Sub-attachment A.5.1

Cell 1

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Abbreviations

CUSUM	Shewhart-cumulative sum
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
PCB	polychlorinated biphenyl
SCL	Shewhart control limit

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.1-1)
- Annual leachate collection system (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)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.1-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12338 water yield (refer to Figure A.5.1-3)
- Great Miami Aquifer (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 through A.5.1-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.1-30)
- Control charts (refer to Figures A.5.1-31 through A.5.1-45)

A.5.1.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF was operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. Summary statistics are provided in Table A.5.1-1.

Based on capacitance probe readings, the LDS tank of Cell 1 was not dry during 2014. It should be noted though that the capacitance probes have the ability of measuring to within hundredths of a foot of water present in the bottom of the tank. So, while water may register via the probes, there may not be enough water present to physically obtain a sample. This was the case in 2014 for the LDS in Cell 1. Therefore, from a sampling ability, the LDS in Cell 1 was considered to be dry all year.

As shown in Table A.5.1-1, and summarized below, five parameters (uranium, nitrate/nitrite as nitrogen, arsenic, boron, and selenium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 1

Parameter	HTW 12338	GMA-U[a] 22201	GMA-D[a] 22198
Total Uranium	Up	Up	
Nitrate/Nitrite as Nitrogen		Up	
Arsenic			Up
Boron		Up	
Selenium			Up

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

The (uranium-sodium) bivariate plot for the Cell 1 LCS, LDS, and HTW is provided in Figure A.5.1-30. 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, upward concentration trends measured beneath Cell 1 (i.e., in the HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

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 Shewhart-cumulative sum (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 "not in control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart 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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.1-1 in gray shading, 12 parameters in the HTW and GMA wells of Cell 1 meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 15 control charts.

These 15 control charts are presented in Figures A.5.1-31 through A.5.1-45. All of the control charts for Cell 1 indicate "in control" conditions.

Parameter	Monitoring Point[a]	Well Number	Assessment	Figure Number
Alkalinity	GMA-U	22201	In Control	A.5.1-31
Chloride	GMA-U	22201	In Control	A.5.1-32
Chloride	GMA-D	22198	In Control	A.5.1-33
TDS	GMA-D	22198	In Control	A.5.1-34
Calcium	GMA-D	22198	In Control	A.5.1-35
Chromium	GMA-D	22198	In Control	A.5.1-36
Iron	GMA-U	22201	In Control	A.5.1-37
Lithium	GMA-U	22201	In Control	A.5.1-38
Lithium	GMA-D	22198	In Control	A.5.1-39
Magnesium	GMA-U	22201	In Control	A.5.1-40
Magnesium	GMA-D	22198	In Control	A.5.1-41
Manganese	GMA-U	22201	In Control	A.5.1-42
Nickel	GMA-U	22201	In Control	A.5.1-43
Potassium	GMA-U	22201	In Control	A.5.1-44
Zinc	GMA-D	22198	In Control	A.5.1-45

[a] 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 biannually. No new Appendix I or polychlorinated biphenyl (PCB) parameters were detected in the LCS of Cell 1 in 2014.

A.5.1.4 Summary and Conclusions

- Five parameters have an upward concentration trend beneath Cell 1 in the HTW and/or GMA wells: uranium, nitrate-nitrite as nitrogen, 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. Therefore, upward concentration trends beneath Cell 1 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Fifteen control charts were constructed for Cell 1 parameters for monitoring horizons beneath the facility (HTW and GMA wells). 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 2014.

A.5.1.5 References

DOE (U.S. Department of Energy), 1994. *Fernald Environmental Management Project Fernald, Ohio Remedial Investigation and Feasibility Study*, May.

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial [d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12338C	63	64	98.4	ND	206	84.0	37.0	Normal	Up	Detected	
	LDS	12338D	37	37	100	1.5	37	10.8	6.8	Undefined	Up	Detected	
	HTW	12338	60	62	96.8	ND	12.7	8.54	3.80	Undefined	Up	Detected	
	GMA-U	22201	65	69	94.2	ND	11.2	3.99	3.14	Undefined	Up	Detected	
	GMA-D	22198	70	70	100	0.574	15.2	4.98	2.77	Undefined	None	Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12338C	33	33	100	227	721	339	136	Undefined	Down	Not Detected	
	LDS	12338D	7	7	100	206	528	362	109	Normal	None	Not Detected	
	GMA-U	22201	14	14	100	420	563	502	43	Normal	None	Not Detected	
	GMA-D	22198	14	14	100	224	383	367	49	Undefined	None	Not Detected	
Chloride (mg/L)	LCS	12338C	33	33	100	21.8	72.1	40.9	8.8	Undefined	Up	Detected	
	LDS	12338D	7	7	100	87.1	202	128	38.5	Normal	None	Not Detected	
	GMA-U	22201	14	14	100	32.6	45.0	38.4	3.5	Normal	None	Not Detected	75.0(Q2-11)
	GMA-D	22198	14	14	100	20.2	23.7	22.0	1.0	Normal	None	Not Detected	27.3(Q2-12)
Nitrate, Nitrite (mg/L)	LCS	12338C	32	44	72.7	ND	49	2.76	19.0	Undefined	Up	Detected	
	LDS	12338D	5	10	50	ND	359	0.0536	113	Undefined	None	Not Detected	
	GMA-U	22201	10	14	71.4	ND	1.11	0.379	0.354	LogNormal	Up	Not Detected	
	GMA-D	22198	9	34	26.5	ND	0.55	0.025	0.203	Undefined	Down	Detected	
Sulfate (mg/L)	LCS	12338C	50	50	100	707	2910	1660	670	Undefined	Up	Detected	
	LDS	12338D	19	19	100	675	3500	1850	780	LogNormal	Up	Detected	
	HTW	12338	40	40	100	484	907	671	112	Normal	Down	Detected	
	GMA-U	22201	45	45	100	91.8	1980	291	292	LogNormal	None	Detected	
	GMA-D	22198	45	45	100	101	506	178	98	Undefined	Down	Not Detected	
Total Dissolved Solids	LCS	12338C	43	43	100	1790	5200	3130	960	Undefined	Up	Detected	
	LDS	12338D	6	6	100	2430	7540	5170	2000	Normal	None	Not Detected	
	GMA-U	22201	21	21	100	703	1260	959	154	Normal	Down	Detected	
	GMA-D	22198	21	21	100	577	805	665	70	LogNormal	None	Not Detected	
Total Organic Carbon	LCS	12338C	62	64	96.9	ND	123	18.0	15.8	Undefined	Down	Detected	
	LDS	12338D	34	38	89.5	ND	15.7	6.51	2.96	Normal	None	Not Detected	80.9(Q2-98)
	GMA-U	22201	56	69	81.2	ND	59.7	2.44	7.53	Undefined	Down	Detected	
	GMA-D	22198	50	68	73.5	ND	15.8	1.51	2.57	Undefined	None	Not Detected	52.5(Q2-98)
Total Organic Halogens	LCS	12338C	60	65	92.3	ND	1.52	0.188	0.214	Undefined	None	Detected	
	LDS	12338D	28	38	73.7	ND	0.361	0.0527	0.0587	LogNormal	None	Not Detected	
	GMA-U	22201	28	69	40.6	ND	0.308	0.0075	0.0375	Undefined	Down	Not Detected	
	GMA-D	22198	12	68	17.6	ND	0.1	0.00256	0.0170	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12338C	14	38	36.8	ND	0.0786	0.00678	0.0128	LogNormal	None	Not Detected	
	LDS	12338D	1	9	11.1	ND	0.0125	INSUFF	INSUFF	LogNormal	None	Not Detected	
	HTW	12338	4	30	13.3	ND	0.0607	0.0025	0.0115	Undefined	None	Not Detected	
	GMA-U	22201	5	21	23.8	ND	0.04	0.0025	0.0092	Undefined	None	Not Detected	
	GMA-D	22198	8	55	14.6	ND	0.0372	0.0025	0.0071	Undefined	Up	Detected	
Barium (mg/L)	LCS	12338C	33	33	100	0.0241	0.205	0.0680	0.0444	LogNormal	Down	Detected	
	LDS	12338D	7	7	100	0.0146	0.0173	0.0156	0.0010	Normal	None	Not Detected	
	GMA-U	22201	15	15	100	0.0399	0.124	0.0739	0.0195	Normal	Down	Not Detected	
	GMA-D	22198	16	16	100	0.0562	0.138	0.0683	0.0206	Undefined	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial [d,g] Correlation	Outliers[h,i]
Boron (mg/L)	LCS	12338C	64	65	98.5	ND	2.81	0.999	0.502	Undefined	Down	Detected	
	LDS	12338D	37	38	97.4	0.169	0.345	0.243	0.043	LogNormal	None	Not Detected	0(Q3-00), 0.0296(Q1-98)
	GMA-U	22201	67	69	97.1	ND	0.158	0.121	0.028	Undefined	Up	Detected	
	GMA-D	22198	64	68	94.1	ND	0.0858	0.0557	0.0138	Normal	None	Detected	0.131(Q1-07)
Calcium (mg/L)	LCS	12338C	33	33	100	377	939	551	131	LogNormal	None	Not Detected	1,500(Q3-05)
	LDS	12338D	7	7	100	324	553	396	78	Normal	Up	Not Detected	
	GMA-U	22201	14	14	100	163	271	211	33	Normal	Down	Not Detected	
	GMA-D	22198	14	14	100	137	192	161	15	Normal	None	Not Detected	
Chromium (mg/L)	LCS	12338C	8	27	29.6	ND	0.00635	0.00120	$0.00170	Undefined	Up	Detected	
	LDS	12338D	2	6	33.3	ND	0.0071	INSUFF	INSUFF	Undefined	None	Not Detected	
	GMA-U	22201	4	7	57.1	ND	0.0475	0.00816	0.0171	LogNormal	Down	Not Detected	
	GMA-D	22198	5	21	23.8	ND	0.0111	0.00180	0.00269	LogNormal	None	Not Detected	
Cobalt (mg/L)	LCS	12338C	17	38	44.7	ND	0.0575	0.00100	0.0129	Undefined	Down	Detected	
	LDS	12338D	6	9	66.7	ND	0.0019	0.00110	0.00050	Normal	None	Not Detected	
	GMA-U	22201	4	21	19.0	ND	0.00223	0.000500	0.000533	Undefined	None	Not Detected	
	GMA-D	22198	6	41	14.6	ND	0.0045	0.000500	0.000796	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12338C	25	34	73.5	ND	0.0285	0.00965	0.00696	Undefined	None	Not Detected	
	LDS	12338D	6	8	75.0	ND	0.0231	0.00980	0.00692	Normal	None	Not Detected	
	GMA-U	22201	6	14	42.9	ND	0.011	0.00150	0.00377	Undefined	Down	Not Detected	
	GMA-D	22198	6	15	40.0	ND	0.0104	0.00150	0.00322	Undefined	None	Not Detected	
Iron (mg/L)	LCS	12338C	33	38	86.8	ND	101	0.172	16.9	Undefined	Down	Detected	
	LDS	12338D	7	9	77.8	ND	2.55	1.3	1.0	Normal	None	Detected	
	GMA-U	22201	20	21	95.2	ND	4.42	1.56	1.50	LogNormal	None	Not Detected	
	GMA-D	22198	34	34	100	0.531	6.92	2.90	1.44	Undefined	Down	Detected	
Lithium (mg/L)	LCS	12338C	30	30	100	0.103	0.232	0.157	0.036	Normal	Up	Detected	
	LDS	12338D	9	9	100	0.0333	0.075	0.0561	0.0137	Normal	None	Not Detected	
	GMA-U	22201	21	21	100	0.00723	0.0153	0.0108	0.0025	Normal	None	Not Detected	
	GMA-D	22198	21	21	100	0.00624	0.0107	0.00912	0.00097	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12338C	33	33	100	71.4	525	319	162	Undefined	Up	Detected	
	LDS	12338D	7	7	100	120	326	179	68	LogNormal	None	Not Detected	
	GMA-U	22201	14	14	100	36.1	65.3	46.2	8.0	Normal	None	Not Detected	
	GMA-D	22198	14	14	100	36.2	47.8	41.8	3.4	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12338C	16	38	42.1	ND	7.7	0.01	1.63	Undefined	Down	Detected	
	LDS	12338D	8	9	88.9	ND	0.184	0.0277	0.0579	LogNormal	Down	Not Detected	
	GMA-U	22201	23	23	100	0.0322	2.06	0.821	0.657	LogNormal	None	Not Detected	
	GMA-D	22198	54	55	98.2	ND	1.09	0.513	0.189	LogNormal	None	Detected	
Nickel (mg/L)	LCS	12338C	31	38	81.6	ND	0.0535	0.00357	0.0163	Undefined	Down	Detected	
	LDS	12338D	9	9	100	0.00486	0.0353	0.0169	0.0082	Normal	None	Not Detected	
	GMA-U	22201	20	21	95.2	ND	0.0115	0.00472	0.00244	Normal	None	Not Detected	
	GMA-D	22198	19	55	34.6	ND	0.13	0.000800	0.0174	Undefined	Down	Not Detected	
Potassium (mg/L)	LCS	12338C	33	33	100	10.8	30	23.7	5.5	Undefined	Up	Detected	
	LDS	12338D	7	7	100	13.2	35.4	19.8	7.4	LogNormal	None	Not Detected	
	GMA-U	22201	14	14	100	2.28	3.97	3.16	0.47	Normal	None	Not Detected	
	GMA-D	22198	14	14	100	1.58	2.07	1.82	0.14	Normal	Down	Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial [d,g] Correlation	Outliers[h,i]
Selenium (mg/L)	LCS	12338C	17	38	44.7	ND	0.0715	0.00514	0.0155	LogNormal	Up	Not Detected	
	LDS	12338D	1	9	11.1	ND	0.076	Insufficient	Insufficient	Undefined	Up	Not Detected	
	GMA-U	22201	0	21	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22198	4	41	9.8	ND	0.00758	0.00250	0.00133	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12338C	38	38	100	11.7	29.3	18.4	3.4	LogNormal	Up	Detected	
	LDS	12338D	9	9	100	335	896	571	216	Normal	Up	Not Detected	
	HTW	12338	30	30	100	10.2	23.8	15.2	3.7	LogNormal	Down	Detected	
	GMA-U	22201	21	21	100	38.2	65.5	47.9	9.5	Undefined	Down	Detected	
	GMA-D	22198	21	21	100	12.9	17.1	14.6	1.2	Normal	Down	Not Detected	
Zinc (mg/L)	LCS	12338C	20	38	52.6	ND	0.575	0.0141	0.128	Undefined	Down	Detected	
	LDS	12338D	9	9	100	0.0557	0.671	0.239	0.190	LogNormal	None	Not Detected	
	GMA-U	22201	11	21	52.4	ND	0.0127	0.00568	0.00365	Undefined	None	Not Detected	
	GMA-D	22198	20	55	36.4	ND	0.0116	0.00372	0.00250	LogNormal	None	Not Detected	0.0474(Q2-97)

Note 1: 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 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater Background)	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched Water)
General Chemistry											
Ammonia (mg/L)	17	13	76.5	Yes	0.03	4.5	0.662	-	4.2 mg/L(1)	4.34 mg/L(1)	220 mg/L(0)
Inorganic											
Beryllium (mg/L)	17	2	11.8	No	0.0000674	0.000120	0.000100	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	17	4	23.5	No	0.000140	0.000840	0.000400	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Lead (mg/L)	17	2	11.8	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)	31	2	6.5	No	0.00000024	0.000470	0.000200	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Silver (mg/L)	17	1	5.9	No	0.000140	-	-	0.05 mg/L(0)	0.0117 mg/L(0)	0.0031 mg/L(0)	0.264 mg/L(0)
Thallium (mg/L)	17	2	11.8	No	0.000700	0.00756	0.00410	-	-	-	0.0028 mg/L(1)
Radionuclide											
Technetium-99 (pCi/L)	33	8	24.2	Yes	1.81	30.4	12.5	94 pCi/L(0)	22 pCi/L(1)	30 pCi/L(1)	6130 pCi/L(0)
Organic											
4-Nitroaniline (ug/L)	30	1	3.3	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the final remediation level (FRL), groundwater background, perched water background, or perched water 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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

