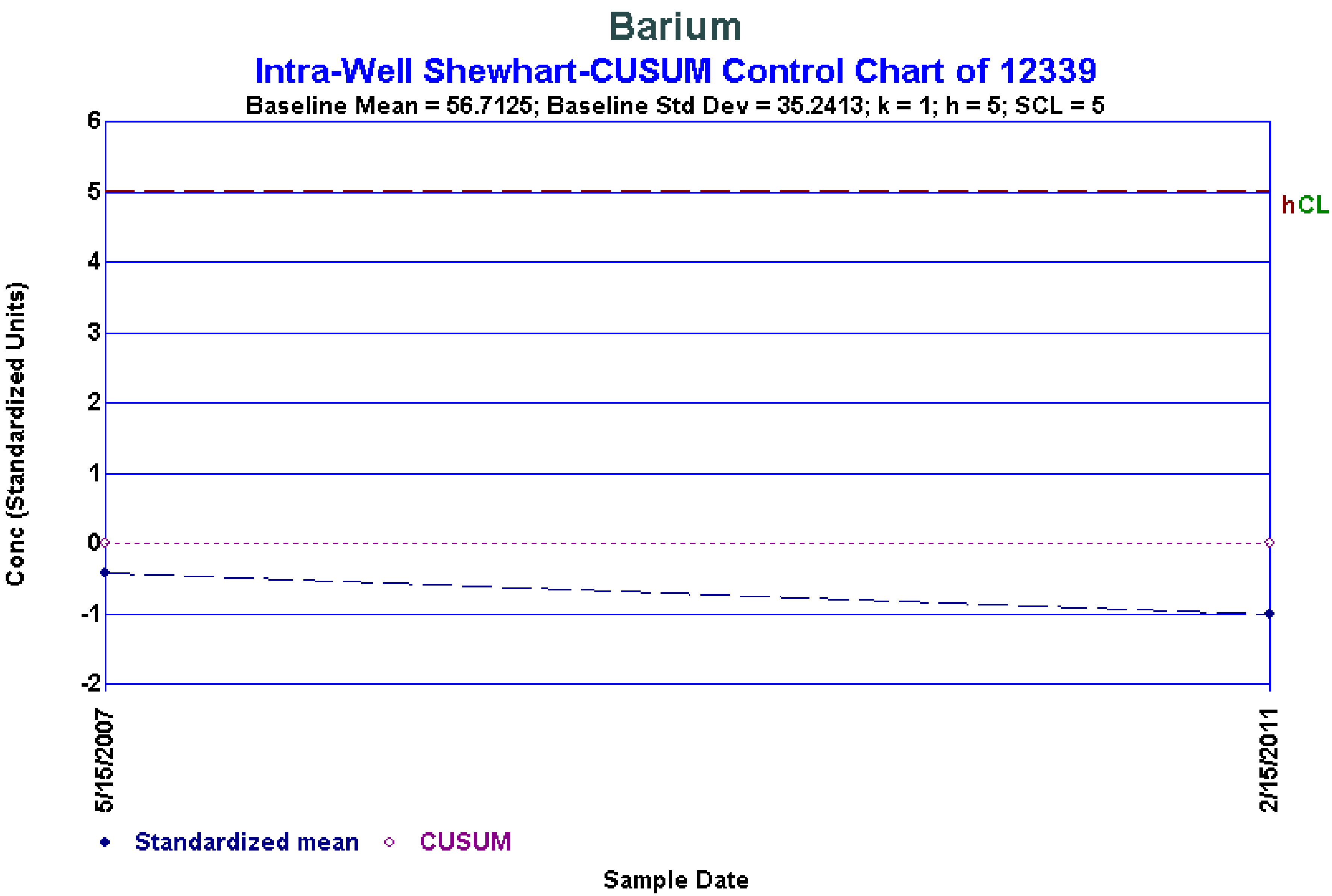


Figure A.5.2−31. Intra-Well Shewhart-CUSUM Control Chart (Barium 12339)

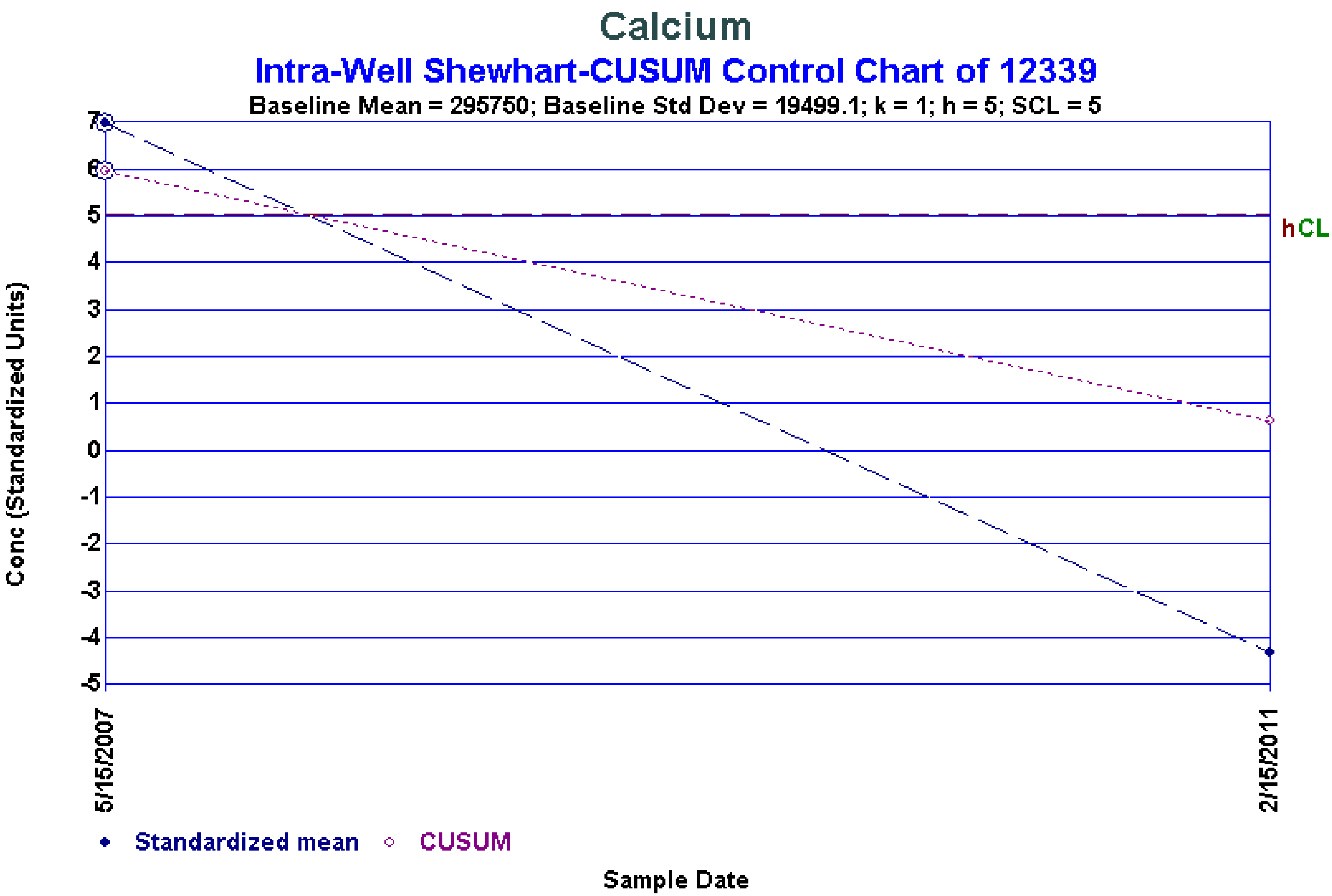


Figure A.5.2−32. Intra-Well Shewhart-CUSUM Control Chart (Calcium 12339)

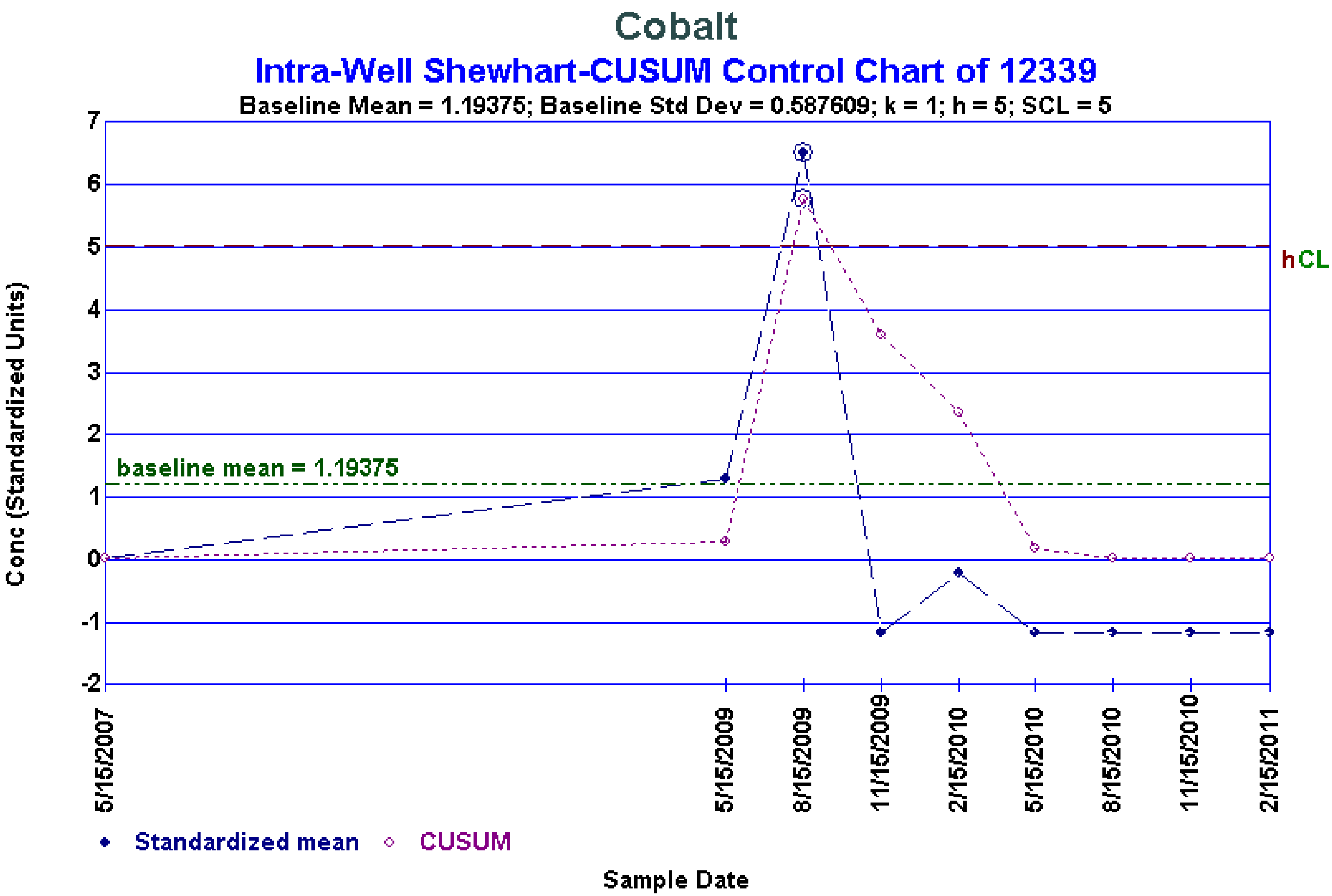


Figure A.5.2−33. Intra-Well Shewhart-CUSUM Control Chart (Cobalt 12339)

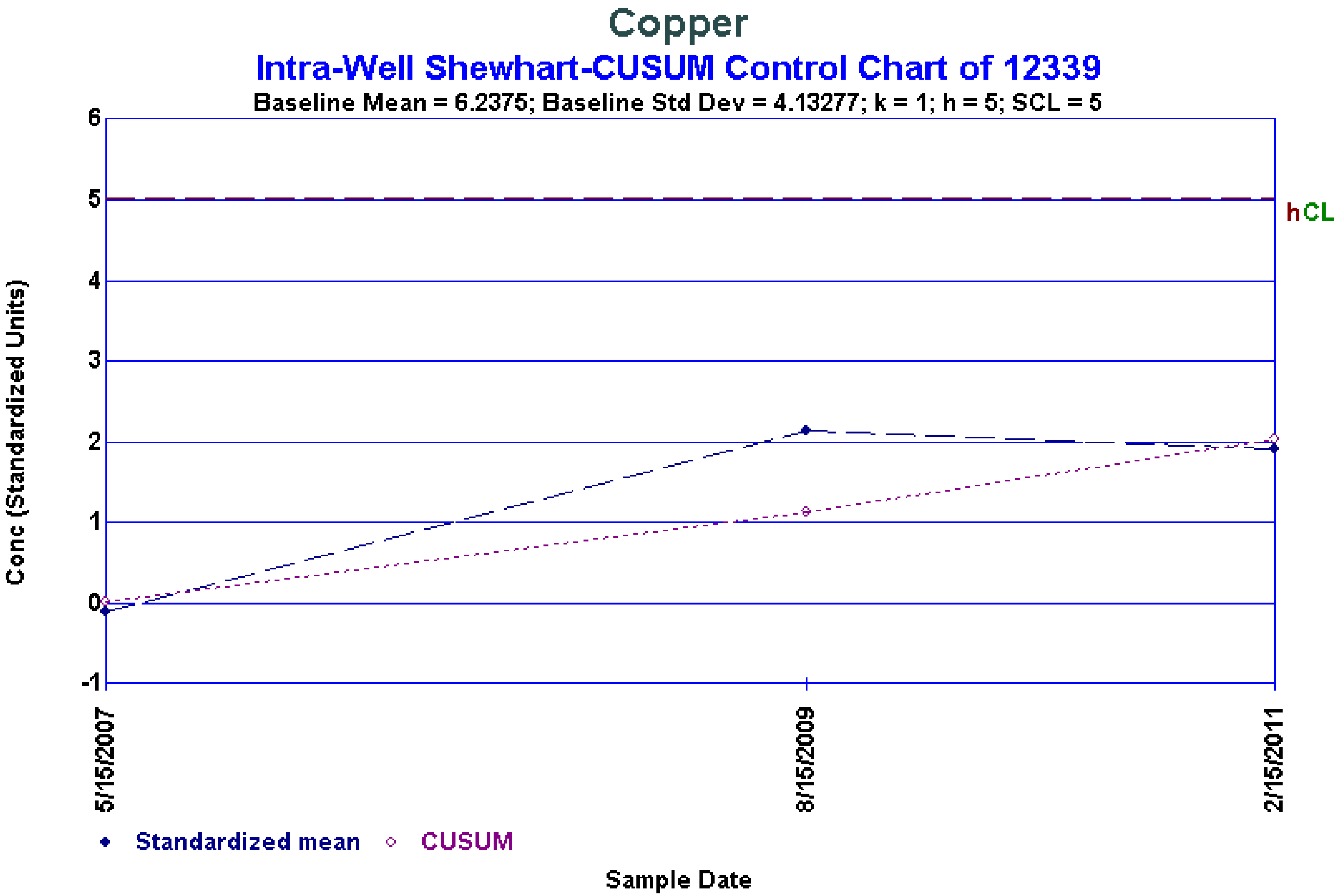


Figure A.5.2−34. Intra-Well Shewhart-CUSUM Control Chart (Copper 12339)

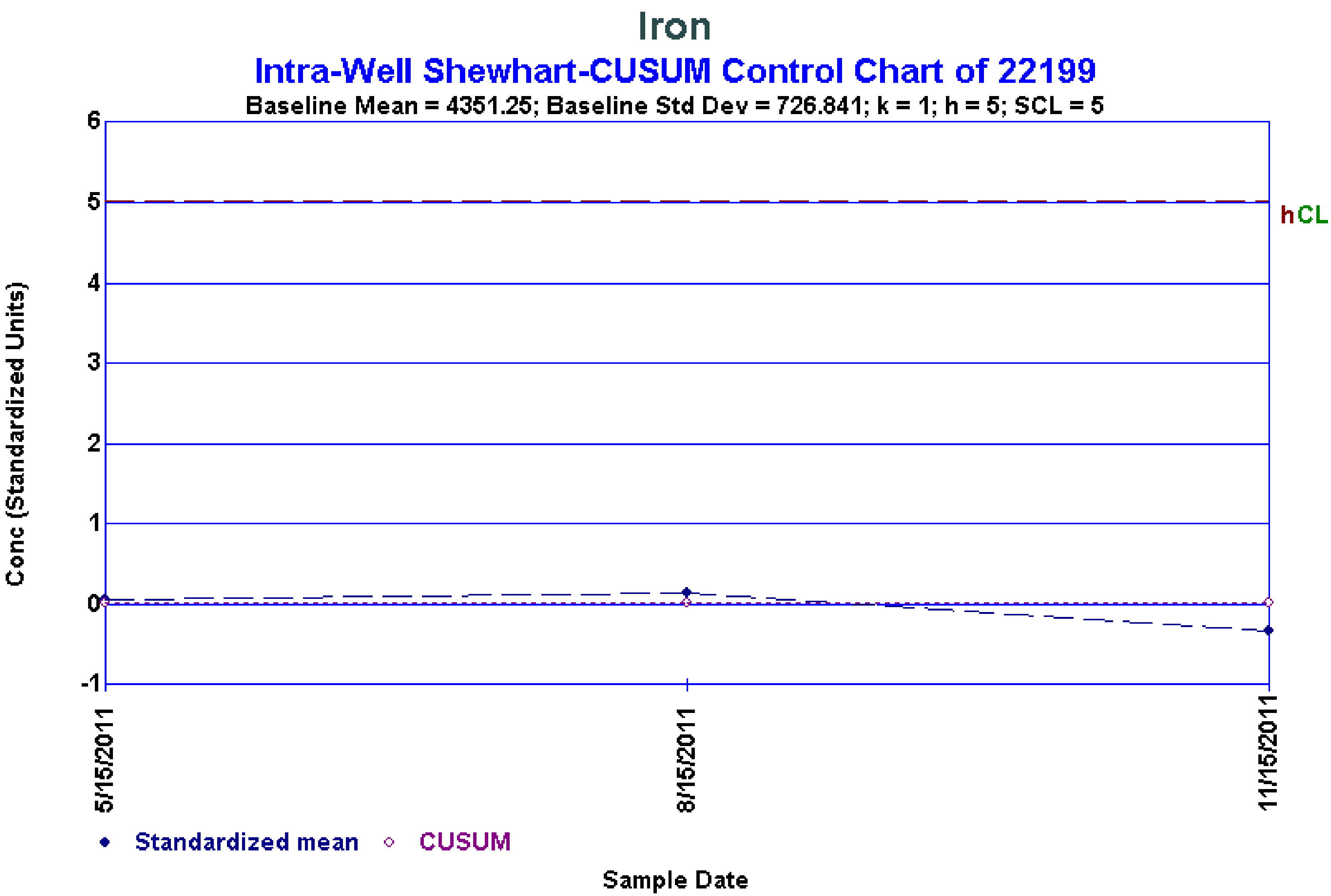


Figure A.5.2−35. Intra-Well Shewhart-CUSUM Control Chart (Iron 22199)

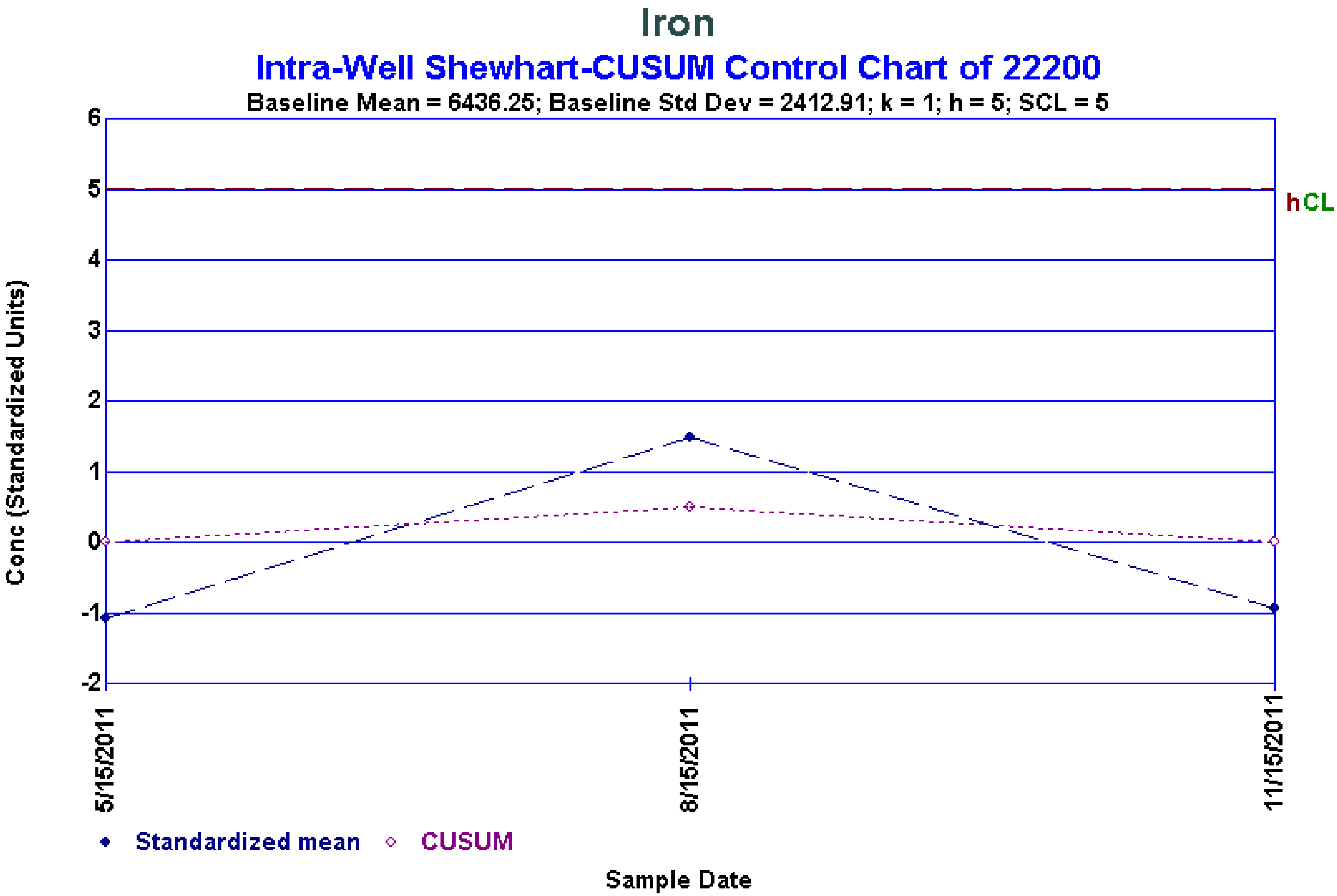


Figure A.5.2−36. Intra-Well Shewhart-CUSUM Control Chart (Iron 22200)

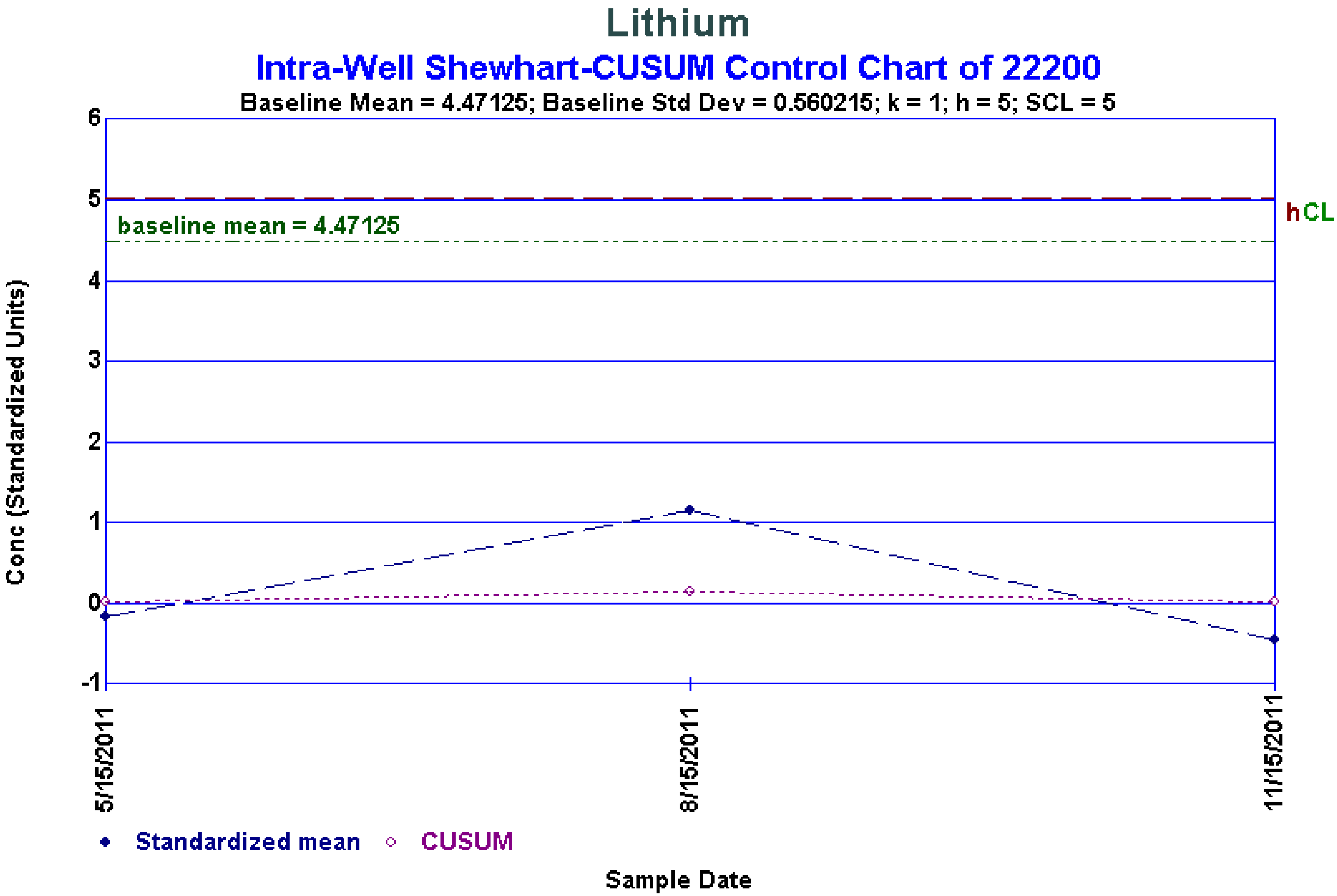


Figure A.5.2−37. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22200)

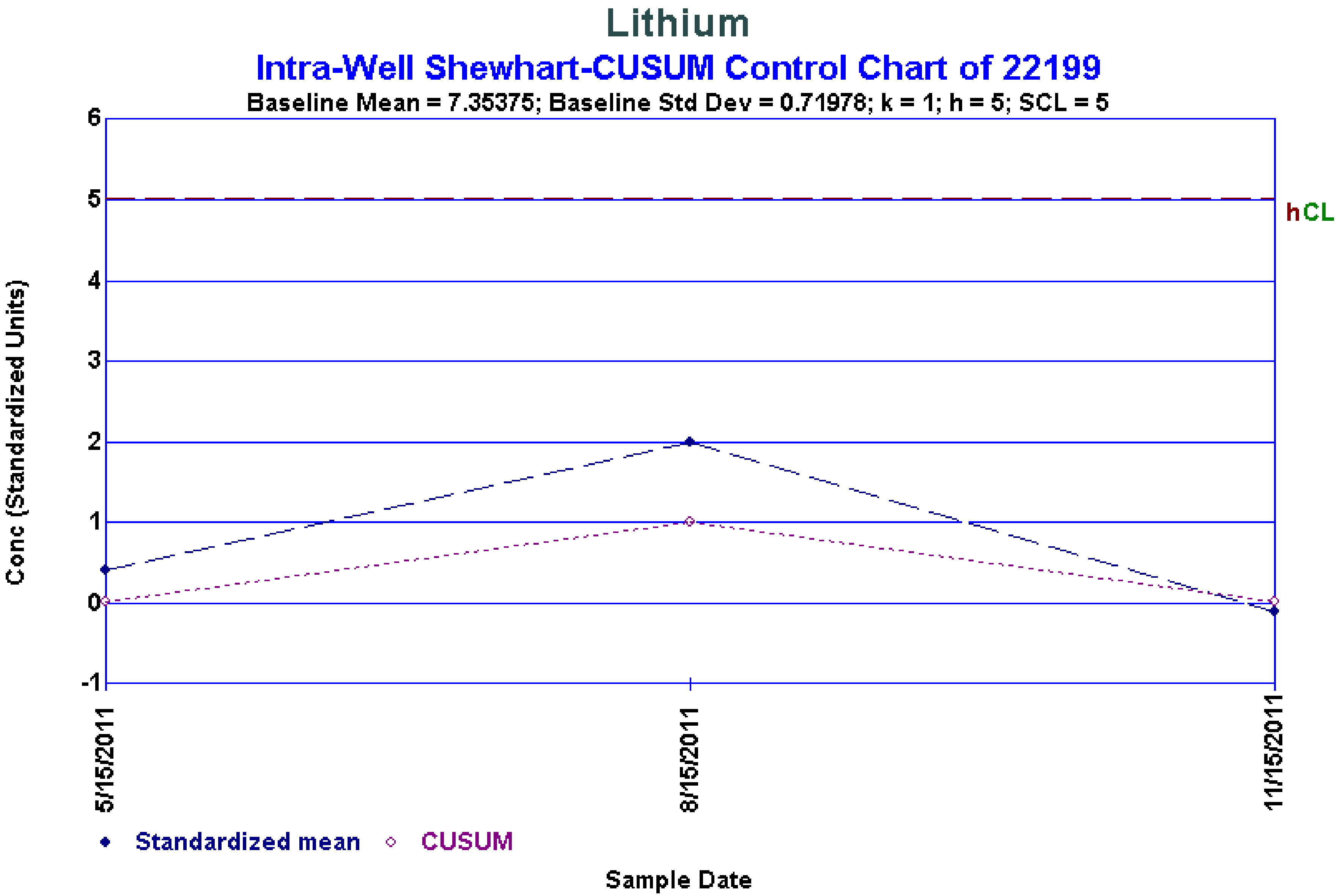


Figure A.5.2−38. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22199)

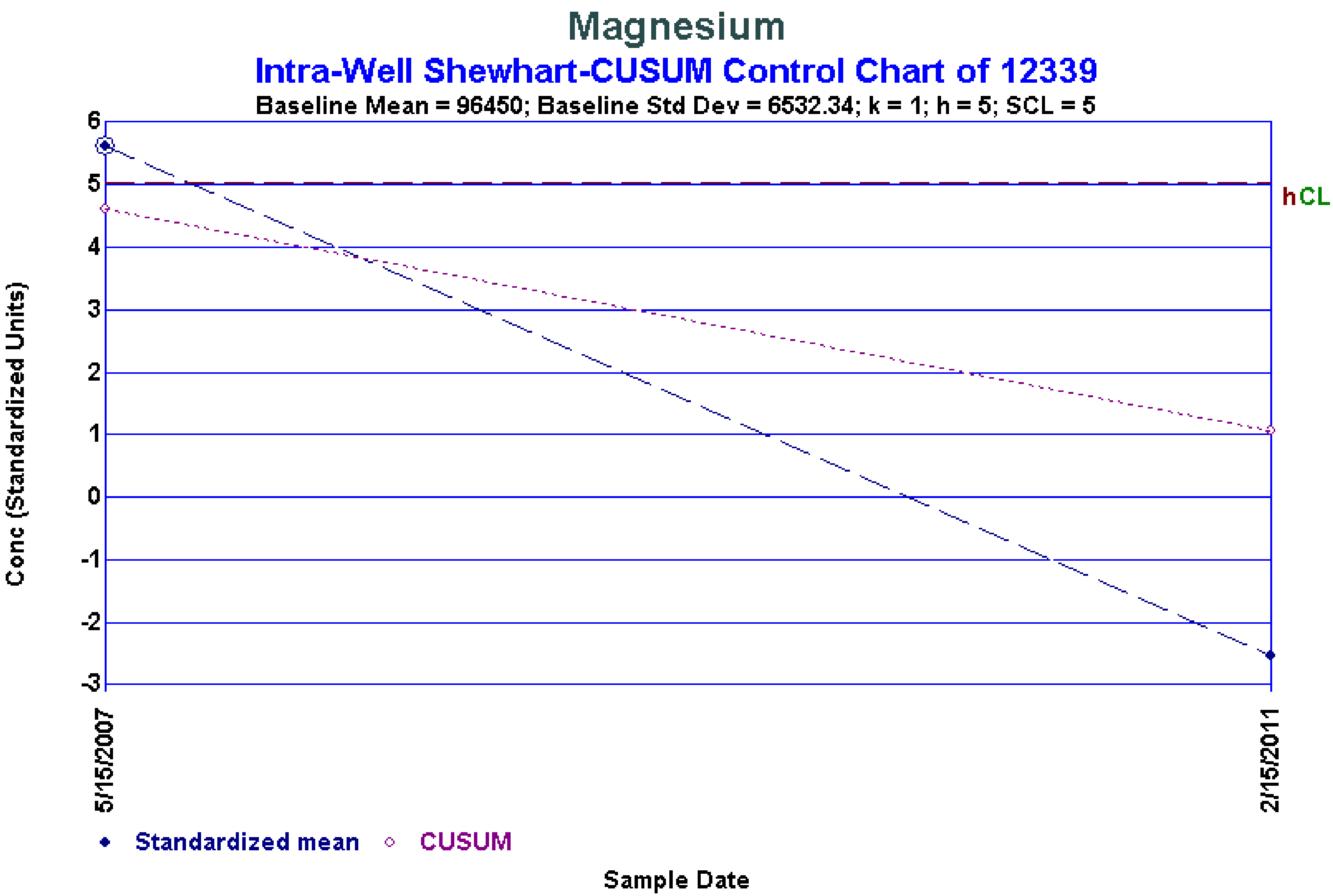


Figure A.5.2−39. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 12339)

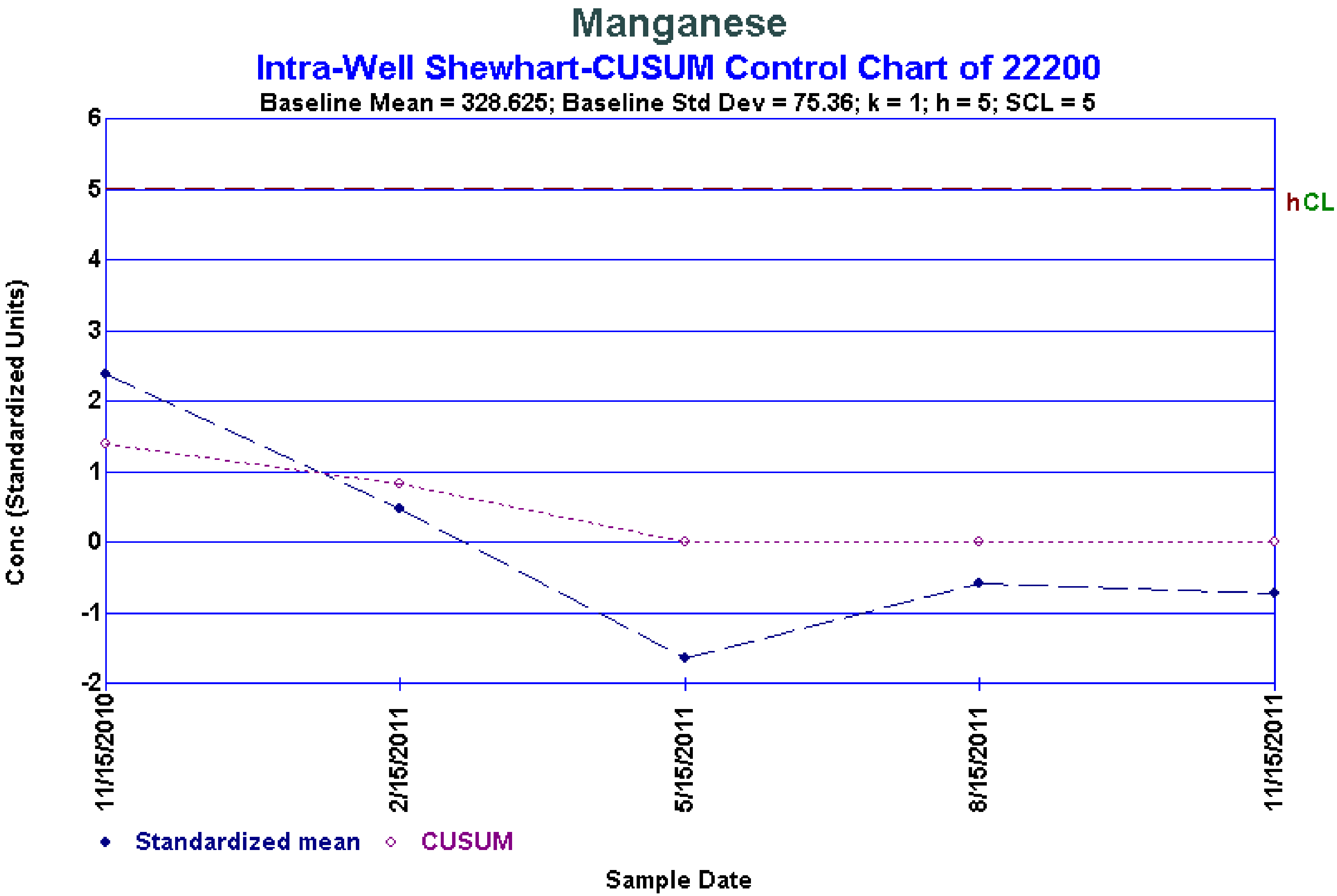


Figure A.5.2−40. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22200)

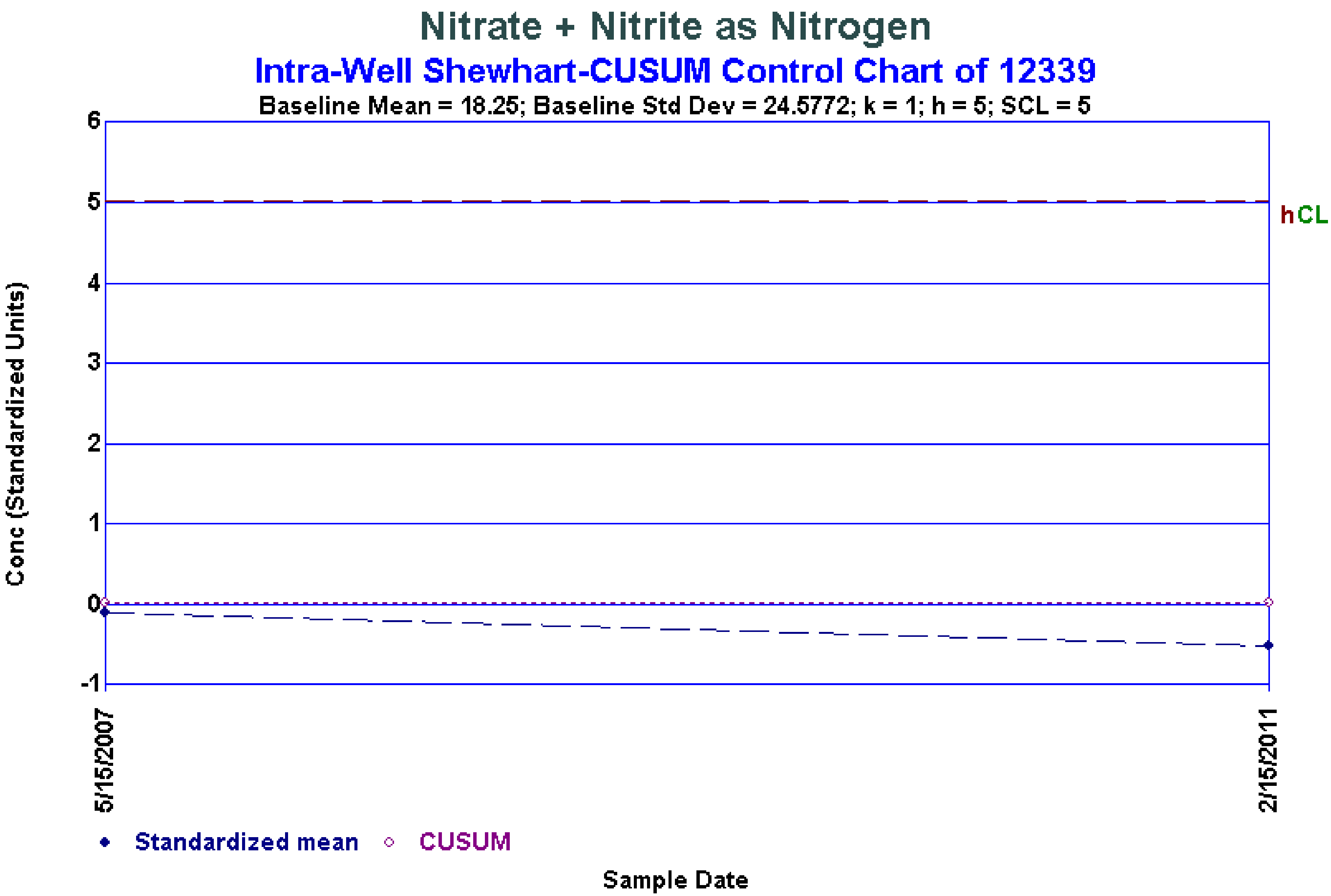


Figure A.5.2−41. Intra-Well Shewhart-CUSUM Control Chart (Nitrate 12339)

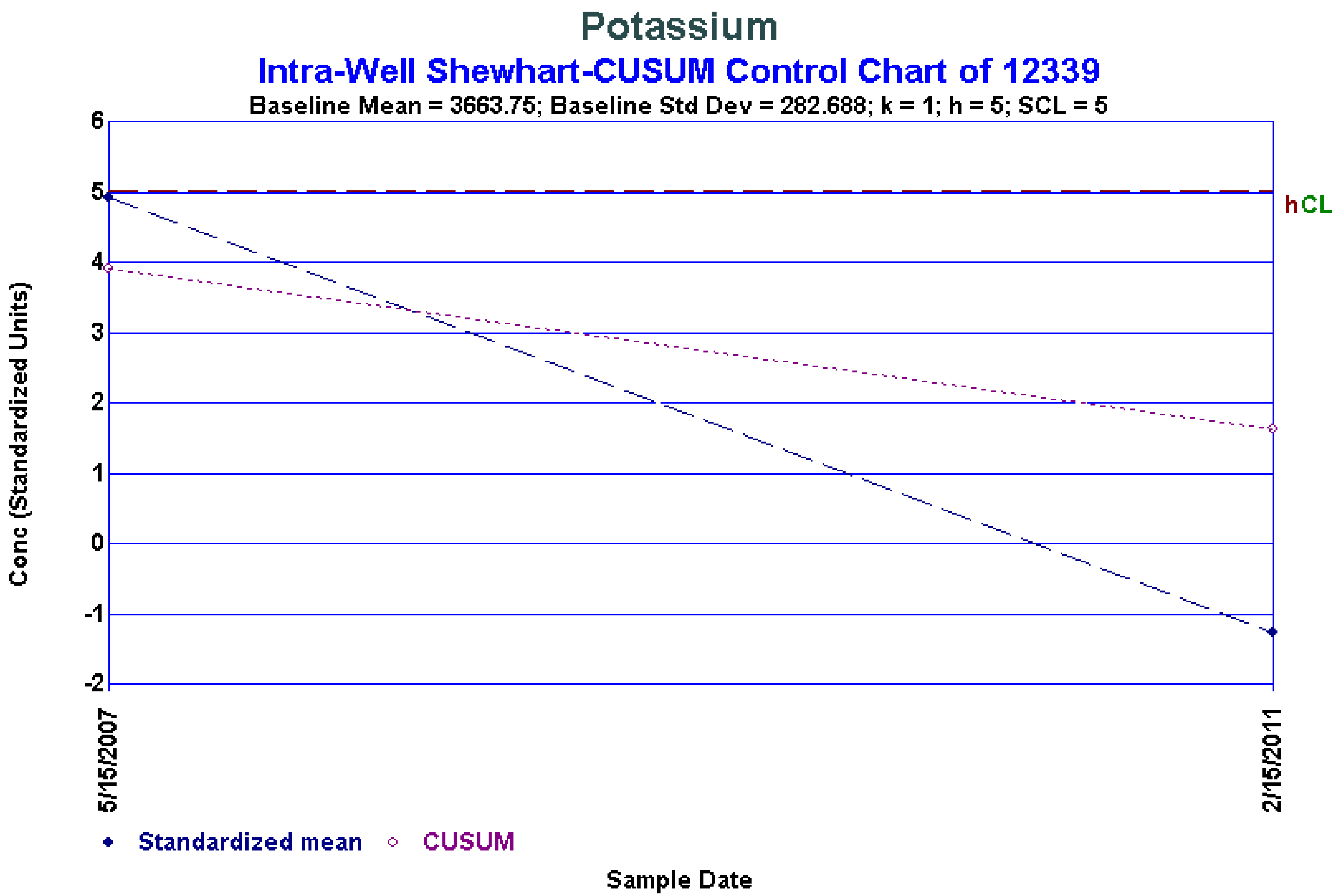


Figure A.5.2−42. Intra-Well Shewhart-CUSUM Control Chart (Potassium 12339)

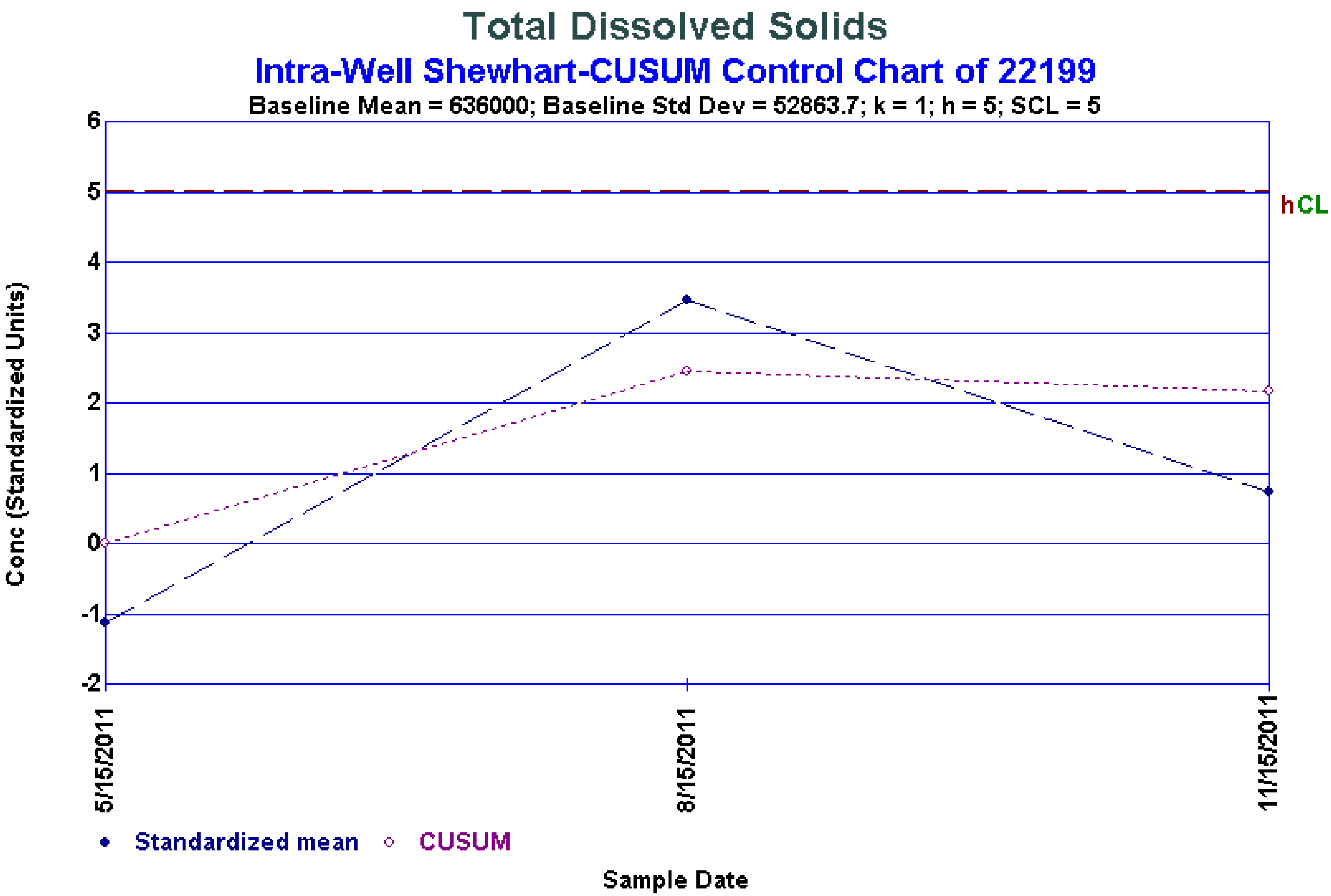


Figure A.5.2−43. Intra-Well Shewhart-CUSUM Control Chart (TDS 22199)

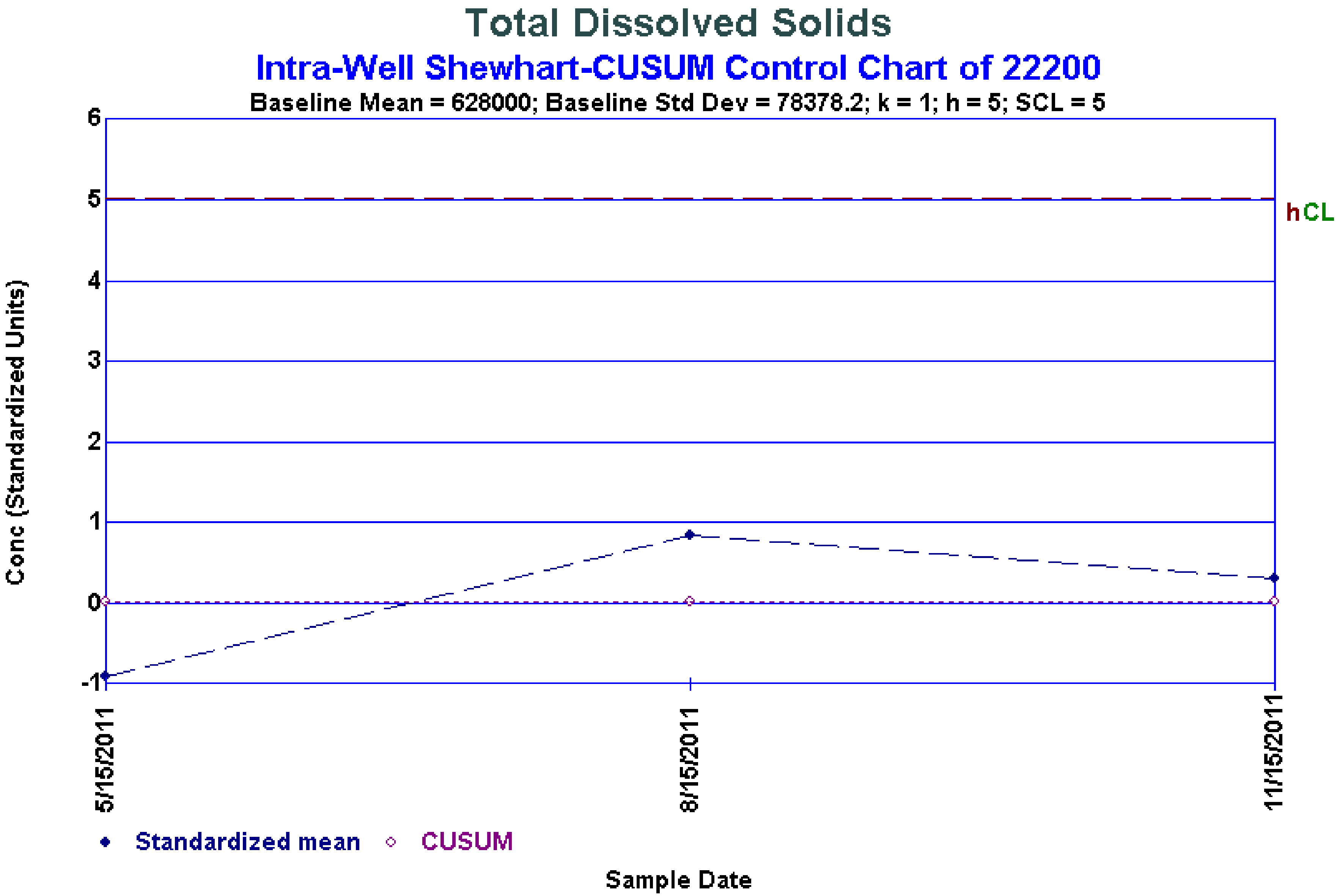


Figure A.5.2−44. Intra-Well Shewhart-CUSUM Control Chart (TDS 22200)

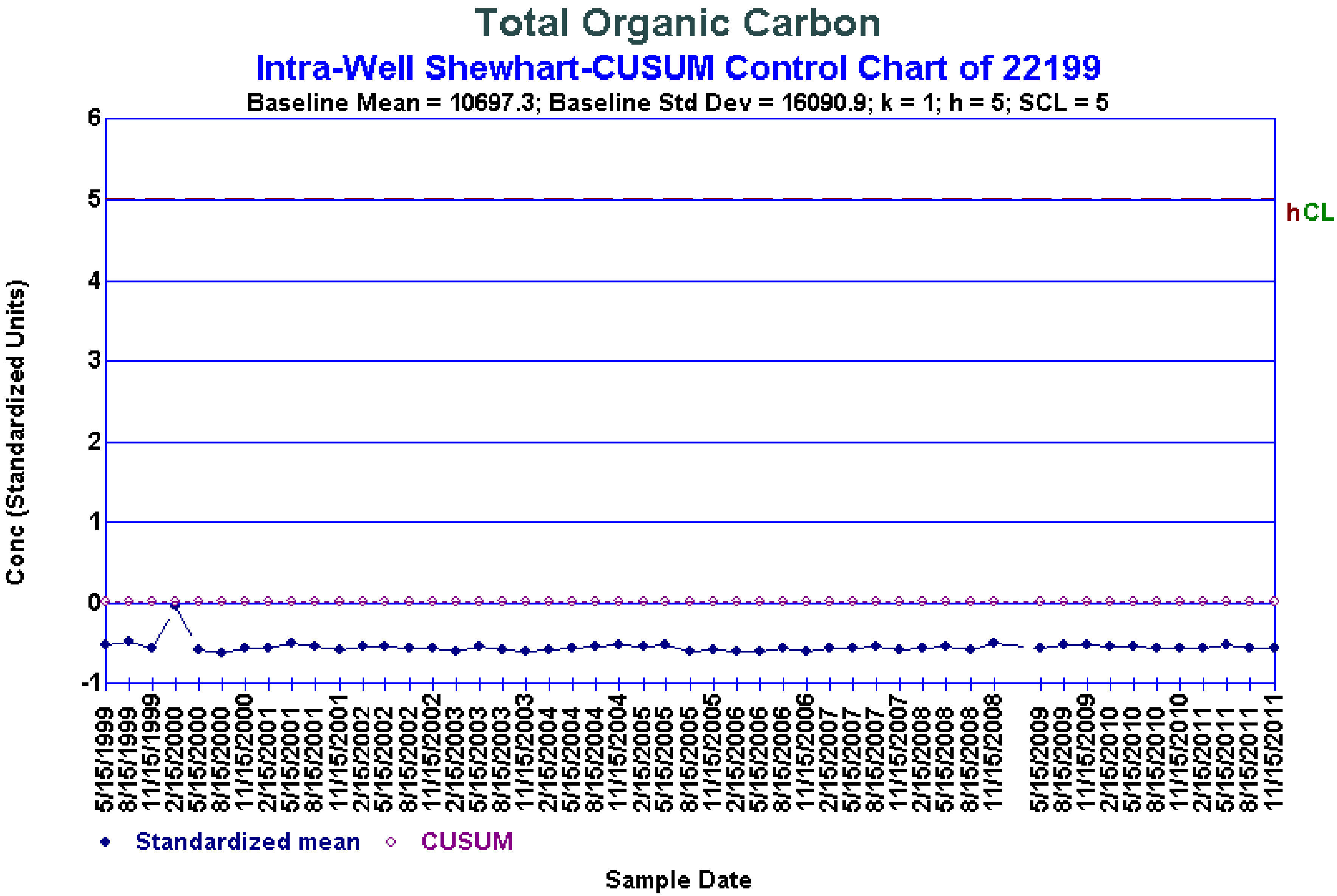


Figure A.5.2−45. Intra-Well Shewhart-CUSUM Control Chart (TOC 22199)

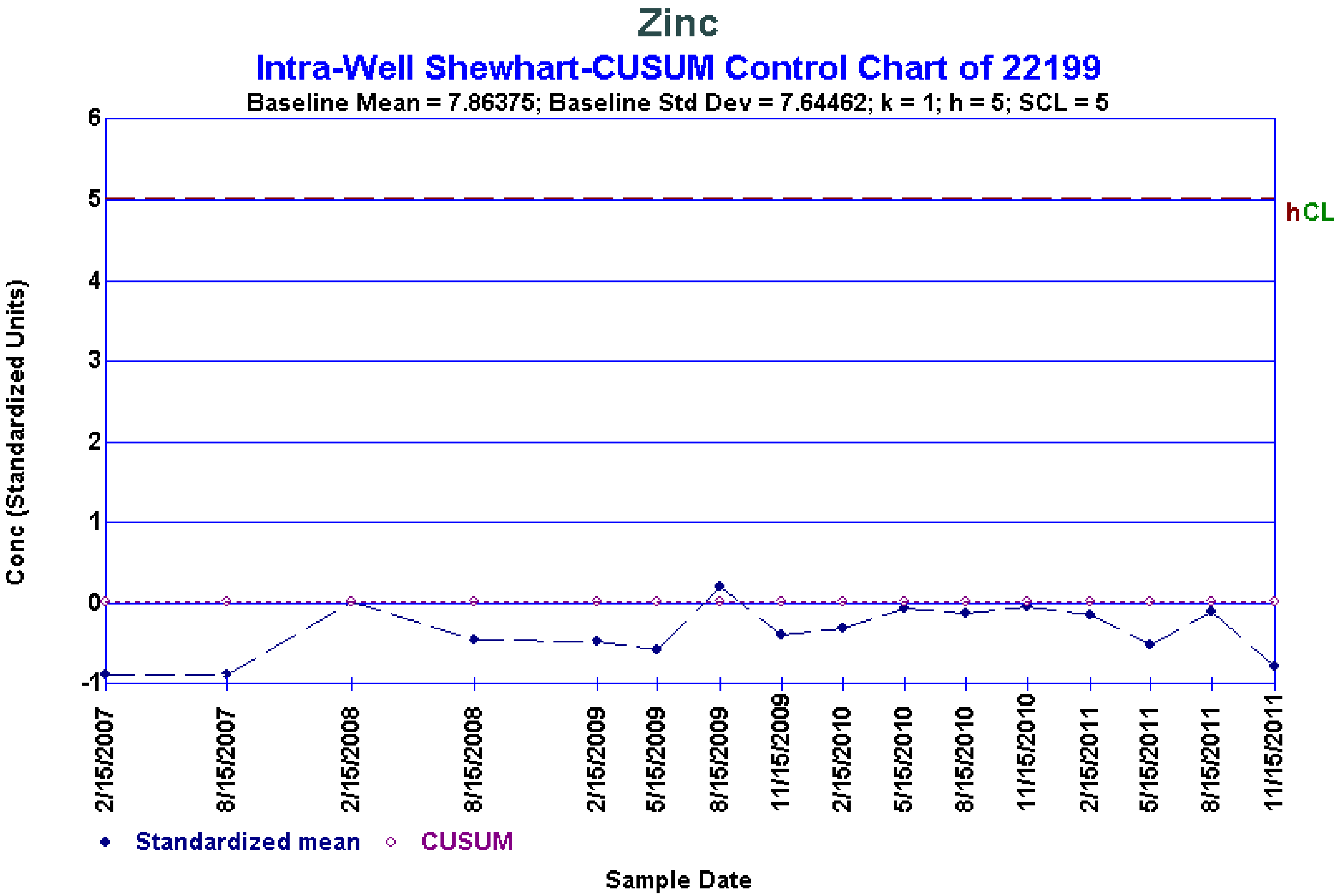


Figure A.5.2−46. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22199)

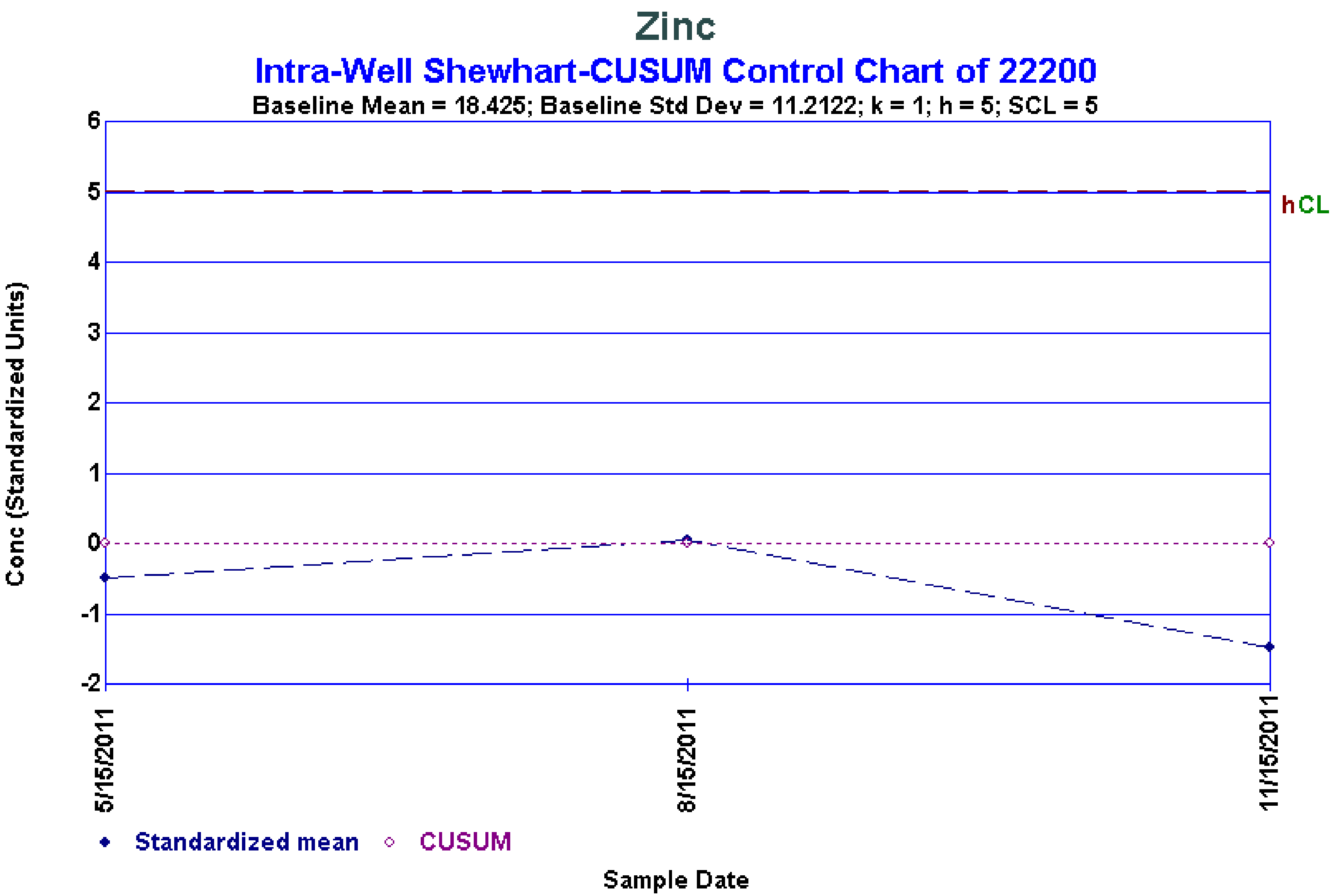


Figure A.5.2−47. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22200)

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Sub-attachment A.5.3

Cell 3

The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.3−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.3−2)
- LCS monthly accumulation volumes (refer to Figure A.5.3−1)
- LDS monthly accumulation volumes (refer to Figure A.5.3−2)
- OSDF horizontal till well 12340 water yield (refer to Figure A.5.3−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.3−4 and A.5.3−5)
- Plots of concentration versus time (refer to Figures A.5.3−6A to A.5.3−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.3−29)
- Control charts (refer to Figures A.5.3−30 to A.5.3−47)

A.5.3.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on LMICP (revision 4). Tritium results for all cells are reported in Section A.5.5.

The LDS of Cell 3 has been dry since 2007. As shown in Table A.5.3–1, 7 of the 23 parameters sampled quarterly in the LCS, LDS, HTW, and GMA wells, (uranium, TOC, TOX, arsenic, boron, copper, and sodium) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall Test for trend.

Horizontal Till Well

The HTW is located beneath the liner penetration box of each cell by design. The liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, uranium, TOC, TOX, boron, and copper are increasing in the HTW of Cell 3 (as indicated in the table below). The bivariate plot for the Cell 3 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.3−29. The plot shows that the chemical signature for uranium-sodium in the LCS

LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured in the HTW of Cell 3 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Uranium	Up		Up
TOC	Up		Up
TOX	Up		
Arsenic			Up
Boron	Up	Up	Up
Copper	Up		
Sodium		Up	

[a]HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer;
GMA-D = downgradient Great Miami Aquifer. No entry indicates that the trend was not up.

The plot of uranium concentrations versus time in the HTW of Cell 3 is presented in Figure A.5.3–6A to A.5.3–6B. The data indicate that concentrations in the overall dataset (1997 to 2011) are increasing; however, when the data collected prior to cap completion (September 20, 2004) and the outlier collected on August 15, 2009, (58.5 µg/L) are removed, the data become normally distributed with no Mann-Kendall trend.

Great Miami Aquifer Wells

GMA monitoring wells are positioned and labeled for post-aquifer-remediation flow conditions, when flow directions will be from west to east. Water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells, for uranium, TOC, arsenic, boron, and sodium, are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.3–1) measured in the LDS, and GMA wells for parameters with increasing concentrations in the Cell 3 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
Uranium (µg/L)	**17.0**	1.93	4.86
TOC (mg/L)	**5.77**	1.55	1.44
Arsenic (mg/L)	**0.0085**[b]	0.0025	0.0025
Boron (mg/L)	**0.128**	0.0416	0.0424
Sodium (mg/L)	**315**	21.0	18.0

Note: The highest averages are shown in bold.
[a] LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer,
GMA-D = downgradient Great Miami Aquifer.
[b] Arsenic has only been detected once in the LDS of Cell 3 (second quarter 2006, 0.0085 mg/L).

A.5.3.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared “out of control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a “work-a-round”, the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.3−1 in gray shading, 12 parameters in the HTW and GMA wells of Cell 3 meet the criteria for control charts (i.e., more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 18 control charts.

These 18 control charts are presented in Figures A.5.3−30 through A.5.3−47. Sixteen of the control charts for Cell 3 exhibit “in control” conditions. Two control charts exhibit “out of control” conditions; TDS in the GMA-U and Iron in the HTW. Both charts are “out of control” because the CUSUM plot trace exceeds the CUSUM control limit. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 3 indicate that water is not mixing between the horizons, so the out of control conditions are attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

Parameter and Monitoring Point[a]	Assessment
Alkalinity in the HTW	In Control
Nitrate in the HTW	In Control
Sulfate in the GMA-D	In Control
TDS in the GMA-U	**Out of Control**
TDS in the GMA-D	In Control
Barium in the HTW	In Control
Calcium in the HTW	In Control
Iron in the HTW	**Out of Control**
Iron in the GMA-U	In Control
Iron in the GMA-D	In Control
Lithium in the GMA-U	In Control
Lithium in the GMA-D	In Control
Magnesium in the HTW	In Control
Manganese in the GMA-U	In Control
Manganese in the GMA-D	In Control
Potassium in the HTW	In Control
Zinc in the GMA-U	In Control
Zinc in the GMA-D	In Control

[a]HTW = horizontal till well; GMA-D = downgradient Great Miami Aquifer;
GMA-U = upgradient Great Miami Aquifer

A.5.3.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 3 are provided in Table A.5.3−2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 3 in 2011.

A.5.3.4 Summary and Conclusions

- Seven parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 3 (uranium, TOC, TOX, arsenic, boron, copper, and sodium).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 3 indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 3 are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Eighteen control charts were constructed for Cell 3 parameters. Sixteen of the eighteen charts exhibit "in control" conditions. Out of control conditions are exhibited by TDS in the GMA-U well and iron in the HTW.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 3 in 2011.

Table A.5.3−1. Summary Statistics for Cell 3

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12340C	48	48	100.0	9.35	113	63.1	26.1	Normal	Up	Detected	
	LDS	12340D	21	21	100.0	8.90	27.7	17.0	5.0	Normal	Down	Not Detected	72.4 Q3-04)
	HTW	12340	51	51	100.0	3.89	29.3	20.1	7.2	Undefined	Up	Detected	58.5 (Q3-09)
	GMA-U	22203	50	53	94.3	0.118	7.92	1.93	1.93	Lognormal	None	Detected	
	GMA-D	22204	53	54	98.2	ND	22.9	4.86	4.87	Lognormal	Up	Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12340C	23	23	100.0	72	1080	480	212	Undefined	None	Detected	
	LDS	12340D	9	9	100.0	108	267	161	54	Normal	None	Not Detected	693 (Q4-05)
	HTW	12340	10	10	100.0	256	333	306	25	Normal	None	Not Detected	
	GMA-U	22203	4	4	100.0	389	451	413	28	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	359	381	371	9	Normal	None	Insuff	
Choride (mg/L)	LCS	12340C	23	23	100.0	4.7	52.1	34.2	14.2	Undefined	Up	Detected	
	LDS	12340D	9	9	100.0	54.1	74.2	61.8	6.5	Normal	None	Not Detected	
	HTW	12340	10	10	100.0	40.4	186	156	42	Undefined	Down	Detected	
	GMA-U	22203	4	4	100.0	29.8	44.0	37.3	6.3	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	20.7	22.3	21.4	0.7	Normal	None	Insuff	
Nitrate/Nitrite as N (mg/L)	LCS	12340C	20	30	66.7	ND	2.20	0.220	0.614	Undefined	Down	Detected	
	LDS	12340D	6	9	66.7	ND	5.71	1.06	1.92	Lognormal	None	Not Detected	
	HTW	12340	1	9	11.1	ND	0.0519	Insuff	INsuff	Lognormal	None	Not Detected	
	GMA-U	22203	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22204	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sulfate (mg/L)	LCS	12340C	40	40	100.0	26.1	2650	1700	590	Undefined	Up	Detected	
	LDS	12340D	19	19	100.0	112	2510	1250	700	Undefined	Down	Not Detected	
	HTW	12340	32	32	100.0	352	958	696	155	Normal	None	Detected	
	GMA-U	22203	35	35	100.0	67.3	735	252	152	Normal	Down	Detected	
	GMA-D	22204	35	35	100.0	232	779	490	152	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12340C	29	29	100.0	233	3490	3120	1200	Undefined	Up	Detected	
	LDS	12340D	0	0	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12340	8	8	100.0	1280	1650	1430	130	Normal	Down	Not Detected	
	GMA-U	22203	11	11	100.0	524	1190	686	188	Normal	None	Not Detected	
	GMA-D	22204	11	11	100.0	724	1530	1070	250	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12340C	35	47	74.5	ND	4.21	2.01	0.75	Normal	Up	Detected	17.4 (Q4-99)
	LDS	12340D	17	21	81.0	ND	8.02	5.77	2.26	Undefined	None	Not Detected	
	HTW	12340	37	47	78.7	ND	3.21	2.22	0.64	Undefined	Up	Detected	9.81 (Q1-00)
	GMA-U	22203	39	53	73.6	ND	2.9	1.55	0.54	Normal	None	Detected	5.66 (Q1-00) 14.1 (Q4-00)
	GMA-D	22204	36	53	67.9	ND	2.92	1.44	0.52	Normal	Up	Not Detected	8.83 (Q1-00)
Total Organic Halogens (mg/L)	LCS	12340C	16	48	33.3	ND	0.0590	0.0125	0.0137	Undefined	Down	Detected	0.141 (Q4-99)
	LDS	12340D	10	21	47.6	ND	0.0838	0.0251	0.0187	Lognormal	None	Not Detected	
	HTW	12340	36	49	73.5	ND	0.0960	0.0138	0.0176	Undefined	Up	Detected	
	GMA-U	22203	23	53	43.4	ND	0.0231	0.00535	0.00605	Undefined	Down	Detected	0.213 (Q2-00) 0.075 (Q2-10)
	GMA-D	22204	10	53	18.9	ND	0.0194	0.00572	0.00525	Undefined	Down	Detected	0.165 (Q2-00)
Arsenic (mg/L)	LCS	12340C	5	28	17.9	ND	0.131	0.0025	0.0303	Undefined	None	Not Detected	
	LDS	12340D	1	9	11.1	ND	0.0085	Insuff	Insuff	Undefined	None	Not Detected	
	HTW	12340	3	20	15.0	ND	0.025	0.0025	Insuff	Undefined	None	Not Detected	
	GMA-U	22203	3	11	27.3	ND	0.0372	0.0025	Insuff	Undefined	None	Not Detected	
	GMA-D	22204	4	24	16.7	ND	0.0382	0.0025	0.0111	Undefined	Up	Detected	
Barium (mg/L)	LCS	12340C	23	23	100.0	0.0295	0.118	0.045	0.019	Undefined	None	Detected	
	LDS	12340D	9	9	100.0	0.0135	0.0386	0.0196	0.0078	Lognormal	None	Not Detected	
	HTW	12340	10	10	100.0	0.0173	0.0558	0.0352	0.0098	Normal	None	Not Detected	
	GMA-U	22203	4	4	100.0	0.0766	0.141	0.115	0.027	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	0.0396	0.0592	0.050	0.008	Normal	None	Insuff	

Table A.5.3−1 (continued). Summary Statistics for Cell 3

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12340C	48	49	98.0	ND	9.19	4.47	2.13	Undefined	Up	Detected	
	LDS	12340D	20	21	95.2	ND	0.557	0.128	0.149	Undefined	Down	Detected	
	HTW	12340	48	48	100.0	0.0481	0.259	0.135	0.056	Undefined	Up	Detected	0.960 (Q3-06)
	GMA-U	22203	42	53	79.2	ND	0.0709	0.0416	0.0127	Normal	Up	Detected	
	GMA-D	22204	45	53	84.9	ND	0.0887	0.0424	0.0168	Lognormal	Up	Detected	
Calcium (mg/L)	LCS	12340C	23	23	100.0	50.3	666	596	208	Undefined	Up	Detected	1200 (Q3-05)
	LDS	12340D	9	9	100.0	121	363	199	71	Normal	None	Not Detected	
	HTW	12340	10	10	100.0	218	318	274	37	Normal	None	Not Detected	
	GMA-U	22203	4	4	100.0	135	264	187	59	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	179	365	297	81	Normal	None	Insuff	
Cobalt (mg/L)	LCS	12340C	19	28	67.9	ND	0.0666	0.00239	0.0187	Undefined	None	Detected	
	LDS	12340D	8	9	88.9	ND	0.0011	0.00071	0.00026	Normal	None	Not Detected	
	HTW	12340	13	17	76.5	ND	0.0019	0.00118	0.00041	Normal	Down	Not Detected	0.00655 (Q3-09)
	GMA-U	22203	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22204	2	11	18.2	ND	0.00176	Insuff	Insuff	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12340C	20	24	83.3	0.00118	0.0311	0.0064	0.0073	Undefined	None	Detected	
	LDS	12340D	6	9	66.7	ND	0.016	0.0081	0.0049	Normal	None	Not Detected	
	HTW	12340	8	11	72.3	ND	0.015	0.00736	0.00448	Normal	Up	Detected	
	GMA-U	22203	4	4	100.0	0.00178	0.00924	0.00658	0.00337	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	0.00306	0.0107	0.00702	0.00327	Normal	None	Insuff	
Iron (mg/L)	LCS	12340C	27	28	96.4	0.0757	16.6	3.91	3.77	Lognormal	None	Detected	
	LDS	12340D	8	9	88.9	0.622	2.14	1.22	0.53	Normal	None	Not Detected	
	HTW	12340	17	17	100.0	0.513	22.8	3.77	5.28	Lognormal	None	Not Detected	
	GMA-U	22203	11	11	100.0	2.9	22.2	9.89	5.23	Normal	None	Not Detected	
	GMA-D	22204	11	11	100.0	3.15	11.3	6.2	2.3	Normal	None	Not Detected	
Lithium (mg/L)	LCS	12340C	20	20	100.0	0.683	1.02	0.778	0.094	Undefined	None	Not Detected	
	LDS	12340D	9	9	100.0	0.0313	0.0645	0.0427	0.0106	Normal	Down	Not Detected	
	HTW	12340	17	17	100.0	0.0129	0.0305	0.0205	0.0065	Undefined	Down	Detected	
	GMA-U	22203	11	11	100.0	0.00577	0.0119	0.00797	0.00183	Normal	None	Not Detected	
	GMA-D	22204	11	11	100.0	0.00694	0.0102	0.0085	0.0012	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12340C	23	23	100.0	10.2	380	195	88	Undefined	Up	Detected	
	LDS	12340D	9	9	100.0	87.2	138	110	15	Normal	None	Not Detected	
	HTW	12340	10	10	100.0	81.1	111	93.3	11.0	Normal	None	Not Detected	
	GMA-U	22203	4	4	100.0	32.5	58.1	42.2	11.3	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	40.4	66.6	58.1	12.2	Normal	None	Insuff	
Manganese (mg/L)	LCS	12340C	27	28	96.4	0.0014	7.27	0.368	2.75	Undefined	None	Detected	
	LDS	12340D	8	9	88.9	0.0015	0.146	0.0256	0.0463	Lognormal	None	Not Detected	
	HTW	12340	17	17	100.0	0.0315	0.288	0.121	0.076	Normal	Down	Detected	0.697 (Q3-05)
	GMA-U	22203	13	13	100.0	0.202	0.634	0.359	0.138	Normal	None	Not Detected	
	GMA-D	22204	23	24	95.8	ND	3.01	1.33	0.54	Lognormal	None	Not Detected	
Nickel (mg/L)	LCS	12340C	28	28	100.0	0.0021	0.102	0.0116	0.0361	Undefined	None	Detected	
	LDS	12340D	9	9	100.0	0.0034	0.0097	0.0062	0.0019	Normal	None	Not Detected	
	HTW	12340	7	17	41.2	ND	0.0107	0.00355	0.00362	Undefined	Down	Not Detected	
	GMA-U	22203	1	11	9.1	ND	0.00219	Insuff	Insuff	Undefined	None	Detected	
	GMA-D	22204	9	24	37.5	ND	0.0127	0.000828	0.00324	Undefined	None	Not Detected	
Potassium (mg/L)	LCS	12340C	23	23	100.0	0.575	35	25.9	10.4	Undefined	Up	Detected	
	LDS	12340D	9	9	100.0	9.47	15.7	11.8	1.8	Normal	None	Not Detected	
	HTW	12340	9	10	90.0	3.40	4.36	3.92	0.34	Normal	None	Not Detected	1.70 (Q1-06)
	GMA-U	22203	4	4	100.0	2.12	3.1	2.62	0.40	Normal	None	Insuff	
	GMA-D	22204	4	4	100.0	2.03	3.07	2.65	0.44	Normal	None	Insuff	

Table A.5.3−1 (continued). Summary Statistics for Cell 3

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12340C	5	28	17.9	ND	0.0392	0.00642	0.0077	Lognormal	None	Not Detected	
	LDS	12340D	0	9	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	HTW	12340	0	17	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-U	22203	1	11	9.1	ND	NA	Insuff	Insuff	Undefined	None	Detected	0.00617 (Q2-09) 0.00386 (Q1-10)
	GMA-D	22204	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12340C	28	28	100.0	4.35	49.9	25.4	9.8	Undefined	Up	Not Detected	
	LDS	12340D	9	9	100.0	263	344	315	27	Normal	None	Not Detected	
	HTW	12340	20	20	100.0	33.4	74.1	50.2	13.8	Lognormal	Down	Detected	
	GMA-U	22203	11	11	100.0	18.5	23.8	21.0	1.8	Normal	Up	Detected	
	GMA-D	22204	11	11	100.0	15.5	20.5	18.0	1.5	Normal	Down	Not Detected	
Zinc (mg/L)	LCS	12340C	21	28	75.0	ND	0.042	0.0164	0.0093	Normal	None	Detected	
	LDS	12340D	8	9	88.9	ND	0.499	0.161	0.175	Lognormal	Up	Not Detected	
	HTW	12340	13	17	76.5	0.0045	0.569	0.0156	0.153	Undefined	None	Detected	
	GMA-U	22203	6	11	54.6	ND	0.013	0.00712	0.00391	Normal	None	Not Detected	
	GMA-D	22204	17	24	70.8	ND	0.0405	0.0114	0.0095	Lognormal	None	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires n ≥ 3. In addition, Standard Deviation requires n ≥ 4.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where 3 ≤ n ≤ 50) or Shapiro Francia (where n > 50).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with n ≥ 4.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with n ≥ 6.

[h]Outliers determined by Rosner's (where n > 25) or Dixon procedure (where 4 ≤ n ≤ 25).

[i]Q = quarterly

Table A.5.3−2. Cell 3 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	14	3	21.4	Yes	0.0242	0.103	0.0647	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	14	1	7.1	No	0.0002	-	-	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	14	3	21.4	No	0.000065	0.00044	0.0002	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	14	8	57.1	Yes	0.00093	0.006	0.0026	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(2)	0.818 mg/L(0)
Lead (mg/L)	14	2	14.3	No	0.00146	0.0266	0.014	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(1)	0.0114 mg/L(1)
Thallium (mg/L)	14	1	7.1	No	0.0021	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	14	3	21.4	No	0.0034	0.00959	0.0056	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(1)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	24	2	8.3	No	3.84	9.89	6.86	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethane (ug/L)	10	2	20.0	No	0.351	0.79	0.57	280 ug/L(0)	-	-	-
1,1-Dichloroethene (ug/L)	31	10	32.3	No	0.112	13.1	4.45	7 ug/L(3)	-	-	-
1,1,1-Trichloroethane (ug/L)	11	2	18.2	No	0.54	0.64	0.59	-	-	-	-
4-Nitroaniline	22	1	4.5	No	2.94	-	-	-	-	-	-
Bromodichloromethane (ug/L)	23	1	4.3	No	0.5	-	-	100 ug/L(0)	-	-	-
Chlorodibromomethane (ug/L)	11	1	9.1	No	1	-	-	-	-	-	-
Trans-1,3-dichloropropene (ug/L)	10	1	10.0	No	1	-	-	-	-	-	-
Vinyl chloride (ug/L)	23	2	8.7	No	0.539	16.1	8.32	2 ug/L(1)	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

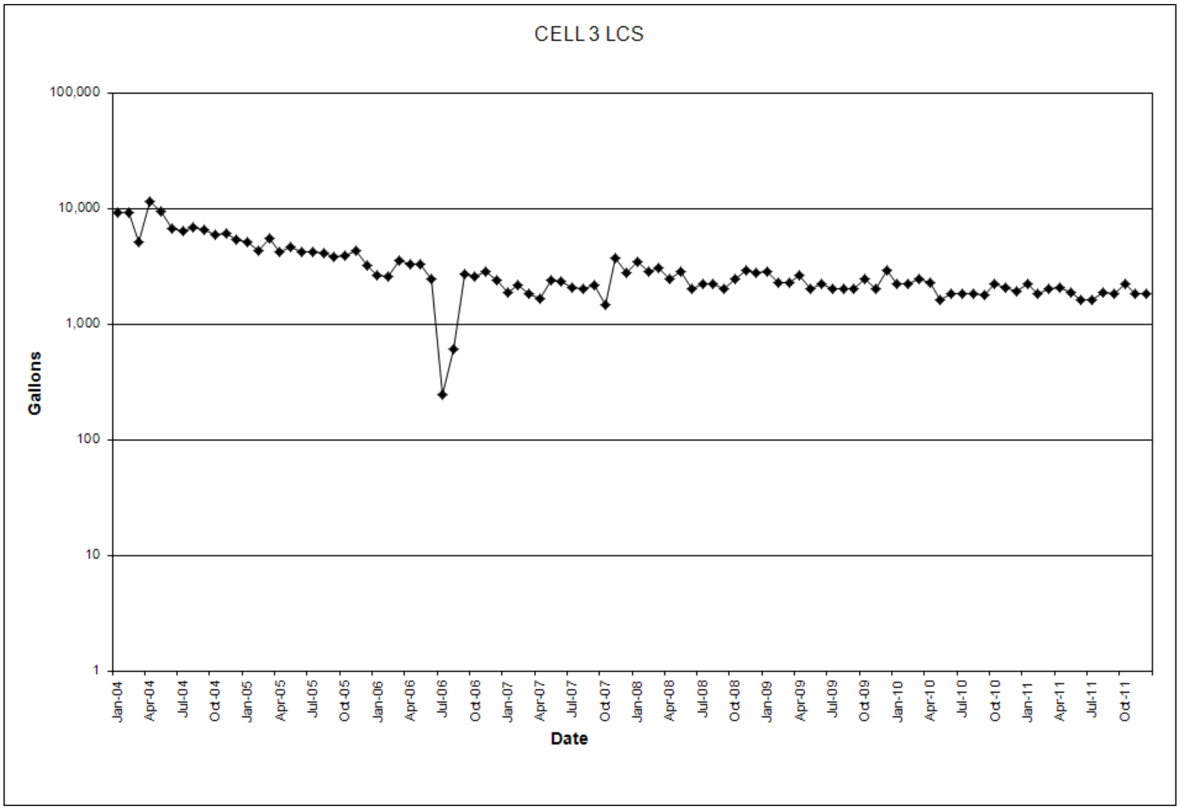


Figure A.5.3–1. Monthly Accumulation Volumes For Cell 3 LCS

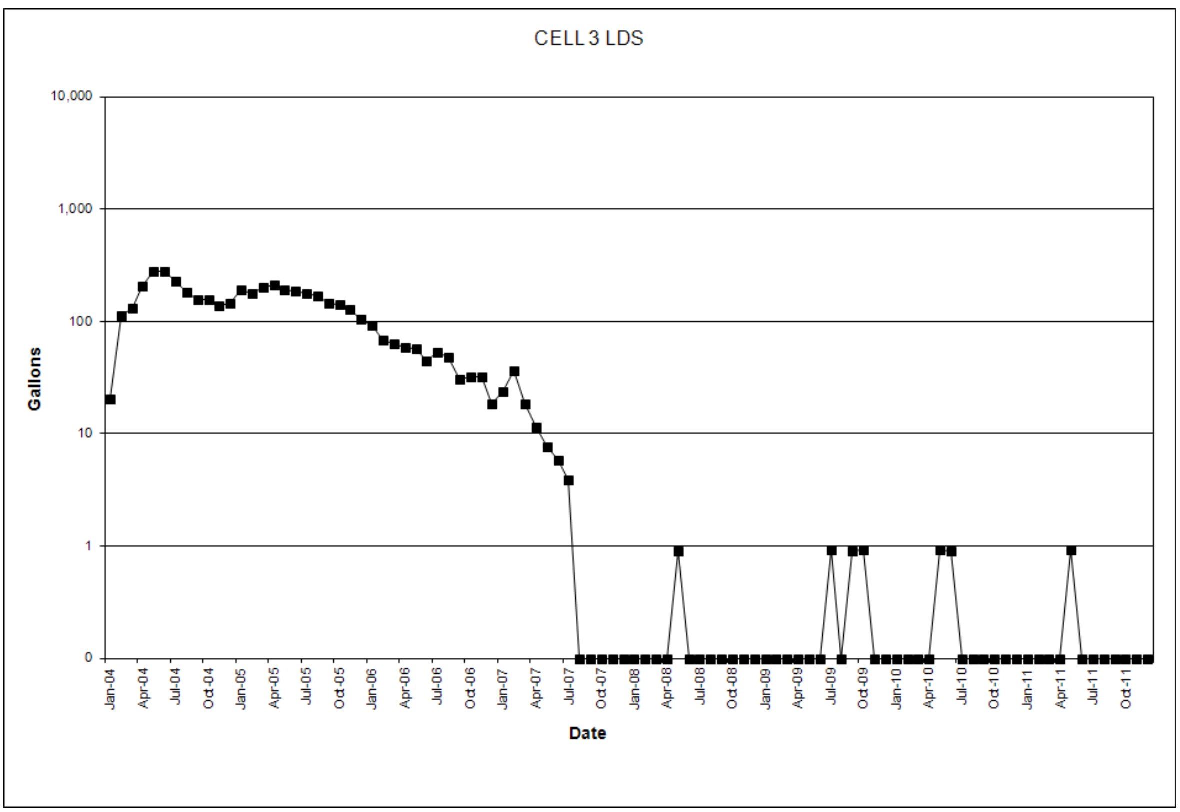
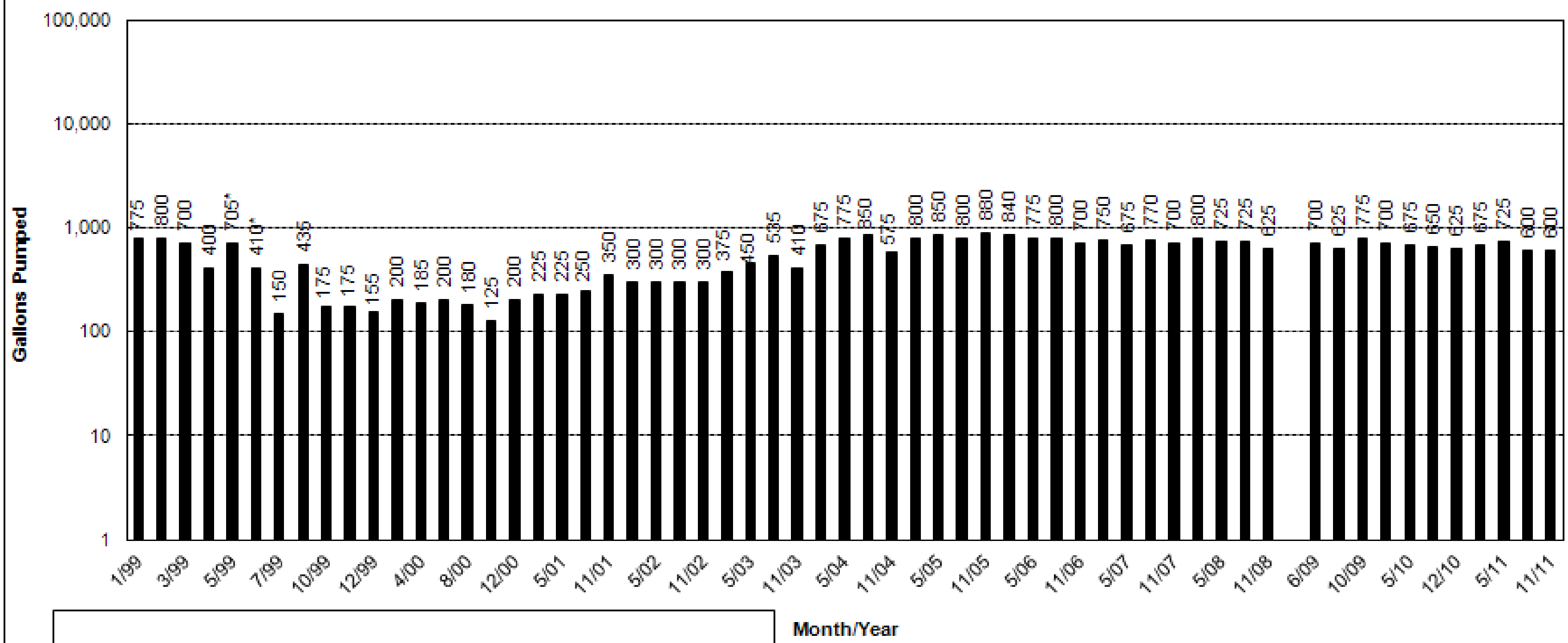


Figure A.5.3–2. Monthly Accumulation Volumes For Cell 3 LDS



12340 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	4880	n=11	444
2000:	1090	n=6	182
2001:	1050	n=4	263
2002:	1200	n=4	300
2003:	1770	n=4	443
2004:	2875	n=4	719
2005:	3330	n=4	833
2006:	3115	n=4	779
2007:	2895	n=4	724
2008:	2875	n=4	719
2009:	2100	n=3	700
2010:	2650	n=4	663
2011:	2600	n=4	650
Overall:			541

*More than one purge of the well was completed during these months to help evaluate well yield.

Figure A.5.3–3. OSDF Horizontal Till Well 12340 (Cell 3) Water Yield

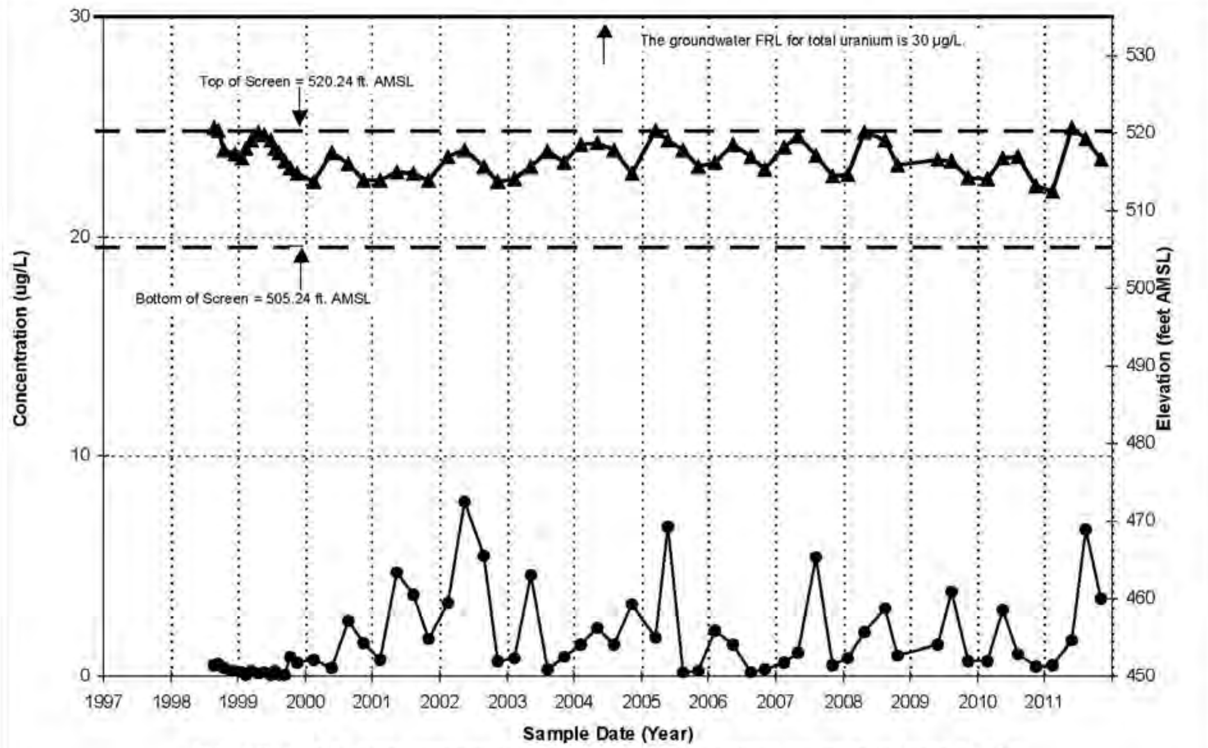


FIGURE A.5.3-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 3 Upgradient Monitoring Well 22203

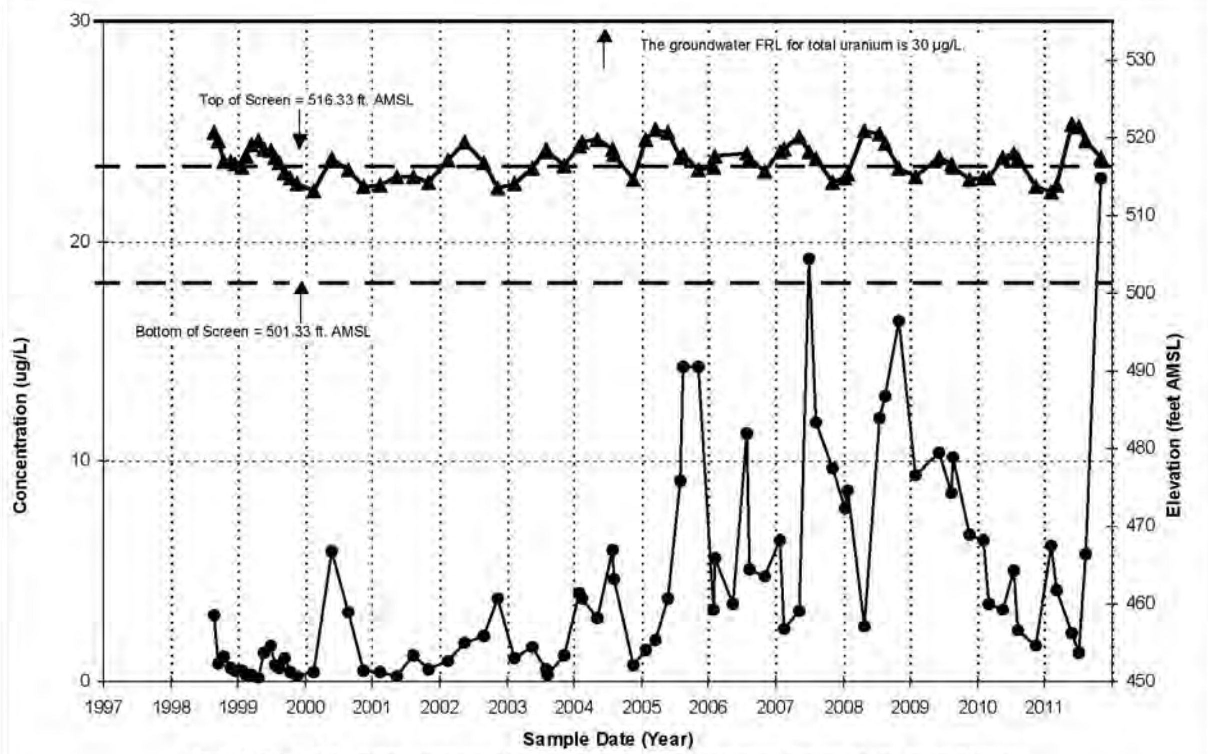


FIGURE A.5.3-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 3 Downgradient Monitoring Well 22204