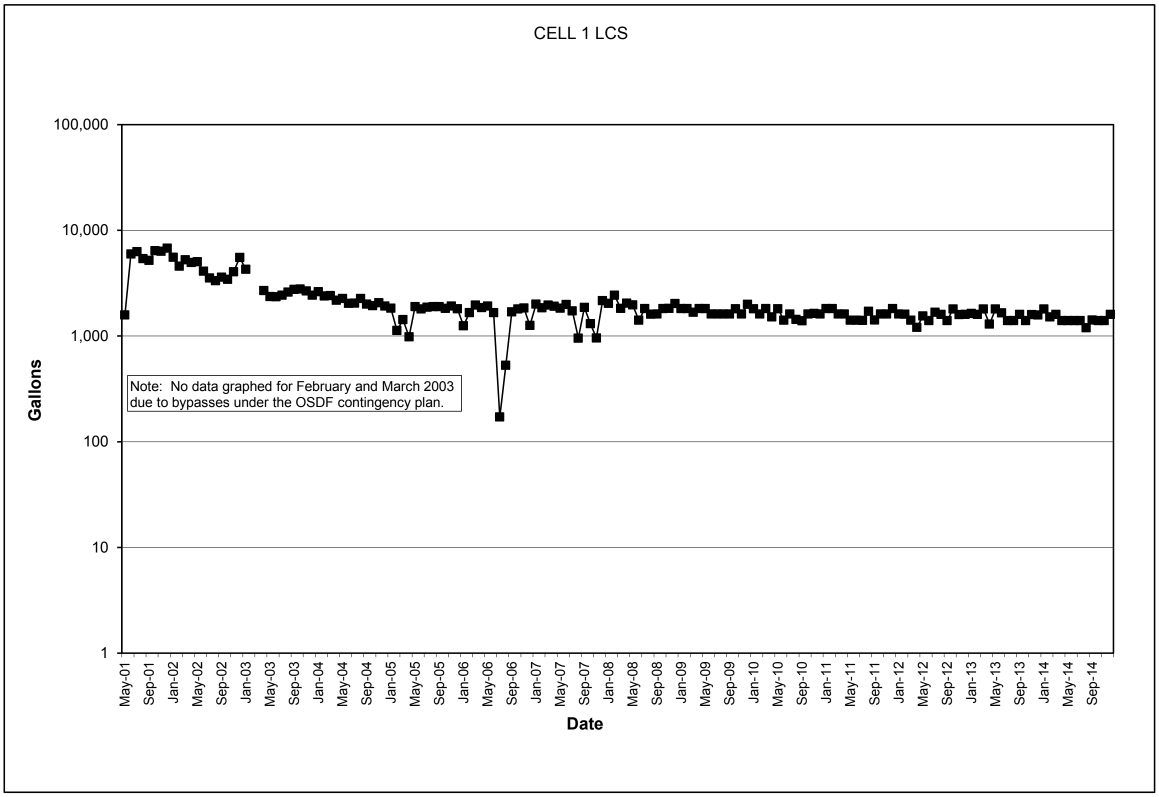


Figure A.5.1-1. Monthly Accumulation Volumes For Cell 1 LCS

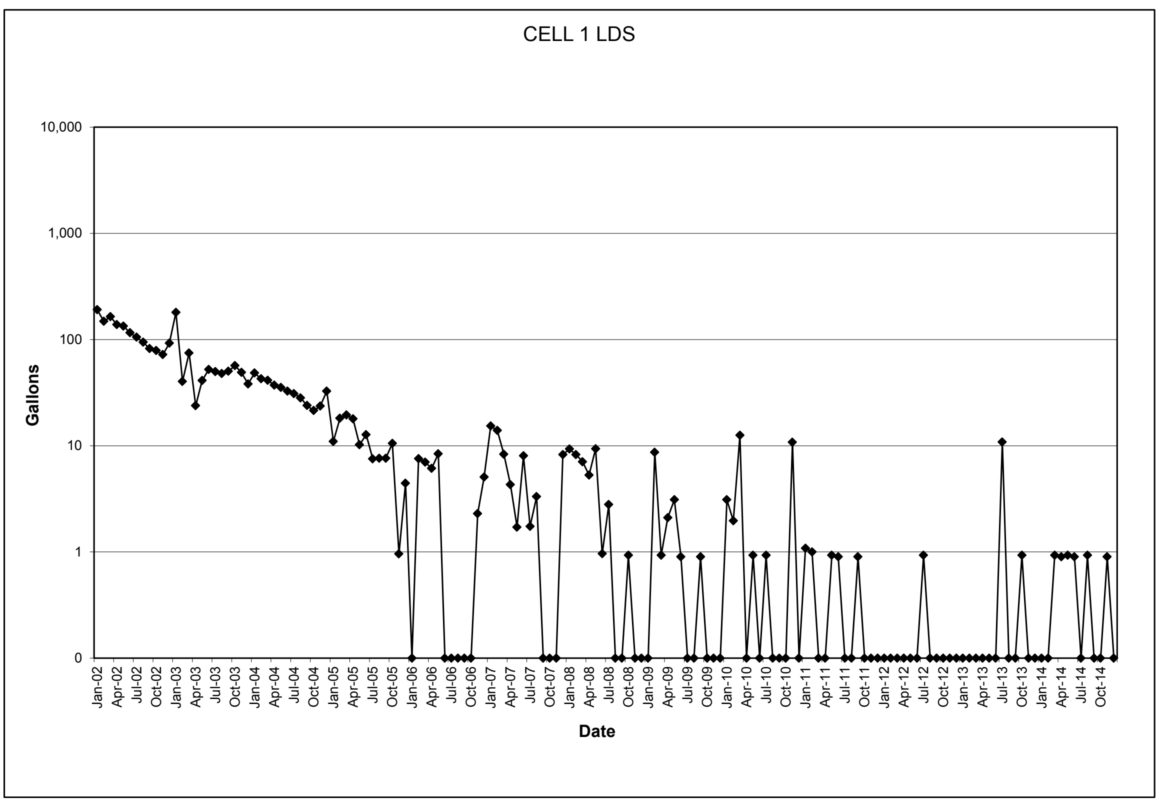
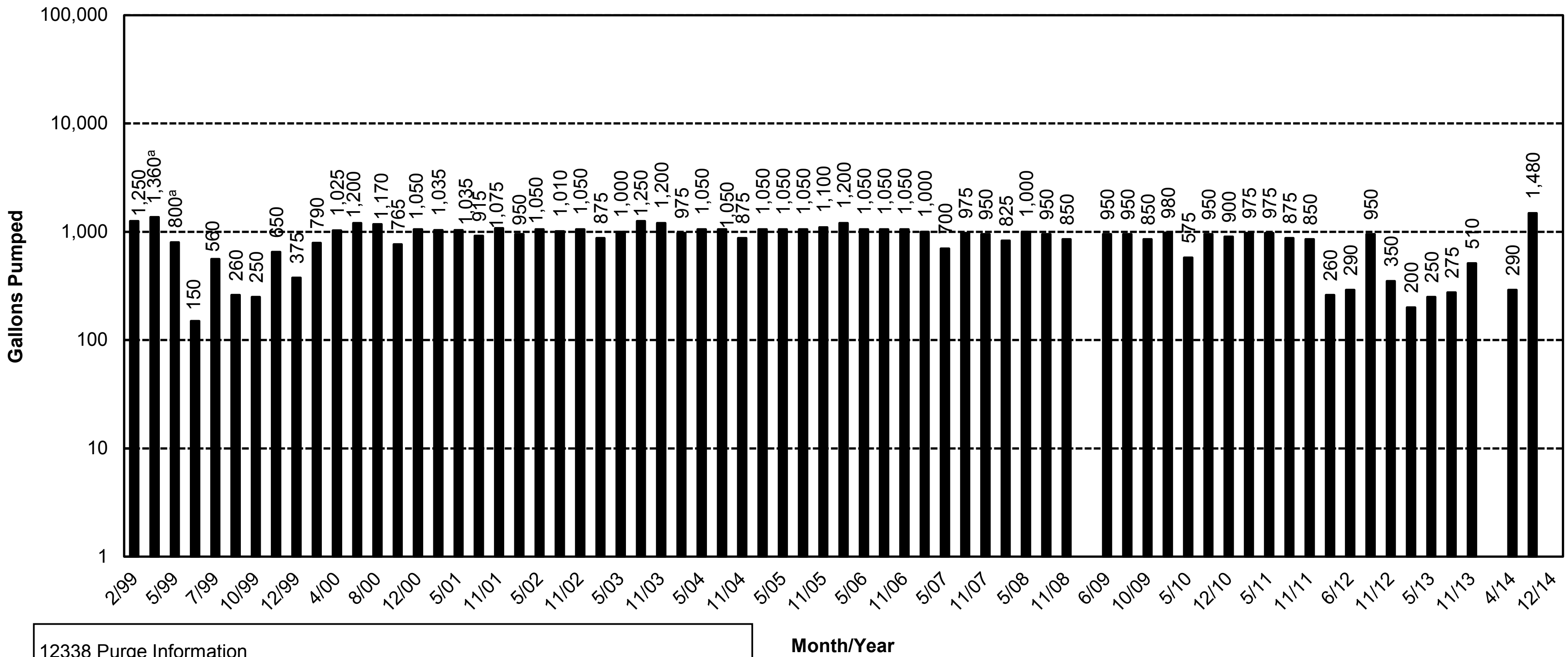


Figure A.5.1-2. Monthly Accumulation Volumes For Cell 1 LDS



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
2012:	1850	n=4	463
2013:	1235	n=4	309
2014[b]:	1770	n=2	885
Overall:			862

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

[b]Sampling schedule reduced to semi-annual sampling in 2014.

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

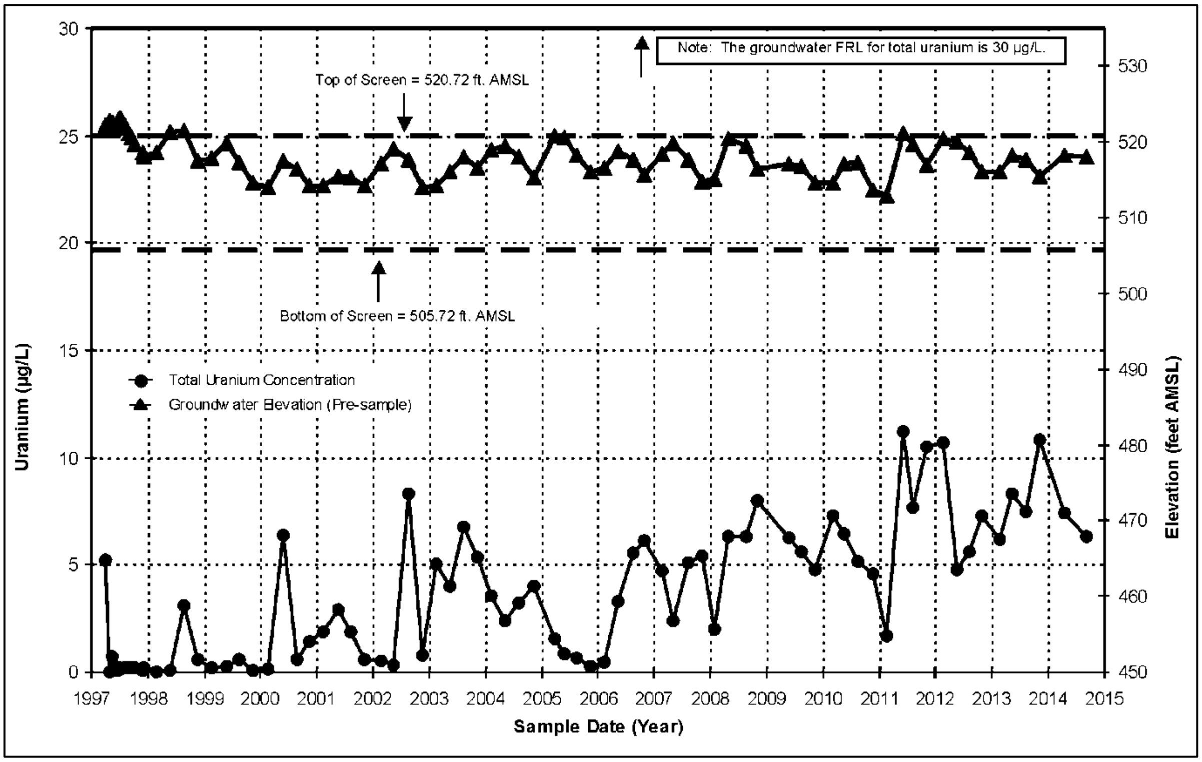


Figure A.5.1-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 1 Upgradient Monitoring Well 22201

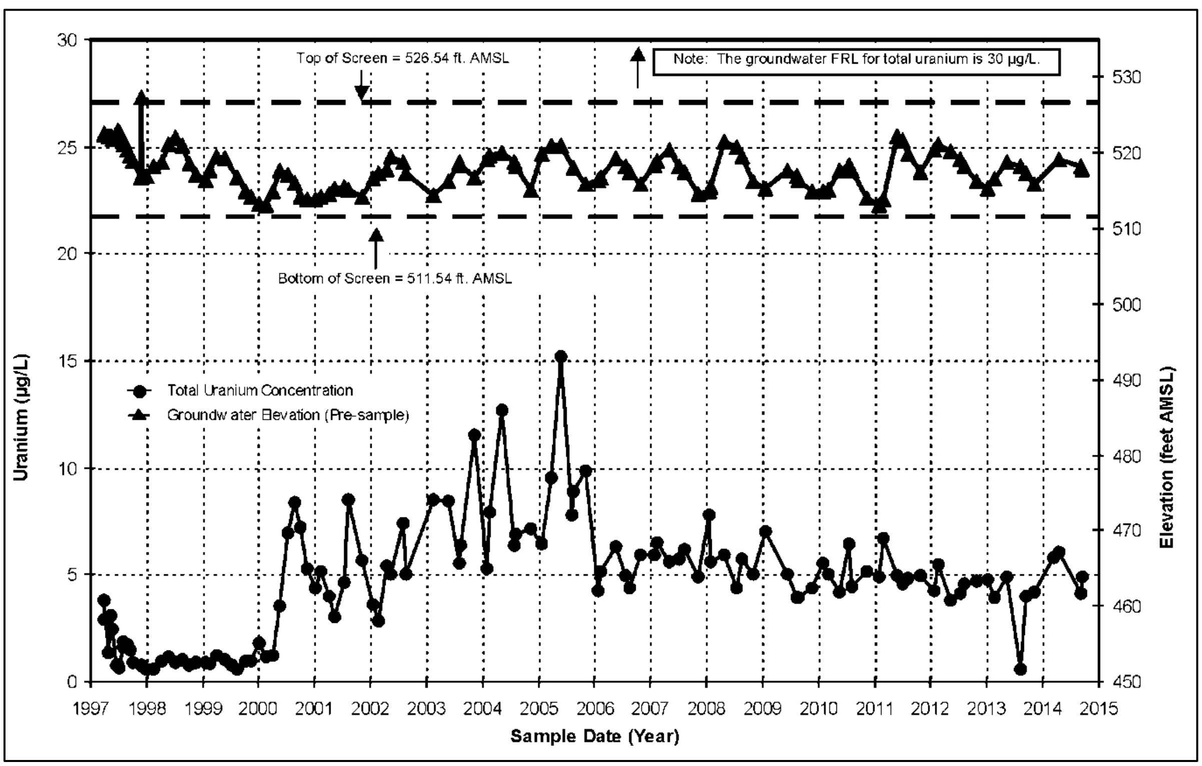


Figure A.5.1-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 1 Downgradient Monitoring Well 22198

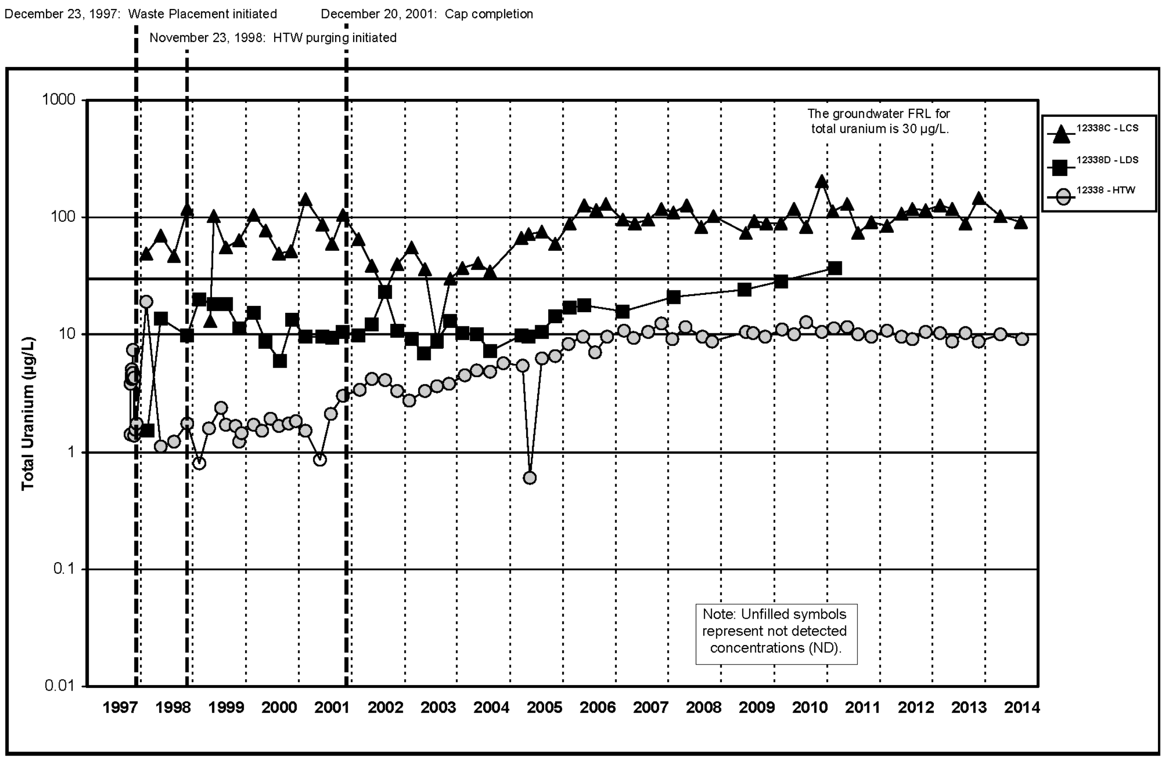


Figure A.5.1-6A. Cell 1 Total Uranium Concentration Versus Time Plot for LCS, LDS, and HTW

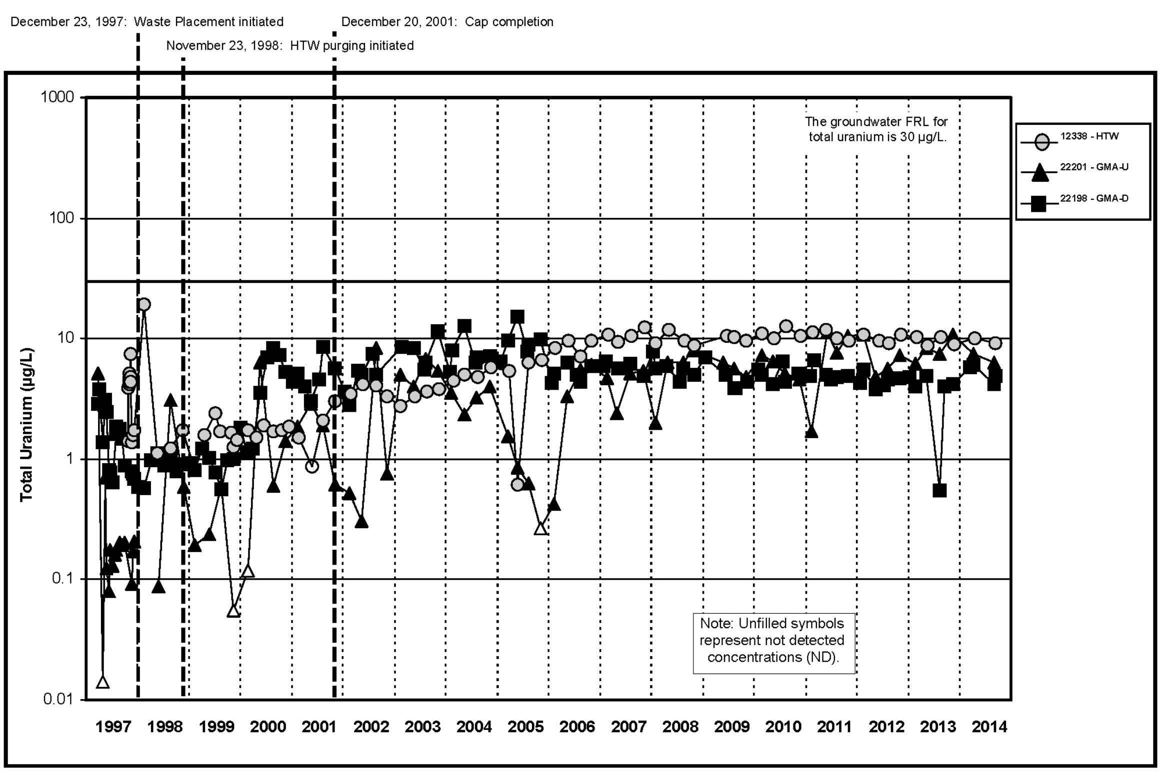


Figure A.5.1-6B. Cell 1 Total Uranium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

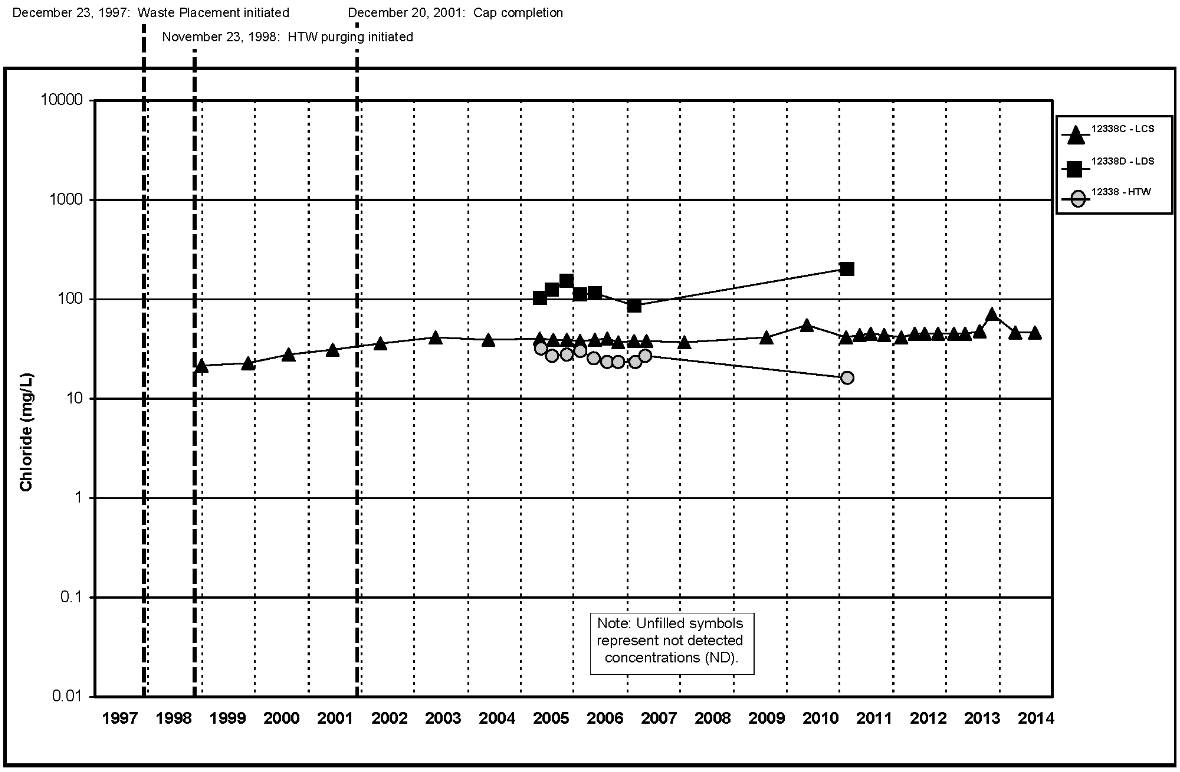


Figure A.5.1-7A. Cell 1 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

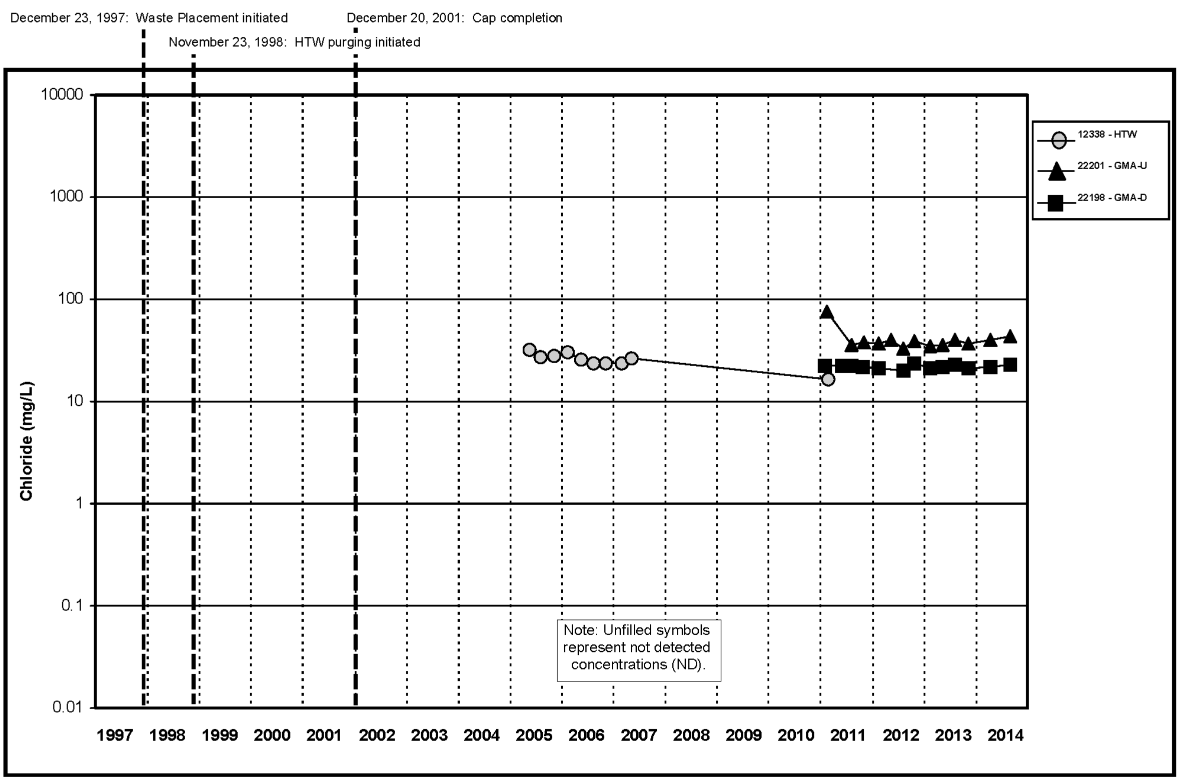


Figure A.5.1-7B. Cell 1 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

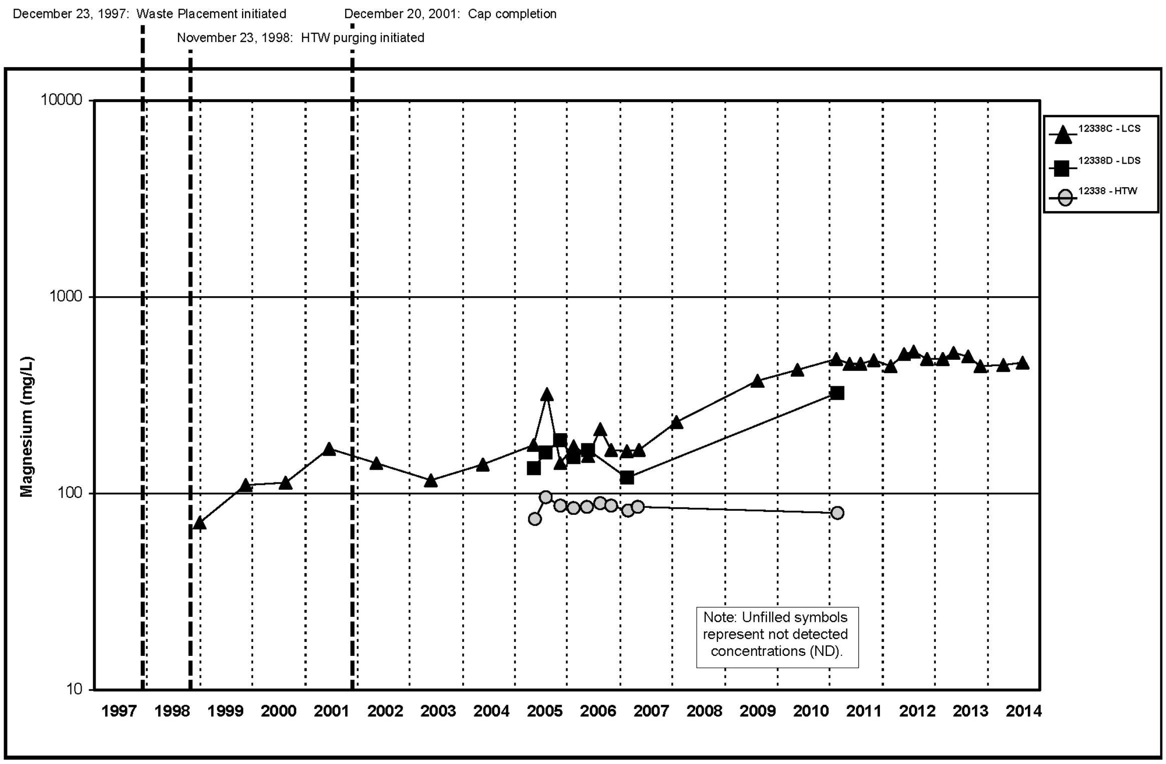


Figure A.5.1-8A. Cell 1 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

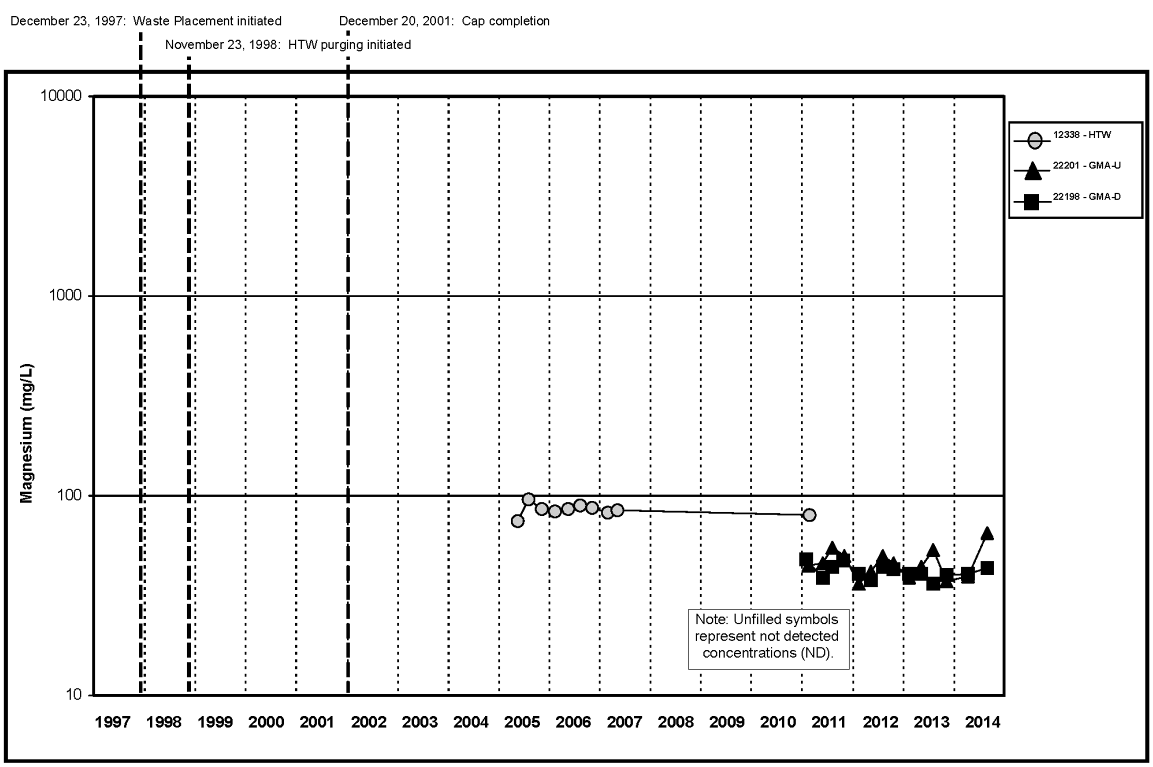


Figure A.5.1-8B. Cell 1 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

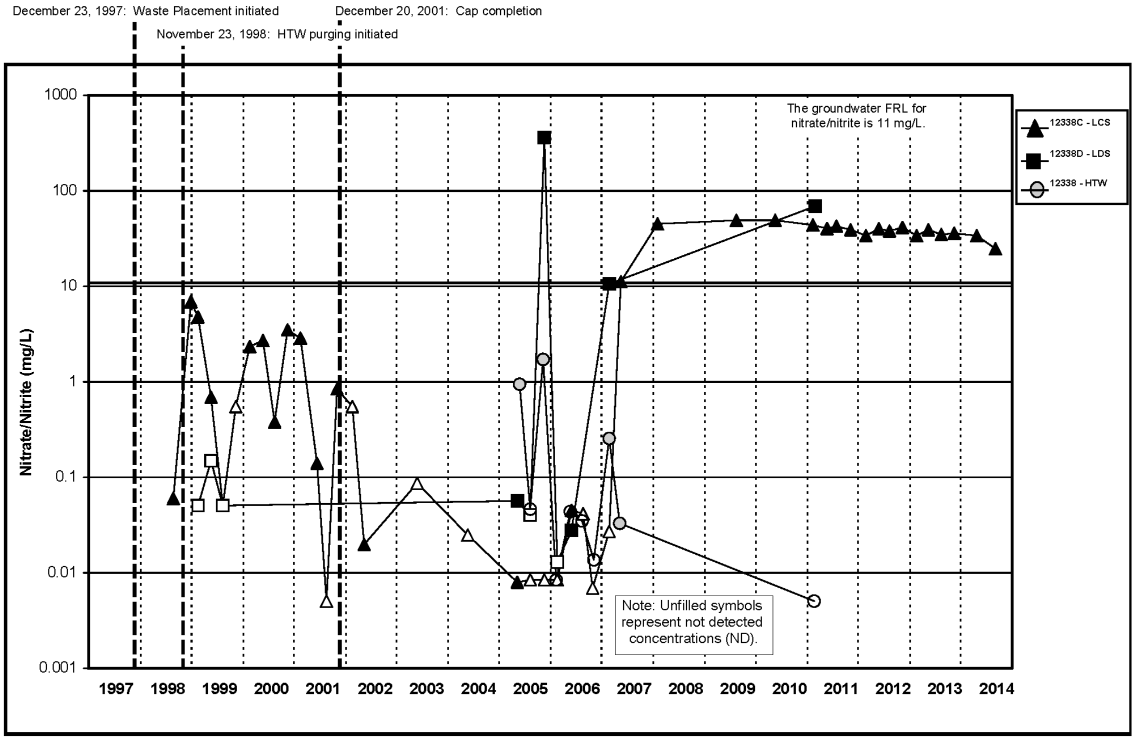


Figure A.5.1-9A. Cell 1 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

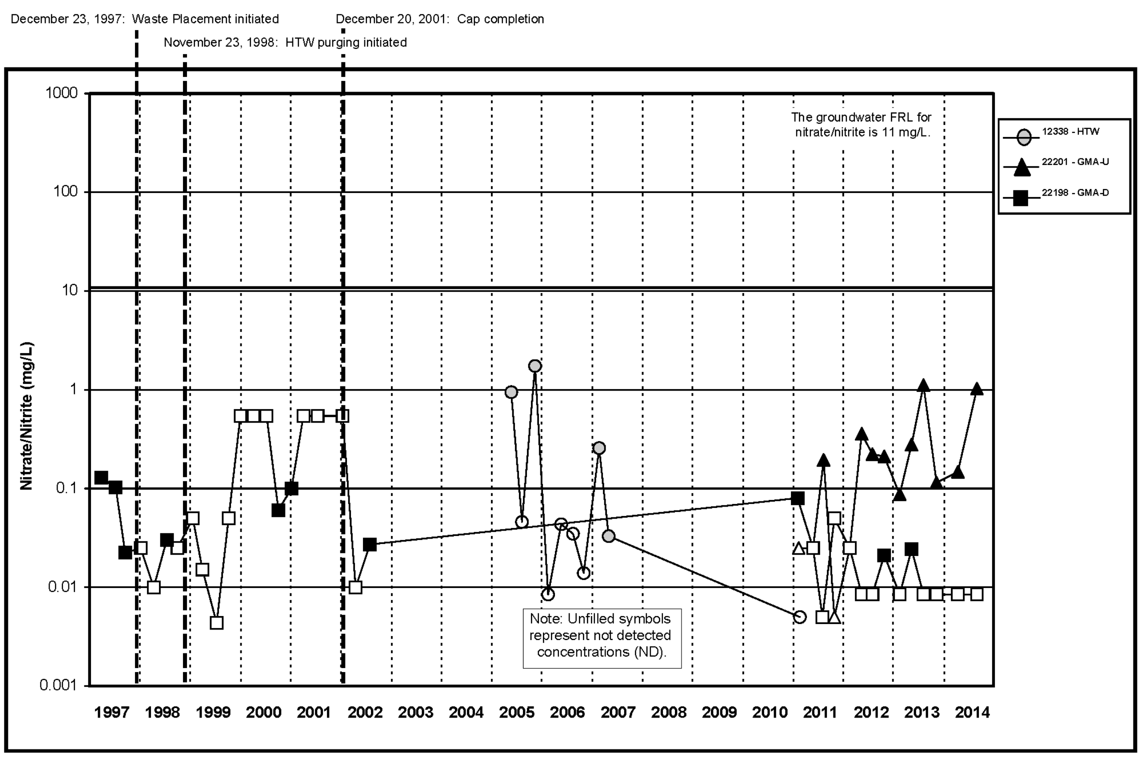


Figure A.5.1-9B. Cell 1 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

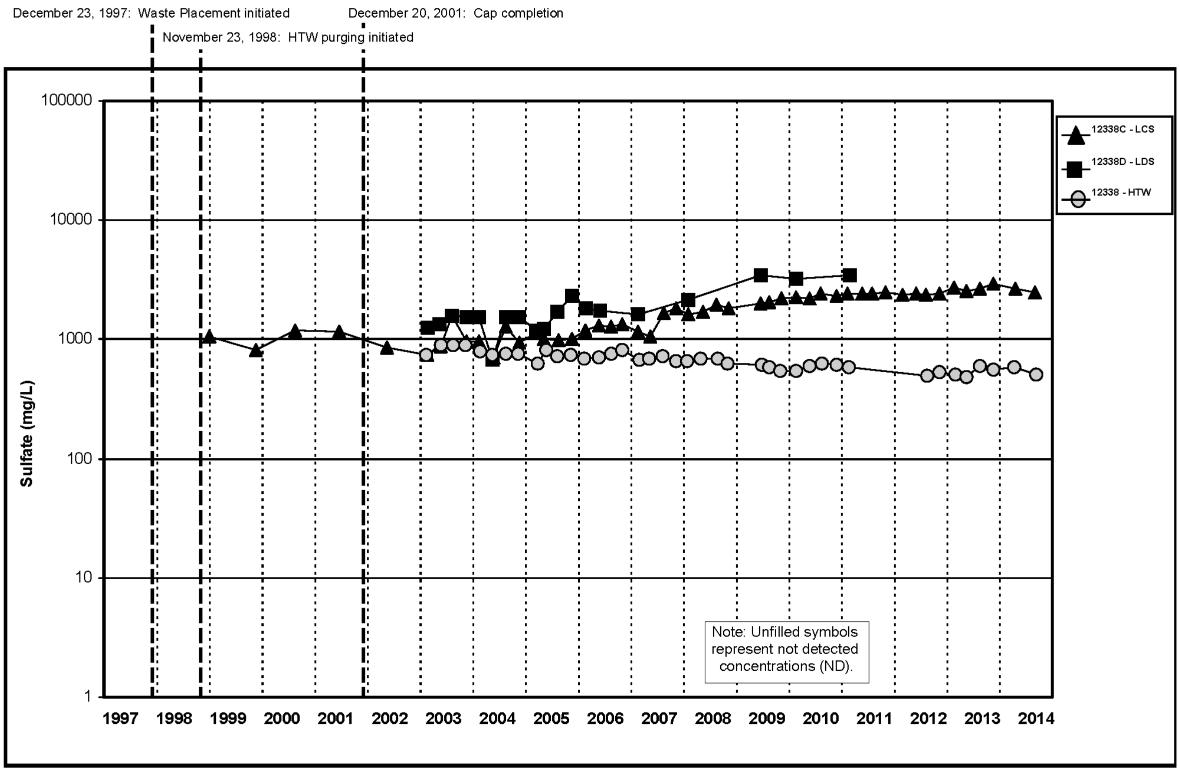


Figure A.5.1-10A. Cell 1 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

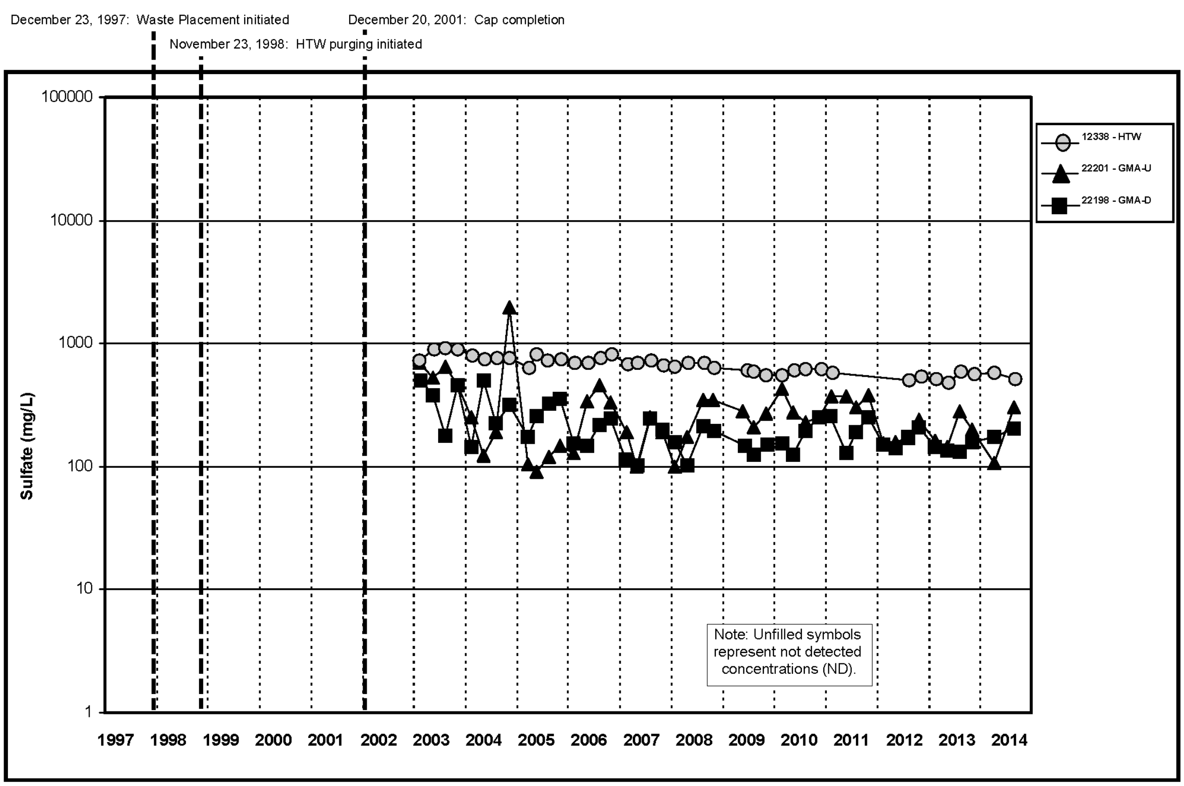


Figure A.5.1-10B. Cell 1 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

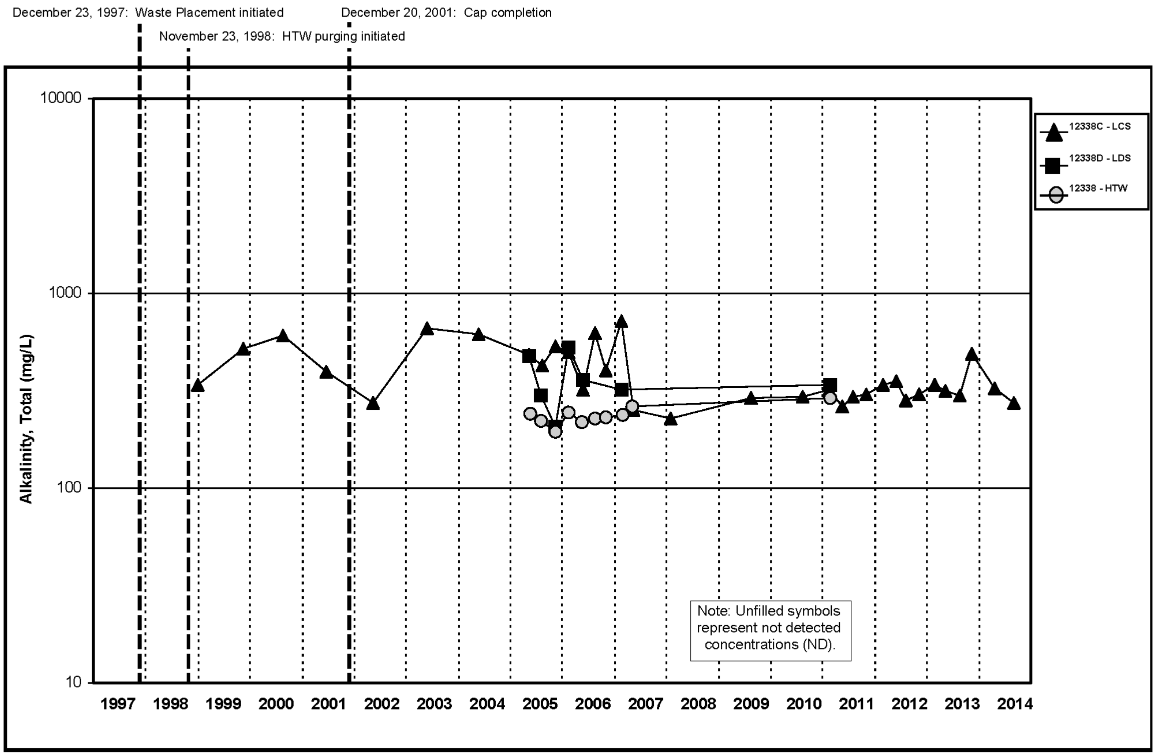


Figure A.5.1-11A. Cell 1 Alkalinity, Total (As $CaCO_3$) Concentration Versus Time Plot for LCS, LDS, and HTW