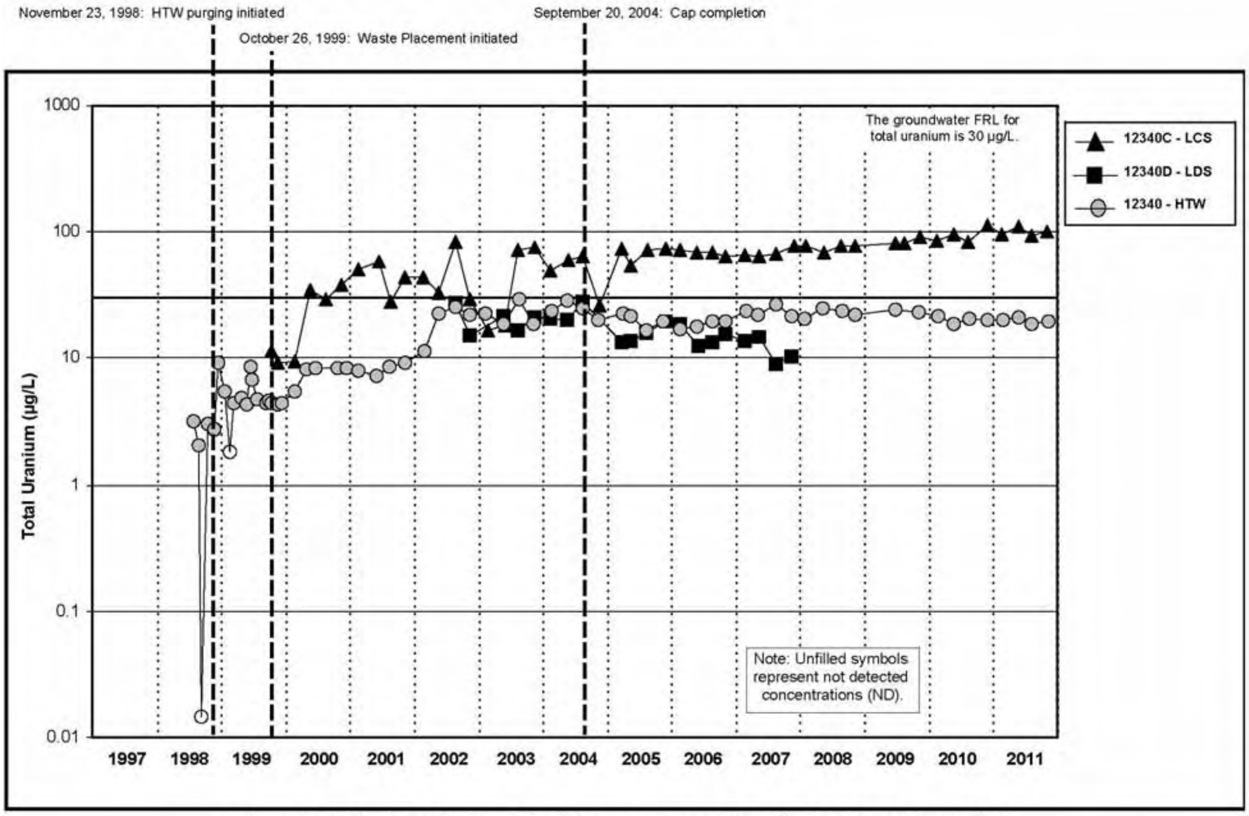


Figure A.5.3-6A. Cell 3 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

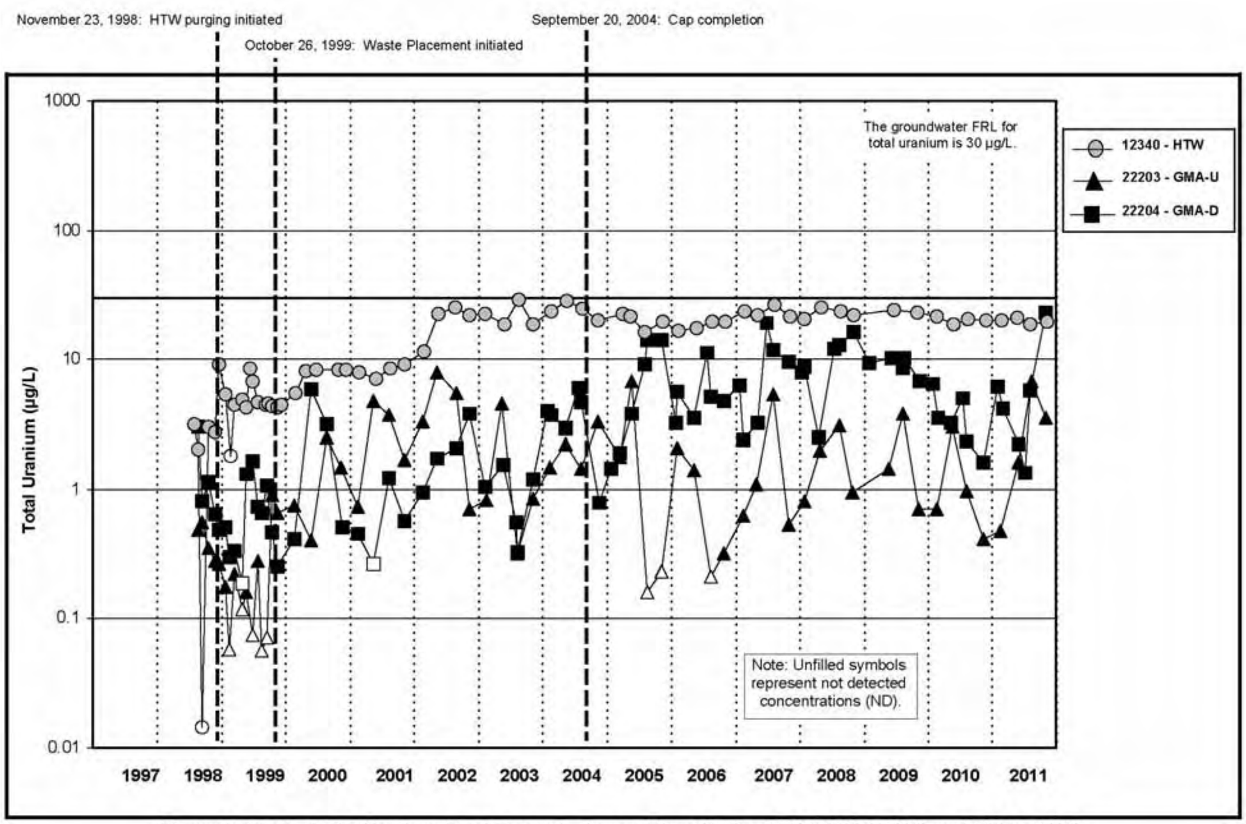


Figure A.5.3-6B. Cell 3 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

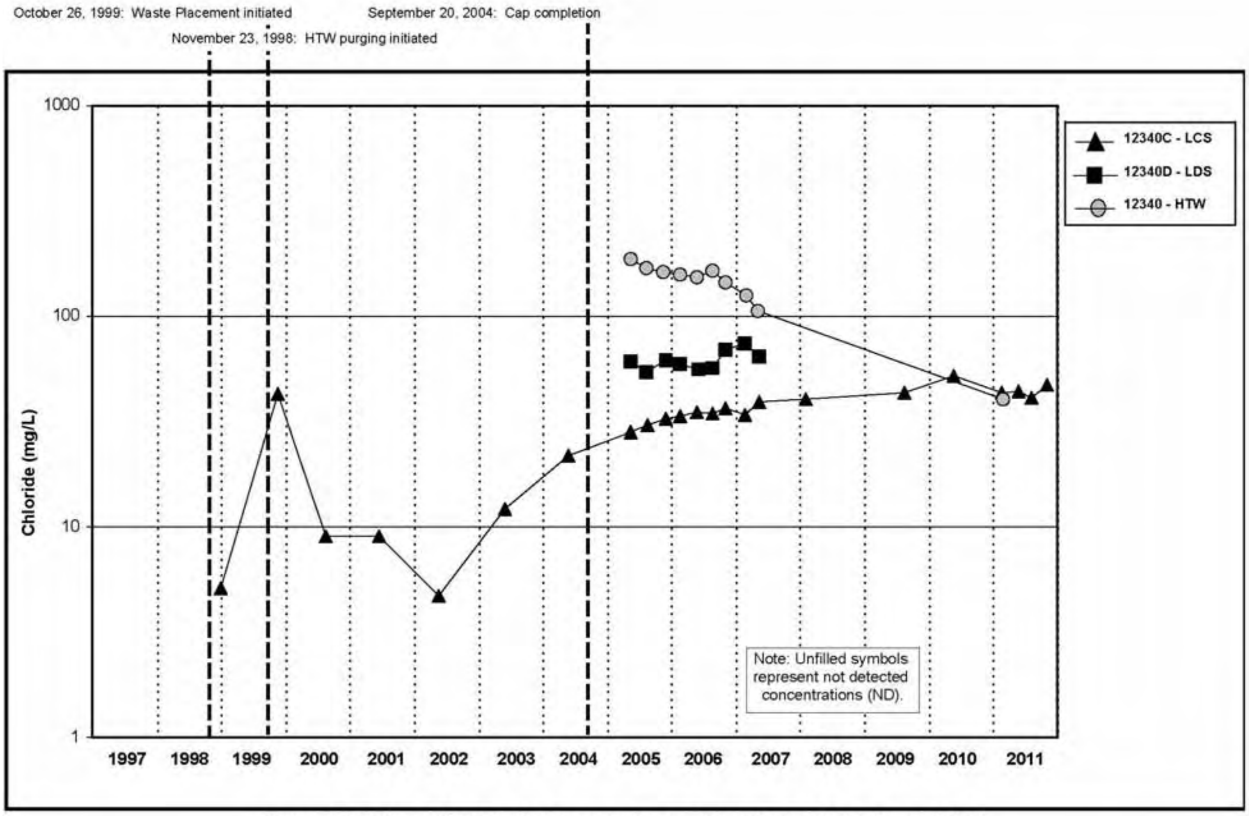


Figure A.5.3-7A. Cell 3 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

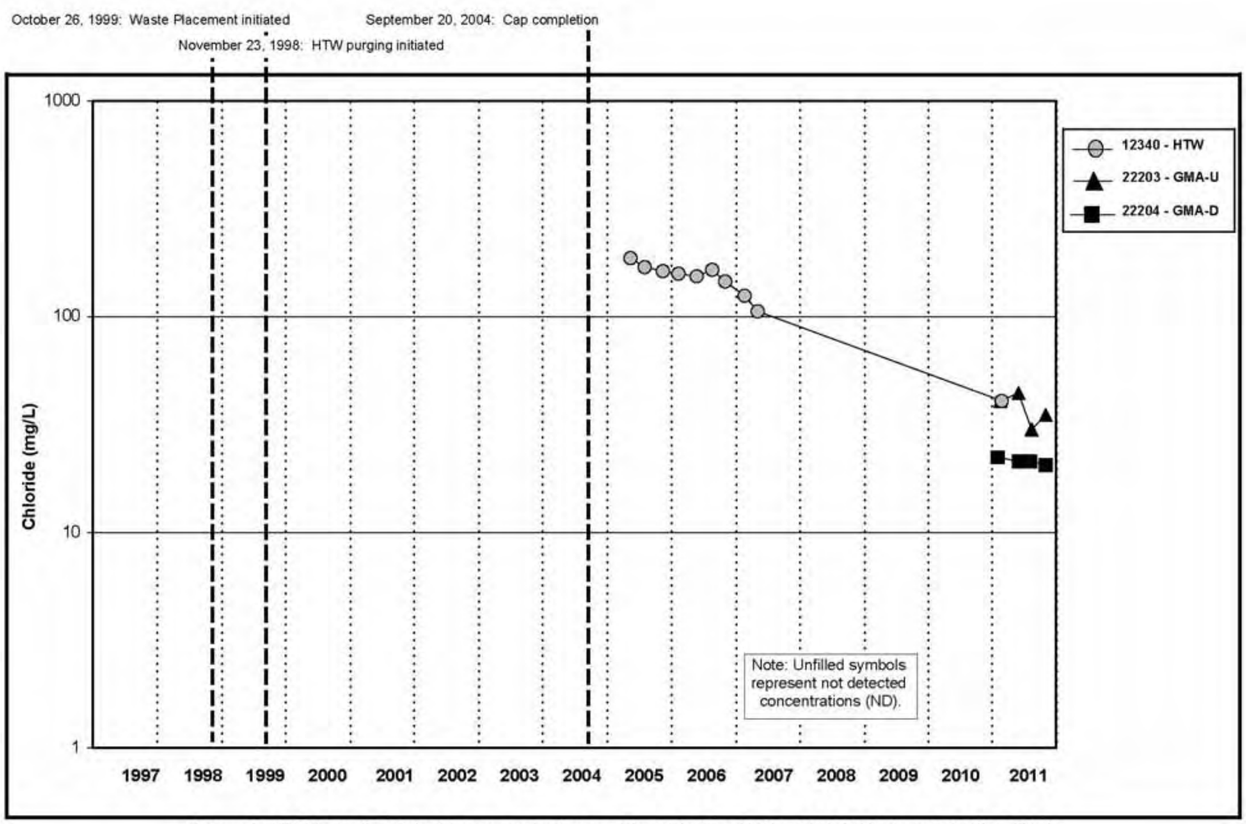


Figure A.5.3-7B. Cell 3 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

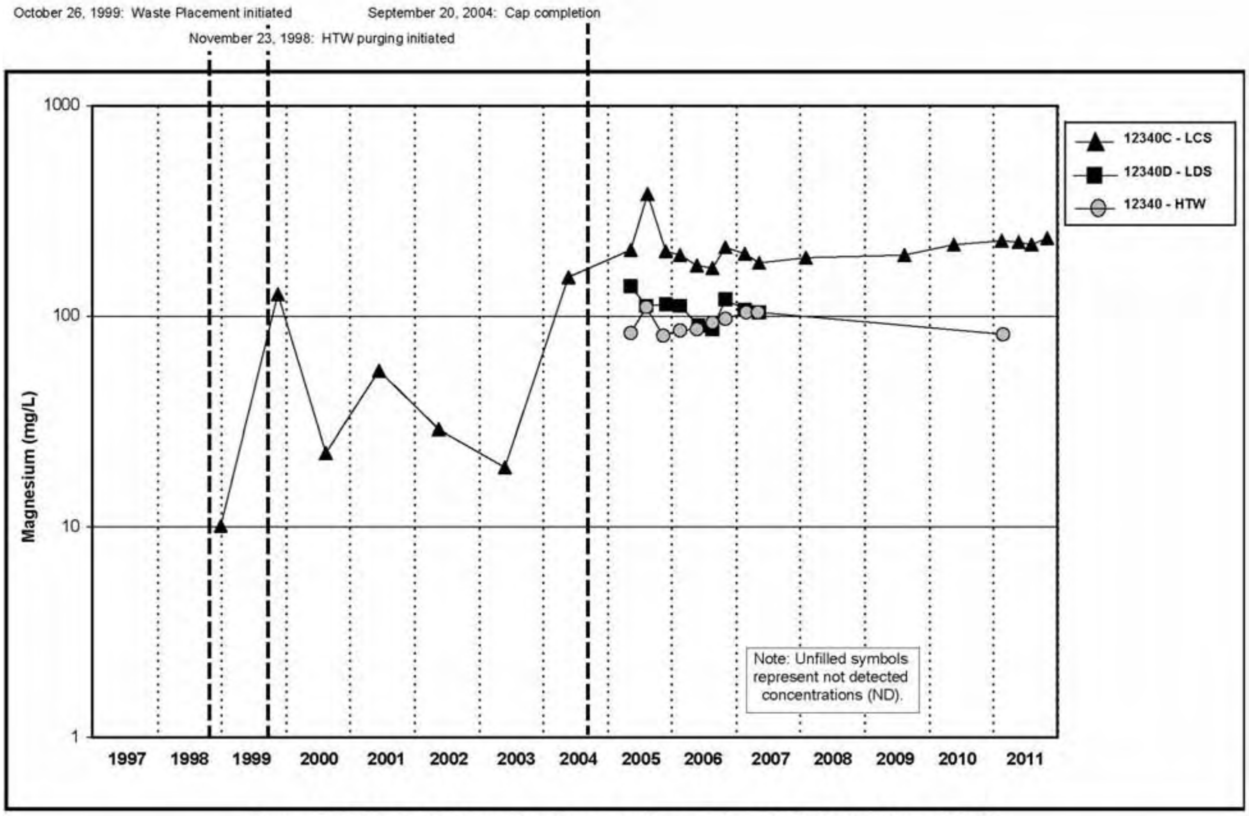


Figure A.5.3-8A. Cell 3 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

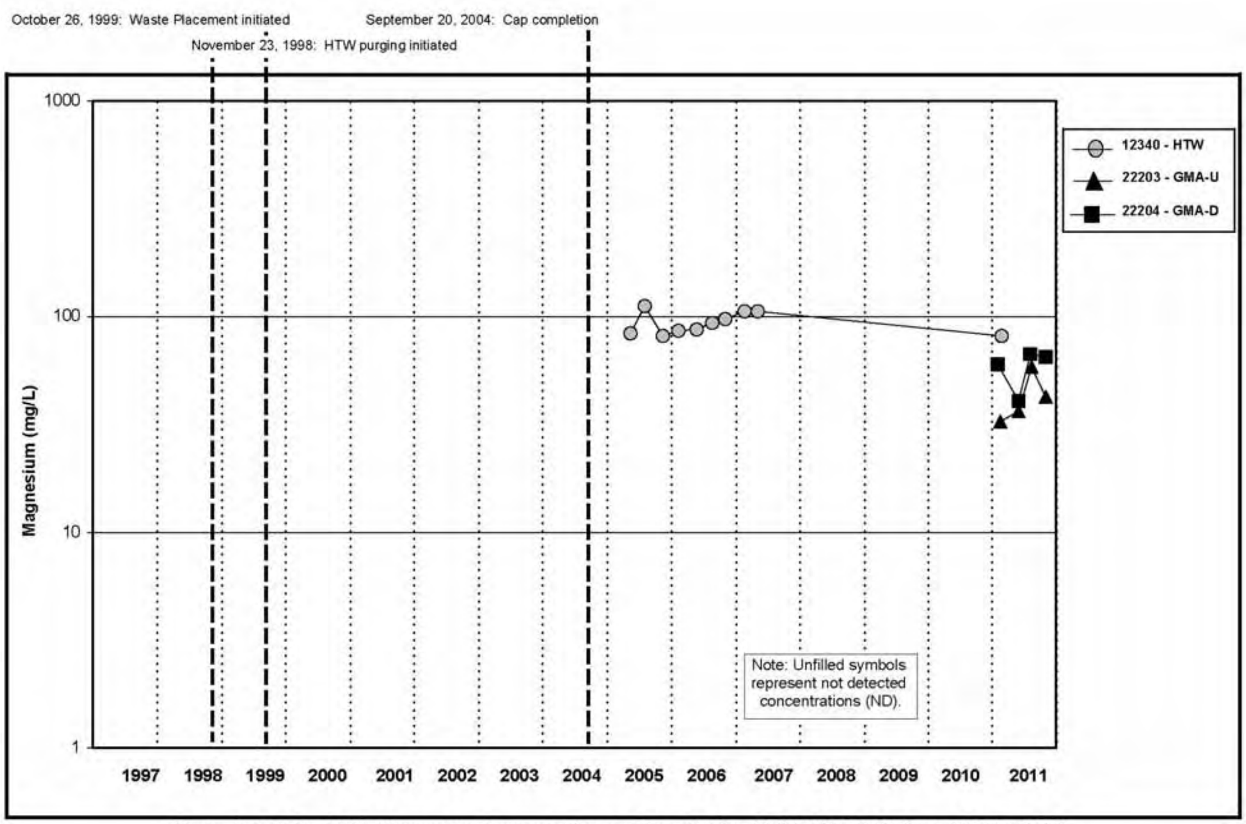


Figure A.5.3-8B. Cell 3 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

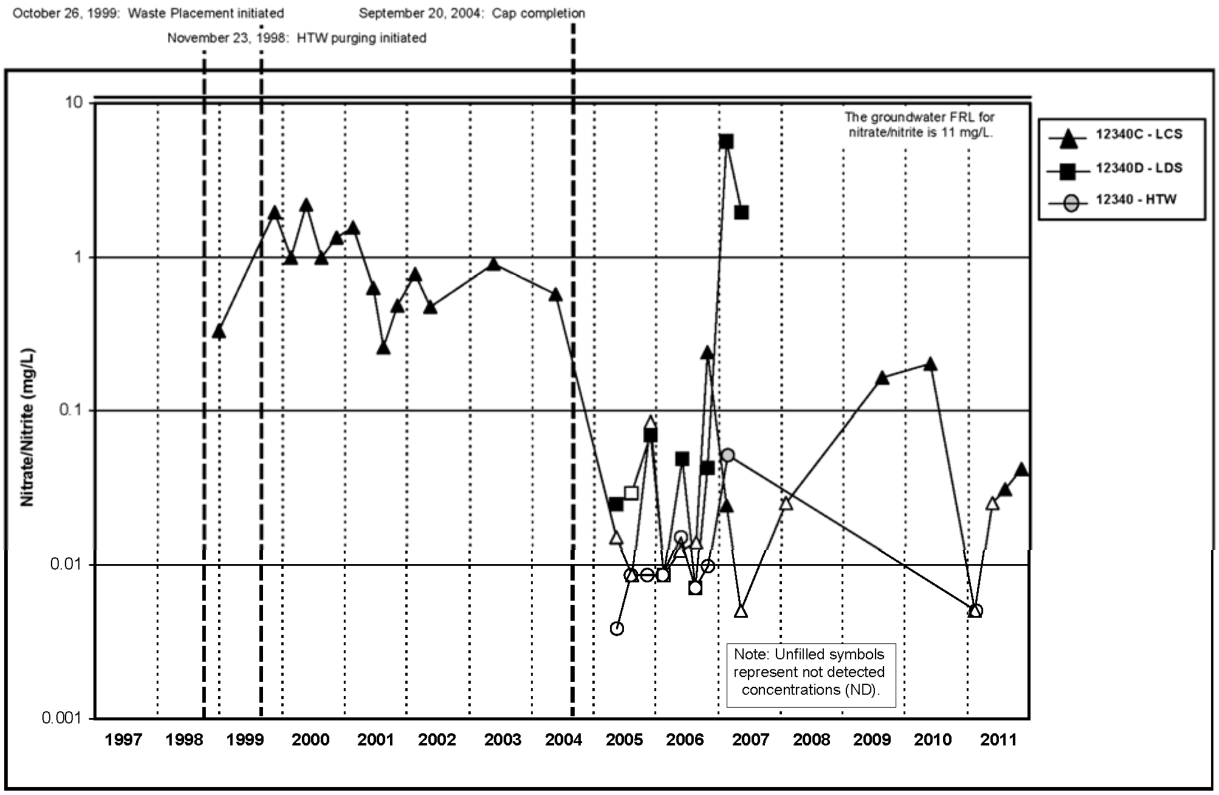


Figure A.5.3-9A. Cell 3 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

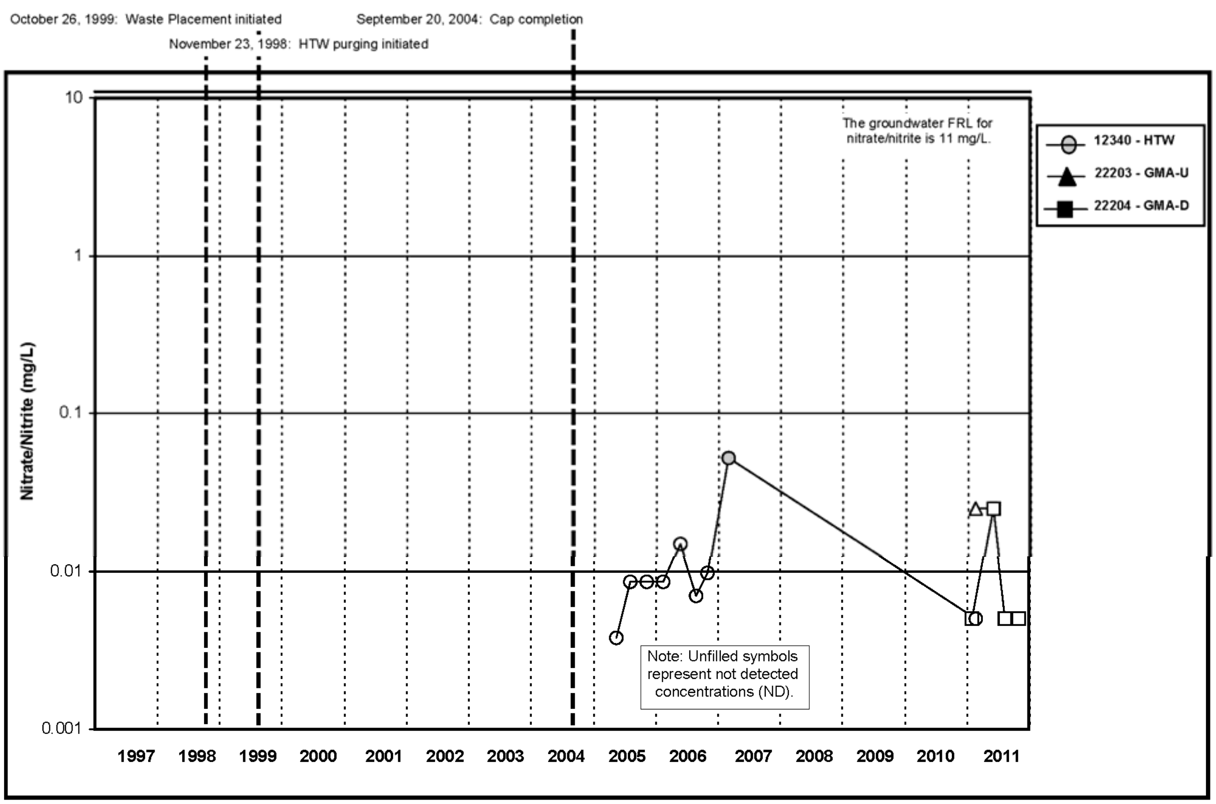


Figure A.5.3-9B. Cell 3 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

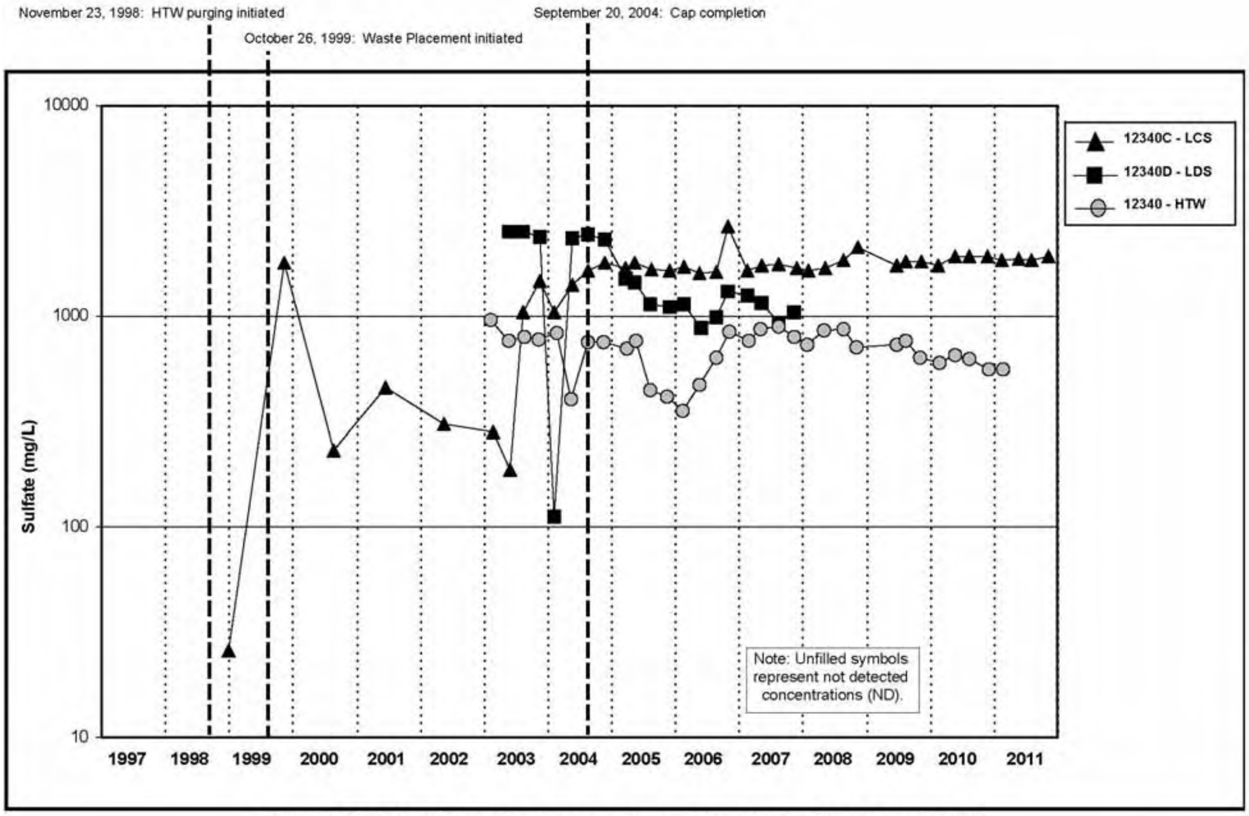


Figure A.5.3-10A. Cell 3 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

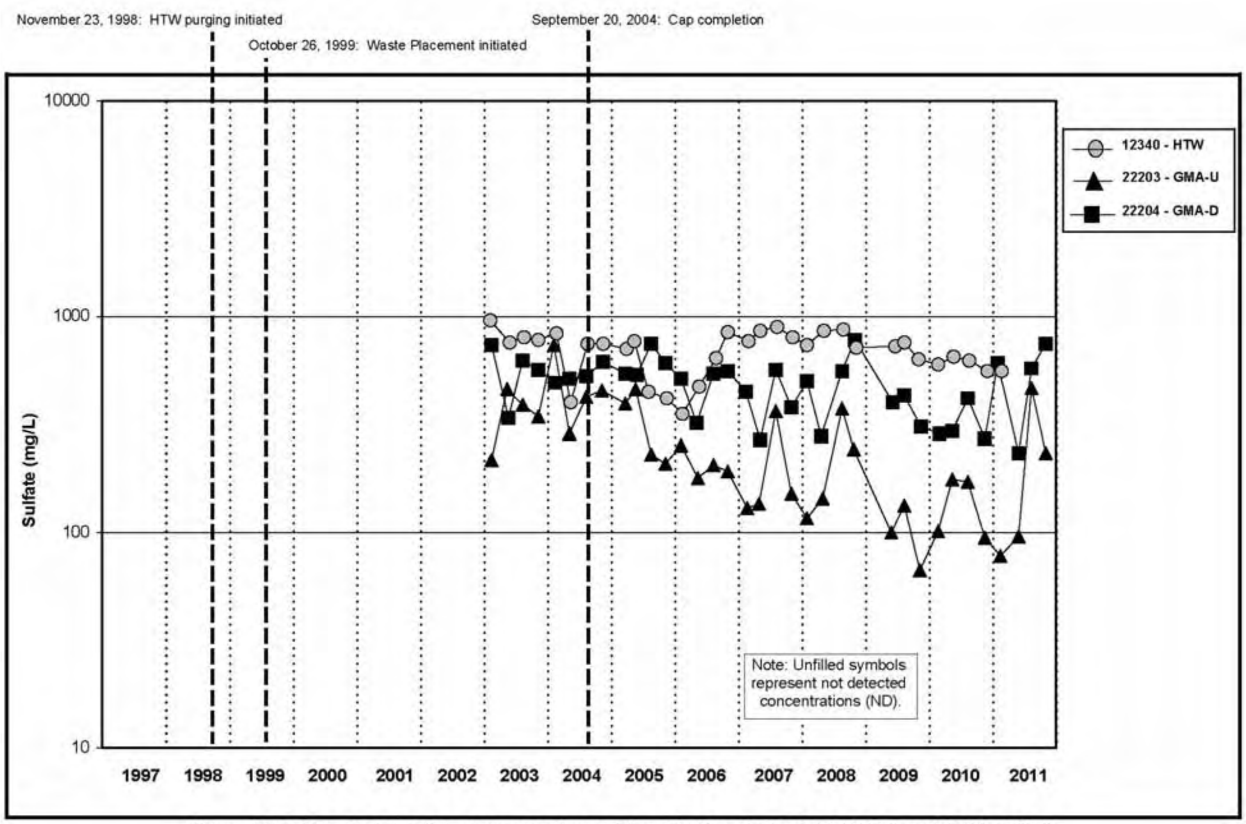


Figure A.5.3-10B. Cell 3 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

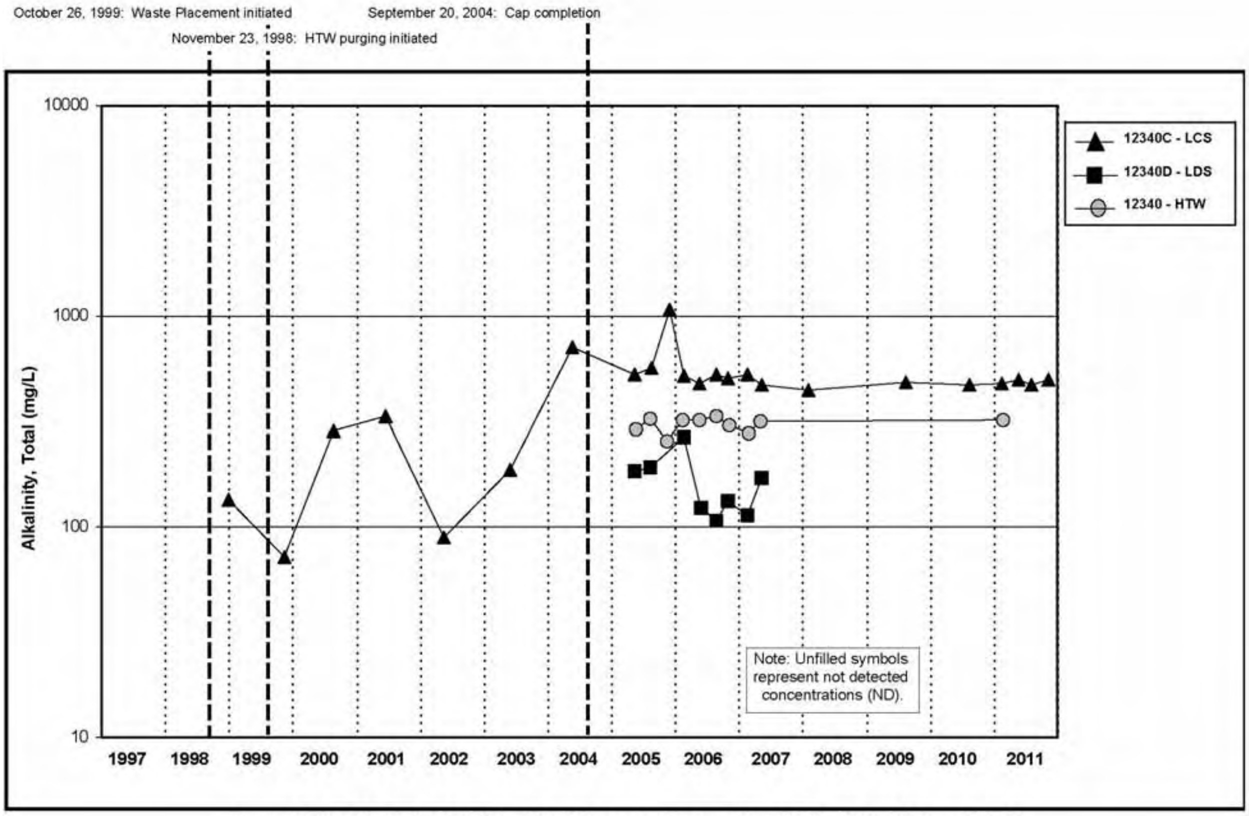


Figure A.5.3-11A. Cell 3 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

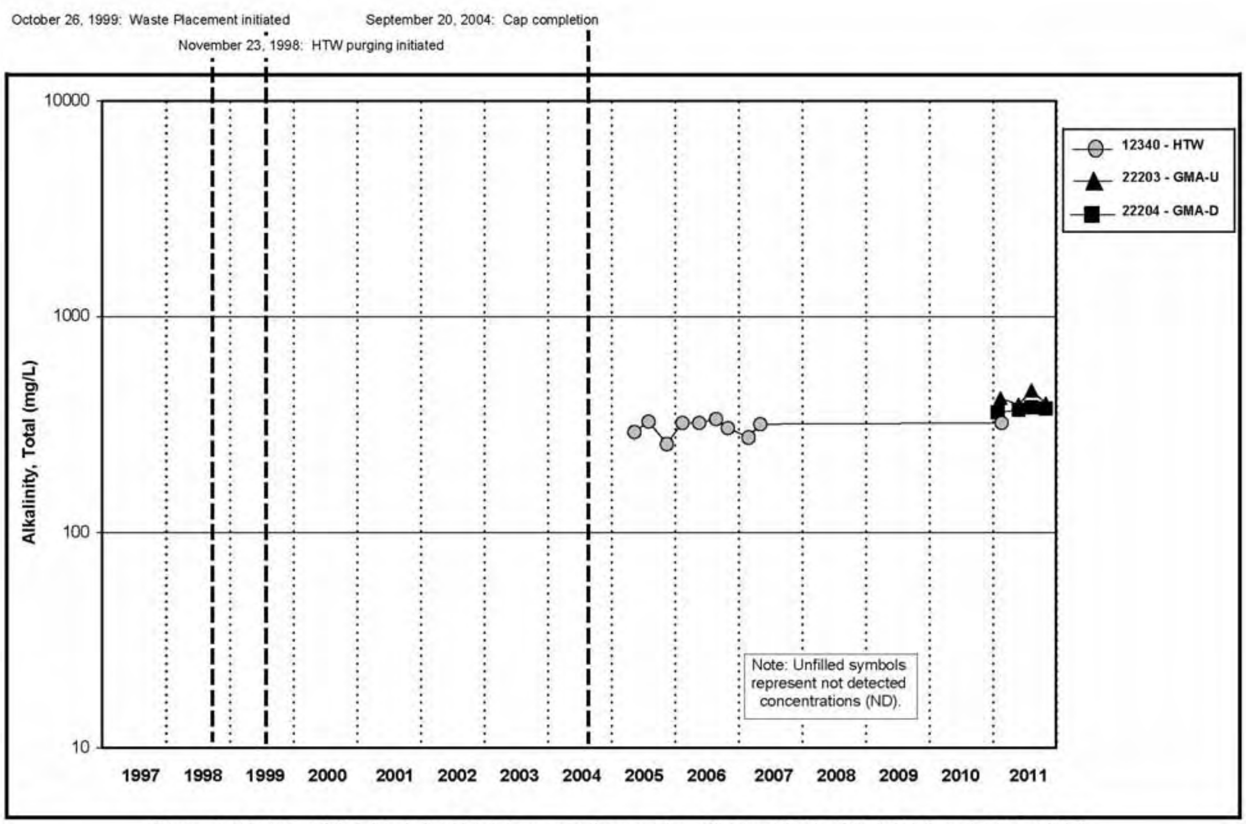


Figure A.5.3-11B. Cell 3 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

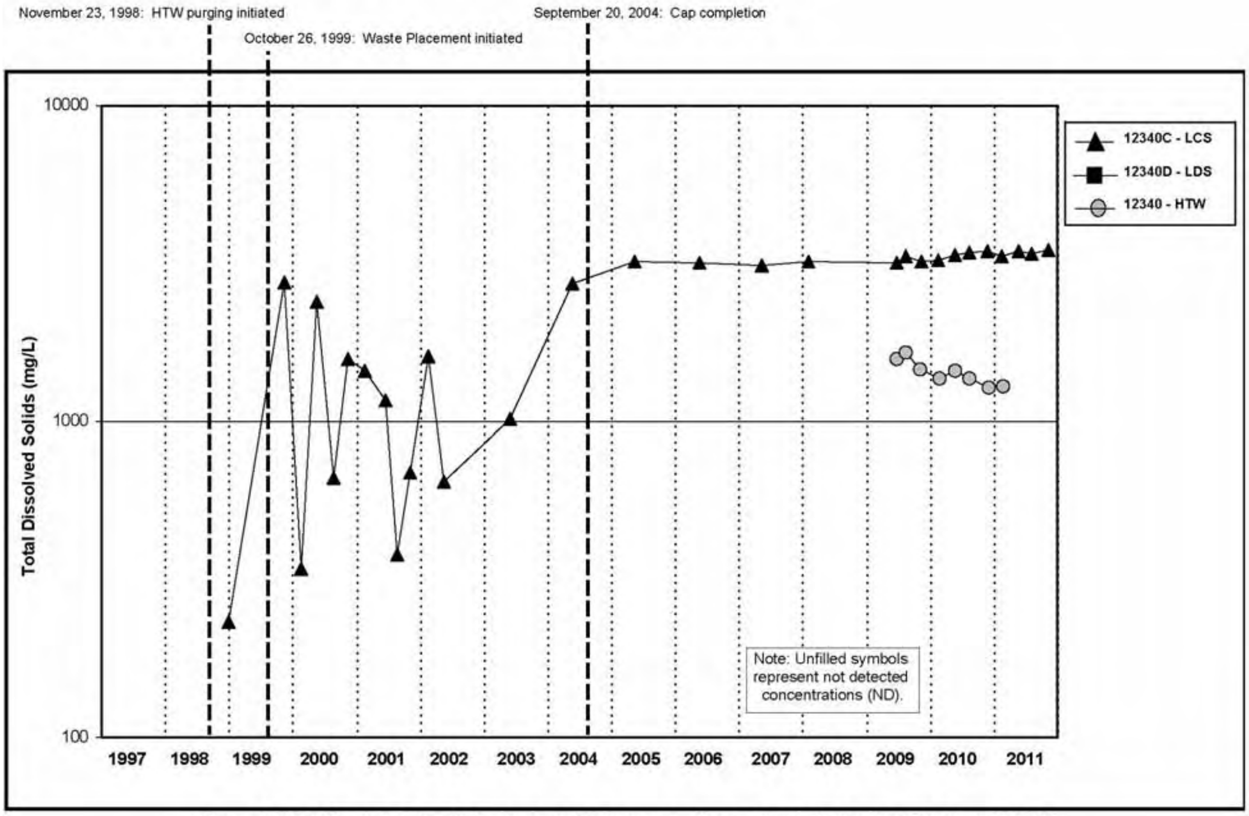


Figure A.5.3-12A. Cell 3 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

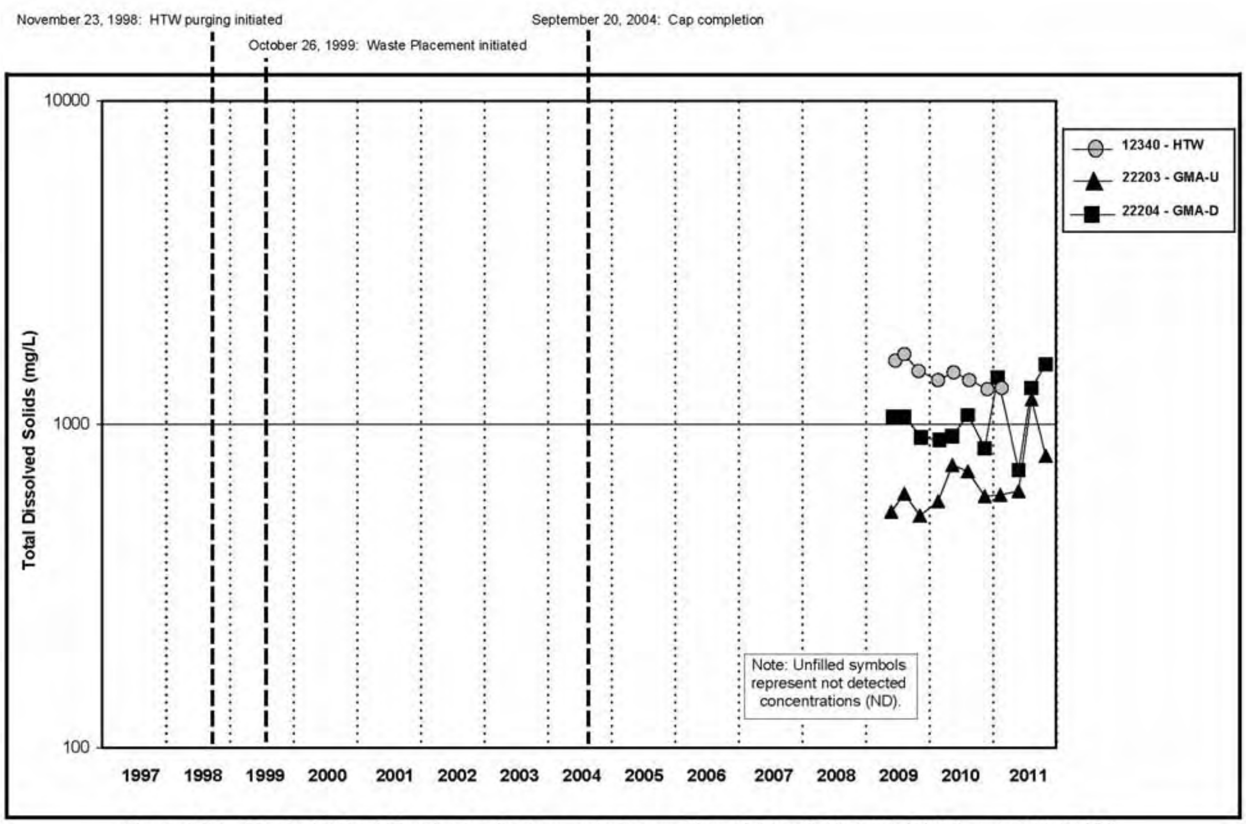


Figure A.5.3-12B. Cell 3 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

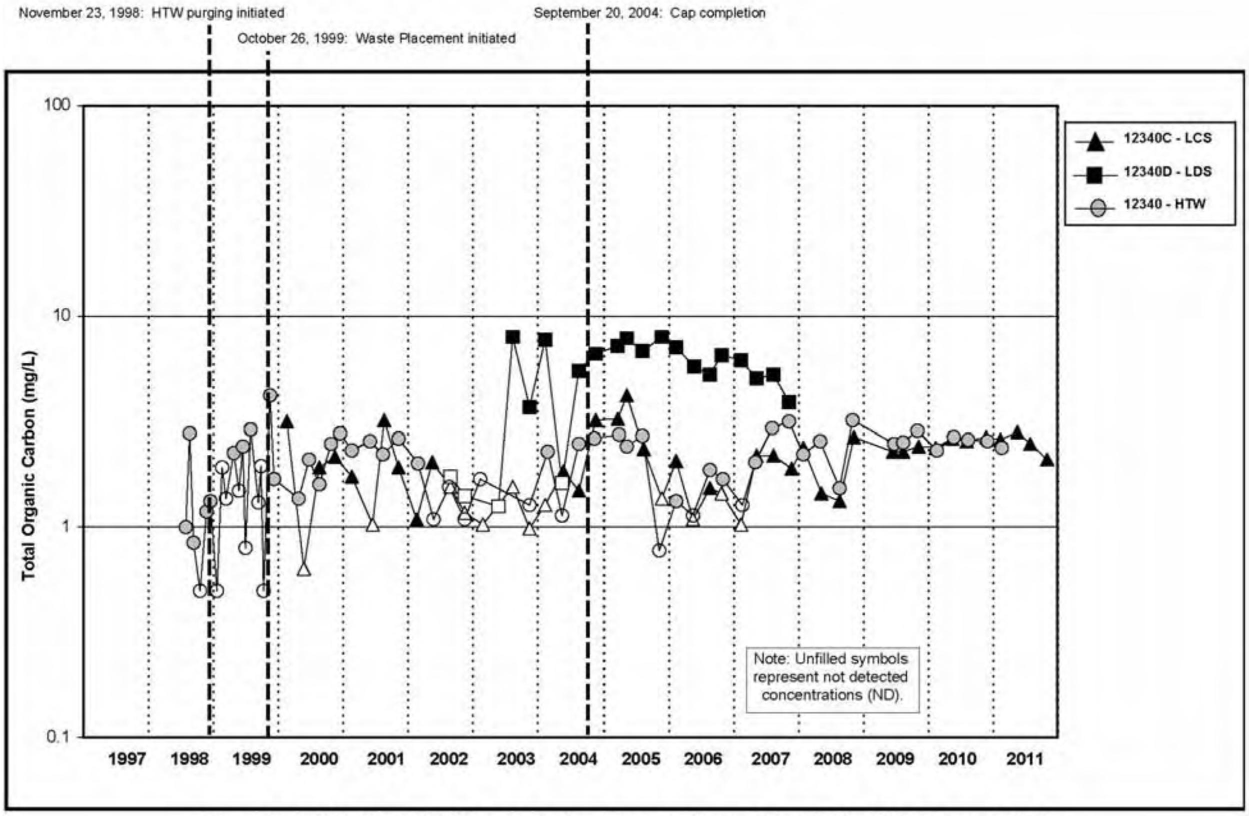


Figure A.5.3-13A. Cell 3 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

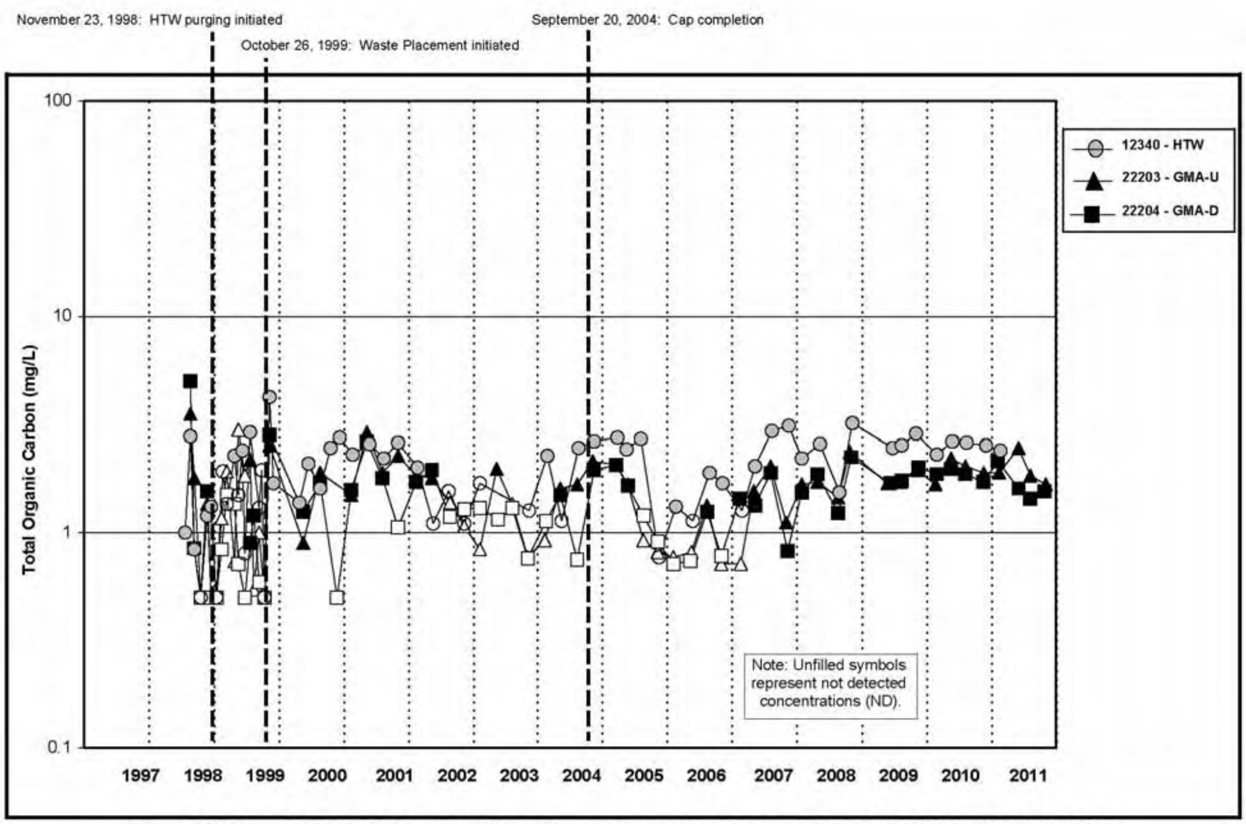


Figure A.5.3-13B. Cell 3 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

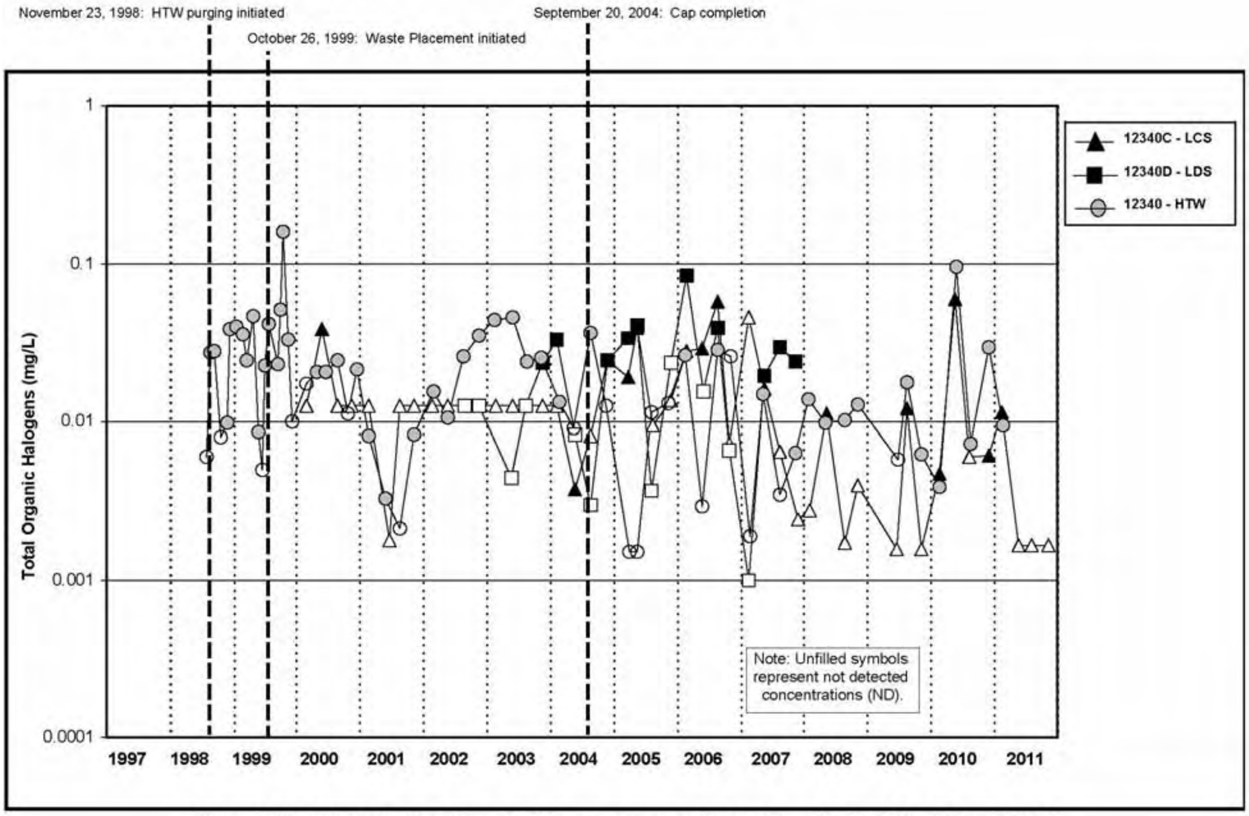


Figure A.5.3-14A. Cell 3 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

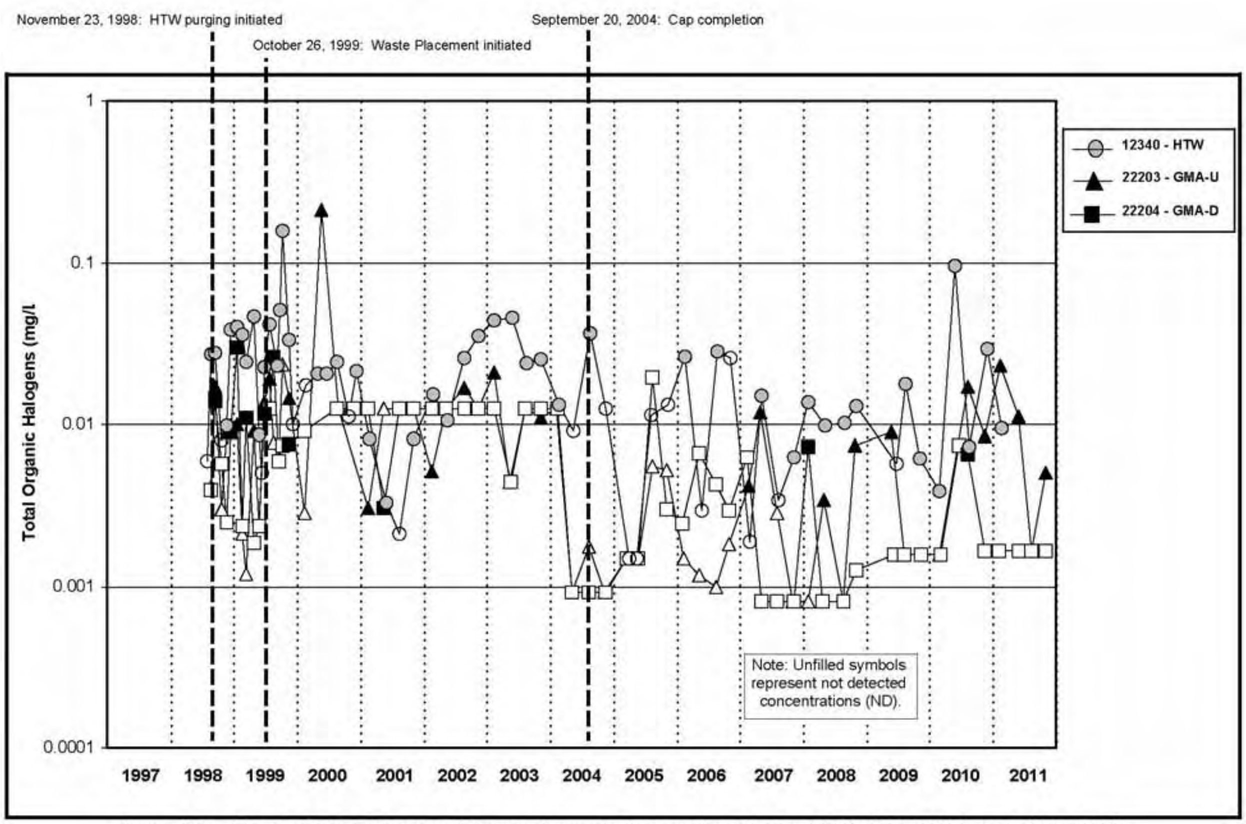


Figure A.5.3-14B. Cell 3 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

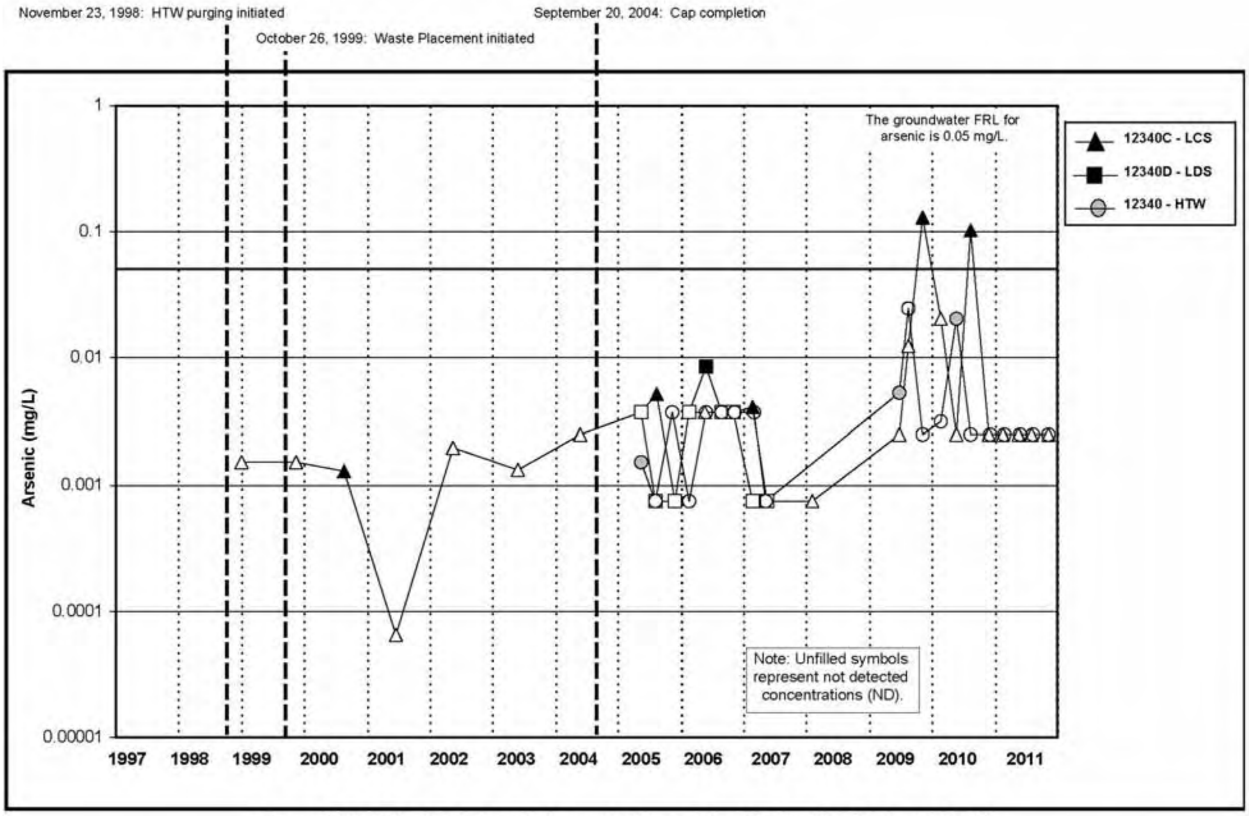


Figure A.5.3-15A. Cell 3 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

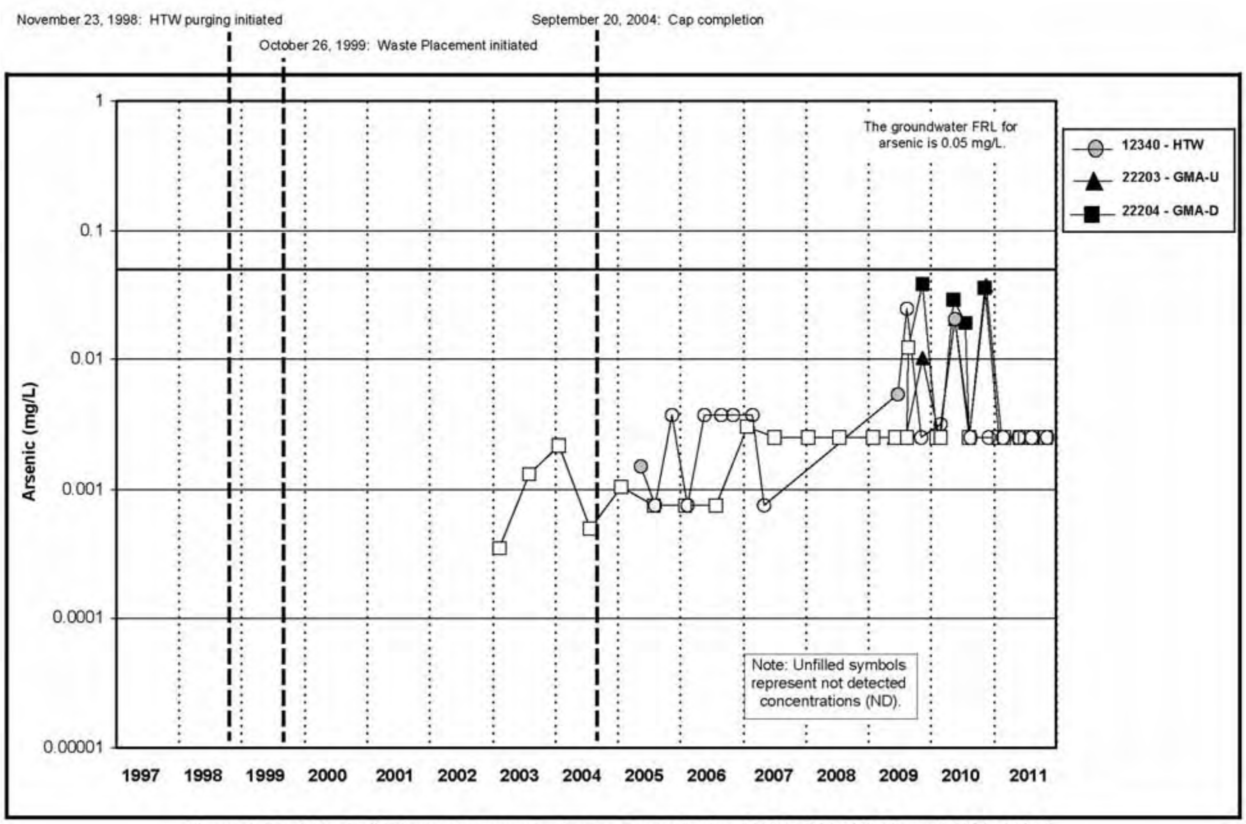


Figure A.5.3-15B. Cell 3 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

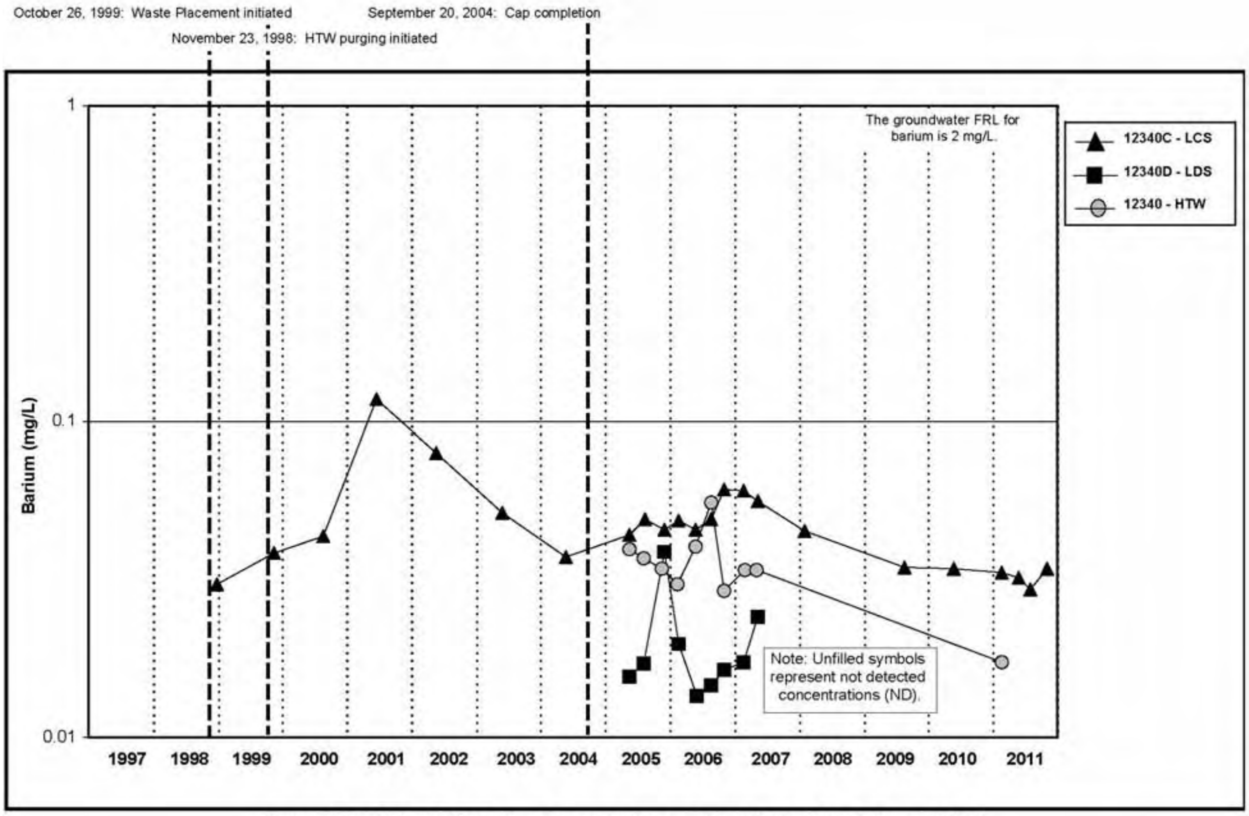


Figure A.5.3-16A. Cell 3 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

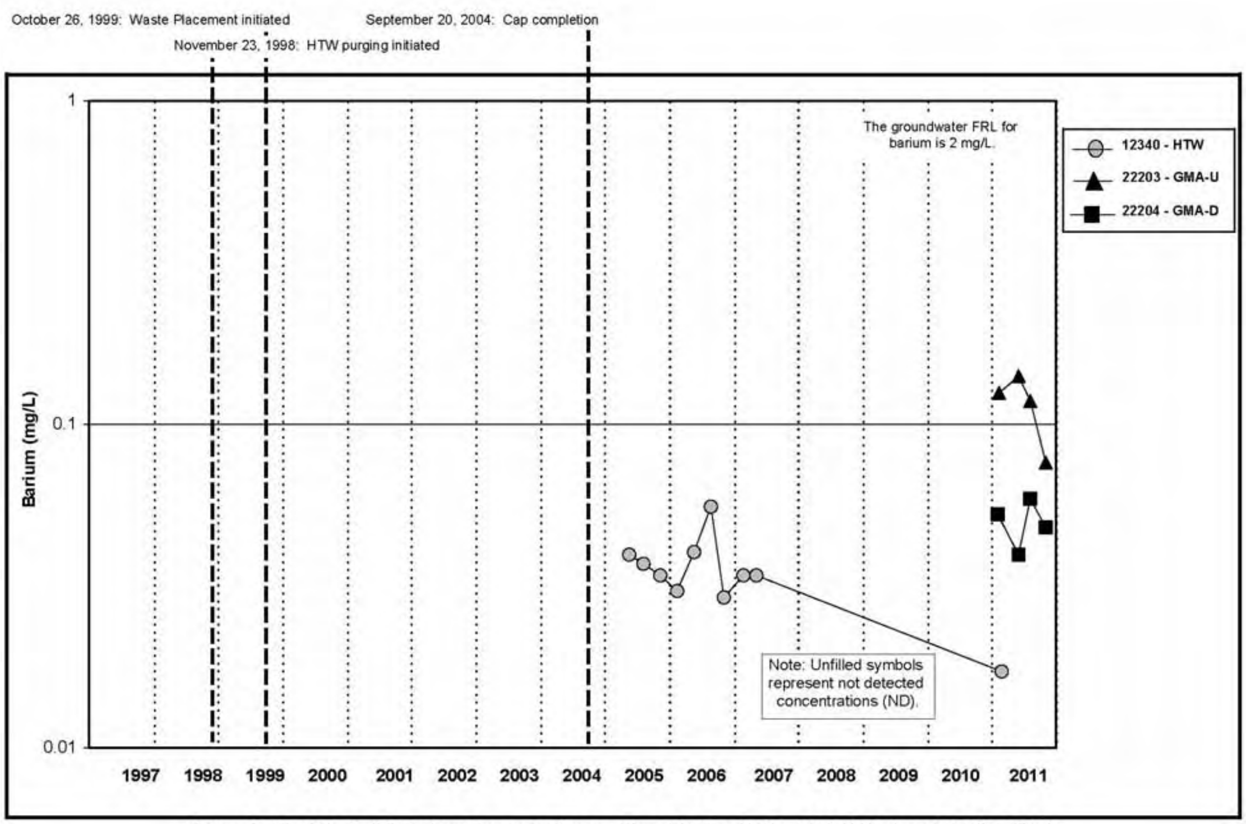


Figure A.5.3-16B. Cell 3 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

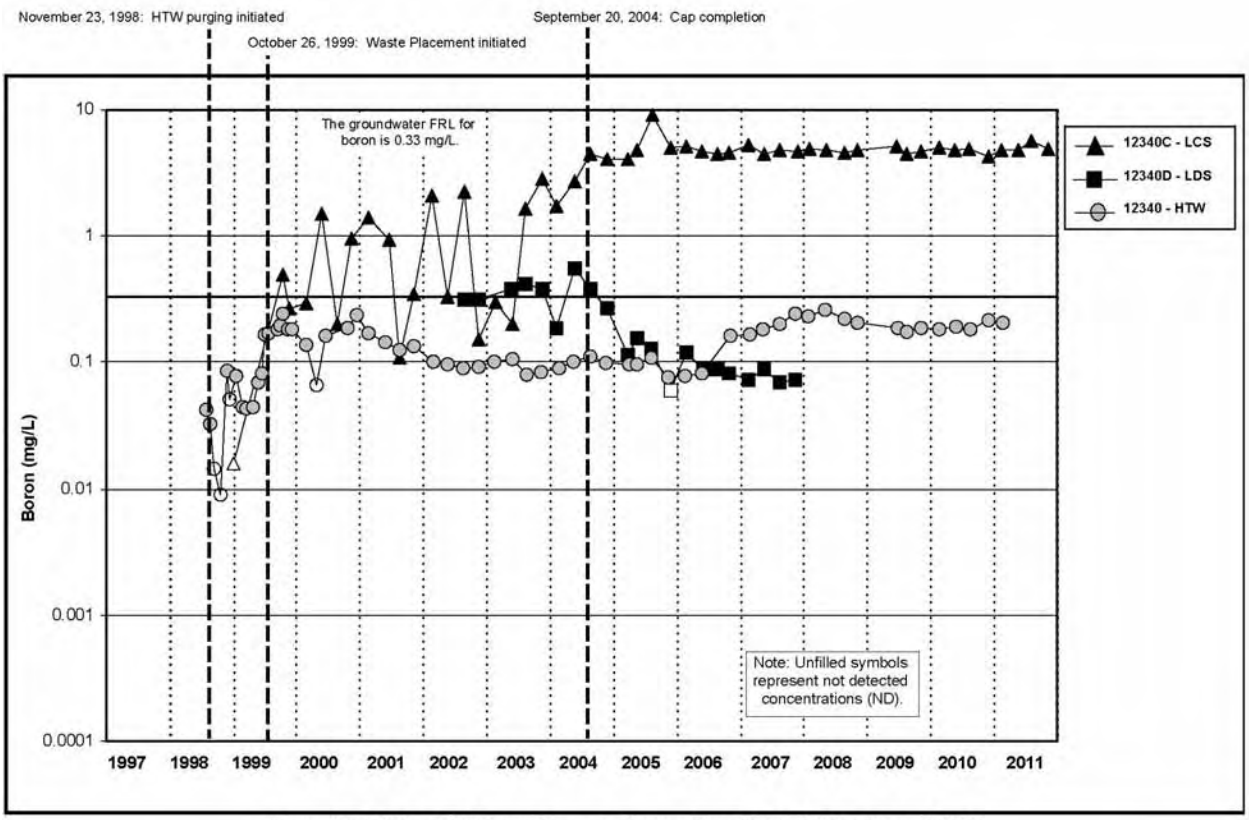


Figure A.5.3-17A. Cell 3 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

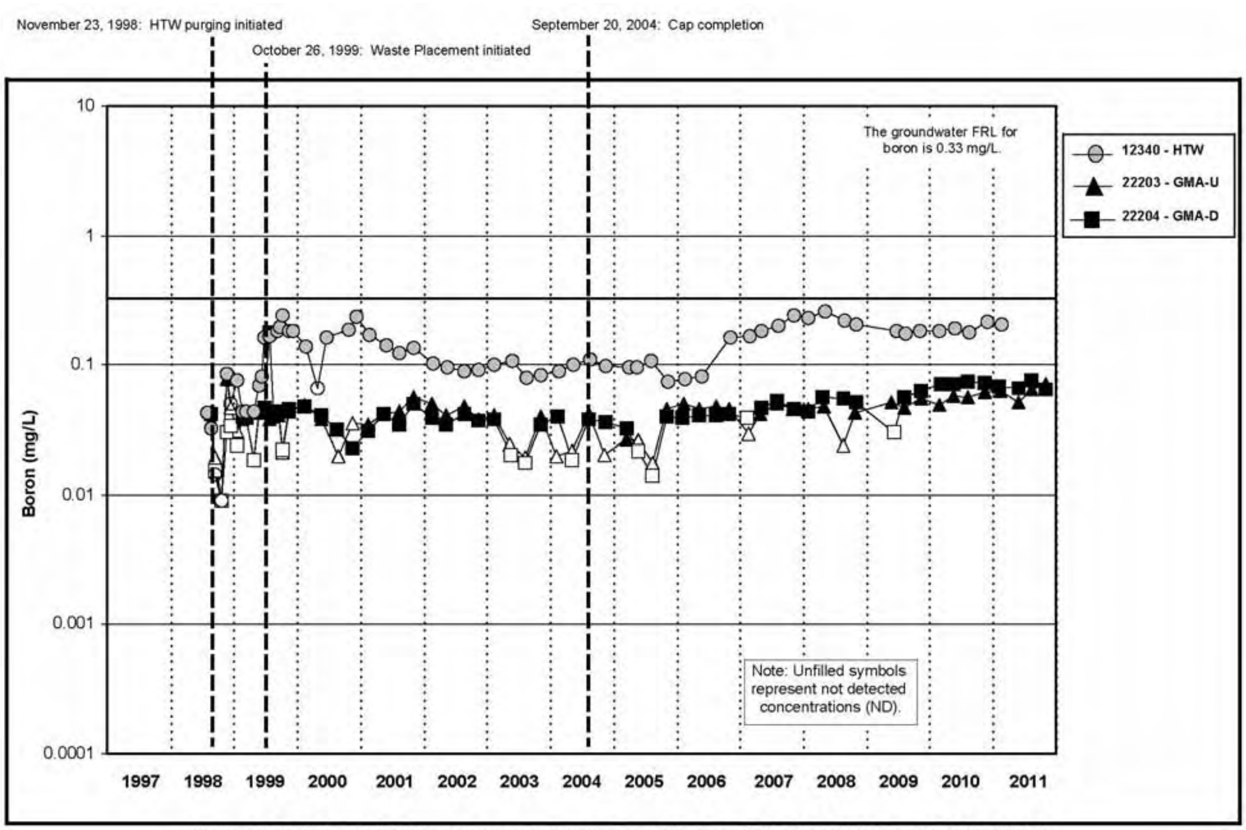


Figure A.5.3-17B. Cell 3 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

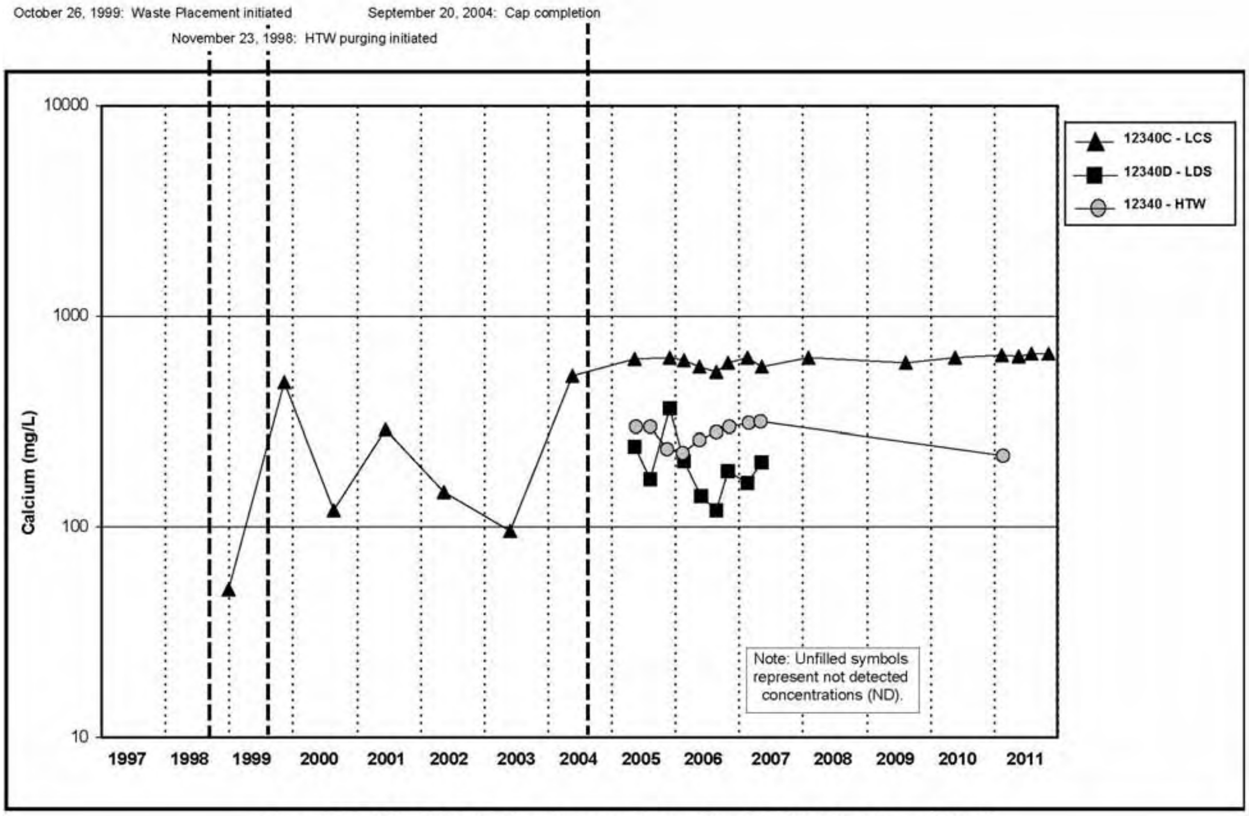


Figure A.5.3-18A. Cell 3 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

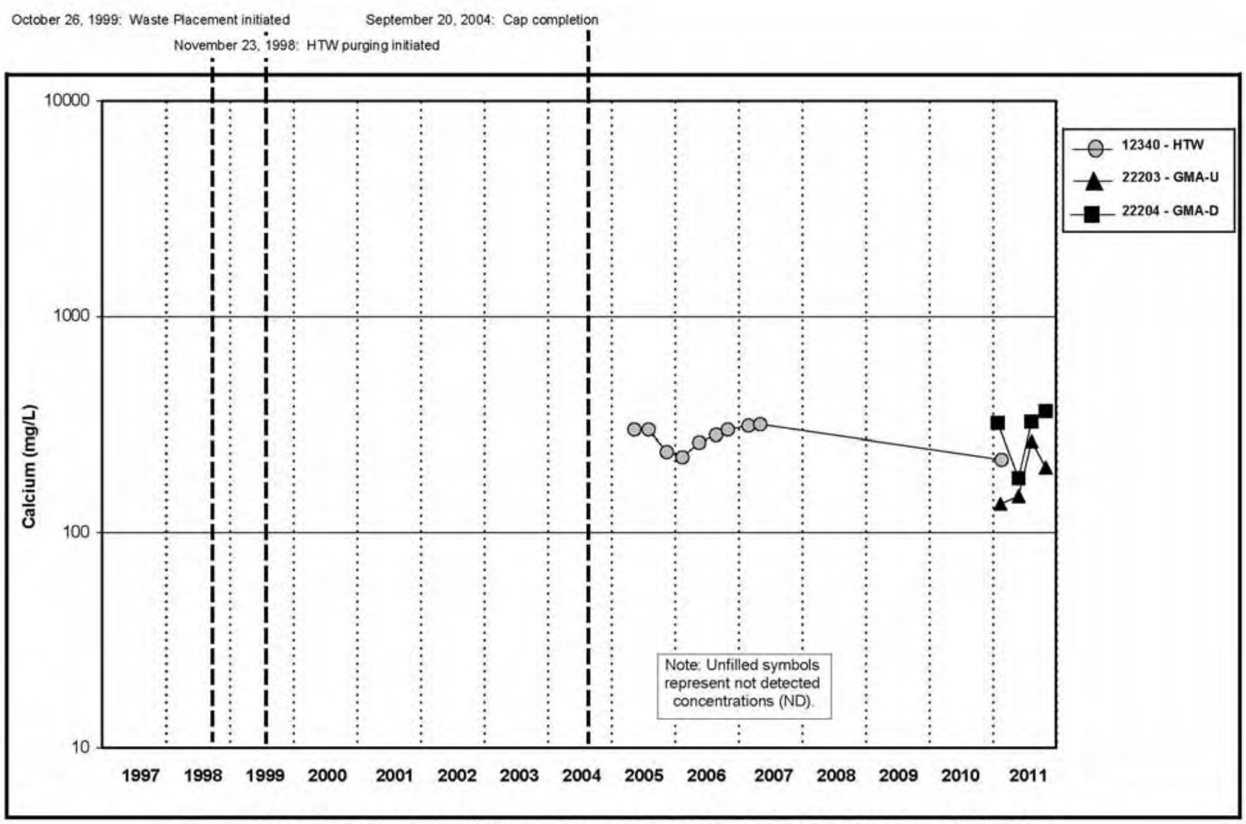


Figure A.5.3-18B. Cell 3 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

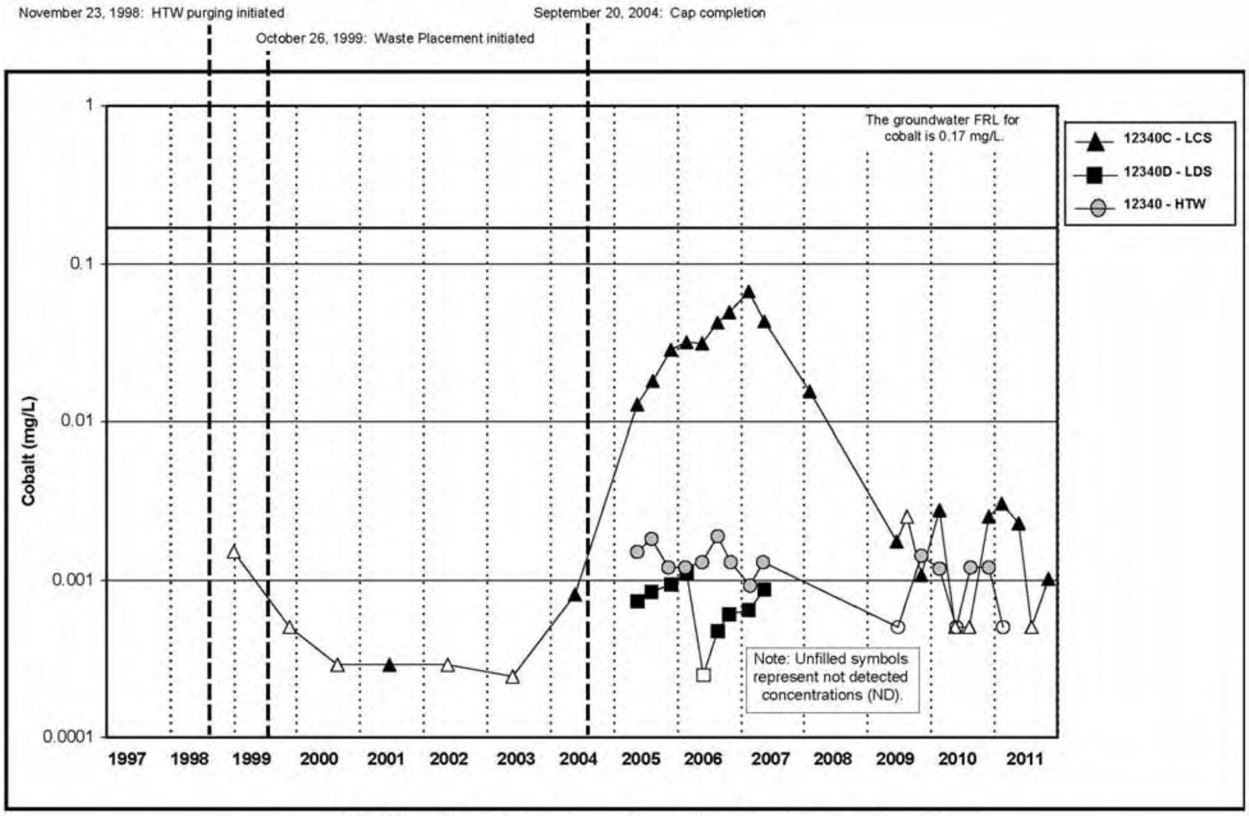


Figure A.5.3-19A. Cell 3 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

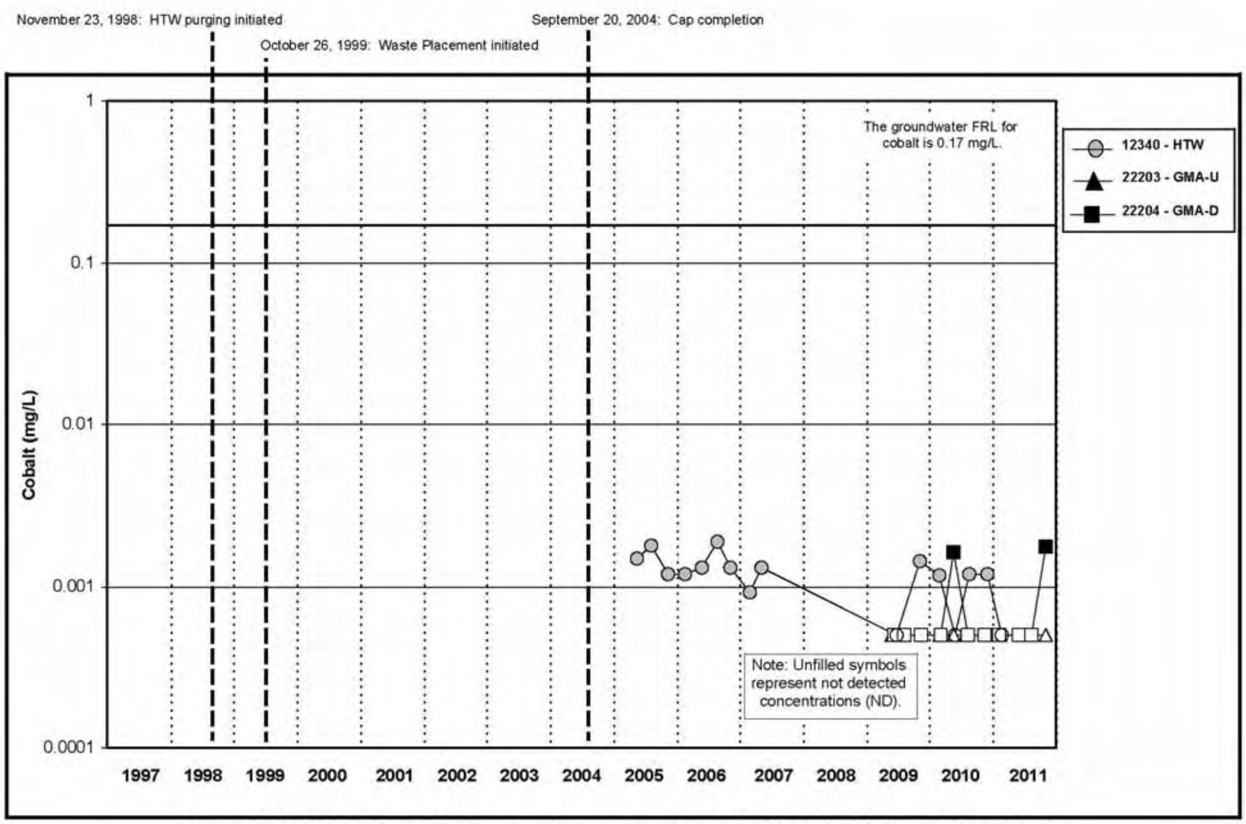


Figure A.5.3-19B. Cell 3 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

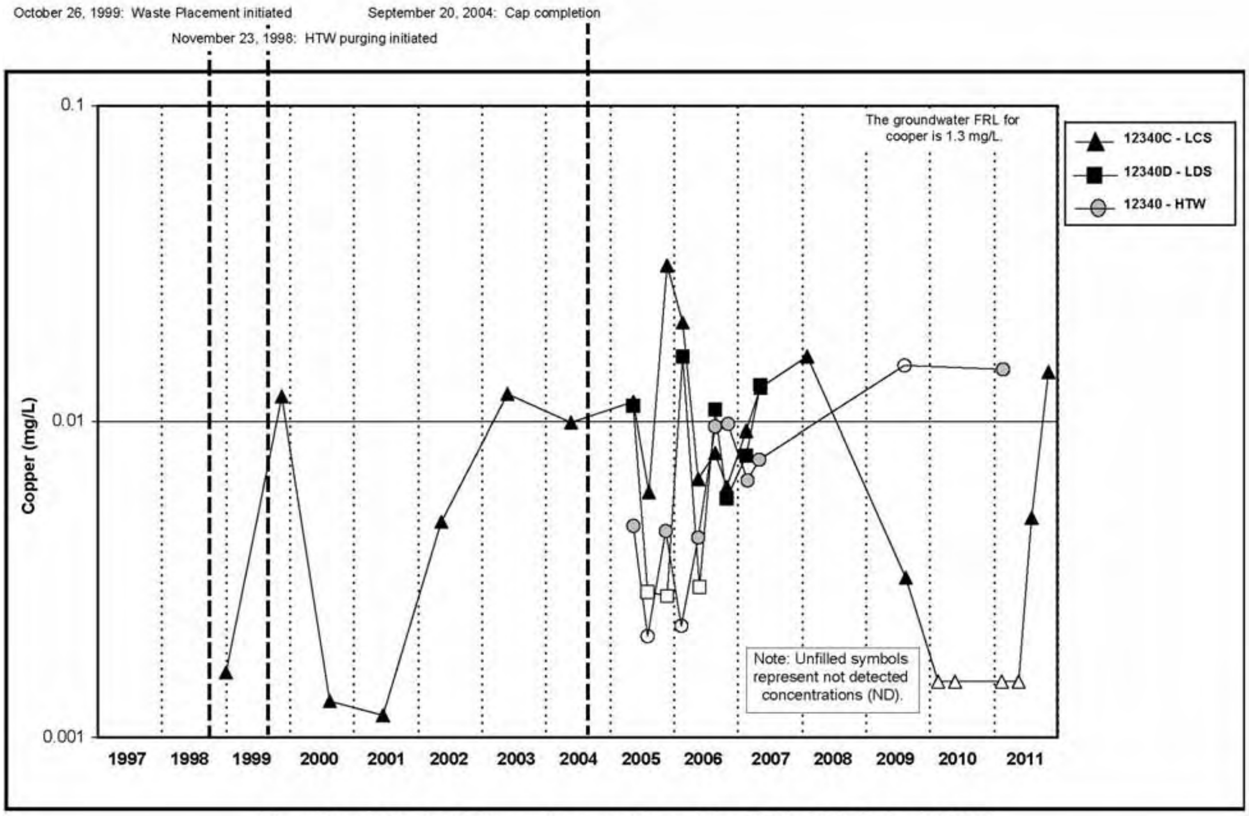


Figure A.5.3-20A. Cell 3 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

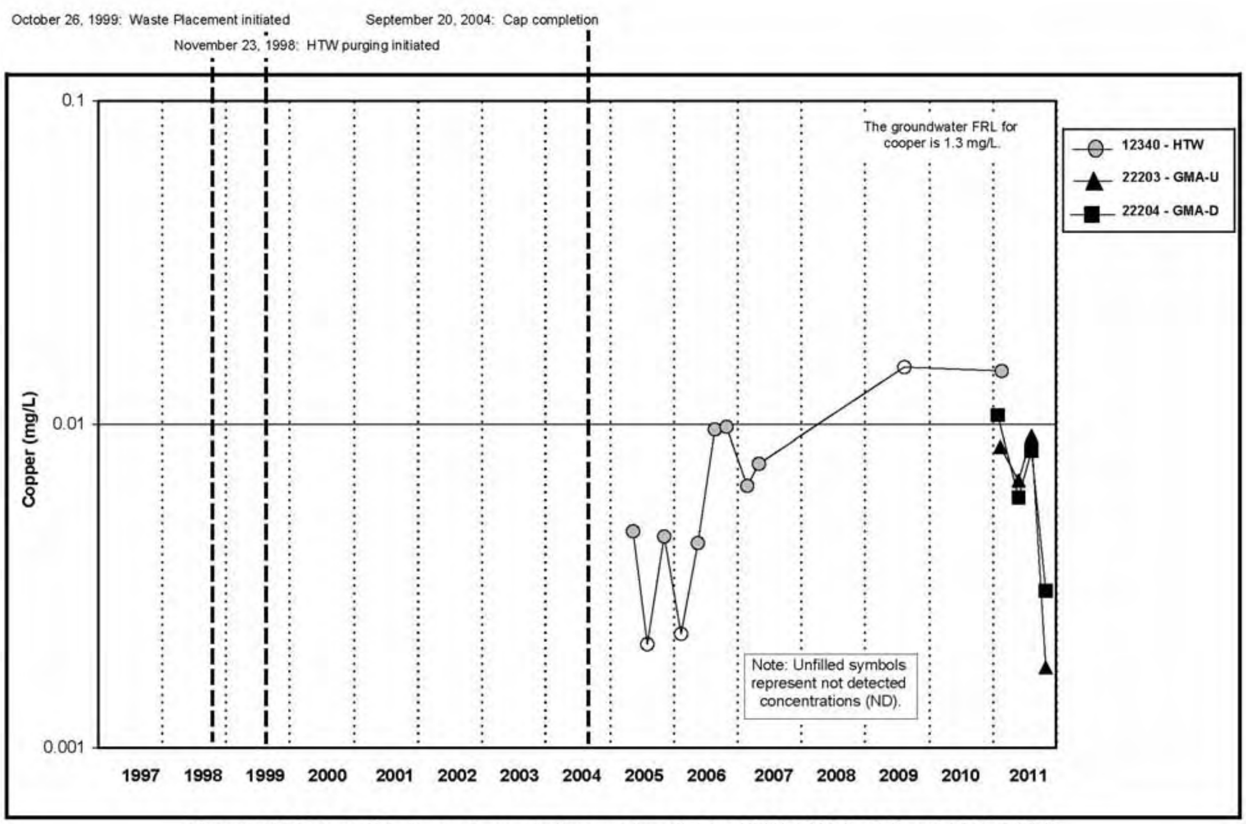


Figure A.5.3-20B. Cell 3 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

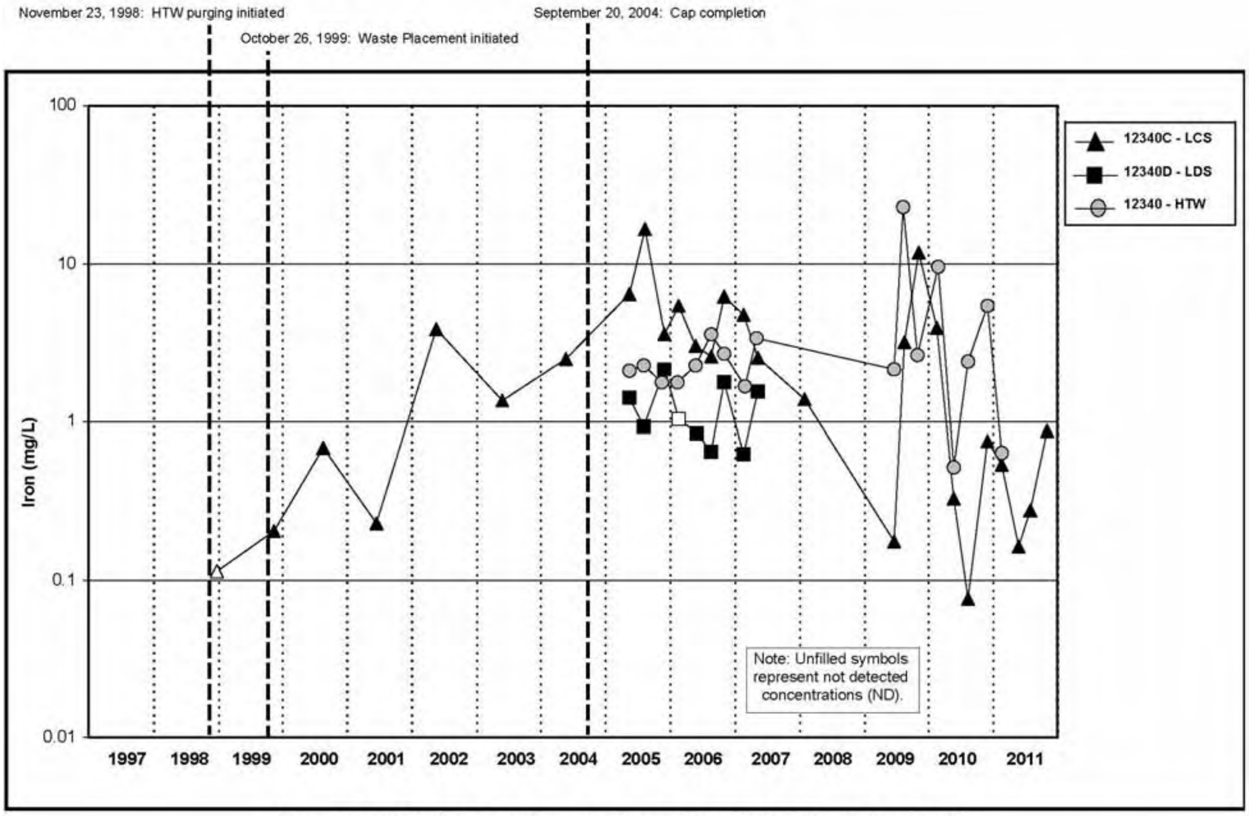


Figure A.5.3-21A. Cell 3 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

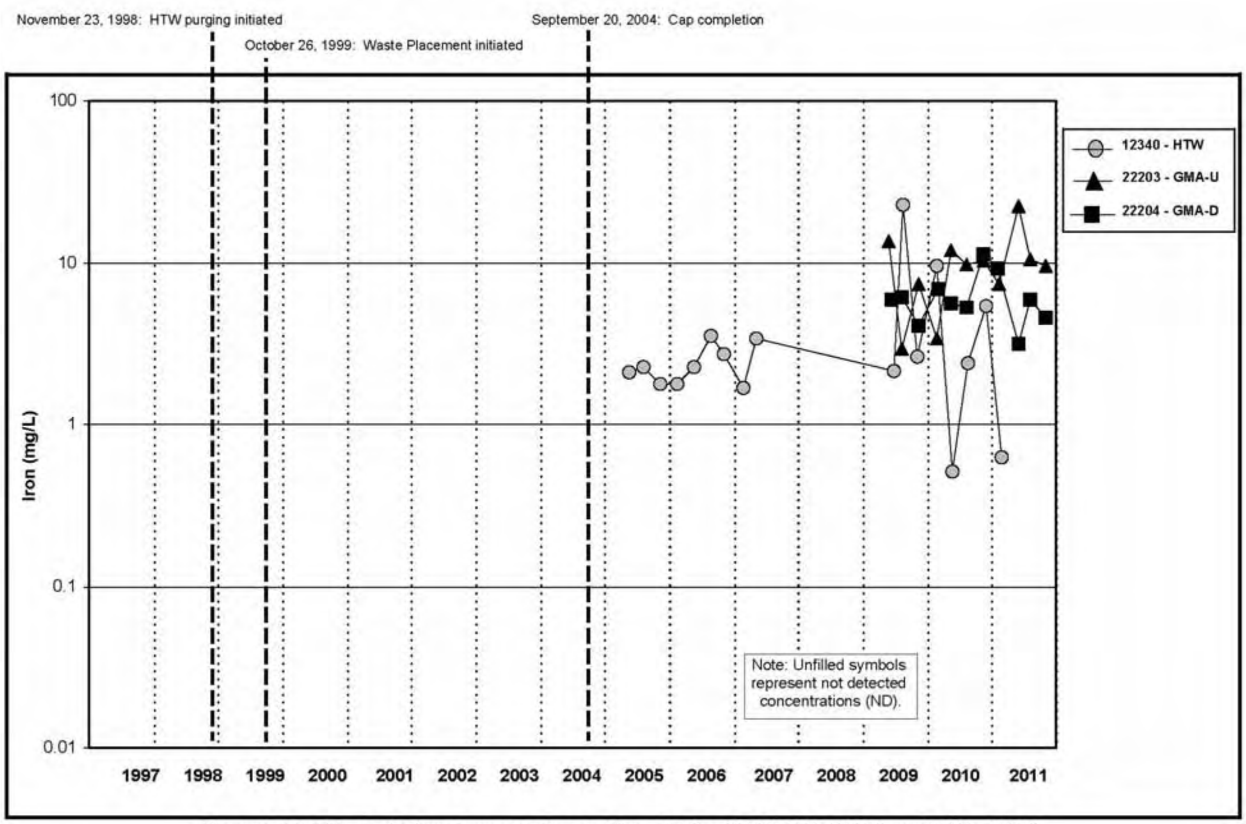


Figure A.5.3-21B. Cell 3 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

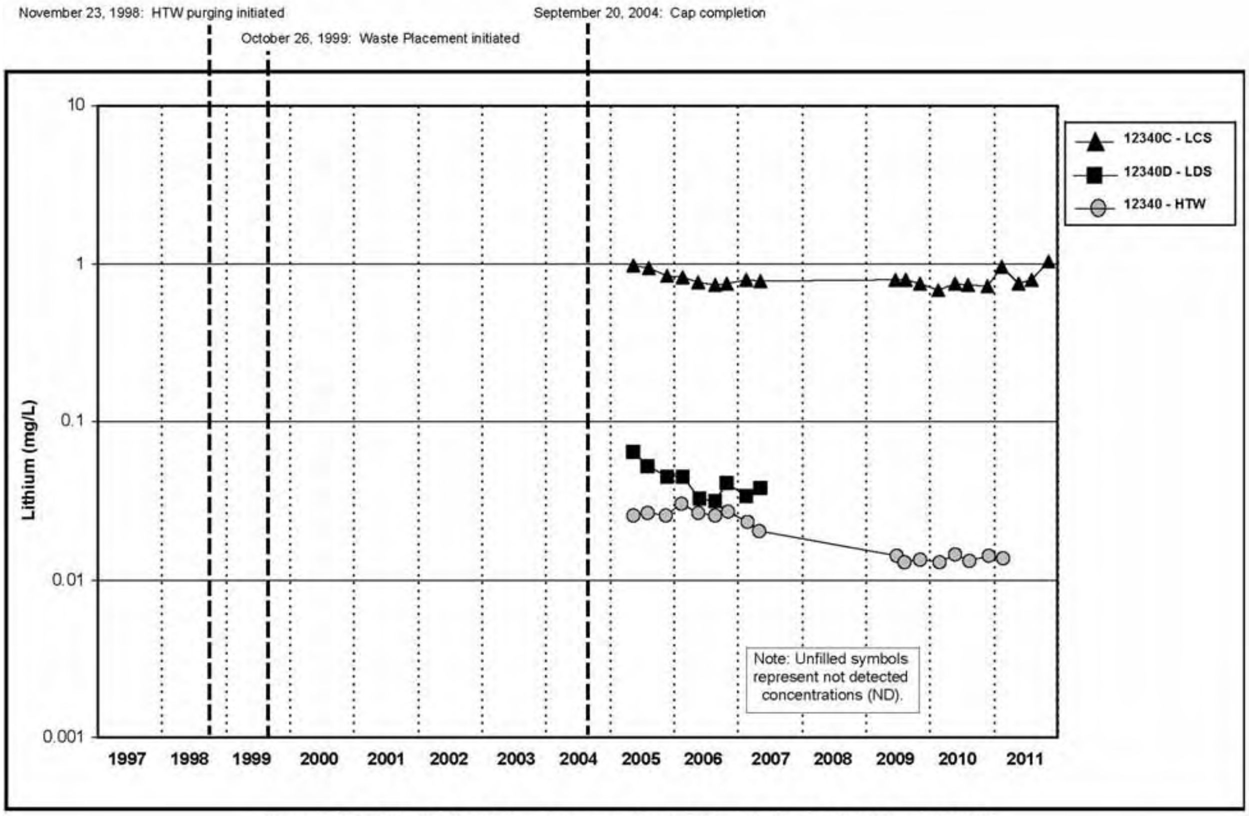


Figure A.5.3-22A. Cell 3 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

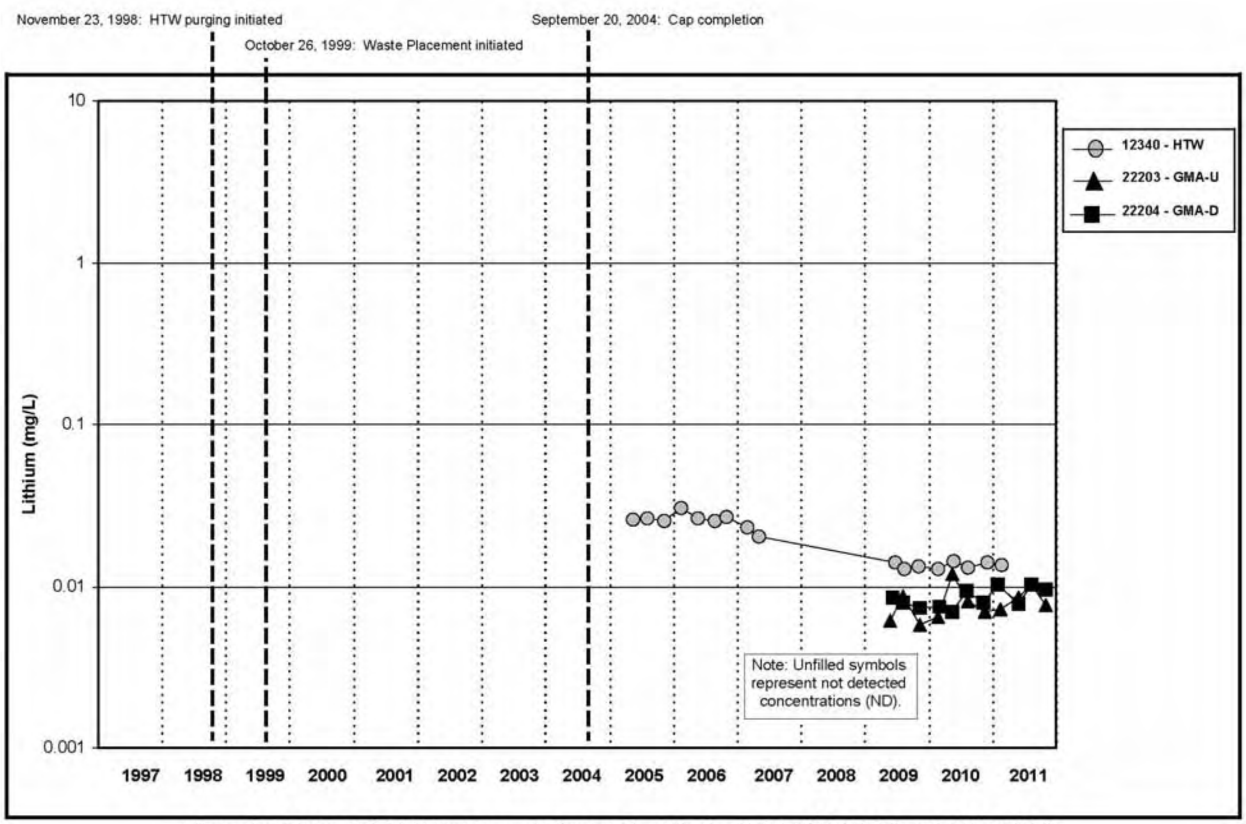


Figure A.5.3-22B. Cell 3 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

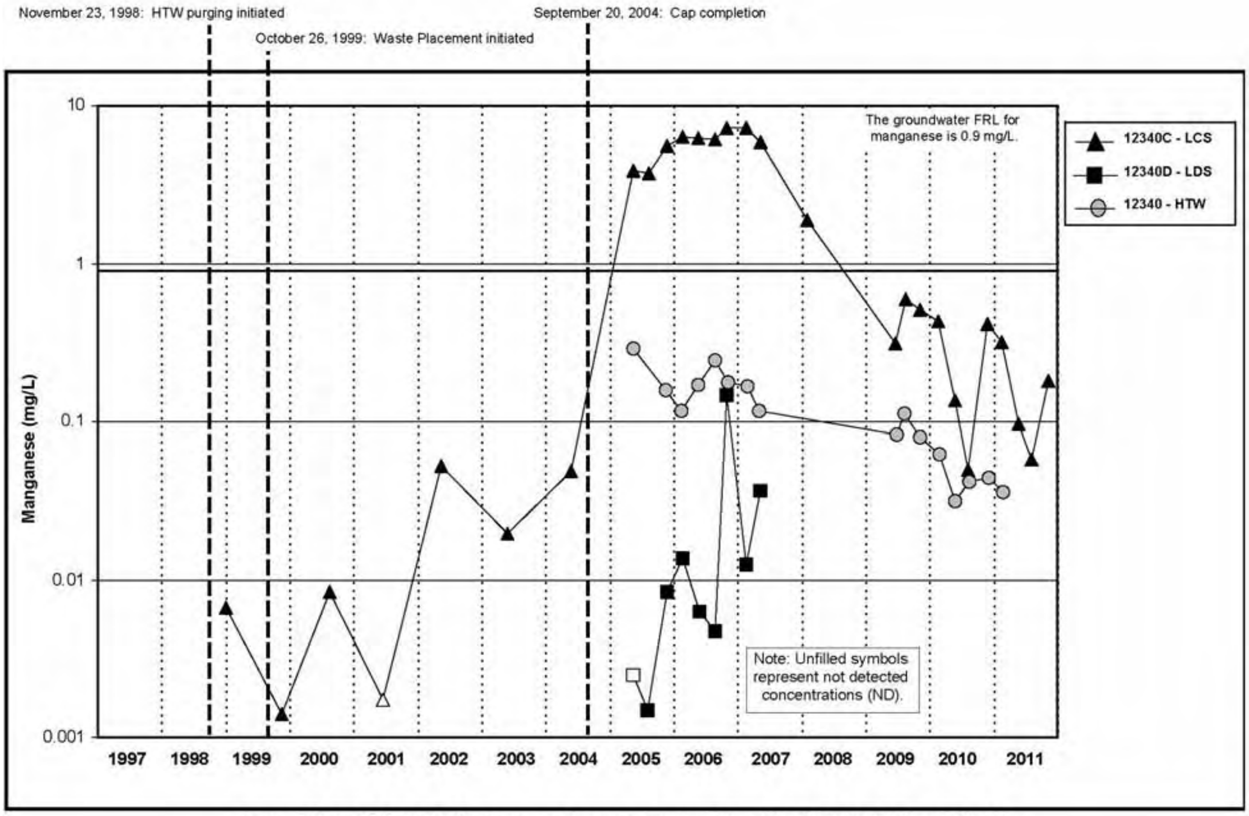


Figure A.5.3-23A. Cell 3 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

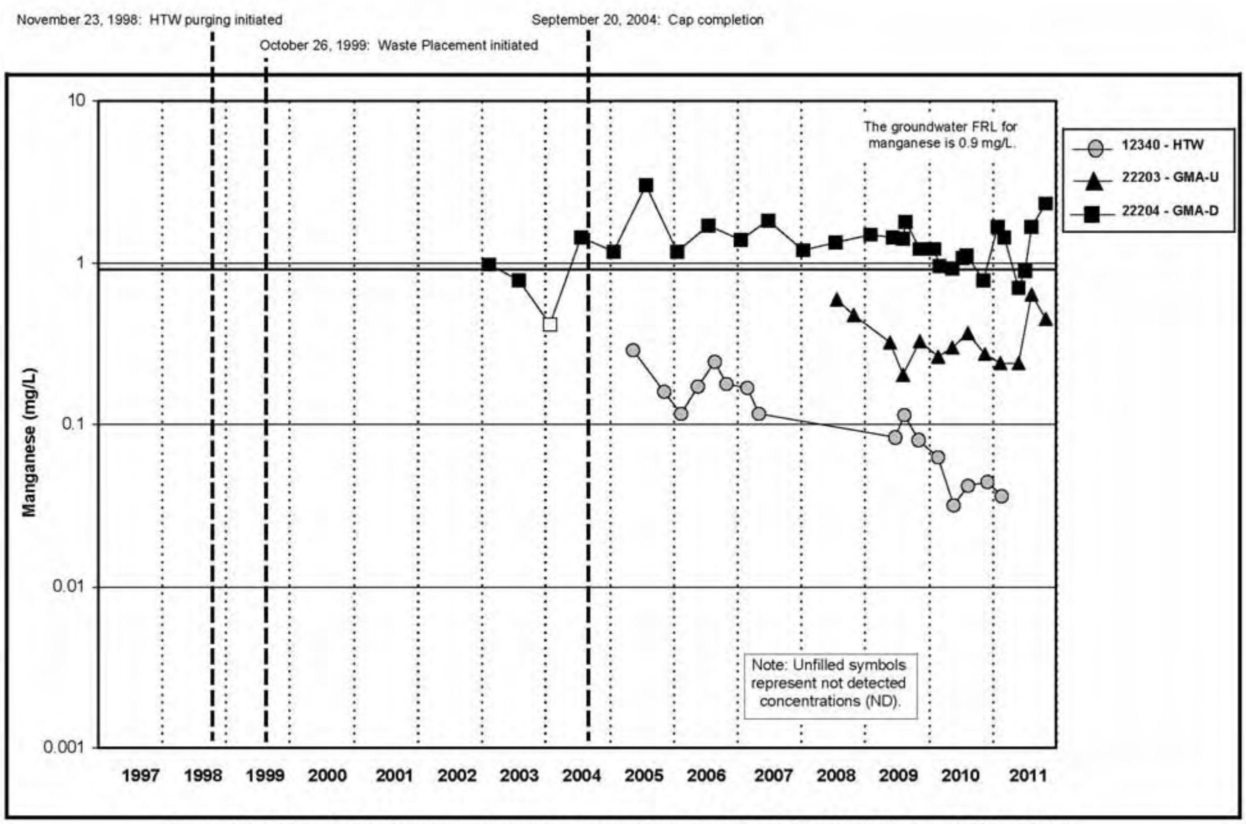


Figure A.5.3-23B. Cell 3 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

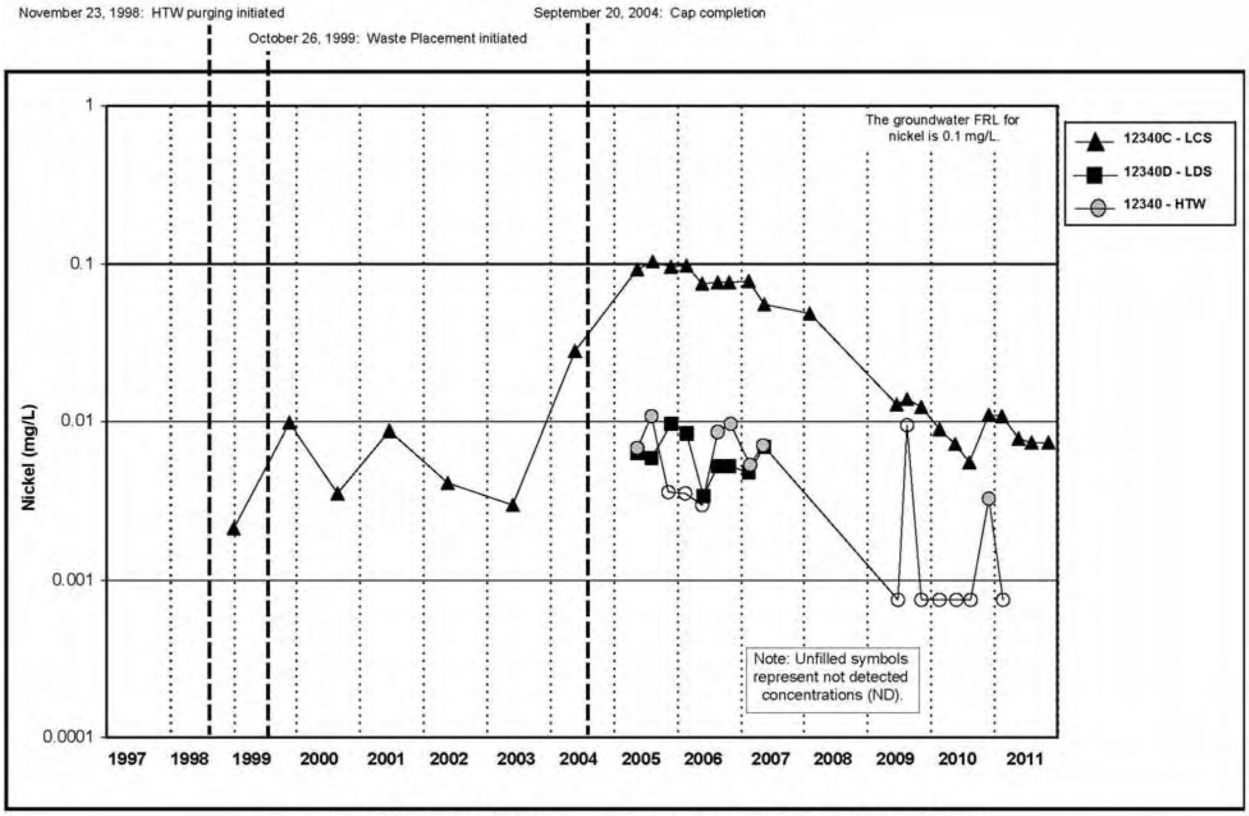


Figure A.5.3-24A. Cell 3 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

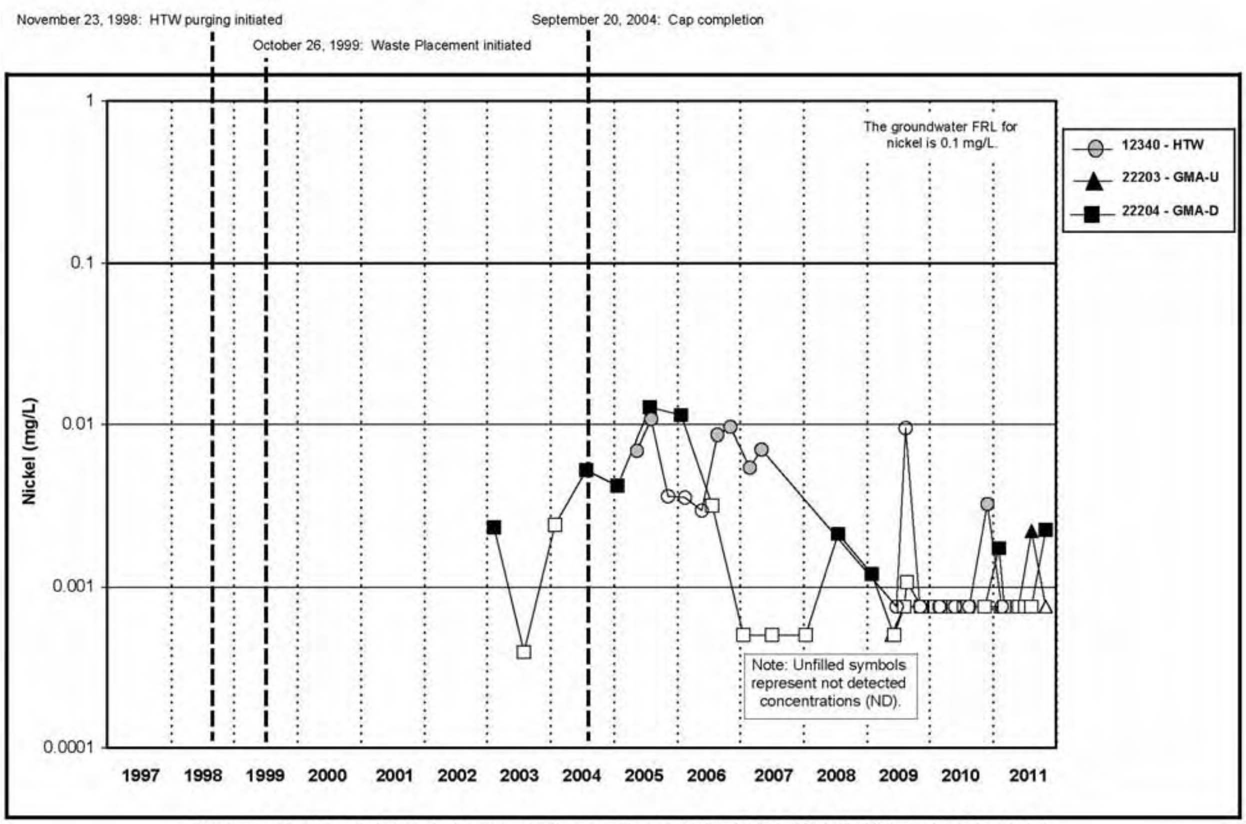


Figure A.5.3-24B. Cell 3 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

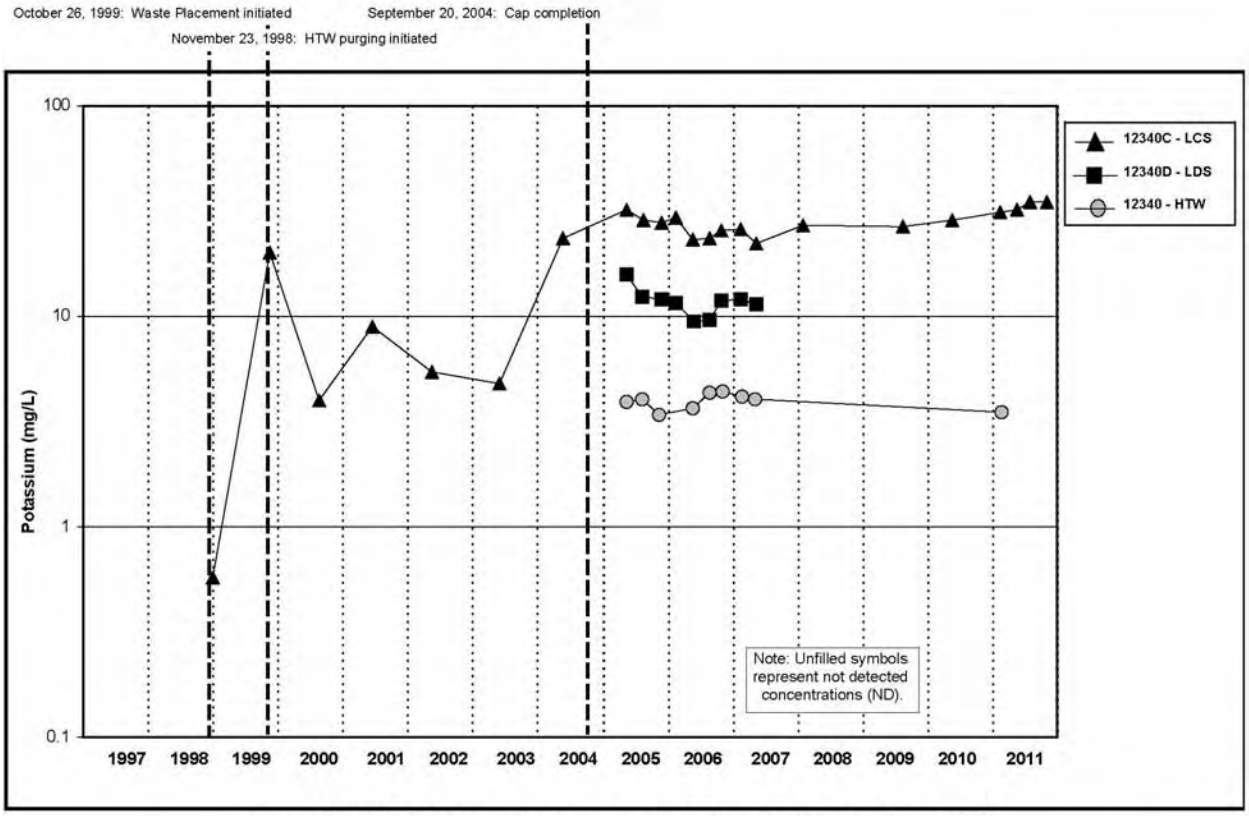


Figure A.5.3-25A. Cell 3 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

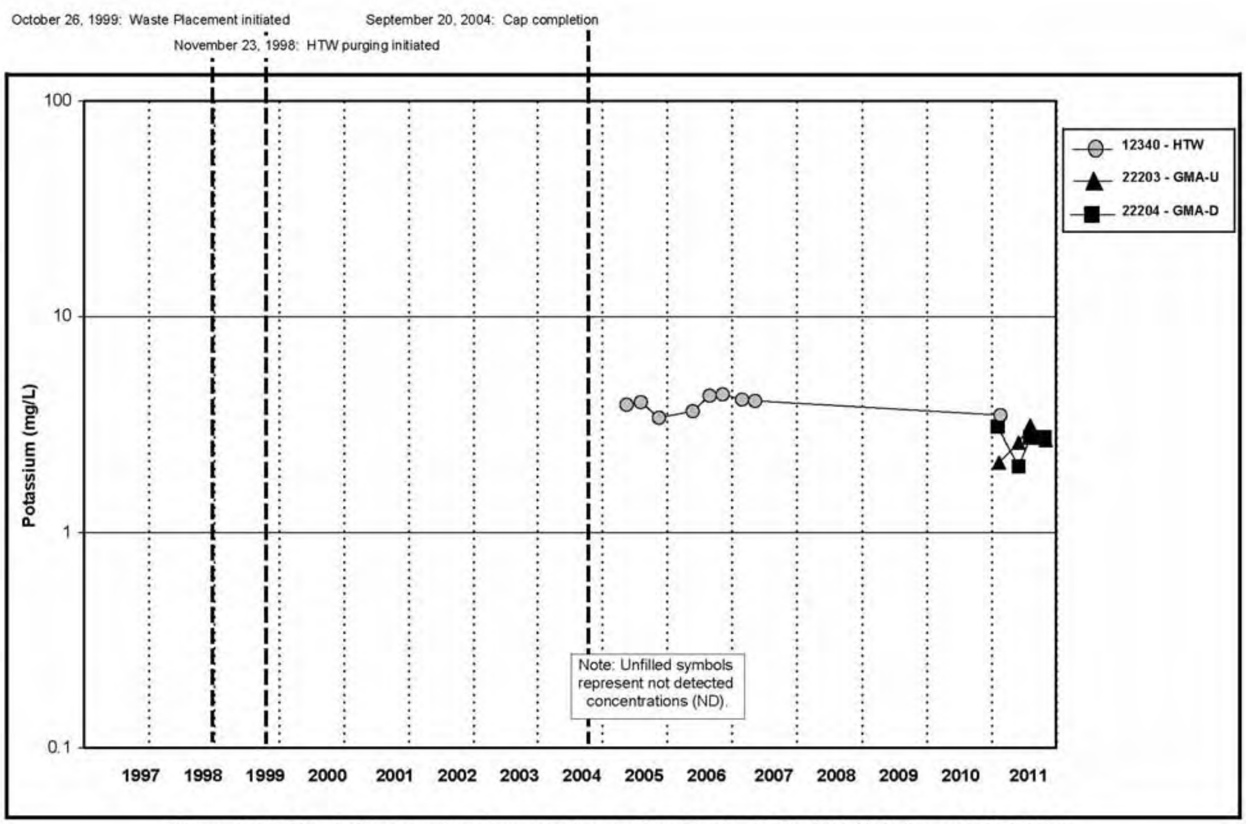


Figure A.5.3-25B. Cell 3 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

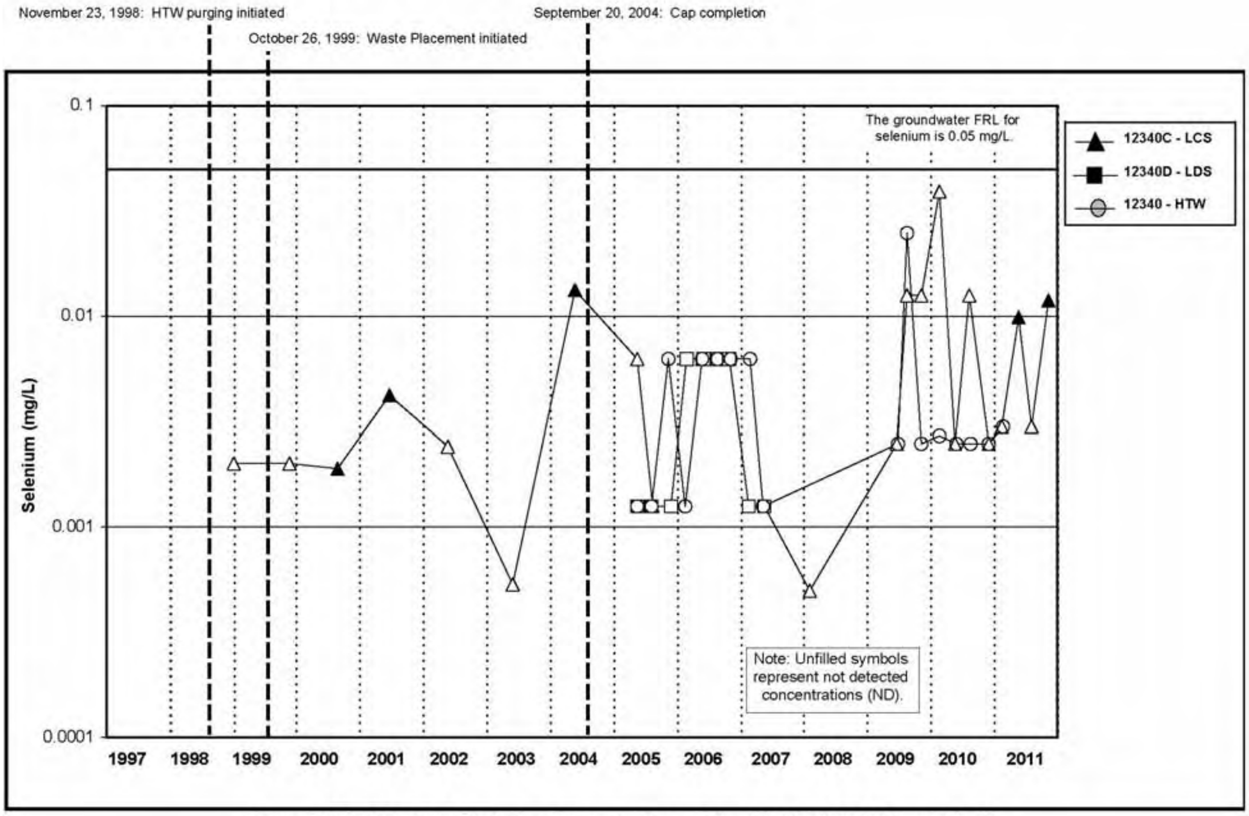


Figure A.5.3-26A. Cell 3 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

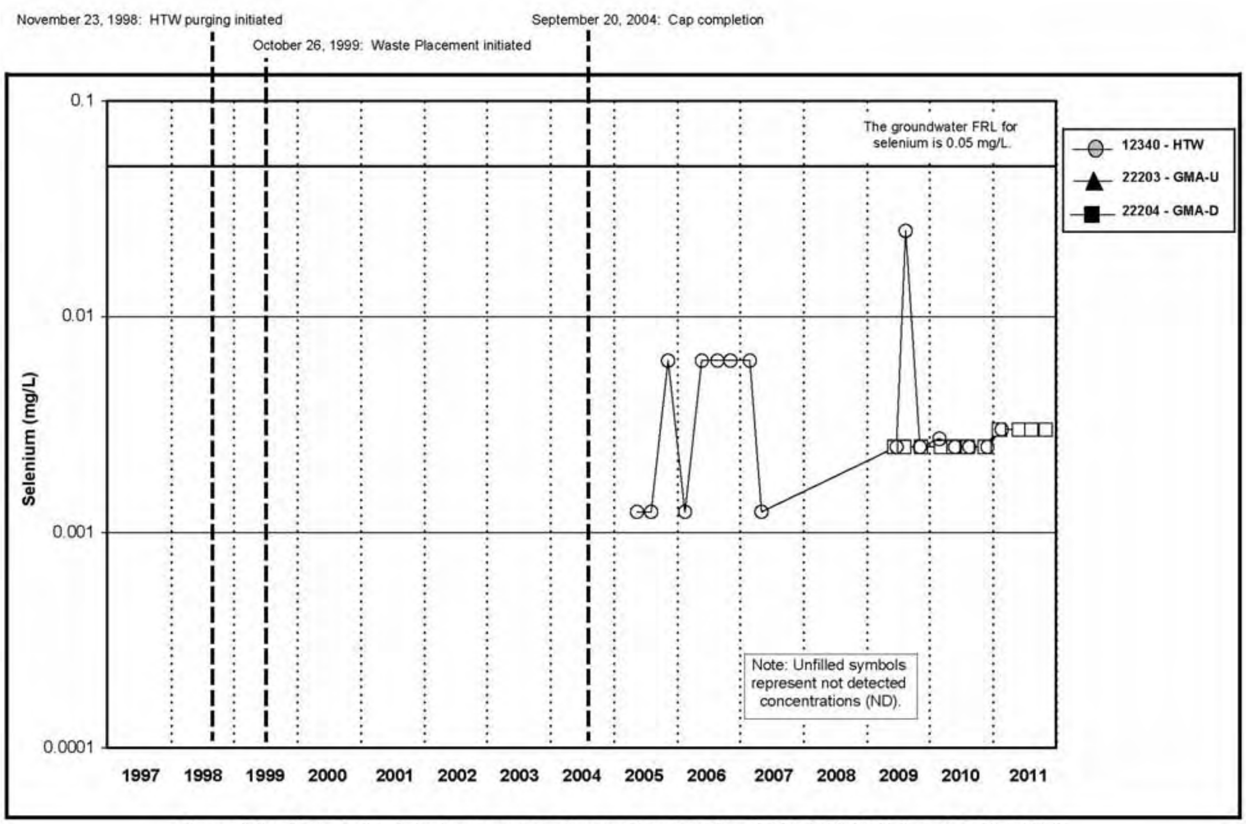


Figure A.5.3-26B. Cell 3 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

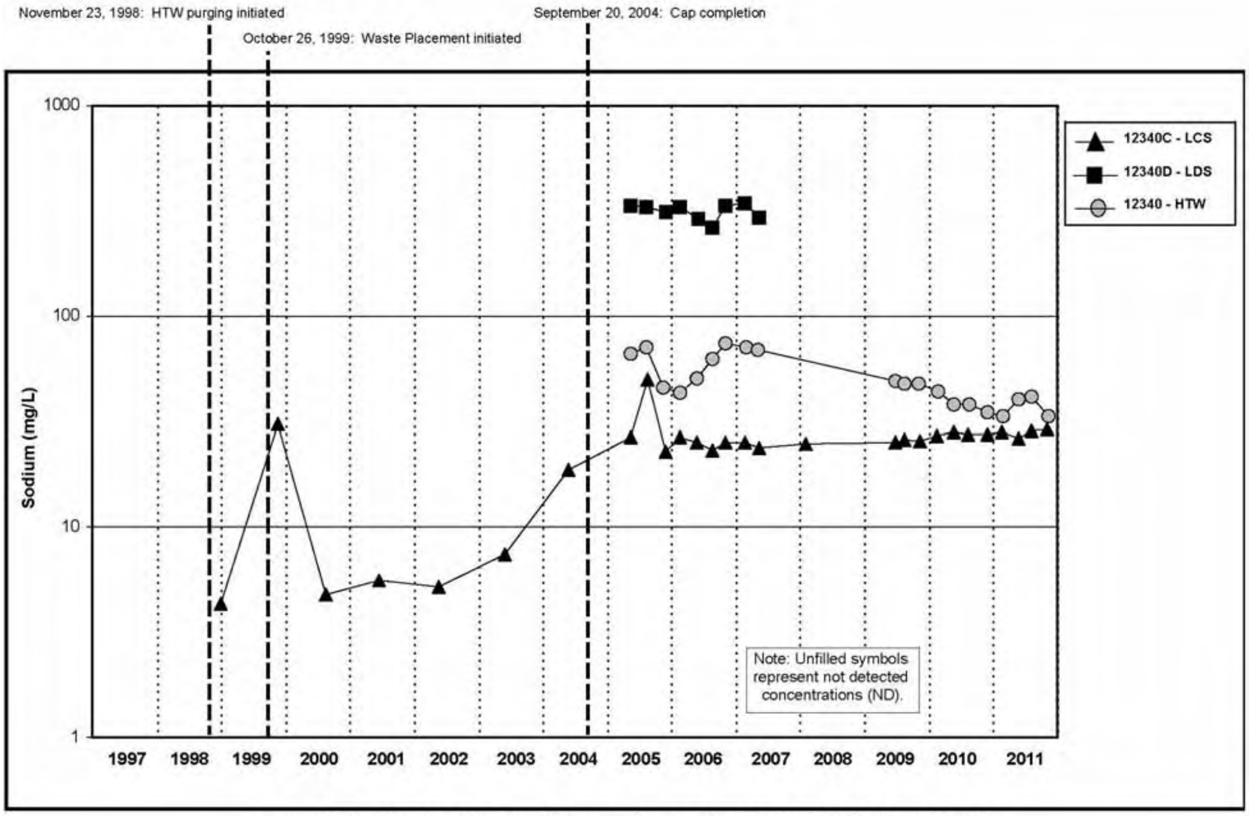


Figure A.5.3-27A. Cell 3 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

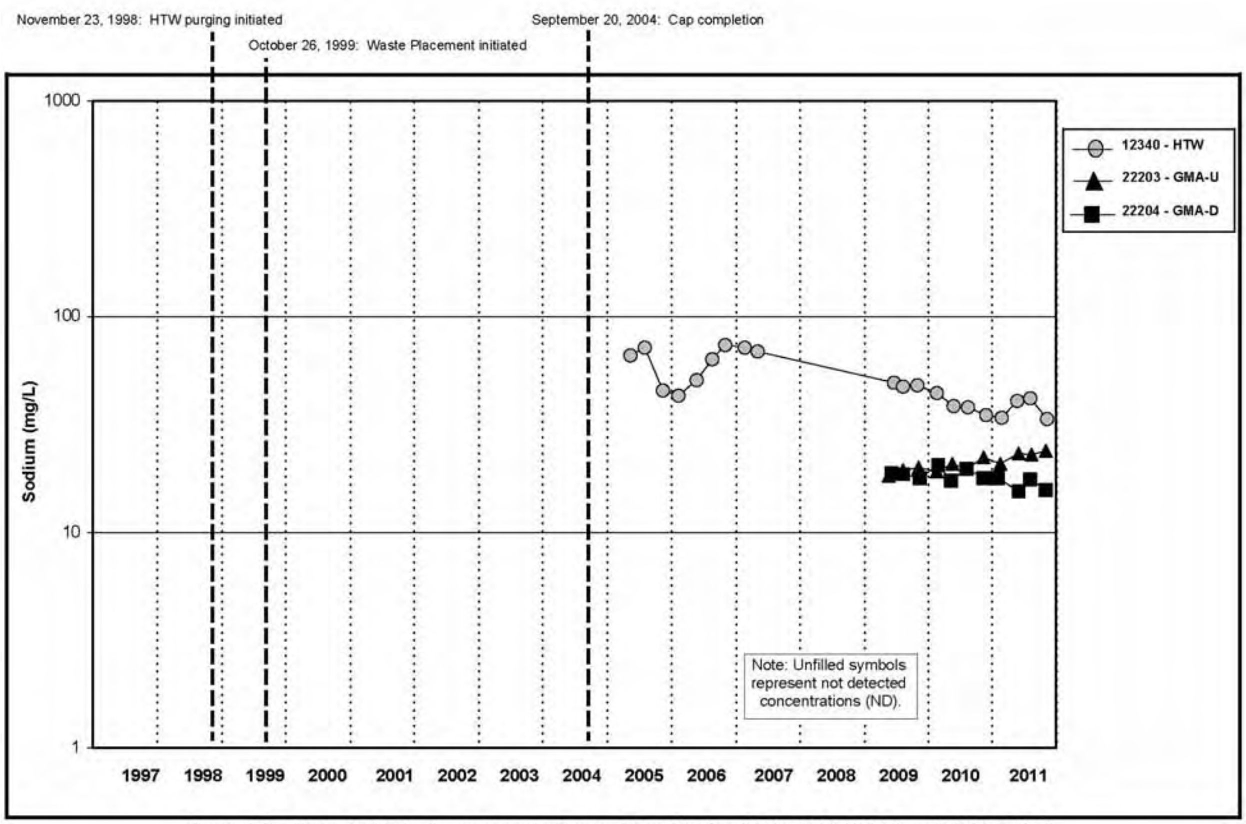


Figure A.5.3-27B. Cell 3 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

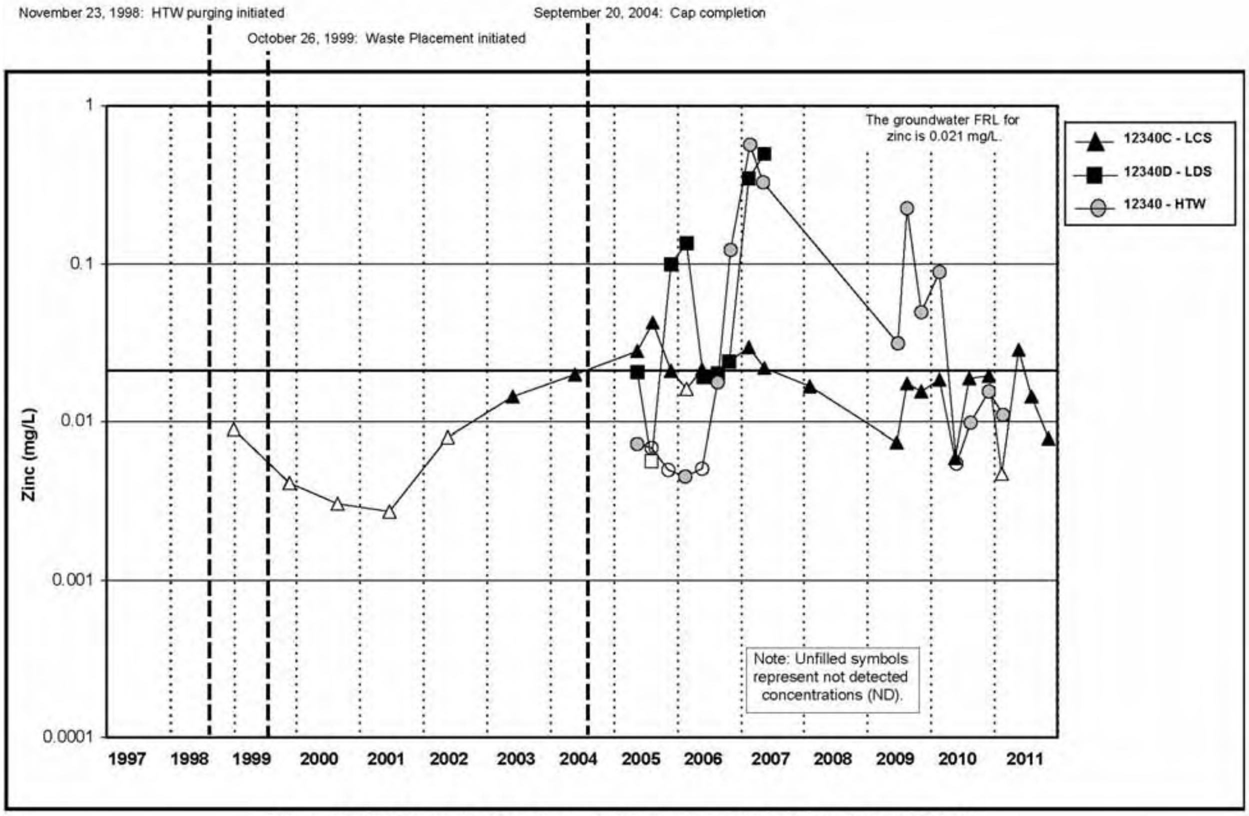


Figure A.5.3-28A. Cell 3 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

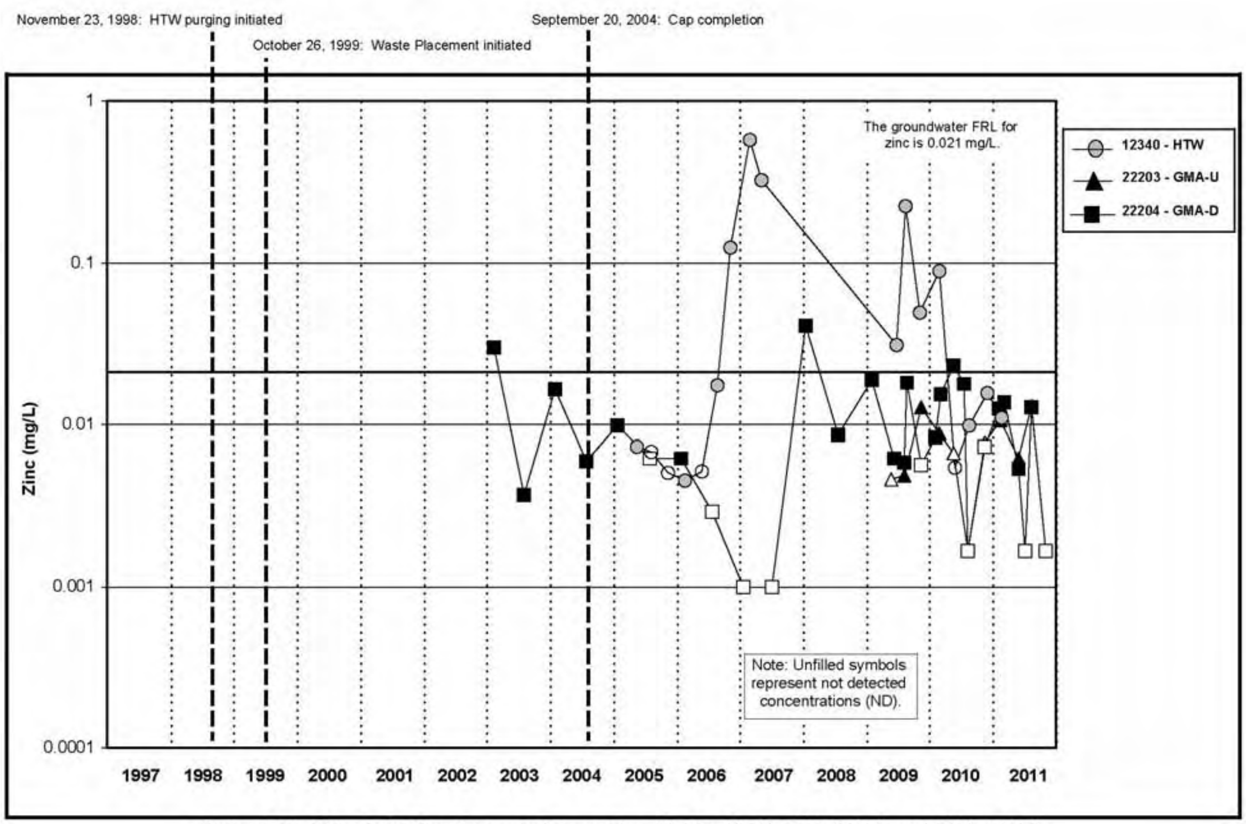


Figure A.5.3-28B. Cell 3 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

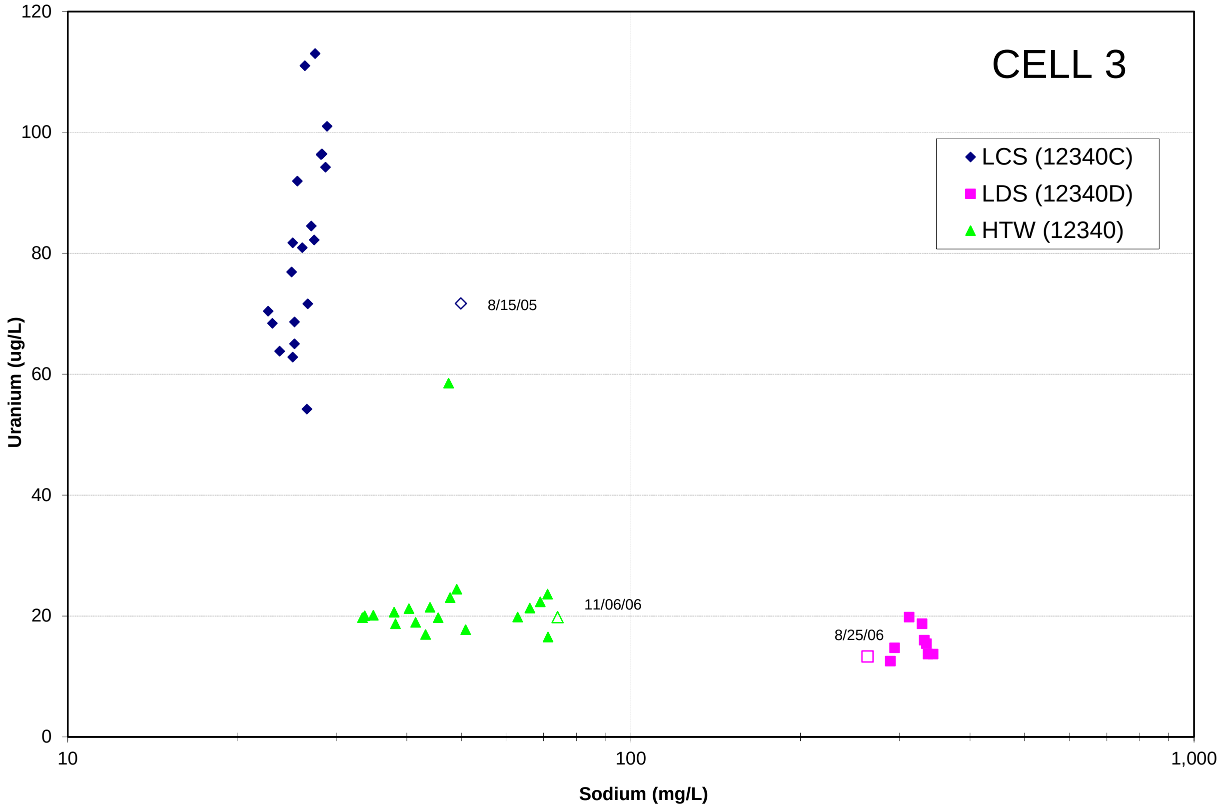


Figure A.5.3−29. Cell 3 Bivariate Plot for Uranium and Sodium

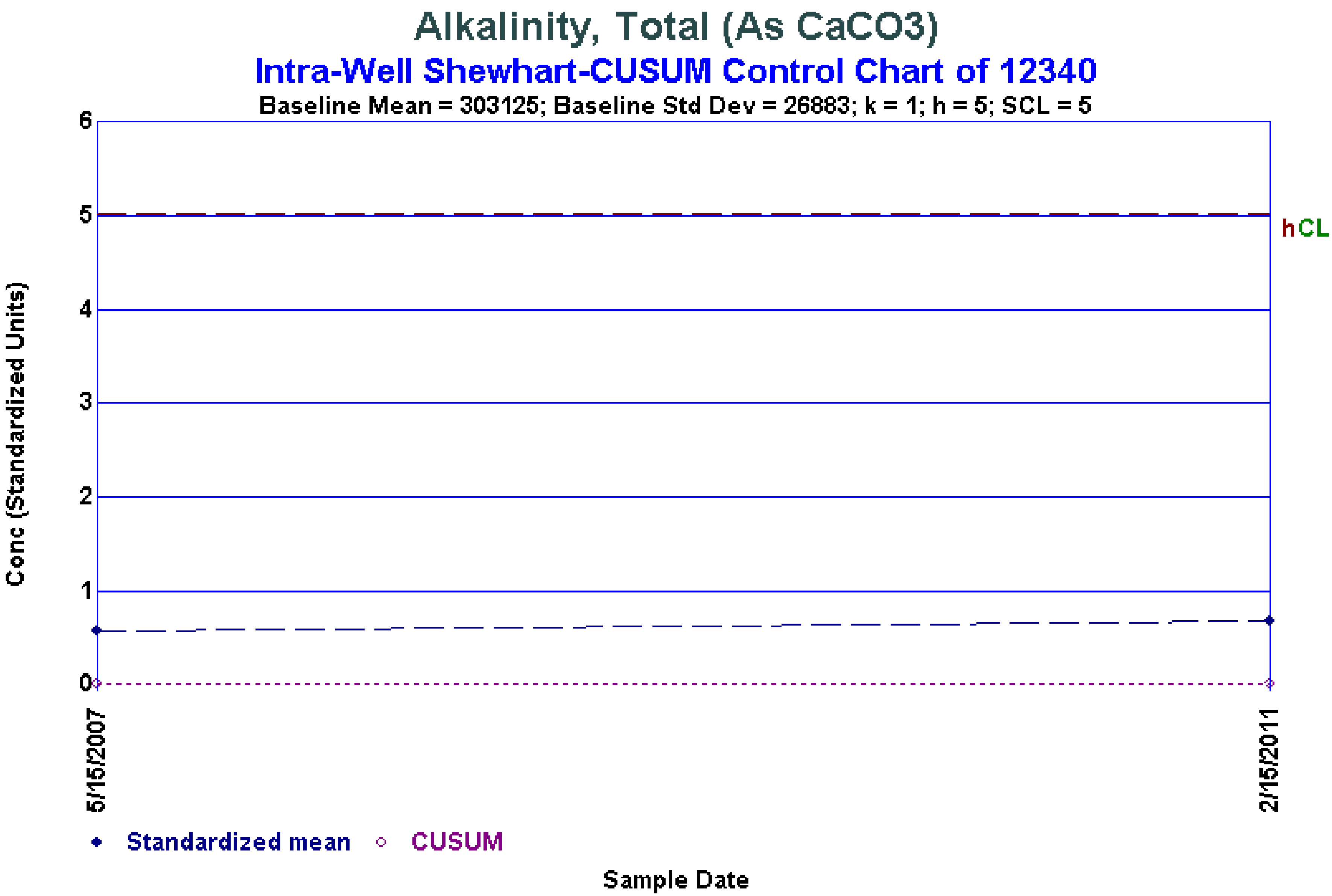


Figure A.5.3−30. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 12340)

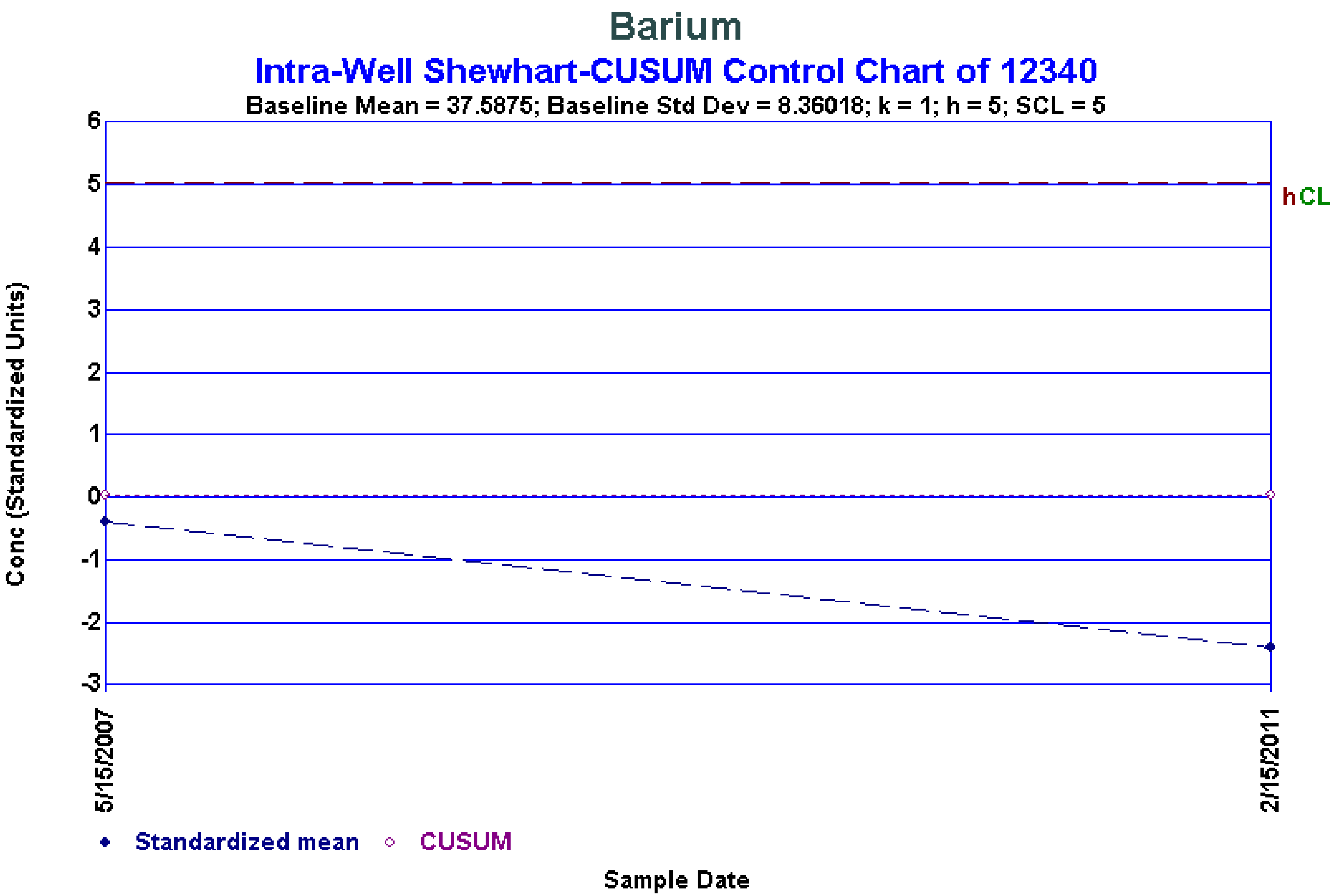


Figure A.5.3−31. Intra-Well Shewhart-CUSUM Control Chart (Barium 12340)

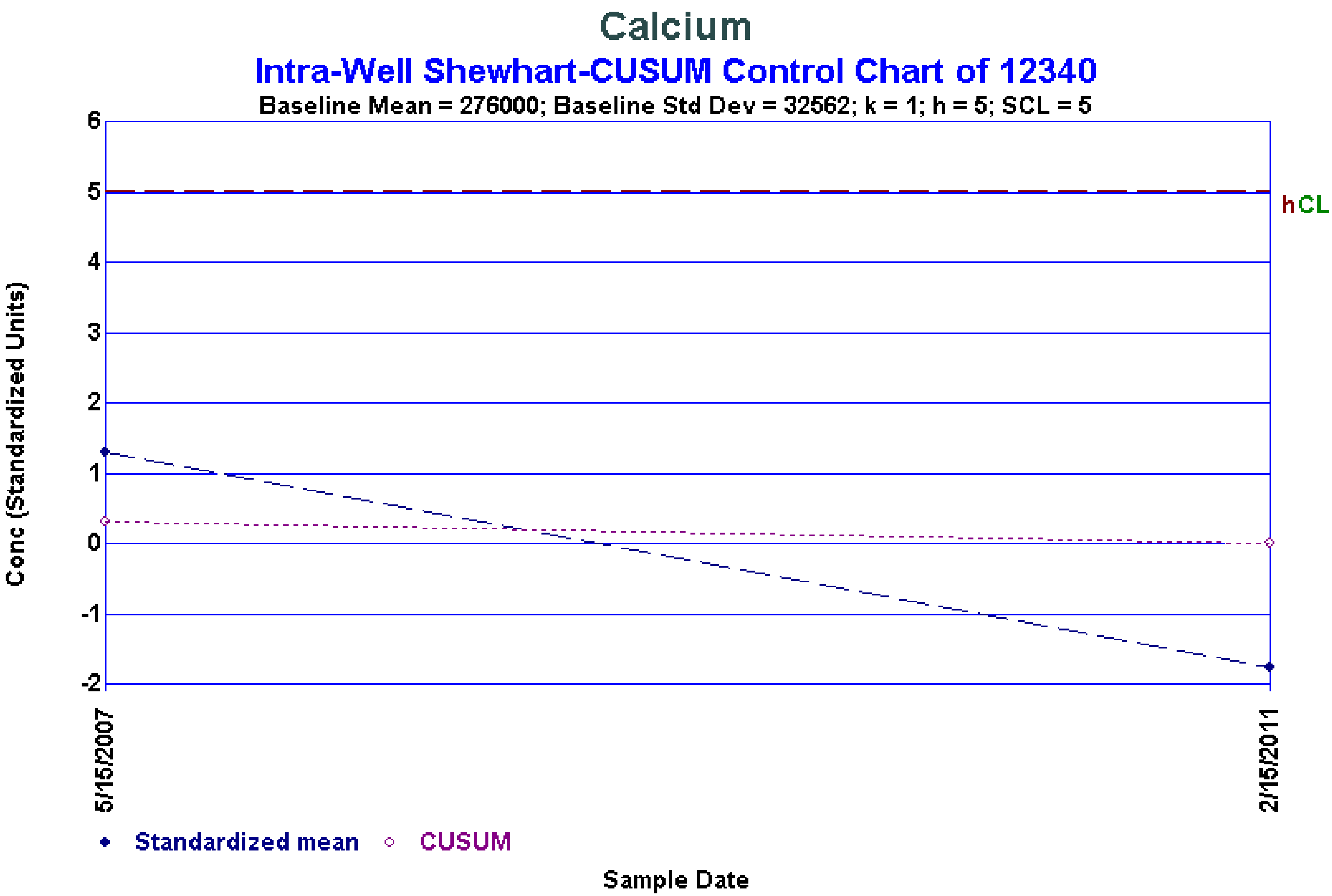


Figure A.5.3−32. Intra-Well Shewhart-CUSUM Control Chart (Calcium 12340)

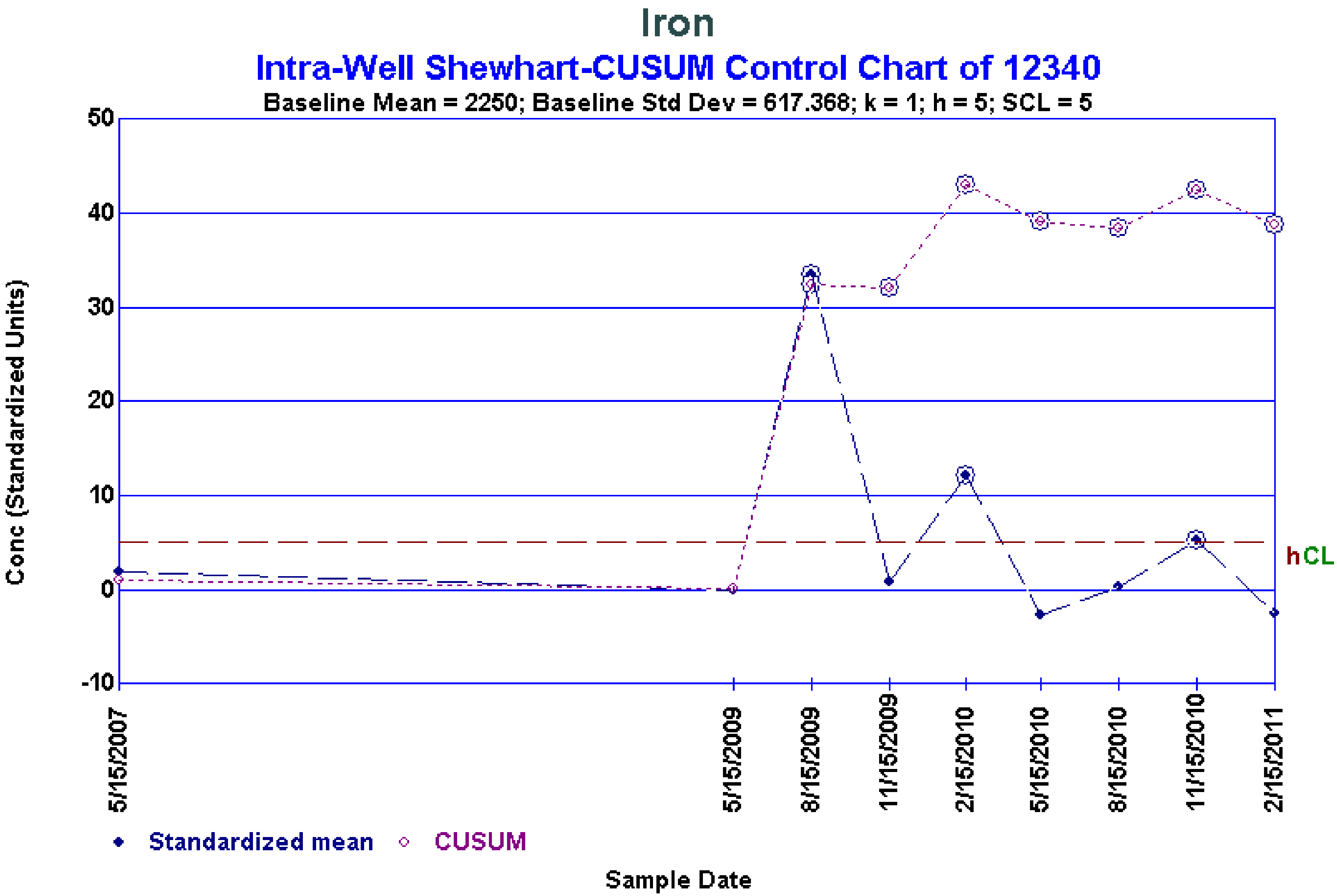


Figure A.5.3−33. Intra-Well Shewhart-CUSUM Control Chart (Iron 12340)

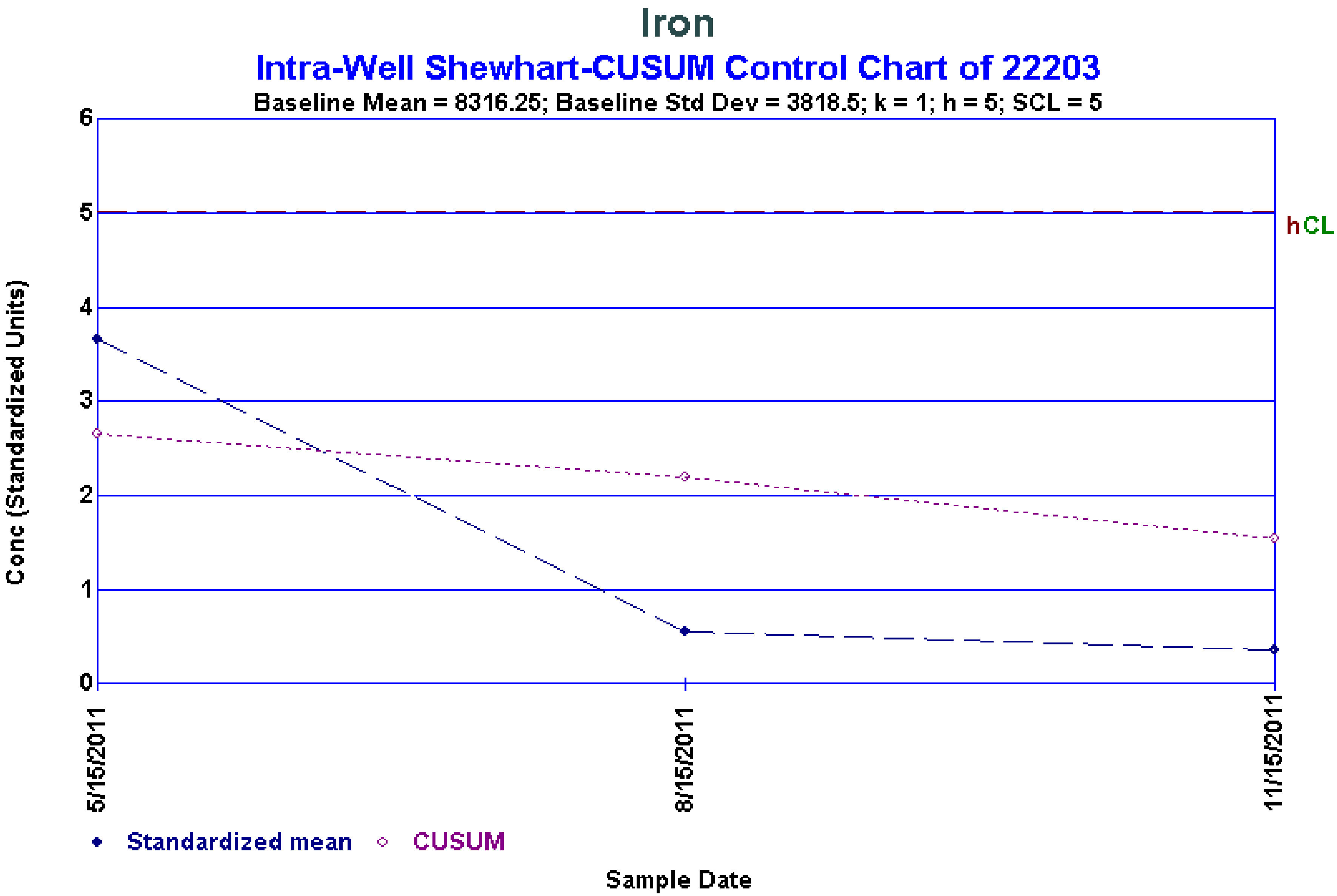


Figure A.5.3−34. Intra-Well Shewhart-CUSUM Control Chart (Iron 22203)

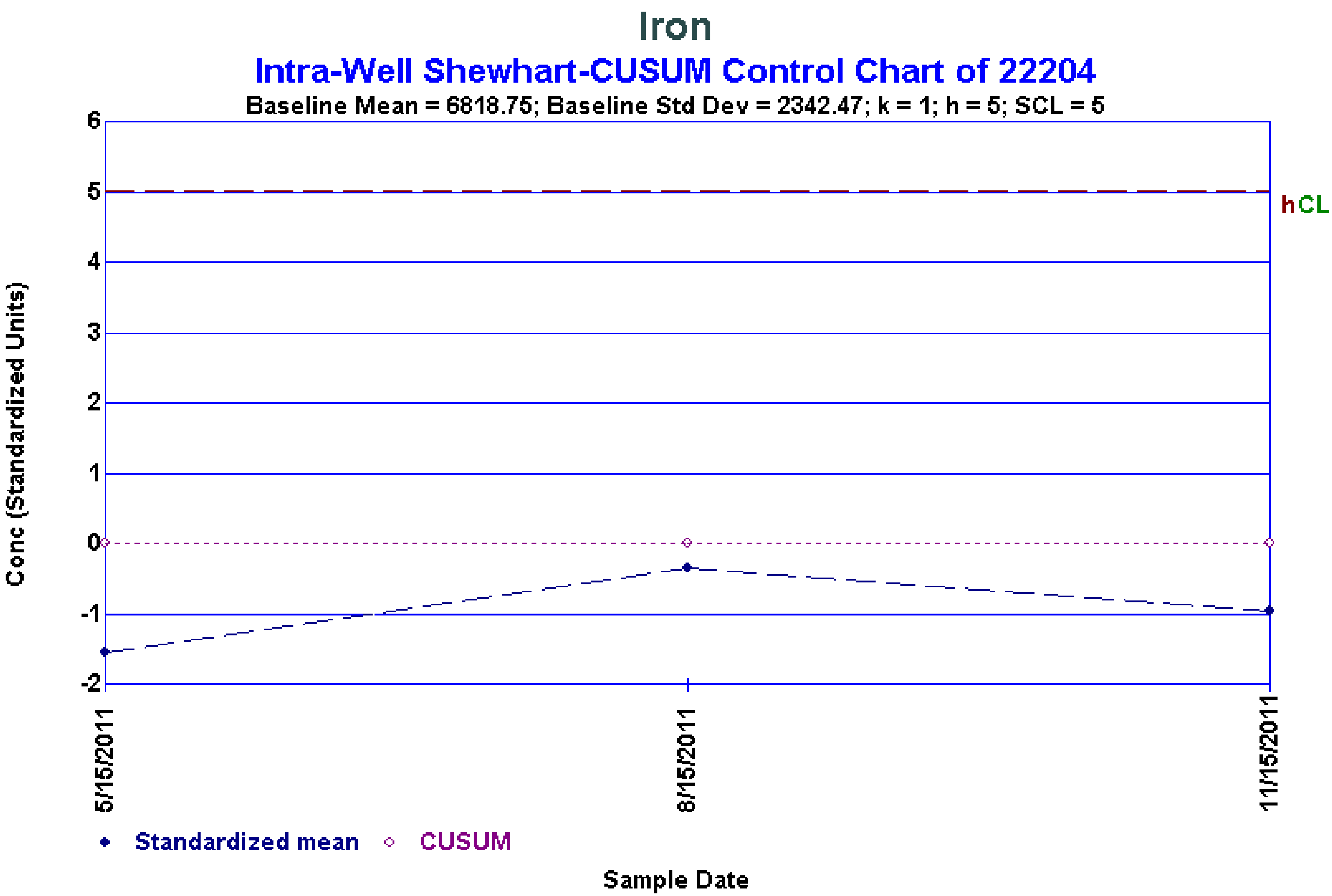


Figure A.5.3−35. Intra-Well Shewhart-CUSUM Control Chart (Iron 22204)

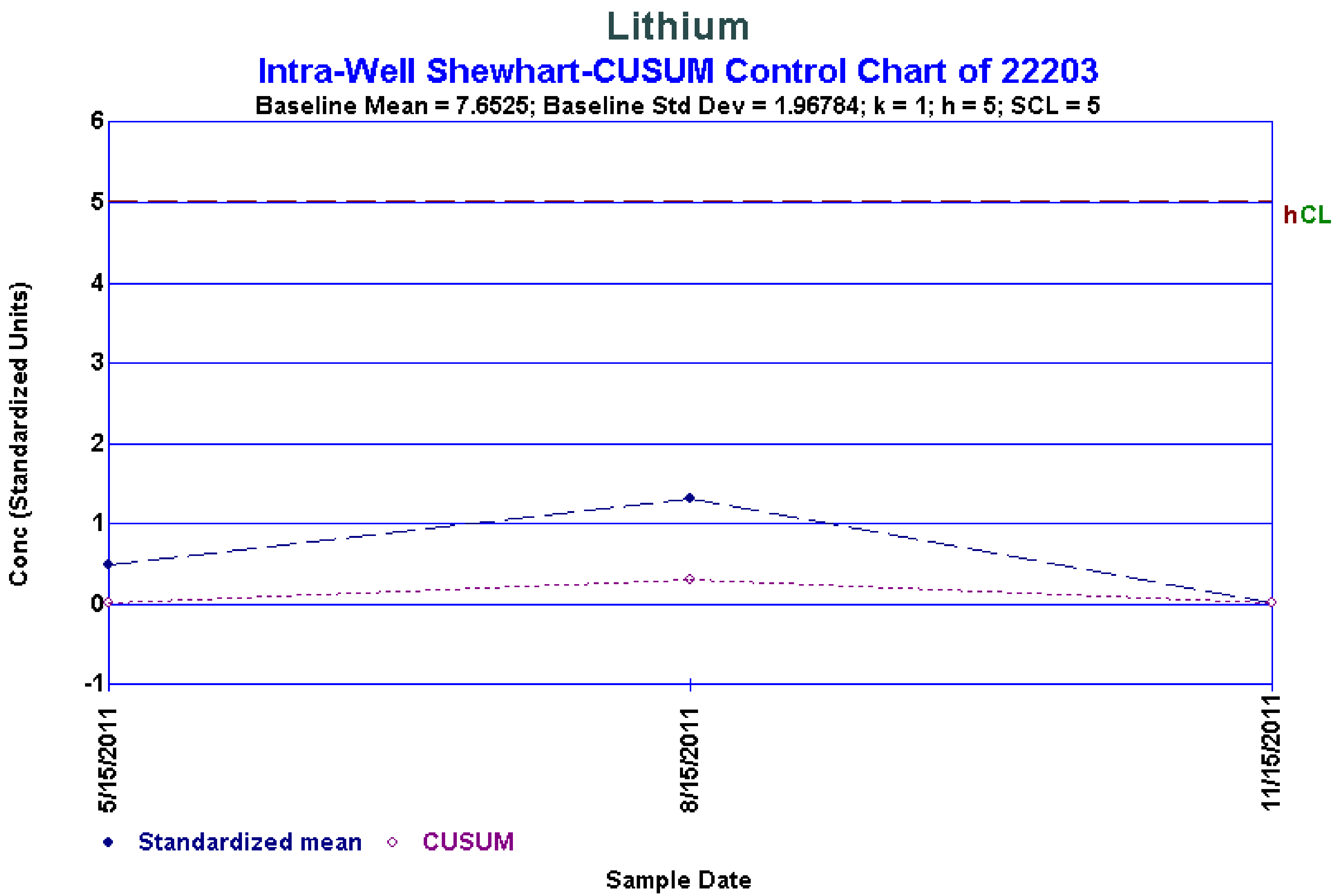


Figure A.5.3−36. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22203)

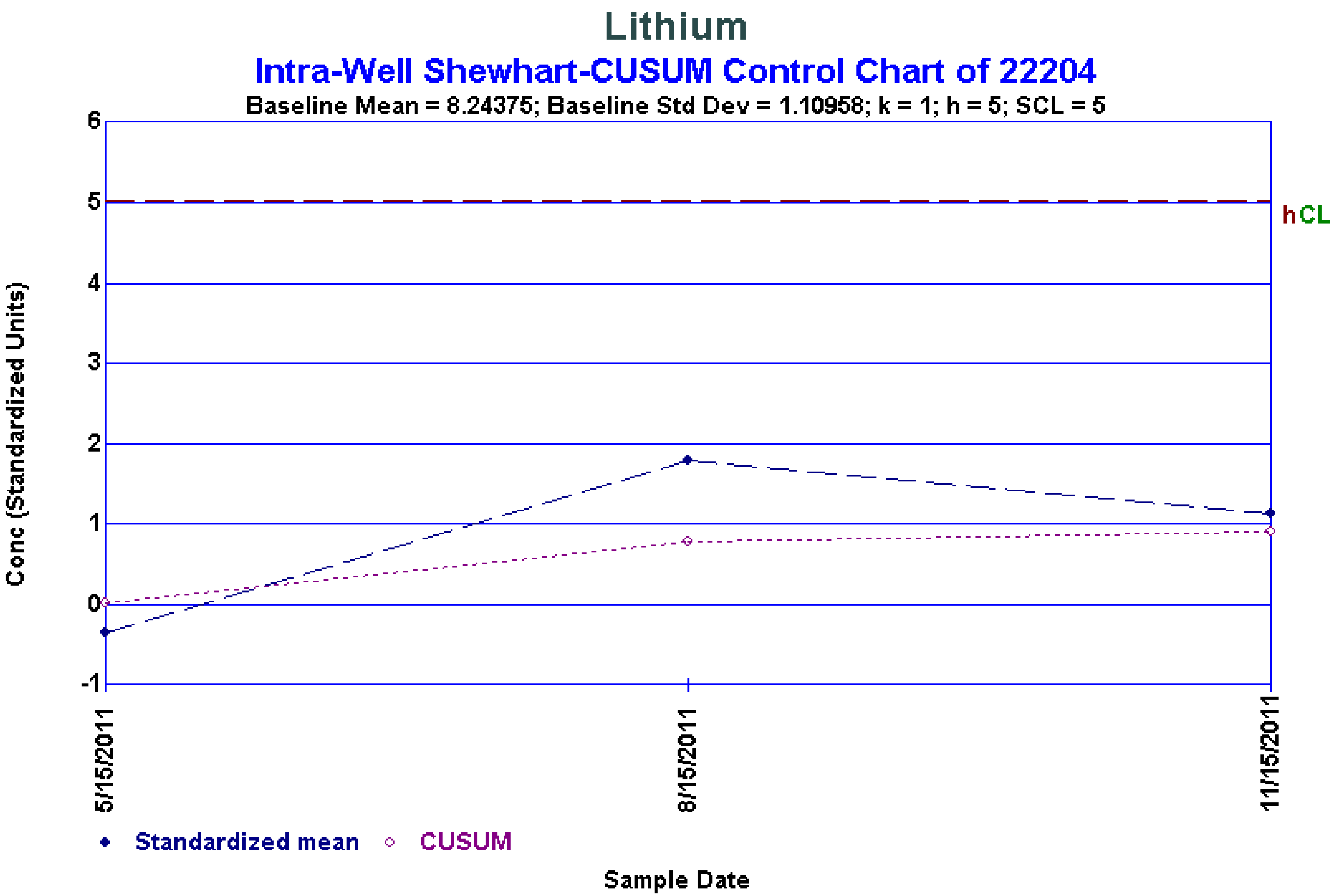


Figure A.5.3−37. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22204)

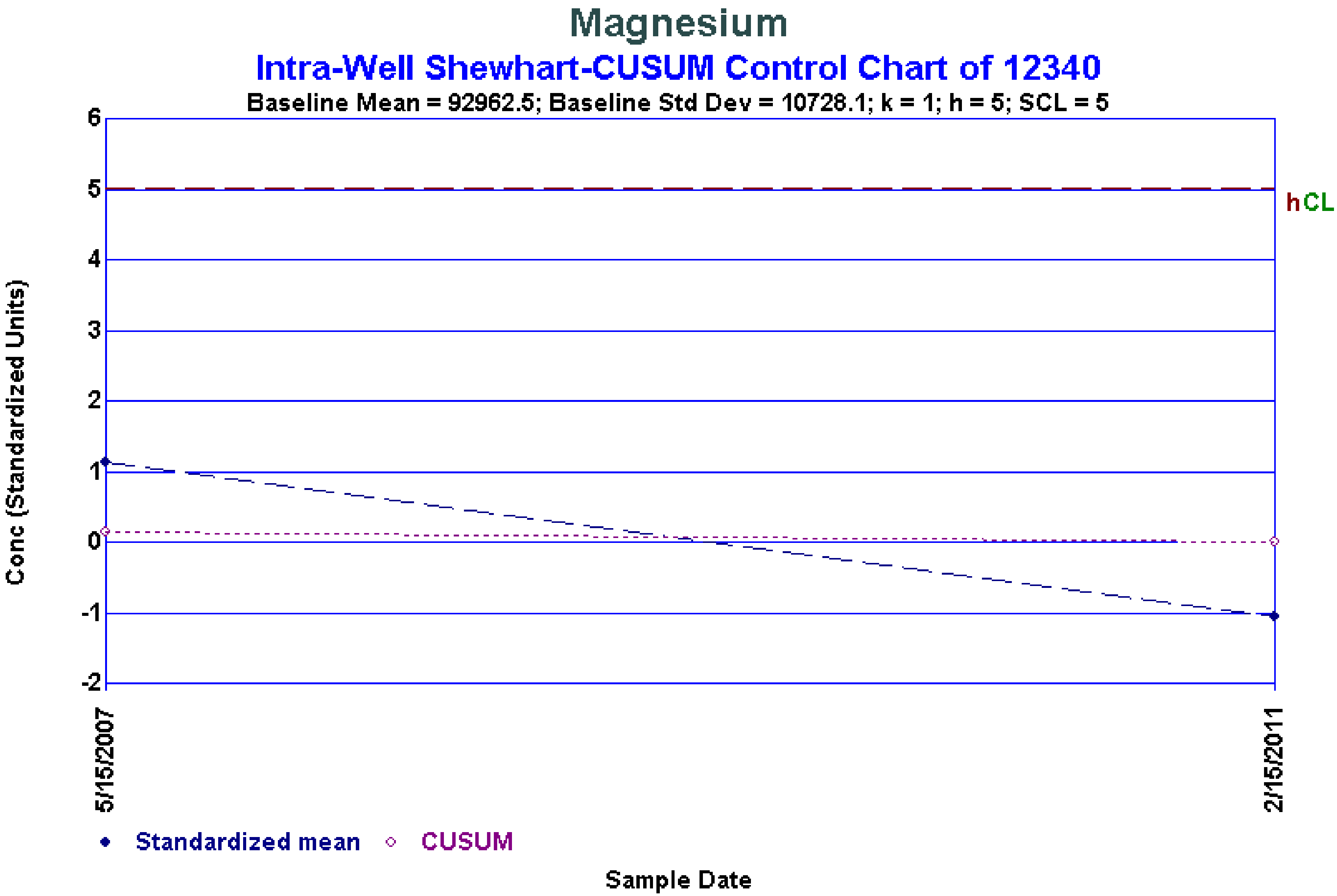


Figure A.5.3−38. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 12340)

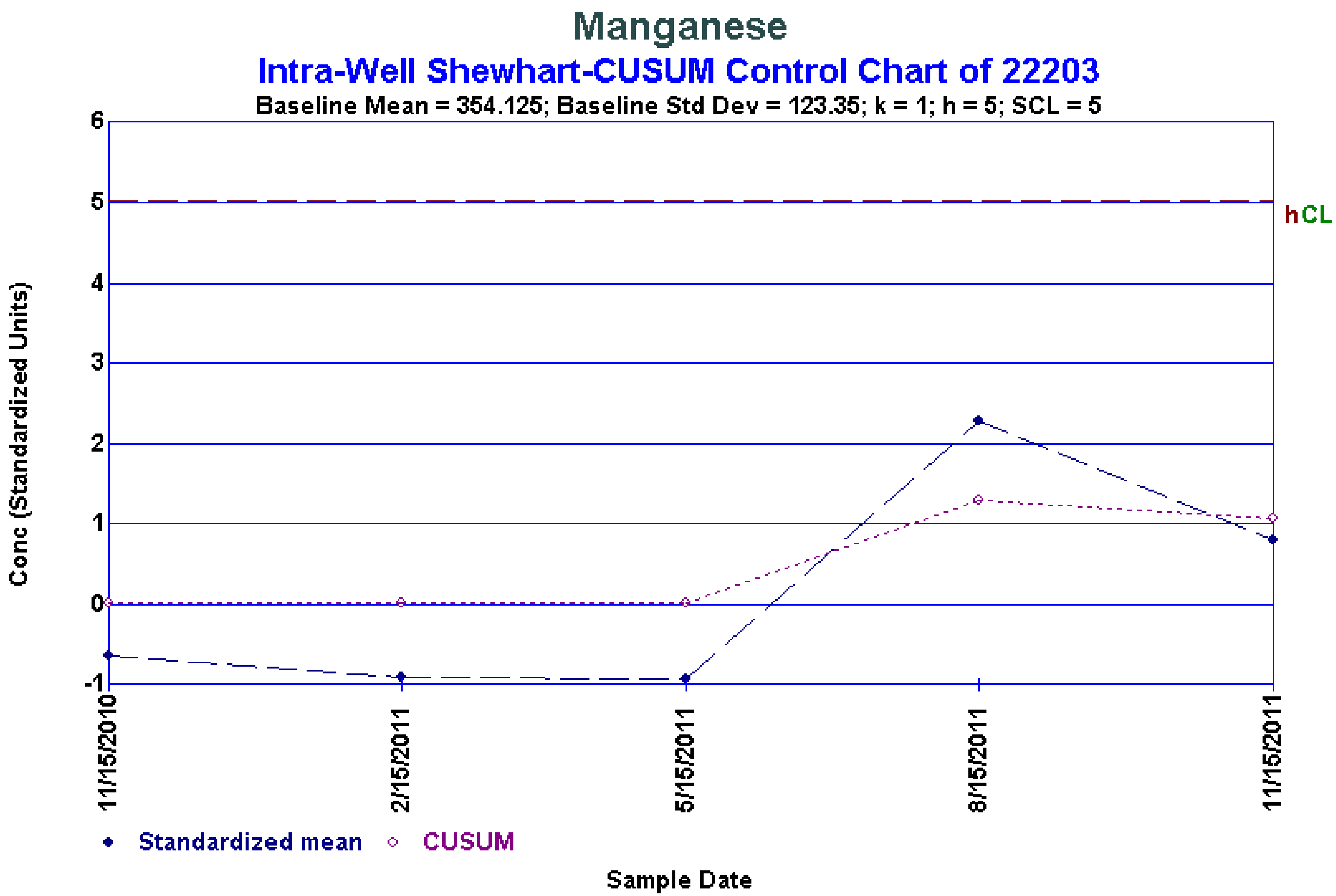


Figure A.5.3−39. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22203)

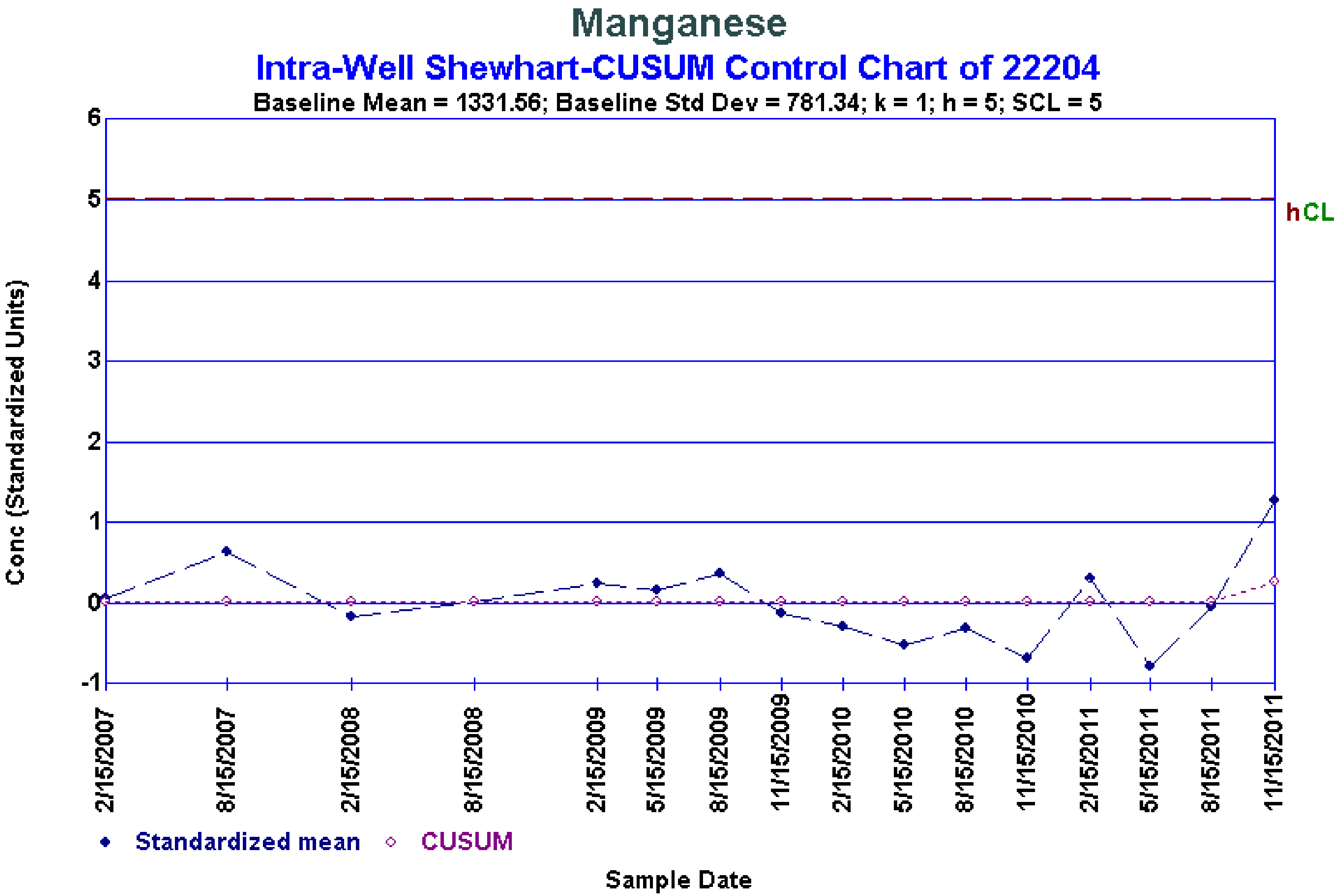


Figure A.5.3−40. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22204)

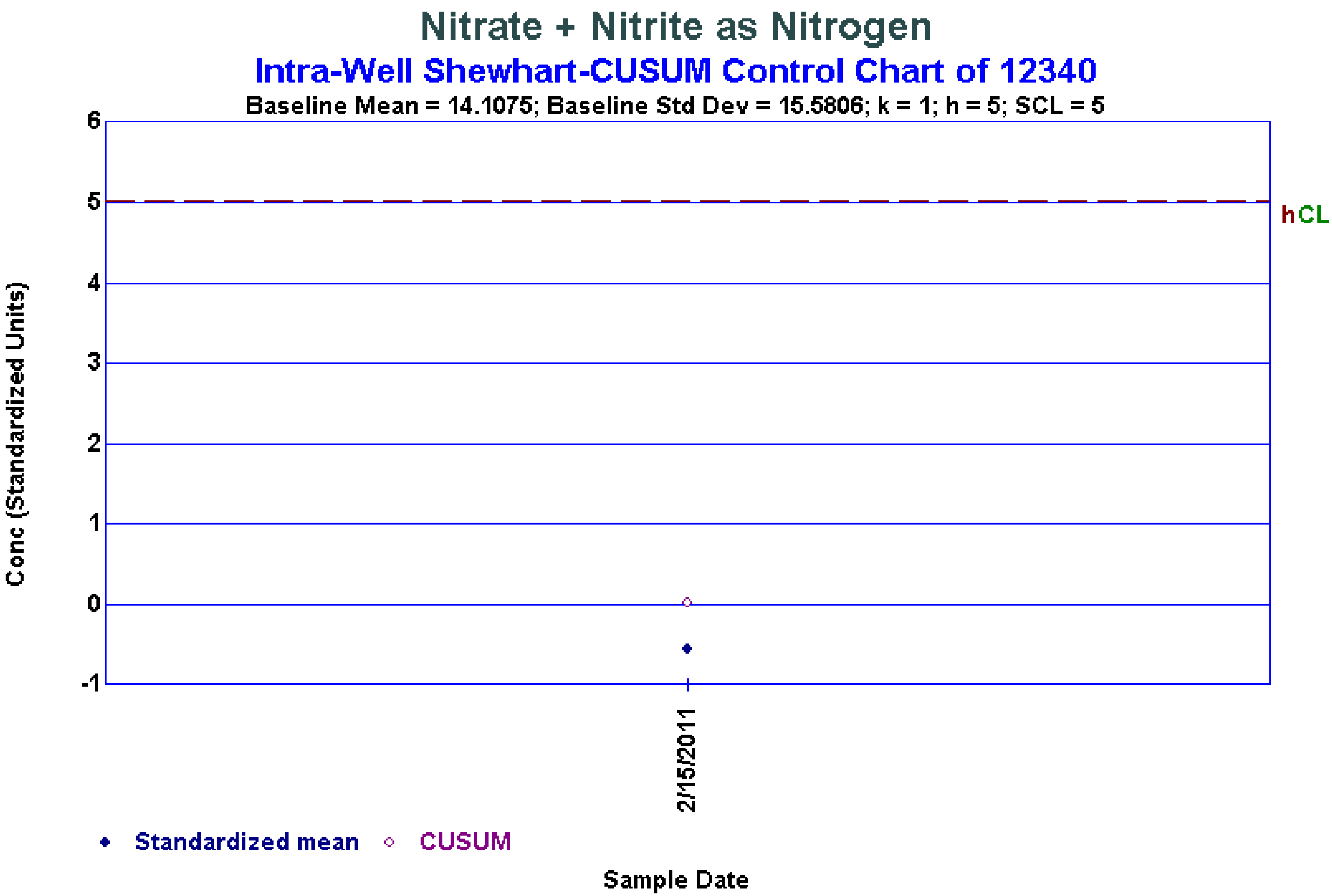


Figure A.5.3−41. Intra-Well Shewhart-CUSUM Control Chart (Nitrate 12340)

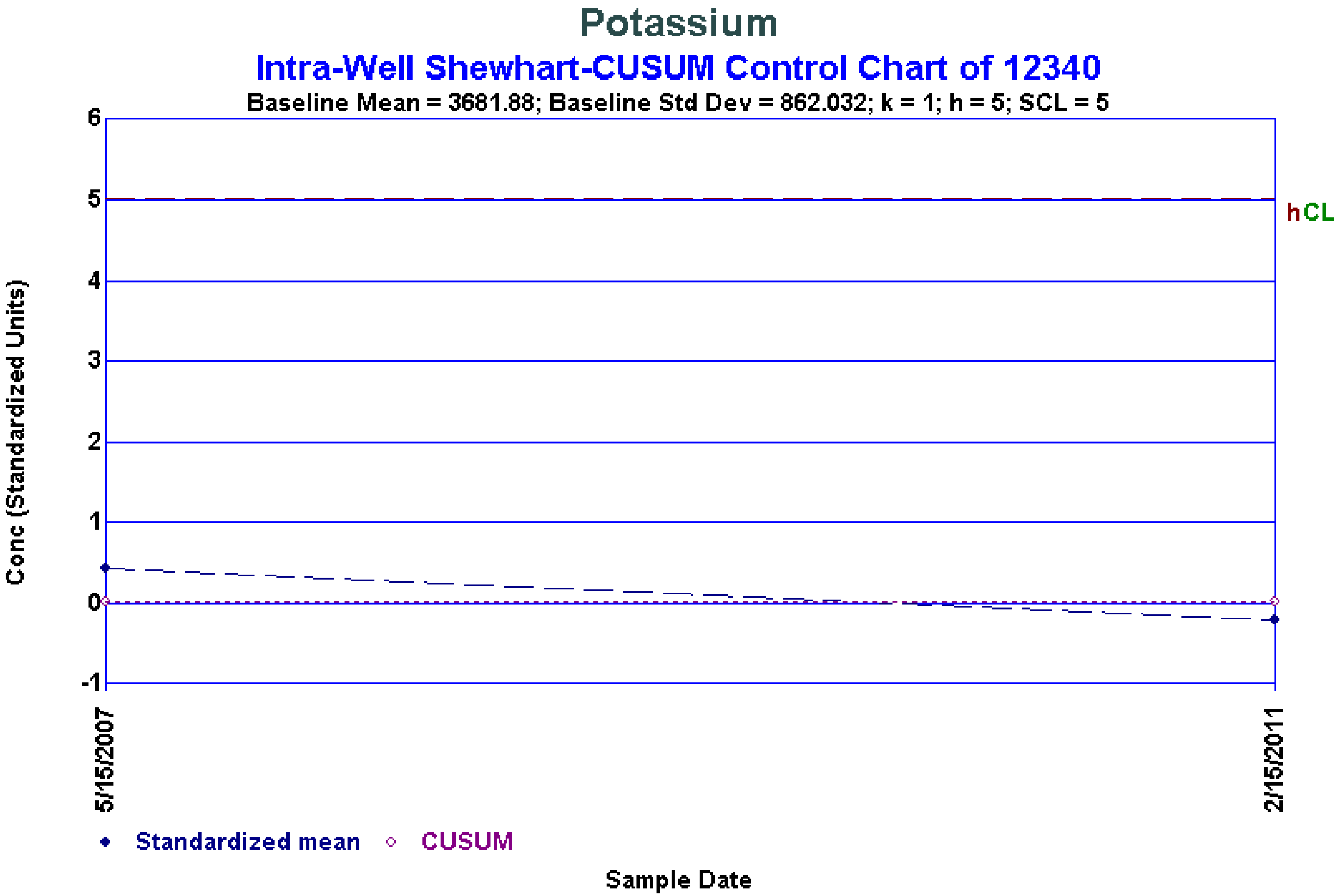


Figure A.5.3−42. Intra-Well Shewhart-CUSUM Control Chart (Potassium 12340)

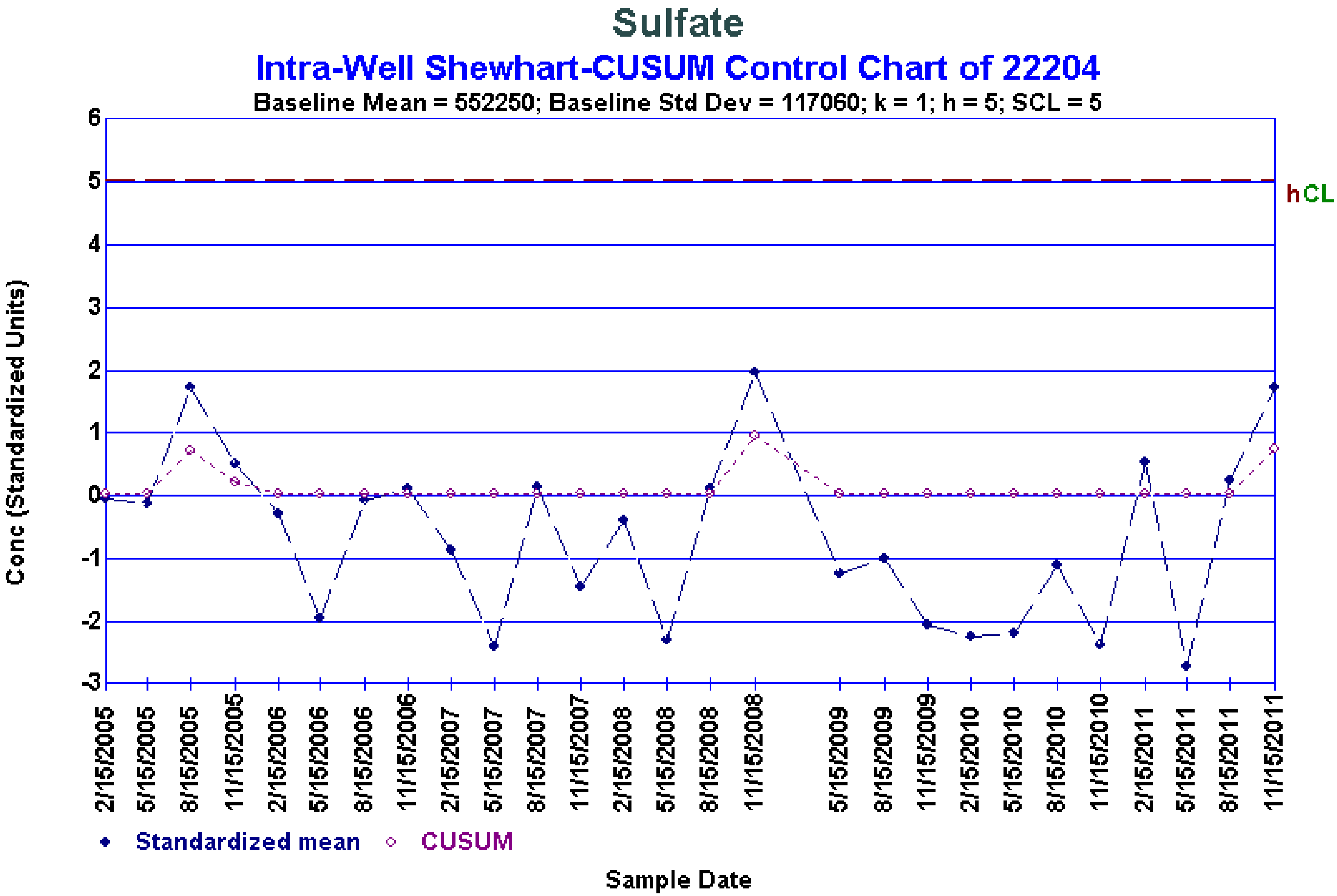


Figure A.5.3−43. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22204)

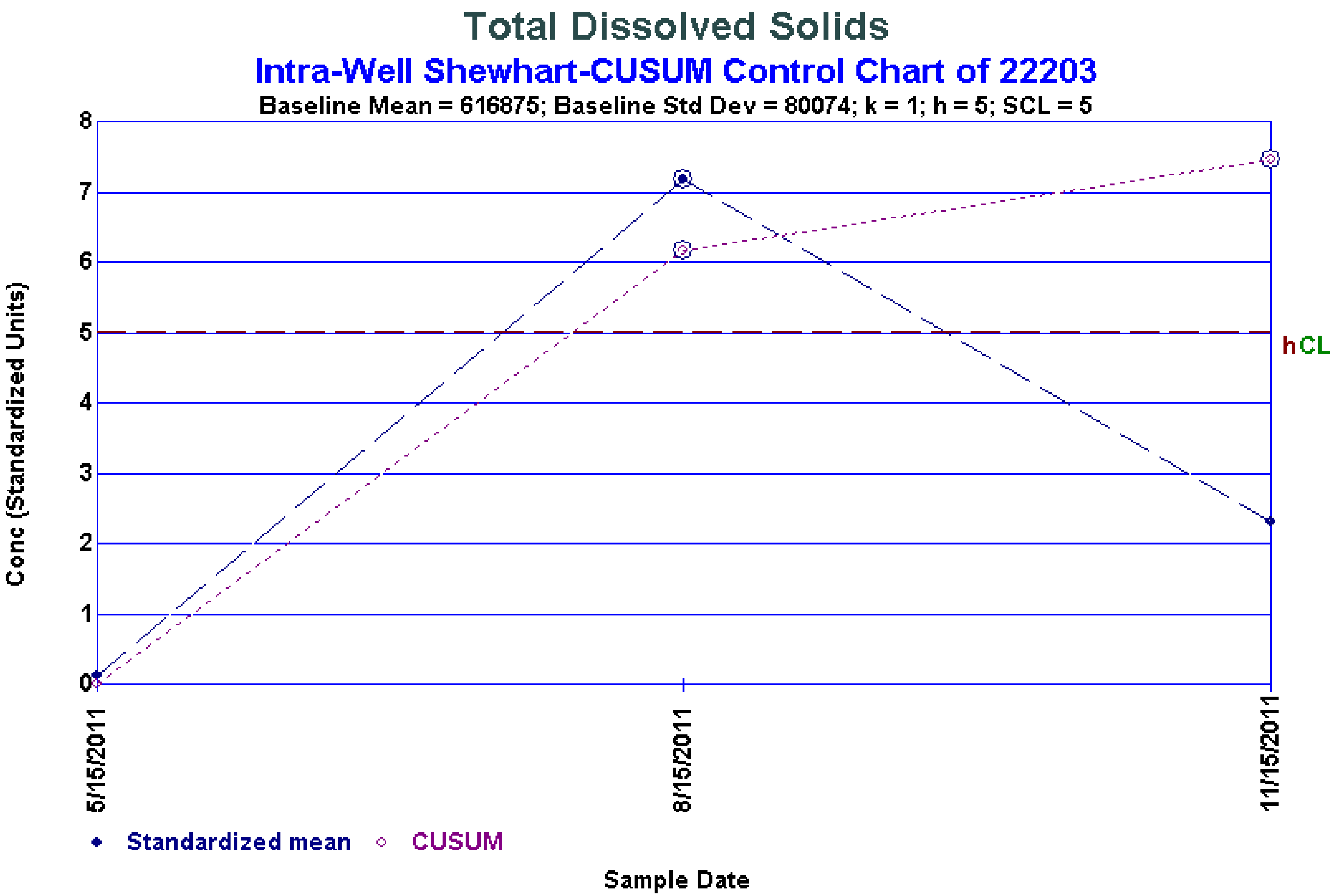


Figure A.5.3−44. Intra-Well Shewhart-CUSUM Control Chart (TDS 22203)

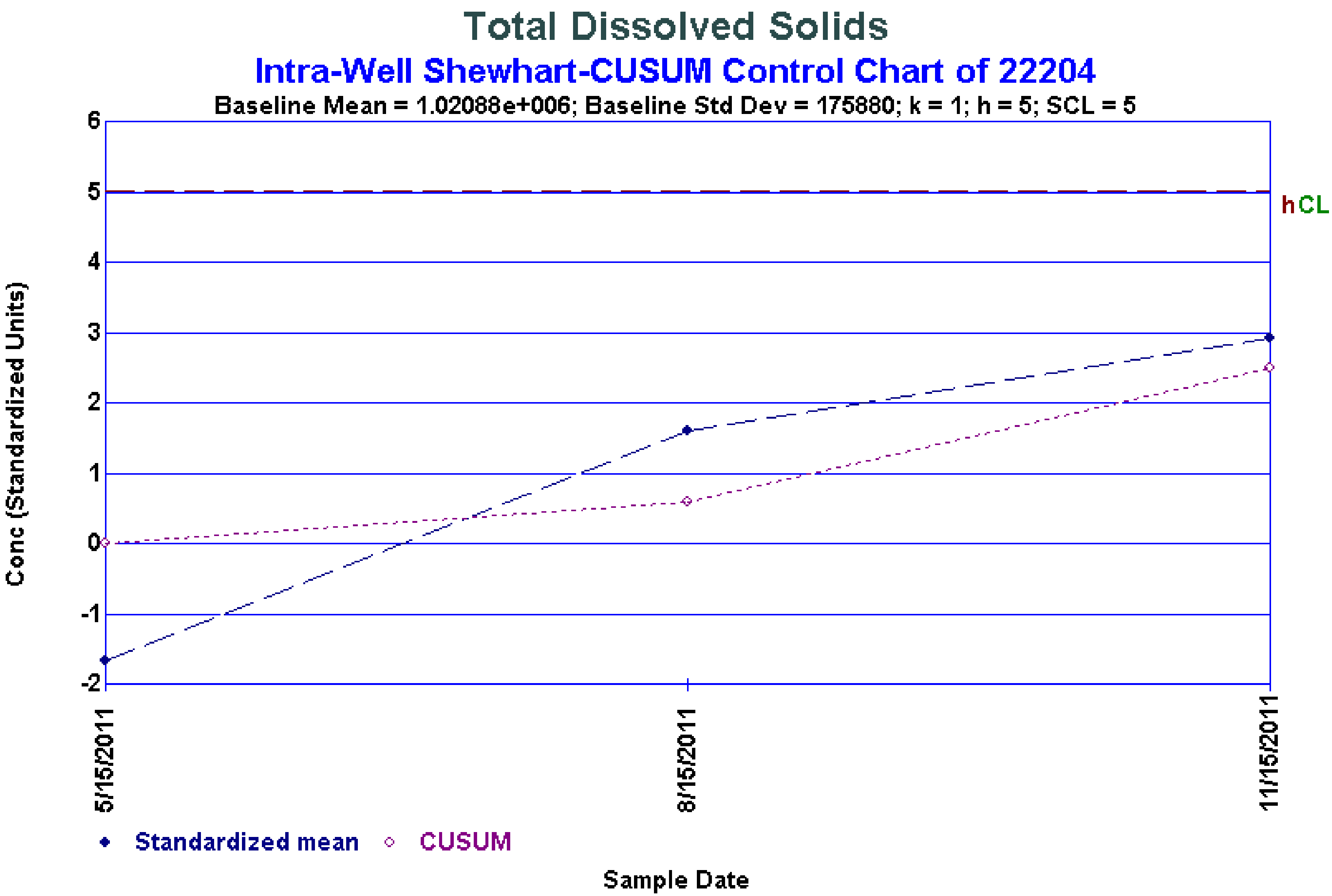


Figure A.5.3−45. Intra-Well Shewhart-CUSUM Control Chart (TDS 22204)

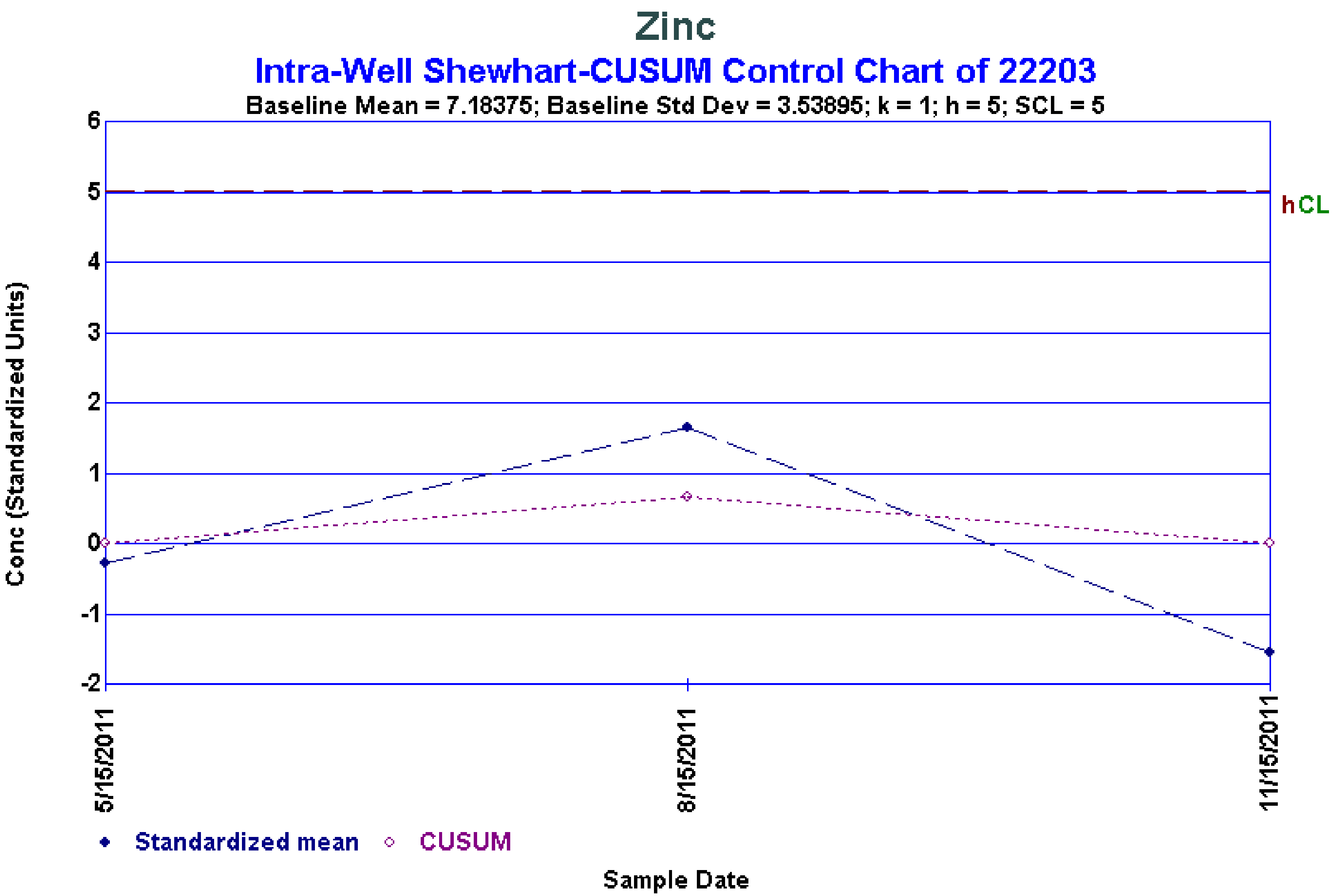


Figure A.5.3−46. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22203)

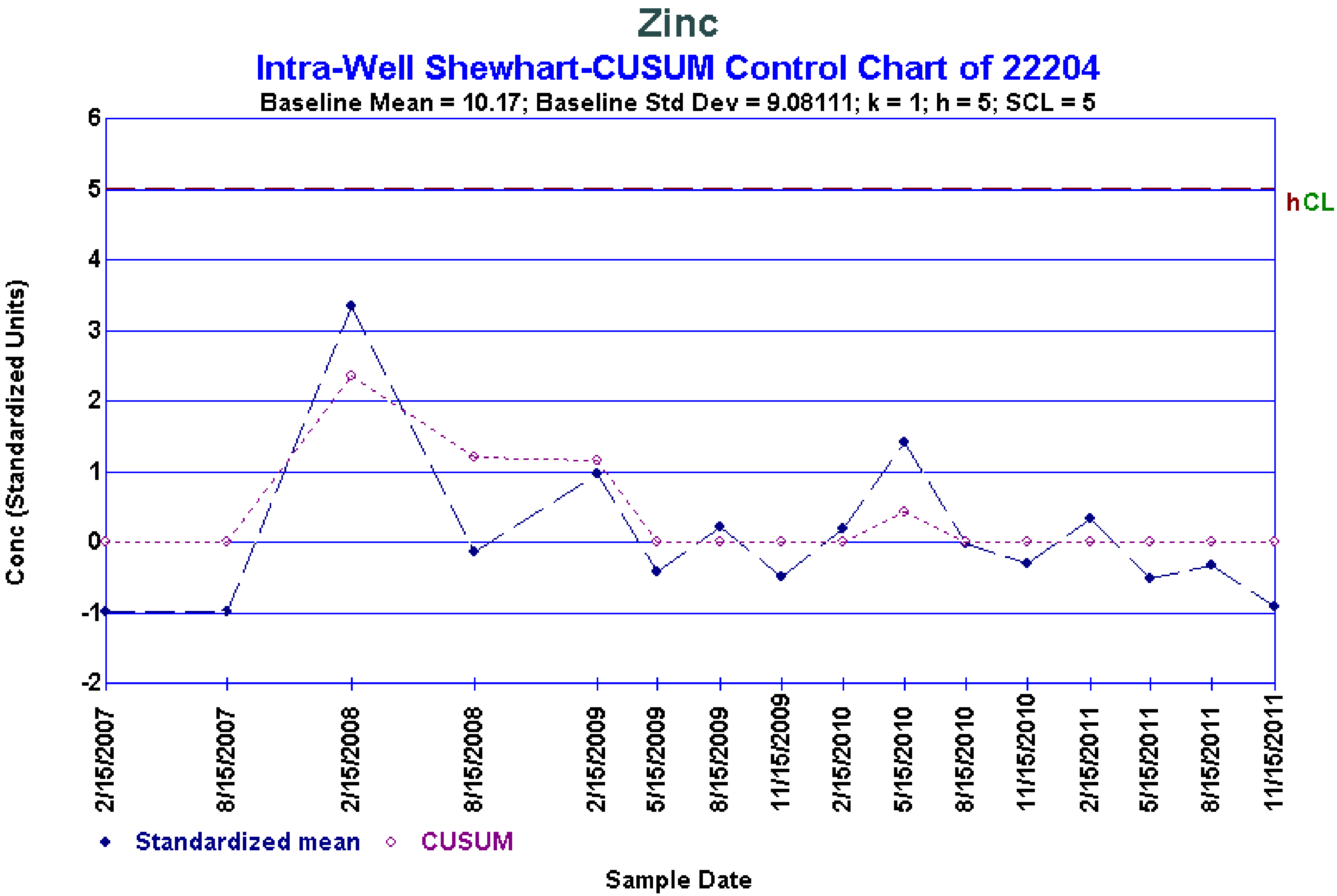


Figure A.5.3−47. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22204)

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Sub-attachment A.5.4

Cell 4

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.4−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.4−2)
- LCS monthly accumulation volumes (refer to Figure A.5.4−1)
- LDS monthly accumulation volumes (refer to Figure A.5.4−2)
- OSDF horizontal till well 12341 water yield (refer to Figure A.5.4−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.4−4 and A.5.4−5)
- Plots of concentration versus time (refer to Figures A.5.4−6A to A.5.4−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.4−29)
- Control charts (refer to Figures A.5.4−30 to A.5.4−45)

A.5.4.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA Wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on LMICP (revision 4). Tritium results for all cells are reported in Section A.5.5.

The LDS of Cell 4 was dry during the fourth quarter of 2011. As shown in Table A.5.4–1, 5 of the 23 parameters sampled quarterly in the LCS, LDS, HTW, and GMA wells (alkalinity, sulfate, TDS, TOC, arsenic, boron, calcium, cobalt, copper, iron, lithium, magnesium, manganese, sodium, and zinc) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Horizontal Till Well

The HTW is located beneath the liner penetration box of each cell by design. The liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, alkalinity, sulfate, calcium, cobalt, copper, iron, magnesium, and manganese are increasing in the HTW of Cell 4 (as indicated in the table below). The bivariate plot for the Cell 4 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.4−29. The plot shows that the chemical signature for uranium-sodium in the LCS, LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore the increasing concentrations measured in the HTW of Cell 4 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Alkalinity	Up		
Sulfate	Up		
TDS			Up
TOC		Up	Up
Arsenic			Up
Boron			Up
Calcium	Up		
Cobalt	Up		
Copper	Up		
Iron	Up		
Lithium			Up
Magnesium	Up		
Manganese	Up		
Sodium			Up
Zinc			Up

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer, TDS = total dissolved solids; TOC = total organic carbon. No entry indicates that the trend was not up.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing TDS and arsenic concentrations seen in the GMA wells, are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.4–1) measured in the LDS, and GMA wells for parameters with increasing concentrations in the Cell 4 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
TDS (mg/L)	**5920**	624	955
TOC (mg/L)	**4.52**	1.41	1.52
Arsenic (mg/L)	**0.00682**	0.0025	0.0025
Boron (mg/L)	**0.634**	0.0409	0.0395
Lithium (mg/L)	**0.174**	0.0149	0.00828
Sodium (mg/L)	**458**	13.8	19.0
Zinc (mg/L)	**0.311**	0.00908	0.00396

Note: The highest averages are shown in bold.
[a] LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer.

A.5.4.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limits on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.4−1 in gray shading, twelve parameters in the HTW and/or GMA wells of Cell 4 (uranium, nitrate, sulfate, TOX, barium, iron, lithium, manganese, nickel, potassium, sodium and zinc) meet the criteria for control charts (i.e., 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 16 control charts.

These 16 control charts are presented in Figures A.5.4−30 to A.5.4−45. All of the control charts for Cell 4 (with the exception of TOX in the HTW) exhibit "in control" conditions. The CUSUM trace for TOX in the HTW exceeds the CUSUM control limit beginning in 2010. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 4 indicate that water is not mixing between horizons, so the out of control condition is attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

Parameter and Monitoring Point[a]	Assessment
Uranium in the GMA-U	In Control
Uranium in the GMA-D	In Control
Nitrate in the HTW	In Control
Sulfate in the GMA-D	In Control
TOX in the HTW	**Out of Control**
Barium in the HTW	In Control
Iron in the GMA-U	In Control
Iron in the GMA-D	In Control
Lithium in the GMA-U	In Control
Manganese in the GMA-U	In Control
Manganese in the GMA-D	In Control
Nickel in the HTW	In Control
Potassium in the HTW	In Control
Sodium in the HTW	In Control
Sodium in the GMA-U	In Control
Zinc in the GMA-U	In Control

[a]HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer;
GMA-D = downgradient Great Miami Aquifer; TOX = total organic halogen

A.5.4.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 4 are provided in Table A.5.4−2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix J or PCB parameters were detected in the LCS of Cell 4 in 2011.

A.5.4.4 Summary and Conclusions

- The concentrations of 15 parameters monitored quarterly are increasing in either the HTW and/or GMA wells of Cell 4 (alkalinity, sulfate, TDS, TOC, arsenic, boron, calcium, cobalt, copper, iron, lithium, magnesium, manganese, sodium, and zinc).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 4 indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 4 are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Sixteen control charts were constructed for Cell 4 parameters. All but one (TOX in the HTW) exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 4 in 2011.

Table A.5.4−1. Summary Statistics for Cell 4

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12341C	34	34	100.0	4.41	171	90.4	35.3	Undefined	None	Detected	
	LDS	12341D	34	34	100.0	5.74	21.3	14.2	2.9	Normal	None	Detected	
	HTW	12341	39	39	100.0	4.82	7.89	5.70	0.83	Undefined	Down	Not Detected	
	GMA-U	22206	36	40	90.0	ND	4.67	1.15	1.05	Lognormal	None	Not Detected	
	GMA-D	22205	41	41	100.0	0.525	12.1	2.73	2.80	Lognormal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12341C	19	19	100.0	48.0	583	352	141	Normal	None	Detected	
	LDS	12341D	13	13	100.0	142	450	305	106	Normal	None	Not Detected	
	HTW	12341	10	10	100.0	357	513	376	120	Undefined	Up	Not Detected	744 (4Q-05)
	GMA-U	22206	4	4	100.0	356	377	368	9	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	397	426	414	12	Normal	None	Insuff	
Chloride (mg/L)	LCS	12341C	18	19	94.7	ND	131	102	37	Undefined	Up	Detected	
	LDS	12341D	13	13	100.0	62.8	146	75.8	65.8	Undefined	Up	Not Detected	298 (Q4-02)
	HTW	12341	10	10	100.0	25.1	43.0	34.5	4.5	Normal	None	Not Detected	
	GMA-U	22206	4	4	100.0	29.3	36.5	32.4	3.3	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	21.4	22.9	22.2	0.6	Normal	Down	Insuff	
Nitrate/Nitrite as N (mg/L)	LCS	12341C	14	23	60.9	ND	6.34	0.81	1.76	Undefined	None	Not Detected	
	LDS	12341D	5	13	38.5	ND	2.28	1.01	0.78	Lognormal	Up	Detected	
	HTW	12341	1	9	11.1	ND	0.0304	Insuff	Insuff	Lognormal	None	Not Detected	
	GMA-U	22206	0	4	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22205	1	4	25.0	ND	0.0326	Insuff	Insuff	Normal	None	Insuff	
Sulfate (mg/L)	LCS	12341C	34	34	100.0	140	3940	2400	850	Undefined	Up	Detected	
	LDS	12341D	34	34	100.0	1470	4490	2480	850	Lognormal	Up	Detected	7870 (Q2-11)
	HTW	12341	32	32	100.0	153	313	222	43	Normal	Up	Detected	
	GMA-U	22206	35	35	100.0	90.4	559	259	110	Normal	Down	Detected	
	GMA-D	22205	35	35	100.0	199	535	332	89	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12341C	22	22	100.0	351	5020	4440	1600	Undefined	Up	Detected	
	LDS	12341D	11	11	100.0	4810	7140	5920	890	Normal	Up	Detected	
	HTW	12341	8	8	100.0	929	1060	1010	50	Normal	None	Not Detected	
	GMA-U	22206	11	11	100.0	560	877	624	110	Undefined	None	Not Detected	
	GMA-D	22205	11	11	100.0	753	1180	955	141	Normal	Up	Not Detected	
Total Organic Carbon (mg/L)	LCS	12341C	27	34	79.4	ND	5.39	2.6	1.1	Normal	None	Not Detected	
	LDS	12341D	31	34	91.2	ND	8.0	4.52	1.52	Normal	Down	Detected	
	HTW	12341	29	35	82.9	ND	4.42	2.43	0.85	Normal	None	Detected	
	GMA-U	22206	29	40	72.5	ND	2.39	1.41	0.47	Normal	Up	Detected	9.84 (Q2-03)
	GMA-D	22205	29	40	72.5	ND	2.74	1.52	0.50	Normal	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12341C	22	34	64.7	ND	0.060	0.0146	0.0123	Undefined	None	Not Detected	
	LDS	12341D	26	34	76.5	ND	0.0445	0.0206	0.0112	Normal	None	Not Detected	0.070 (2Q-10)
	HTW	12341	23	36	63.9	ND	0.077	0.0136	0.0148	Lognormal	None	Not Detected	
	GMA-U	22206	15	40	37.5	ND	0.064	0.00776	0.0107	Lognormal	Down	Not Detected	
	GMA-D	22205	7	40	17.5	ND	0.0142	0.00304	0.00451	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12341C	4	24	16.7	ND	0.126	0.00338	0.0297	Undefined	None	Detected	
	LDS	12341D	6	20	30.0	ND	0.0274	0.00682	0.00761	Lognormal	None	Not Detected	
	HTW	12341	8	20	40.0	ND	0.0307	0.0036	0.0207	Undefined	None	Not Detected	0.0938 (Q3-09)
	GMA-U	22206	4	11	36.4	ND	0.0365	0.0025	0.0118	Undefined	None	Not Detected	
	GMA-D	22205	4	24	16.7	ND	0.0344	0.0025	0.0102	Undefined	Up	Detected	
Barium (mg/L)	LCS	12341C	19	19	100.0	0.0155	0.0580	0.0275	0.0107	Undefined	Down	Detected	
	LDS	12341D	13	13	100.0	0.0167	0.0775	0.0388	0.0201	Normal	Down	Detected	
	HTW	12341	10	10	100.0	0.0489	0.0675	0.0587	0.0054	Normal	None	Not Detected	
	GMA-U	22206	4	4	100.0	0.0580	0.0782	0.0682	0.0095	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	0.0588	0.0703	0.0643	0.0056	Normal	None	Insuff	

Table A.5.4−1 (continued). Summary Statistics for Cell 4

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12341C	34	34	100.0	0.0626	1.27	0.891	0.296	Undefined	None	Detected	1.93 (Q3-05)
	LDS	12341D	34	34	100.0	0.415	1.81	0.634	0.310	Undefined	None	Detected	
	HTW	12341	33	36	91.7	ND	1.24	0.116	0.231	Undefined	Down	Detected	
	GMA-U	22206	35	40	87.5	ND	0.0617	0.0409	0.0094	Undefined	None	Not Detected	
	GMA-D	22205	33	40	82.5	ND	0.0807	0.0395	0.0129	Normal	Up	Detected	
Calcium (mg/L)	LCS	12341C	19	19	100.0	52.9	1110	556	201	Undefined	None	Not Detected	
	LDS	12341D	13	13	100.0	284	578	424	88	Normal	None	Not Detected	
	HTW	12341	10	10	100.0	127	224	151	29	Lognormal	Up	Not Detected	
	GMA-U	22206	4	4	100.0	141	217	179	42	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	233	268	250	16	Normal	None	Insuff	
Cobalt (mg/L)	LCS	12341C	13	24	54.2	ND	0.0057	0.0012	0.0015	Undefined	None	Detected	
	LDS	12341D	11	20	55.0	ND	0.0064	0.0015	0.0018	Undefined	Down	Detected	
	HTW	12341	15	17	88.2	ND	0.00634	0.00287	0.00138	Lognormal	Up	Not Detected	
	GMA-U	22206	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22205	2	11	18.2	ND	0.00211	Insuff	Insuff	Undefined	None	Detected	
Copper (mg/L)	LCS	12341C	13	20	65.0	0.00076	0.0309	0.00860	0.00846	Undefined	None	Detected	
	LDS	12341D	10	15	66.7	ND	0.0259	0.0115	0.0080	Normal	None	Not Detected	
	HTW	12341	5	11	45.4	ND	0.0158	0.0043	0.0056	Lognormal	Up	Detected	
	GMA-U	22206	4	4	100.0	0.00228	0.0106	0.00772	0.00385	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	0.00160	0.0102	0.00736	0.0039	Normal	None	Insuff	
Iron (mg/L)	LCS	12341C	18	24	75.0	ND	4.18	0.117	1.36	Undefined	Down	Detected	
	LDS	12341D	16	20	80.0	ND	27.8	9.02	6.39	Lognormal	Down	Detected	
	HTW	12341	17	17	100.0	0.922	13.4	2.62	2.97	Lognormal	Up	Detected	
	GMA-U	22206	11	11	100.0	0.986	15.0	9.03	3.98	Normal	None	Not Detected	
	GMA-D	22205	11	11	100.0	2.30	7.71	5.86	1.55	Normal	None	Not Detected	
Lithium (mg/L)	LCS	12341C	20	20	100.0	0.0818	0.187	0.122	0.028	Normal	Up	Detected	
	LDS	12341D	19	19	100.0	0.0951	0.331	0.174	0.066	Normal	Up	Detected	
	HTW	12341	17	17	100.0	0.00812	0.0134	0.0107	0.0018	Normal	Down	Detected	
	GMA-U	22206	11	11	100.0	0.0133	0.0175	0.0149	0.0013	Normal	None	Not Detected	
	GMA-D	22205	11	11	100.0	0.00685	0.00946	0.00828	0.00081	Normal	Up	Detected	0.0167 (Q3-11)
Magnesium (mg/L)	LCS	12341C	19	19	100.0	15.0	732	413	188	Normal	Up	Detected	
	LDS	12341D	13	13	100.0	159	548	189	158	Undefined	Up	Detected	
	HTW	12341	10	10	100.0	47.2	74.1	58.7	7.9	Normal	Up	Not Detected	
	GMA-U	22206	4	4	100.0	30.2	43.8	36.0	6.4	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	47.4	63.2	52.8	7.3	Normal	None	Insuff	
Manganese (mg/L)	LCS	12341C	15	24	62.5	ND	2.14	0.0138	0.484	Undefined	None	Detected	
	LDS	12341D	12	20	60.0	ND	1.85	0.955	0.496	Lognormal	Down	Detected	
	HTW	12341	17	17	100.0	0.182	0.564	0.307	0.136	Undefined	Up	Detected	
	GMA-U	22206	13	13	100.0	0.311	0.708	0.445	0.119	Normal	None	Not Detected	
	GMA-D	22205	23	24	95.8	ND	1.10	0.655	0.205	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12341C	20	24	83.3	ND	0.0474	0.0132	0.0127	Lognormal	None	Detected	
	LDS	12341D	18	20	90.0	ND	0.0474	0.0178	0.0118	Normal	None	Detected	
	HTW	12341	13	17	76.5	ND	0.0101	0.00609	0.00192	Normal	None	Not Detected	
	GMA-U	22206	1	11	9.1	ND	0.00147	Insuff	Insuff	Undefined	None	Detected	
	GMA-D	22205	9	24	37.5	ND	0.0135	0.00075	0.00295	Undefined	None	Detected	
Potassium (mg/L)	LCS	12341C	19	19	100.0	3.81	78.4	21.6	14.5	Undefined	None	Not Detected	
	LDS	12341D	13	13	100.0	31.0	137	36.5	30.3	Undefined	None	Detected	
	HTW	12341	9	10	90.0	ND	2.29	1.87	0.37	Normal	None	Not Detected	
	GMA-U	22206	4	4	100.0	3.84	4.39	4.05	0.25	Normal	None	Insuff	
	GMA-D	22205	4	4	100.0	2.70	3.22	2.92	0.22	Normal	None	Insuff	

Table A.5.4−1 (continued). Summary Statistics for Cell 4

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12341C	6	24	52.0	ND	0.231	0.0132	0.0484	Lognormal	None	Not Detected	
	LDS	12341D	2	20	10.0	ND	0.067	Insuff	Insuff	Undefined	None	Not Detected	
	HTW	12341	0	17	0.0	NA	NA	Insuff	Insuff	Undefined	None	Detected	
	GMA-U	22206	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22205	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12341C	24	24	100.0	22.0	117	50.0	18.1	Undefined	Up	Not Detected	
	LDS	12341D	20	20	100.0	307	623	458	87	Normal	Up	Detected	
	HTW	12341	20	20	100.0	14.1	18.1	15.3	0.97	Lognormal	None	Not Detected	
	GMA-U	22206	11	11	100.0	12.3	15.8	13.8	0.97	Normal	None	Not Detected	
	GMA-D	22205	11	11	100.0	14.9	22.2	19.0	2.51	Normal	Up	Not Detected	
Zinc (mg/L)	LCS	12341C	11	24	45.8	ND	0.0446	0.0138	0.0100	Lognormal	Up	Not Detected	
	LDS	12341D	17	20	85.0	ND	0.775	0.311	0.251	Lognormal	None	Detected	
	HTW	12341	11	17	64.7	ND	0.351	0.00845	0.121	Undefined	None	Detected	
	GMA-U	22206	6	11	54.6	ND	0.0201	0.00908	0.00532	Normal	None	Not Detected	
	GMA-D	22205	12	24	50.0	ND	0.00859	0.00396	0.00214	Normal	Up	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires n ≥ 3. In addition, Standard Deviation requires n ≥ 4.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where 3 ≤ n ≤ 50) or Shapiro Francia (where n > 50).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with n ≥ 4.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with n ≥ 6.

[h]Outliers determined by Rosner's (where n > 25) or Dixon procedure (where 4 ≤ n ≤ 25).

[i]Q = quarterly

Table A.5.4−2. Cell 4 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	10	4	40.0	Yes	0.0268	0.133	0.0556	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganic											
Chromium (mg/L)	10	4	40.0	Yes	0.003	0.0137	0.0065	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(2)	0.818 mg/L(0)
Lead (mg/L)	10	1	10.0	No	0.0185	-	-	0.015 mg/L(1)	0.022 mg/L(0)	0.0016 mg/L(1)	0.0114 mg/L(1)
Radionuclides											
Technetium-99 (pCi/L)	16	5	31.2	No	1.21	37.8	14.5	94 pCi/L(0)	22 pCi/L(1)	30 pCi/L(1)	6130 pCi/L(0)
Organics											
1,1-Dichloroethane (ug/L)	9	1	11.1	No	0.332	-	-	280 ug/L(0)	-	-	-
Acetone (ug/L)	9	1	11.1	No	2.35	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundw ater background, PW background, or PW maximum.

[a]If more than one sample is collected per w ell per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample w ith the maximum representative concentration is used for all the summary information

[b]Rejected data qualified w ith an R or Z w ere not included.

[c]If the number of detected samples is equal to tw o, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundw ater w hich w as developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched w ater as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

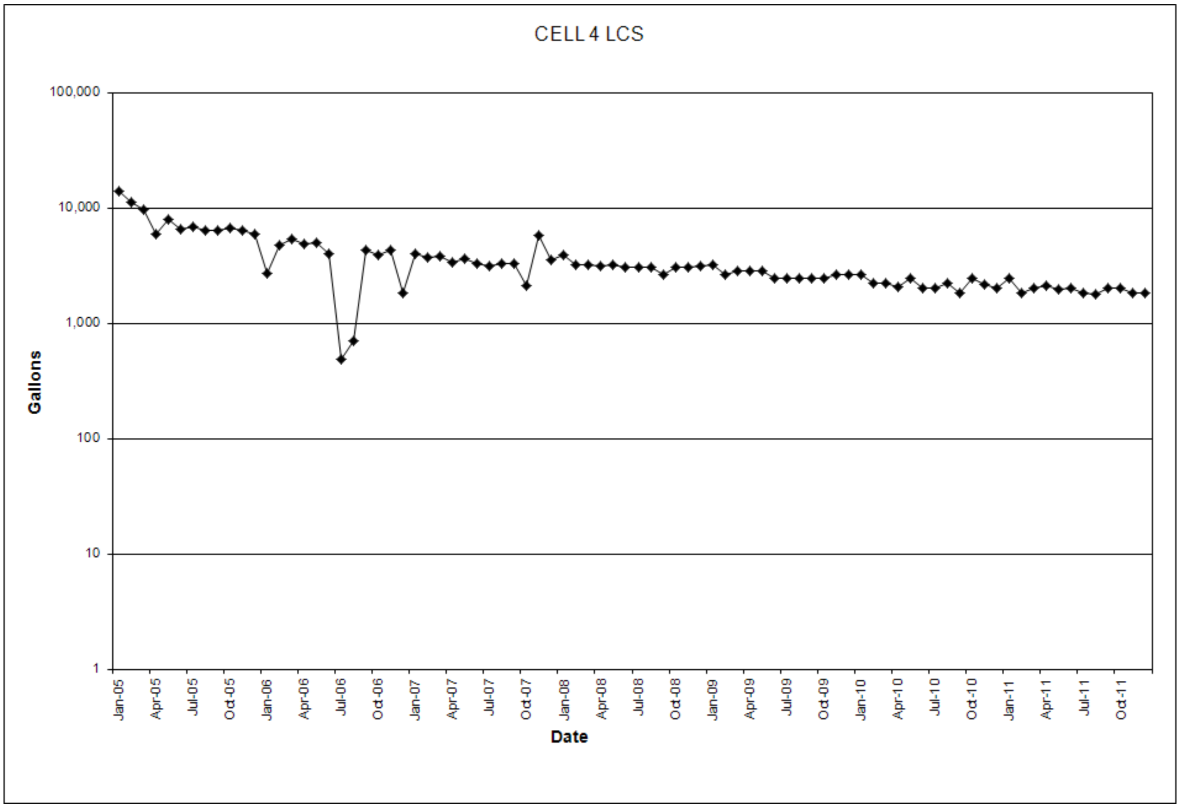


Figure A.5.4–1. Monthly Accumulation Volumes For Cell 4 LCS

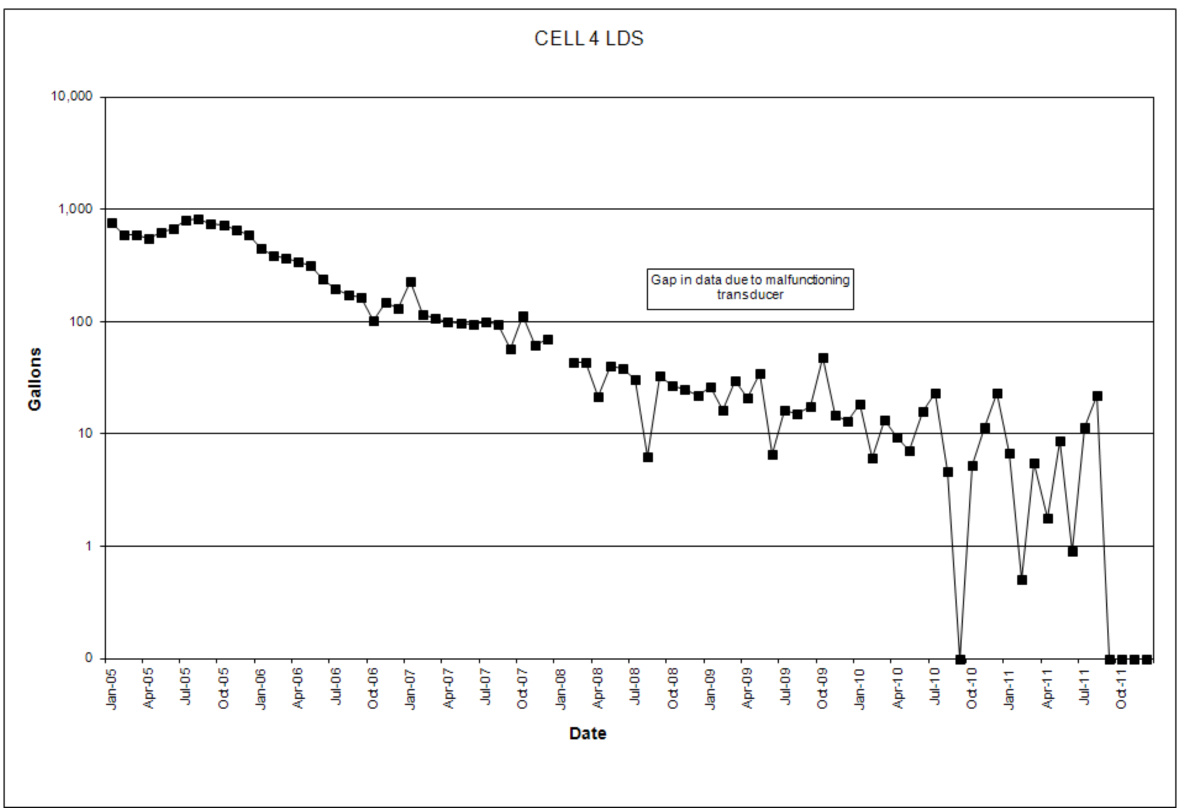
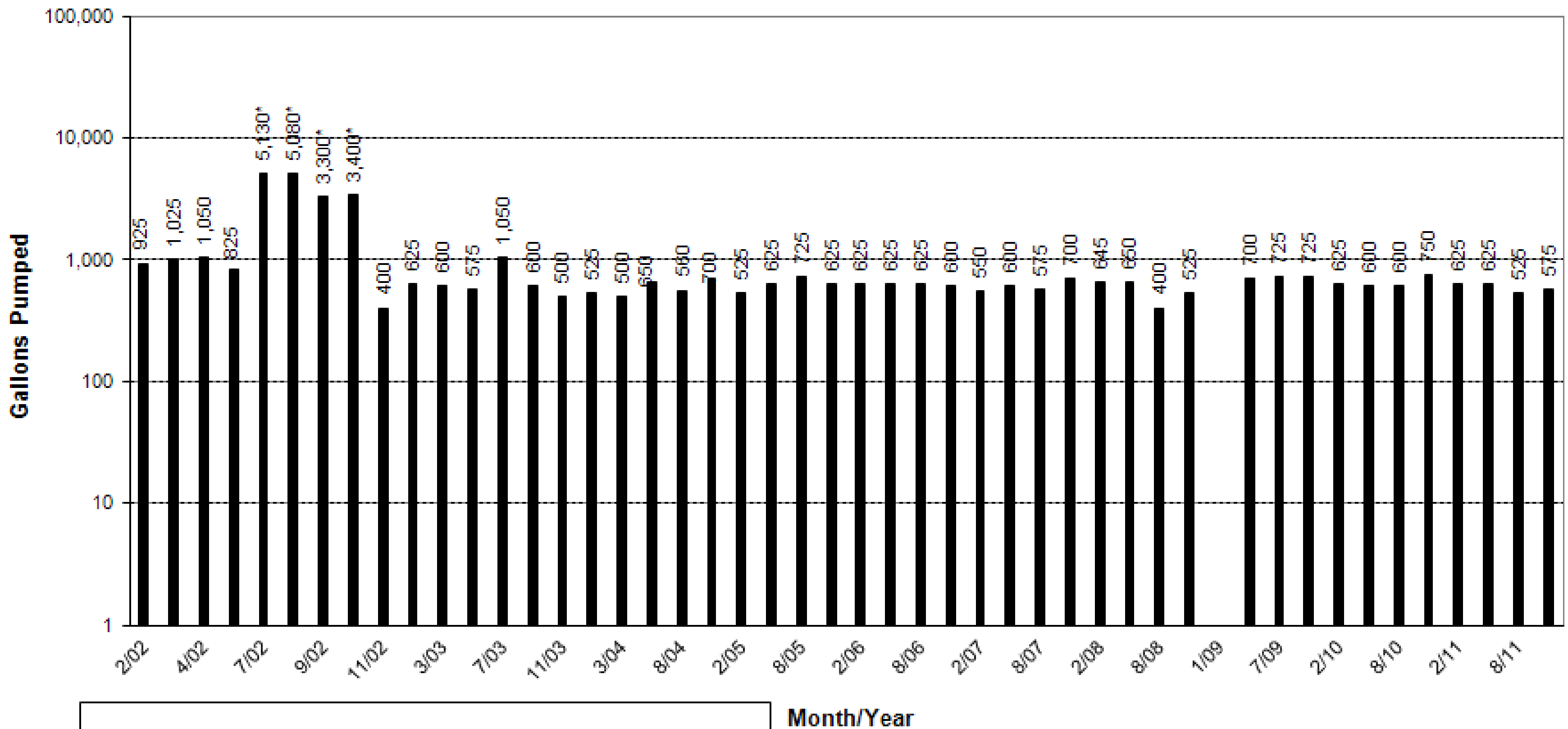


Figure A.5.4–2. Monthly Accumulation Volumes For Cell 4 LDS



12341 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2002:	21115	n=9	2346
2003:	3950	n=6	658
2004:	2935	n=5	587
2005:	2500	n=4	625
2006:	2475	n=4	619
2007:	2425	n=4	606
2008:	2220	n=4	555
2009:	2150	n=3	717
2010:	2575	n=4	644
2011:	2350	n=4	588
Overall:			951

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

Figure A.5.4–3. OSDF Horizontal Till Well 12341 (Cell 4) Water Yield

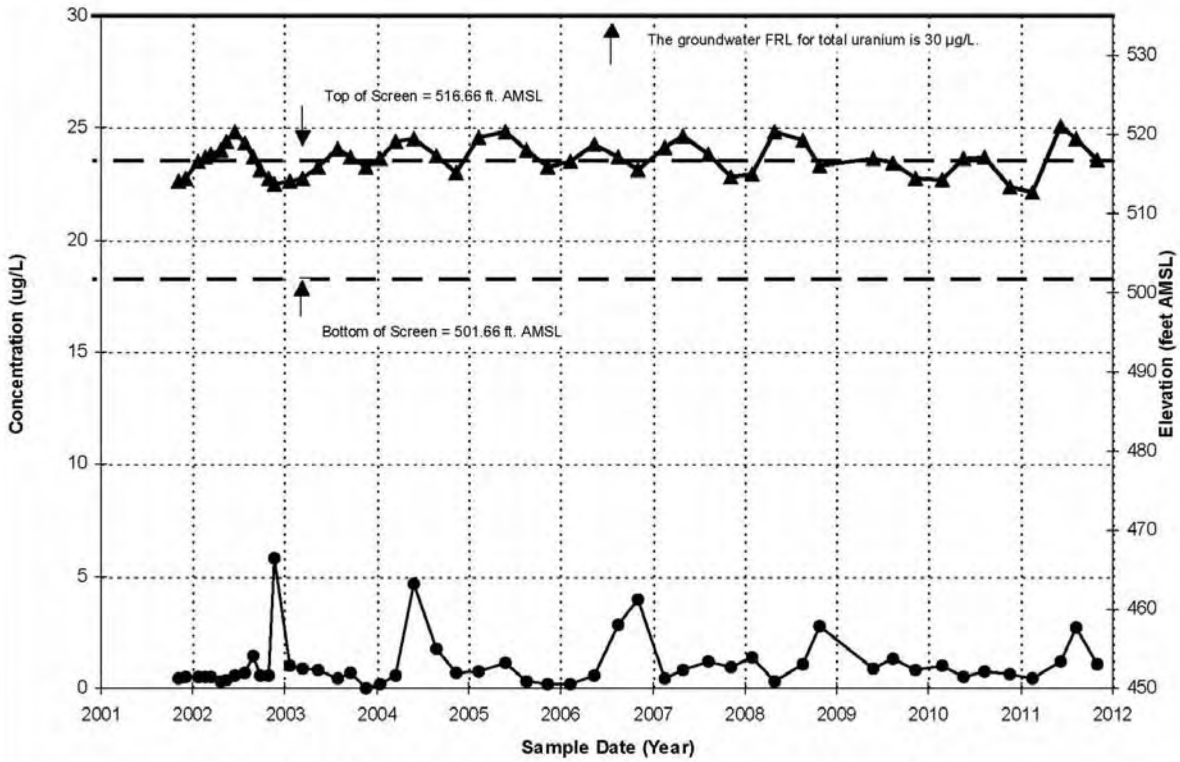


FIGURE A.5.4-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 4 Upgradient Monitoring Well 22206

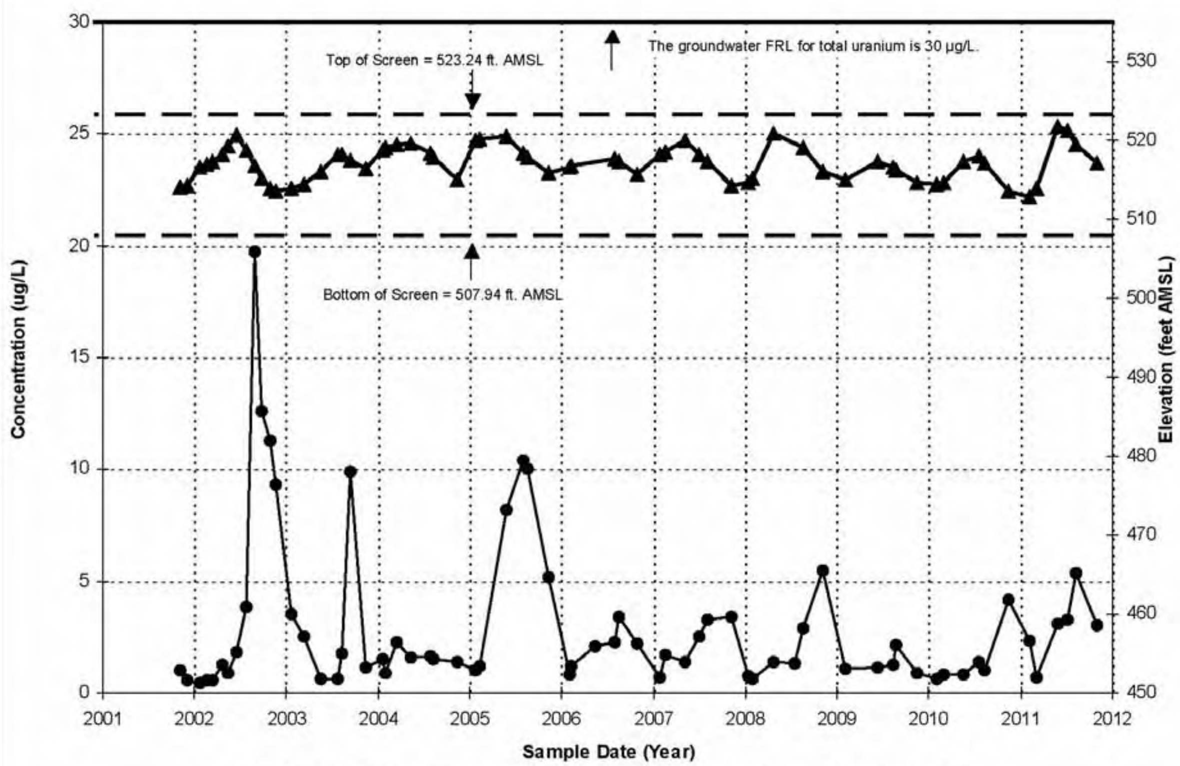


FIGURE A.5.4-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 4 Downgradient Monitoring Well 22205