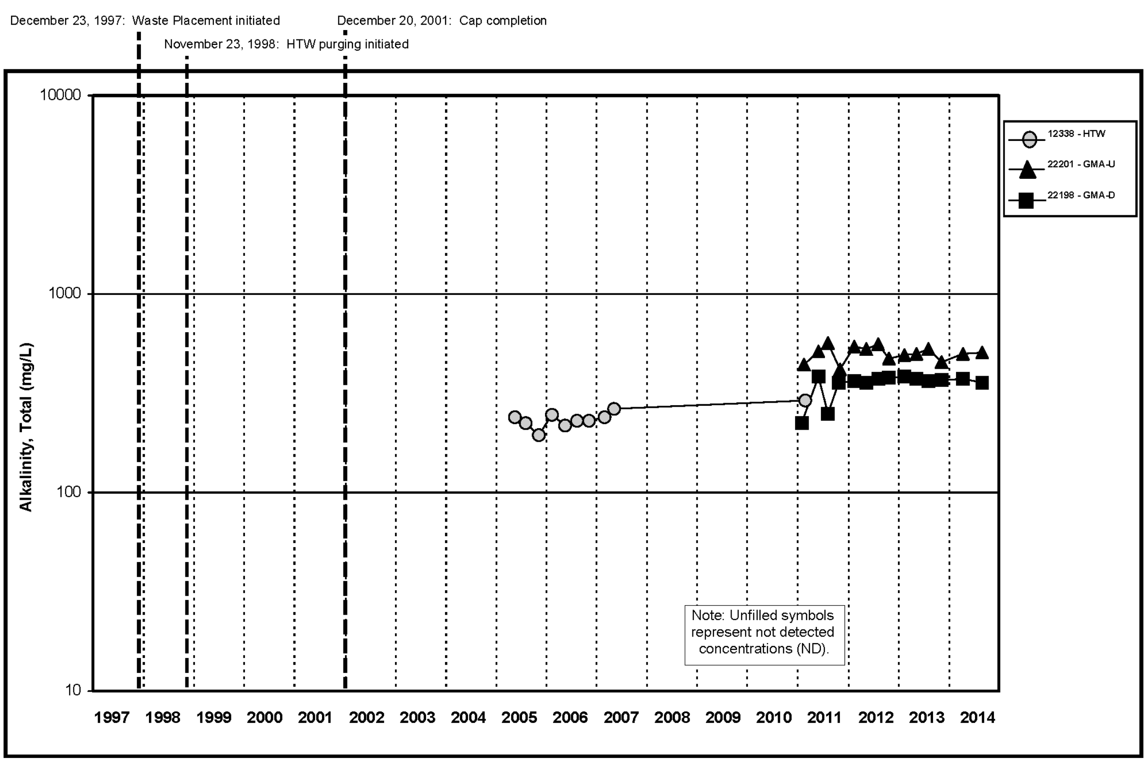


Figure A.5.1-11B. Cell 1 Alkalinity, Total (As $CaCO_3$) Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