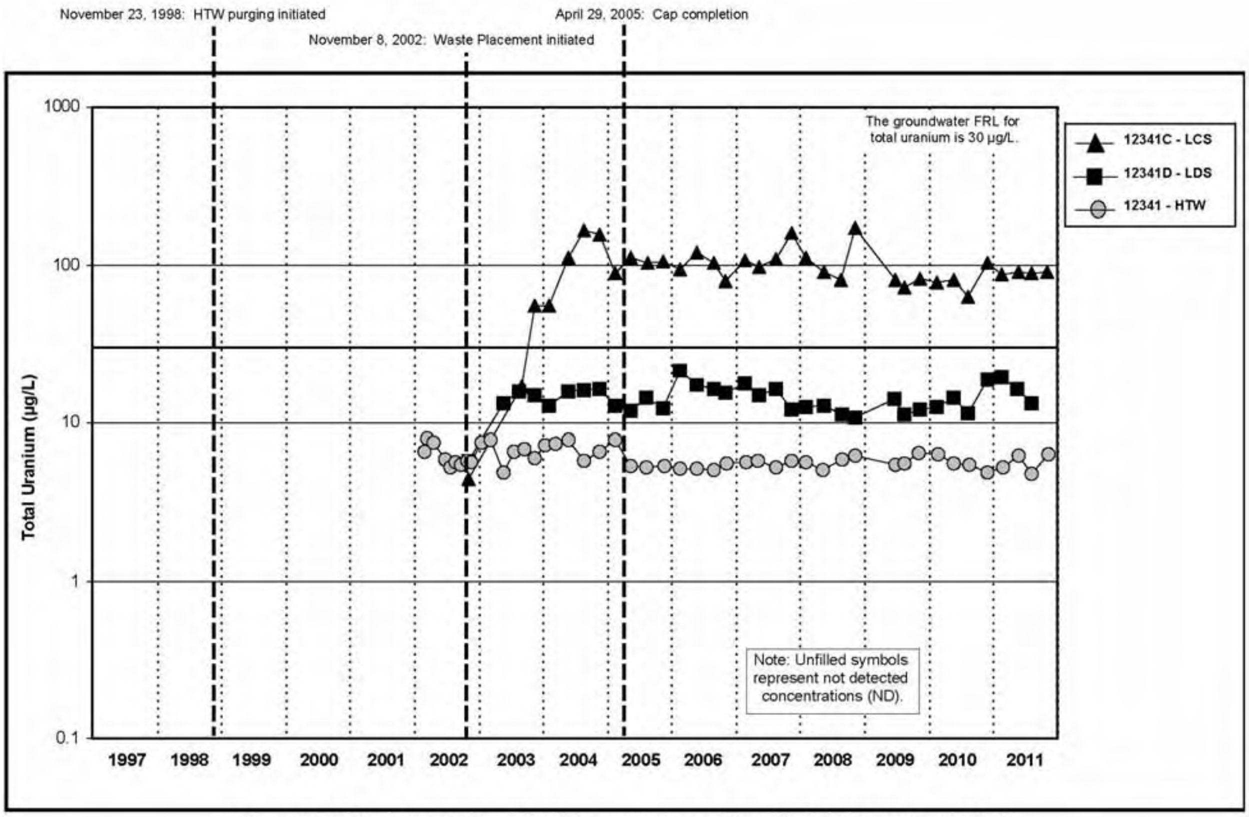


Figure A.5.4-6A. Cell 4 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

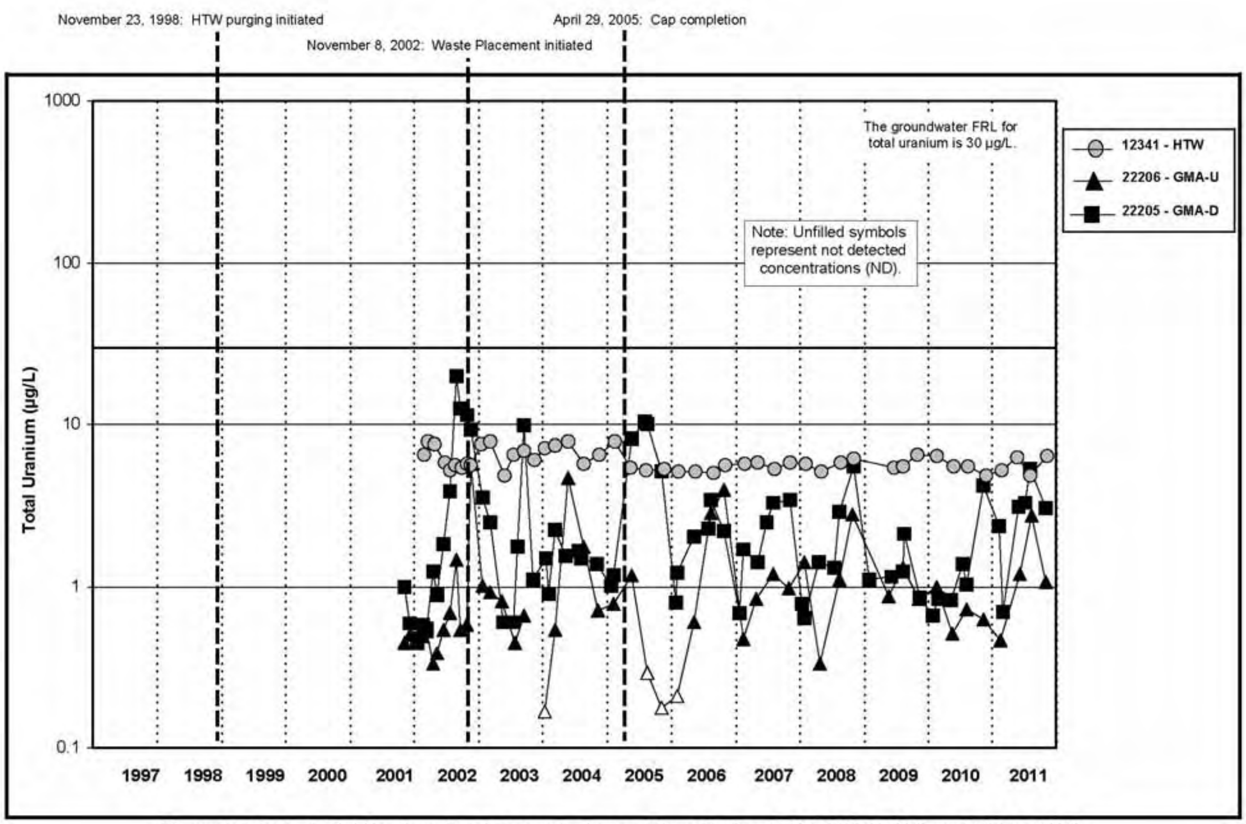


Figure A.5.4-6B. Cell 4 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

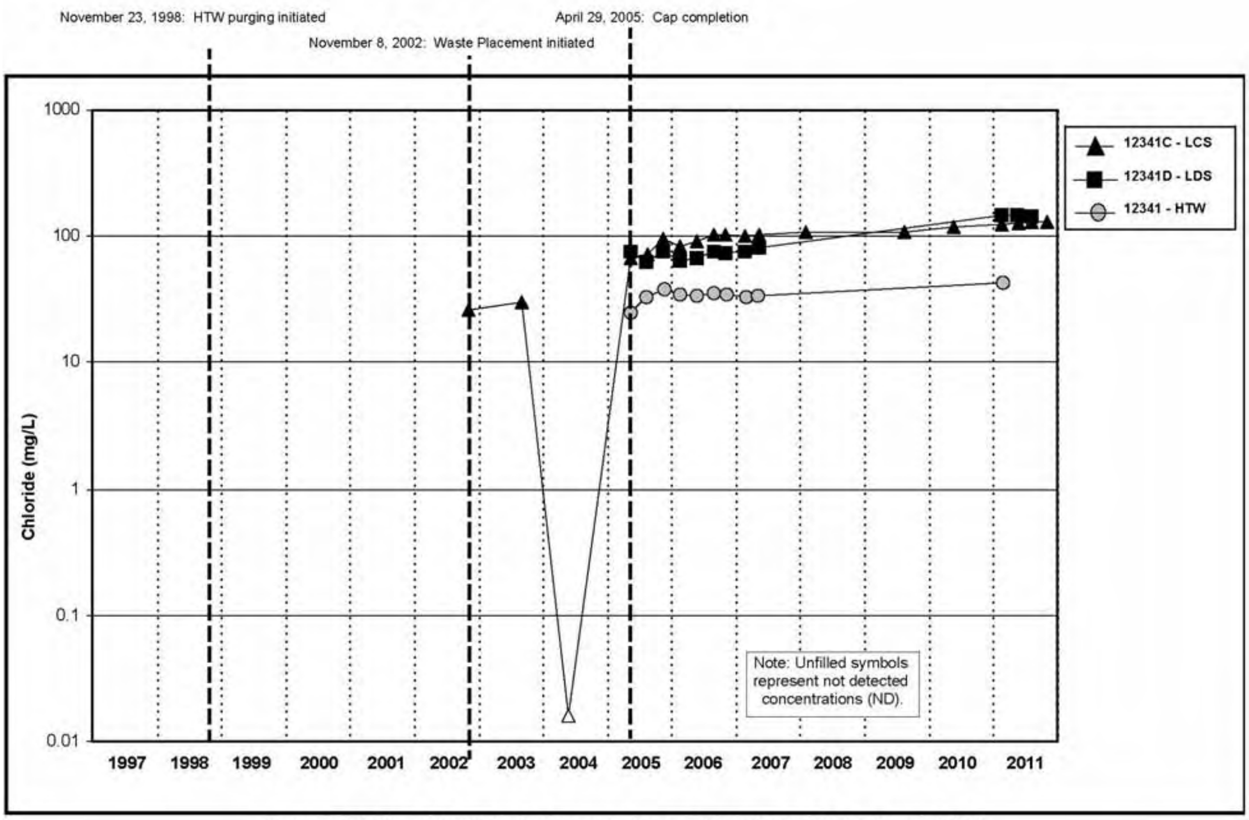


Figure A.5.4-7A. Cell 4 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

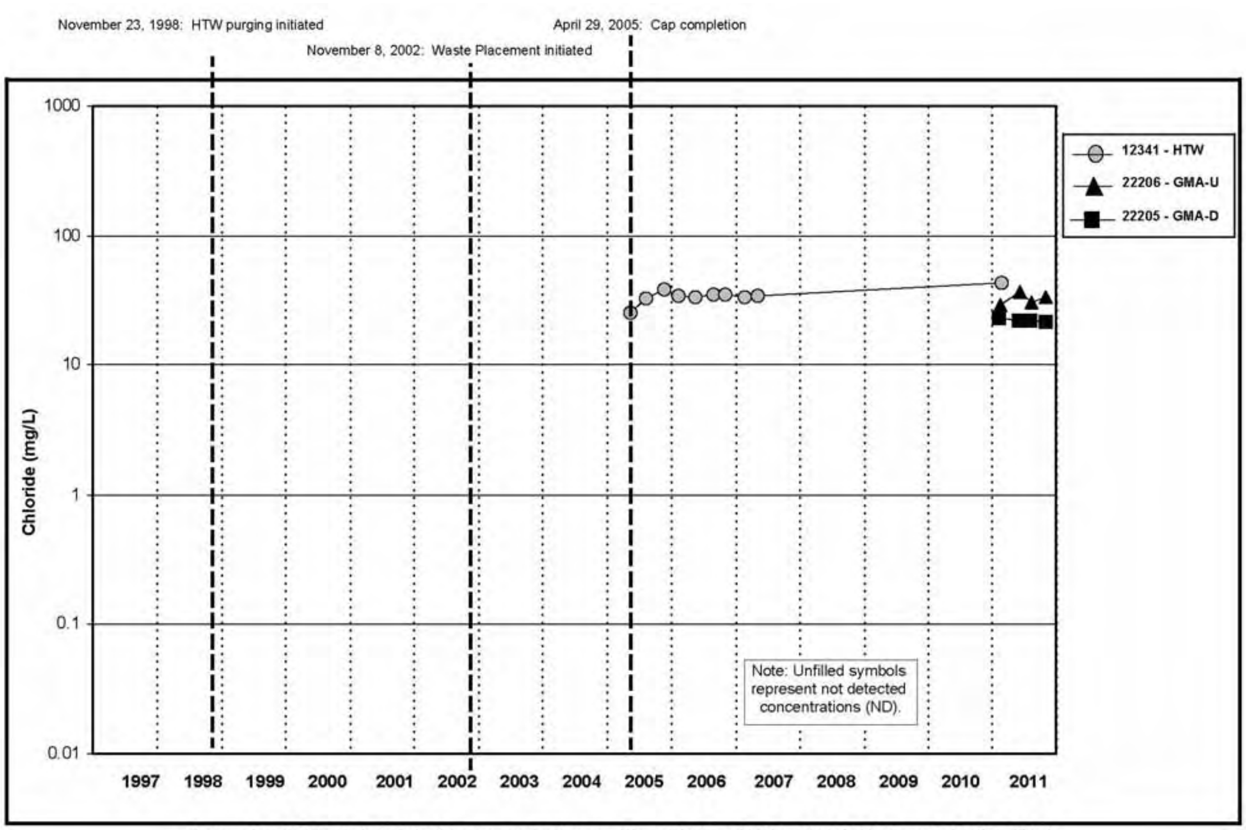


Figure A.5.4-7B. Cell 4 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

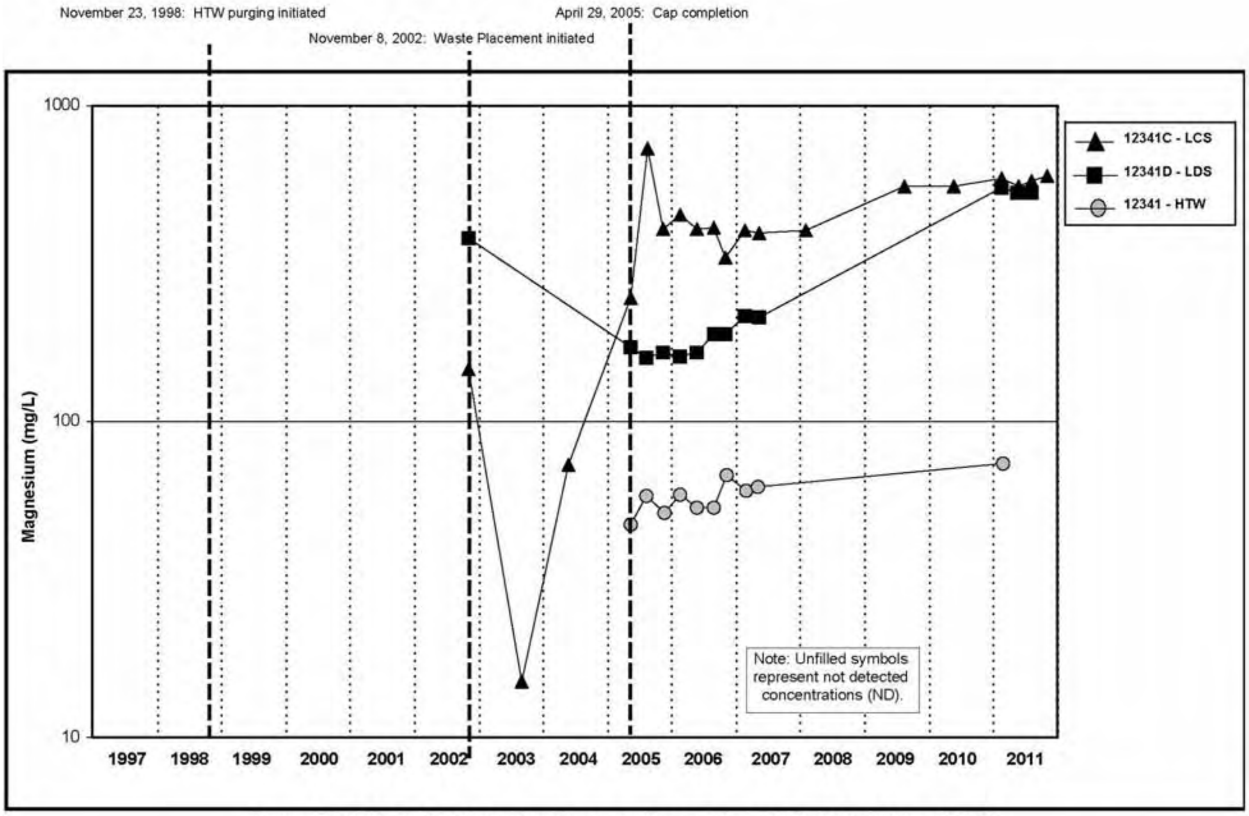


Figure A.5.4-8A. Cell 4 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

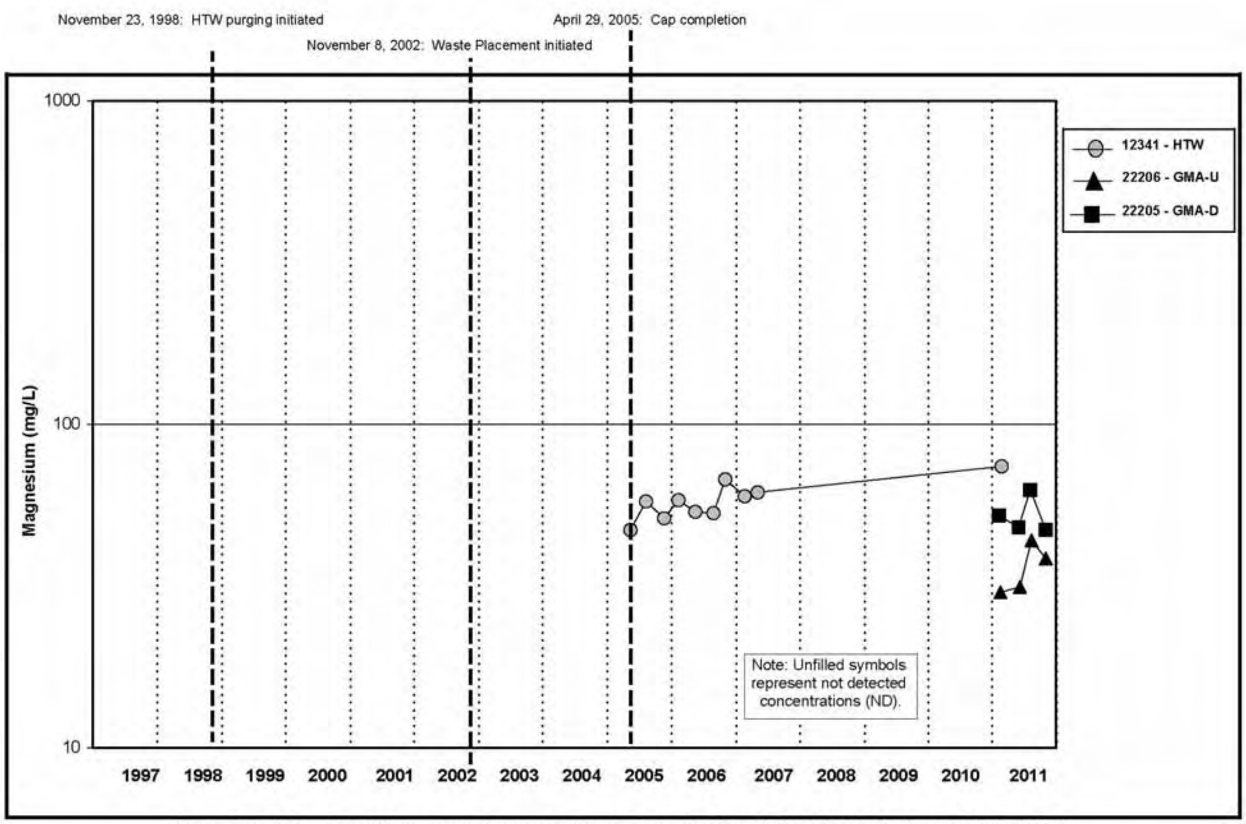


Figure A.5.4-8B. Cell 4 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

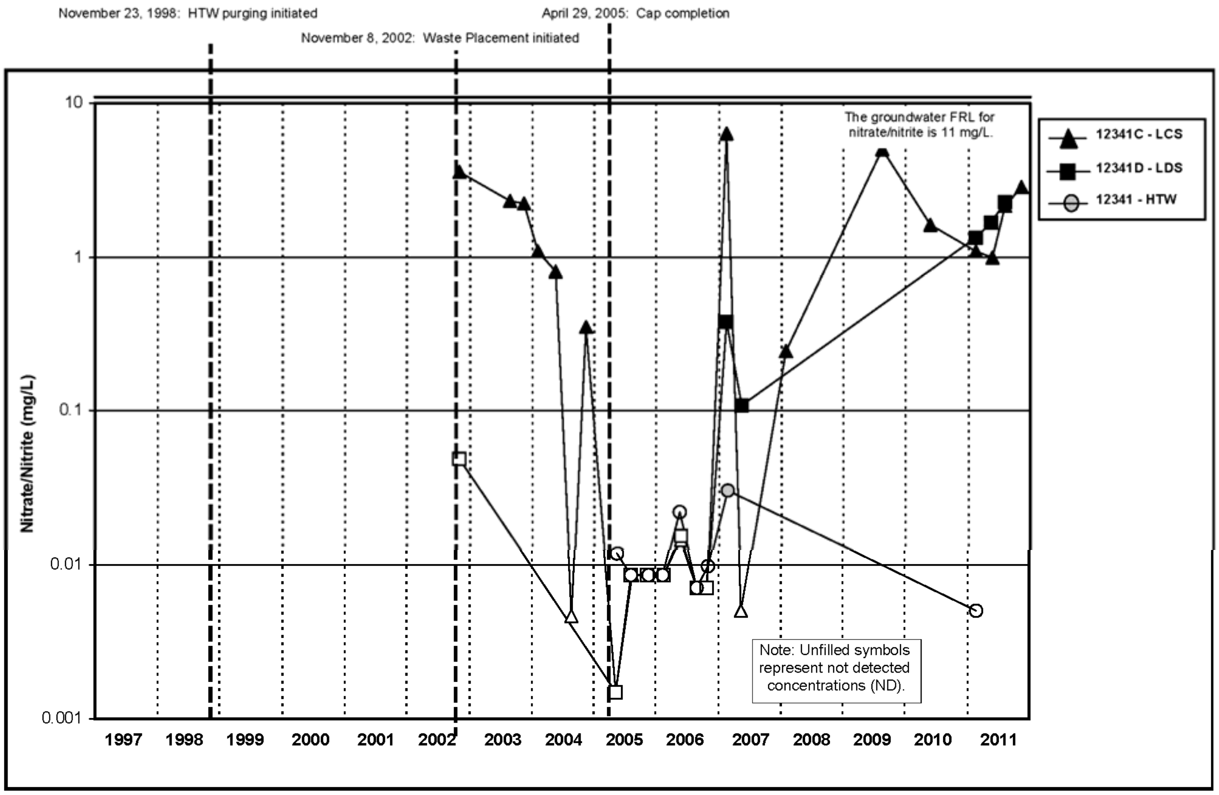


Figure A.5.4-9A. Cell 4 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

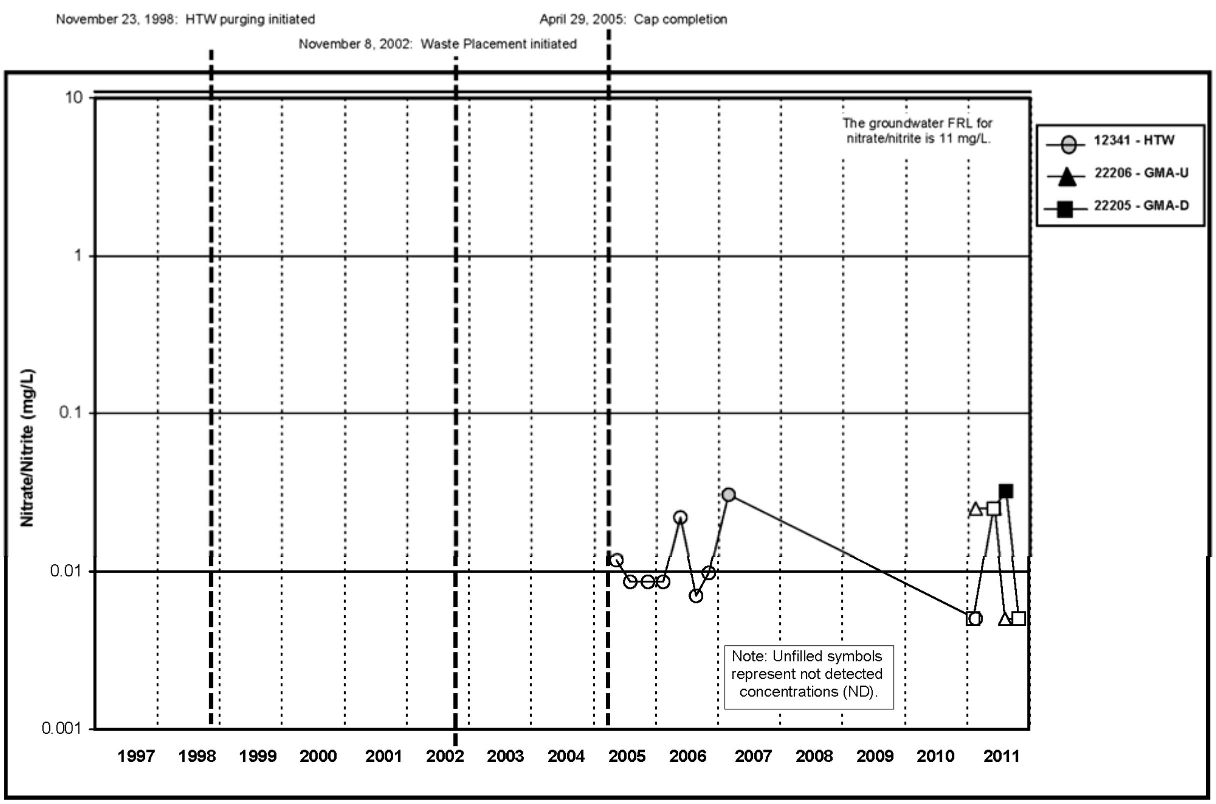


Figure A.5.4-9B. Cell 4 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

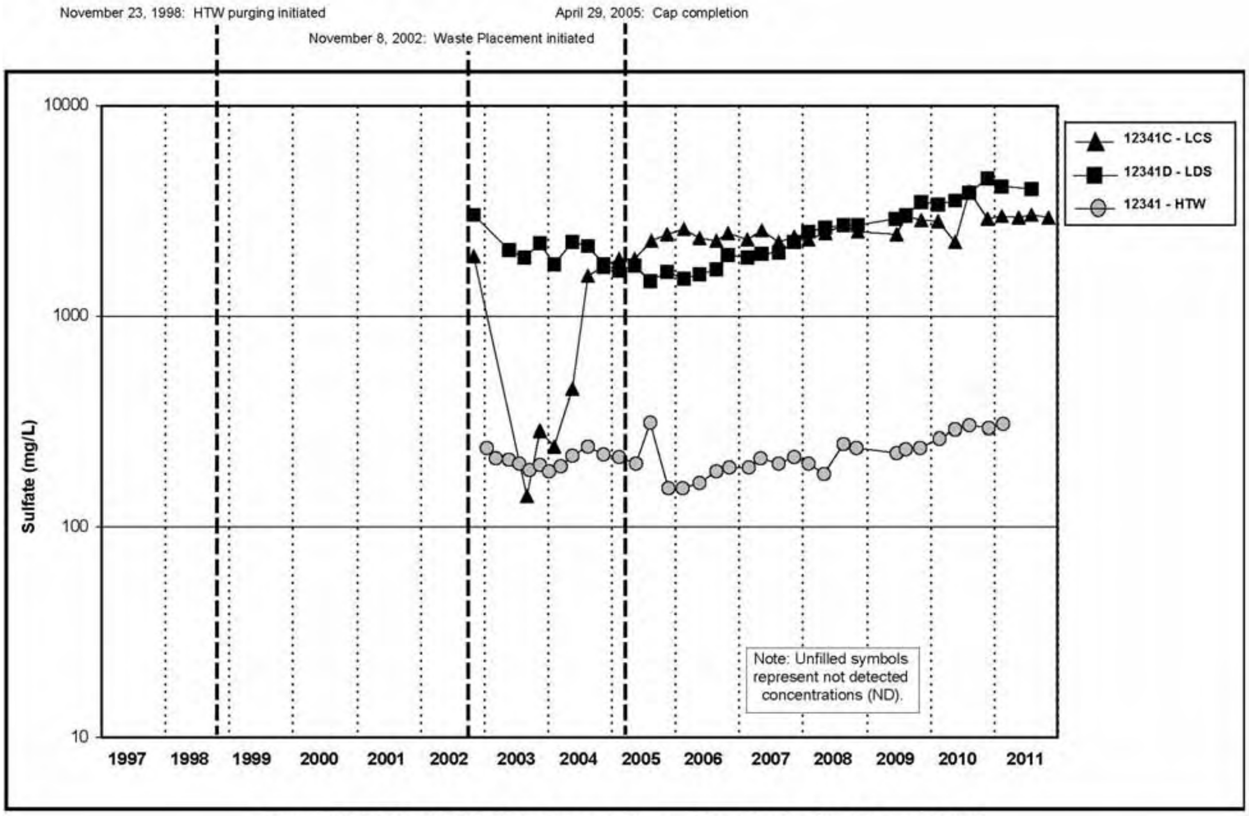


Figure A.5.4-10A. Cell 4 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

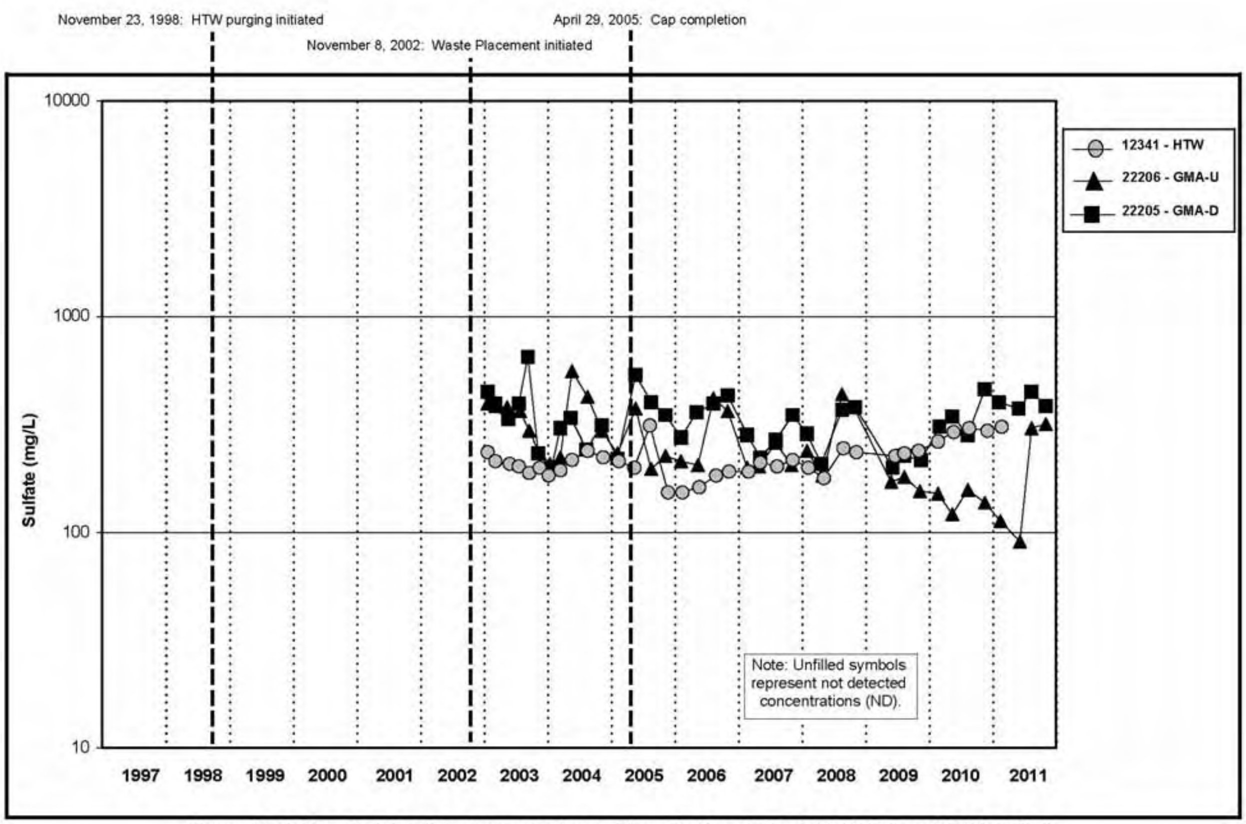


Figure A.5.4-10B. Cell 4 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

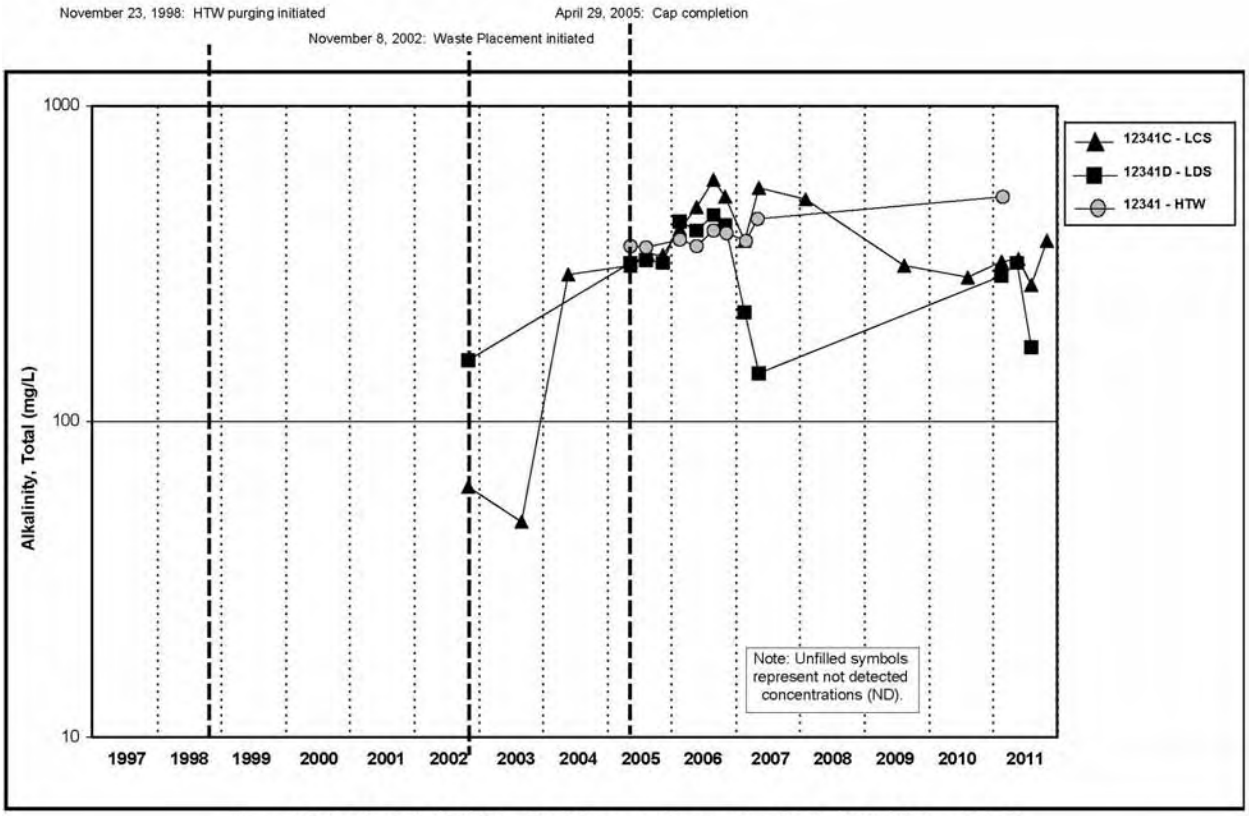


Figure A.5.4-11A. Cell 4 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

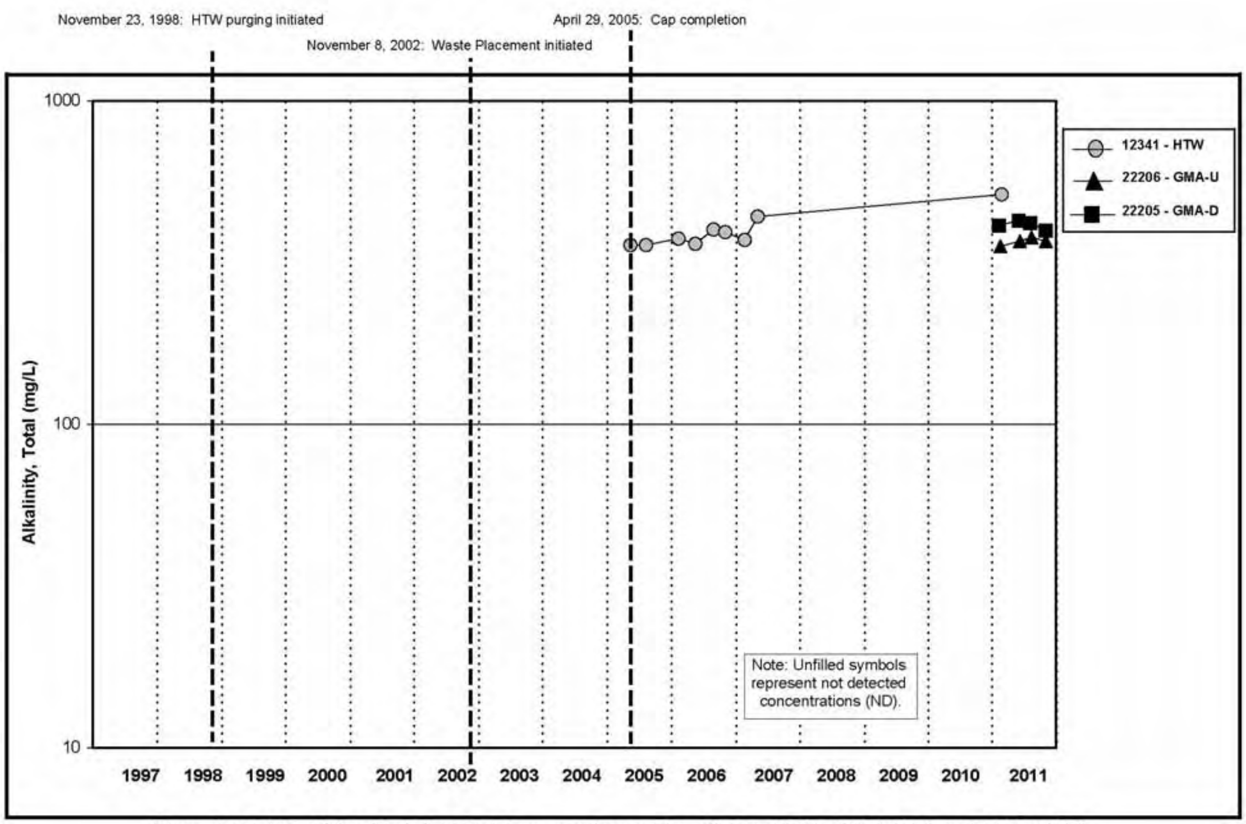


Figure A.5.4-11B. Cell 4 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

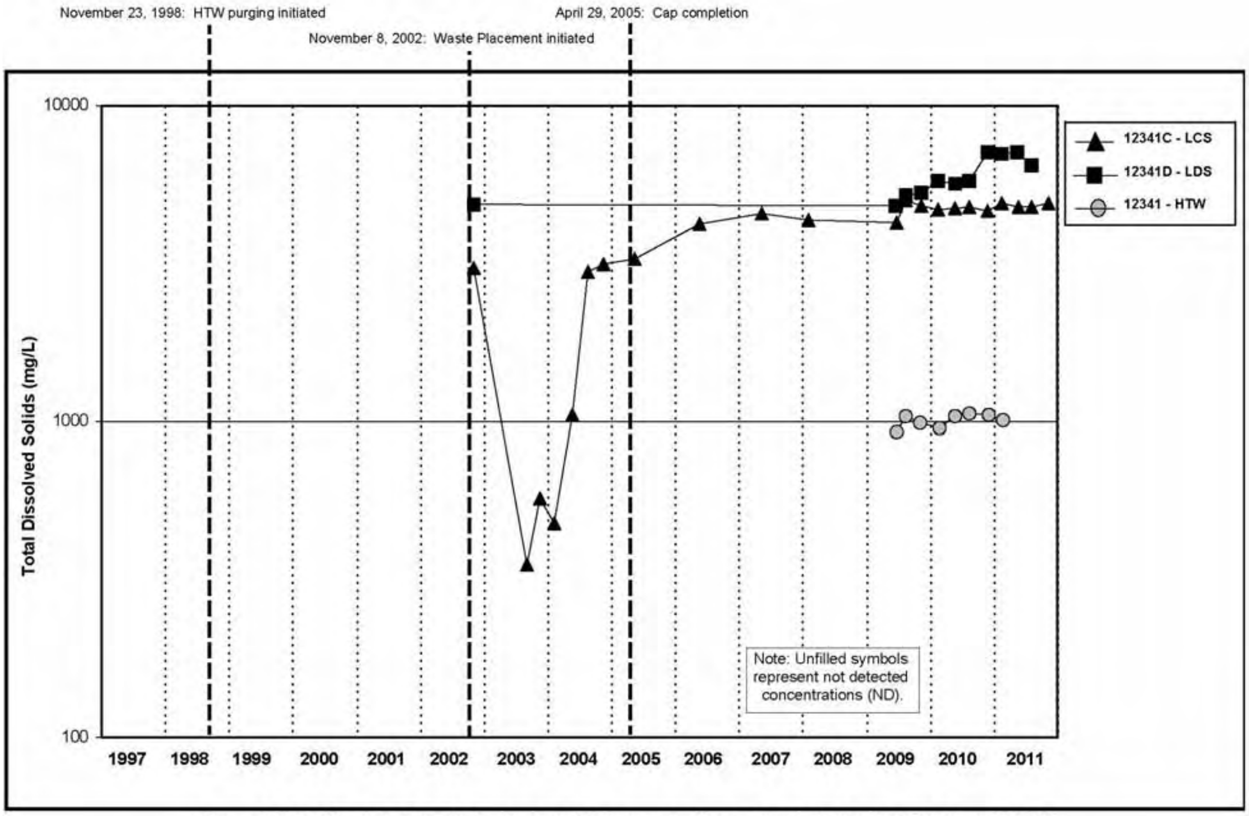


Figure A.5.4-12A. Cell 4 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

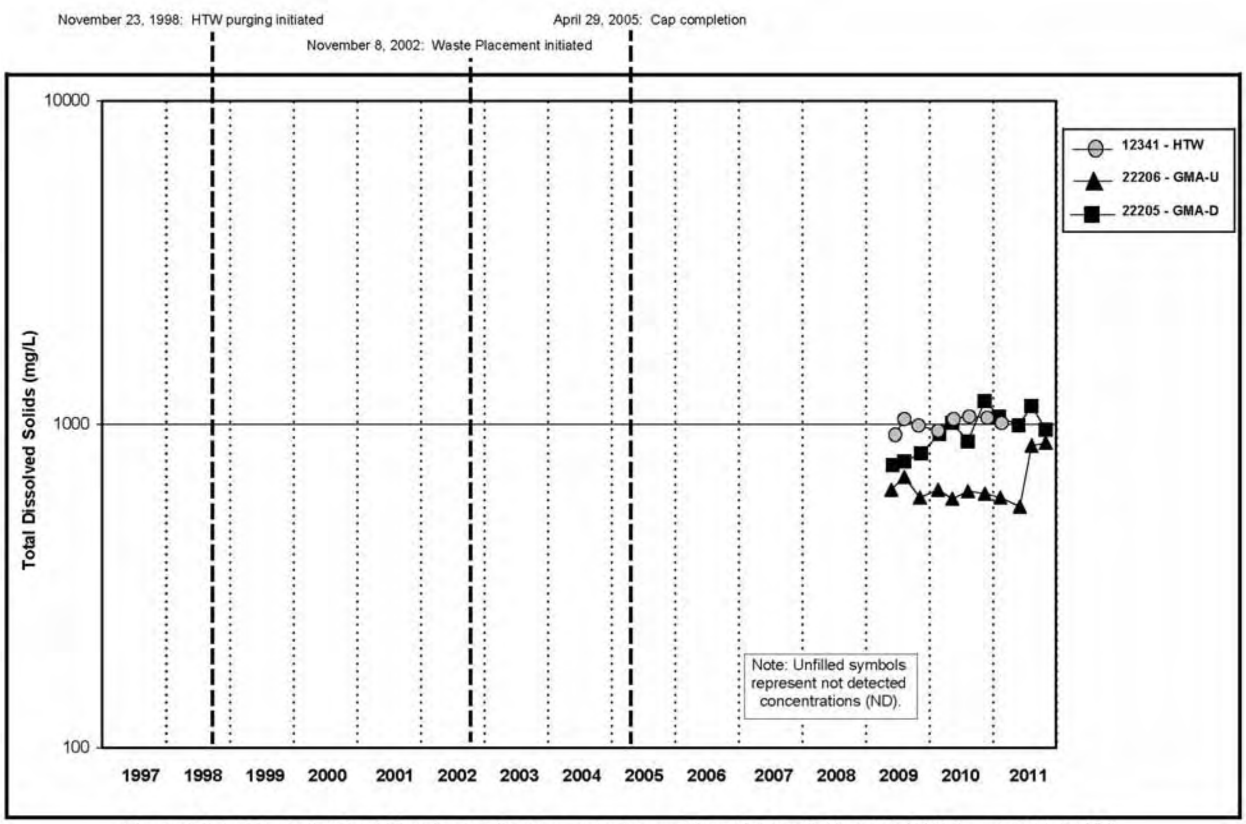


Figure A.5.4-12B. Cell 4 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

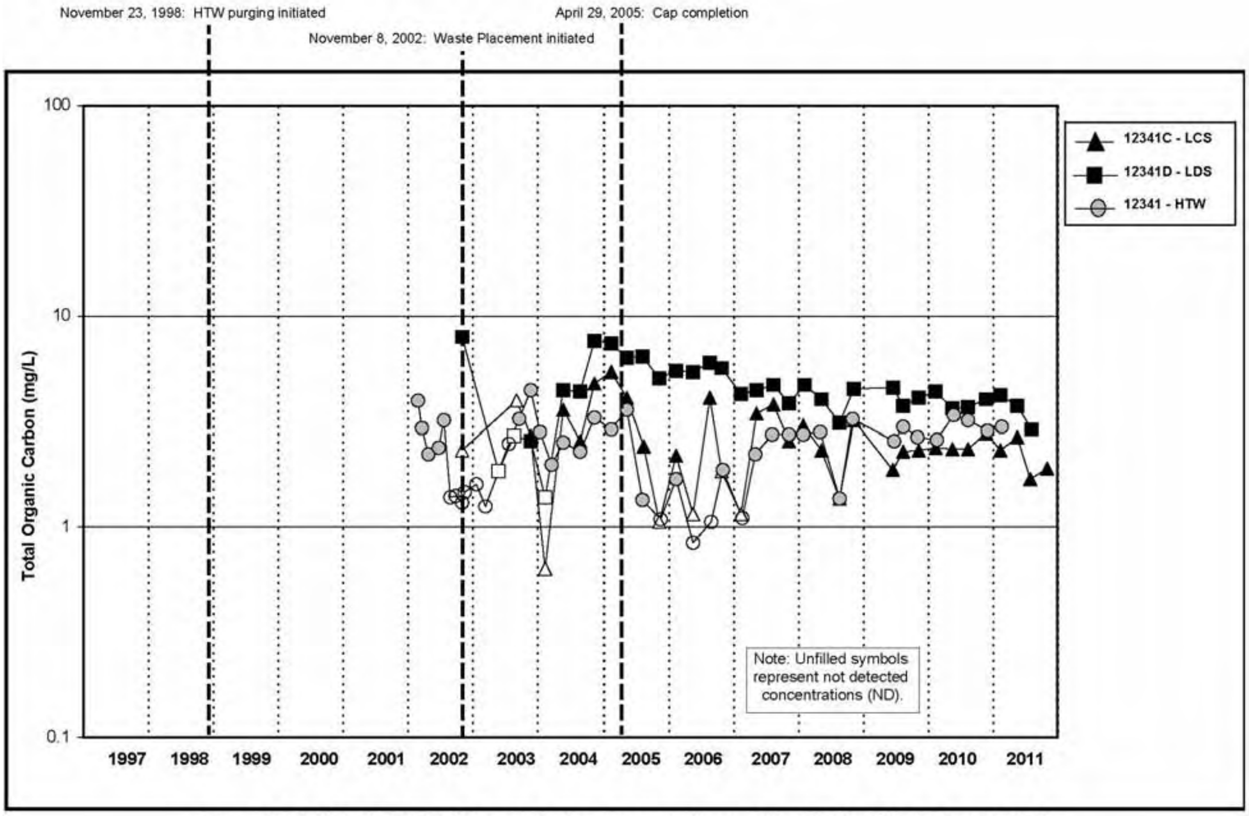


Figure A.5.4-13A. Cell 4 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

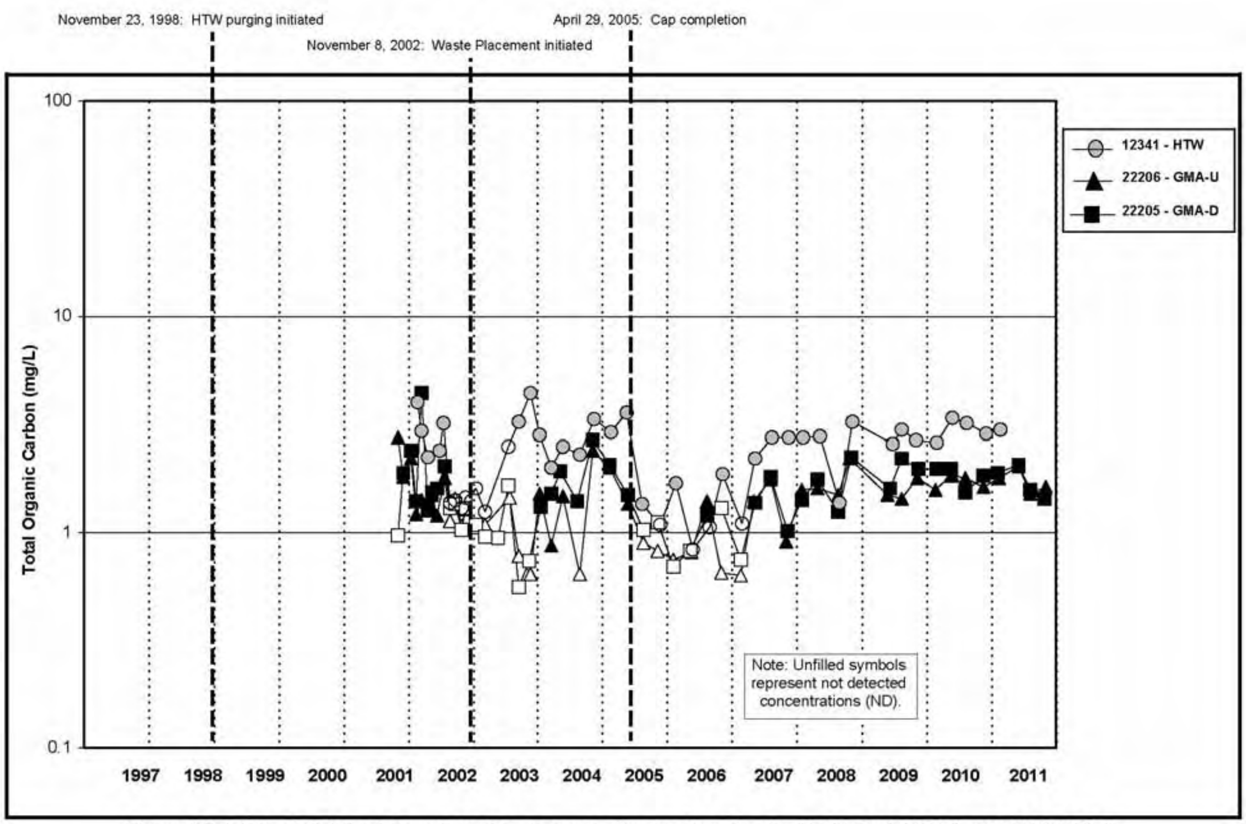


Figure A.5.4-13B. Cell 4 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

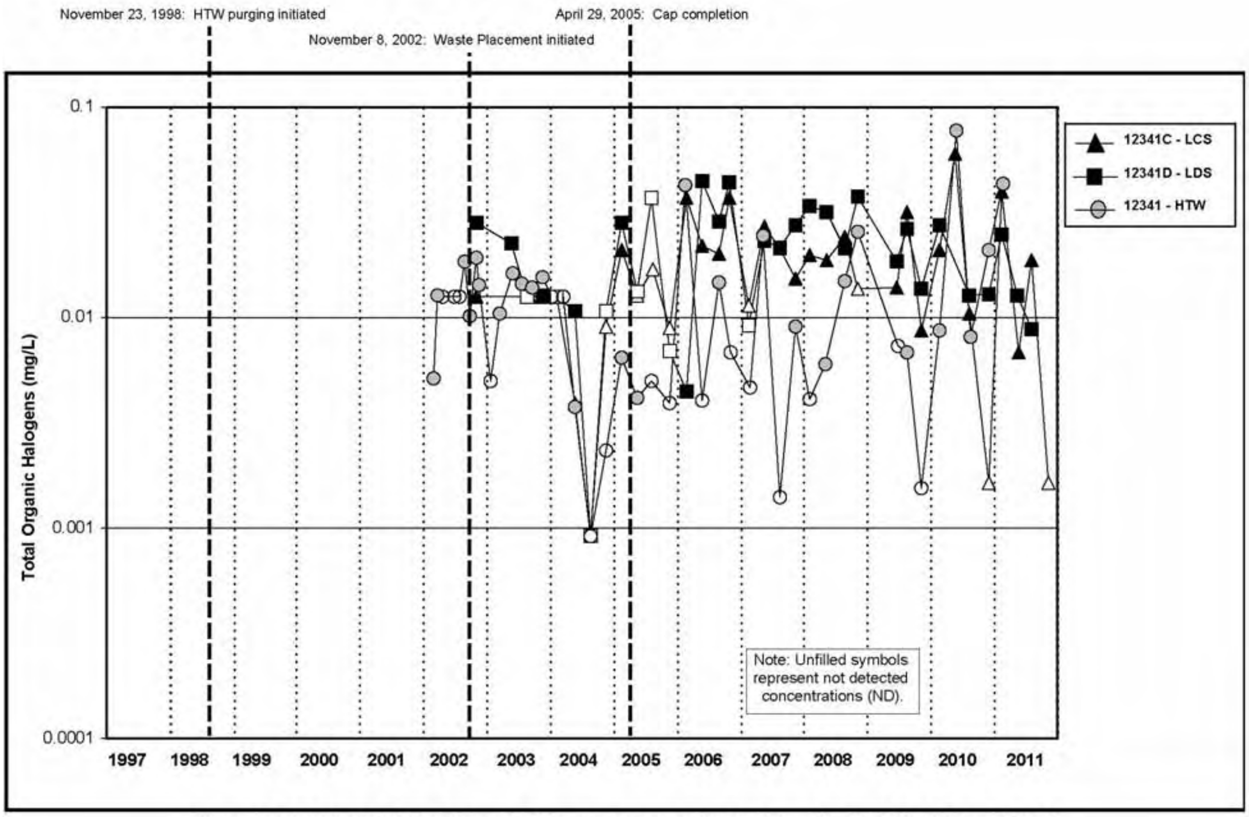


Figure A.5.4-14A. Cell 4 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

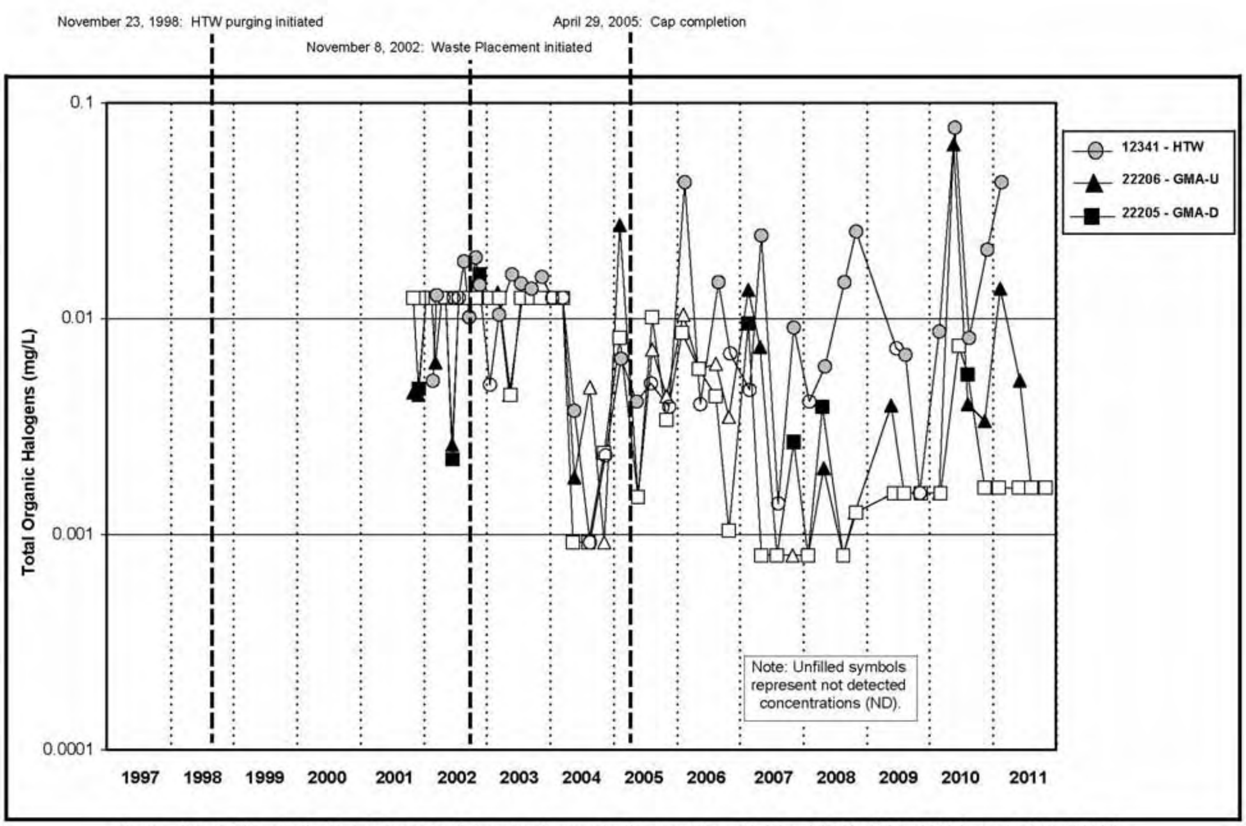


Figure A.5.4-14B. Cell 4 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

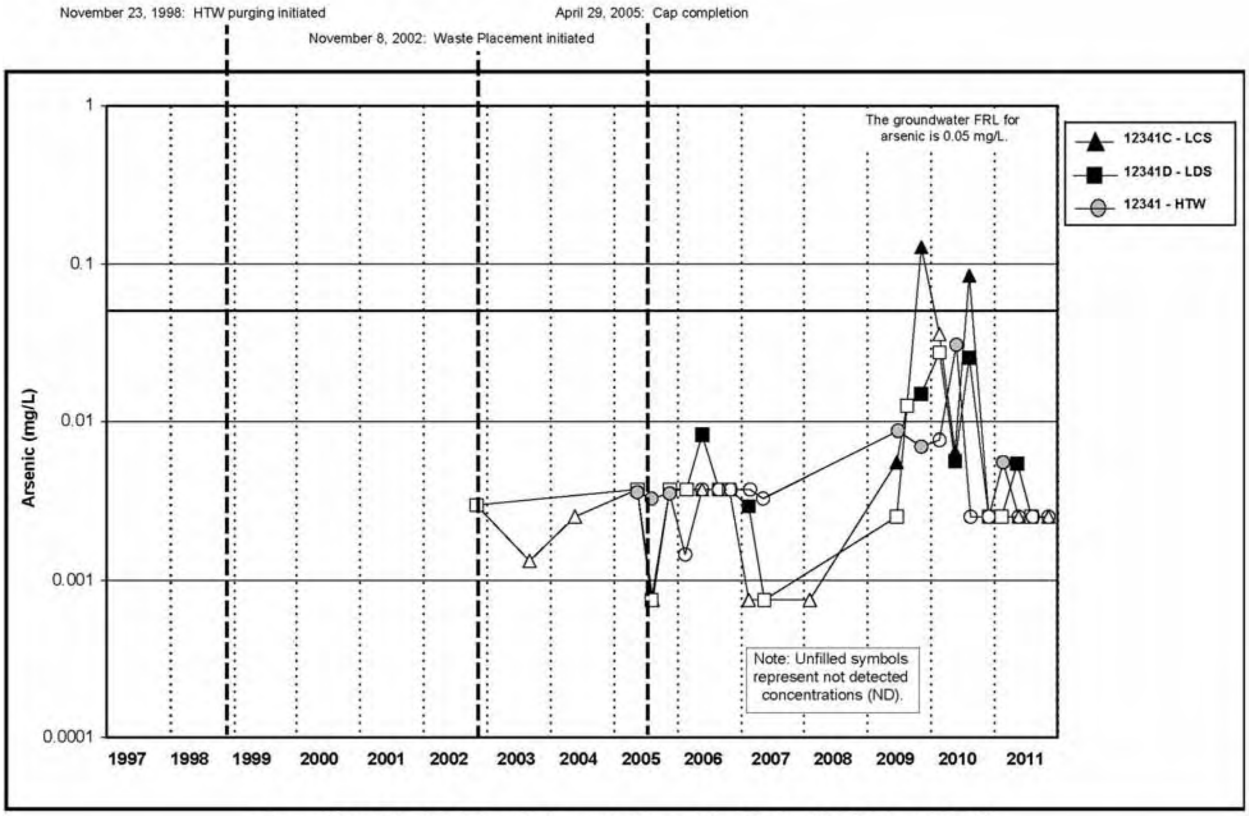


Figure A.5.4-15A. Cell 4 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

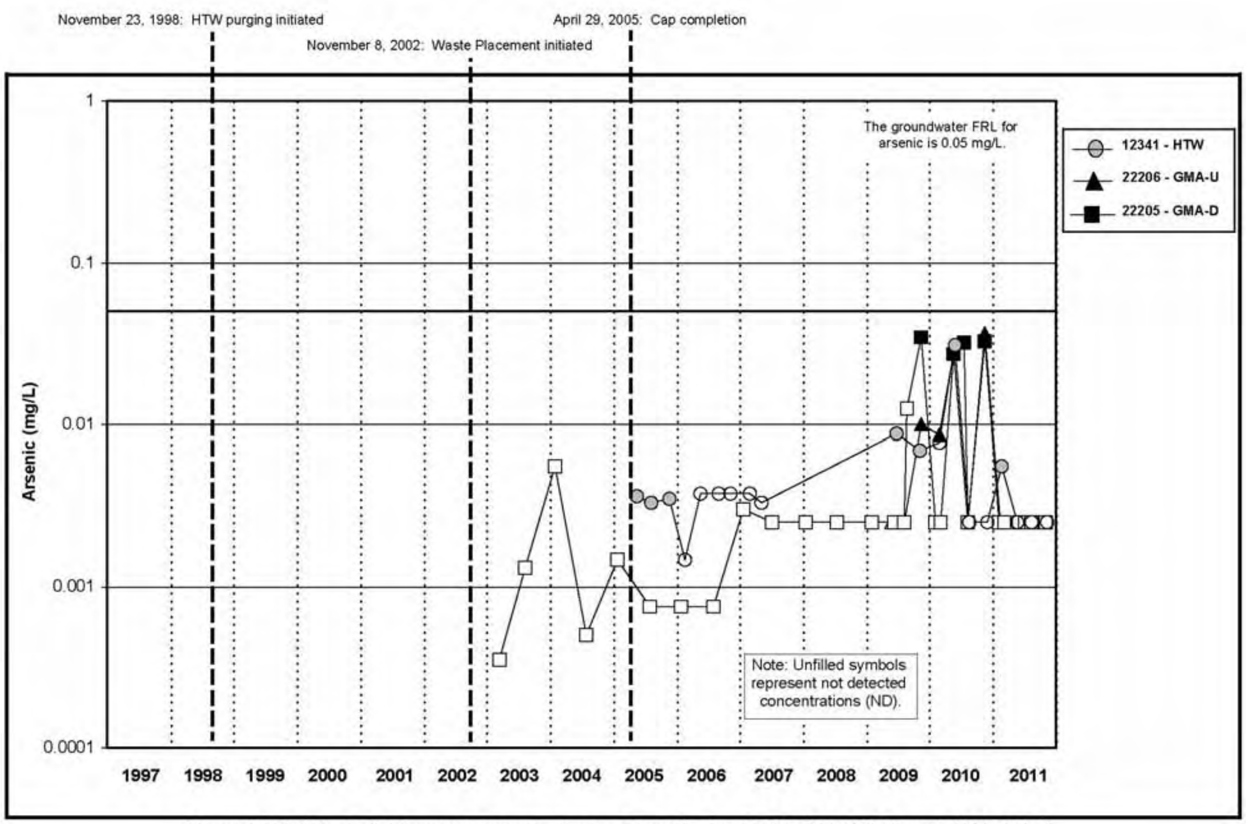


Figure A.5.4-15B. Cell 4 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

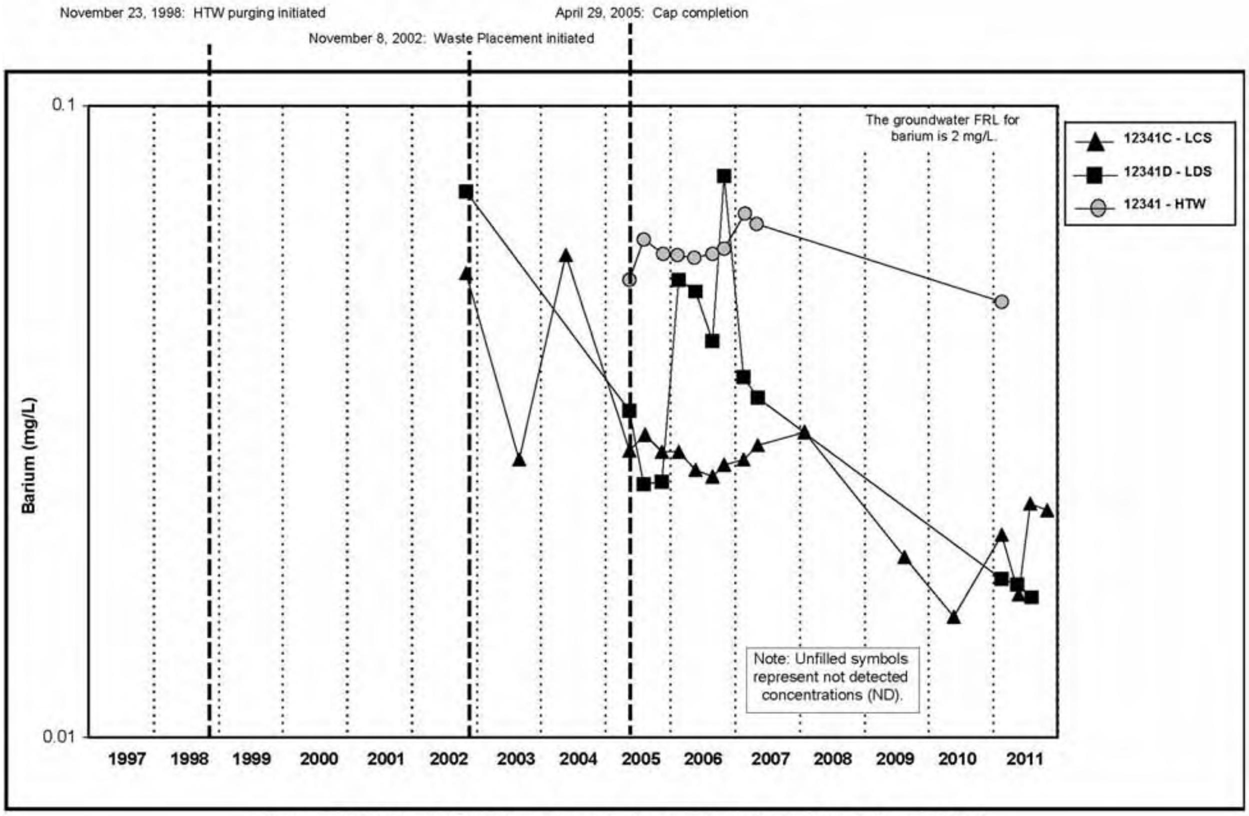


Figure A.5.4-16A. Cell 4 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

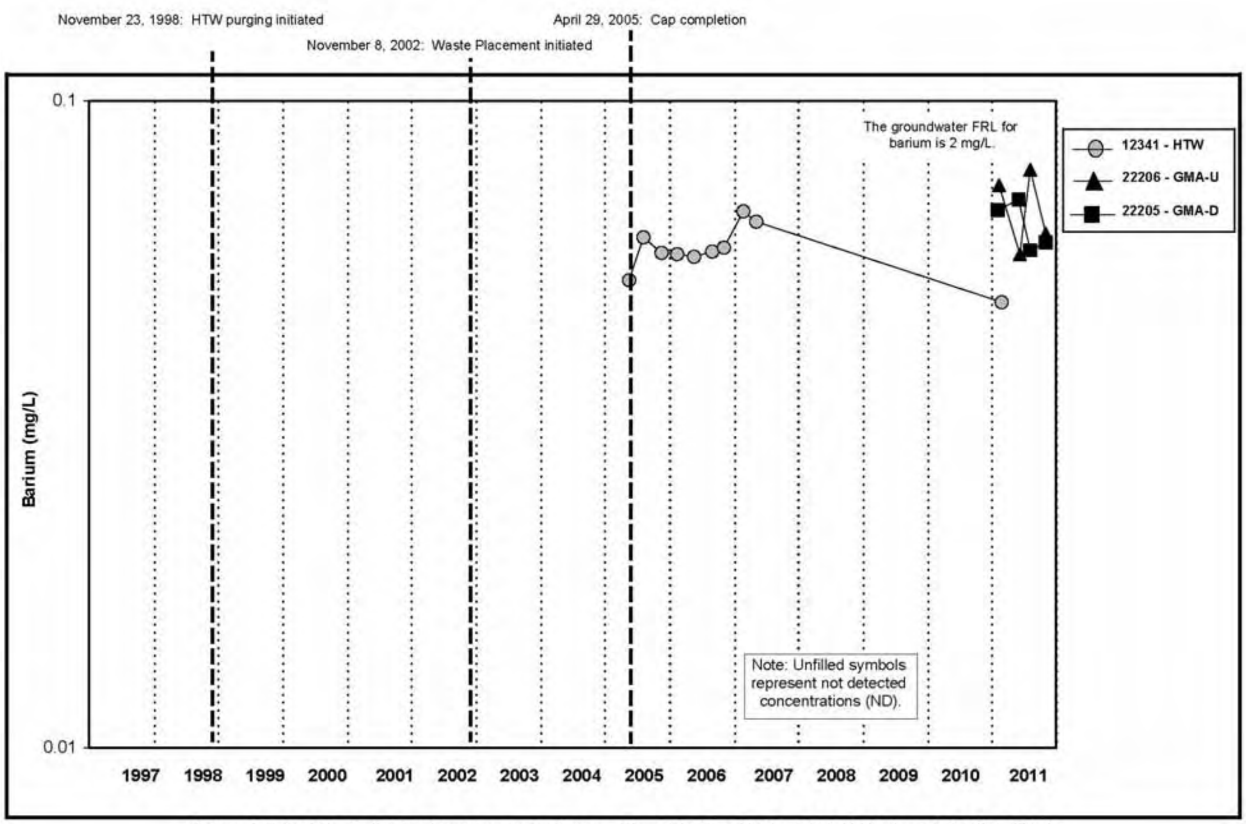


Figure A.5.4-16B. Cell 4 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

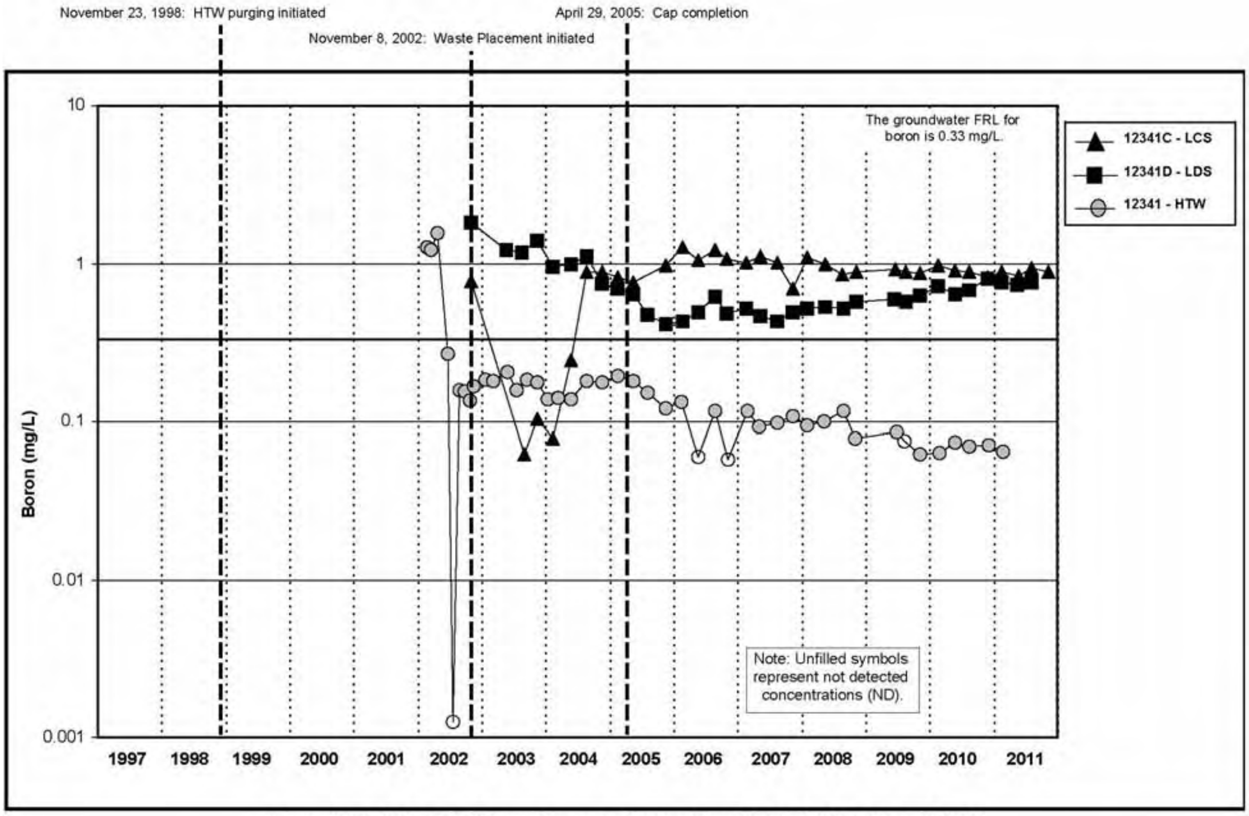


Figure A.5.4-17A. Cell 4 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

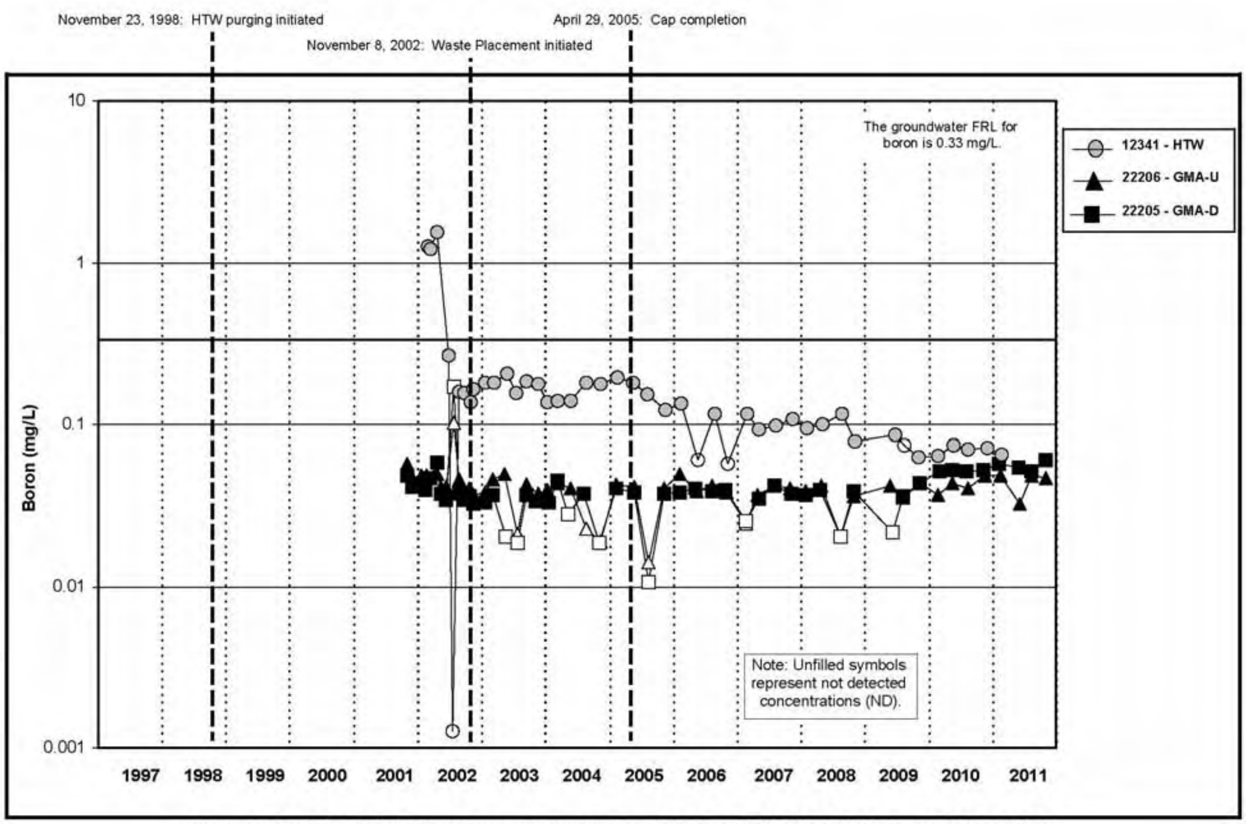


Figure A.5.4-17B. Cell 4 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

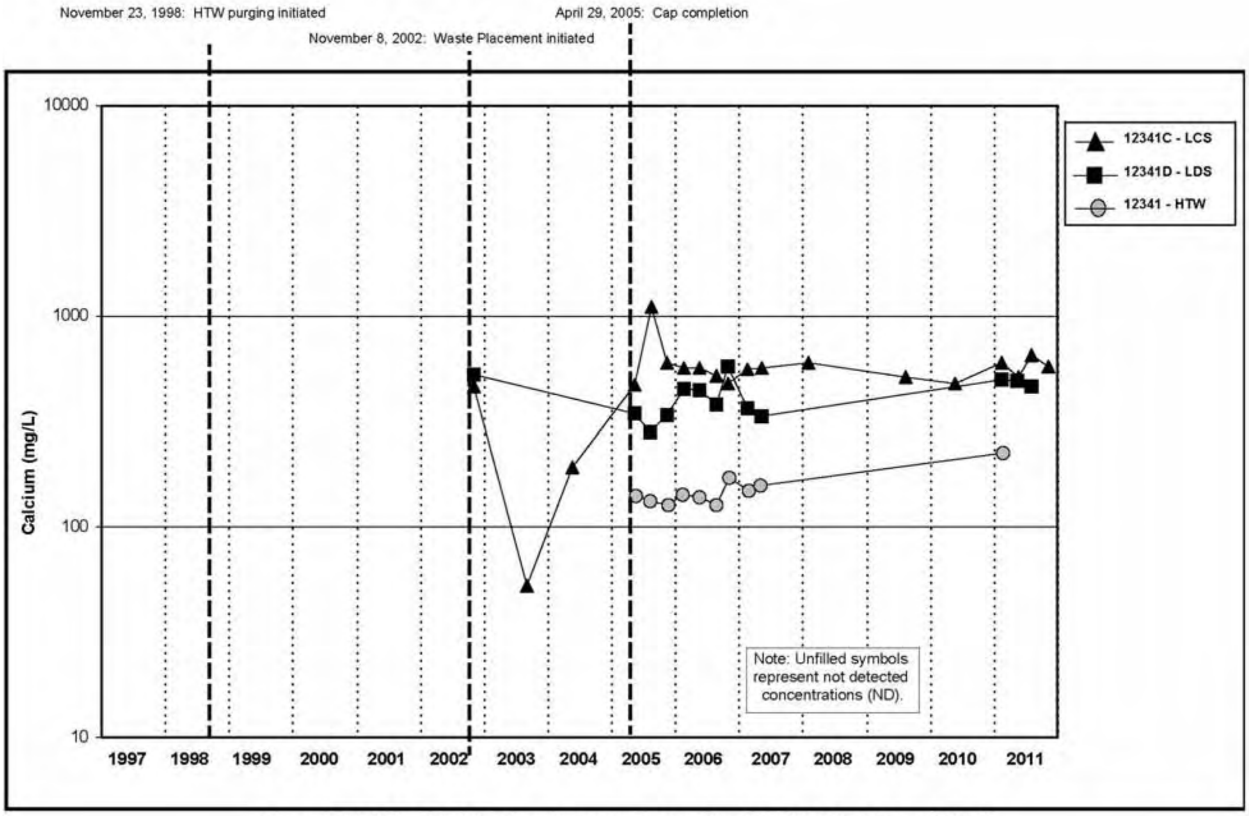


Figure A.5.4-18A. Cell 4 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

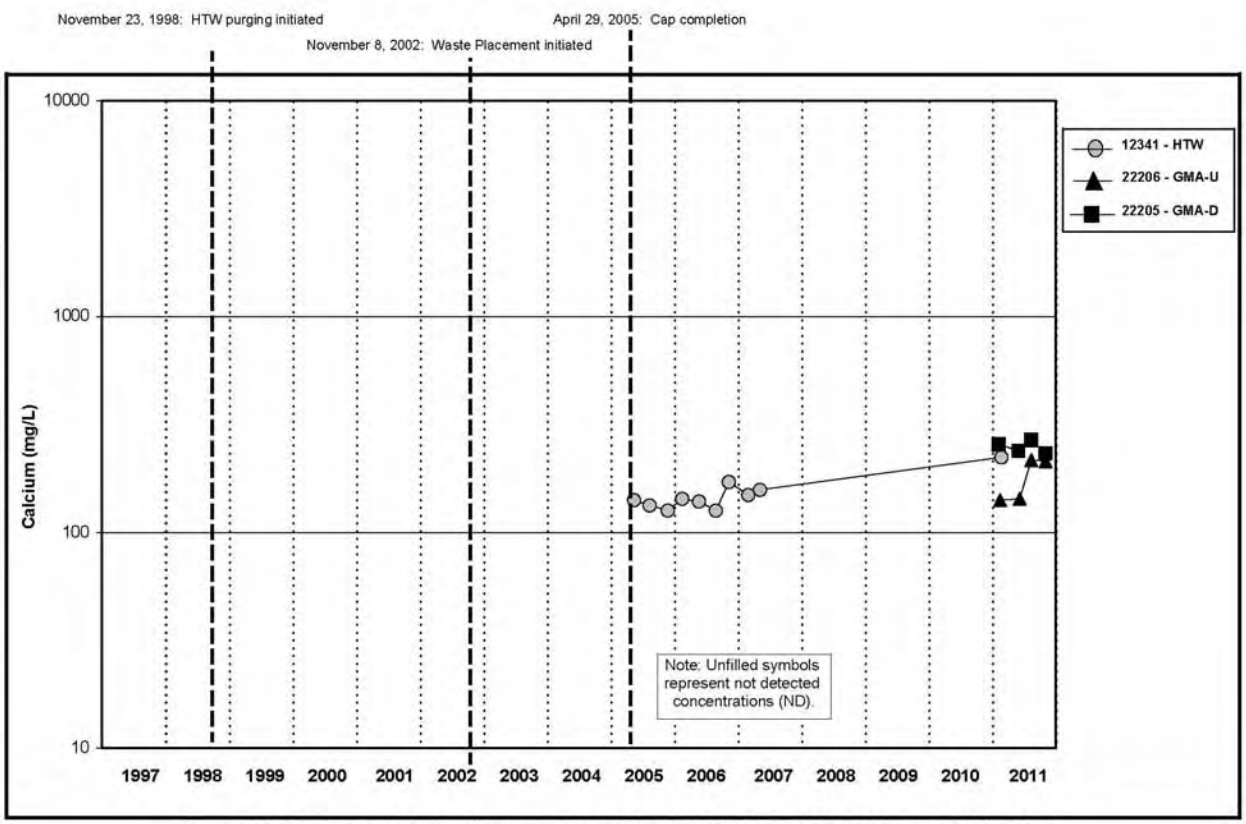


Figure A.5.4-18B. Cell 4 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

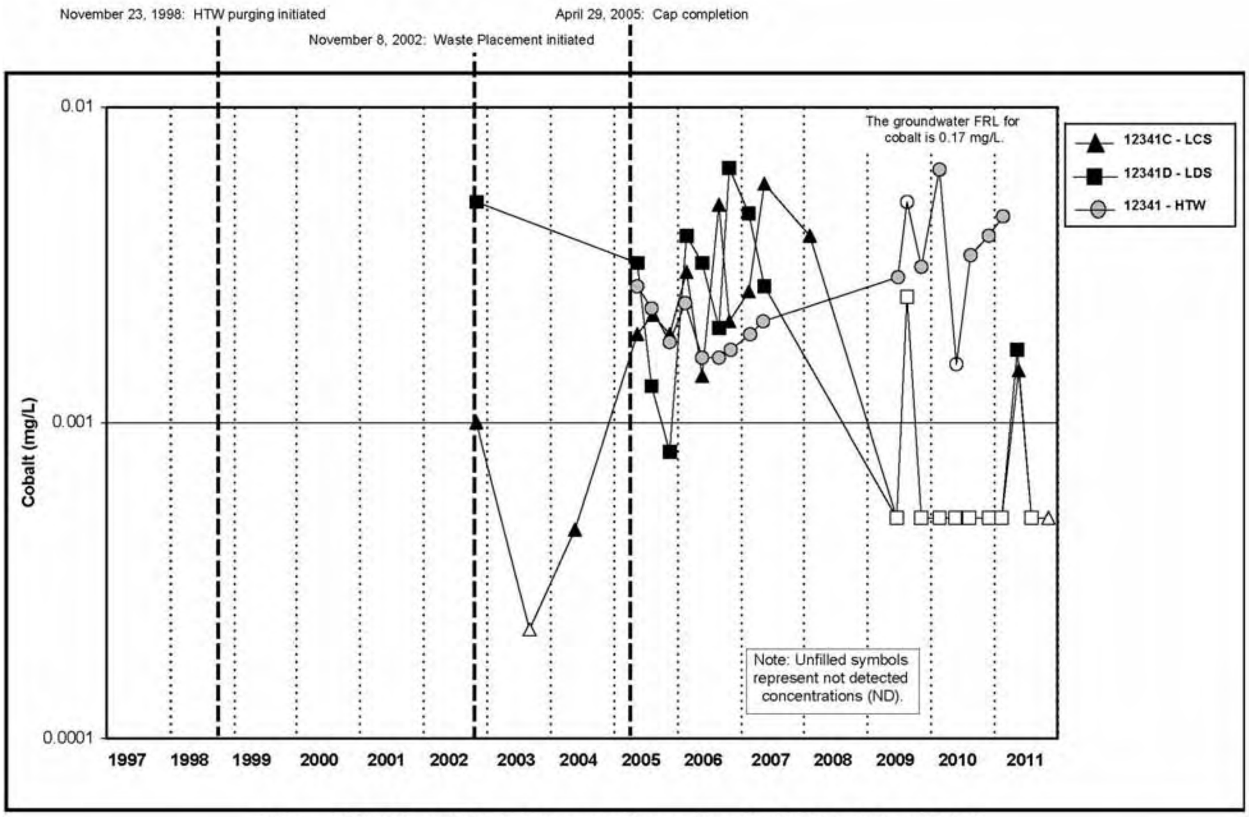


Figure A.5.4-19A. Cell 4 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

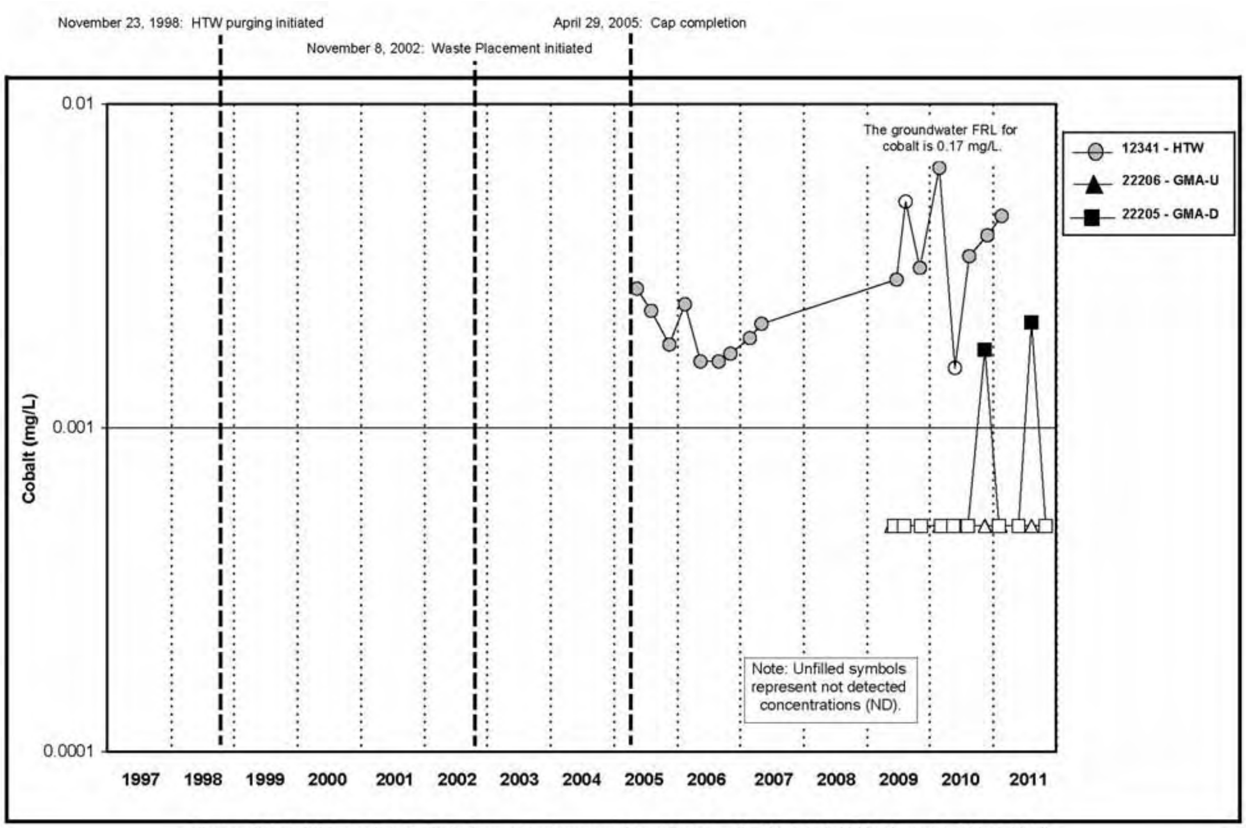


Figure A.5.4-19B. Cell 4 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

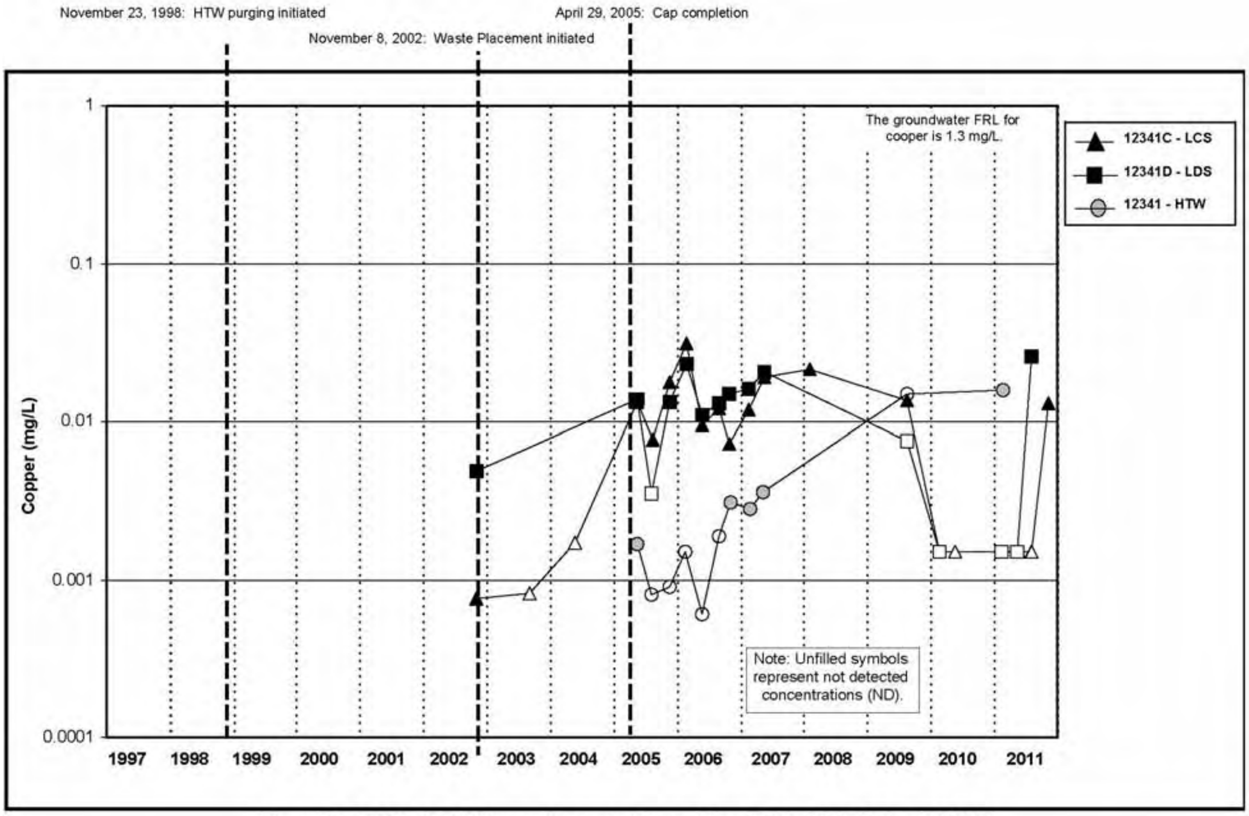


Figure A.5.4-20A. Cell 4 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

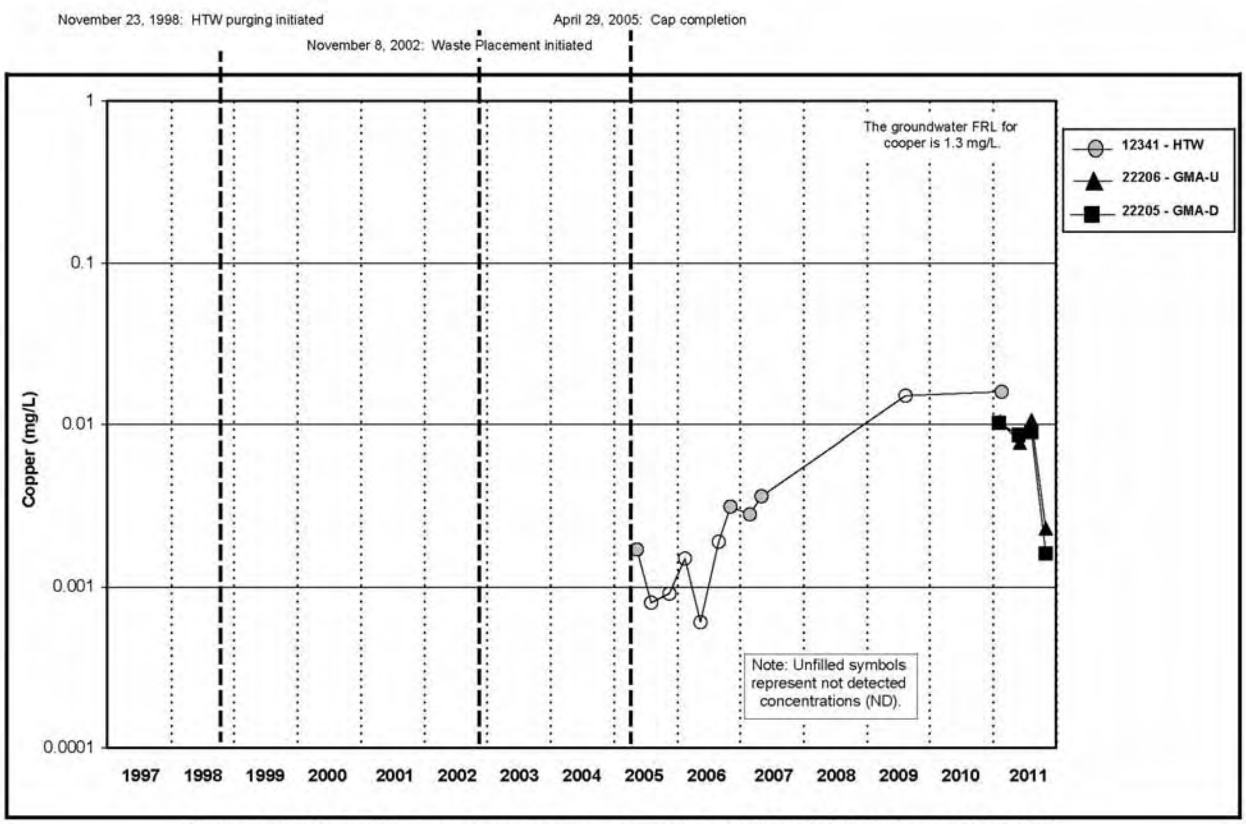


Figure A.5.4-20B. Cell 4 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

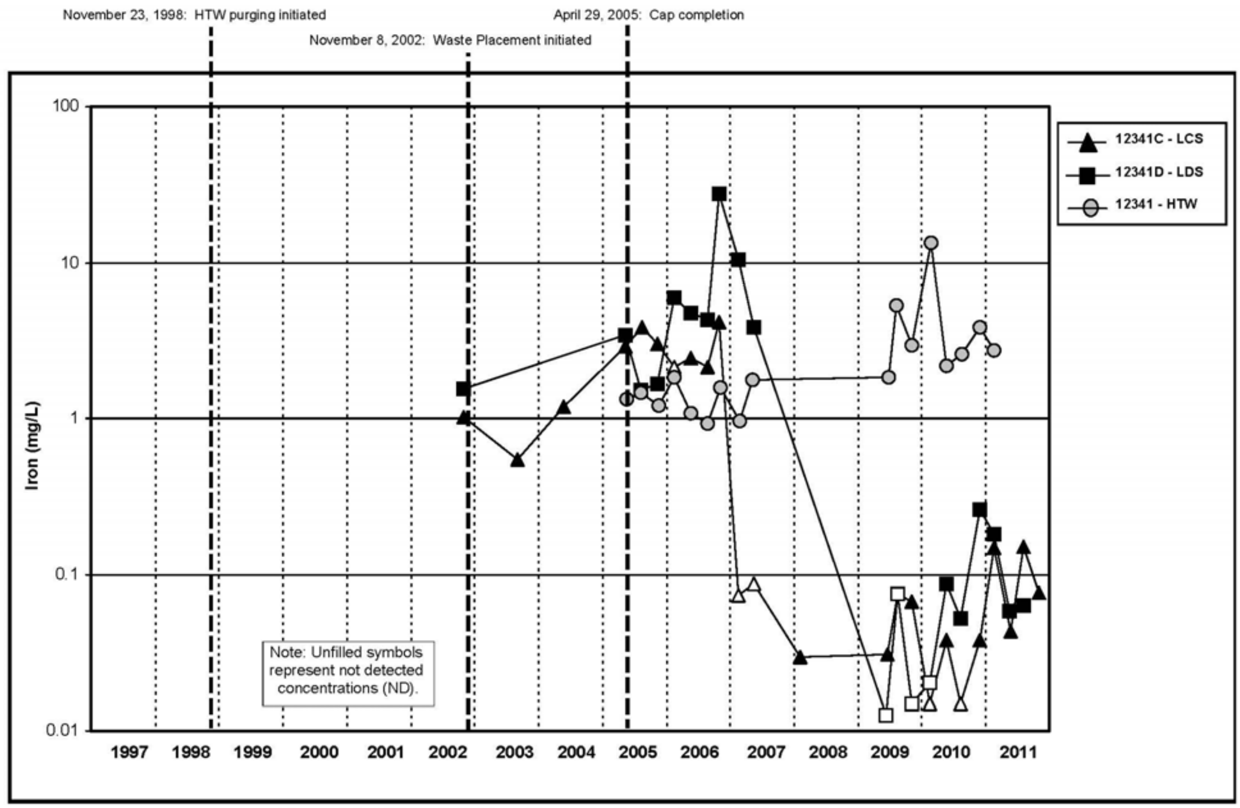


Figure A.5.4-21A. Cell 4 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

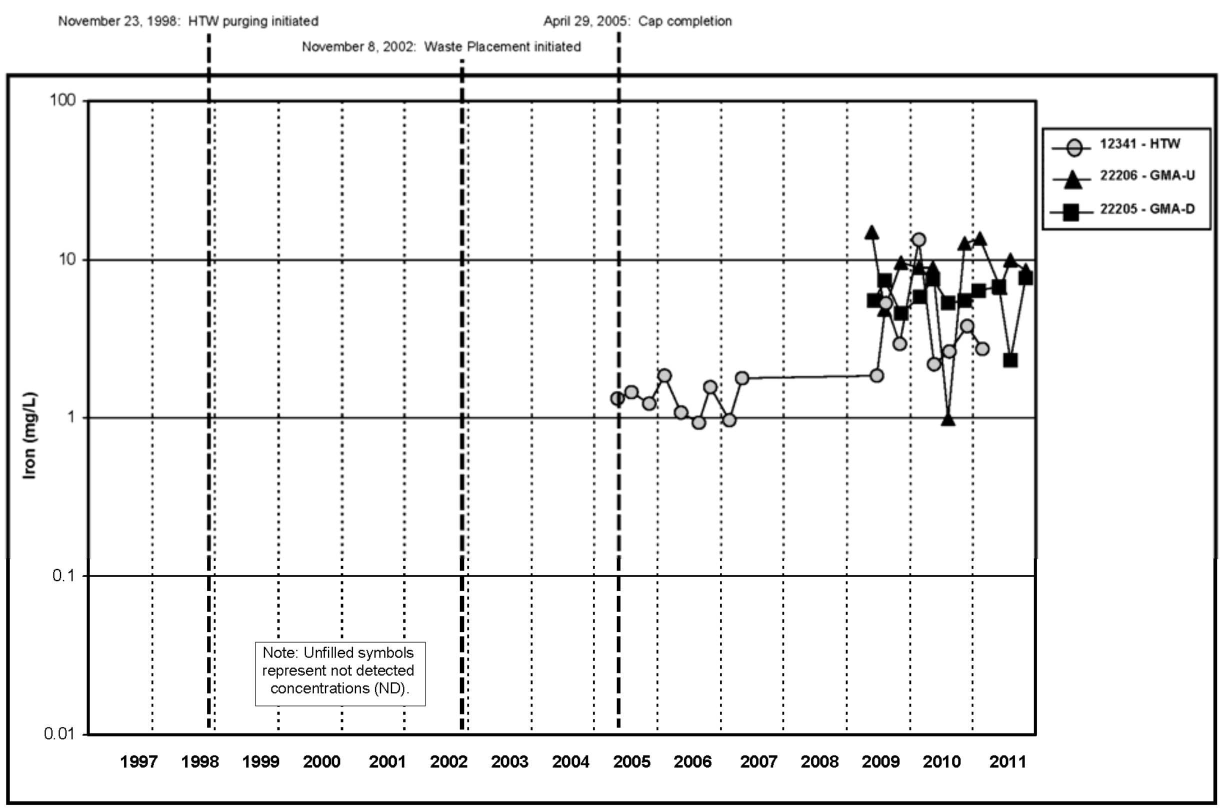


Figure A.5.4-21B. Cell 4 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

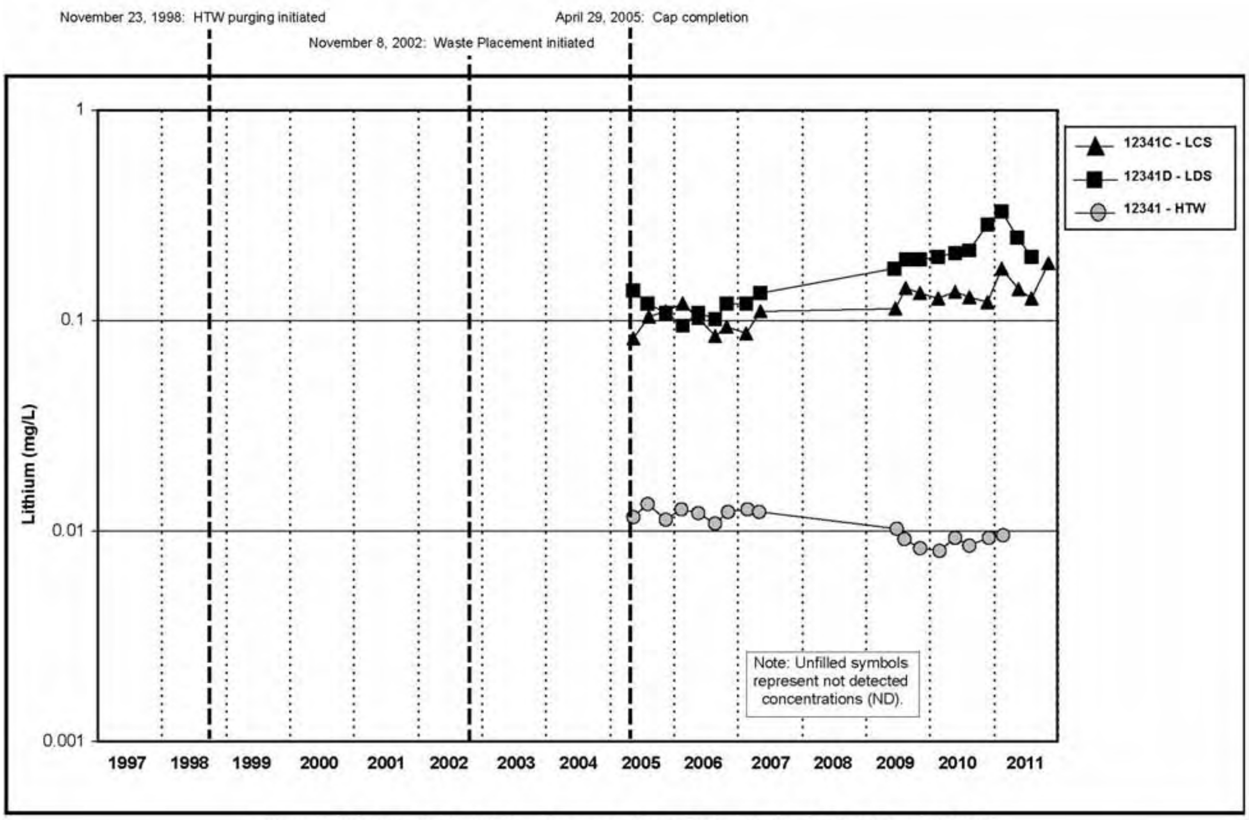


Figure A.5.4-22A. Cell 4 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

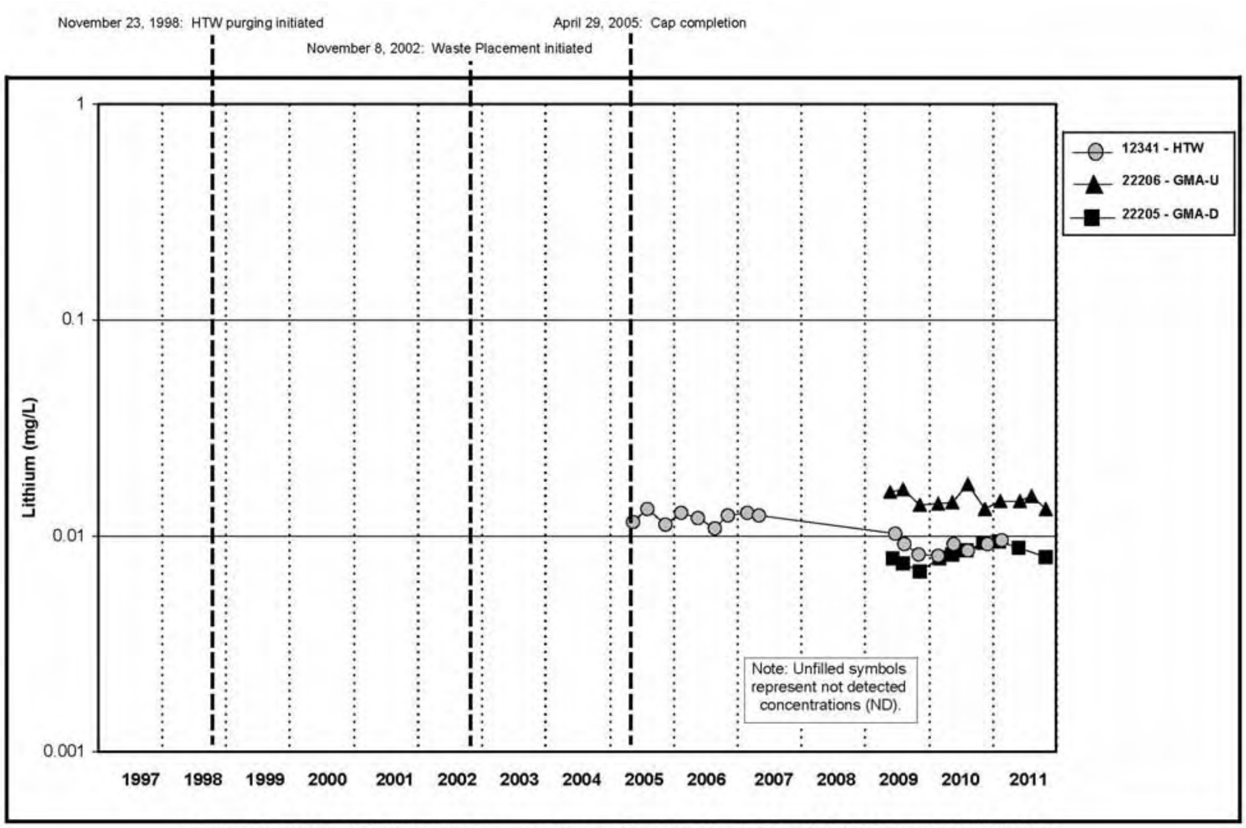


Figure A.5.4-22B. Cell 4 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

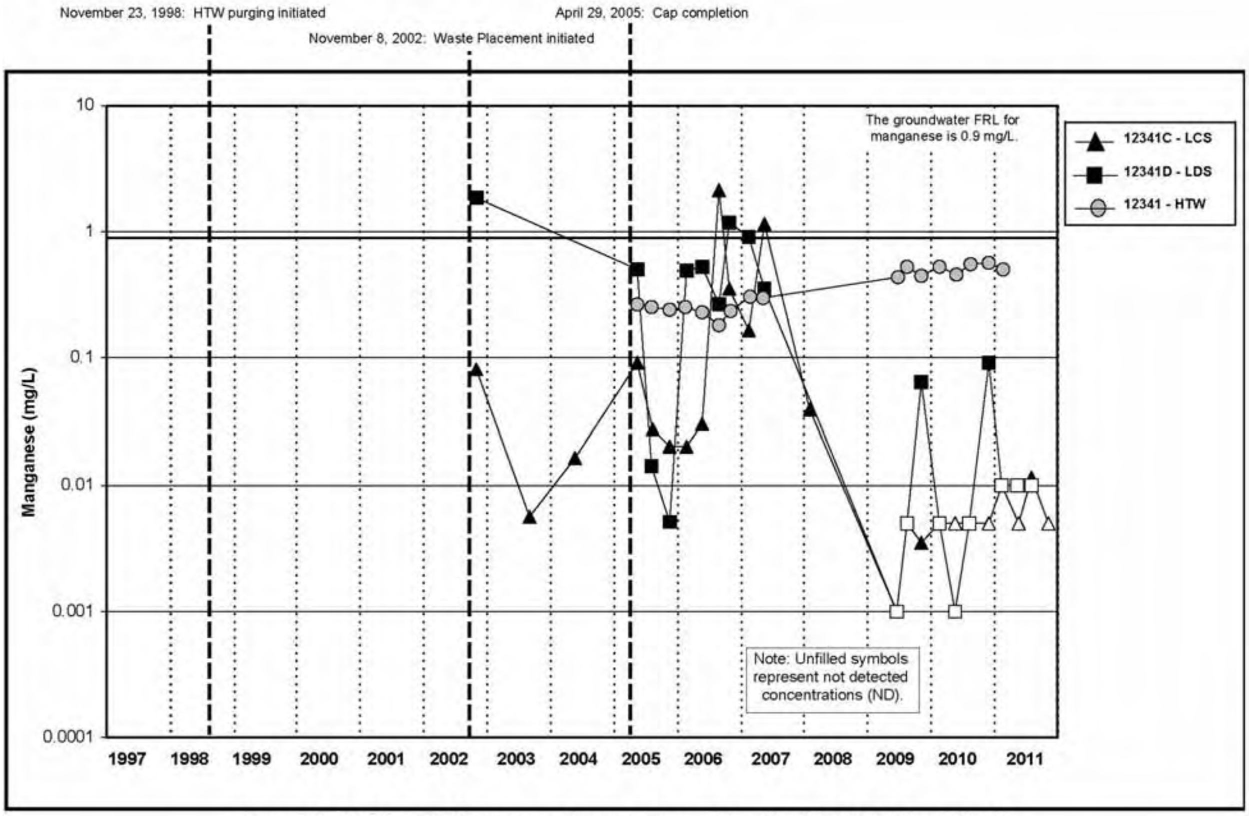


Figure A.5.4-23A. Cell 4 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

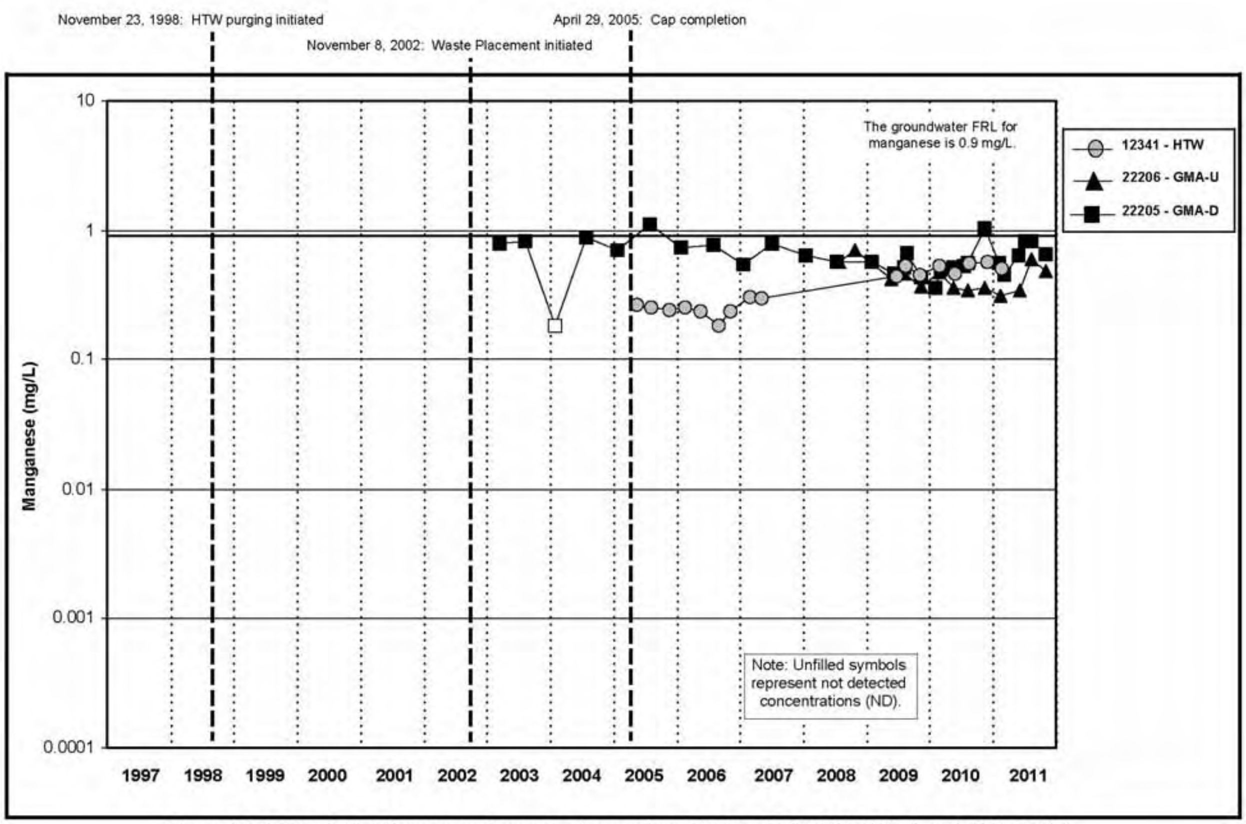


Figure A.5.4-23B. Cell 4 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

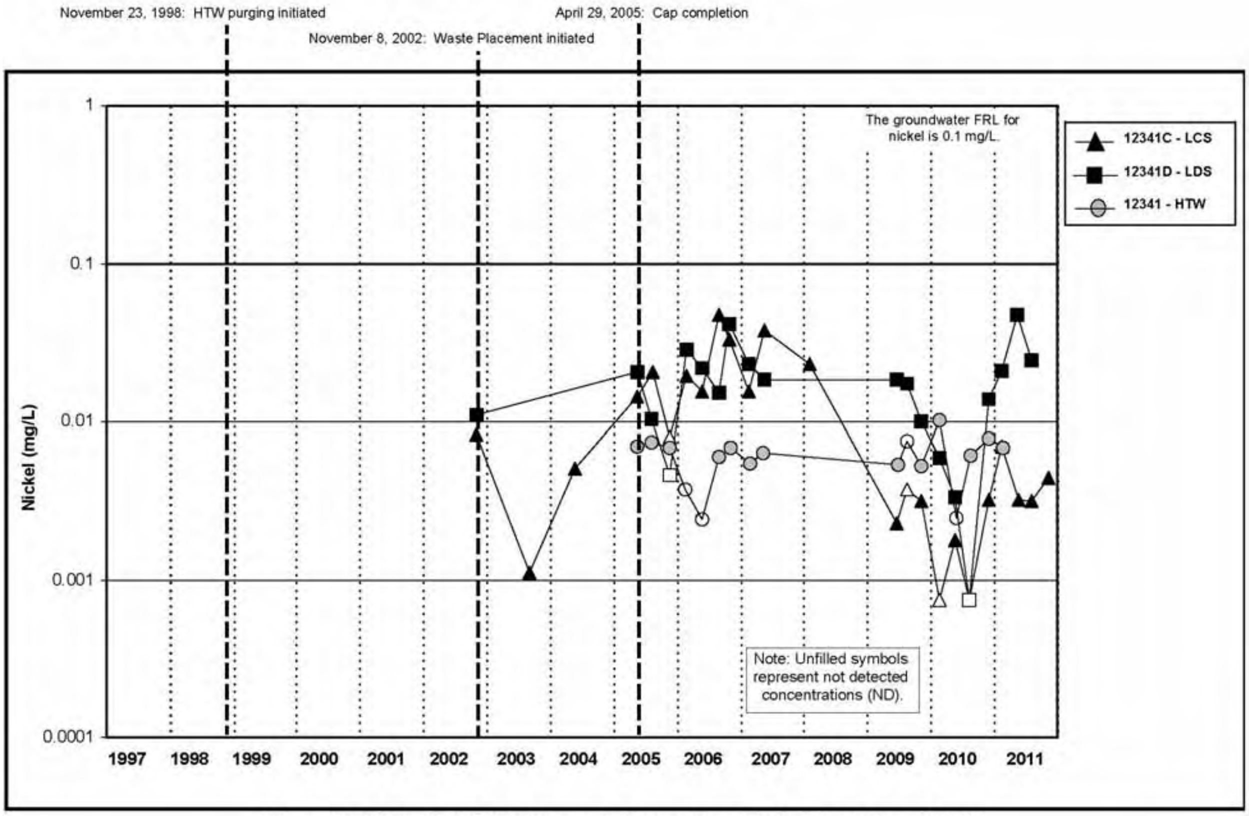


Figure A.5.4-24A. Cell 4 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

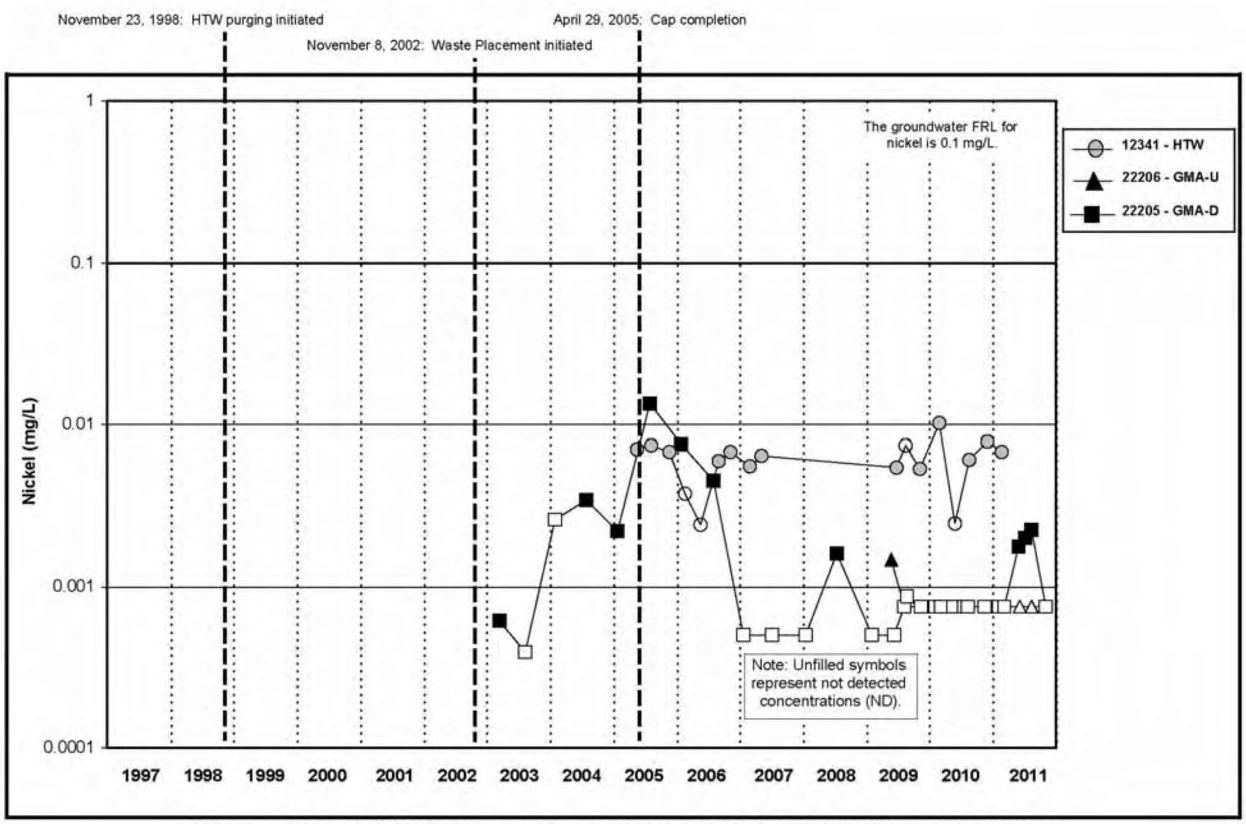


Figure A.5.4-24B. Cell 4 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

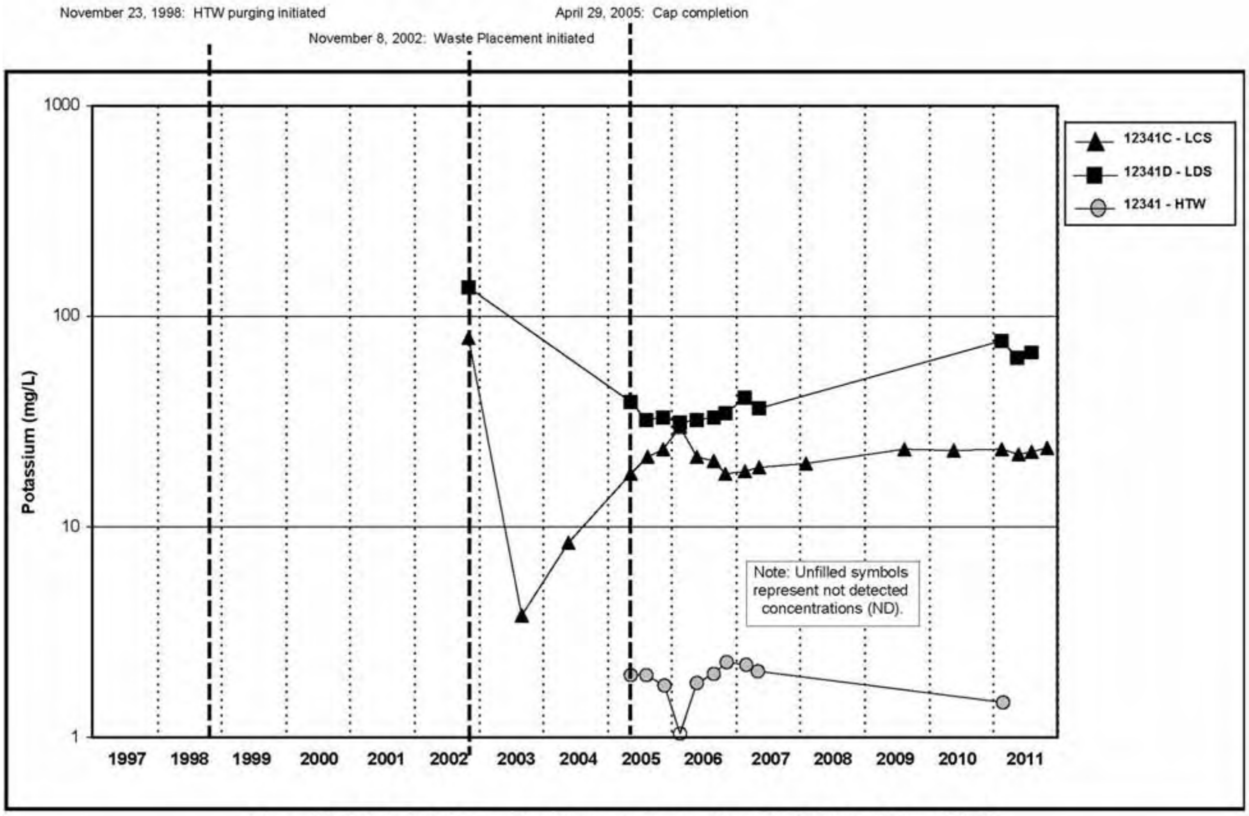


Figure A.5.4-25A. Cell 4 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

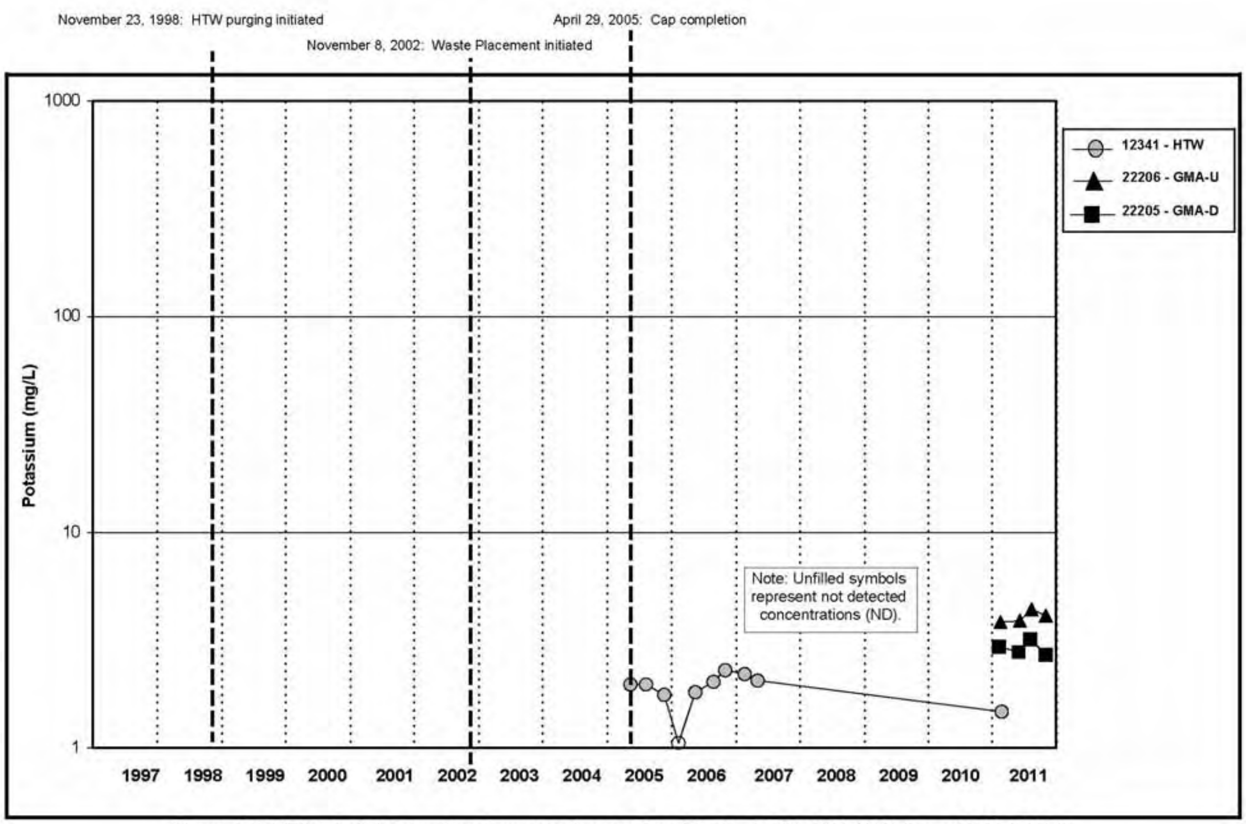


Figure A.5.4-25B. Cell 4 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

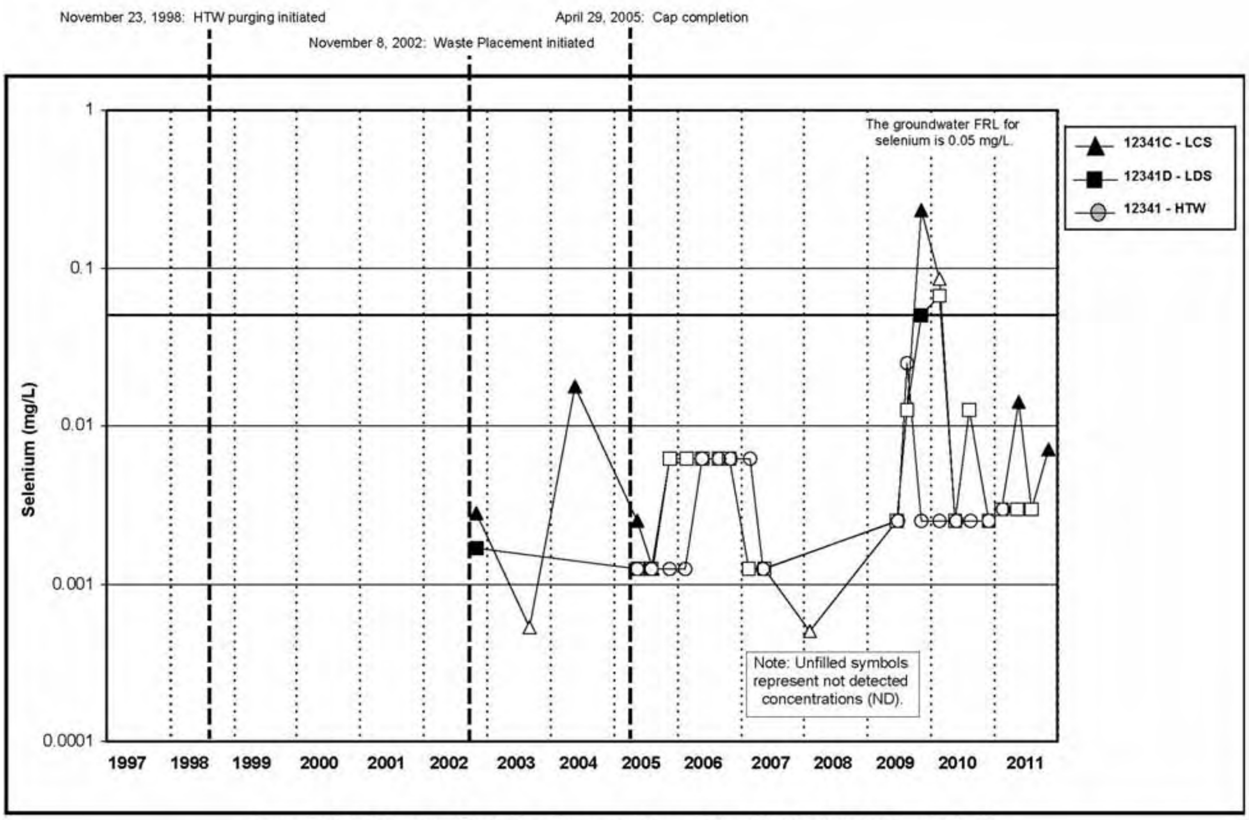


Figure A.5.4-26A. Cell 4 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

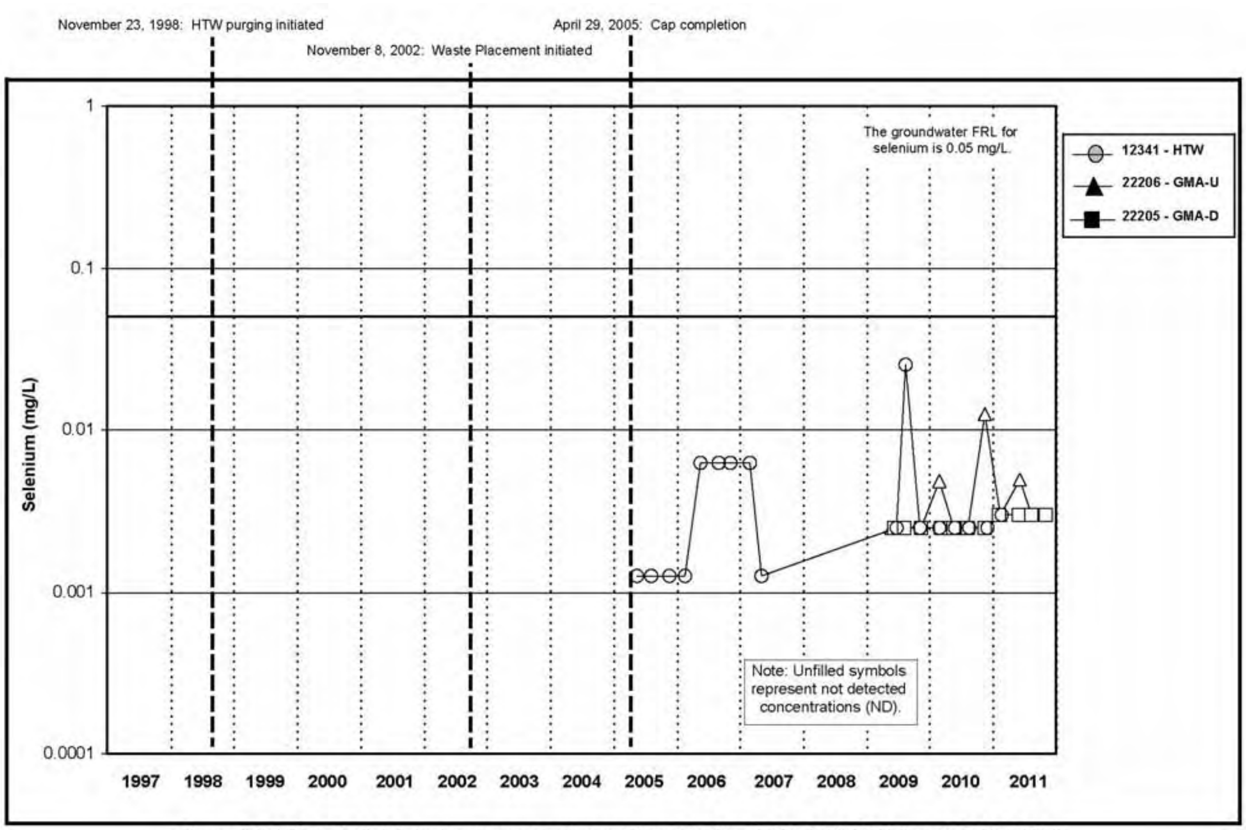


Figure A.5.4-26B. Cell 4 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

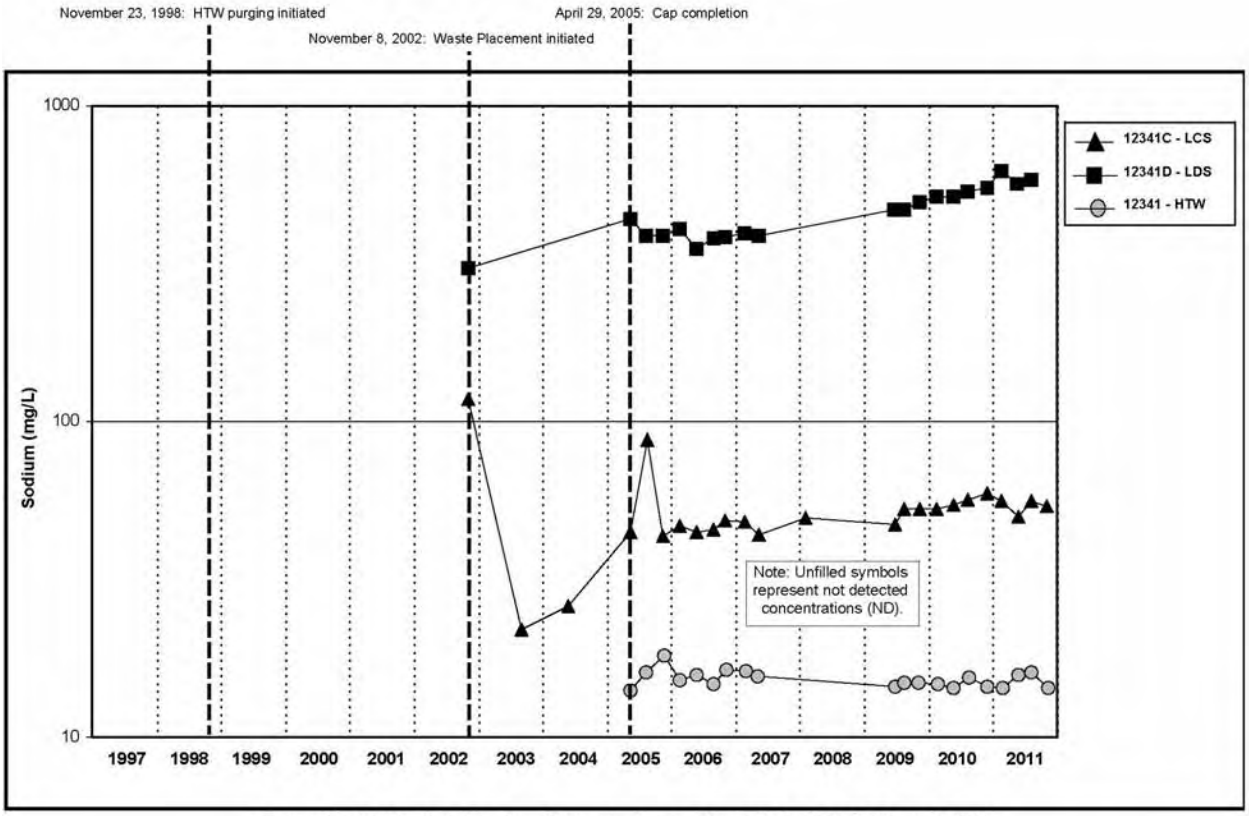


Figure A.5.4-27A. Cell 4 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

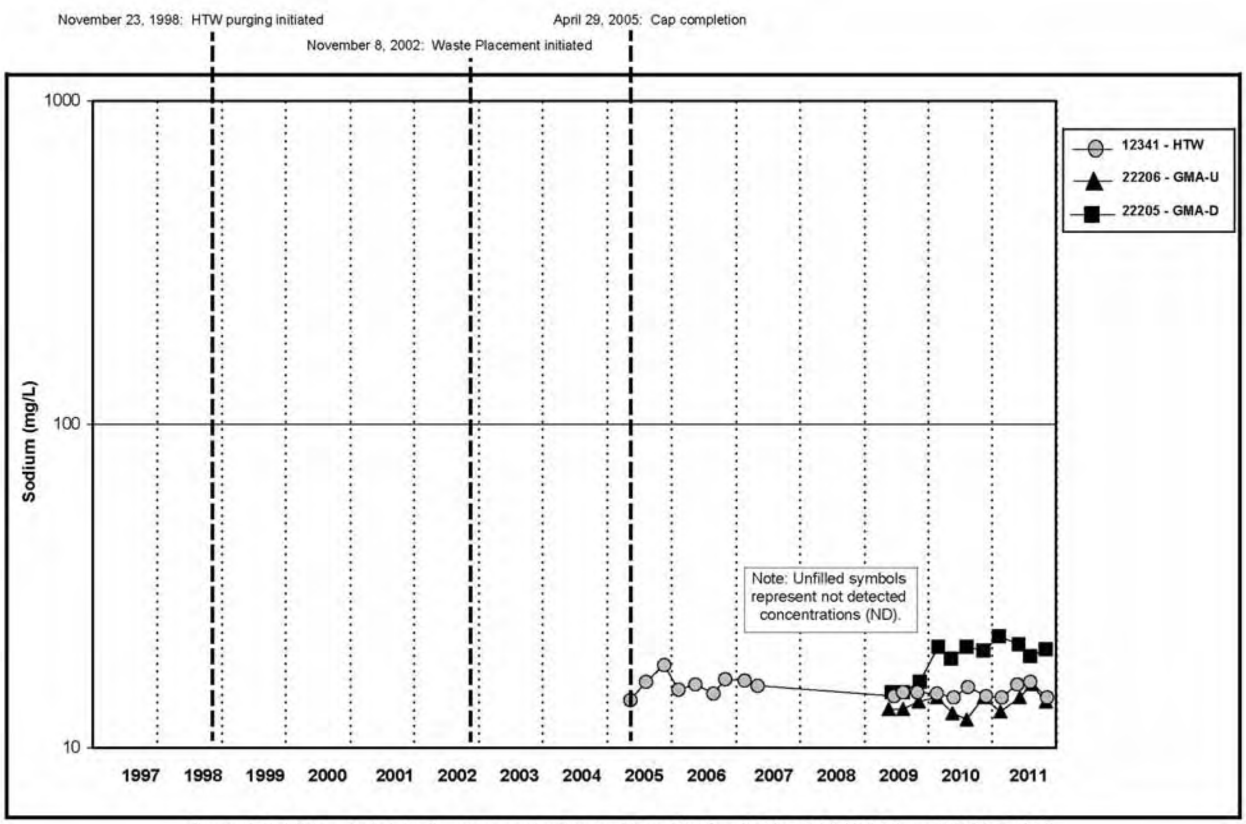


Figure A.5.4-27B. Cell 4 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

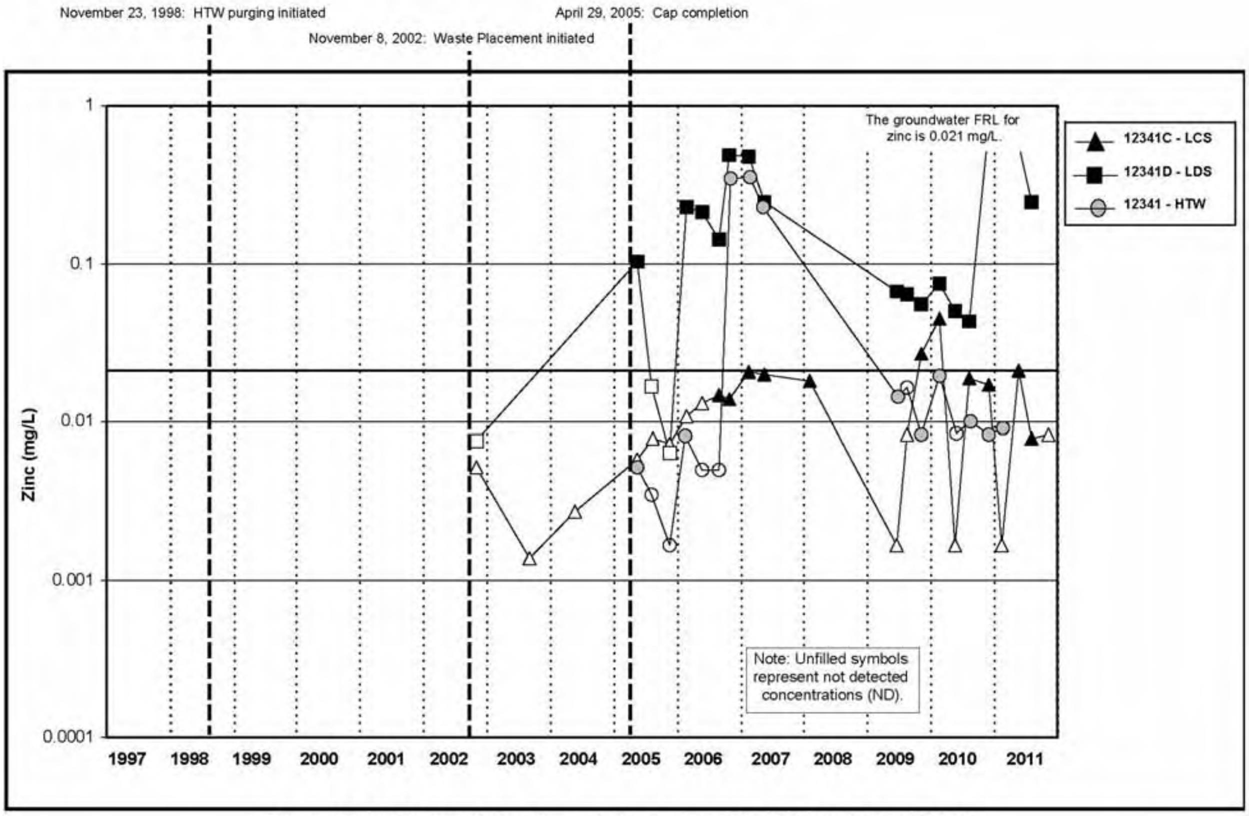


Figure A.5.4-28A. Cell 4 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

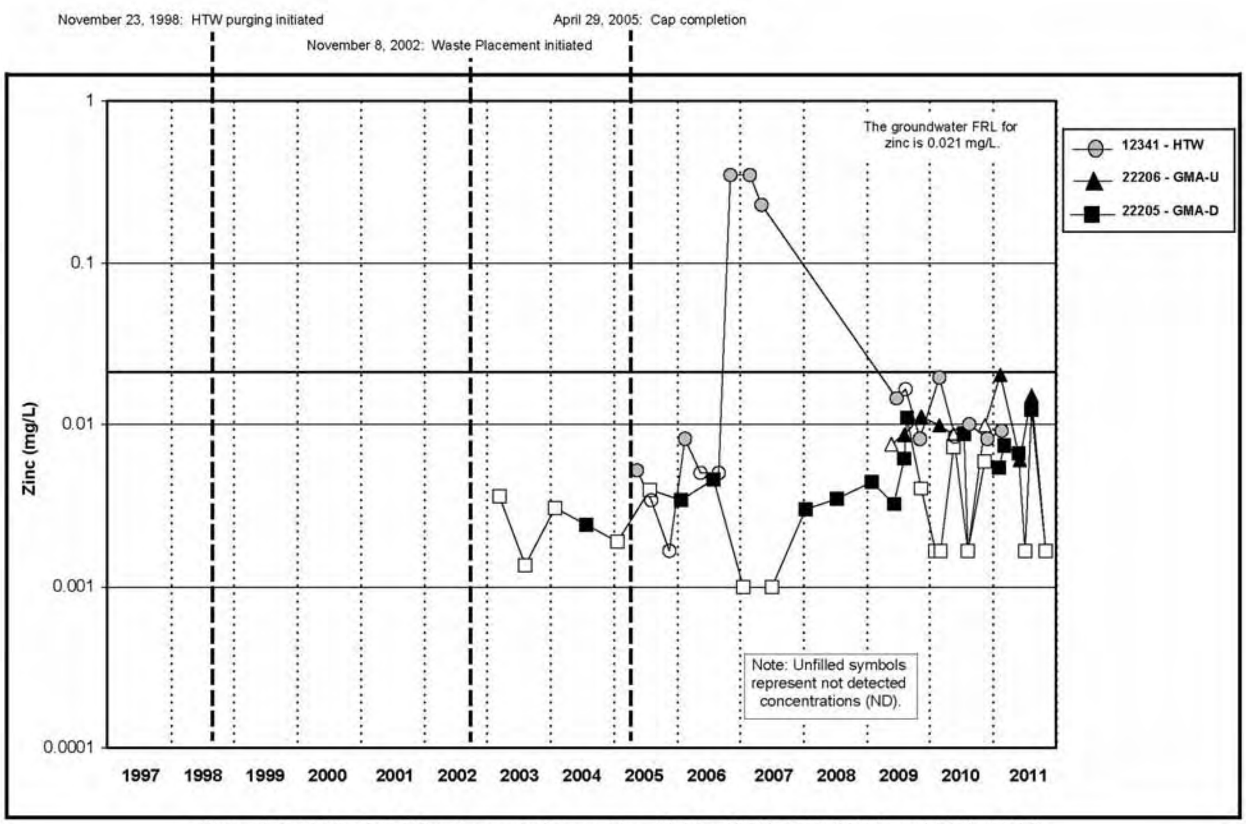


Figure A.5.4-28B. Cell 4 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

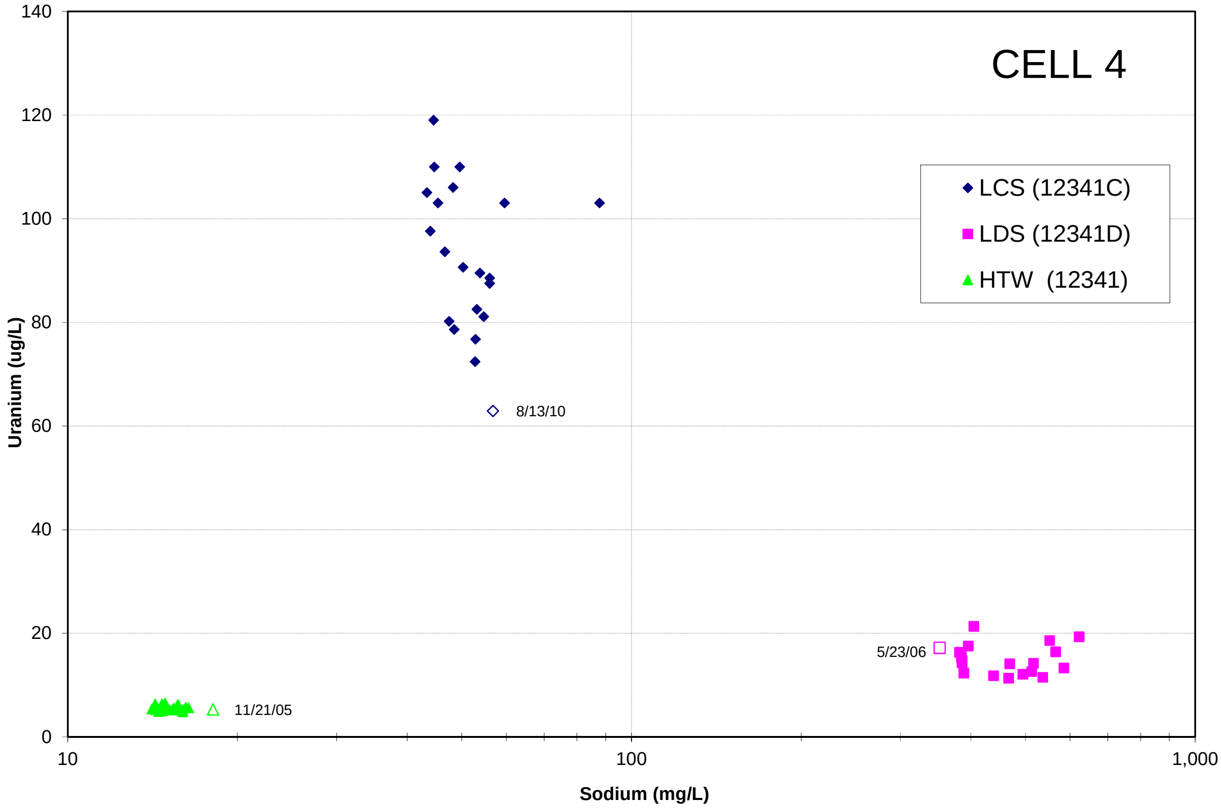


Figure A.5.4−29. Cell 4 Bivariate Plot for Uranium and Sodium

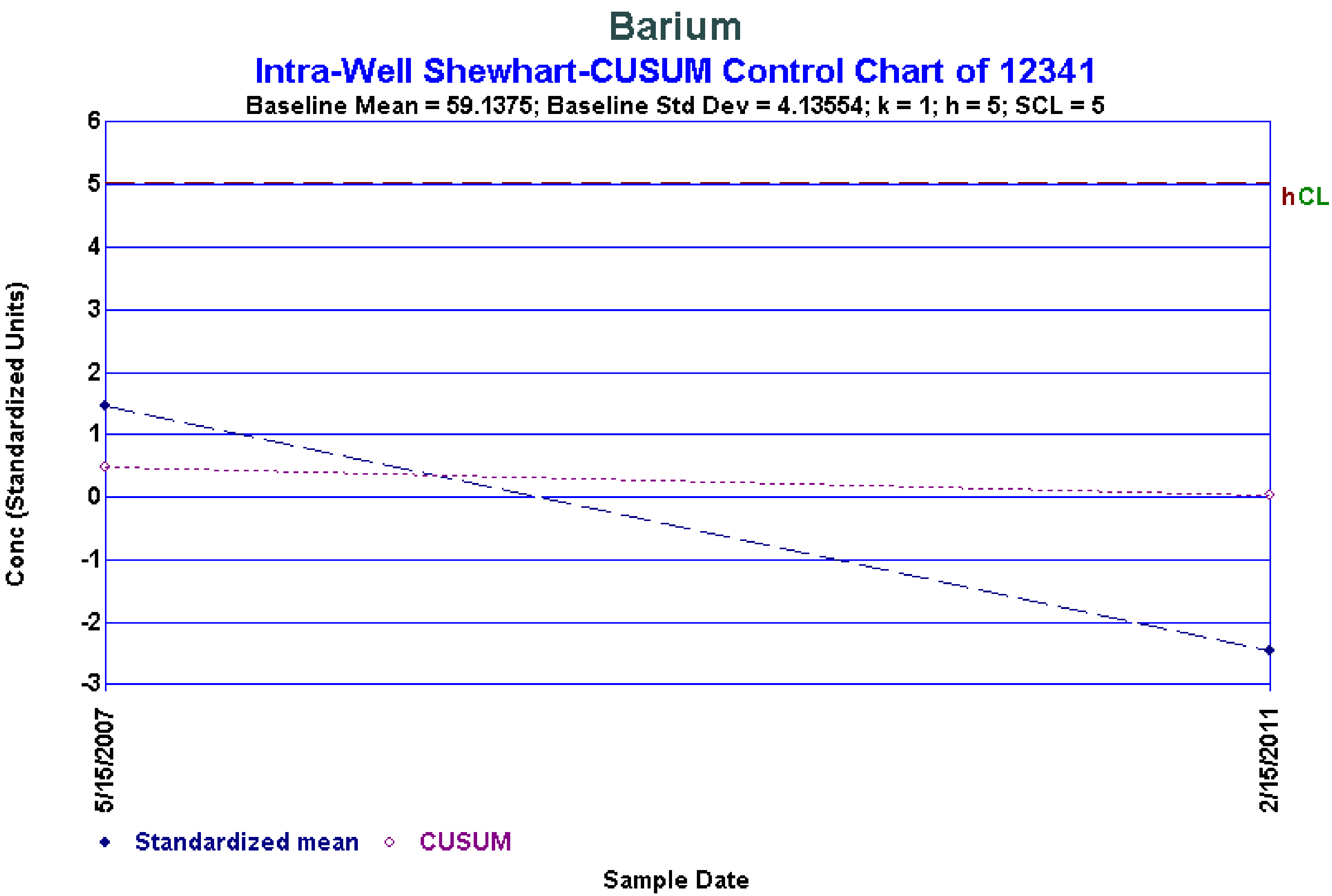


Figure A.5.4−30. Intra-Well Shewhart-CUSUM Control Chart (Barium 12341)

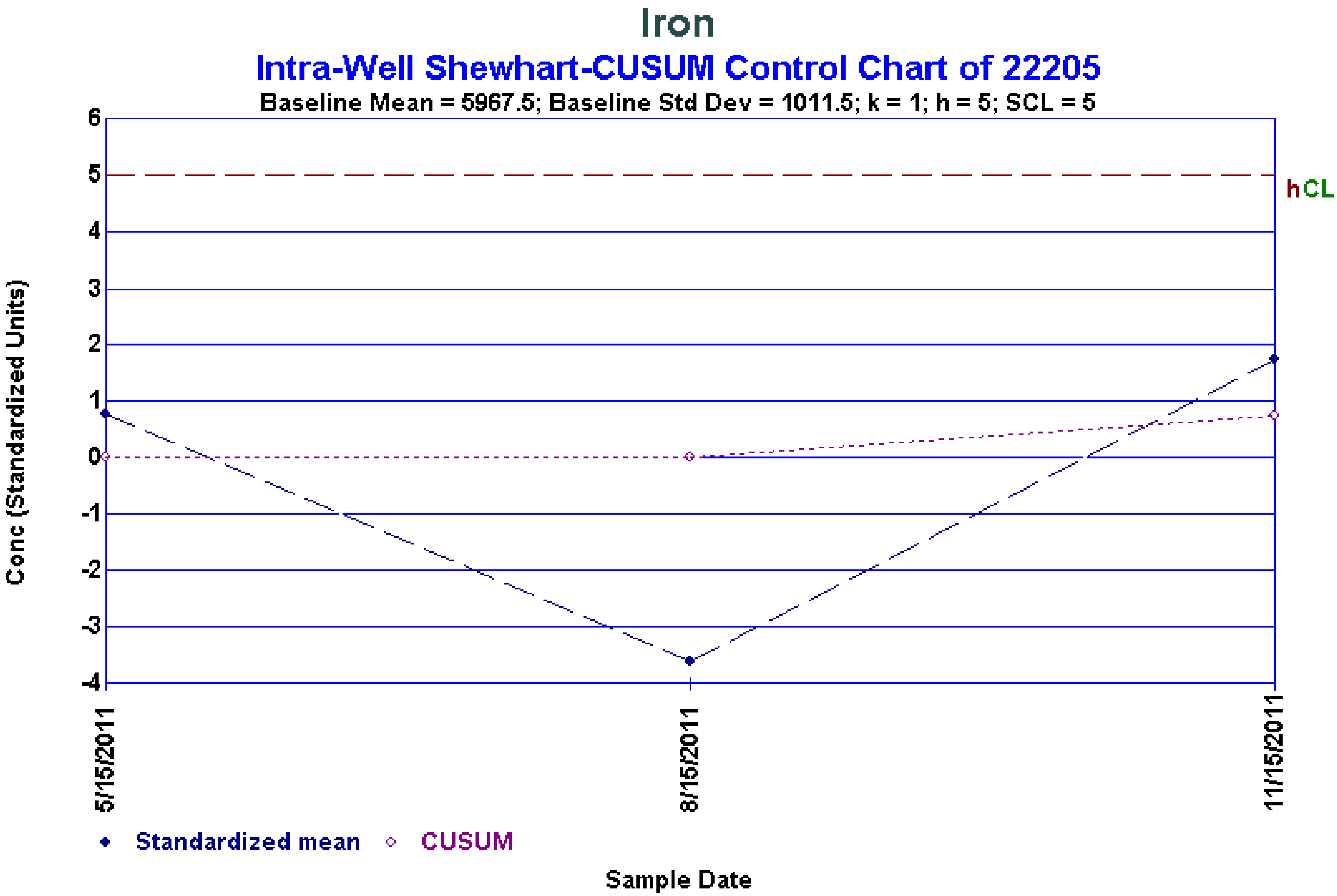


Figure A.5.4−31. Intra-Well Shewhart-CUSUM Control Chart (Iron 22205)

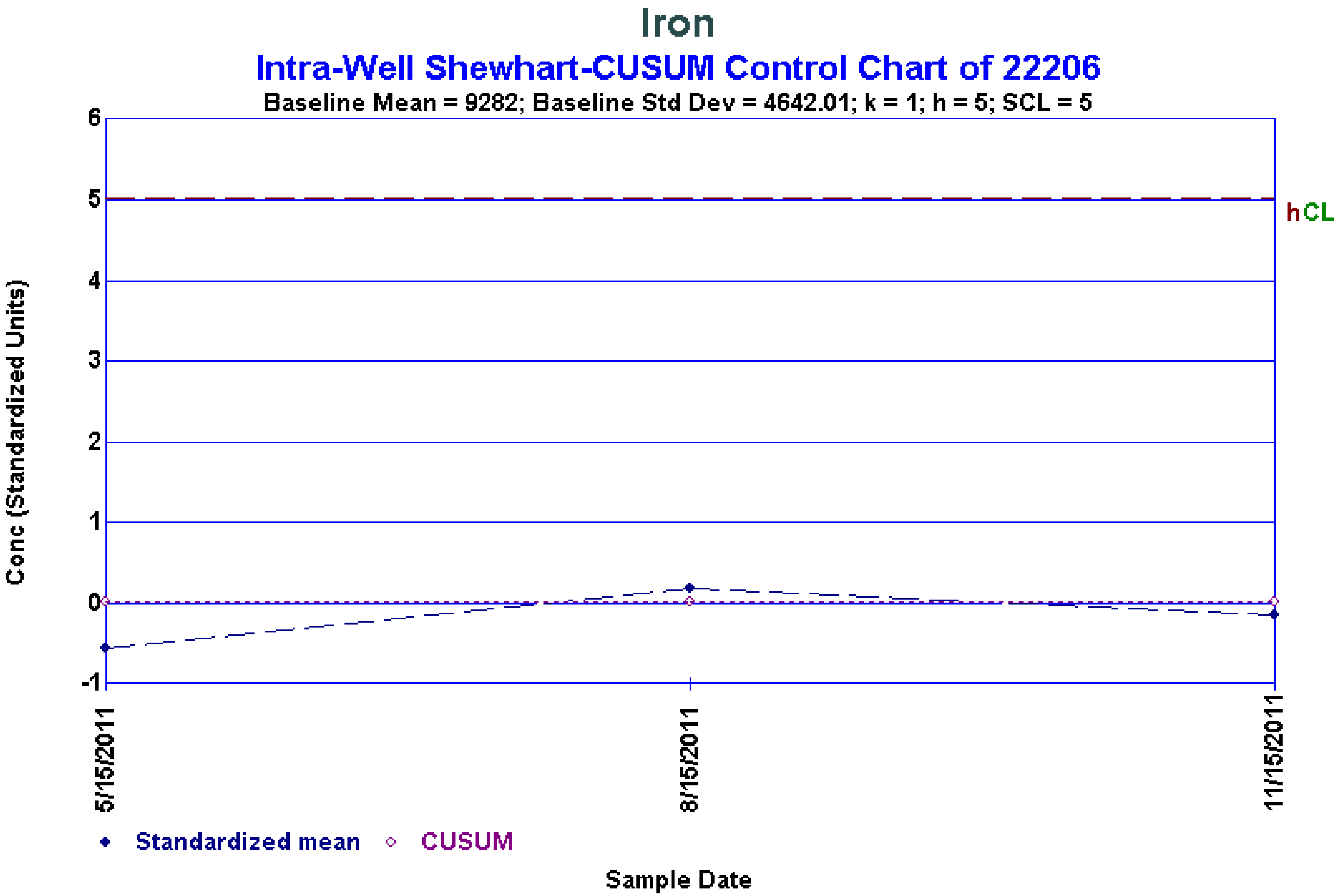


Figure A.5.4−32. Intra-Well Shewhart-CUSUM Control Chart (Iron 22206)

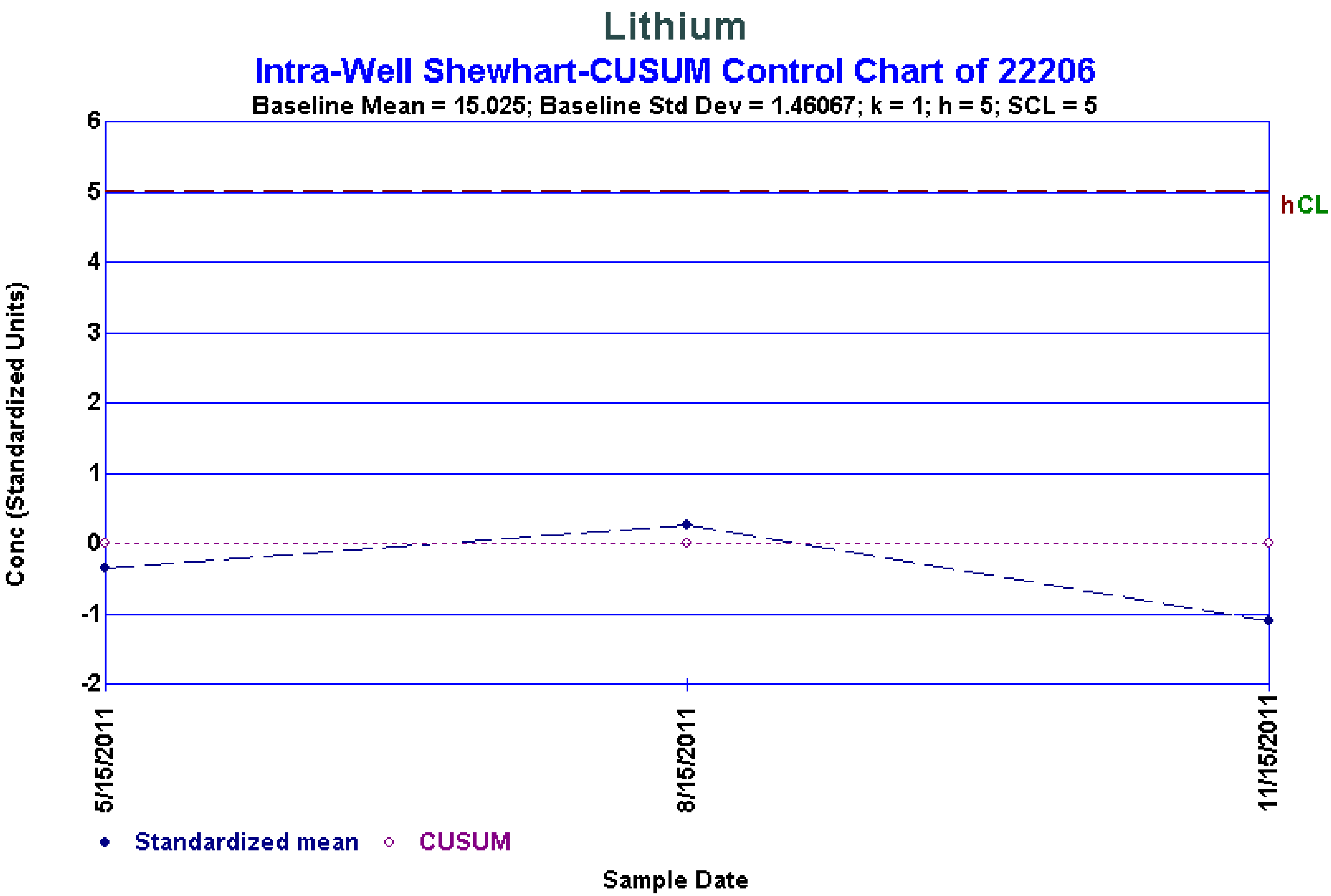


Figure A.5.4−33. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22206)

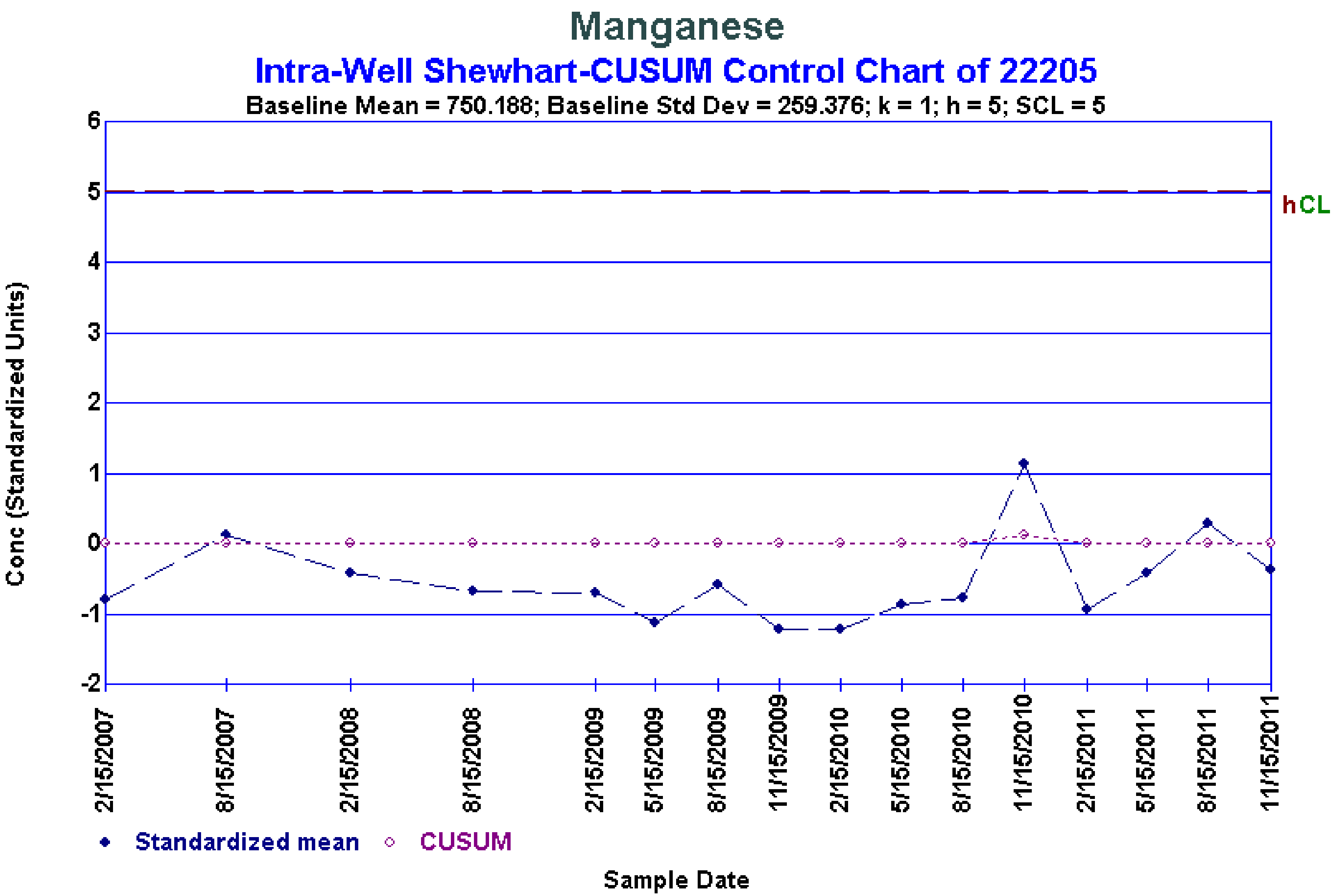


Figure A.5.4−34. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22205)

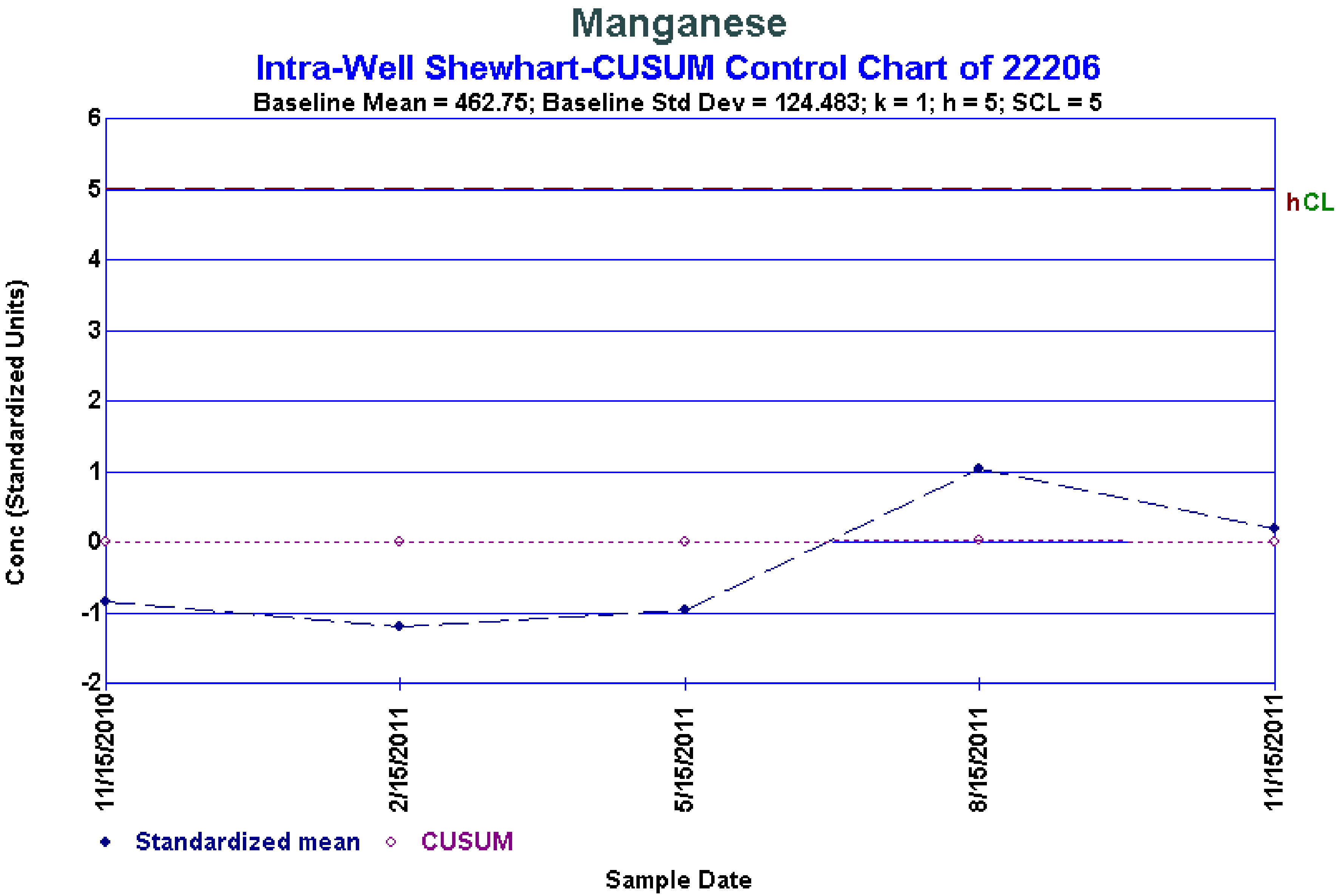


Figure A.5.4−35. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22206)

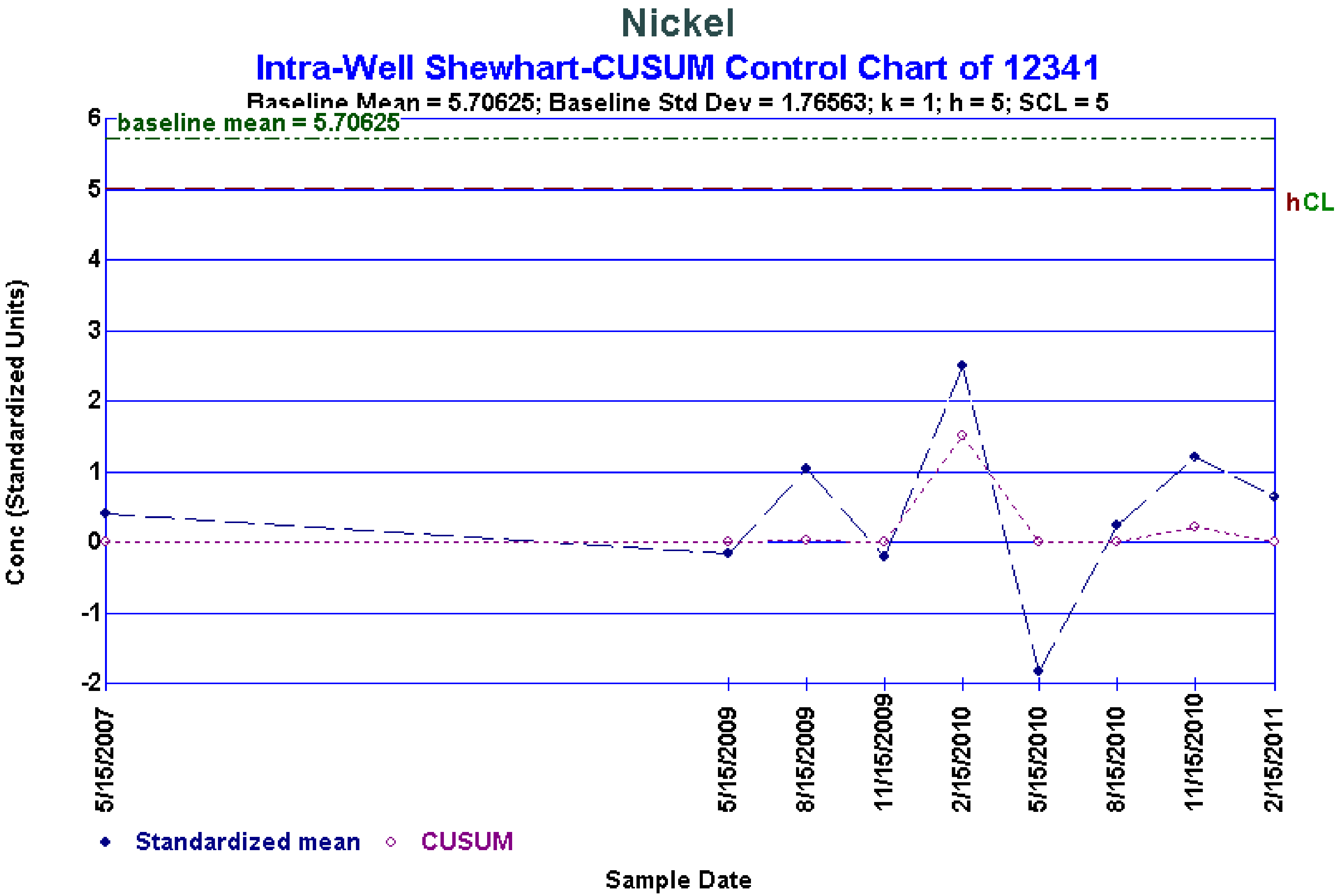


Figure A.5.4−36. Intra-Well Shewhart-CUSUM Control Chart (Nickel 12341)

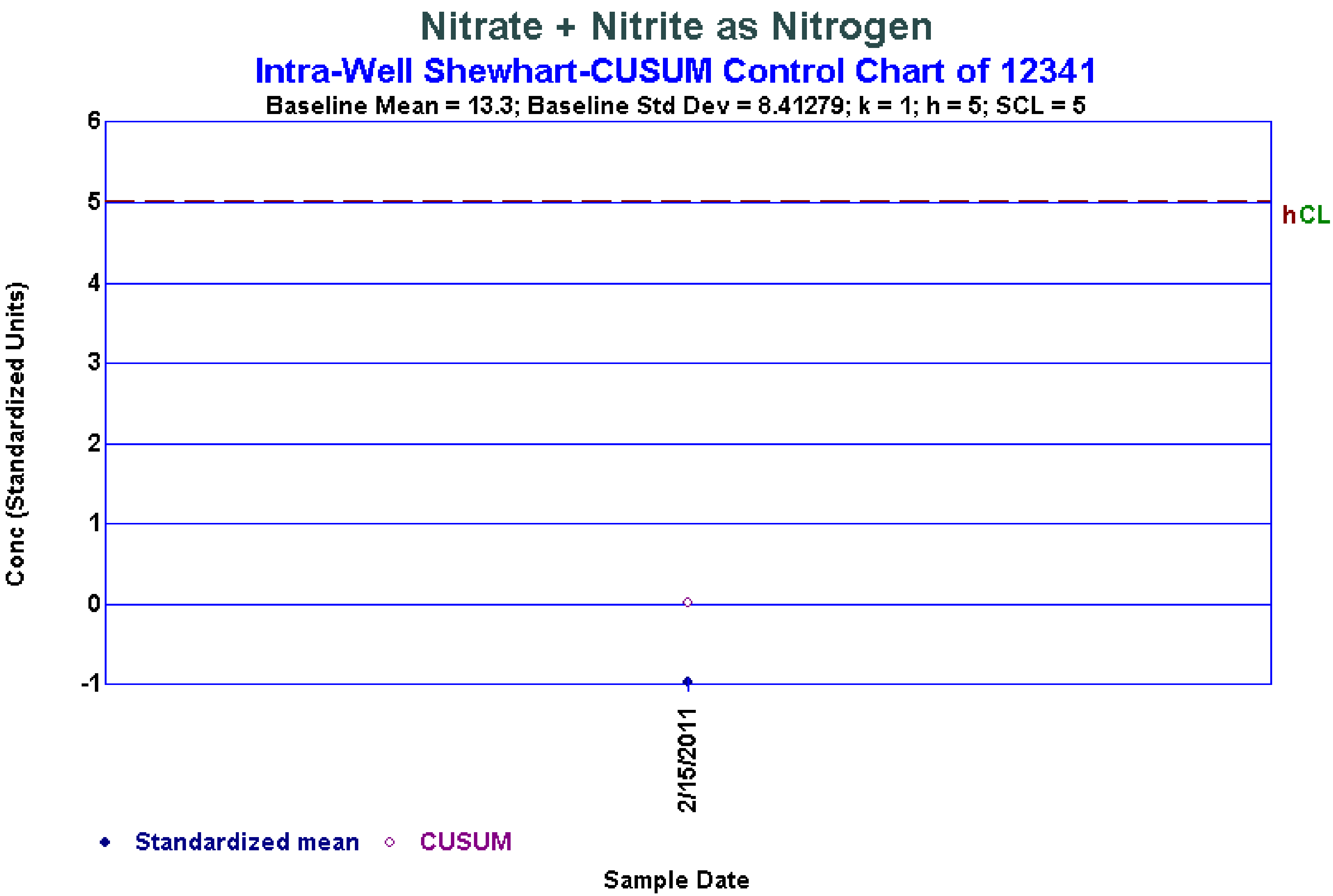


Figure A.5.4−37. Intra-Well Shewhart-CUSUM Control Chart (Nitrate 12341)

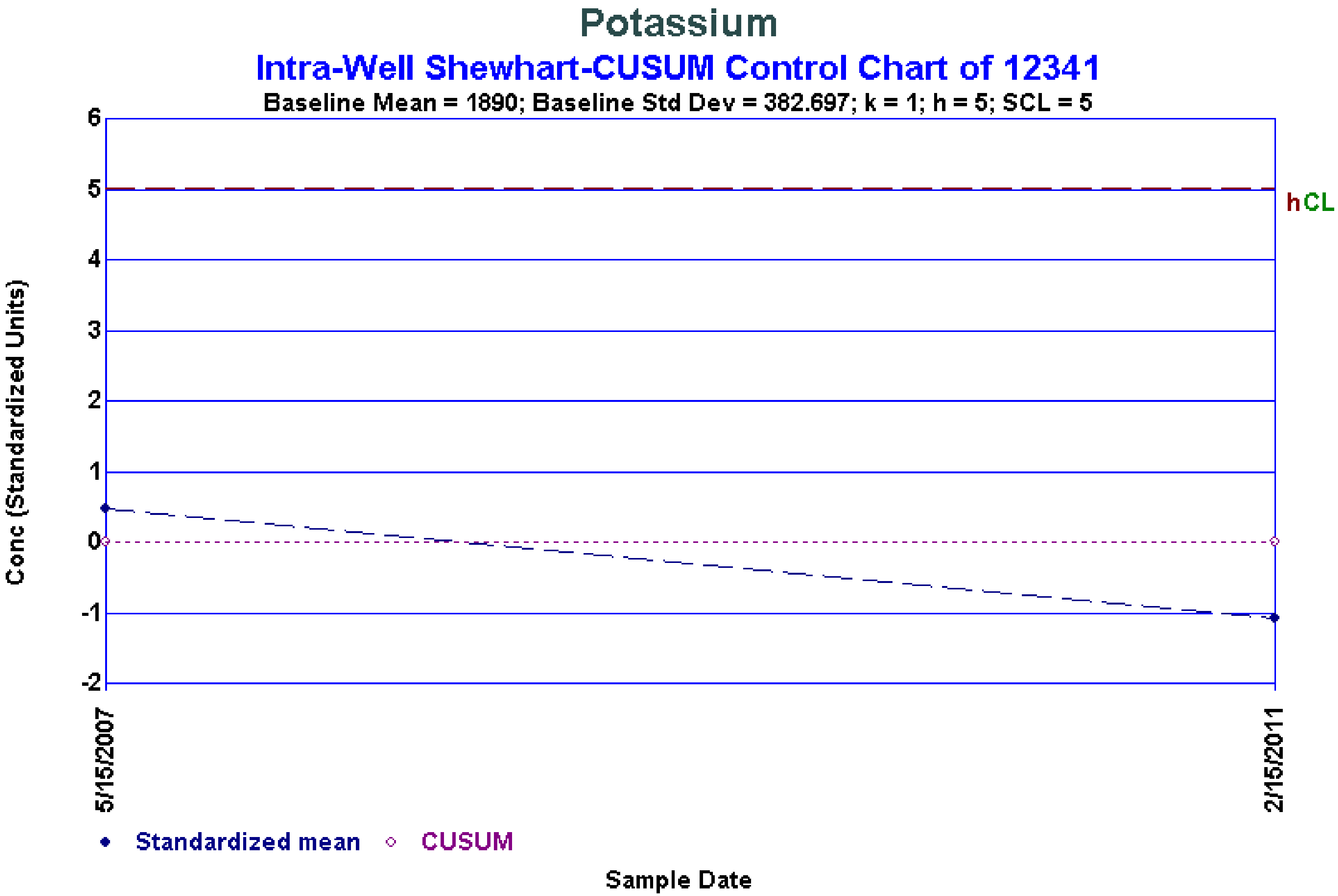


Figure A.5.4−38. Intra-Well Shewhart-CUSUM Control Chart (Potassium 12341)

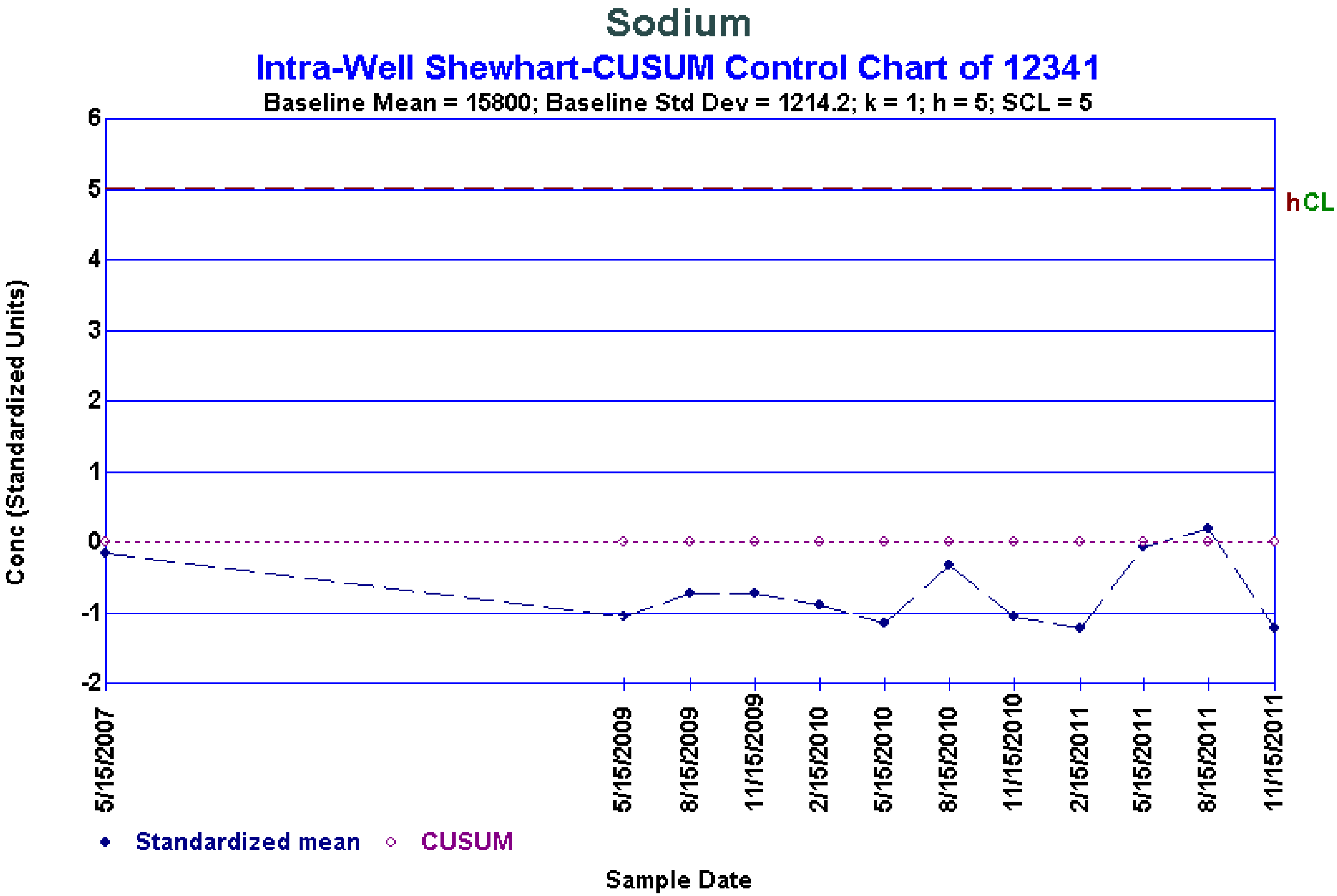


Figure A.5.4−39. Intra-Well Shewhart-CUSUM Control Chart (Sodium 12341)

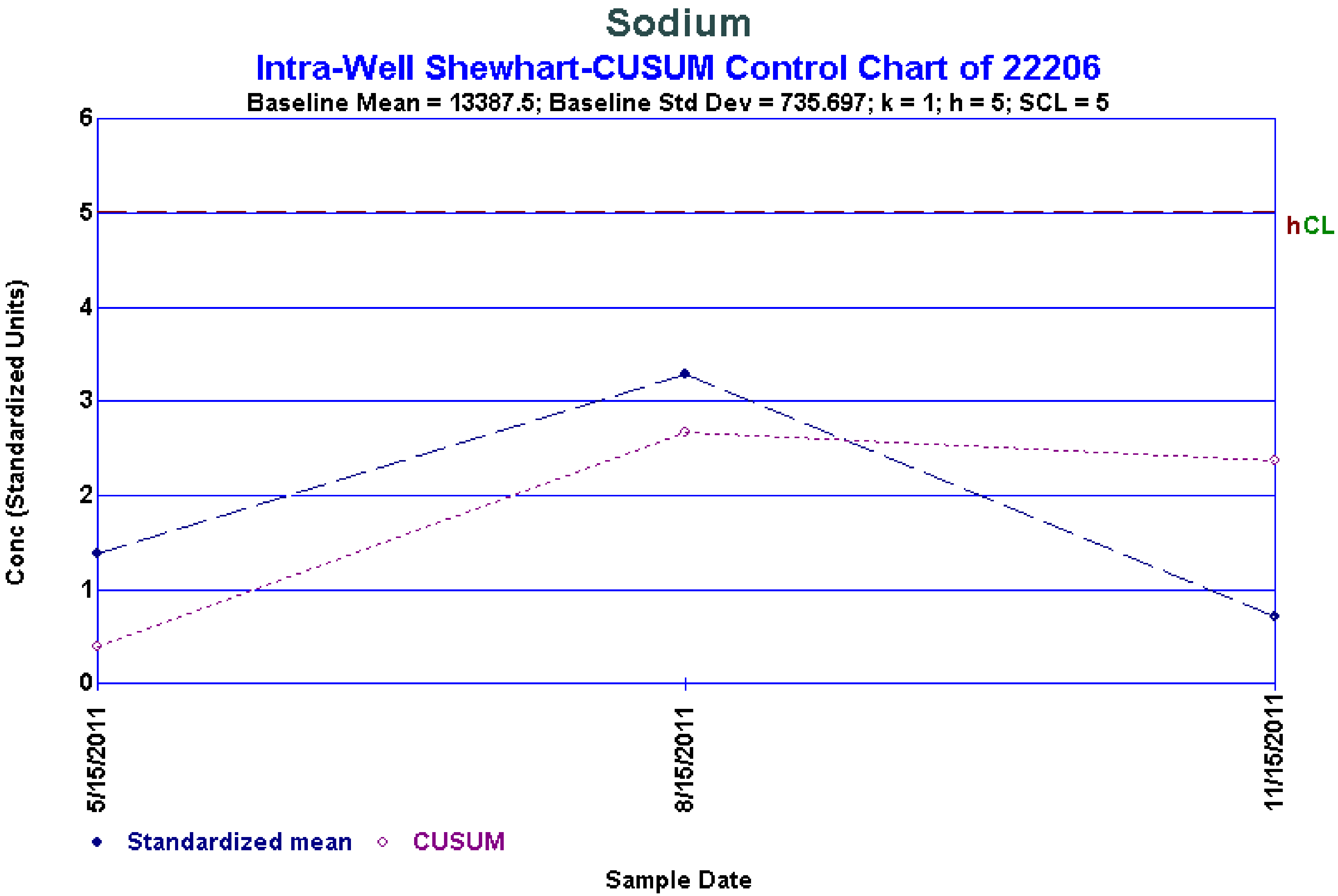


Figure A.5.4−40. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22206)

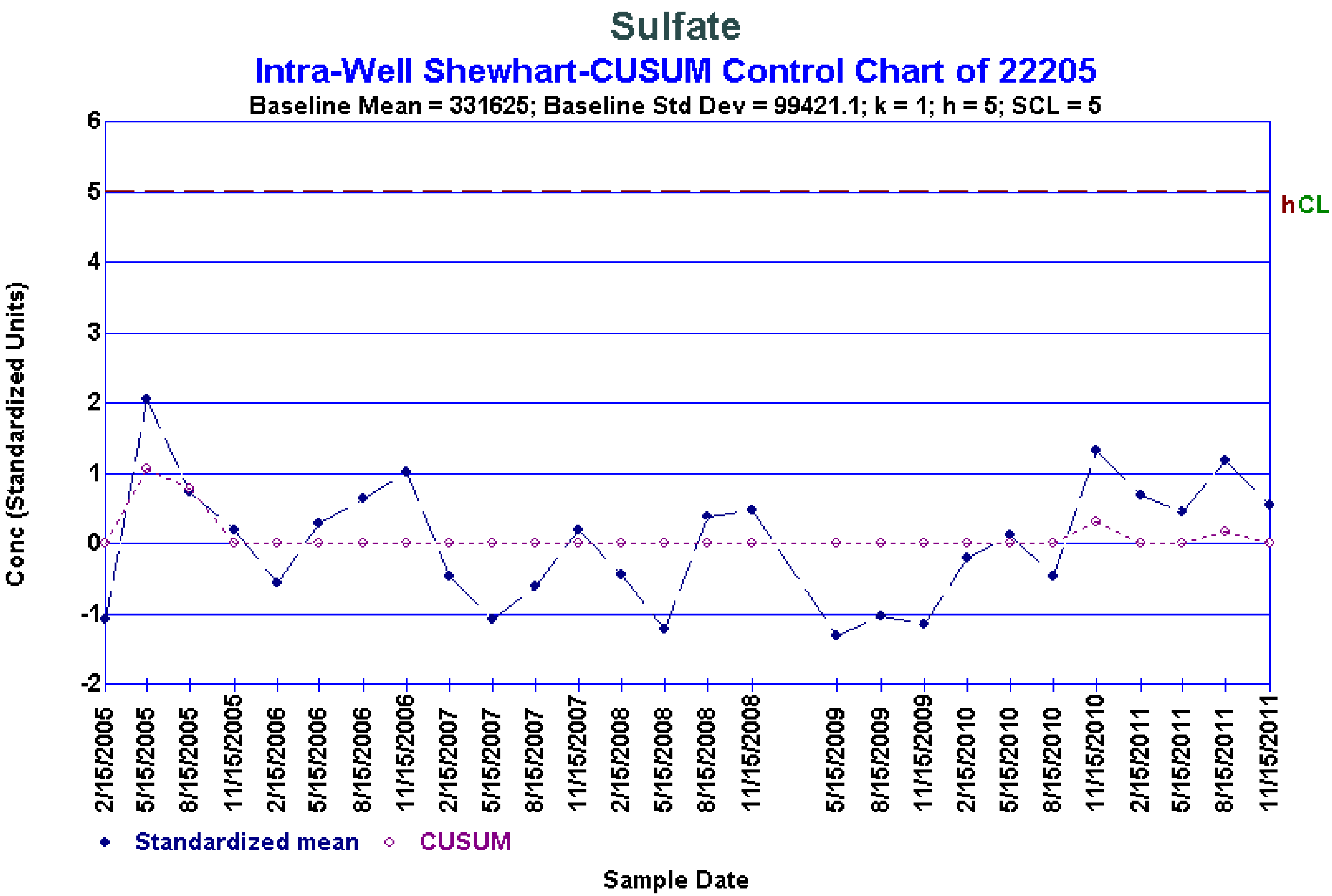


Figure A.5.4−41. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22205)

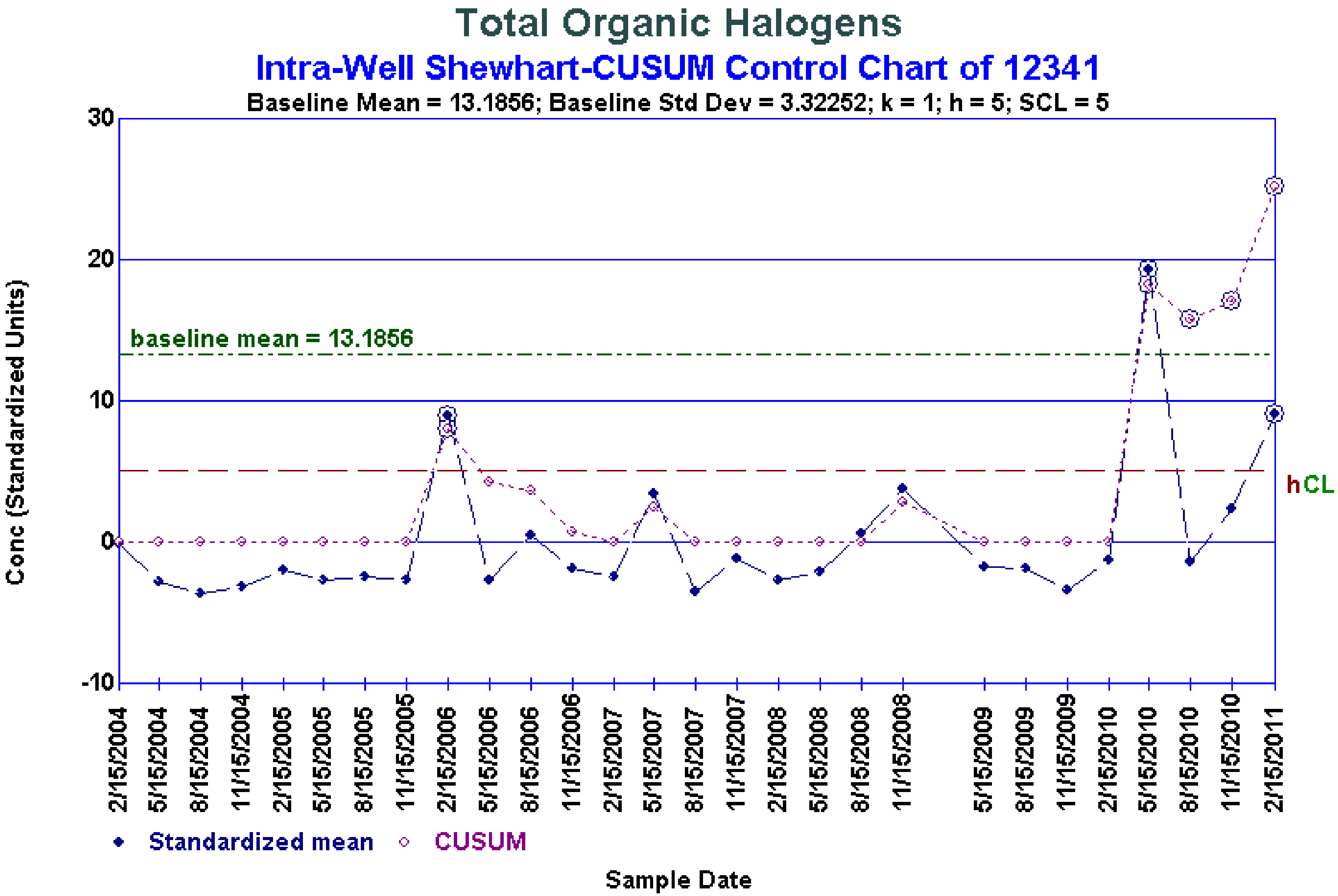


Figure A.5.4−42. Intra-Well Shewhart-CUSUM Control Chart (TOX 12341)

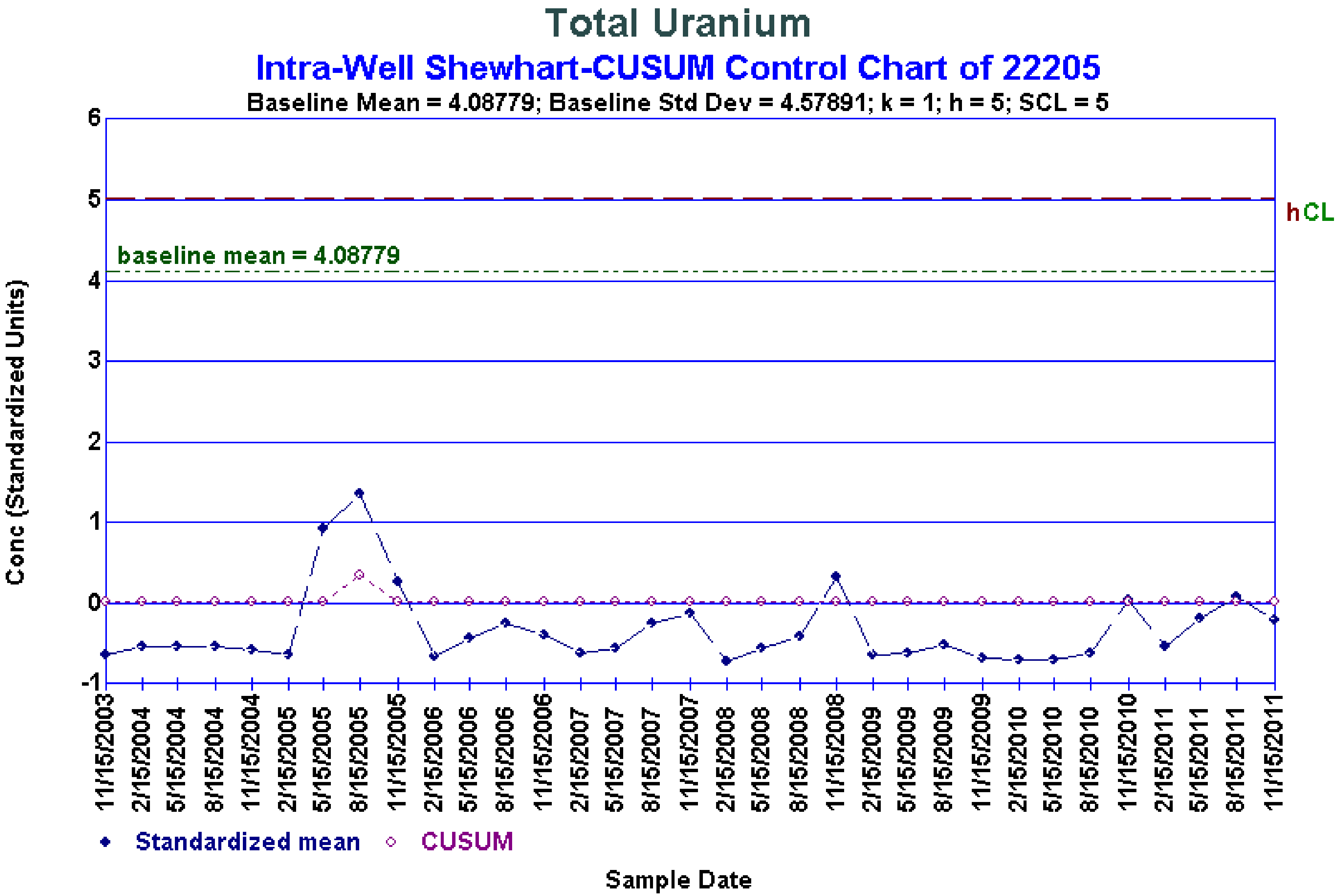


Figure A.5.4−43. Intra-Well Shewhart-CUSUM Control Chart (Uranium 22205)

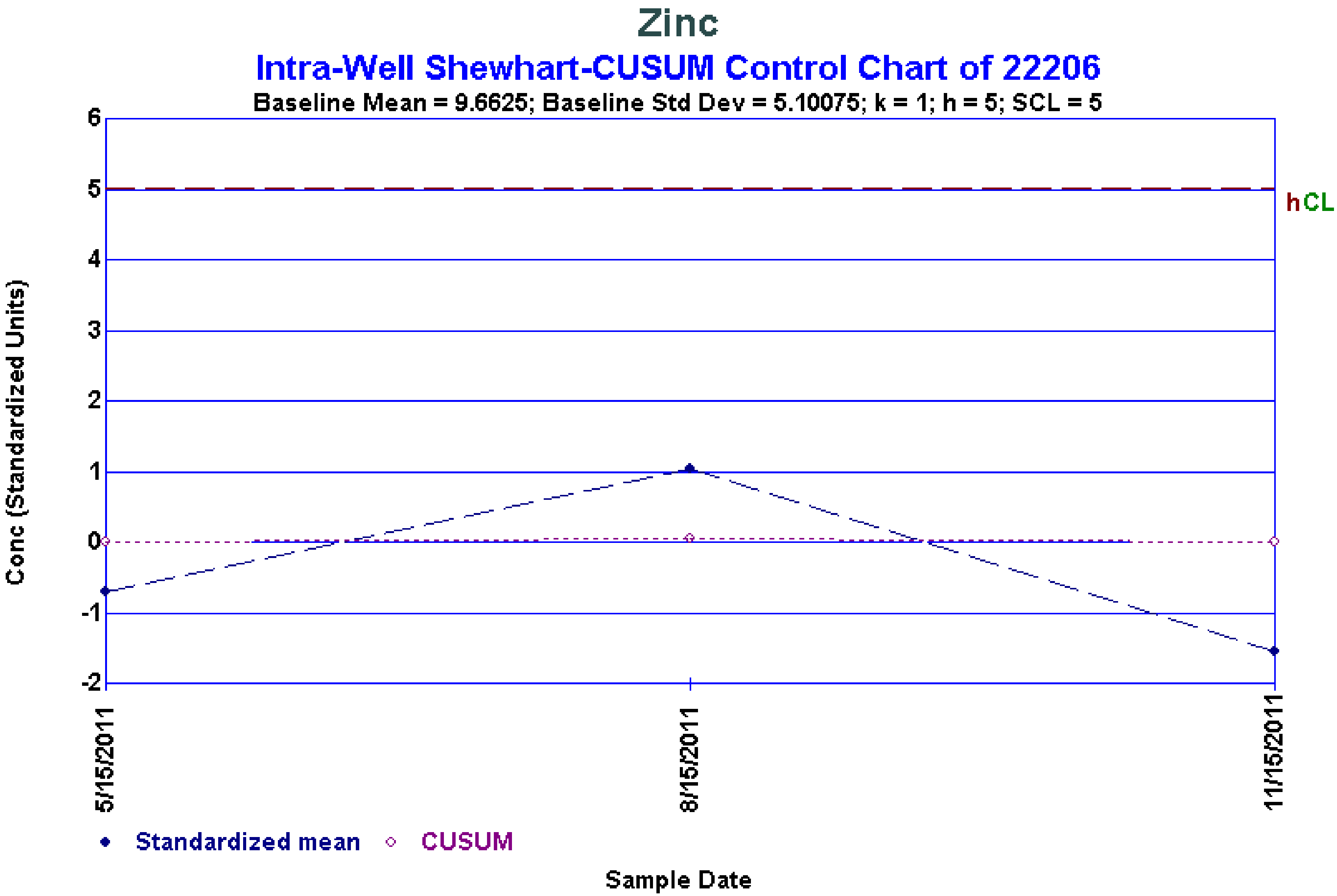


Figure A.5.4−44. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22206)

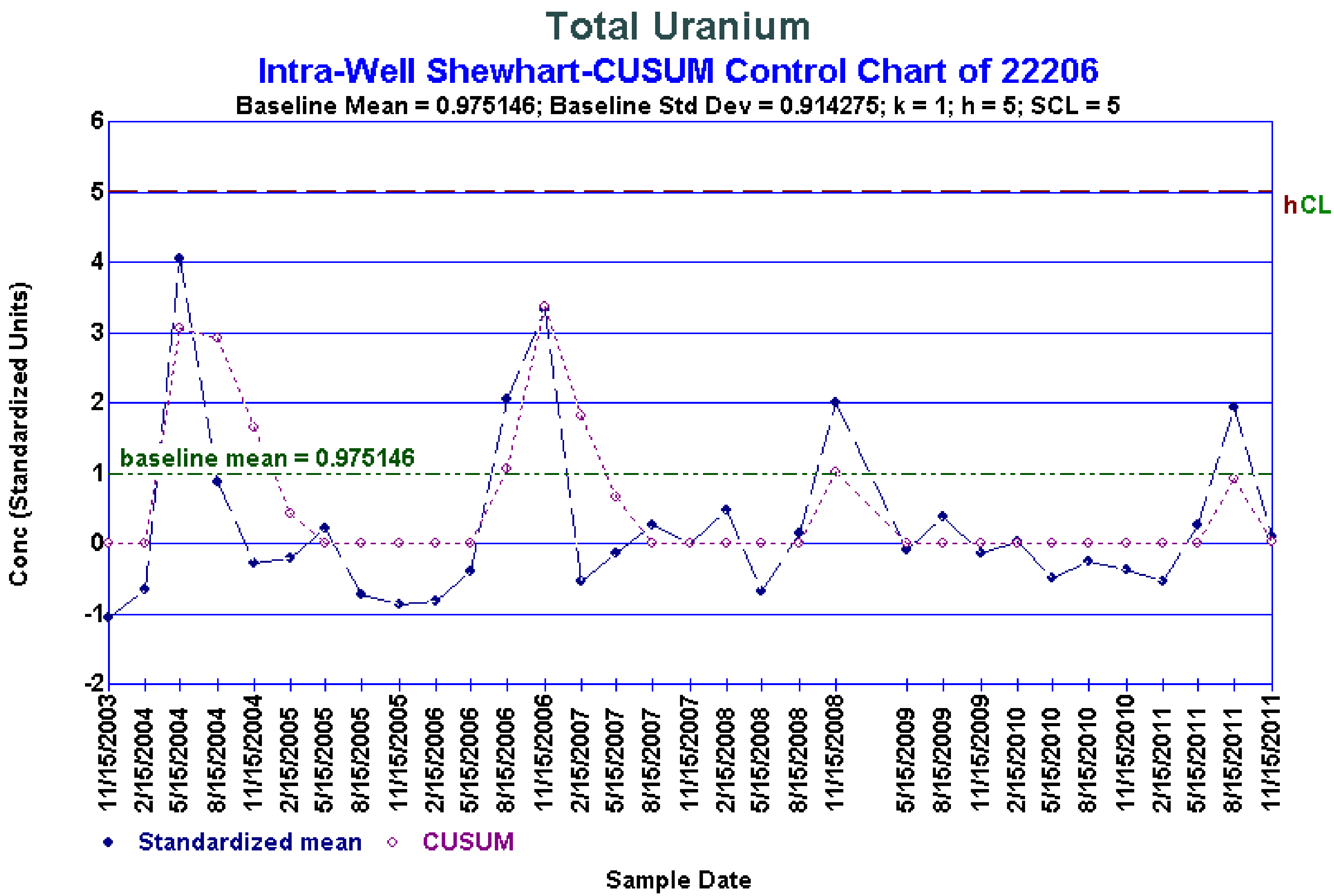


Figure A.5.4−45. Intra-Well Shewhart-CUSUM Control Chart (Uranium 22206)

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Sub-attachment A.5.5

Cell 5

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.5−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.5−2)
- LCS monthly accumulation volumes (refer to Figure A.5.5−1)
- LDS monthly accumulation volumes (refer to Figure A.5.5−2)
- OSDF horizontal till well 12342 water yield (refer to Figure A.5.5−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.5−4 and A.5.5−5)
- Plots of concentration versus time (refer to Figures A.5.5−6A to A.5.5−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.5−29)
- Control charts (refer to Figures A.5.5−30 to A.5.5−42)

A.5.5.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on LMICP (revision 4). Tritium results for all cells are reported in Section A.5.5.

The LDS of Cell 5 was dry during the fourth quarter of 2011. As shown in Table A.5.5–1, 8 of the 23 parameters sampled quarterly in the LCS, LDS, HTW, and GMA wells (sulfate, arsenic, boron, copper, iron, lithium, manganese, and sodium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Horizontal Till Well

The HTW is located beneath the liner penetration box of each cell by design. The liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, sulfate copper, and sodium are increasing in the HTW of Cell 5 (as indicated in the table below). The bivariate plot for the Cell 5 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.5−29. The plot shows that the chemical signature for uranium-sodium in the LCS LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured in the HTW of Cell 5 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Sulfate	Up		
Arsenic			Up
Boron			Up
Copper	Up		
Iron			Up
Lithium		Up	
Manganese			Up
Sodium	Up		

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer.
No entry indicates that the trend was not up.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.5–1) measured in the LDS and GMA wells for parameters with increasing concentrations in the Cell 5 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
Arsenic (mg/L)	**0.0187**[b]	0.00250	0.00729
Boron (mg/L)	**0.359**	0.0370	0.0307
Iron (mg/L)	1.29	**10.4**	6.84
Lithium (mg/L)	**0.117**	0.00974	0.00785
Manganese (mg/L)	0.0348	0.329	**0.376**

Note: The highest averages are shown in bold.
[a] LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer.
[b] Arsenic has only had one detect in the LDS (fourth quarter 2009, 0.0187 mg/L).

As shown in the table above, iron and manganese have higher concentrations in the GMA than in the LDS of Cell 5.

A.5.5.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart.

Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.5−1 in gray shading, thirteen parameters in the HTW and/or GMA wells of Cell 5 (nitrate, sulfate, TOC, calcium, cobalt, iron, lithium, magnesium, manganese, nickel, potassium, sodium, and zinc) meet the criteria for control charts (i.e., 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 13 control charts.

Parameter and Monitoring Point[a]	**Assessment**
Nitrate in the HTW	In Control
Sulfate in the GMA-D	In Control
TOC in the GMA-U	In Control
Calcium in the HTW	In Control
Cobalt in the HTW	**Out of Control**
Iron in the GMA-U	In Control
Lithium in the GMA-D	In Control
Magnesium in the HTW	In Control
Manganese in the HTW	**Out of Control**
Nickel in the HTW	In Control
Potassium in the HTW	In Control
Sodium in the GMA-D	In Control
Zinc in the GMA-D	In Control

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; and TOC = total organic carbon.

These 13 control charts are presented in Figures A.5.5−30 to A.5.5−42. All of the control charts, with the exception of two, exhibit "in control" conditions. The two exceptions are cobalt and manganese in the HTW. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 5 indicate that water is not mixing between the horizons, so the out of control conditions are attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

A.5.5.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 5 are provided in Table A.5.5−2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I of PCB parameters were detected in the LCS of Cell 5 in 2011.

A.5.5.4 Summary and Conclusions

- The concentrations of eight parameters monitored quarterly are increasing in either the HTW and/or GMA wells of Cell 5 (sulfate, arsenic, boron, copper, iron, lithium, manganese, and sodium).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 5 indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 5 are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Thirteen control charts were constructed for Cell 5 parameters. Eleven of the thirteen control charts exhibit “in control” conditions. Control charts for cobalt and manganese in the HTW are not in control.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 5 in 2011.

Table A.5.5−1. Summary Statistics for Cell 5

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12342C	36	36	100.0	3.39	285	131	52	Normal	None	Detected	
	LDS	12342D	33	33	100.0	2.93	27.1	16.6	5.3	Normal	None	Detected	
	HTW	12342	39	39	100.0	7.45	19.2	9.47	2.54	Undefined	None	Detected	
	GMA-U	22207	33	40	82.5	ND	2.39	0.295	0.356	Undefined	Down	Detected	
	GMA-D	22208	34	41	82.9	ND	2.10	0.375	0.308	Undefined	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12342C	19	19	100.0	58.0	563	445	131	Undefined	None	Detected	
	LDS	12342D	13	13	100.0	120	651	493	197	Undefined	None	Not Detected	
	HTW	12342	10	10	100.0	497	1060	527	170	Undefined	None	Not Detected	
	GMA-U	22207	4	4	100.0	337	353	346	7	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	392	421	418	14	Undefined	None	Insuff	
Chloride (mg/L)	LCS	12342C	19	19	100.0	16.9	112	88.9	29.5	Undefined	Up	Detected	
	LDS	12342D	13	13	100.0	41.3	50.0	44.3	3.03	Lognormal	None	Not Detected	6.2 (Q2-02)
	HTW	12342	10	10	100.0	20.9	60.8	45.2	13.5	Normal	Down	Detected	
	GMA-U	22207	4	4	100.0	24.5	32.9	28.3	3.5	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	24.4	31.9	27.1	3.4	Normal	None	Insuff	
Nitrate/Nitrite as N (mg/L)	LCS	12342C	18	25	72.0	ND	4.18	0.957	1.01	Undefined	None	Detected	
	LDS	12342D	5	13	38.5	ND	0.953	0.429	0.320	Lognormal	Up	Not Detected	
	HTW	12342	2	9	22.2	ND	0.211	Insuff	Insuff	Lognormal	None	Not Detected	
	GMA-U	22207	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22208	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sulfate (mg/L)	LCS	12342C	36	36	100.0	218	5910	2430	1300	Normal	Up	Detected	
	LDS	12342D	33	33	100.0	1130	3400	1860	590	Lognormal	Up	Detected	
	HTW	12342	32	32	100.0	101	399	228	110	Undefined	Up	Detected	
	GMA-U	22207	35	35	100.0	110	470	262	88	Lognormal	Down	Detected	552 (Q3-04) 770 (Q2-05)
	GMA-D	22208	35	35	100.0	221	583	377	93	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12342C	24	24	100.0	436	6260	4700	2130	Undefined	Down	Detected	
	LDS	12342D	11	11	100.0	2080	4560	4300	710	Undefined	Up	Detected	
	HTW	12342	8	8	100.0	1090	1190	1140	30	Normal	None	Not Detected	
	GMA-U	22207	11	11	100.0	552	987	679	122	Normal	Down	Not Detected	
	GMA-D	22208	11	11	100.0	882	1290	945	119	Undefined	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12342C	27	35	77.1	ND	4.21	1.99	0.88	Normal	None	Not Detected	
	LDS	12342D	30	33	90.9	ND	10.7	6.02	2.37	Normal	None	Detected	
	HTW	12342	30	35	85.7	ND	5.27	2.89	0.92	Normal	None	Detected	
	GMA-U	22207	29	40	72.5	ND	4.15	1.44	0.66	Lognormal	None	Not Detected	
	GMA-D	22208	30	40	75.0	ND	2.45	1.43	0.47	Normal	None	Detected	8.93 (Q4-01)
Total Organic Halogens (mg/L)	LCS	12342C	19	36	52.8	ND	0.0604	0.0117	0.0122	Undefined	None	Not Detected	
	LDS	12342D	23	33	69.7	ND	0.0717	0.0309	0.0199	Normal	None	Not Detected	
	HTW	12342	23	36	63.9	ND	0.0320	0.00764	0.00696	Undefined	None	Not Detected	
	GMA-U	22207	11	40	27.5	ND	0.0150	0.00376	0.00487	Undefined	Down	Detected	0.047 (Q2-10)
	GMA-D	22208	9	40	22.5	ND	0.0132	0.0040	0.00436	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12342C	5	24	20.8	ND	0.140	0.00375	0.0373	Undefined	None	Not Detected	
	LDS	12342D	1	20	5.0	ND	0.0187	Insuff	Insuff	Undefined	None	Not Detected	
	HTW	12342	9	20	45.0	ND	0.0528	0.00375	0.0116	Undefined	None	Not Detected	
	GMA-U	22207	5	11	45.4	ND	0.0363	0.00250	0.0114	Undefined	None	Not Detected	
	GMA-D	22208	5	24	20.8	ND	0.0390	0.00729	0.0110	Lognormal	Up	Detected	
Barium (mg/L)	LCS	12342C	19	19	100.0	0.0176	0.0707	0.0318	0.0148	Lognormal	Down	Detected	
	LDS	12342D	13	13	100.0	0.00698	0.0659	0.0240	0.0148	Lognormal	Down	Not Detected	
	HTW	12342	10	10	100.0	0.0518	0.0902	0.0802	0.0107	Undefined	None	Not Detected	
	GMA-U	22207	4	4	100.0	0.0622	0.0738	0.0664	0.0053	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	0.0421	0.0617	0.0505	0.0085	Normal	None	Insuff	

Table A.5.5−1 (continued). Summary Statistics for Cell 5

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
	LCS	12342C	34	36	94.4	ND	1.59	0.759	0.335	Undefined	None	Detected	
	LDS	12342D	33	33	100.0	0.202	1.20	0.359	0.300	Undefined	None	Detected	
Boron (mg/L)	HTW	12342	34	36	94.4	ND	0.221	0.110	0.047	Lognormal	None	Detected	
	GMA-U	22207	35	40	87.5	ND	0.0480	0.0370	0.0086	Undefined	None	Not Detected	
	GMA-D	22208	34	40	85.0	ND	0.0464	0.0307	0.0096	Normal	Up	Detected	
	LCS	12342C	19	19	100.0	163	990	520	165	Undefined	None	Not Detected	
	LDS	12342D	13	13	100.0	222	386	304	44	Normal	None	Not Detected	
Calcium (mg/L)	HTW	12342	10	10	100.0	184	233	201	18	Normal	None	Not Detected	
	GMA-U	22207	4	4	100.0	143	155	148	6	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	222	285	243	29	Normal	None	Insuff	
	LCS	12342C	13	24	54.2	ND	0.0116	0.00111	0.00314	Undefined	None	Detected	
	LDS	12342D	9	20	45.0	ND	0.0034	0.00076	0.00092	Undefined	Down	Detected	
Cobalt (mg/L)	HTW	12342	15	17	88.2	ND	0.0106	0.00333	0.00226	Lognormal	None	Not Detected	
	GMA-U	22207	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22208	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	LCS	12342C	14	20	70.0	ND	0.0862	0.0112	0.0188	Undefined	None	Not Detected	
	LDS	12342D	8	15	53.3	ND	0.0209	0.0071	0.0065	Undefined	None	Not Detected	
Copper (mg/L)	HTW	12342	6	11	54.6	ND	0.0150	0.00457	0.00514	Lognormal	Up	Detected	
	GMA-U	22207	4	4	100.0	0.00144	0.00762	0.0050	0.0026	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	0.00207	0.00925	0.00681	0.00322	Normal	None	Insuff	
	LCS	12342C	20	24	83.3	ND	4.61	0.596	1.62	Undefined	Down	Detected	
	LDS	12342D	19	20	95.0	ND	3.67	1.29	1.07	Normal	Down	Not Detected	
Iron (mg/L)	HTW	12342	17	17	100.0	1.74	18.9	3.31	5.21	Undefined	None	Not Detected	
	GMA-U	22207	11	11	100.0	5.54	18.2	10.4	4.5	Normal	None	Not Detected	
	GMA-D	22208	11	11	100.0	4.92	8.60	6.84	1.01	Normal	Up	Detected	
	LCS	12342C	20	20	100.0	0.107	0.293	0.178	0.055	Normal	Up	Detected	
	LDS	12342D	19	19	100.0	0.0484	0.218	0.117	0.052	Undefined	Up	Detected	
Lithium (mg/L)	HTW	12342	13	17	76.5	0.0026	0.0050	0.00348	0.00080	Undefined	None	Detected	
	GMA-U	22207	11	11	100.0	0.00642	0.0141	0.00974	0.00296	Normal	Up	Detected	
	GMA-D	22208	11	11	100.0	0.00659	0.00901	0.00785	0.00075	Normal	None	Not Detected	
	LCS	12342C	19	19	100.0	57.7	913	512	267	Normal	Up	Detected	
	LDS	12342D	13	13	100.0	104	354	112	102	Undefined	None	Not Detected	
Magnesium (mg/L)	HTW	12342	10	10	100.0	42.9	61.1	52.1	6.3	Normal	None	Not Detected	
	GMA-U	22207	4	4	100.0	27.1	31.5	29.6	2.2	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	52.5	66.4	57.0	6.4	Normal	None	Insuff	
	LCS	12342C	13	24	54.2	ND	2.96	0.0100	0.986	Undefined	None	Detected	
	LDS	12342D	16	20	80.0	ND	0.146	0.0348	0.0535	Undefined	Down	Not Detected	0.783 (Q2-02) 0.333 (Q1-06)
Manganese (mg/L)	HTW	12342	17	17	100.0	0.574	1.30	0.905	0.173	Normal	None	Not Detected	
	GMA-U	22207	11	11	100.0	0.276	0.650	0.329	0.108	Undefined	Down	Not Detected	
	GMA-D	22208	23	24	95.8	ND	0.513	0.376	0.094	Undefined	Up	Not Detected	
	LCS	12342C	20	24	83.3	ND	0.0452	0.0175	0.0161	Lognormal	None	Detected	
	LDS	12342D	18	20	90.0	0.00163	0.0230	0.00832	0.00630	Lognormal	Down	Detected	
Nickel (mg/L)	HTW	12342	15	17	88.2	0.00322	0.0172	0.00805	0.00346	Normal	None	Not Detected	
	GMA-U	22207	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22208	8	24	33.3	ND	0.0069	0.00075	0.00177	Undefined	None	Detected	
	LCS	12342C	19	19	100.0	6.22	65.5	25.4	11.5	Undefined	Up	Detected	
	LDS	12342D	13	13	100.0	10.0	42.7	12.2	10.0	Undefined	None	Detected	
Potassium (mg/L)	HTW	12342	9	10	90.0	ND	1.99	1.54	0.36	Normal	None	Not Detected	
	GMA-U	22207	4	4	100.0	2.75	3.09	2.92	0.14	Normal	None	Insuff	
	GMA-D	22208	4	4	100.0	3.14	3.41	3.30	0.12	Normal	None	Insuff	

Table A.5.5−1 (continued). Summary Statistics for Cell 5

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12342C	6	24	25.0	ND	0.212	0.00625	0.0448	Undefined	None	Not Detected	
	LDS	12342D	2	20	10.0	0.00086	0.0525	Insuff	Insuff	Undefined	None	Not Detected	
	HTW	12342	0	17	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-U	22207	1	11	9.1	ND	0.00509	Insuff	Insuff	Undefined	None	Detected	
	GMA-D	22208	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12342C	23	24	95.8	16.4	108	70.8	19.9	Undefined	Up	Not Detected	
	LDS	12342D	20	20	100.0	323	474	384	50	Normal	Up	Detected	84.6 (Q4-02)
	HTW	12342	20	20	100.0	17.0	33.6	26.1	5.4	Normal	Up	Detected	
	GMA-U	22207	11	11	100.0	13.0	17.1	14.9	1.2	Normal	Down	Not Detected	
	GMA-D	22208	11	11	100.0	14.3	17.7	16.0	1.1	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12342C	9	24	37.5	ND	0.040	0.0142	0.0092	Lognormal	None	Not Detected	
	LDS	12342D	14	20	70.0	ND	0.131	0.0321	0.0299	Lognormal	None	Not Detected	
	HTW	12342	11	17	64.7	ND	0.0869	0.0180	0.0229	Lognormal	None	Detected	
	GMA-U	22207	3	11	27.3	ND	0.0123	0.00286	Insuff	Undefined	None	Not Detected	
	GMA-D	22208	13	24	54.2	ND	0.0124	0.00438	0.00267	Lognormal	None	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires n ≥ 3. In addition, Standard Deviation requires n ≥ 4.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where 3 ≤ n ≤ 50) or Shapiro Francia (where n > 50).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with n ≥ 4.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with n ≥ 6.

[h]Outliers determined by Rosner's (where n > 25) or Dixon procedure (where 4 ≤ n ≤ 25).