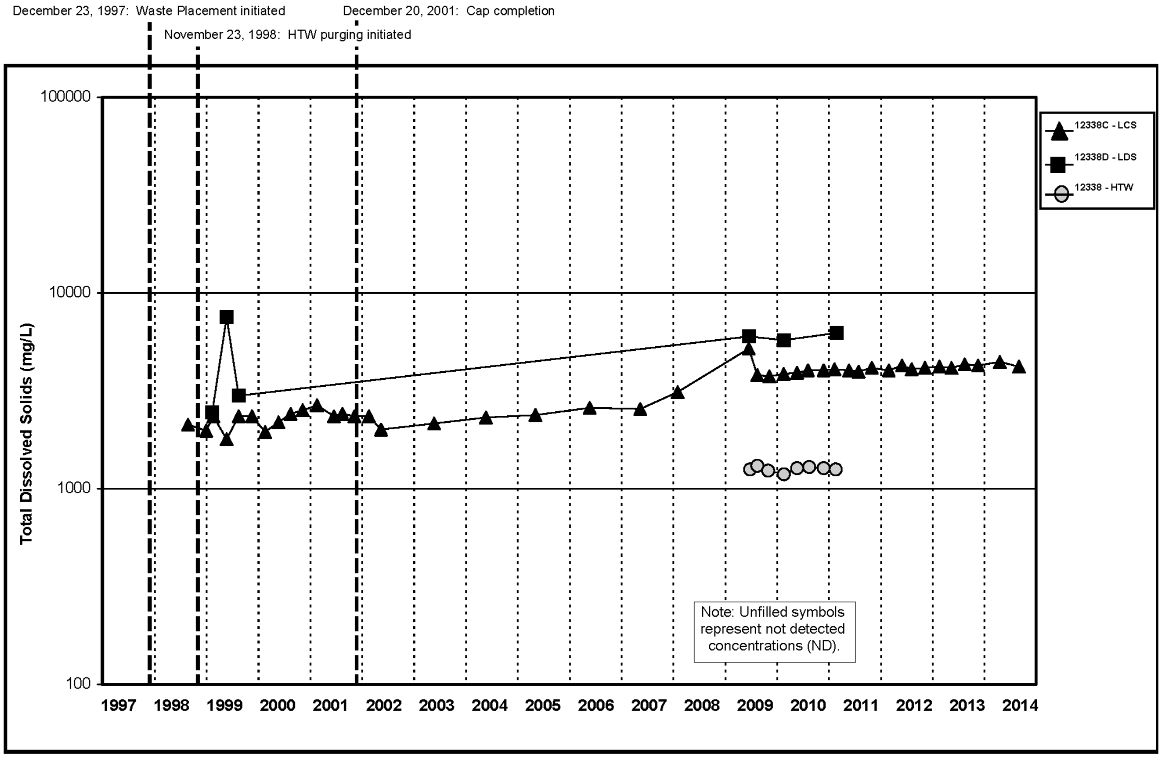


Figure A.5.1-12A. Cell 1 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

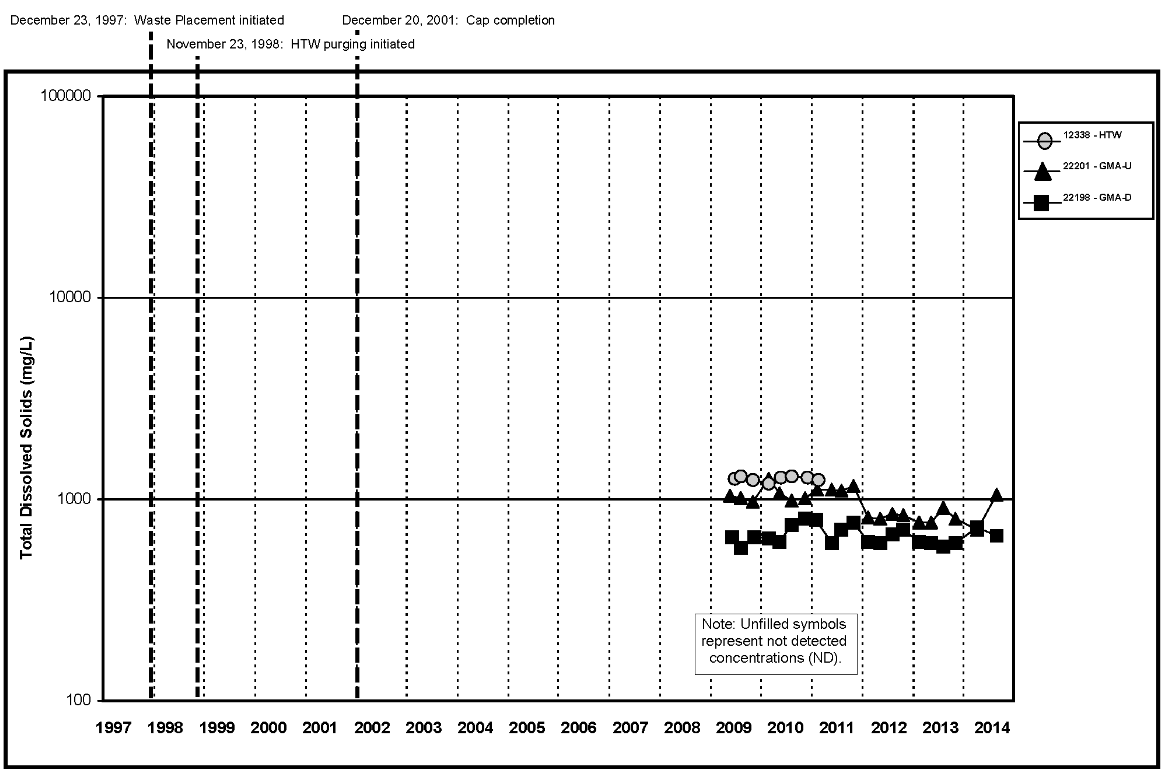


Figure A.5.1-12B. Cell 1 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

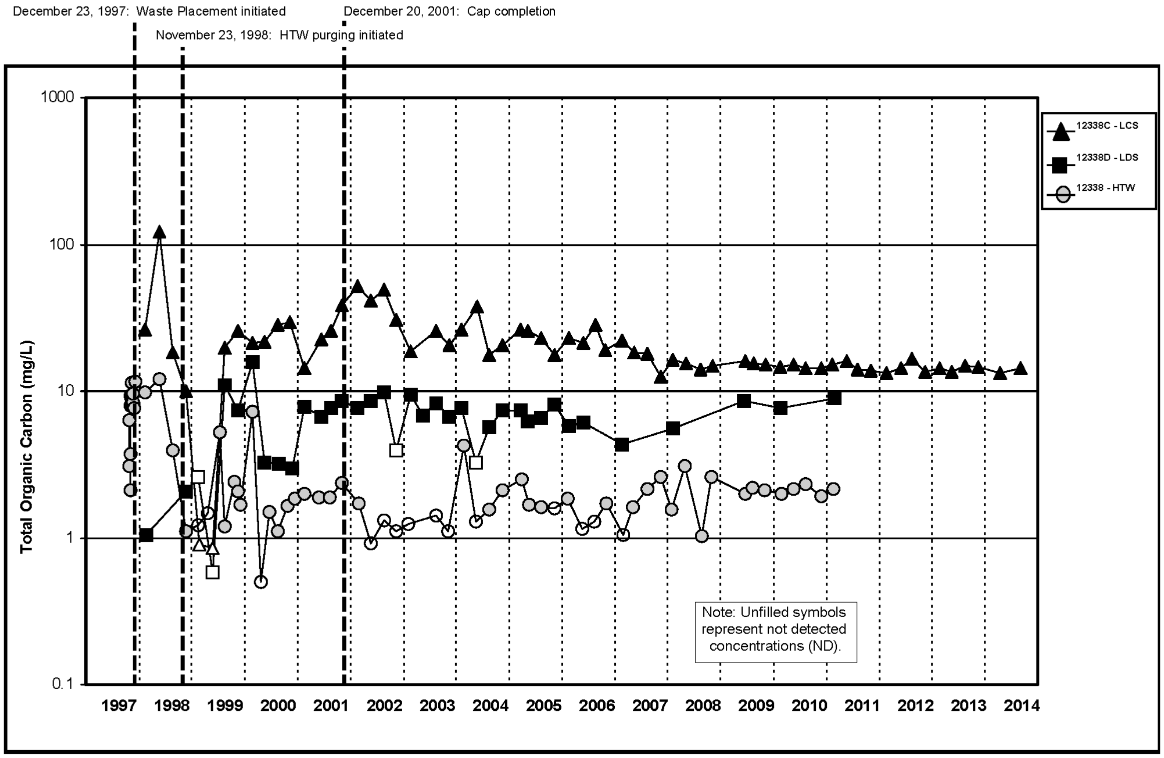


Figure A.5.1-13A. Cell 1 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

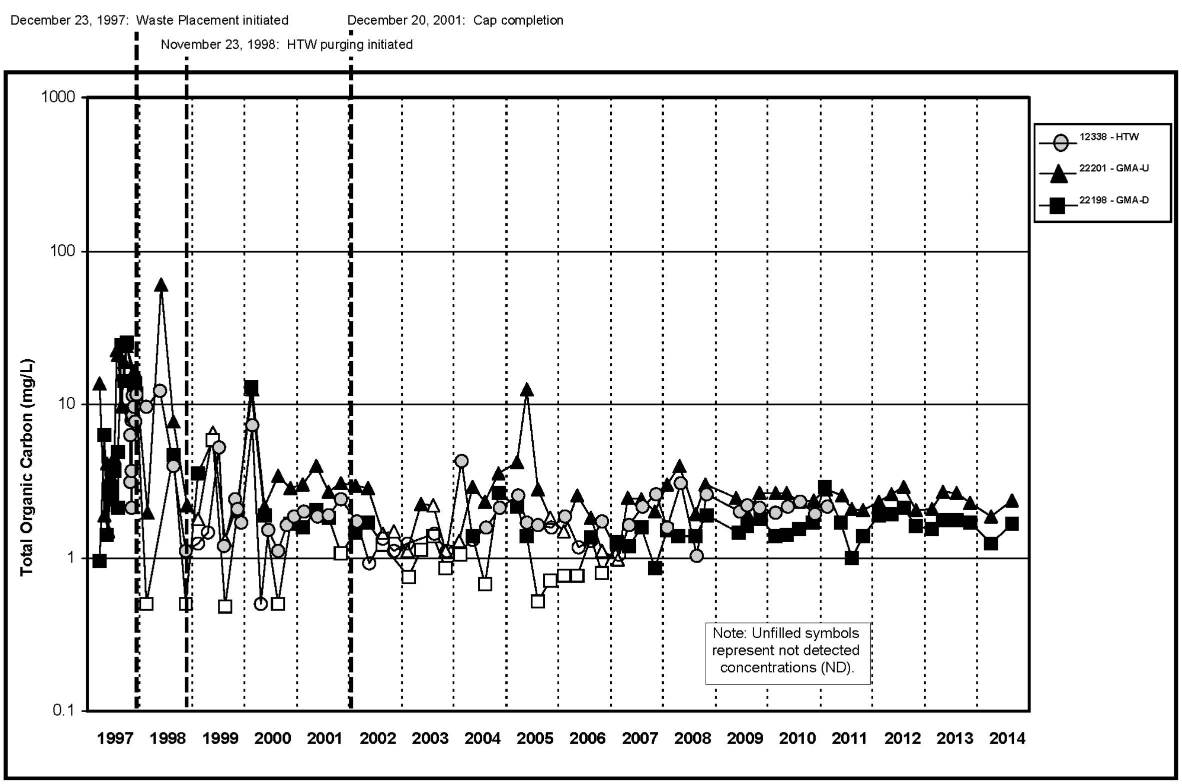


Figure A.5.1-13B. Cell 1 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

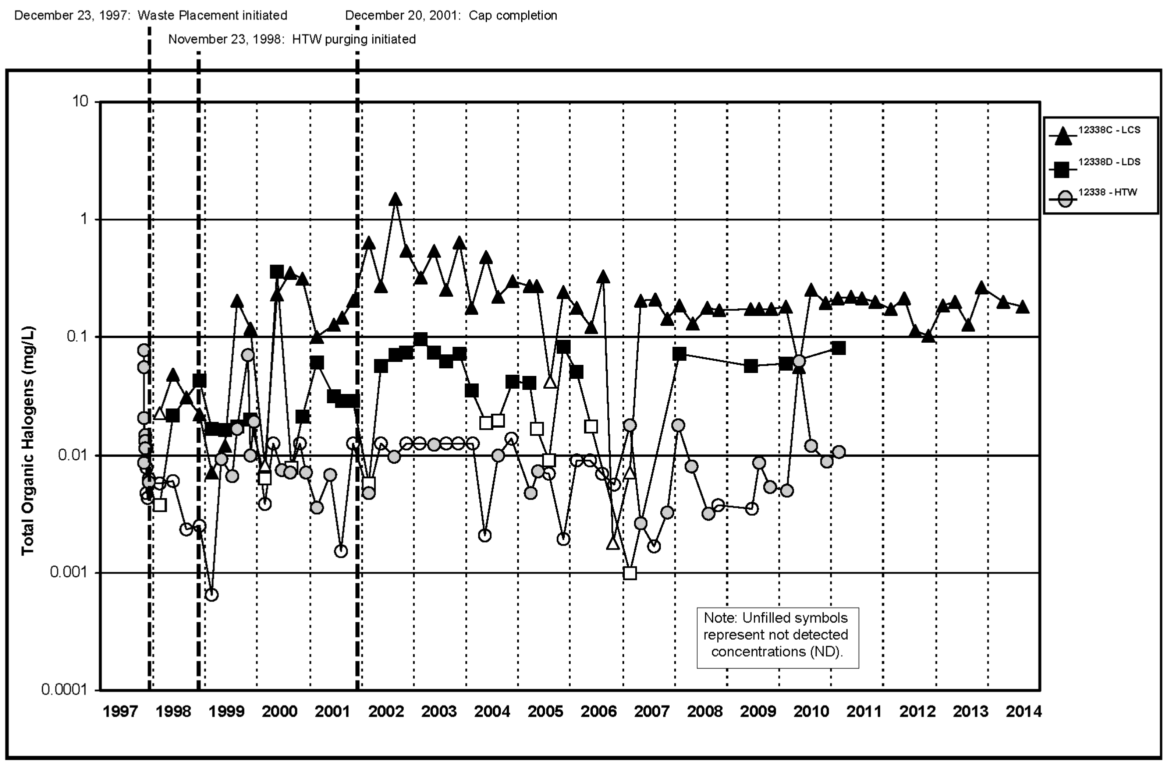


Figure A.5.1-14A. Cell 1 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

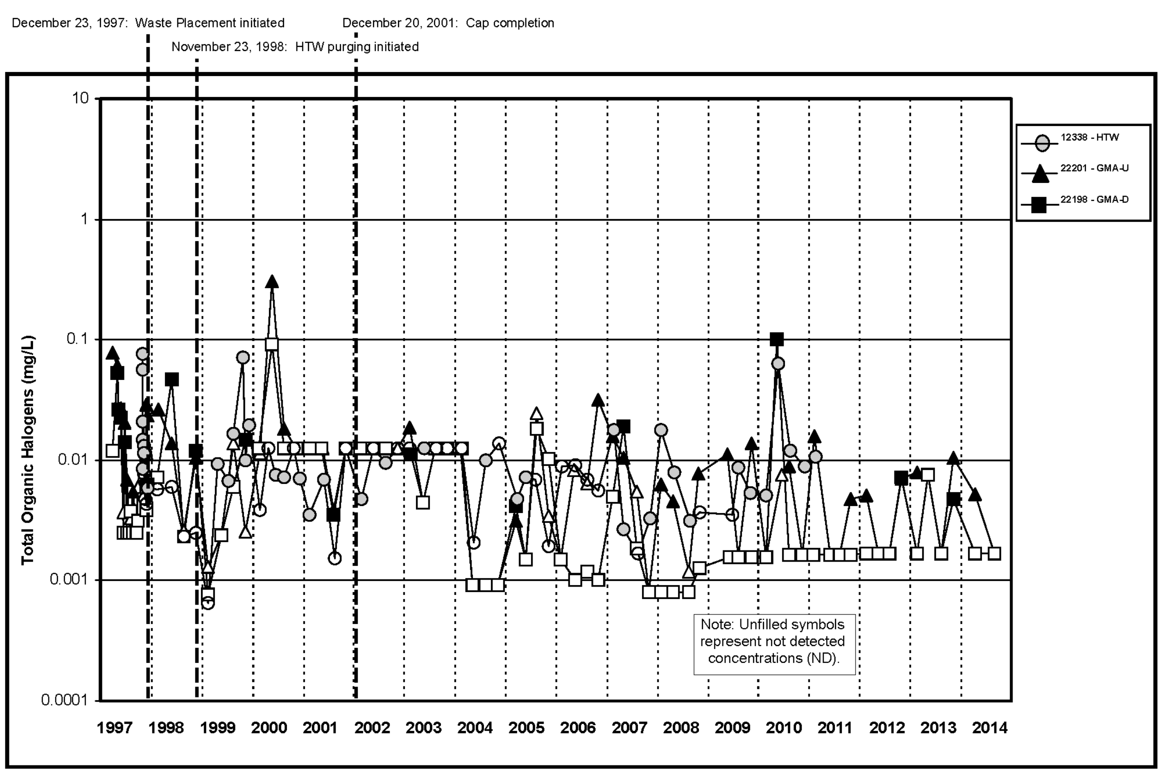


Figure A.5.1-14B. Cell 1 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

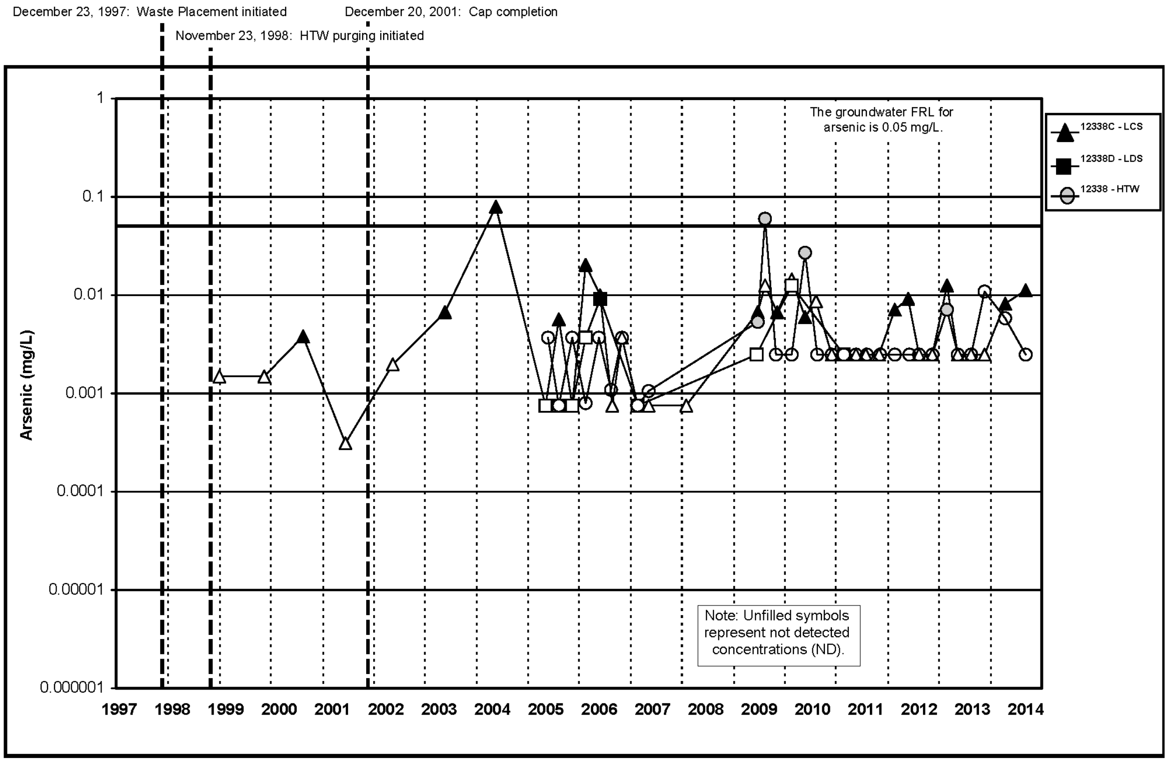


Figure A.5.1-15A. Cell 1 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

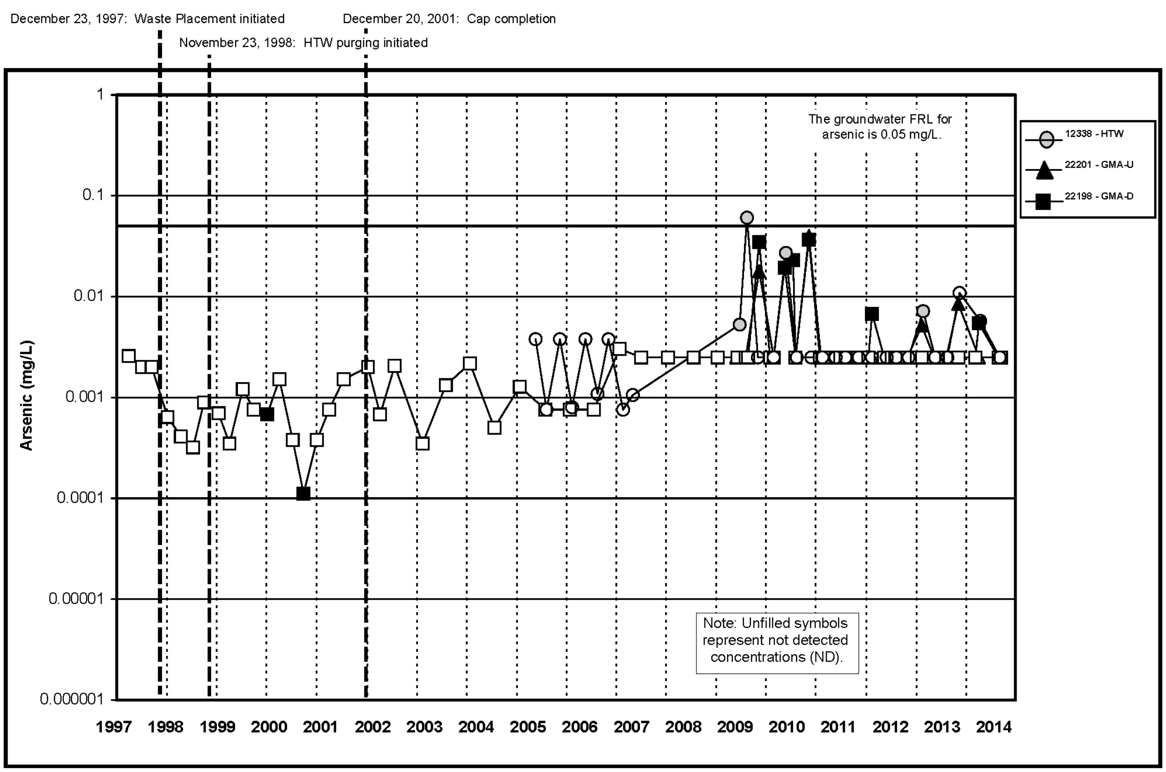


Figure A.5.1-15B. Cell 1 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

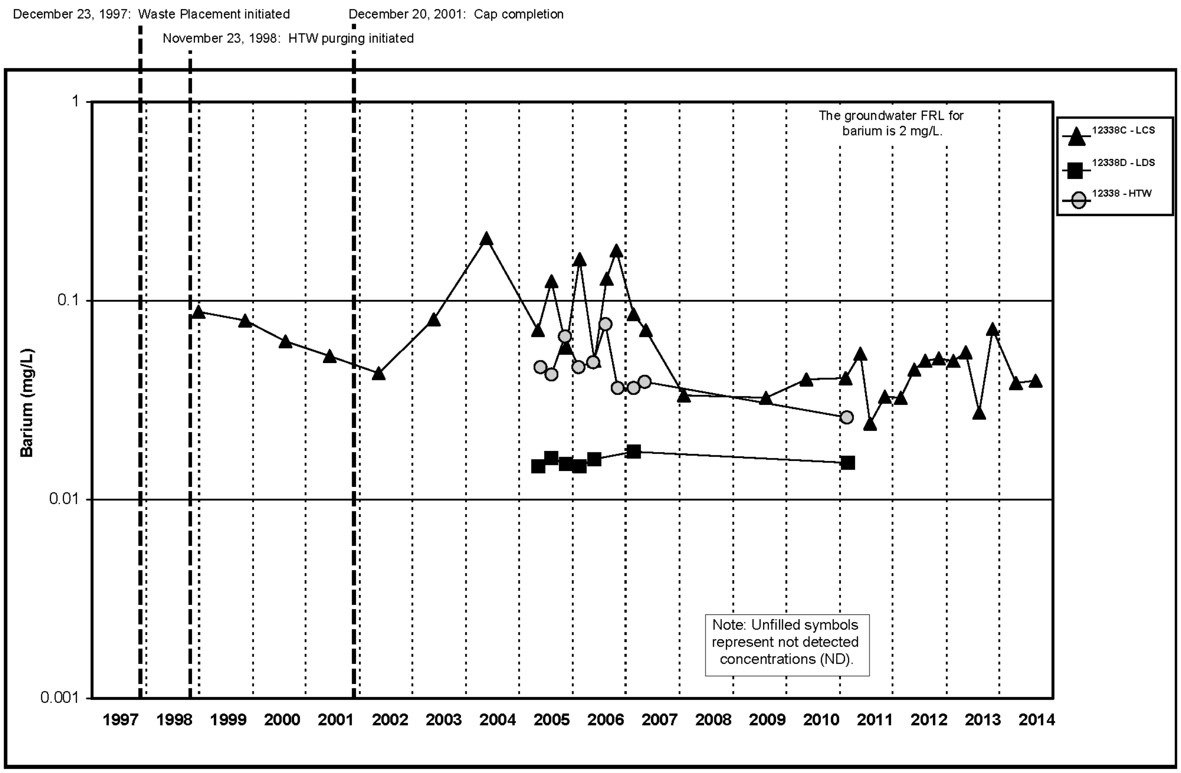


Figure A.5.1-16A. Cell 1 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