[i]Q = quarterly

Table A.5.5−2. Cell 5 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	10	3	30.0	Yes	0.02	0.815	0.292	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	10	1	10.0	No	0.000038	-	-	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Chromium (mg/L)	10	2	20.0	Yes	0.0013	0.00457	0.0029	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(0)	0.818 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	18	8	44.4	No	2.04	19	10.3	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethane (ug/L)	9	1	11.1	No	0.498	-	-	280 ug/L(0)	-	-	-
1,1-Dichloroethene (ug/L)	18	1	5.6	No	0.744	-	-	7 ug/L(0)	-	-	-
4-Methyl-2-Pentanone (ug/L)	9	1	11.1	No	0.46	-	-	-	-	-	-
Acetone (ug/L)	9	1	11.1	No	2.7	-	-	-	-	-	-
Carbon Disulfide (ug/L)	9	1	11.1	No	0.33	-	-	5.5 ug/L(0)	-	-	-
Toluene (ug/L)	9	1	11.1	No	0.416	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

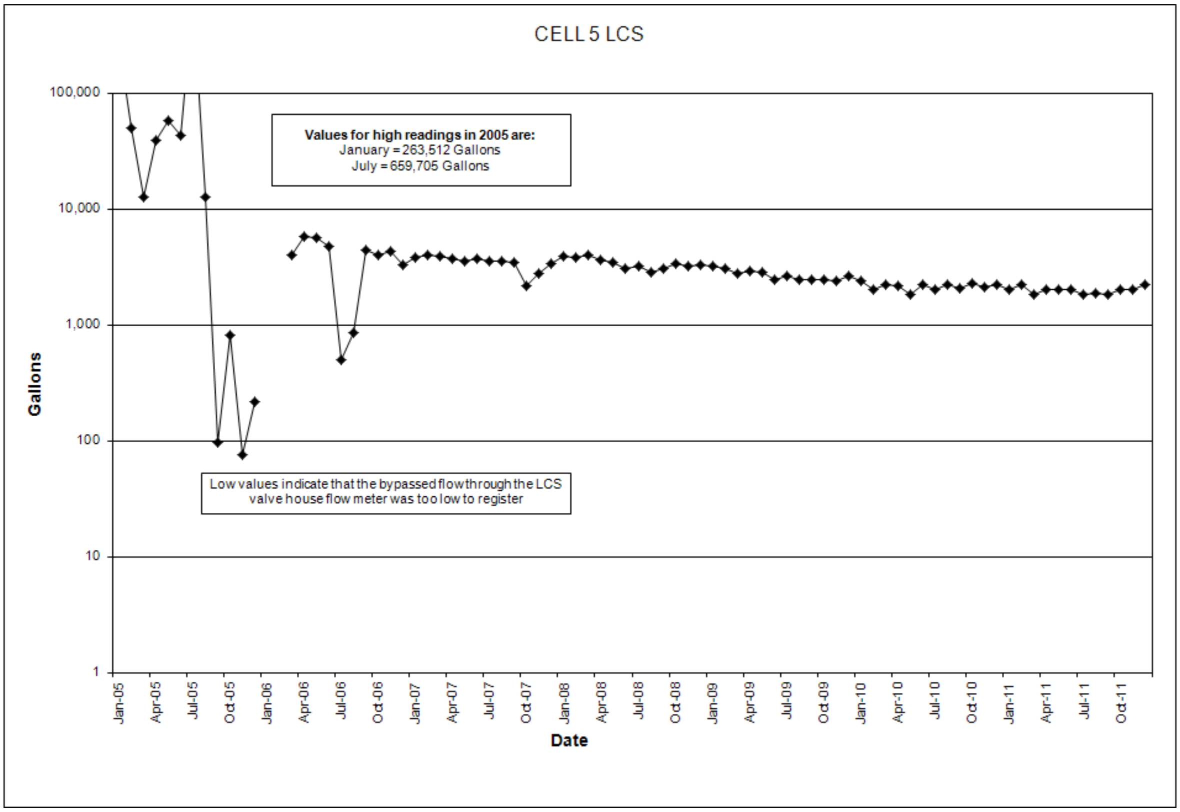


Figure A.5.5–1. Monthly Accumulation Volumes For Cell 5 LCS

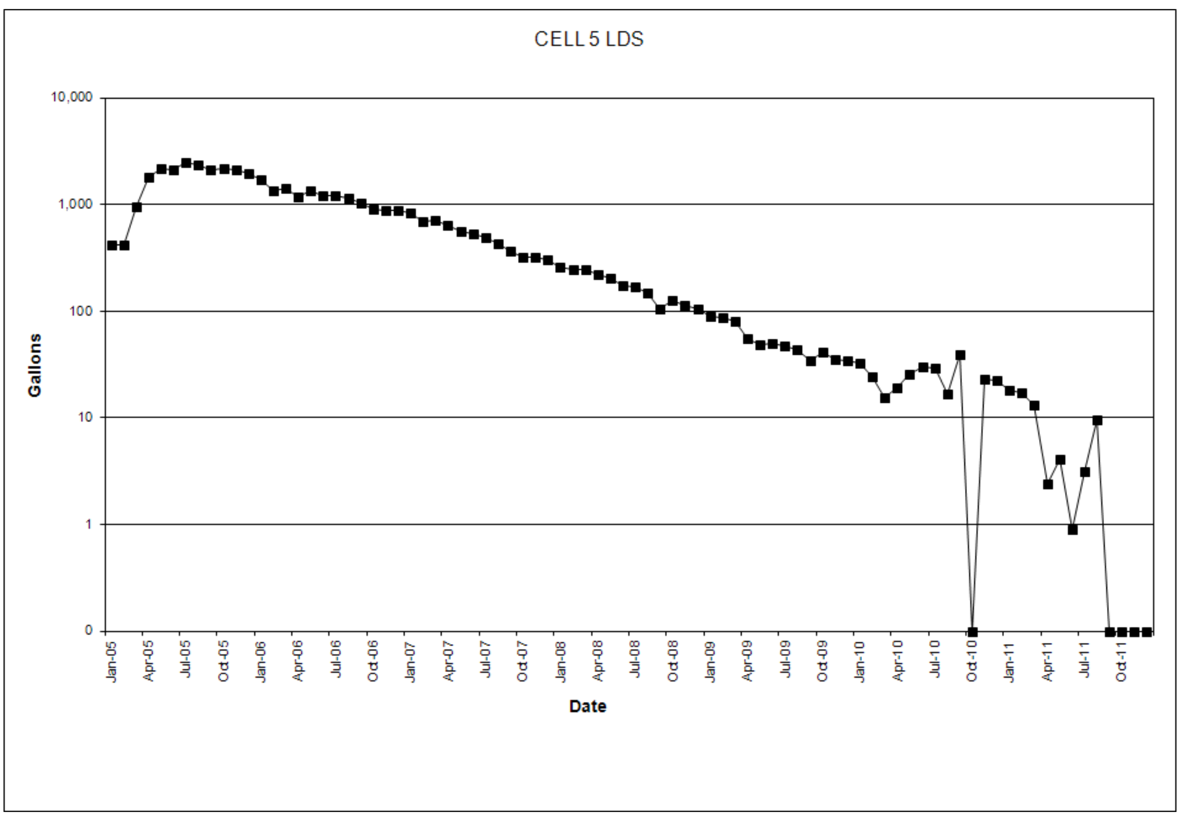
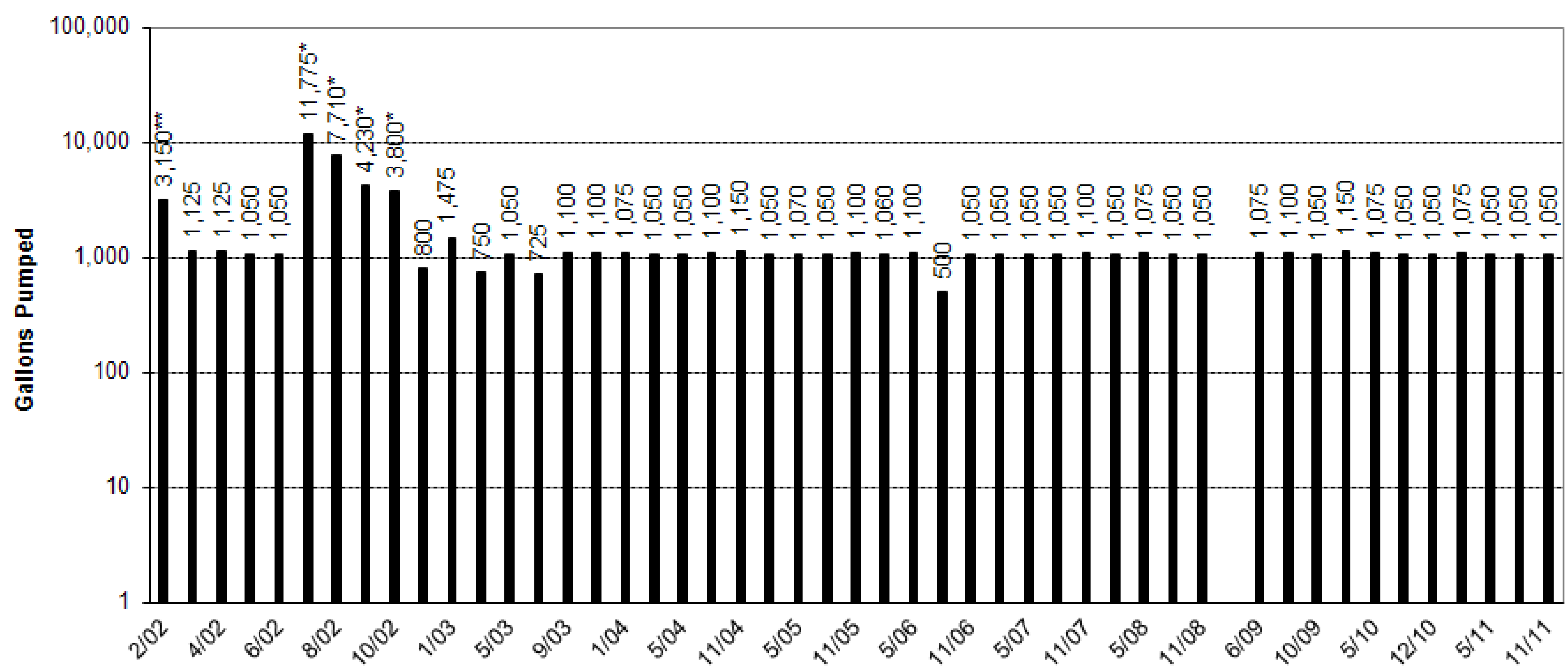


Figure A.5.5–2. Monthly Accumulation Volumes For Cell 5 LDS



12342 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2002	35815	n=10	3582
2003:	6200	n=6	1033
2004:	5425	n=5	1085
2005:	4270	n=4	1068
2006:	3710	n=4	928
2007:	4250	n=4	1063
2008:	4225	n=4	1056
2009:	3225	n=3	1075
2010:	4325	n=4	1081
2011:	4225	n=4	1056
Overall:			1576

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

**Excess water was pumped from this well in February 2002 for well development.

Figure A.5.5–3. OSDF Horizontal Till Well 12342 (Cell 5) Water Yield

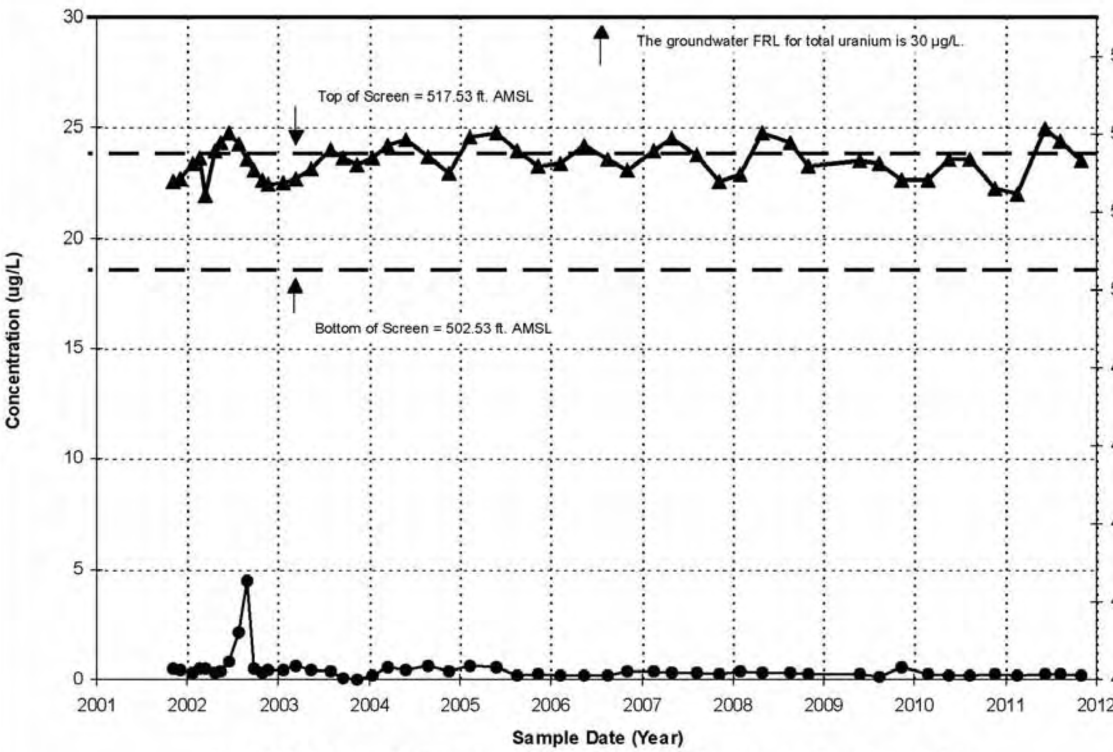


FIGURE A.5.5-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 5 Upgradient Monitoring Well 22207

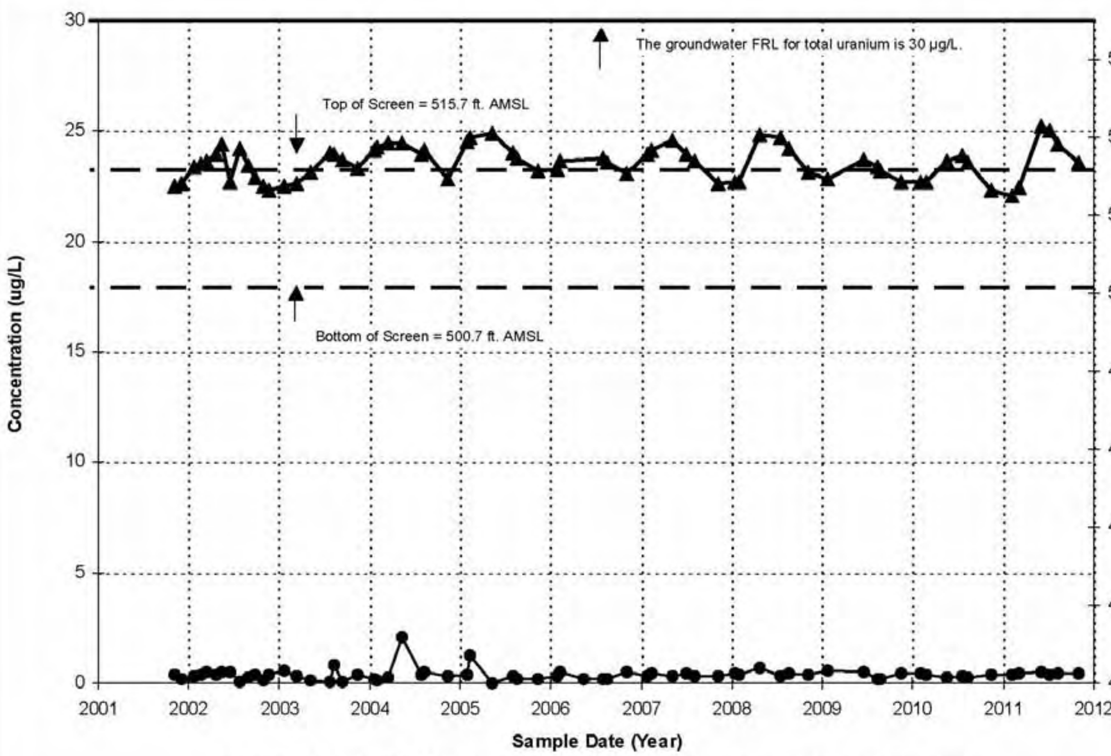


FIGURE A.5.5-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 5 Downgradient Monitoring Well 22208

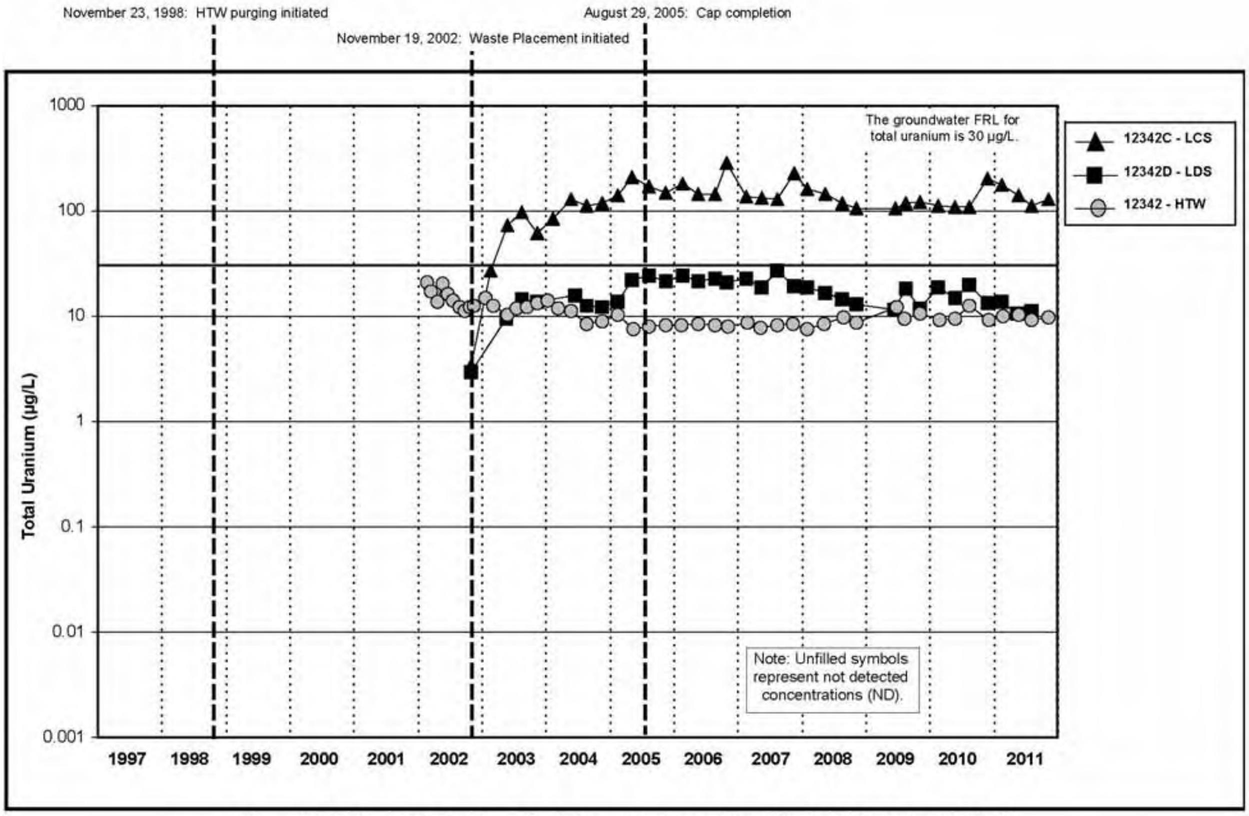


Figure A.5.5-6A. Cell 5 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

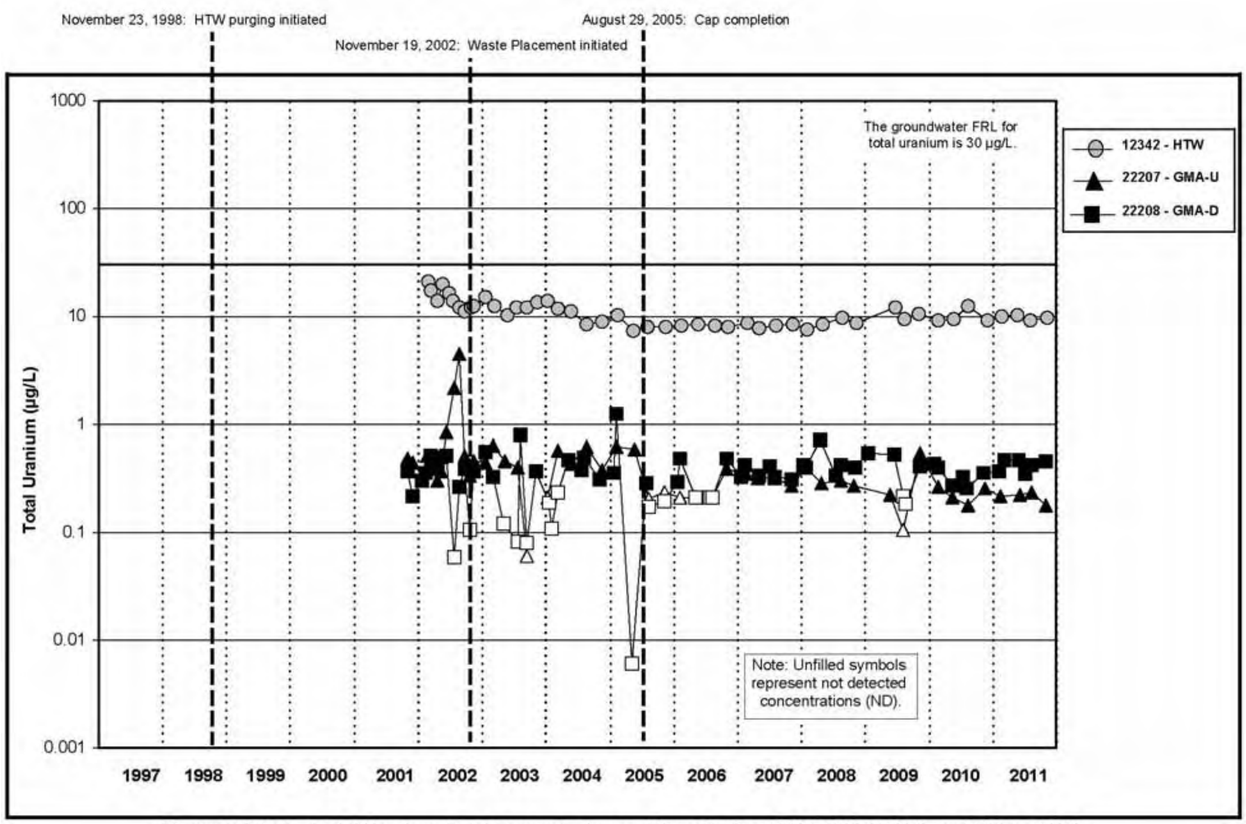


Figure A.5.5-6B. Cell 5 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

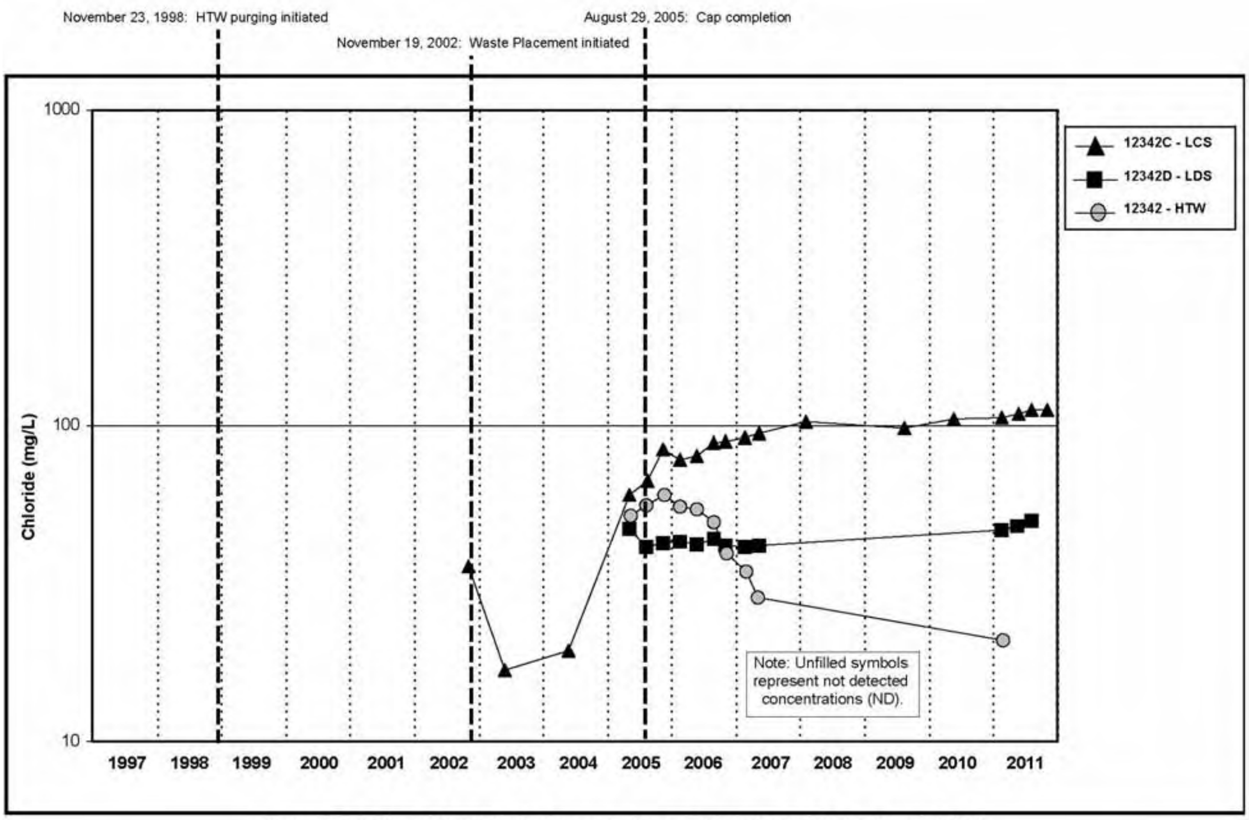


Figure A.5.5-7A. Cell 5 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

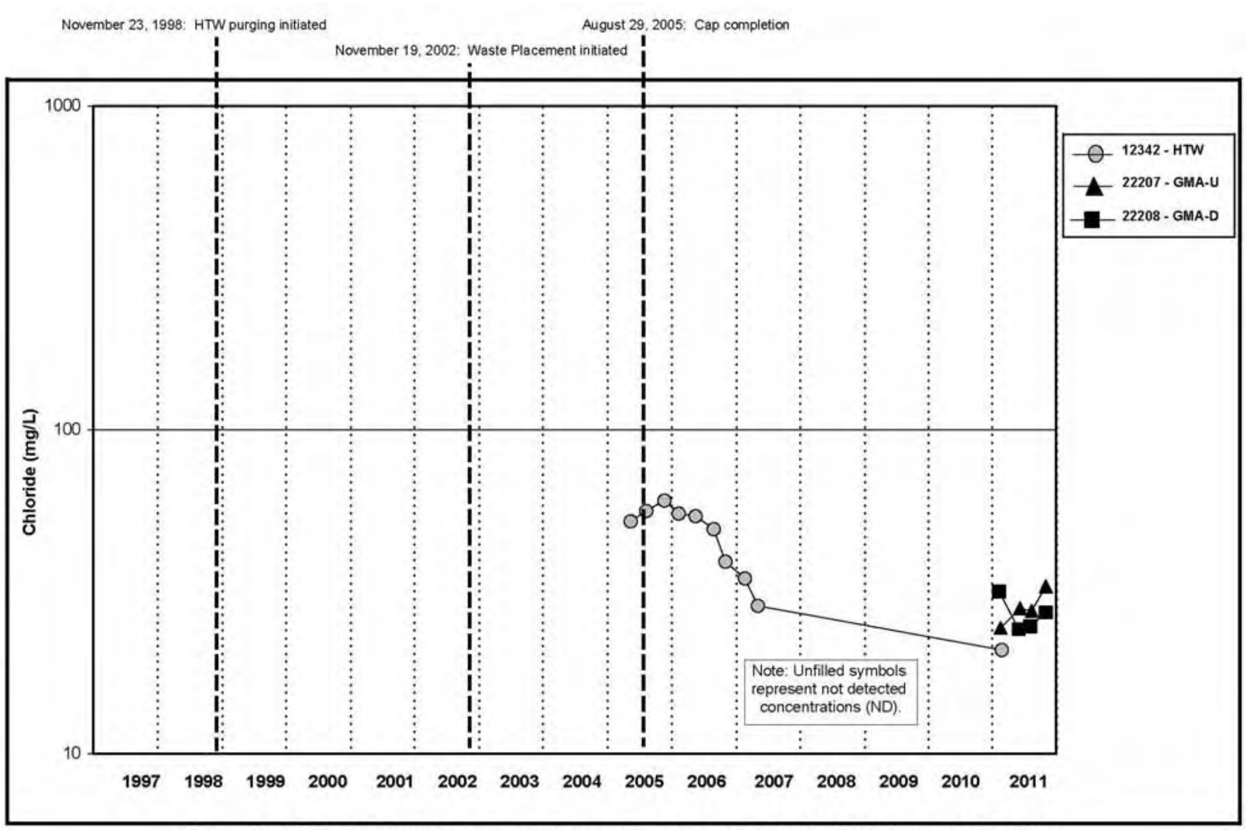


Figure A.5.5-7B. Cell 5 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

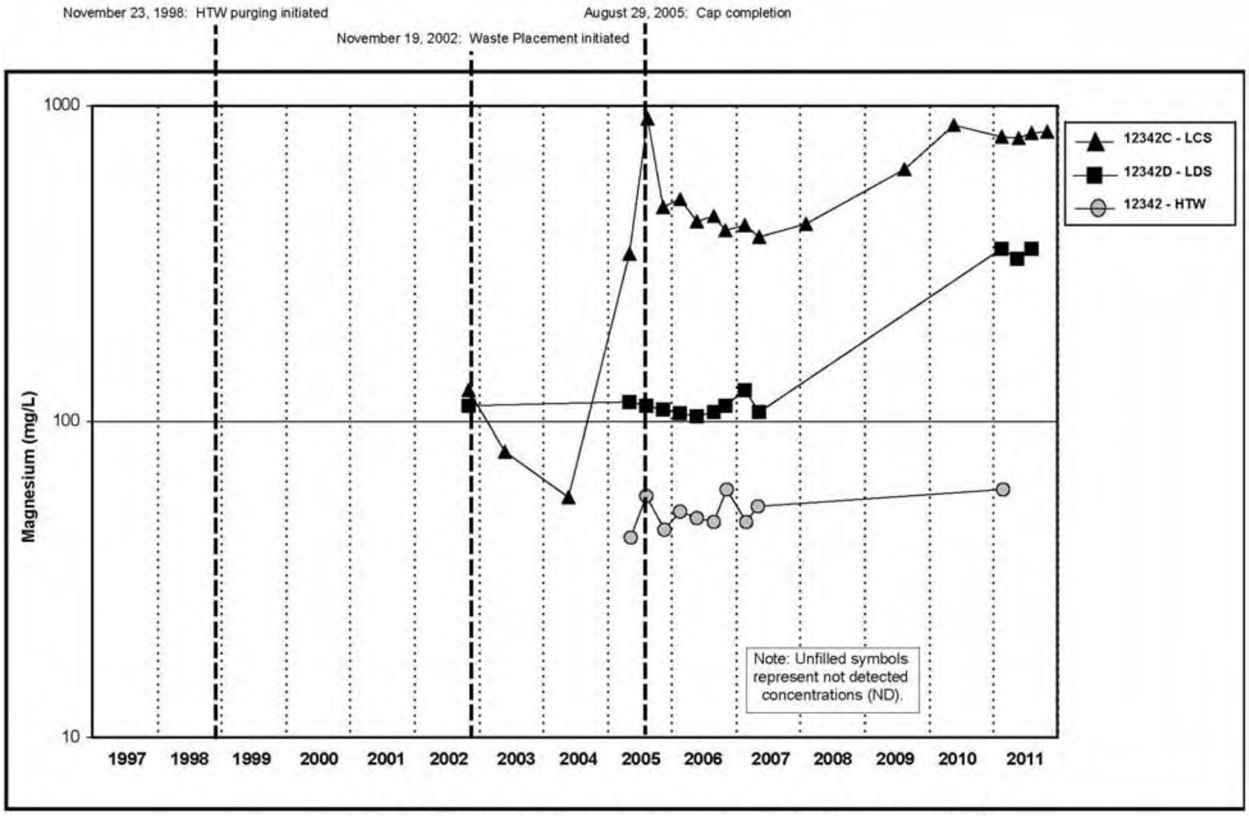


Figure A.5.5-8A. Cell 5 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

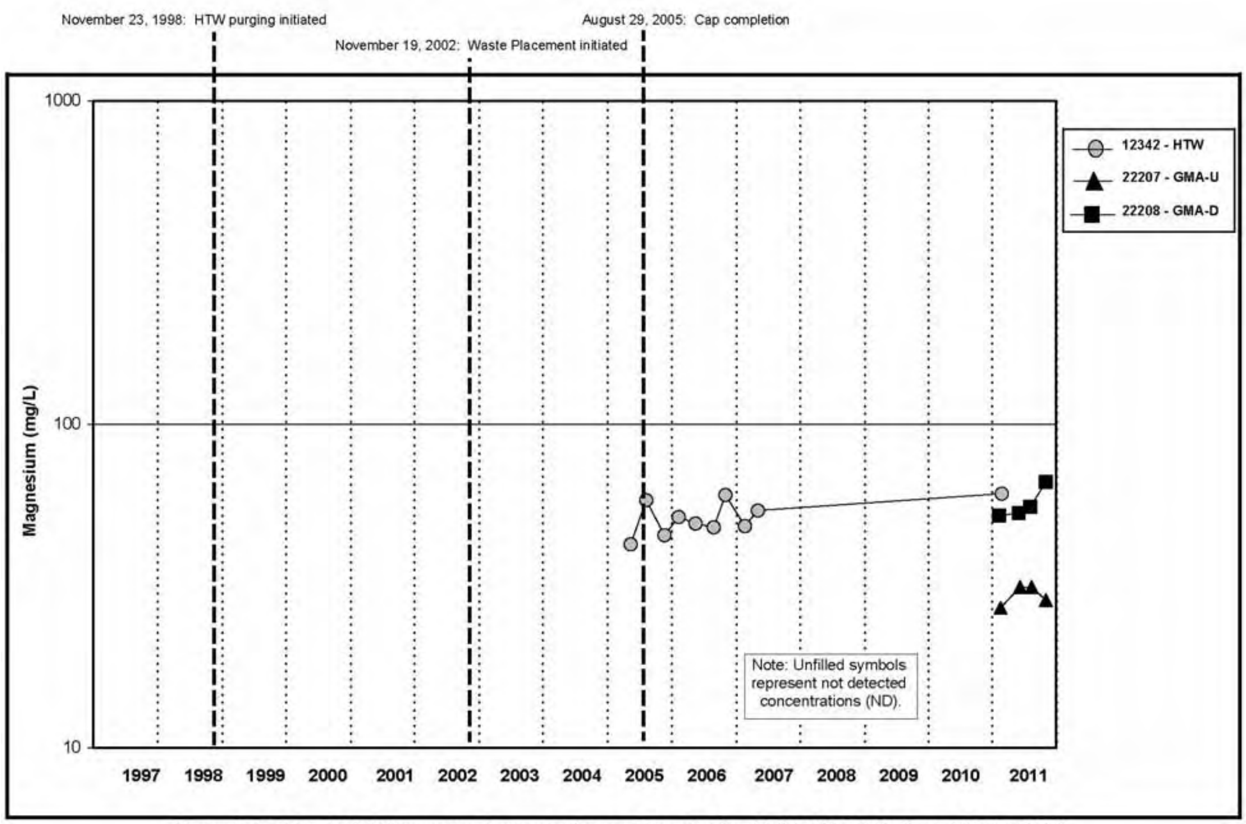


Figure A.5.5-8B. Cell 5 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

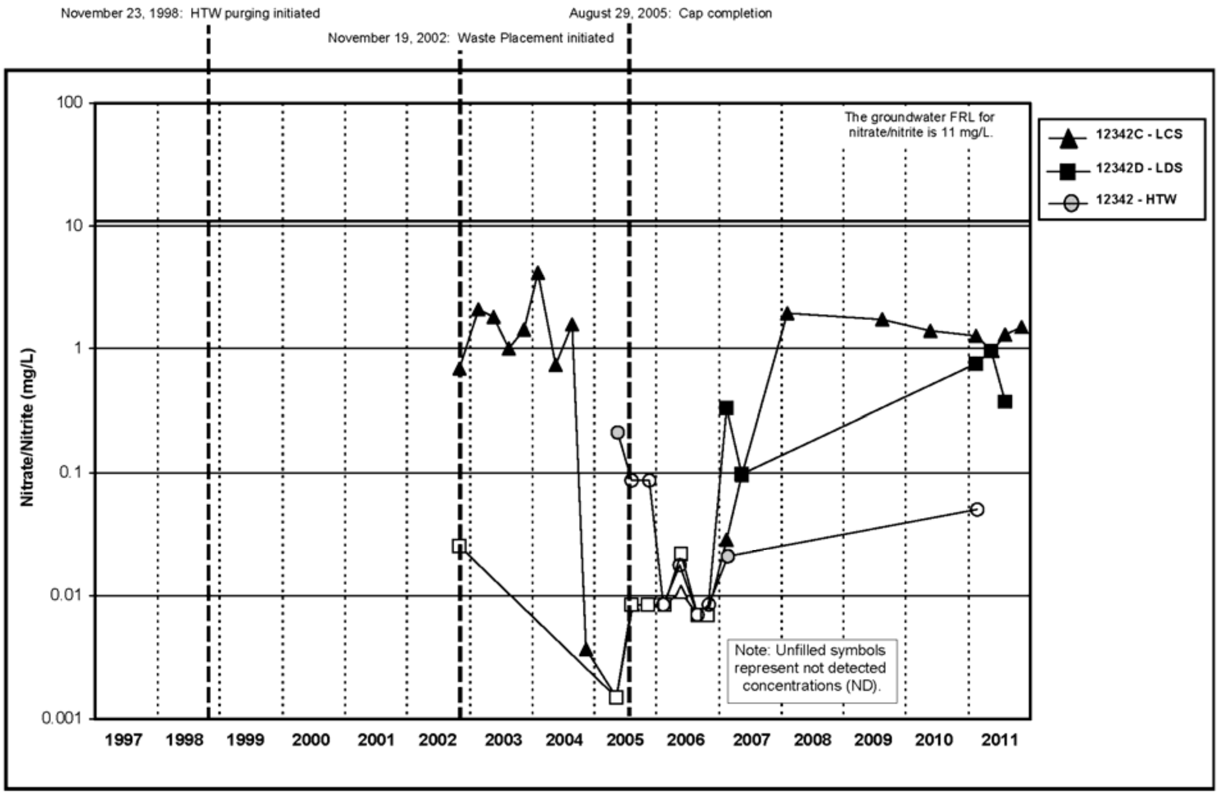


Figure A.5.5-9A. Cell 5 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

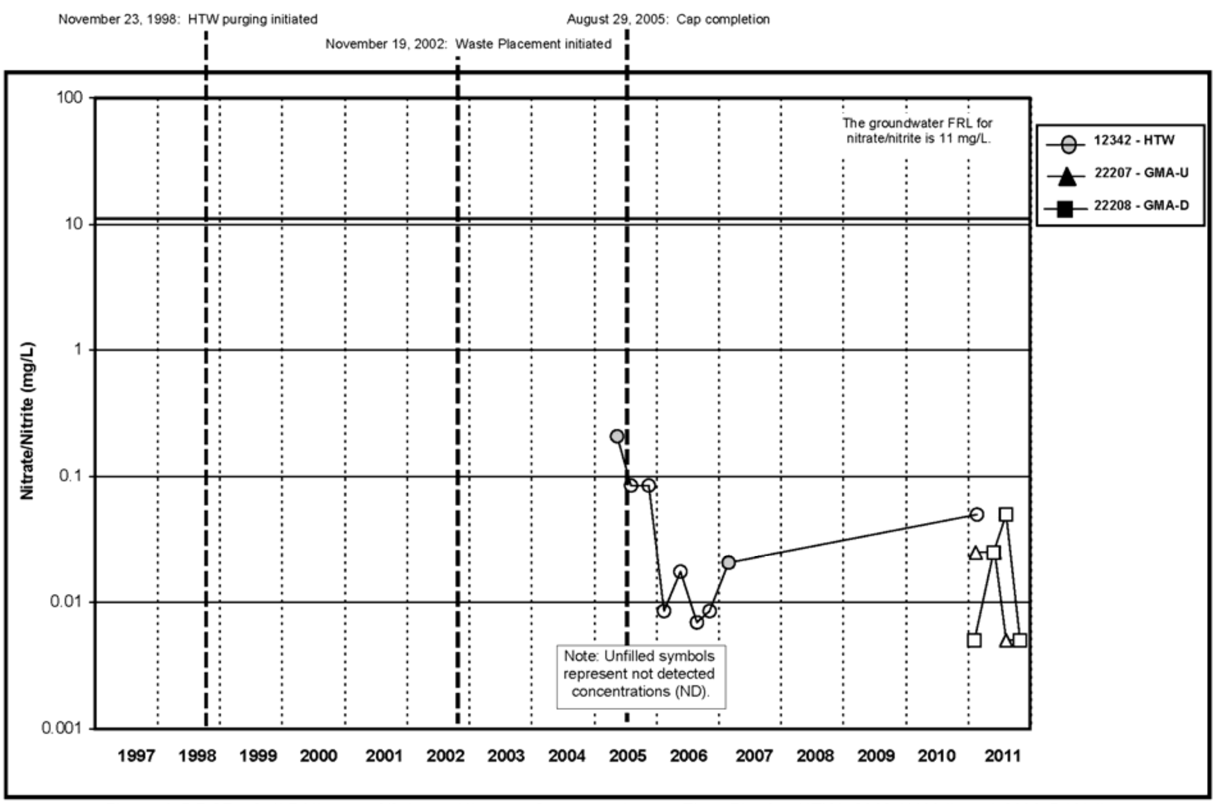


Figure A.5.5-9B. Cell 5 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

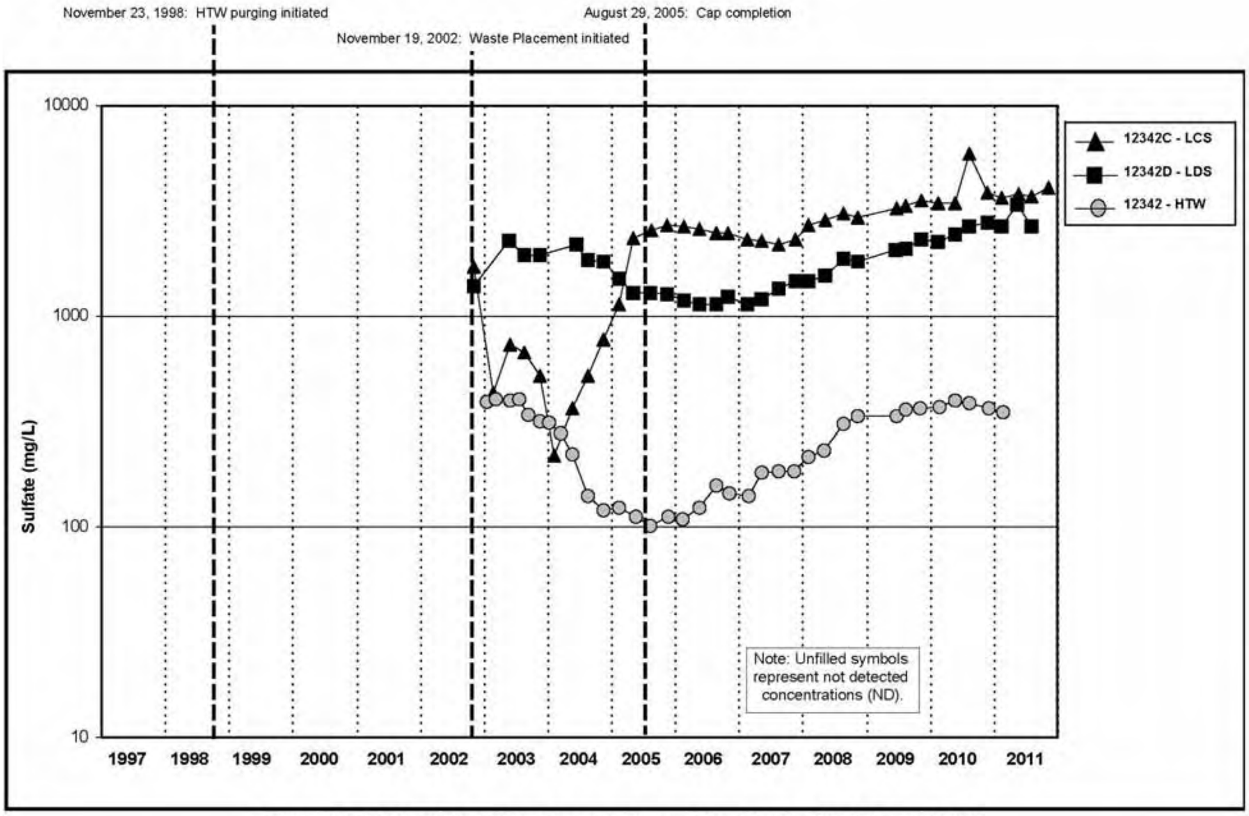


Figure A.5.5-10A. Cell 5 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

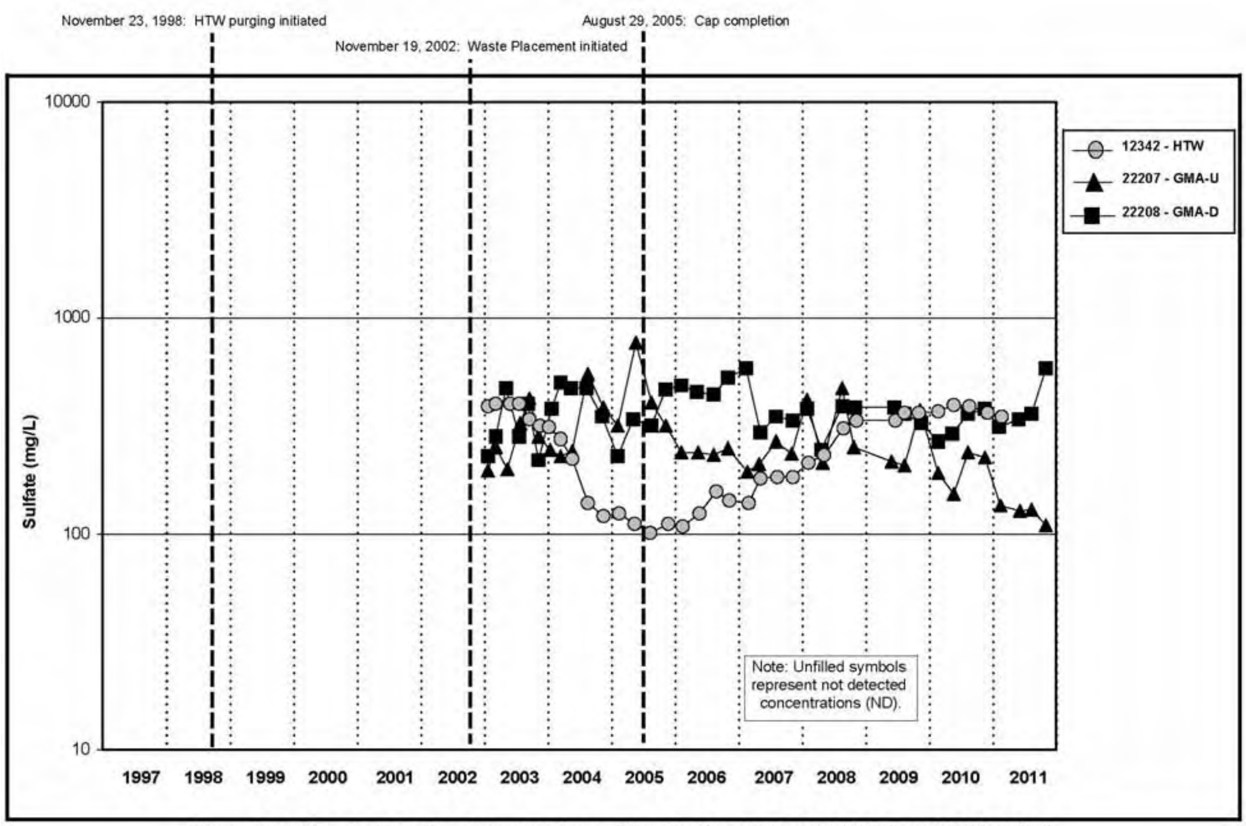


Figure A.5.5-10B. Cell 5 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

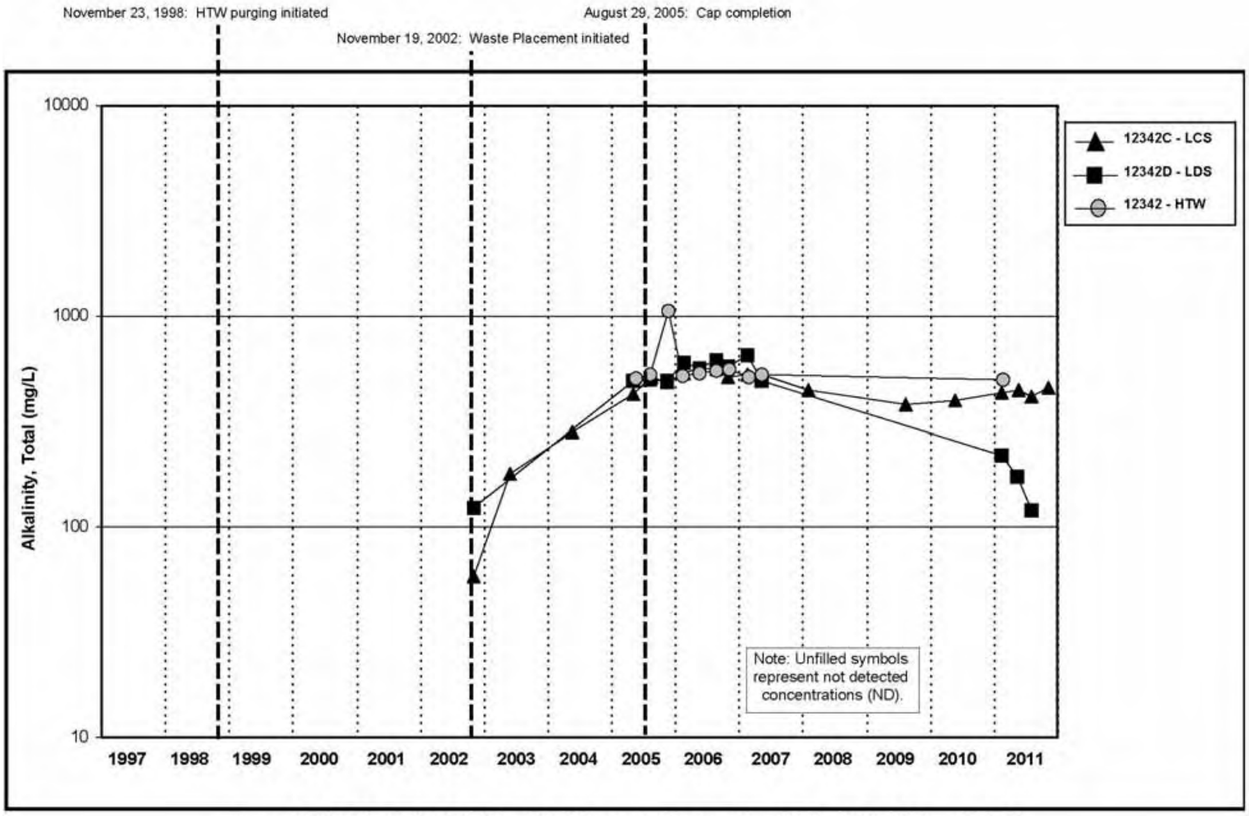


Figure A.5.5-11A. Cell 5 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

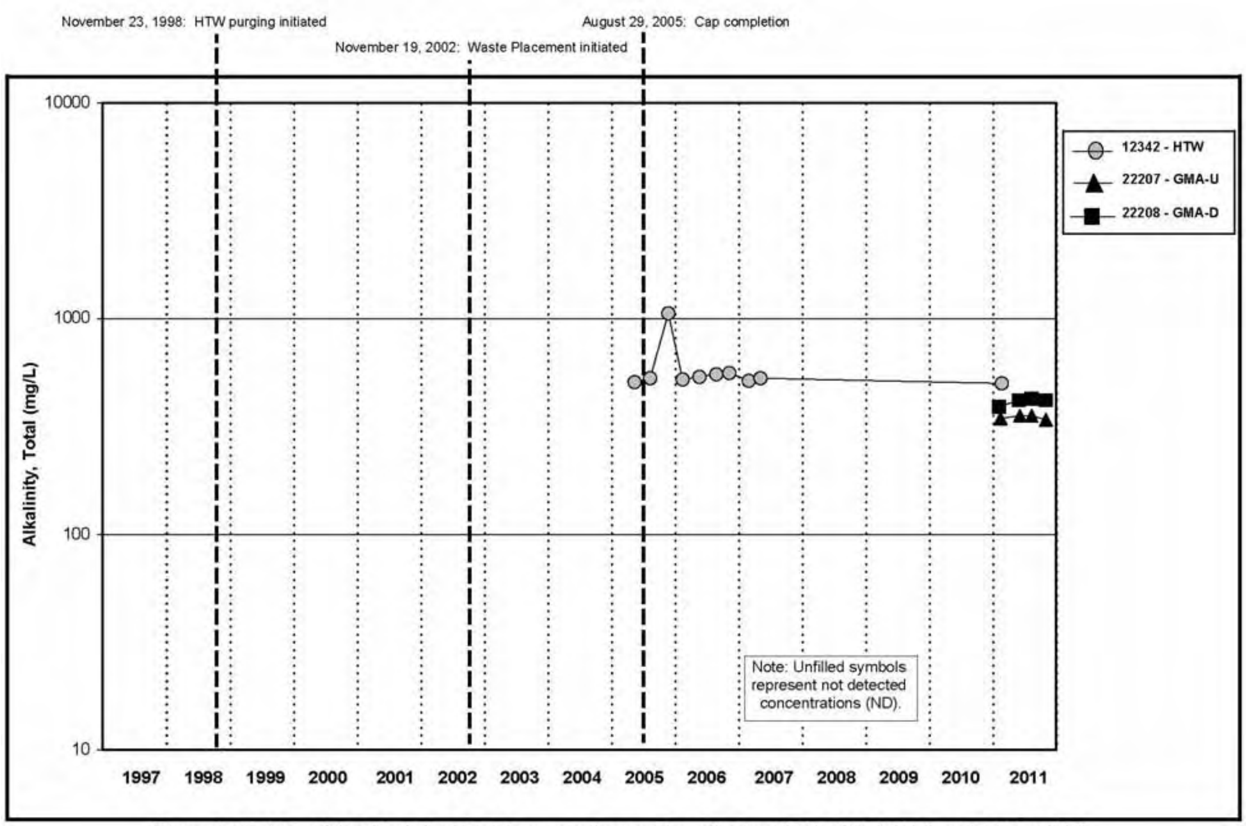


Figure A.5.5-11B. Cell 5 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

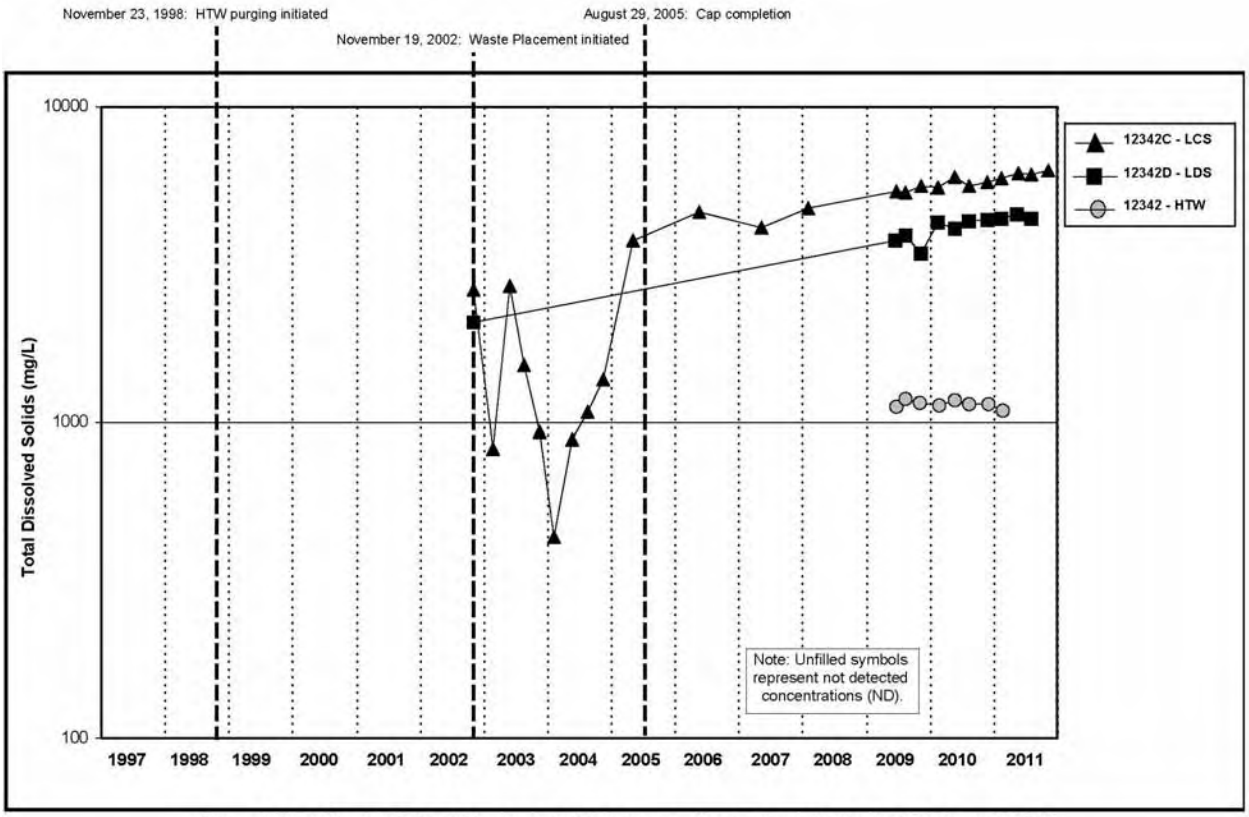


Figure A.5.5-12A. Cell 5 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

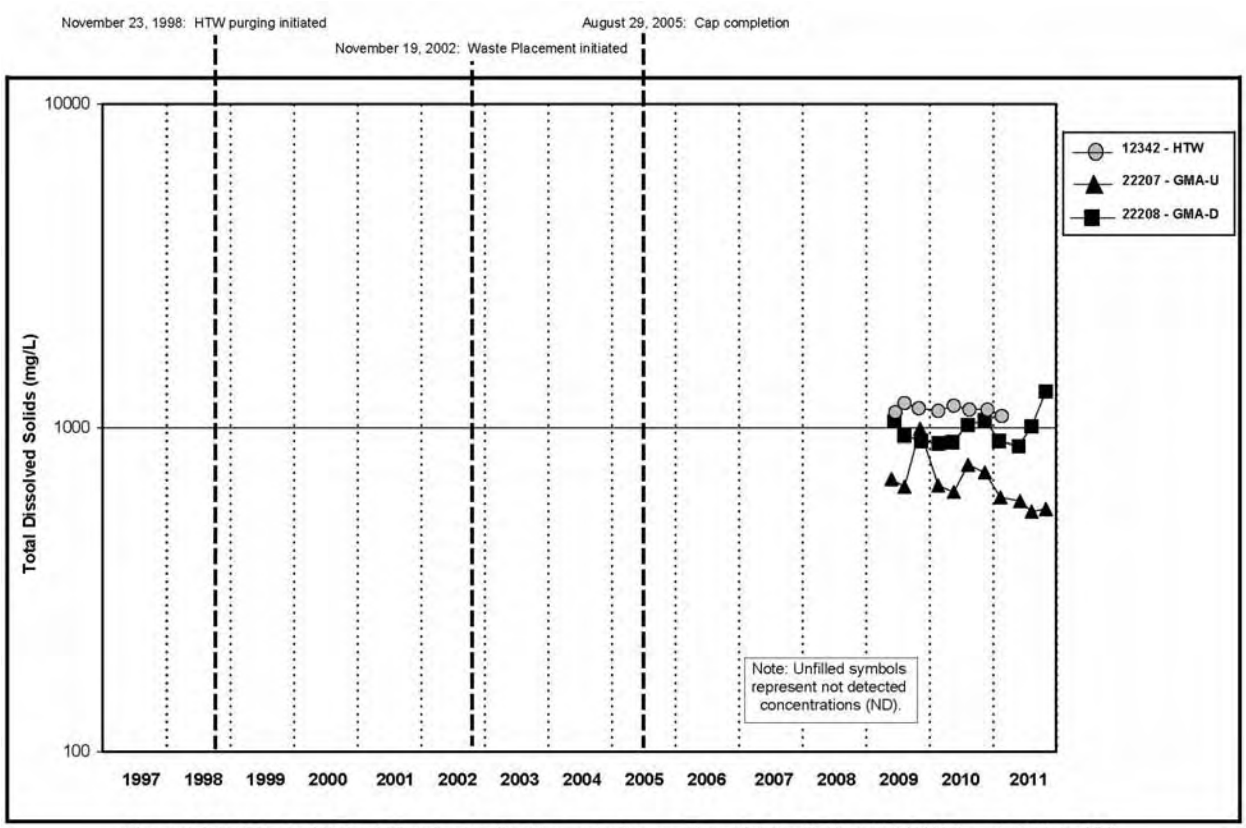


Figure A.5.5-12B. Cell 5 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

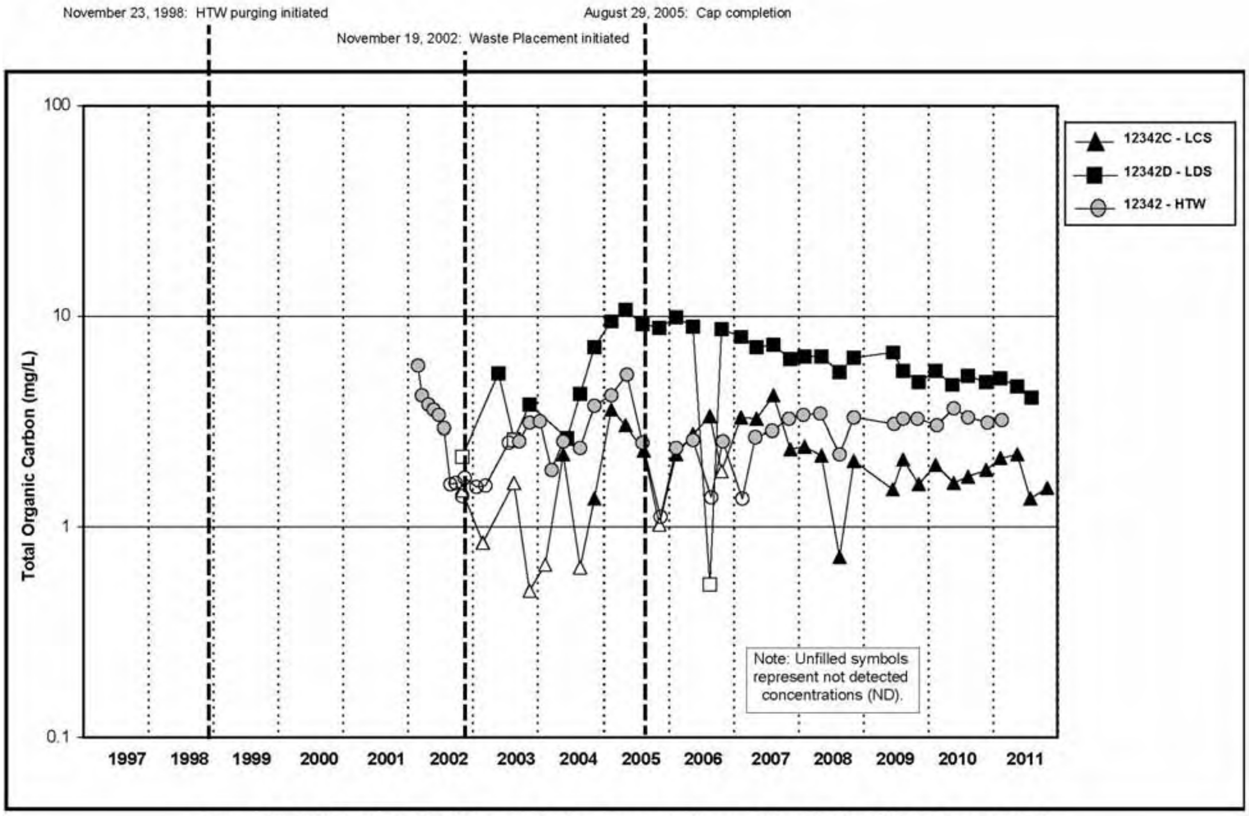


Figure A.5.5-13A. Cell 5 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

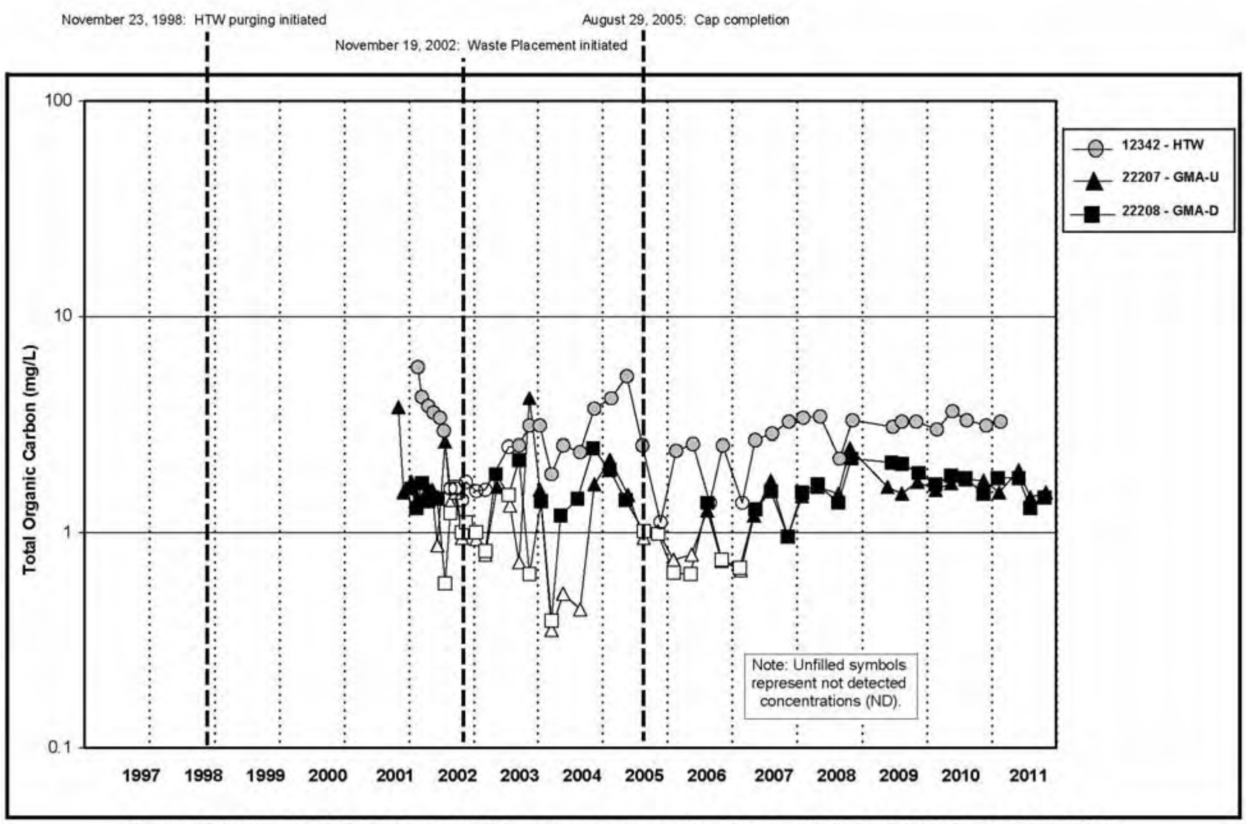


Figure A.5.5-13B. Cell 5 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

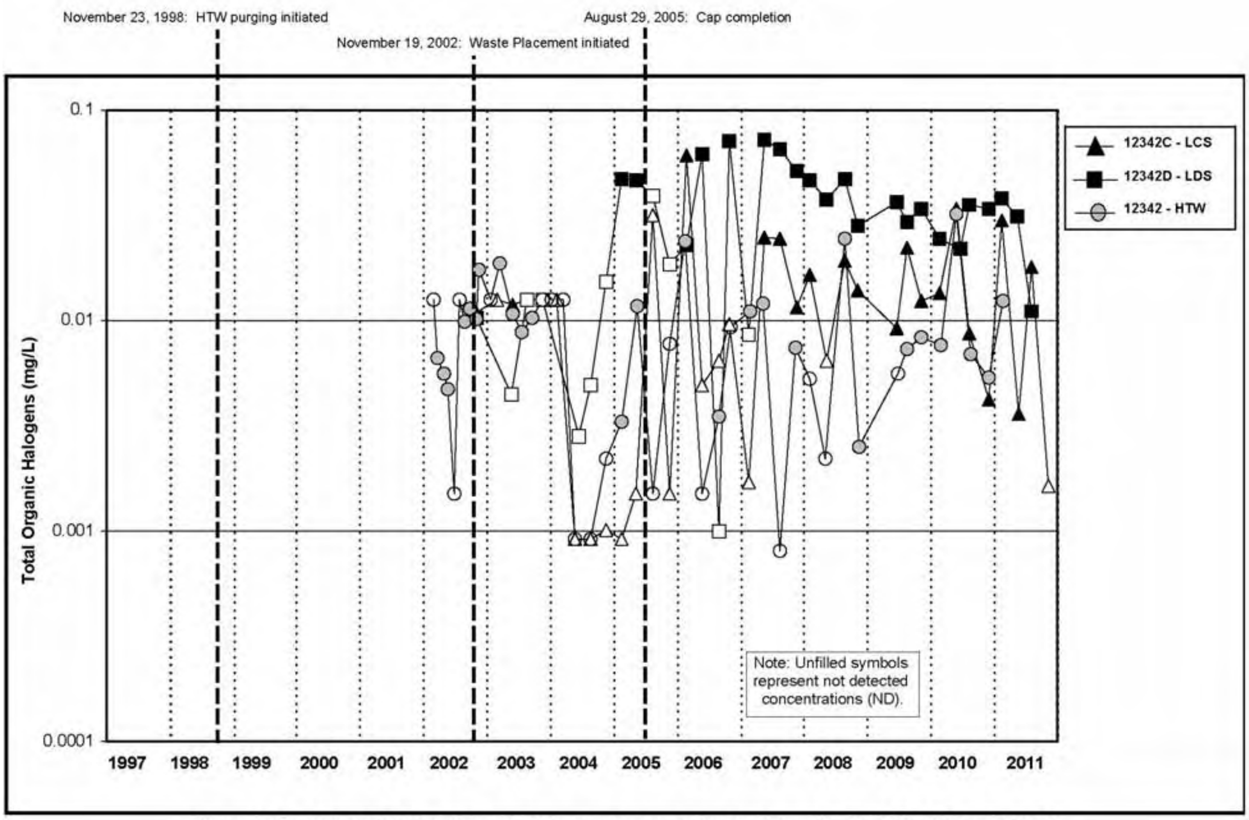


Figure A.5.5-14A. Cell 5 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

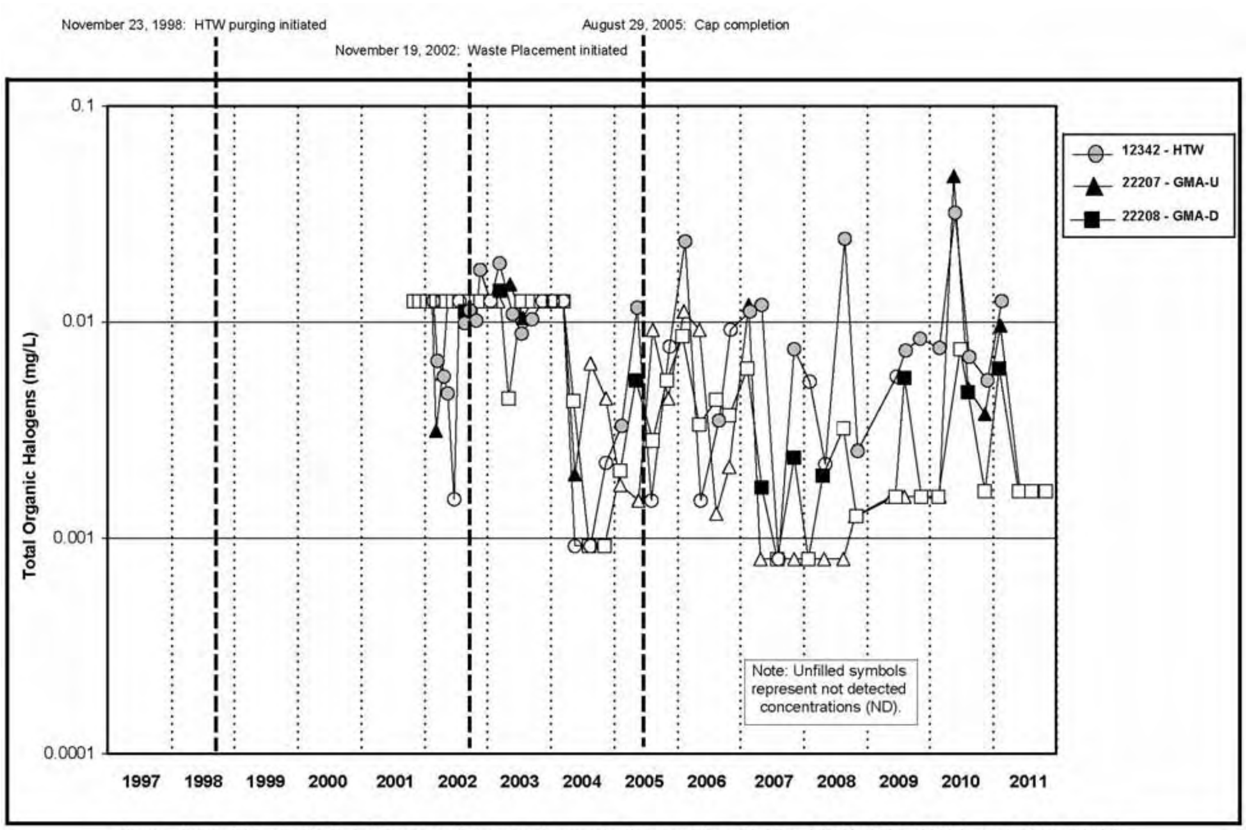


Figure A.5.5-14B. Cell 5 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

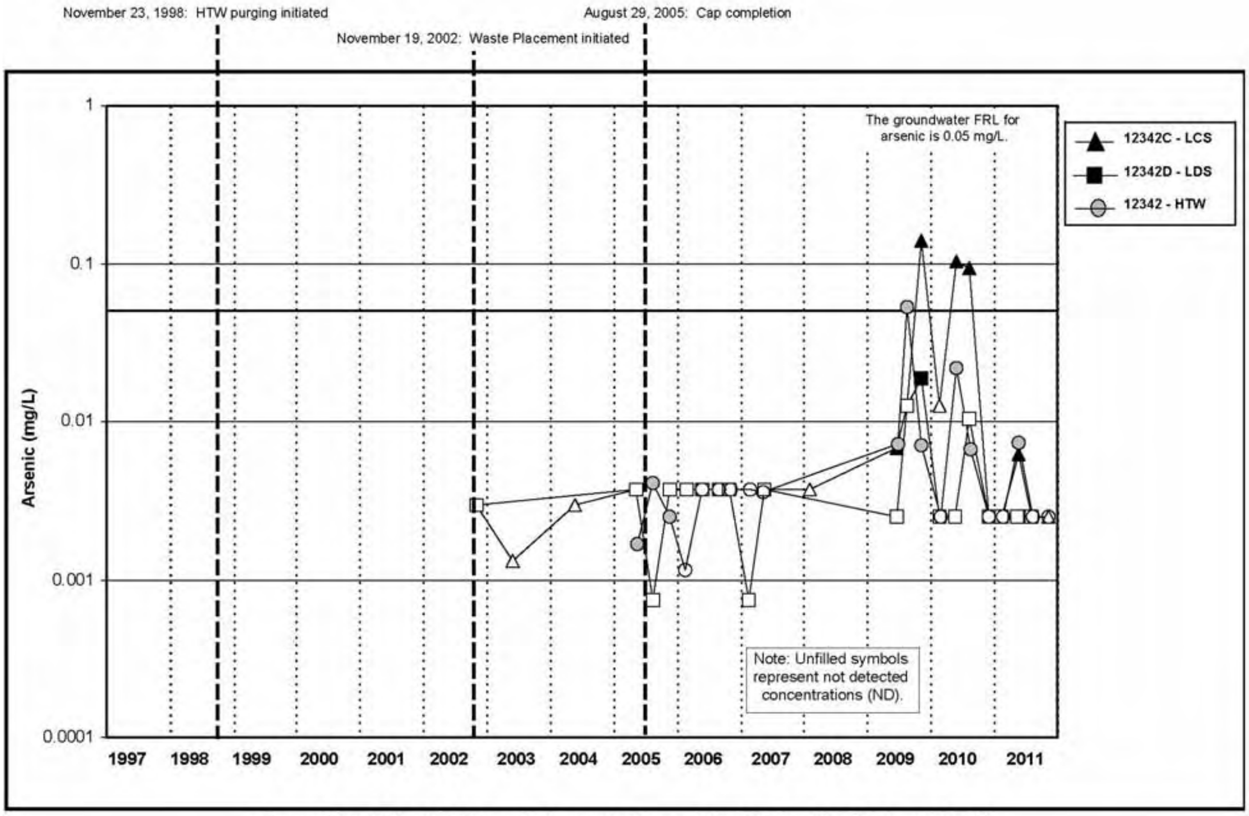


Figure A.5.5-15A. Cell 5 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

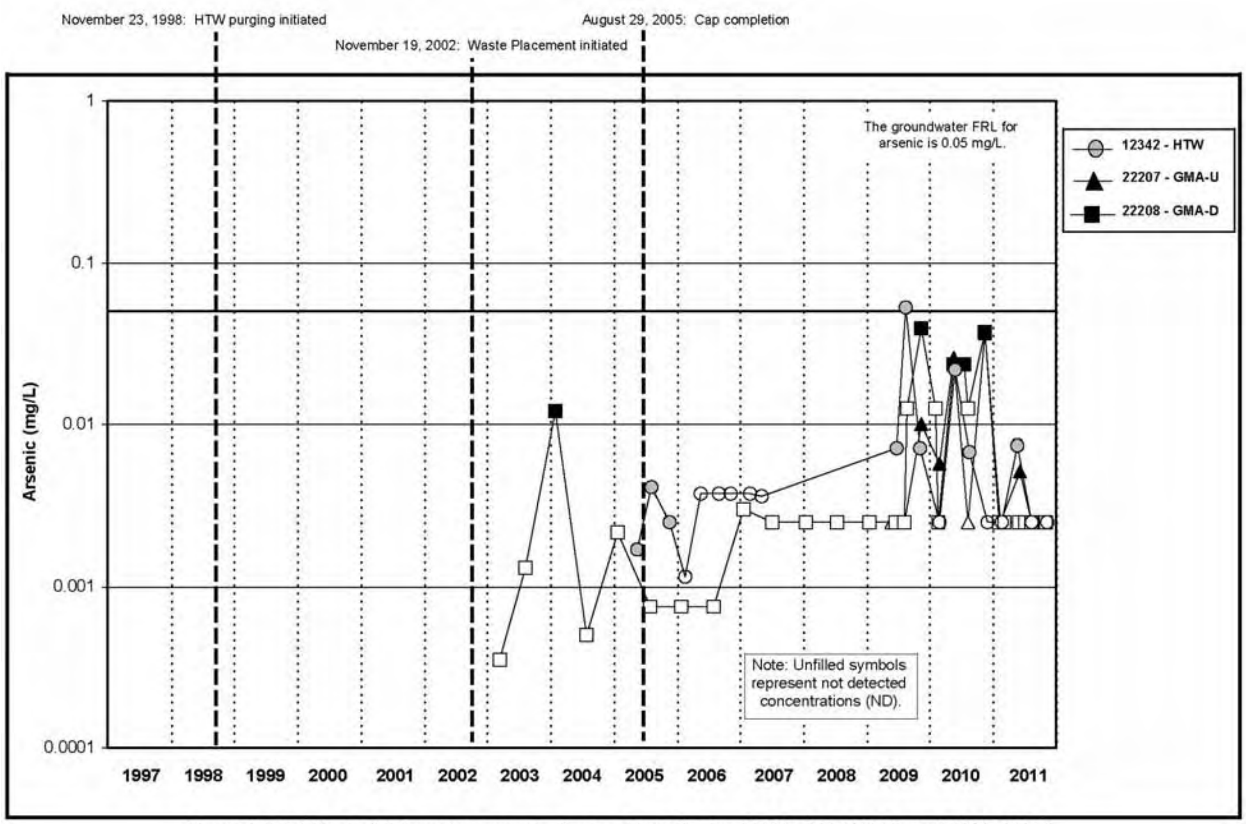


Figure A.5.5-15B. Cell 5 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

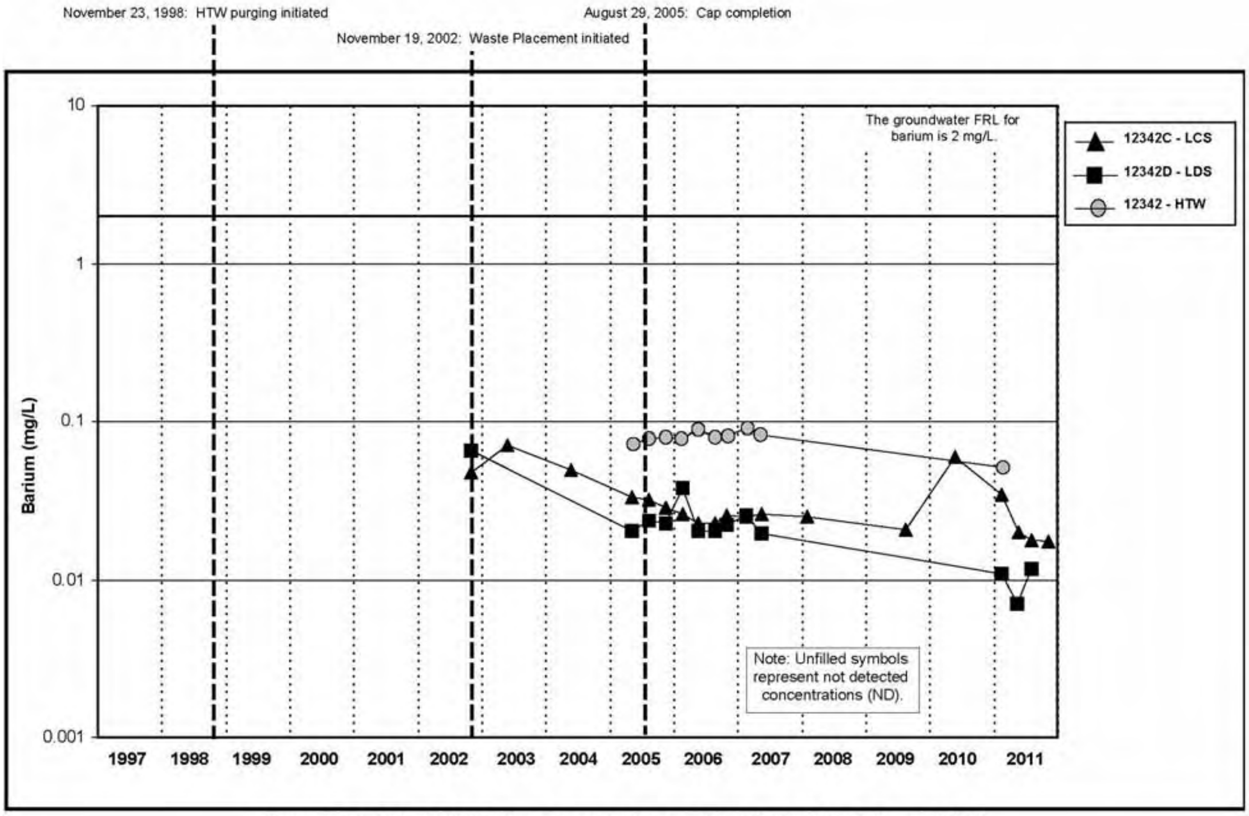


Figure A.5.5-16A. Cell 5 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

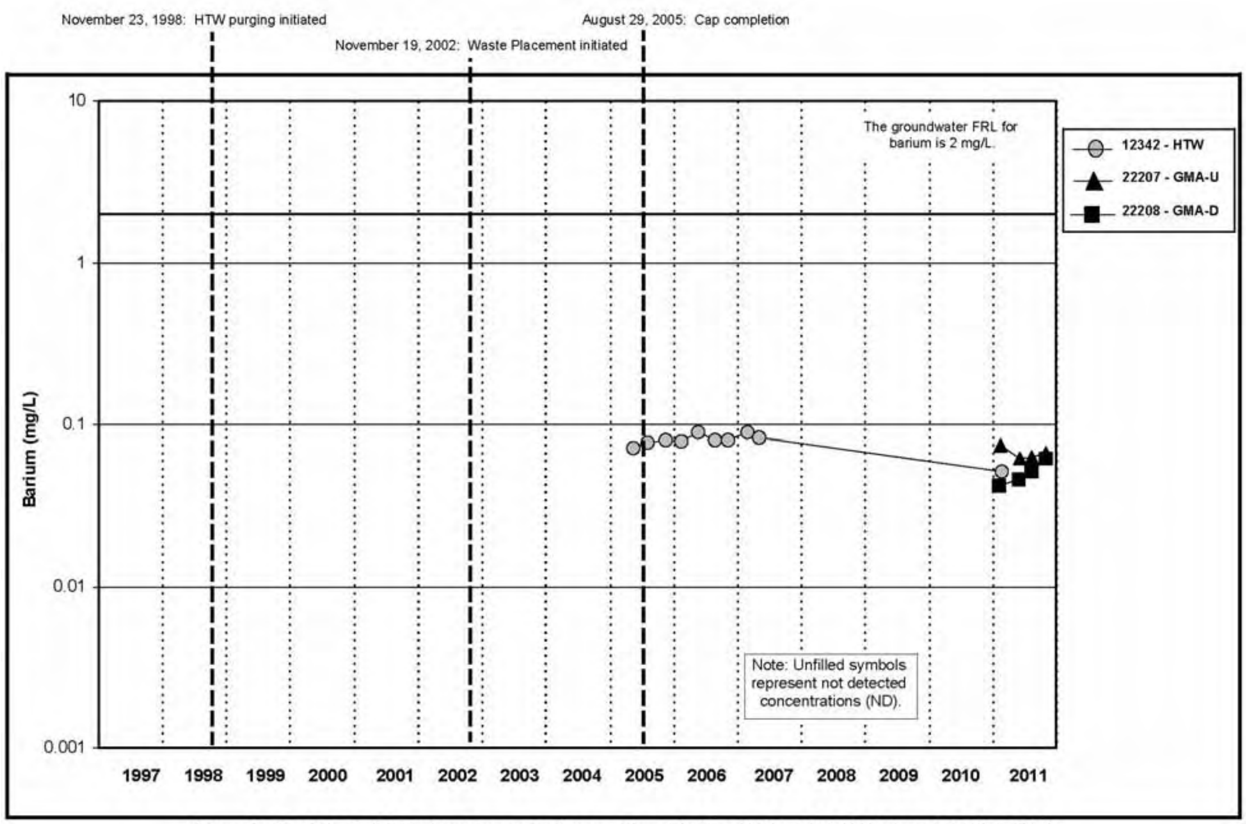


Figure A.5.5-16B. Cell 5 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

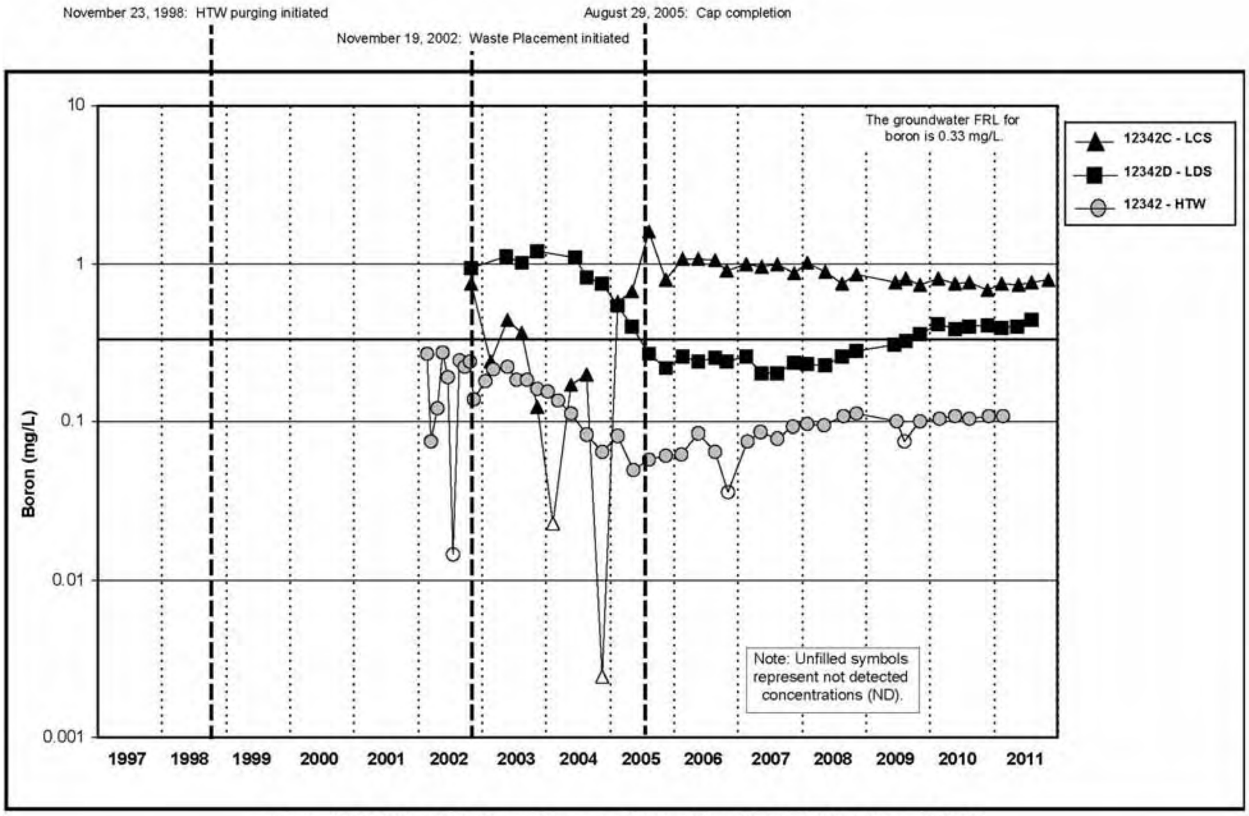


Figure A.5.5-17A. Cell 5 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

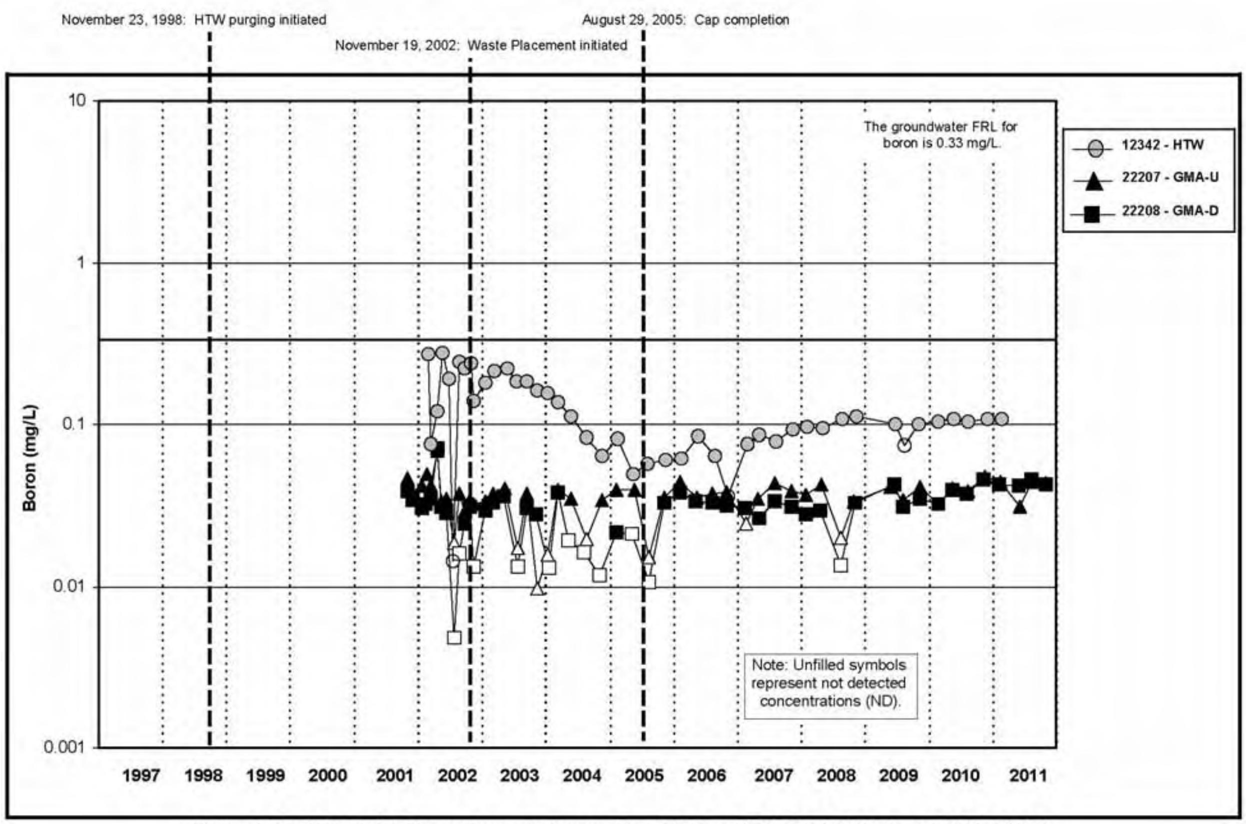


Figure A.5.5-17B. Cell 5 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

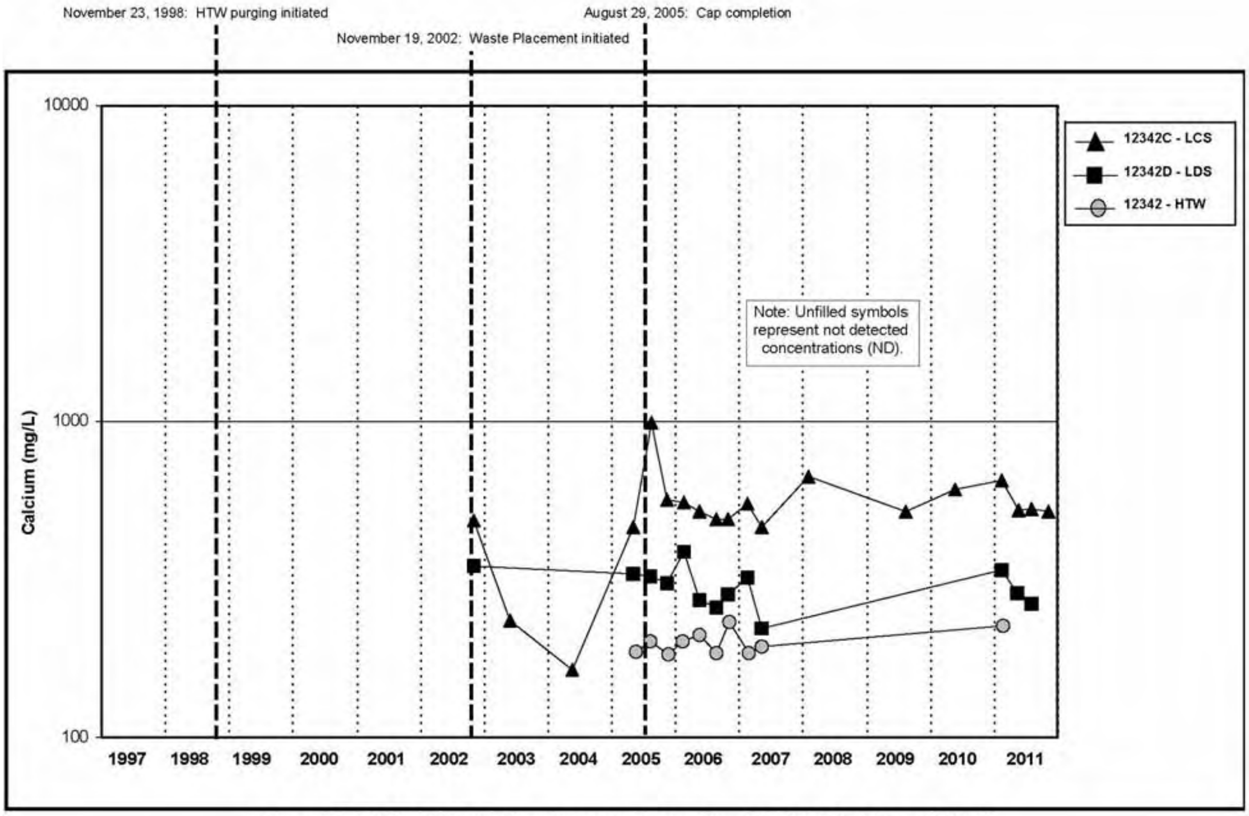


Figure A.5.5-18A. Cell 5 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

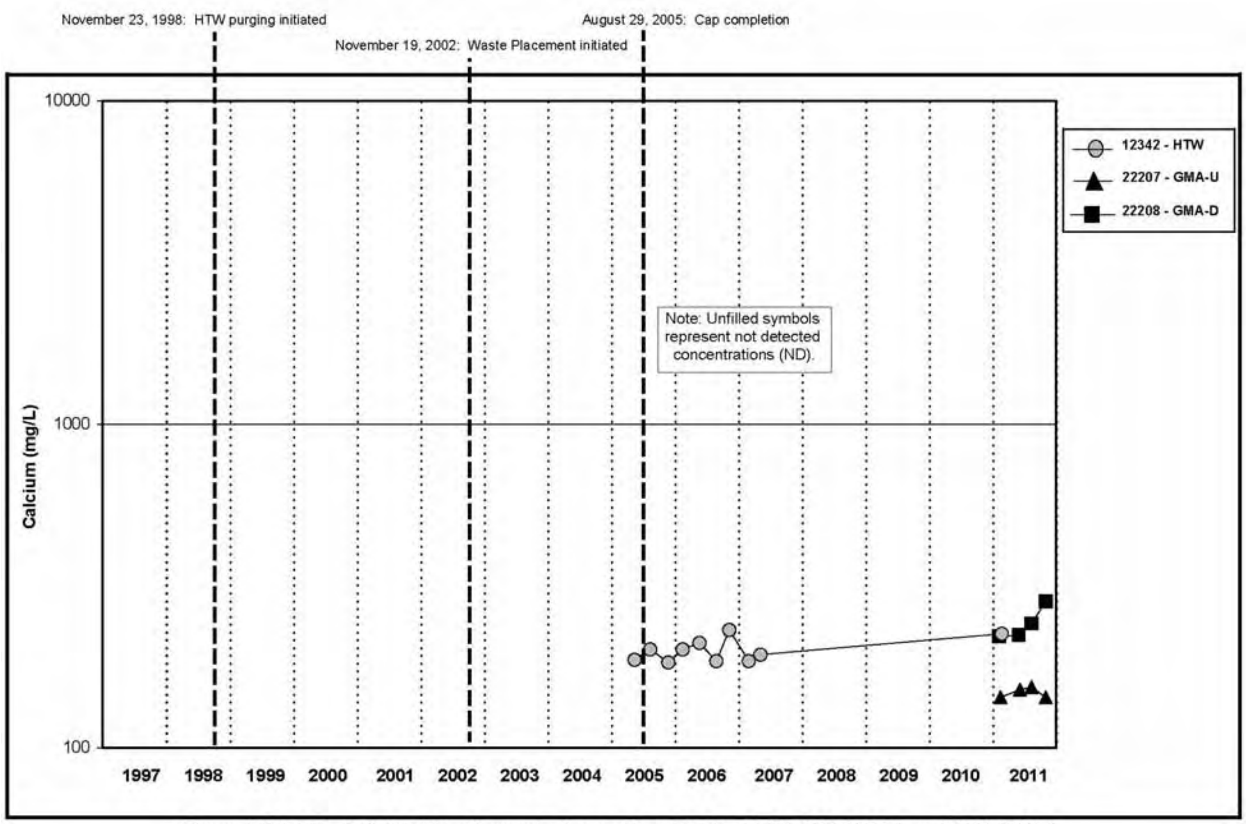


Figure A.5.5-18B. Cell 5 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

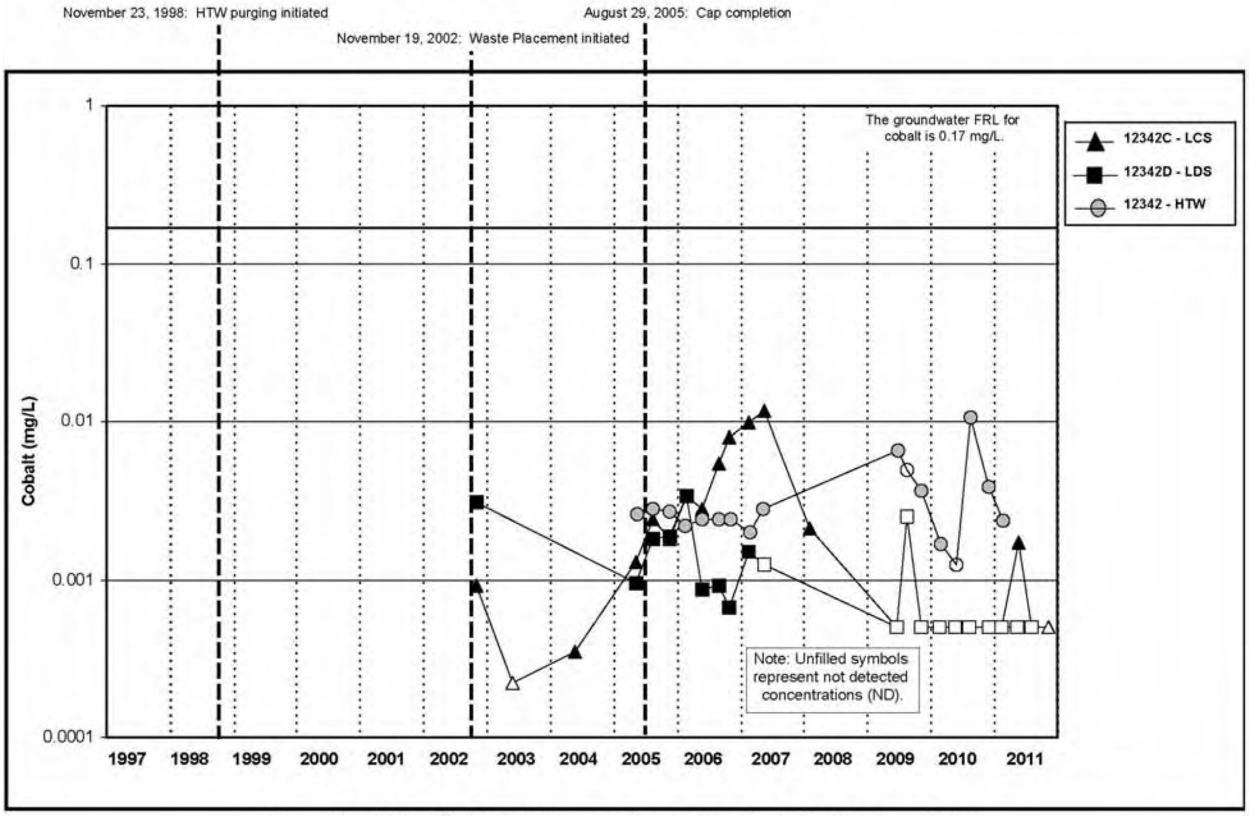


Figure A.5.5-19A. Cell 5 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

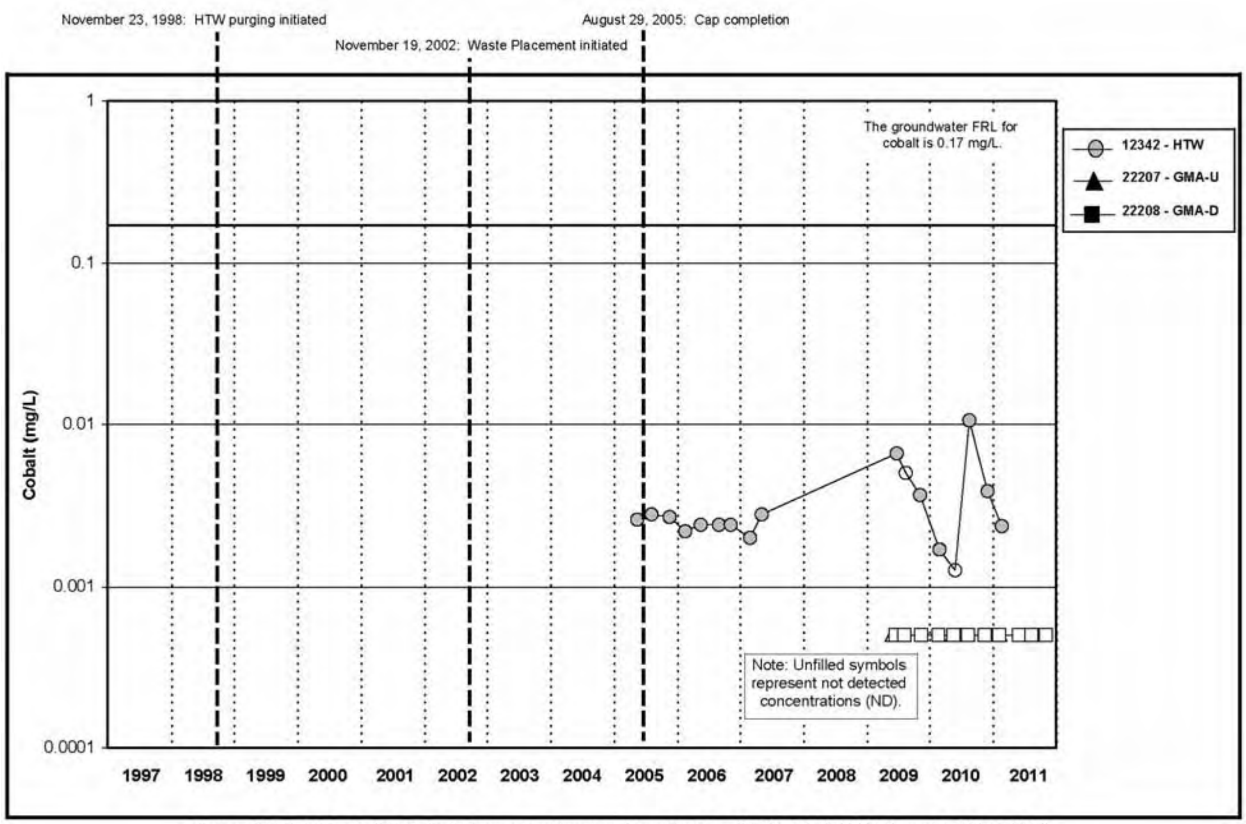


Figure A.5.5-19B. Cell 5 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

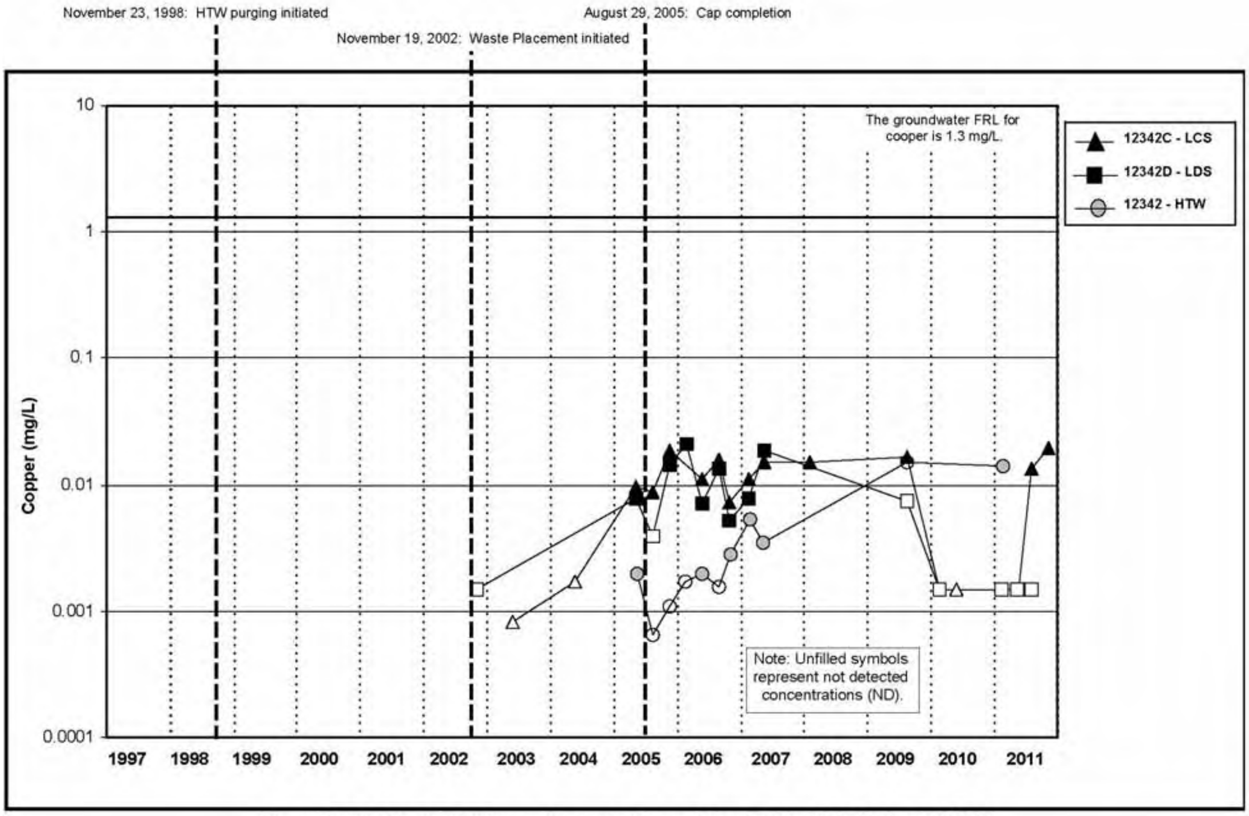


Figure A.5.5-20A. Cell 5 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

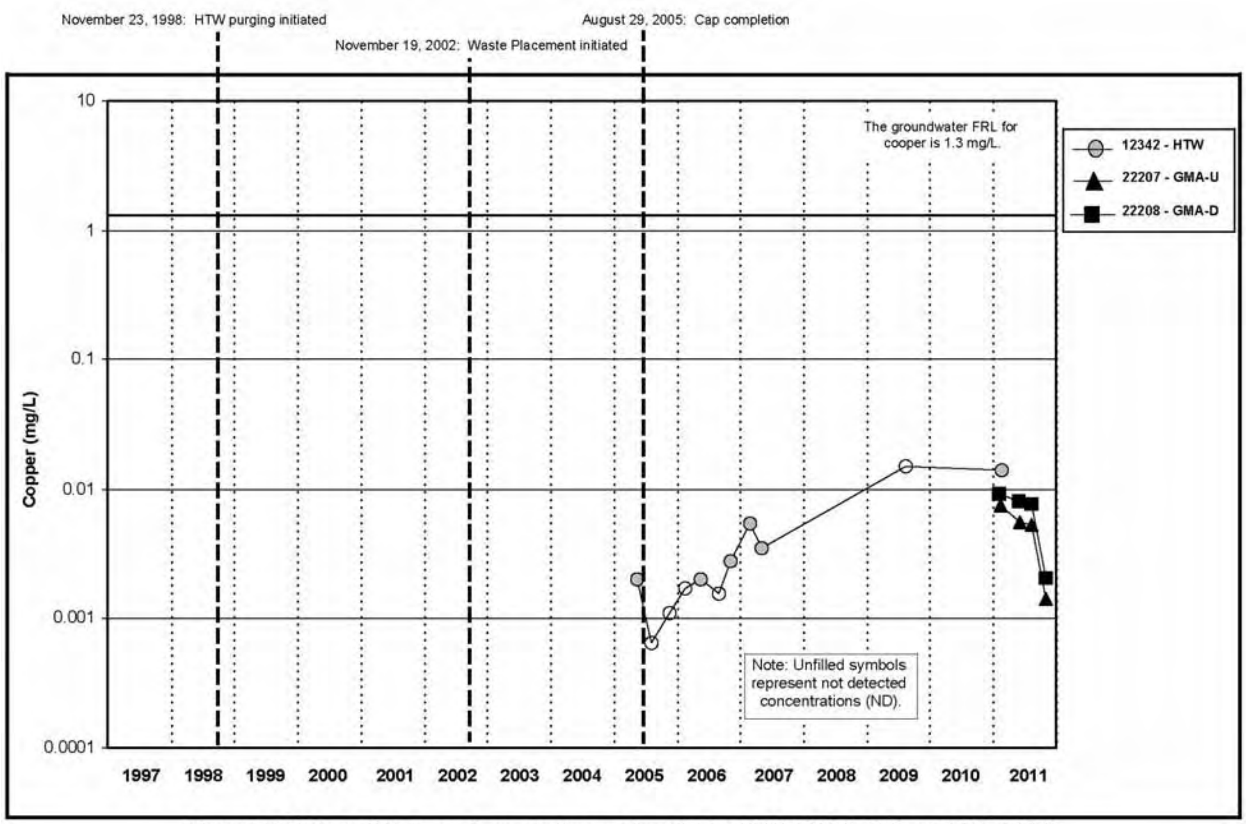


Figure A.5.5-20B. Cell 5 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

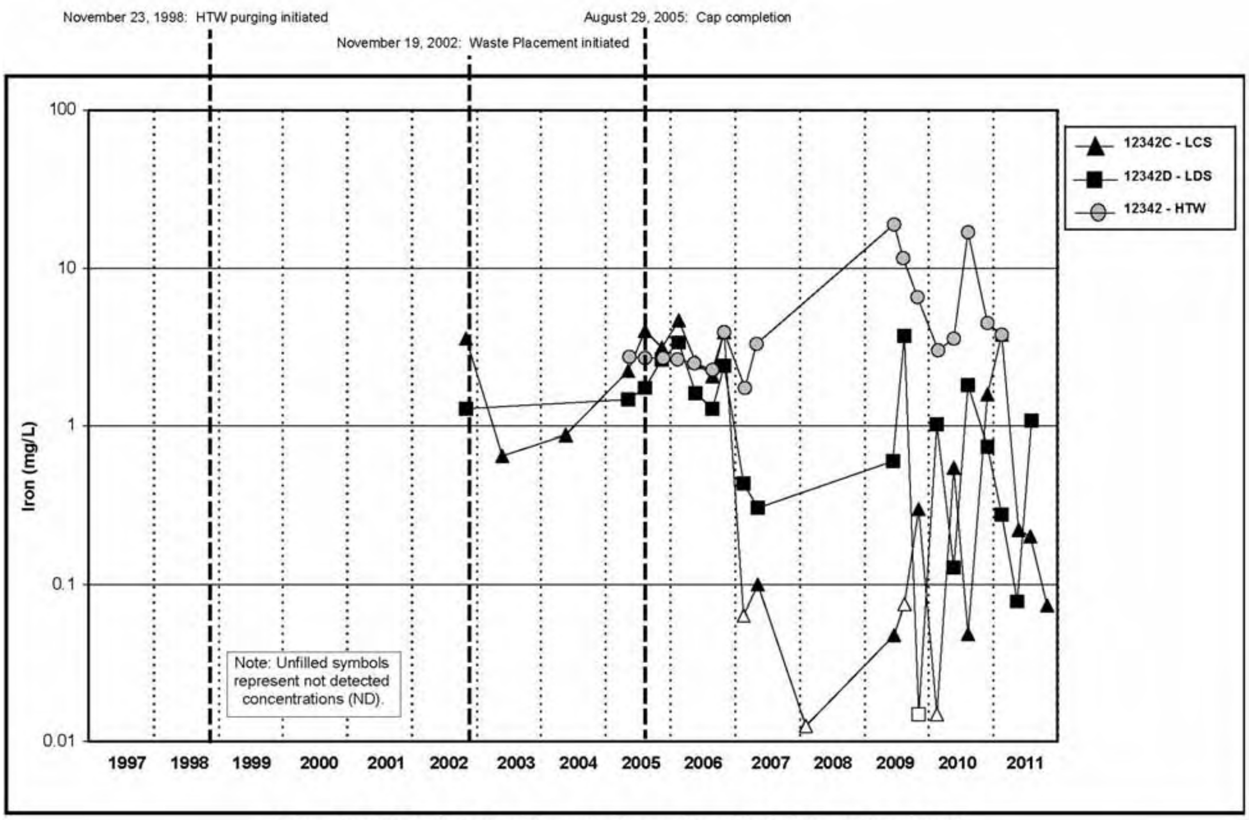


Figure A.5.5-21A. Cell 5 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

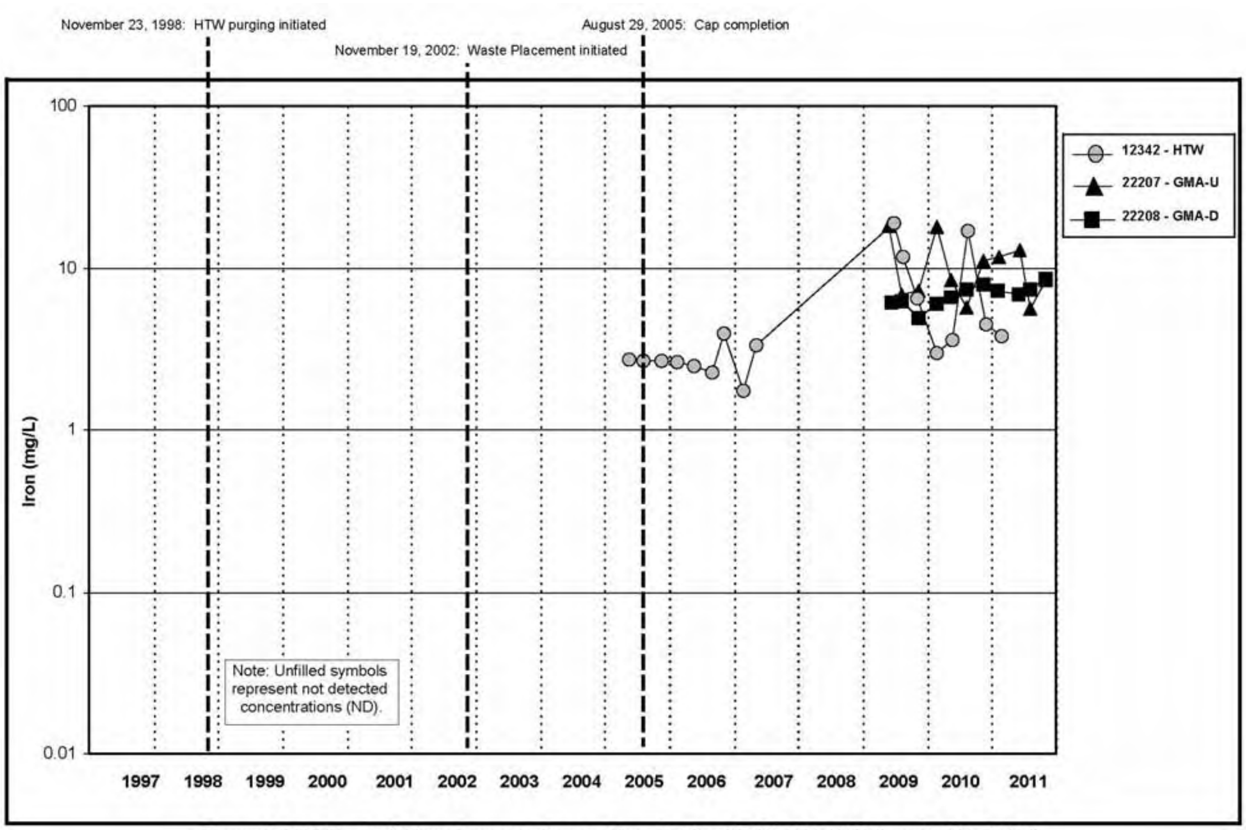


Figure A.5.5-21B. Cell 5 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

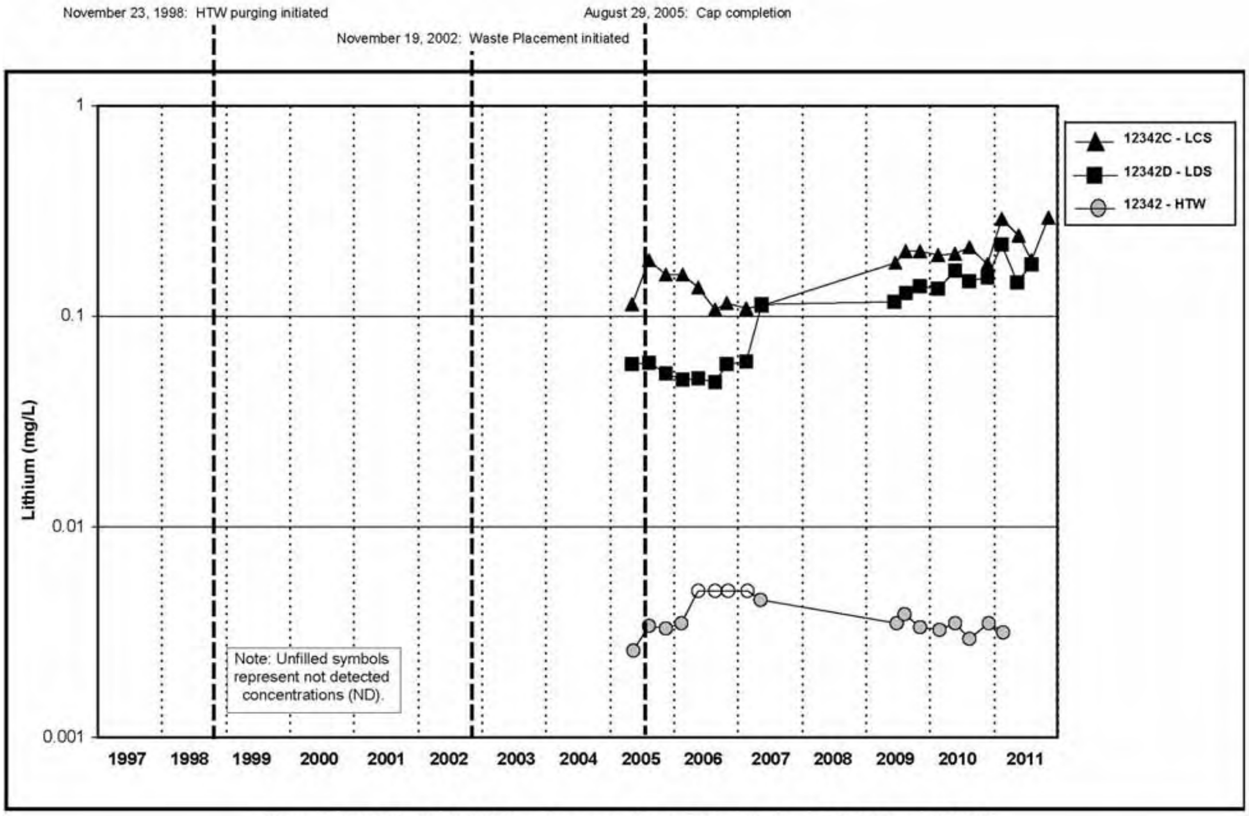


Figure A.5.5-22A. Cell 5 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

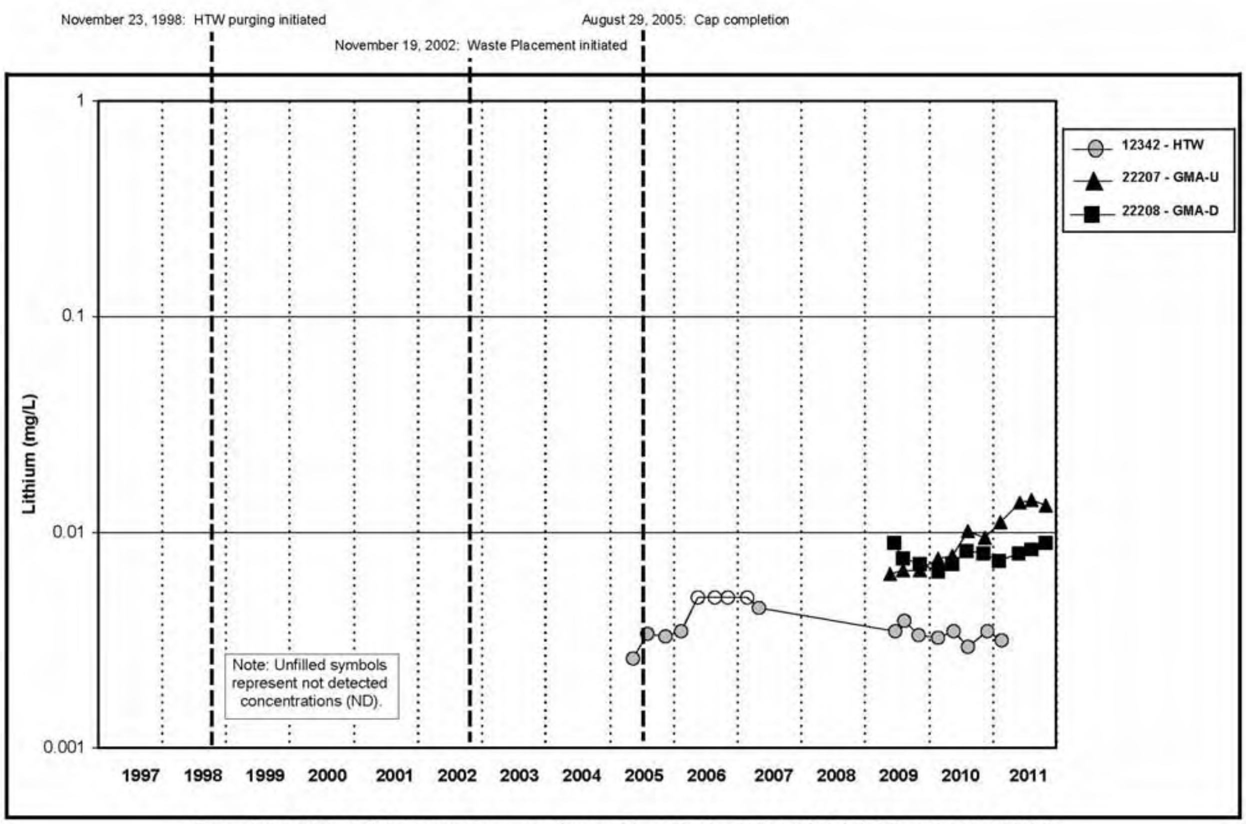


Figure A.5.5-22B. Cell 5 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

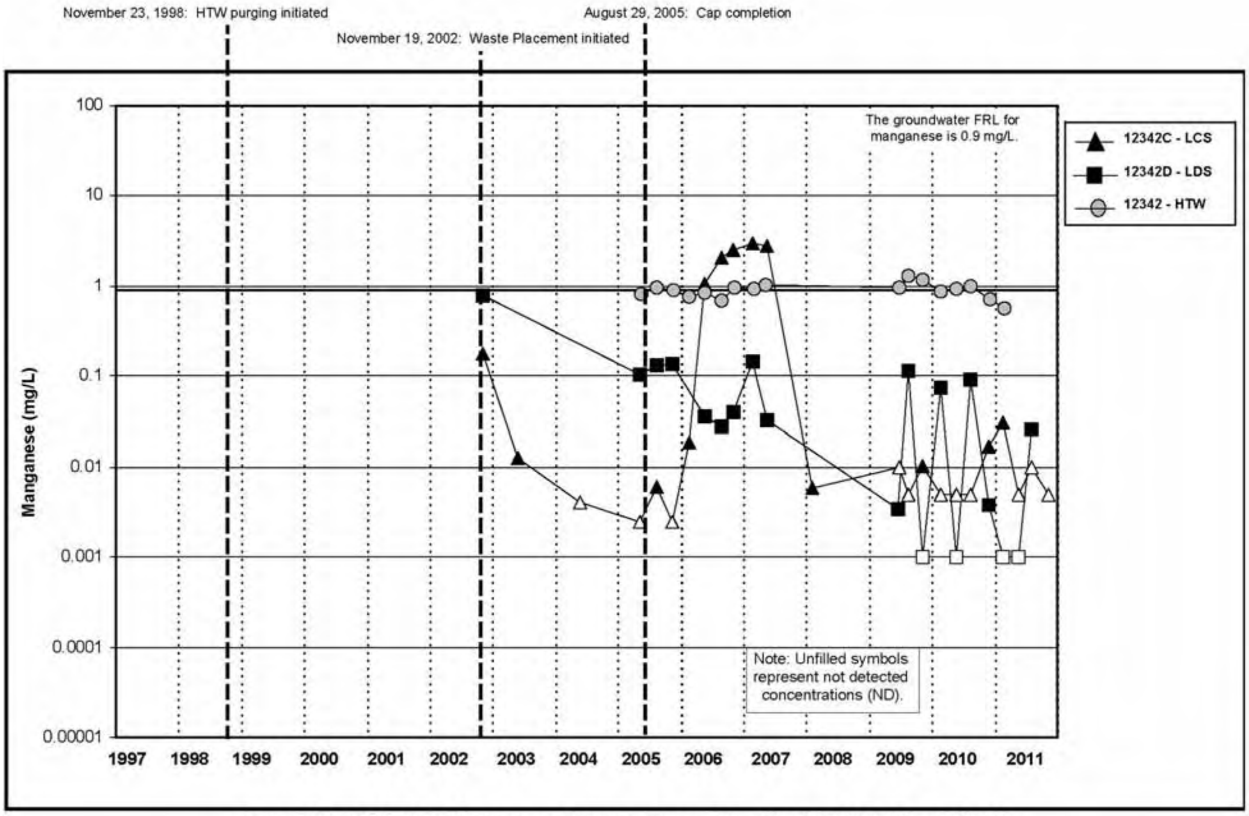


Figure A.5.5-23A. Cell 5 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

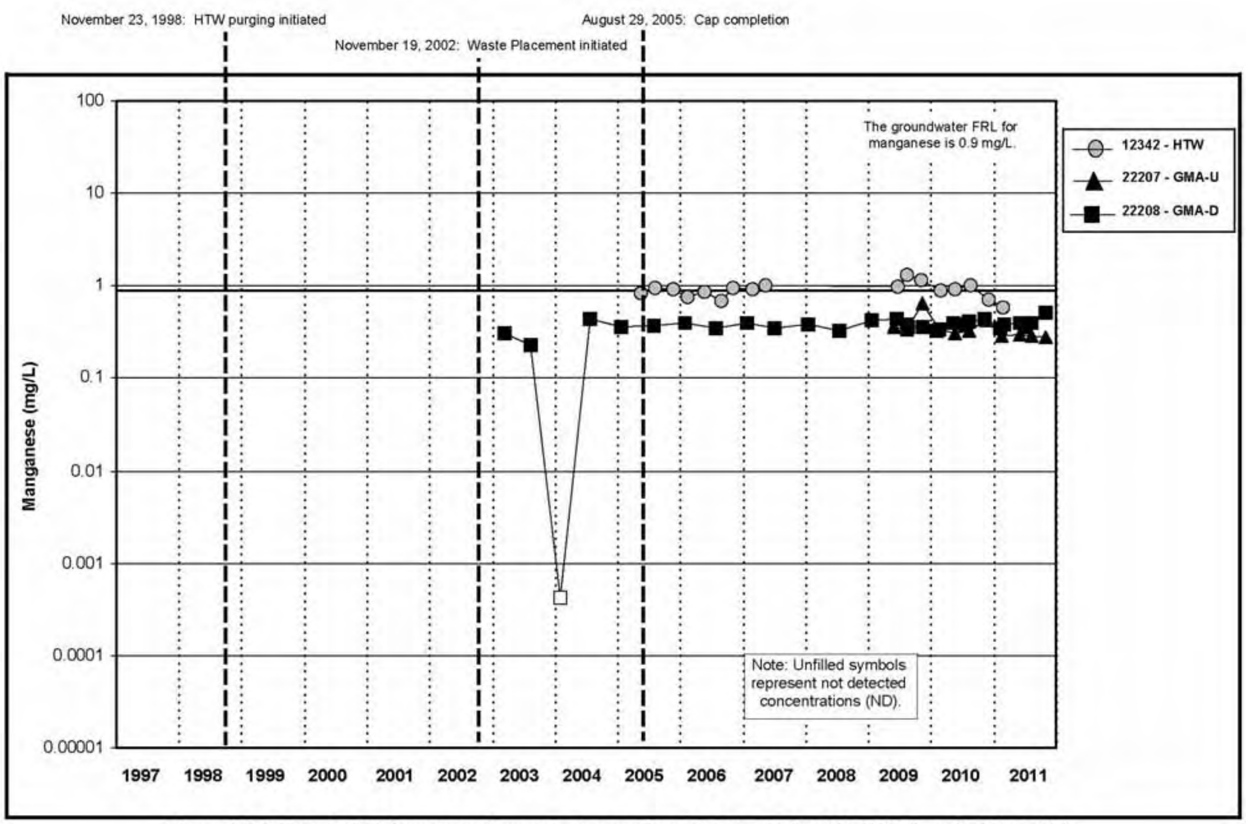


Figure A.5.5-23B. Cell 5 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

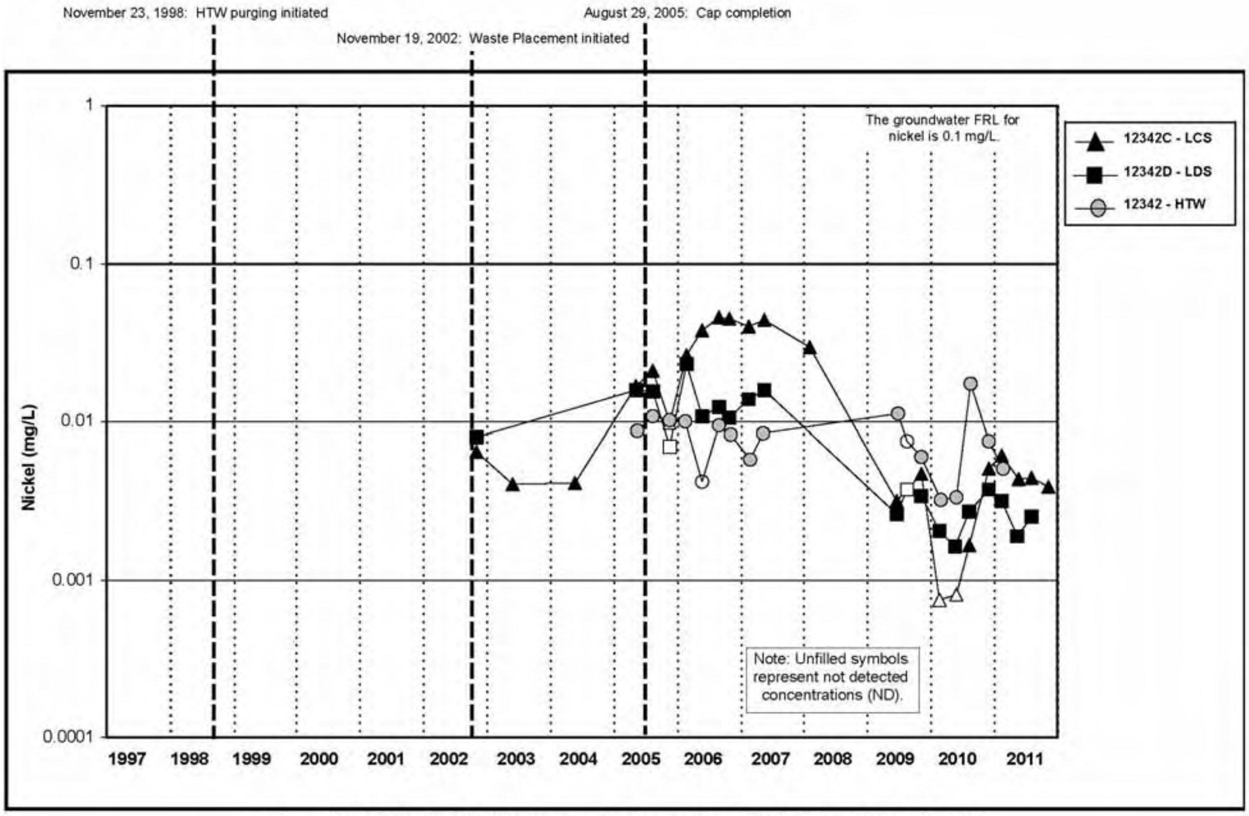


Figure A.5.5-24A. Cell 5 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

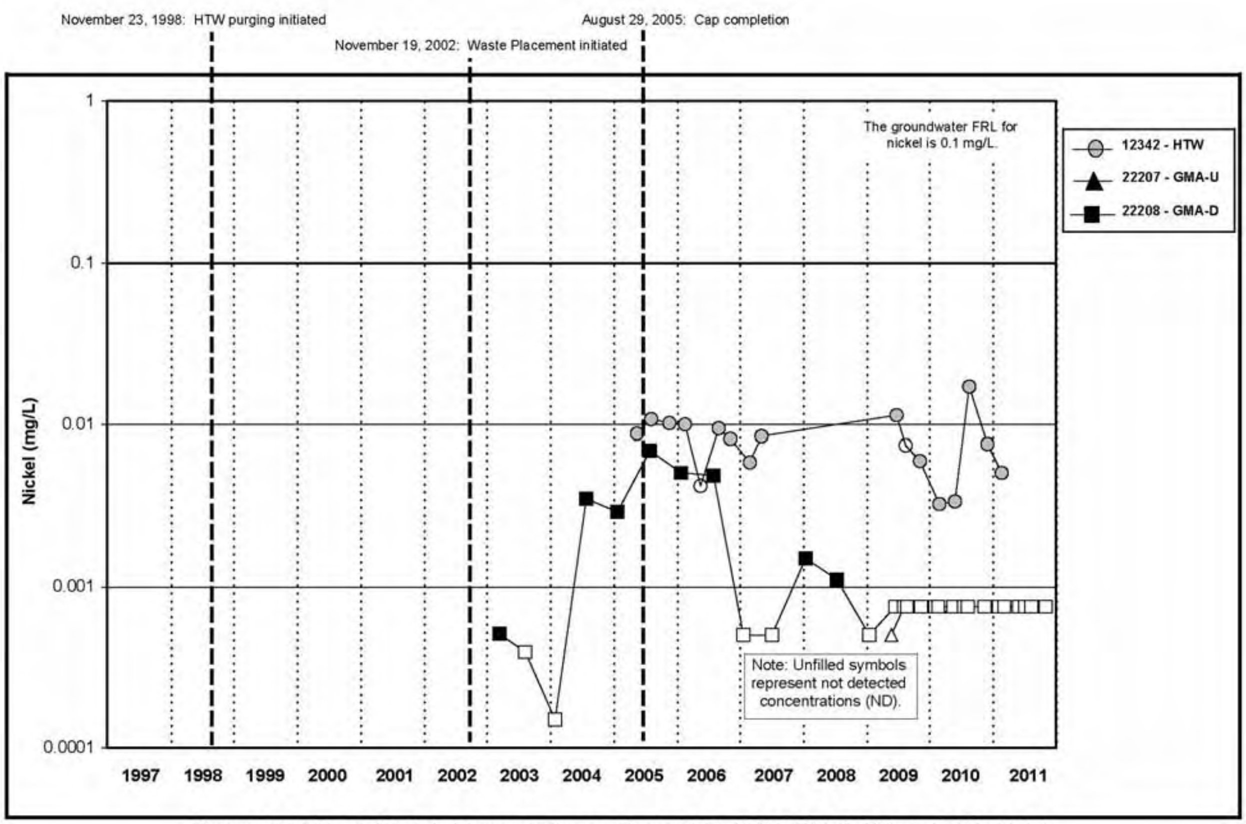


Figure A.5.5-24B. Cell 5 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

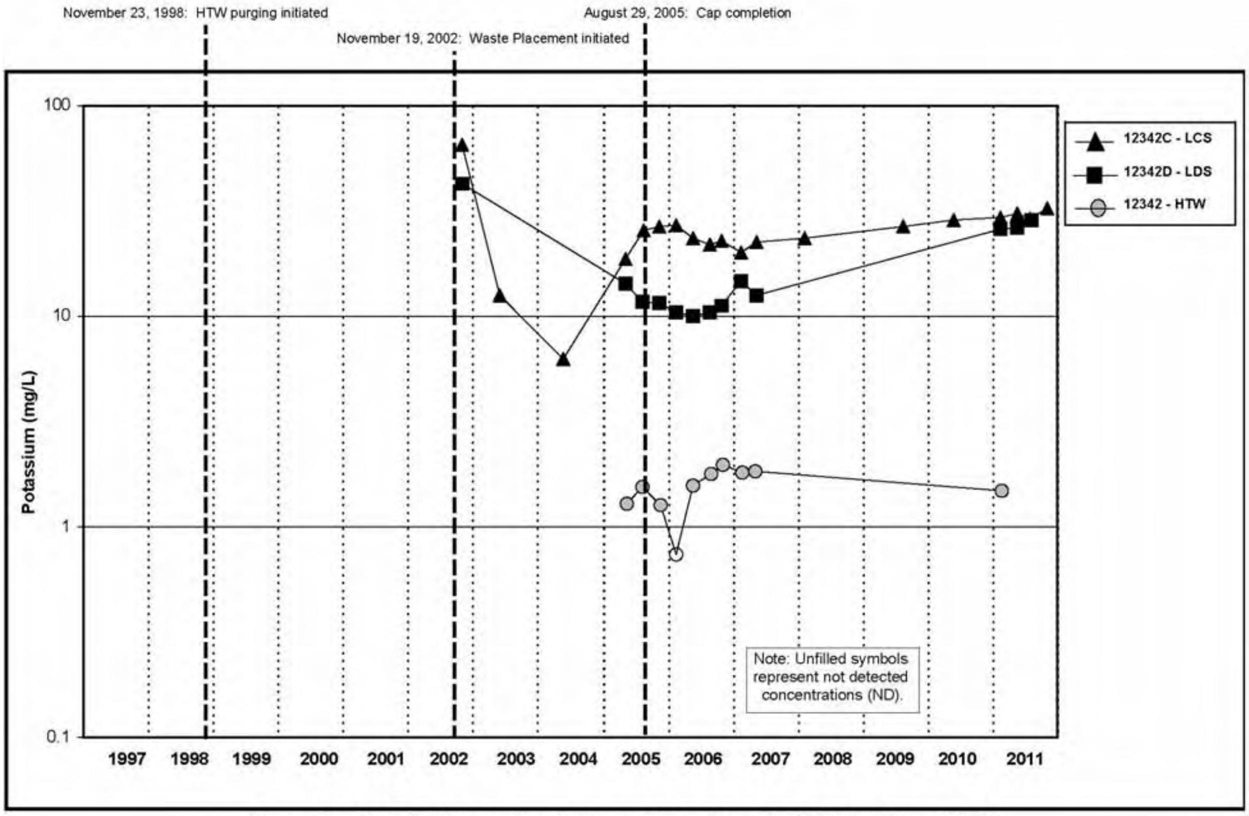


Figure A.5.5-25A. Cell 5 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

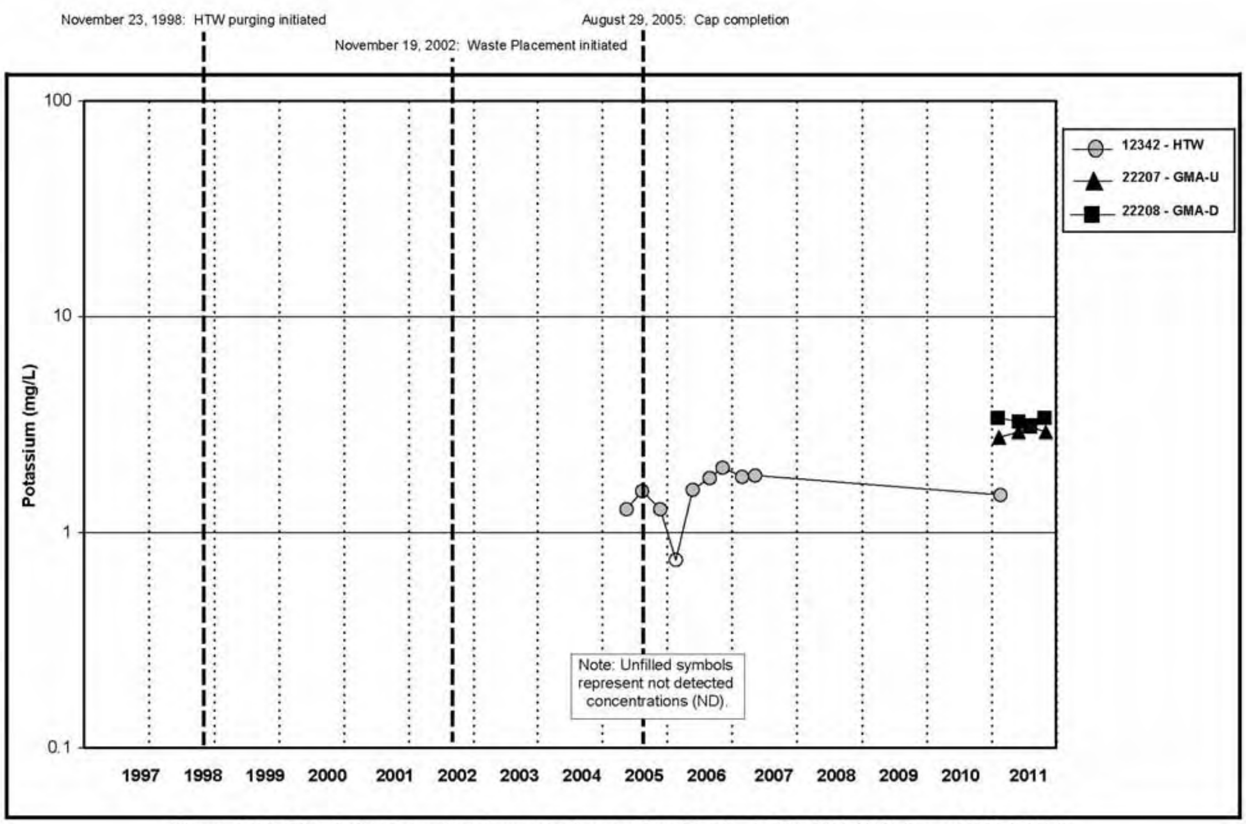


Figure A.5.5-25B. Cell 5 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

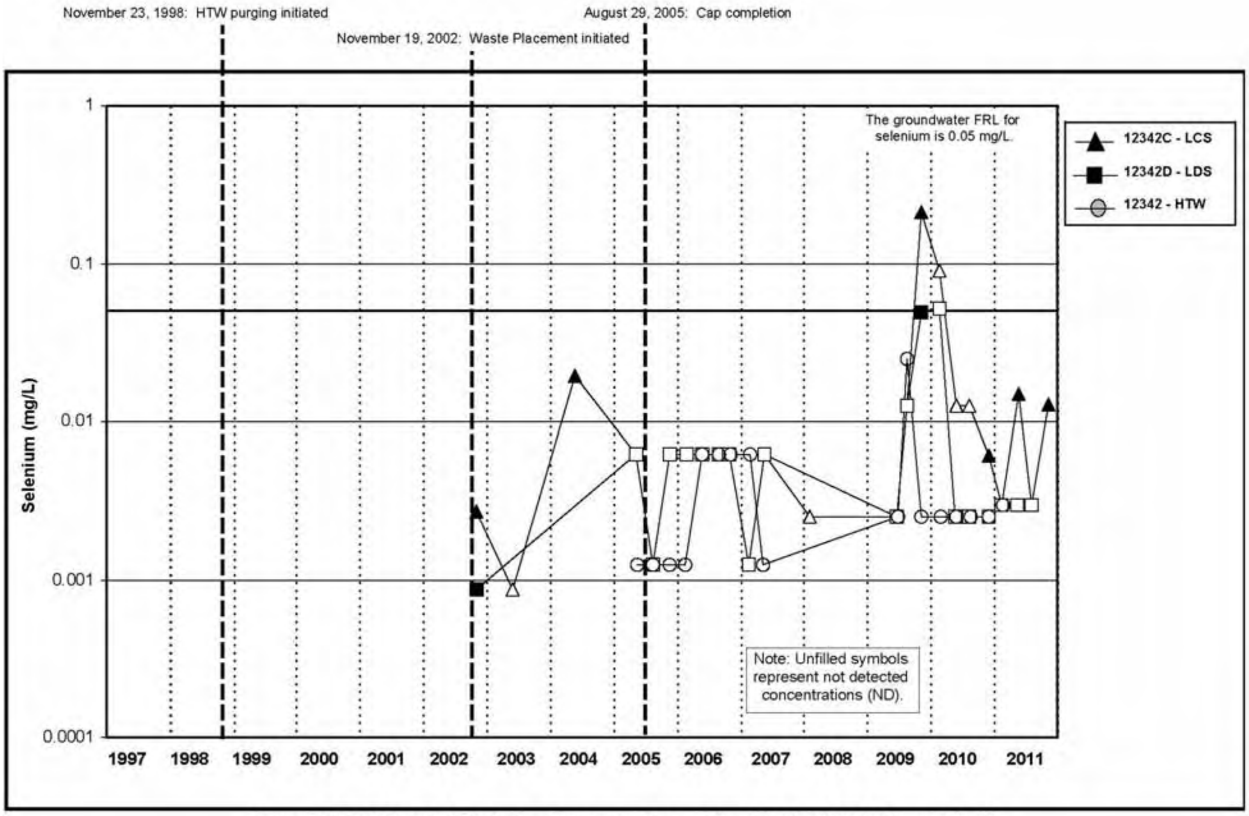


Figure A.5.5-26A. Cell 5 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

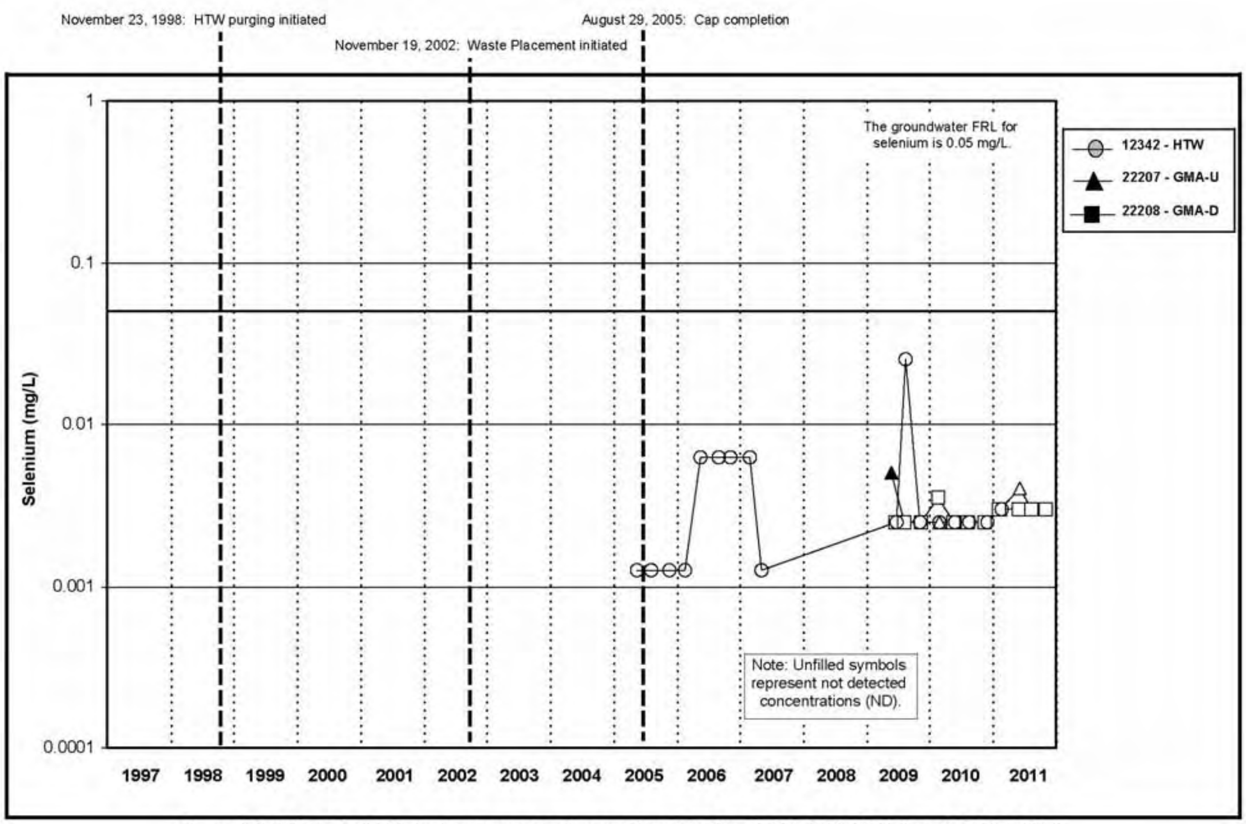


Figure A.5.5-26B. Cell 5 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

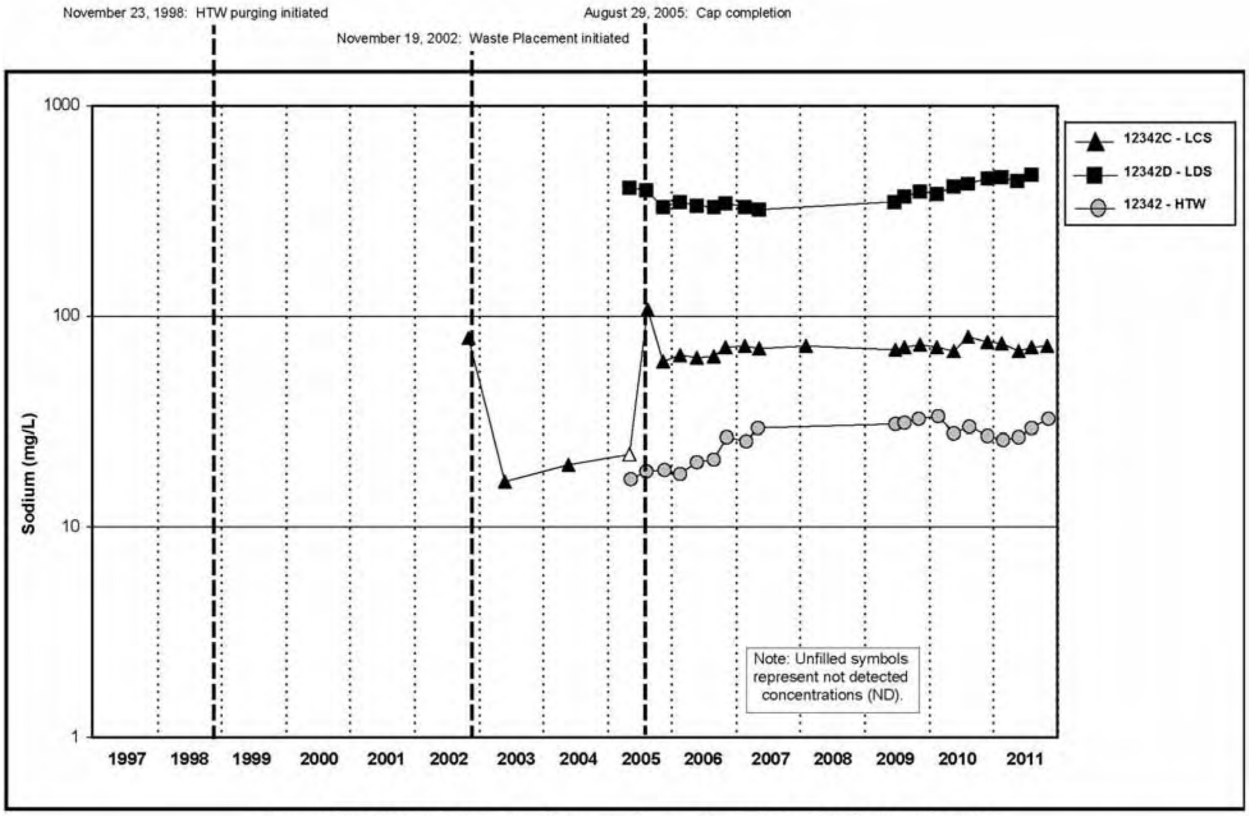


Figure A.5.5-27A. Cell 5 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

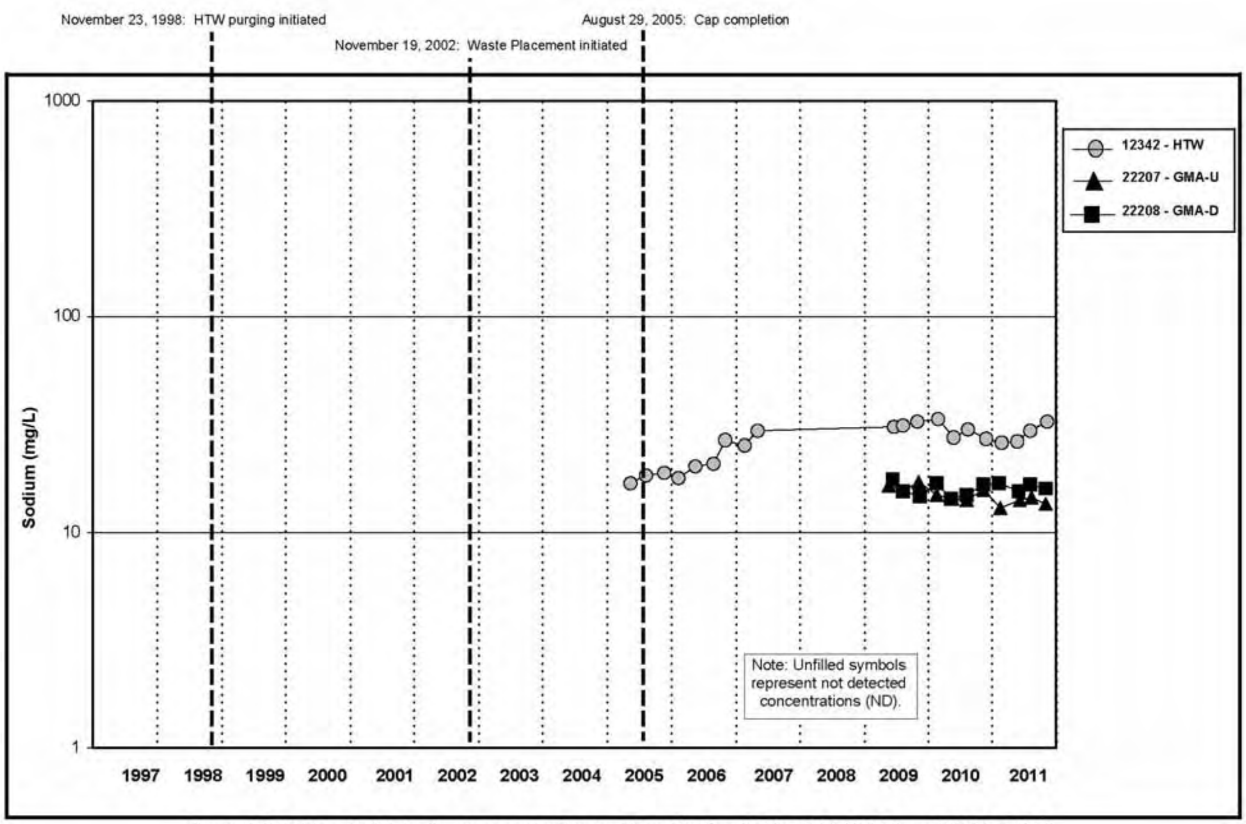


Figure A.5.5-27B. Cell 5 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

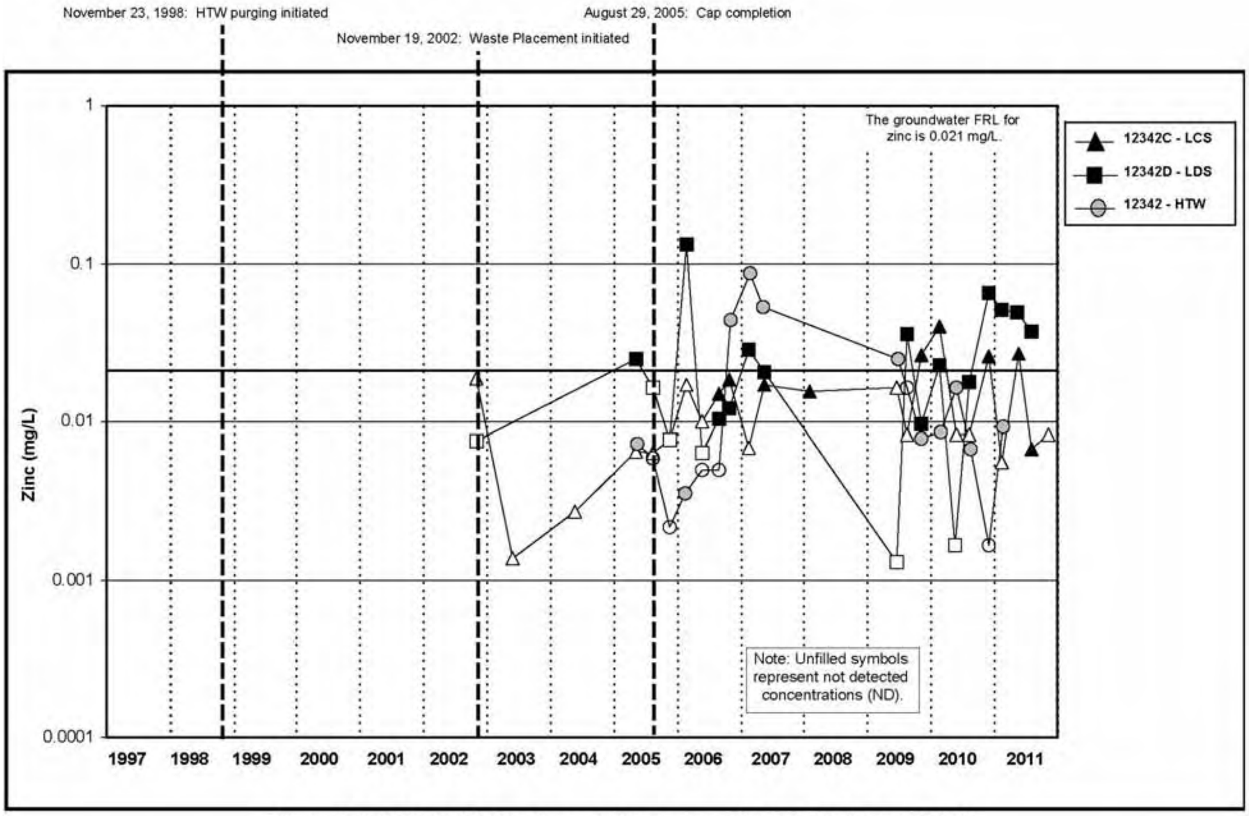


Figure A.5.5-28A. Cell 5 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

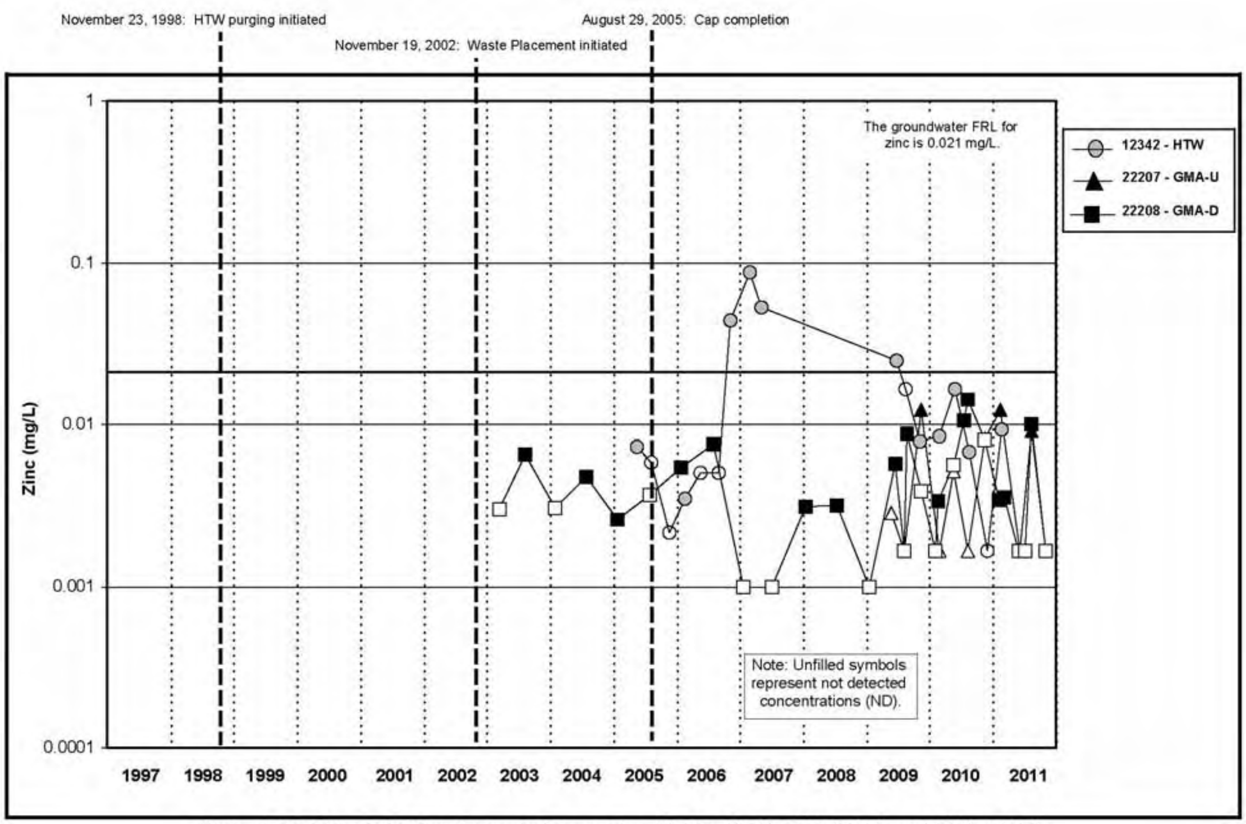


Figure A.5.5-28B. Cell 5 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

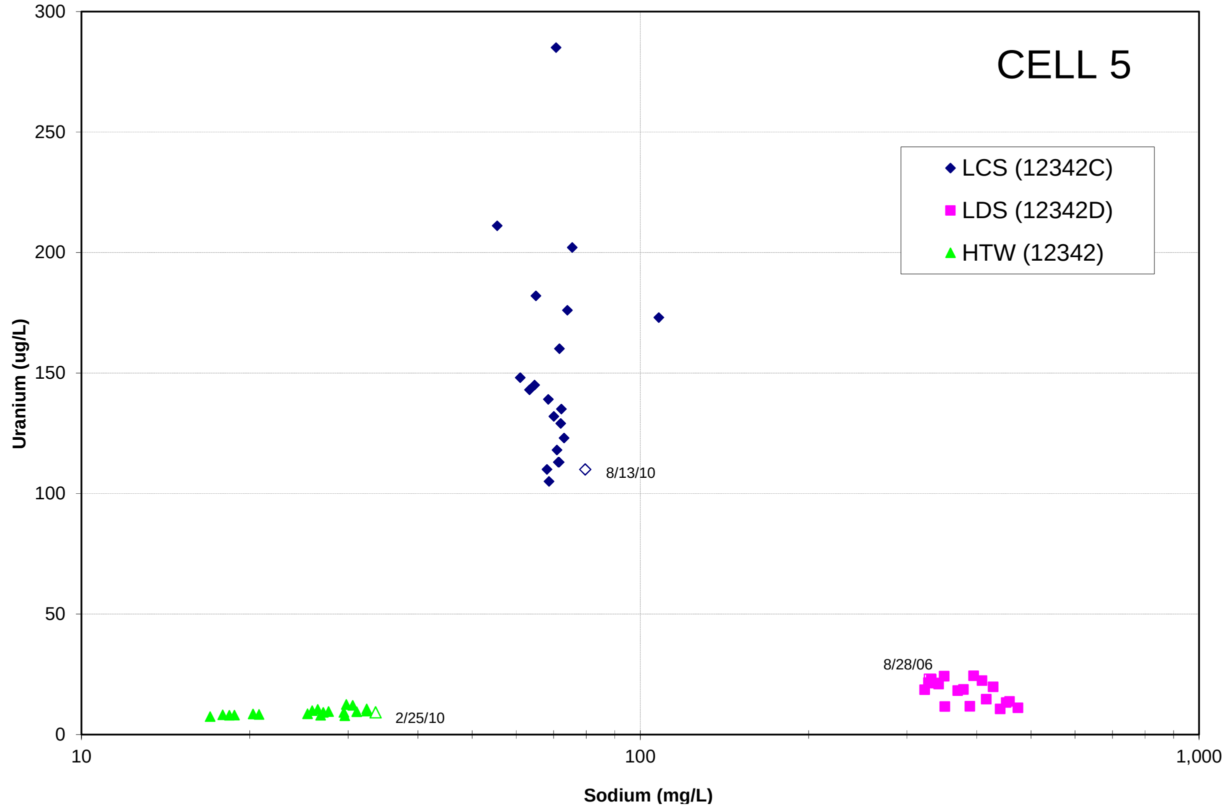


Figure A.5.5−29. Cell 5 Bivariate Plot for Uranium and Sodium

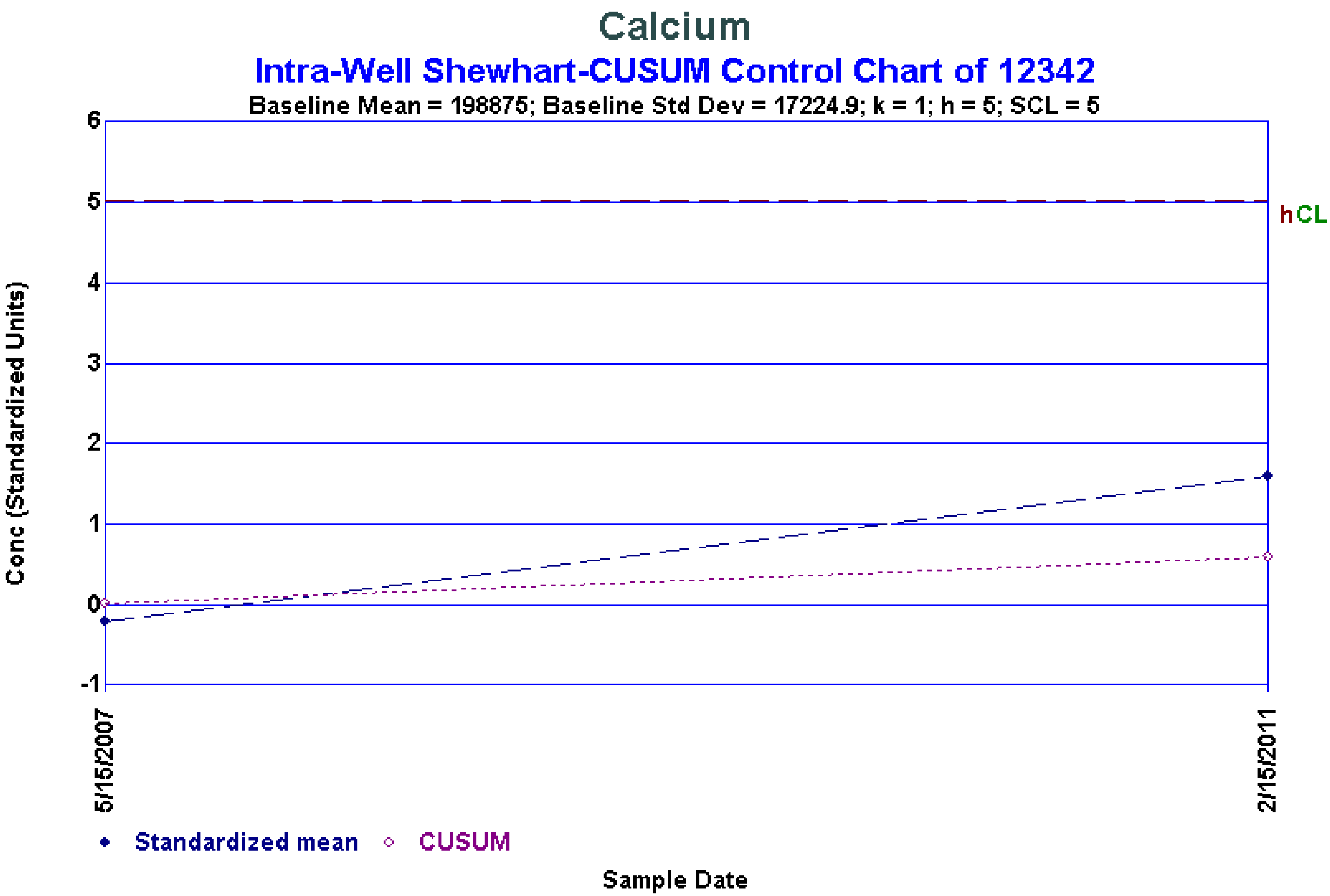


Figure A.5.5−30. Intra-Well Shewhart-CUSUM Control Chart (Calcium 12342)

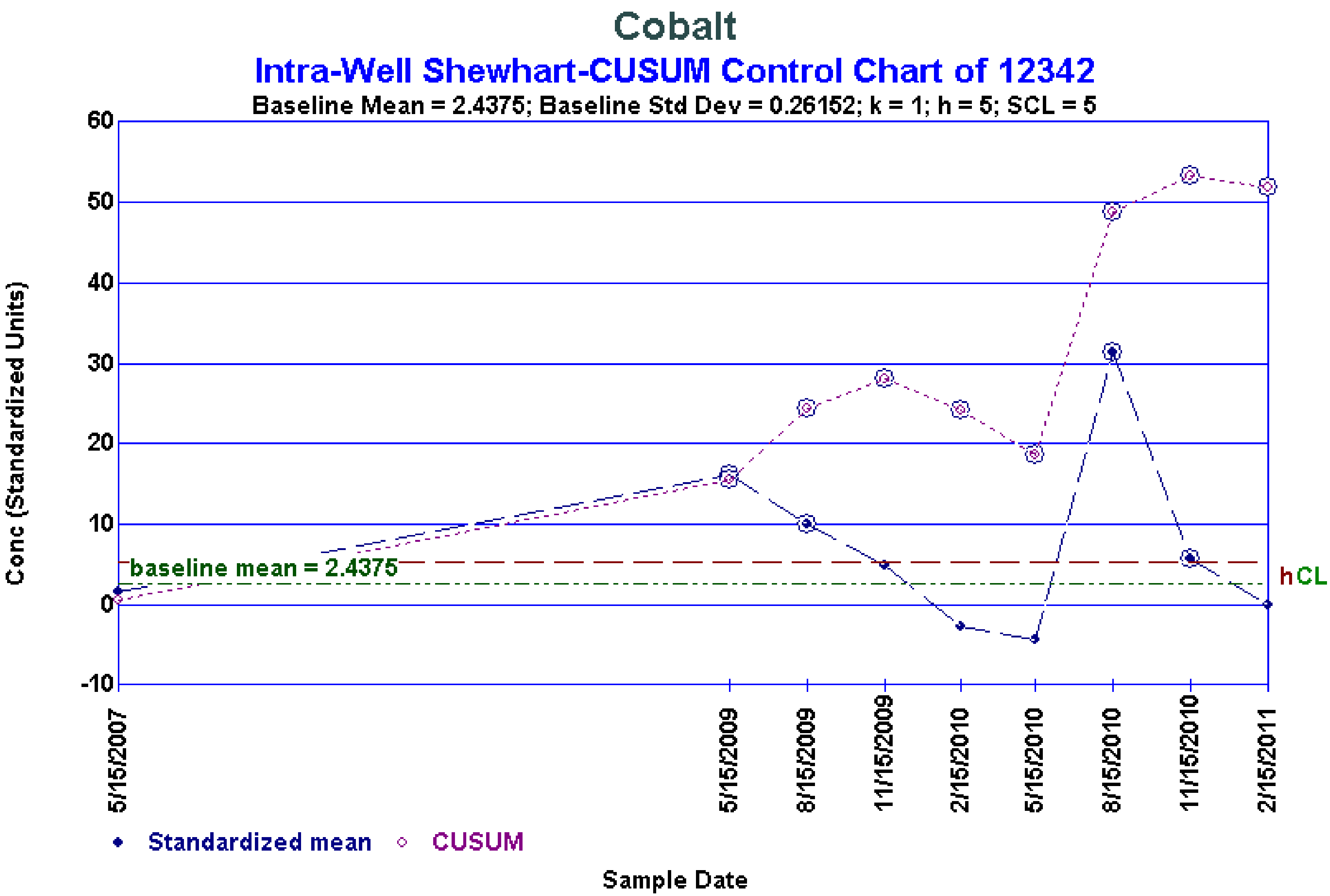


Figure A.5.5−31. Intra-Well Shewhart-CUSUM Control Chart (Cobalt 12342)

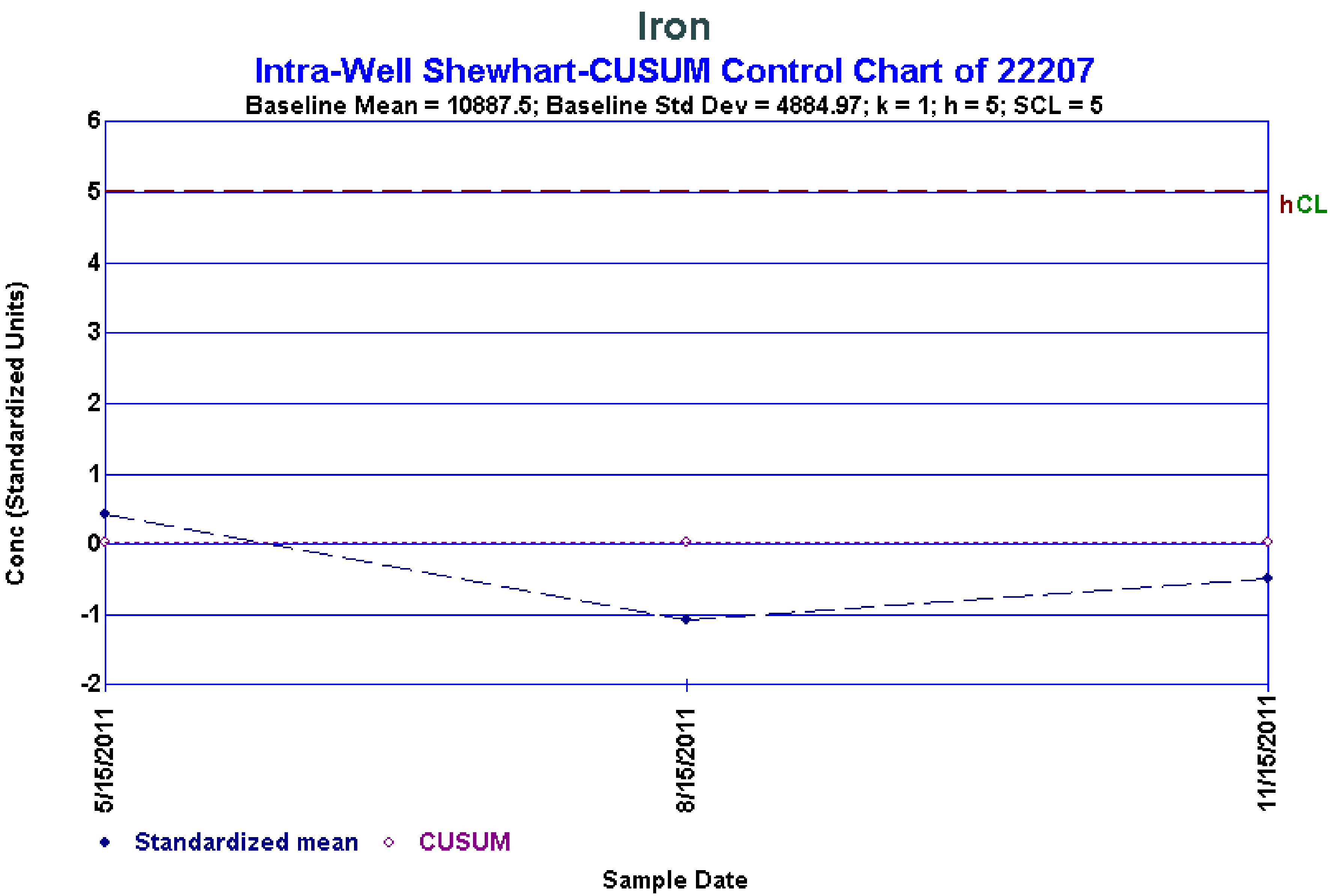


Figure A.5.5−32. Intra-Well Shewhart-CUSUM Control Chart (Iron 22207)

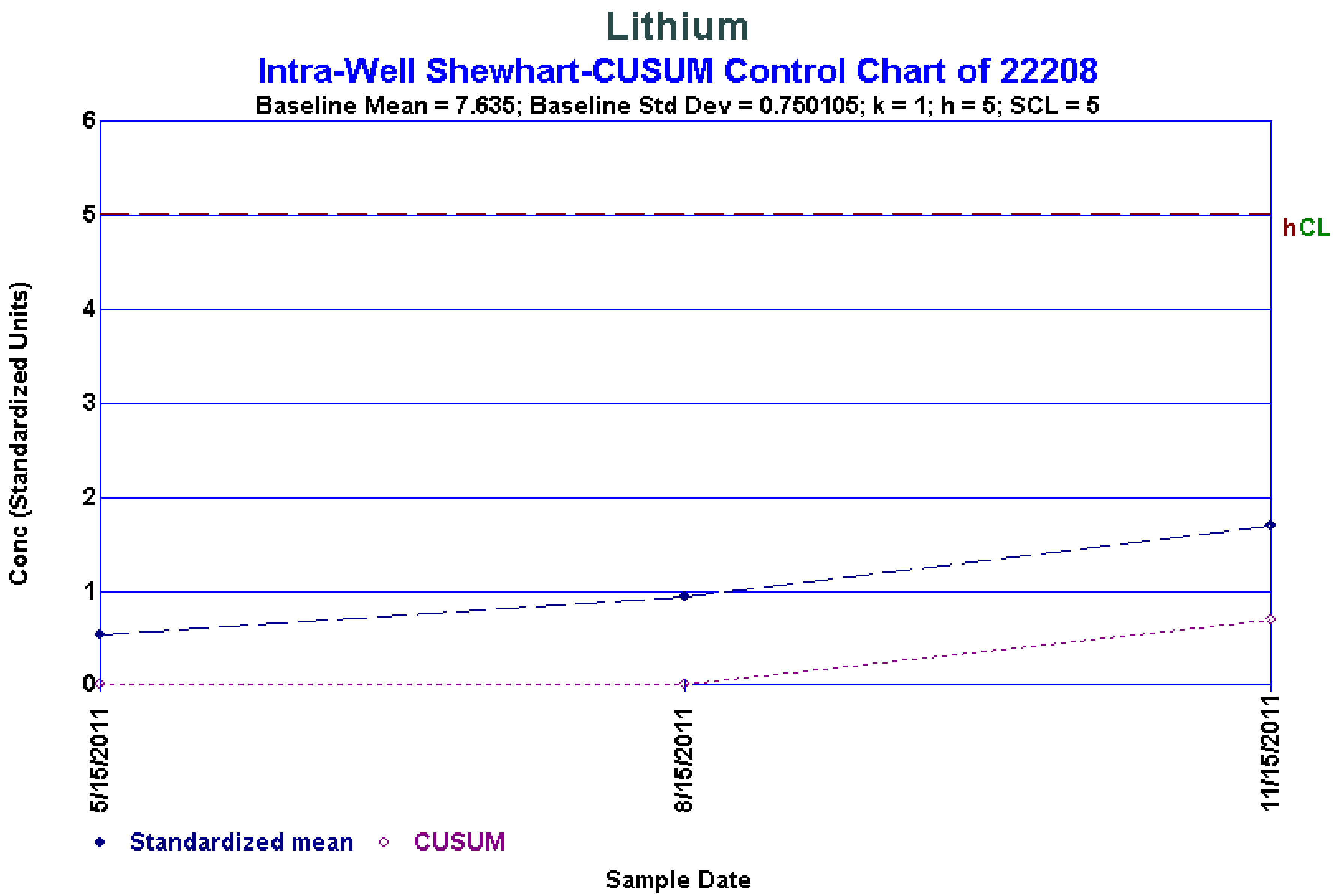


Figure A.5.5−33. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22208)

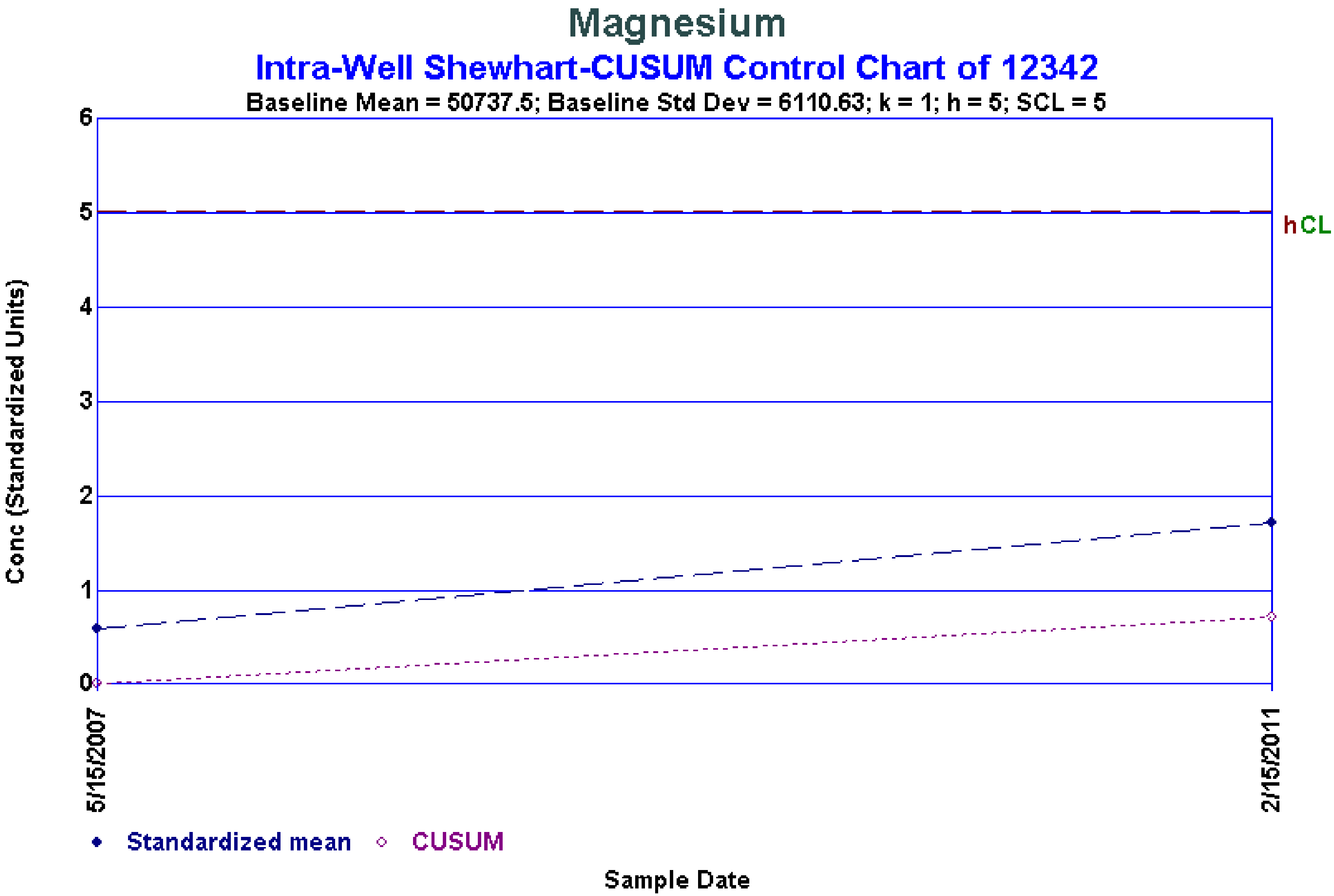


Figure A.5.5−34. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 12342)

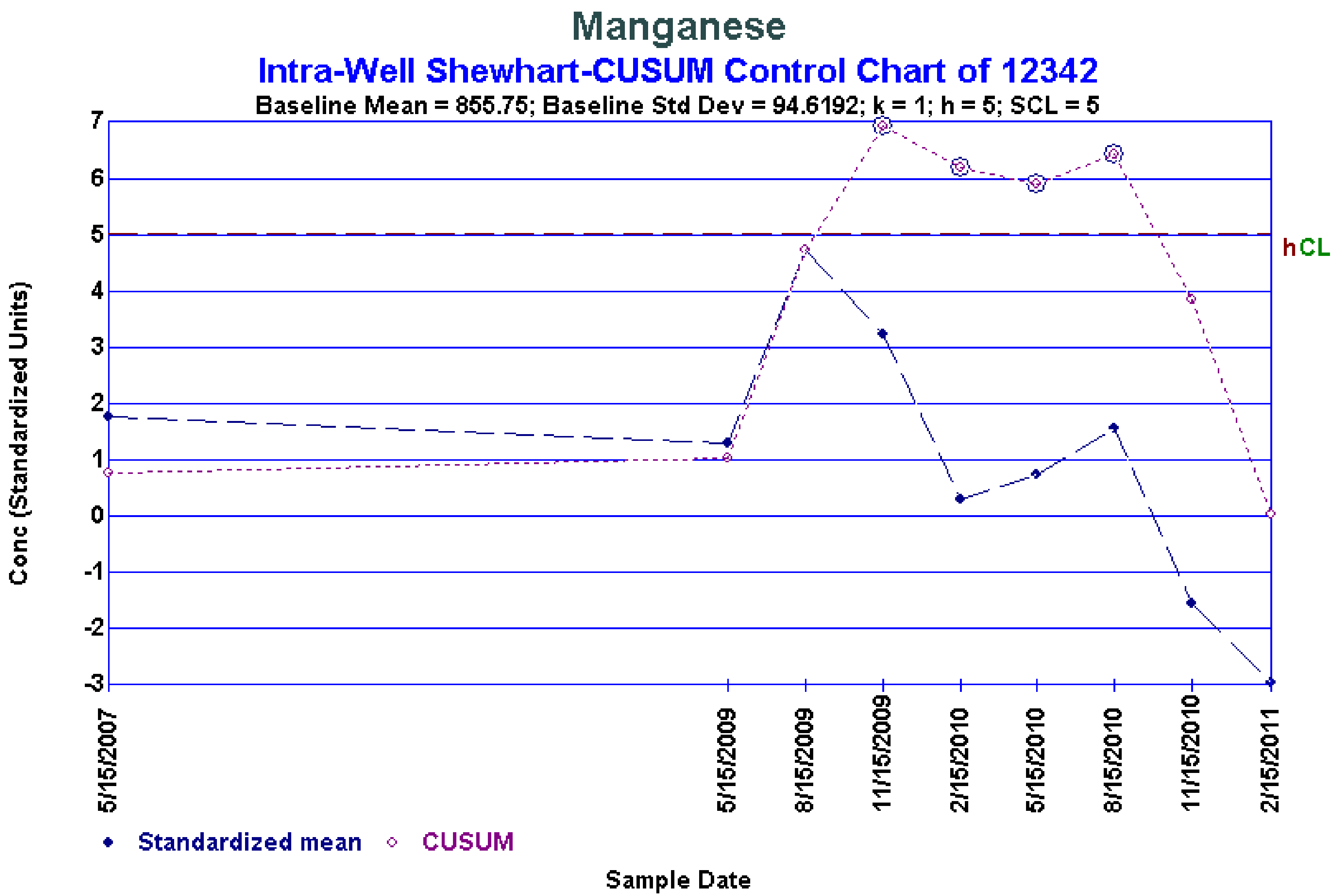


Figure A.5.5−35. Intra-Well Shewhart-CUSUM Control Chart (Manganese 12342)

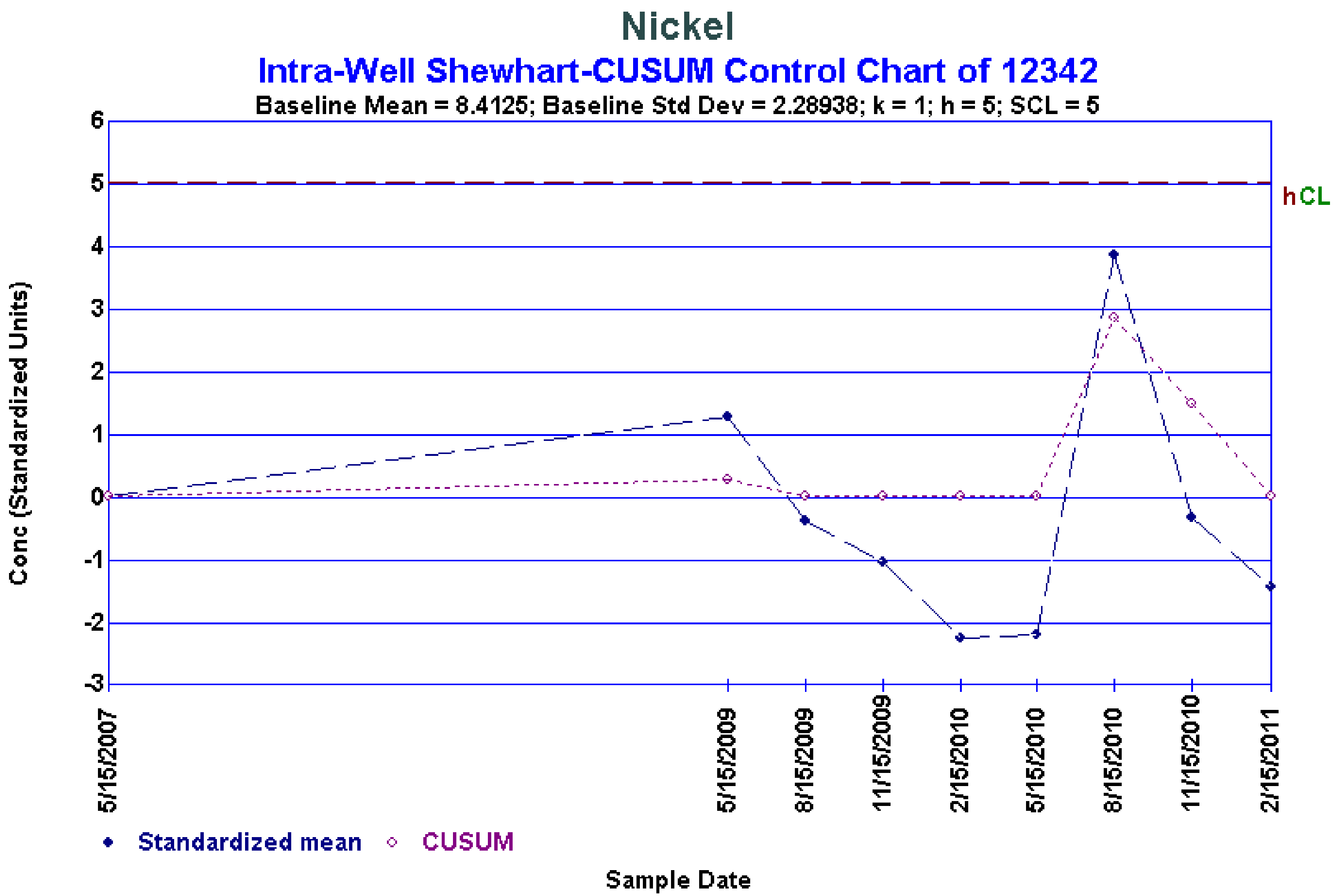


Figure A.5.5−36. Intra-Well Shewhart-CUSUM Control Chart (Nickel 12342)

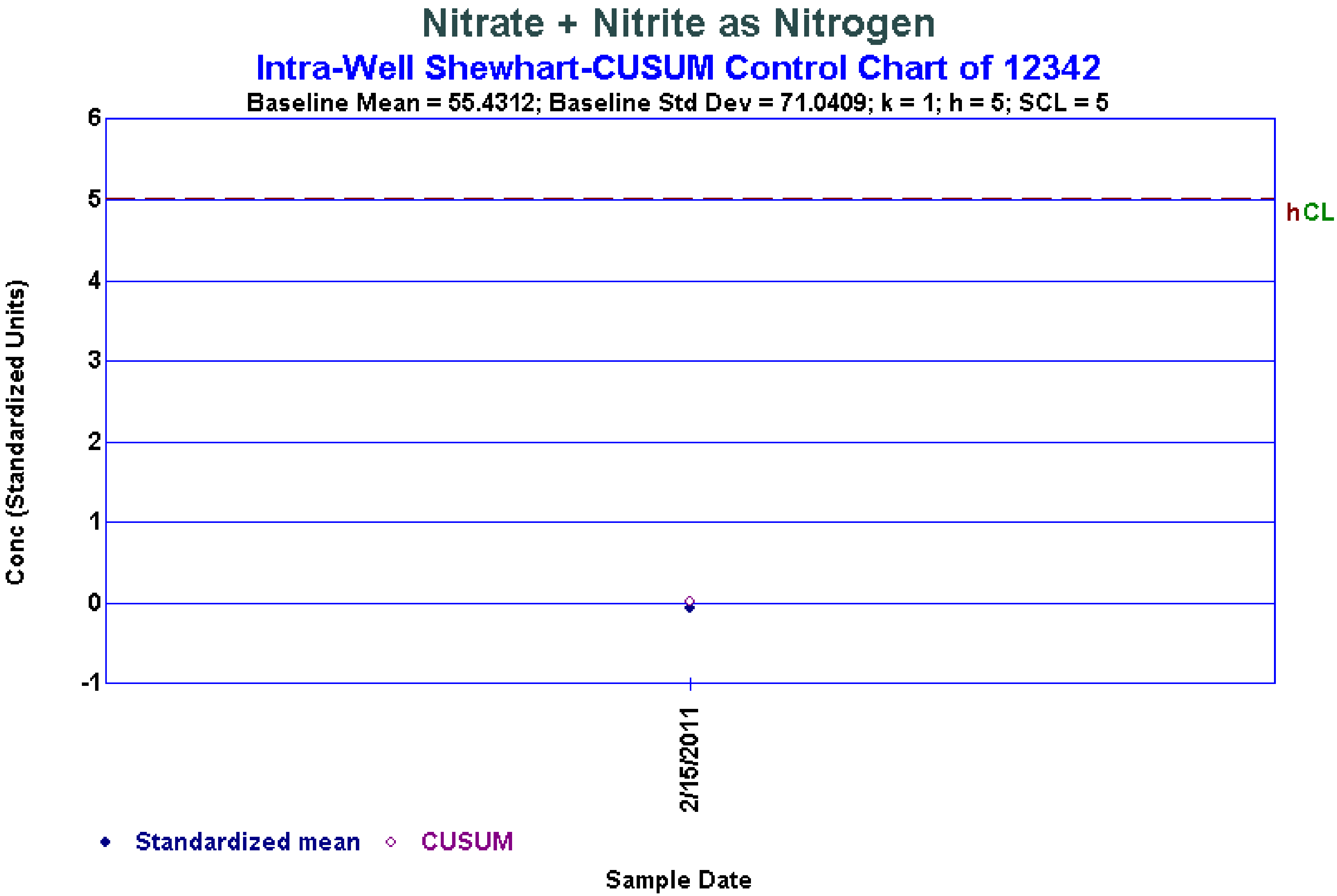


Figure A.5.5−37. Intra-Well Shewhart-CUSUM Control Chart (Nitrate 12342)

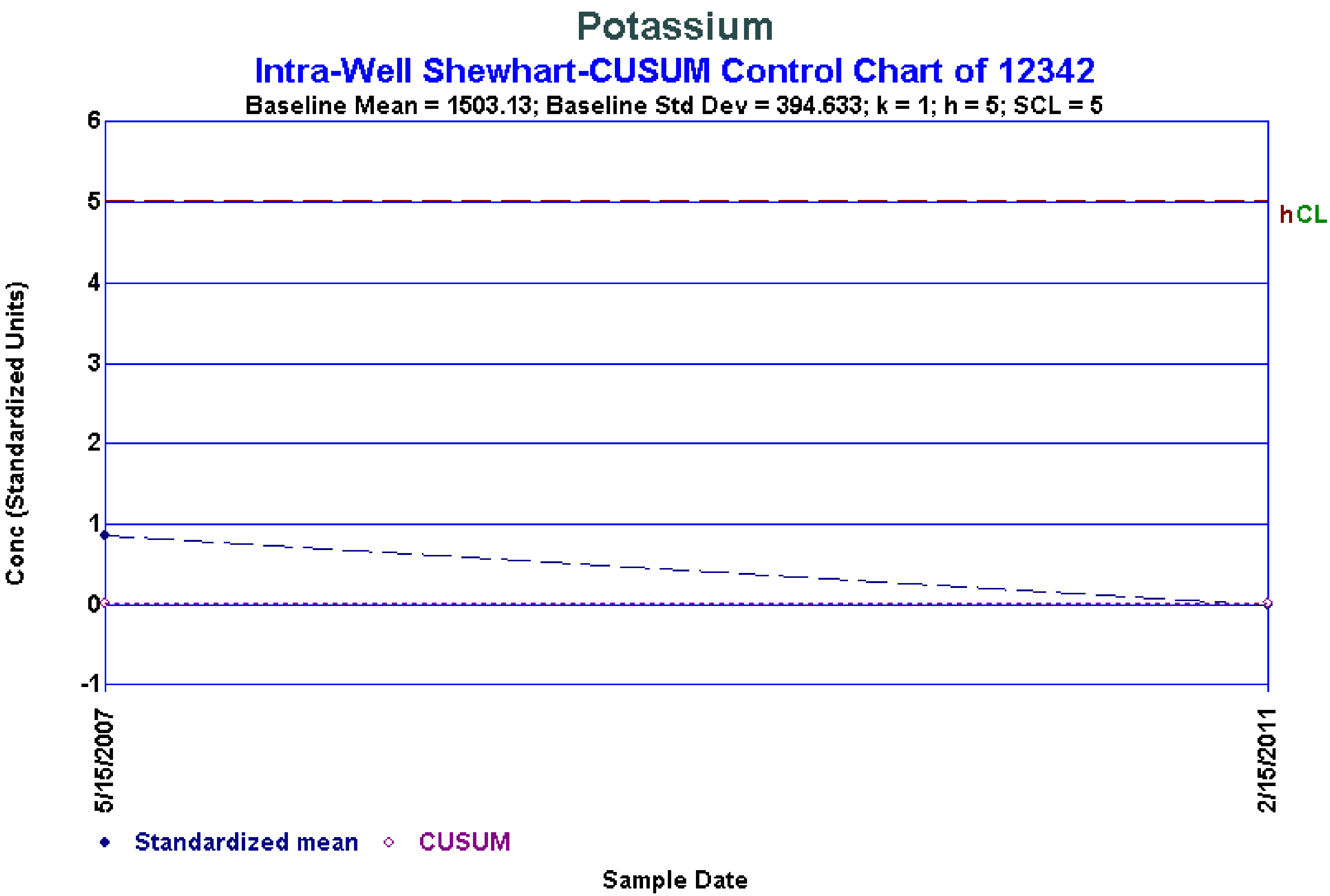


Figure A.5.5−38. Intra-Well Shewhart-CUSUM Control Chart (Potassium 12342)

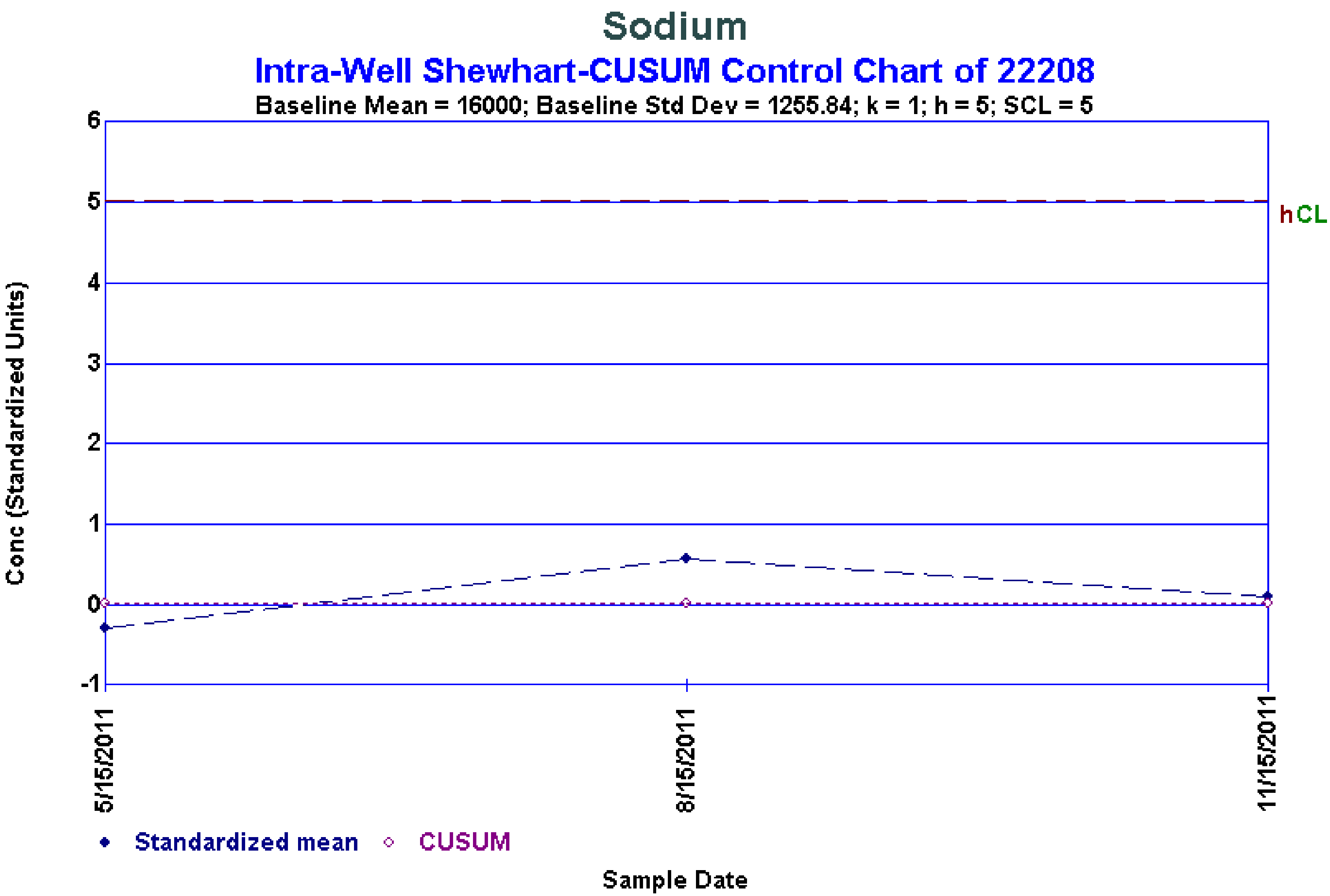


Figure A.5.5−39. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22208)

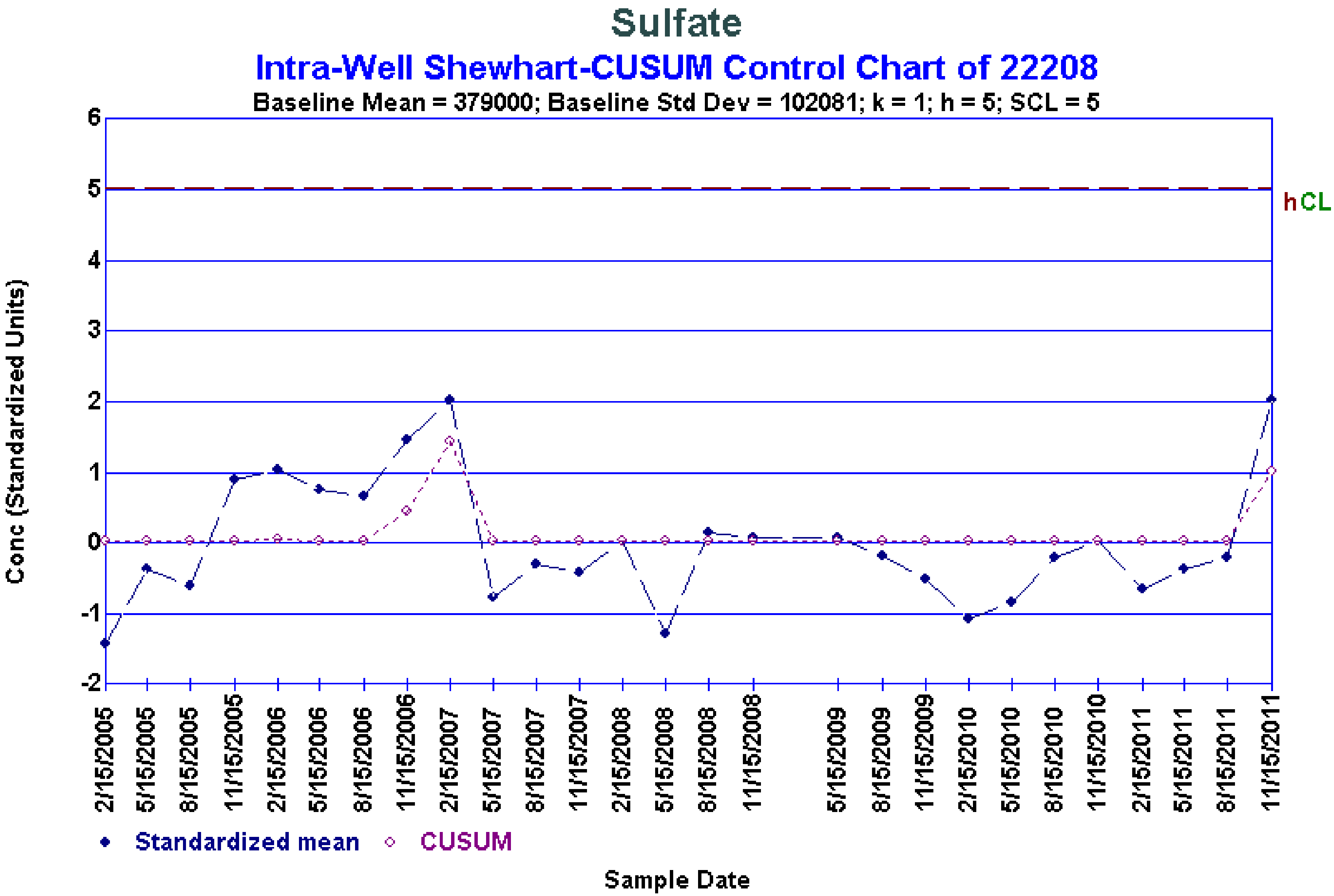


Figure A.5.5−40. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22208)

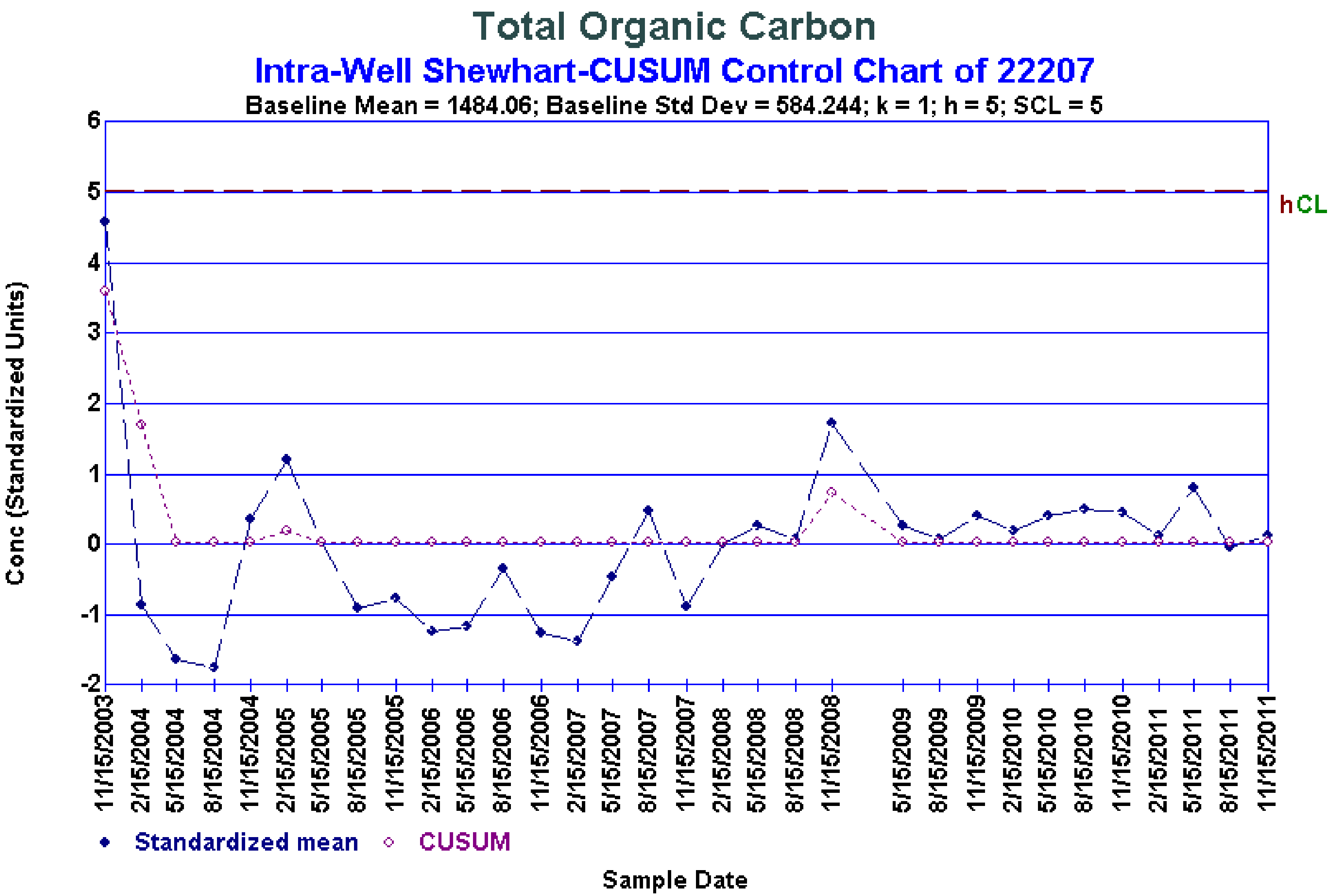


Figure A.5.5−41. Intra-Well Shewhart-CUSUM Control Chart (TOC 22207)

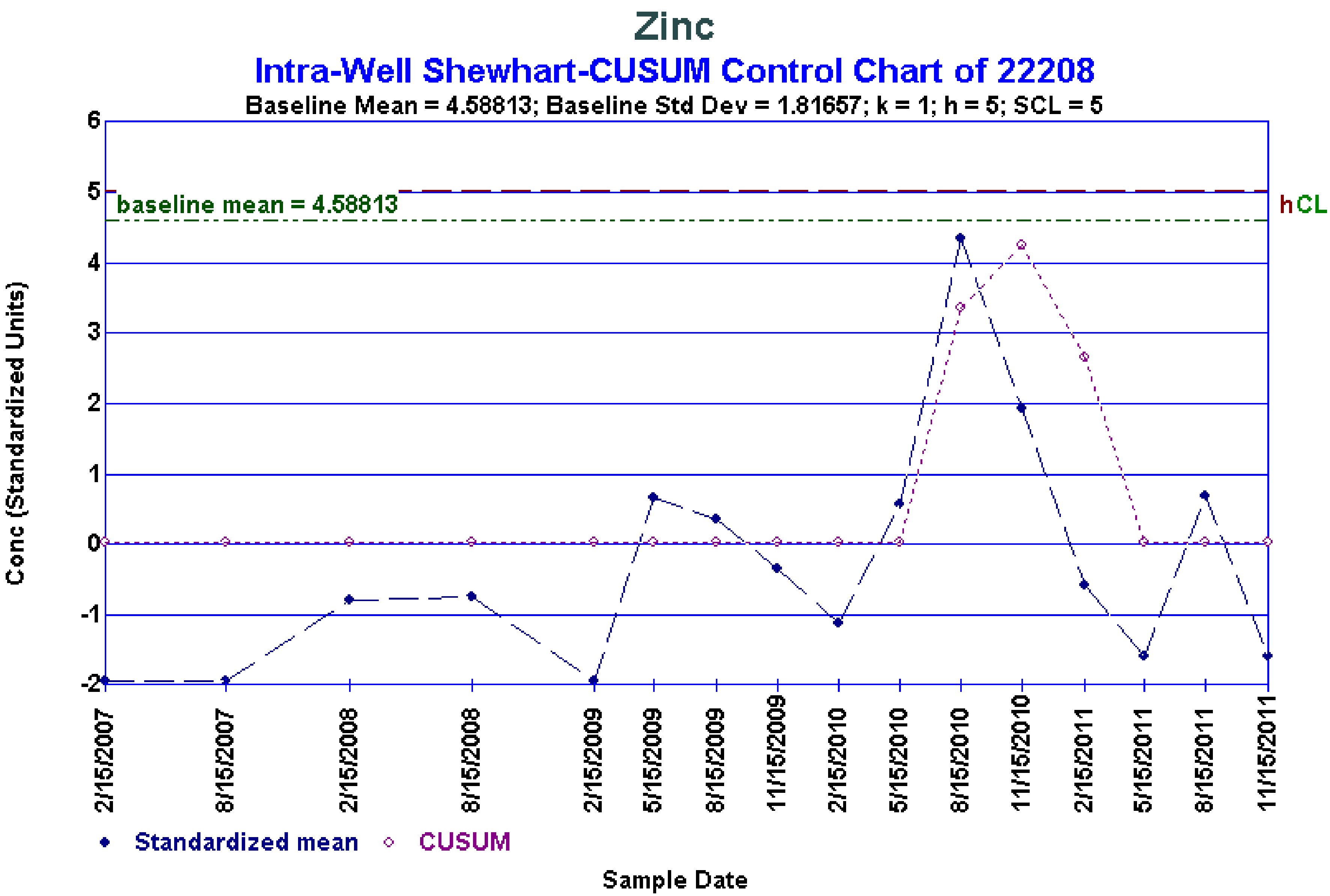


Figure A.5.5−42. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22208)

Sub-attachment A.5.6

Cell 6

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.6−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.6−2)
- LCS monthly accumulation volumes (refer to Figure A.5.6−1)
- LDS monthly accumulation volumes (refer to Figure A.5.6−2)
- OSDF horizontal till well 12343 water yield (refer to Figure A.5.6−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.6−4 and A.5.6−5)
- Plots of concentration versus time (refer to Figures A.5.6−6A to A.5.6−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.6−29)
- Control charts (refer to Figures A.5.6−30 to A.5.6−46)

A.5.6.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA Wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on LMICP (revision 4). Tritium results for all cells are reported in Section A.5.5.

As shown in Table A.5.6–1, 10 of the 23 parameters sampled quarterly in the LCS, LDS, HTW, and GMA wells, (uranium, sulfate, TDS, TOC, arsenic, boron, cobalt, copper, iron, and lithium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Horizontal Till Well

The HTW is located beneath the liner penetration box of each cell by design. This area of the liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, uranium, sulfate, cobalt, copper, iron, and lithium are increasing in the HTW of Cell 6 (as indicated in the table below). The bivariate plot for the Cell 6 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.6−29. The plot shows that the chemical signature for uranium-sodium in the LCS LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured in the HTW of Cell 6 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Uranium	Up		
Sulfate	Up		Up
TDS			Up
TOC		Up	Up
Arsenic			Up
Boron			Up
Cobalt	Up		
Copper	Up		
Iron	Up		
Lithium	Up		

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids; TOC = total organic carbon.
No entry indicates that the trend was not up.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.6–1) measured in the LDS, HTW, and GMA wells for parameters with increasing concentrations in the Cell 6 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
Sulfate (mg/L)	**2140**	188	264
TDS (mg/L)	**5290**	672	911
TOC (mg/L)	**4.85**	1.23	1.30
Arsenic (mg/L)	0.00375	**0.00250**	**0.00250**
Boron (mg/L)	**0.392**	0.0363	0.0340

Note: The highest averages are shown in bold.
[a]LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids, TOC = total organic carbon

As shown in the table above, the average concentration of arsenic in the GMA is higher than the average in the LDS of Cell 6.

A.5.6.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limits on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.6−1 in gray shading, thirteen parameters in the HTW and/or GMA wells of Cell 6 (uranium, chloride, TDS, TOC, barium, calcium, iron, lithium, magnesium, manganese, nickel, sodium, and zinc) meet the criteria for control charts (i.e., more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 17 control charts.

Control charts are presented in Figures A.5.6−30 to A.5.6−46. All of the control charts with the exception of one (i.e., iron in the GMA-D well) exhibit "in control" conditions. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 6 indicate that water is not mixing between the horizons, so out of control conditions are attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

Parameter and Monitoring Point[a]	Assessment
Uranium in the GMA-D	In Control
Chloride in the HTW	In Control
TDS in the GMA-U	In Control
TOC in the HTW	In Control
Barium in the HTW	In Control
Calcium in the HTW	In Control
Iron in the GMA-U	In Control
Iron in the GMA-D	**Out of Control**
Lithium in the GMA-U	In Control
Lithium in the GMA-D	In Control
Magnesium in the HTW	In Control
Manganese in the HTW	In Control
Manganese in the GMA-D	In Control
Nickel in the HTW	In Control
Sodium in the GMA-D	In Control
Zinc in the GMA-U	In Control
Zinc in the GMA-D	In Control

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids; TOC = total organic carbon

A.5.6.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 6 are provided in Table A.5.6−2 for those parameters detected at least once, and not being sampled quarterly. One new Appendix I parameter (chromium) was detected in 2010 at Cell 6. Chromium was detected again in the LCS of Cell 6 in 2011. As directed in the GWLMP, detection of chromium again in the LCS of Cell 6 in 2011 triggers sampling for chromium in the LDS of Cell 6 during the subsequent next scheduled sampling event. No new Appendix I or PCB parameters were detected in the LCS of Cell 6 in 2011.

A.5.6.4 Summary and Conclusions

- The concentrations of ten parameters monitored quarterly are increasing in either the HTW and/or GMA wells of Cell 6 (uranium, sulfate, TDS, TOC, arsenic, boron, cobalt, copper, iron, and lithium).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 6 indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 6 are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Seventeen control charts were constructed for Cell 6 parameters. Sixteen of the control charts exhibit “in control” conditions. Iron in the GMA-D well exhibits “out of control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 6 in 2011.
- Chromium was detected in the LCS of Cell 6 for a second time in 2011. It was first detected in 2010. Because chromium has been detected two consecutive times in the LCS, chromium will be sampled for in the LDS of Cell 6 during the subsequent next scheduled sampling event.

Table A.5.6−1. Summary Statistics for Cell 6

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12343C	32	32	100.0	43.3	197	136	32	Undefined	None	Detected	
	LDS	12343D	32	32	100.0	3.10	43.7	23.2	9.0	Normal	Up	Detected	
	HTW	12343	32	32	100.0	6.32	24.2	12.1	3.8	Lognormal	Up	Detected	
	GMA-U	22209	32	36	88.9	ND	2.43	0.53	0.47	Undefined	None	Not Detected	
	GMA-D	22210	35	37	94.6	ND	0.95	0.63	0.18	Normal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12343C	18	18	100.0	64.0	557	454	104	Normal	Down	Not Detected	
	LDS	12343D	14	14	100.0	161	549	356	129	Normal	None	Not Detected	
	HTW	12343	9	9	100.0	353	714	389	112	Undefined	None	Not Detected	
	GMA-U	22209	5	5	100.0	273	340	318	27	Normal	None	Insuff	
	GMA-D	22210	4	4	100.0	405	409	406	2	Normal	None	Insuff	
Chloride (mg/L)	LCS	12343C	18	18	100.0	20.1	139	114	35	Undefined	Up	Not Detected	
	LDS	12343D	14	14	100.0	51.5	149	59	41	Undefined	Up	Detected	
	HTW	12343	9	9	100.0	24.0	26.9	25.1	1.0	Normal	None	Not Detected	
	GMA-U	22209	5	5	100.0	22.2	33.4	25.6	4.6	Normal	None	Insuff	
	GMA-D	22210	4	4	100.0	28.6	34.6	30.6	2.7	Normal	None	Insuff	
Nitriate/Nitrite as N (mg/L)	LCS	12343C	14	21	66.7	ND	4.67	0.995	1.39	Undefined	None	Detected	
	LDS	12343D	6	14	42.9	ND	4.1	0.0138	1.16	Undefined	Up	Detected	
	HTW	12343	1	8	12.5	ND	0.0264	Insuff	Insuff	Lognormal	None	Not Detected	
	GMA-U	22209	0	5	0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22210	0	4	0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sulfate (mg/L)	LCS	12343C	32	32	100.0	491	4800	2360	950	Normal	Up	Detected	
	LDS	12343D	32	32	100.0	1300	3910	2140	810	Undefined	Up	Detected	
	HTW	12343	28	29	96.6	ND	595	446	81	Normal	Up	Detected	
	GMA-U	22209	35	35	100.0	2.07	406	188	73	Undefined	None	Not Detected	
	GMA-D	22210	35	35	100.0	127	578	264	90	Lognormal	Up	Detected	
Total Dissolved Solids (mg/L)	LCS	12343C	20	20	100.0	267	5970	5040	1800	Undefined	Up	Detected	
	LDS	12343D	12	12	100.0	3690	6340	5290	770	Normal	Up	Detected	
	HTW	12343	8	8	100.0	1210	1350	1290	50	Normal	None	Not Detected	
	GMA-U	22209	11	11	100.0	573	876	672	78	Normal	None	Not Detected	876 (Q3-11)
	GMA-D	22210	11	11	100.0	827	992	911	40	Normal	Up	Detected	
Total Organic Carbon (mg/L)	LCS	12343C	29	32	90.6	ND	3.55	2.15	0.61	Normal	None	Not Detected	14.6 (Q4-03)
	LDS	12343D	30	32	93.8	ND	10.4	4.85	2.17	Normal	Down	Detected	
	HTW	12343	24	29	82.8	ND	4.93	2.34	0.71	Lognormal	None	Not Detected	
	GMA-U	22209	24	36	66.7	ND	2.28	1.23	0.46	Normal	Up	Detected	
	GMA-D	22210	25	36	69.4	ND	2.39	1.30	0.46	Normal	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12343C	21	32	65.6	ND	0.060	0.0153	0.0119	Lognormal	None	Not Detected	
	LDS	12343D	24	32	75.0	ND	0.0446	0.0245	0.0109	Normal	None	Not Detected	0.091 (Q2-10)
	HTW	12343	14	29	48.3	ND	0.0560	0.00869	0.0105	Lognormal	Down	Not Detected	
	GMA-U	22209	8	36	22.2	ND	0.0377	0.00303	0.00883	Undefined	None	Detected	
	GMA-D	22210	6	36	16.7	ND	0.0125	0.00204	0.00415	Undefined	Down	Not Detected	0.059 (Q2-10)
Arsenic (mg/L)	LCS	12343C	4	23	17.4	ND	0.093	0.00375	0.0282	Undefined	None	Detected	
	LDS	12343D	4	21	19.0	ND	0.023	0.00375	0.00518	Undefined	None	Not Detected	
	HTW	12343	1	19	5.3	ND	0.033	Insuff	Insuff	Undefined	None	Not Detected	
	GMA-U	22209	5	11	45.4	ND	0.0396	0.00250	0.0133	Undefined	None	Not Detected	
	GMA-D	22210	5	20	25.0	ND	0.0381	0.00250	0.0116	Undefined	Up	Detected	
Barium (mg/L)	LCS	12343C	18	18	100.0	0.0190	0.0868	0.0373	0.0195	Lognormal	Down	Detected	
	LDS	12343D	14	14	100.0	0.0127	0.067	0.0298	0.0138	Lognormal	Down	Detected	
	HTW	12343	9	9	100.0	0.0307	0.0427	0.0354	0.0038	Normal	None	Not Detected	
	GMA-U	22209	4	4	100.0	0.0738	0.093	0.0855	0.0084	Normal	None	Insuff	
	GMA-D	22210	4	4	100.0	0.0332	0.0459	0.0403	0.0054	Normal	None	Insuff	

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
	LCS	12343C	32	32	100.0	0.0566	1.37	0.782	0.248	Undefined	None	Detected	
	LDS	12343D	32	32	100.0	0.289	2.38	0.392	0.385	Undefined	None	Detected	
Boron (mg/L)	HTW	12343	25	29	86.2	ND	0.124	0.0857	0.0212	Normal	None	Detected	
	GMA-U	22209	31	36	86.1	ND	0.0447	0.0363	0.0080	Undefined	None	Not Detected	
	GMA-D	22210	33	36	91.7	ND	0.0468	0.0340	0.0075	Undefined	Up	Detected	
	LCS	12343C	18	18	100.0	225	996	516	159	Undefined	None	Not Detected	
	LDS	12343D	14	14	100.0	302	518	392	70	Normal	None	Not Detected	
Calcium (mg/L)	HTW	12343	9	9	100.0	150	228	176	23	Normal	None	Not Detected	
	GMA-U	22209	4	4	100.0	144	242	148	48	Undefined	None	Insuff	
	GMA-D	22210	4	4	100.0	212	235	221	10	Normal	None	Insuff	
	LCS	12343C	11	23	47.8	ND	0.0029	0.00075	0.00076	Undefined	None	Detected	
	LDS	12343D	10	21	47.6	ND	0.0105	0.00076	0.00215	Undefined	Down	Not Detected	
Cobalt (mg/L)	HTW	12343	12	16	75.0	ND	0.00666	0.00230	0.00224	Lognormal	Up	Not Detected	0.0333 (Q4-10)
	GMA-U	22209	0	11	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22210	0	11	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	LCS	12343C	15	19	79.0	ND	0.0254	0.00992	0.00700	Normal	None	Not Detected	
	LDS	12343D	11	16	68.8	ND	0.0224	0.0104	0.0076	Normal	None	Not Detected	
Copper (mg/L)	HTW	12343	6	10	60.0	ND	0.0150	0.00803	0.00507	Normal	Up	Not Detected	
	GMA-U	22209	4	4	100.0	0.000928	0.00815	0.00491	0.00302	Normal	None	Insuff	
	GMA-D	22210	4	4	100.0	0.00302	0.0109	0.00742	0.00329	Normal	None	Insuff	
	LCS	12343C	12	23	52.2	ND	4.48	0.0719	1.58	Undefined	Down	Detected	
	LDS	12343D	15	21	71.4	ND	3.69	0.215	1.15	Undefined	Down	Detected	
Iron (mg/L)	HTW	12343	16	16	100.0	0.23	31.9	6.88	8.46	Lognormal	Up	Not Detected	
	GMA-U	22209	11	11	100.0	3.35	5.58	4.21	0.72	Lognormal	None	Not Detected	
	GMA-D	22210	11	11	100.0	1.57	4.55	2.33	0.92	Lognormal	None	Not Detected	
	LCS	12343C	20	20	100.0	0.0234	0.267	0.134	0.063	Normal	Up	Detected	
	LDS	12343D	20	20	100.0	0.0703	0.193	0.114	0.036	Normal	Up	Detected	
Lithium (mg/L)	HTW	12343	15	16	93.8	ND	0.0124	0.0111	0.0018	Undefined	Up	Not Detected	
	GMA-U	22209	11	11	100.0	0.00524	0.00739	0.00597	0.00071	Normal	None	Not Detected	
	GMA-D	22210	11	11	100.0	0.00631	0.00797	0.0073	0.0006	Normal	None	Not Detected	
	LCS	12343C	18	18	100.0	92.4	791	334	238	Undefined	Up	Detected	
	LDS	12343D	14	14	100.0	130	494	190	130	Undefined	Up	Detected	
Magnesium (mg/L)	HTW	12343	9	9	100.0	65.1	83.5	76.7	5.4	Normal	None	Not Detected	
	GMA-U	22209	4	4	100.0	27.0	31.6	29.5	2.0	Normal	None	Insuff	
	GMA-D	22210	4	4	100.0	50.8	55.5	52.3	2.2	Normal	None	Insuff	
	LCS	12343C	9	23	39.1	ND	1.41	0.0069	0.307	Undefined	None	Not Detected	
	LDS	12343D	10	21	47.6	ND	0.0913	0.0152	0.0202	Lognormal	None	Not Detected	3.24 (Q4-03)
Manganese (mg/L)	HTW	12343	16	16	100.0	0.0212	1.18	0.305	0.305	Lognormal	None	Not Detected	
	GMA-U	22209	11	11	100.0	0.243	0.287	0.267	0.014	Normal	Down	Not Detected	0.748 (Q3-11)
	GMA-D	22210	20	20	100.0	0.0735	0.420	0.203	0.102	Lognormal	None	Not Detected	
	LCS	12343C	18	23	78.3	ND	0.0319	0.0128	0.0101	Lognormal	Down	Detected	
	LDS	12343D	15	21	71.4	ND	0.0572	0.0111	0.0119	Lognormal	Down	Detected	
Nickel (mg/L)	HTW	12343	12	16	75.0	0.00151	0.0472	0.00959	0.011	Normal	None	Not Detected	47.2 (Q3-10)
	GMA-U	22209	0	11	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22210	18	20	90.0	ND	0.0099	0.00376	0.00274	Lognormal	Down	Detected	
	LCS	12343C	18	18	100.0	9.0	75.5	25.5	14.0	Lognormal	Up	Detected	
	LDS	12343D	14	14	100.0	24.5	69.8	29.4	13.8	Undefined	None	Detected	
Potassium (mg/L)	HTW	12343	9	9	100.0	2.66	4.27	3.31	0.49	Normal	None	Detected	
	GMA-U	22209	4	4	100.0	3.0	3.78	3.33	0.33	Normal	None	Insuff	
	GMA-D	22210	4	4	100.0	3.14	3.62	3.39	0.20	Normal	None	Insuff	

Table A.5.6−1 (continued). Summary Statistics for Cell 6

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12343C	5	23	21.7	ND	0.140	0.00625	0.0304	Undefined	None	Not Detected	
	LDS	12343D	3	21	14.3	ND	0.0545	0.00893	Insuff	Lognormal	None	Not Detected	
	HTW	12343	0	16	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-U	22209	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22210	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12343C	23	23	100.0	23.1	107	61.0	18.3	Normal	Up	Not Detected	
	LDS	12343D	21	21	100.0	109	532	430	84	Undefined	Up	Detected	
	HTW	12343	19	19	100.0	33.9	66.0	52.1	9.7	Normal	None	Detected	
	GMA-U	22209	11	11	100.0	15.2	22.5	19.0	2.1	Normal	Down	Detected	
	GMA-D	22210	11	11	100.0	17.4	20.4	18.6	0.9	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12343C	8	23	34.8	ND	0.0432	0.0127	0.0096	Lognormal	None	Not Detected	
	LDS	12343D	13	21	61.9	ND	2.61	0.0321	0.626	Undefined	Up	Detected	
	HTW	12343	14	16	87.5	0.0108	7.19	0.0228	1.78	Undefined	None	Not Detected	
	GMA-U	22209	4	11	36.4	ND	0.0133	0.00576	0.00420	Normal	None	Not Detected	
	GMA-D	22210	15	20	75.0	ND	0.0244	0.0117	0.0061	Lognormal	None	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires n ≥ 3. In addition, Standard Deviation requires n ≥ 4.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where 3 ≤ n ≤ 50) or Shapiro Francia (where n > 50).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with n ≥ 4.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with n ≥ 6.

[h]Outliers determined by Rosner's (where n > 25) or Dixon procedure (where 4 ≤ n ≤ 25).

[i]Q = quarterly

Table A.5.6−2. Cell 6 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	9	3	33.3	Yes	0.0198	1	0.369	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganic											
Chromium (mg/L)	9	2	22.2	Yes	0.00288	0.0058	0.0043	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(1)	0.818 mg/L(0)
Mercury (mg/L)	15	1	6.7	No	0.000338	-	-	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Vanadium (mg/L)	9	1	11.1	No	0.00088	-	-	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(0)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	15	4	26.7	No	1.83	11.7	7.22	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
Acetone (ug/L)	9	1	11.1	No	2.66	-	-	-	-	-	-
Toluene (ug/L)	9	1	11.1	No	0.716	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundw ater background, PW background, or PW maximum.

[a]If more than one sample is collected per w ell per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample w ith the maximum representative concentration is used for all the summary information

[b]Rejected data qualified w ith an R or Z w ere not included.

[c]If the number of detected samples is equal to tw o, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundw ater w hich w as developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched w ater as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

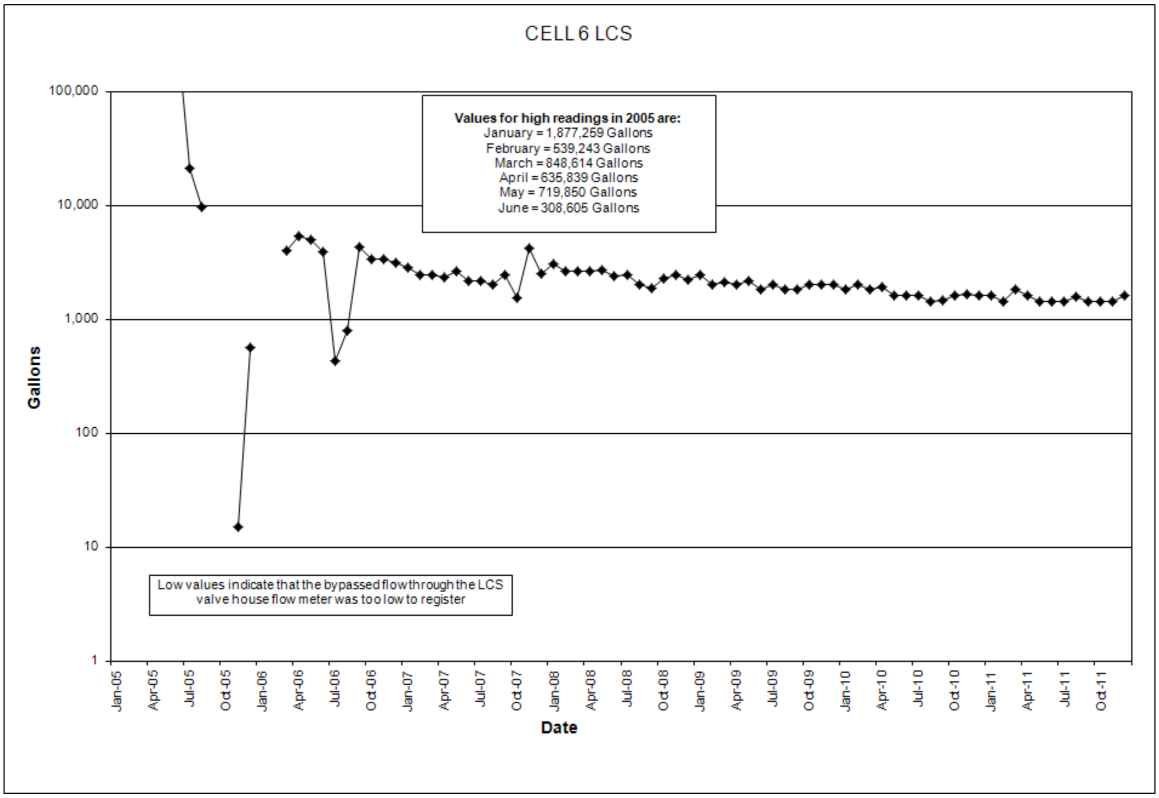


Figure A.5.6–1. Monthly Accumulation Volumes for Cell 6 LCS

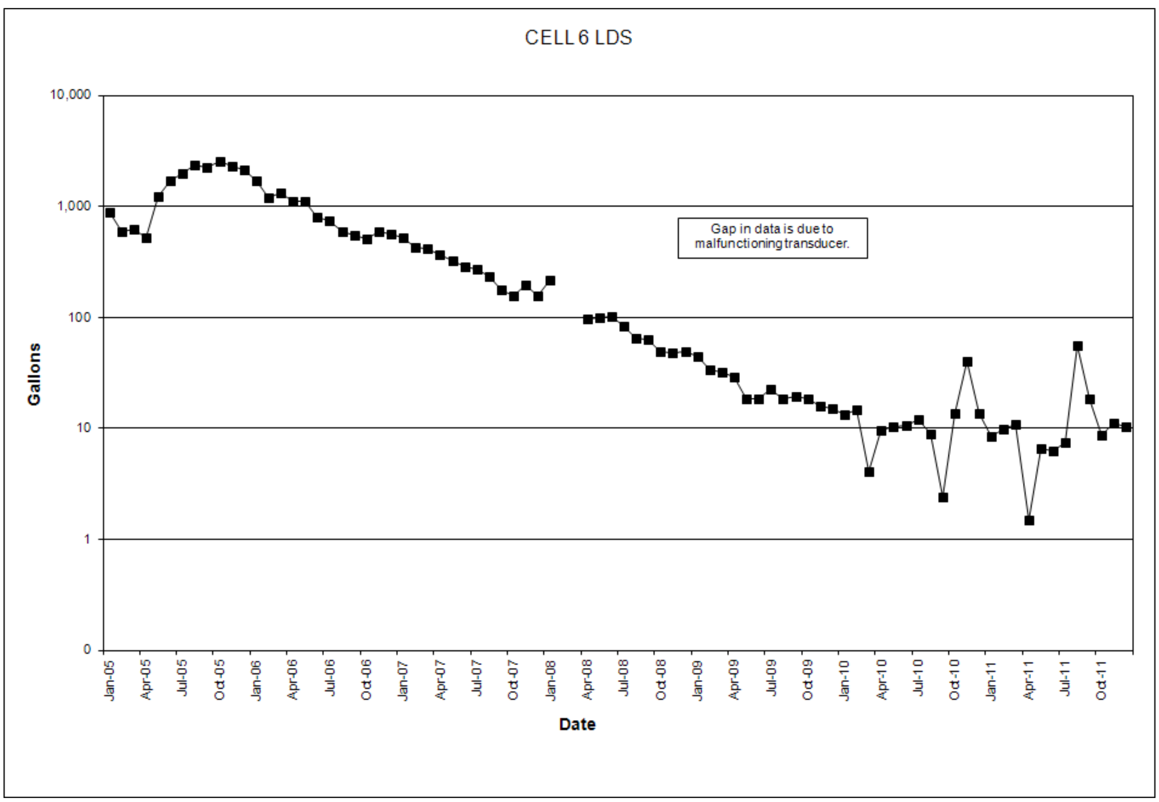
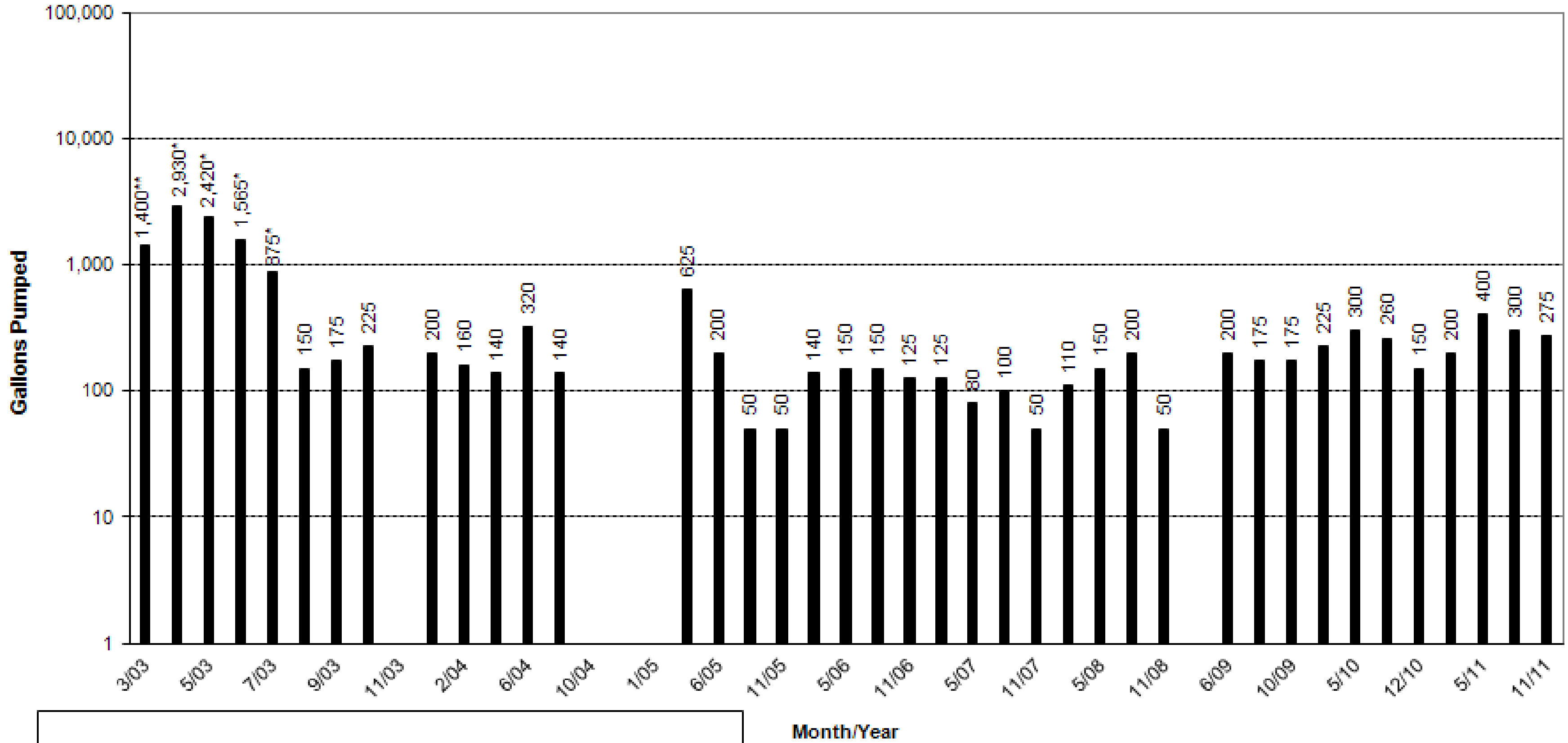


Figure A.5.6–2. Monthly Accumulation Volumes for Cell 6 LDS



12343 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2003:	9940	n=10	994
2004:	760	n=6	127
2005:	925	n=5	185
2006:	565	n=4	141
2007:	355	n=4	89
2008:	510	n=4	128
2009:	550	n=3	183
2010:	935	n=4	234
2011:	1175	n=4	294
Overall:			357

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

**Excess water was pumped from this well in March 2003 for well development.

Figure A.5.6–3. OSDF Horizontal Till Well 12343 (Cell 6) Water Yield

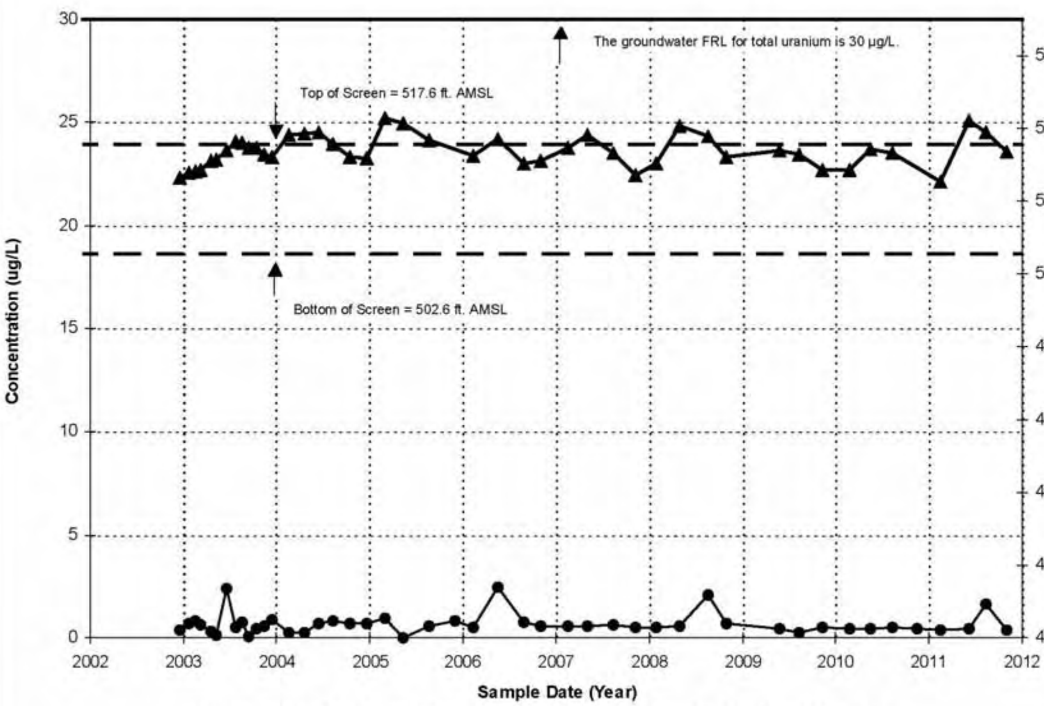


FIGURE A.5.6-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 6 Upgradient Monitoring Well 22209

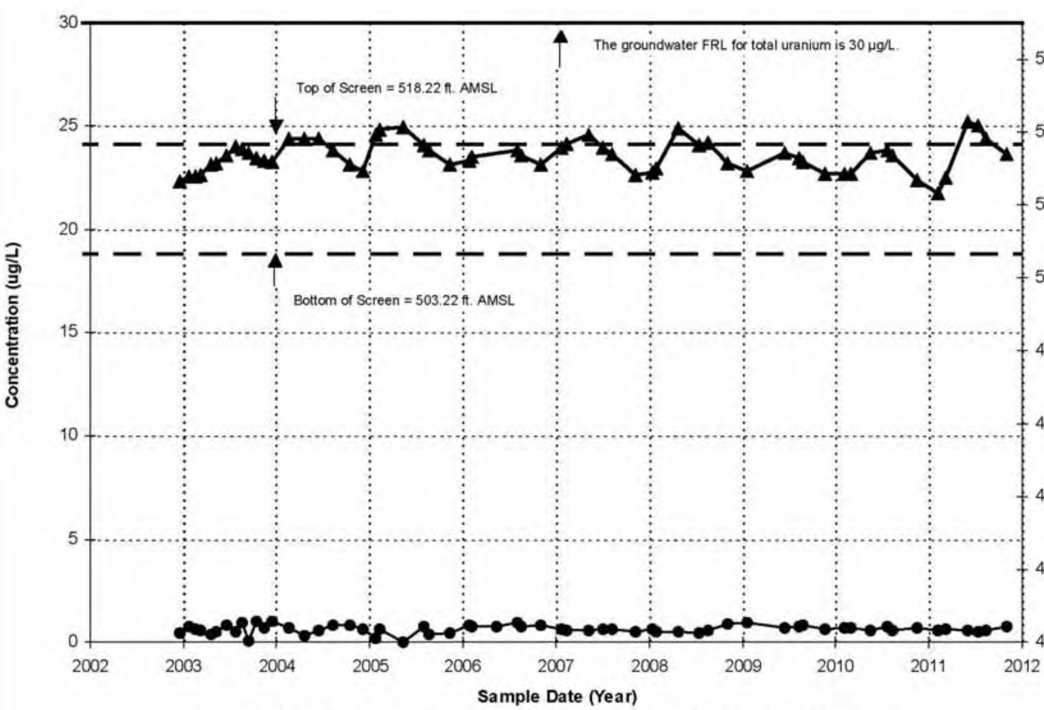


FIGURE A.5.6-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 6 Downgradient Monitoring Well 22210

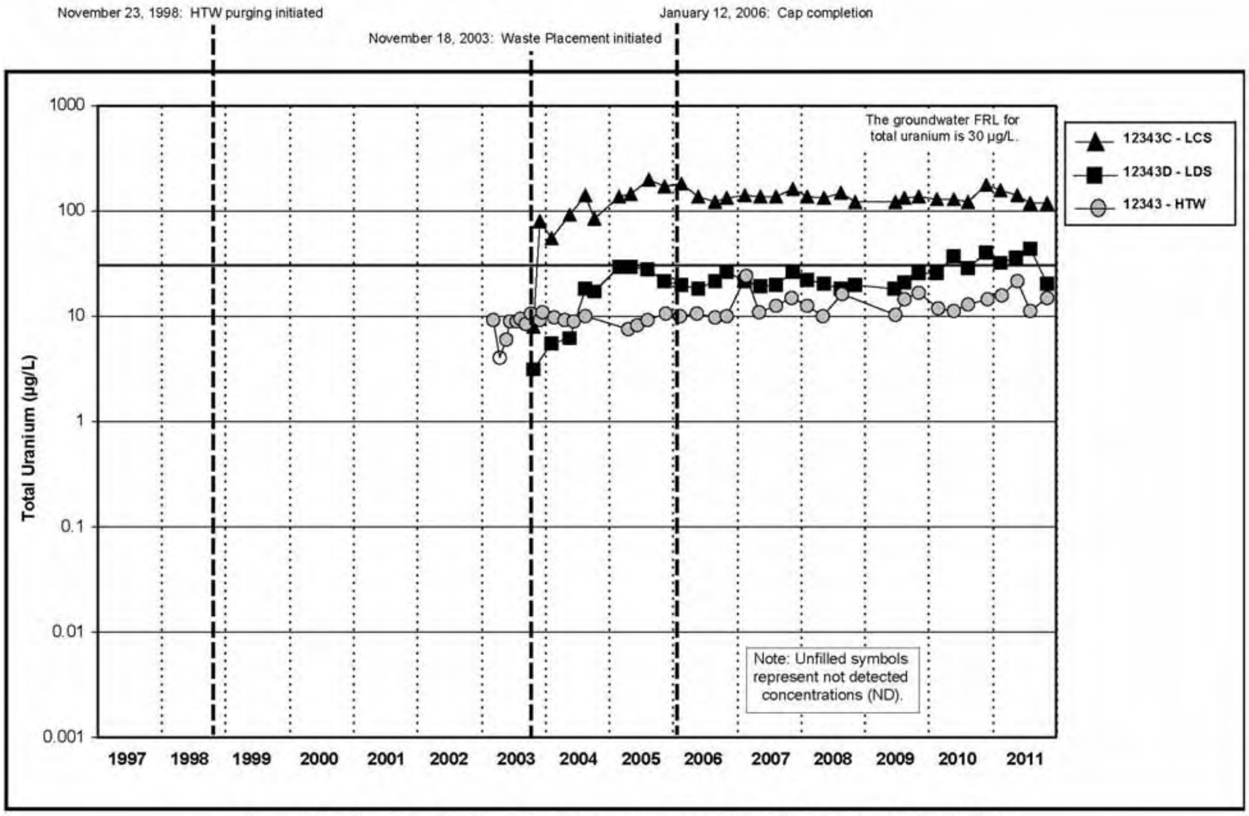


Figure A.5.6-6A. Cell 6 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

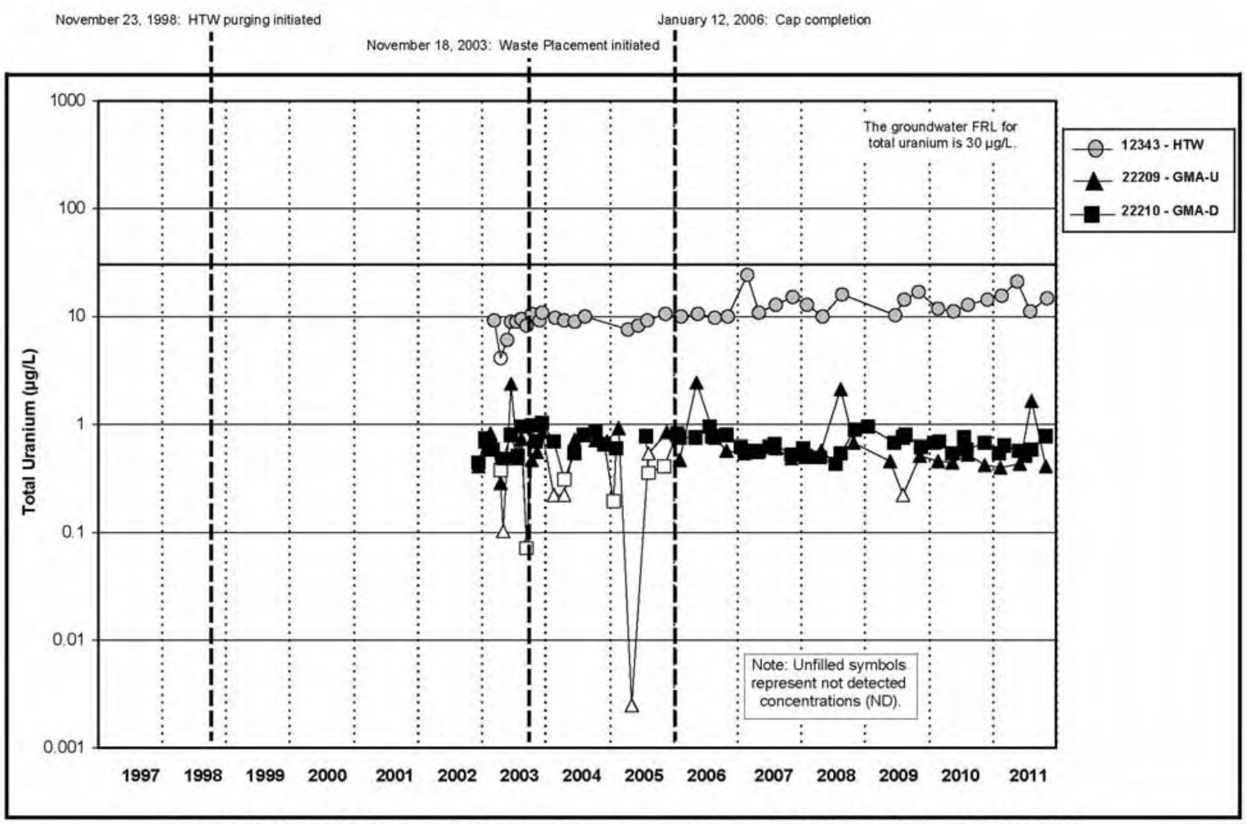


Figure A.5.6-6B. Cell 6 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

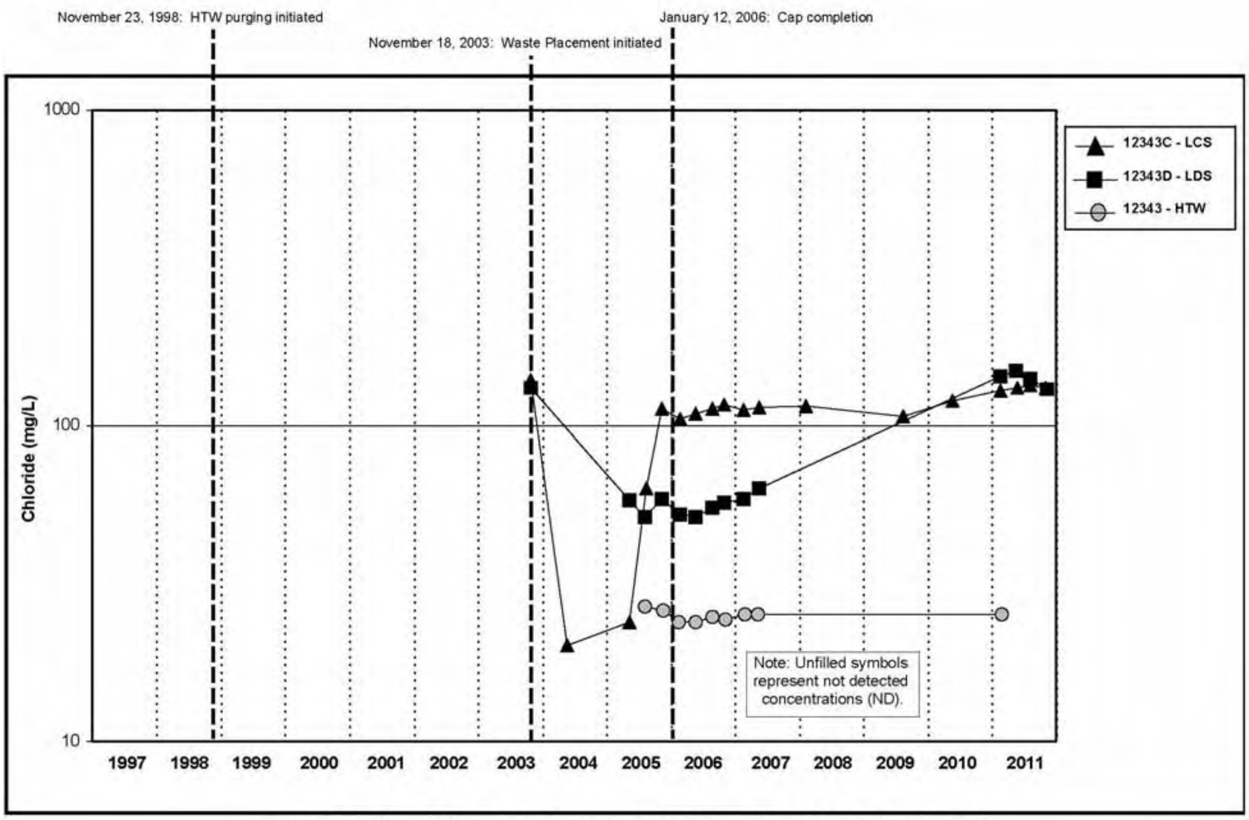


Figure A.5.6-7A. Cell 6 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

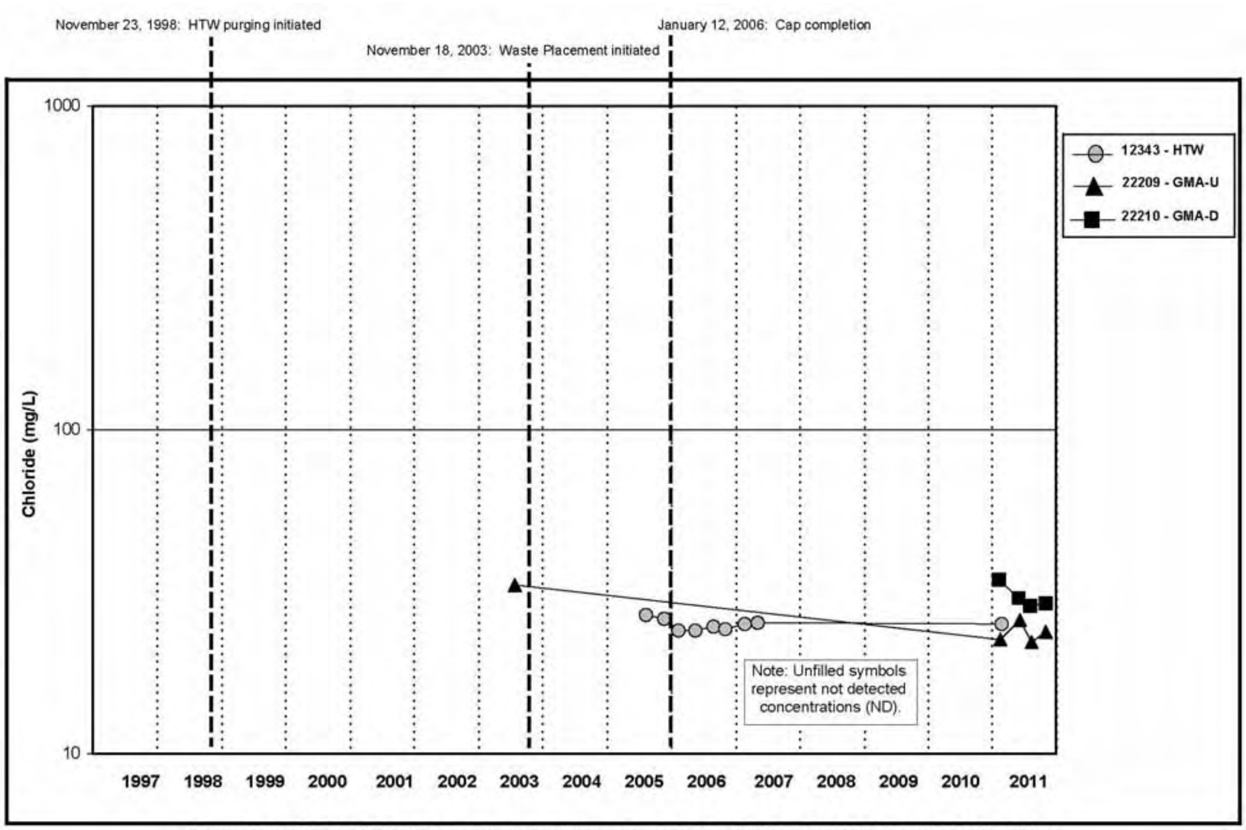


Figure A.5.6-7B. Cell 6 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

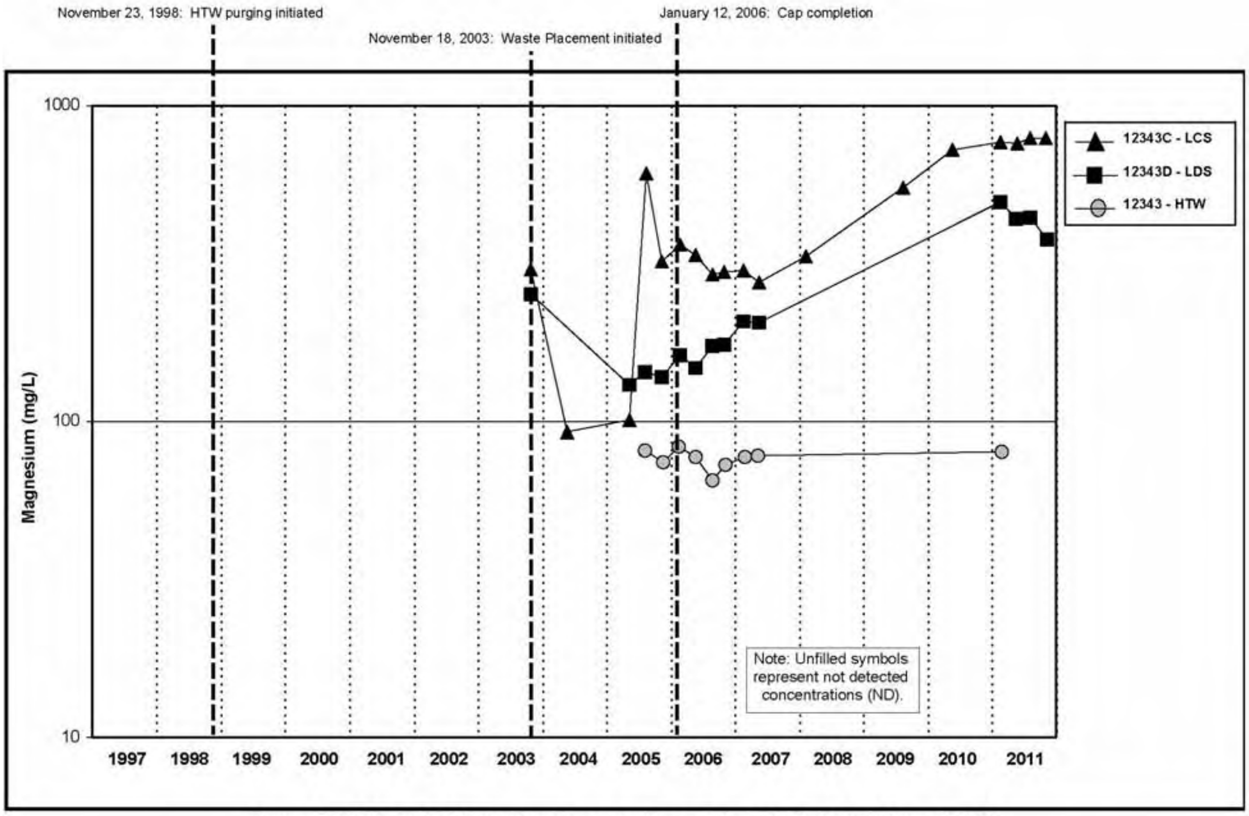


Figure A.5.6-8A. Cell 6 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

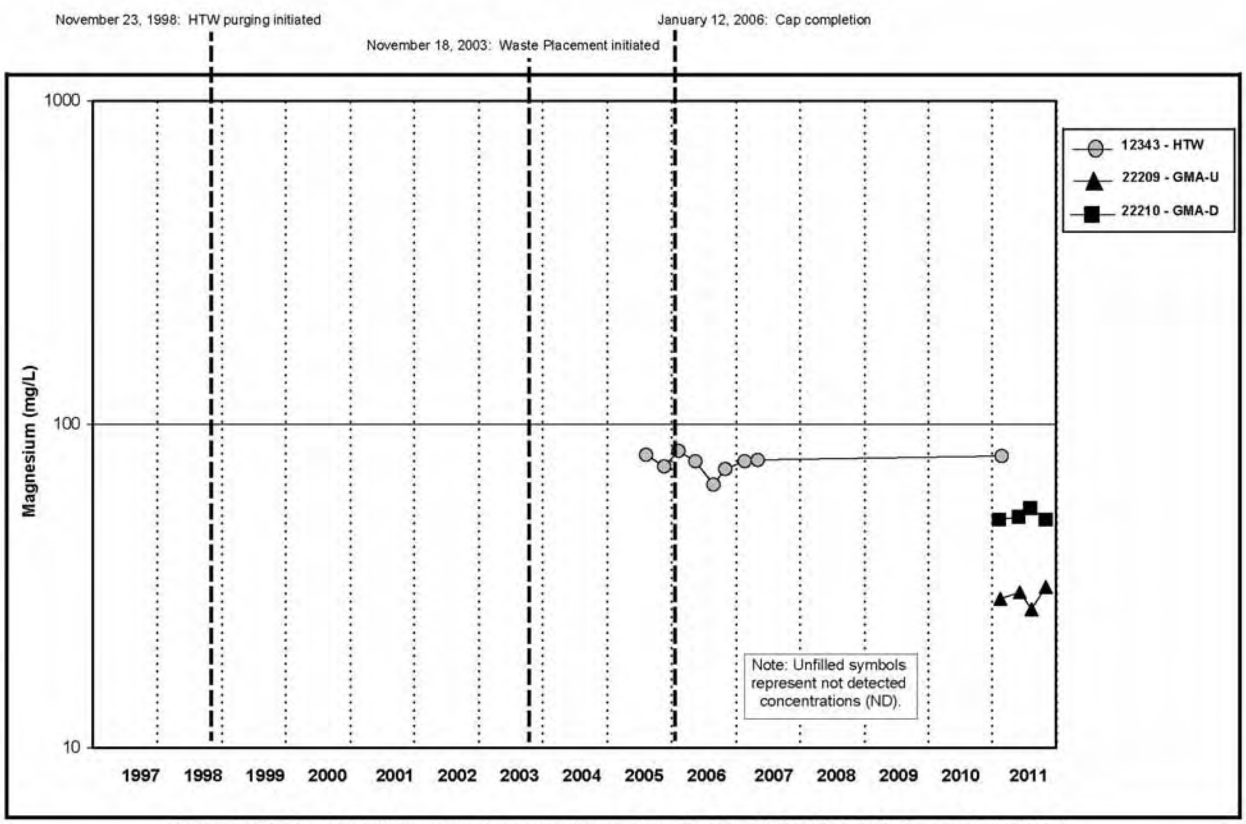


Figure A.5.6-8B. Cell 6 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

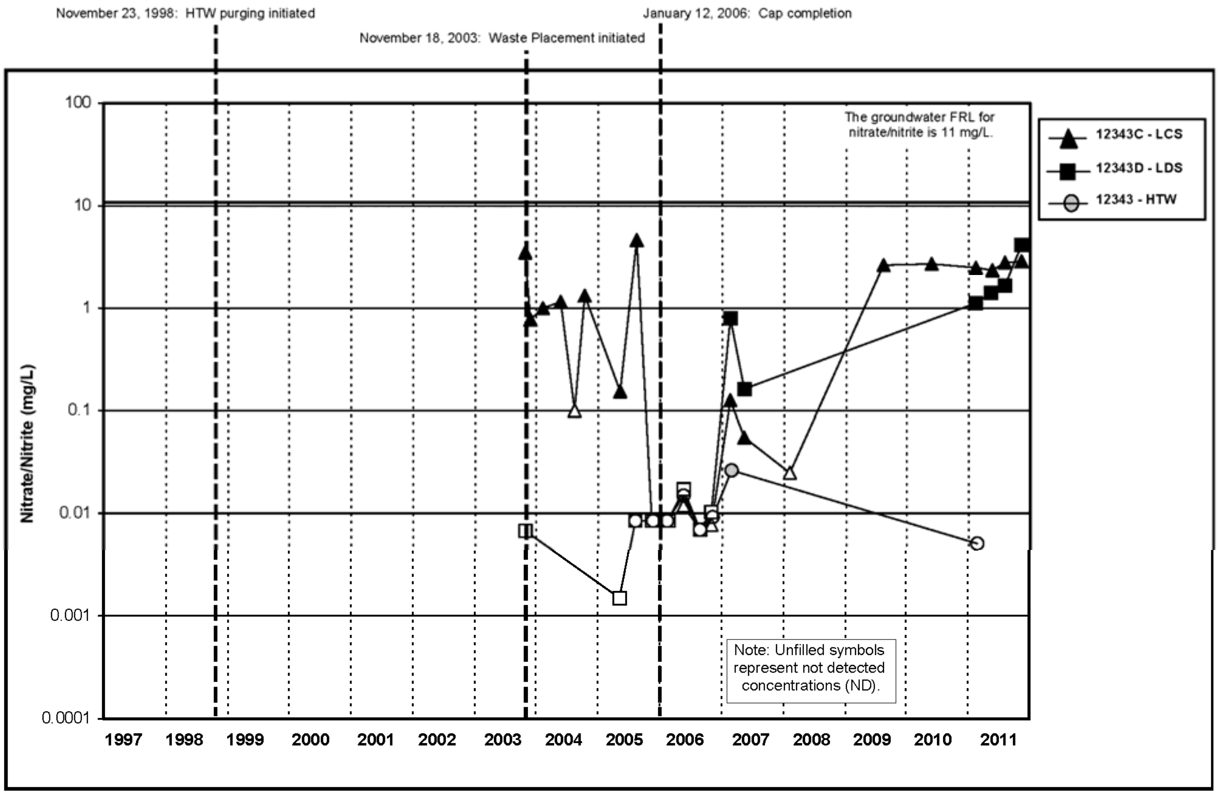


Figure A.5.6-9A. Cell 6 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

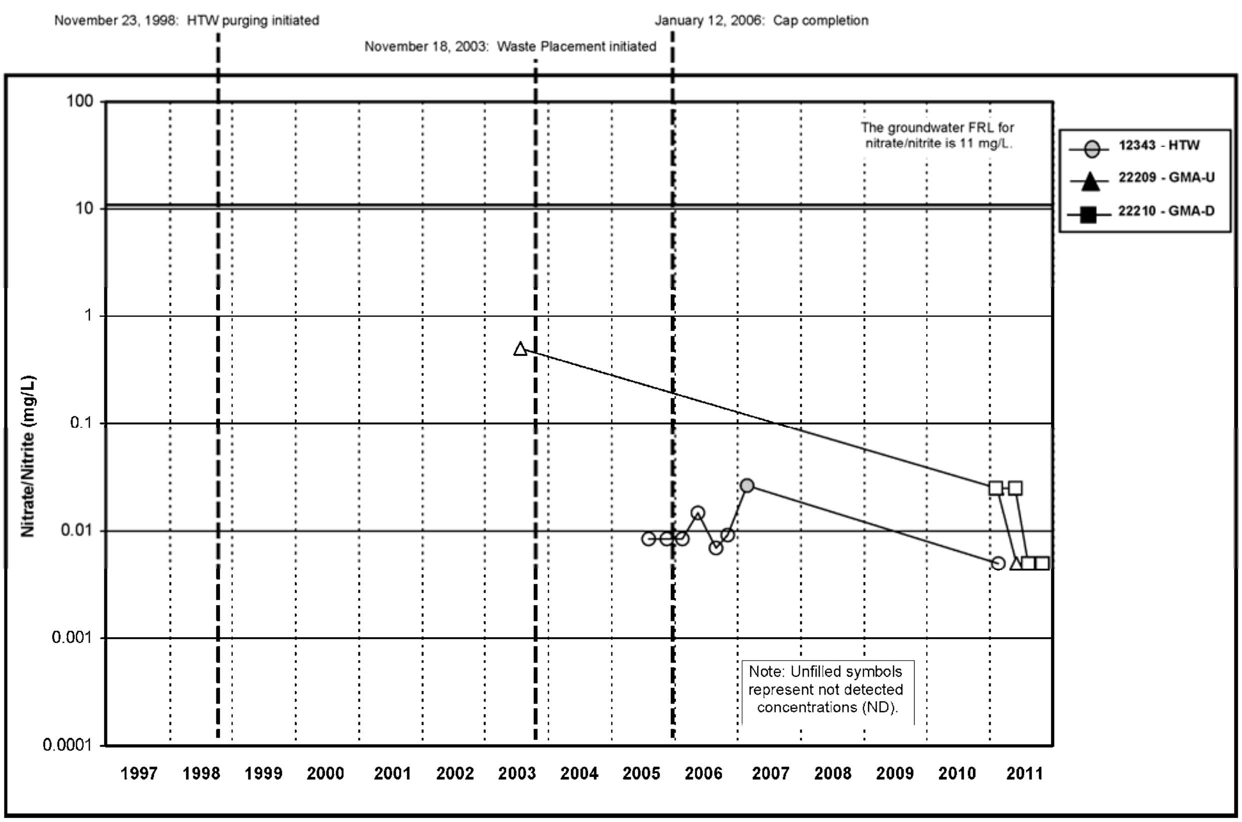


Figure A.5.6-9B. Cell 6 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

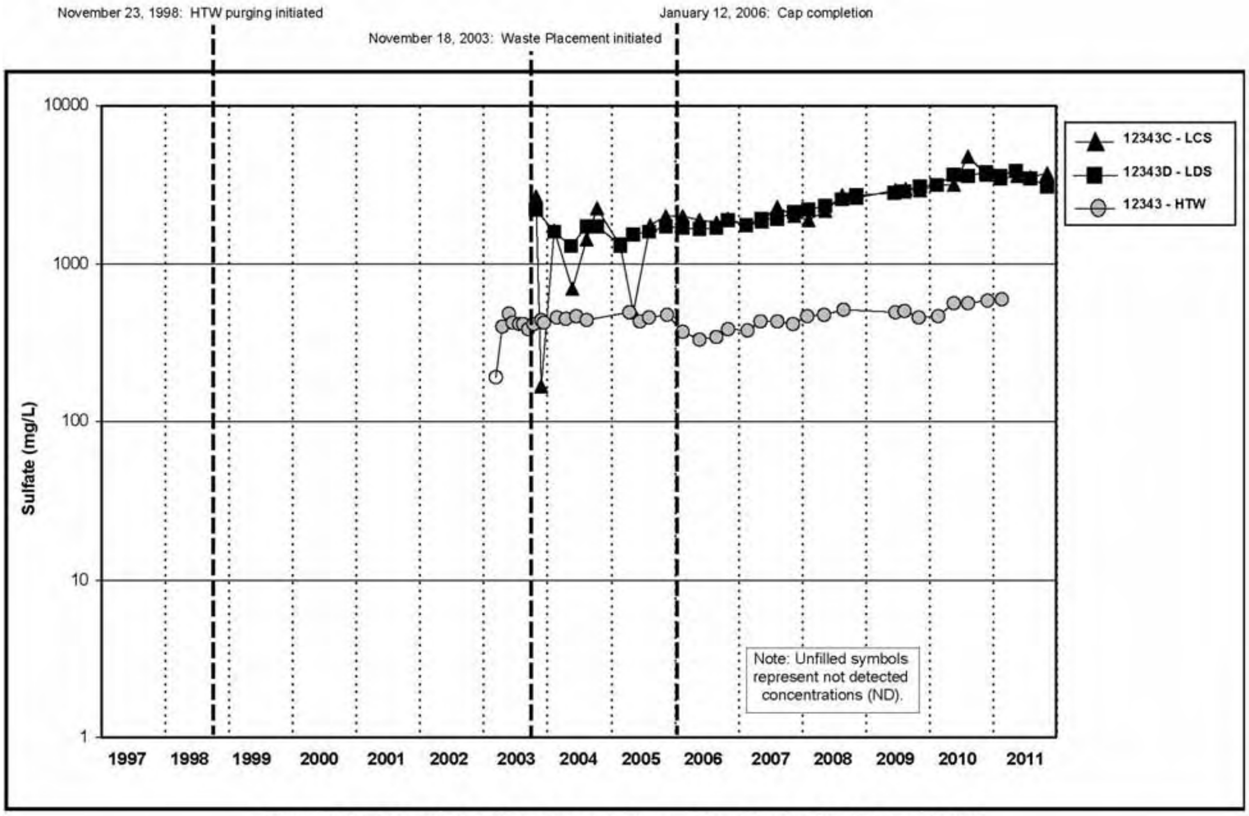


Figure A.5.6-10A. Cell 6 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

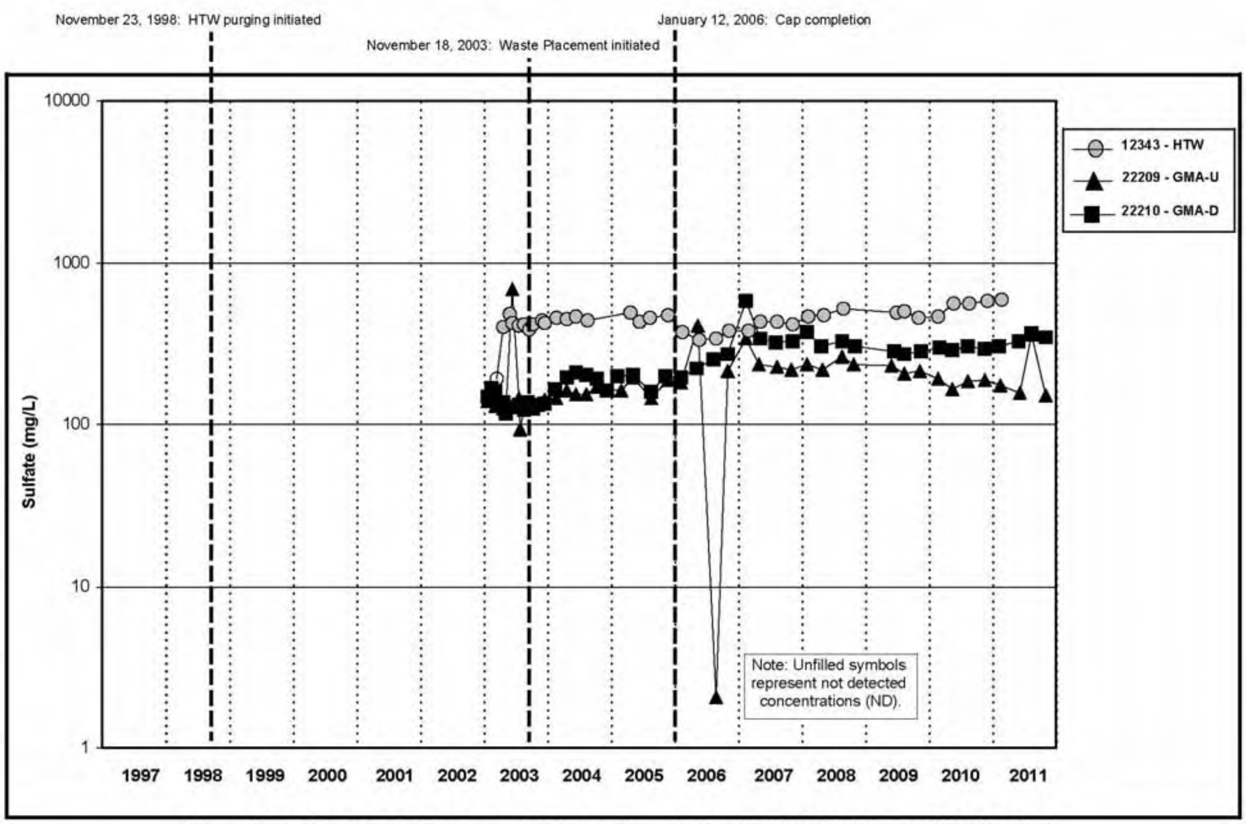


Figure A.5.6-10B. Cell 6 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

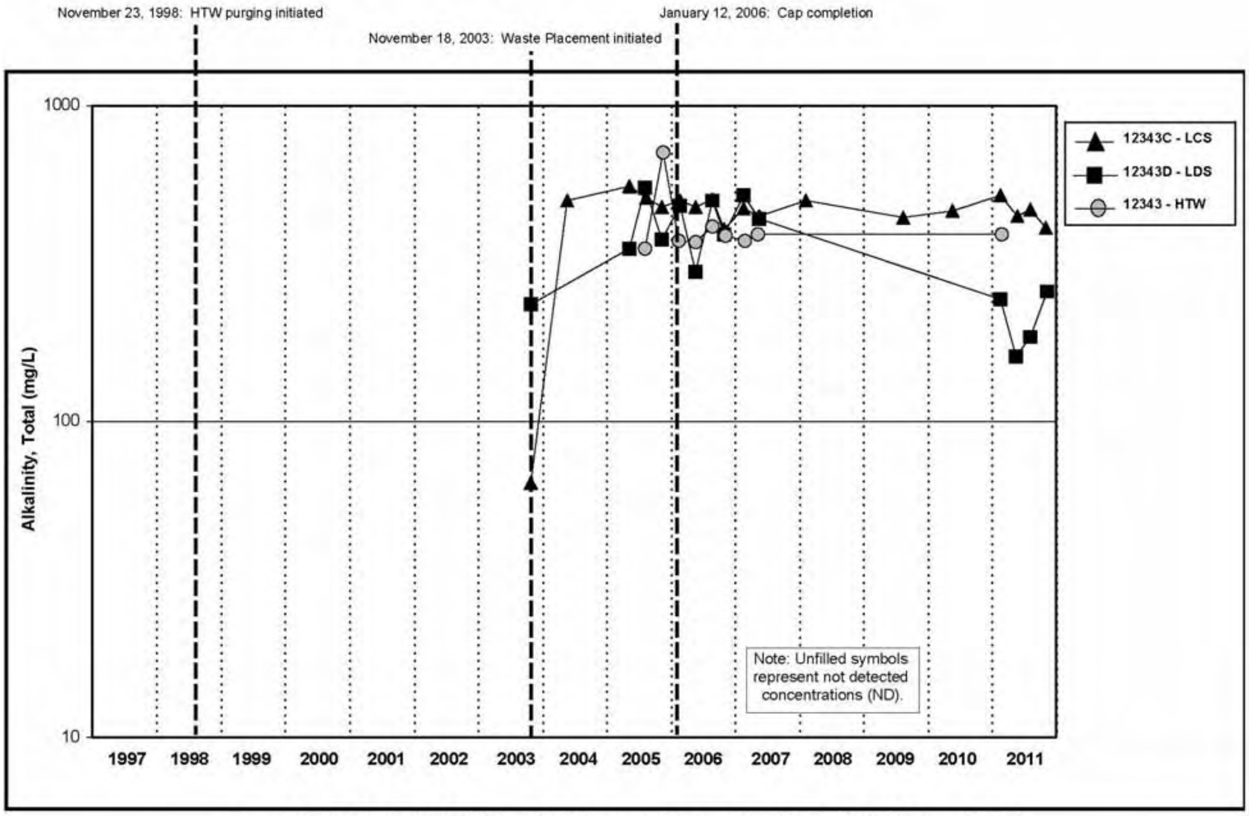


Figure A.5.6-11A. Cell 6 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

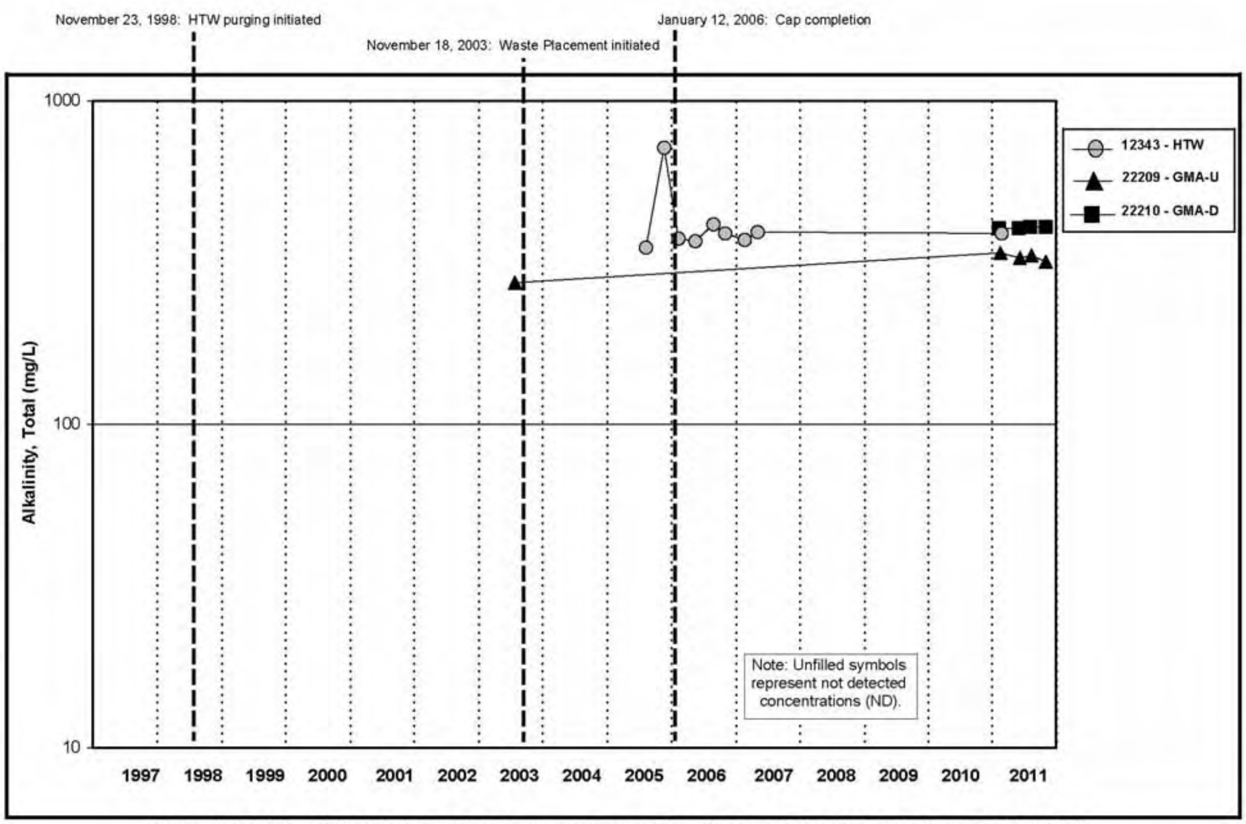


Figure A.5.6-11B. Cell 6 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

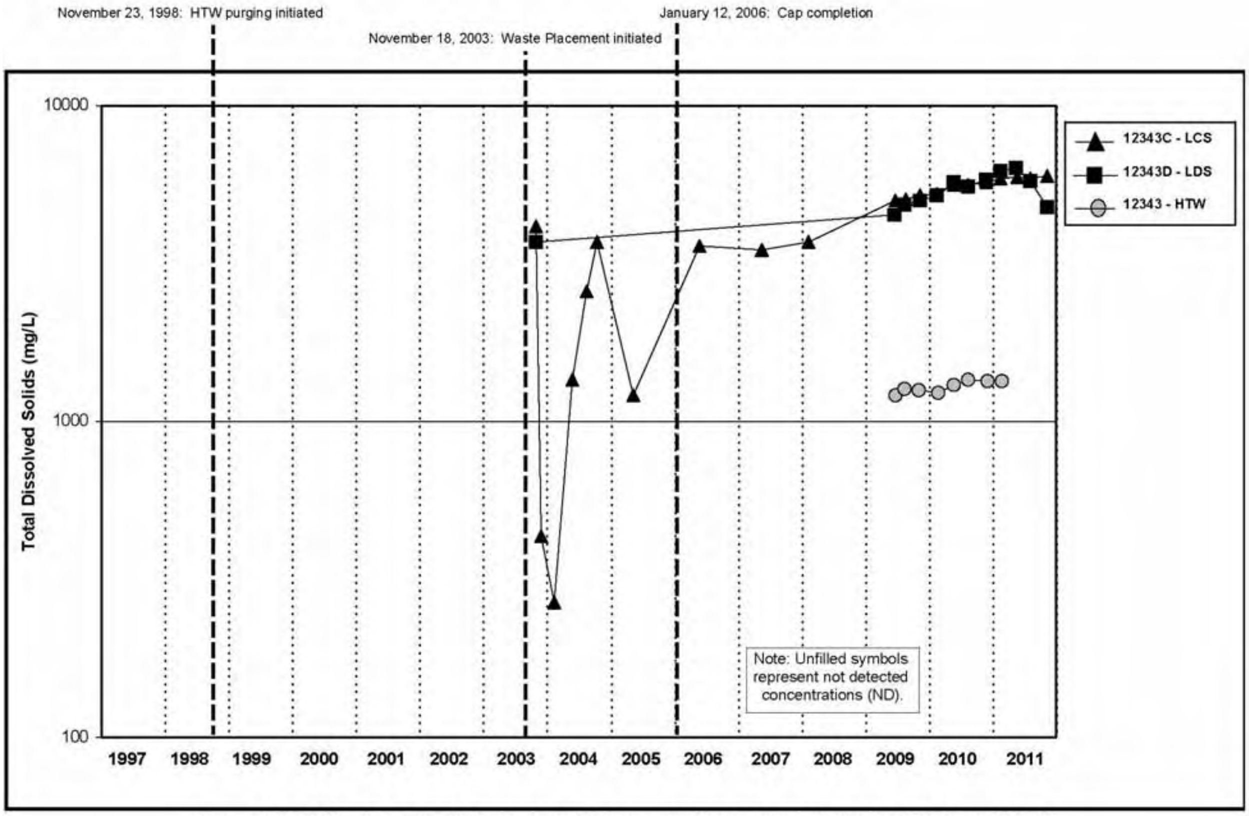


Figure A.5.6-12A. Cell 6 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

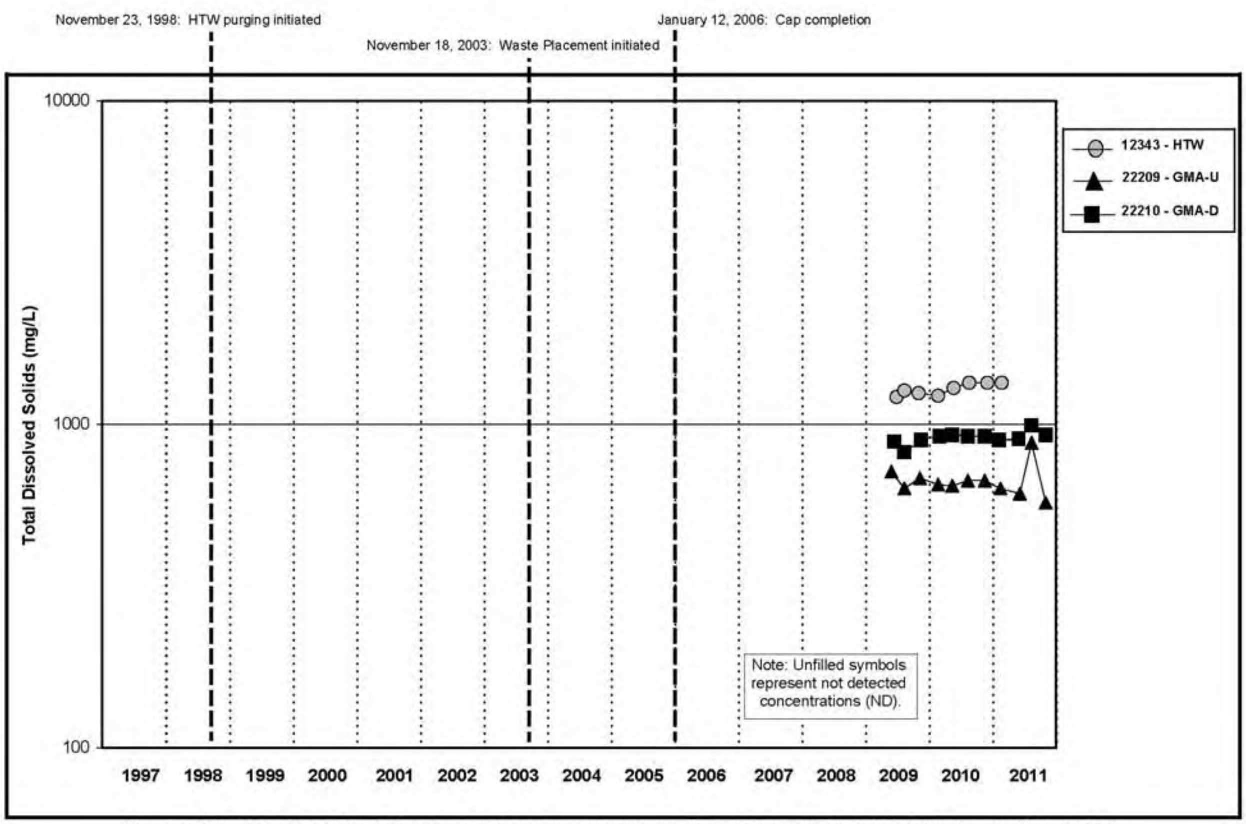


Figure A.5.6-12B. Cell 6 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

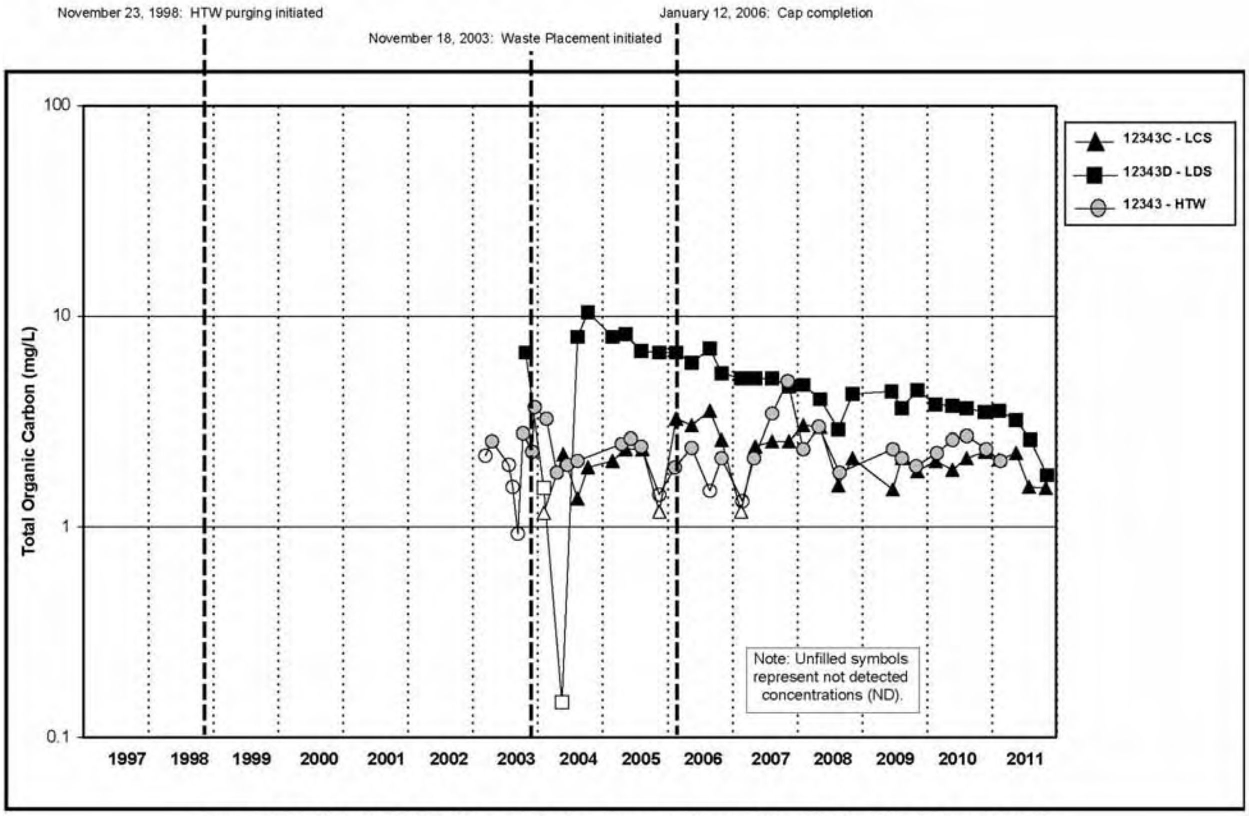


Figure A.5.6-13A. Cell 6 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

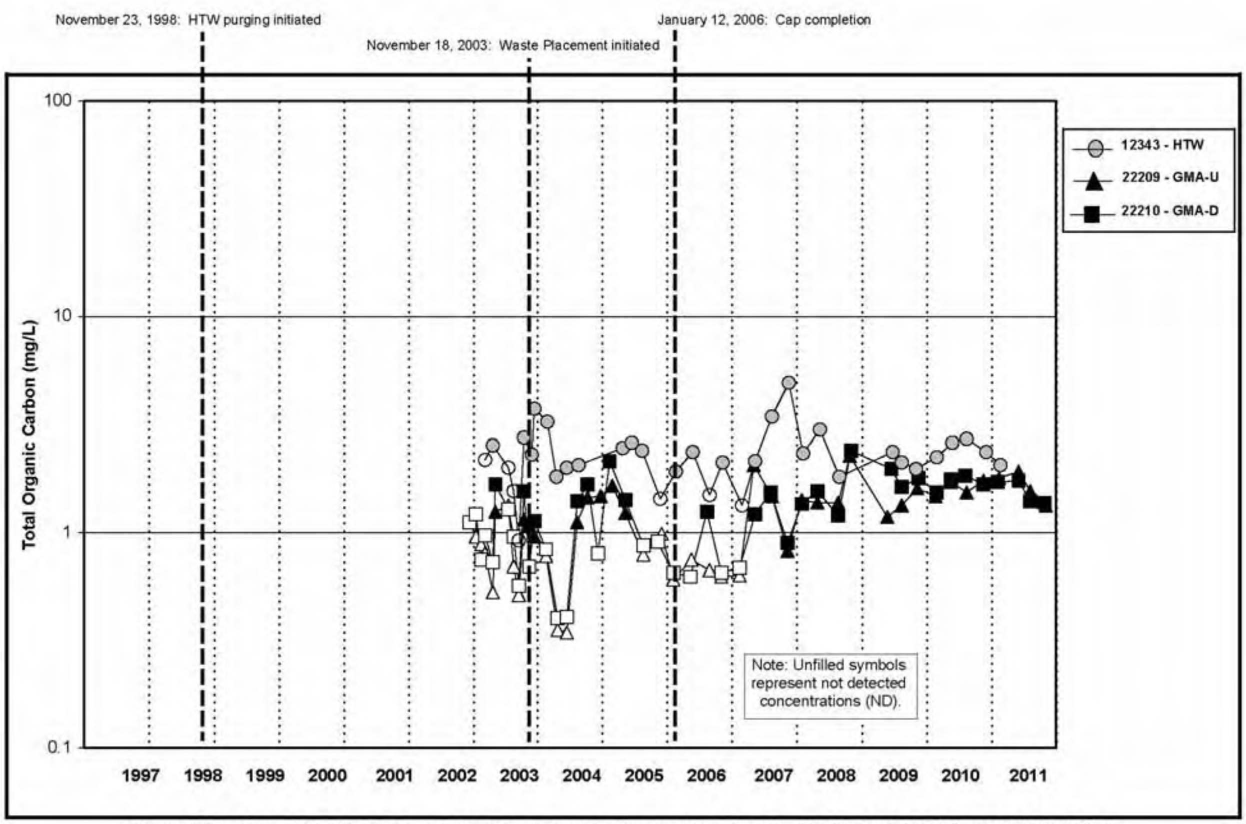


Figure A.5.6-13B. Cell 6 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

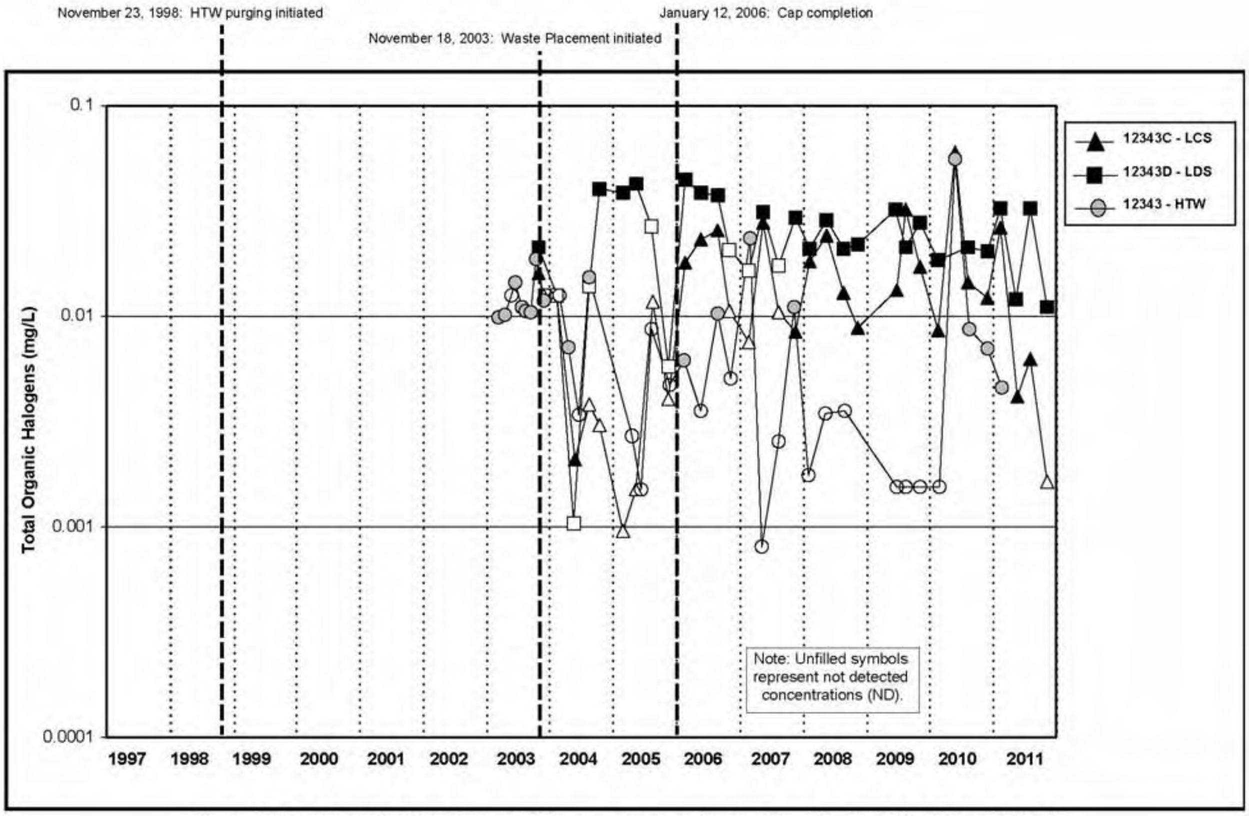


Figure A.5.6-14A. Cell 6 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

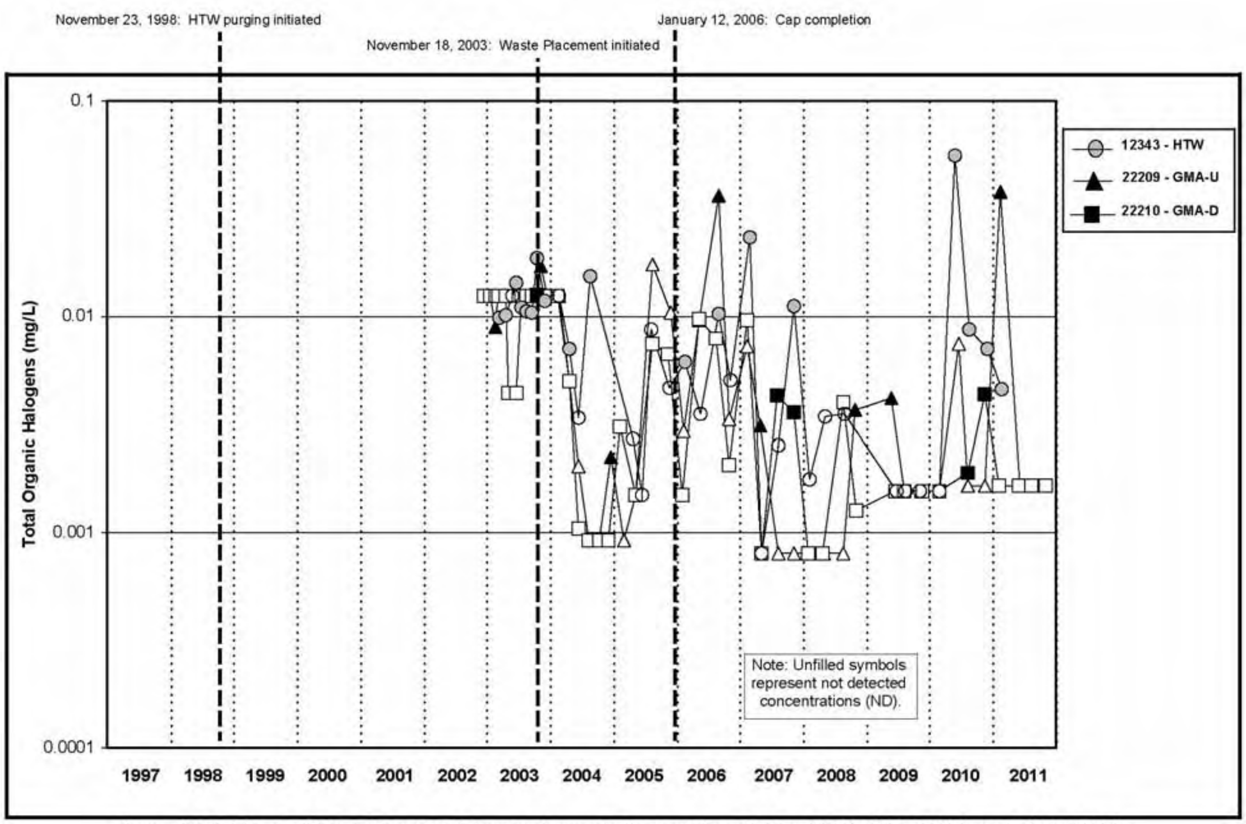


Figure A.5.6-14B. Cell 6 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

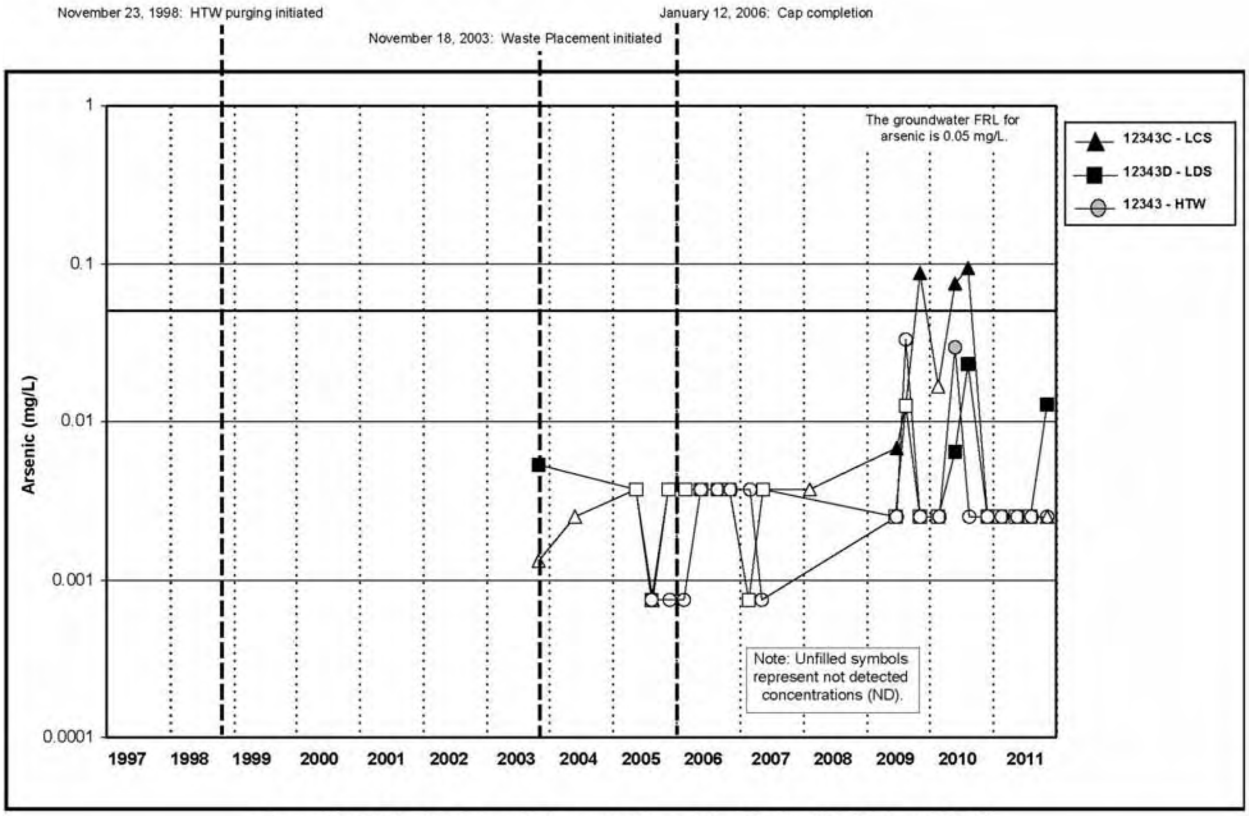


Figure A.5.6-15A. Cell 6 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

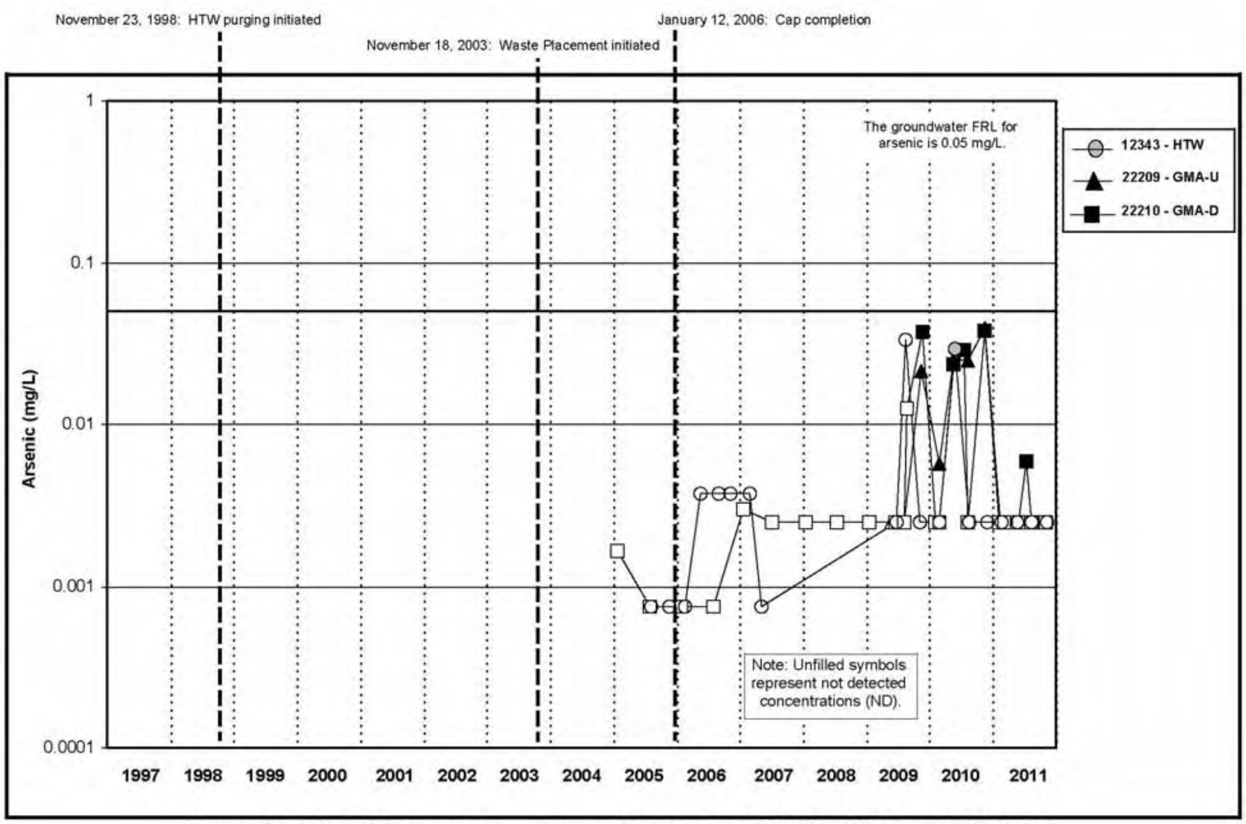


Figure A.5.6-15B. Cell 6 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

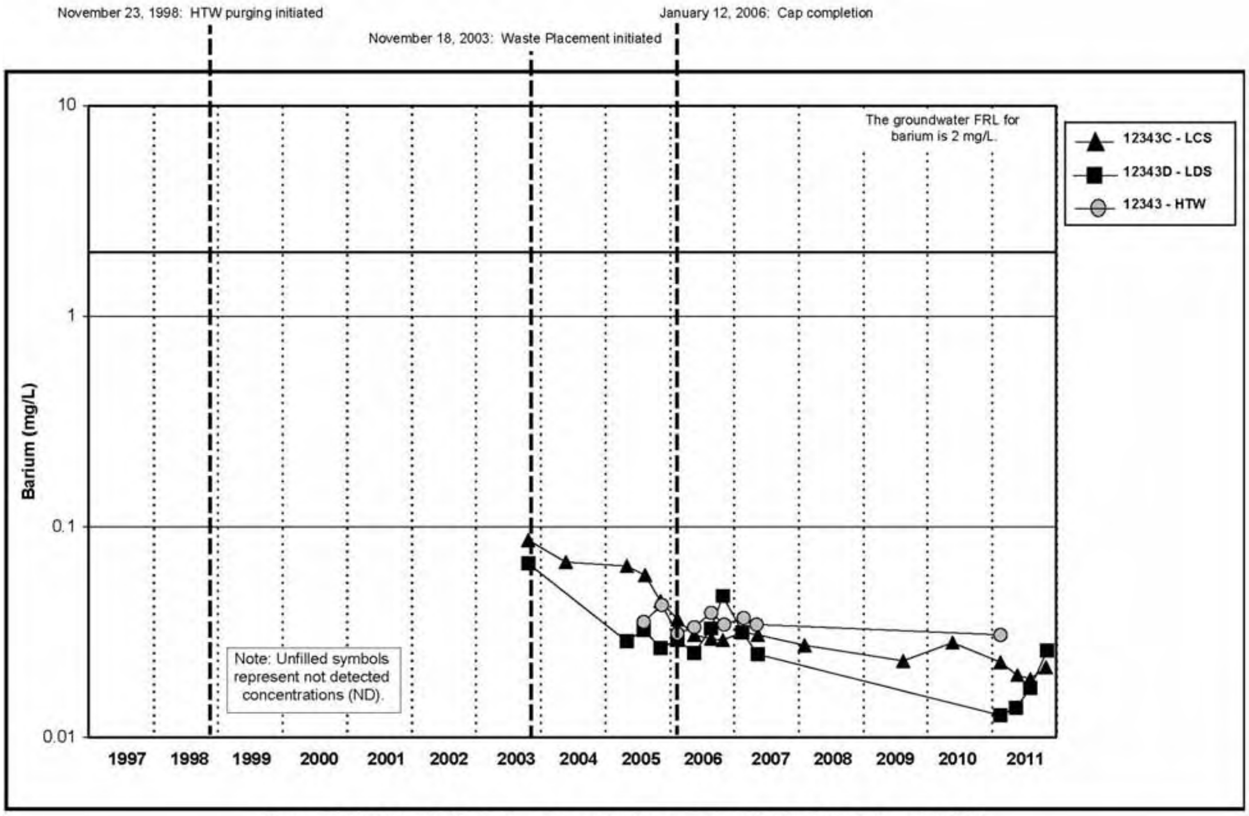


Figure A.5.6-16A. Cell 6 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

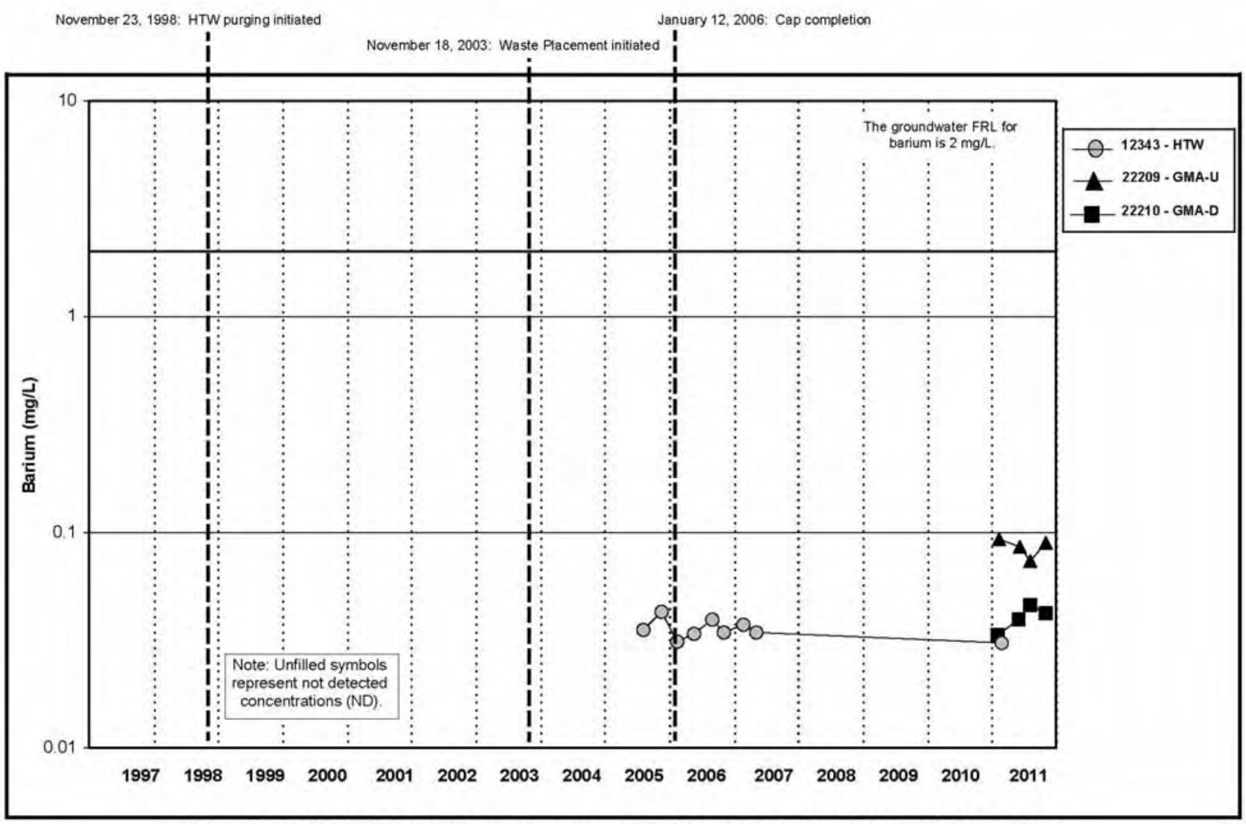


Figure A.5.6-16B. Cell 6 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

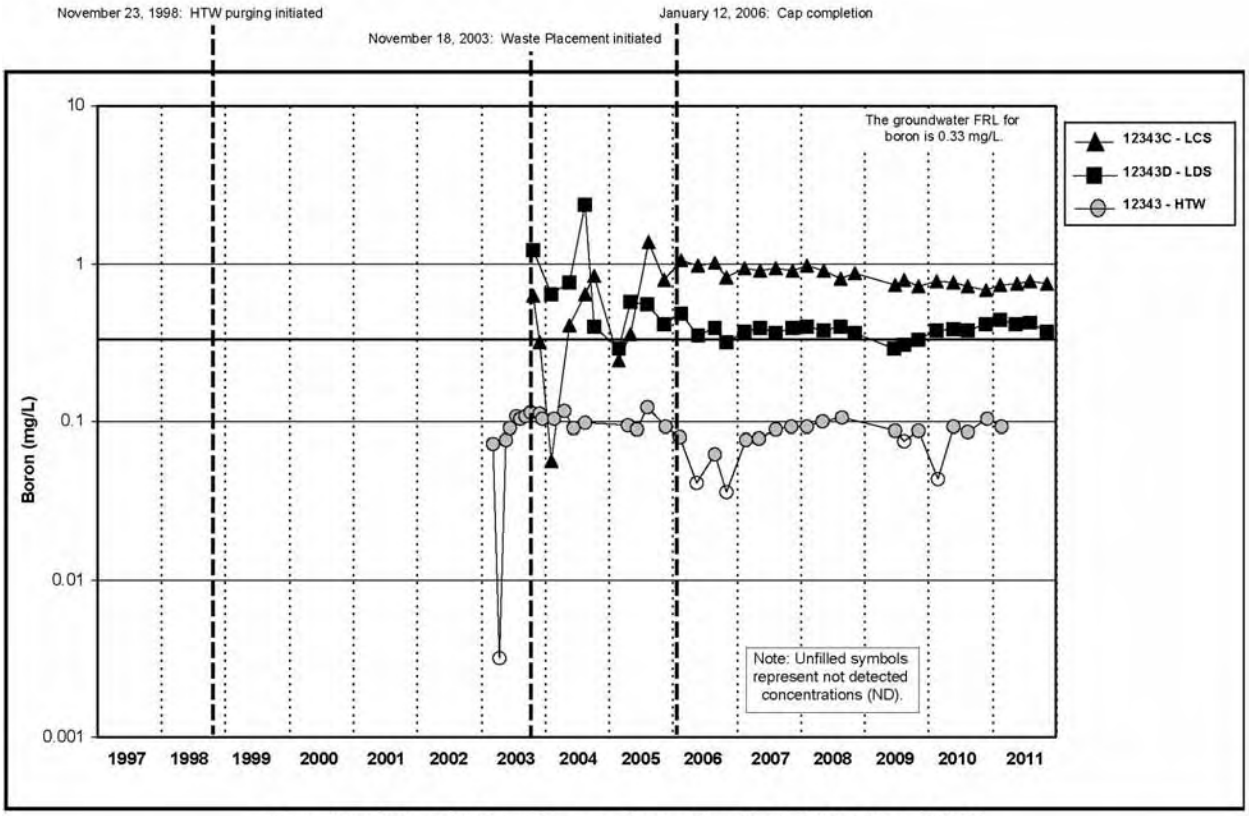


Figure A.5.6-17A. Cell 6 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

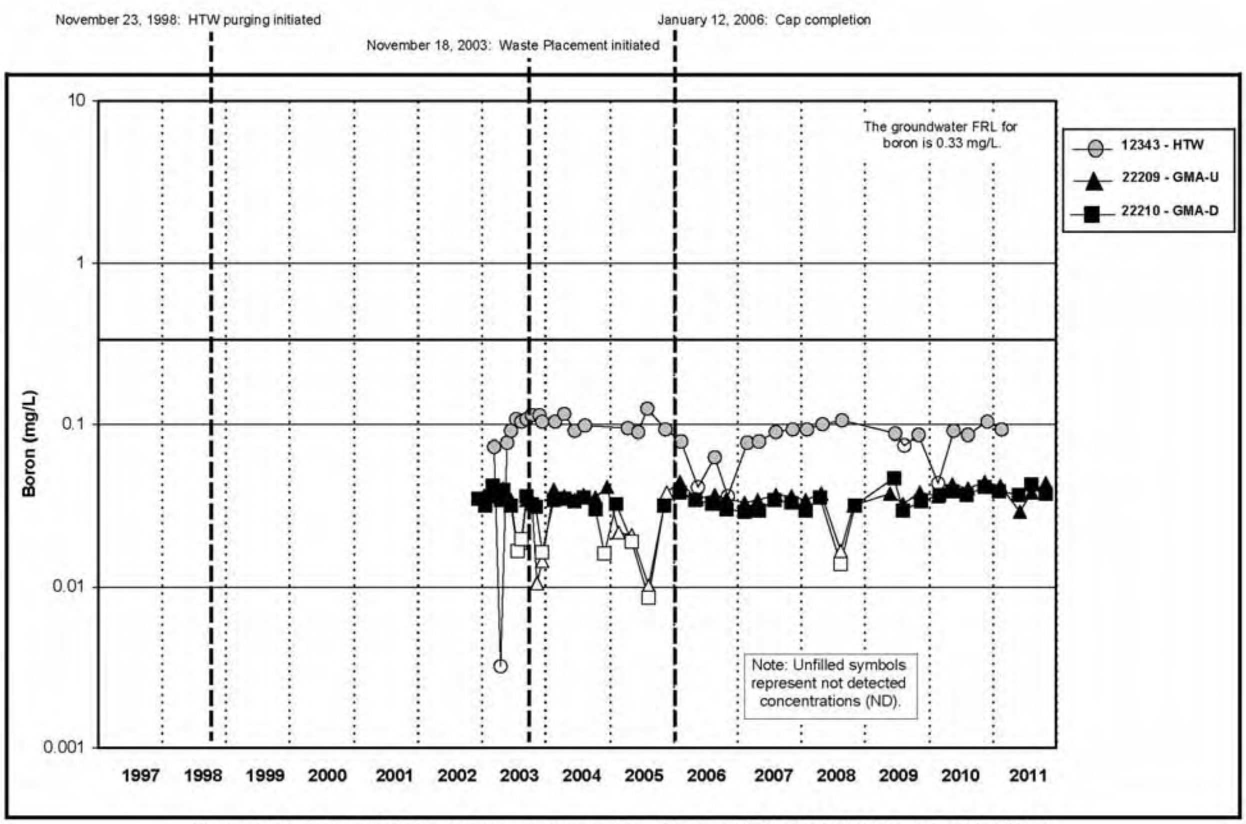


Figure A.5.6-17B. Cell 6 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

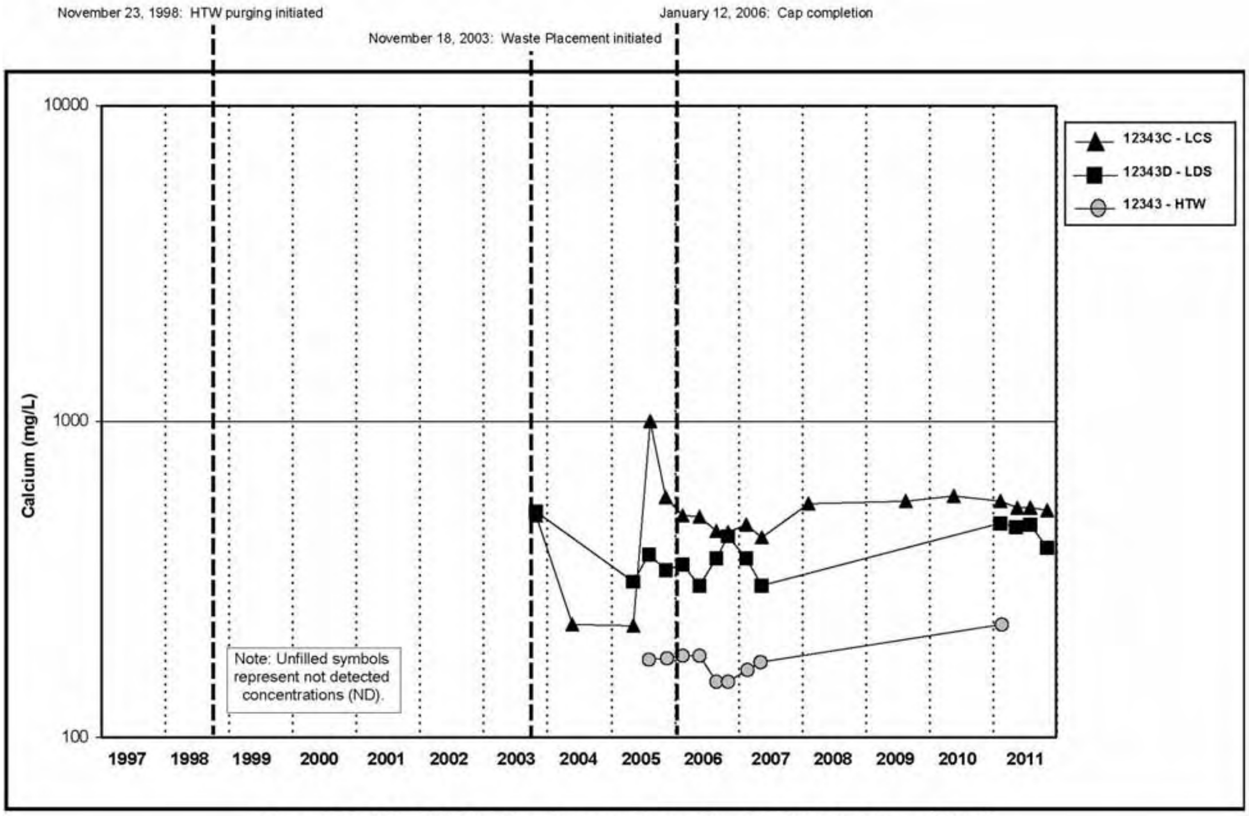


Figure A.5.6-18A. Cell 6 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

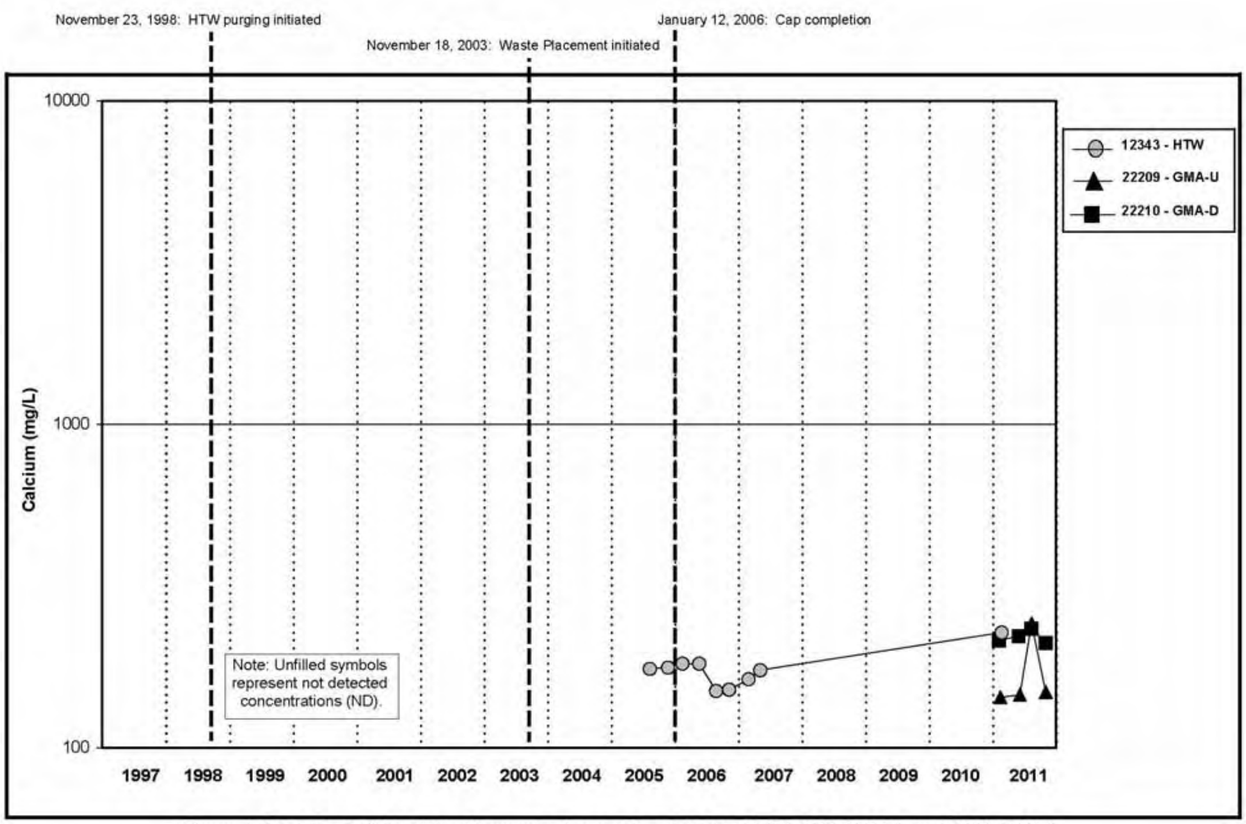


Figure A.5.6-18B. Cell 6 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

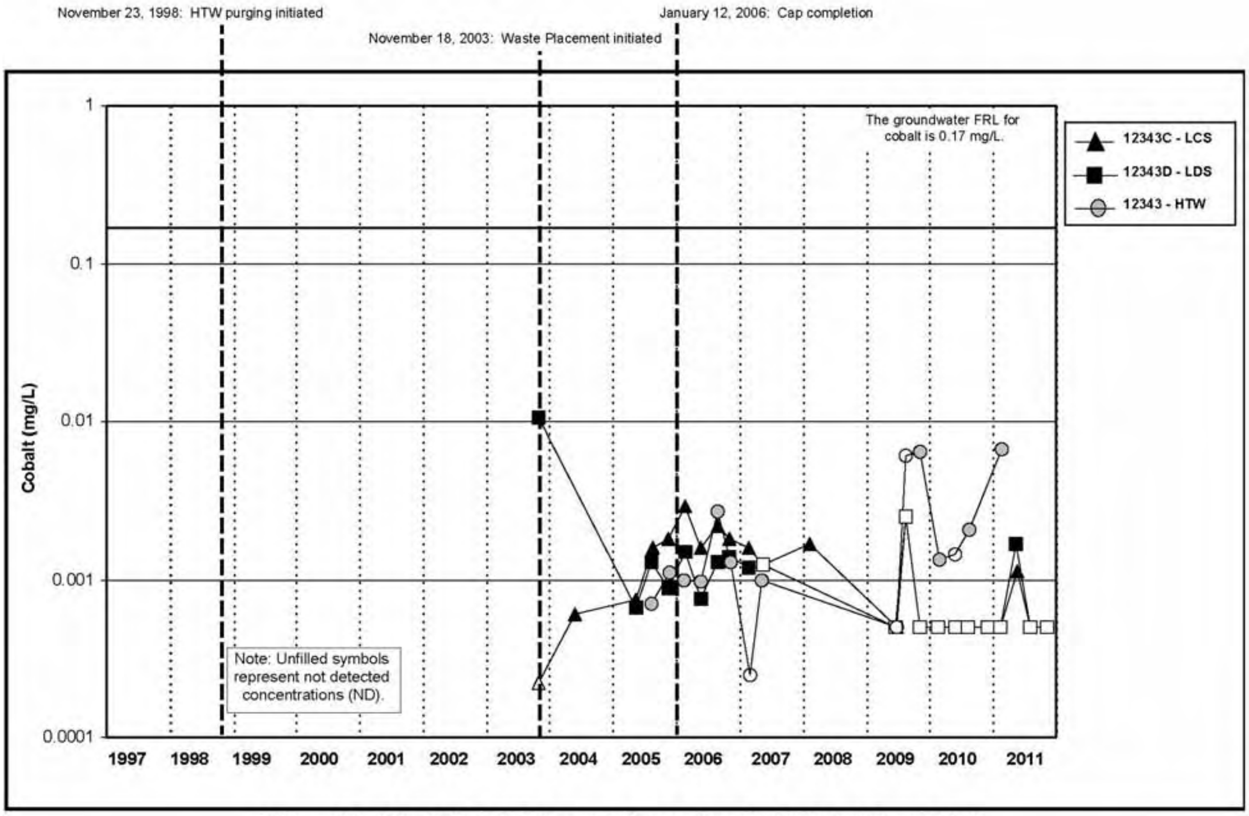


Figure A.5.6-19A. Cell 6 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

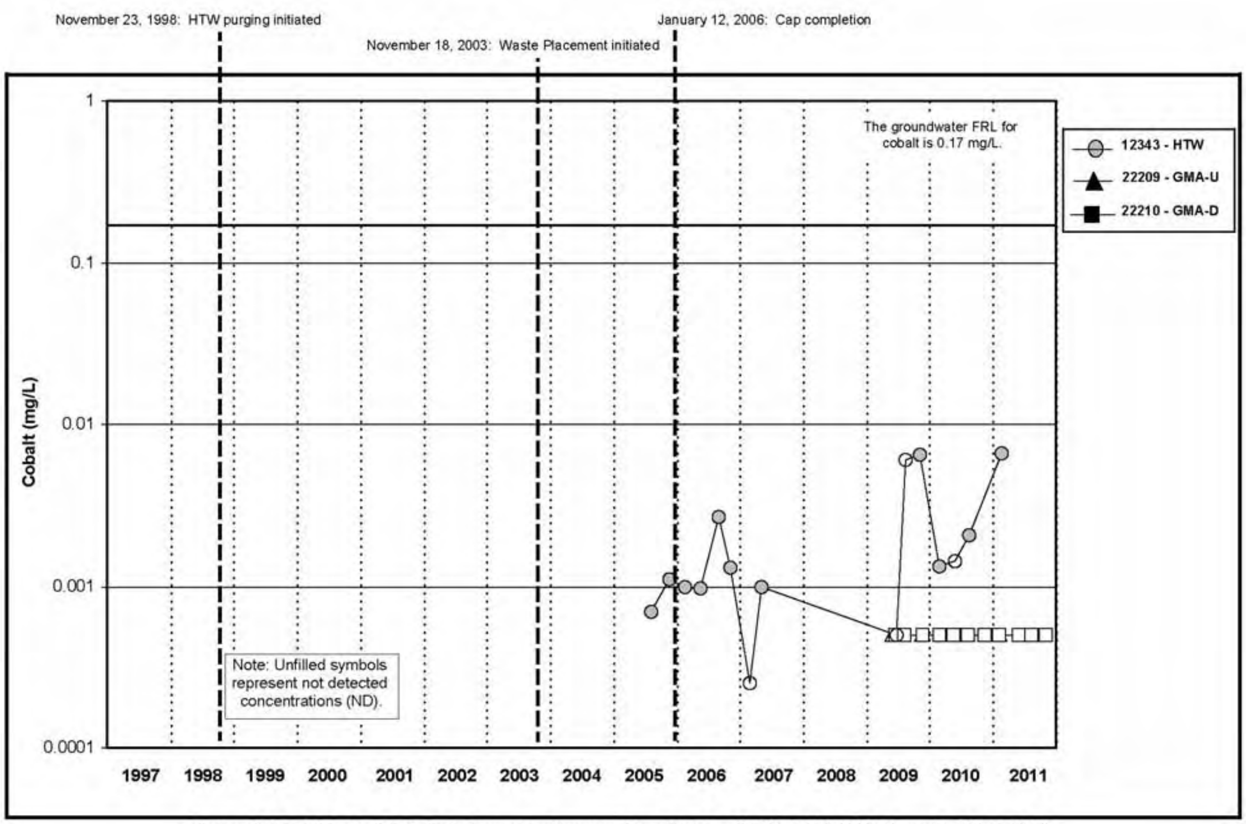


Figure A.5.6-19B. Cell 6 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

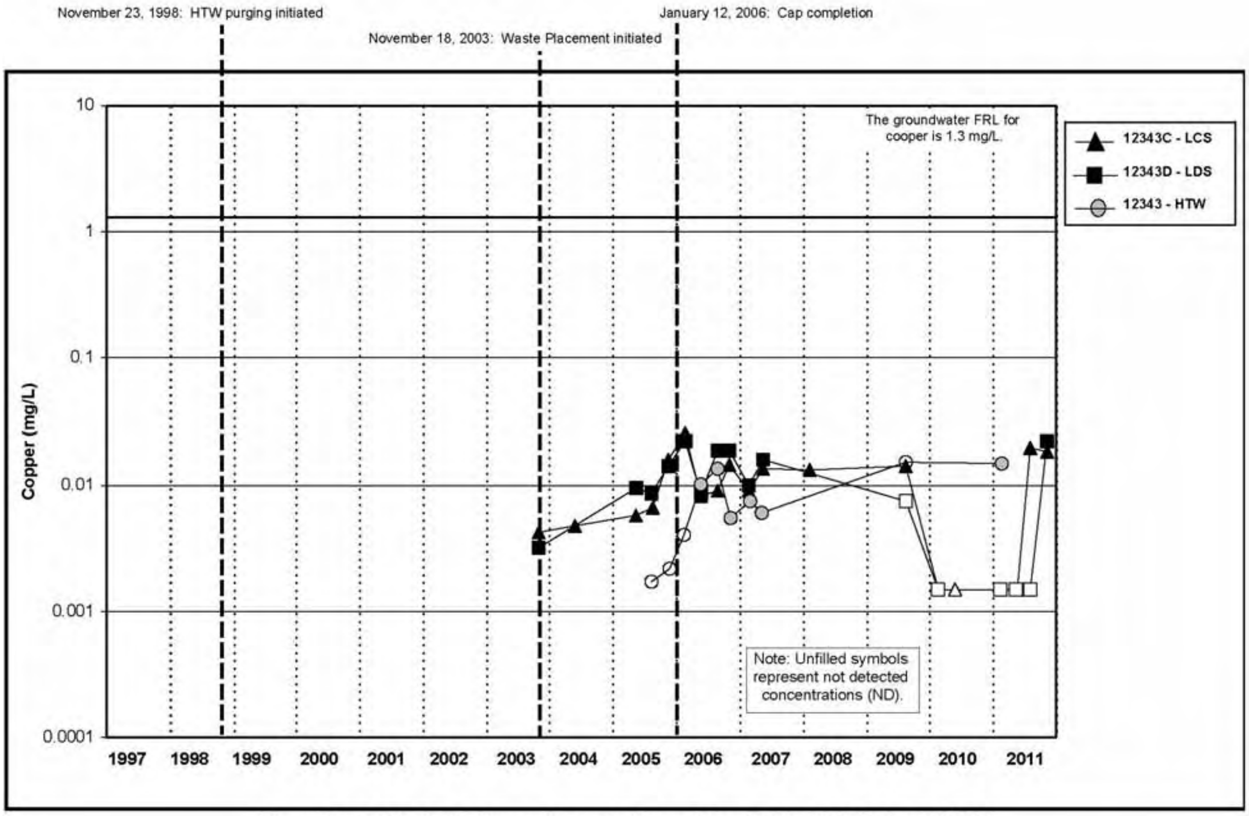


Figure A.5.6-20A. Cell 6 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

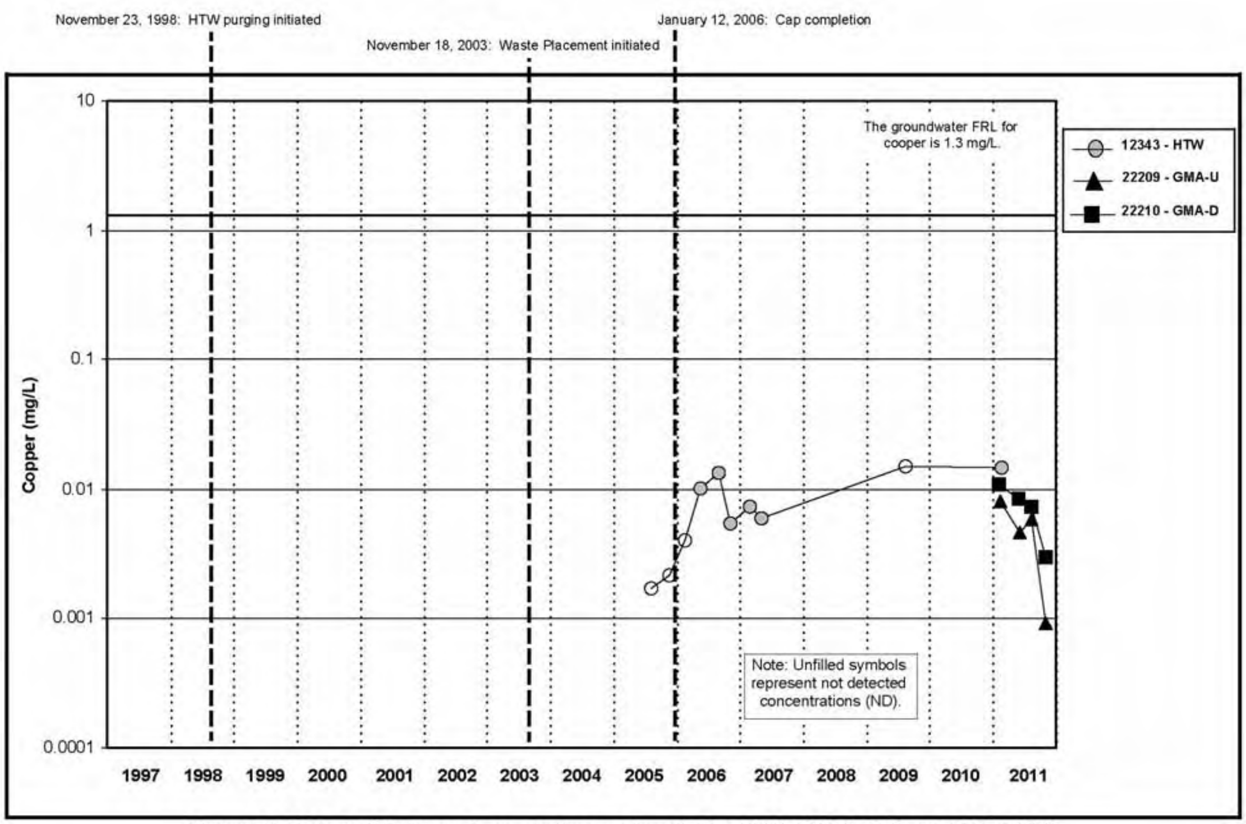


Figure A.5.6-20B. Cell 6 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

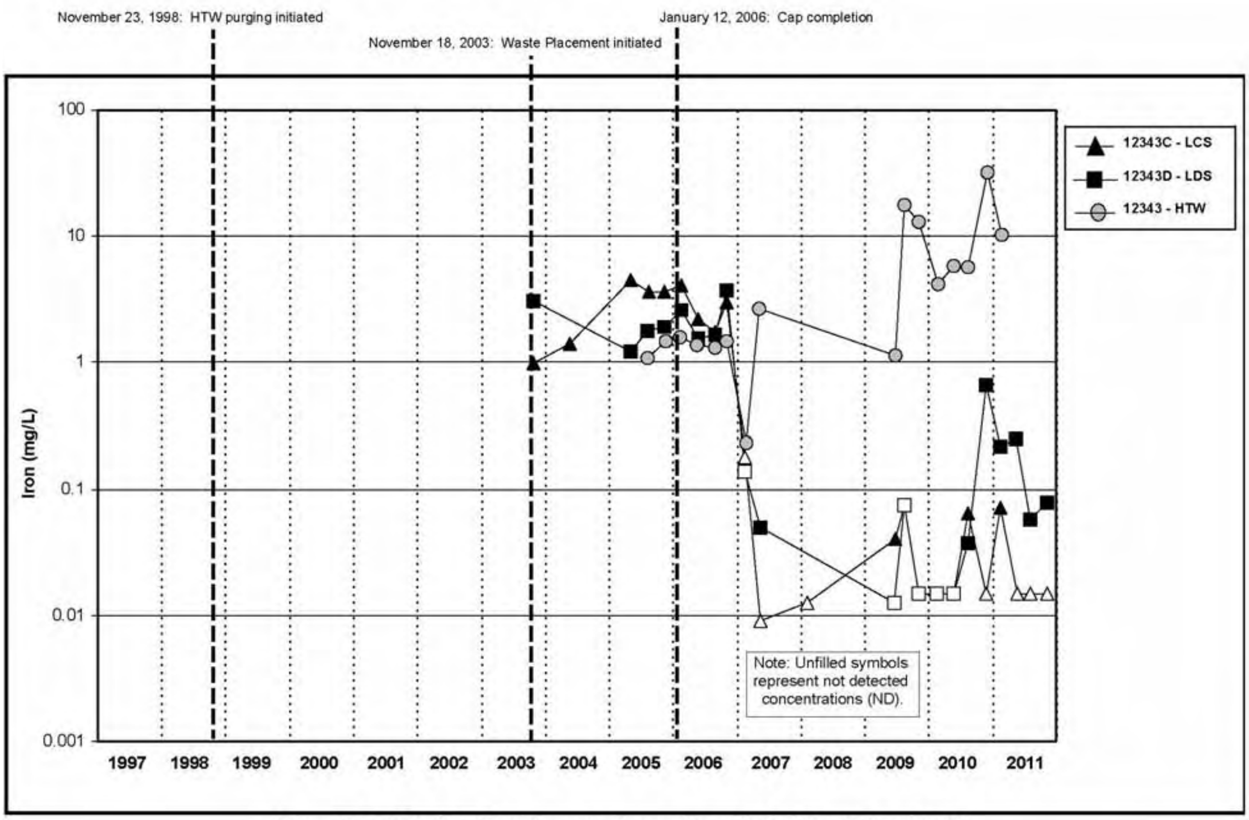


Figure A.5.6-21A. Cell 6 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

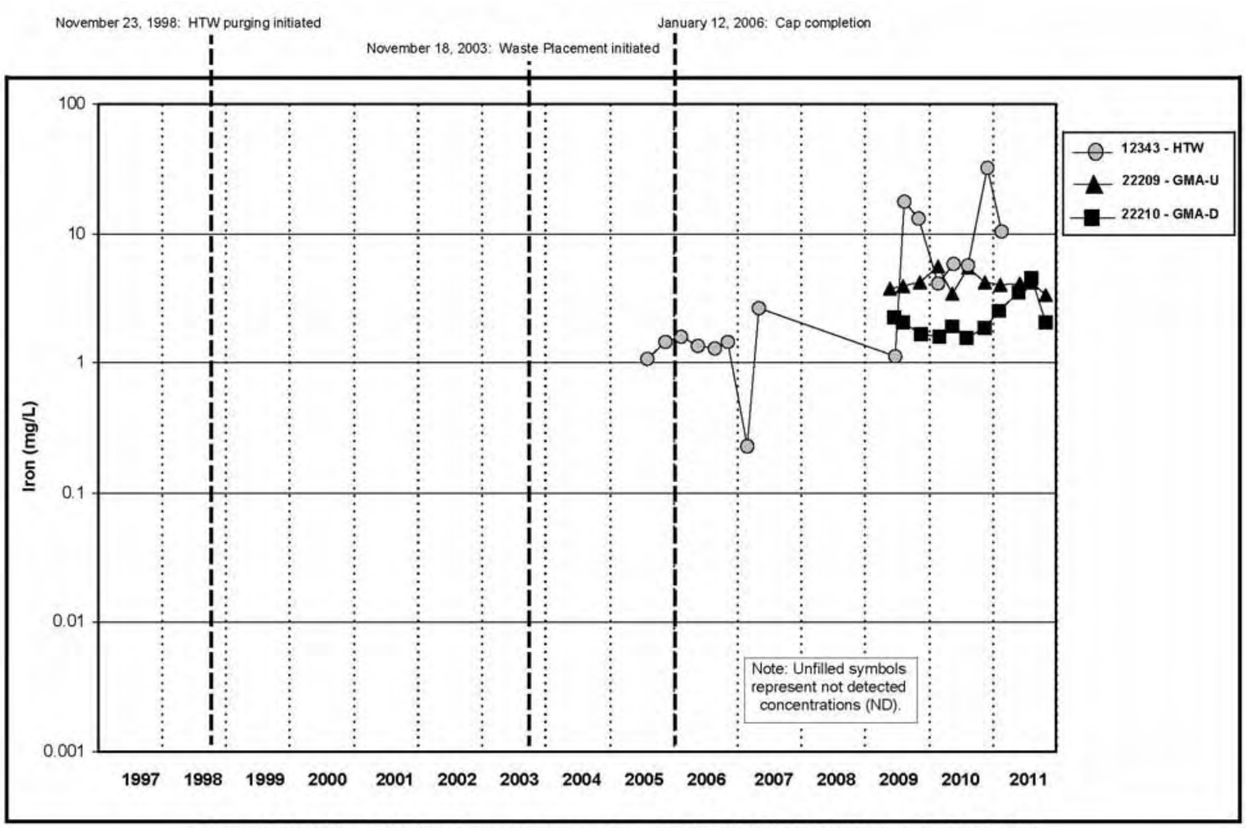


Figure A.5.6-21B. Cell 6 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

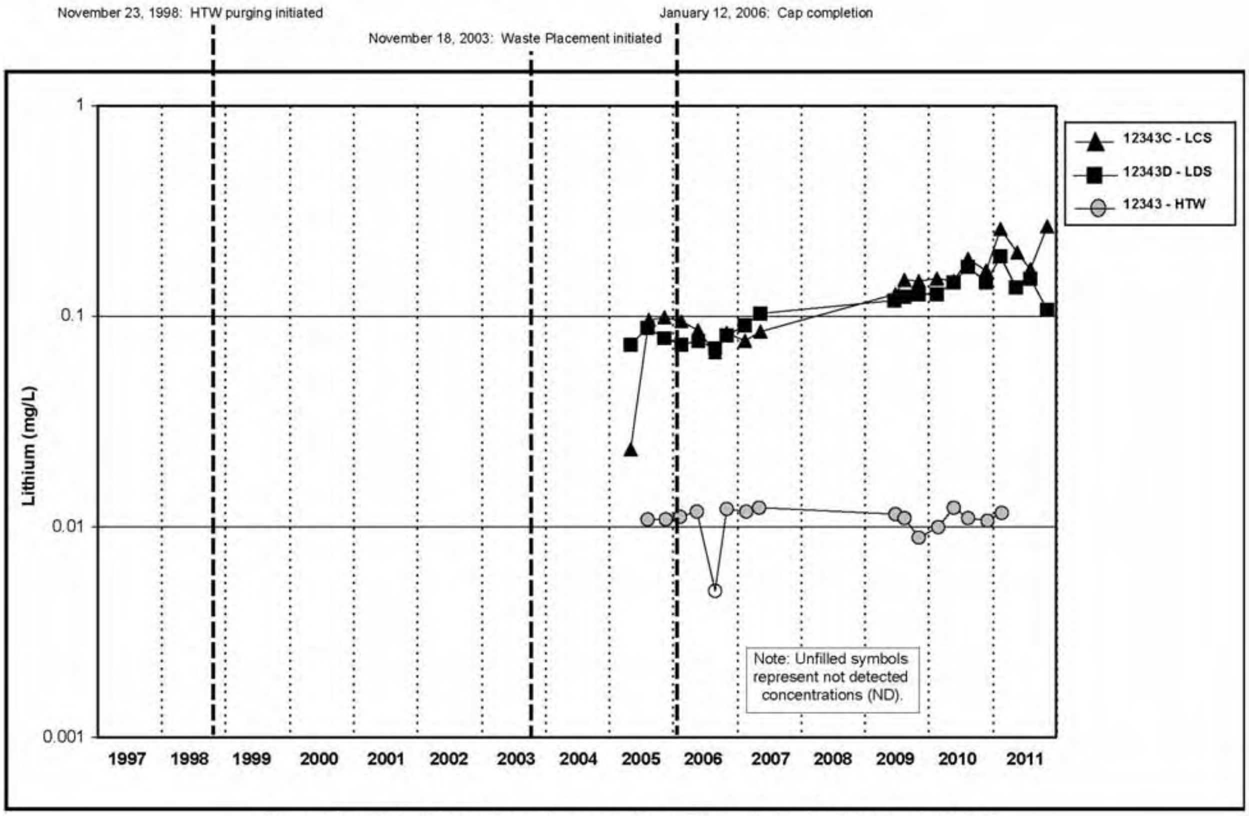


Figure A.5.6-22A. Cell 6 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

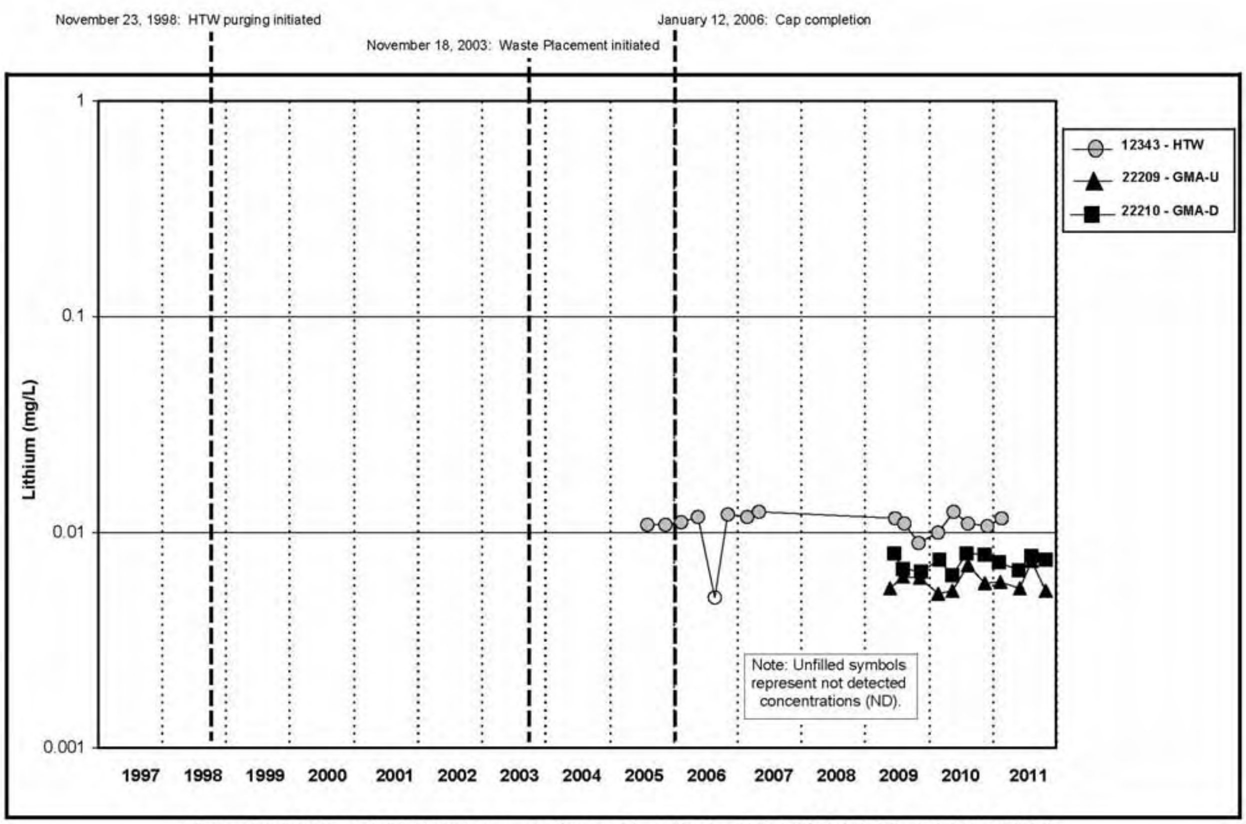


Figure A.5.6-22B. Cell 6 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

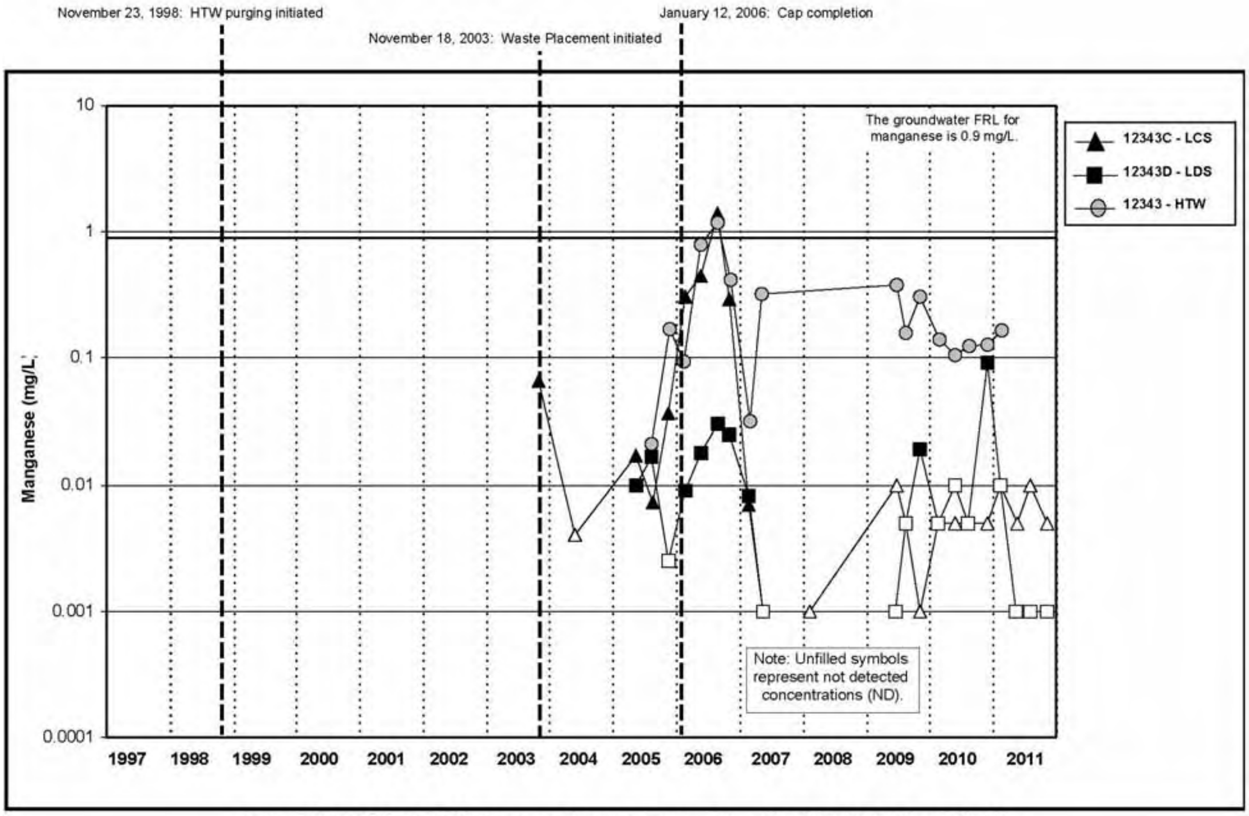


Figure A.5.6-23A. Cell 6 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

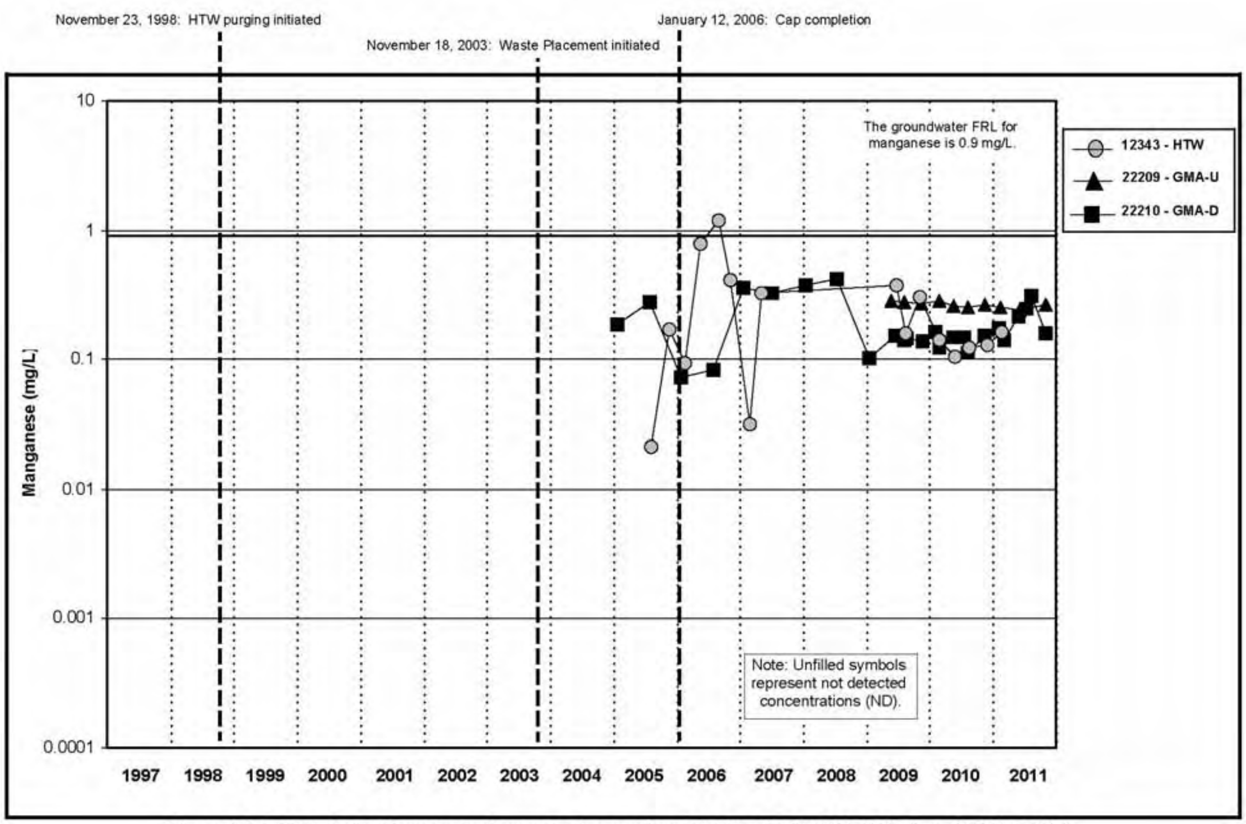


Figure A.5.6-23B. Cell 6 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

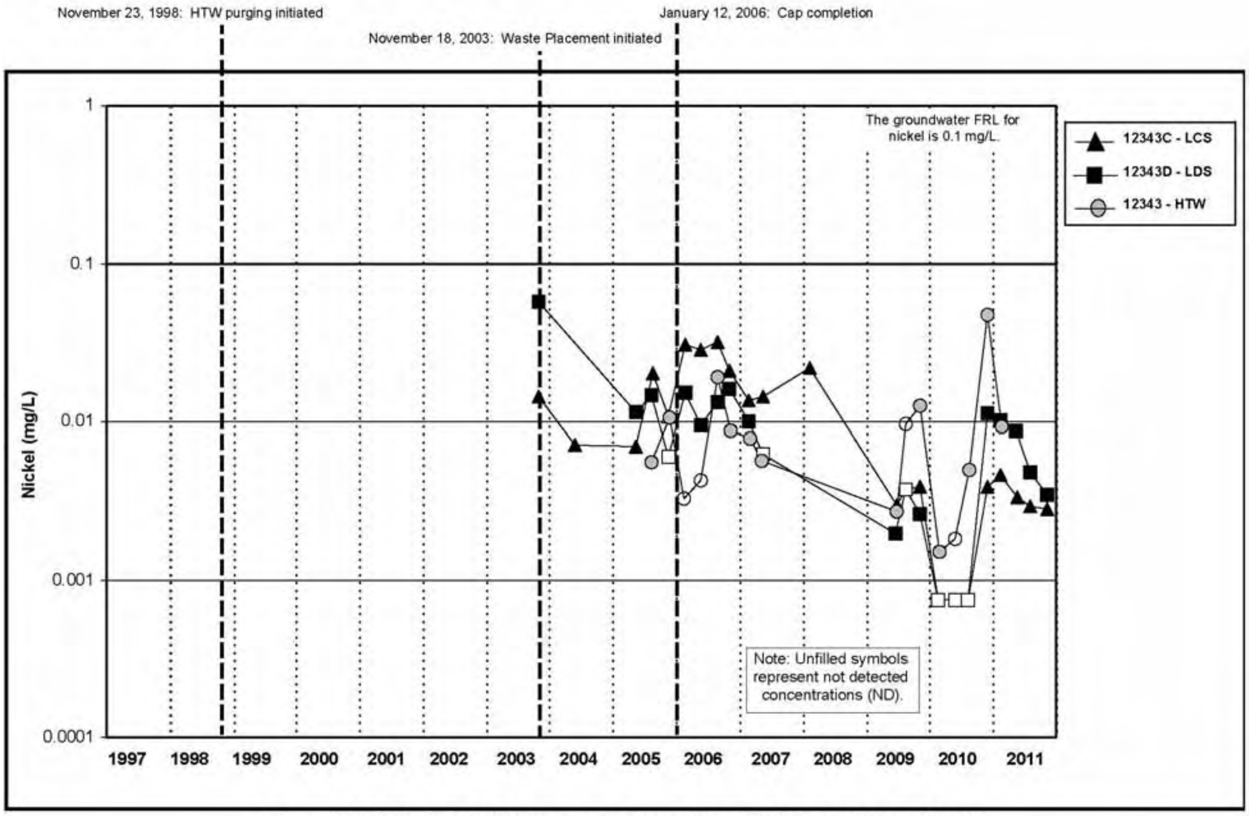


Figure A.5.6-24A. Cell 6 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

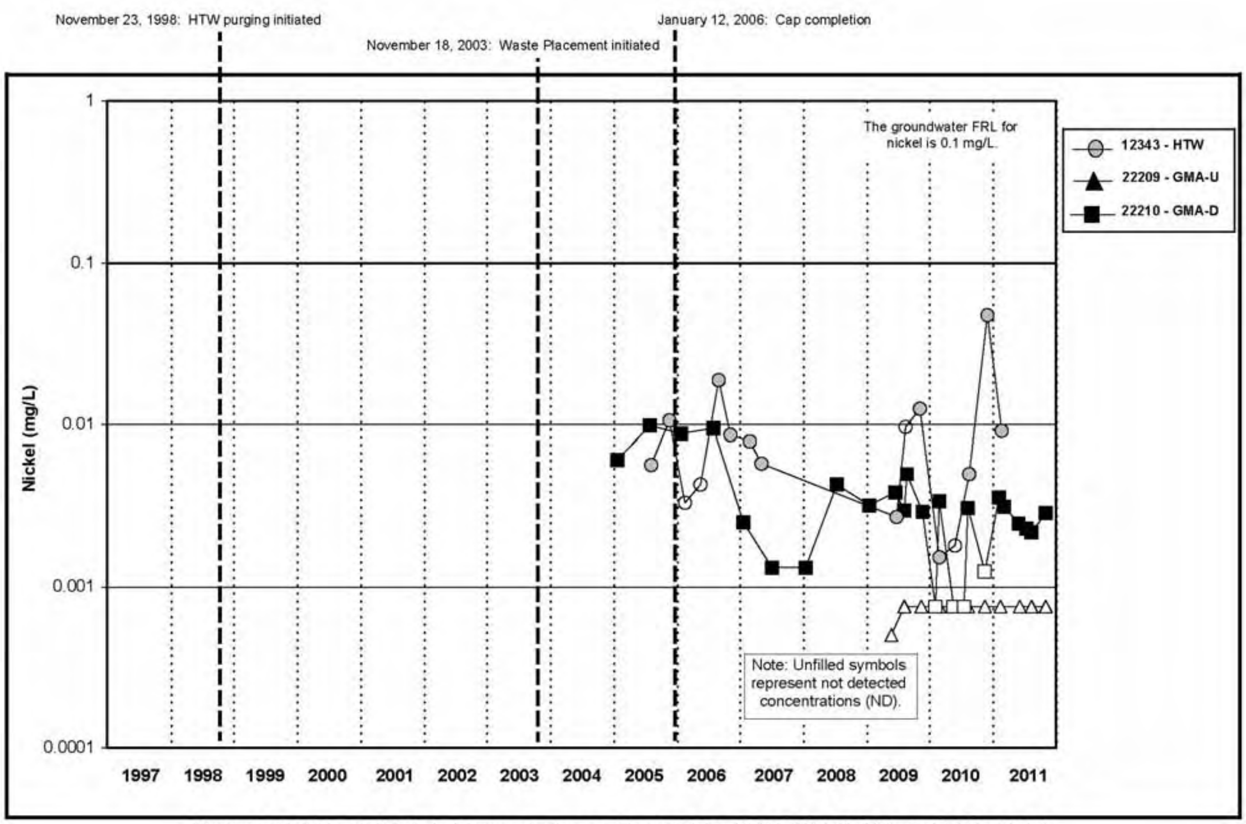


Figure A.5.6-24B. Cell 6 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

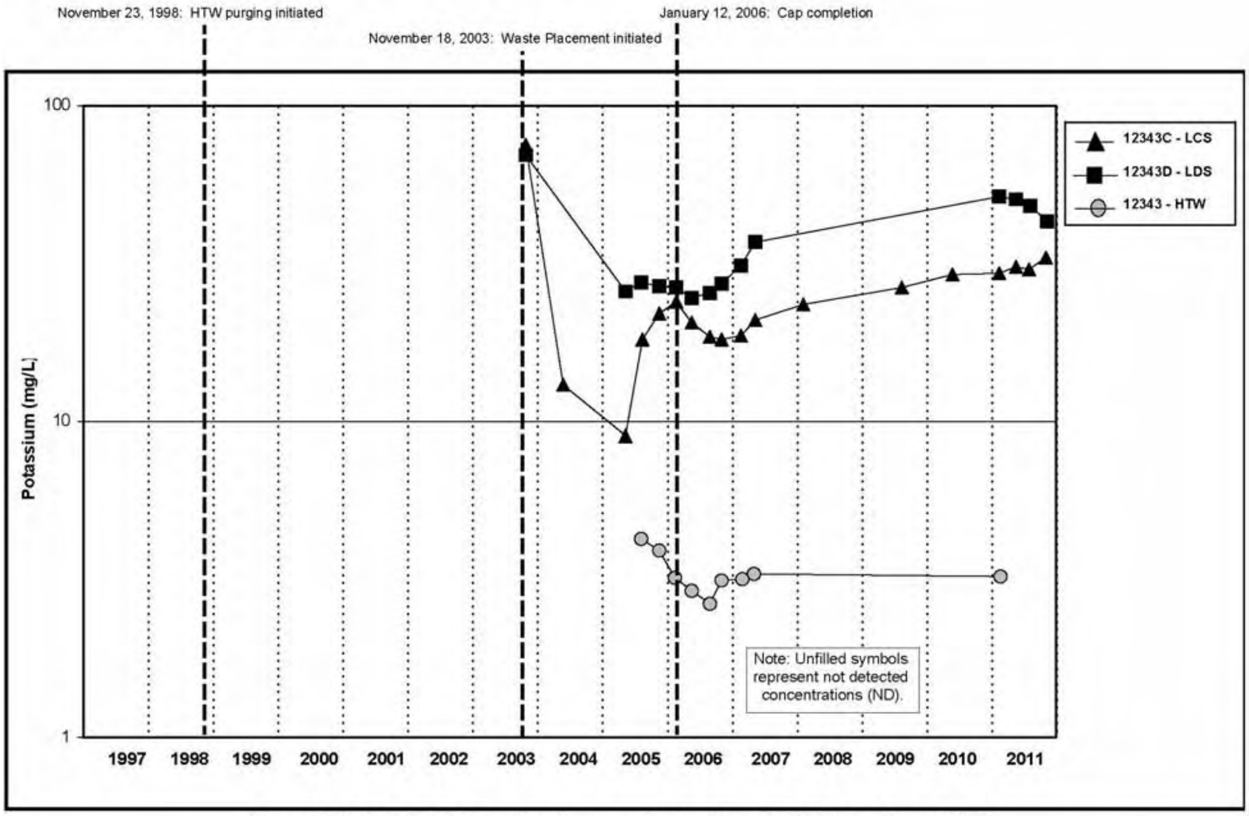


Figure A.5.6-25A. Cell 6 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

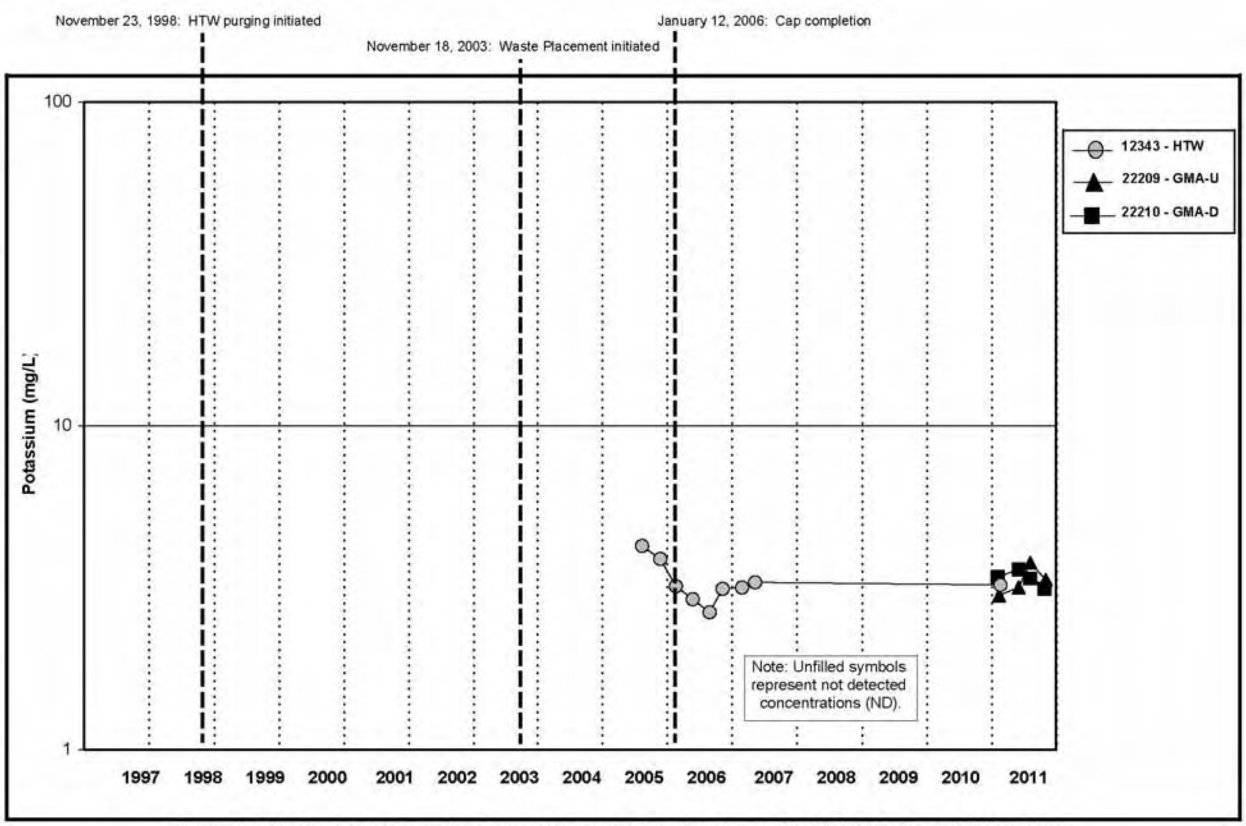


Figure A.5.6-25B. Cell 6 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

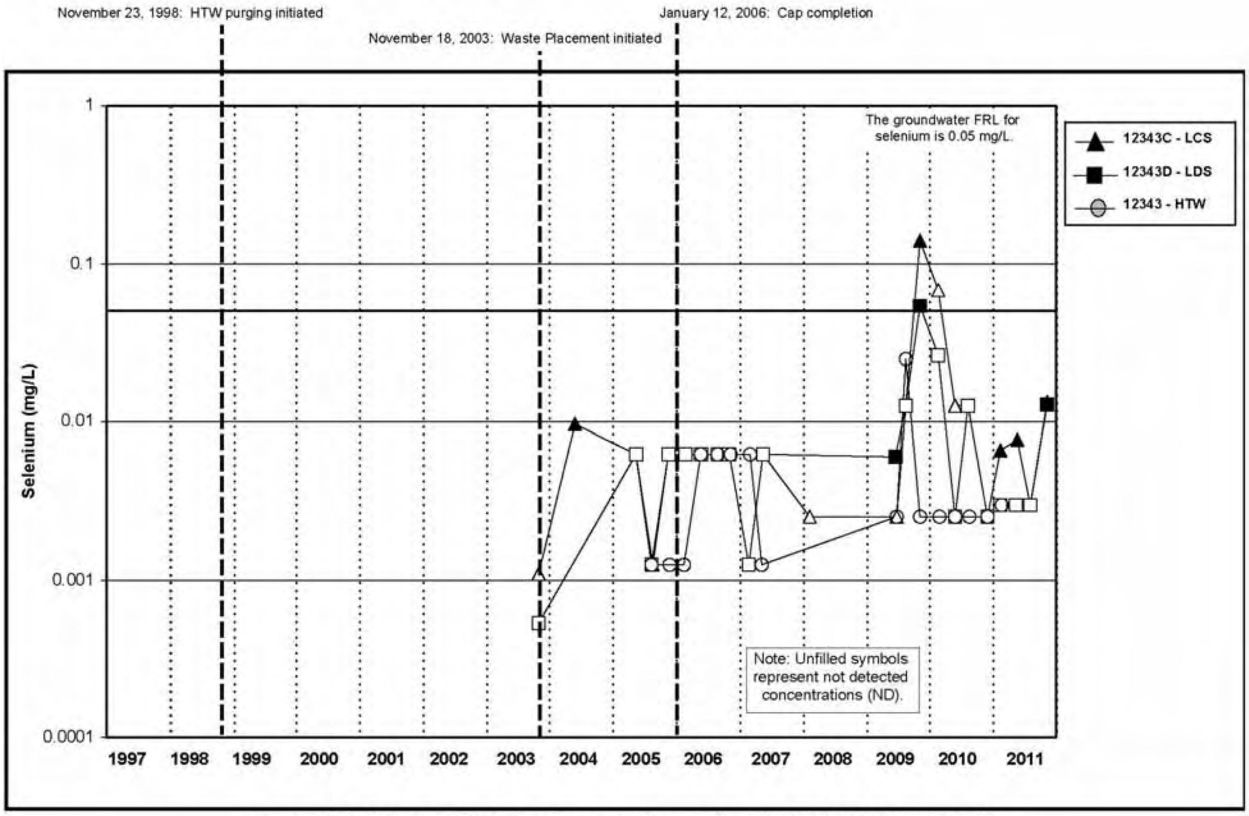


Figure A.5.6-26A. Cell 6 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

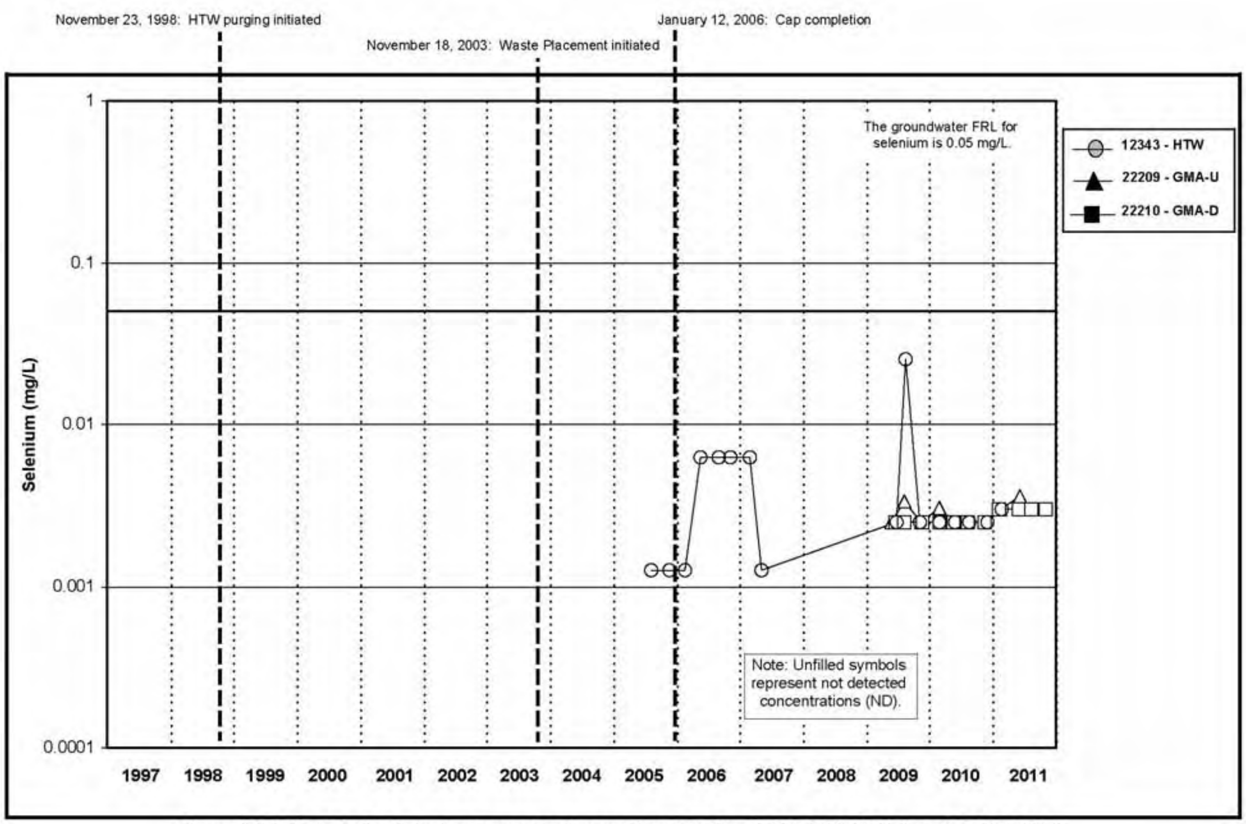


Figure A.5.6-26B. Cell 6 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

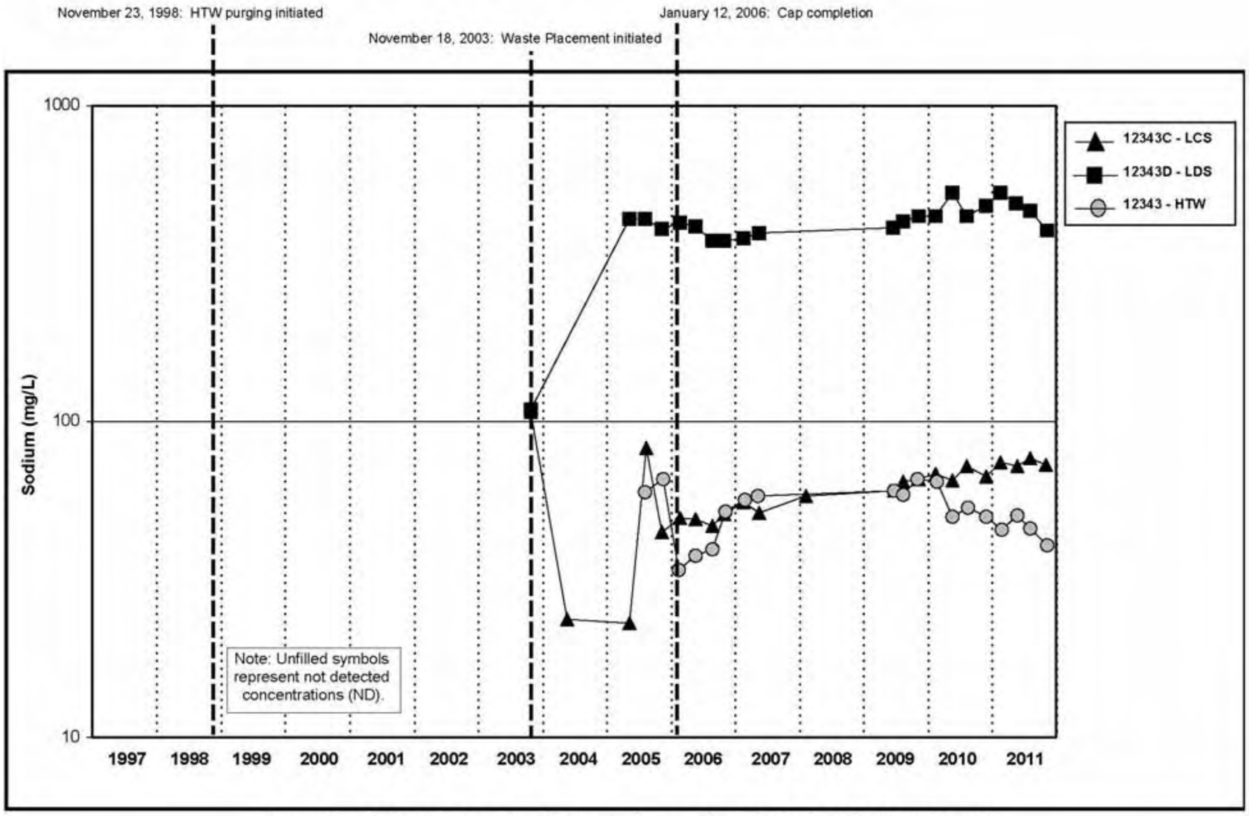


Figure A.5.6-27A. Cell 6 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

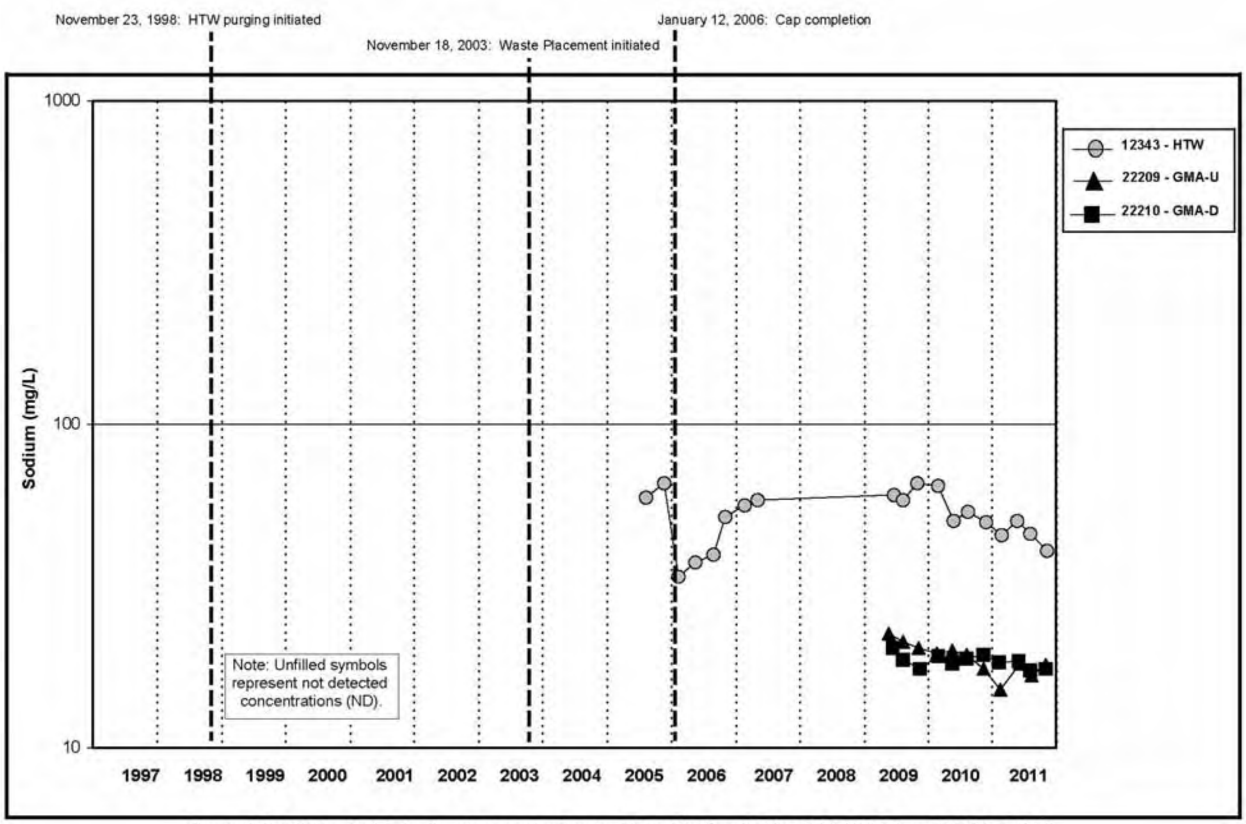


Figure A.5.6-27B. Cell 6 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

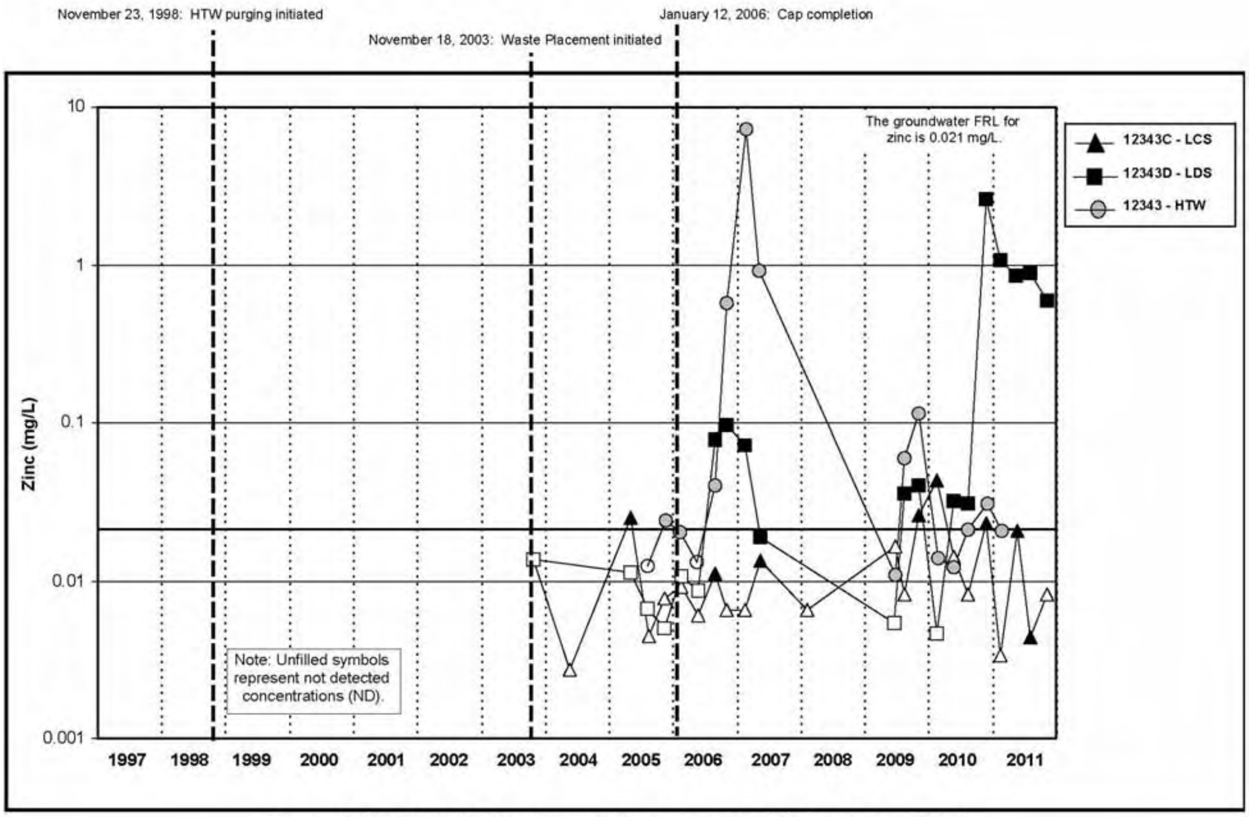


Figure A.5.6-28A. Cell 6 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

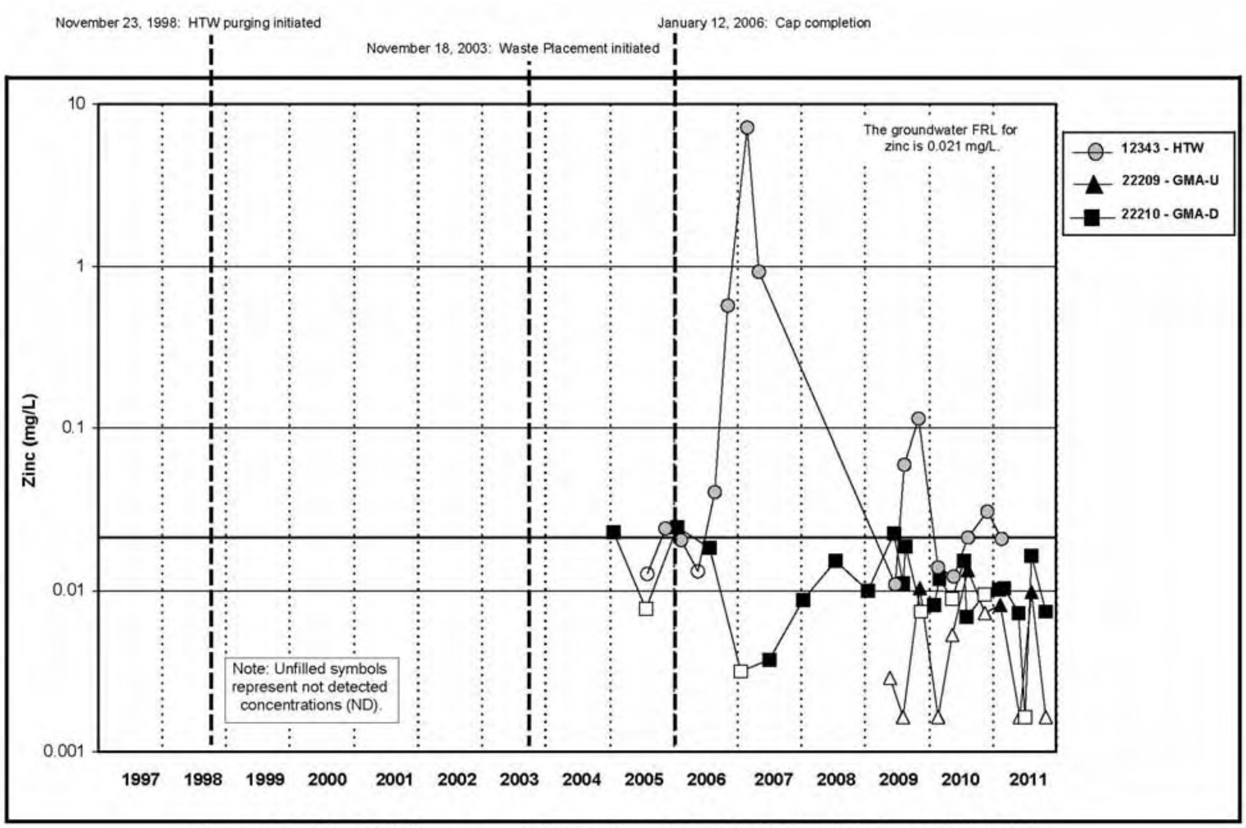


Figure A.5.6-28B. Cell 6 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

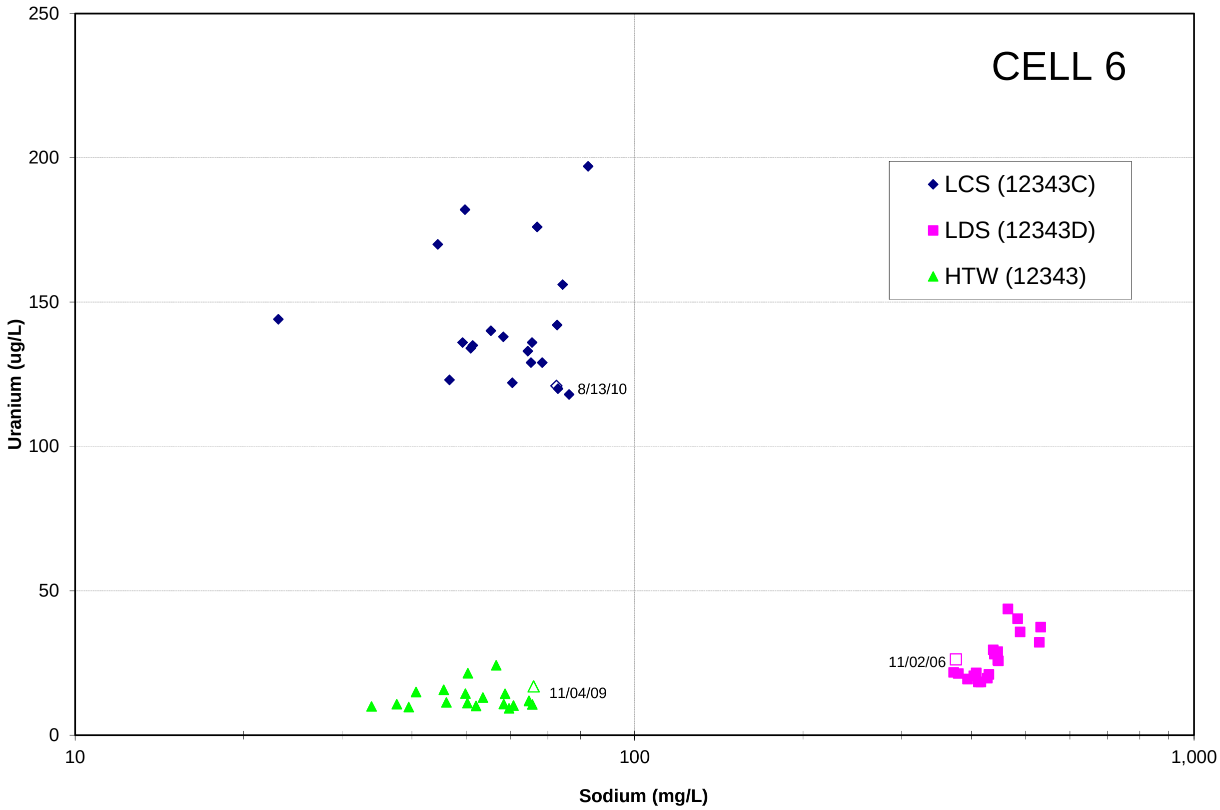


Figure A.5.6−29. Cell 6 Bivariate Plot for Uranium and Sodium

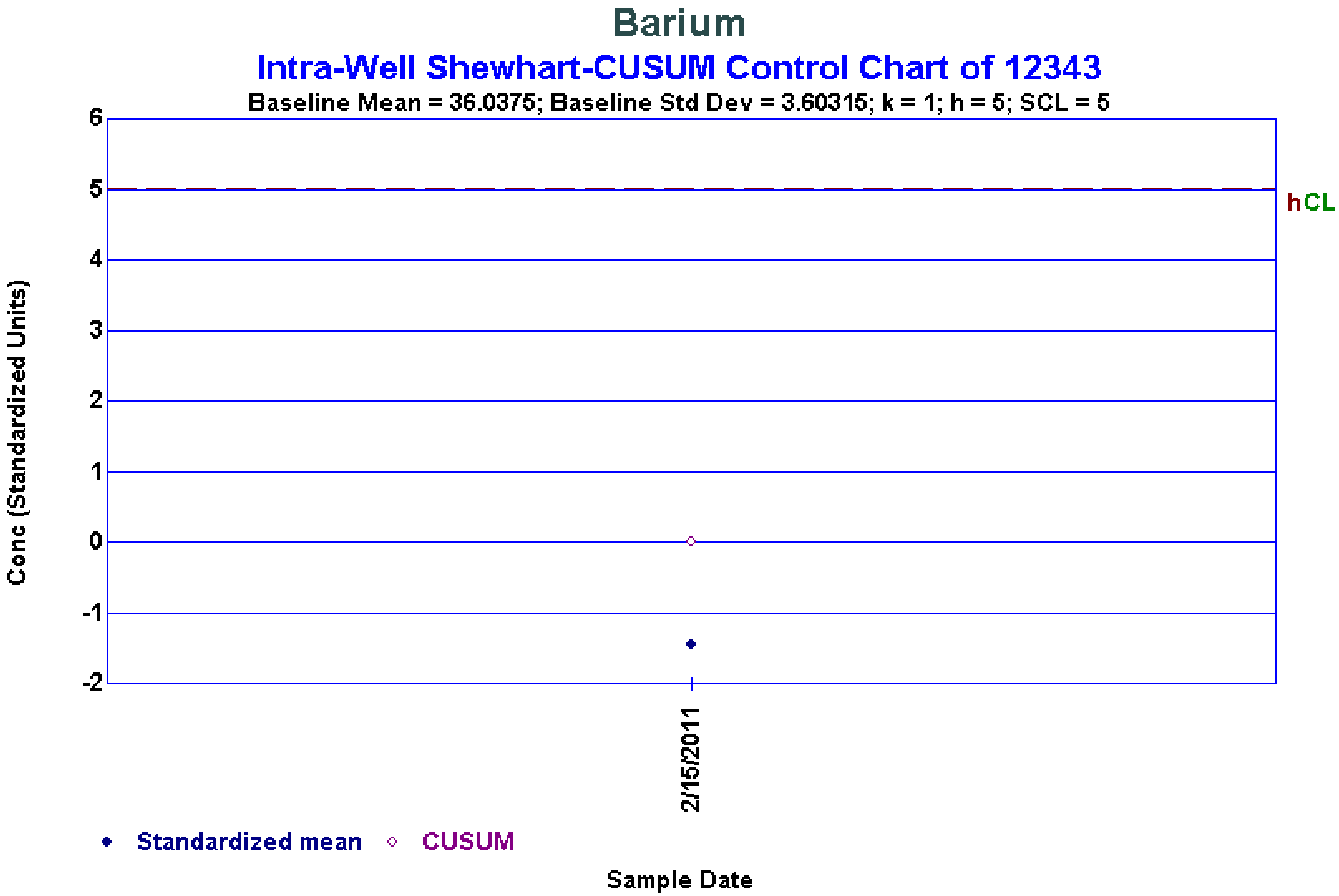


Figure A.5.6−30. Intra-Well Shewhart-CUSUM Control Chart (Barium 12343)

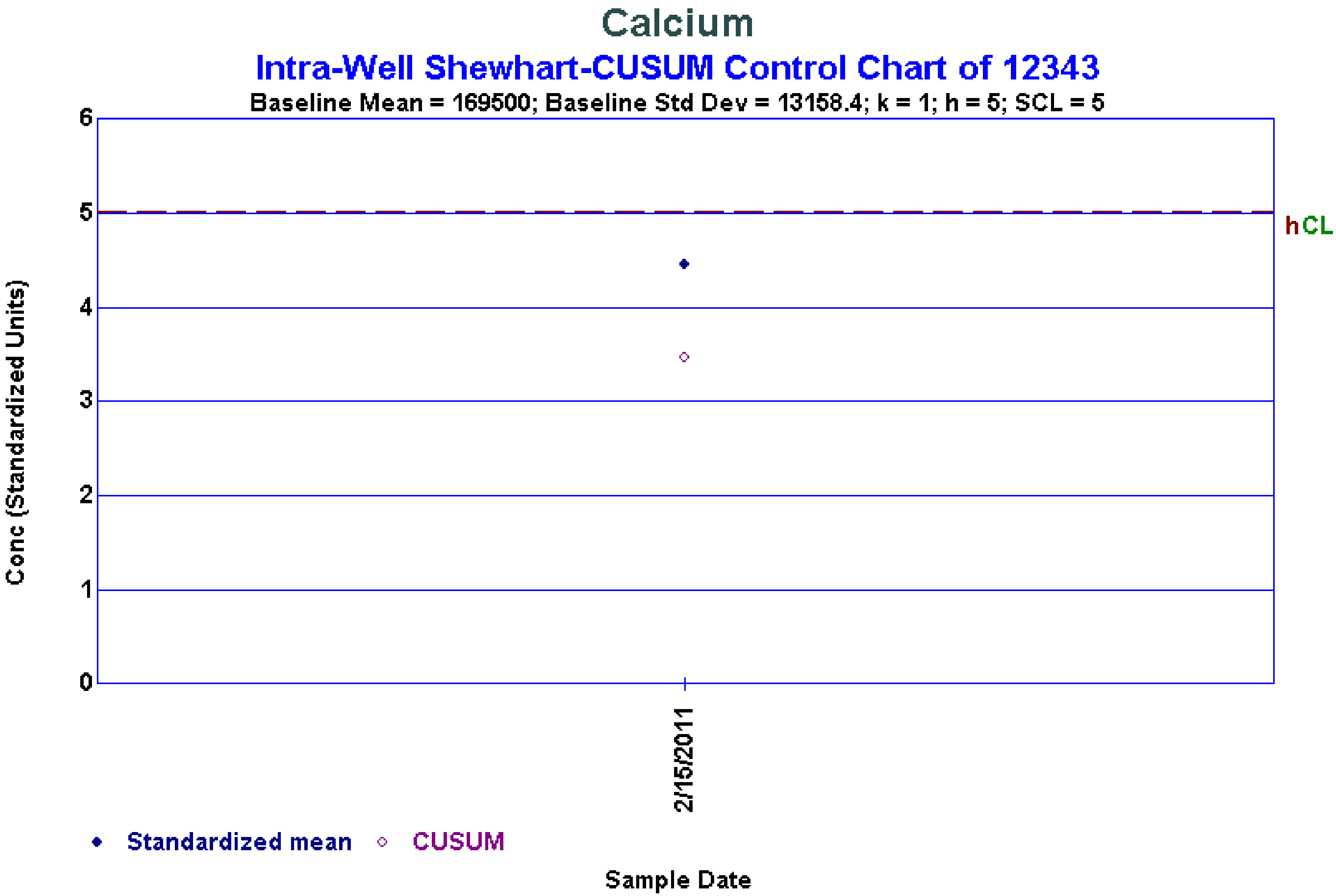


Figure A.5.6−31. Intra-Well Shewhart-CUSUM Control Chart (Calcium 12343)

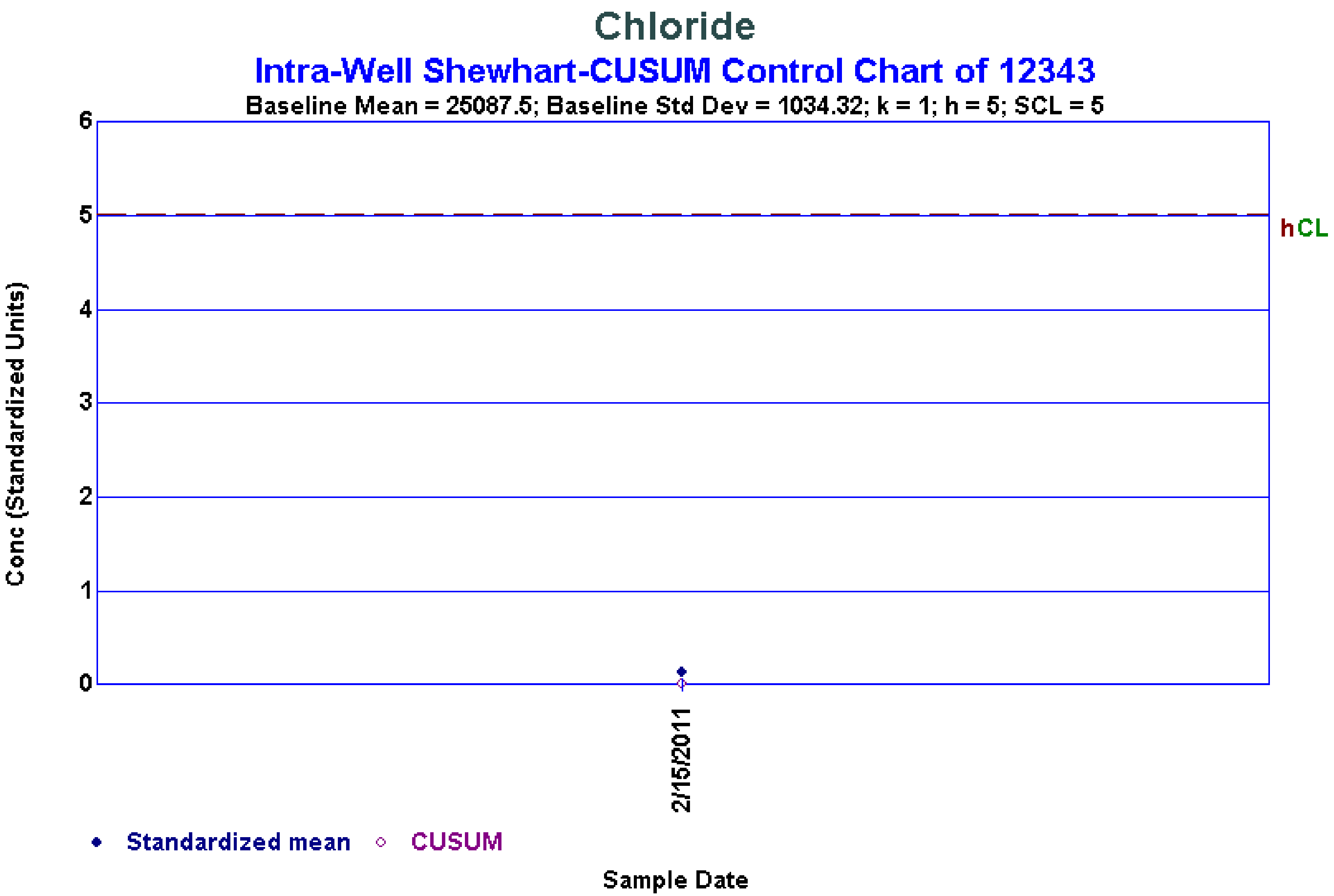


Figure A.5.6−32. Intra-Well Shewhart-CUSUM Control Chart (Chloride 12343)