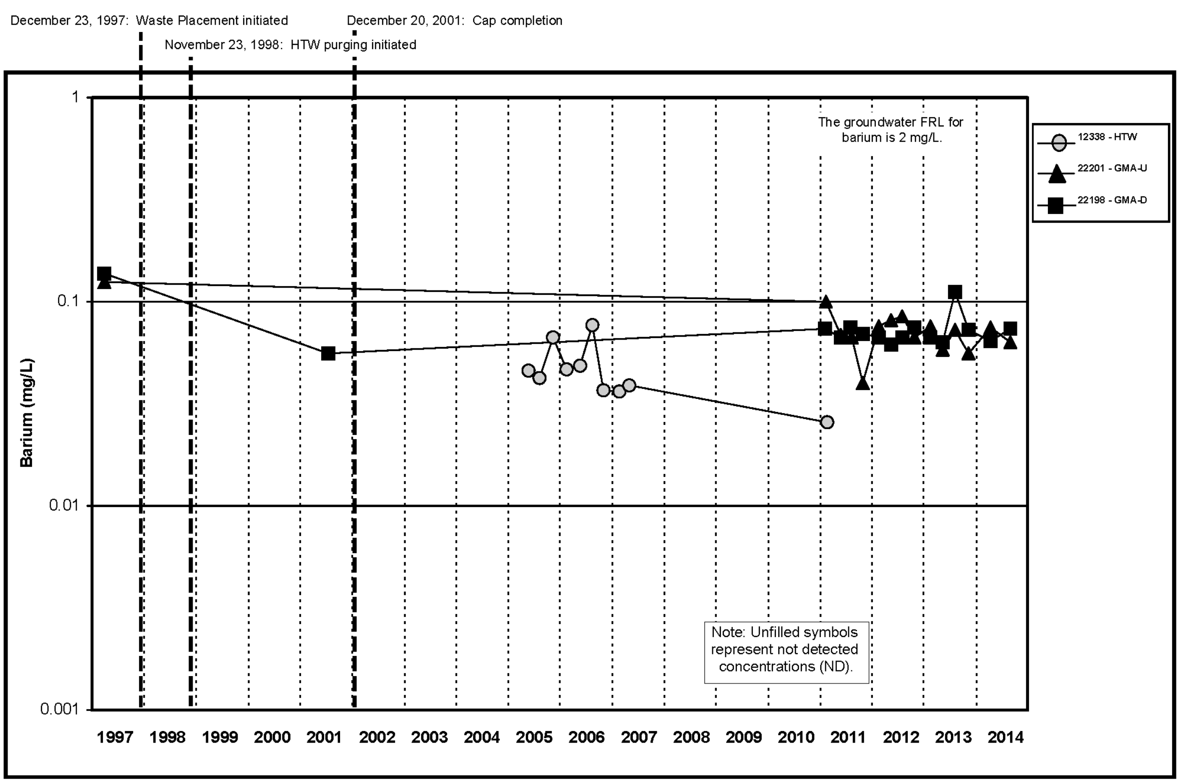


Figure A.5.1-16B. Cell 1 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

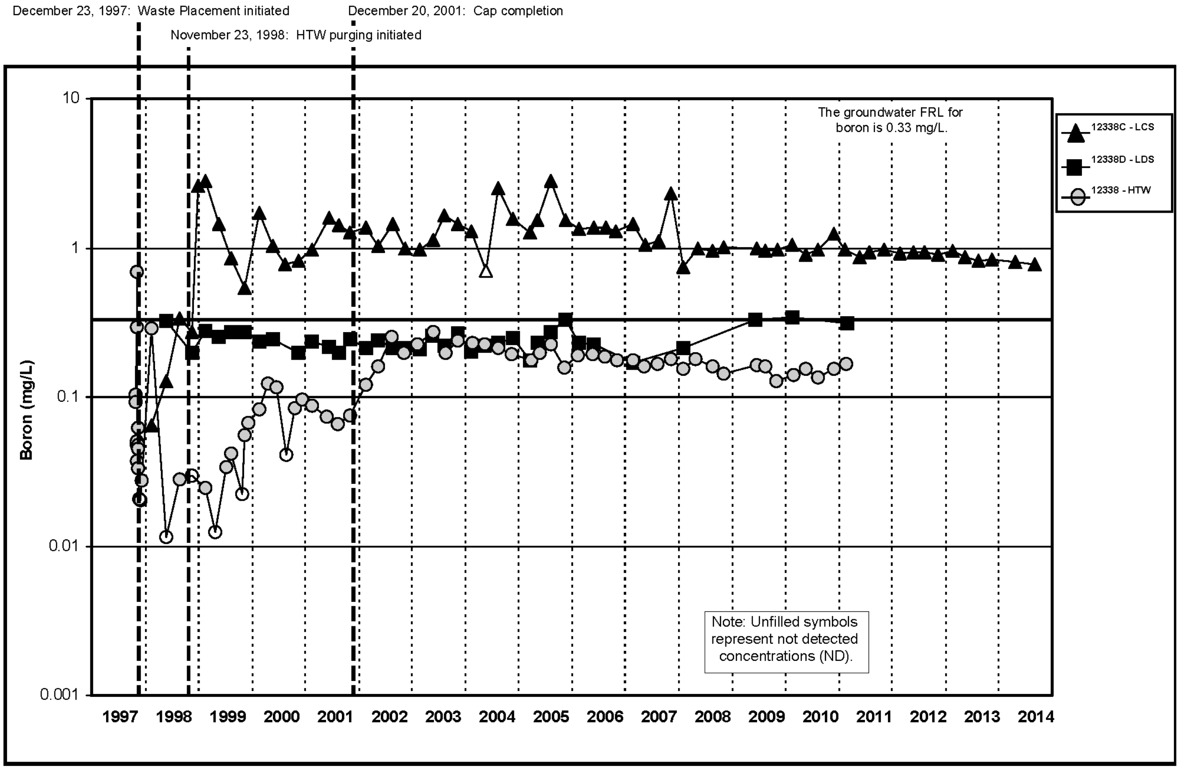


Figure A.5.1-17A. Cell 1 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

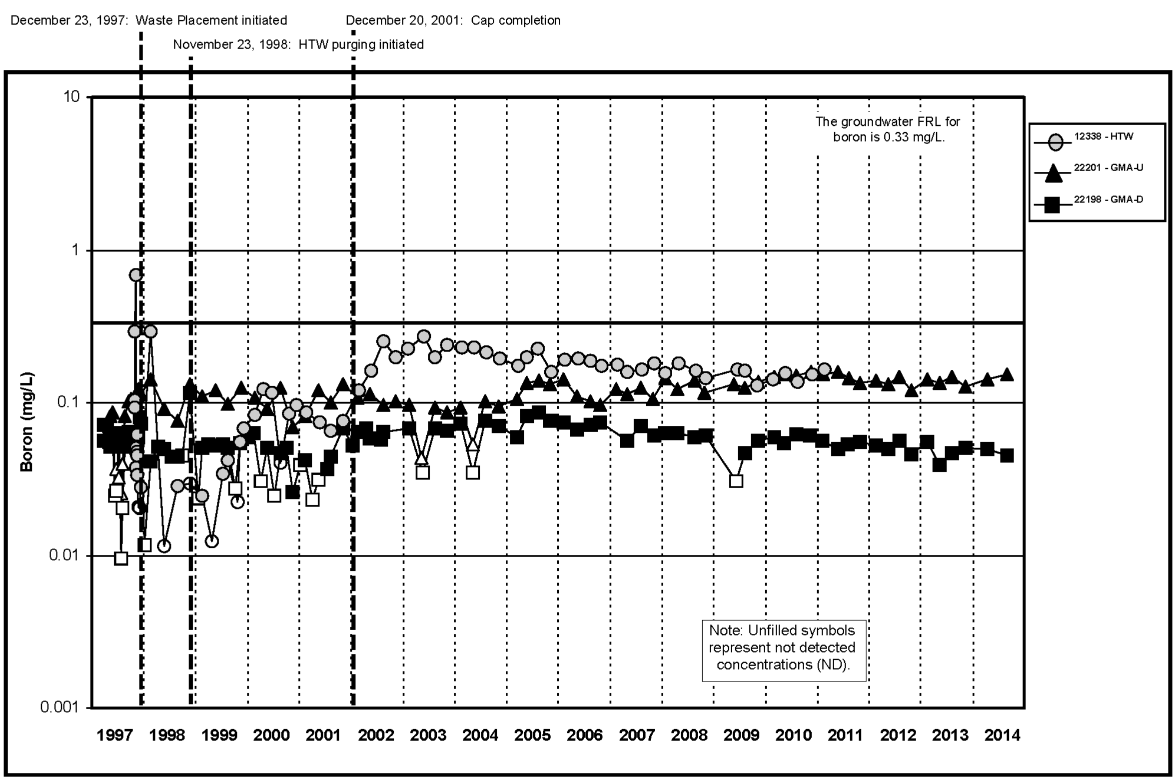


Figure A.5.1-17B. Cell 1 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

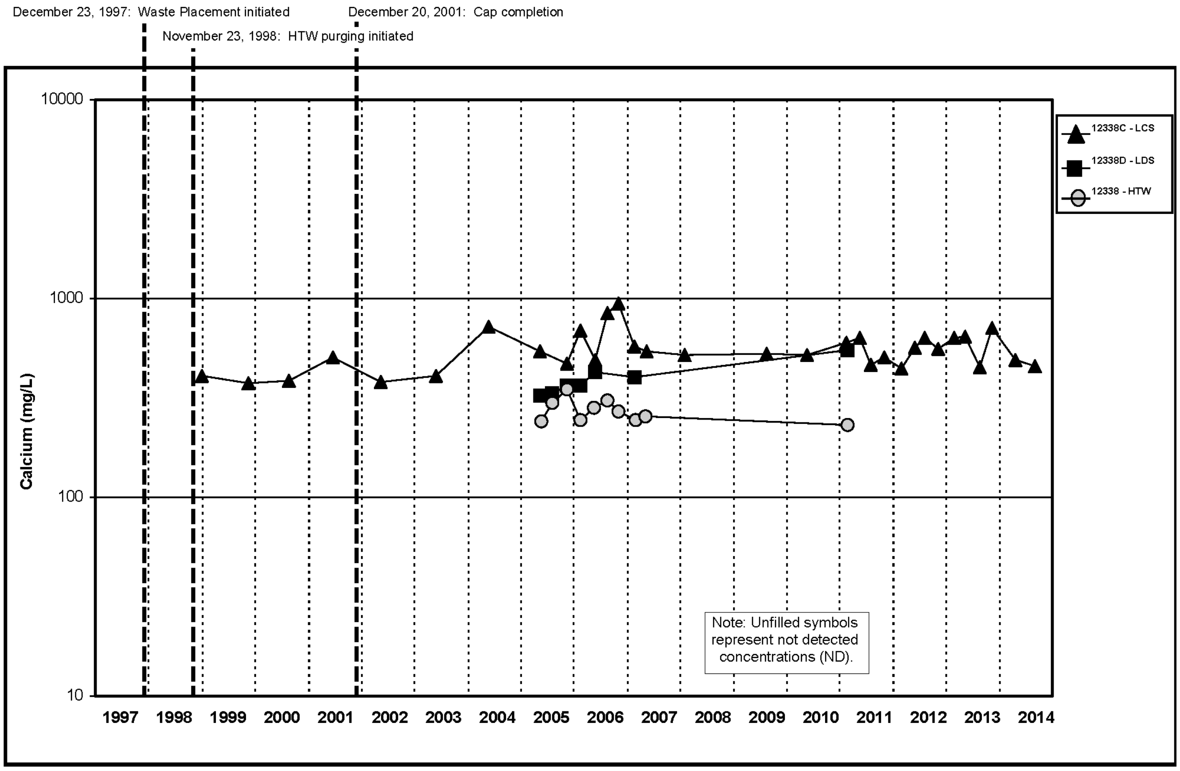


Figure A.5.1-18A. Cell 1 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

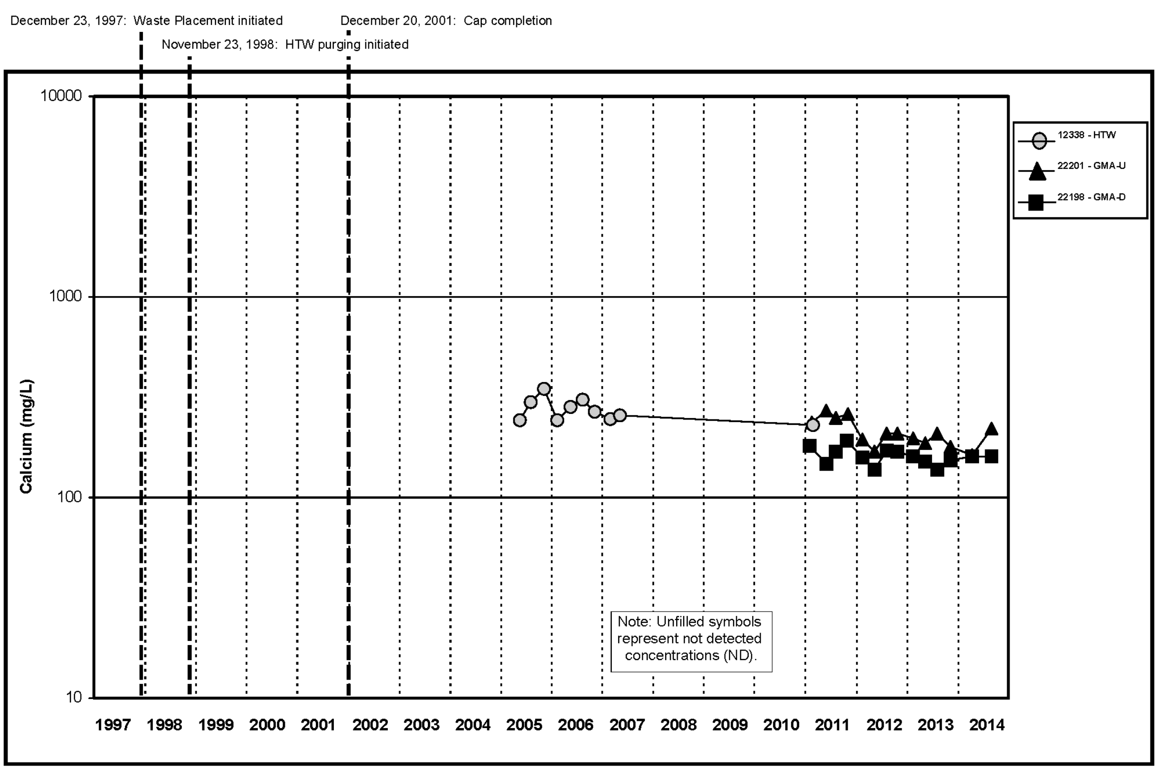


Figure A.5.1-18B. Cell 1 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

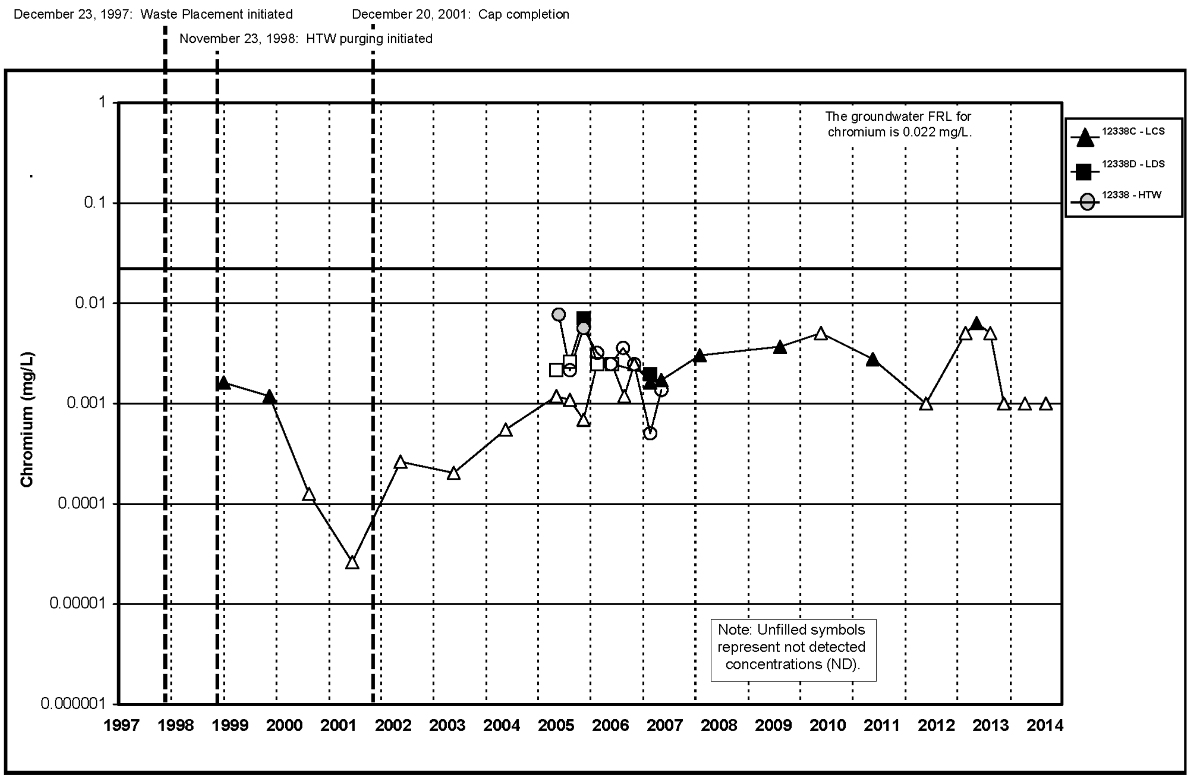


Figure A.5.1-19A. Cell 1 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

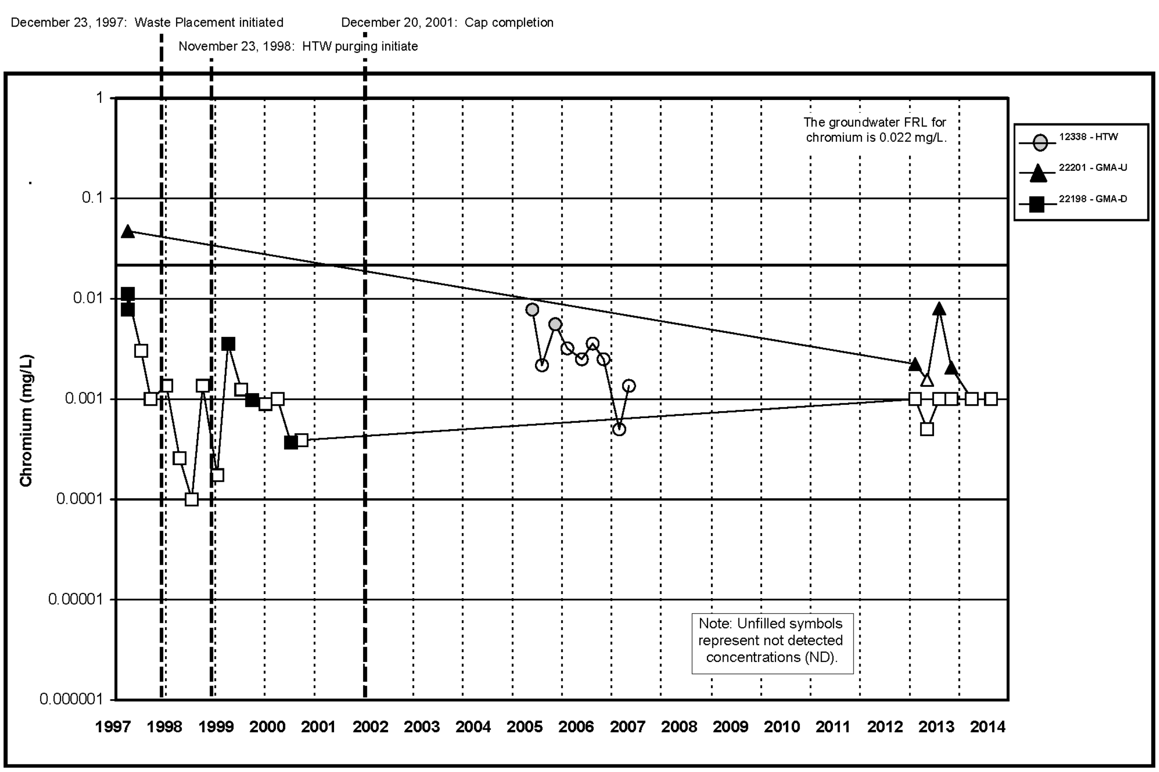


Figure A.5.1-19B. Cell 1 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

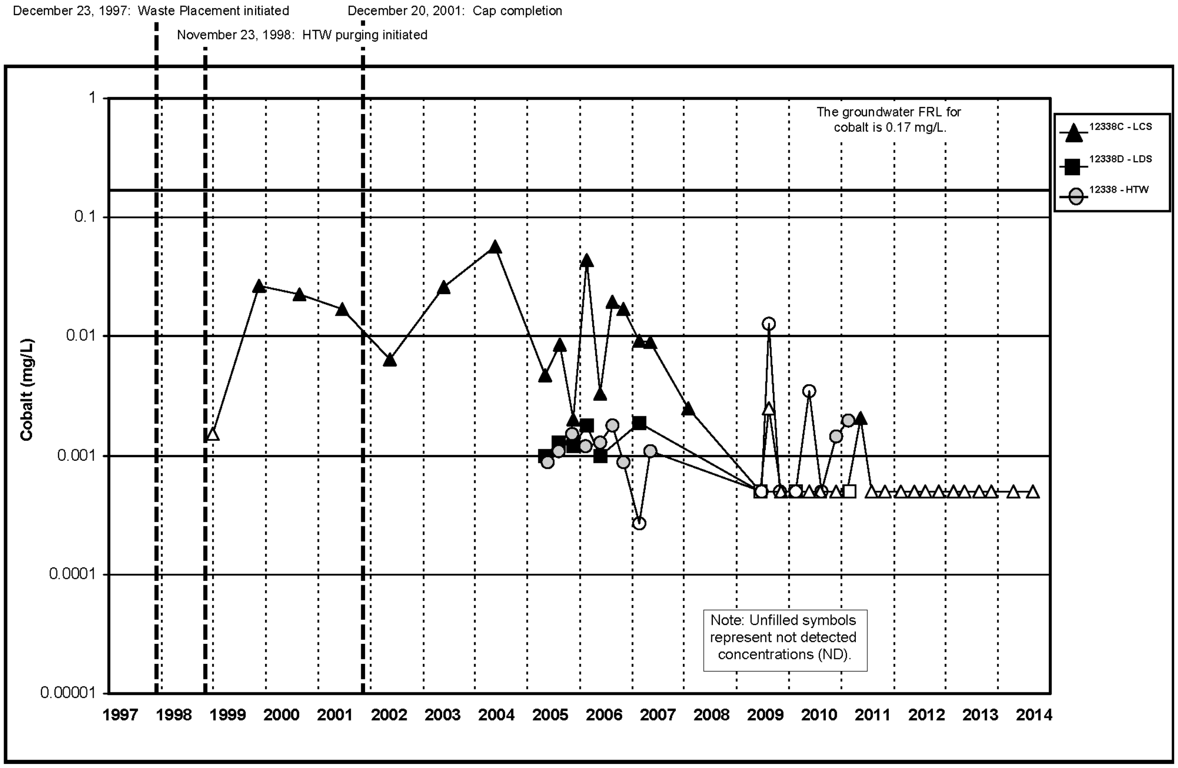


Figure A.5.1-20A. Cell 1 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

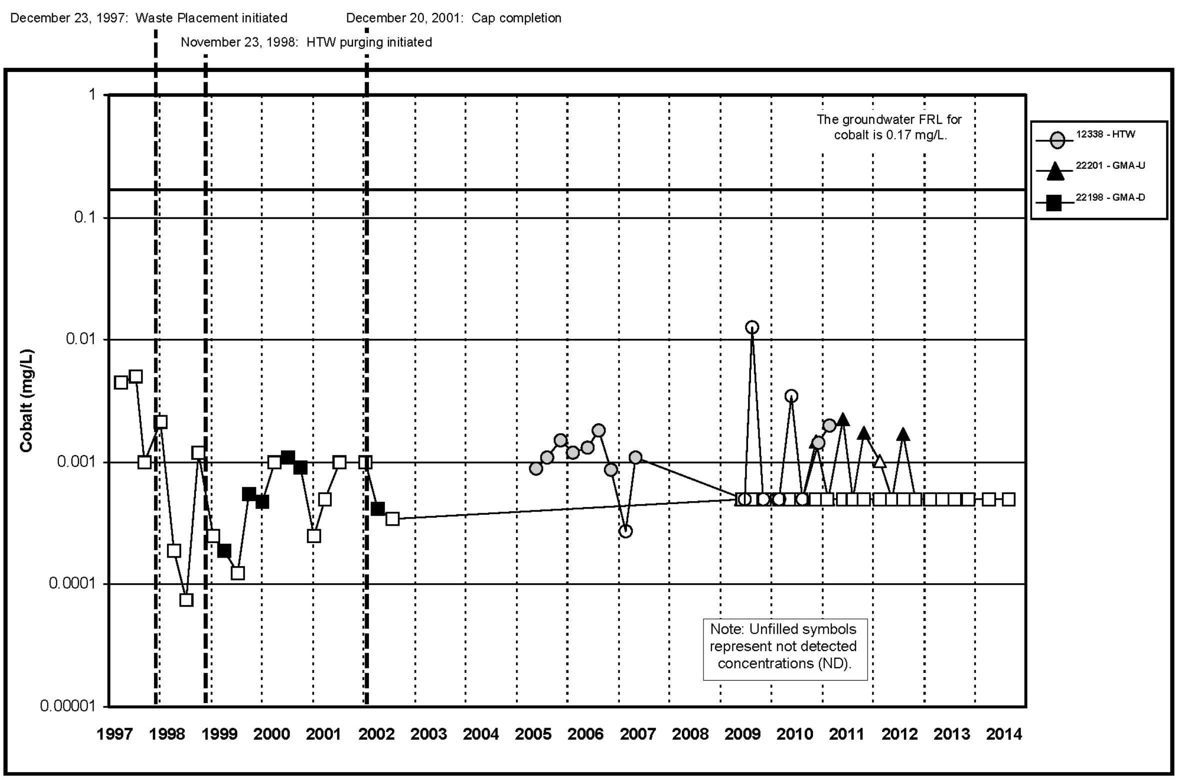


Figure A.5.1-20B. Cell 1 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