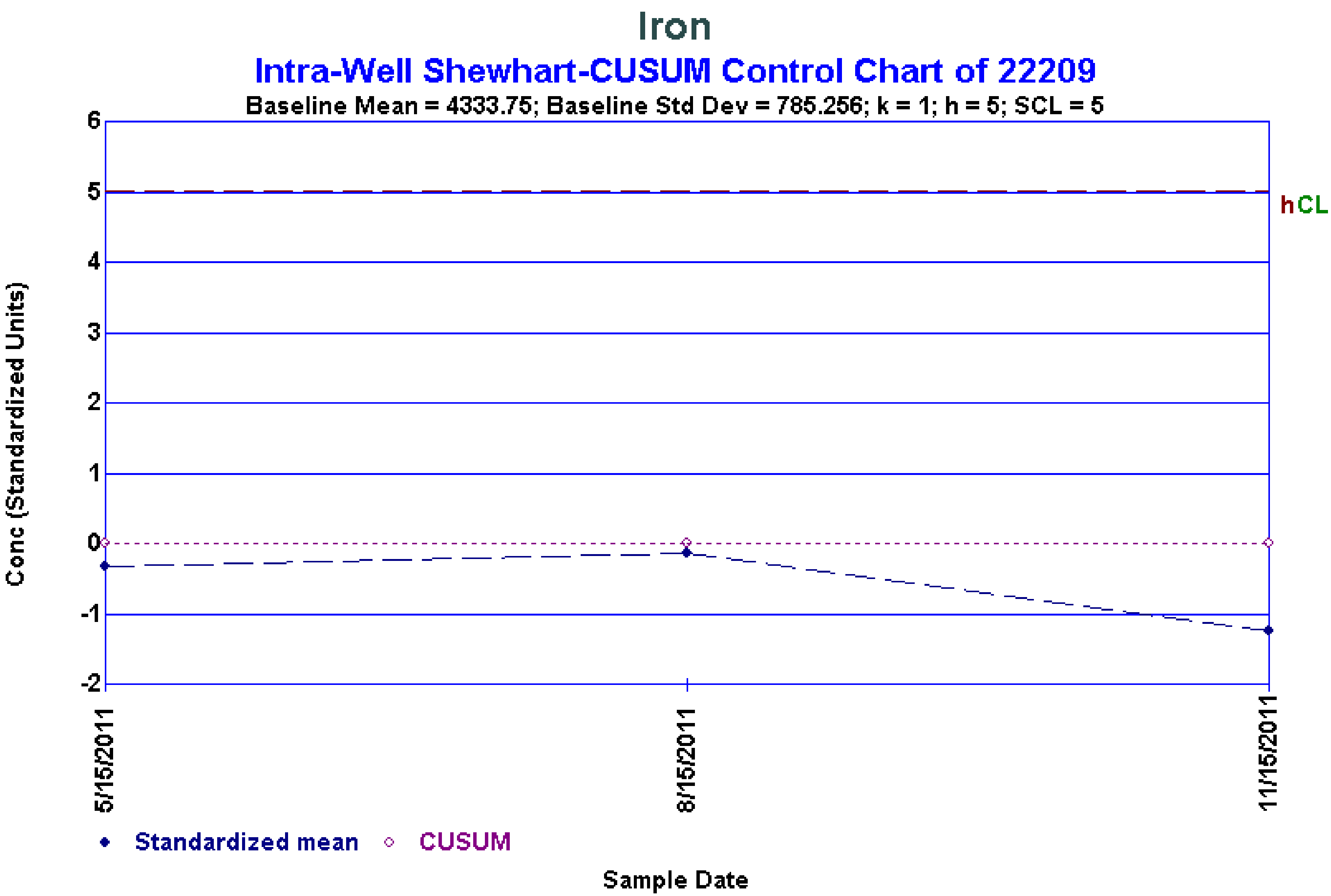


Figure A.5.6−33. Intra-Well Shewhart-CUSUM Control Chart (Iron 22209)

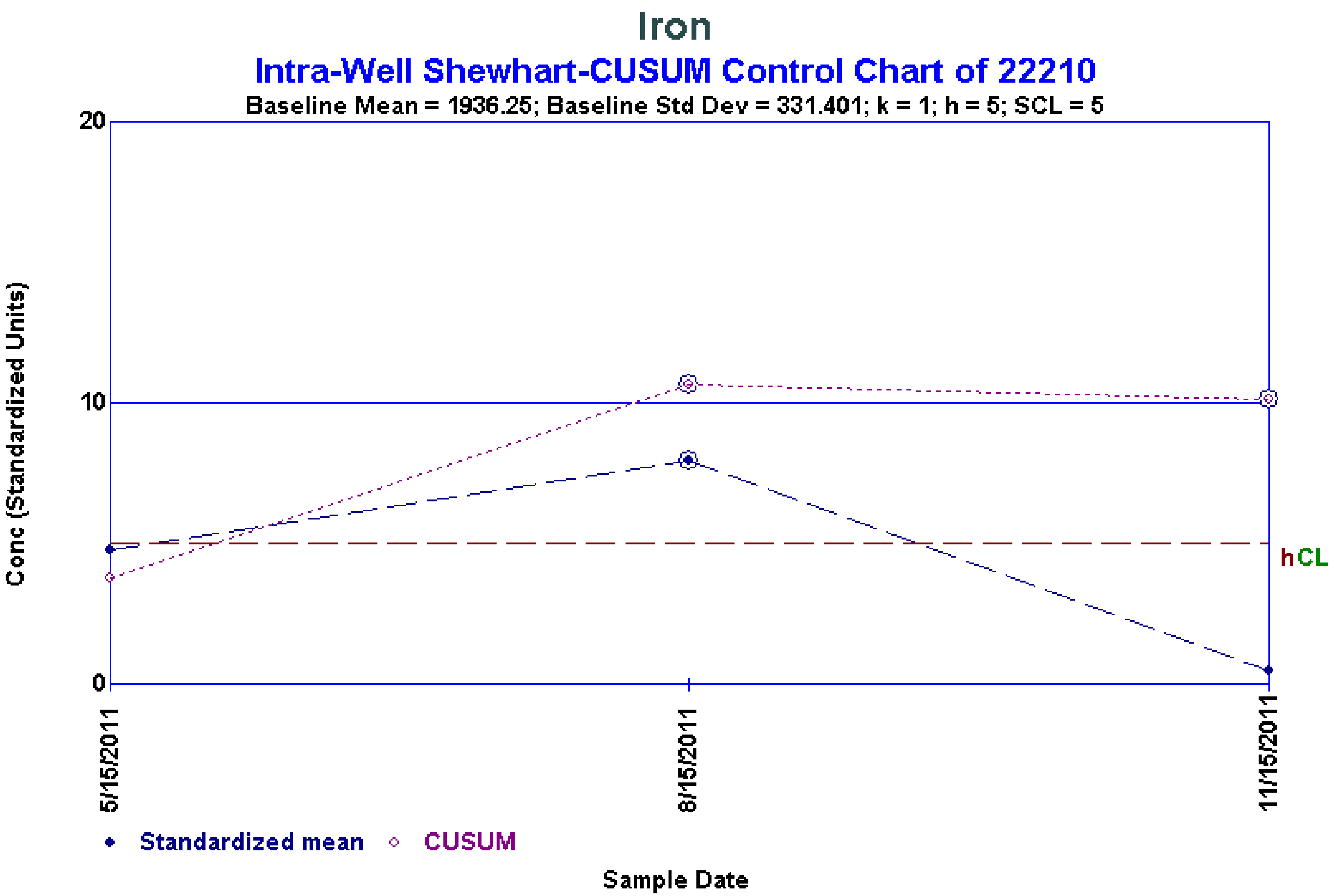


Figure A.5.6−34. Intra-Well Shewhart-CUSUM Control Chart (Iron 22210)

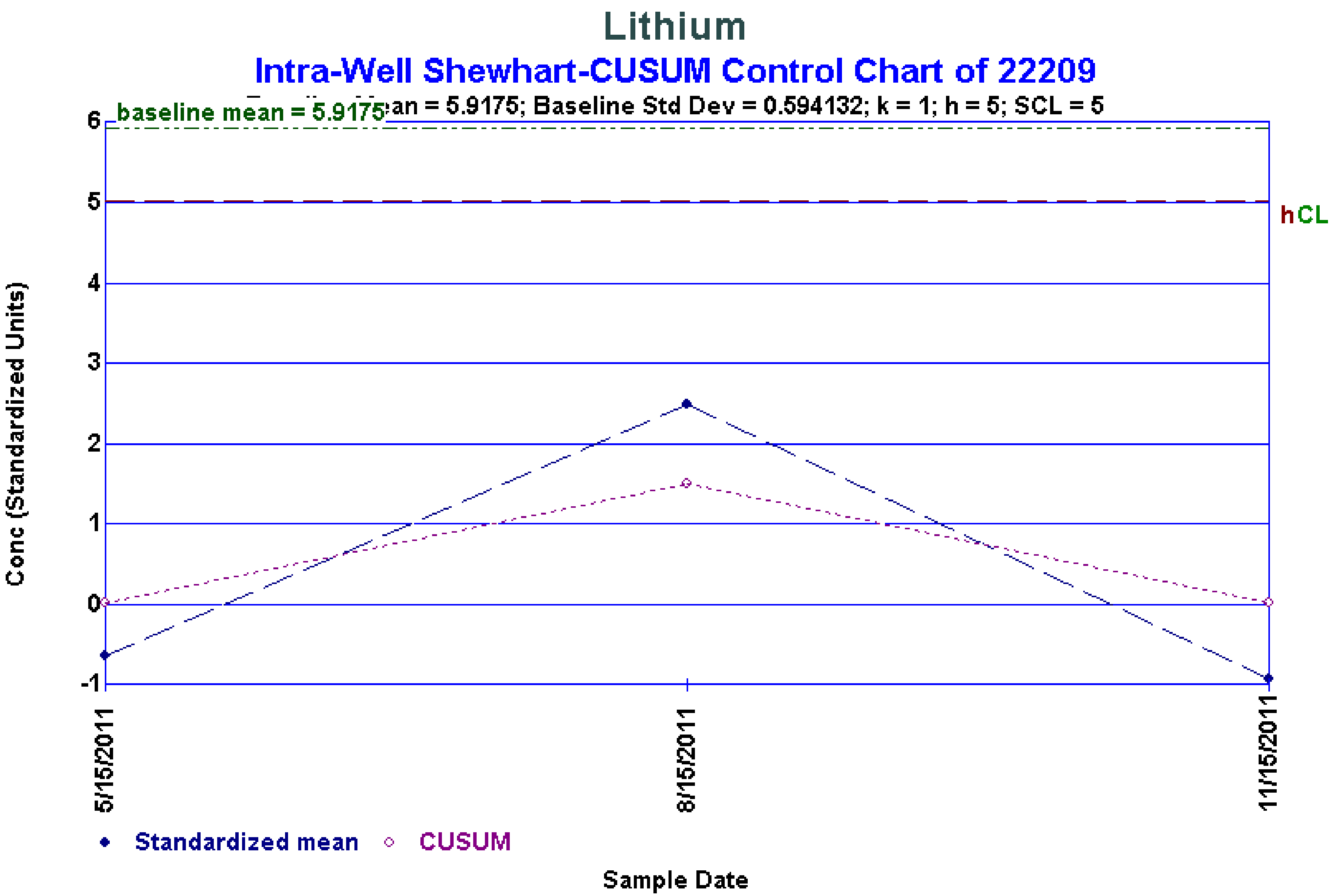


Figure A.5.6−35. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22209)

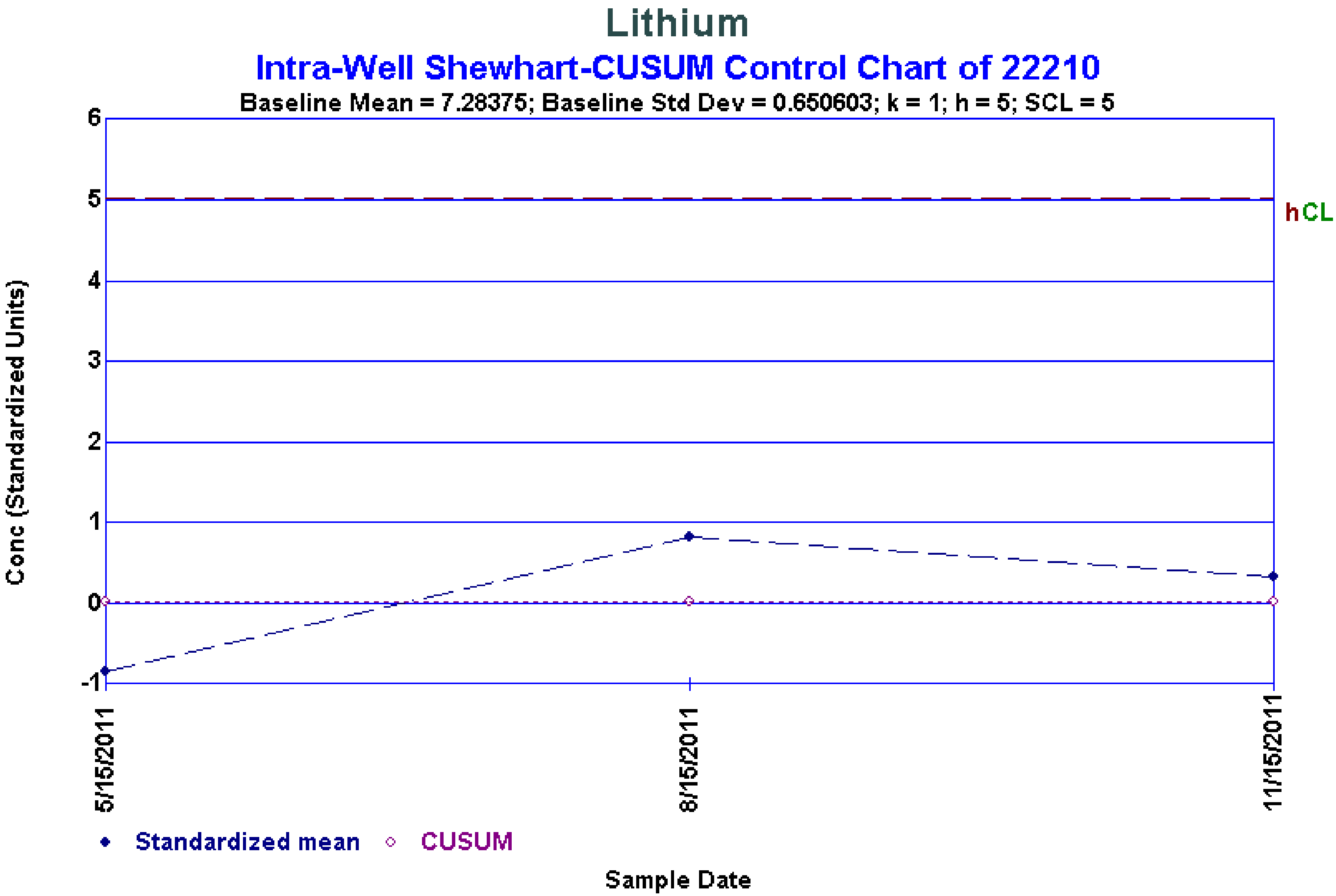


Figure A.5.6−36. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22210)

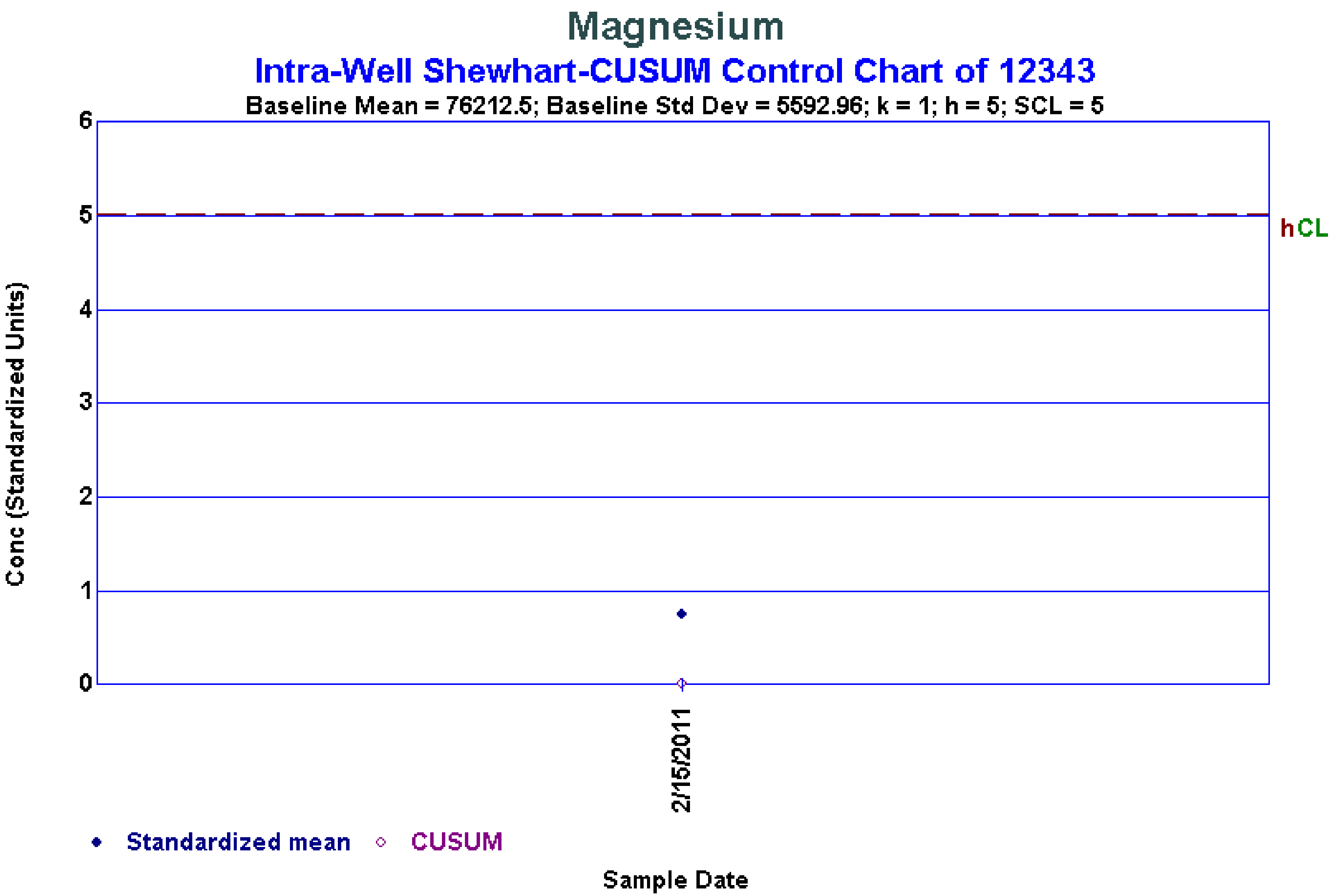


Figure A.5.6−37. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 12343)

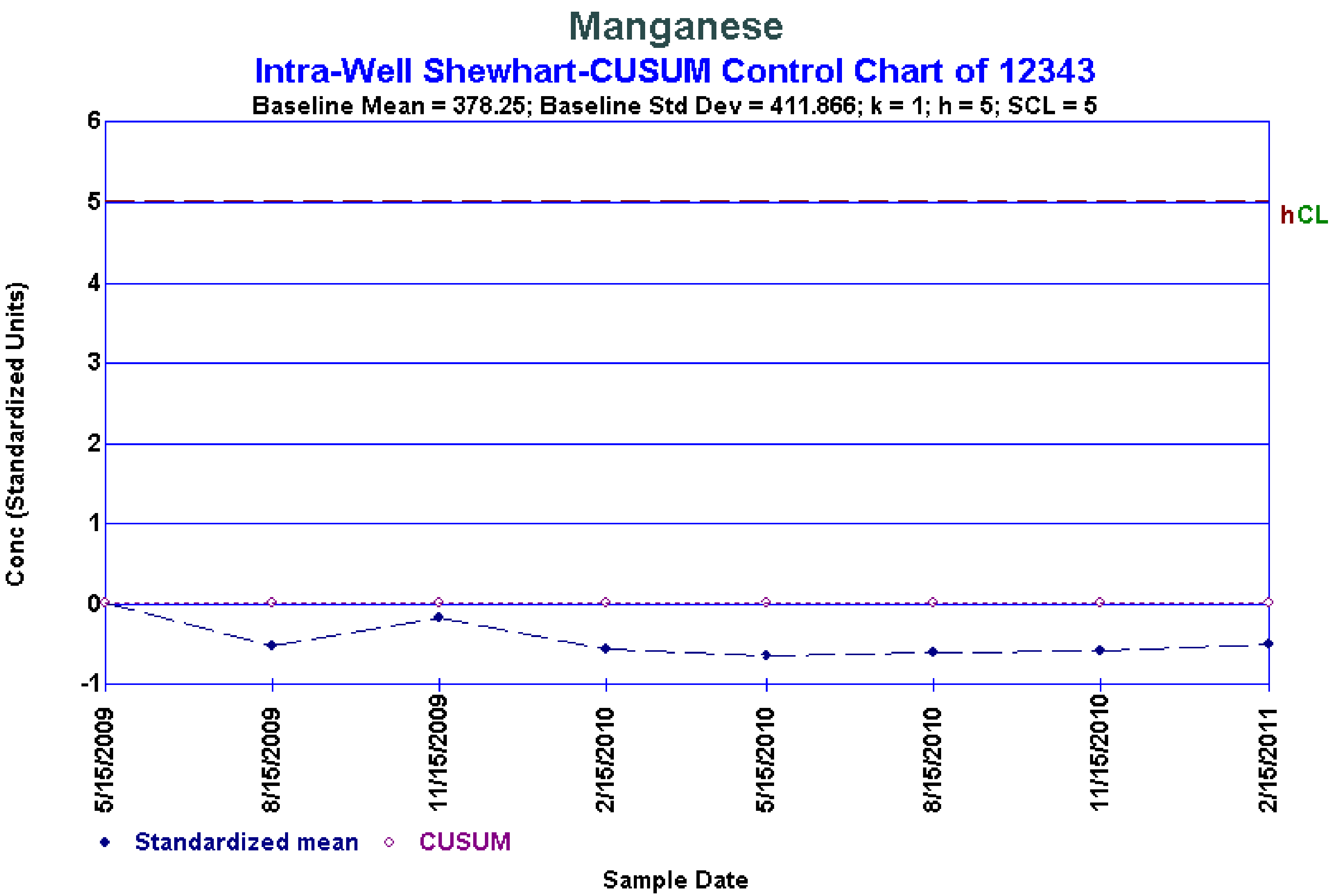


Figure A.5.6−38. Intra-Well Shewhart-CUSUM Control Chart (Manganese 12343)

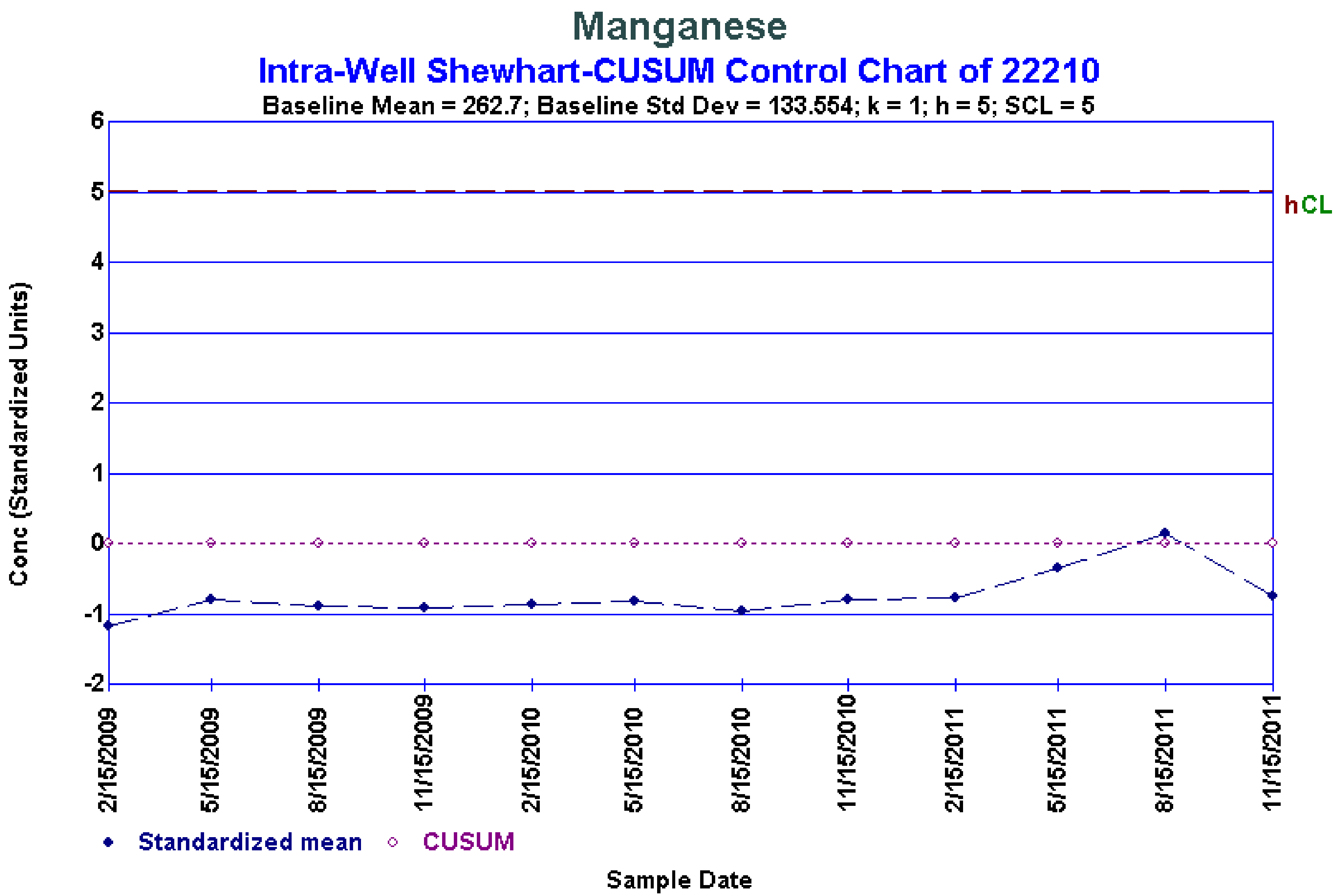


Figure A.5.6−39. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22210)

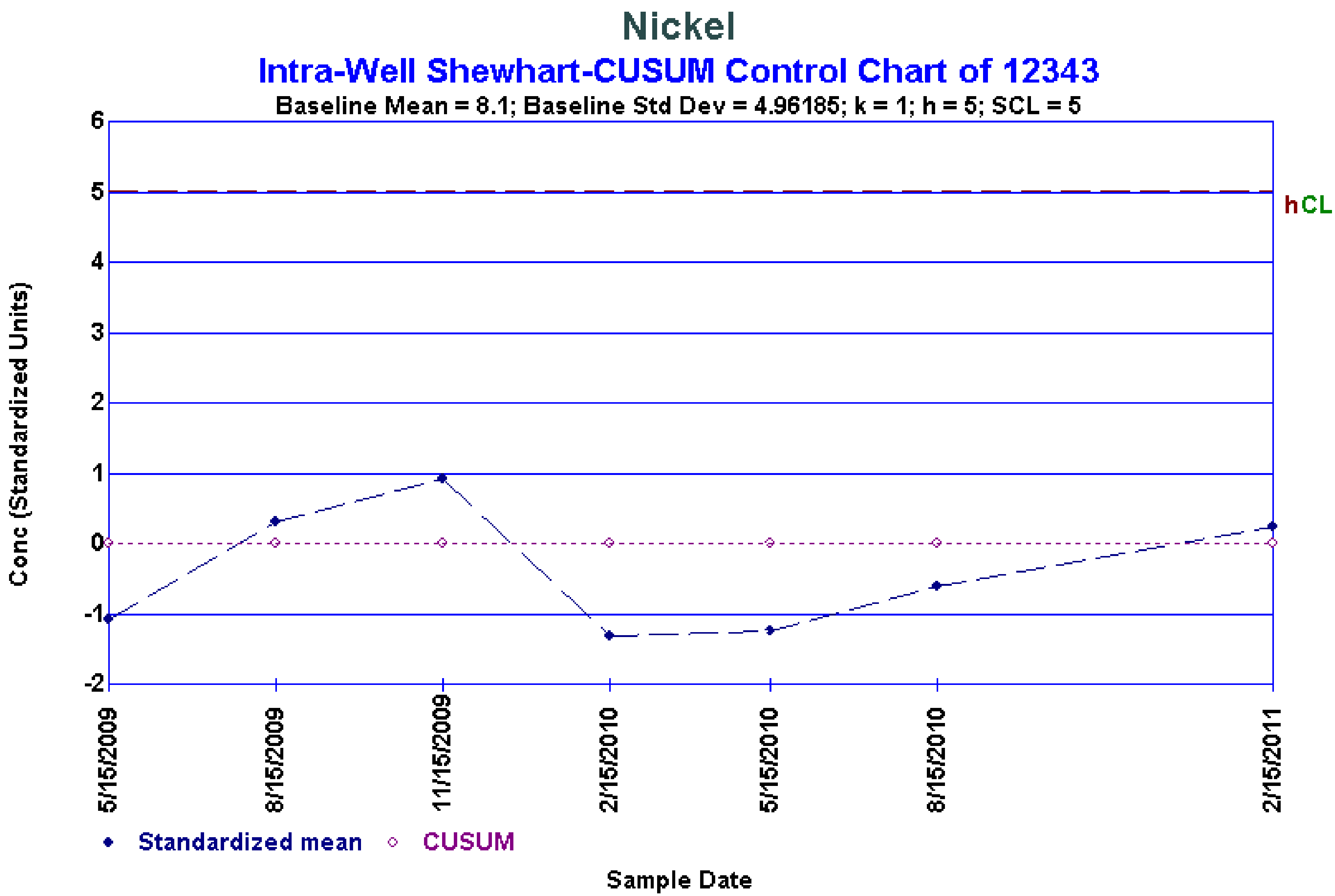


Figure A.5.6−40. Intra-Well Shewhart-CUSUM Control Chart (Nickel 12343)

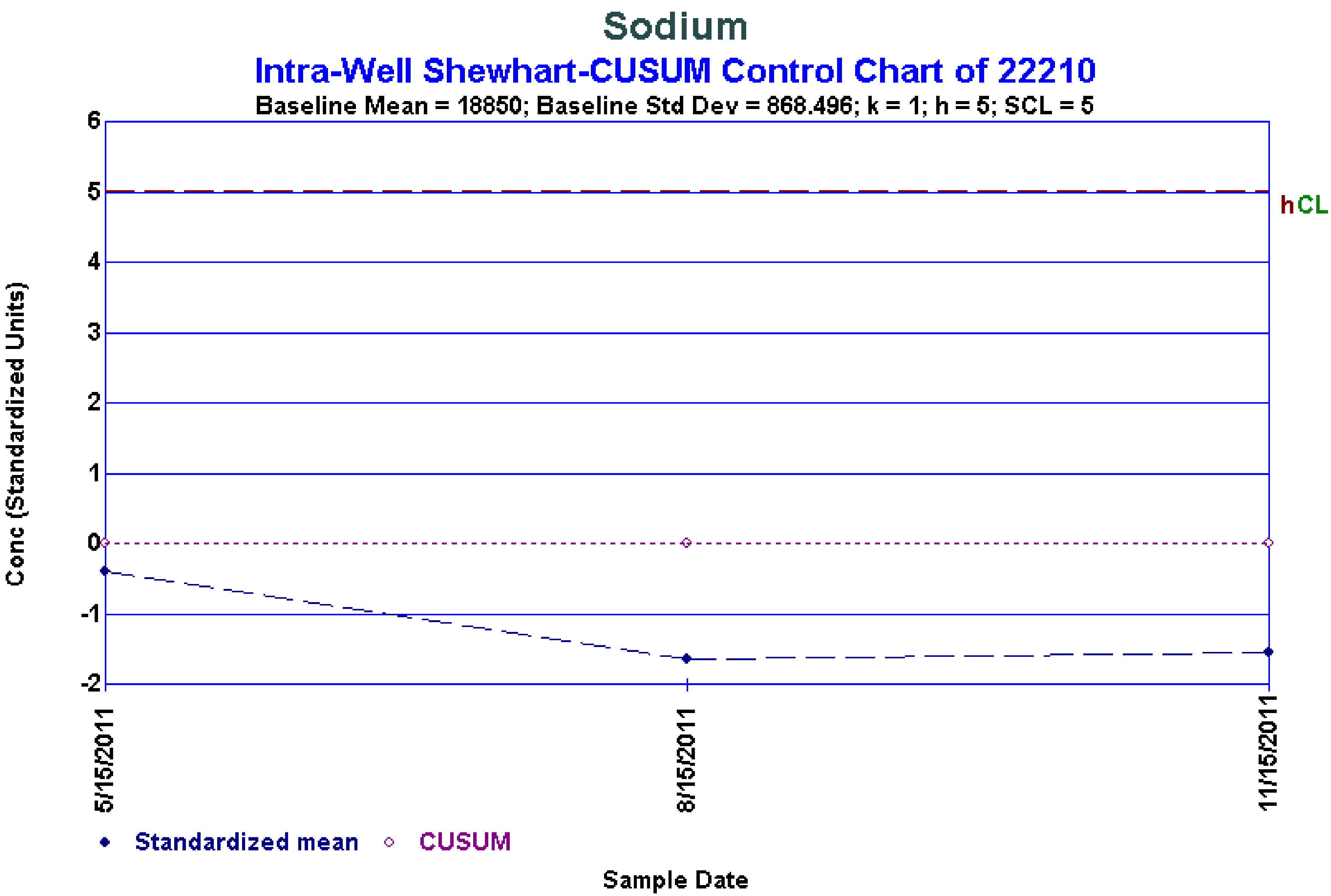


Figure A.5.6−41. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22210)

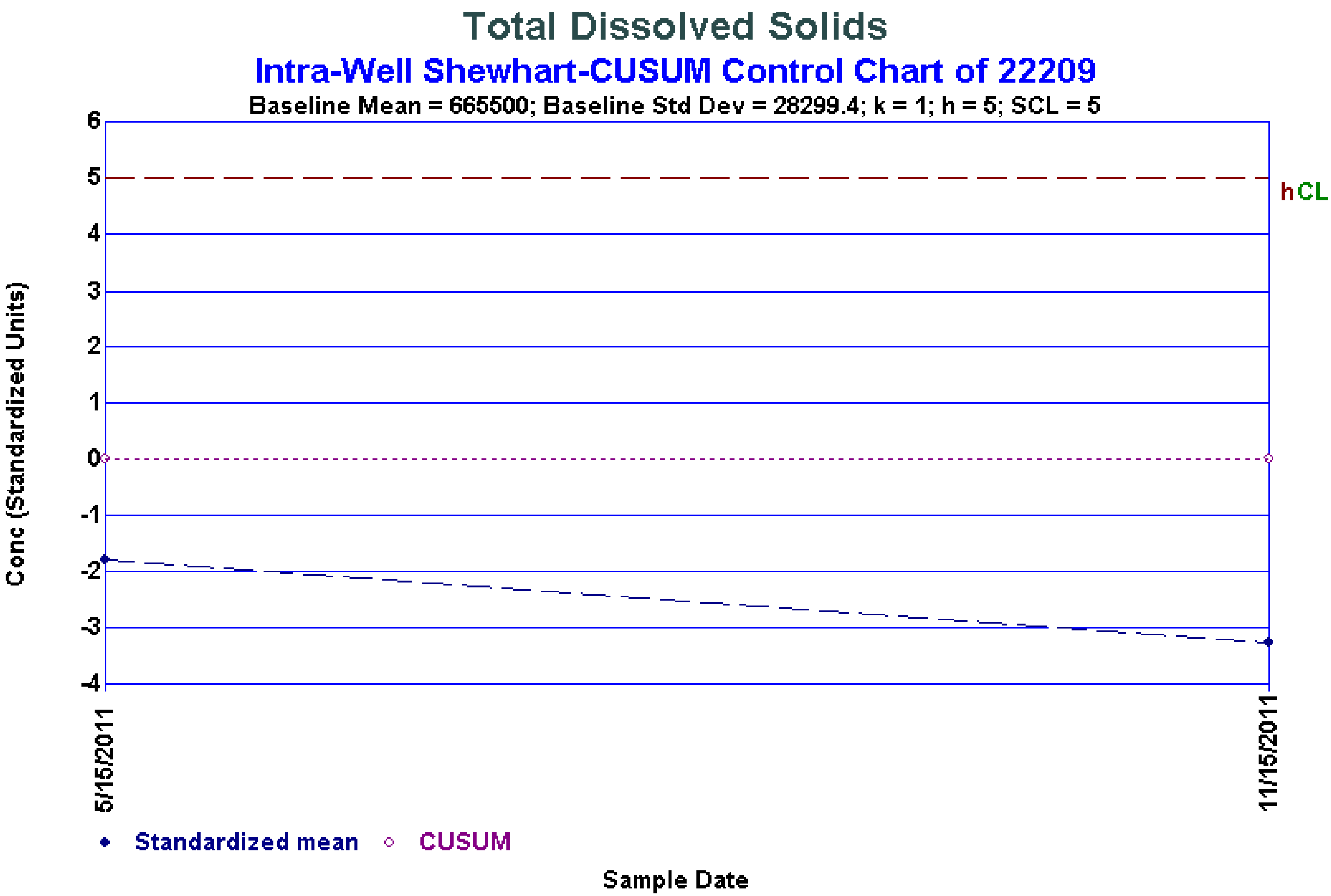


Figure A.5.6−42. Intra-Well Shewhart-CUSUM Control Chart (TDS 22209)

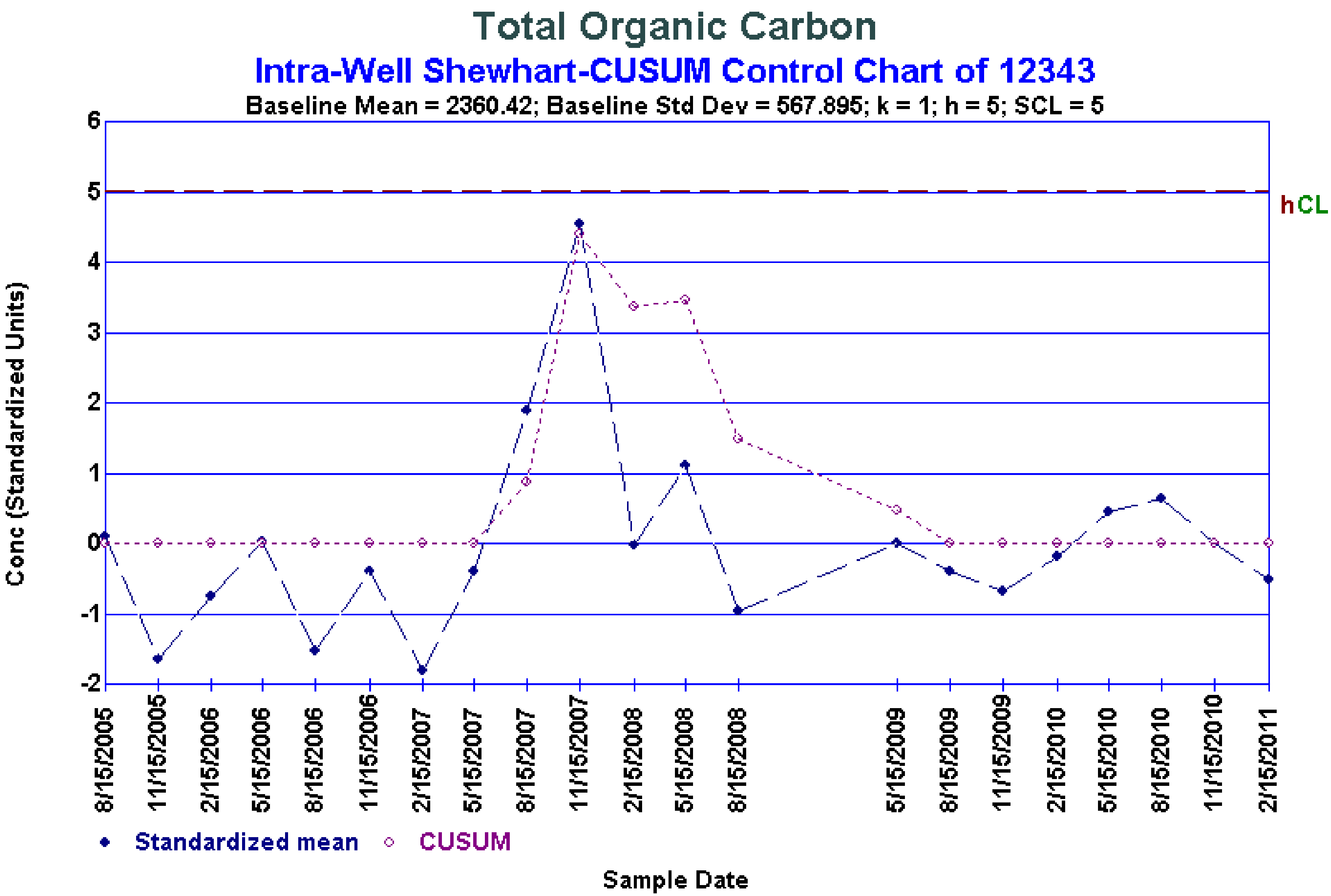


Figure A.5.6−43. Intra-Well Shewhart-CUSUM Control Chart (TOC 12343)

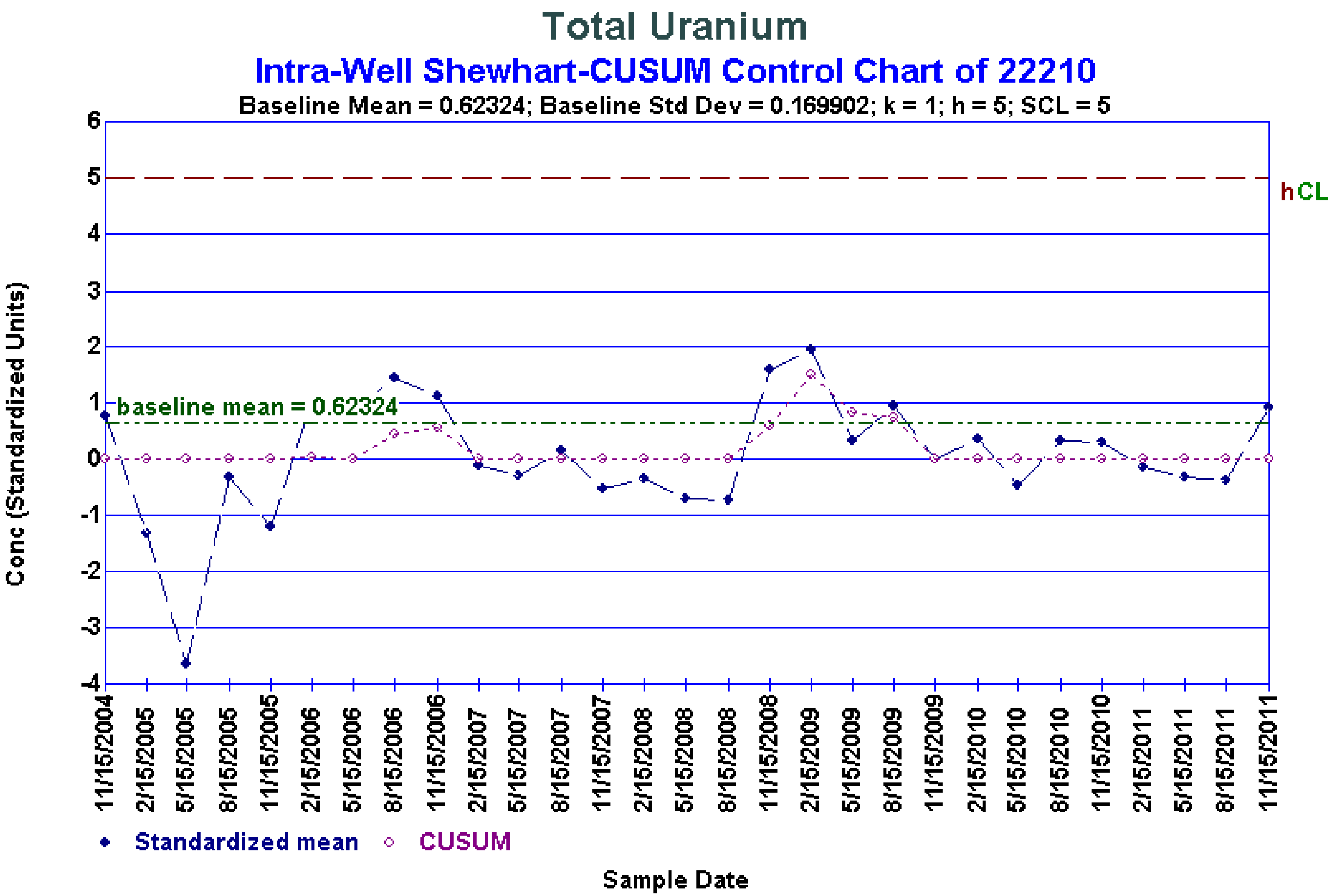


Figure A.5.6−44. Intra-Well Shewhart-CUSUM Control Chart (Uranium 22210)

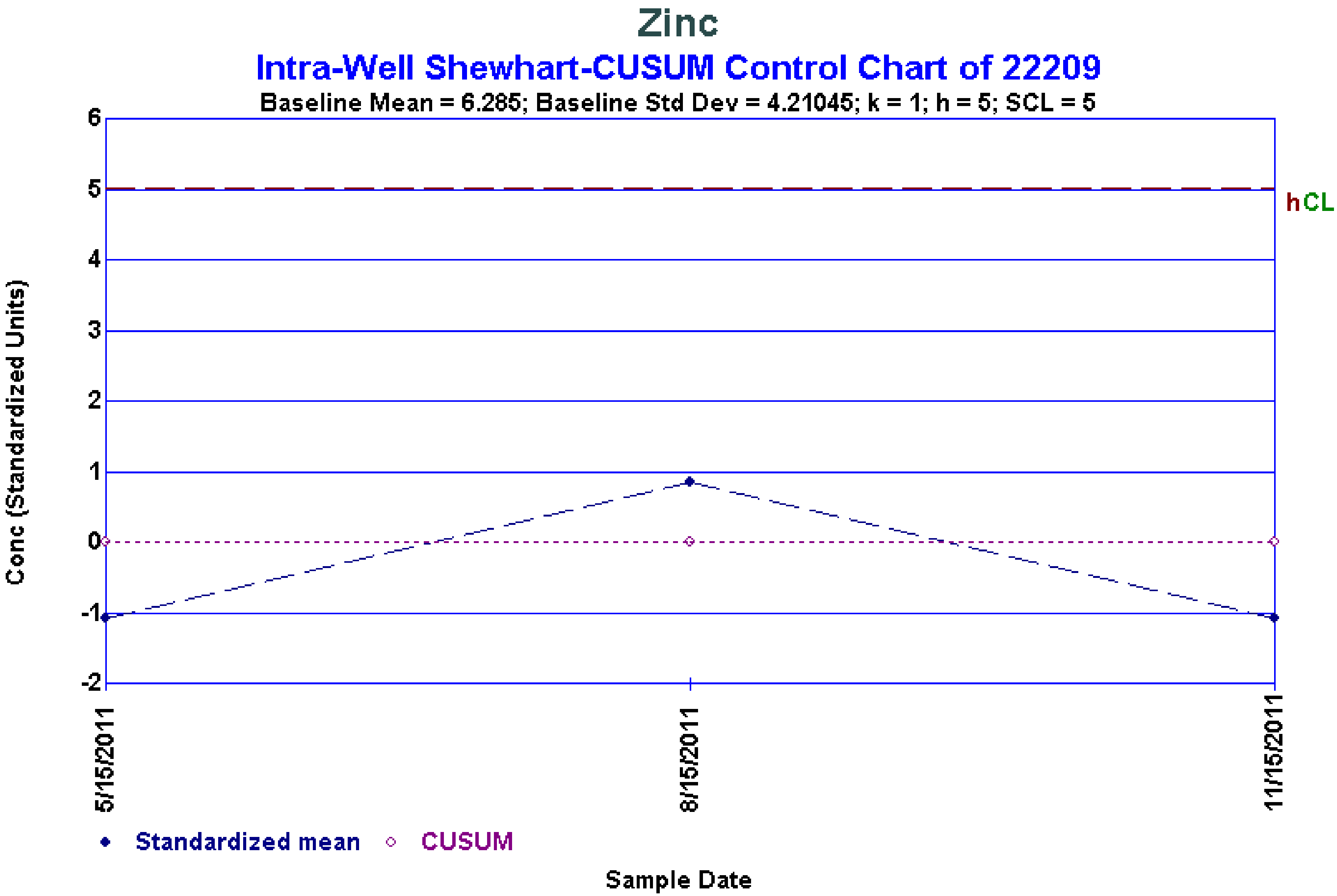


Figure A.5.6−45. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22209)

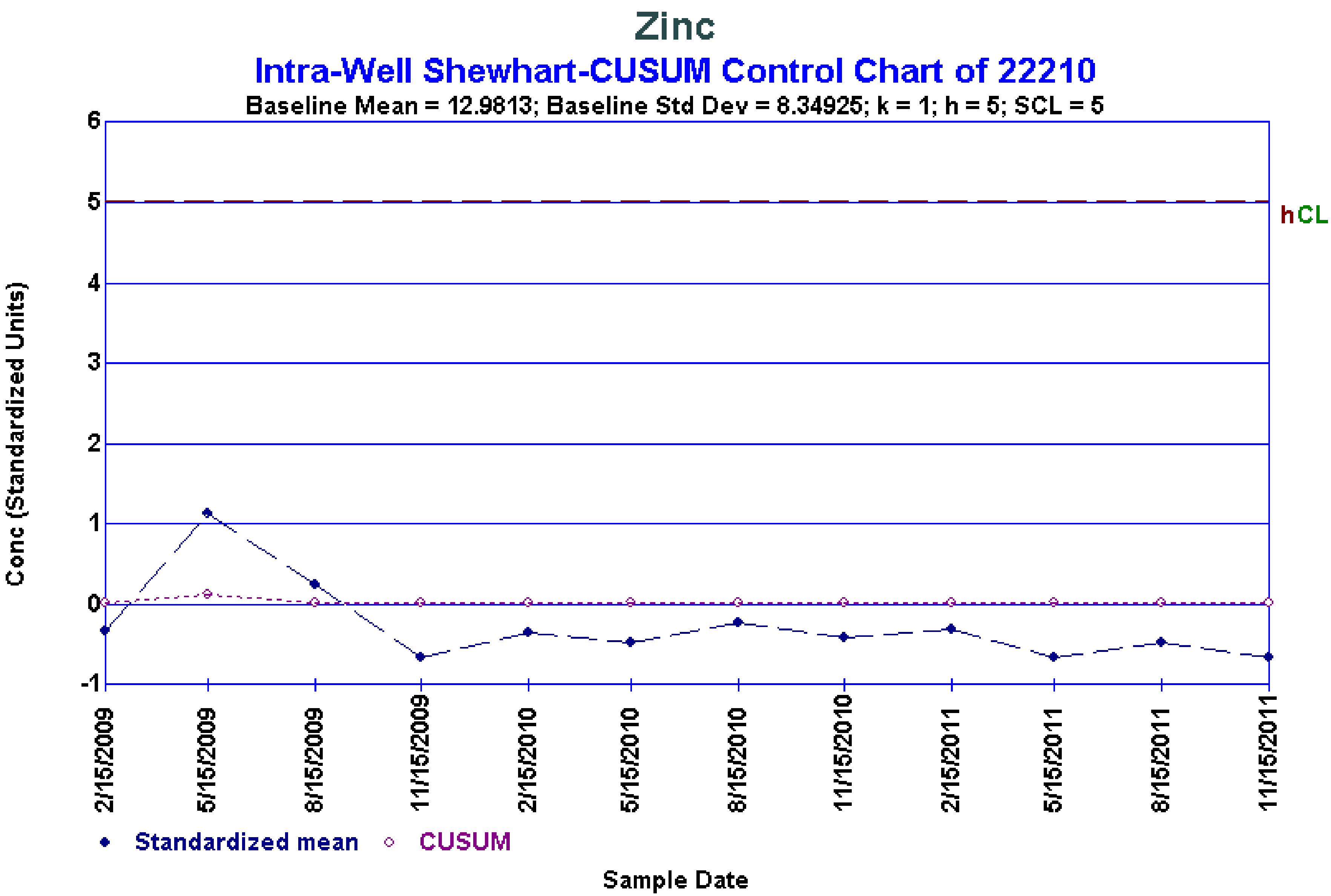


Figure A.5.6−46. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22210)

Sub-attachment A.5.7

Cell 7

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.7−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.7−2)
- Site-specific parameter selection results (refer to Table A.5.7–3)
- LCS monthly accumulation volumes (refer to Figure A.5.7−1)
- LDS monthly accumulation volumes (refer to Figure A.5.7−2)
- OSDF horizontal till well 12344 water yield (refer to Figure A.5.7−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.7−4 and A.5.7−5)
- Plots of concentration versus time (refer to Figures A.5.7−6A to A.5.7−28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.7−29)
- Control charts (refer to Figures A.5.7−30 to A.5.7−43)

A.5.7.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA Wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on LMICP (revision 4). Tritium results for all cells are reported in Section A.5.5.

The Cell 7 HTW was dry during the first quarter of 2011, and the Cell 7 LDS was dry during the fourth quarter of 2011. As shown in Table A.5.7–1, 8 of the 23 constituents sampled quarterly in the LCS, LDS, HTW, and GMA wells (uranium, sulfate, TOC, boron, cobalt, iron, manganese, and sodium) have upward concentration trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Horizontal Till Well

The HTW is located beneath the liner penetration box of each cell by design. This area of the liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, uranium, sulfate, cobalt, iron, sodium, and zinc concentrations are increasing in the HTW of Cell 7 (as indicated in the table below). The bivariate plot for the Cell 7 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.7−29. The plot shows that the chemical signature for uranium-sodium in the LCS, LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured in the HTW of Cell 7 are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]
Uranium	Up		
Sulfate	Up	Up	Up
TOC		Up	Up
Boron			Up
Cobalt	Up		
Iron	Up	Up	
Manganese			Up
Sodium	Up		

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; TOC = total organic carbon. No entry indicates that the trend was not up.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 though indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation taking place to the west and southwest. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells are attributed to fluctuating ambient conditions that are not related to cell performance.

The table below provides a summary of the average concentration (as reported in Table A.5.7–1) measured in the LDS and GMA wells for parameters with increasing concentrations in the Cell 7 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]
Sulfate (mg/L)	**1740**	241	331
TOC (mg/L)	**5.60**	1.26	1.36
Boron (mg/L)	**0.309**	0.0344	0.0286
Iron (mg/L)	0.987	**9.17**	8.19
Manganese (mg/L)	0.083	0.310	**0.459**

Note: The highest averages are shown in bold.
[a] LDS = leak detection system, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; TOC = total organic carbon

As shown above, both iron and manganese have higher concentration averages in the GMA than they do in the LDS of Cell 7.

A.5.7.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM control limit on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.7−1 in gray shading, 10 constituents in the HTW and GMA wells of Cell 7 (TDS, TOX, barium, boron, copper, lithium, manganese, nickel, sodium, and zinc) meet the criteria for control charts (i.e., more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in fourteen control charts.

Constituent and Monitoring Point[a]	Assessment
TDS in the GMA-U	In Control
TDS in the GMA-D	In Control
TOX in the HTW	In Control
TOX in the GMA-U	In Control
TOX in the GMA-D	In Control
Boron in the HTW	In Control
Copper in the HTW	**Out of Control**
Lithium in the GMA-U	In Control
Lithium in the GMA-D	In Control
Manganese in the HTW	**Out of Control**
Nickel in the HTW	**Out of Control**
Sodium in the GMA-D	In Control
Zinc in the HTW	In Control
Zinc in the GMA-D	In Control

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids; TOX = total organic halogens

The control charts are presented in Figures A.5.7−30 to A.5.7−43. All but three of the fourteen control charts exhibit “in control” conditions. Out of control conditions are indicated for copper, manganese, and nickel in the HTW. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 7 indicate that water is not mixing between the horizons, so the out of control conditions are attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

A.5.7.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 7 are provided in Table A.5.7−2 for those parameters that have been detected at least once, and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 7 in 2011.

As reported in the 2009 SER, 1,1-dichloroethene was detected for the first time in the LCS of Cell 7 in 2009. In 2010, 1,1-dichloroethene was detected again in the LCS of Cell 7. As stated in Appendix B of the GWLMP (DOE 2010a) “two consecutive detects in a cell’s LCS triggers sampling in the cell’s LDS during the next scheduled sampling round.” Sampled for twice in the LDS of Cell 7 in 2011, 1,1-dichloroethene was not detected in the LDS of Cell 7. Since it continues to be detected in the LCS of Cell 7 sampling in the LDS will continue.

A.5.7.4 Site-Specific Parameter Selection for Cell 7

The sample size of the Cell 7 dataset reached a minimum of eight samples at the end of 2011; therefore, the site-specific leachate monitoring parameter selection approach presented in Figures A.5–5A and A.5–5B was followed to determine if any of the Appendix I and PCB parameters detected in Cell 7 should be selected as site-specific monitoring parameters.

As discussed in Attachment A.5, the objective of the selection process is to determine if the mean concentration of an Appendix I or PCB parameter (that has been sampled eight times and detected more than 25 percent of the time) is statistically greater than the mean of either the pre-design or background data for the parameter. If the mean is greater, then the parameter is selected for more quarterly monitoring in the LCS, LDS, HTW, and GMA wells of the cell.

The null hypothesis used for each statistical test is that the mean of the concentration of the LCS dataset is less than or equal to the mean of the pre-design or background dataset. Failure of the null hypothesis indicates that the mean of the LCS dataset is greater than the mean of the pre-design or background dataset.

As shown in Table A.5.7-2 four of the Appendix I parameters not already being sampled for quarterly have been detected at least 25 percent of the time (ammonia, beryllium, chromium, and technetium-99). As reported in the *Fernald Preserve 2009 Site Environmental Report* (DOE 2010b), technetium was already evaluated for Cell 7 and passed the null hypothesis therefore it was not evaluated again this year.

Pre-design and/or background data does not exist for beryllium so parameter selection statistics could not be conducted. The low beryllium detections (maximum of 0.00025 mg/L) indicate that adding the constituent to the quarterly sampling program would not significantly enhance the early detection capability of the monitoring program. Therefore, beryllium will not be added to the quarterly sampling list.

Parameter selection statistics were conducted for the remaining two parameters (ammonia and chromium). Results for Cell 7 are presented in Table A.5.7−3. Ammonia passed the null hypothesis and chromium failed the null hypothesis for the Tarone-Ware Test. Based on those results, chromium will be added to the quarterly sampling list for the LCS, LDS, and GMA wells of each cell beginning in January 2013.

A.5.7.5 Summary and Conclusions

- The concentrations of 8 parameters monitored quarterly are increasing in either the HTW and/or GMA wells of Cell 7 (uranium, sulfate, TOC, boron, cobalt, iron, manganese, and sodium).
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 7 indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 7 are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Fourteen control charts were constructed for Cell 7 parameters. Eleven of the fourteen control charts exhibit “in control” conditions. Control charts for copper, manganese, and nickel in the HTW are not in control.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 7 in 2011.
- Chromium has been sampled at least 8 times in the LCS of Cell 7 and detected at least 25 percent of the time. It failed the null hypothesis of the Tarone-Ware test and will be added to the quarterly sampling list for the LCS, LDS, and GMA wells of each cell beginning in January 2013.
- Ammonia has been sampled at least 8 times in the LCS of Cell 7 and detected at least 25 percent of the time. It passed the null hypothesis of the Tarone-Ware test and will not be added to the quarterly sampling list.
- Beryllium has been sampled 8 times in the LCS of Cell 7 and detected at least 25 percent of the time. Parameter selection statistics were not conducted because no pre-design or background data sets exist. The small concentrations detected (maximum of 0.00025 mg/L) imply that the adding the constituent to the quarterly sampling program would not significantly enhance the early detection capability of the monitoring program. Therefore, beryllium will not be added to the quarterly sampling list.

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Table A.5.7−1. Summary Statistics for Cell 7

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
	LCS	12344C	29	29	100.0	4.72	355	175	61	Normal	None	Not Detected	
	LDS	12344D	27	27	100.0	12.2	33.7	24.5	5.4	Normal	None	Not Detected	
Total Uranium (µg/L)	HTW	12344	30	30	100.0	2.00	8.61	3.54	1.54	Lognormal	Up	Detected	
	GMA-U	22212	29	31	93.6	ND	5.53	0.490	1.17	Undefined	None	Not Detected	
	GMA-D	22211	31	32	96.9	0.131	2.30	0.328	0.535	Undefined	None	Not Detected	
	LCS	12344C	17	17	100.0	86.0	822	432	174	Undefined	None	Not Detected	
	LDS	12344D	13	13	100.0	155	586	383	122	Normal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	HTW	12344	8	8	100.0	377	455	414	26	Normal	None	Not Detected	
	GMA-U	22212	4	4	100.0	316	345	333	13	Normal	None	Insuff	
	GMA-D	22211	4	4	100.0	284	399	360	51	Normal	None	Insuff	
	LCS	12344C	17	17	100.0	26.7	175	114	49	Normal	Up	Detected	
	LDS	12344D	13	13	100.0	43.0	197	46.4	47.2	Undefined	None	Detected	
Chloride (mg/L)	HTW	12344	8	8	100.0	69.4	84.0	76.7	5.8	Normal	None	Not Detected	
	GMA-U	22212	4	4	100.0	24.2	31.9	26.9	3.4	Normal	None	Insuff	
	GMA-D	22211	4	4	100.0	19.7	31.7	25.2	5.1	Normal	None	Insuff	
	LCS	12344C	13	18	72.2	ND	4.89	0.796	1.92	Undefined	Up	Detected	10.7 (Q4-05)
	LDS	12344D	10	13	76.9	ND	3.61	0.908	1.41	Normal	Up	Not Detected	9.03 (Q3-04)
Nitrate/Nitrite as N (mg/L)	HTW	12344	5	8	62.5	ND	0.34	0.172	0.108	Lognormal	None	Not Detected	
	GMA-U	22212	0	4	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22211	0	4	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	LCS	12344C	29	29	100.0	122	3920	2850	1120	Undefined	Up	Detected	
	LDS	12344D	27	27	100.0	1280	4030	1740	780	Undefined	Up	Detected	
Sulfate (mg/L)	HTW	12344	27	27	100.0	80.4	465	208	135	Normal	Up	Detected	
	GMA-U	22212	31	31	100.0	96.7	731	241	136	Lognormal	Up	Detected	
	GMA-D	22211	31	31	100.0	152	572	331	126	Normal	Up	Detected	
	LCS	12344C	17	17	100.0	960	6400	5710	1810	Undefined	Up	Detected	
	LDS	12344D	11	11	100.0	2590	6870	4440	1450	Normal	Up	Not Detected	
Total Dissolved Solids (mg/L)	HTW	12344	7	7	100.0	1020	1200	1120	60	Normal	None	Not Detected	
	GMA-U	22212	11	11	100.0	609	1510	870	299	Lognormal	None	Not Detected	
	GMA-D	22211	11	11	100.0	602	1350	1050	230	Normal	None	Not Detected	
	LCS	12344C	25	29	86.2	ND	5.55	2.33	0.88	Lognormal	None	Not Detected	
	LDS	12344D	27	27	100.0	2.99	8.80	5.60	1.36	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	HTW	12344	24	27	88.9	ND	3.72	2.24	0.72	Normal	None	Detected	
	GMA-U	22212	26	31	83.9	ND	2.24	1.26	0.51	Normal	Up	Detected	
	GMA-D	22211	25	31	80.6	0.555	2.15	1.36	0.50	Undefined	Up	Detected	
	LCS	12344C	20	29	69.0	ND	0.039	0.0130	0.0114	Undefined	Up	Detected	
	LDS	12344D	20	27	74.1	ND	0.064	0.0291	0.0140	Normal	None	Not Detected	
Total Organic Halogens (mg/L)	HTW	12344	12	27	44.4	ND	0.035	0.0101	0.0098	Lognormal	None	Not Detected	
	GMA-U	22212	10	31	32.3	ND	0.050	0.00532	0.00876	Lognormal	None	Not Detected	
	GMA-D	22211	7	31	22.6	0.00062	0.0134	0.00352	0.00341	Lognormal	None	Not Detected	0.054 (Q2-10)
	LCS	12344C	6	22	27.3	ND	0.179	0.00375	0.0470	Undefined	None	Not Detected	
	LDS	12344D	4	20	20.0	ND	0.048	0.0025	0.0108	Undefined	None	Not Detected	
Arsenic (mg/L)	HTW	12344	1	18	5.6	ND	0.0298	Insff	Insuff	Undefined	None	Not Detected	
	GMA-U	22212	3	11	27.3	ND	0.0394	0.0025	Insuff	Undefined	None	Not Detected	
	GMA-D	22211	5	20	25.0	ND	0.0323	0.0025	0.0094	Undefined	None	Detected	
	LCS	12344C	17	17	100.0	0.0234	0.112	0.0509	0.0283	Lognormal	Down	Not Detected	
	LDS	12344D	13	13	100.0	0.0197	0.0891	0.0362	0.0193	Lognormal	Down	Not Detected	
Barium (mg/L)	HTW	12344	8	8	100.0	0.0922	0.121	0.111	0.010	Normal	None	Not Detected	
	GMA-U	22212	4	4	100.0	0.0508	0.0971	0.0770	0.0218	Normal	None	Insuff	
	GMA-D	22211	4	4	100.0	0.0429	0.0693	0.0558	0.0111	Normal	None	Insuff	

Table A.5.7−1 (continued). Summary Statistics for Cell 7

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12344C	29	29	100.0	0.926	1.35	1.18	0.10	Normal	None	Not Detected	0.299 (Q4-04) 0.0625 (Q1-05) 0.288 (Q2-05) 0.249 (Q3-05) 0.249 (Q4-05)
	LDS	12344D	27	27	100.0	0.168	2.10	0.309	0.382	Undefined	Up	Detected	
	HTW	12344	19	27	70.4	ND	0.075	0.0248	0.0137	Normal	None	Not Detected	
	GMA-U	22212	29	31	93.6	ND	0.0458	0.0344	0.0063	Normal	None	Detected	
	GMA-D	22211	28	31	90.3	ND	0.0433	0.0286	0.0069	Undefined	Up	Not Detected	
Calcium (mg/L)	LCS	12344C	17	17	100.0	153	759	577	178	Undefined	Up	Not Detected	
	LDS	12344D	13	13	100.0	155	474	312	121	Lognormal	None	Detected	
	HTW	12344	8	8	100.0	149	187	164	13	Normal	None	Not Detected	
	GMA-U	22212	4	4	100.0	146	377	156	112	Undefined	None	Insuff	
	GMA-D	22211	4	4	100.0	153	263	206	45	Normal	None	Insuff	
Cobalt (mg/L)	LCS	12344C	12	22	54.6	ND	0.0080	0.0017	0.0022	Undefined	Down	Not Detected	
	LDS	12344D	10	20	50.0	ND	0.0025	0.000826	0.00053	Lognormal	None	Not Detected	
	HTW	12344	10	15	66.7	ND	0.0433	0.00675	0.0132	Normal	Up	Detected	
	GMA-U	22212	1	11	9.1	ND	0.00138	Insuff	Insuff	Undefined	None	Detected	
	GMA-D	22211	0	11	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Copper (mg/L)	LCS	12344C	16	22	72.7	ND	0.0266	0.0108	0.0089	Undefined	None	Not Detected	
	LDS	12344D	13	20	65.0	ND	0.0239	0.00833	0.00657	Lognormal	Down	Detected	
	HTW	12344	5	9	55.6	ND	0.015	0.00358	0.00434	Lognormal	None	Not Detected	
	GMA-U	22212	4	4	100.0	0.00106	0.00966	0.00636	0.00393	Normal	None	Insuff	
	GMA-D	22211	4	4	100.0	0.00599	0.00956	0.00754	0.00151	Normal	None	Insuff	
Iron (mg/L)	LCS	12344C	21	22	95.4	ND	18.7	5.18	4.99	Lognormal	Down	Not Detected	
	LDS	12344D	18	20	90.0	ND	2.74	0.987	0.820	Undefined	Down	Detected	
	HTW	12344	14	15	93.3	0.119	66.1	21.2	18.2	Lognormal	Up	Detected	
	GMA-U	22212	11	11	100.0	4.15	20.5	9.17	4.68	Lognormal	Up	Not Detected	
	GMA-D	22211	11	11	100.0	4.88	11.2	8.19	2.00	Normal	None	Detected	
Lithium (mg/L)	LCS	12344C	20	20	100.0	0.0188	0.393	0.171	0.095	Normal	Up	Detected	
	LDS	12344D	19	19	100.0	0.0529	0.226	0.119	0.053	Lognormal	Up	Detected	
	HTW	12344	10	15	66.7	ND	0.00874	0.00716	0.00143	Undefined	None	Not Detected	
	GMA-U	22212	11	11	100.0	0.00495	0.00892	0.00620	0.00125	Lognormal	None	Not Detected	
	GMA-D	22211	11	11	100.0	0.00566	0.00827	0.00690	0.00083	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12344C	17	17	100.0	60.5	834	448	276	Normal	Up	Detected	
	LDS	12344D	13	13	100.0	61.1	369	88.8	117	Undefined	None	Detected	
	HTW	12344	8	8	100.0	46.0	58.9	51	4	Normal	None	Not Detected	
	GMA-U	22212	4	4	100.0	28.6	54.6	38.2	11.3	Normal	None	Insuff	
	GMA-D	22211	4	4	100.0	34.6	60.6	47.6	10.6	Normal	None	Insuff	
Manganese (mg/L)	LCS	12344C	14	22	63.6	0.0041	0.991	0.0351	0.276	Undefined	Down	Detected	
	LDS	12344D	13	20	65.0	ND	1.20	0.083	0.266	Normal	None	Not Detected	
	HTW	12344	14	15	93.3	ND	0.223	0.0525	0.0565	Lognormal	None	Not Detected	
	GMA-U	22212	11	11	100.0	0.219	1.23	0.310	0.299	Undefined	None	Not Detected	
	GMA-D	22211	20	20	100.0	0.256	0.680	0.459	0.136	Normal	Up	Detected	
Nickel (mg/L)	LCS	12344C	19	22	86.4	ND	0.0265	0.00999	0.00795	Lognormal	Down	Detected	
	LDS	12344D	16	20	80.0	ND	0.0138	0.00681	0.00384	Normal	None	Not Detected	
	HTW	12344	11	15	73.3	ND	0.0761	0.0114	0.0215	Lognormal	None	Not Detected	
	GMA-U	22212	4	11	36.4	ND	0.00493	0.00075	0.00148	Undefined	None	Not Detected	
	GMA-D	22211	3	20	15.0	ND	0.00520	0.00075	Insuff	Undefined	None	Detected	
Potassium (mg/L)	LCS	12344C	17	17	100.0	8.12	61.4	44.3	15.5	Undefined	Up	Detected	
	LDS	12344D	13	13	100.0	13.2	97.9	32.6	24.3	Lognormal	None	Not Detected	
	HTW	12344	7	8	87.5	ND	2.89	2.15	0.57	Normal	None	Not Detected	
	GMA-U	22212	4	4	100.0	3.47	4.81	3.58	0.64	Undefined	None	Insuff	
	GMA-D	22211	4	4	100.0	2.74	3.40	3.04	0.32	Normal	None	Insuff	

Table A.5.7−1 (continued). Summary Statistics for Cell 7

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12344C	4	22	18.2	ND	0.171	0.00625	0.0368	Undefined	None	Not Detected	
	LDS	12344D	3	20	15.0	ND	0.0477	0.00712	Insuff	Lognormal	None	Not Detected	
	HTW	12344	1	15	6.7	ND	0.0292	Insuff	Insuff	Undefined	None	Not Detected	
	GMA-U	22212	1	11	9.1	ND	0.00827	Insuff	Insuff	Undefined	None	Detected	
	GMA-D	22211	0	11	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12344C	22	22	100.0	18.1	102	80.7	25.3	Undefined	Up	Detected	
	LDS	12344D	20	20	100.0	186	913	584	166	Normal	None	Not Detected	
	HTW	12344	18	18	100.0	19.8	37.4	27.6	7.1	Undefined	Up	Detected	
	GMA-U	22212	11	11	100.0	19.6	27.0	23.1	2.6	Normal	Down	Detected	
	GMA-D	22211	11	11	100.0	11.1	19.2	15.5	2.5	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12344C	14	22	63.6	ND	0.154	0.0294	0.0401	Lognormal	None	Not Detected	
	LDS	12344D	17	20	85.0	ND	5.16	0.0255	1.43	Undefined	Up	Detected	
	HTW	12344	14	15	93.3	0.0048	0.655	0.211	0.213	Lognormal	None	Not Detected	
	GMA-U	22212	6	11	54.6	ND	0.0148	0.00659	0.00429	Normal	None	Not Detected	
	GMA-D	22211	10	20	50.0	ND	0.0205	0.00462	0.00446	Lognormal	None	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires n ≥ 3. In addition, Standard Deviation requires n ≥ 4.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where 3 ≤ n ≤ 50) or Shapiro Francia (where n > 50).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with n ≥ 4.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with n ≥ 6.

[h]Outliers determined by Rosner's (where n > 25) or Dixon procedure (where 4 ≤ n ≤ 25).

[i]Q = quarterly

Table A.5.7−2. Cell 7 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	8	3	37.5	Yes	0.026	0.254	0.113	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	8	2	25.0	No	0.00017	0.00025	0.0002	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	8	1	12.5	No	0.0002	-	-	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	8	2	25	Yes	0.0055	0.0292	0.0174	0.022 mg/L[g](1)	0.021 mg/L(1)	0.0046 mg/L(2)	0.818 mg/L(0)
Lead (mg/L)	8	1	12.5	No	0.0061	-	-	0.015 mg/L(0)	0.022 mg/L(0)	0.0016 mg/L(1)	0.0114 mg/L(0)
Thallium (mg/L)	8	1	12.5	No	0.00046	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	8	1	12.5	No	0.0051	-	-	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(1)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	16	6	37.5	No	0.86	16.2	9.05	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethene (ug/L)	14	3	21.4	Yes	0.455	0.72	0.558	7 ug/L(0)	-	-	-
Acetone (ug/L)	8	1	12.5	No	3.5	-	-	-	-	-	-
Total Xylenes (ug/L)	8	1	12.5	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

Table A.5.7–3. Site-Specific Parameter Selection Results

Parameter	Dataset	Samples	Detects	Detect %	t-Test												Wilcoxon + Quantile		Tarone-Ware Test
					Shapiro-Wilk (N)	Shapiro-Wilk (LN)	Min	Max	Mean (mg/L)	Median	Variance	Std. Dev.	Log Mean	Log SD	F-Test	t-Test Prob	Wilcoxen Group Comparison	Quantile Test	
Ammonia	LCS	8	3	38%			0.005	0.254	0.0518	0.0205	0.0070	0.0837							
	PreDesign**	9	7	78%			0.015	450	54.98	0.604	22100	149							Pass
	* before 2/10/95																		
	** after 2/10/95																		
Chromium	LCS	8	2	25%			0.0010	0.0292	0.0067	0.0038	0.0000858	0.0093							
	PreDesign	40	19	48%			0.002	0.478	0.046	0.004	0.008	0.087							Pass
	PreDesign*	19	17	89%			0.004	0.478	0.093	0.051	0.012	0.110							Pass
	PreDesign**	21	2	10%			0.002	0.012	0.004	0.004	0.000	0.002							Failed
	* before 2/10/95																		
	** after 2/10/95																		

(green)	No significant difference (Pass)
(red)	LCS significantly GREATER than PreDesign (Fail)

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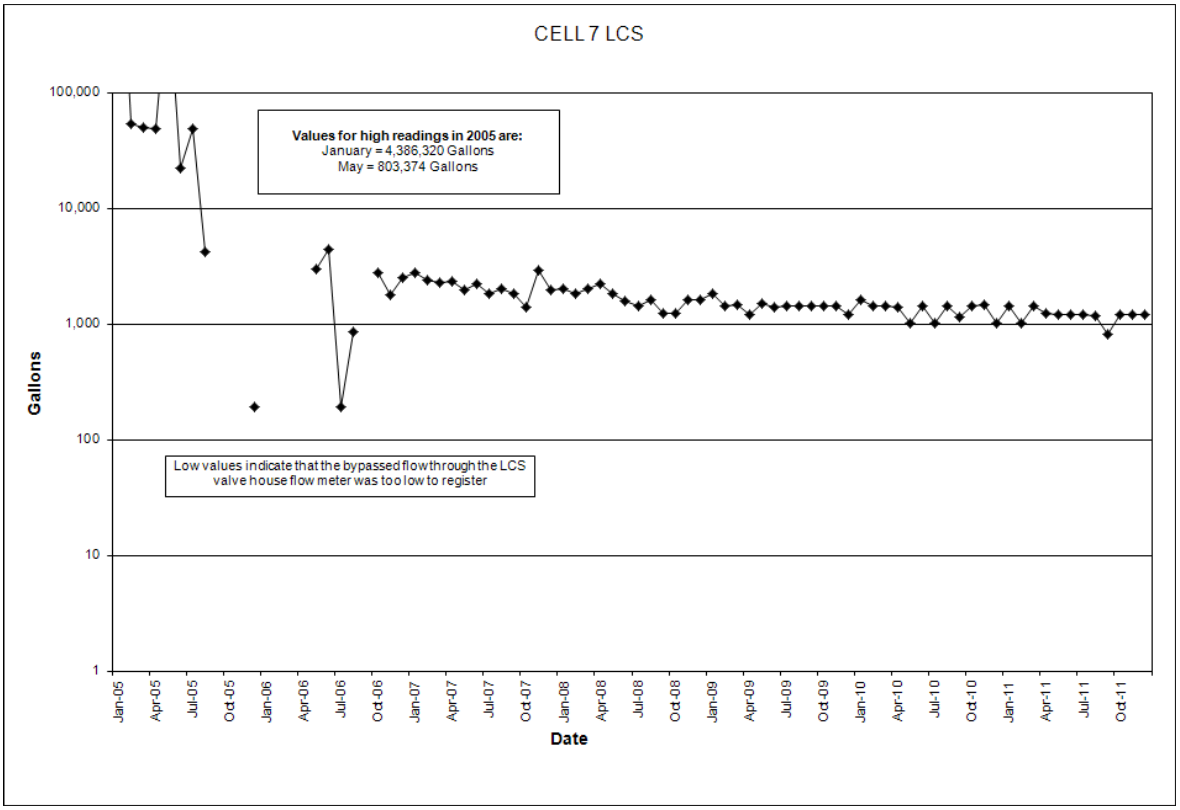


Figure A.5.7-1. Monthly Accumulation Volumes for Cell 7 LCS

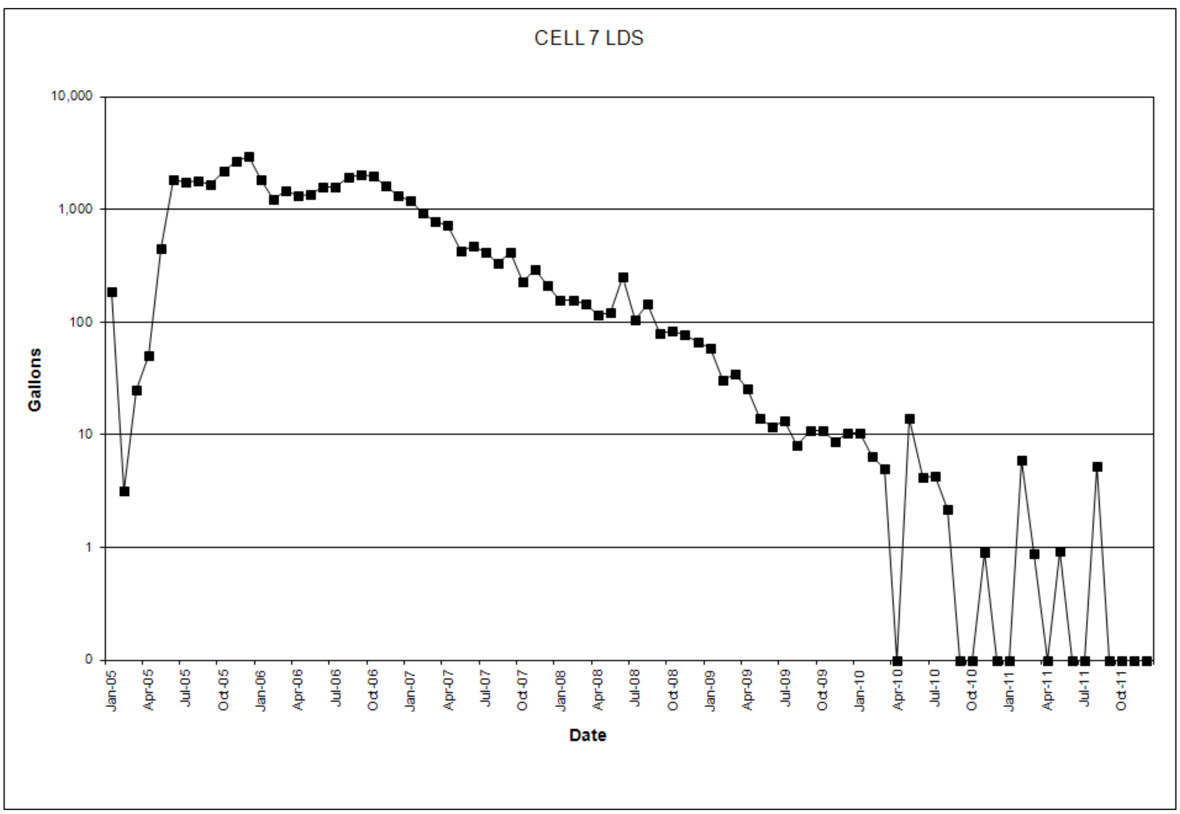
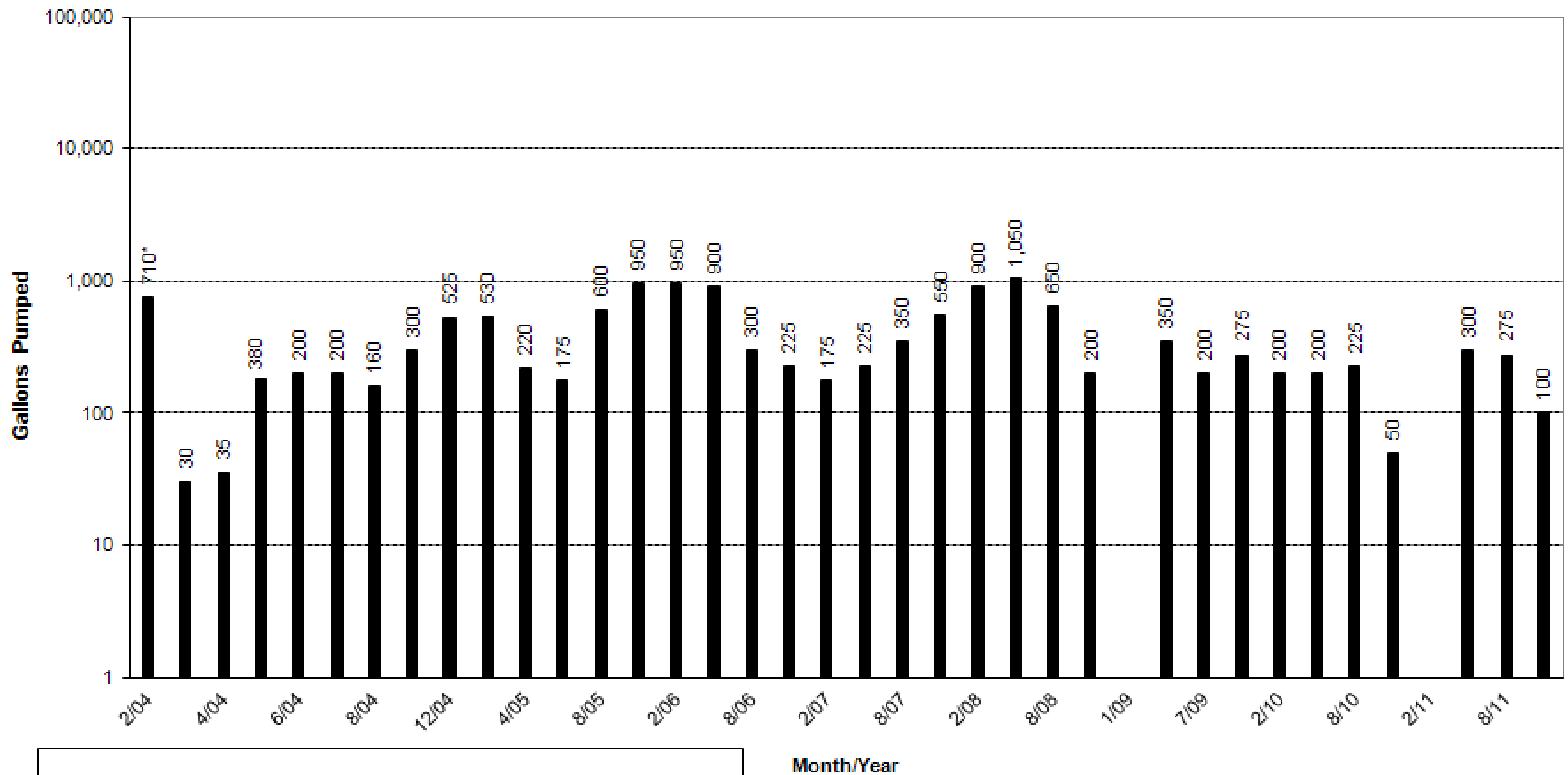


Figure A.5.7-2. Monthly Accumulation Volumes for Cell 7 LDS



12344 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2004:	2380	n=9	264
2005:	2475	n=5	495
2006:	2375	n=4	594
2007:	1300	n=4	325
2008:	2800	n=4	700
2009:	825	n=3	275
2010:	675	n=4	169
2011:	675	n=4	169
Overall:			365

*More than one purge of the well was completed during this month to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

Figure A.5.7-3. OSDF Horizontal Till Well 12343 (Cell 7) Water Yield

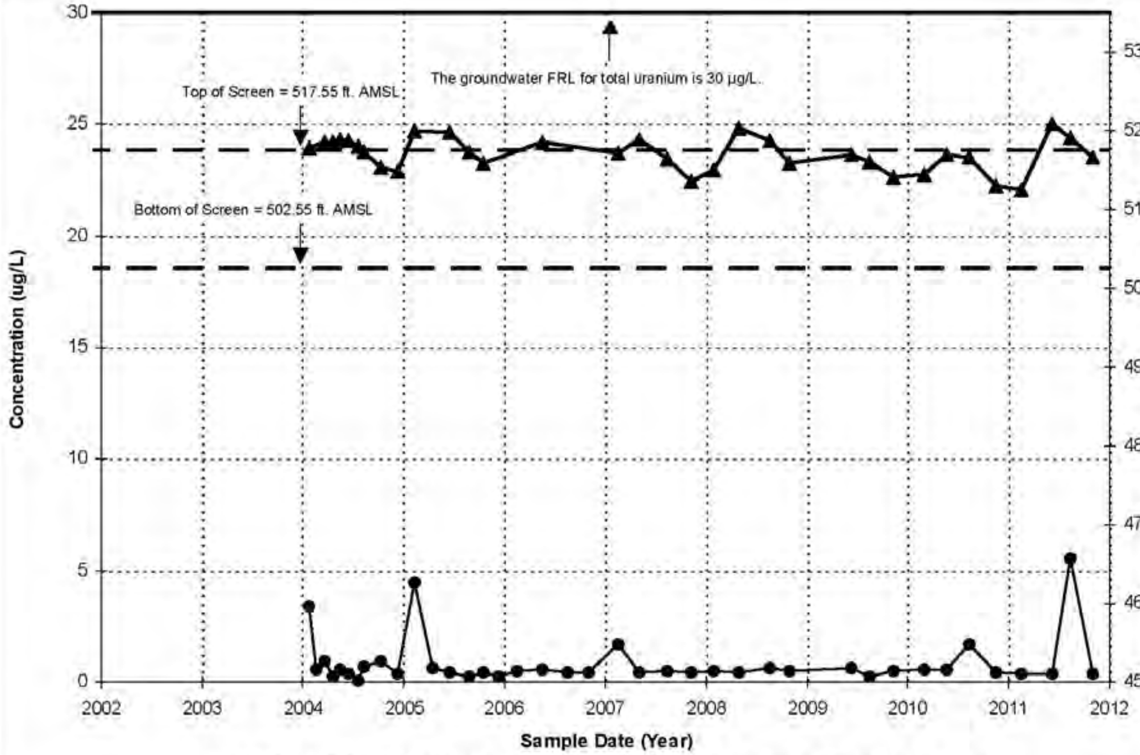


FIGURE A.5.7-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 7 Upgradient Monitoring Well 22212

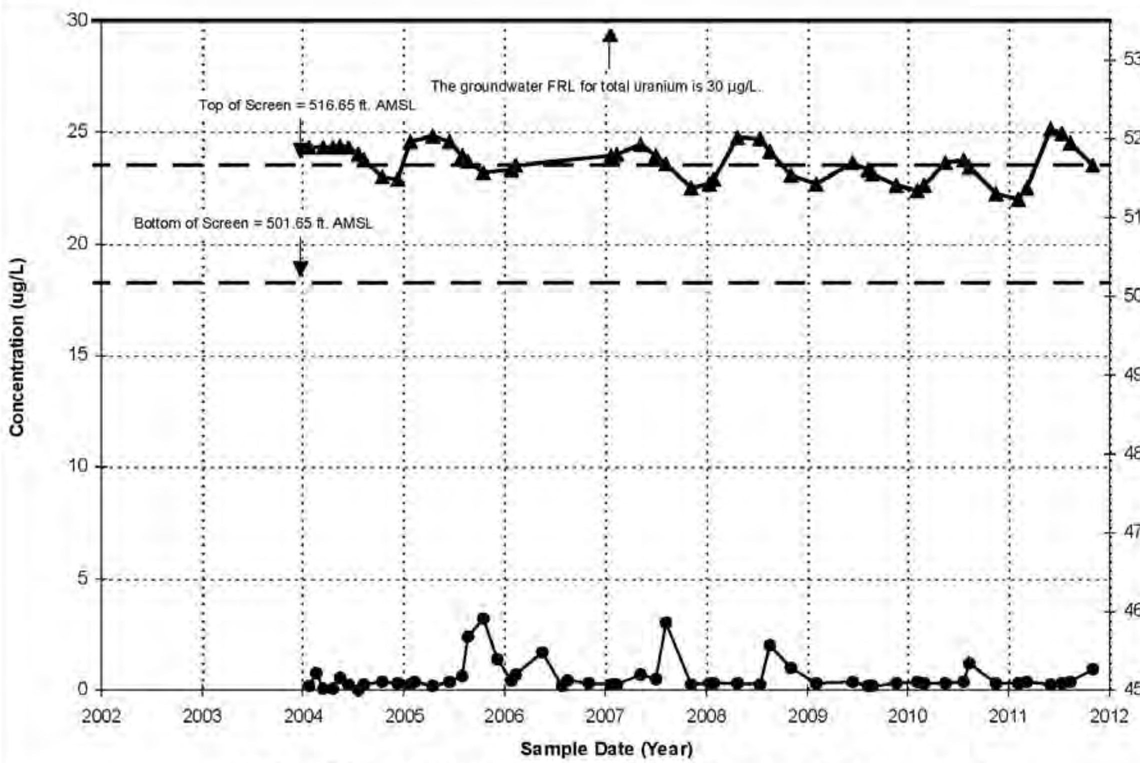


FIGURE A.5.7-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 7 Downgradient Monitoring Well 22211