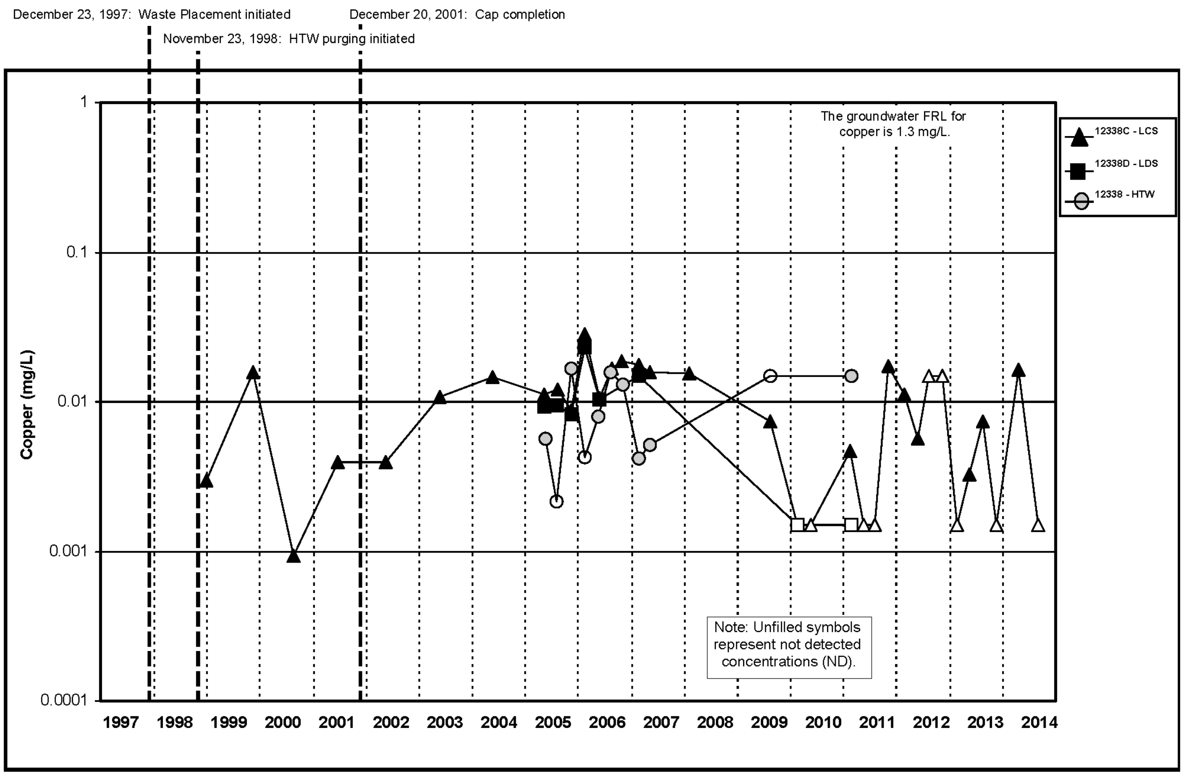


Figure A.5.1-21A. Cell 1 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

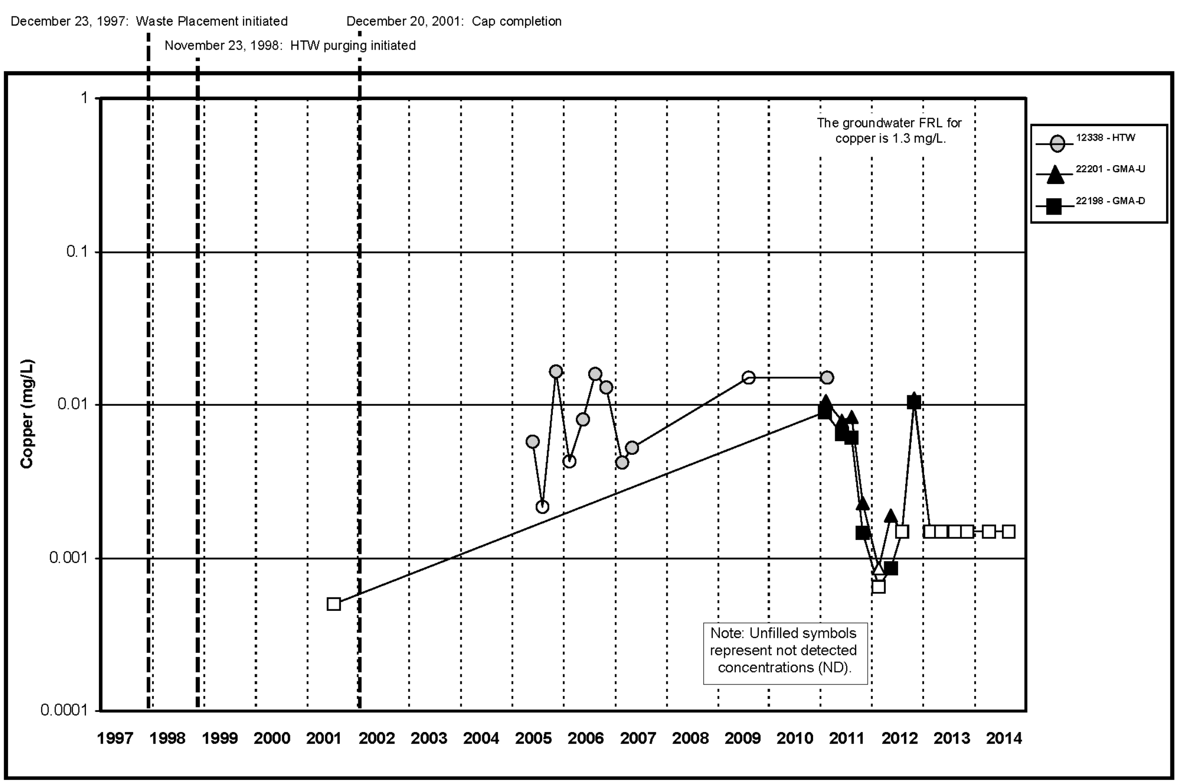


Figure A.5.1-21B. Cell 1 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

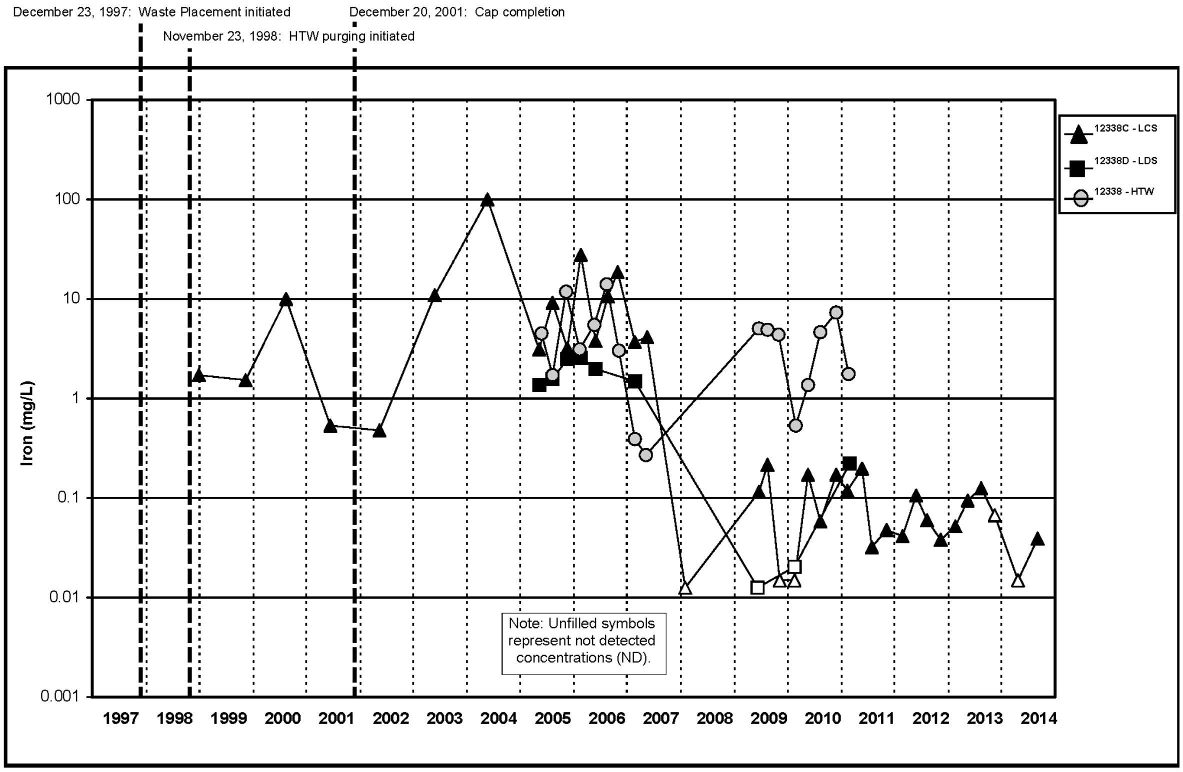


Figure A.5.1-22A. Cell 1 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

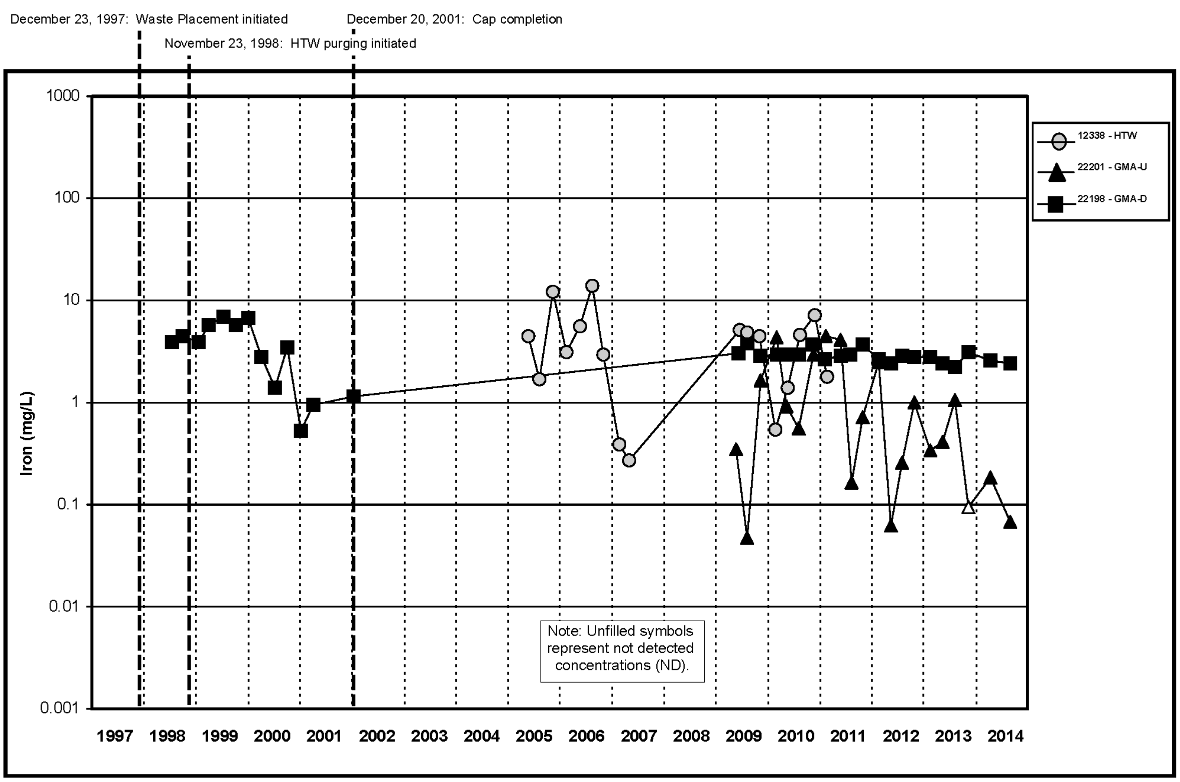


Figure A.5.1-22B. Cell 1 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

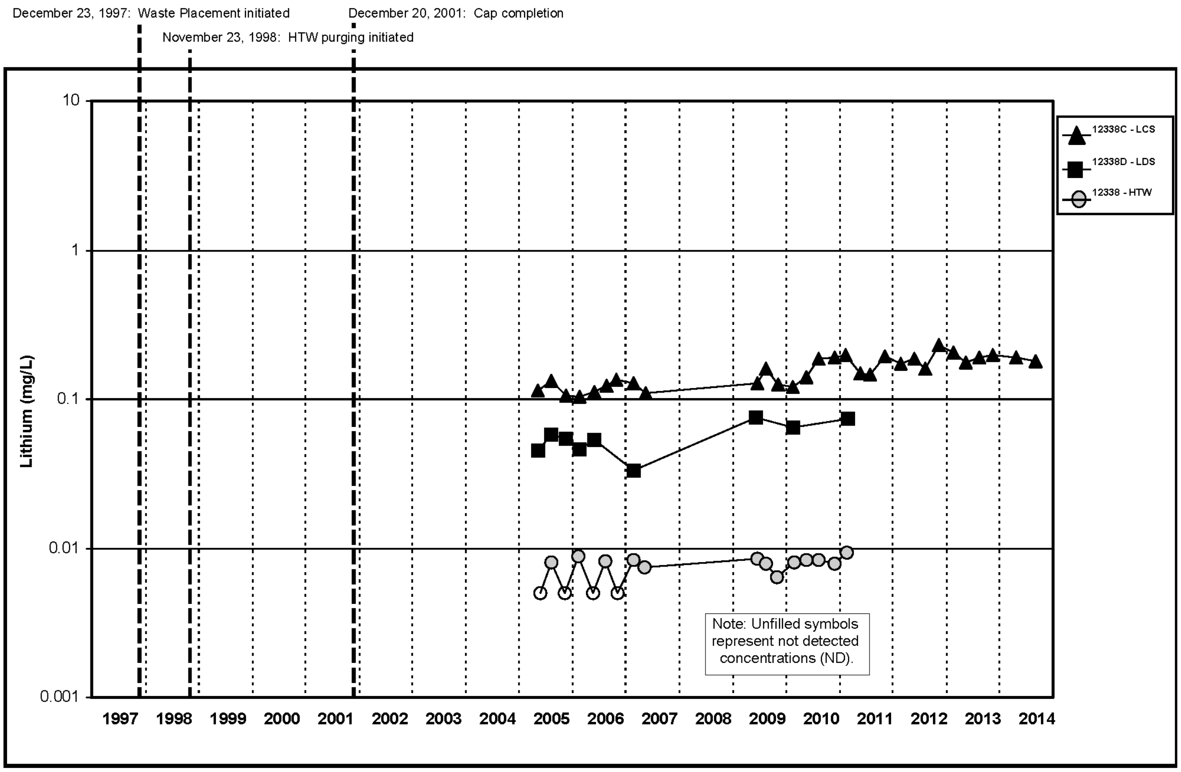


Figure A.5.1-23A. Cell 1 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

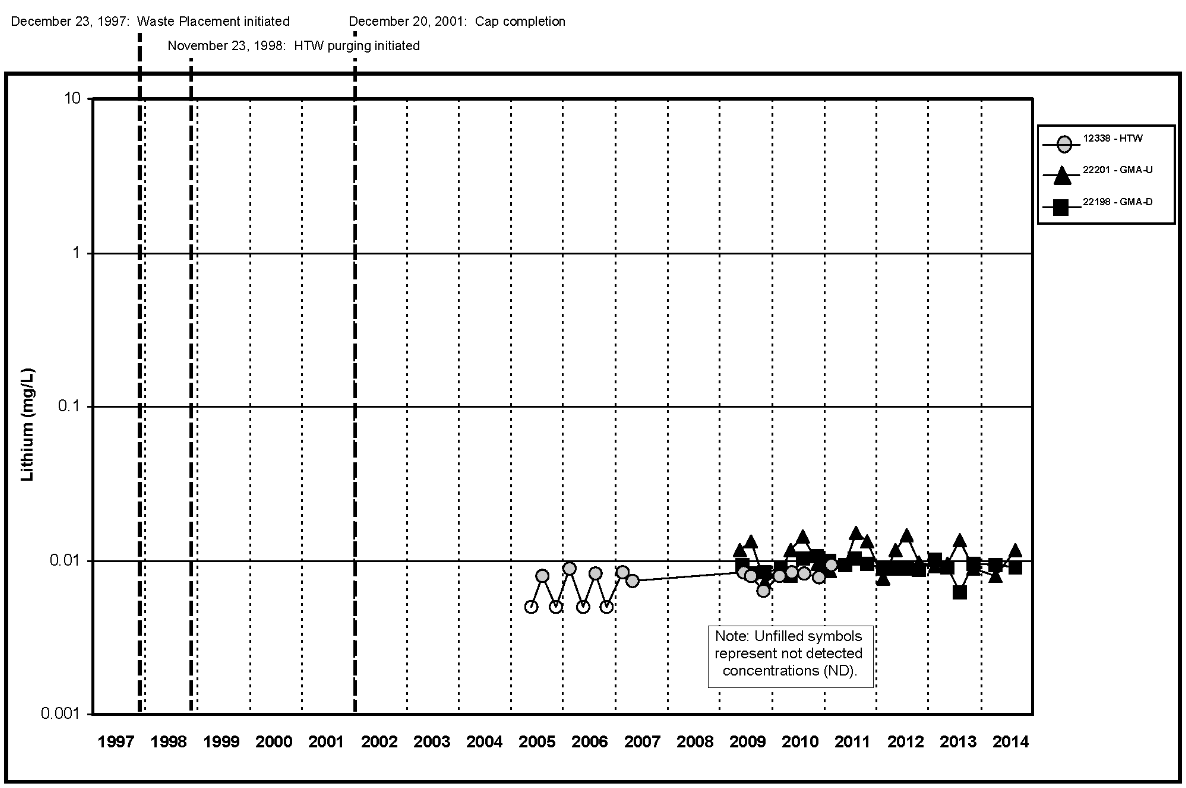


Figure A.5.1-23B. Cell 1 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

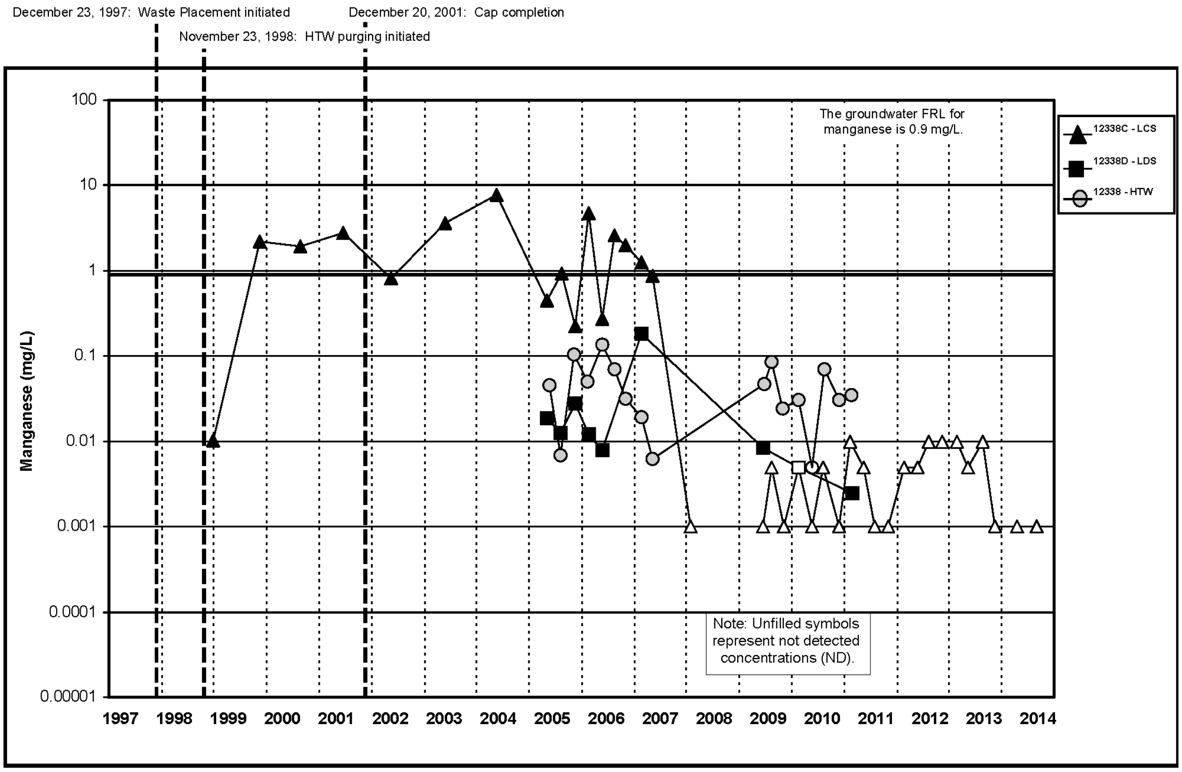


Figure A.5.1-24A. Cell 1 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

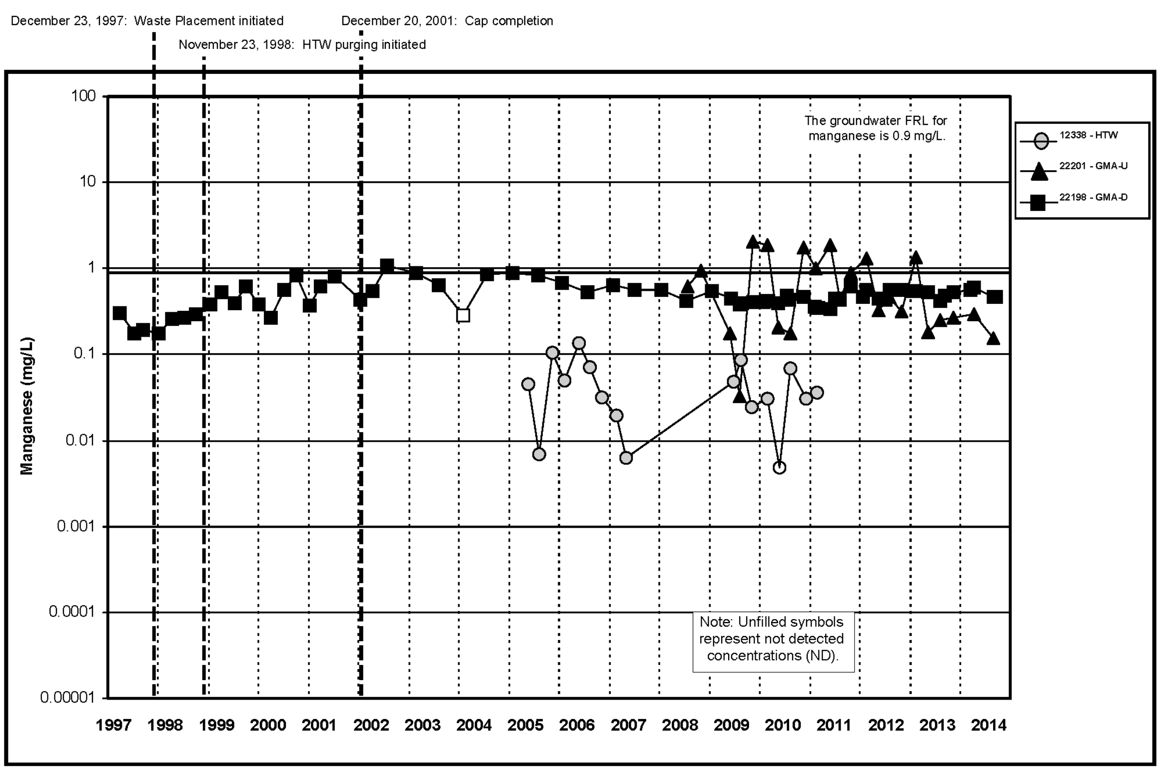


Figure A.5.1-24B. Cell 1 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

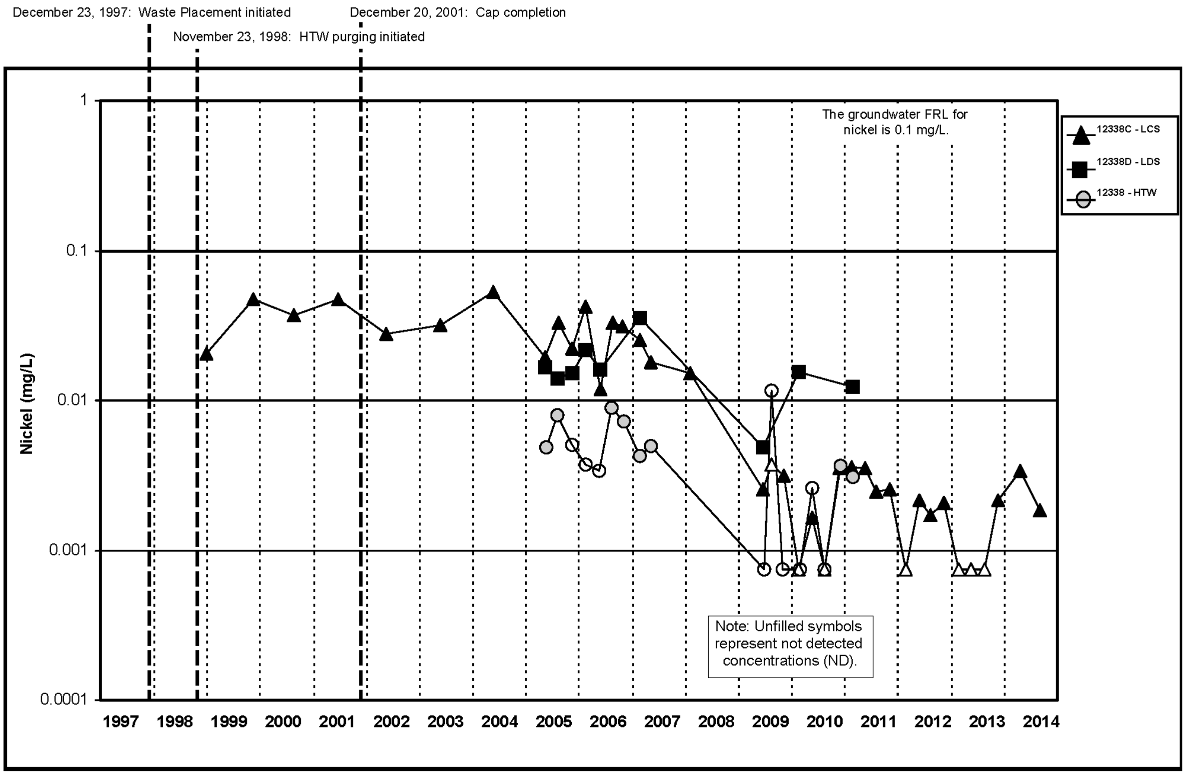


Figure A.5.1-25A. Cell 1 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