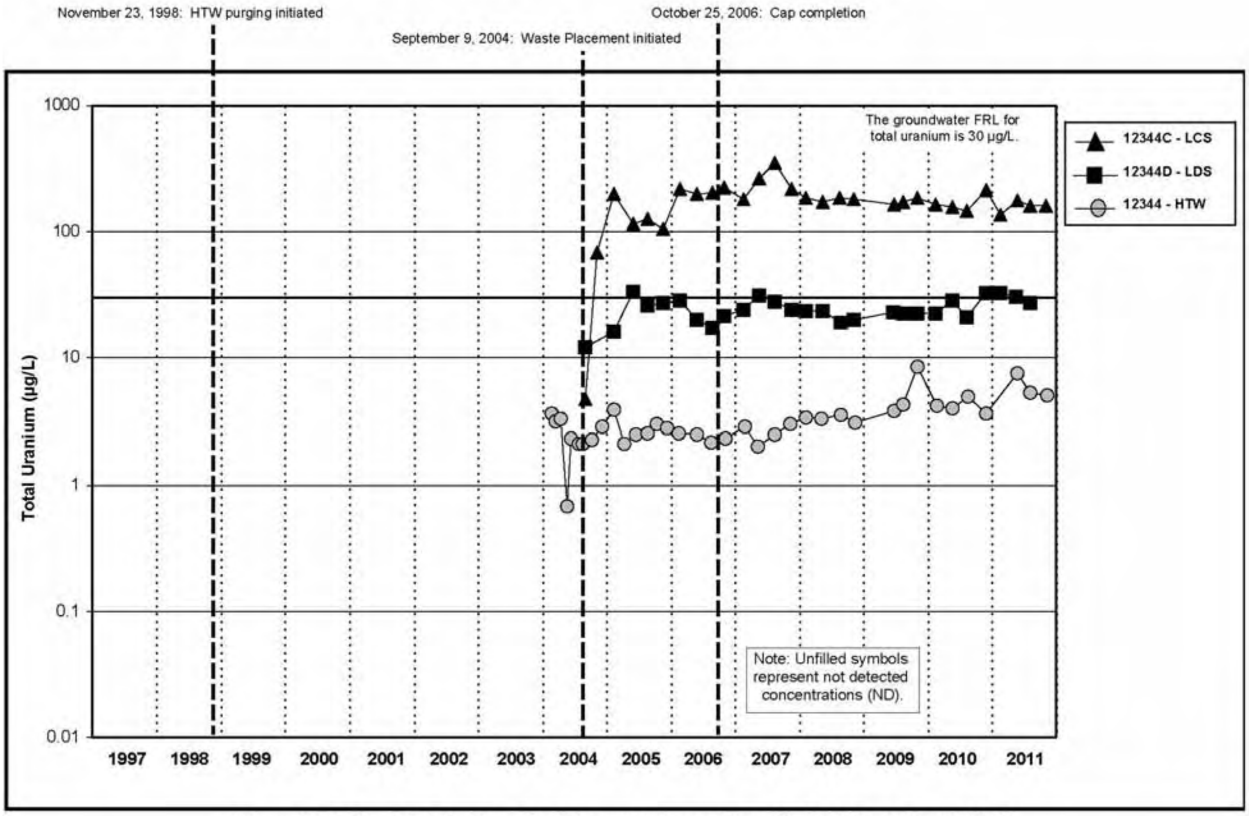


Figure A.5.7-6A. Cell 7 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

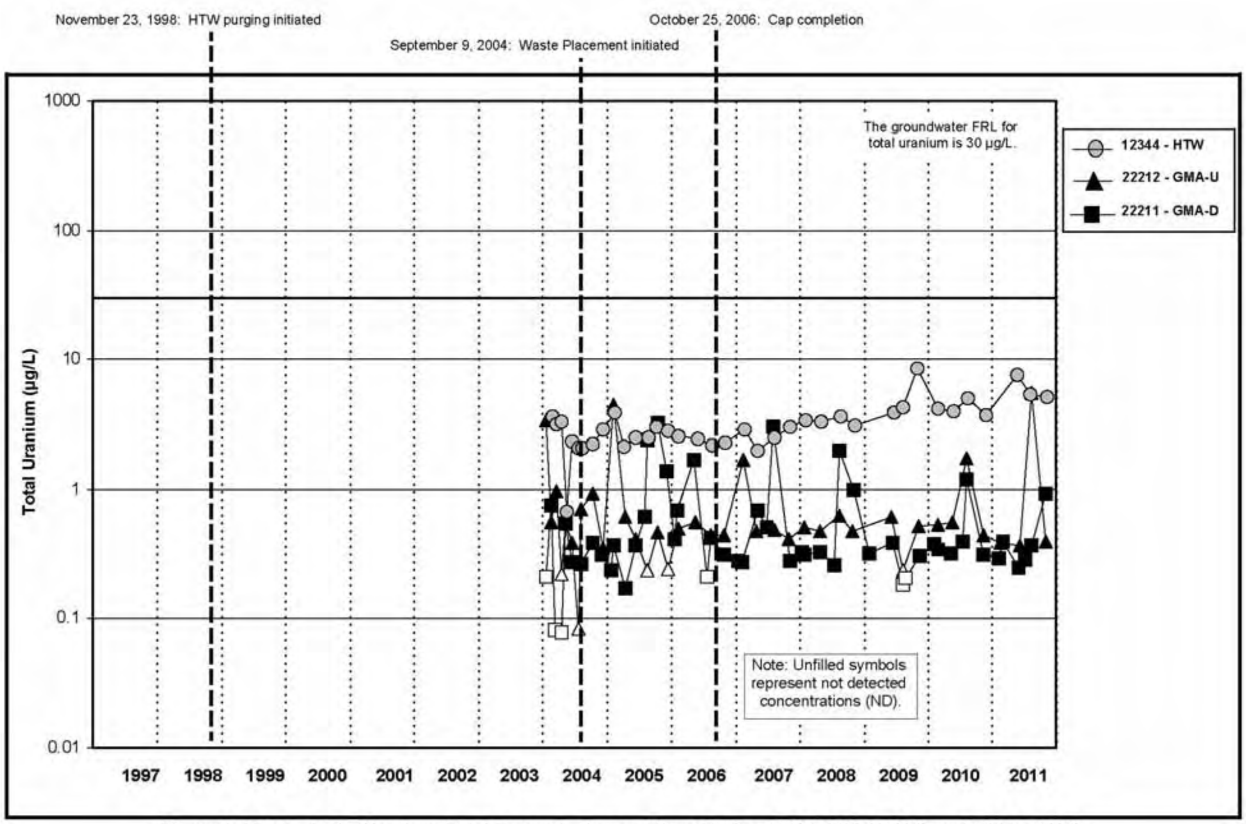


Figure A.5.7-6B. Cell 7 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

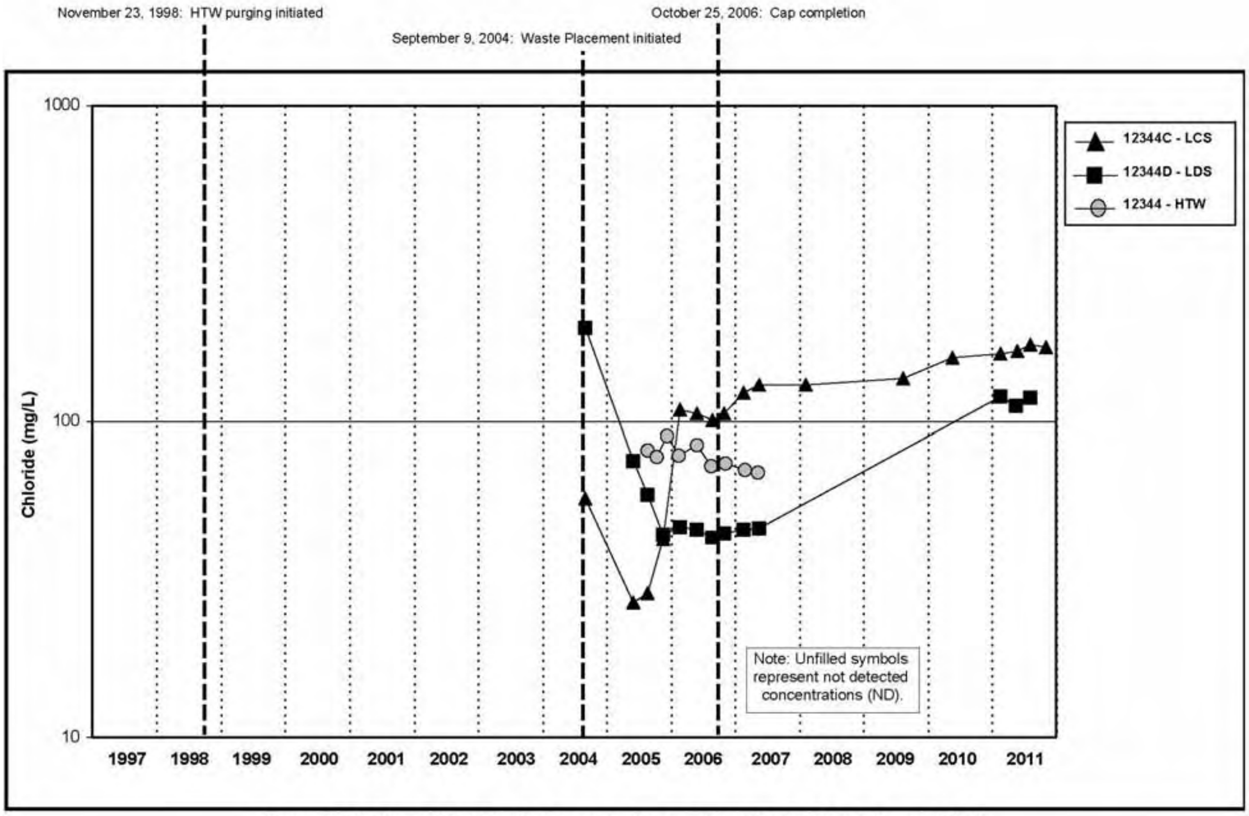


Figure A.5.7-7A. Cell 7 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

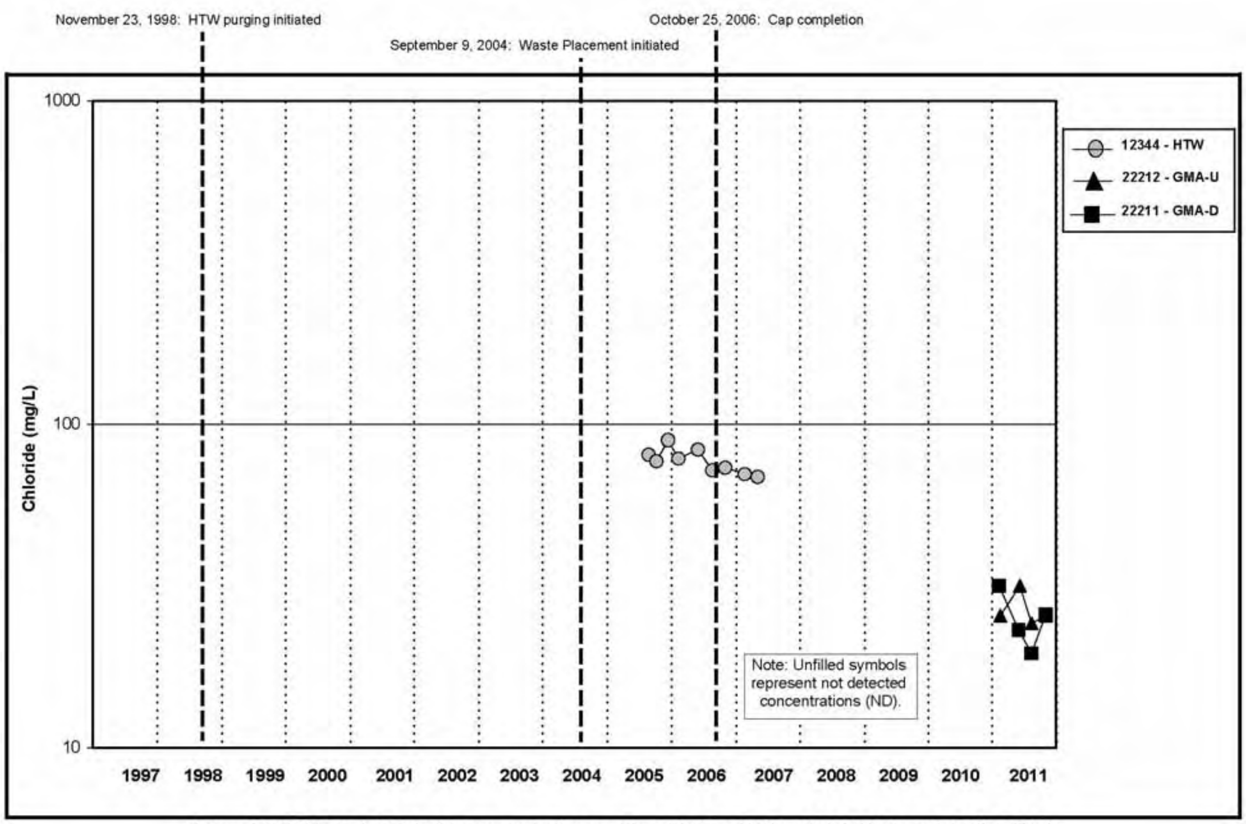


Figure A.5.7-7B. Cell 7 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

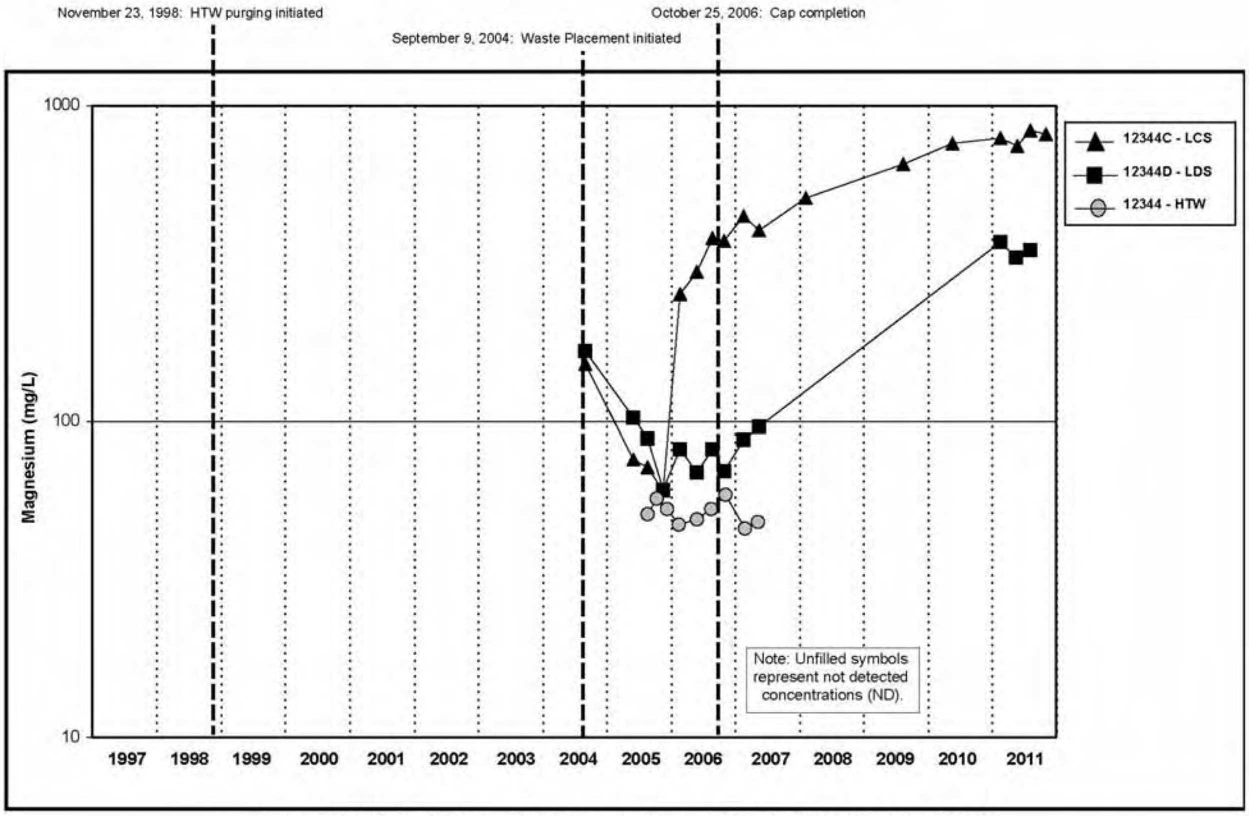


Figure A.5.7-8A. Cell 7 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

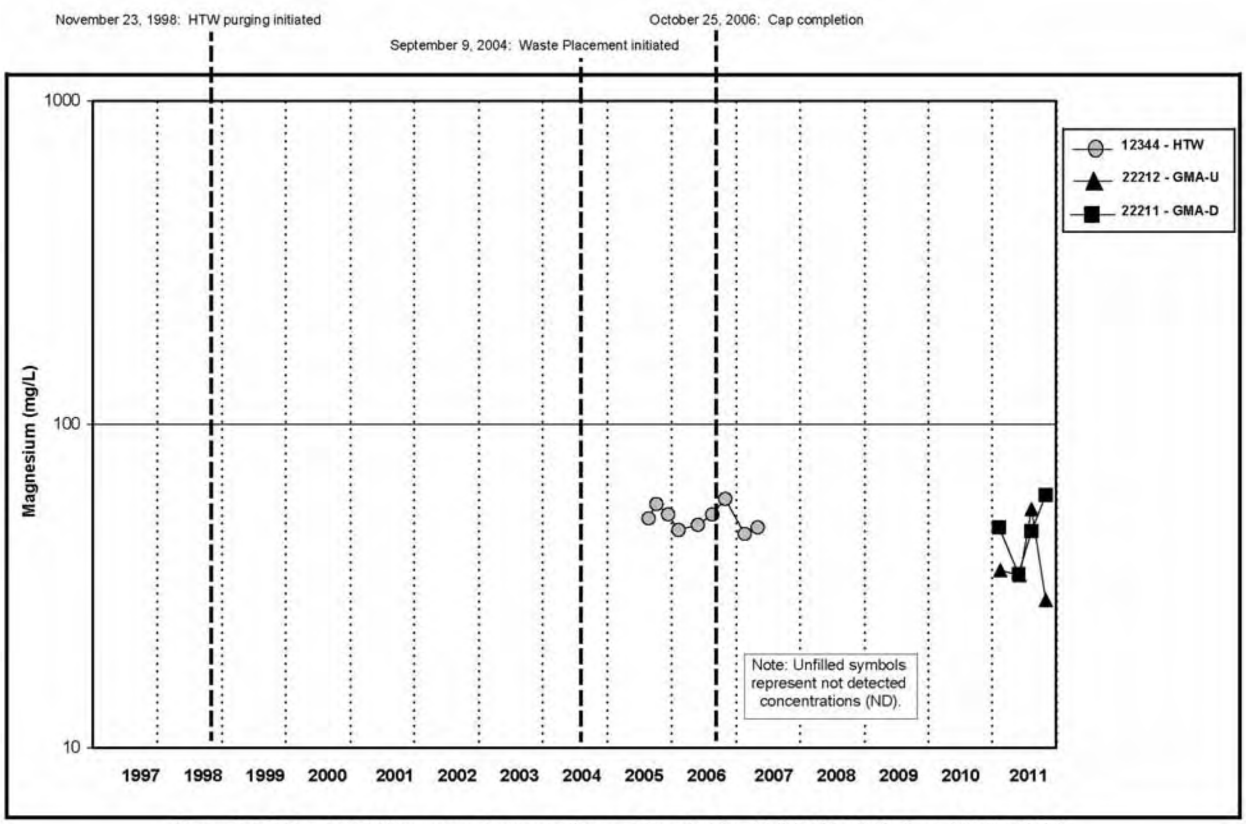


Figure A.5.7-8B. Cell 7 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

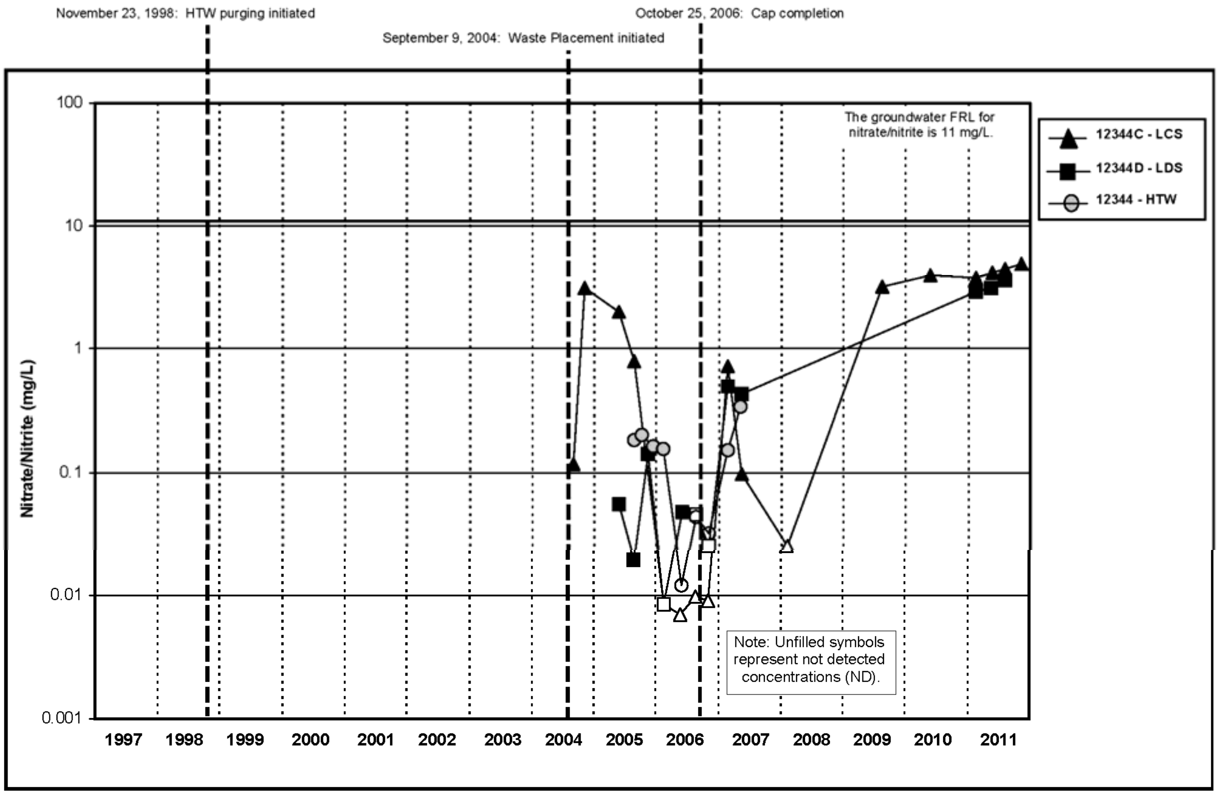


Figure A.5.7-9A. Cell 7 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

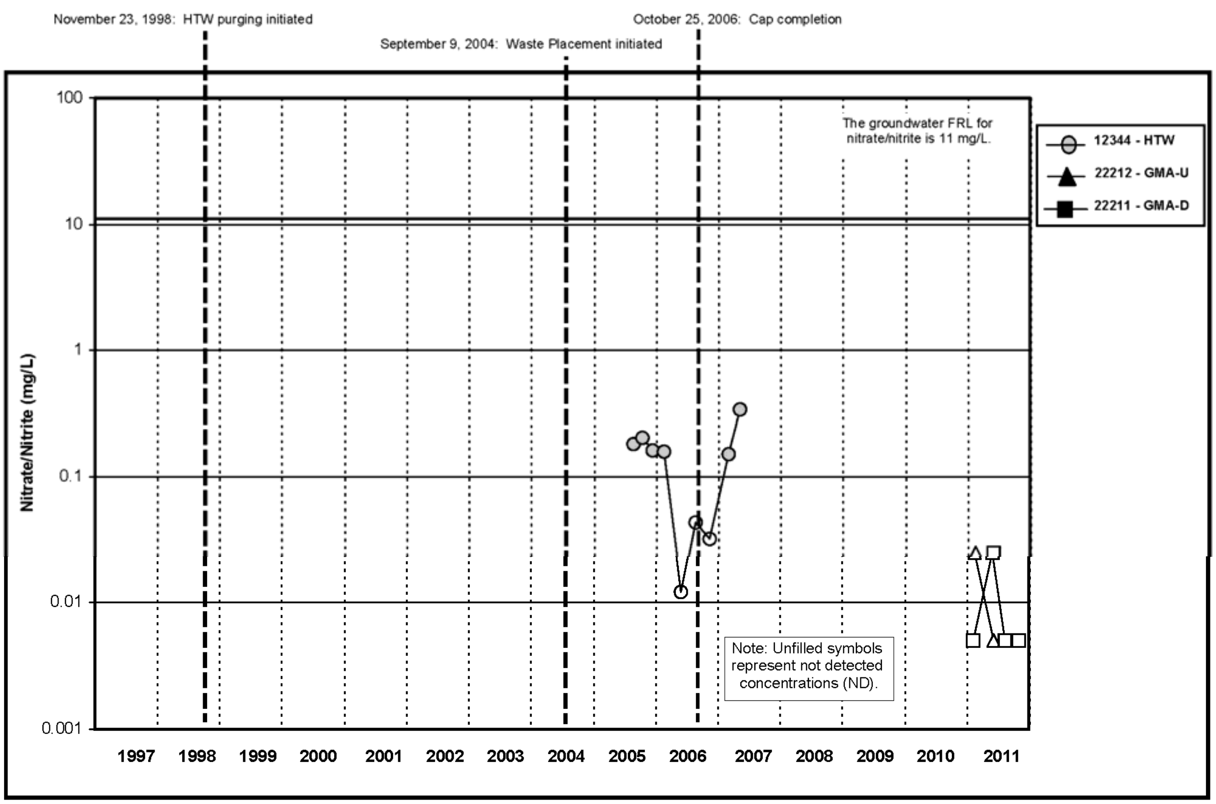


Figure A.5.7-9B. Cell 7 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

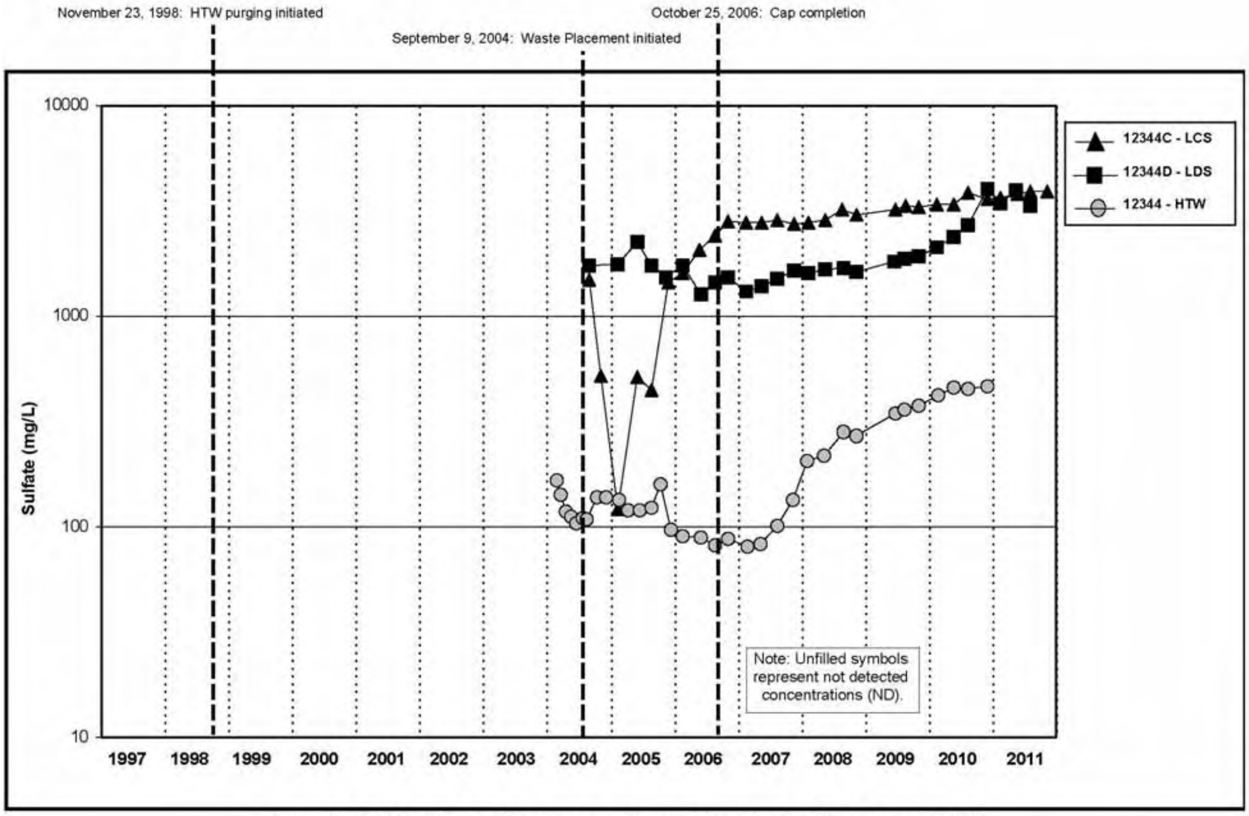


Figure A.5.7-10A. Cell 7 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

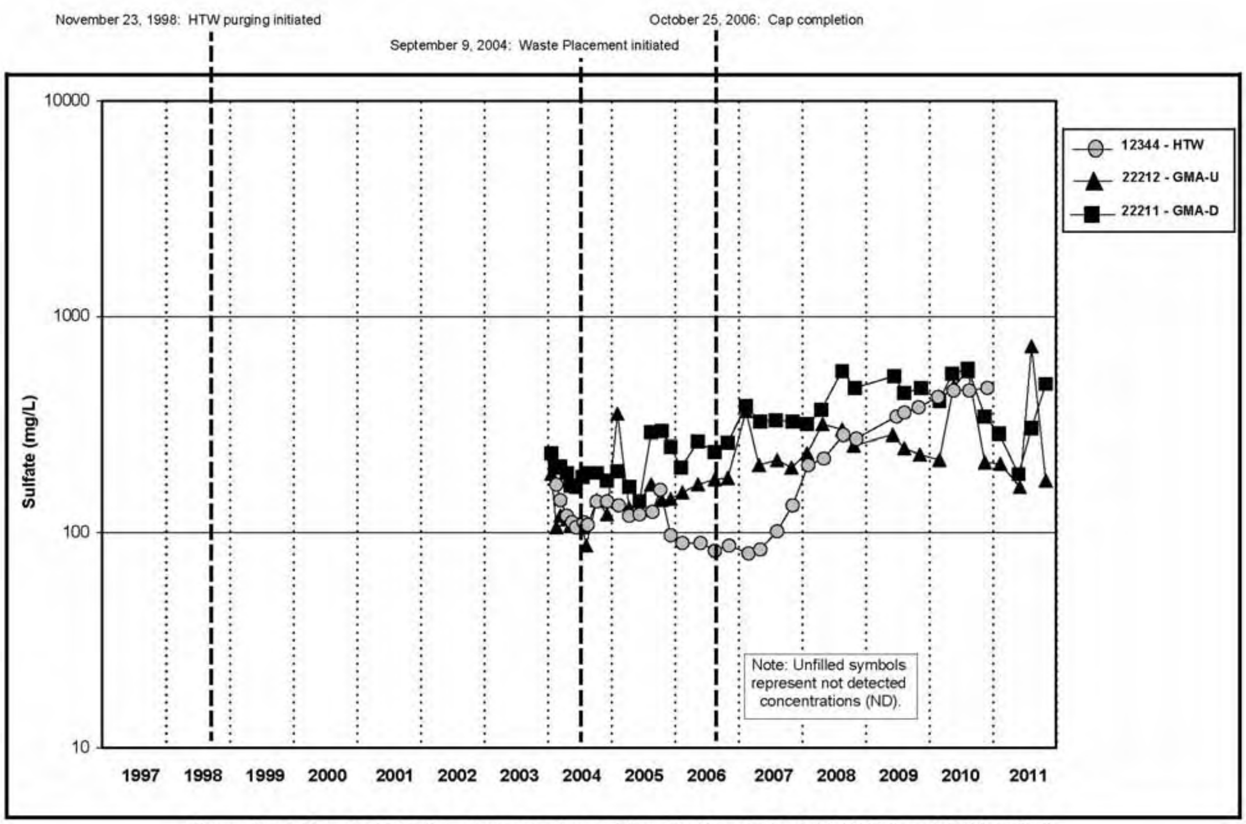


Figure A.5.7-10B. Cell 7 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

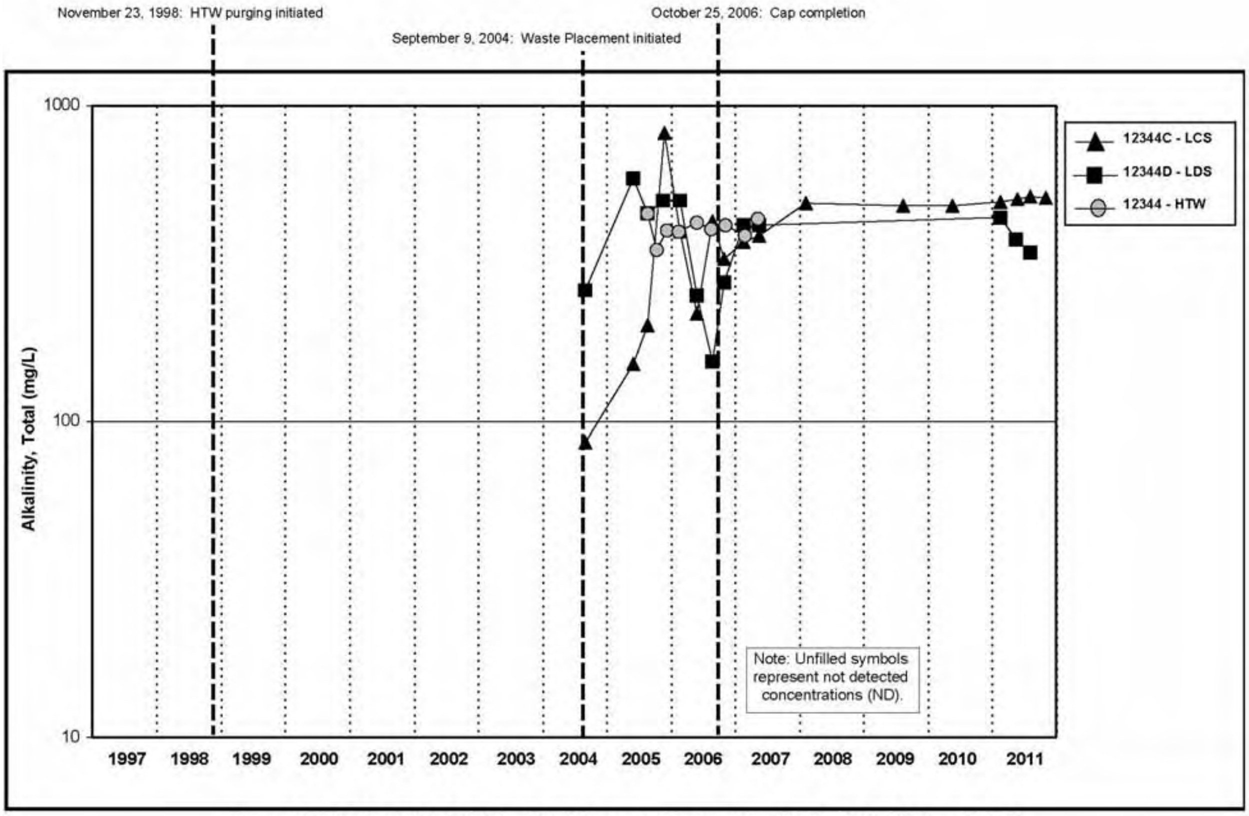


Figure A.5.7-11A. Cell 7 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

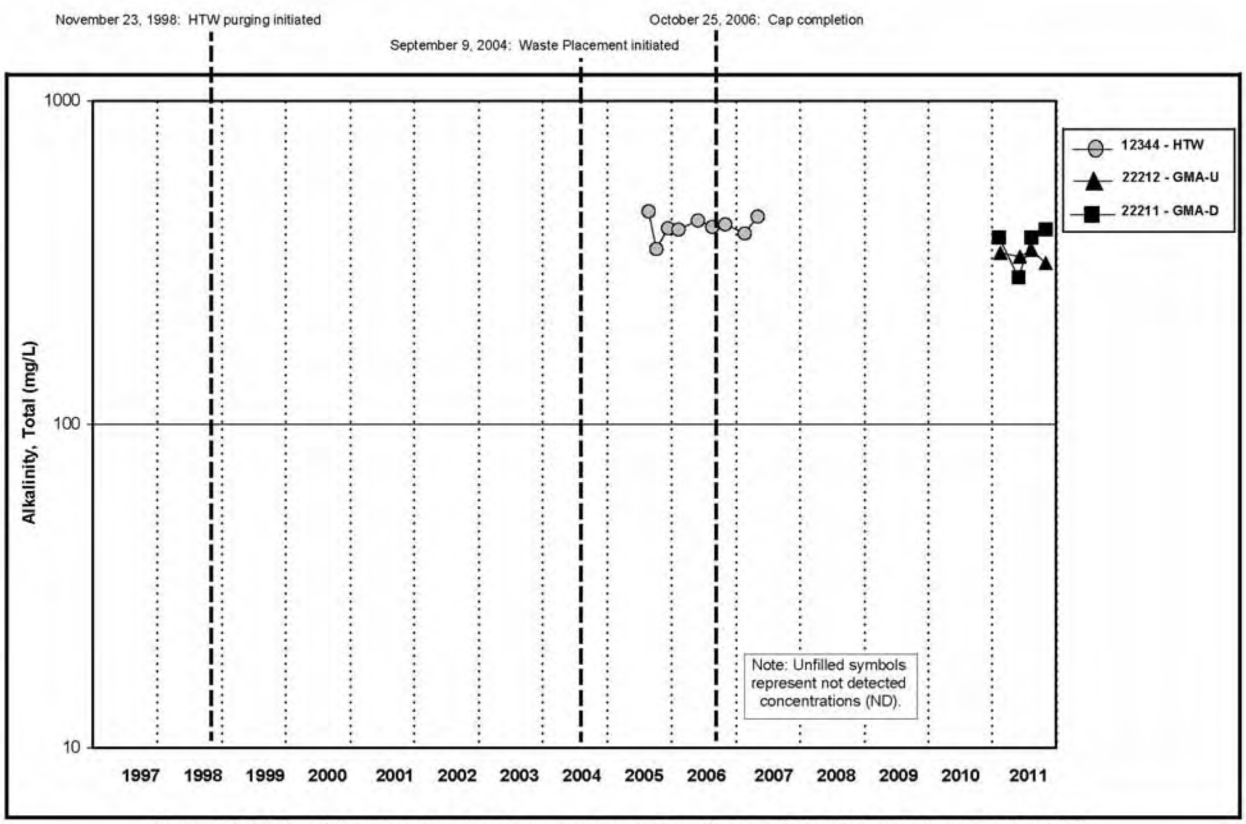


Figure A.5.7-11B. Cell 7 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

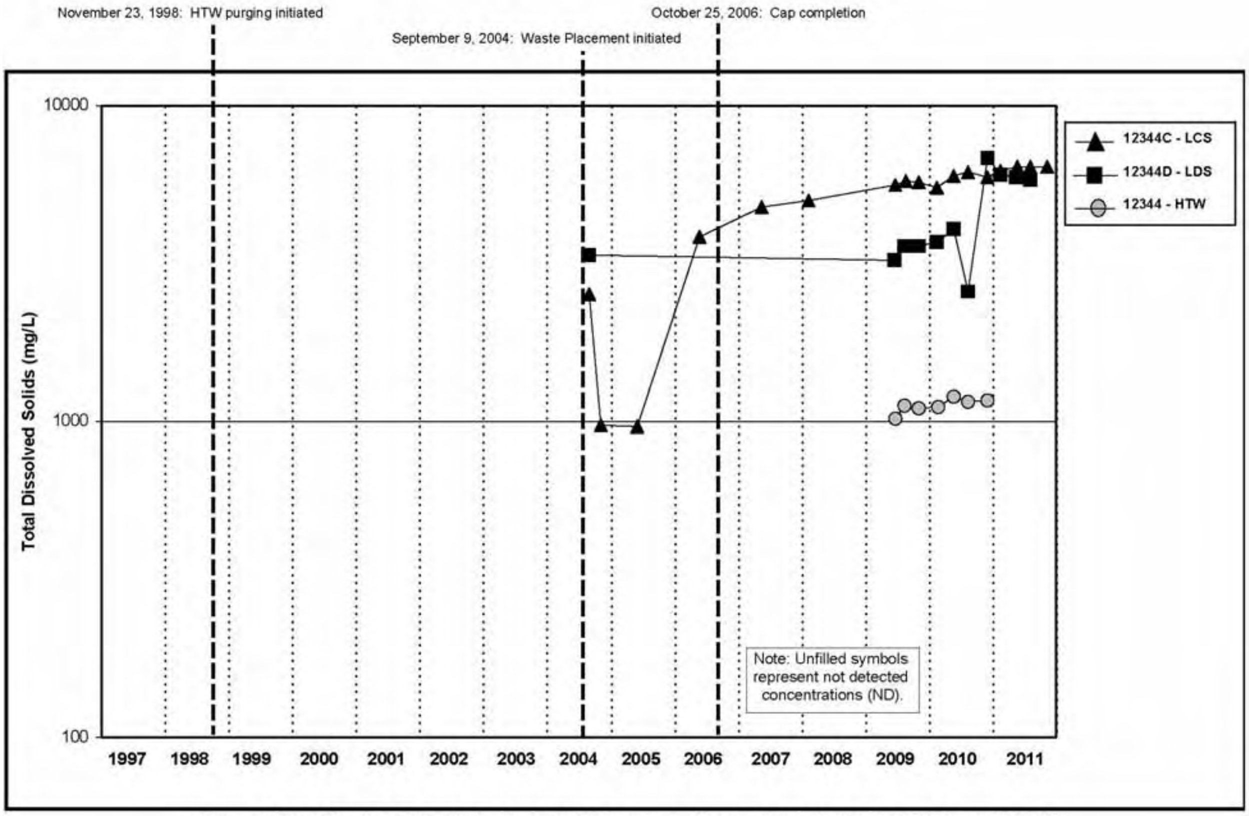


Figure A.5.7-12A. Cell 7 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

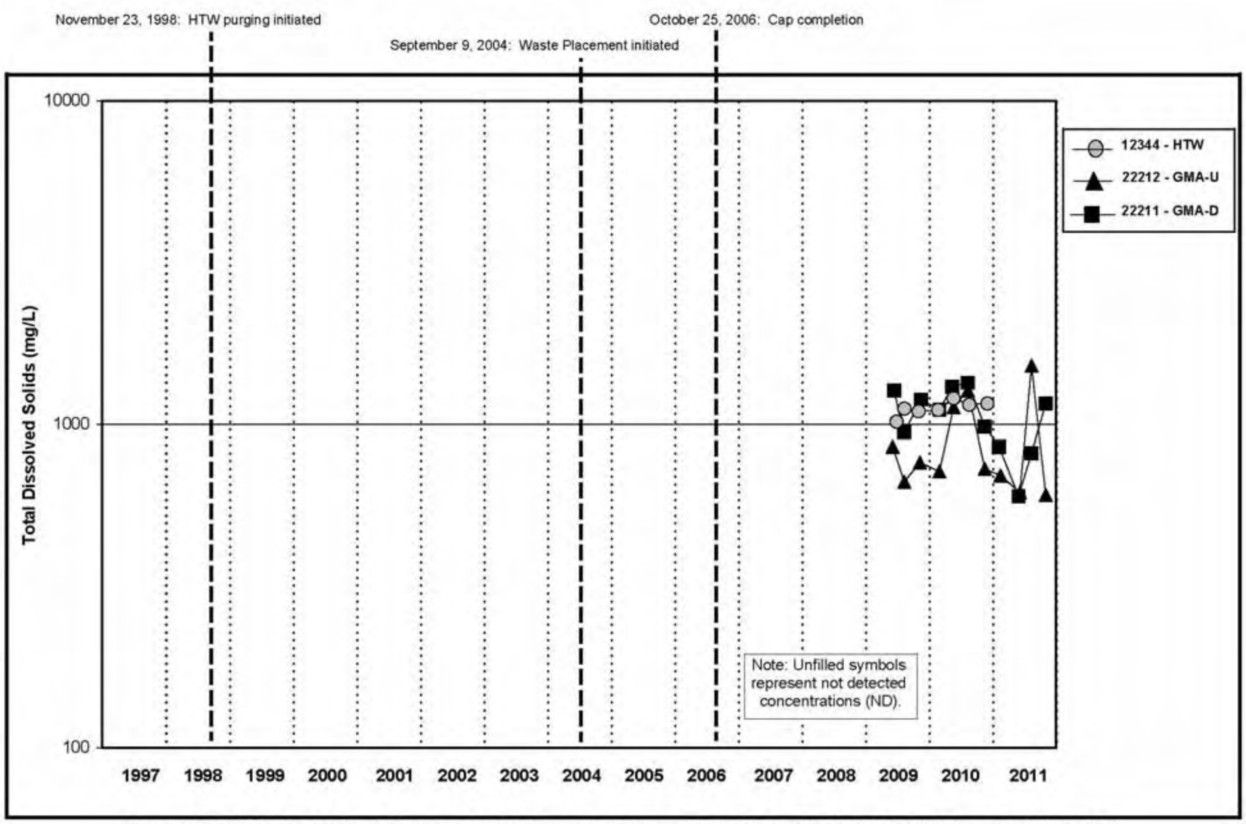


Figure A.5.7-12B. Cell 7 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

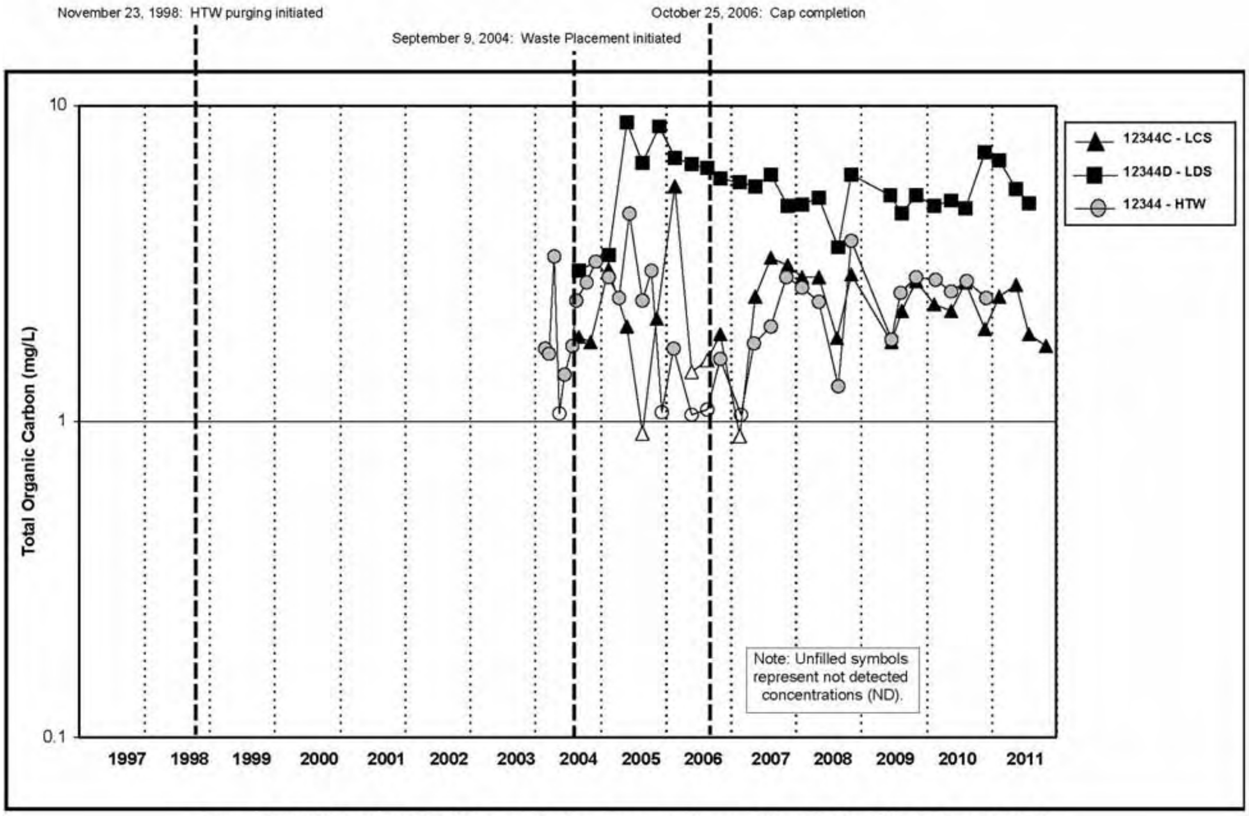


Figure A.5.7-13A. Cell 7 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

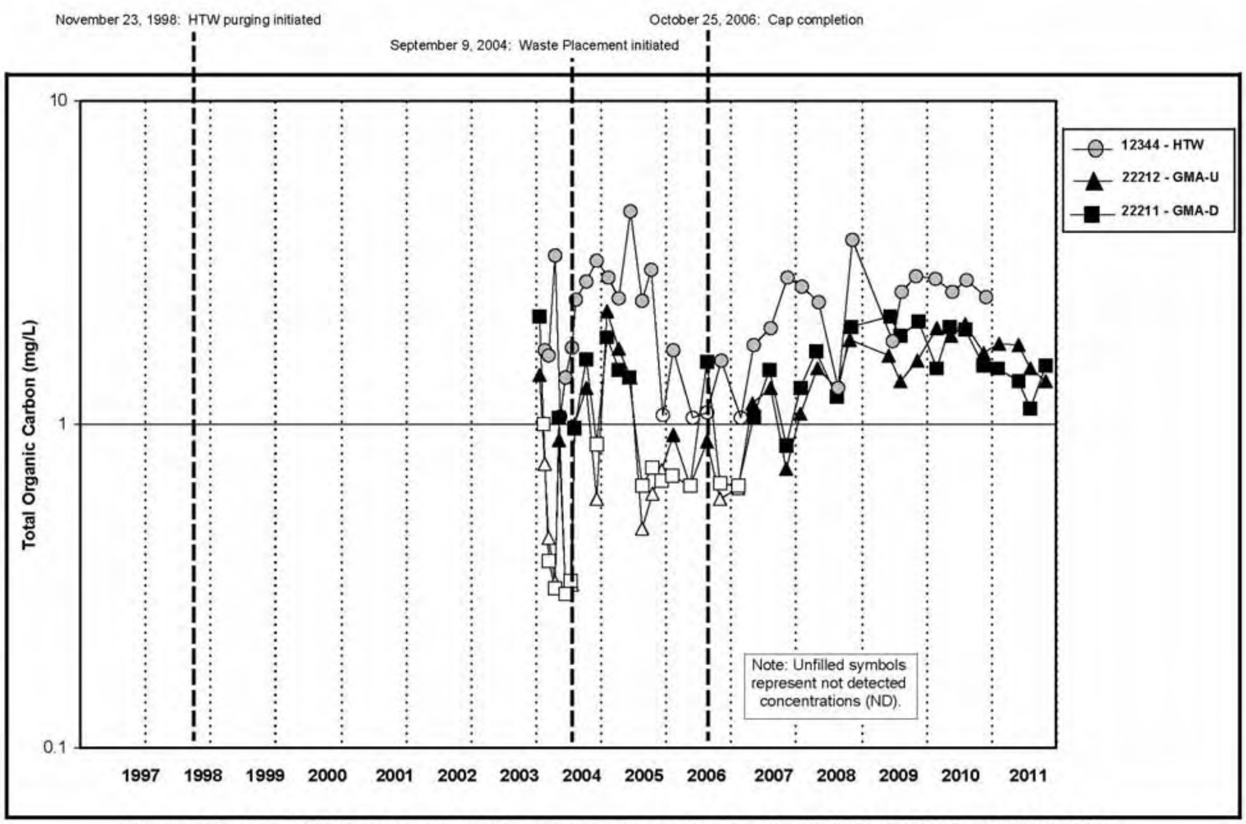


Figure A.5.7-13B. Cell 7 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

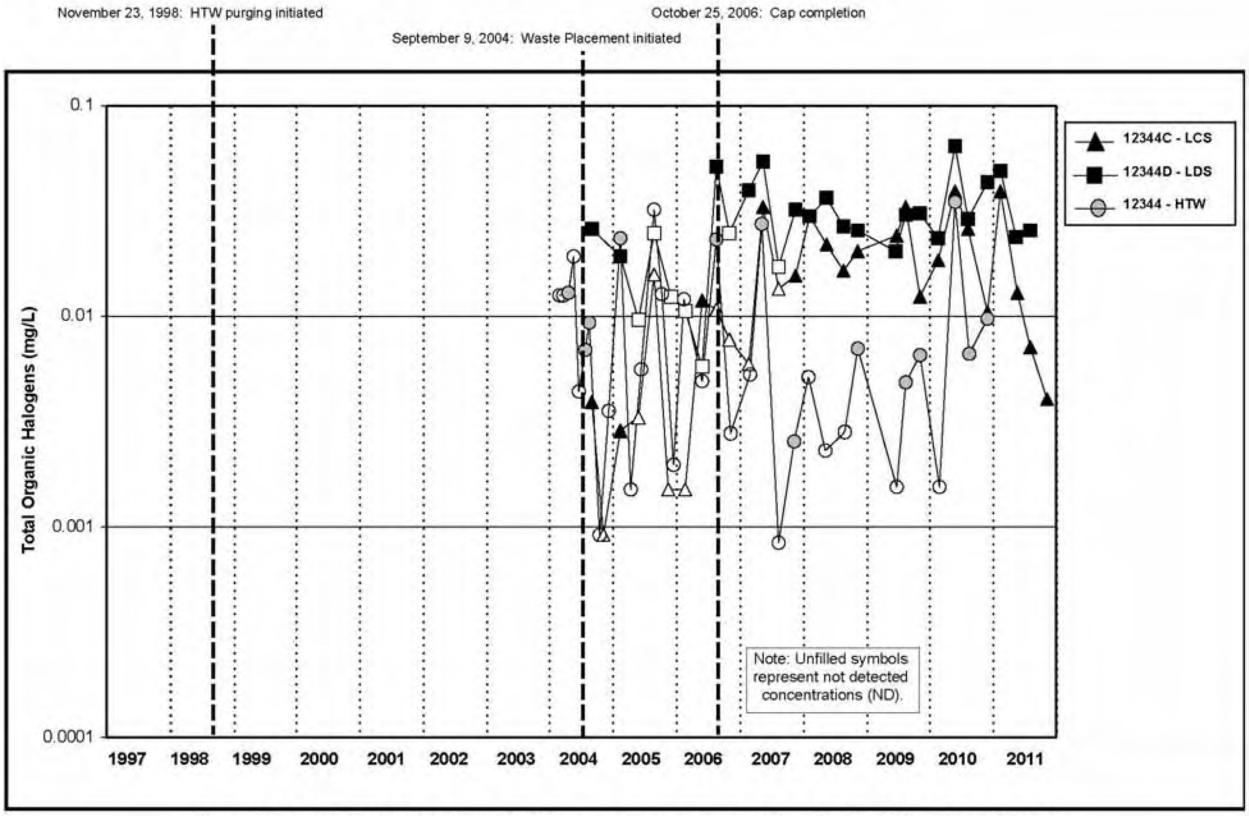


Figure A.5.7-14A. Cell 7 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

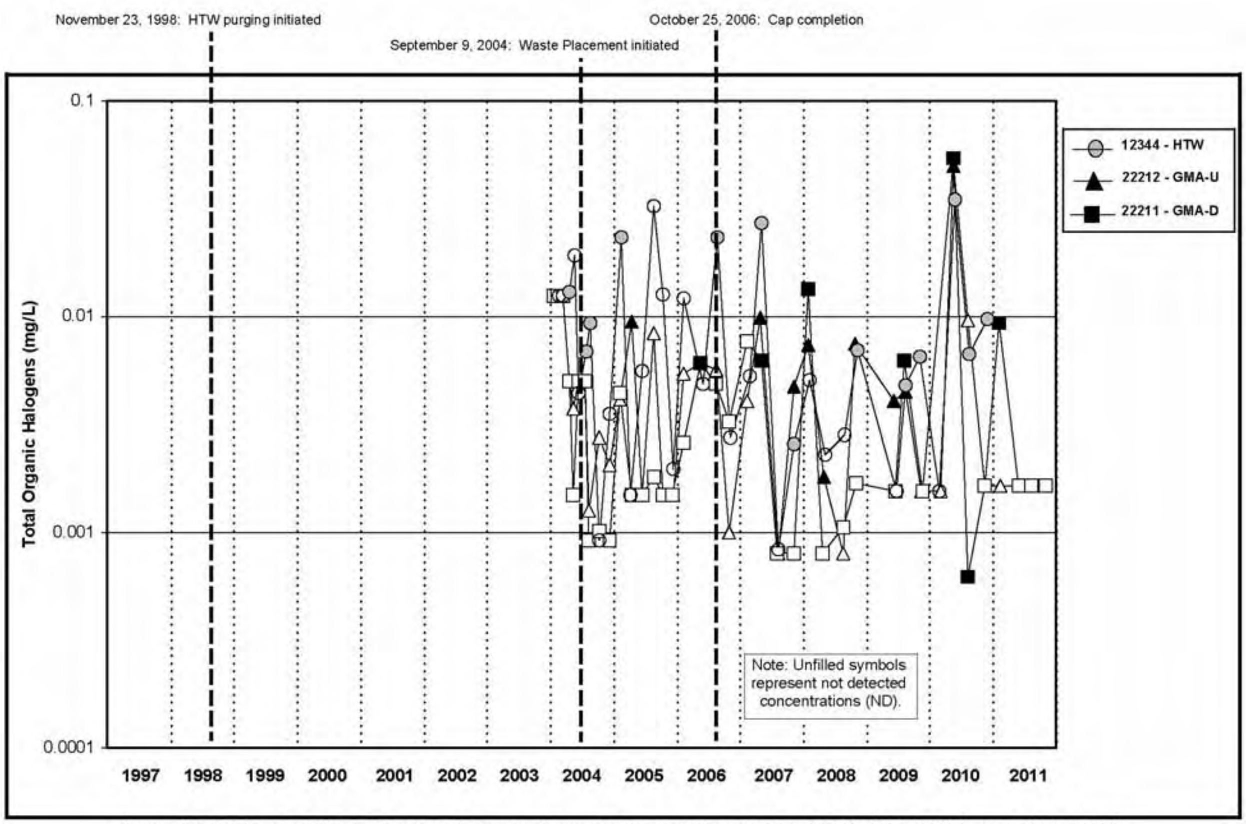


Figure A.5.7-14B. Cell 7 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

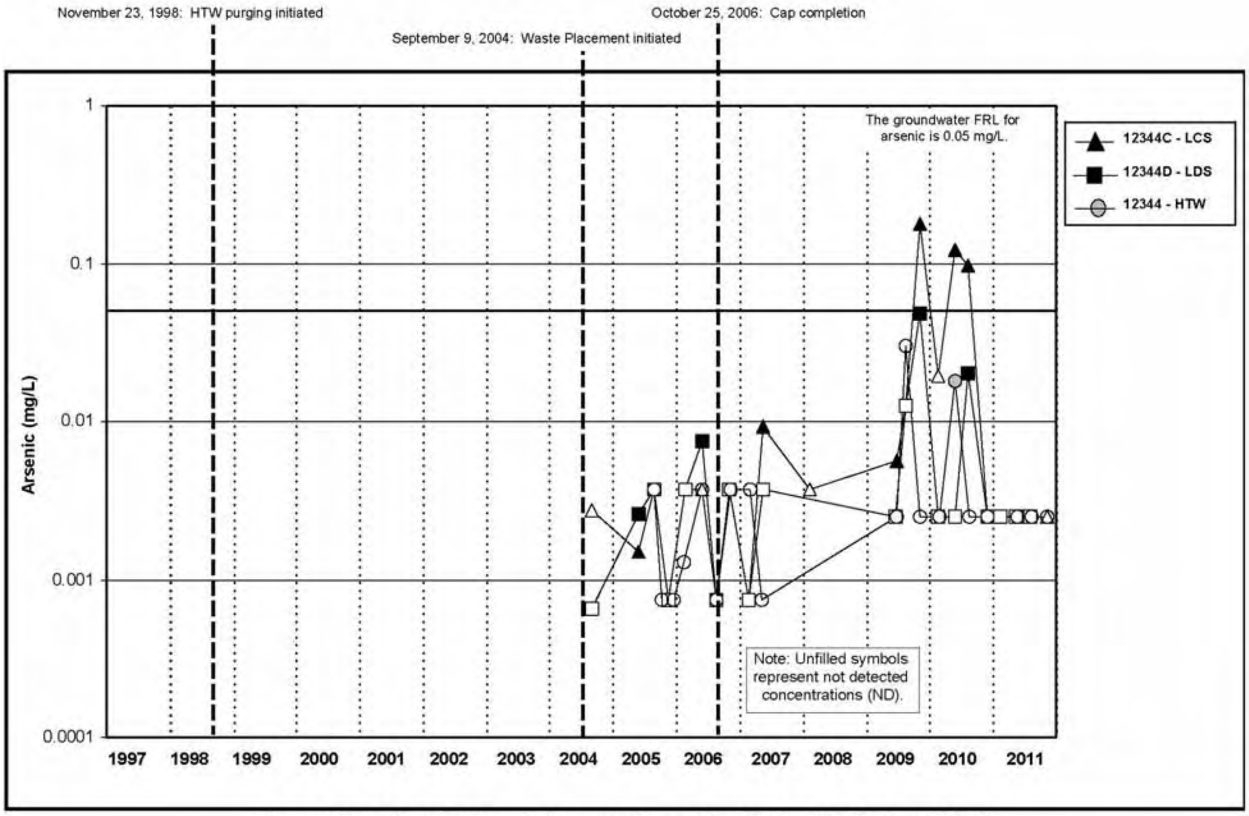


Figure A.5.7-15A. Cell 7 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

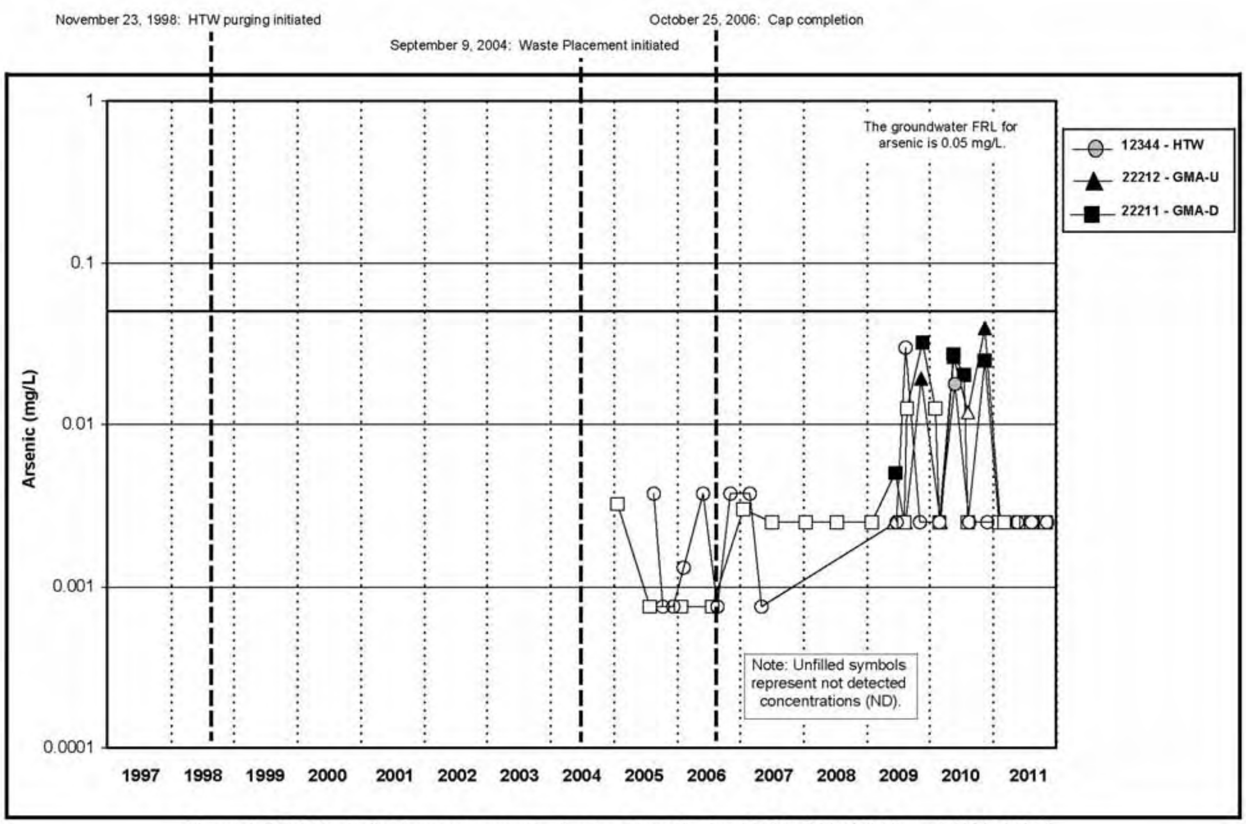


Figure A.5.7-15B. Cell 7 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

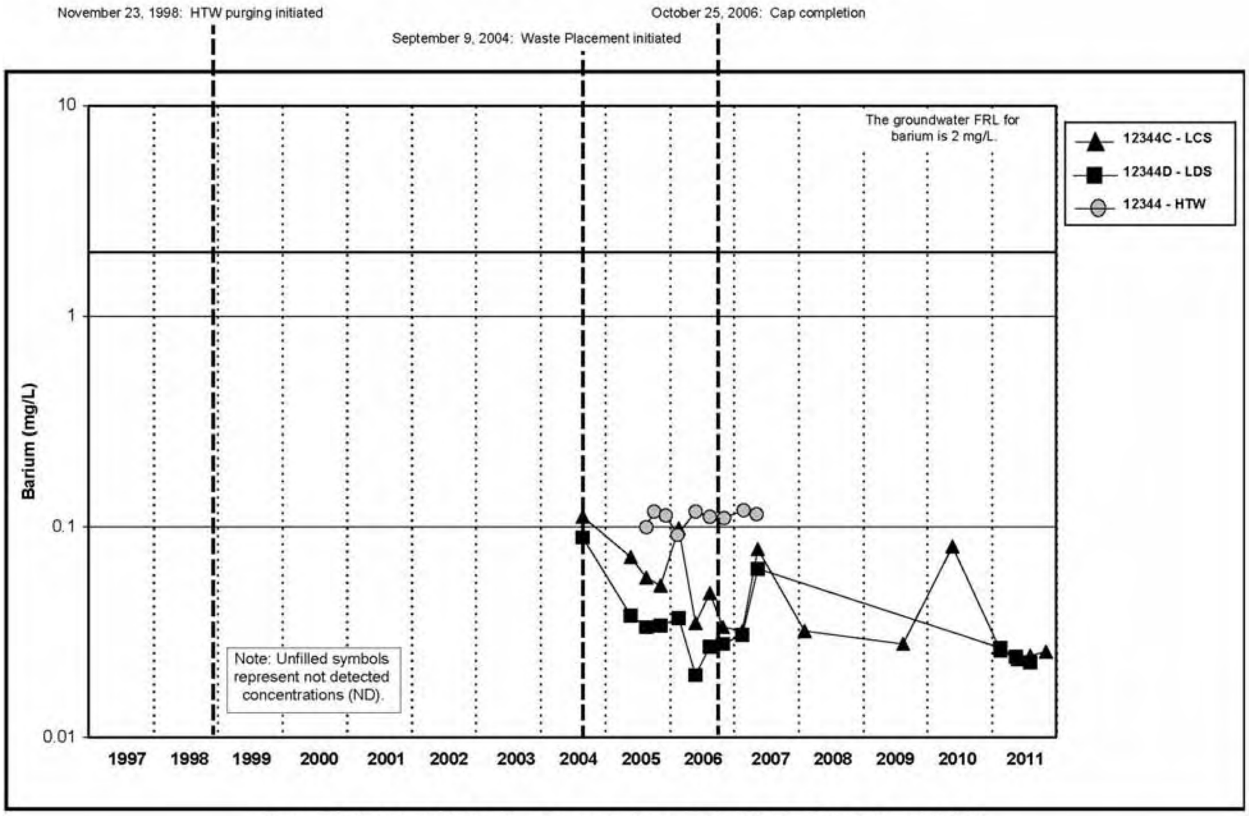


Figure A.5.7-16A. Cell 7 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

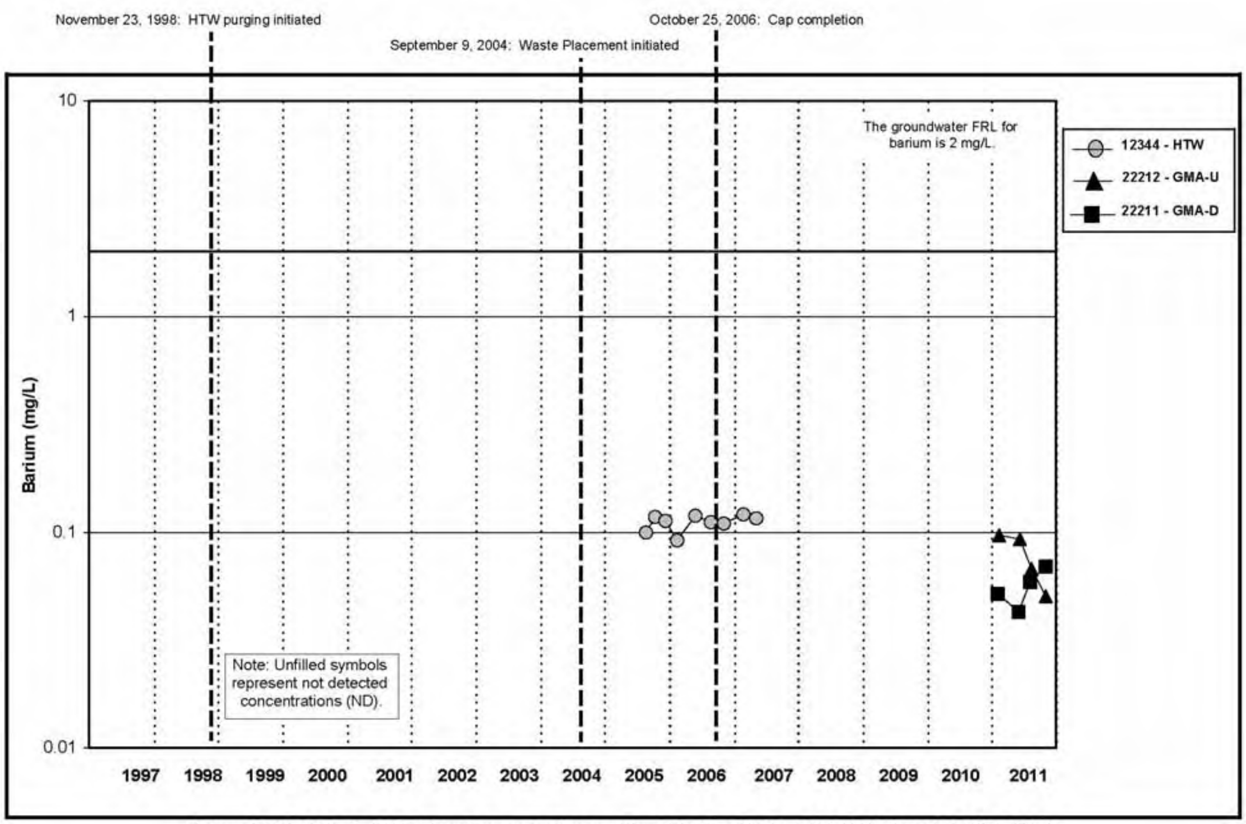


Figure A.5.7-16B. Cell 7 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

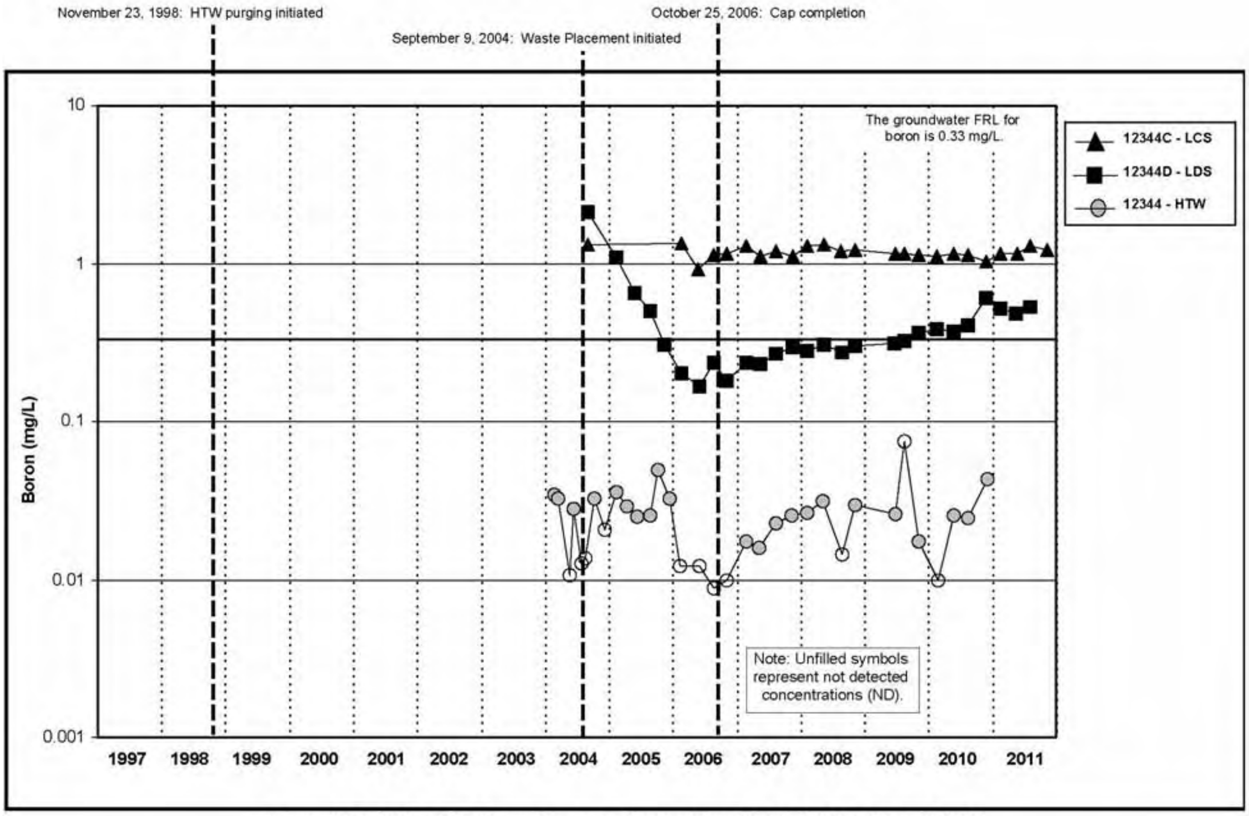


Figure A.5.7-17A. Cell 7 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

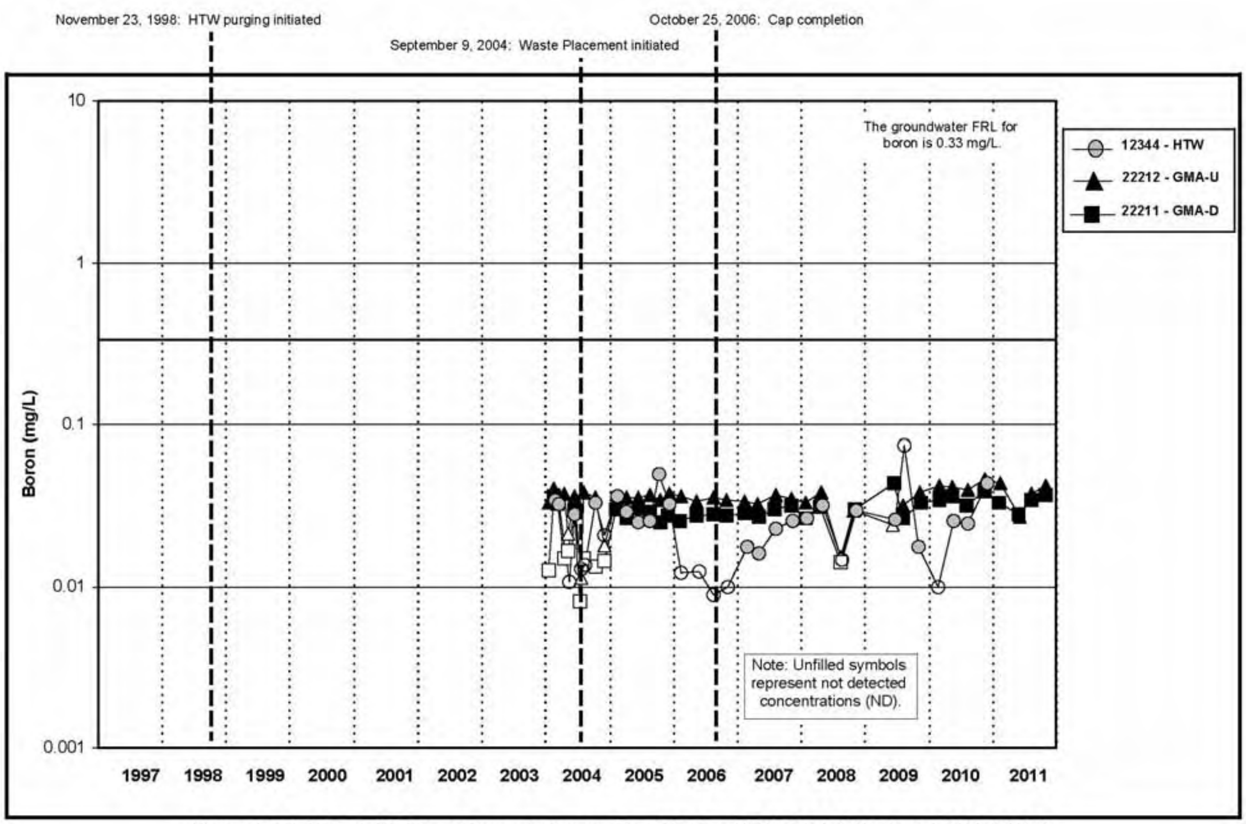


Figure A.5.7-17B. Cell 7 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

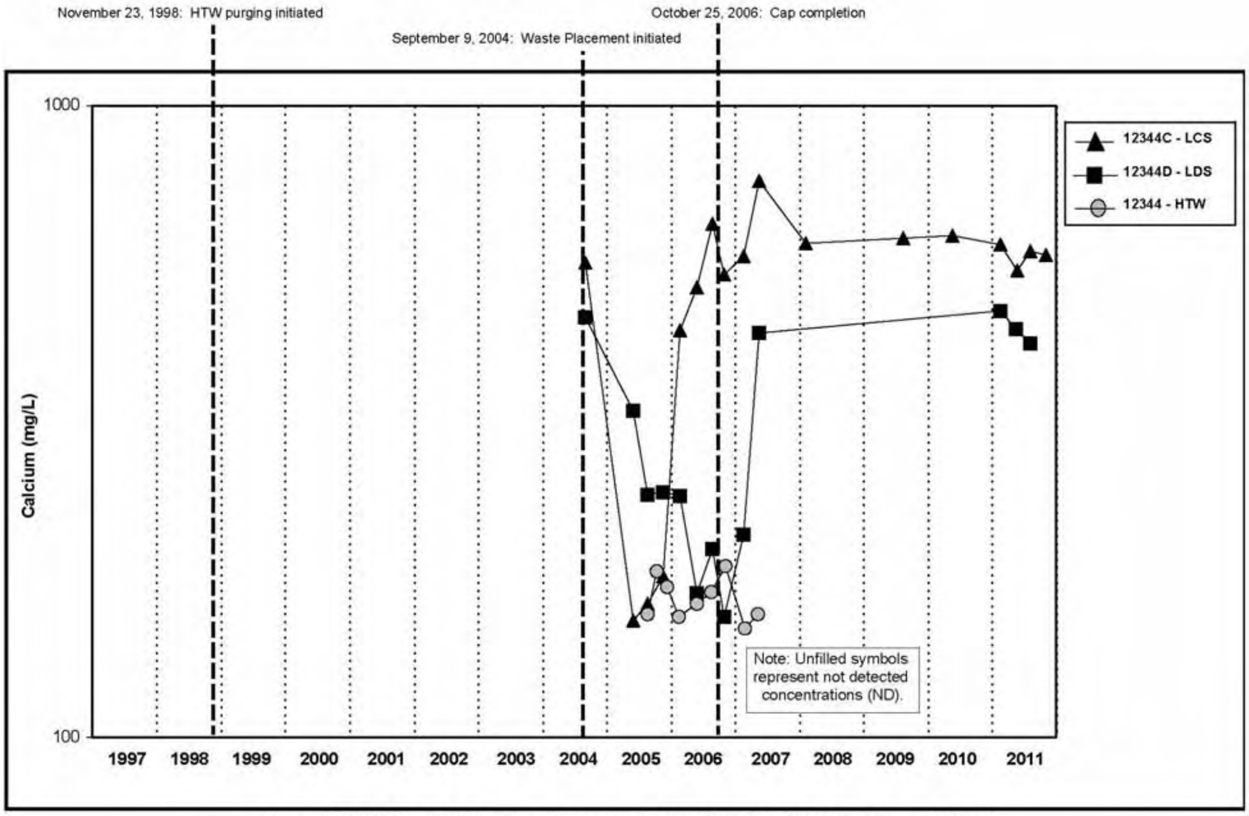


Figure A.5.7-18A. Cell 7 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

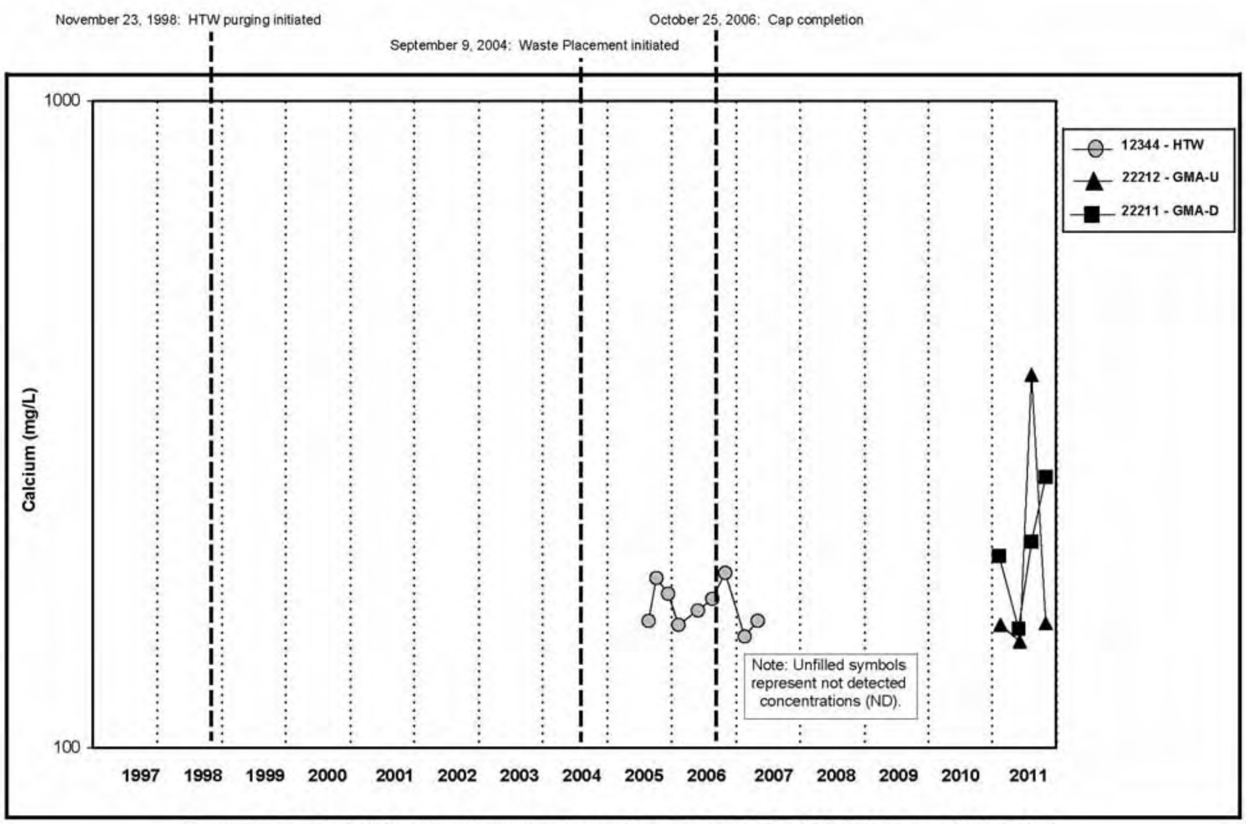


Figure A.5.7-18B. Cell 7 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

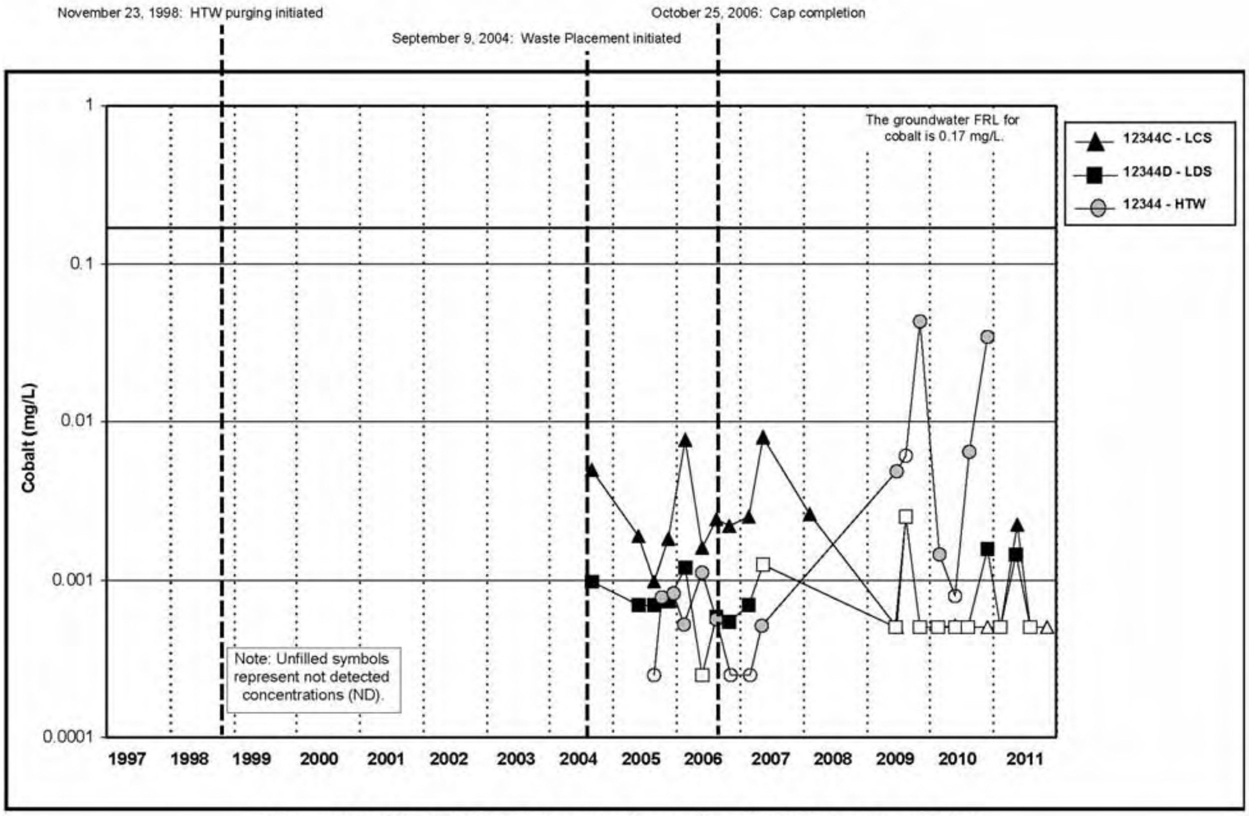


Figure A.5.7-19A. Cell 7 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

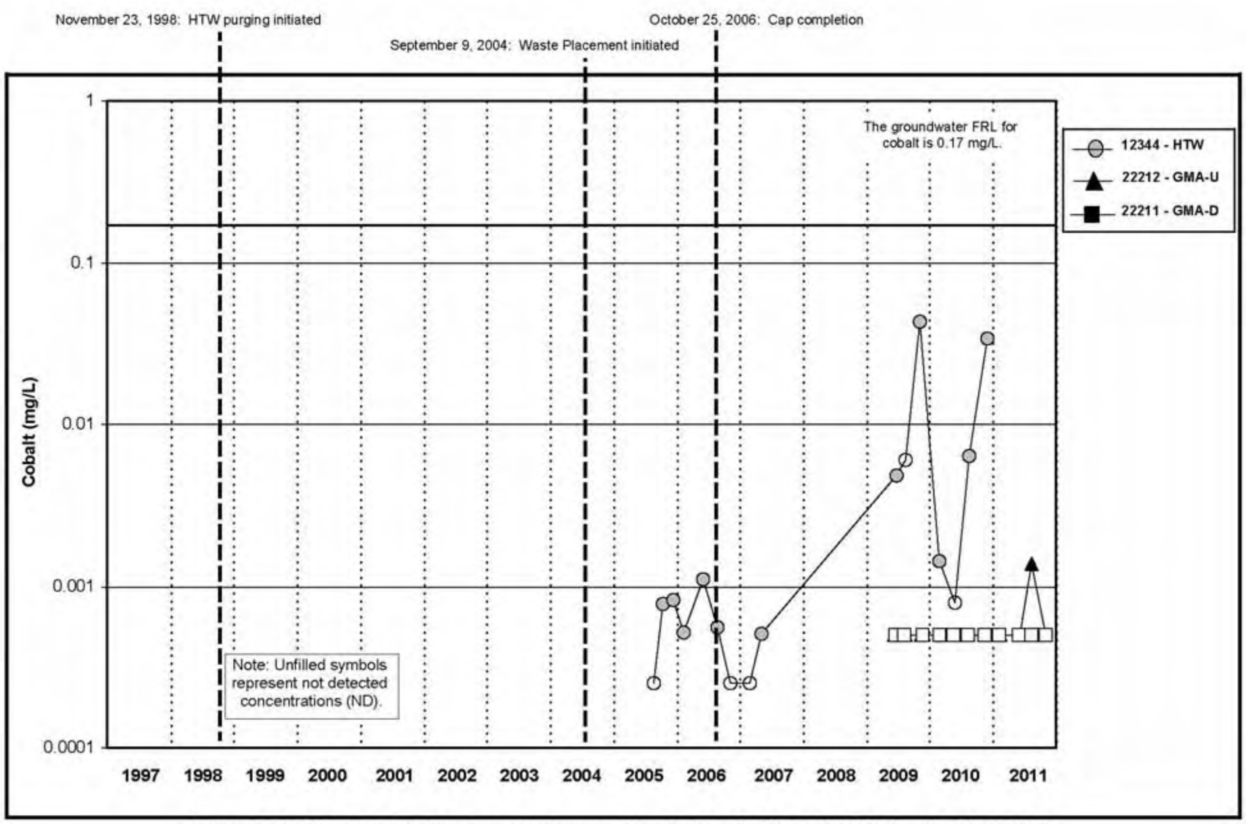


Figure A.5.7-19B. Cell 7 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

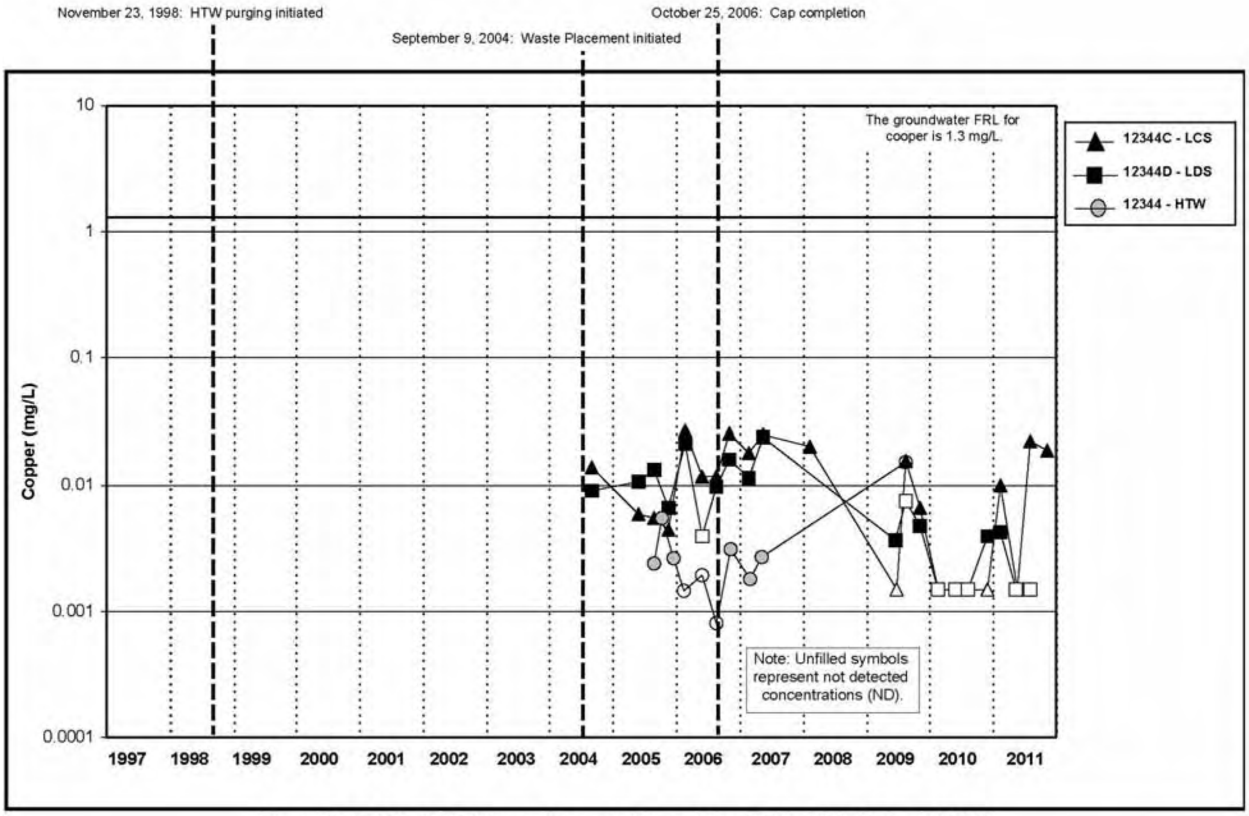


Figure A.5.7-20A. Cell 7 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

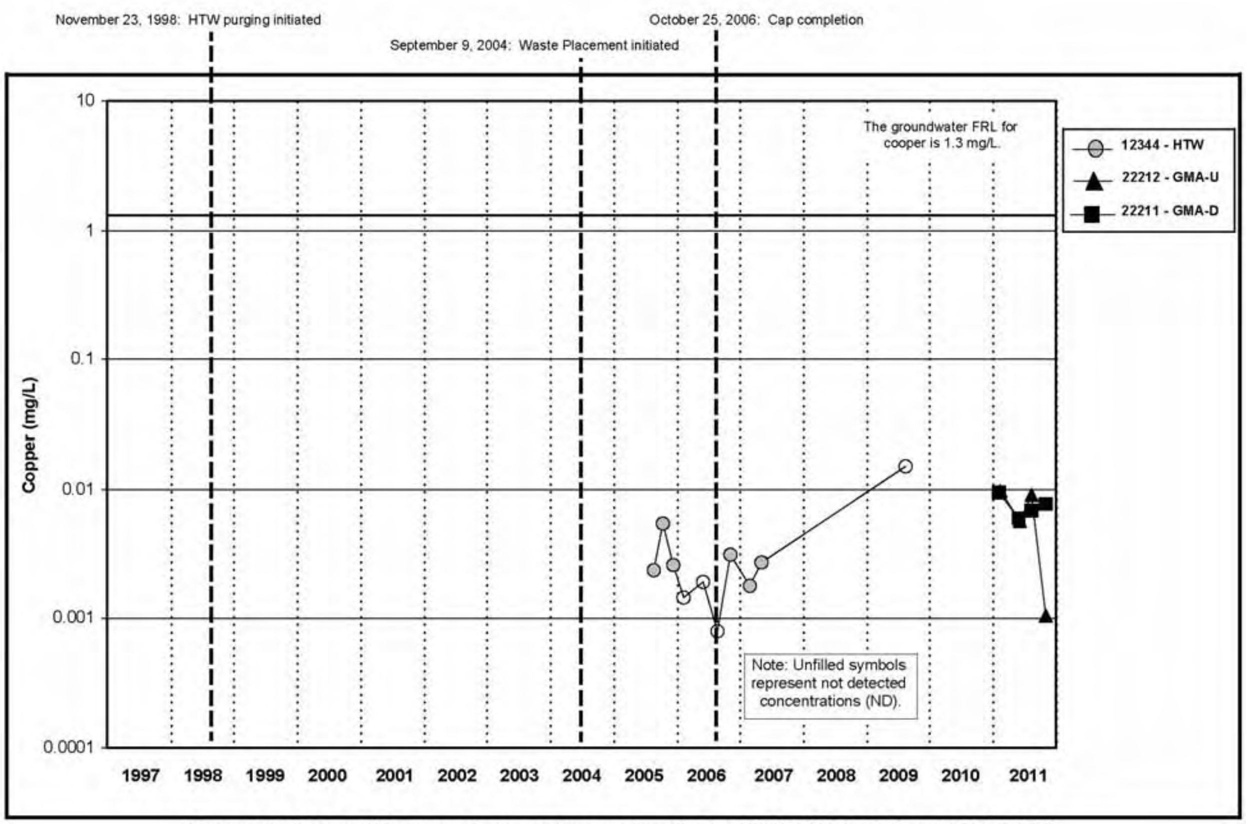


Figure A.5.7-20B. Cell 7 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

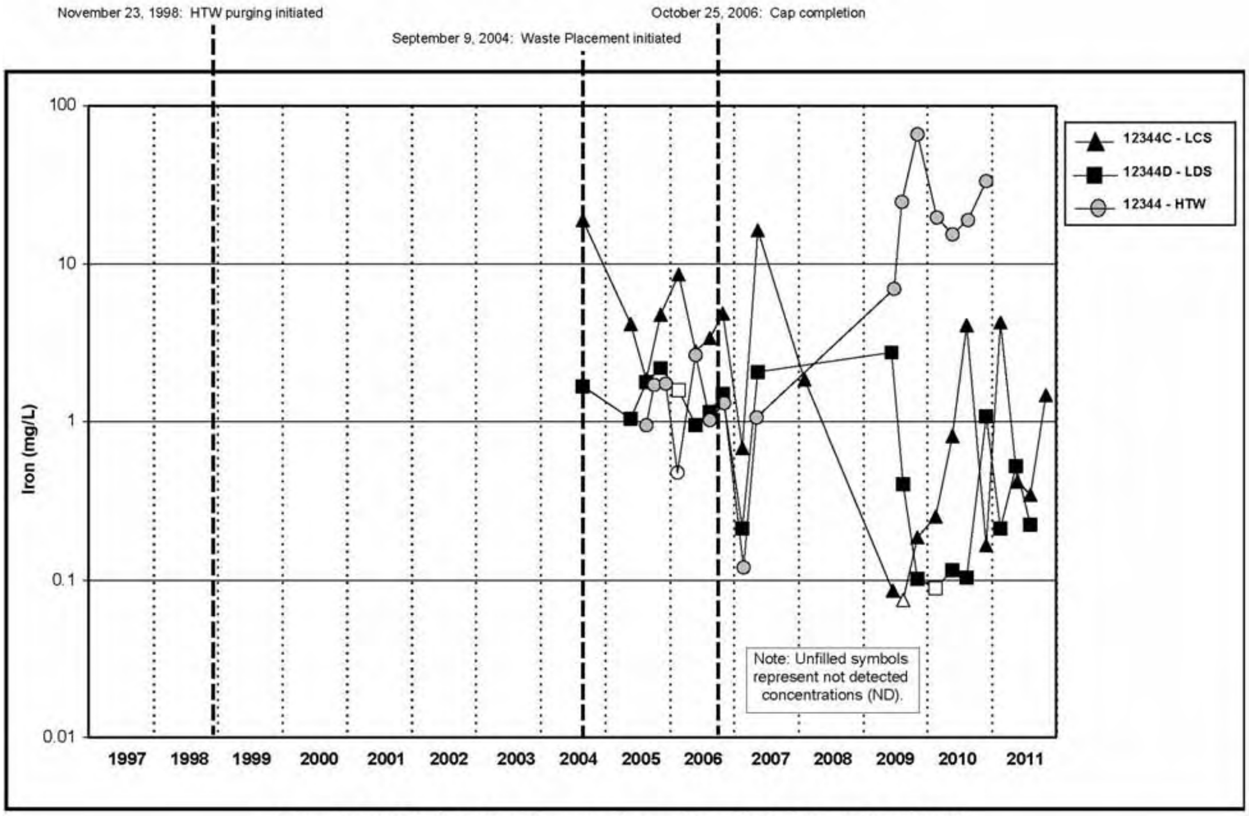


Figure A.5.7-21A. Cell 7 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

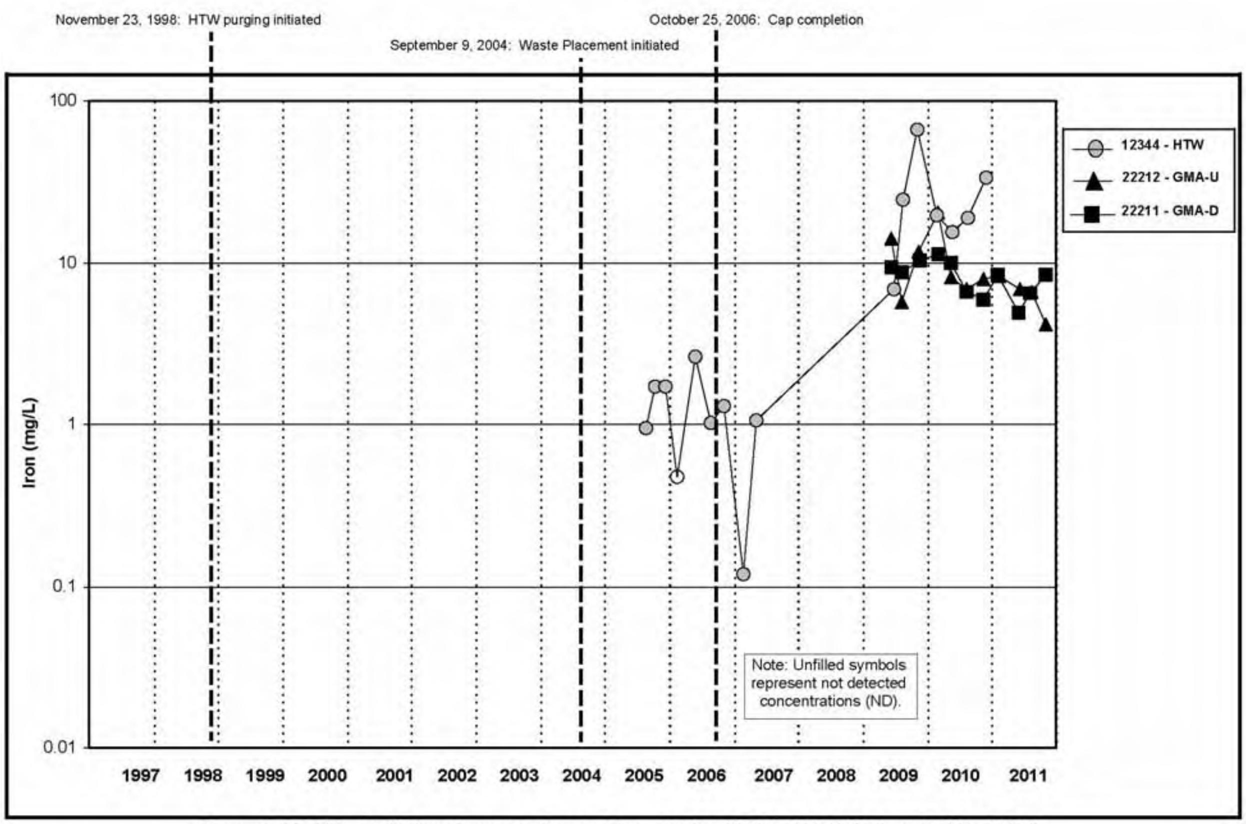


Figure A.5.7-21B. Cell 7 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

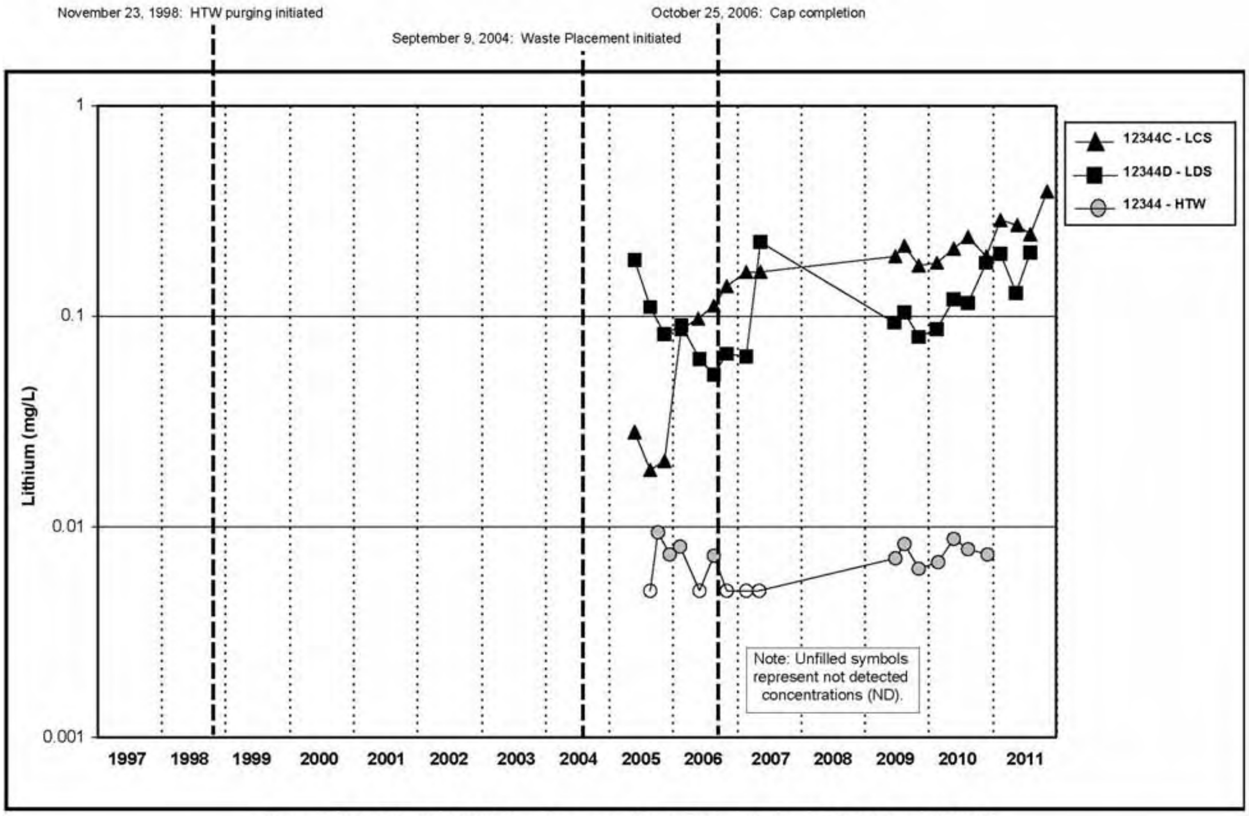


Figure A.5.7-22A. Cell 7 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

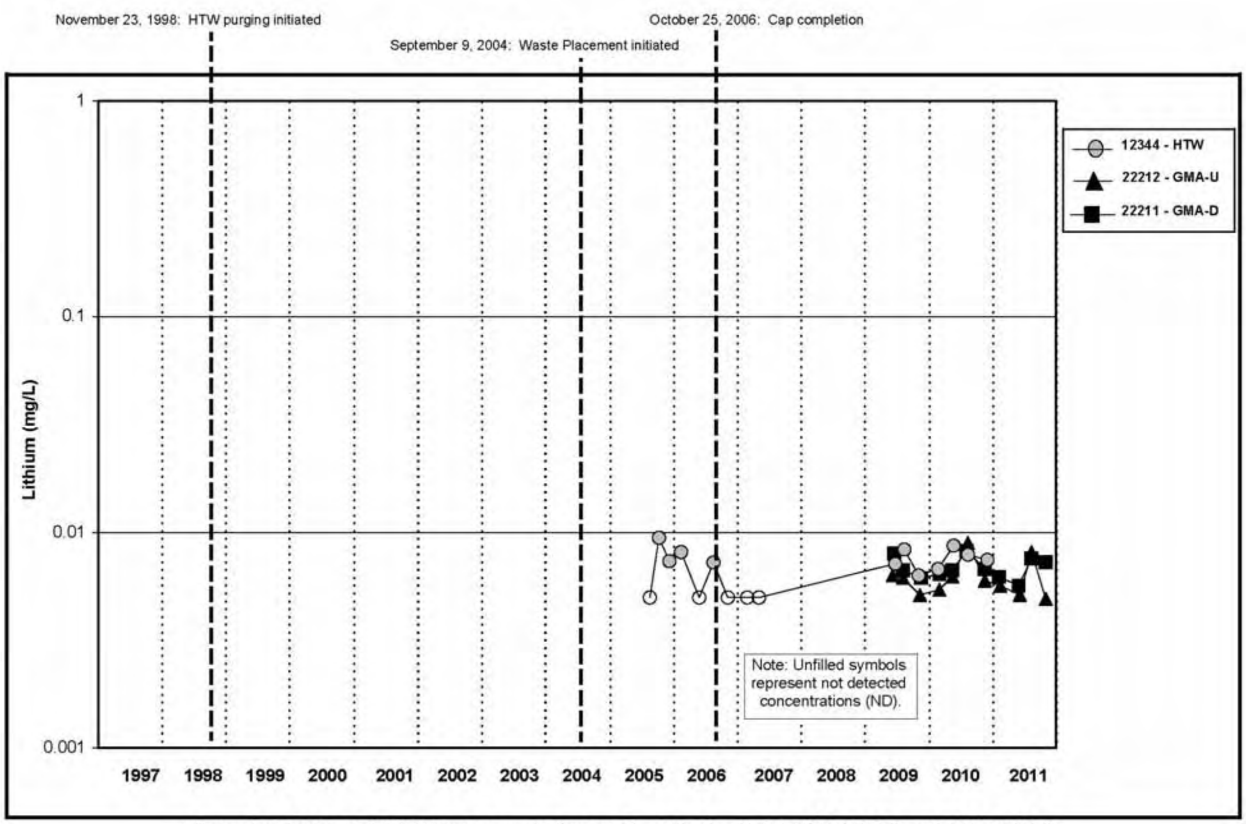


Figure A.5.7-22B. Cell 7 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

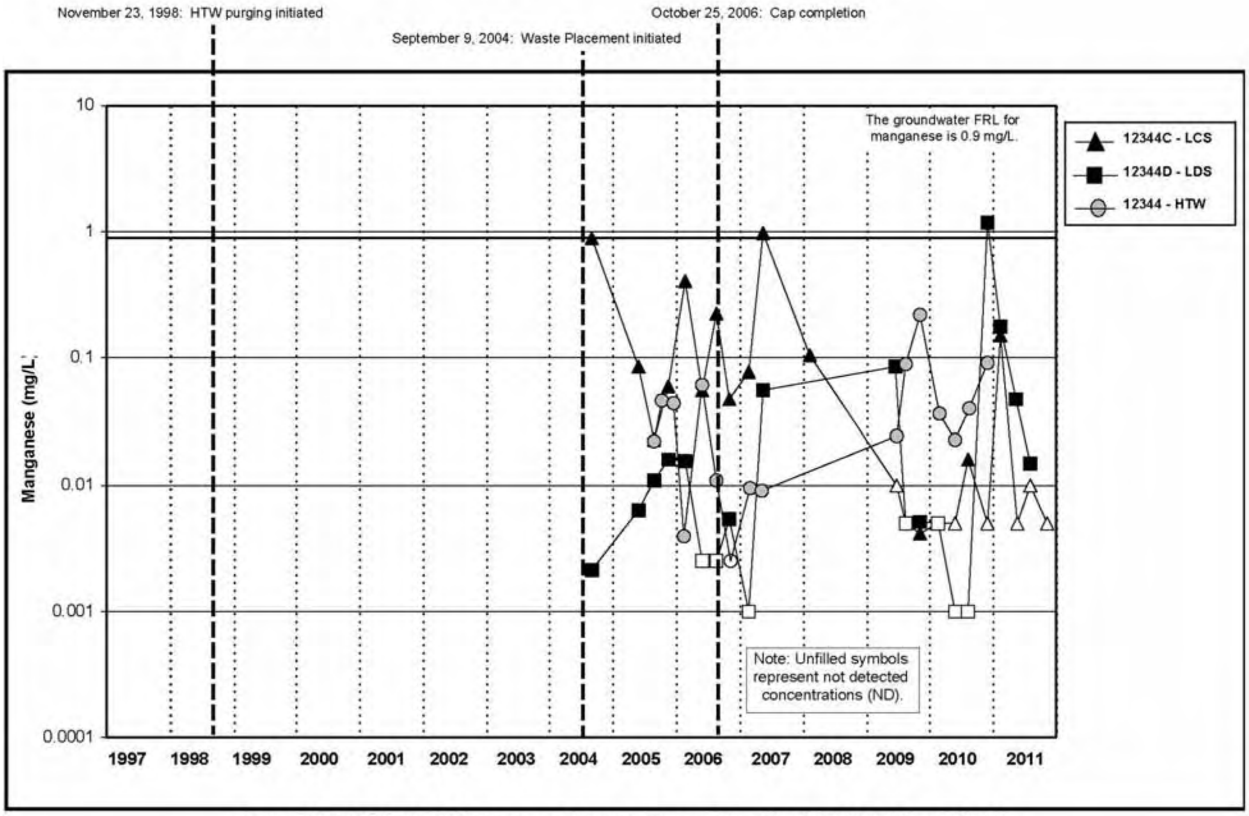


Figure A.5.7-23A. Cell 7 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

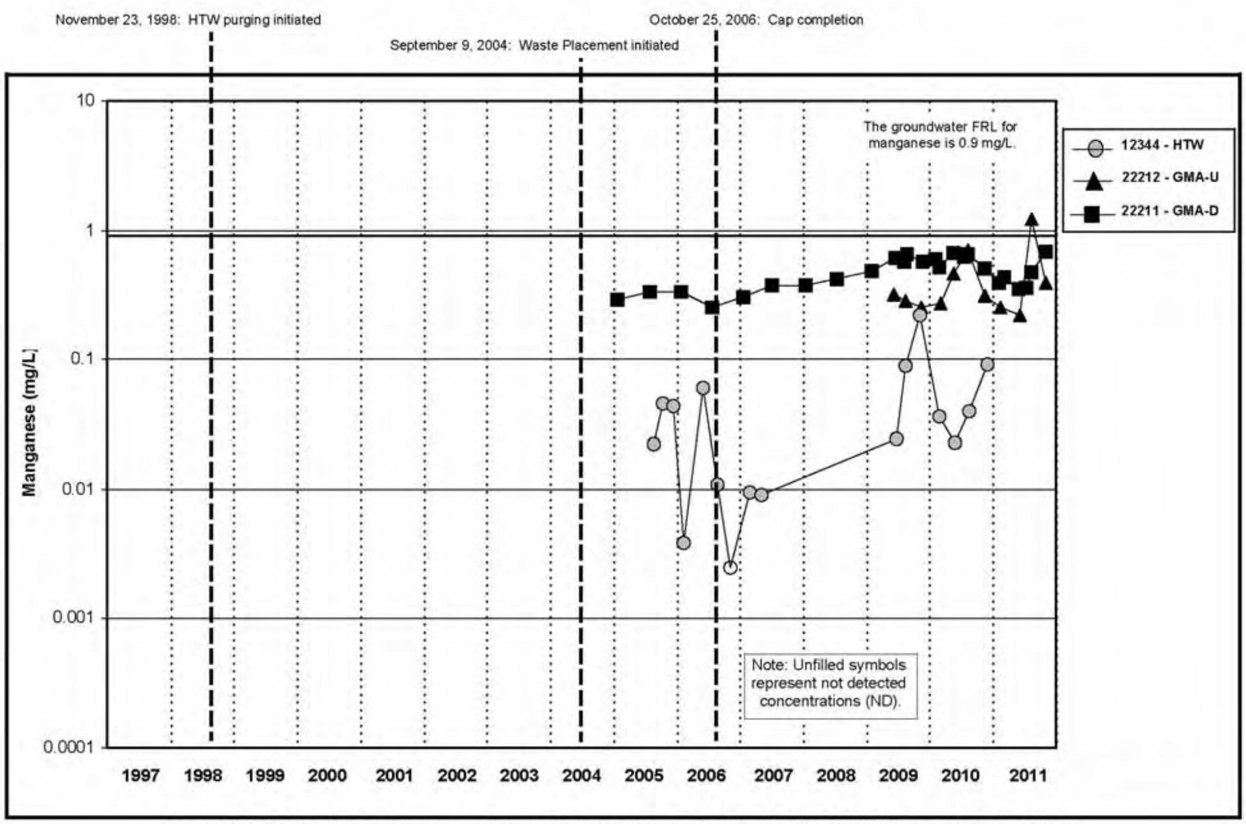


Figure A.5.7-23B. Cell 7 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

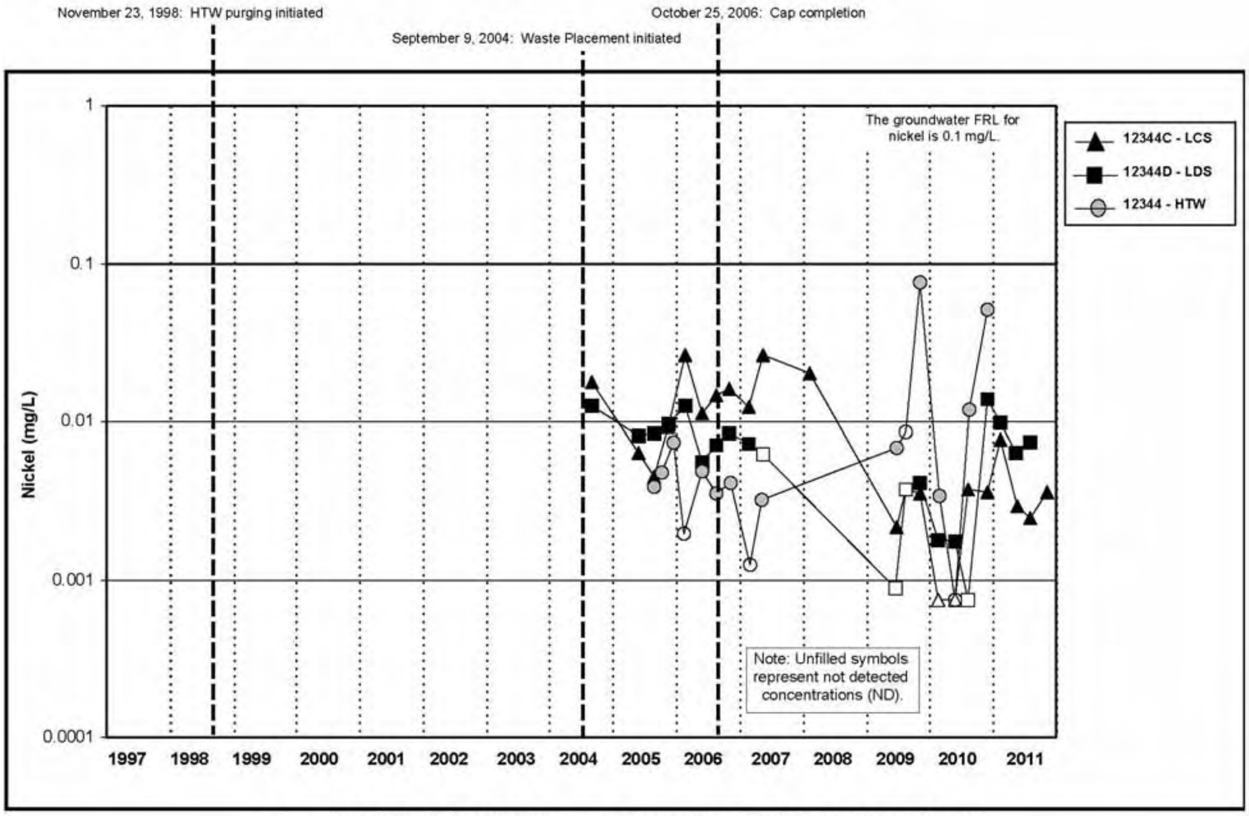


Figure A.5.7-24A. Cell 7 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

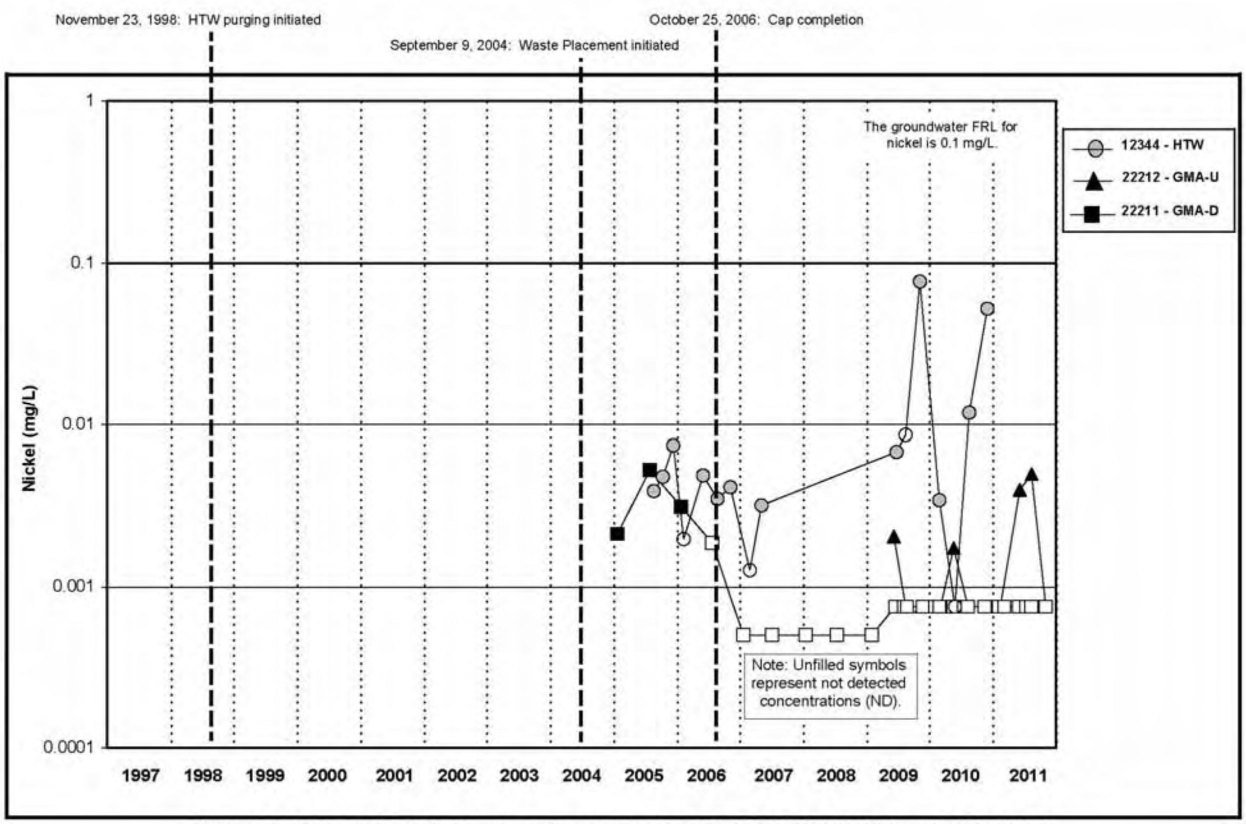


Figure A.5.7-24B. Cell 7 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

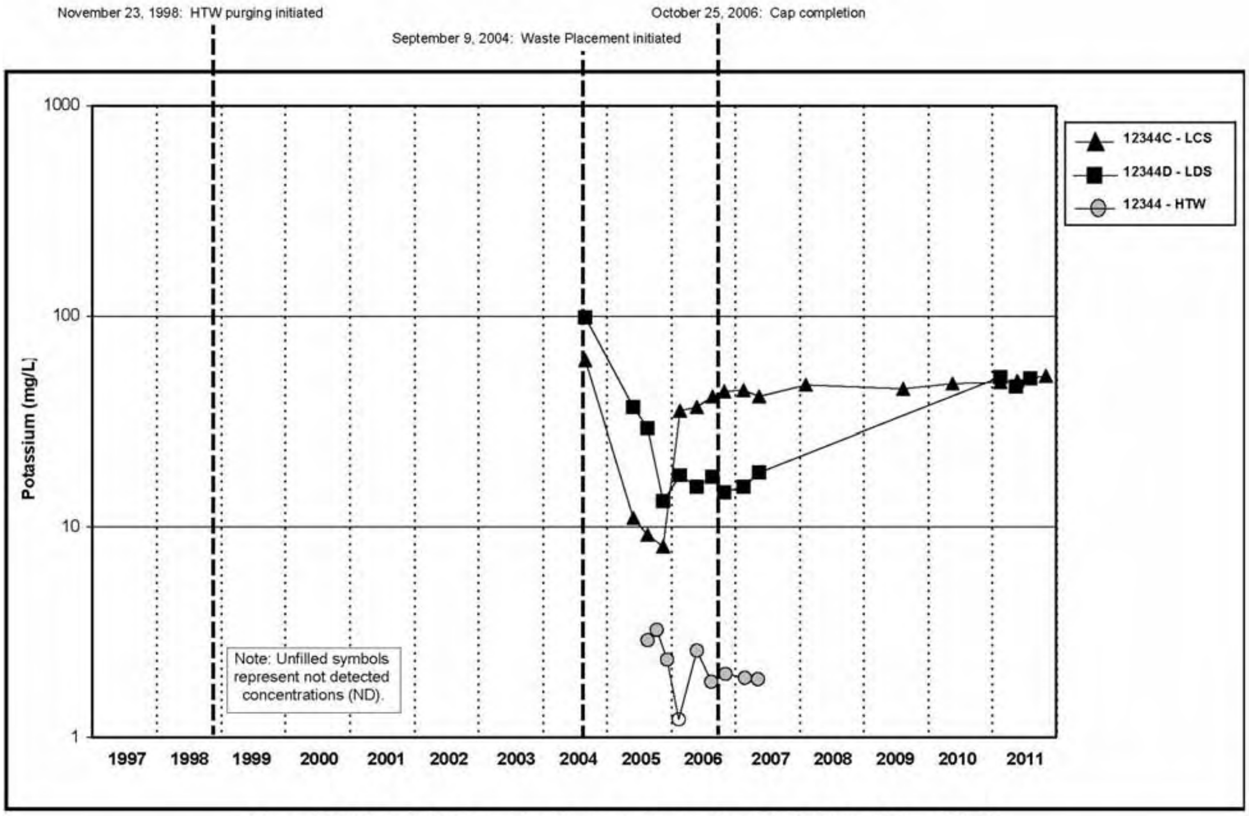


Figure A.5.7-25A. Cell 7 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

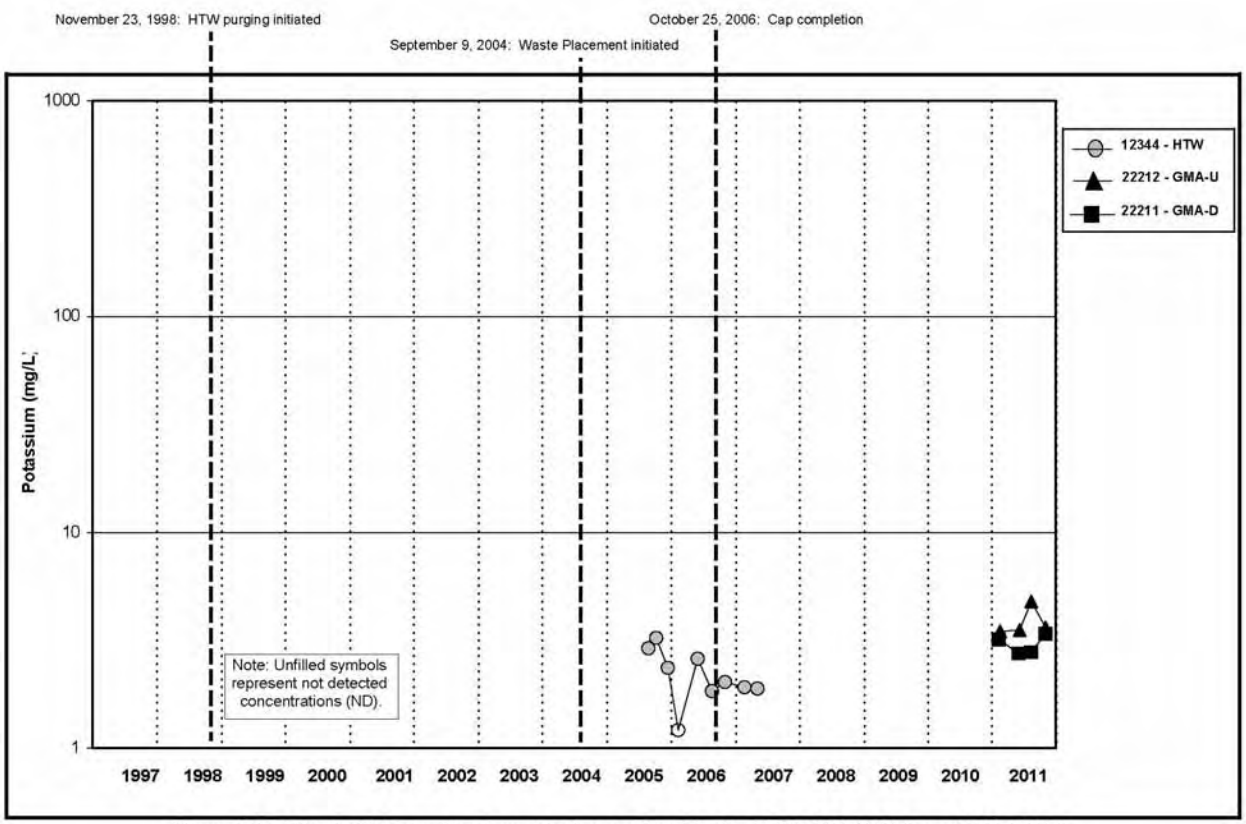


Figure A.5.7-25B. Cell 7 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

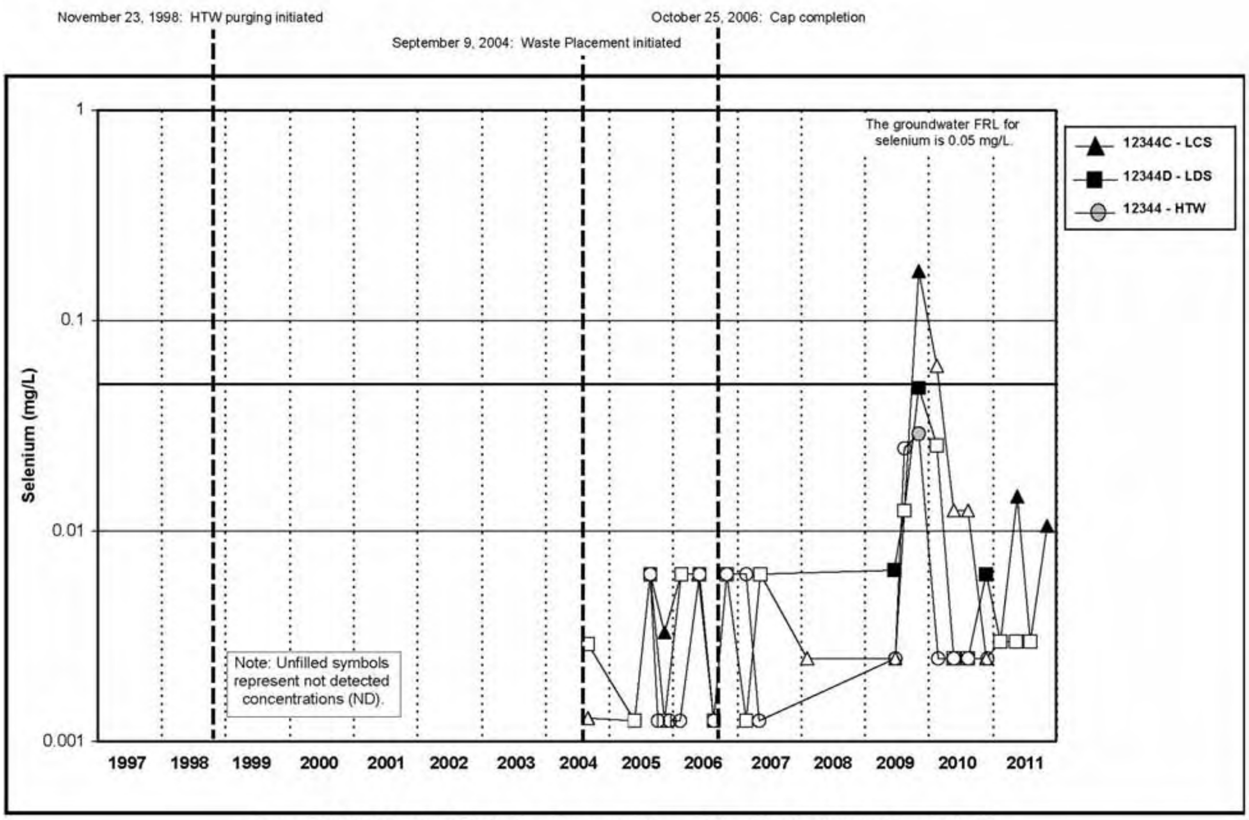


Figure A.5.7-26A. Cell 7 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

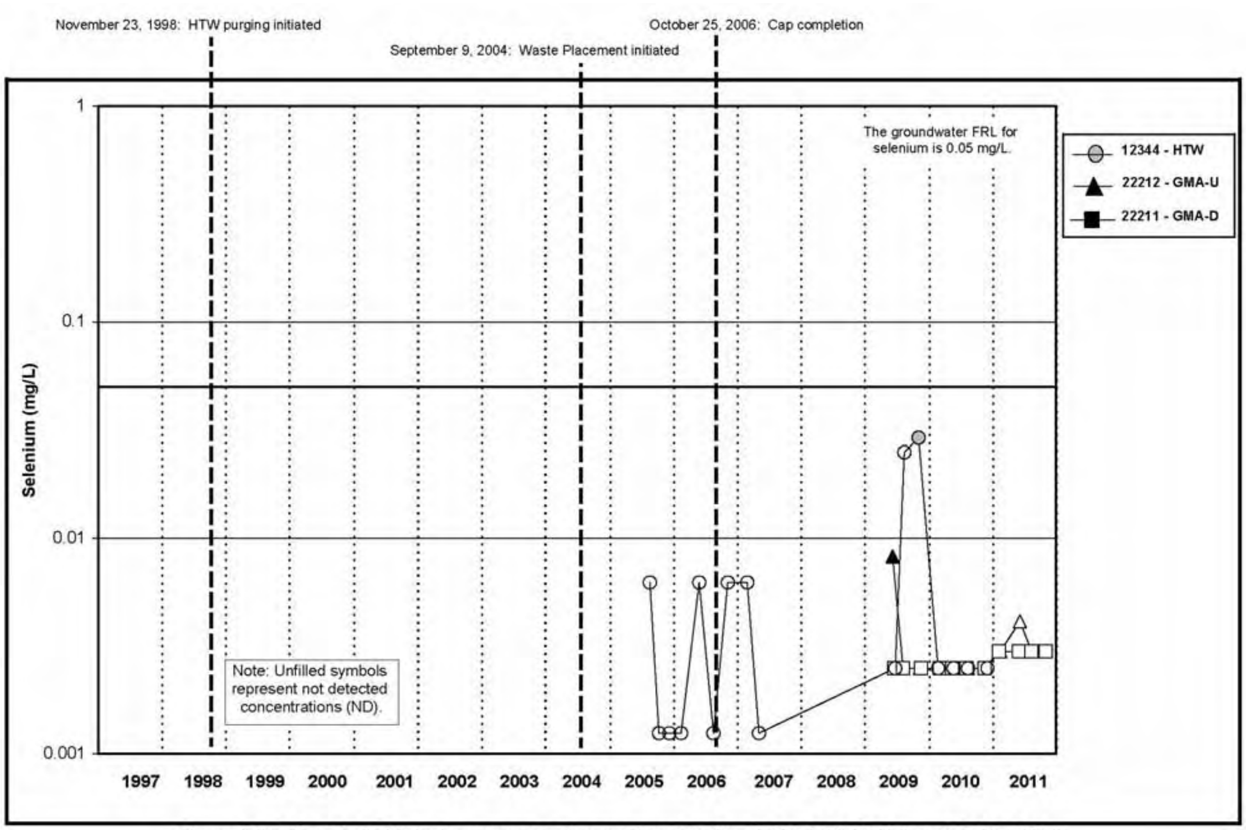


Figure A.5.7-26B. Cell 7 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

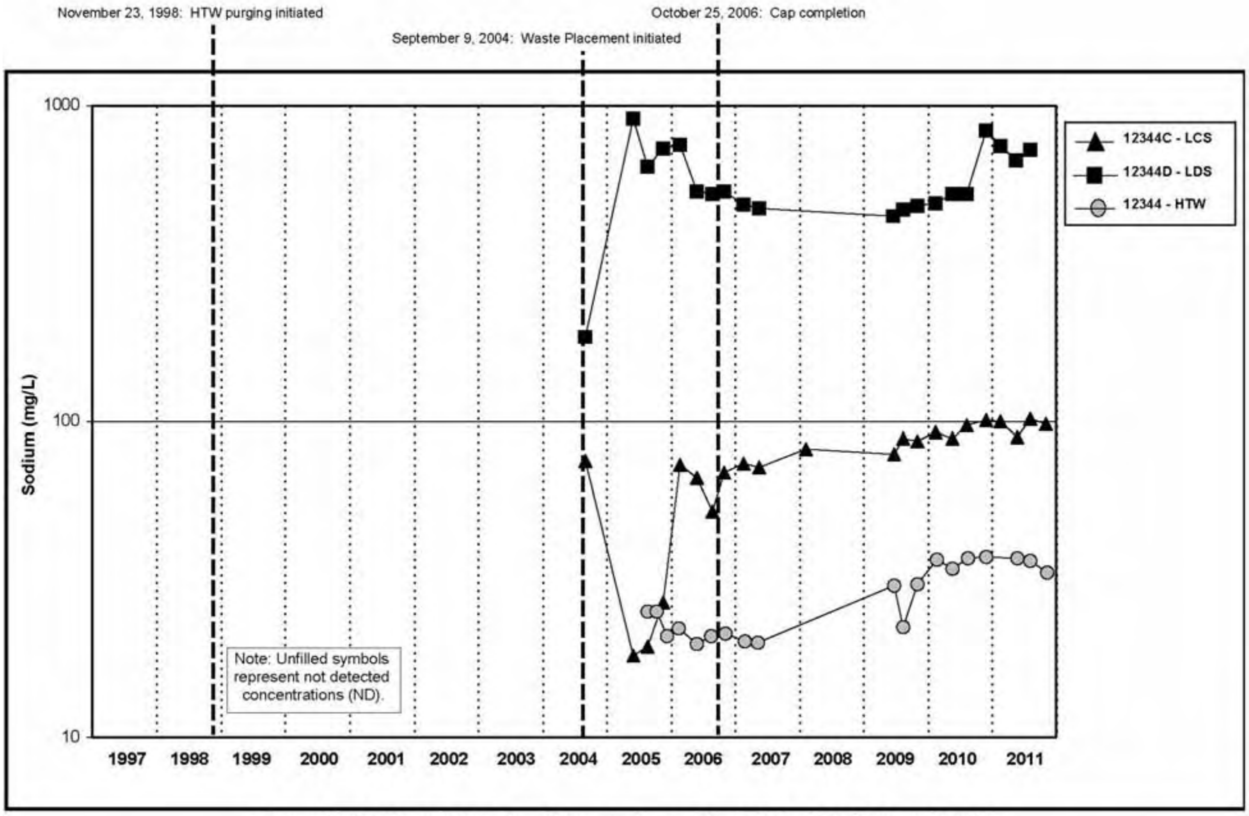


Figure A.5.7-27A. Cell 7 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

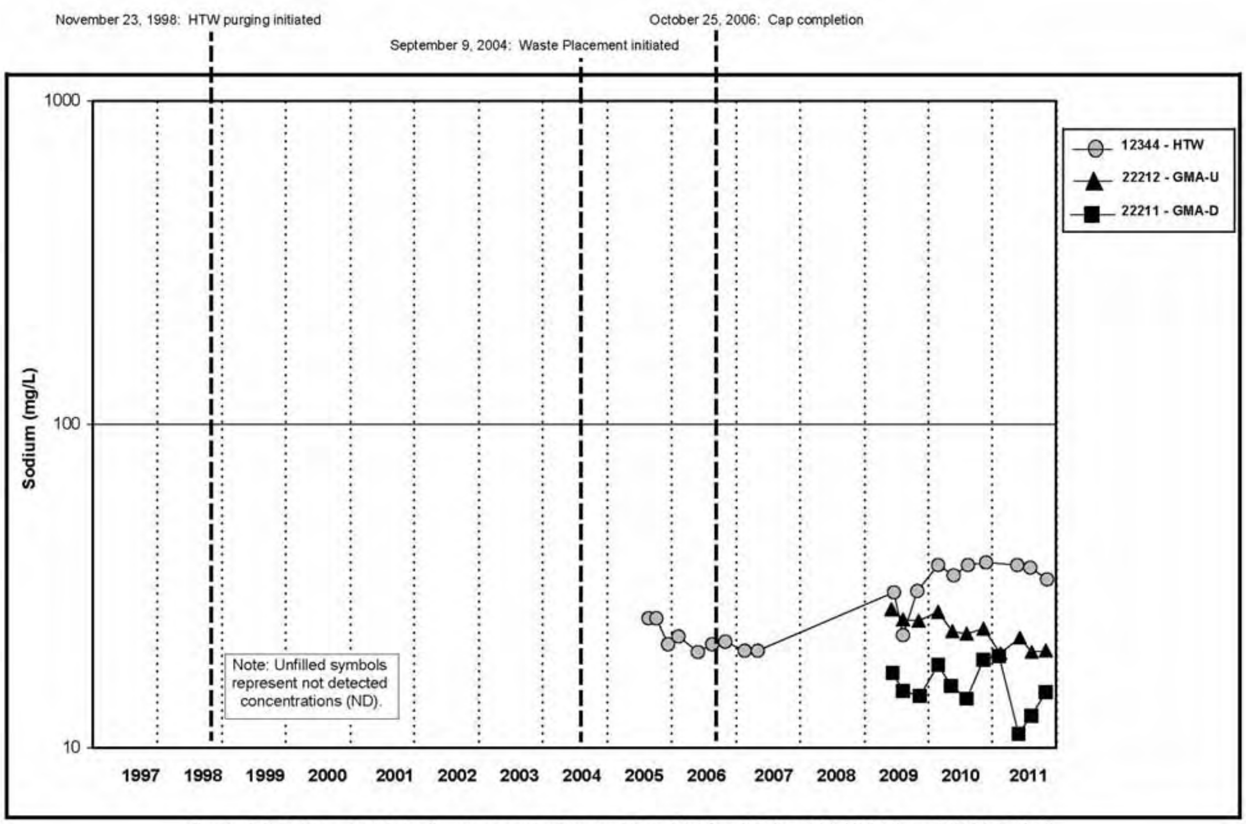


Figure A.5.7-27B. Cell 7 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

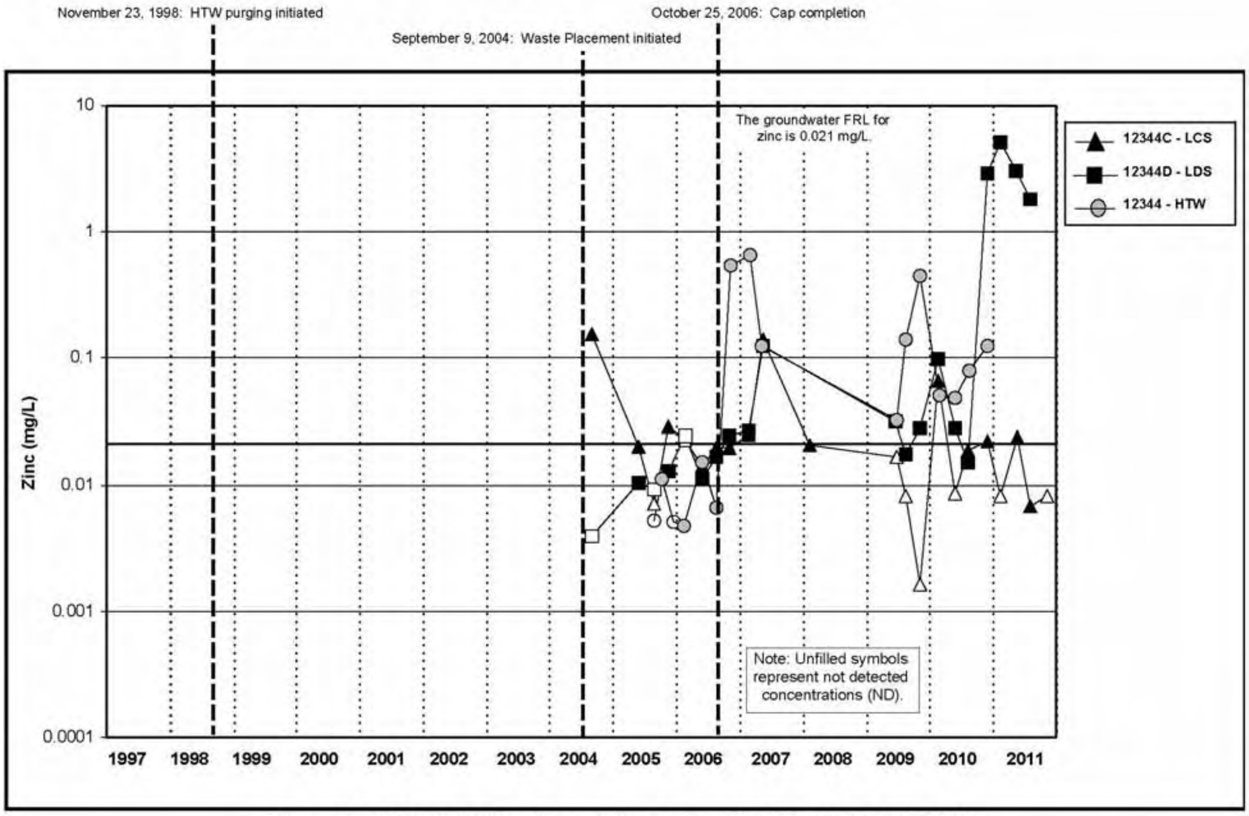


Figure A.5.7-28A. Cell 7 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

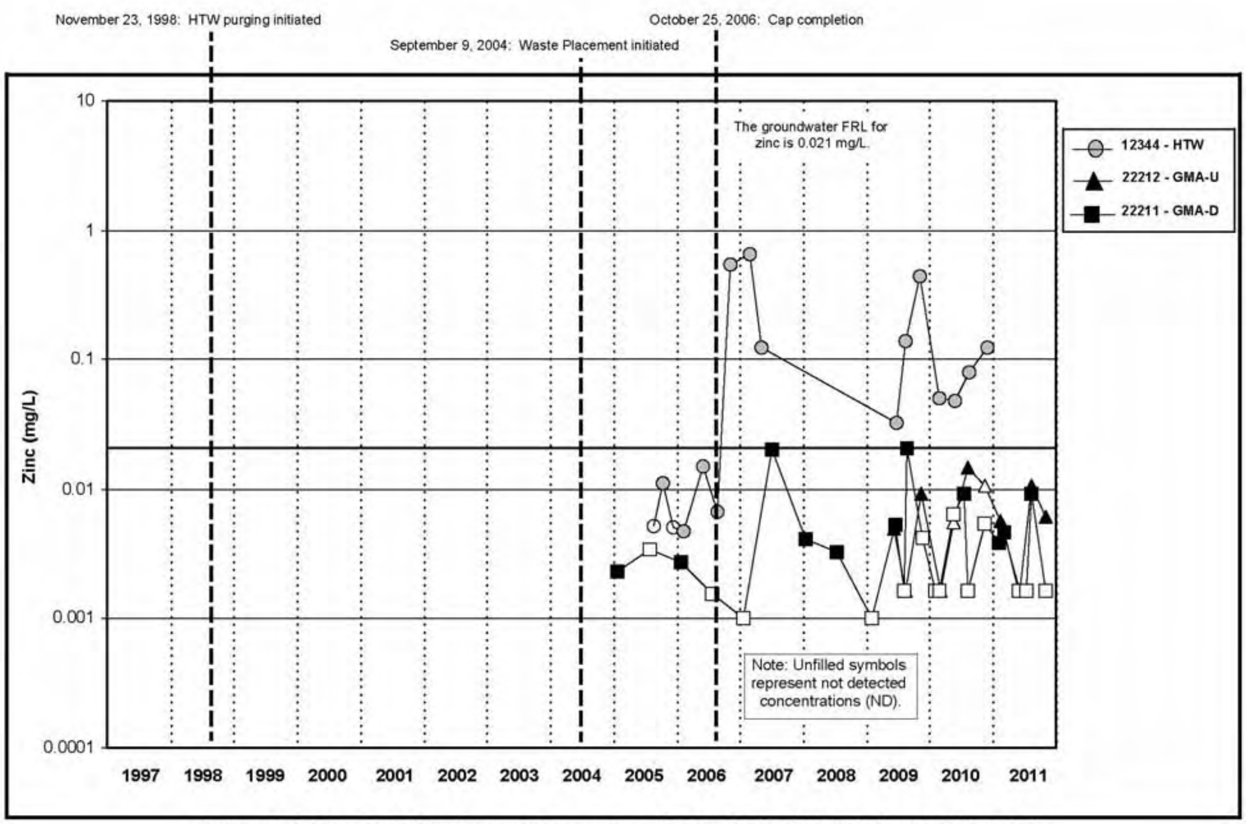


Figure A.5.7-28B. Cell 7 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

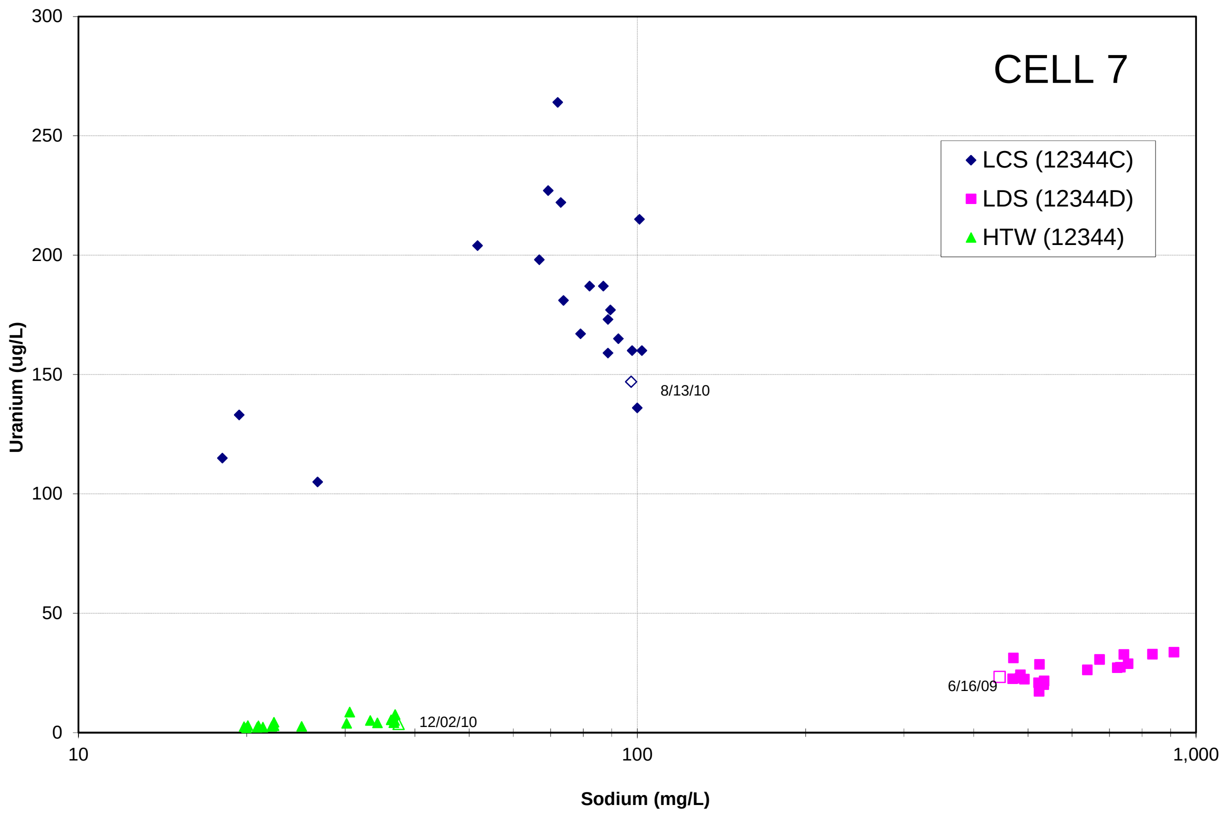


Figure A.5.7−29. Cell 7 Bivariate Plot for Uranium and Sodium

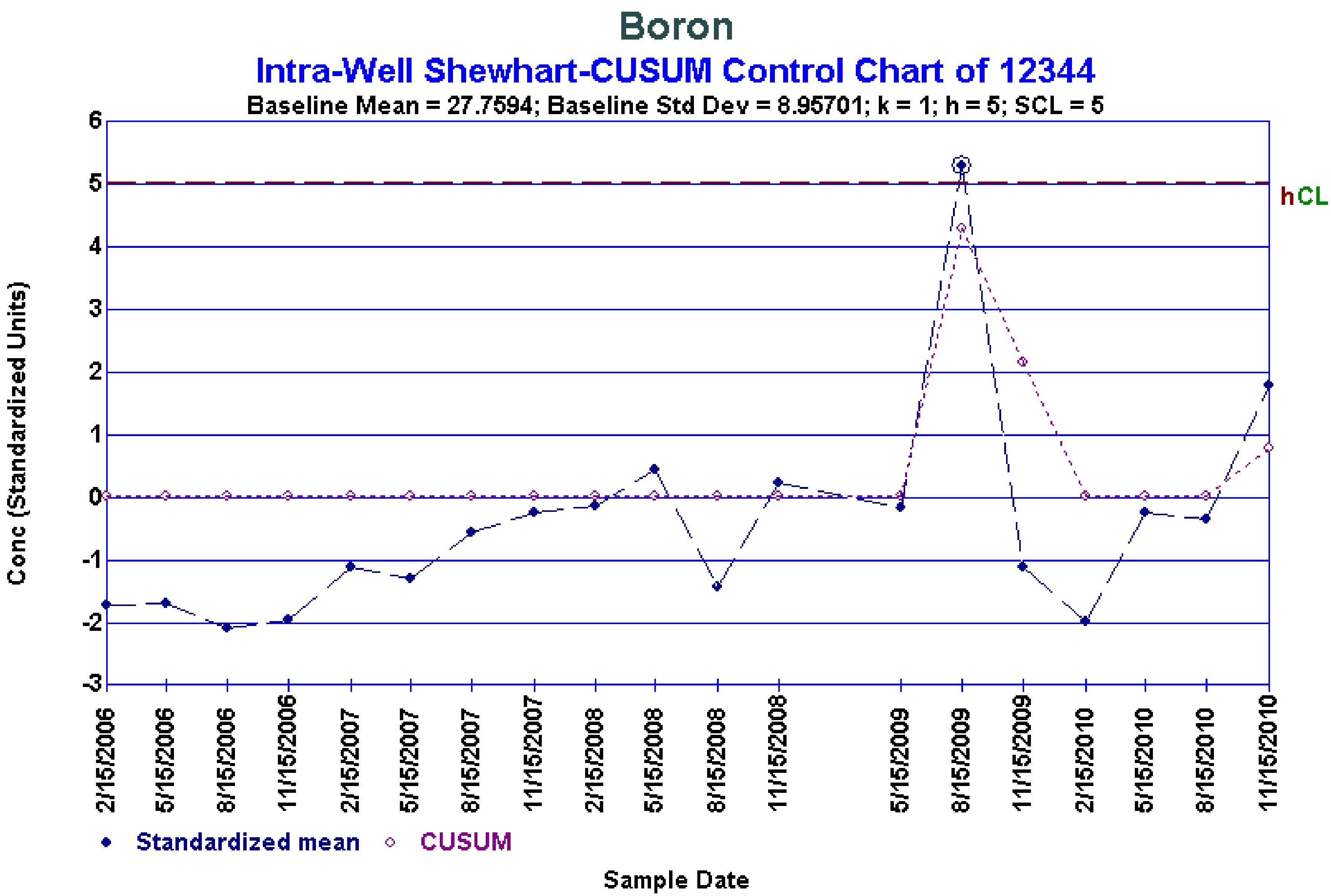


Figure A.5.7−30. Intra-Well Shewhart-CUSUM Control Chart (Boron 12344)

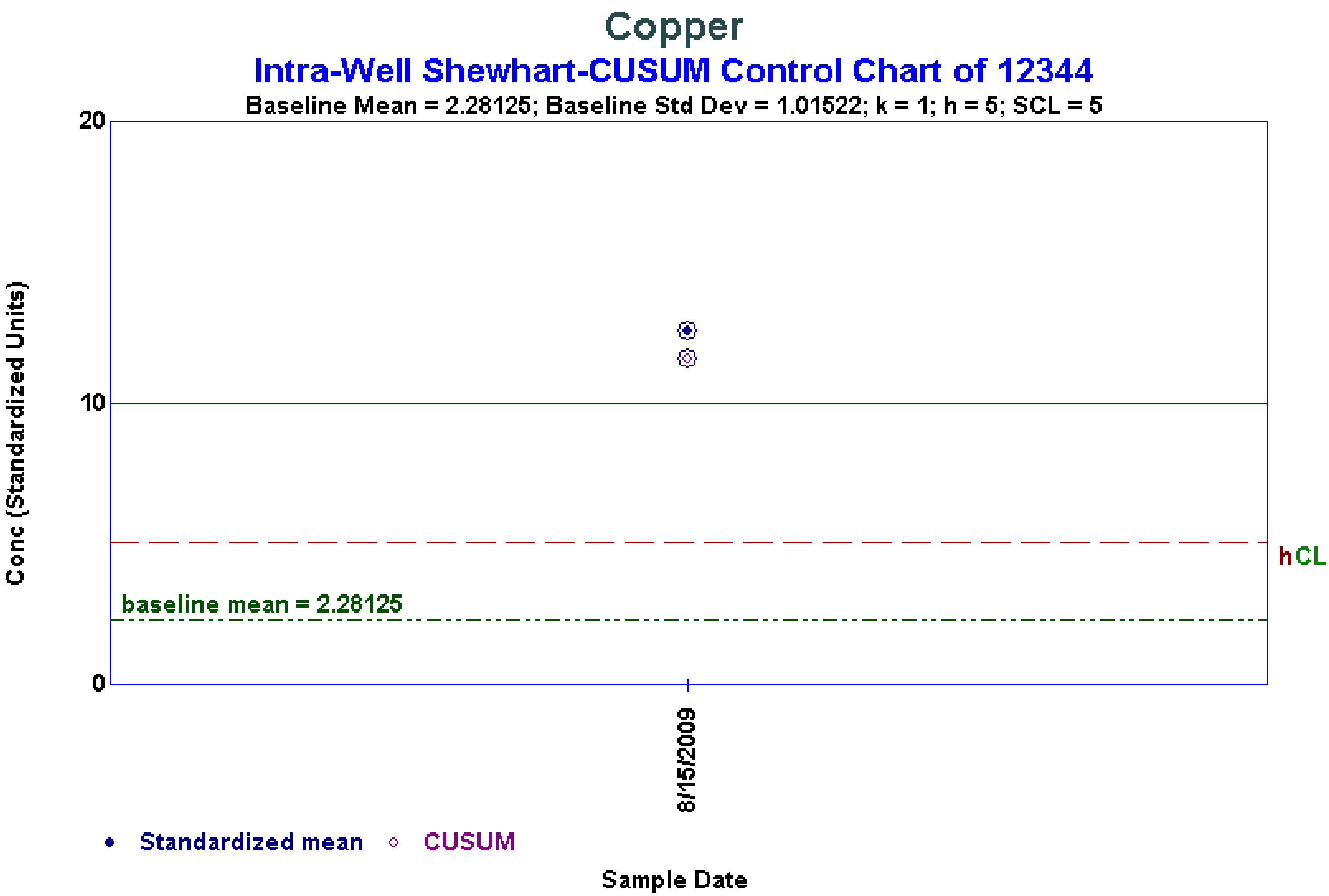


Figure A.5.7−31. Intra-Well Shewhart-CUSUM Control Chart (Copper 12344)

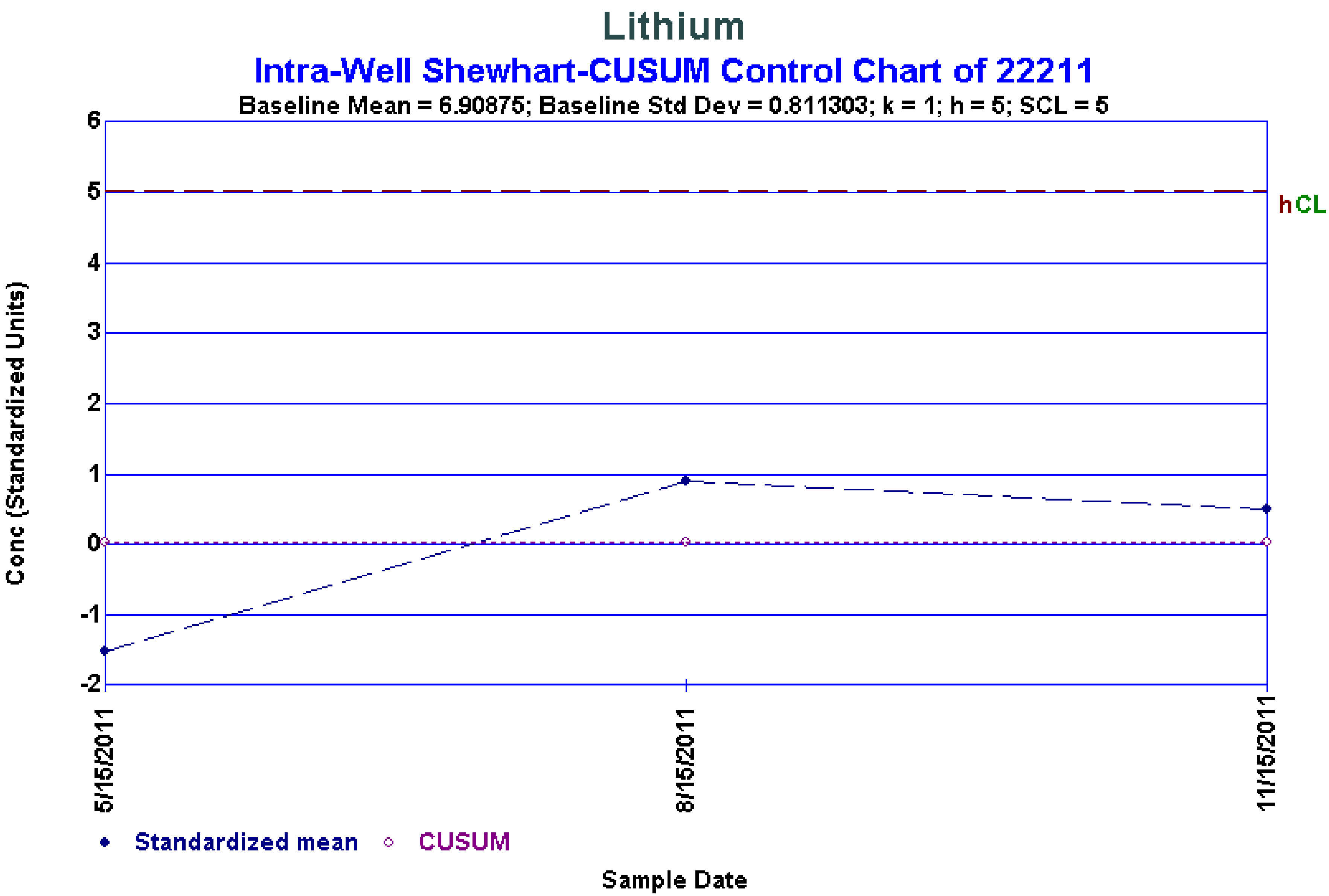


Figure A.5.7−32. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22211)

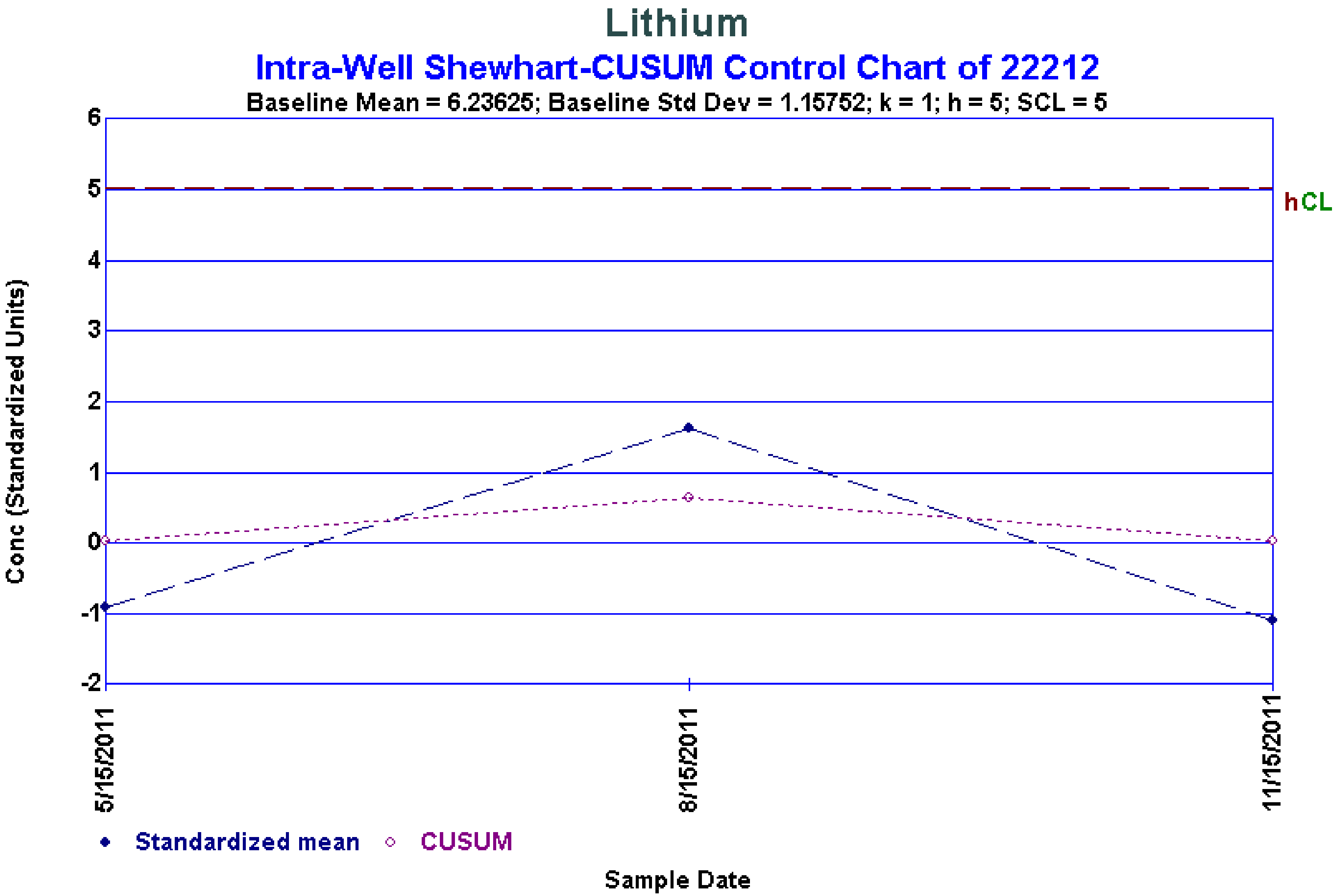


Figure A.5.7−33. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22212)

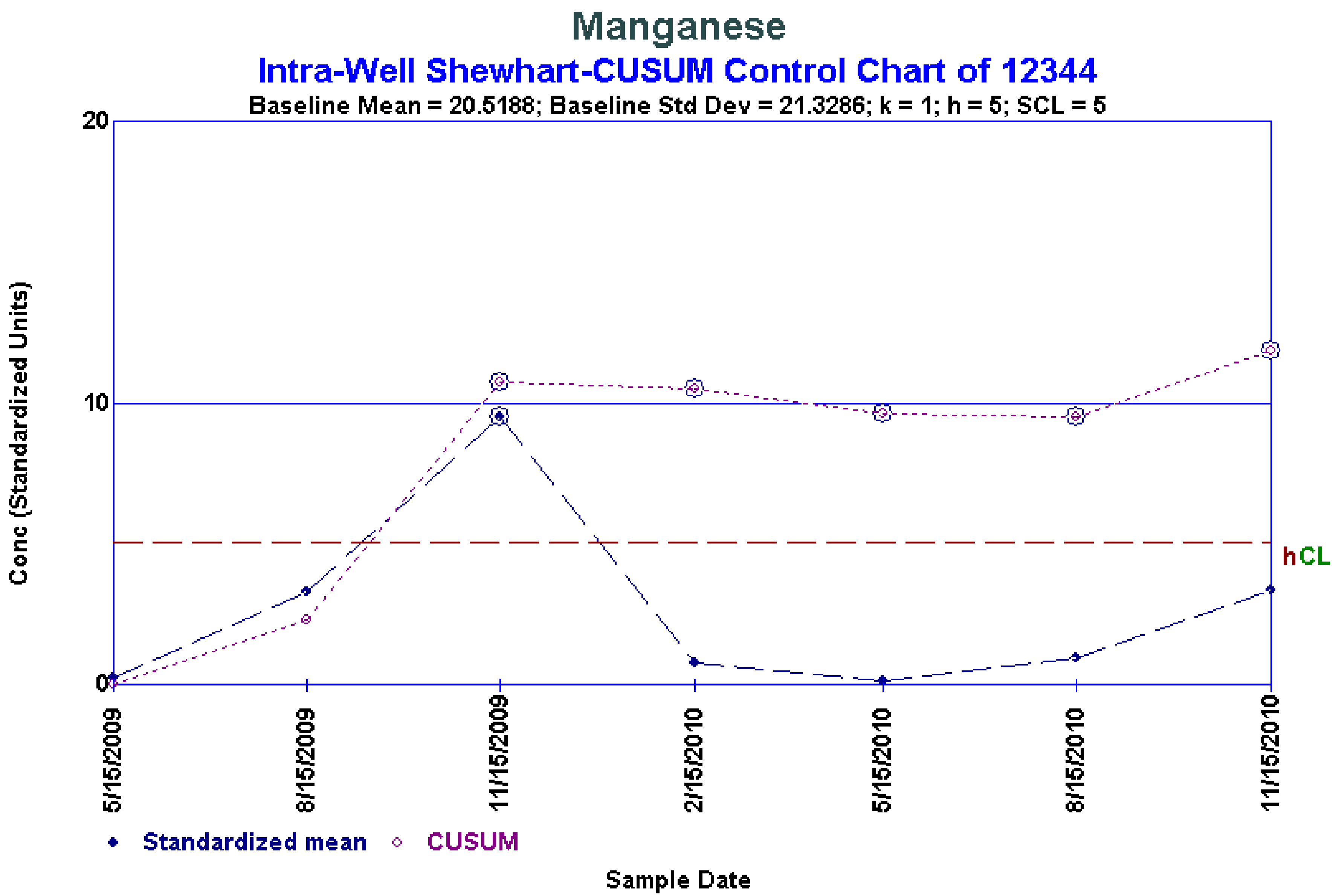


Figure A.5.7−34. Intra-Well Shewhart-CUSUM Control Chart (Manganese 12344)

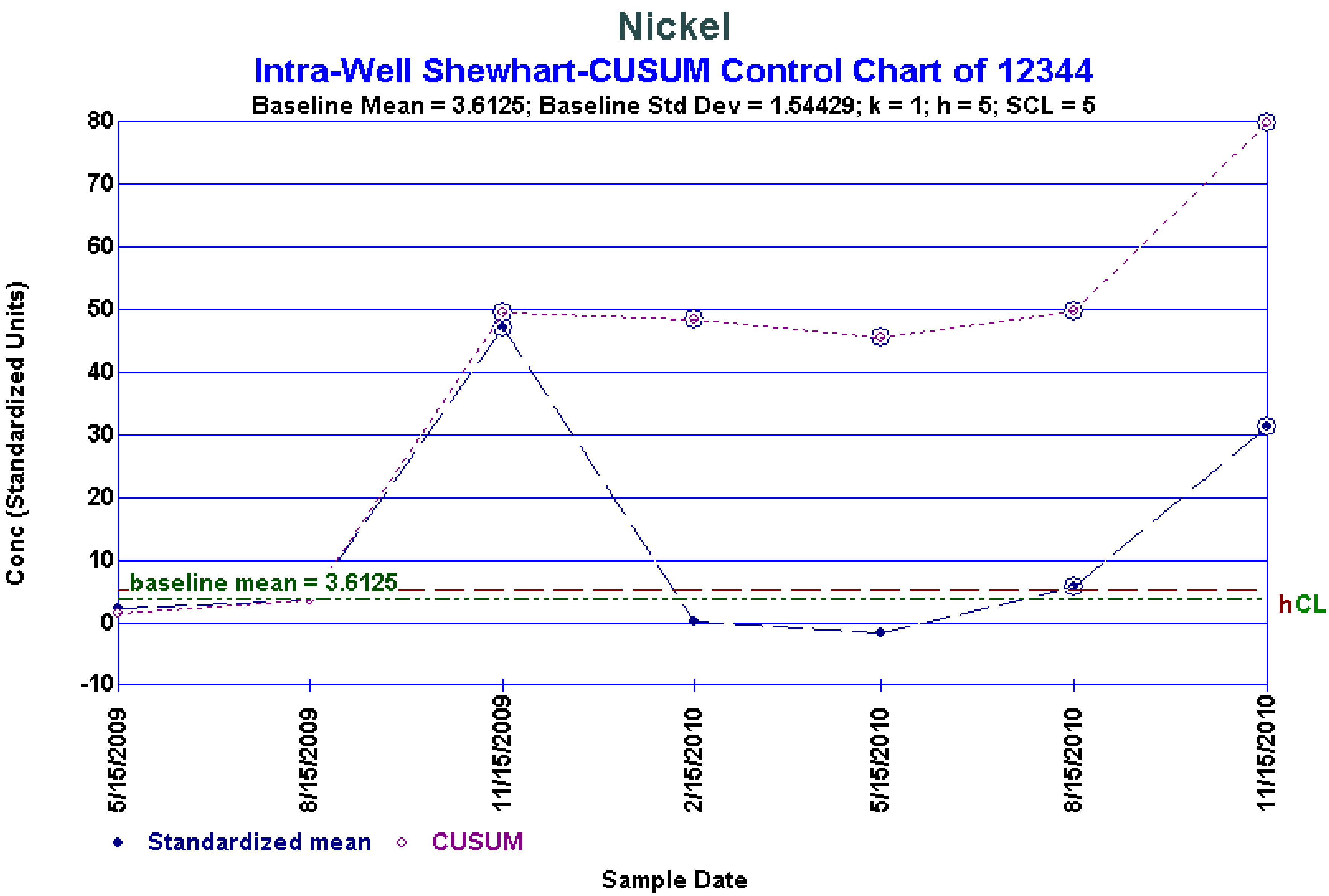


Figure A.5.7−35. Intra-Well Shewhart-CUSUM Control Chart (Nickel 12344)

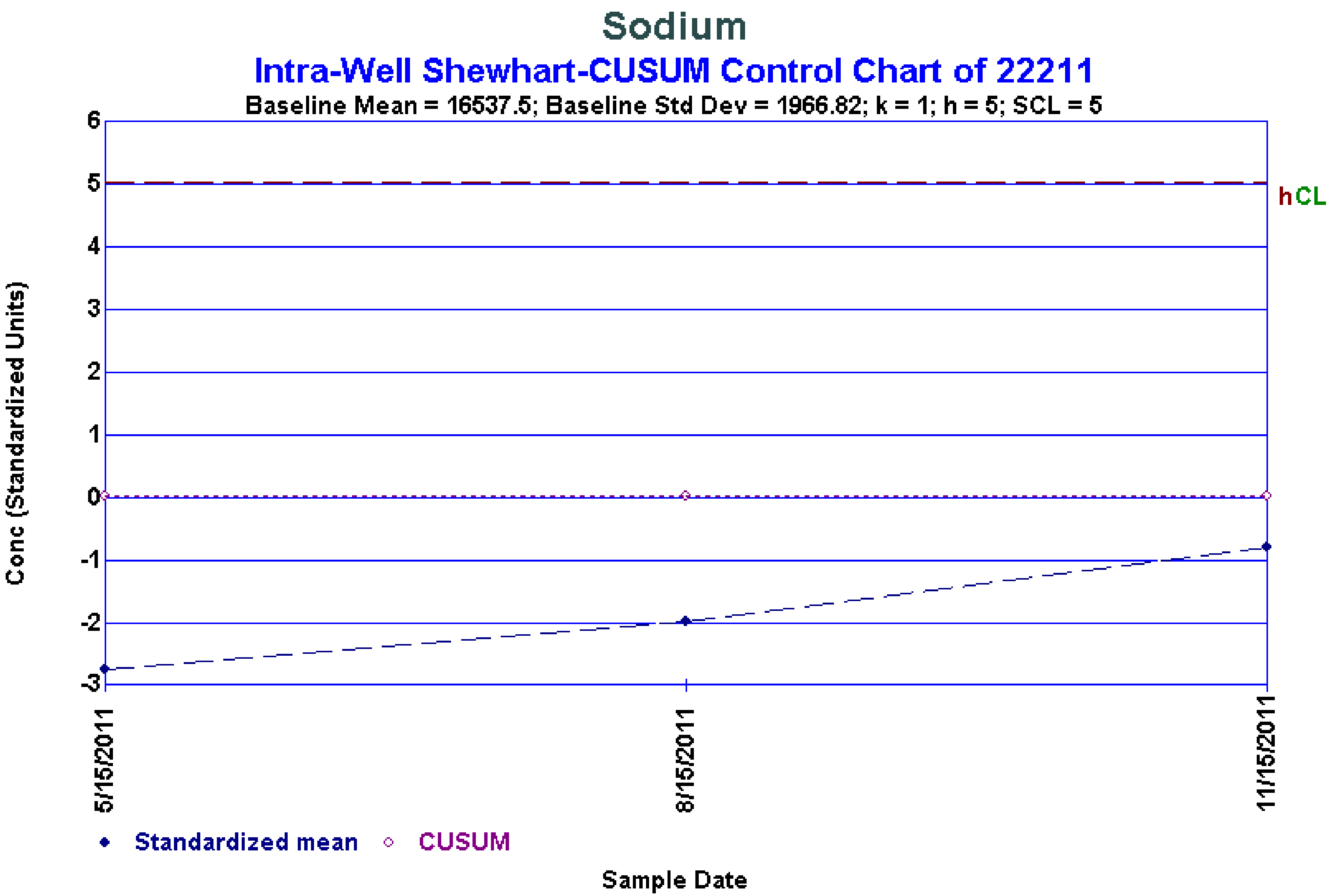


Figure A.5.7−36. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22211)

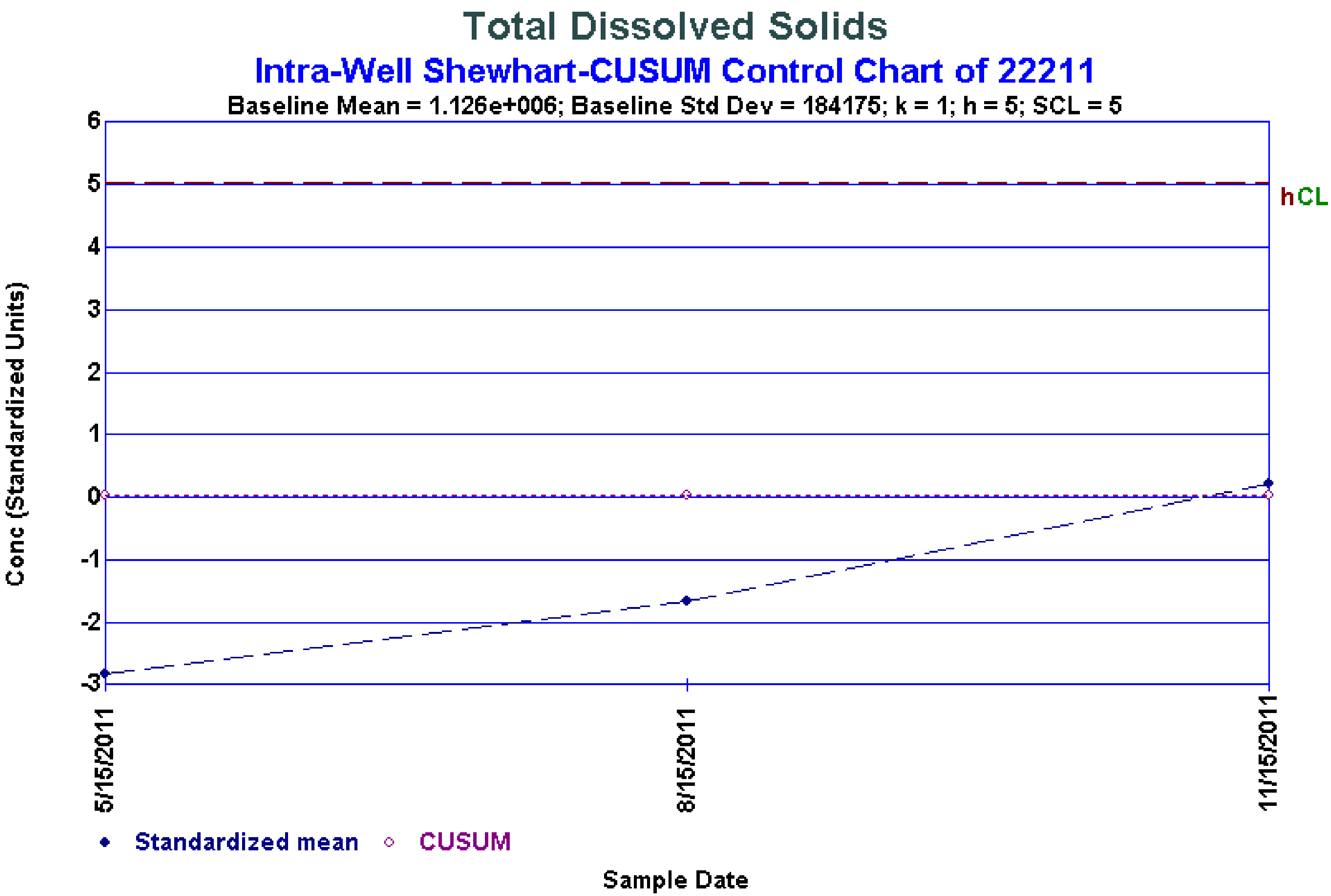


Figure A.5.7−37. Intra-Well Shewhart-CUSUM Control Chart (TDS 22211)

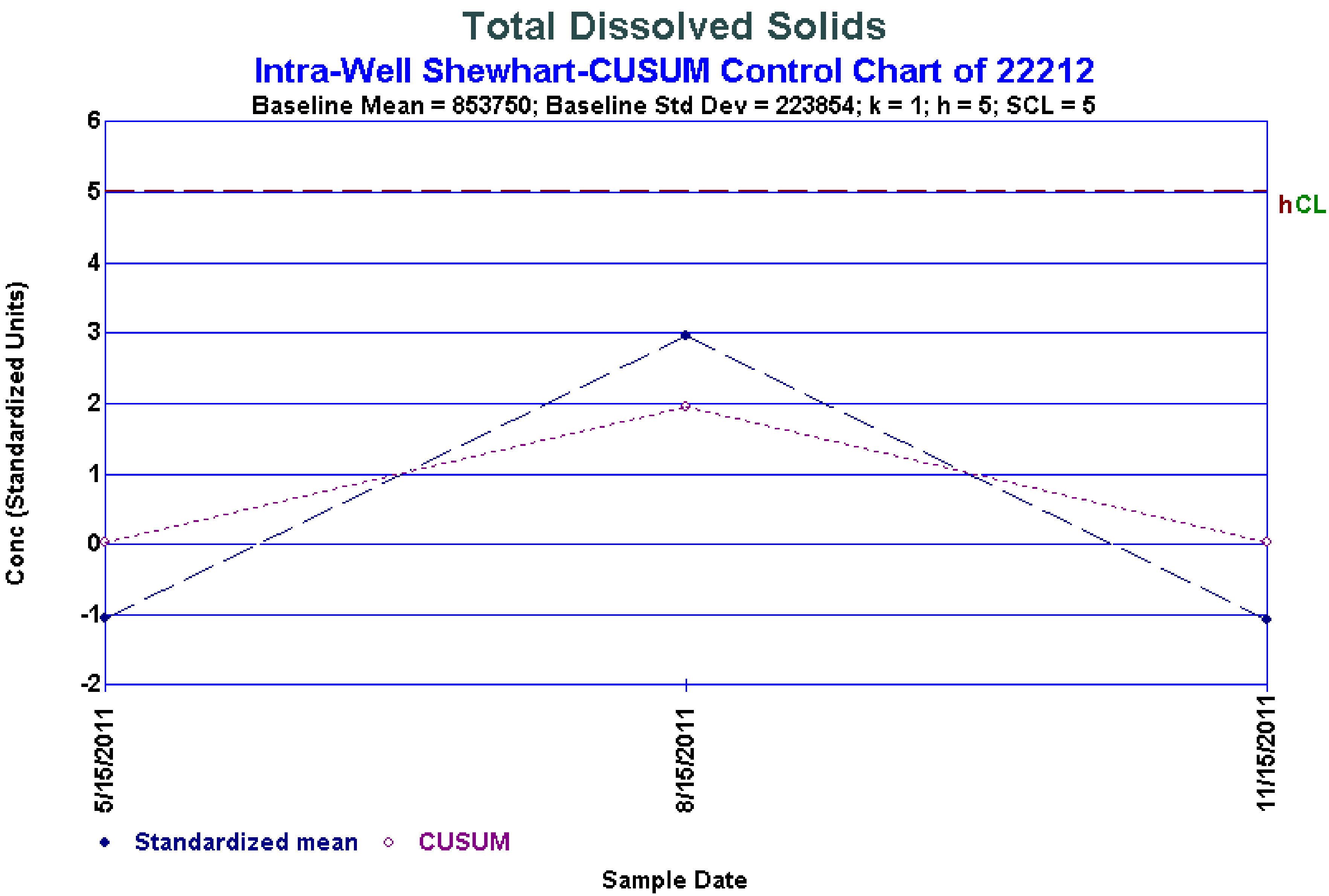


Figure A.5.7−38. Intra-Well Shewhart-CUSUM Control Chart (TDS 22212)

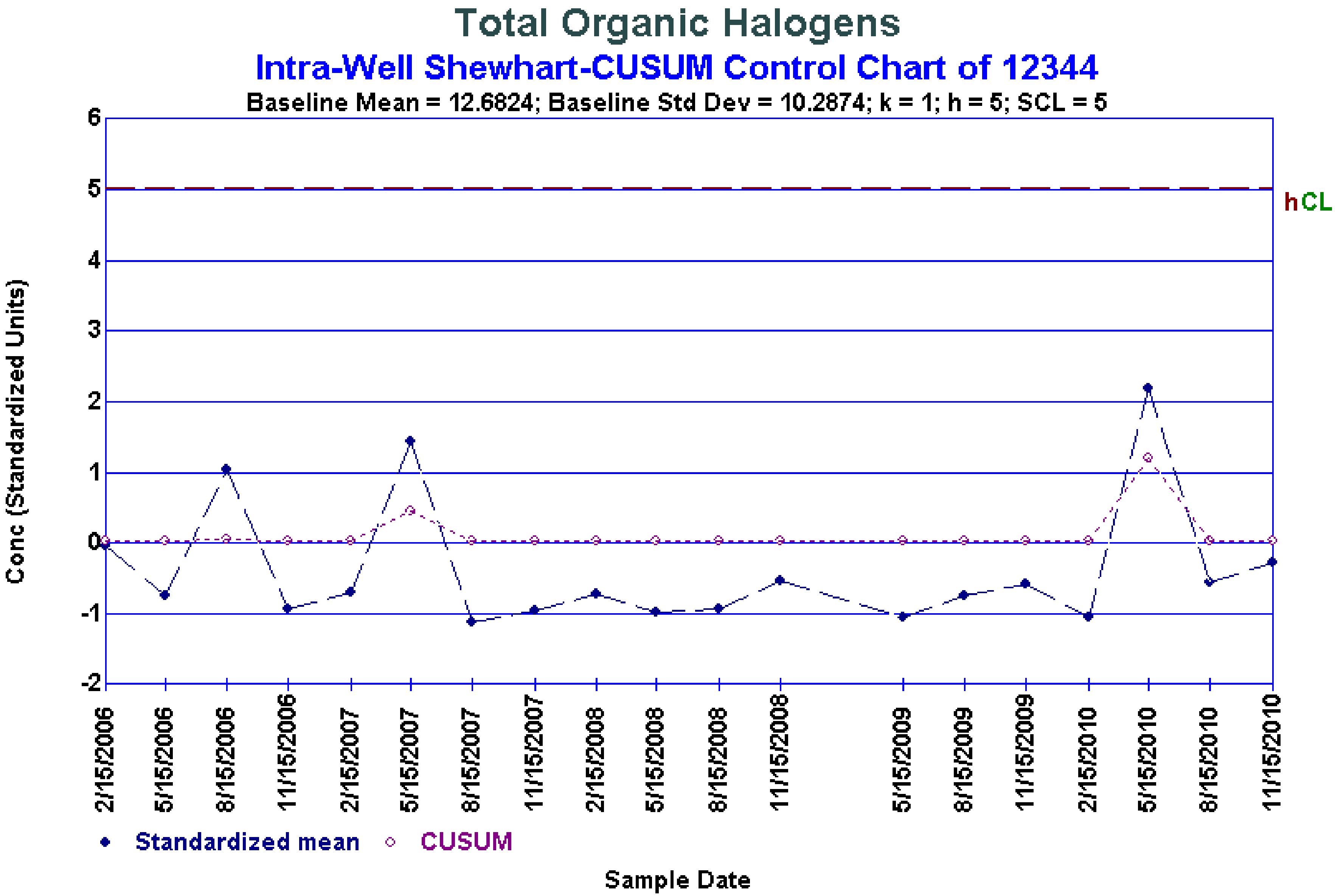


Figure A.5.7−39. Intra-Well Shewhart-CUSUM Control Chart (TOX 12344)

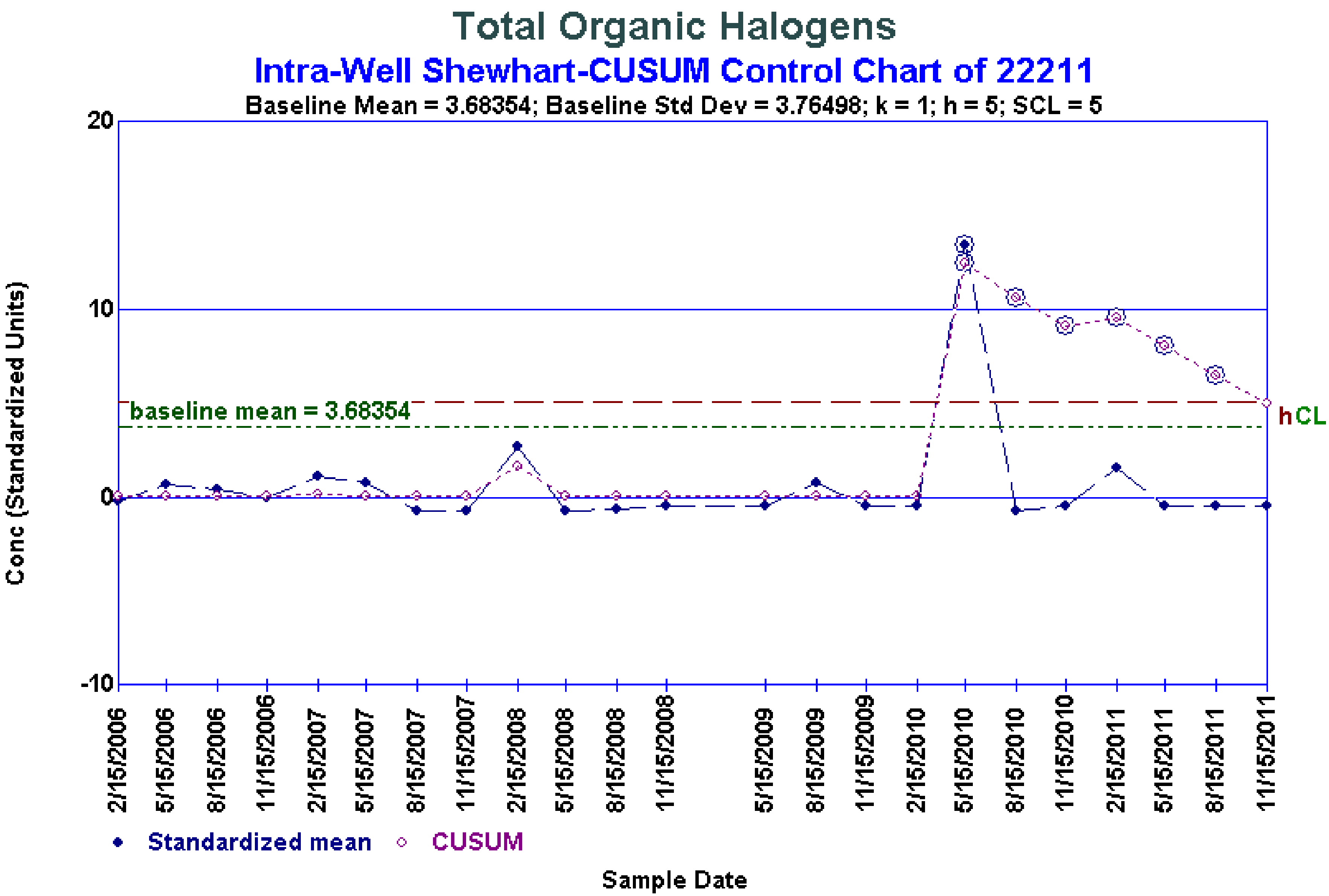


Figure A.5.7−40. Intra-Well Shewhart-CUSUM Control Chart (TOX 22211)

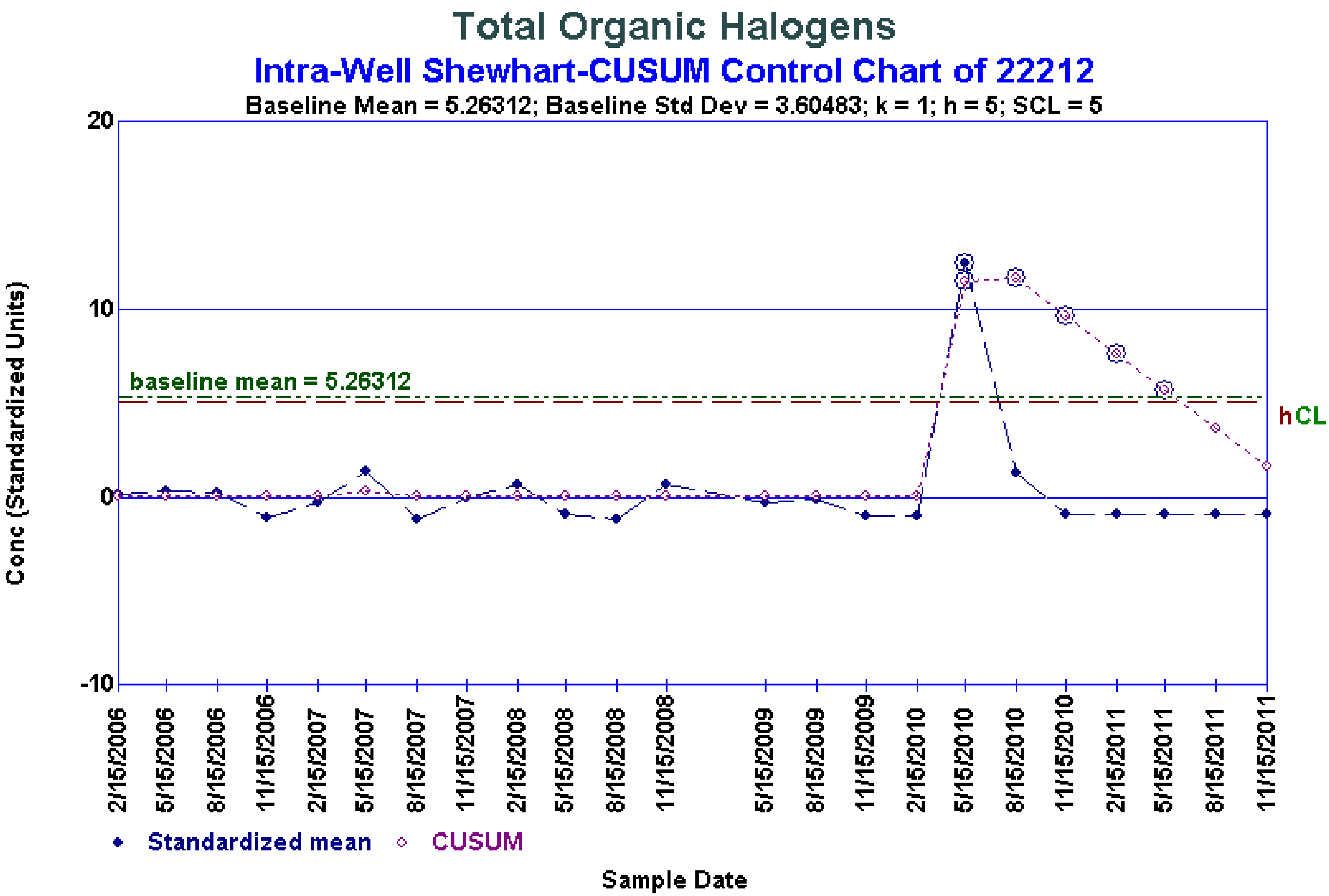


Figure A.5.7−41. Intra-Well Shewhart-CUSUM Control Chart (TOX 22212)

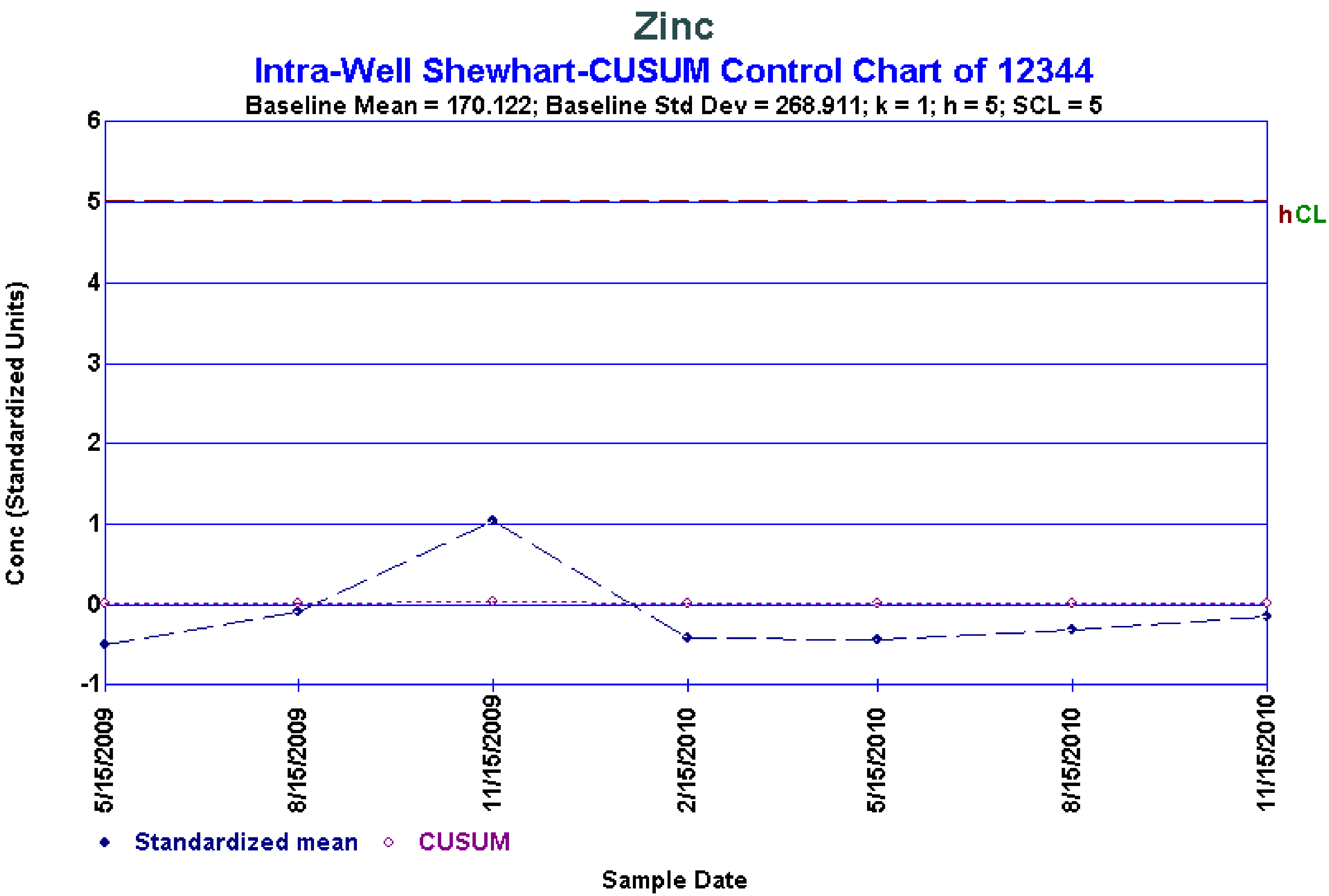


Figure A.5.7−42. Intra-Well Shewhart-CUSUM Control Chart (Zinc 12344)

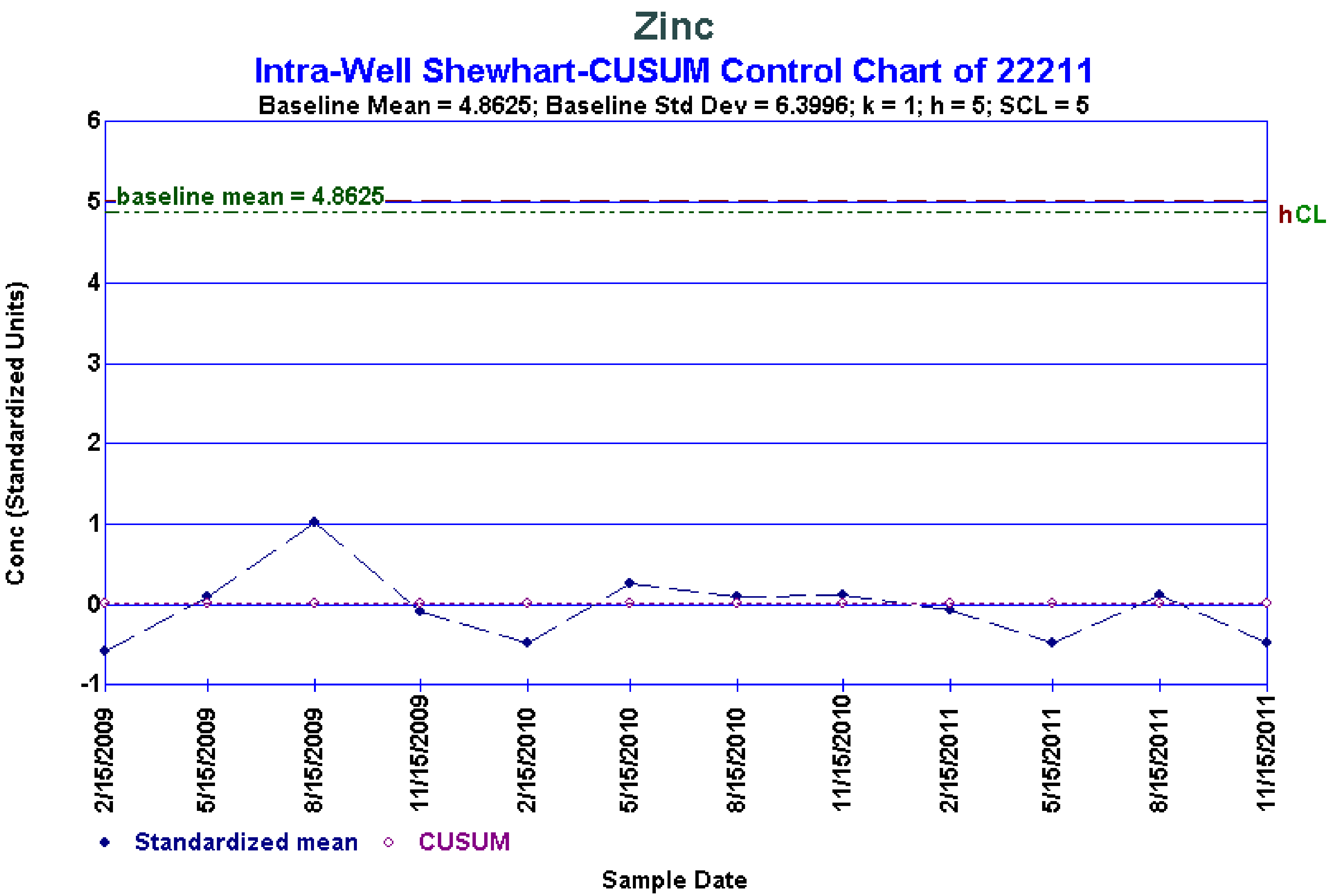


Figure A.5.7−43. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22211)

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Sub-attachment A.5.8

Cell 8

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.8−1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.8−2)
- Site-specific parameter selection results (refer to Table A.5.8–3)
- LCS monthly accumulation volumes (refer to Figure A.5.8−1)
- LDS monthly accumulation volumes (refer to Figure A.5.8−2)
- OSDF horizontal till well 12345 water yield (refer to Figure A.5.8−3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.8−4 and A.5.8−7)
- Plots of concentration versus time (refer to Figures A.5.8−8A to A.5.8−30B)
- A bivariate plots (refer to Figure A.5.8−31 and A.5.8–32)
- Control charts (refer to Figures A.5.8−33 to A.5.8−56)

A.5.8.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In the first quarter of 2011, 23 parameters were sampled in the LCS, LDS, HTW, and GMA wells of each cell. In the second, third, and fourth quarters tritium was added to the analyte list for all horizons (LCS, LDS, HTW, and GMA wells), and the analyte list for the HTWs in all cells was changed to just four parameters: arsenic, uranium, tritium, and sodium. These changes were agreed to via the comment resolution process between Ohio EPA and DOE on LMICP (revision 4). Tritium results for all cells are reported in Section A.5.5.

The Cell 8 HTW was dry for all four quarters of 2011, and the LDS of Cell 8 was dry the fourth quarter of 2011. As shown in Table A.5.8–1, twelve of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, (uranium, nitrate, sulfate, TDS, TOC, arsenic, boron, lithium, manganese, nickel, sodium, and zinc) have upward concentration trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend. Cell 8 is unique in that it has four GMA wells (GMA-U, GMA-D, GMA-SW, and GMA-SE).

Horizontal Till Well

The HTW is located beneath the liner penetration box of each cell by design. This area of the liner penetration box is considered to be potentially the weakest point in the cell design. If a leak were to develop, it should be detected beneath the liner penetration box first. Therefore, the water quality in the HTW represents the first line of evidence that a potential leak from the cell might be occurring. A leak would be indicated by an increasing concentration in the HTW.

Of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, only nitrate concentrations are increasing in the HTW of Cell 8 (as indicated in the table below). A bivariate plot for the Cell 8 LCS, LDS, and HTW (uranium-sodium) is provided in Figure A.5.8−31 and a bivariate plot for the Cell 8 LCS, LDS, and HTW (uranium-sulfate) is provided in Figure A.5.8–32. Both plots show that the chemical signature for uranium-sodium and uranium-sulfate in the LCS are separate and distinct from the signatures seen in the LDS and HTW. The uranium-sulfate plot does a better job than the uranium-sodium plot for showing that the chemical signatures in the LDS and HTW are also separate and distinct. Separate and distinct chemical signatures in the LCS, LDS, and HTW indicate that water is not mixing between the horizons. The increasing nitrate concentrations in the HTW of Cell 8 are therefore due to fluctuating ambient concentrations beneath the cell, and are not related to cell performance.

Parameter	HTW[a]	GMA-U[a]	GMA-D[a]	GMA-SW[a]	GMA-SE[a]
Uranium		Up		Up	
Nitrate	Up				
Sulfate		Up		Up	
TDS			Up	Up	
TOC		Up		Up	
Arsenic			Up		
Boron				Up	
Lithium			Up	Up	
Manganese				Up	
Nickel				Up	
Sodium				Up	
Zinc			Up		

[a]HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; GMA-SE = southeast Great Miami Aquifer; TDS = total dissolved solids; TOC = total organic carbon. No entry indicates that the trend was not up.

Great Miami Aquifer Wells

GMA monitoring wells are positioned for post-aquifer-remediation flow conditions, when flow directions will be from west to east. However, water levels measured in 2011 indicate that groundwater in the GMA in most of the area of the OSDF is moving in a general direction of northeast to south/southwest in response to the active groundwater remediation occurring to the west and southwest. This may be the reason nine parameters had increasing concentration trends in the GMA-SW well of Cell 8 in 2011. Pumping for the groundwater remediation is scheduled to last until 2023. Because bivariate plots (discussed above) indicate that LCS, LDS, and HTW monitoring horizons are not mixing, the increasing concentrations seen in the GMA wells are attributed to fluctuating ambient conditions that are not related to cell performance.

The following table provides a summary of the average concentration (as reported in Table A.5.8–1) measured in the LDS and GMA wells for parameters with increasing concentrations in the Cell 8 GMA wells.

Parameter	LDS[a]	GMA-U[a]	GMA-D[a]	GMA-SW[a]	GMA-SE[a]
Uranium (µg/L)	**22.0**	0.377	0.488	0.480	7.94
Sulfate (mg/L)	**3050**	199	253	138	445
TDS (mg/L)	**6070**	795	712	698	1080
TOC (mg/L)	**3.07**	1.28	1.35	1.32	1.60
Arsenic (mg/L)	**0.0118**	0.00250	0.00250	0.00250	0.00250
Boron (mg/L)	**0.899**	0.0344	0.0294	0.0335	0.0269
Lithium (mg/L)	**0.196**	0.00580	0.00542	0.00584	0.00671
Manganese (mg/L)	0.117	0.257	0.368	0.298	**0.982**
Nickel (mg/L)	**0.0116**	0.00176[b]	0.00075	0.00524[c]	0.00423
Sodium (mg/L)	**408**	27.3	11.1	15.9	14.0
Zinc (mg/L)	**0.130**	0.00703	0.00337	0.00668	0.00698

Note: The highest averages are shown in bold.

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; GMA-SE = southeast Great Miami Aquifer; TDS = total dissolved solids; TOC = total organic carbon.

[b] Nickel has only been detected once in the GMA-U (third quarter 2010, 0.00176 mg/L).

[c] Nickel has only been detected once in the GMA-SW (second quarter 2011, 0.00524 mg/L and third quarter 2011, 0.0019 mg/L)

A.5.8.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009), defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat® software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat® software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat® software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.8−1 in gray shading, eleven parameters in the HTW and/or GMA wells of Cell 8 (uranium, sulfate, TDS, TOC, TOX, boron, iron, lithium, manganese, sodium, and zinc) meet the criteria for control charts (i.e., more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in twenty four control charts.

Parameter and Monitoring Point[a]	Assessment
Uranium in the HTW	In Control
Uranium in the GMA-SE	In Control
Sulfate in the GMA-D	**Out of Control**
Sulfate in the GMA-SE	In Control
TDS in the GMA-SE	In Control
TOC in the HTW	**Out of Control**
TOC in the GMA-SE	In Control
TOX in the HTW	In Control
Boron in the HTW	In Control
Boron in the GMA-U	In Control
Boron in the GMA-SE	In Control
Iron in the GMA-U	In Control
Iron in the GMA-D	In Control
Iron in the GMA-SE	In Control
Lithium in the GMA-U	In Control
Lithium in the GMA-SE	In Control
Manganese in the GMA-U	In Control
Manganese in the GMA-SE	In Control
Sodium in the GMA-U	In Control
Sodium in the GMA-D	In Control
Sodium in the GMA-SE	In Control
Zinc in the GMA-U	In Control
Zinc in the GMA-SW	In Control
Zinc in the GMA-SE	In Control

[a]HTW = horizontal till well; GMA-D = downgradient Great Miami Aquifer;
GMA-U = upgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer;
GMA-SE = southeast Great Miami Aquifer

The control charts are presented in Figures A.5.8−33 to A.5.8−56. With the exception of Sulfate in the GMA-D well and TOC in the HTW, the charts all exhibit “in control” conditions. As discussed above, separate and distinct signatures for uranium-sodium and uranium-sulfate in the LCS, LDS, and HTW of Cell 8 indicate that water is not mixing between the horizons, so the out of control conditions are attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

A.5.8.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 8 are provided in Table A.5.8−2 for those parameters that were detected at least once, and are not being sampled quarterly. One new Appendix I parameter (cadmium) was detected in the LCS of Cell 8 in 2011. Detection of cadmium in the LCS of Cell 8 in 2012 will trigger sampling for cadmium in the LDS of Cell 8 during the subsequent next scheduled sampling event.

As reported last year, in 2009, 1,1-dichloroethene was detected for the first time in the LCS of Cell 8. In 2010, 1,1-dichloroethene was detected again in the LCS of Cell 8. As stated in Appendix B of the GWLMP (DOE 2010a) "two consecutive detects in a cell's LCS will trigger sampling in the cell's LDS during the next scheduled sampling round." Sampled for twice in the LDS of Cell 8 in 2011, 1,1-dichloroethene was not detected in the LDS of Cell 8. Since it continues to be detected in the LCS of Cell 8 sampling in the LDS will continue.

A.5.8.4 Site-Specific Parameter Selection for Cell 8

The sample size of the Cell 8 dataset reached a minimum of eight samples at the end of 2011; therefore, the site-specific leachate monitoring parameter selection approach presented in Figures A.5–5A and A.5–5B was followed to determine if any of the Appendix I and PCB parameters detected in Cell 8 should be selected as site-specific monitoring parameters.

As discussed in Attachment A.5, the objective of the selection process is to determine if the mean concentration of an Appendix I or PCB parameter (that has been sampled eight times and detected more than 25 percent of the time) is statistically greater than the mean of either the pre-design or background data for the parameter. If the mean is greater, then the parameter is selected for more quarterly monitoring in the LCS, LDS, HTW, and GMA wells of the cell.

The null hypothesis used for each statistical test is that the mean of the concentration of the LCS dataset is less than or equal to the mean of the pre-design or background dataset. Failure of the null hypothesis indicates that the mean of the LCS dataset is greater than the mean of the pre-design or background dataset.

As shown in Table A.5.8–2, three of the Appendix I parameters not already being sampled for quarterly have been detected at least 25 percent of the time (ammonia, chromium, and tetrachloroethene). Pre-design and/or background data does not exist for tetrachloroethene so parameter selection statistics could not be conducted. Since 2004, tetrachloroethene has been sampled 19 times and detected 6 times. Four of the six detects were at concentrations that were greater than the MDL but less than either the PQL or RDL. The two other detects were also very low (1.1 ug/L and 1.24 ug/L). Given the low concentrations, adding tetrachloroethene to the quarterly sampling list would not significantly enhance the early detection capability of the monitoring program.

Parameter selection statistics were conducted on ammonia and chromium for Cell 8. Results are presented in Table A.5.8−3. Both ammonia and chromium passed the null hypothesis for the Tarone-Ware test so they do not need to be added to the quarterly sampling list. As stated in Attachment A.5.7, chromium failed the null hypothesis for Cell 7 so has been added to the quarterly sampling list for the LCS, LDS, and GMA wells of each cell beginning in January of 2013.

A.5.8.4 Summary and Conclusions

- The concentrations of 12 parameters monitored quarterly are increasing in either the HTW and/or GMA wells of Cell 8 (uranium, nitrate, sulfate, TDS, TOC, arsenic, boron, lithium, manganese, nickel, sodium, and zinc).
- The chemical signature for uranium-sodium and uranium-sulfate in the LCS of Cell 8 is separate and distinct from the signatures seen in the LDS and HTW. The signature for

uranium-sodium the HTW is also separate and distinct from the LDS, but low uranium concentrations in both horizons have the clusters closer than what is seen in the other seven cells. The signature for uranium-sulfate in the HTW is separate and distinct from the LDS. Separate and distinct chemical signatures in the LCS, LDS, and HTW indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 8 are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance. It should also be noted that the HTW of Cell 8 has been dry since the third quarter of 2008, providing additional evidence that the secondary liner is not leaking.

- Twenty-four control charts were constructed for Cell 8 parameters. Twenty-two of the charts exhibit “in control” conditions. The control chart for sulfate in the GMA-D and TOC in the HTW are not in control.
- One new Appendix I parameter (cadmium) was detected in the LCS of Cell 8 in 2011. Detection of cadmium in the LCS of Cell 8 in 2012 will trigger sampling for cadmium in the LDS of Cell 8 during the subsequent next scheduled sampling event.
- Chromium and ammonia have been sampled at least 8 times in the LCS of Cell 8 and detected at least 25 percent of the time. Both passed the null hypothesis of the Tarone-ware test. Because chromium failed for Cell 7 it is being added to the quarterly sampling list for the LCS, LDS, and GMA wells of each cell beginning in January 2013.
- Tetrachloroethene has been sampled at least 8 times in the LCS of Cell 8 and detected at least 25 percent of the time. Pre-design and/or background data does not exist for tetrachloroethene so parameter selection statistics could not be conducted. Given the low concentrations of the detections, adding tetrachloroethene to the quarterly sampling list would not significantly enhance the early detection capability of the monitoring program.

Table A.5.8−1. Summary Statistics for Cell 8

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12345C	28	28	100.0	1.51	335	178	71	Normal	Up	Detected	
	LDS	12345D	26	26	100.0	9.38	64.4	22.0	11.0	Lognormal	None	Detected	
	HTW	12345	16	16	100.0	3.67	7.30	5.02	0.99	Normal	None	Not Detected	
	GMA-U	22213	25	31	80.6	ND	0.627	0.377	0.135	Normal	Up	Detected	
	GMA-D	22214	31	32	96.9	ND	1.58	0.488	0.410	Undefined	None	Not Detected	
	GMA-SW	22215	22	25	88.0	ND	16.4	0.480	3.40	Undefined	Up	Not Detected	
	GMA-SE	22217	21	21	100.0	0.898	18.3	7.94	5.04	Normal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12345C	17	17	100.0	64.9	466	281	143	Normal	Up	Detected	
	LDS	12345D	12	12	100.0	170	487	422	114	Undefined	None	Not Detected	
	HTW	12345	7	7	100.0	328	921	374	212	Undefined	None	Not Detected	
	GMA-U	22213	4	4	100.0	326	353	341	12	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	291	336	320	20	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	330	338	334	3	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	323	348	338	10	Normal	None	Insuff	
Chloride (mg/L)	LCS	12345C	17	17	100.0	18.9	339	185	115	Normal	Up	Detected	
	LDS	12345D	12	12	100.0	34.5	104	63.9	23.4	Normal	None	Detected	
	HTW	12345	7	7	100.0	743	1290	1020	200	Normal	Down	Detected	
	GMA-U	22213	4	4	100.0	29.7	52.0	39.2	10.1	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	22.8	28.4	25.9	2.8	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	30.2	38.6	34.0	3.7	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	23.1	32.5	27.4	3.9	Normal	None	Insuff	
Nitrate/Nitrite as N (mg/L)	LCS	12345C	16	17	94.1	ND	74.6	32.9	22.9	Normal	None	Detected	
	LDS	12345D	6	12	50.0	ND	3.62	0.0225	1.17	Undefined	Up	Detected	
	HTW	12345	2	7	28.6	ND	0.123	Insuff	Insuff	Normal	Up	Not Detected	
	GMA-U	22213	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22214	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-SW	22215	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-SE	22217	0	4	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sulfate (mg/L)	LCS	12345C	28	28	100.0	146	3030	2340	950	Undefined	Up	Detected	
	LDS	12345D	26	26	100.0	1730	5020	3050	890	Normal	Up	Detected	
	HTW	12345	15	15	100.0	95.5	152	116	18	Normal	None	Detected	
	GMA-U	22213	31	31	100.0	90.3	284	199	67	Undefined	Up	Detected	
	GMA-D	22214	31	31	100.0	172	457	253	73	Lognormal	None	Not Detected	
	GMA-SW	22215	24	25	96.0	ND	911	138	214	Undefined	Up	Detected	
	GMA-SE	22217	21	21	100.0	163	1320	445	248	Lognormal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12345C	16	16	100.0	882	5300	5090	1500	Undefined	Up	Detected	
	LDS	12345D	11	11	100.0	3860	7990	6070	1170	Normal	Up	Detected	
	HTW	12345	0	0	0.0	NA	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-U	22213	11	11	100.0	672	843	795	54	Undefined	None	Not Detected	
	GMA-D	22214	11	11	100.0	531	872	712	122	Normal	Up	Not Detected	
	GMA-SW	22215	11	11	100.0	457	1800	698	459	Undefined	Up	Detected	
	GMA-SE	22217	11	11	100.0	842	1550	1080	250	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12345C	25	28	89.3	1.04	5.31	2.39	0.87	Lognormal	None	Not Detected	
	LDS	12345D	25	26	96.2	ND	5.45	3.07	1.04	Normal	None	Detected	
	HTW	12345	9	15	60.0	ND	3.12	1.63	0.62	Normal	None	Not Detected	
	GMA-U	22213	26	31	83.9	0.486	2.23	1.28	0.48	Normal	Up	Detected	
	GMA-D	22214	25	31	80.6	0.536	2.03	1.35	0.42	Undefined	None	Not Detected	
	GMA-SW	22215	20	25	80.0	ND	2.83	1.32	0.55	Normal	Up	Detected	
	GMA-SE	22217	20	21	95.2	ND	2.33	1.60	0.39	Normal	None	Not Detected	

Table A.5.8−1 (continued). Summary Statistics for Cell 8

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Organic Halogens (mg/L)	LCS	12345C	17	28	60.7	ND	0.080	0.0154	0.0221	Undefined	Up	Detected	
	LDS	12345D	17	26	65.4	0.00274	0.0794	0.0153	0.0156	Lognormal	None	Not Detected	
	HTW	12345	11	15	73.3	ND	0.0942	0.0484	0.0244	Normal	None	Not Detected	
	GMA-U	22213	5	31	16.1	ND	0.0231	0.00165	0.00458	Undefined	None	Not Detected	0.0560 (Q2-10)
	GMA-D	22214	6	31	19.4	ND	0.0590	0.00165	0.0107	Undefined	None	Not Detected	
	GMA-SW	22215	6	25	24.0	ND	0.0460	0.00220	0.00971	Undefined	None	Not Detected	
	GMA-SE	22217	7	21	33.3	ND	0.00658	0.00165	0.00150	Undefined	None	Not Detected	0.0140 (Q4-06) 0.0149 (Q2-07) 0.0730 (Q2-10)
Arsenic (mg/L)	LCS	12345C	4	20	20.0	ND	0.142	0.00375	0.0450	Undefined	None	Not Detected	
	LDS	12345D	3	17	17.6	ND	0.0912	0.0118	Insuff	Normal	None	Not Detected	
	HTW	12345	0	7	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-U	22213	4	11	36.4	ND	0.0406	0.00250	0.0128	Undefined	None	Not Detected	
	GMA-D	22214	5	20	25.0	ND	0.0457	0.00250	0.0132	Undefined	Up	Detected	
	GMA-SW	22215	4	11	36.4	ND	0.0430	0.00250	0.0146	Undefined	None	Not Detected	
	GMA-SE	22217	3	11	27.3	ND	0.0344	0.00250	Insuff	Undefined	None	Not Detected	
Barium (mg/L)	LCS	12345C	15	15	100.0	0.0236	0.103	0.0492	0.0234	Lognormal	Down	Not Detected	
	LDS	12345D	10	10	100.0	0.0146	0.0837	0.0380	0.0220	Normal	Down	Detected	
	HTW	12345	7	7	100.0	0.284	0.444	0.352	0.064	Normal	Down	Detected	
	GMA-U	22213	4	4	100.0	0.112	0.132	0.120	0.009	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	0.0582	0.105	0.0825	0.0231	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	0.0409	0.122	0.0745	0.0349	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	0.0294	0.0844	0.0551	0.0284	Normal	None	Insuff	
Boron (mg/L)	LCS	12345C	28	28	100.0	0.0681	0.776	0.660	0.215	Undefined	Up	Detected	
	LDS	12345D	26	26	100.0	0.582	2.40	0.889	0.468	Undefined	None	Detected	
	HTW	12345	15	15	100.0	0.0683	0.0978	0.0834	0.0078	Normal	None	Not Detected	
	GMA-U	22213	28	31	90.3	ND	0.0463	0.0344	0.0072	Normal	None	Not Detected	
	GMA-D	22214	29	31	93.6	ND	0.0393	0.0294	0.0064	Undefined	None	Not Detected	
	GMA-SW	22215	23	25	92.0	ND	0.0409	0.0335	0.0065	Undefined	Up	Not Detected	
	GMA-SE	22217	19	21	90.5	ND	0.0360	0.0269	0.0062	Normal	None	Not Detected	
Calcium (mg/L)	LCS	12345C	15	15	100.0	65.4	874	468	253	Normal	Up	Detected	
	LDS	12345D	10	10	100.0	279	678	490	119	Normal	None	Detected	
	HTW	12345	7	7	100.0	250	402	338	60	Normal	None	Detected	
	GMA-U	22213	4	4	100.0	167	186	174	9	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	174	230	198	27	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	164	446	307	149	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	204	334	208	64	Undefined	None	Insuff	
Cobalt (mg/L)	LCS	12345C	10	20	50.0	ND	0.00290	0.00077	0.00081	Undefined	None	Not Detected	
	LDS	12345D	7	17	41.2	ND	0.00250	0.00072	0.00081	Undefined	Down	Not Detected	
	HTW	12345	6	7	85.7	ND	0.00145	0.000949	0.000356	Normal	None	Not Detected	
	GMA-U	22213	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22214	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-SW	22215	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-SE	22217	7	11	63.6	ND	0.00216	0.00109	0.00057	Normal	None	Not Detected	
Copper (mg/L)	LCS	12345C	12	20	60.0	ND	0.0309	0.00455	0.00828	Undefined	None	Not Detected	
	LDS	12345D	9	17	52.9	ND	0.0427	0.00750	0.0127	Undefined	Down	Detected	
	HTW	12345	5	7	71.4	ND	0.0106	0.00379	0.00326	Lognormal	None	Not Detected	
	GMA-U	22213	4	4	100.0	0.0016	0.0111	0.00633	0.00391	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	0.00117	0.0105	0.00634	0.00392	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	0.00332	0.0102	0.00799	0.00315	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	0.00191	0.0127	0.00748	0.00456	Normal	None	Insuff	

Table A.5.8−1 (continued). Summary Statistics for Cell 8

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Iron (mg/L)	LCS	12345C	15	20	75.0	ND	3.91	1.20	1.07	Lognormal	Down	Not Detected	
	LDS	12345D	14	17	82.4	ND	6.20	2.37	2.03	Lognormal	Down	Detected	
	HTW	12345	6	7	85.7	0.696	2.68	1.62	0.74	Normal	None	Not Detected	
	GMA-U	22213	11	11	100.0	0.551	2.83	1.91	0.78	Normal	None	Not Detected	
	GMA-D	22214	11	11	100.0	2.87	6.69	4.12	1.13	Normal	None	Not Detected	
	GMA-SW	22215	11	11	100.0	5.25	17.4	6.00	3.63	Undefined	None	Not Detected	
	GMA-SE	22217	11	11	100.0	1.13	10.3	4.86	2.85	Normal	None	Not Detected	
Lithium (mg/L)	LCS	12345C	19	19	100.0	0.0073	0.150	0.106	0.042	Undefined	Up	Detected	
	LDS	12345D	16	16	100.0	0.0702	0.367	0.196	0.076	Normal	Up	Detected	
	HTW	12345	7	7	100.0	0.0145	0.0183	0.0164	0.0015	Normal	None	Not Detected	
	GMA-U	22213	11	11	100.0	0.00489	0.00728	0.00580	0.00067	Normal	None	Not Detected	
	GMA-D	22214	11	11	100.0	0.00431	0.00718	0.00542	0.00096	Normal	Up	Not Detected	
	GMA-SW	22215	11	11	100.0	0.00467	0.00828	0.00584	0.00115	Normal	Up	Not Detected	
	GMA-SE	22217	11	11	100.0	0.00546	0.00799	0.00671	0.00091	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12345C	15	15	100.0	21.9	583	351	221	Undefined	Up	Detected	
	LDS	12345D	10	10	100.0	148	787	359	221	Normal	None	Not Detected	
	HTW	12345	7	7	100.0	77.7	118	104	16	Normal	None	Not Detected	
	GMA-U	22213	4	4	100.0	37.4	42.0	39.1	2.0	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	39.6	48.4	43.8	4.5	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	35.4	74.5	52.0	19.6	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	41.6	55.2	46.2	6.1	Normal	None	Insuff	
Manganese (mg/L)	LCS	12345C	11	20	55.0	ND	0.328	0.0398	0.0795	Lognormal	None	Not Detected	
	LDS	12345D	11	17	64.7	ND	0.687	0.117	0.174	Lognormal	None	Not Detected	
	HTW	12345	7	7	100.0	0.0116	0.199	0.0528	0.0653	Lognormal	None	Not Detected	
	GMA-U	22213	11	11	100.0	0.222	0.281	0.257	0.020	Normal	None	Not Detected	
	GMA-D	22214	20	20	100.0	0.293	0.706	0.368	0.135	Undefined	None	Not Detected	
	GMA-SW	22215	11	11	100.0	0.24	1.94	0.298	0.595	Undefined	Up	Detected	
	GMA-SE	22217	11	11	100.0	0.537	1.57	0.982	0.349	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12345C	16	20	80.0	ND	0.0180	0.00645	0.00458	Normal	None	Not Detected	
	LDS	12345D	15	17	88.2	0.00178	0.0220	0.0116	0.0068	Normal	None	Not Detected	
	HTW	12345	7	7	100.0	0.0057	0.0144	0.00903	0.00312	Normal	None	Not Detected	
	GMA-U	22213	1	11	9.1	ND	0.00176	Insuff	Insuff	Undefined	None	Detected	
	GMA-D	22214	4	20	20.0	ND	0.00630	0.00075	0.00134	Undefined	None	Detected	
	GMA-SW	22215	2	11	18.2	ND	0.00524	Insuff	Insuff	Undefined	Up	Detected	
	GMA-SE	22217	6	11	54.6	ND	0.0228	0.00423	0.00685	Undefined	None	Not Detected	
Potassium (mg/L)	LCS	12345C	15	15	100.0	4.86	27.6	25.1	7.9	Undefined	Up	Detected	
	LDS	12345D	10	10	100.0	38.0	99.4	66.7	21.8	Normal	None	Not Detected	
	HTW	12345	6	7	85.7	ND	2.90	2.43	0.50	Normal	None	Not Detected	
	GMA-U	22213	4	4	100.0	3.67	4.14	3.92	0.20	Normal	None	Insuff	
	GMA-D	22214	4	4	100.0	2.53	3.07	2.77	0.24	Normal	None	Insuff	
	GMA-SW	22215	4	4	100.0	3.18	5.01	4.10	0.90	Normal	None	Insuff	
	GMA-SE	22217	4	4	100.0	2.95	4.09	3.32	0.53	Lognormal	None	Insuff	

Table A.5.8−1 (continued). Summary Statistics for Cell 8

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[c,d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Selenium (mg/L)	LCS	12345C	2	20	10.0	ND	0.151	Insuff	Insuff	Lognormal	None	Not Detected	
	LDS	12345D	1	17	5.9	ND	0.0750	Insuff	Insuff	Lognormal	None	Not Detected	
	HTW	12345	0	7	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-U	22213	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-D	22214	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
	GMA-SW	22215	1	11	9.1	ND	0.00648	Insuff	Insuff	Undefined	None	Detected	
	GMA-SE	22217	0	11	0.0	ND	NA	Insuff	Insuff	Insuff	Insuff	Insuff	
Sodium (mg/L)	LCS	12345C	20	20	100.0	16.8	118	97.0	37.0	Undefined	Up	Detected	
	LDS	12345D	17	17	100.0	76.6	762	408	192	Normal	Up	Not Detected	
	HTW	12345	7	7	100.0	277	385	334	45	Normal	None	Not Detected	
	GMA-U	22213	11	11	100.0	22.7	30.3	27.3	2.4	Normal	None	Not Detected	
	GMA-D	22214	11	11	100.0	9.83	13.6	11.1	1.1	Normal	None	Not Detected	
	GMA-SW	22215	11	11	100.0	13.5	18.8	15.9	1.5	Normal	Up	Detected	
	GMA-SE	22217	11	11	100.0	12.1	16.2	14.0	1.3	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12345C	11	20	55.0	ND	0.0622	0.00463	0.0160	Lognormal	Up	Not Detected	
	LDS	12345D	13	17	76.5	ND	0.333	0.130	0.098	Lognormal	None	Detected	
	HTW	12345	5	7	71.4	0.0062	1.89	0.00855	0.704	Undefined	None	Not Detected	
	GMA-U	22213	6	11	54.6	ND	0.0221	0.00703	0.00589	Lognormal	None	Not Detected	
	GMA-D	22214	10	20	50.0	ND	0.00705	0.00337	0.00185	Normal	Up	Not Detected	
	GMA-SW	22215	6	11	54.6	ND	0.0158	0.00668	0.00458	Normal	None	Not Detected	
	GMA-SE	22217	6	11	54.6	ND	0.0184	0.00698	0.00536	Normal	None	Not Detected	

Note: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note: For results where the concentrations are below the detection limit, the results used in the Average, Standard Deviation, Distribution Type, Trend, Serial Correlation, and Outliers are each set at half the detection limit.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption and requires n ≥ 3. In addition, Standard Deviation requires n ≥ 4.

[d]"Insuff" = Insufficient and is used for Average, Standard Deviation, Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic (where 3 ≤ n ≤ 50) or Shapiro Francia (where n > 50).

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure. Trend testing requires a sample with n ≥ 4.

[g]Serial correlation based on Rank Von Neumann test. Serial Correlation testing requires a sample with n ≥ 6.

[h]Outliers determined by Rosner's (where n > 25) or Dixon procedure (where 4 ≤ n ≤ 25).

[i]Q = quarterly

Table A.5.8−2. Cell 8 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	8	2	25.0	Yes	0.03	0.0451	0.0376	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Cadmium (mg/L)	8	1	12.5	Yes	0.000127	-	-	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	8	3	37.5	Yes	0.0016	0.0269	0.0107	0.022 mg/L[g](1)	0.021 mg/L(1)	0.0046 mg/L(1)	0.818 mg/L(0)
Thallium (mg/L)	8	1	12.5	No	0.00057	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	8	1	12.5	No	0.016	-	-	0.038 mg/L(0)	0.012 mg/L(1)	0.005 mg/L(1)	0.299 mg/L(0)
Radionuclides											
Technetium-99	22	15	68.2	Yes	8.39	101	40.4	94 pCi/L(1)	22 pCi/L(9)	30 pCi/L(8)	6,130 pCi/L(0)
Organics											
1,1-Dichloroethene	19	3	15.8	Yes	0.86	2.11	1.65	7 ug/L(0)	-	-	-
Acetone	8	1	12.5	No	2.31	-	-	-	-	-	-
Aroclor - 1260	8	1	12.5	No	0.058	-	-	-	-	-	-
Tetrachloroethene	19	6	31.6	Yes	0.38	1.24	0.784	-	-	-	-
Trichloroethene	19	3	15.8	No	0.246	1.11	0.587	5 ug/L(0)	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

Table A.5.8–3. Site-Specific Parameter Selection Results

Parameter	Dataset	Samples	Detects	Detect %	t-Test													Wilcoxon + Quantile		Tarone-Ware Test
					Shapiro-Wilk (N)	Shapiro-Wilk (LN)	Min	Max	Mean (mg/L)	Median	Variance	Std. Dev.	Log Mean	Log SD	F-Test	t-Test Prob		Wilcoxen Group Comparison	Quantile Test	
Ammonia	LCS	8	2	25%			0.0050	0.0451	0.0184	0.0150	0.000196	0.0140								
	PreDesign**	9	7	78%			0.015	450	54.98	0.604	22100	149								Pass
	* before 2/10/95																			
	** after 2/10/95																			
Chromium	LCS	8	3	38%			0.0010	0.0269	0.0061	0.0031	0.000075	0.0086								
	PreDesign	40	19	48%			0.002	0.478	0.046	0.004	0.008	0.087								Pass
	PreDesign*	19	17	89%			0.004	0.478	0.093	0.051	0.012	0.110								Pass
	PreDesign**	21	2	10%			0.002	0.012	0.004	0.004	0.000	0.002								Pass
	* before 2/10/95																			
	** after 2/10/95																			

No significant difference (Pass)
LCS significantly GREATER than PreDesign (Fail)

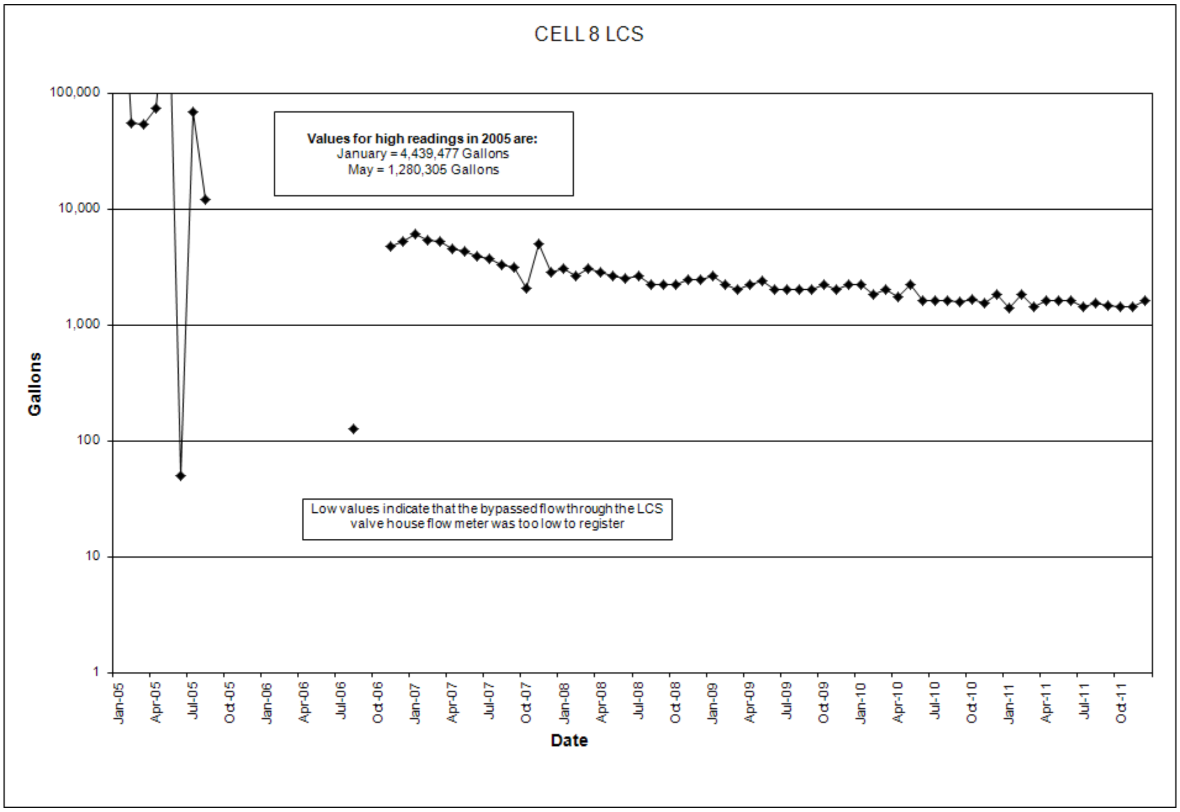


Figure A.5.8–1. Monthly Accumulation Volumes for Cell 8 LCS

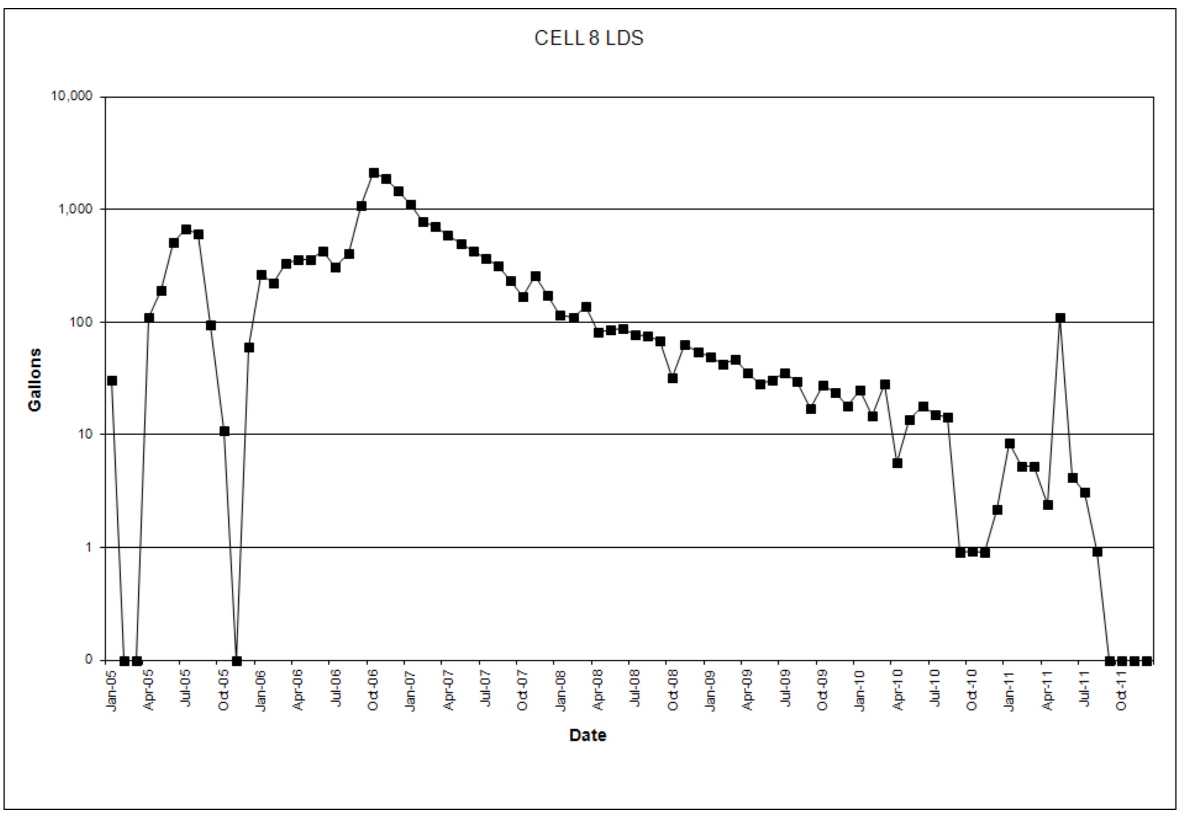
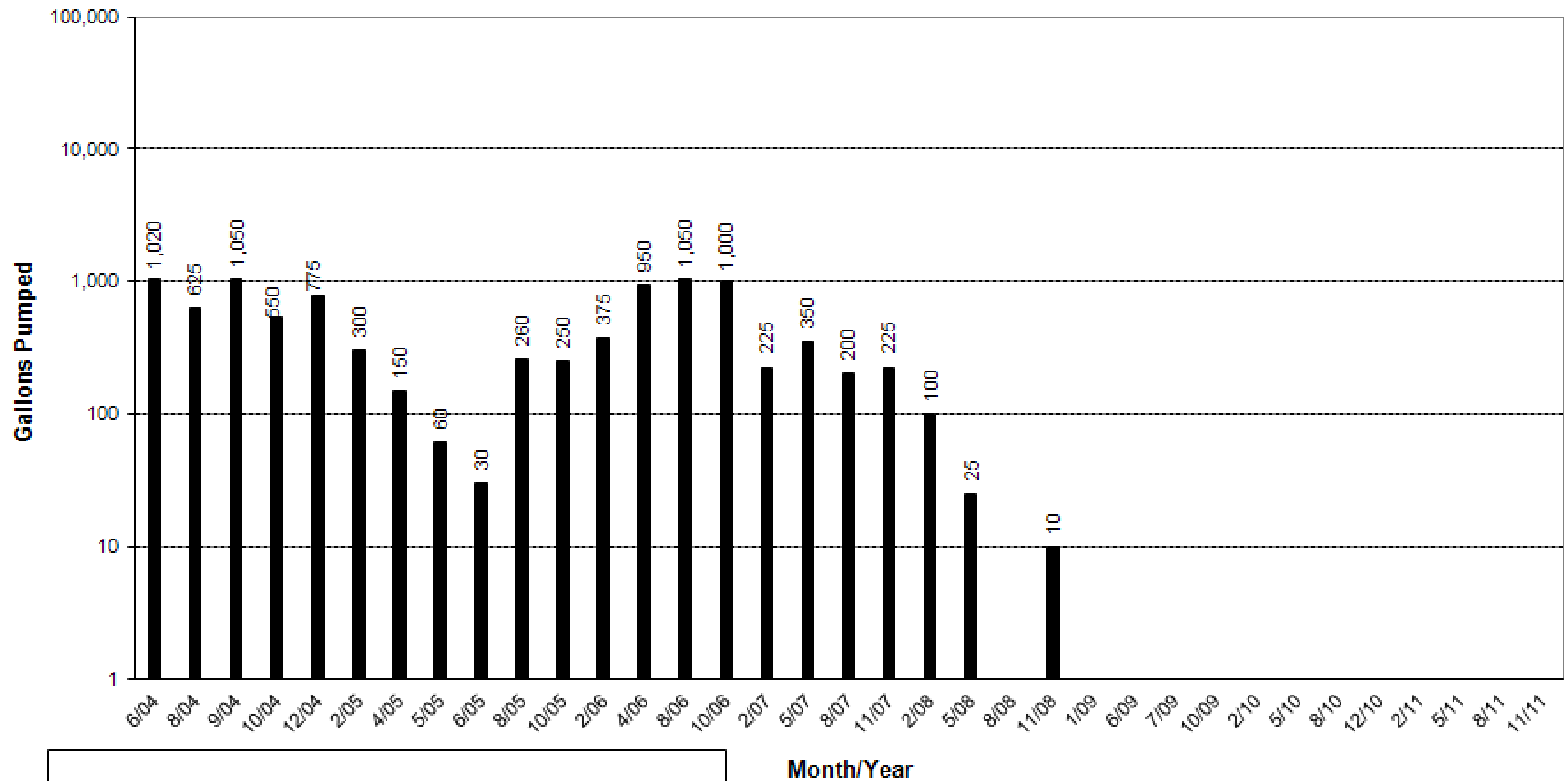


Figure A.5.8–2. Monthly Accumulation Volumes for Cell 8 LDS



12345 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2004:	4020	n=5	804
2005:	1050	n=6	175
2006:	3375	n=4	844
2007:	1000	n=4	250
2008:	135	n=4	34
2009:	0	n=3	0
2010:	0	n=4	0
2011:	0	n=4	0
Overall:			282

Figure A.5.8–3. OSDF Horizontal Till Well 12343 (Cell 8) Water Yield

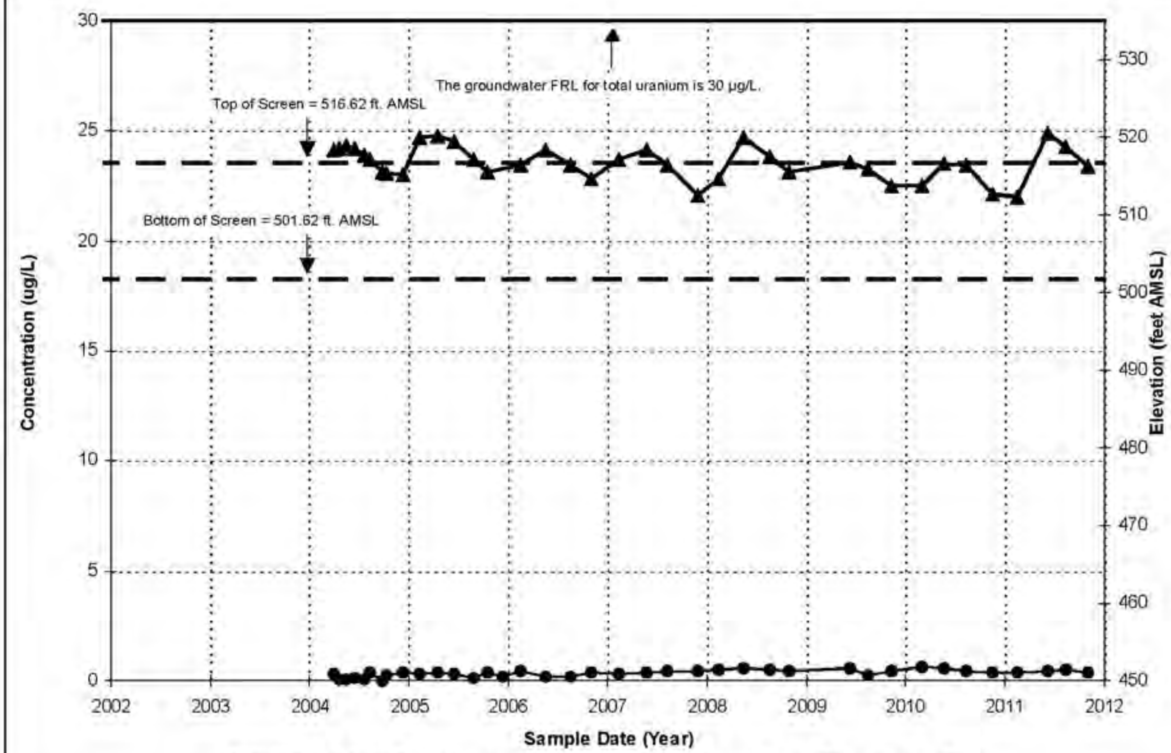


FIGURE A.5.8-4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Upgradient Monitoring Well 22213

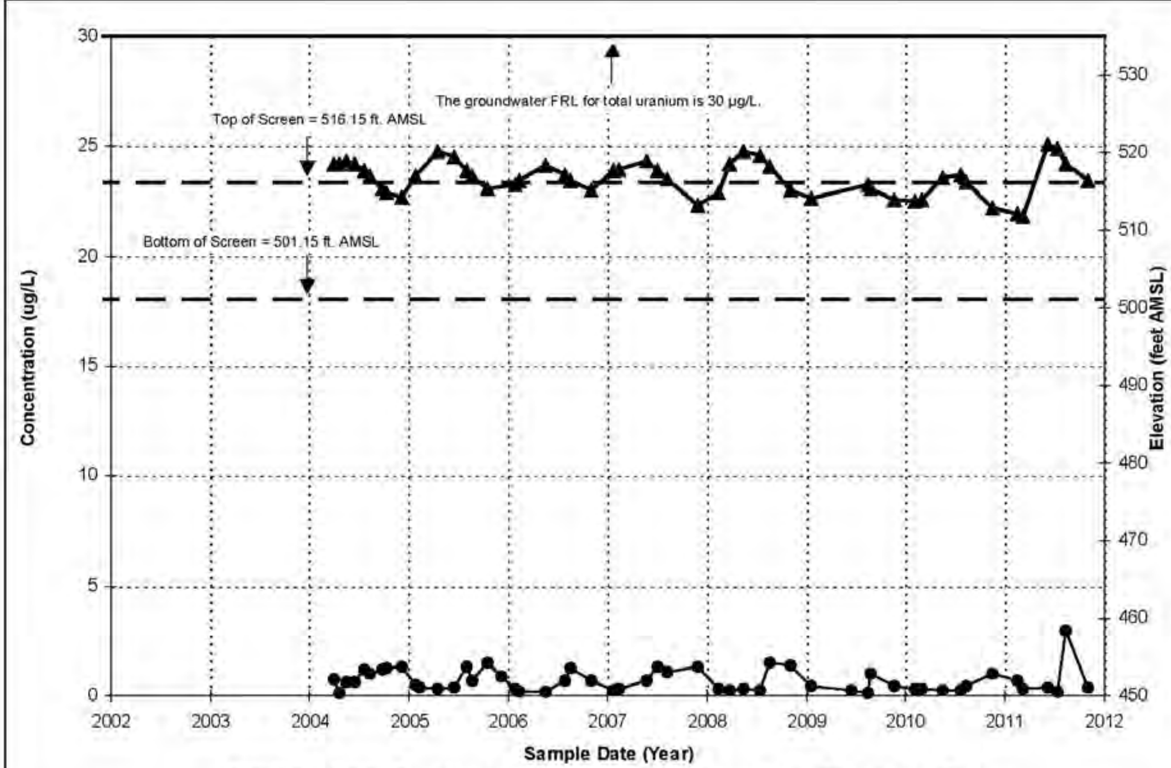


FIGURE A.5.8-5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22214

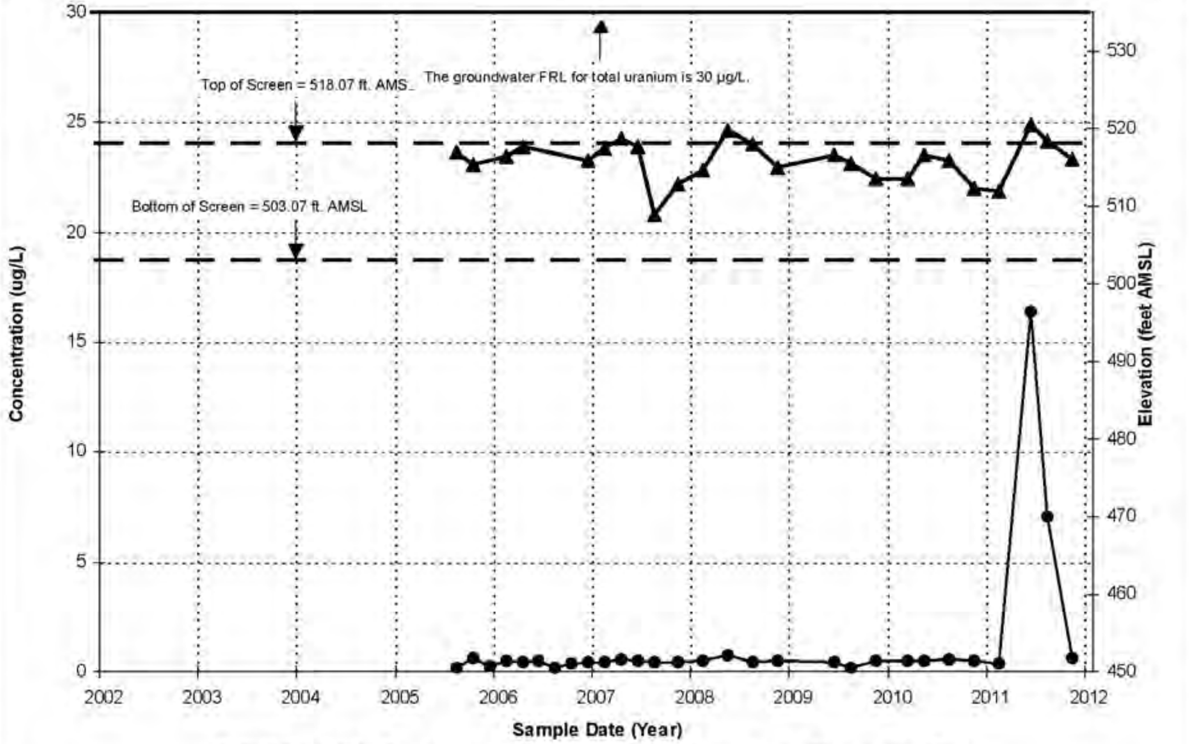


FIGURE A.5.8-6. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22215

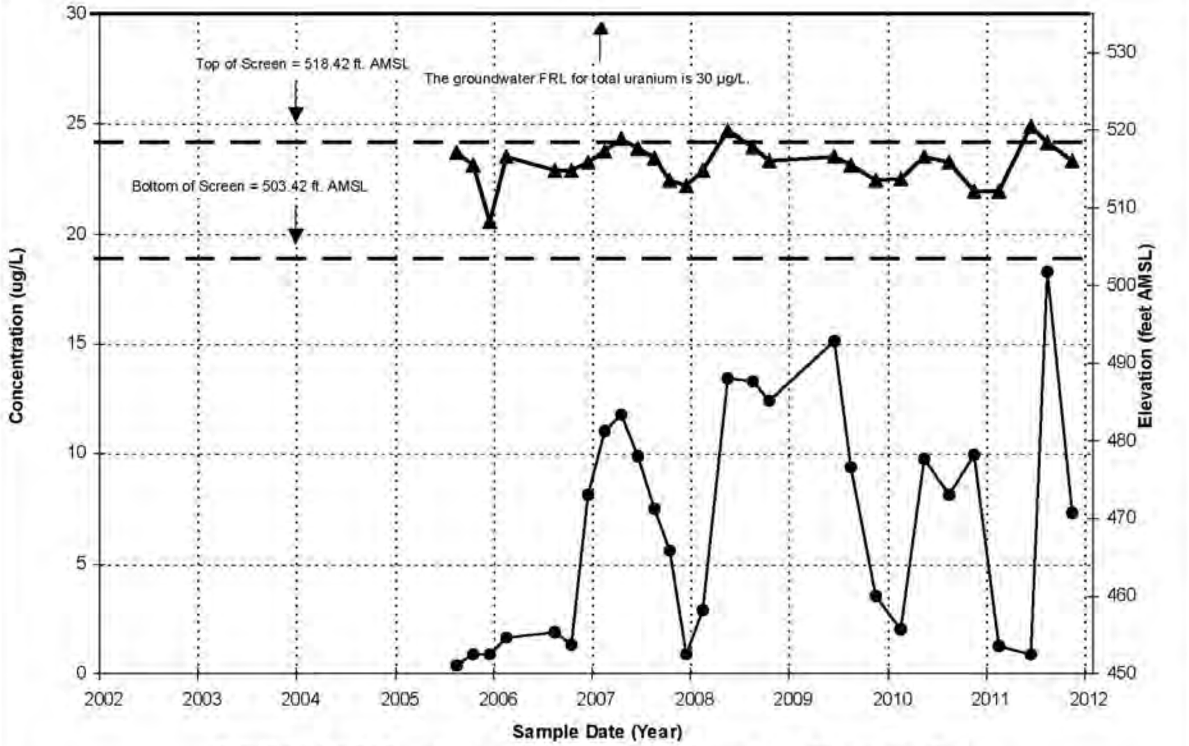


FIGURE A.5.8-7. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22216/22217

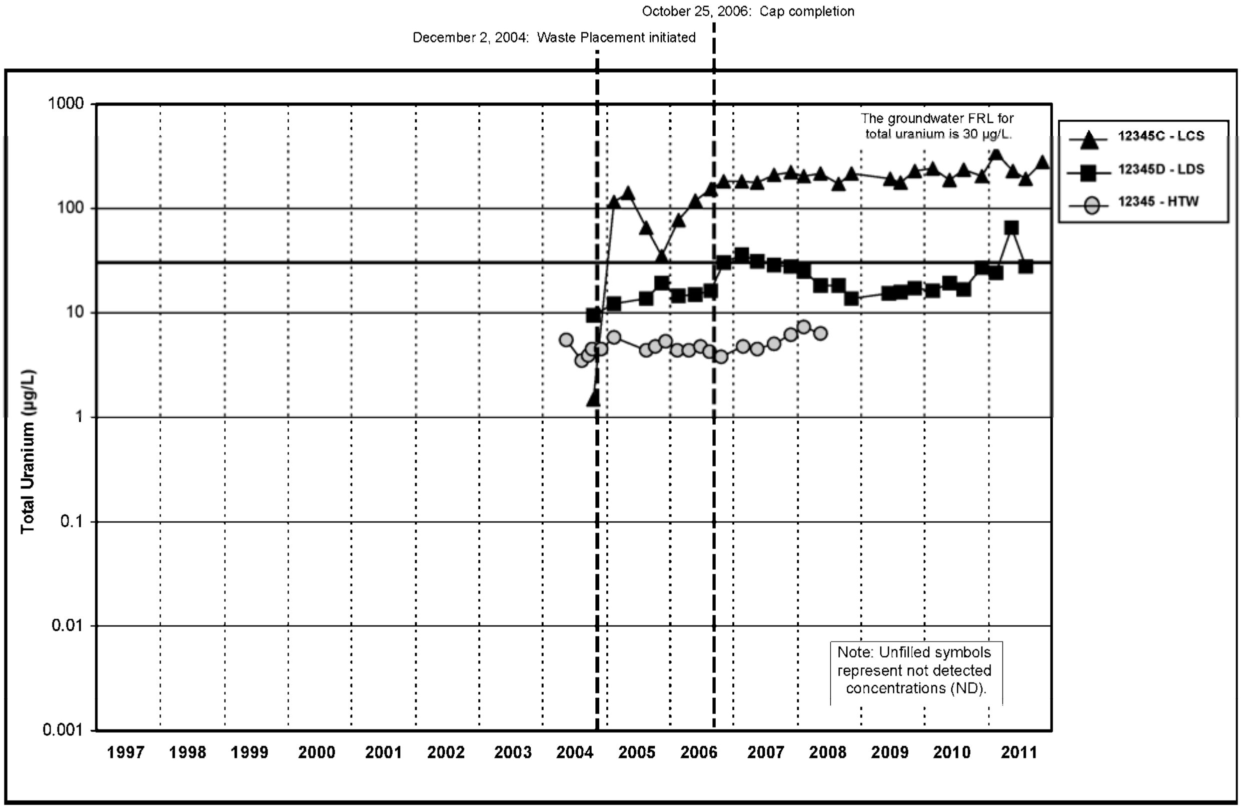


Figure A.5.8-8A. Cell 8 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

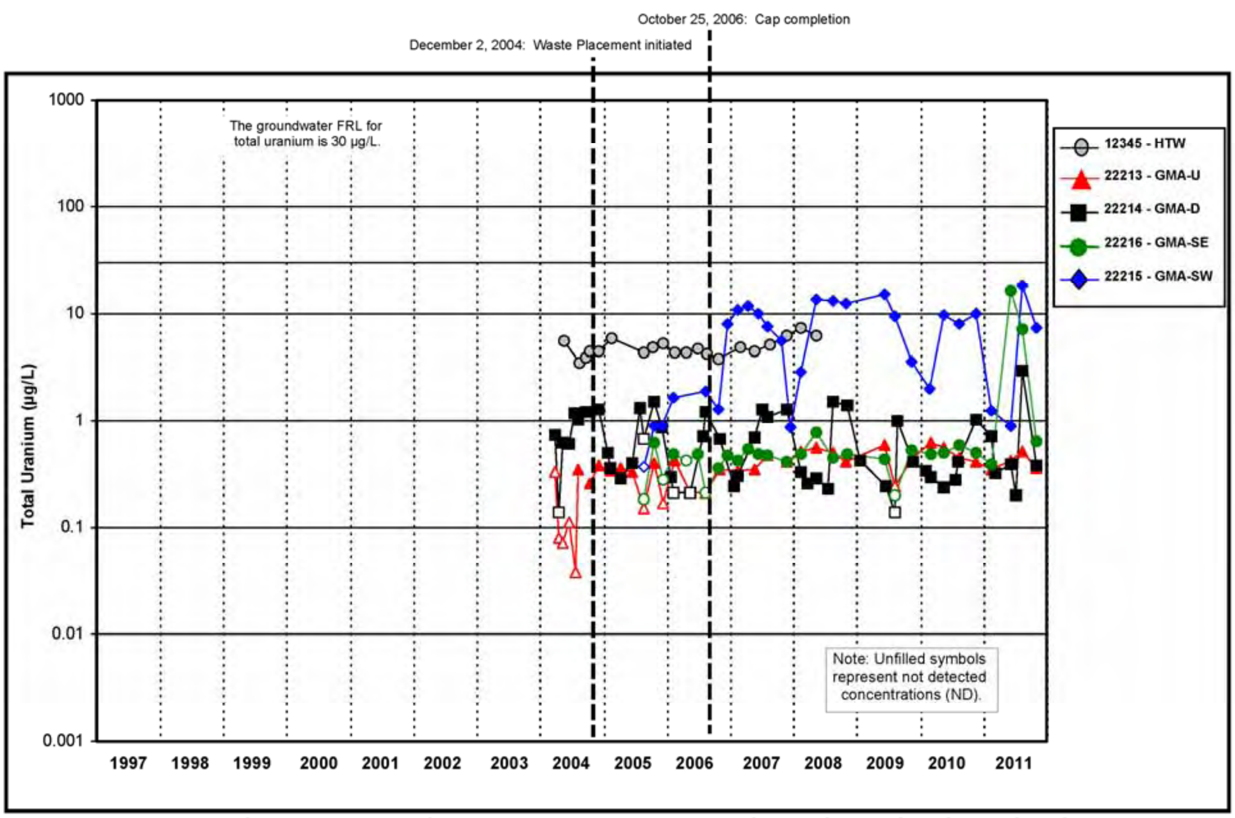


Figure A.5.8-8B. Cell 8 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

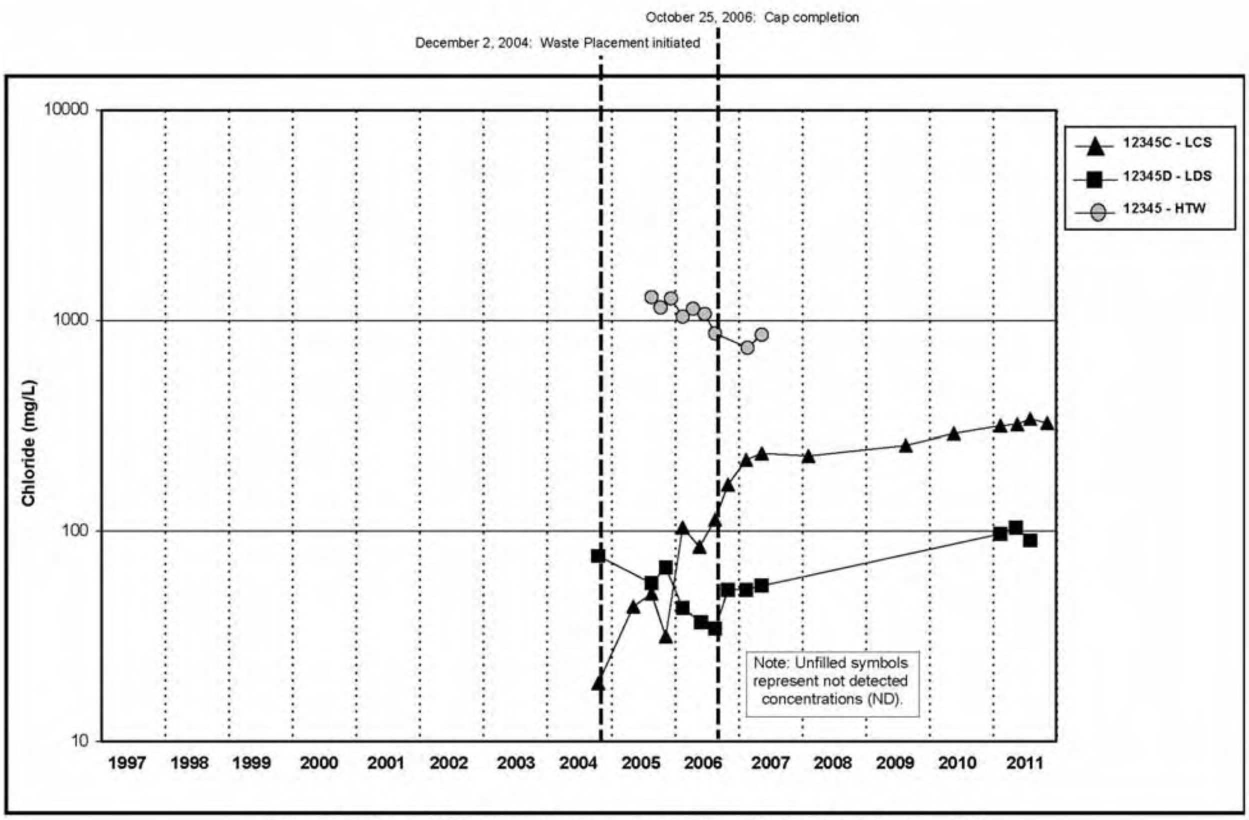


Figure A.5.8-9A. Cell 8 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

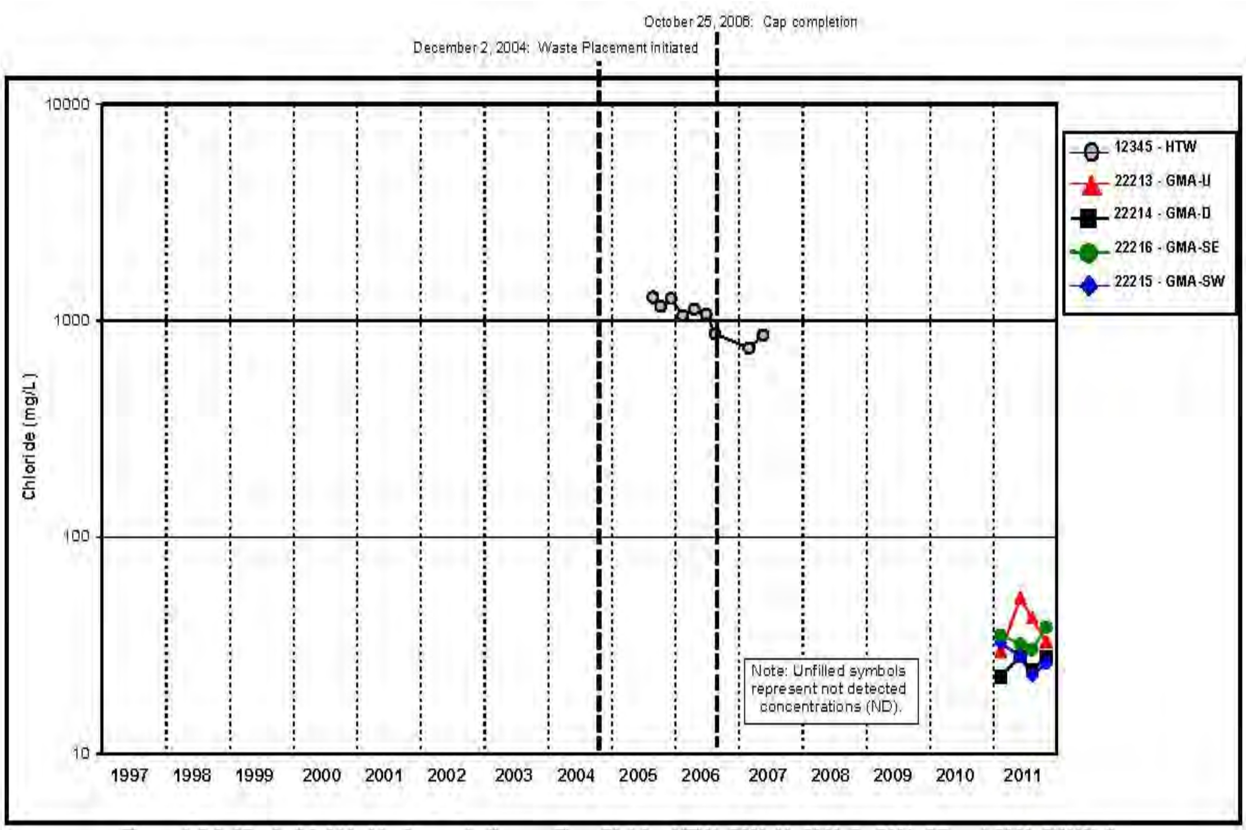


Figure A.5.8-9B. Cell 8 Chloride Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

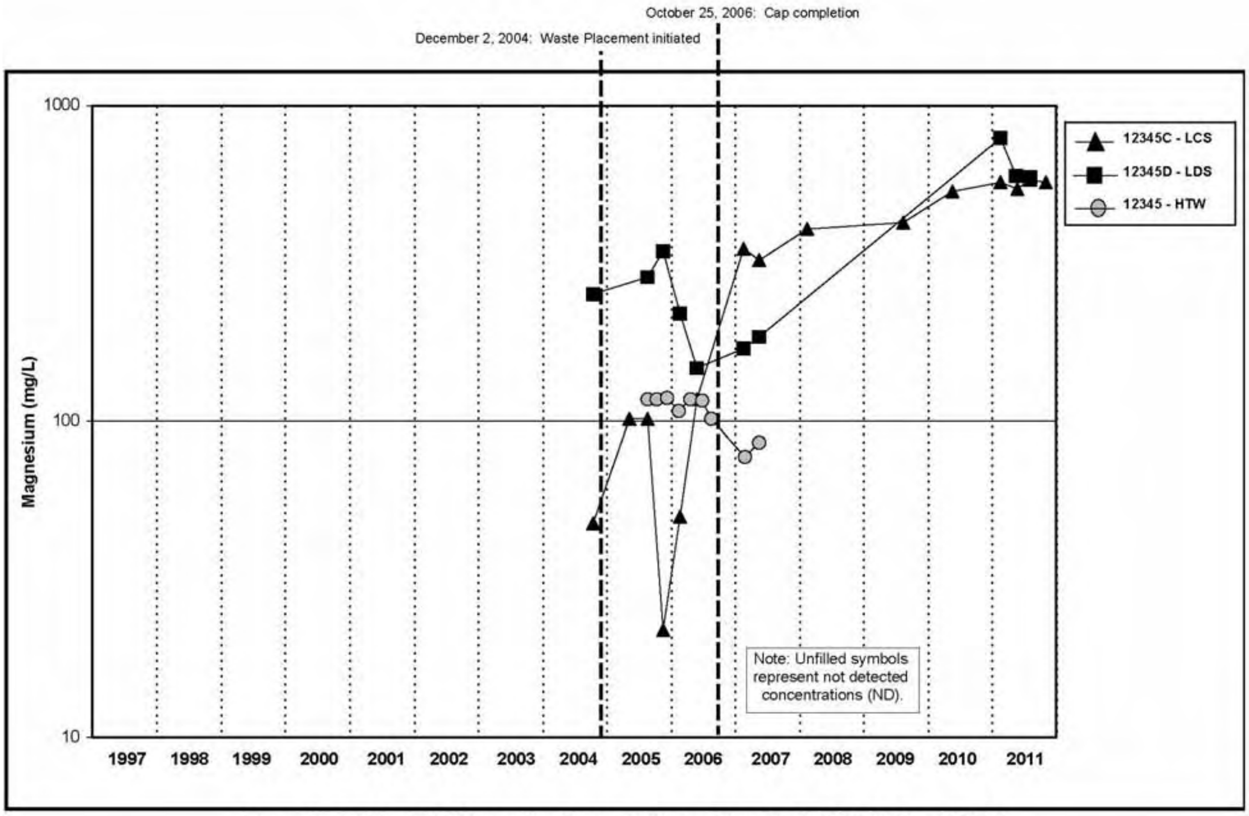


Figure A.5.8-10A. Cell 8 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

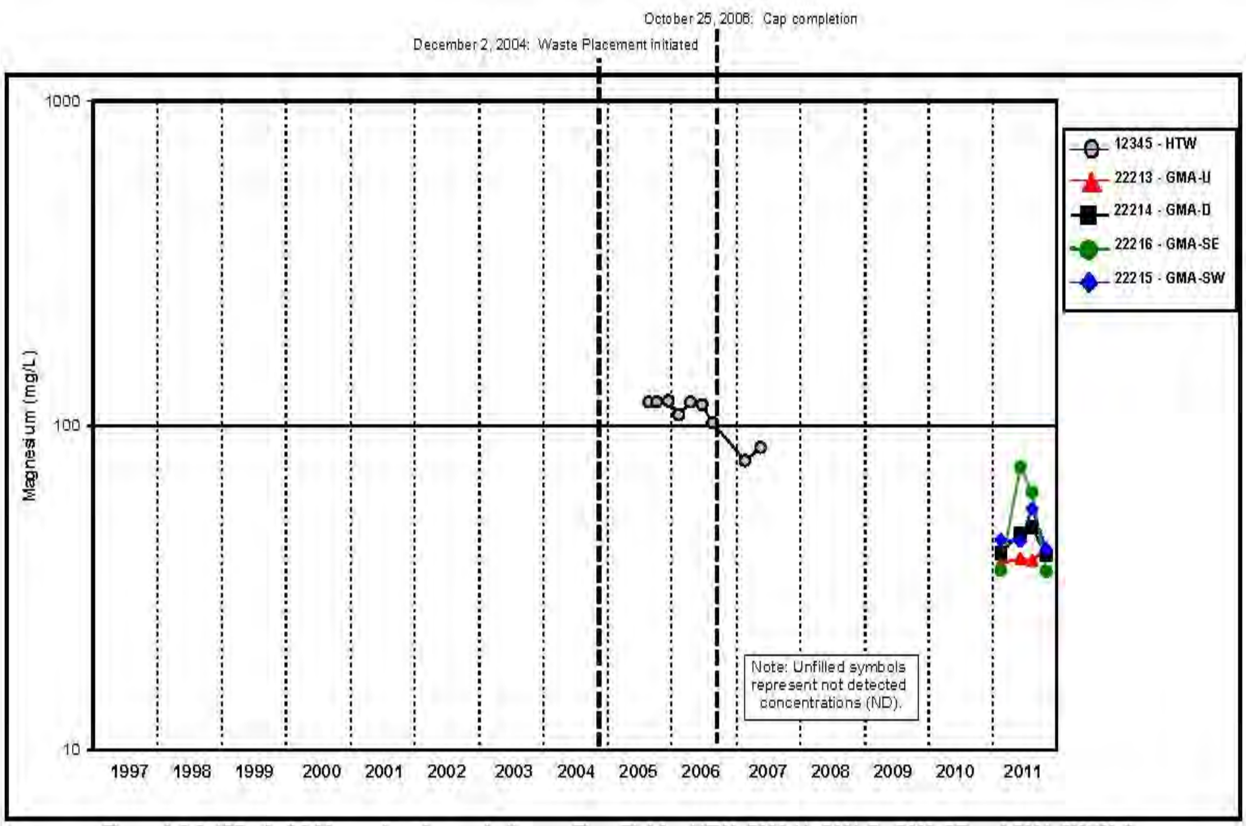


Figure A.5.8-10B. Cell 8 Magnesium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

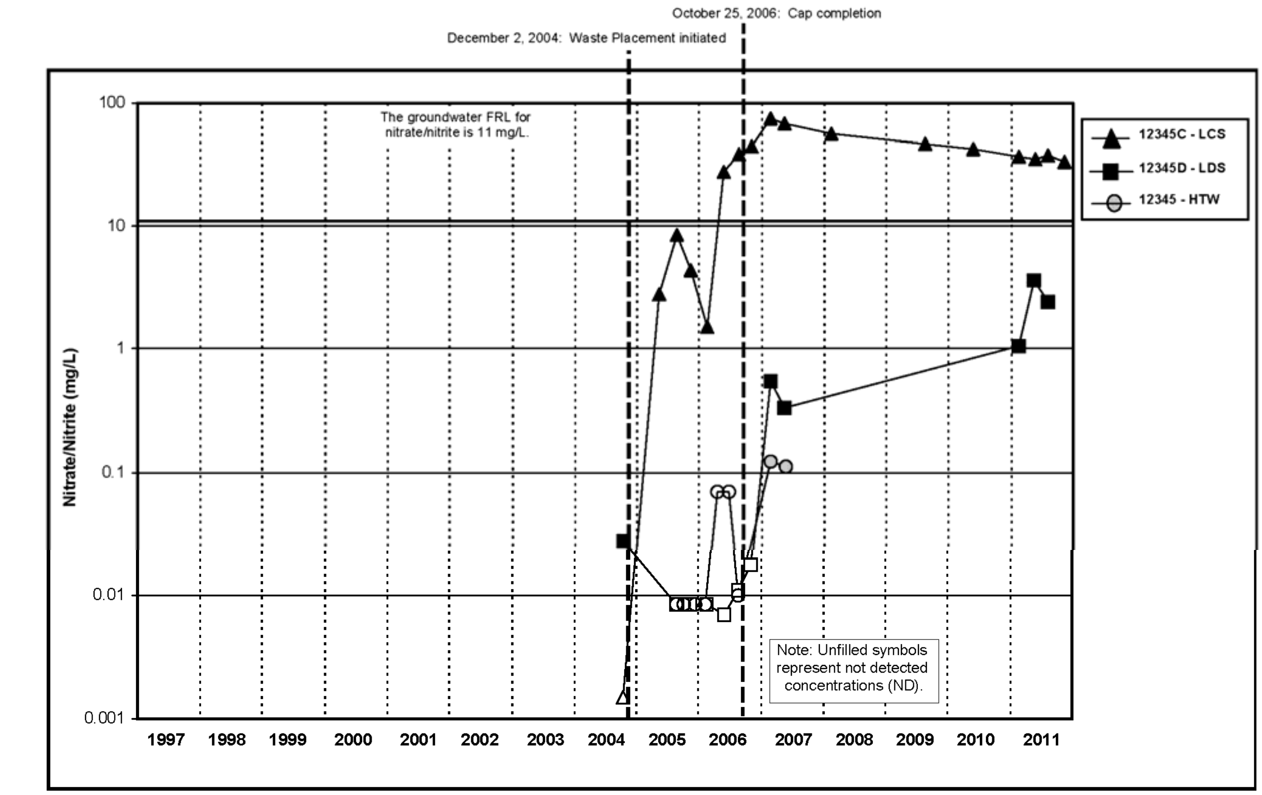


Figure A.5.8-11A. Cell 8 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

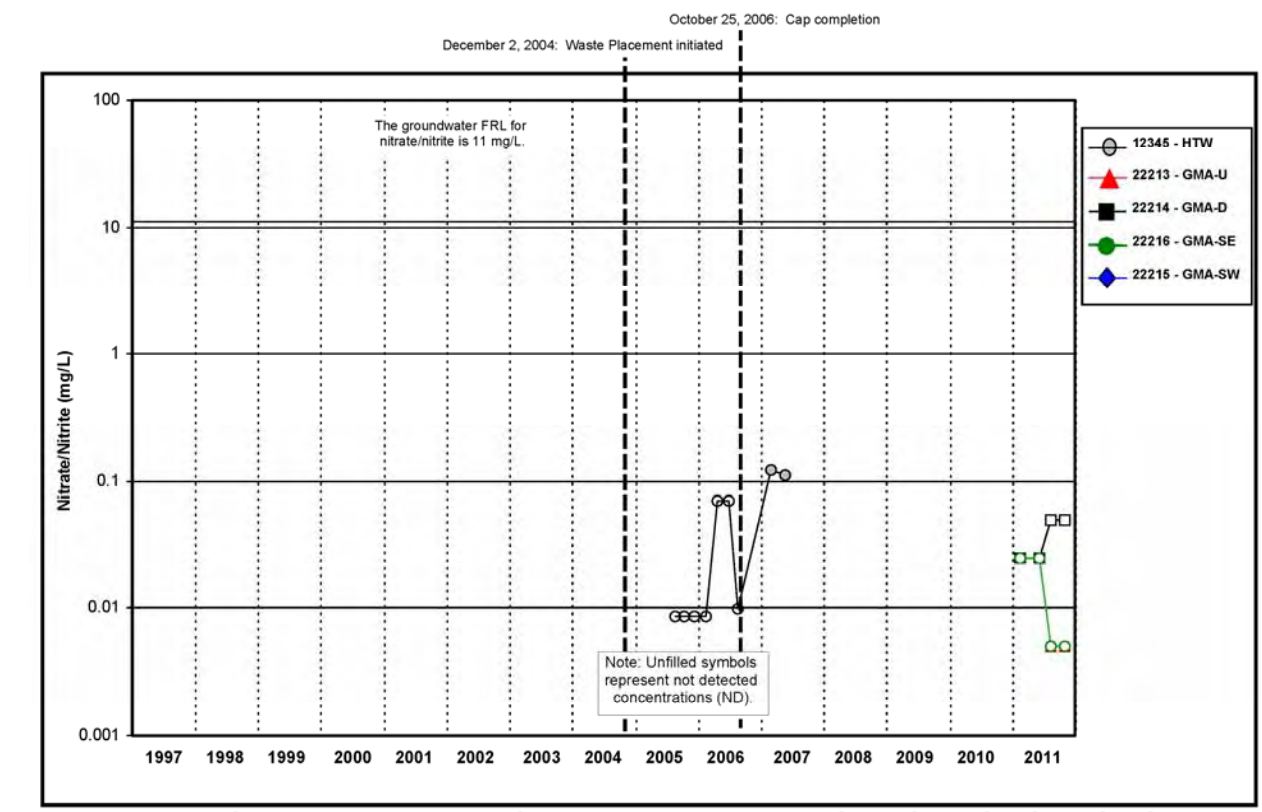


Figure A.5.8-11B. Cell 8 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

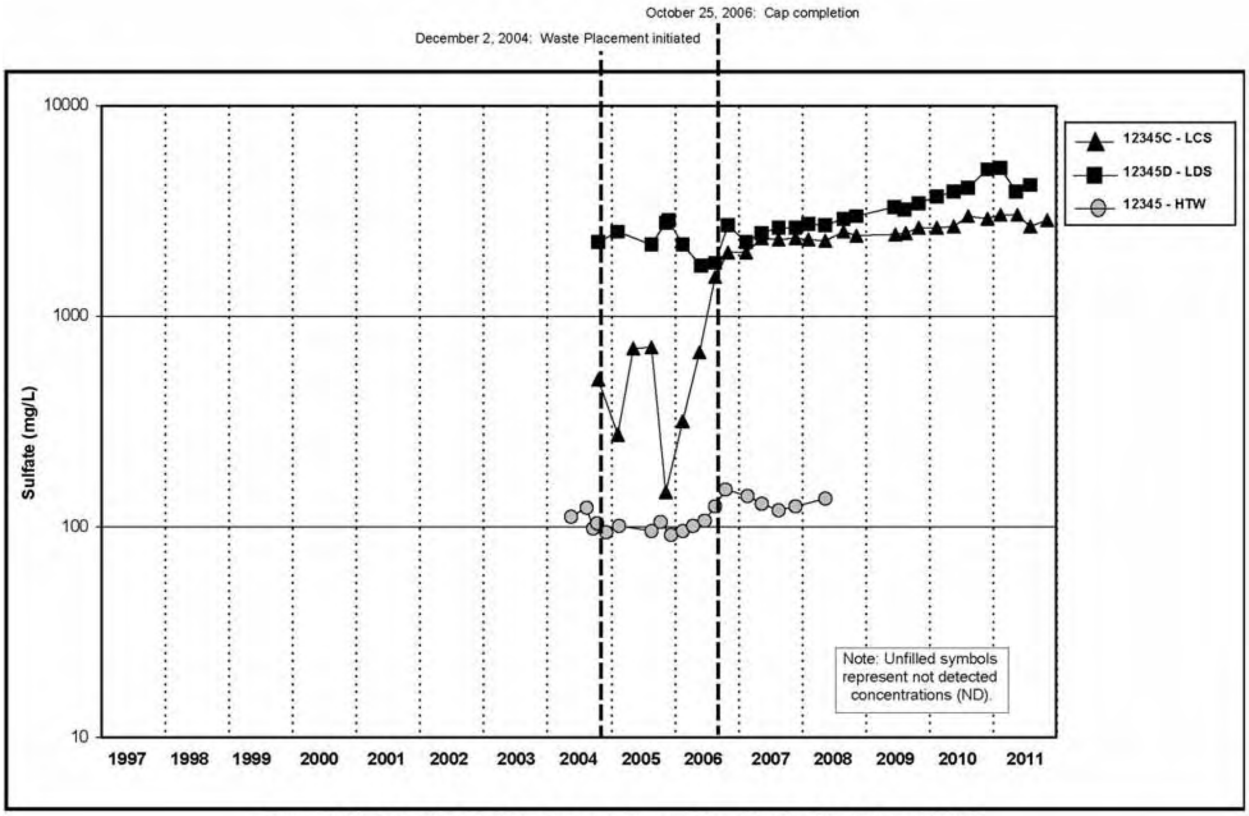


Figure A.5.8-12A. Cell 8 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

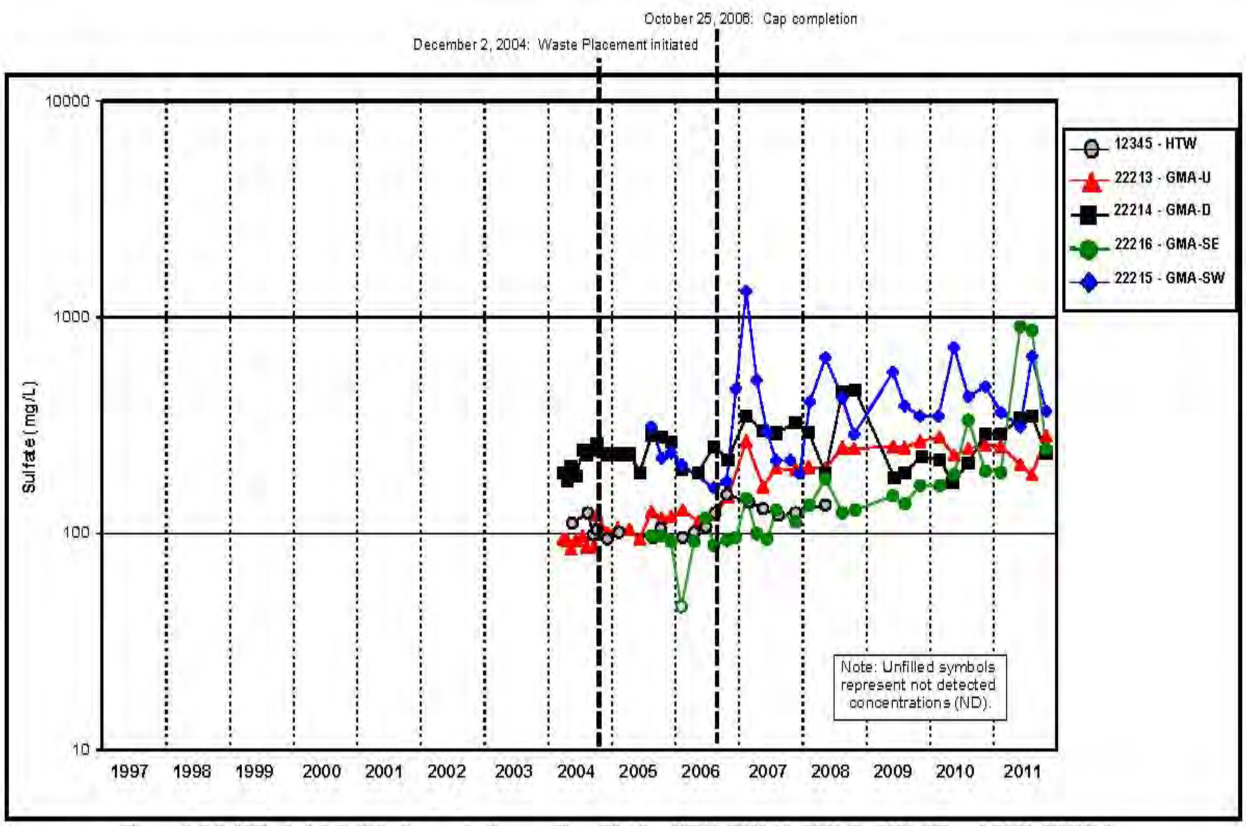


Figure A.5.8-12B. Cell 8 Sulfate Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

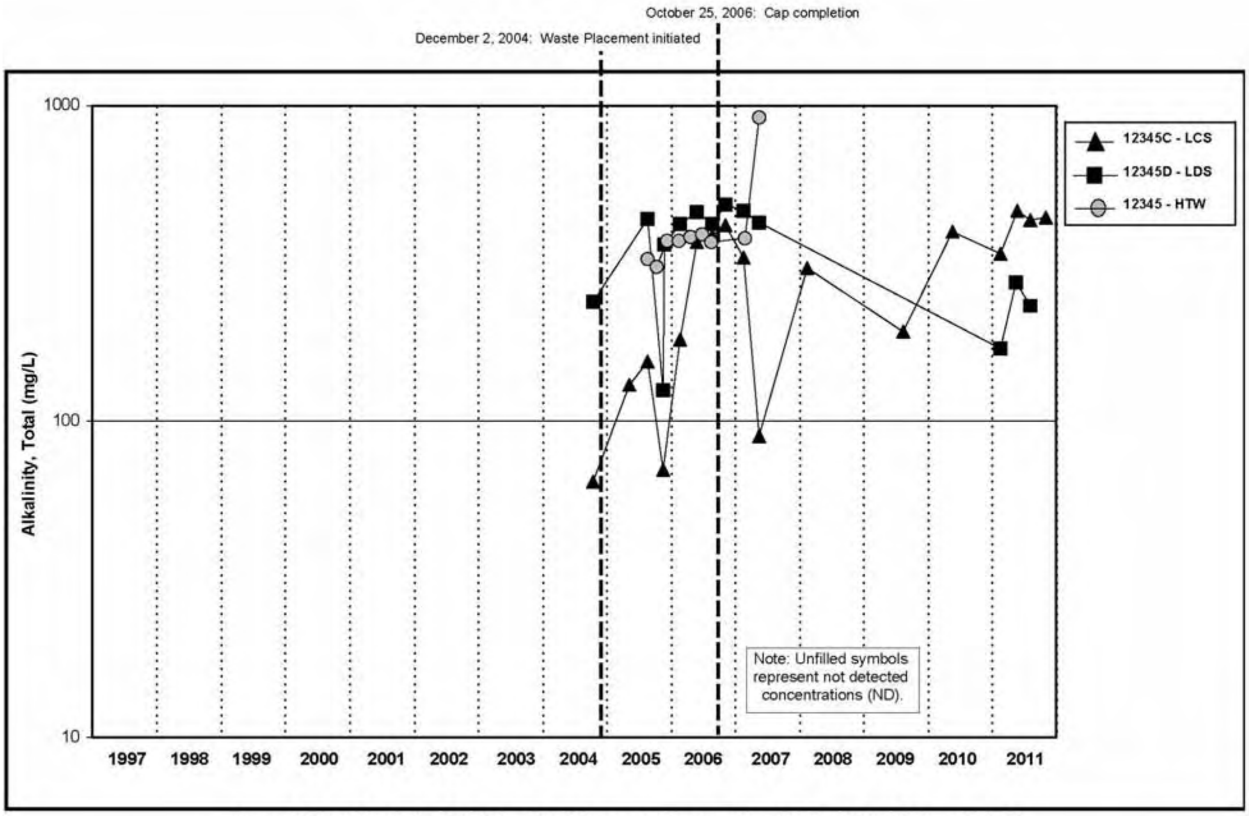


Figure A.5.8-13A. Cell 8 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

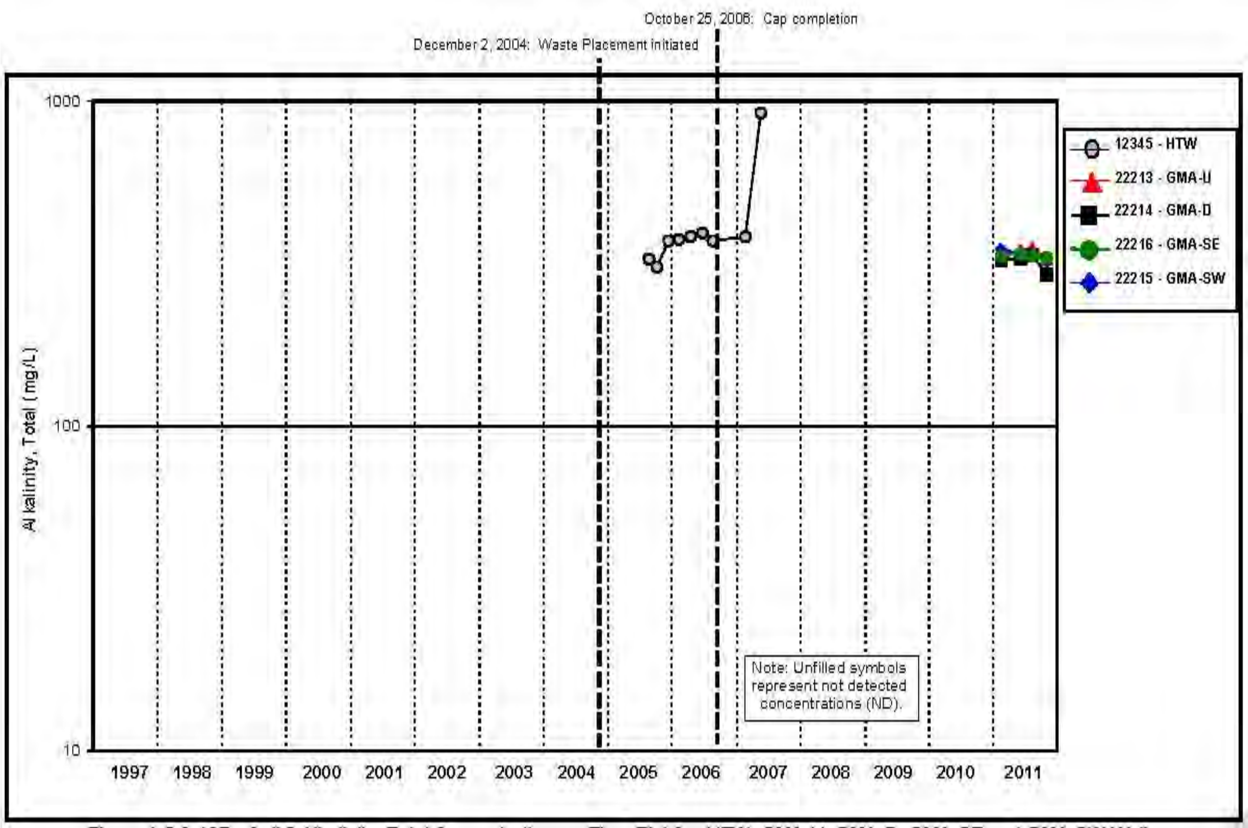


Figure A.5.8-13B. Cell 8 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

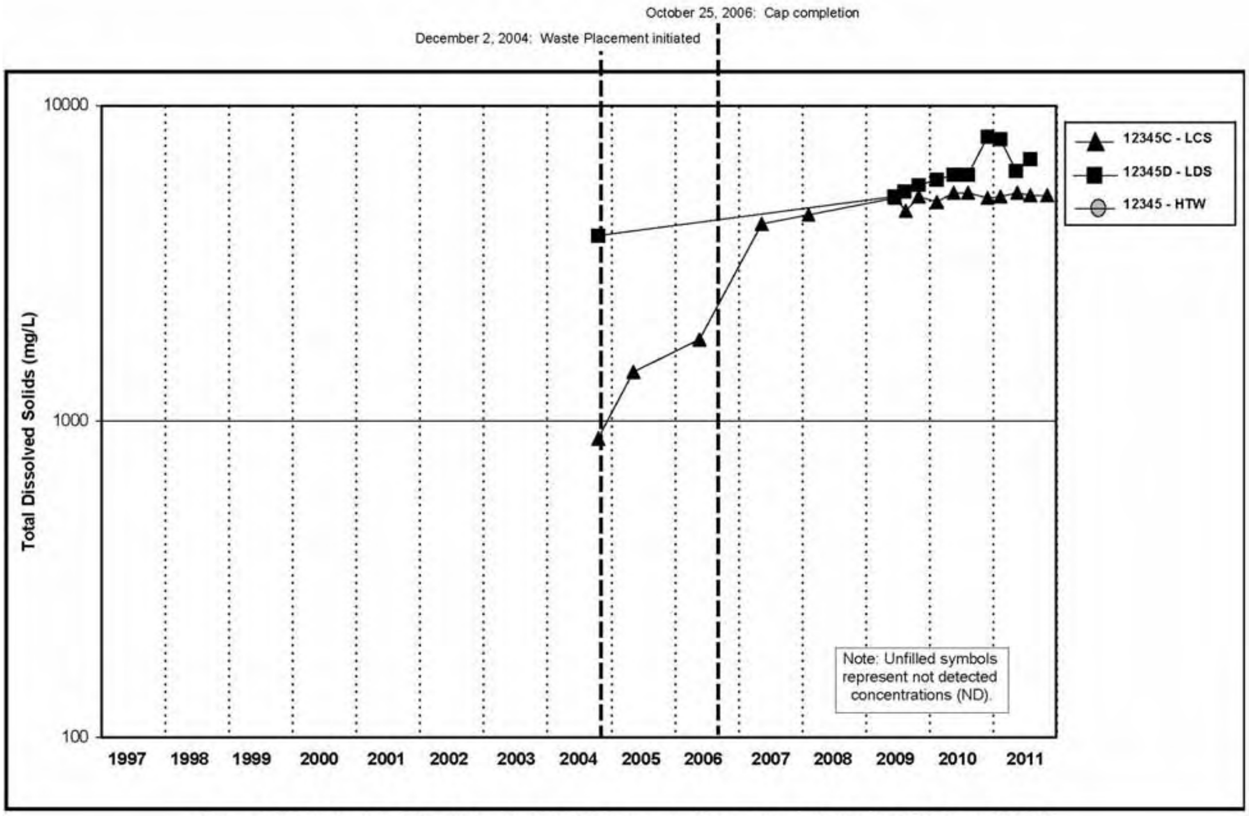


Figure A.5.8-14A. Cell 8 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

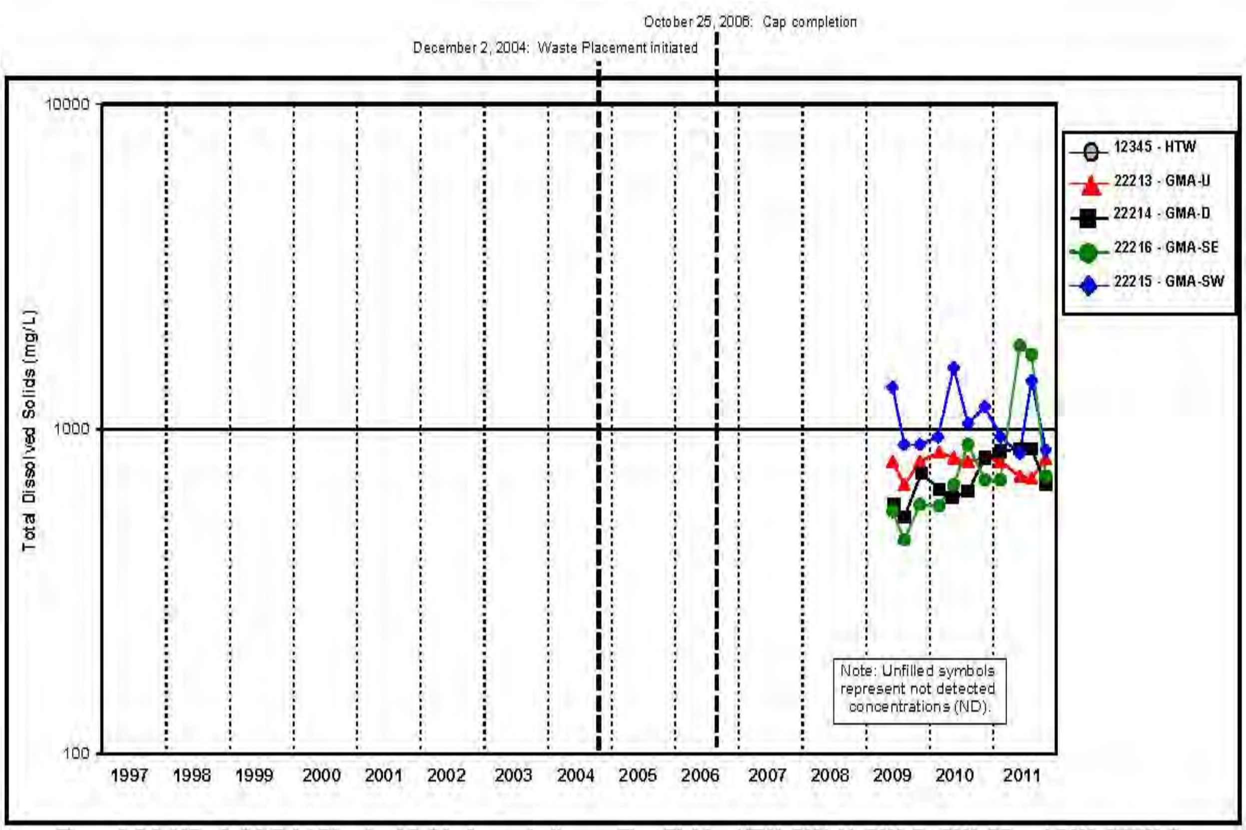


Figure A.5.8-14B. Cell 8 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

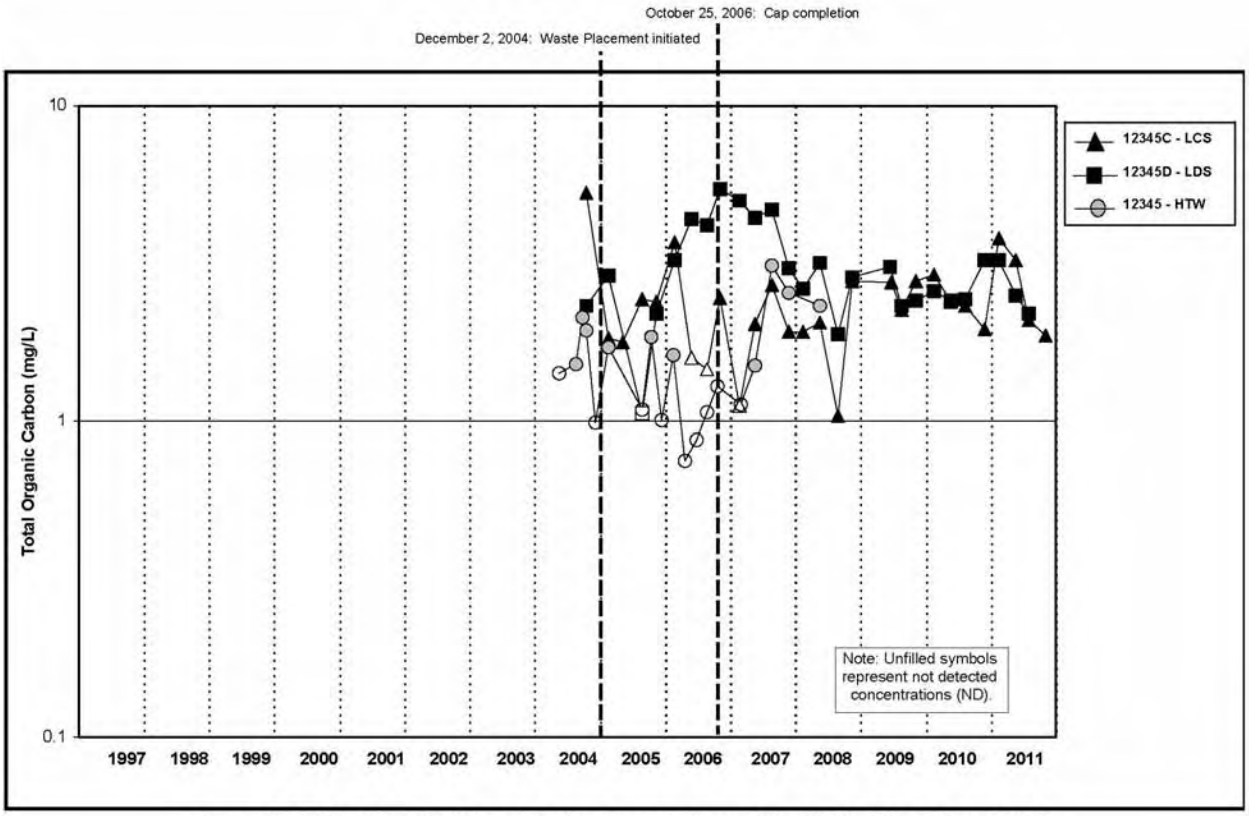


Figure A.5.8-15A. Cell 8 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

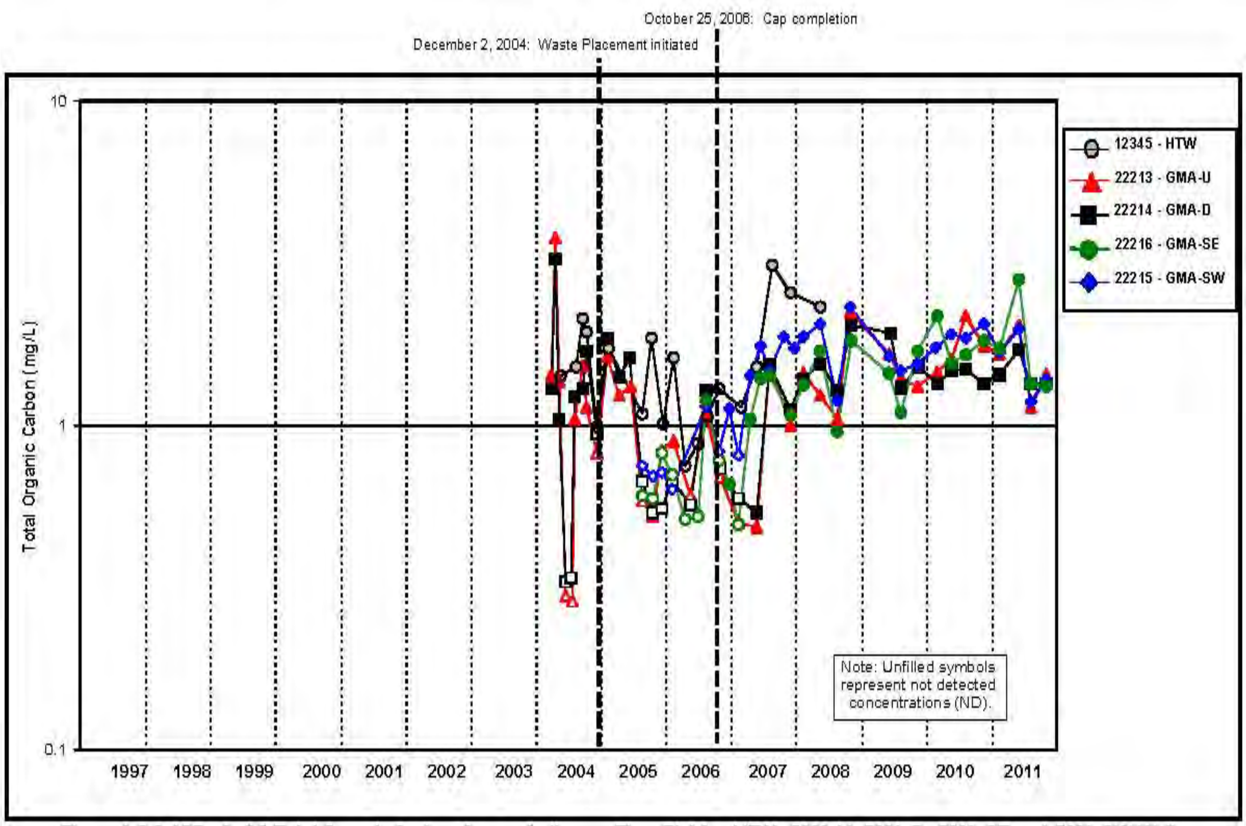


Figure A.5.8-15B. Cell 8 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

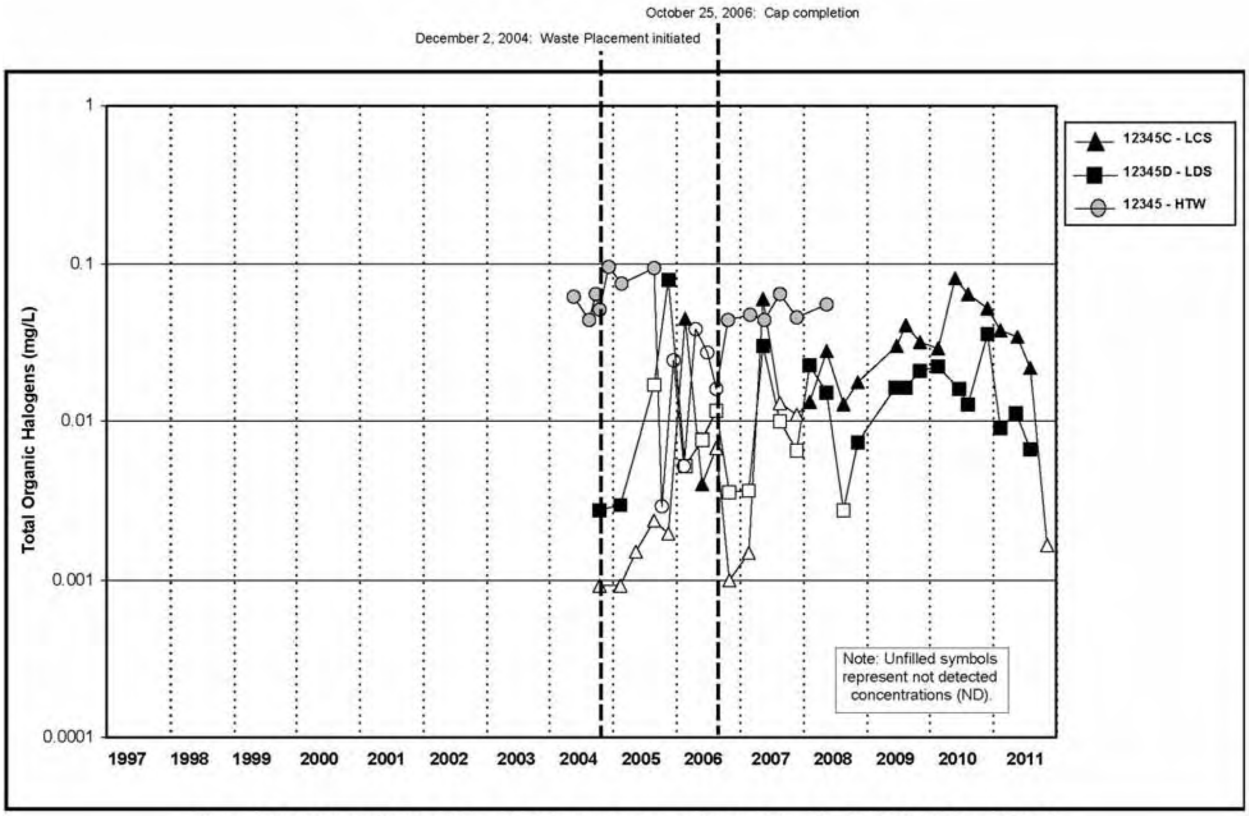


Figure A.5.8-16A. Cell 8 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

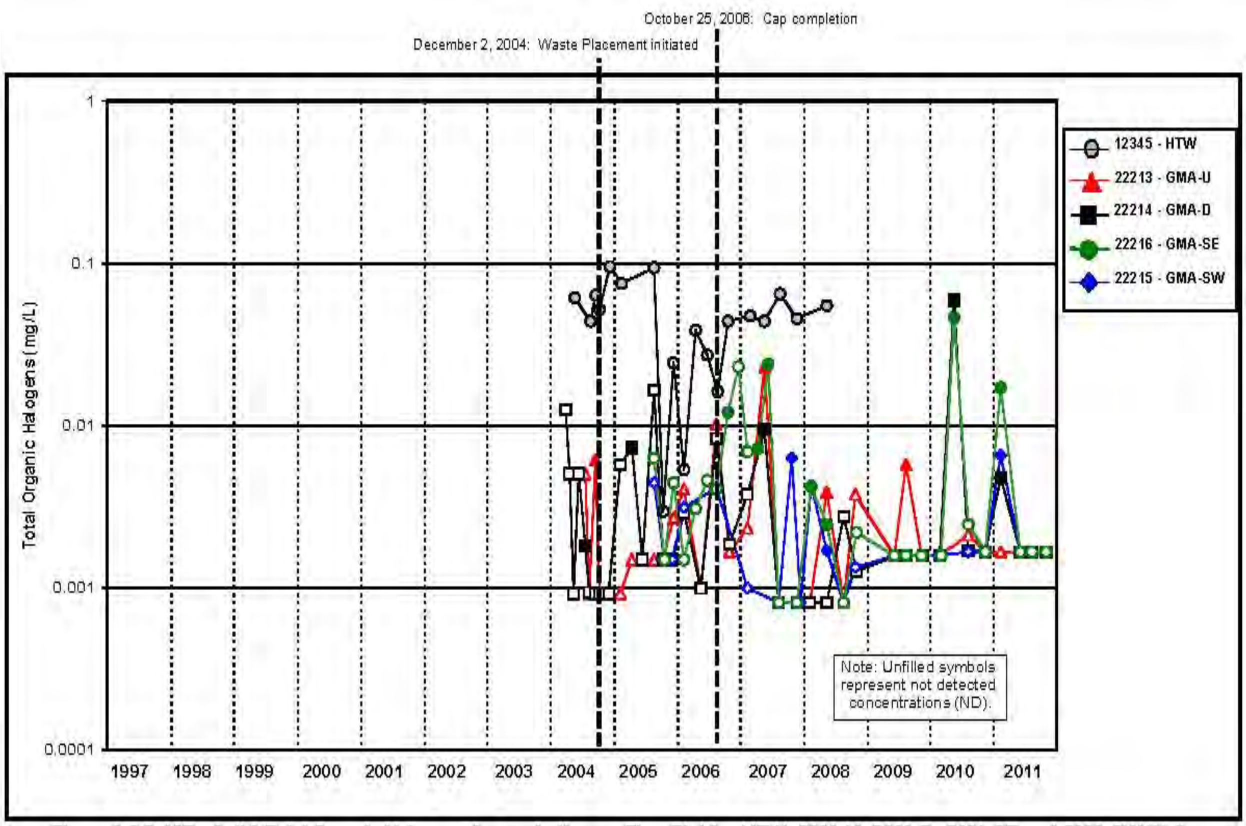


Figure A.5.8-16B. Cell 8 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

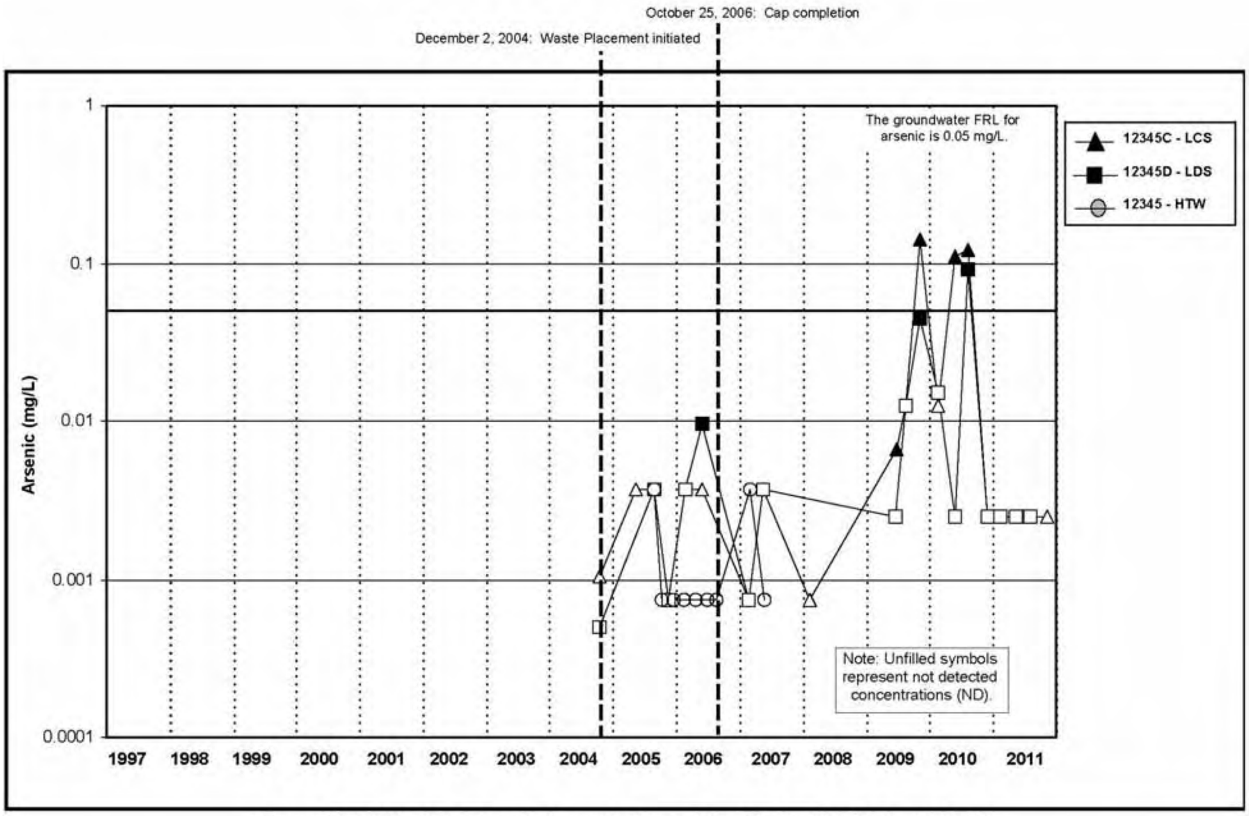


Figure A.5.8-17A. Cell 8 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

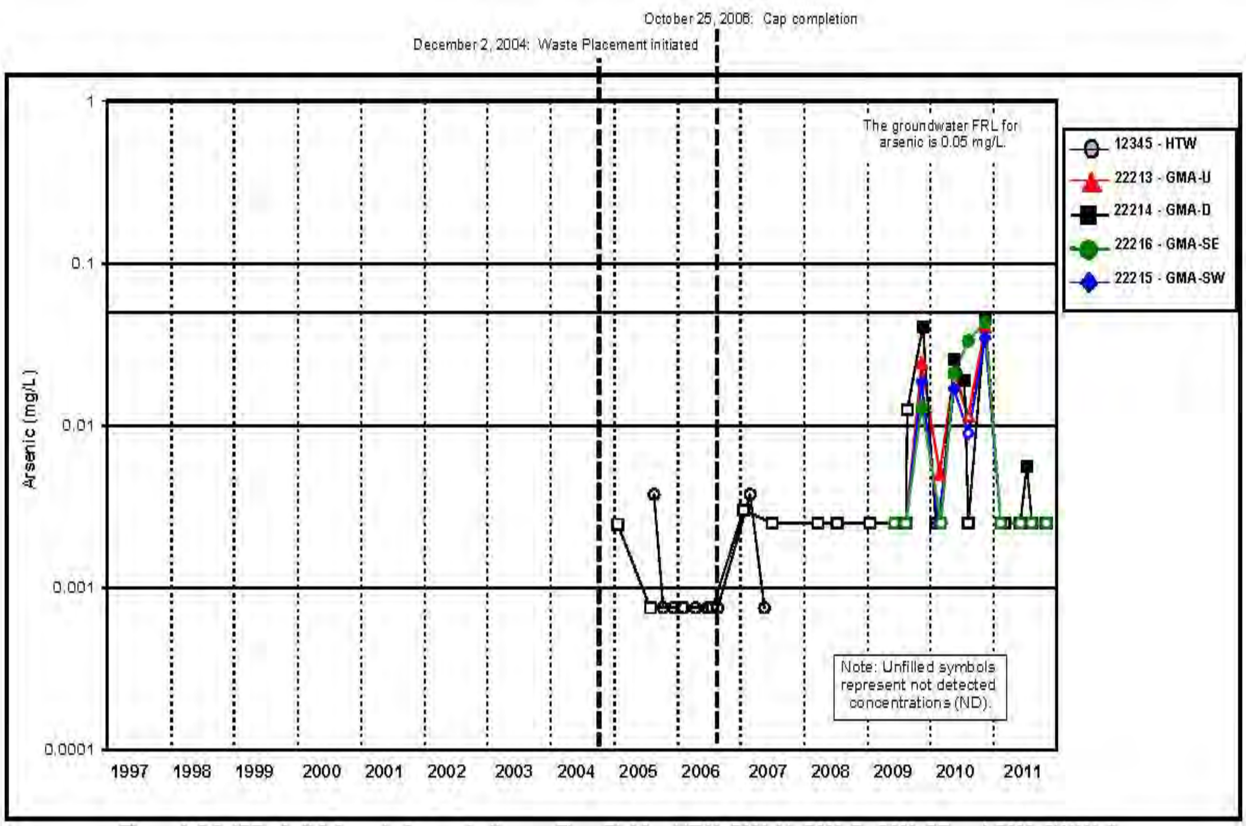


Figure A.5.8-17B. Cell 8 Arsenic Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

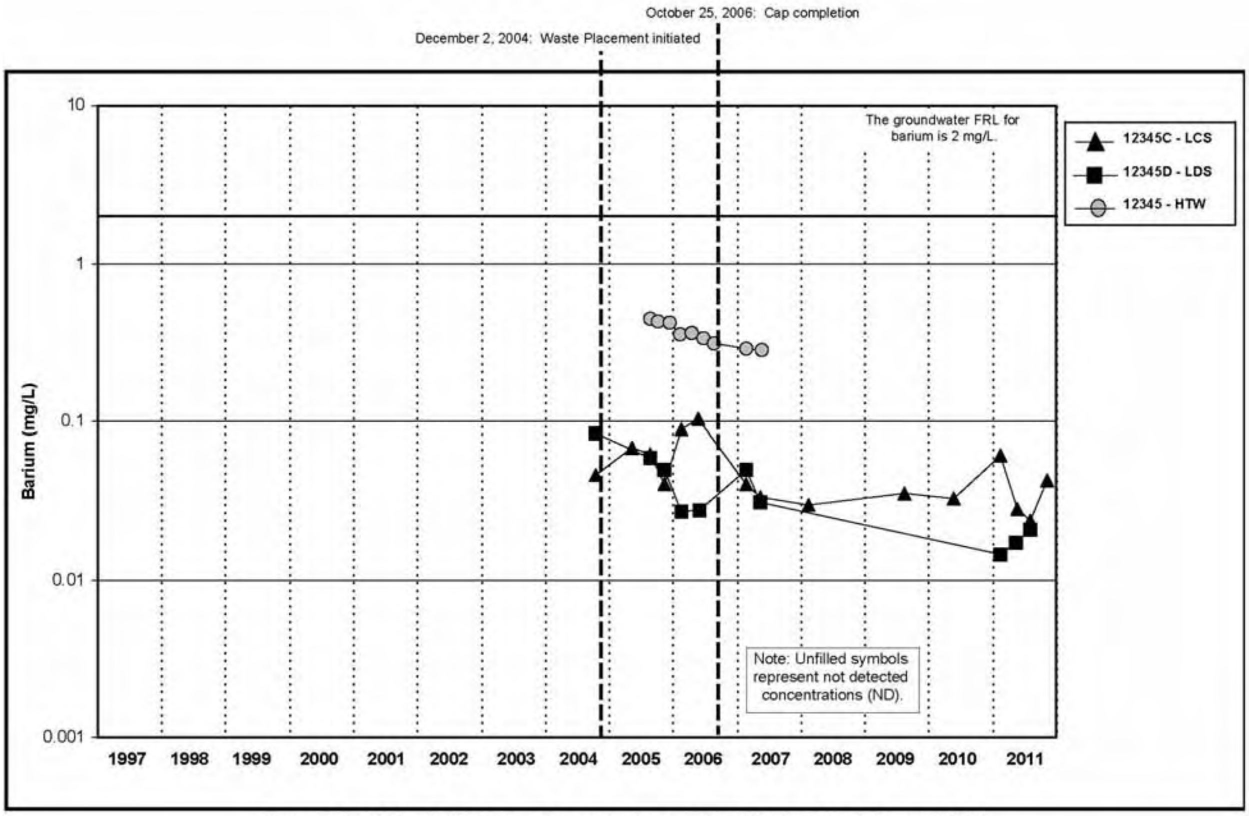


Figure A.5.8-18A. Cell 8 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

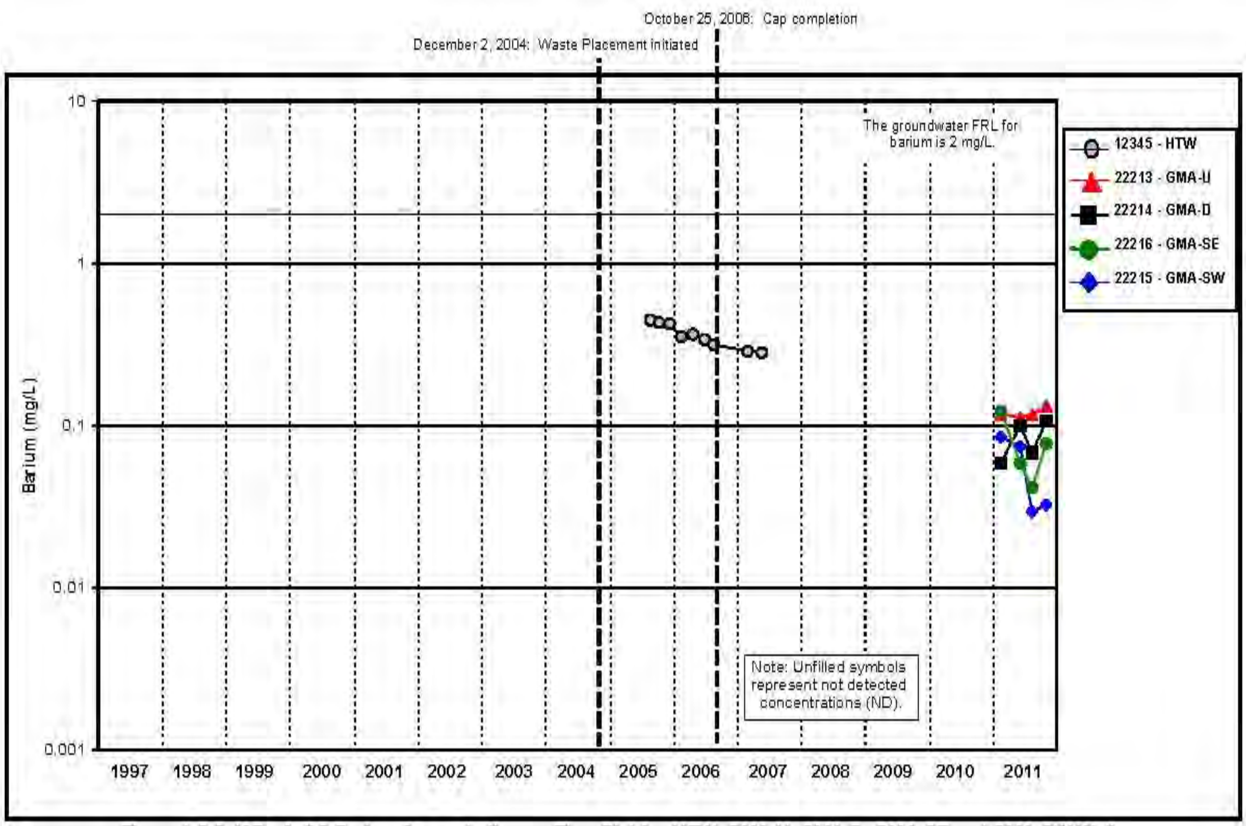


Figure A.5.8-18B. Cell 8 Barium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

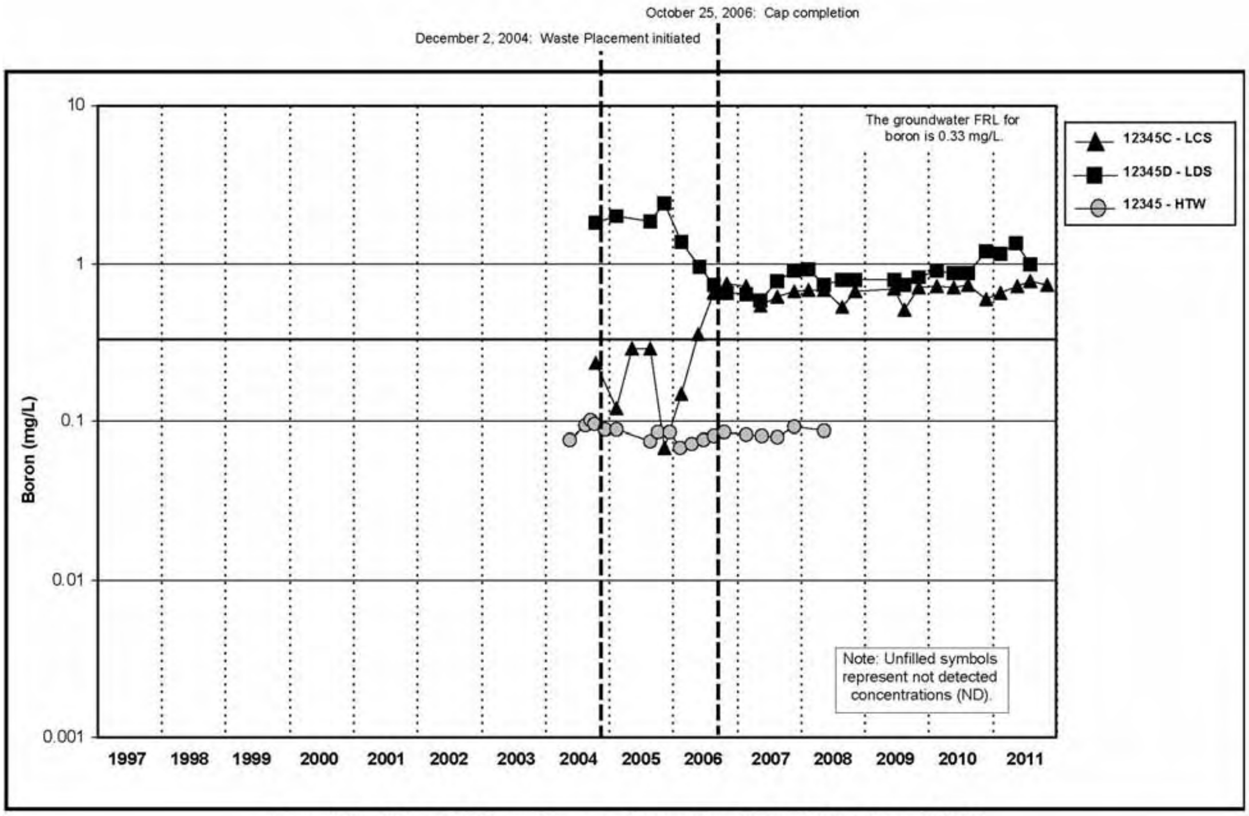


Figure A.5.8-19A. Cell 8 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

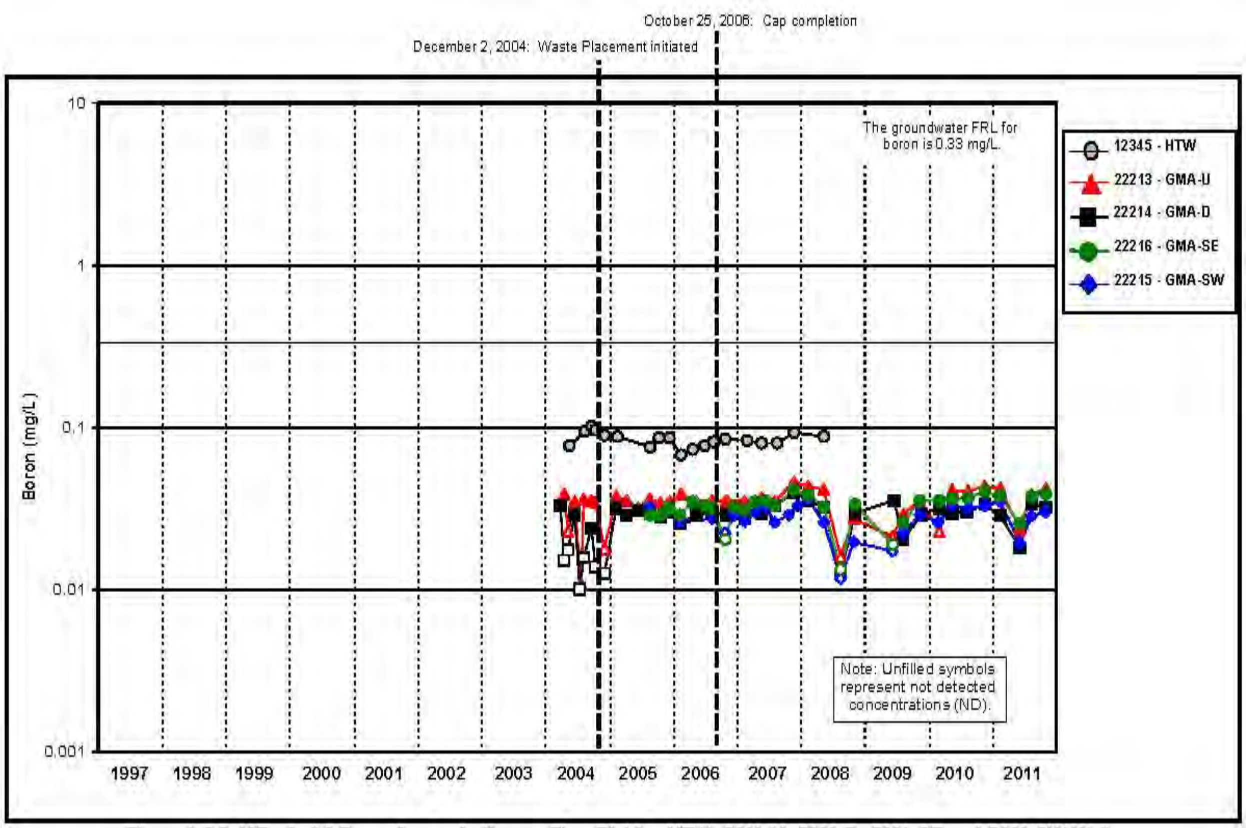


Figure A.5.8-19B. Cell 8 Boron Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

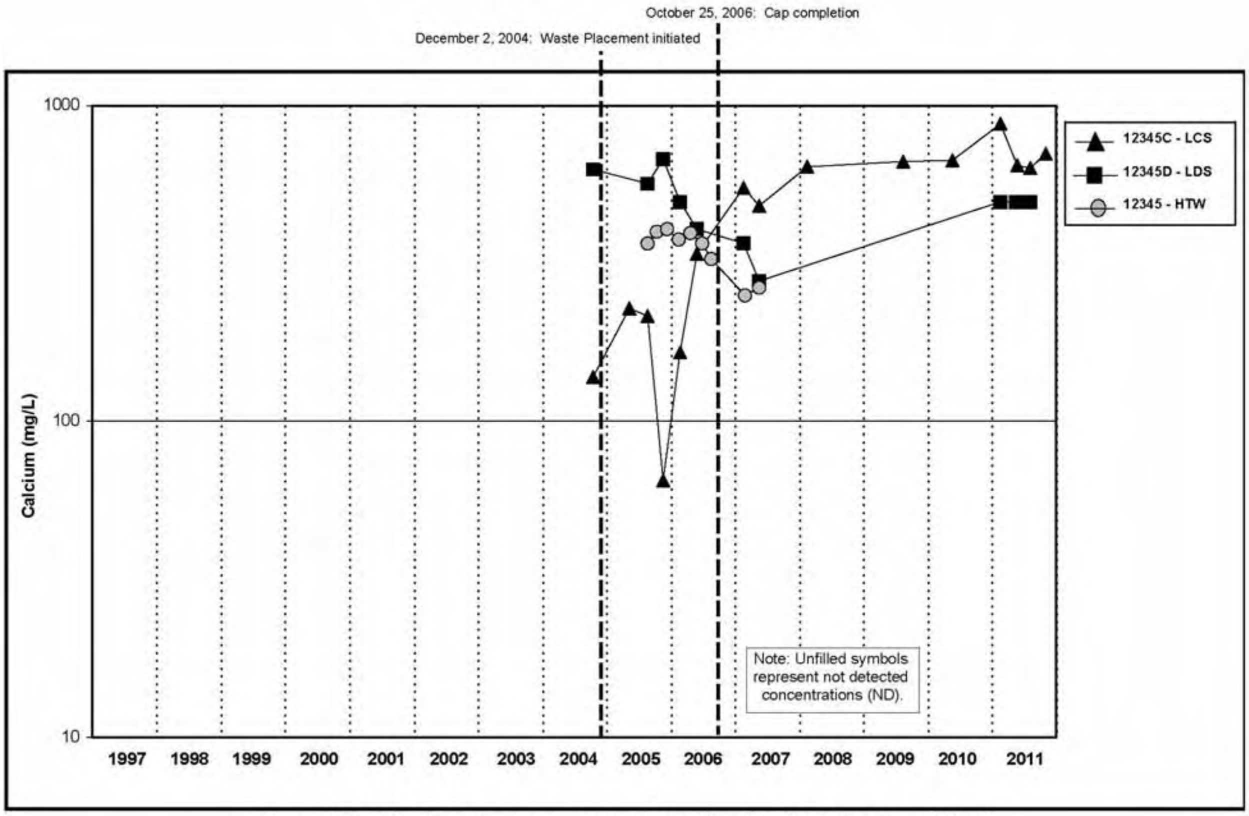


Figure A.5.8-20A. Cell 8 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

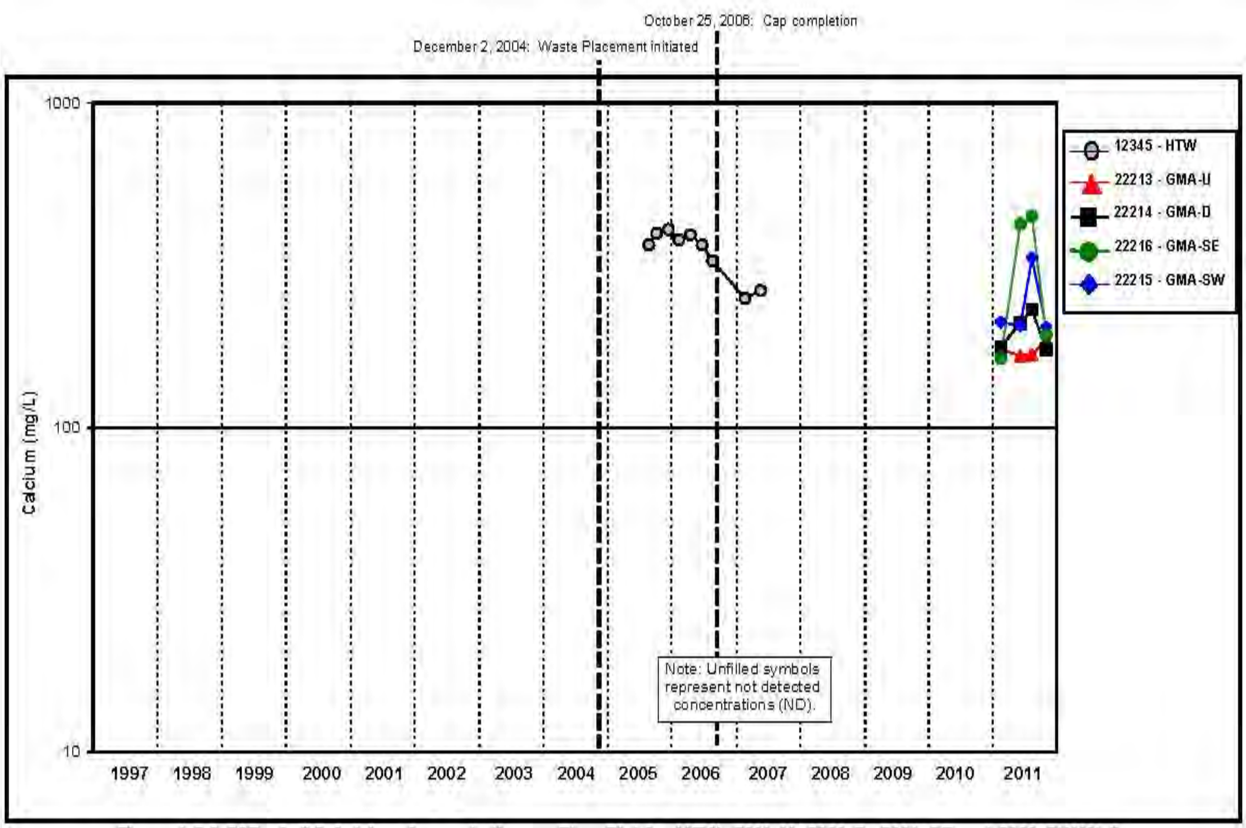


Figure A.5.8-20B. Cell 8 Calcium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

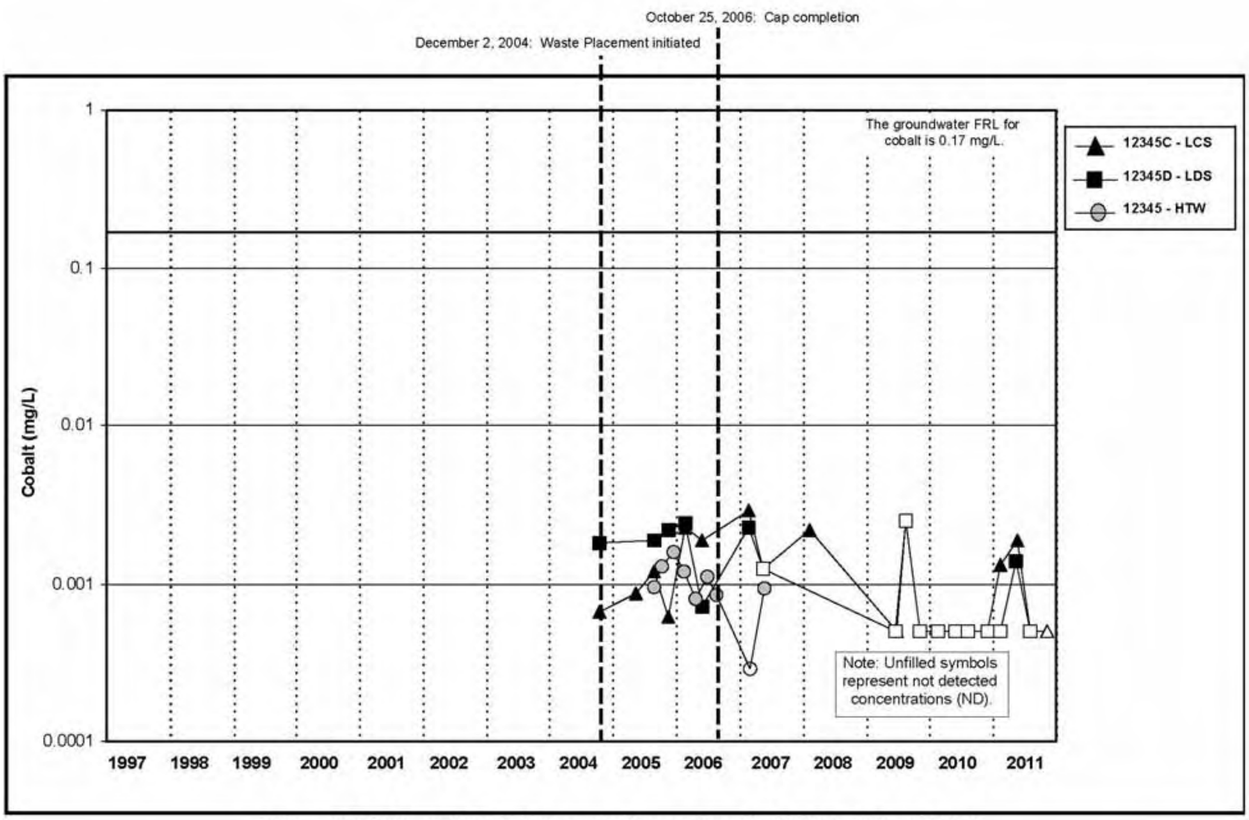


Figure A.5.8-21A. Cell 8 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

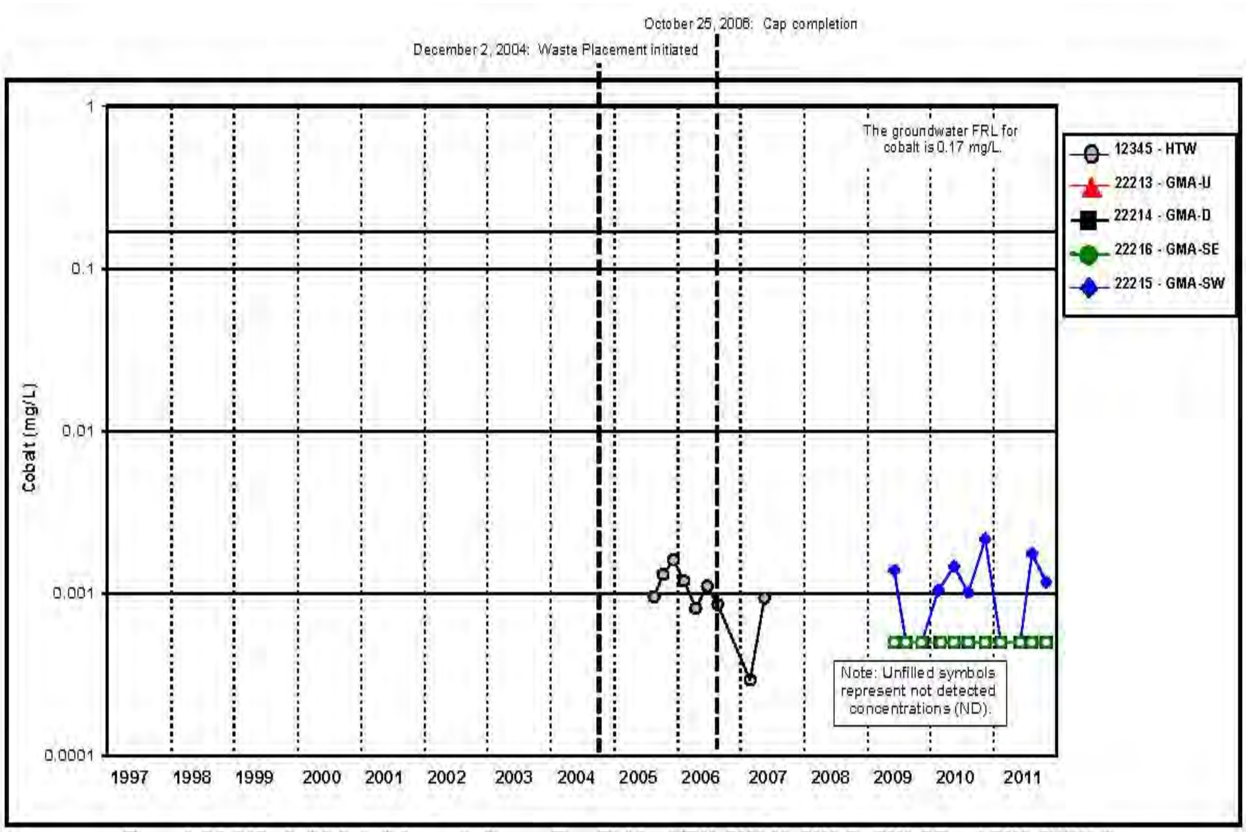


Figure A.5.8-21B. Cell 8 Cobalt Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

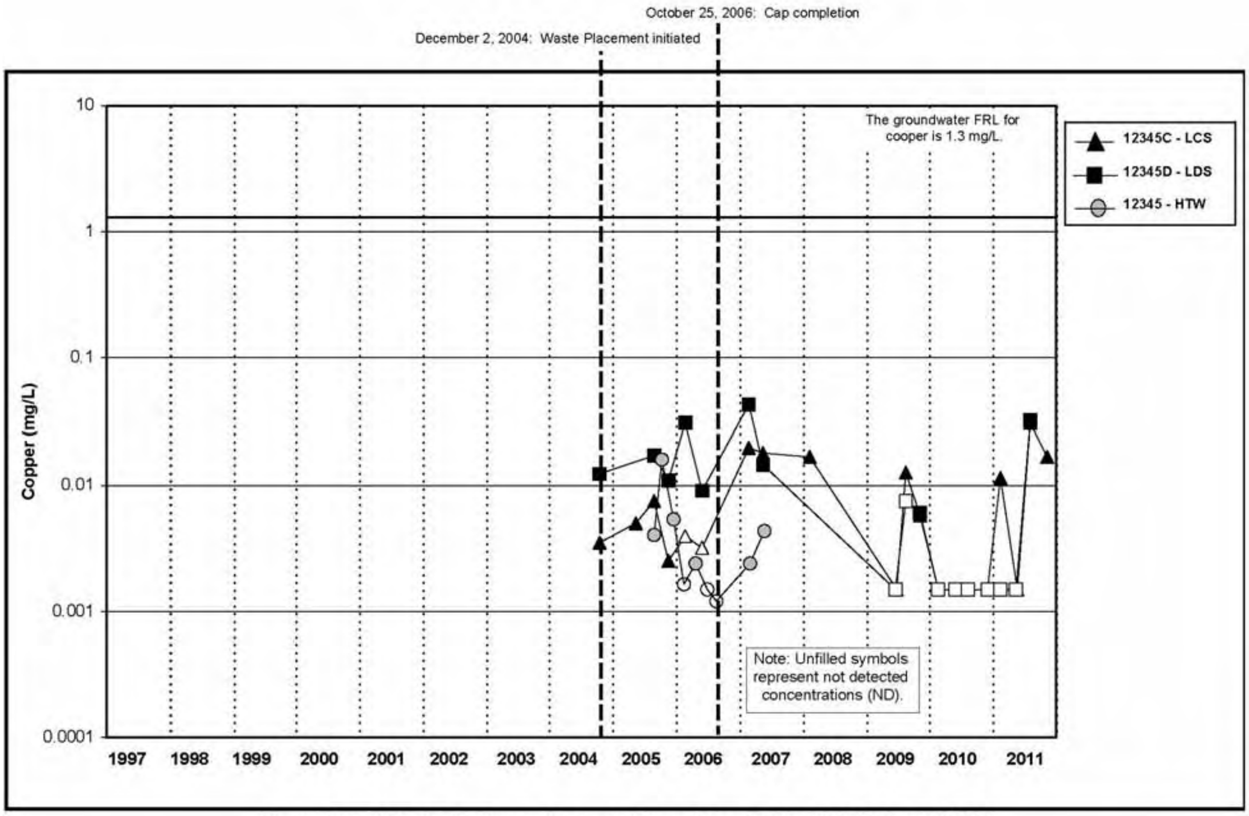


Figure A.5.8-22A. Cell 8 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

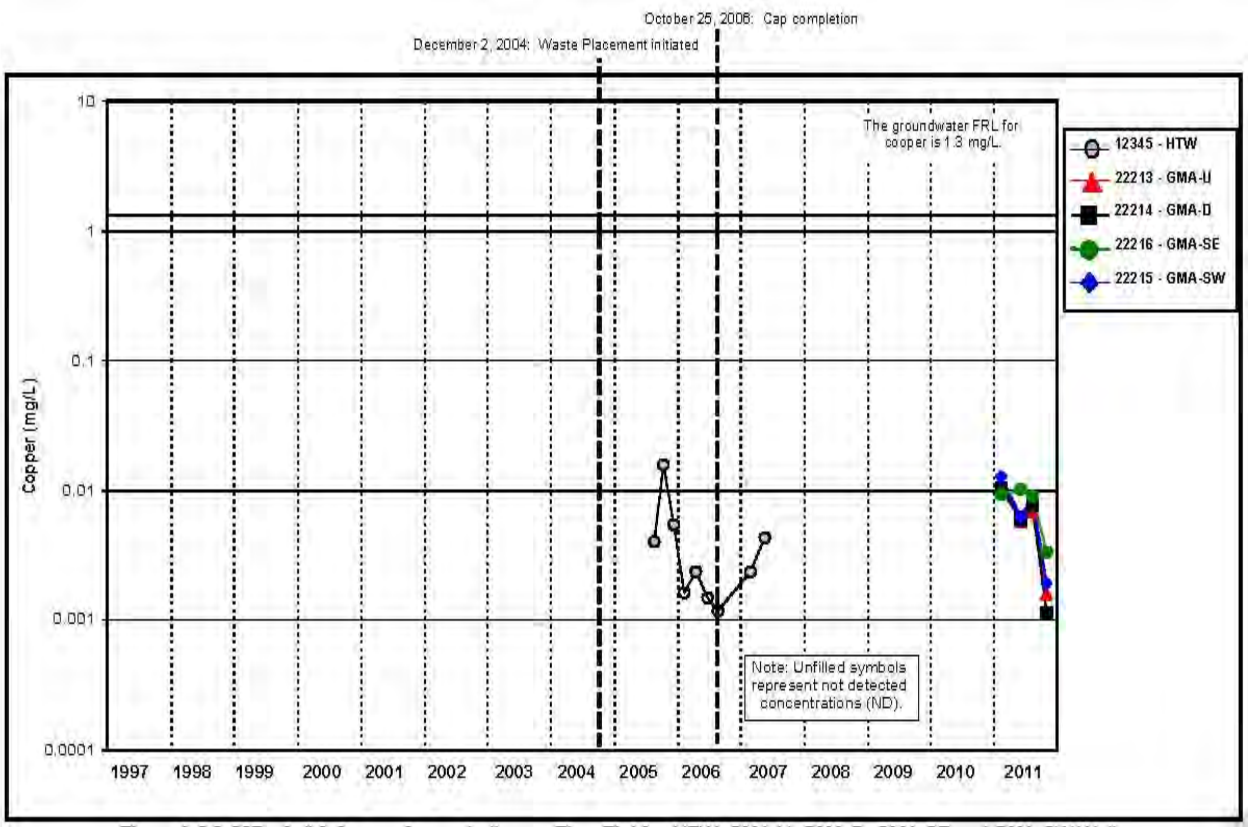


Figure A.5.8-22B. Cell 8 Copper Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

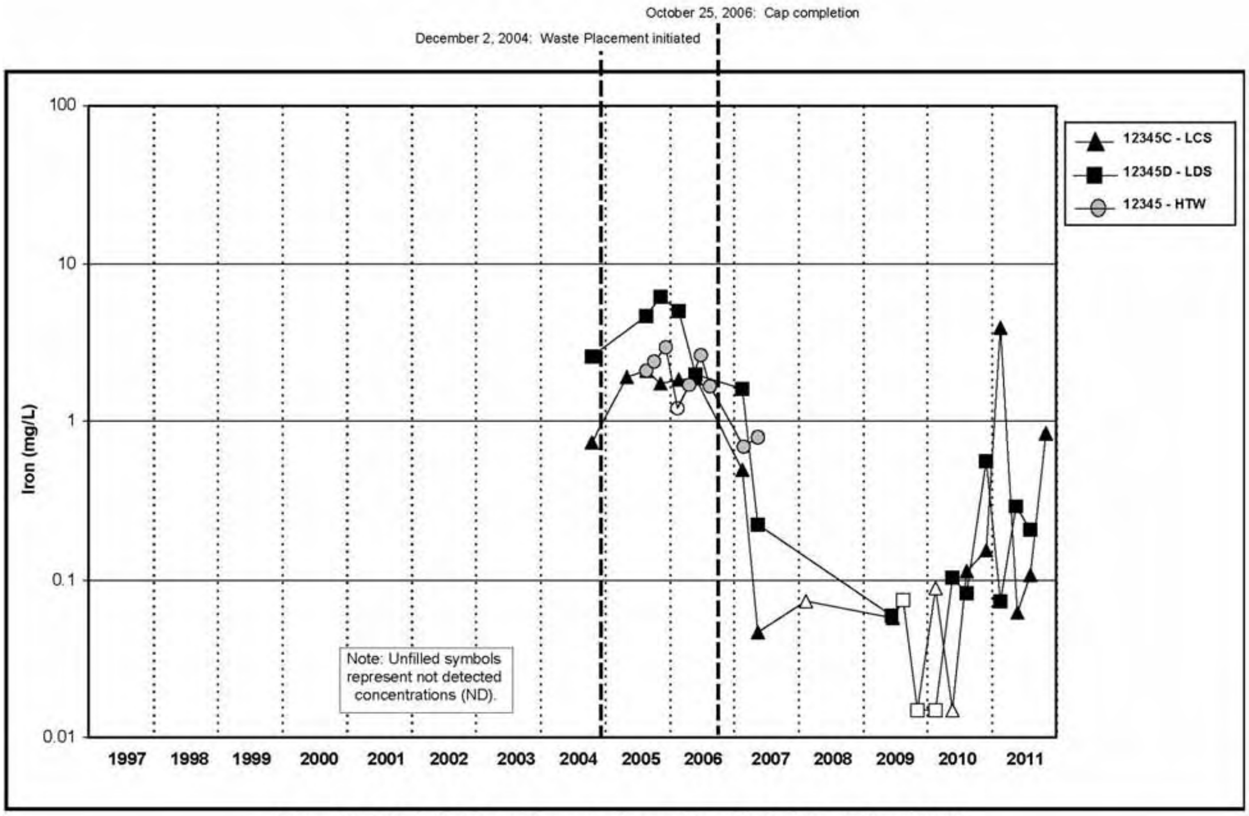


Figure A.5.8-23A. Cell 8 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

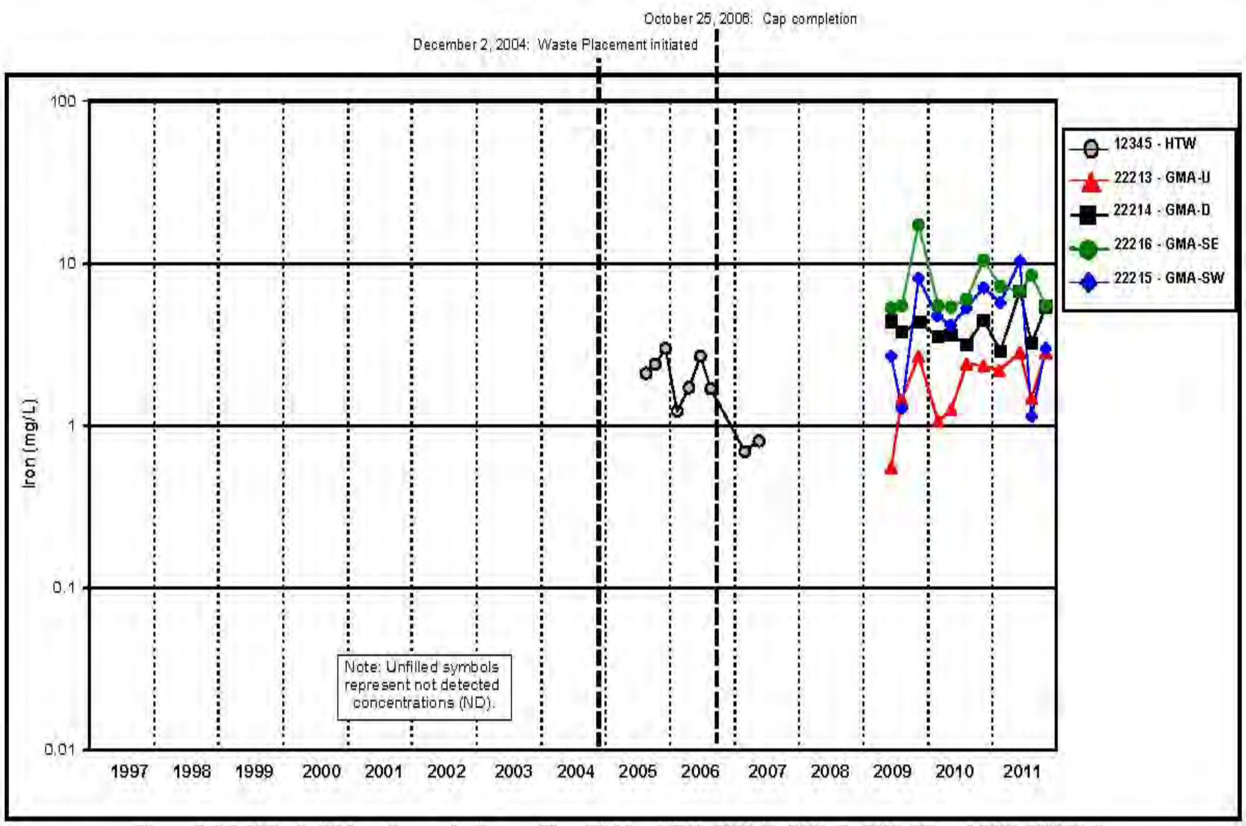


Figure A.5.8-23B. Cell 8 Iron Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

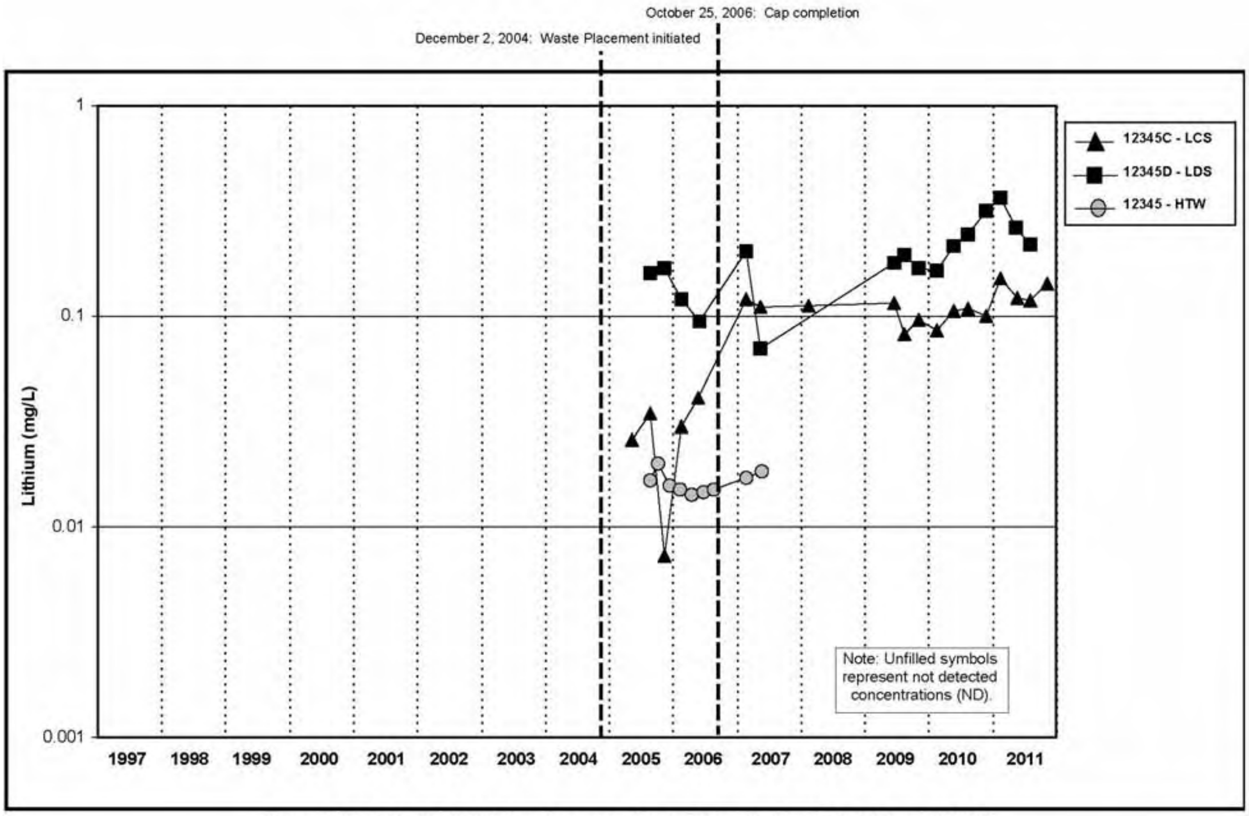


Figure A.5.8-24A. Cell 8 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

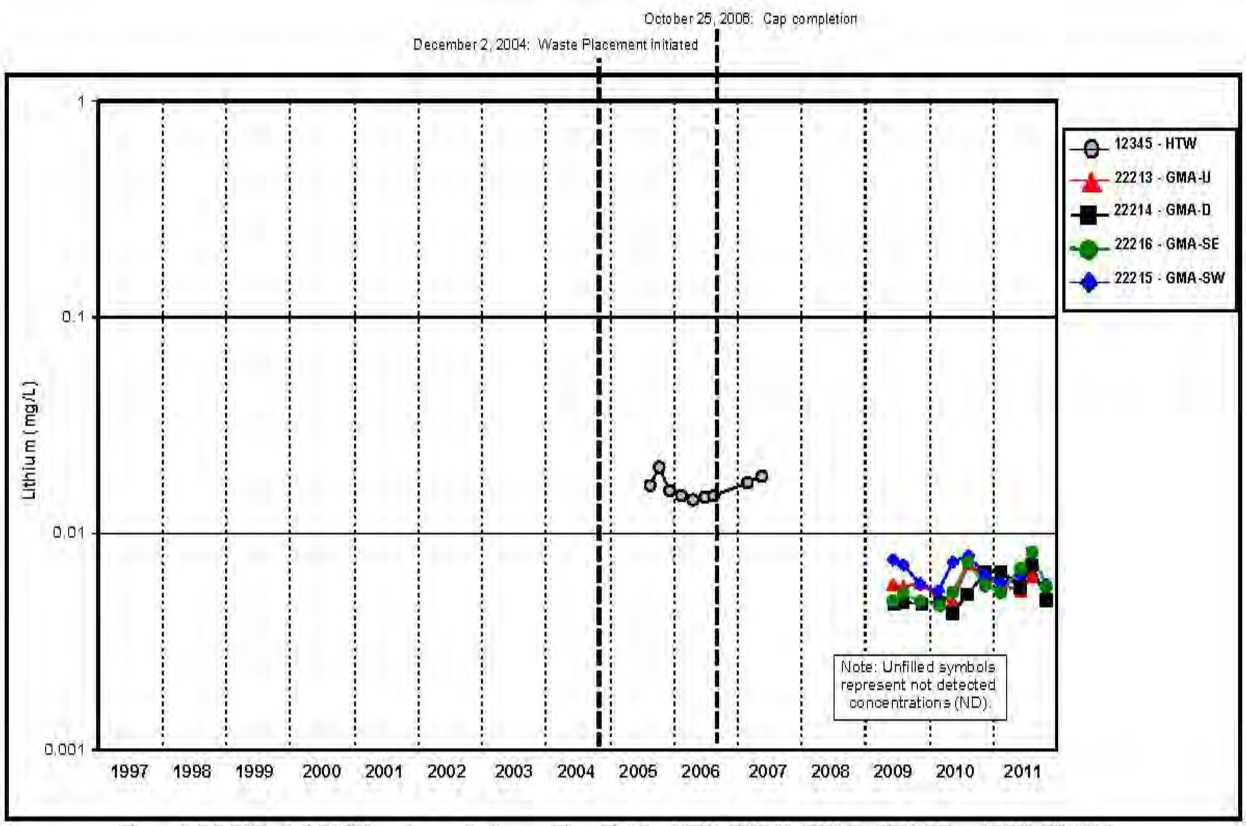


Figure A.5.8-24B. Cell 8 Lithium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

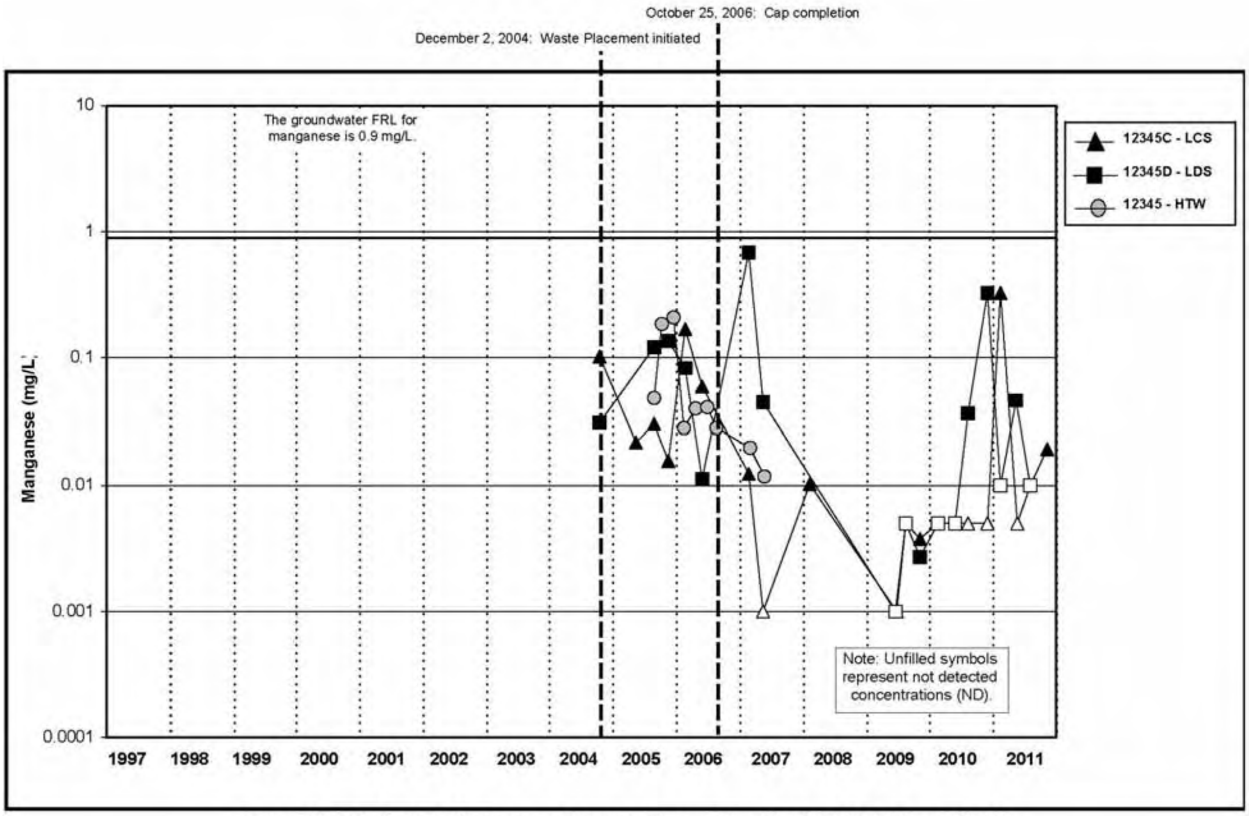


Figure A.5.8-25A. Cell 8 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

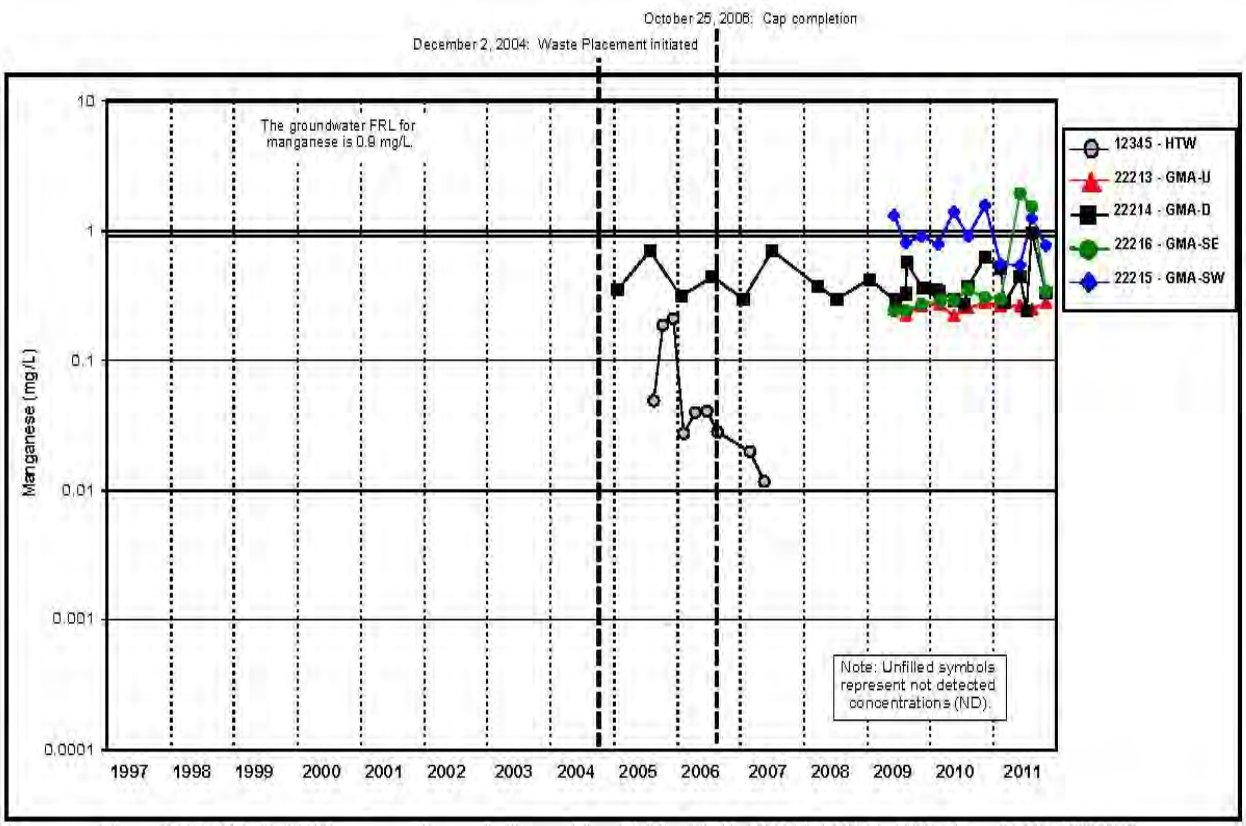


Figure A.5.8-25B. Cell 8 Manganese Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

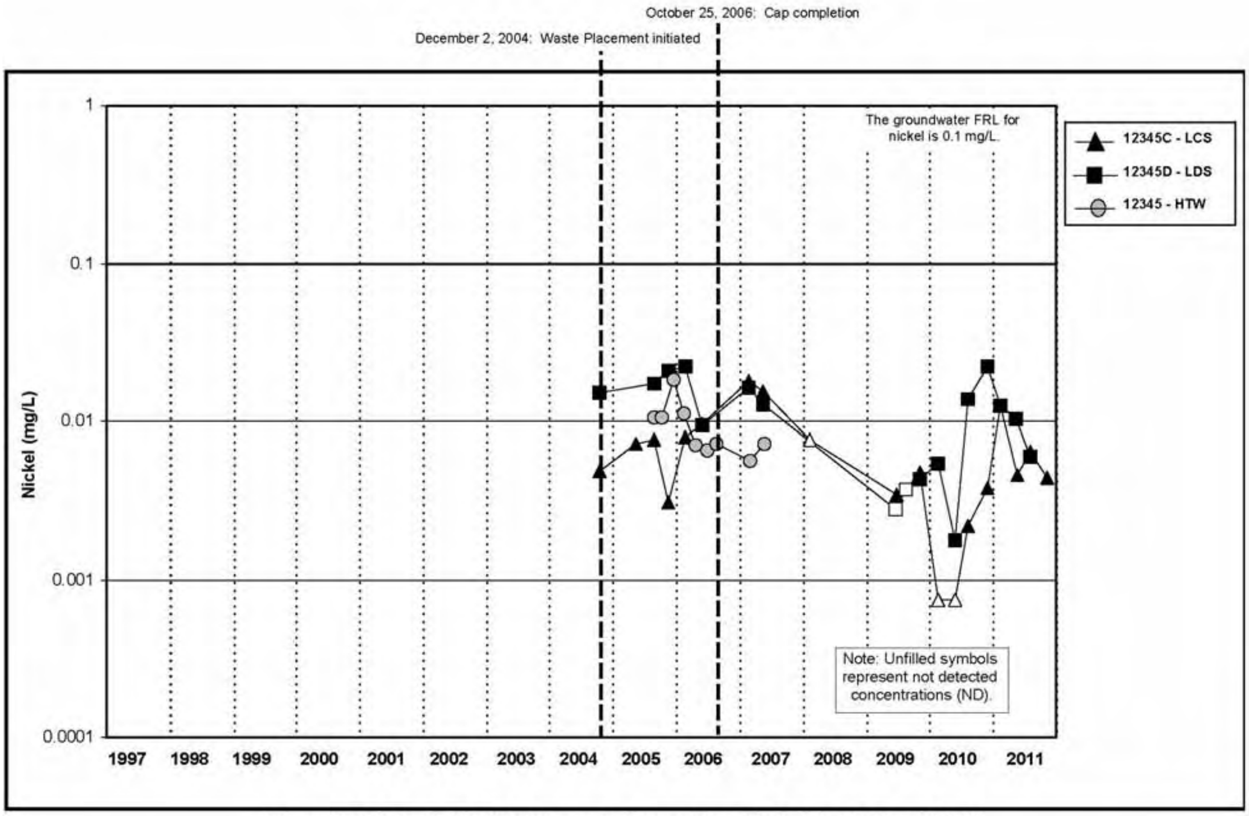


Figure A.5.8-26A. Cell 8 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

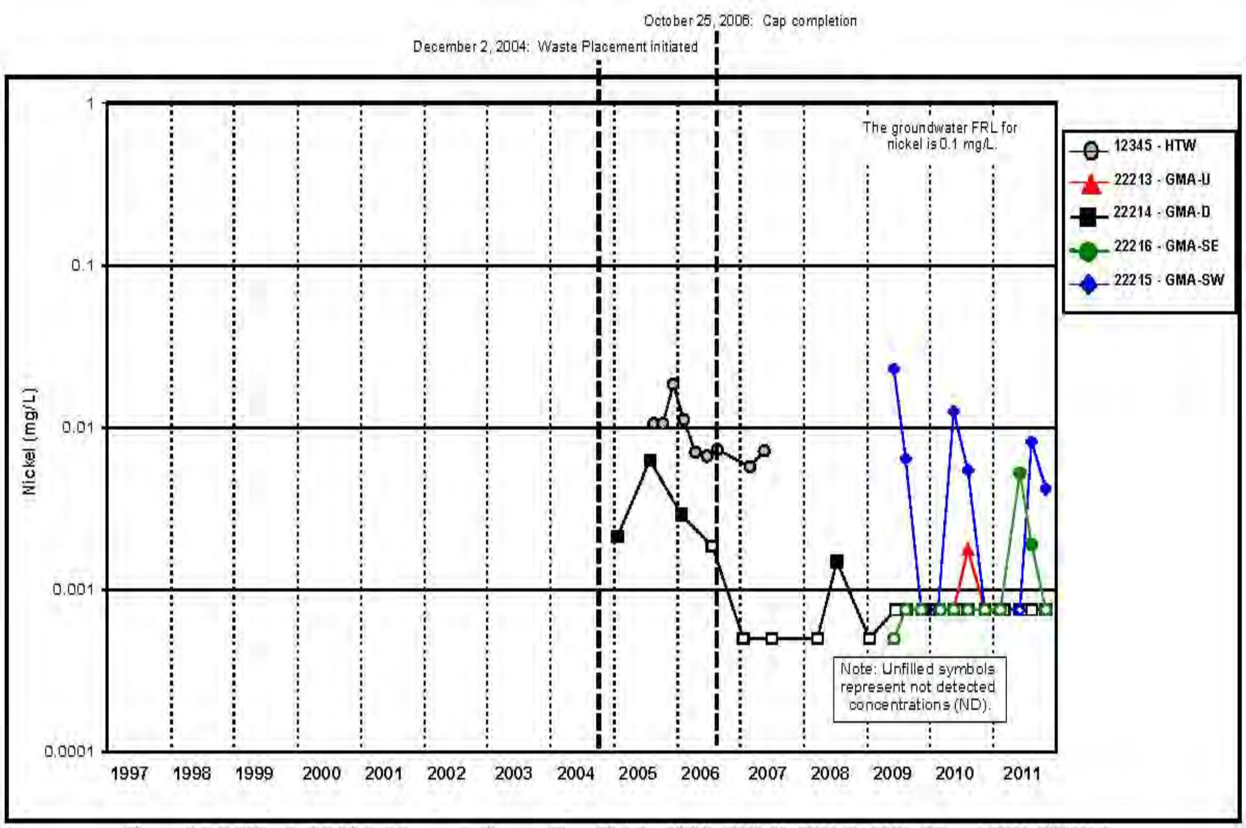


Figure A.5.8-26B. Cell 8 Nickel Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

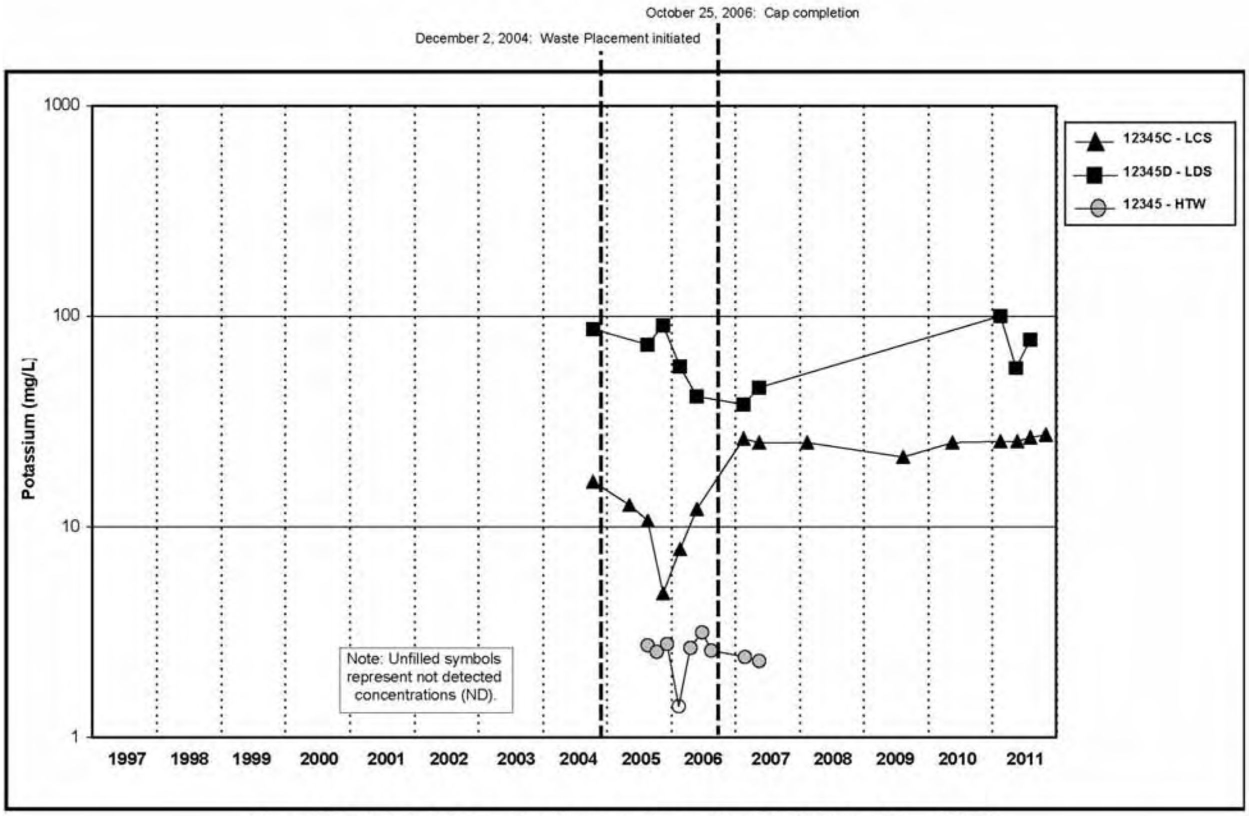


Figure A.5.8-27A. Cell 8 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

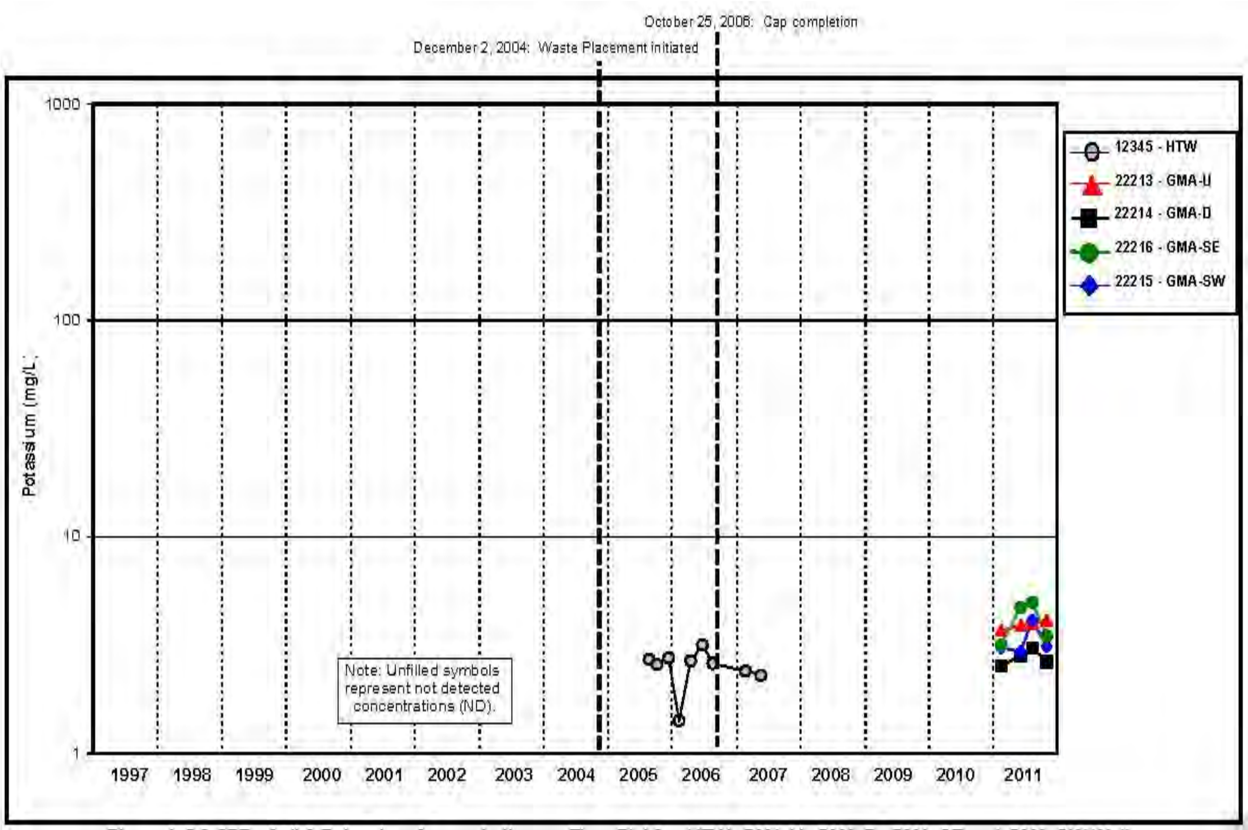


Figure A.5.8-27B. Cell 8 Potassium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

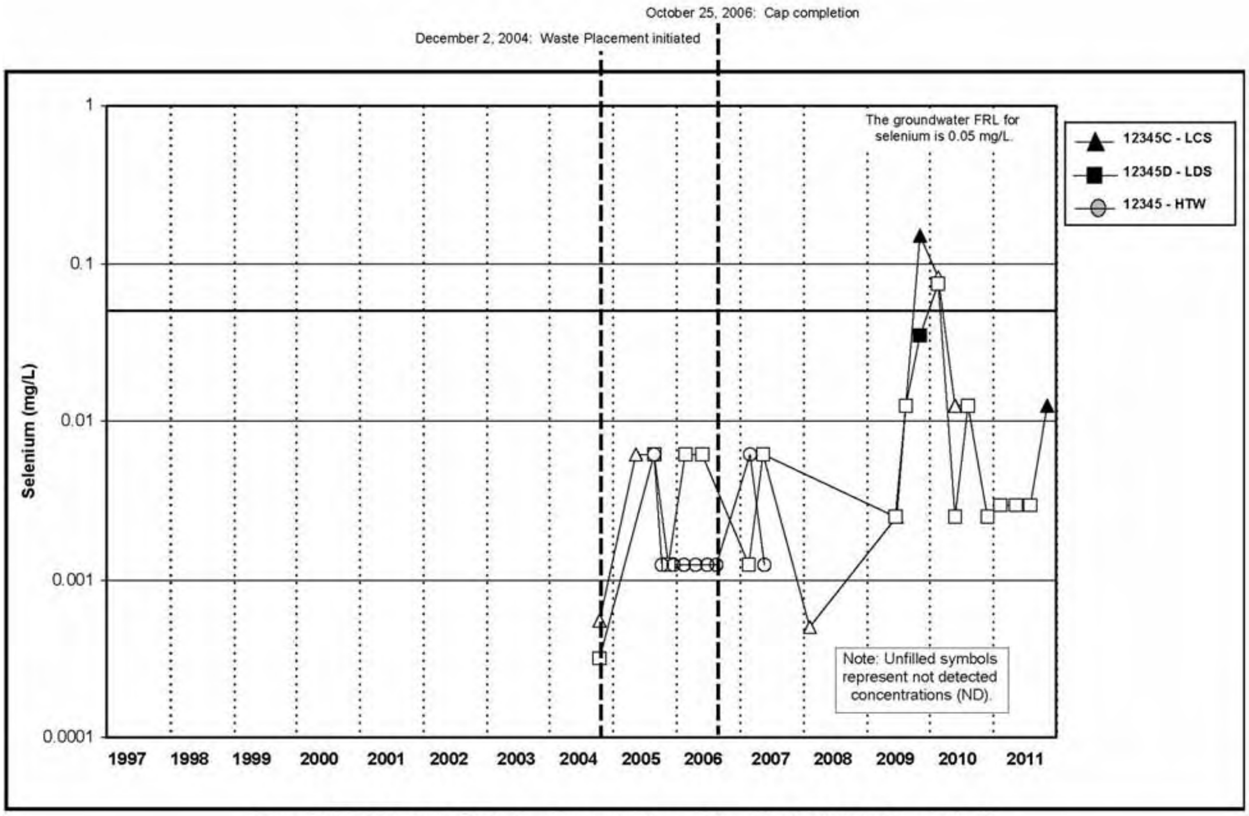


Figure A.5.8-28A. Cell 8 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

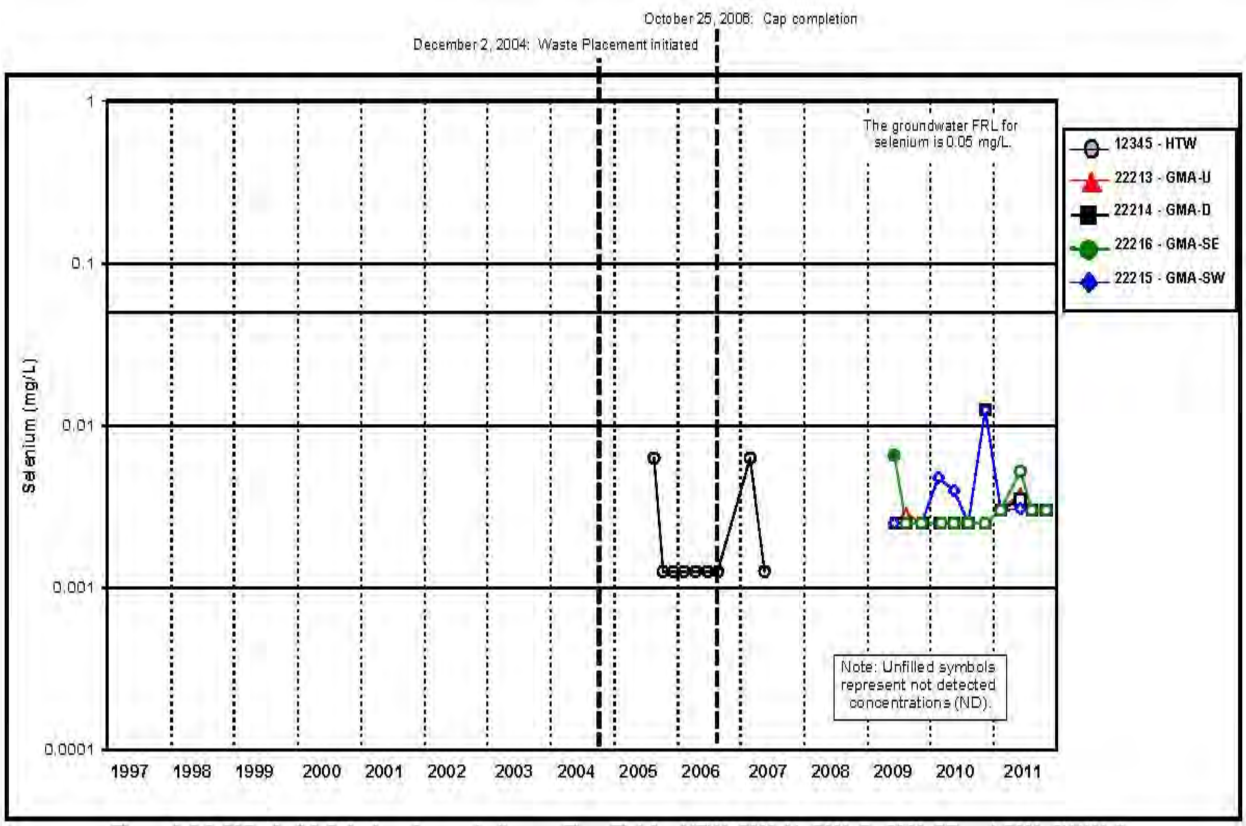


Figure A.5.8-28B. Cell 8 Selenium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

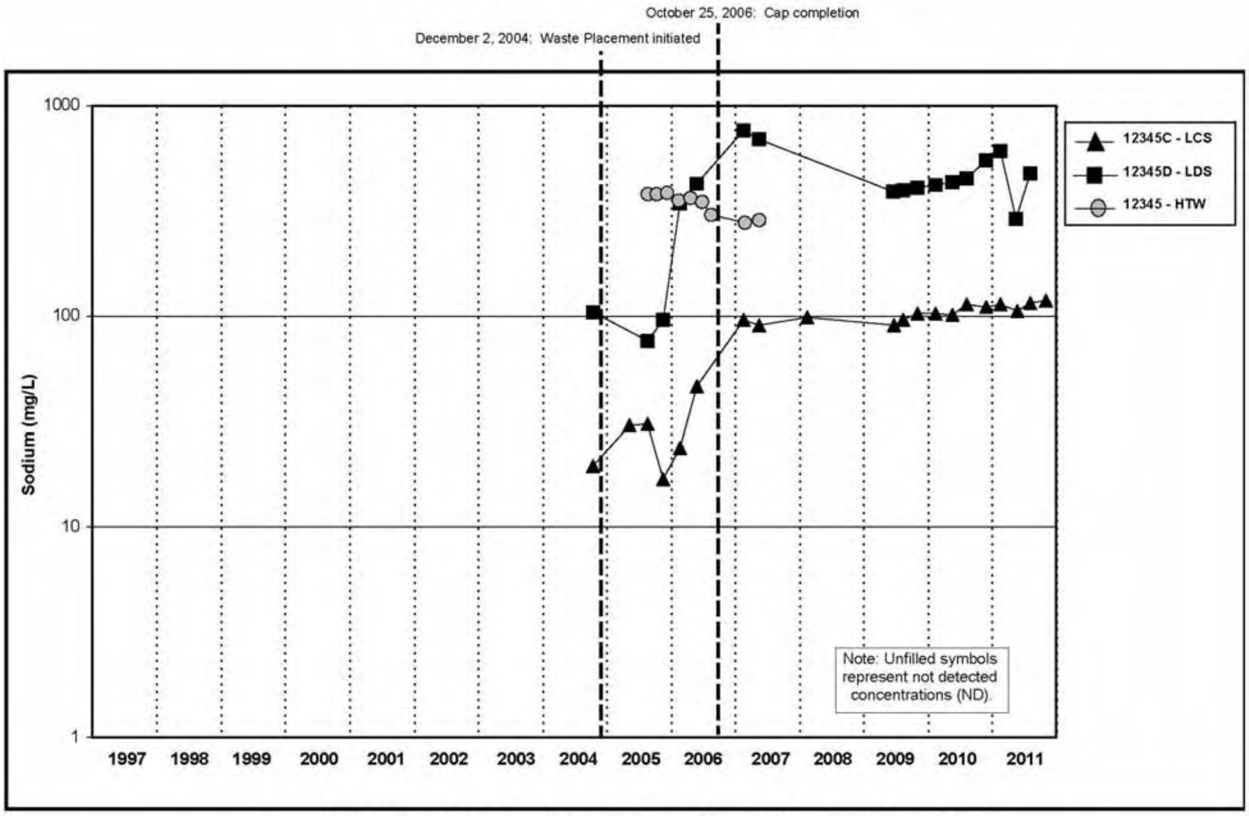


Figure A.5.8-29A. Cell 8 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

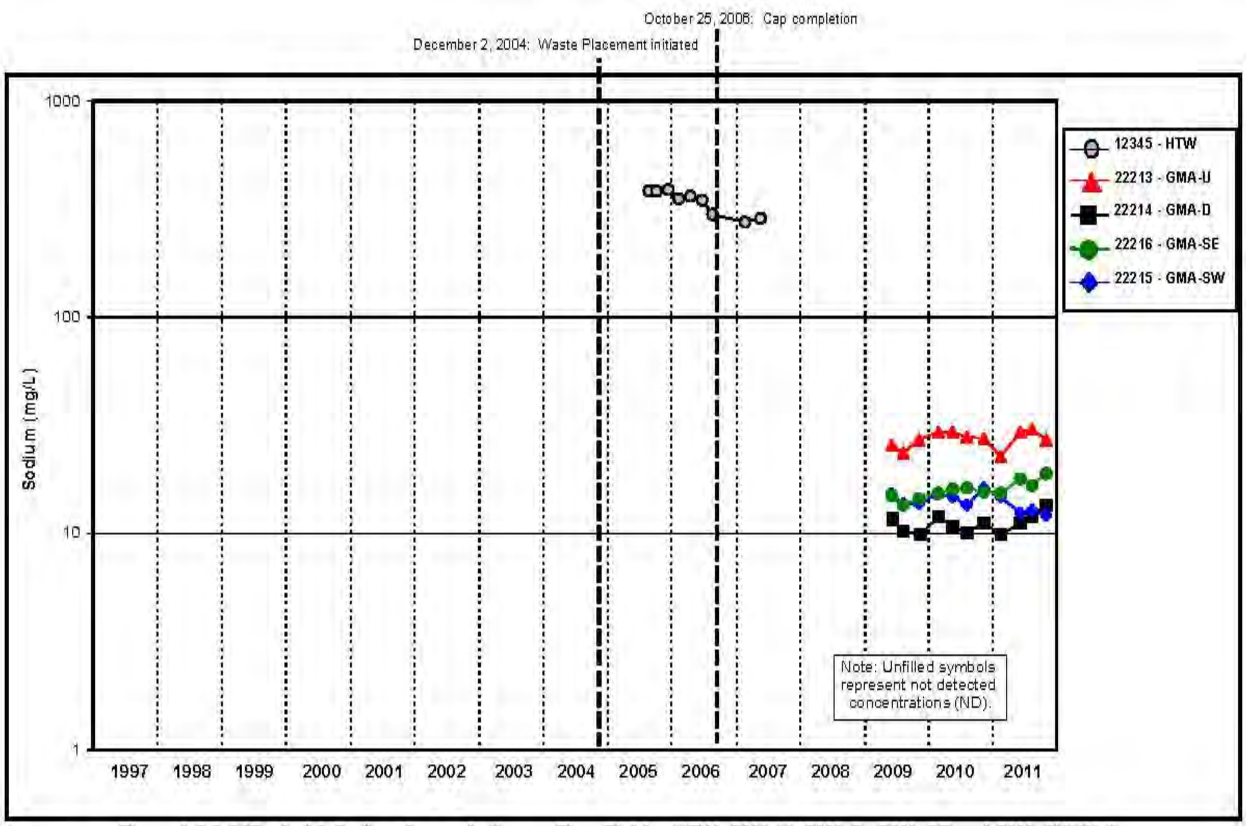


Figure A.5.8-29B. Cell 8 Sodium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

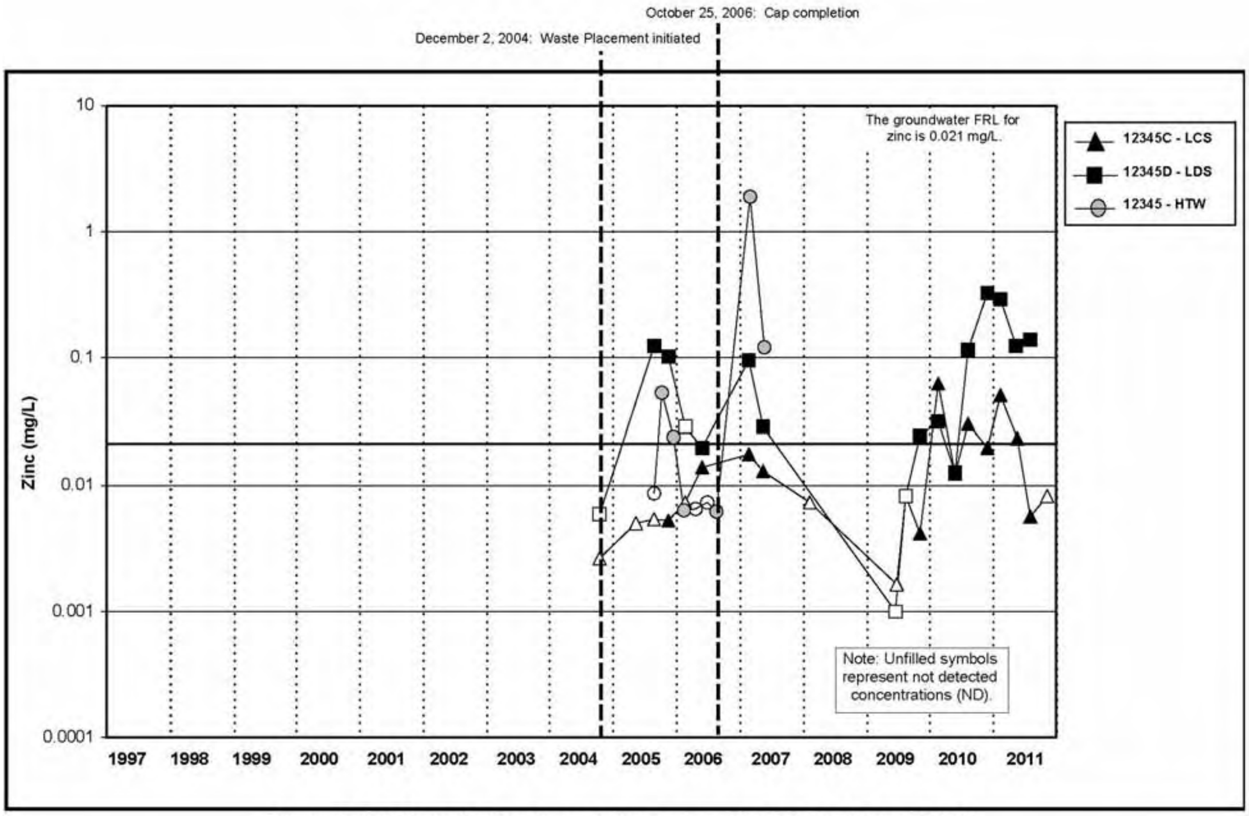


Figure A.5.8-30A. Cell 8 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

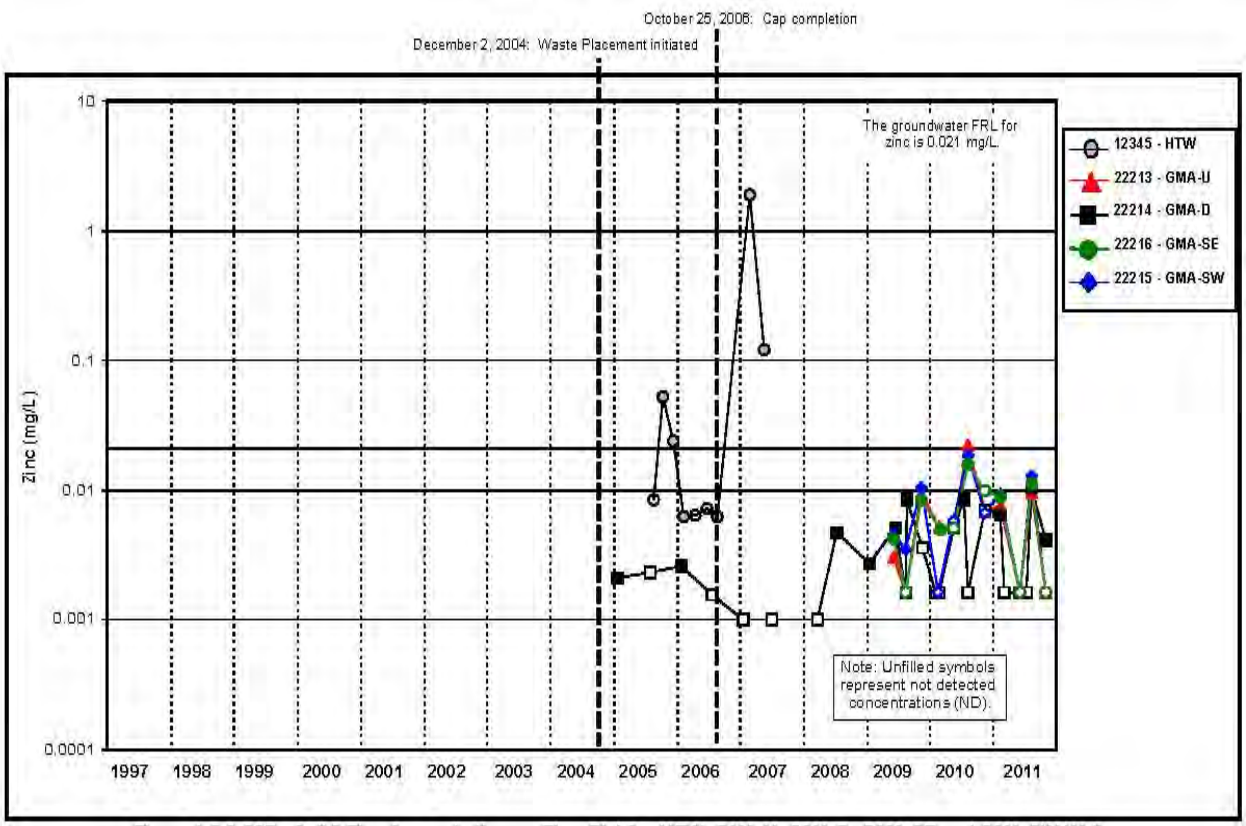


Figure A.5.8-30B. Cell 8 Zinc Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE and GMA-SW Wells

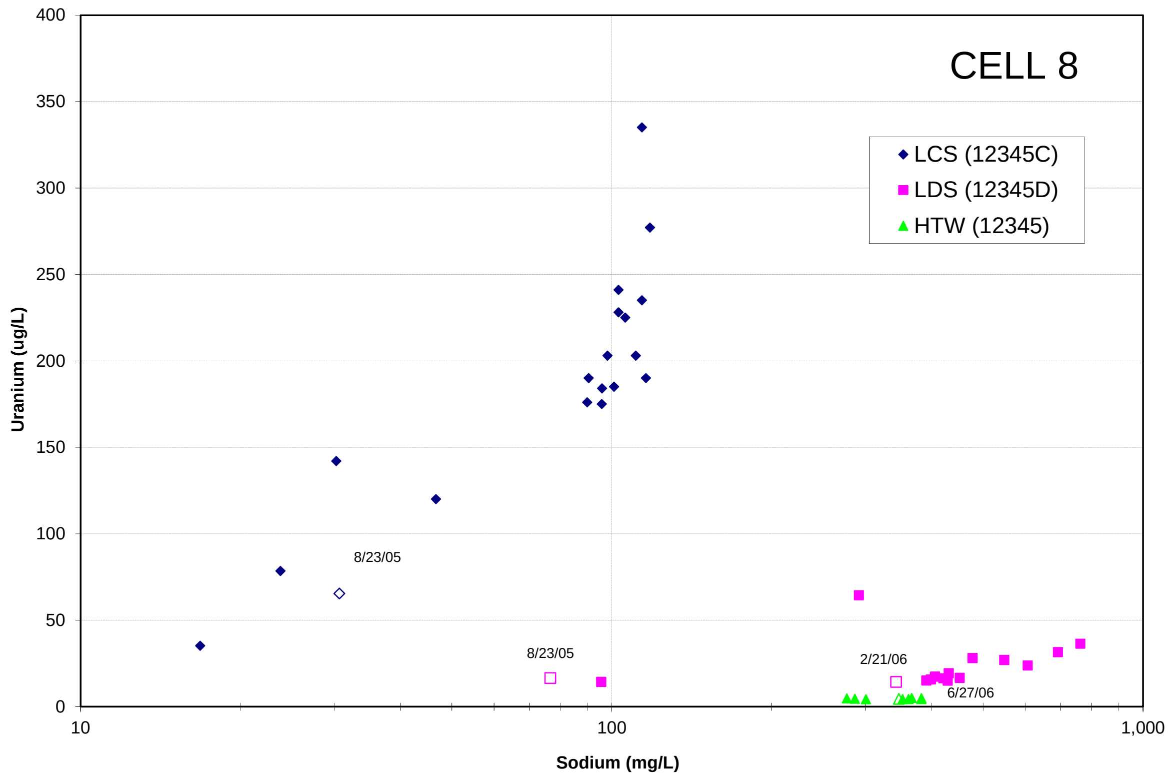


Figure A.5.8−31. Cell 8 Bivariate Plot for Uranium and Sodium

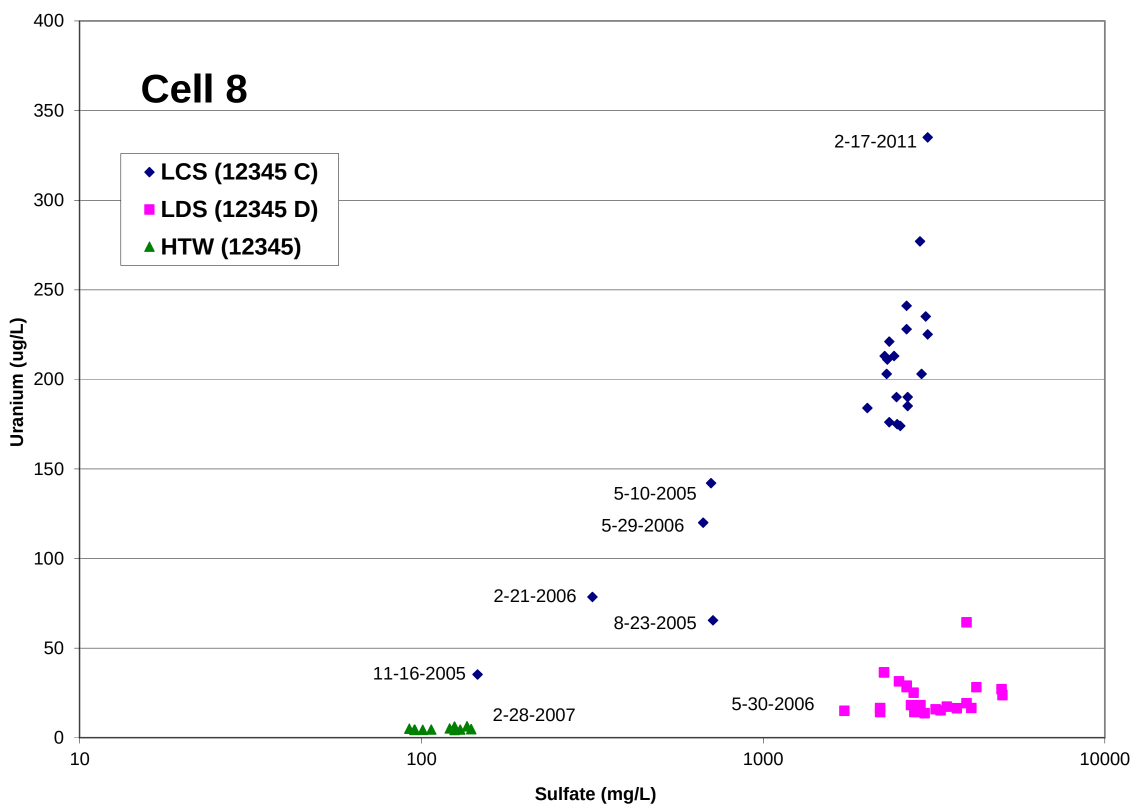


Figure A.5.8−32. Cell 8 Bivariate Plot for Uranium and Sulfate

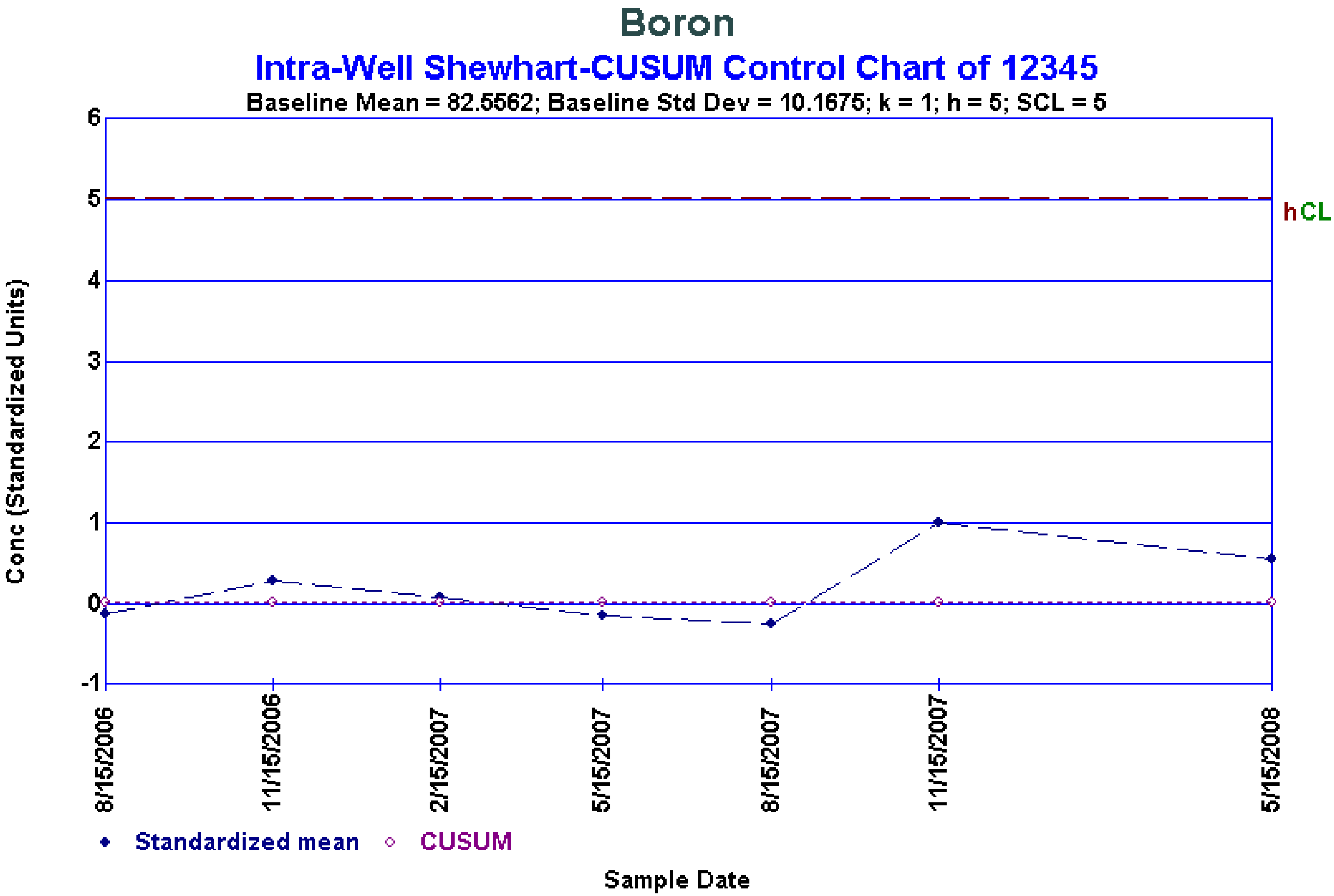


Figure A.5.8−33. Intra-Well Shewhart-CUSUM Control Chart (Boron 12345)

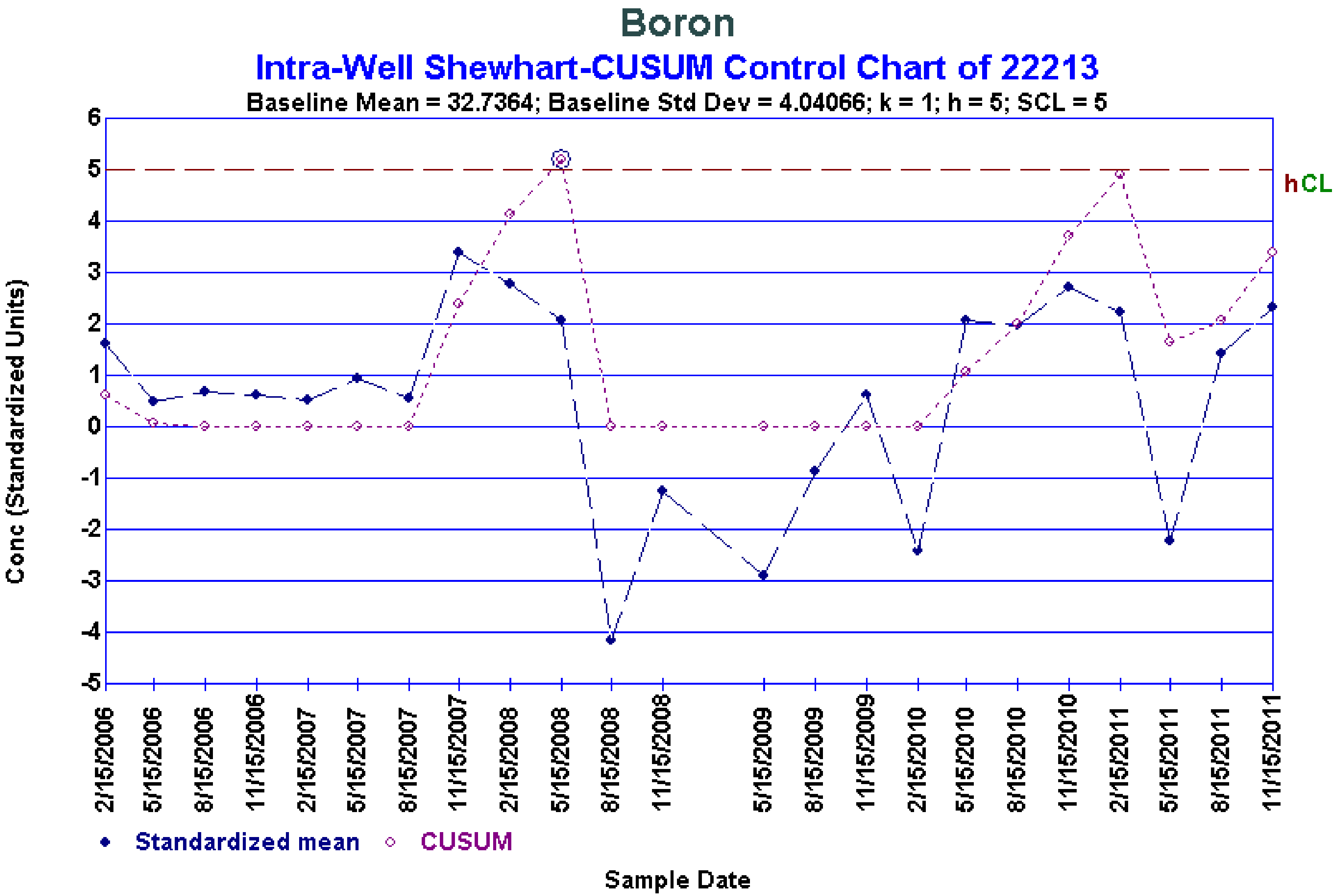


Figure A.5.8−34. Intra-Well Shewhart-CUSUM Control Chart (Boron 22213)

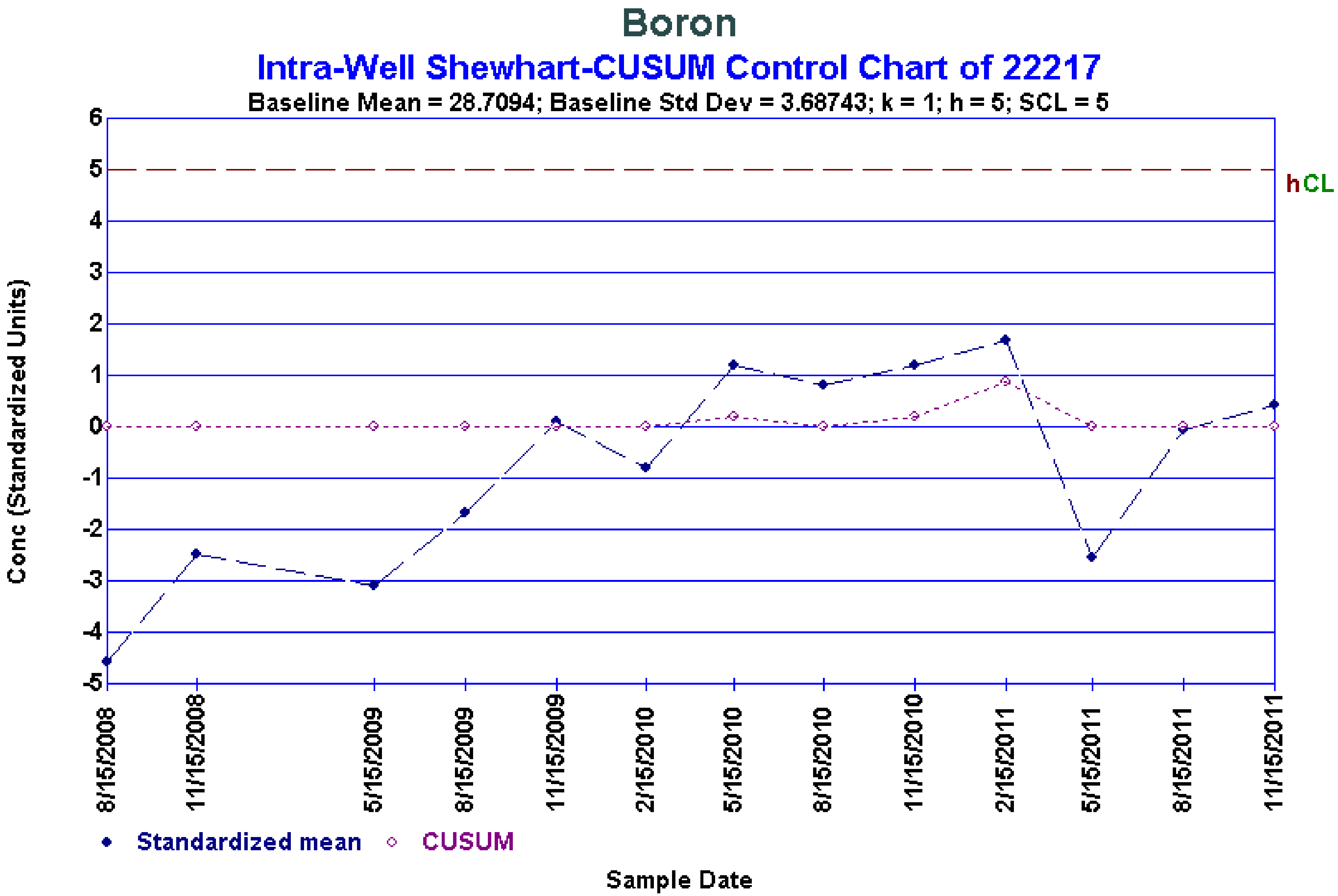


Figure A.5.8−35. Intra-Well Shewhart-CUSUM Control Chart (Boron 22217)

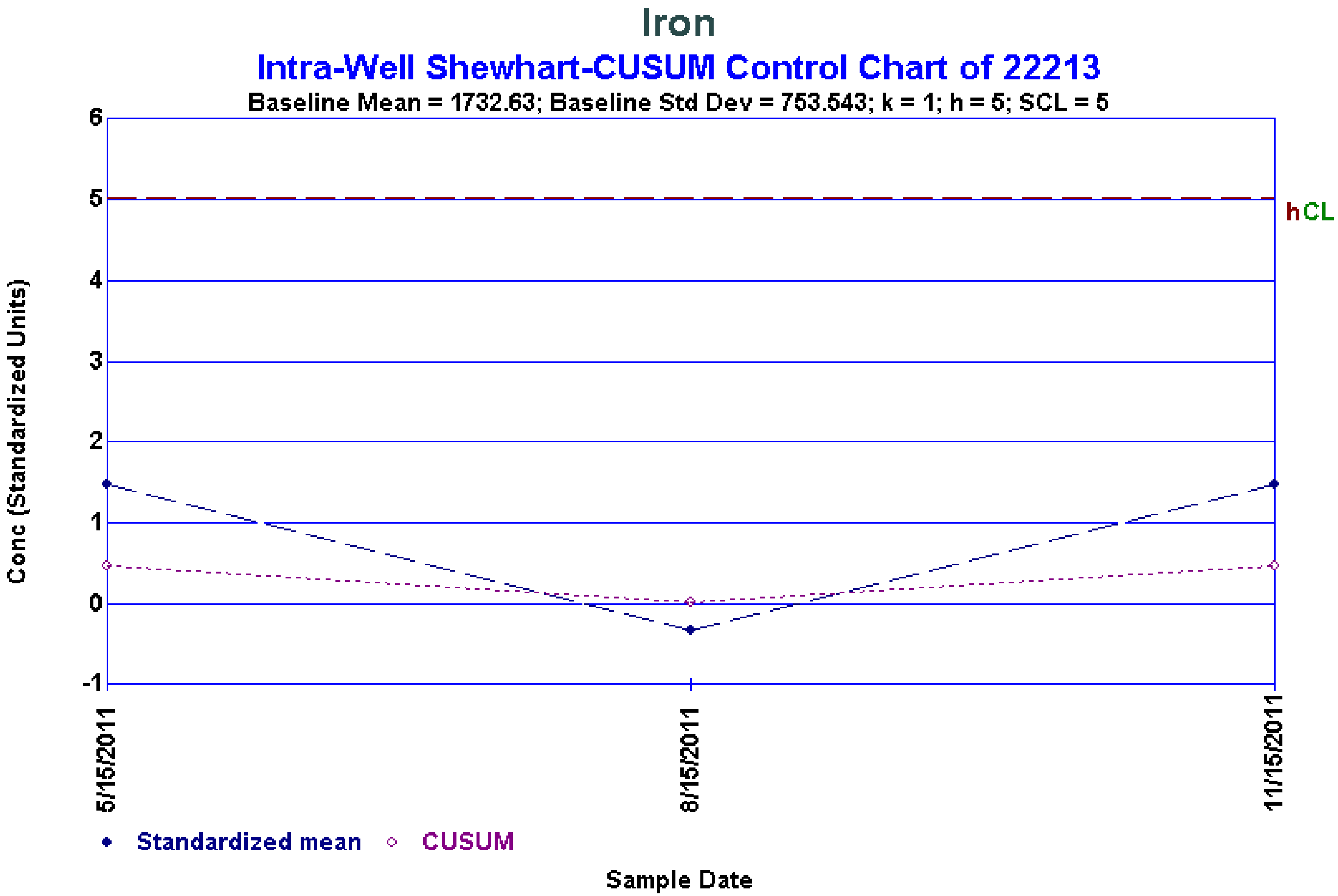


Figure A.5.8−36. Intra-Well Shewhart-CUSUM Control Chart (Iron 22213)

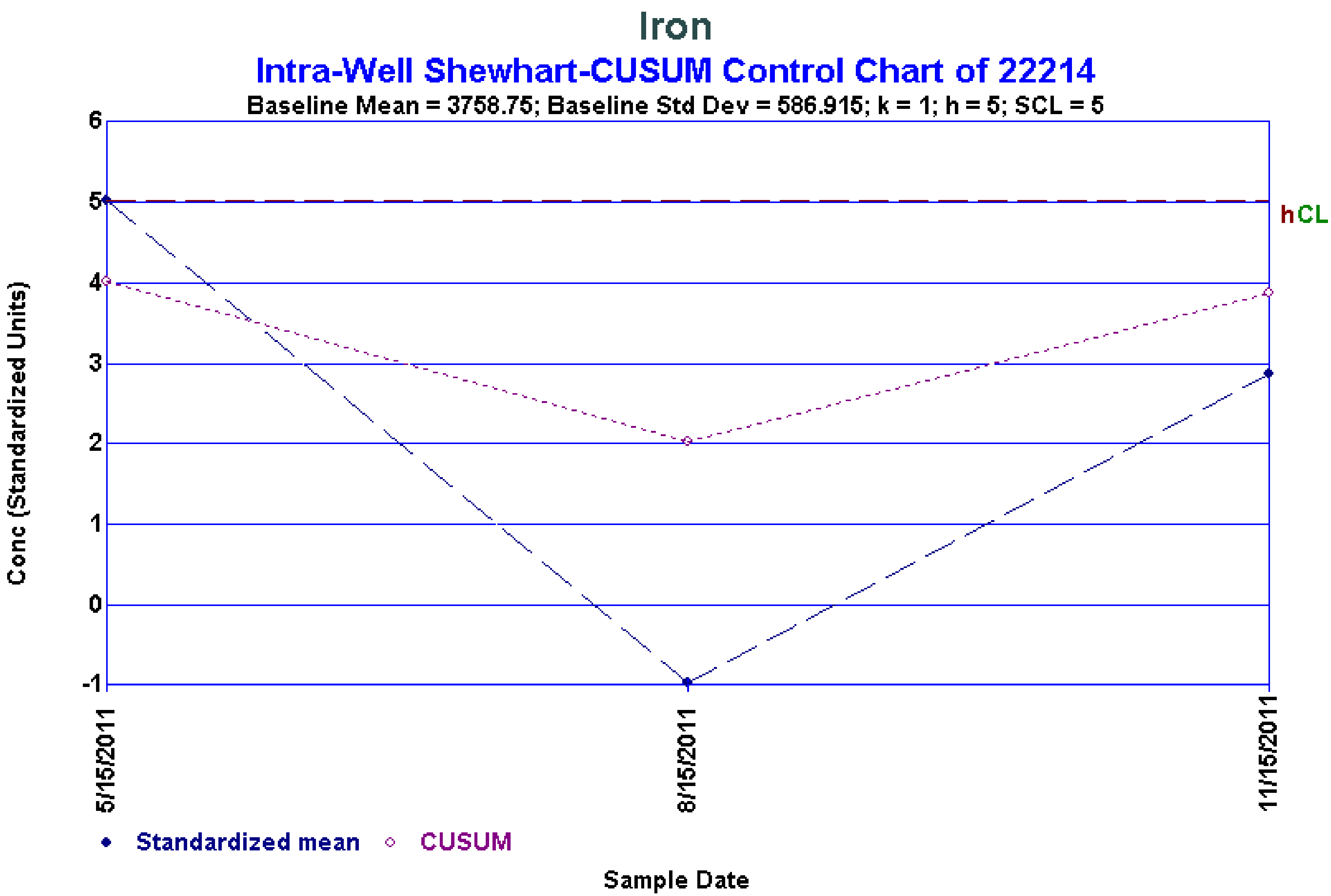


Figure A.5.8−37. Intra-Well Shewhart-CUSUM Control Chart (Iron 22214)

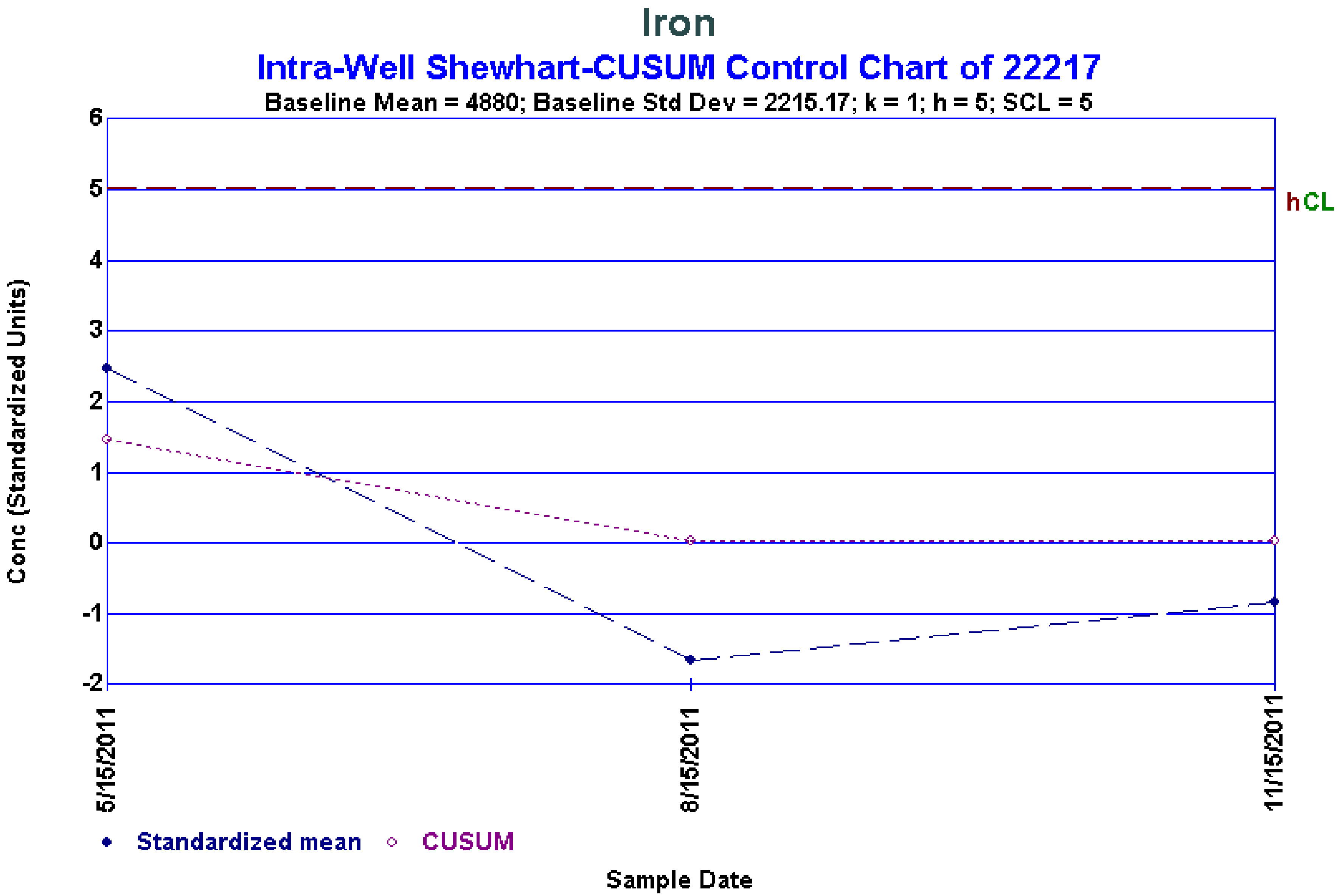


Figure A.5.8−38. Intra-Well Shewhart-CUSUM Control Chart (Iron 22217)

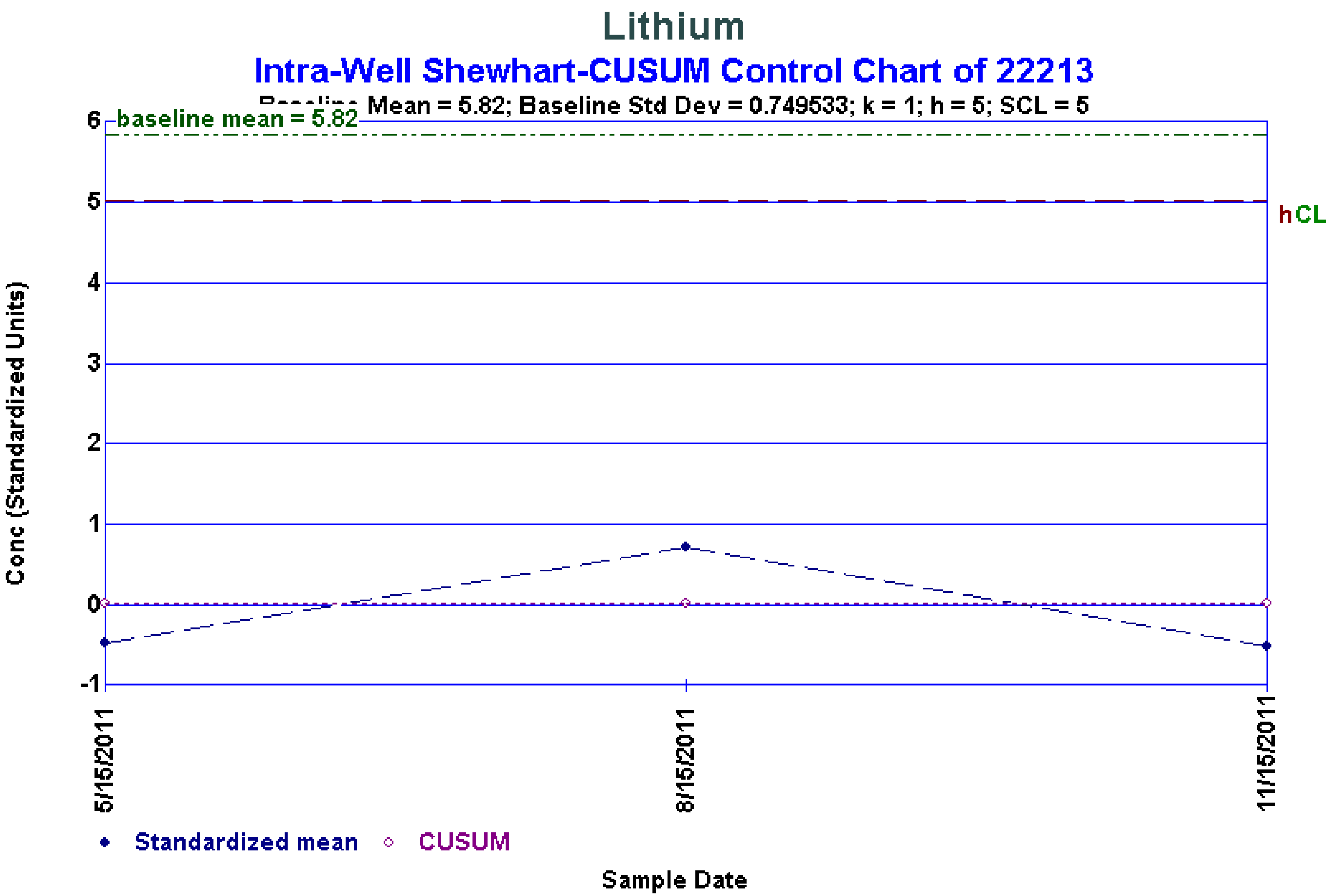


Figure A.5.8−39. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22213)

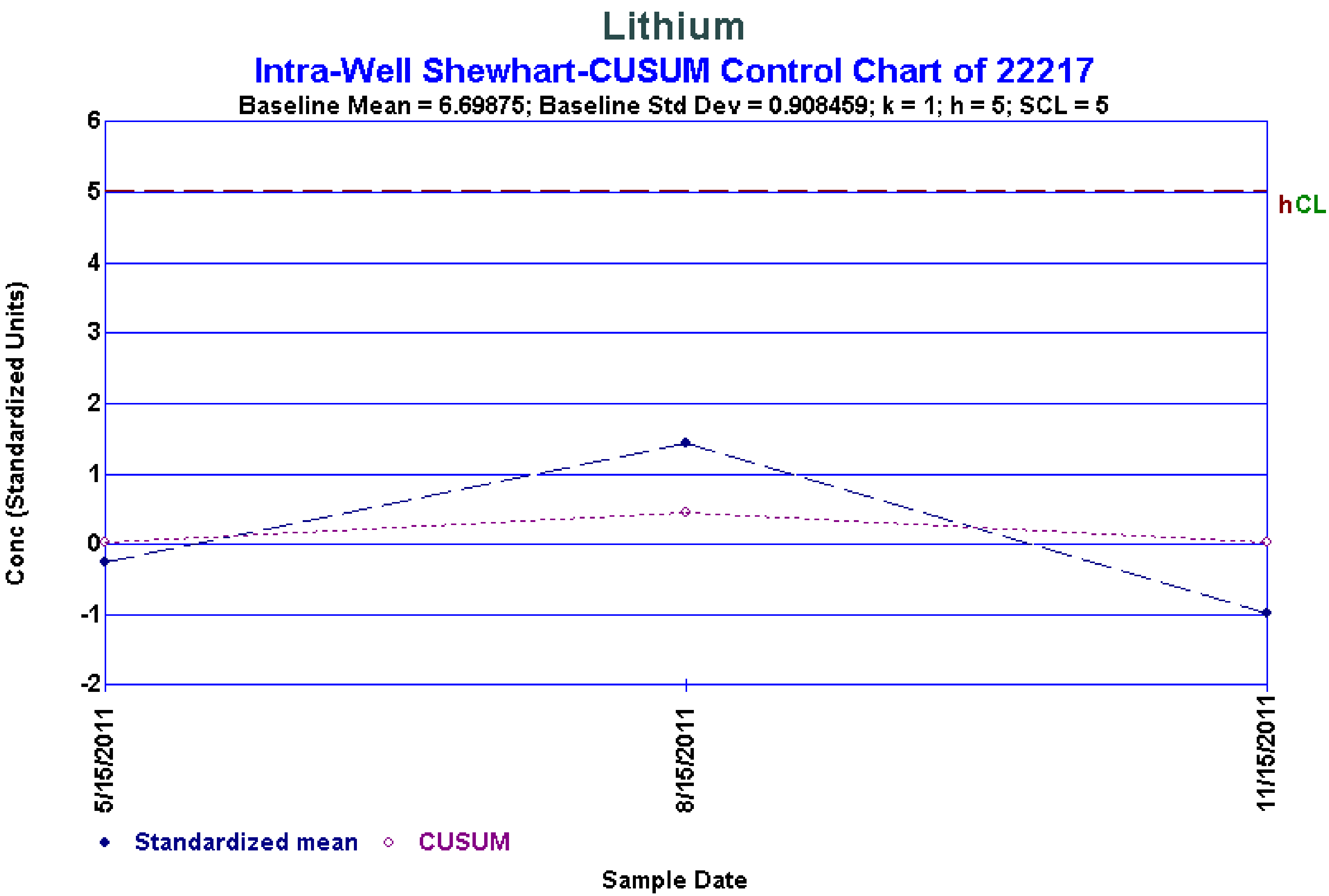


Figure A.5.8−40. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22217)

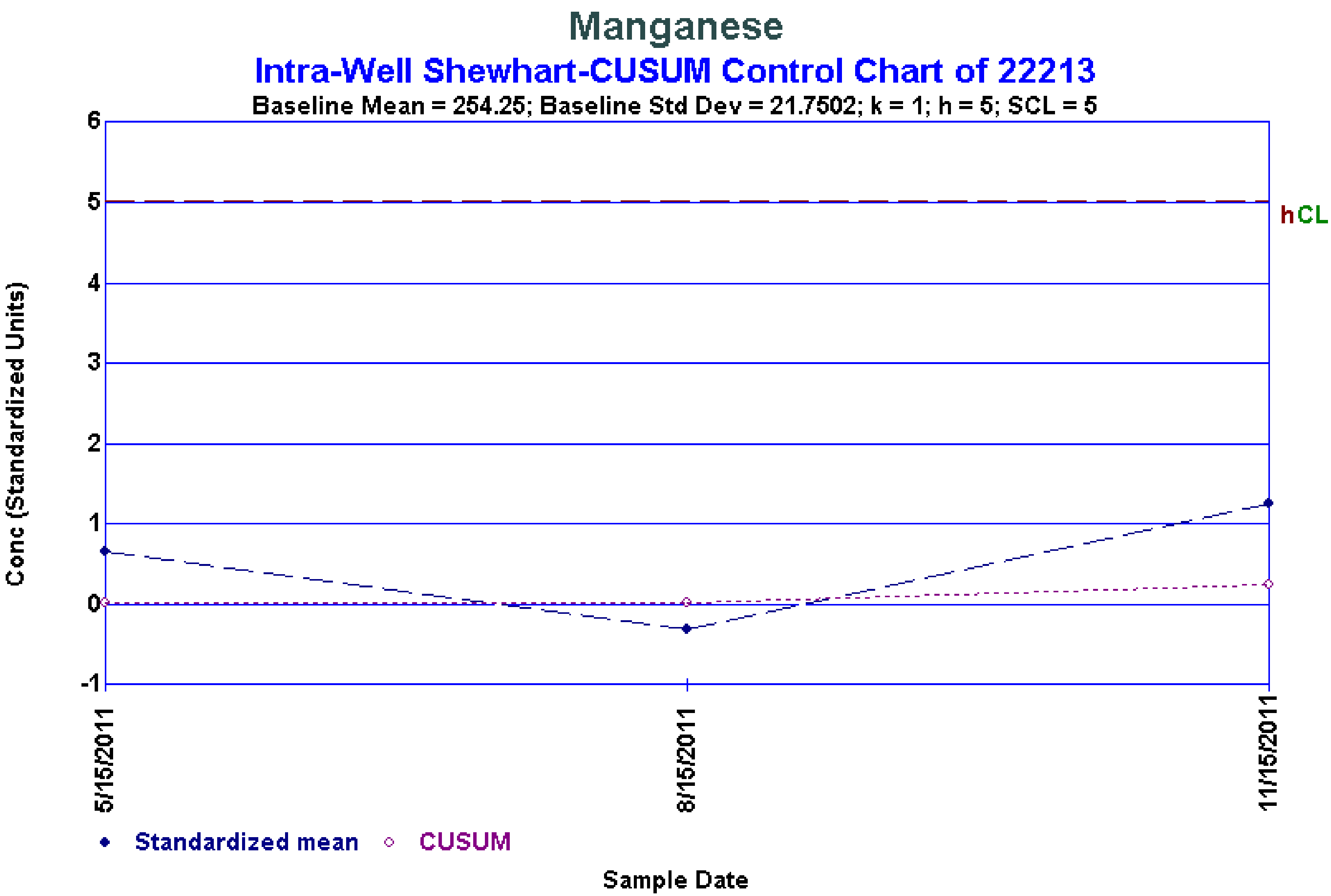


Figure A.5.8−41. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22213)

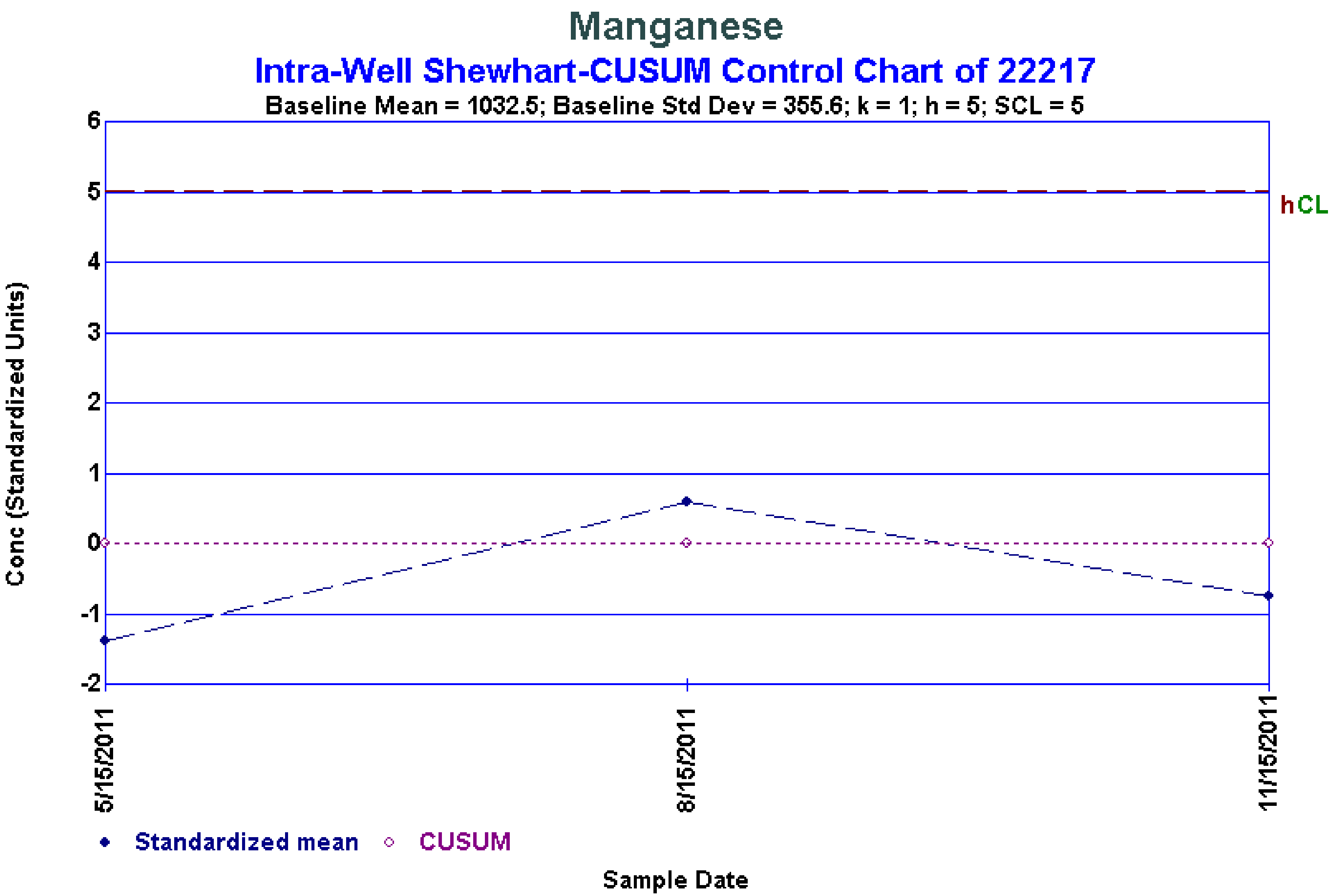


Figure A.5.8−42. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22217)

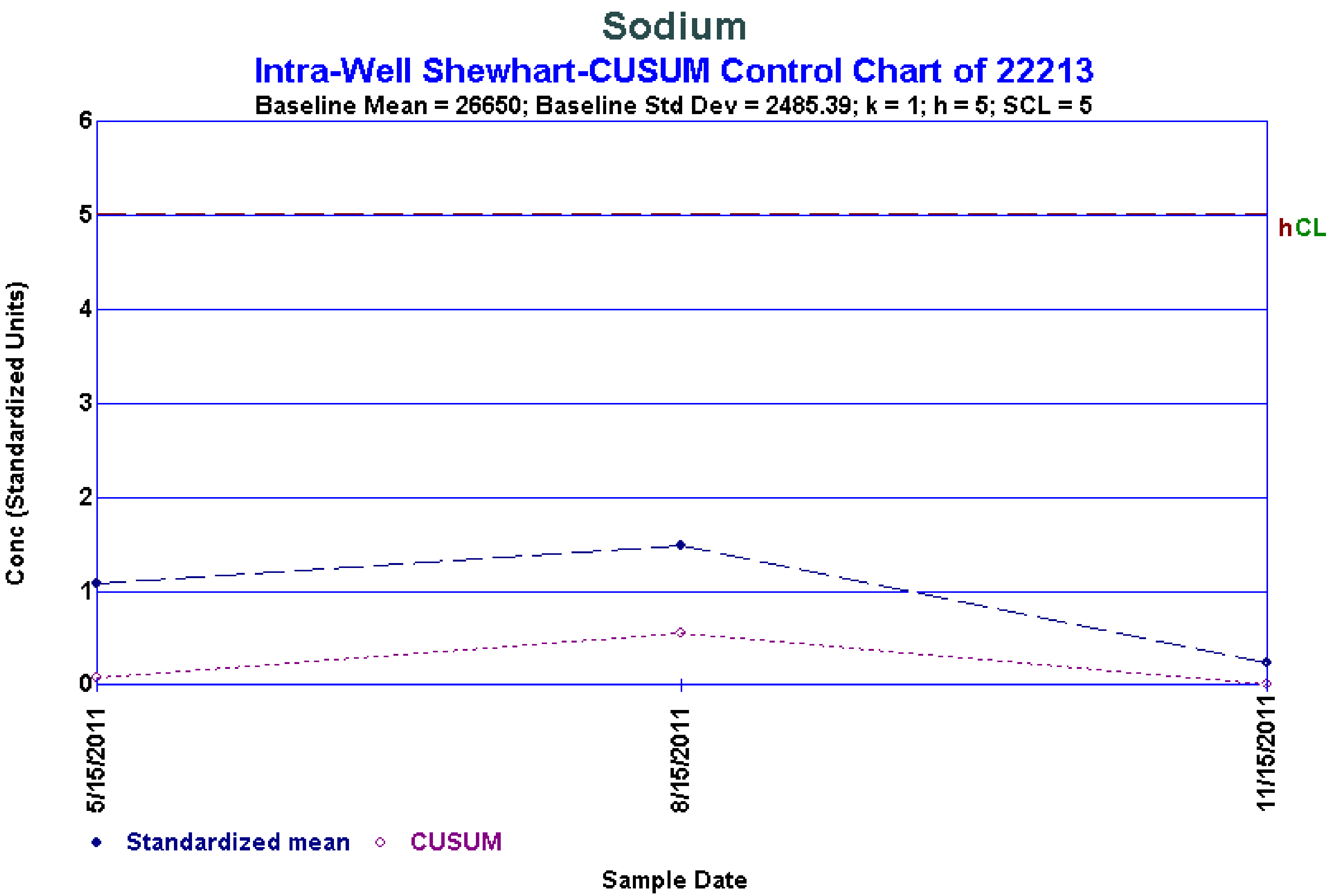


Figure A.5.8−43. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22213)

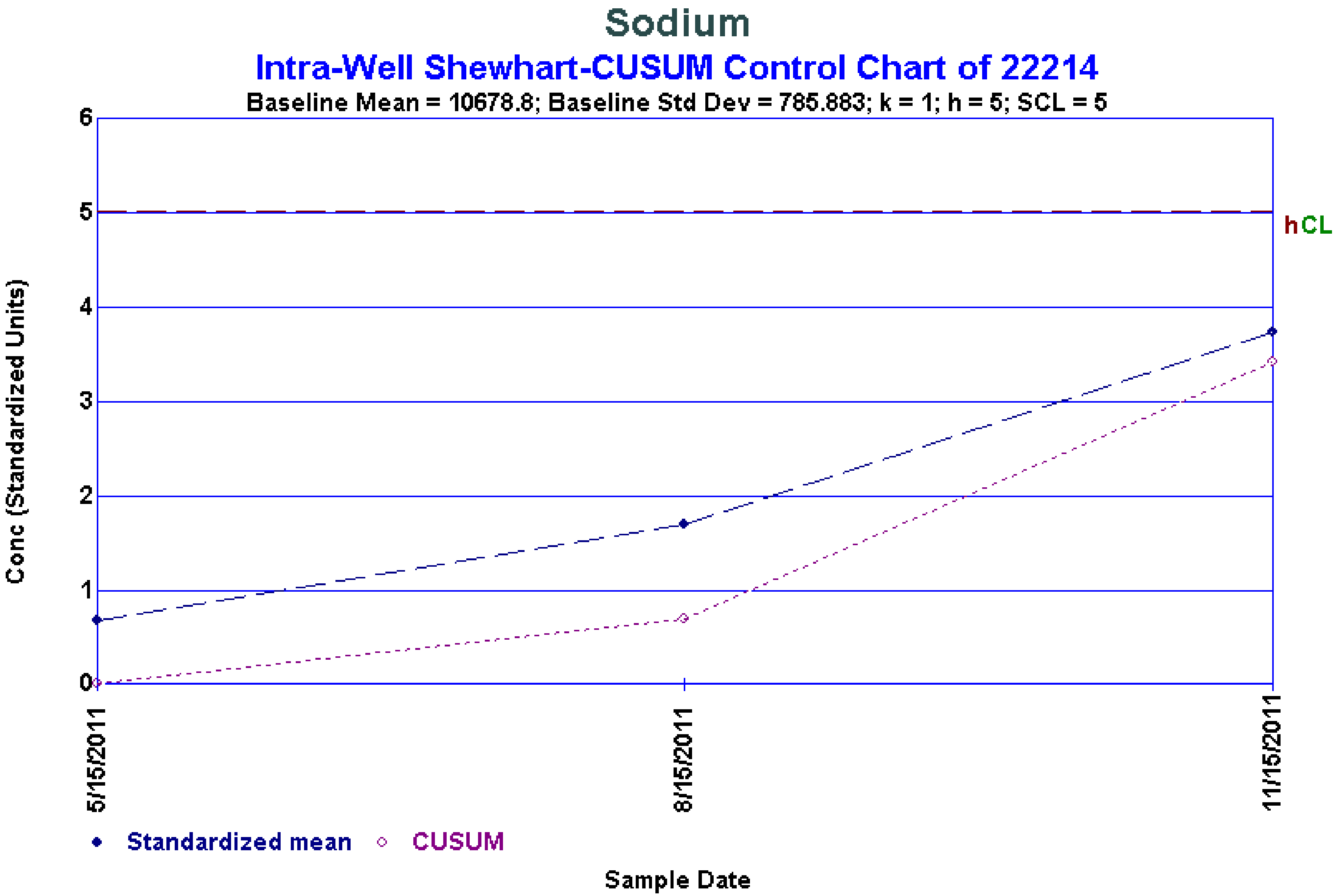


Figure A.5.8−44. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22214)

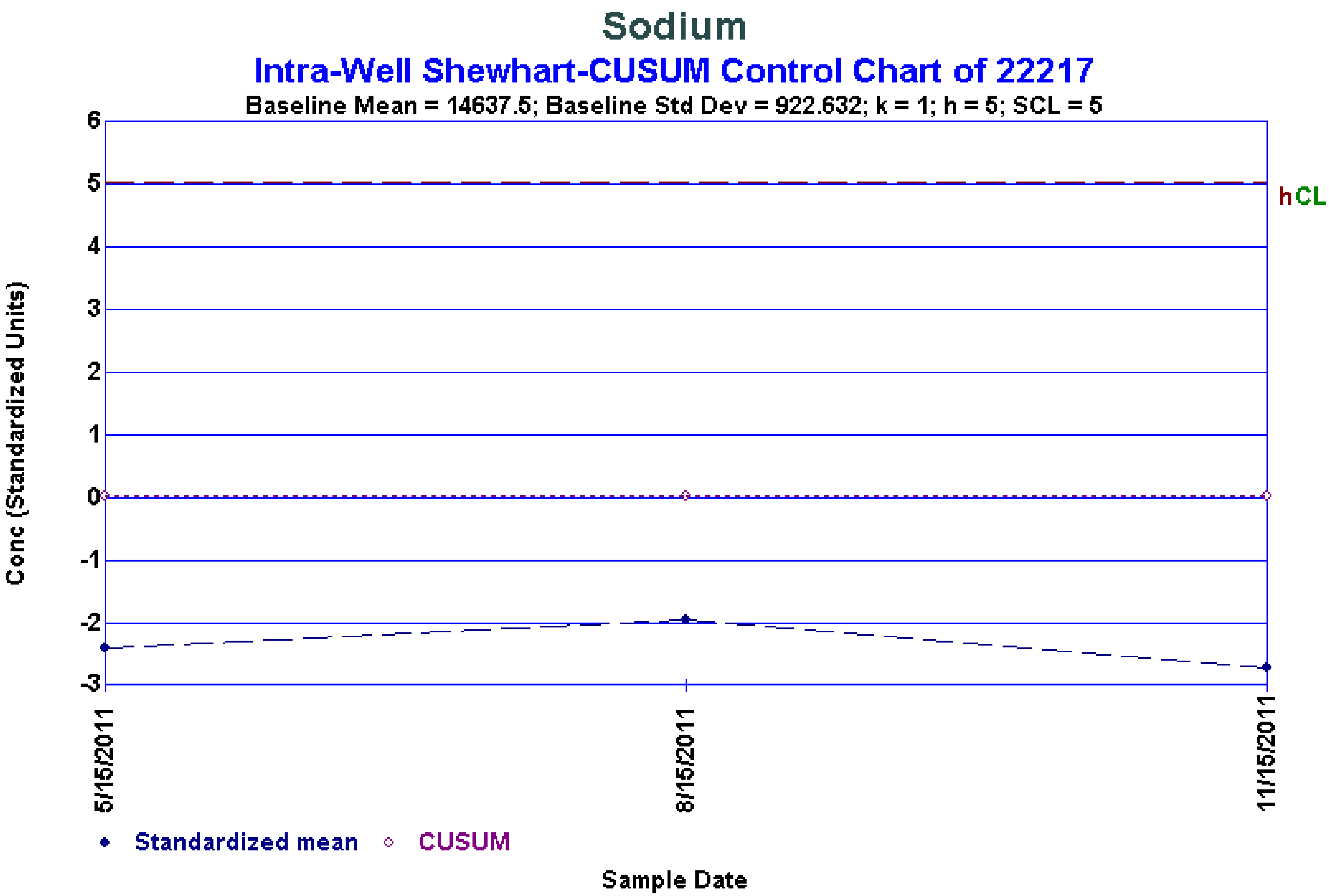


Figure A.5.8−45. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22217)

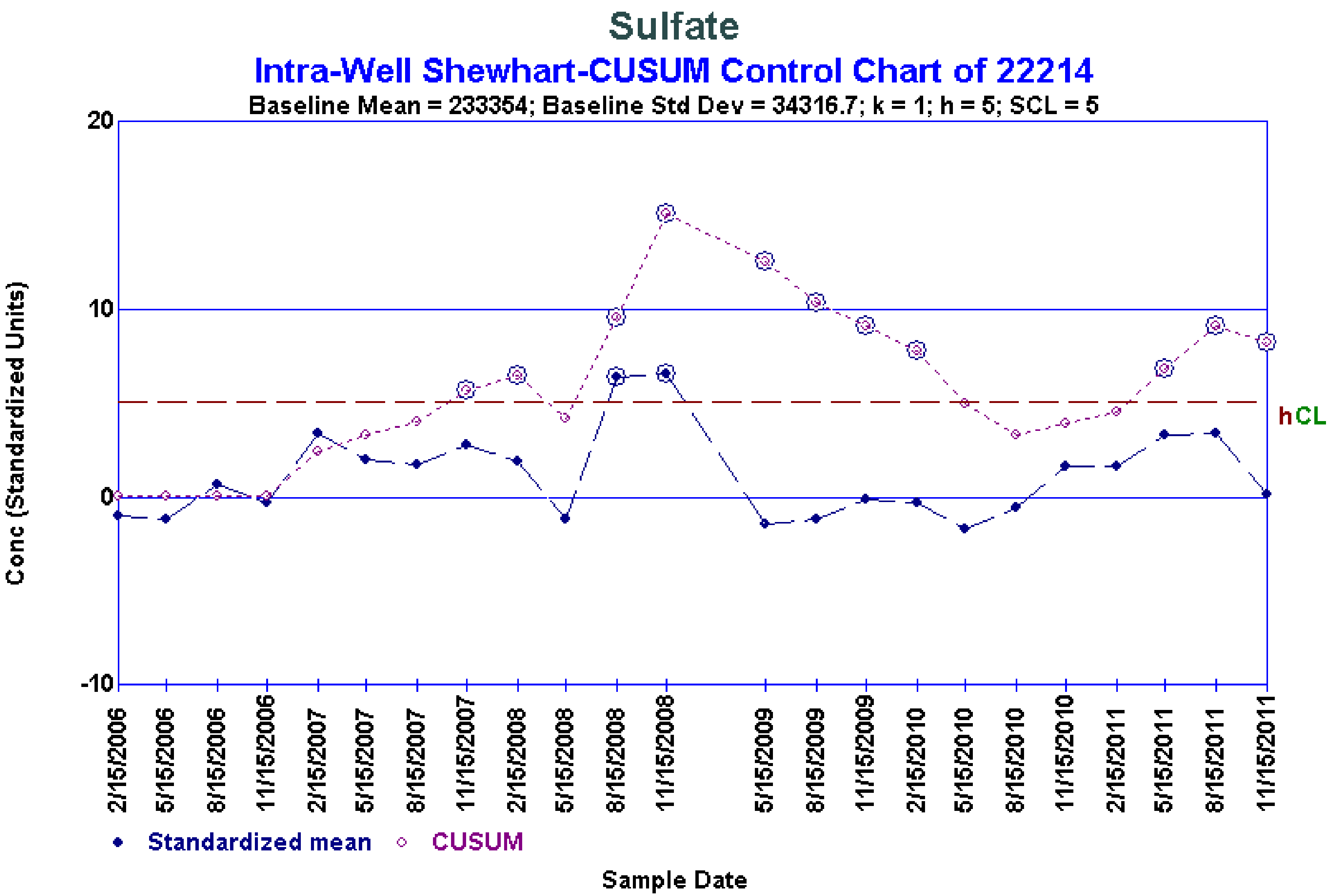


Figure A.5.8−46. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22214)

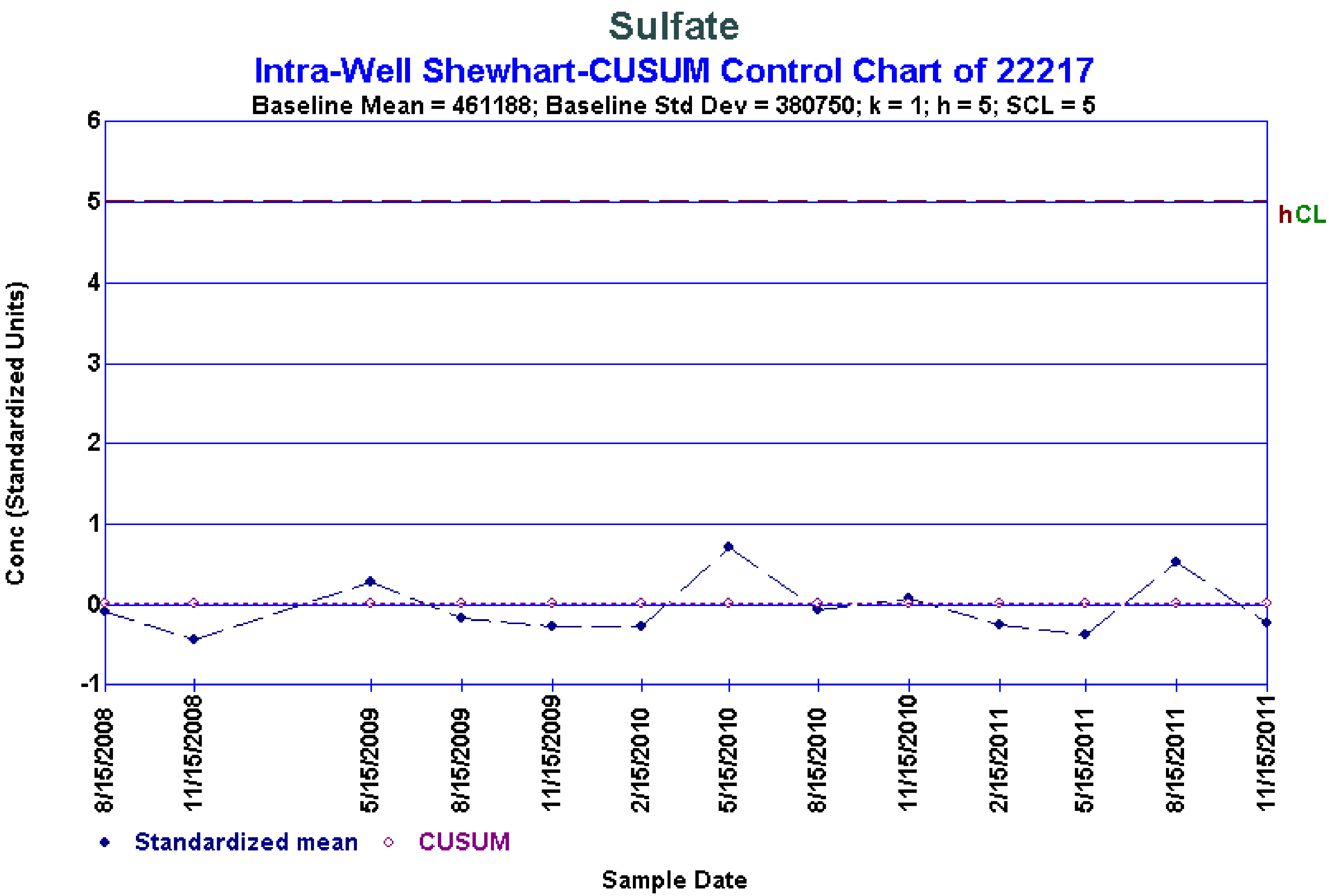


Figure A.5.8−47. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22217)

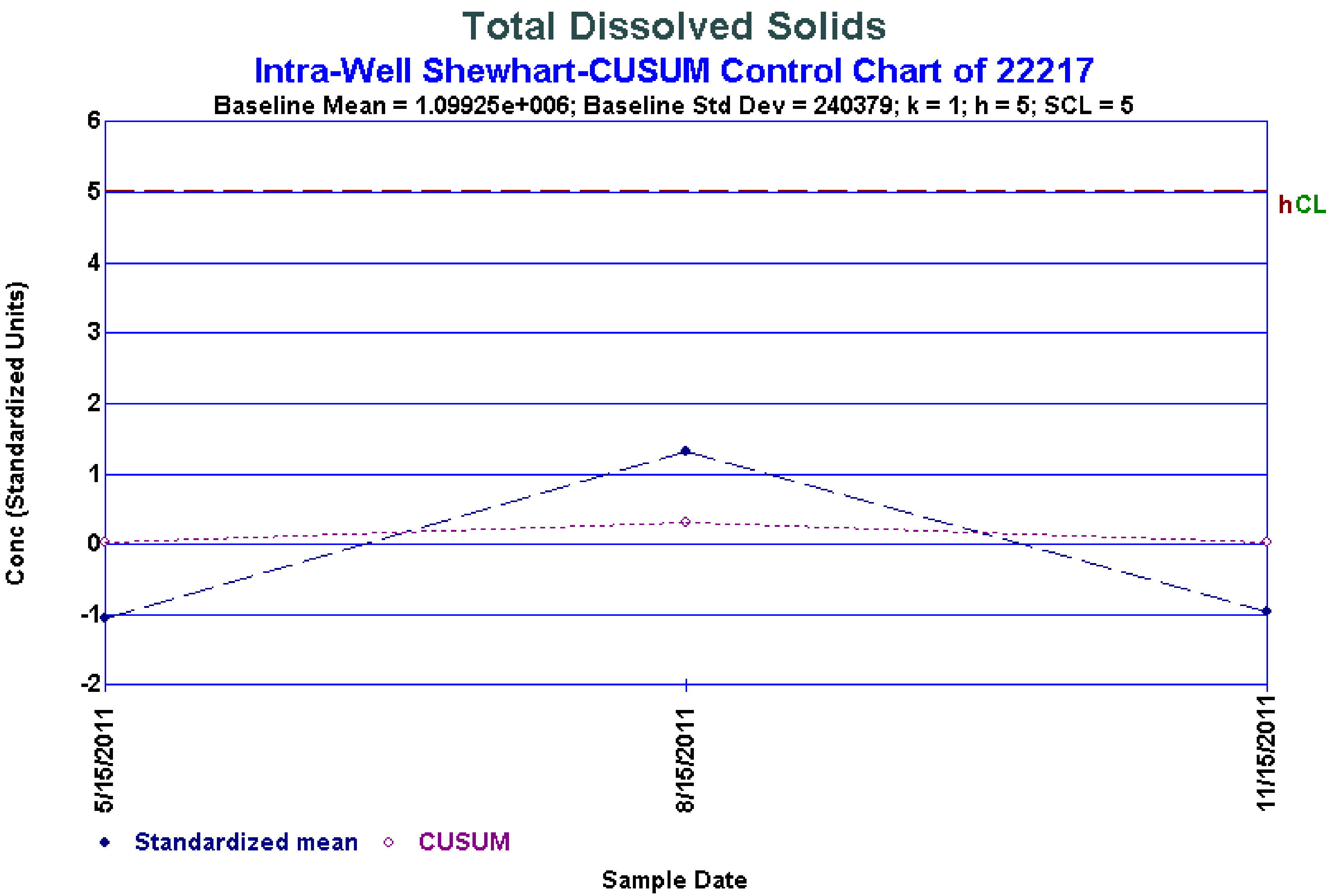


Figure A.5.8−48. Intra-Well Shewhart-CUSUM Control Chart (TDS 22217)

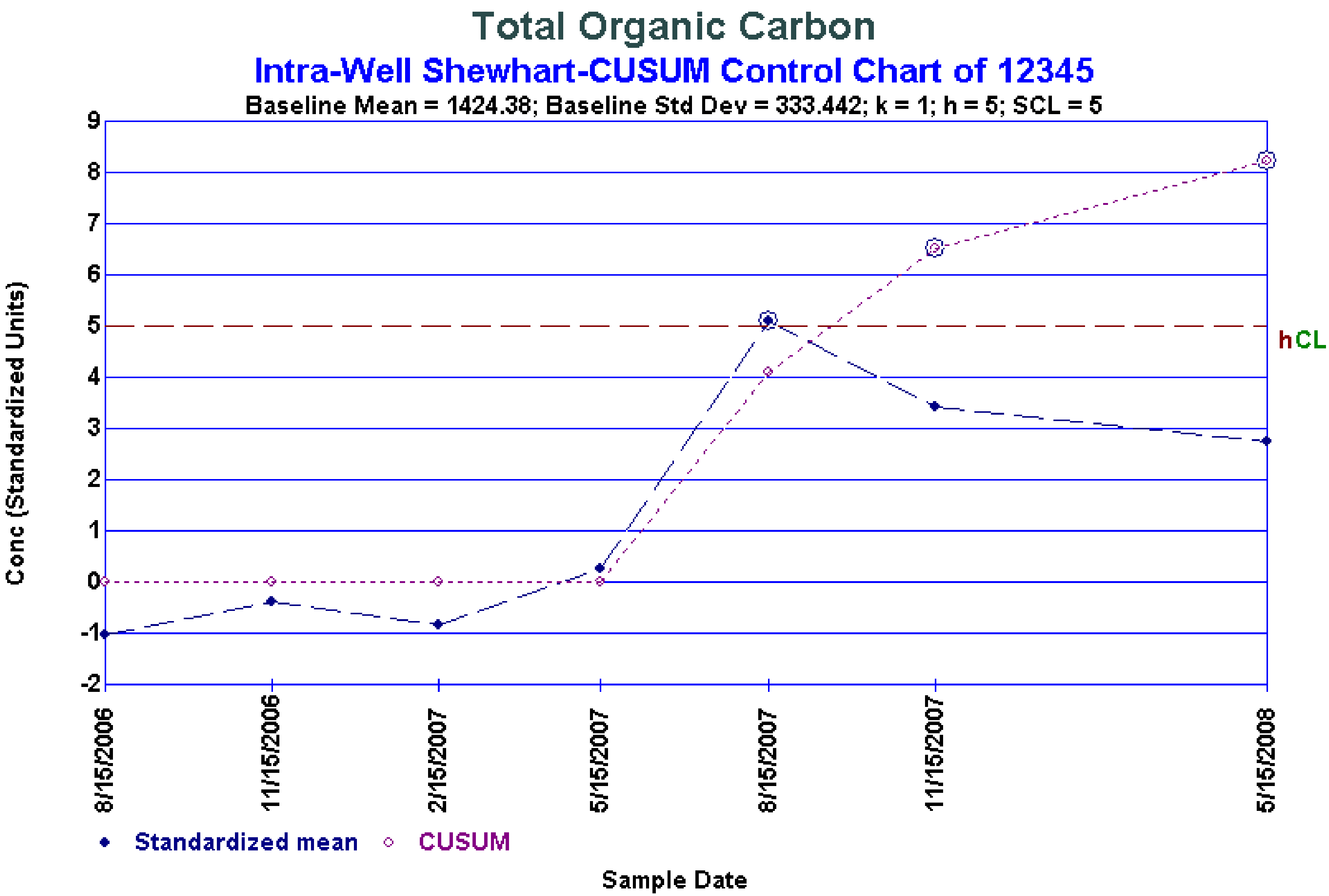


Figure A.5.8−49. Intra-Well Shewhart-CUSUM Control Chart (TOC 12345)

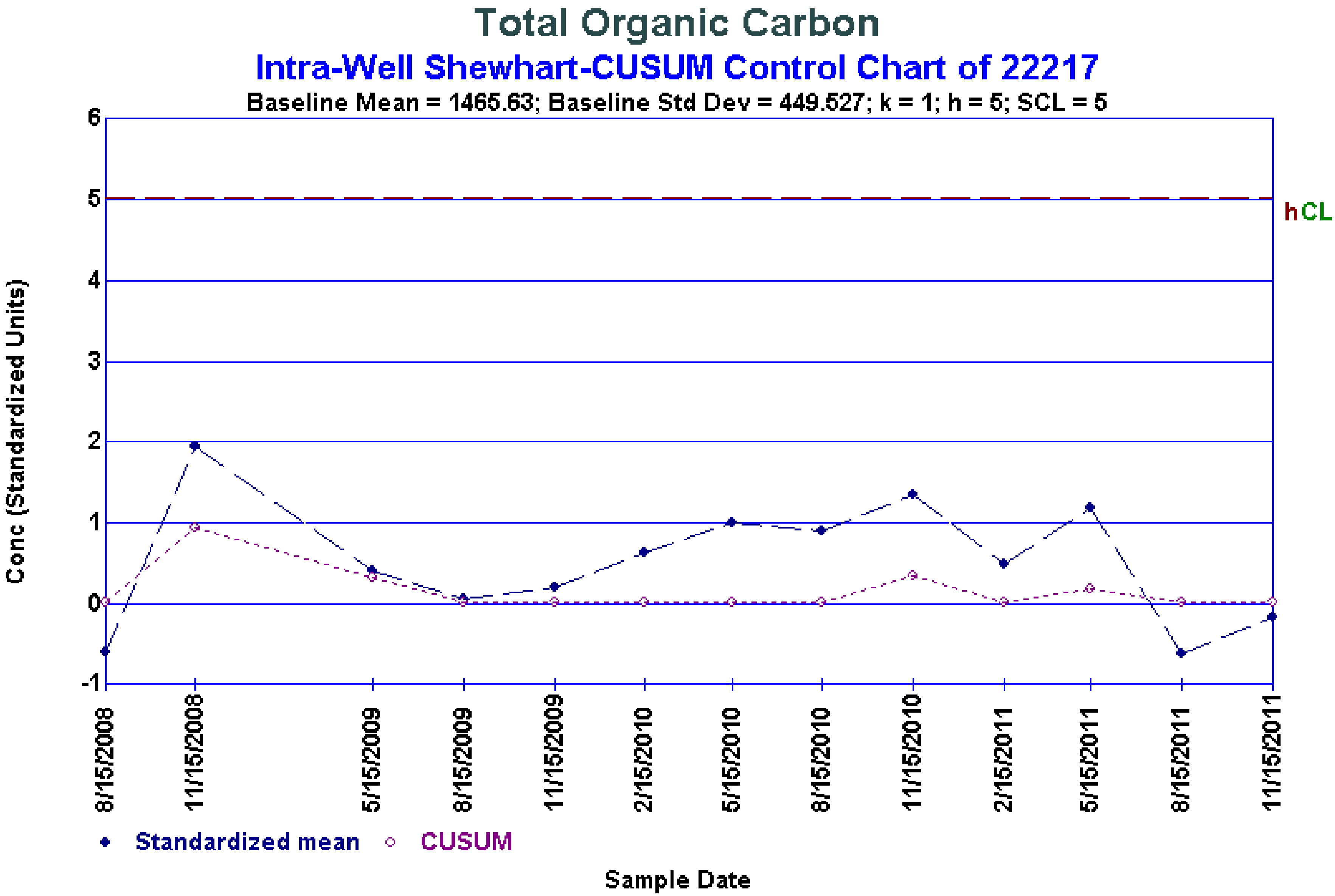


Figure A.5.8−50. Intra-Well Shewhart-CUSUM Control Chart (TOC 22217)

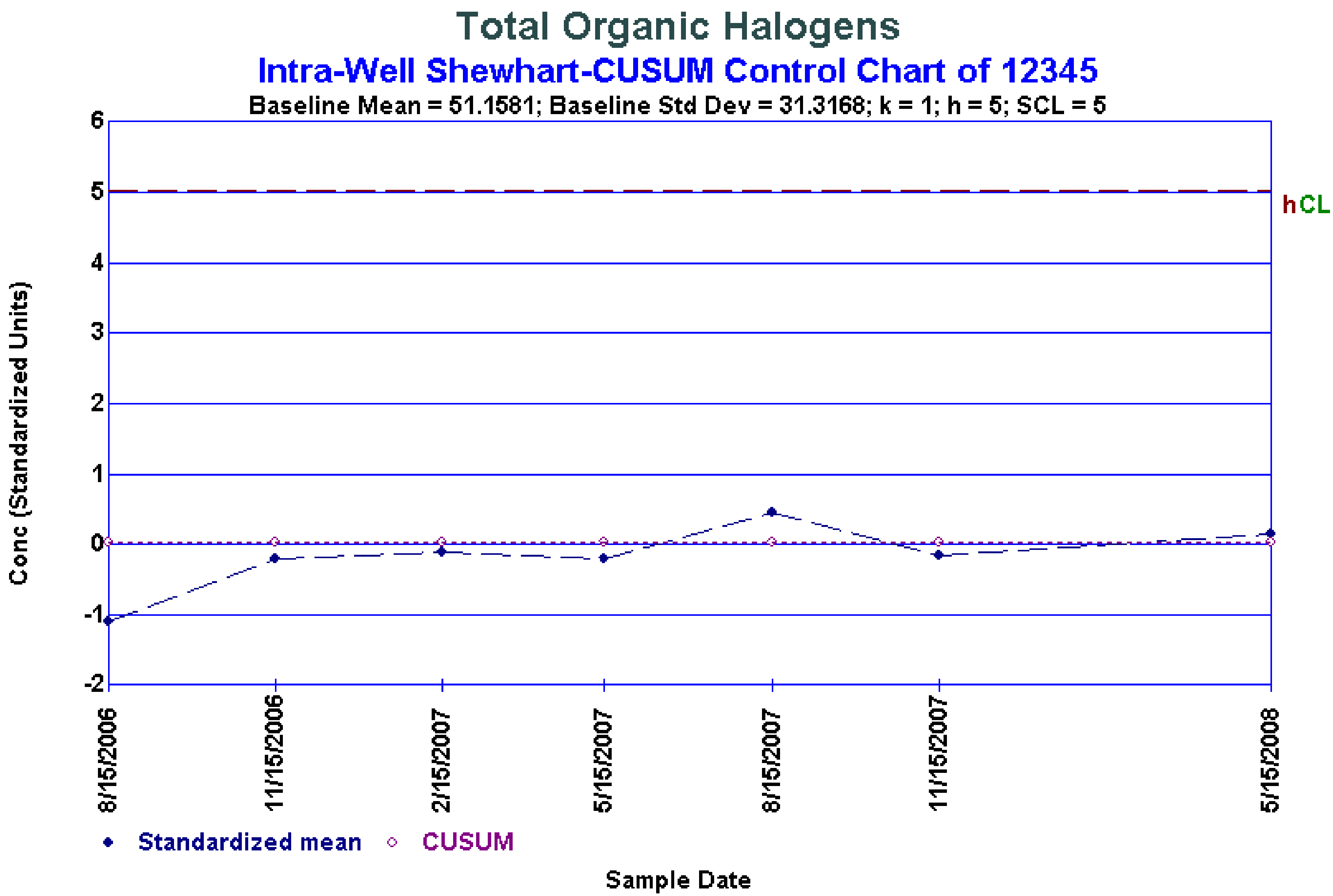


Figure A.5.8−51. Intra-Well Shewhart-CUSUM Control Chart (TOC 12345)

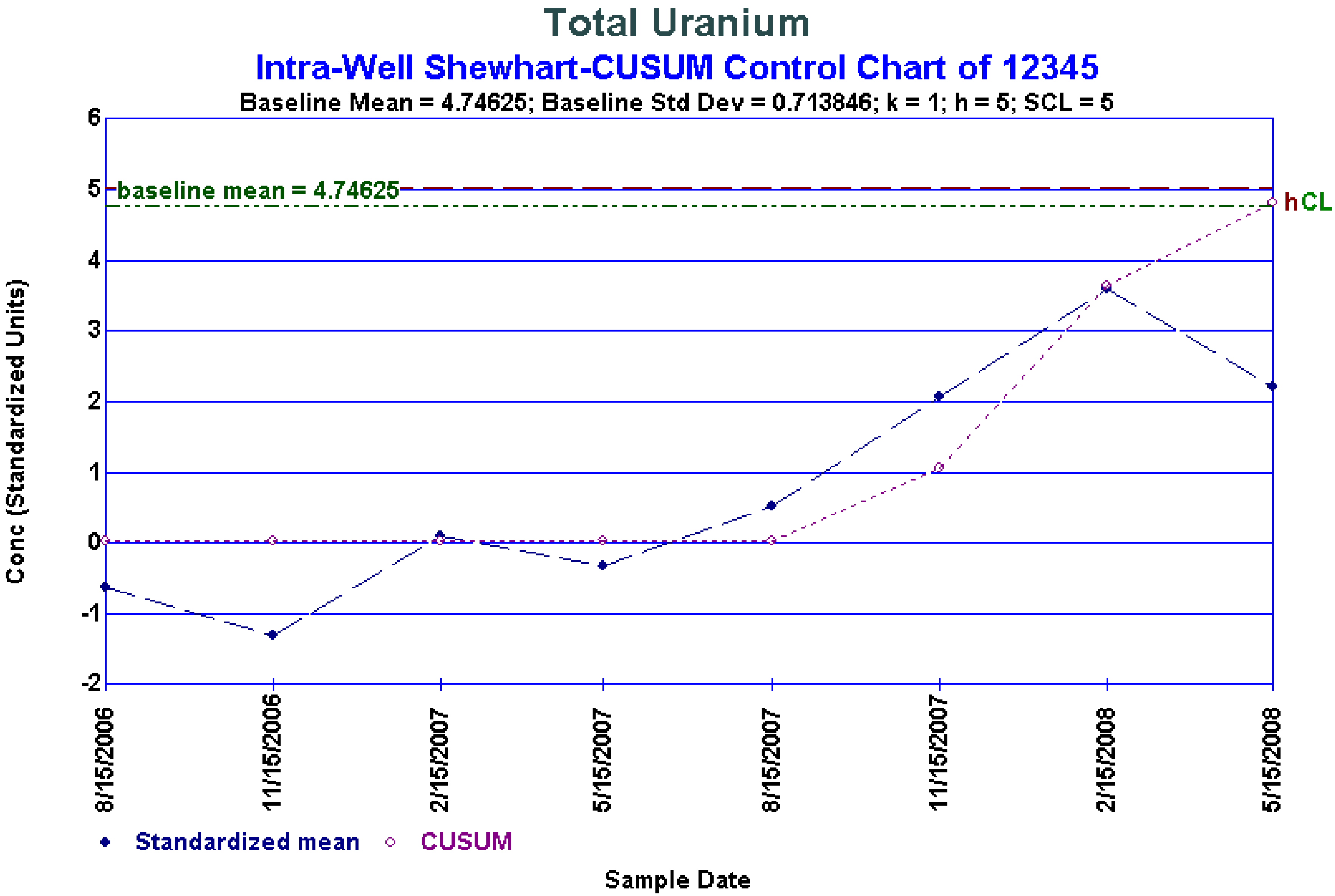


Figure A.5.8−52. Intra-Well Shewhart-CUSUM Control Chart (Uranium 12345)

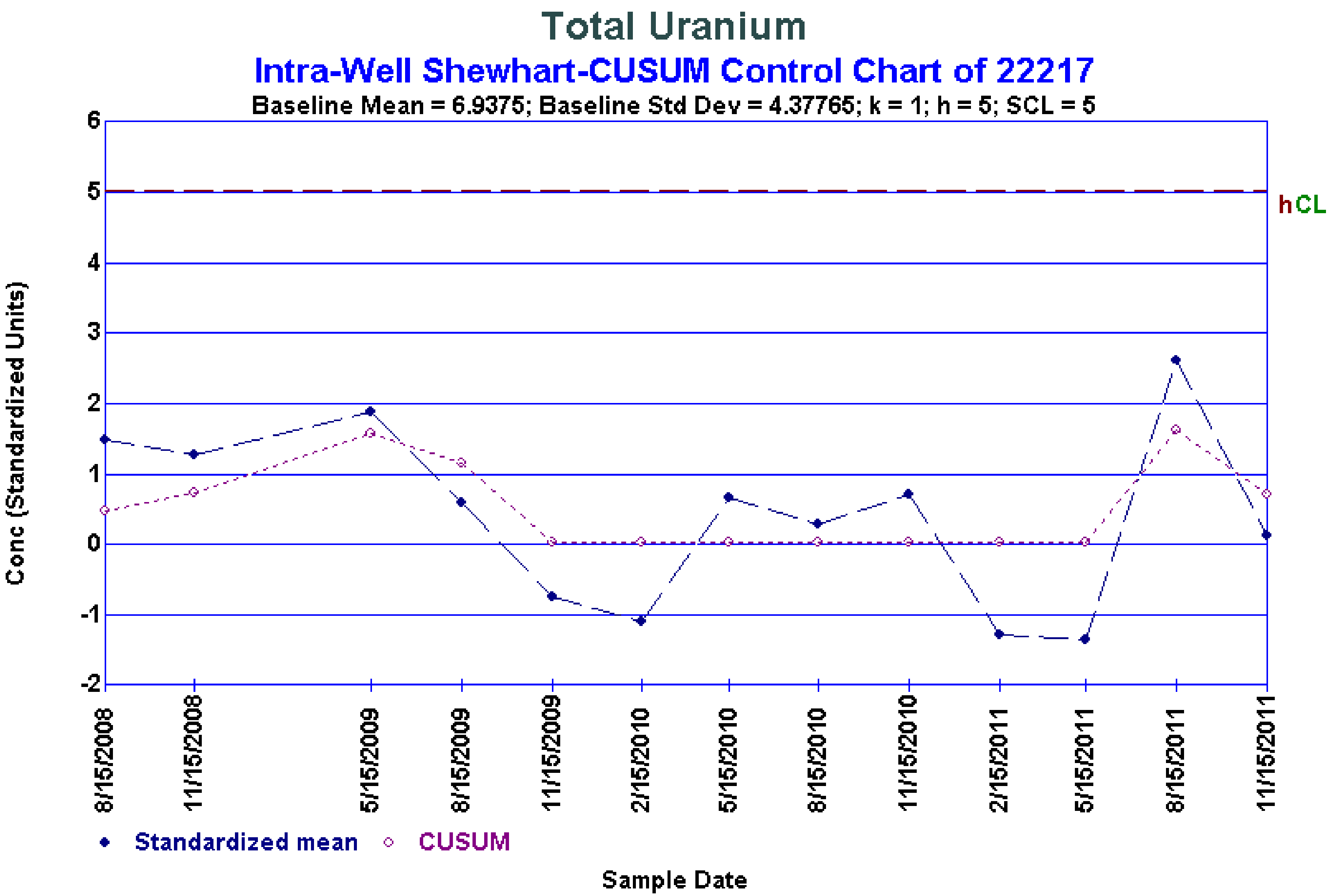


Figure A.5.8−53. Intra-Well Shewhart-CUSUM Control Chart (Uranium 22217)

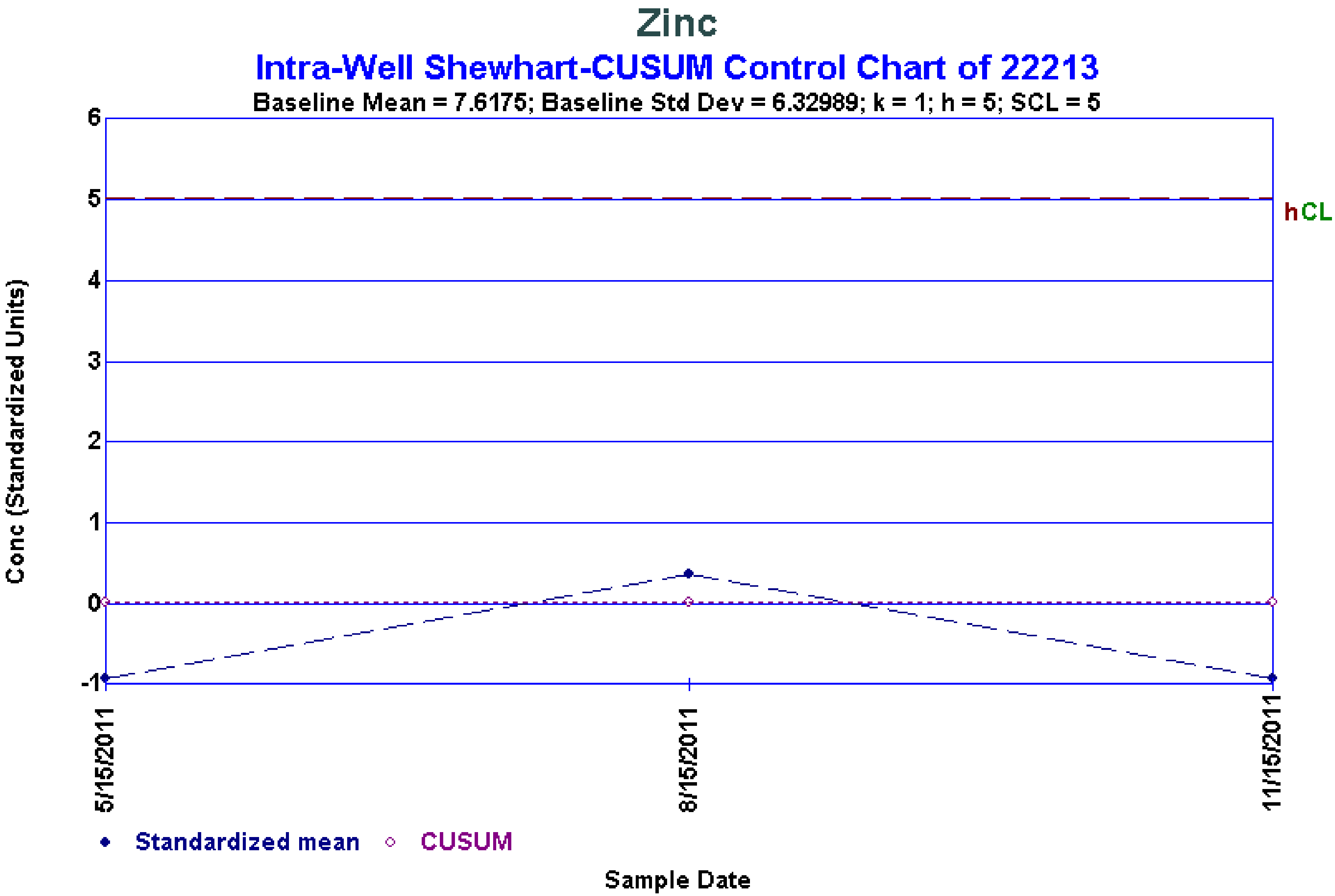


Figure A.5.8−54. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22213)

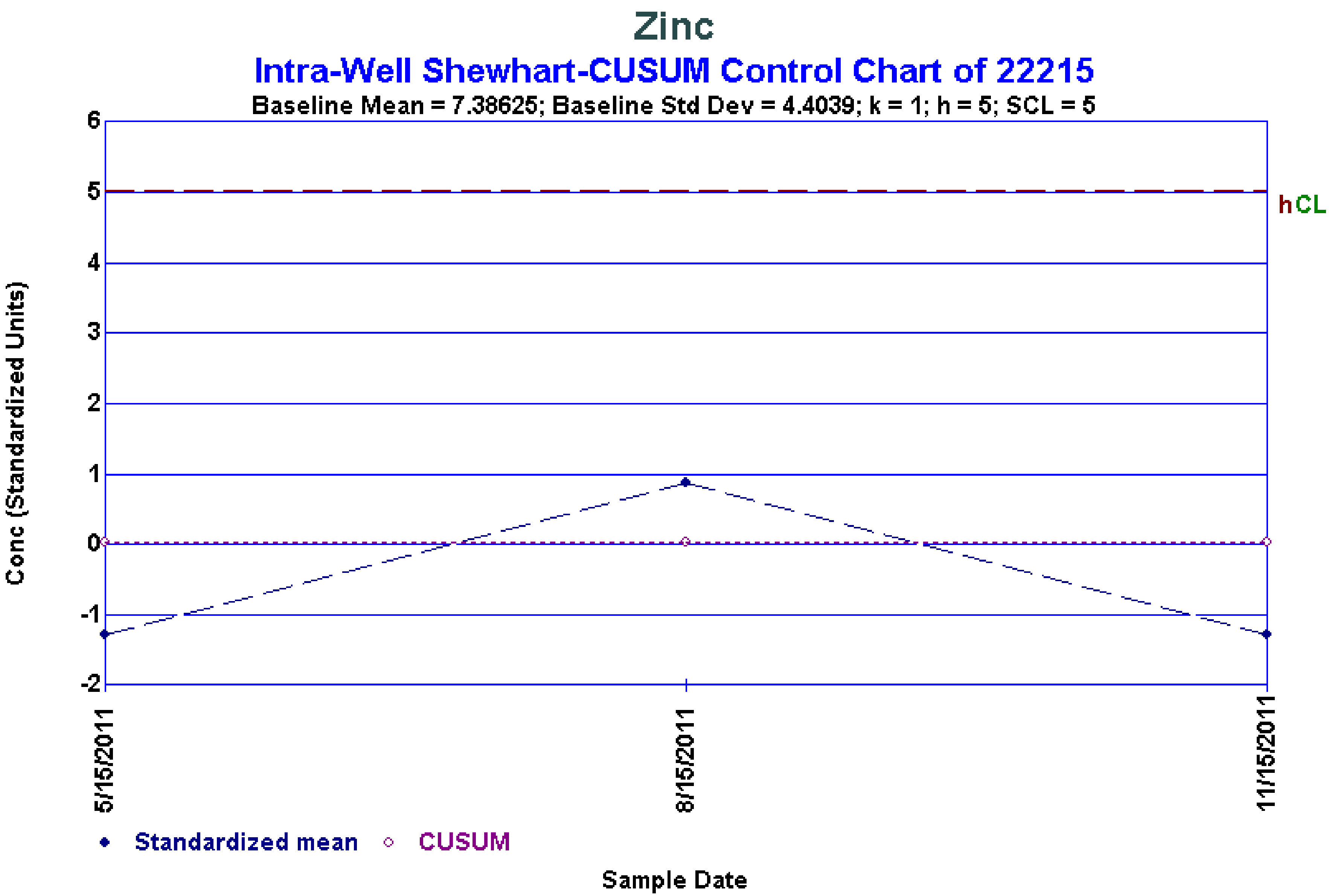


Figure A.5.8−55. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22215)

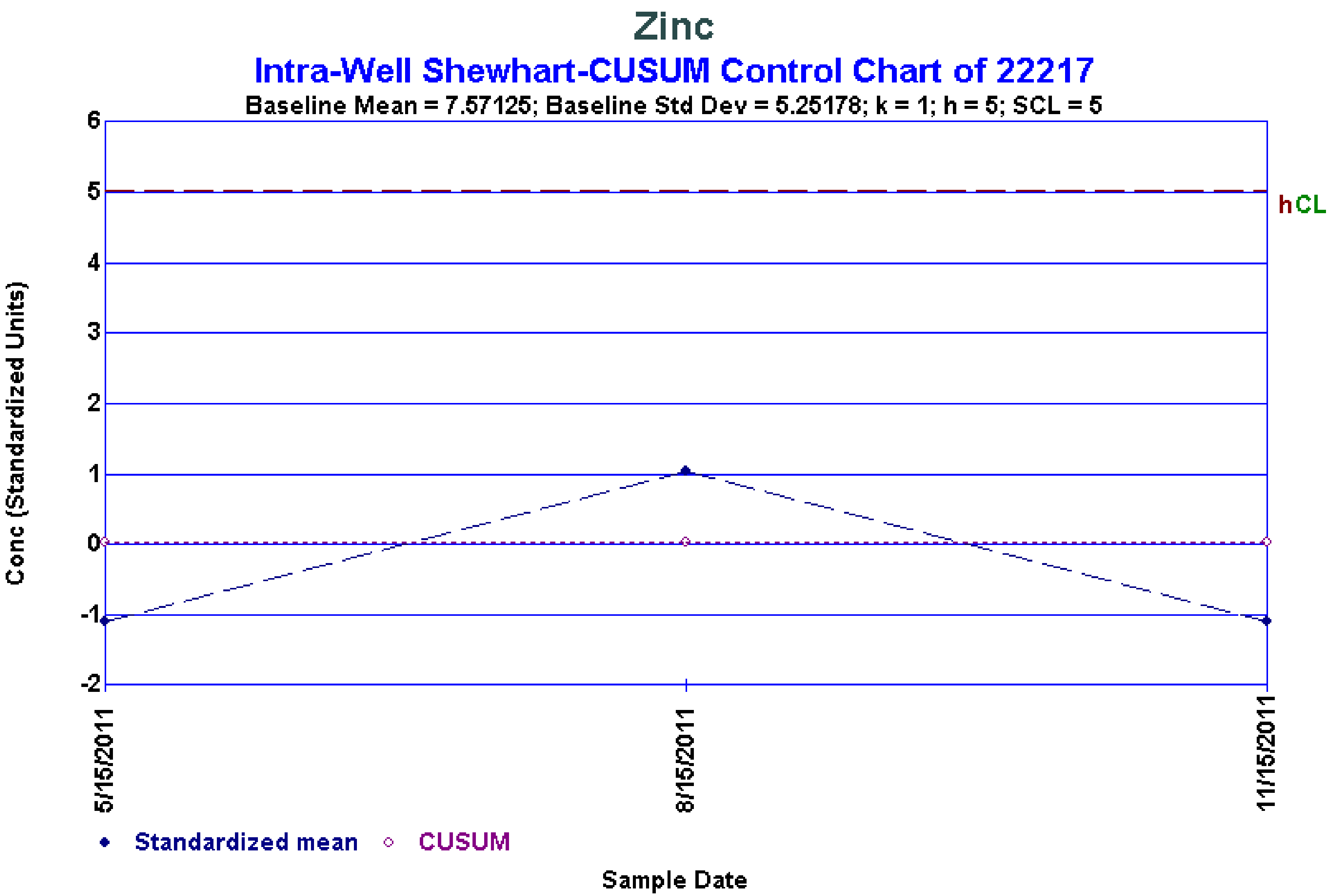


Figure A.5.8−56. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22217)