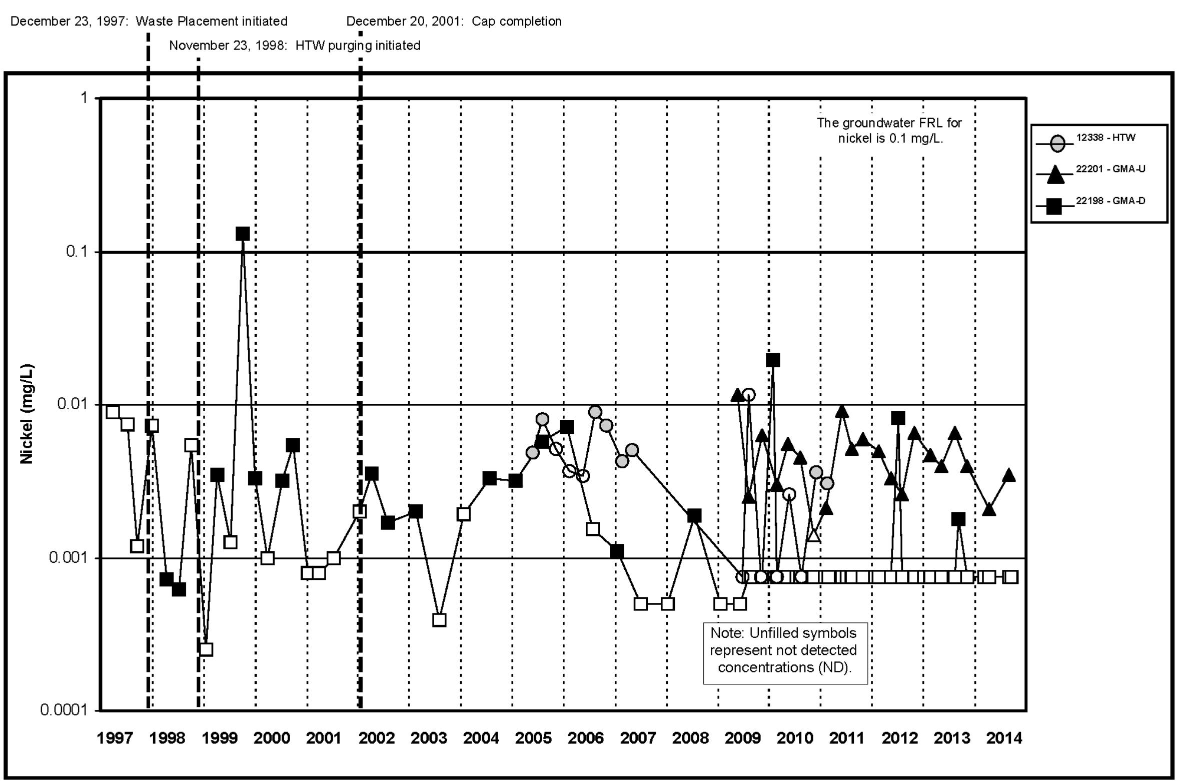


Figure A.5.1-25B. Cell 1 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

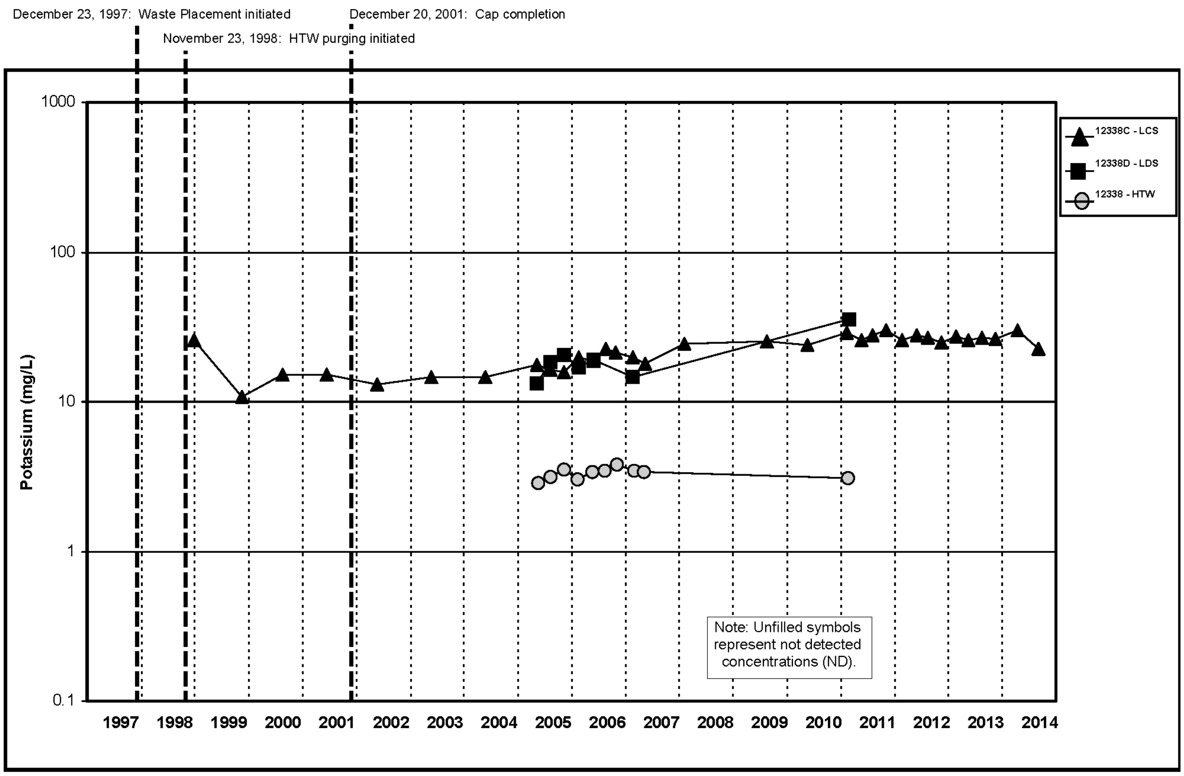


Figure A.5.1-26A. Cell 1 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

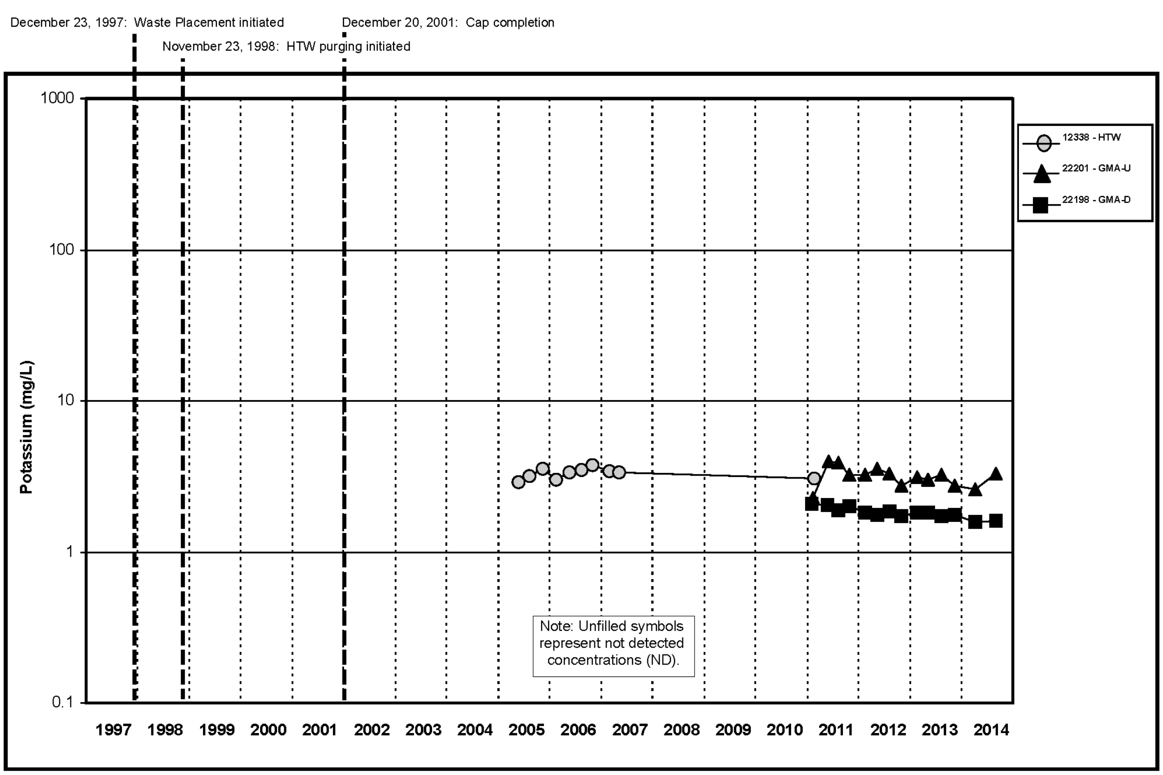


Figure A.5.1-26B. Cell 1 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

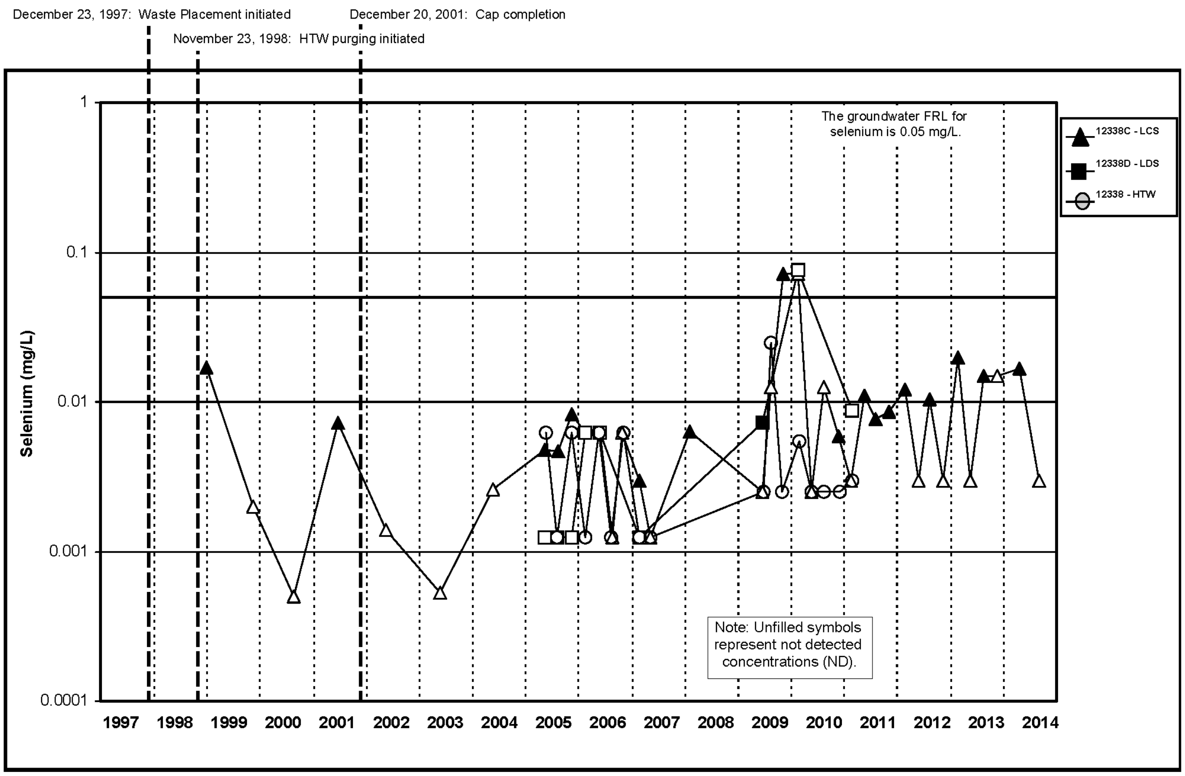


Figure A.5.1-27A. Cell 1 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

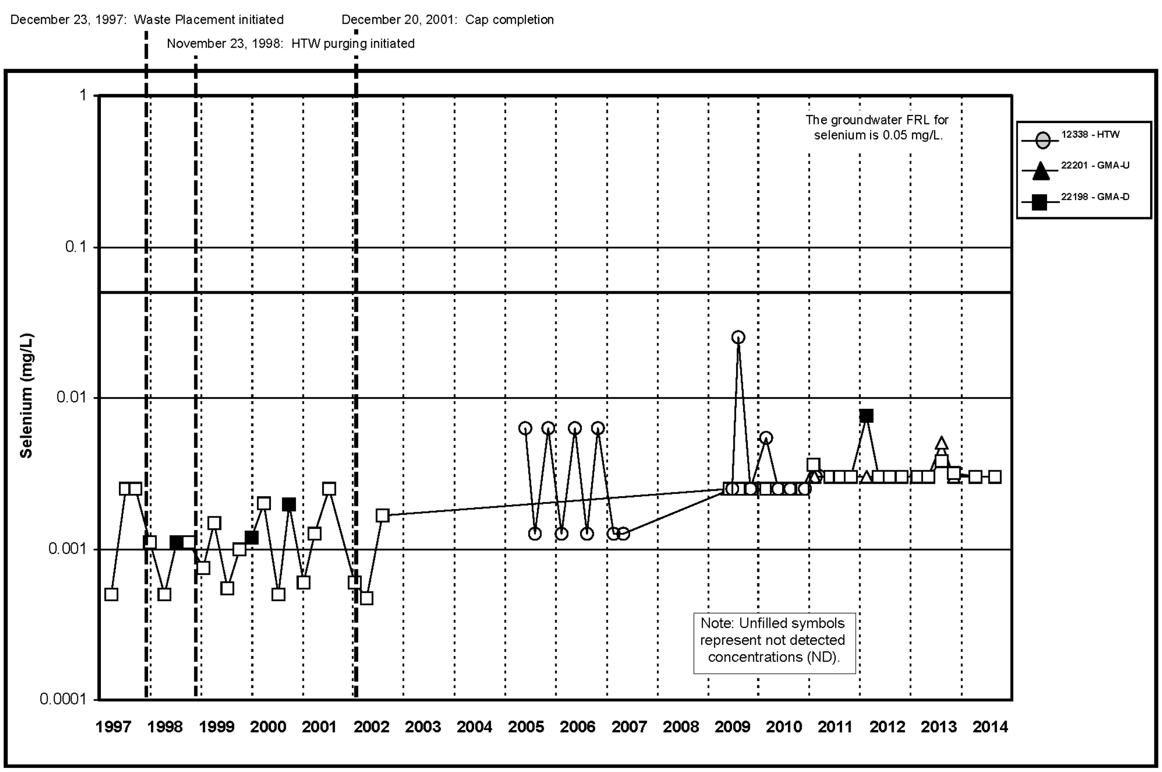


Figure A.5.1-27B. Cell 1 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

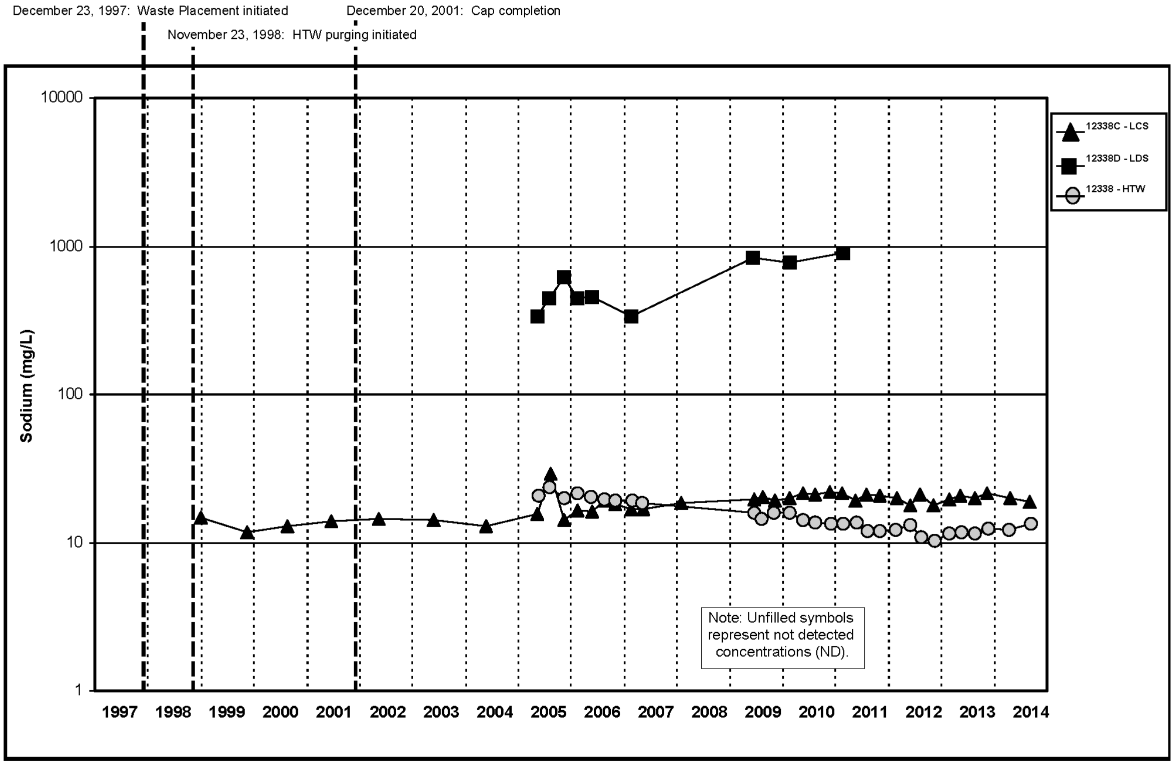


Figure A.5.1-28A. Cell 1 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

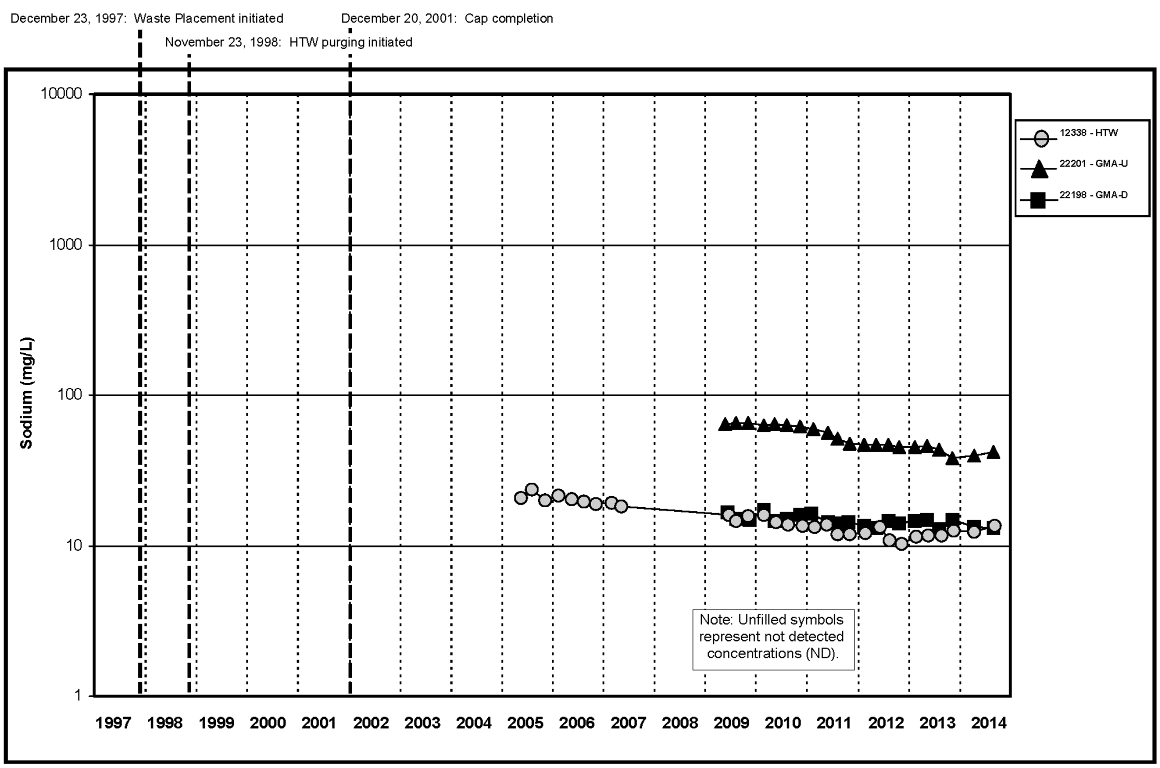


Figure A.5.1-28B. Cell 1 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

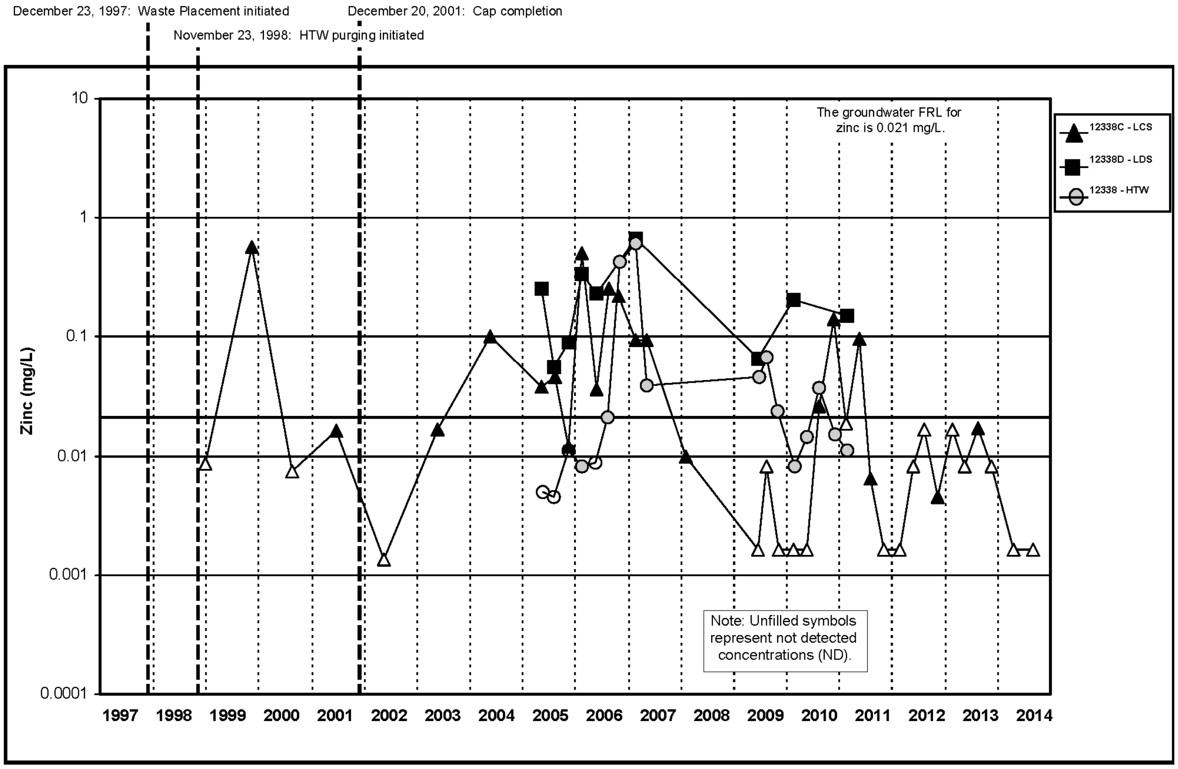


Figure A.5.1-29A. Cell 1 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

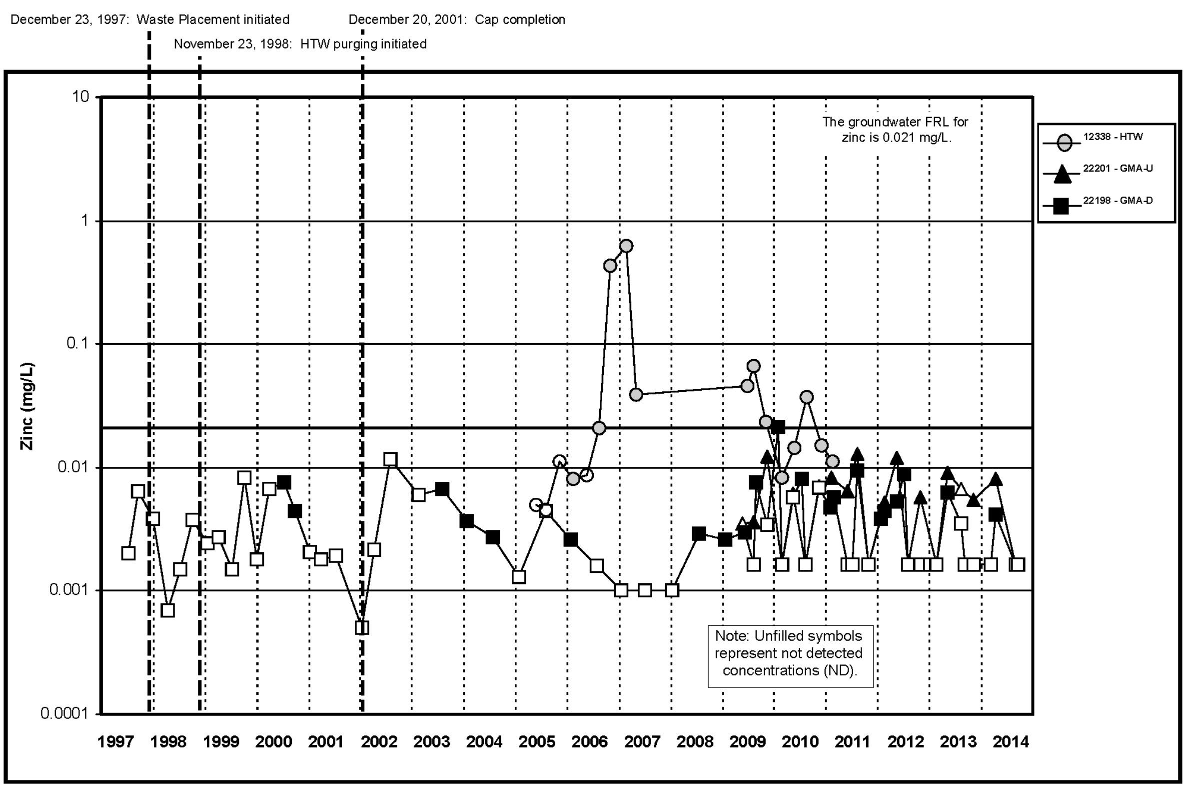


Figure A.5.1-29B. Cell 1 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

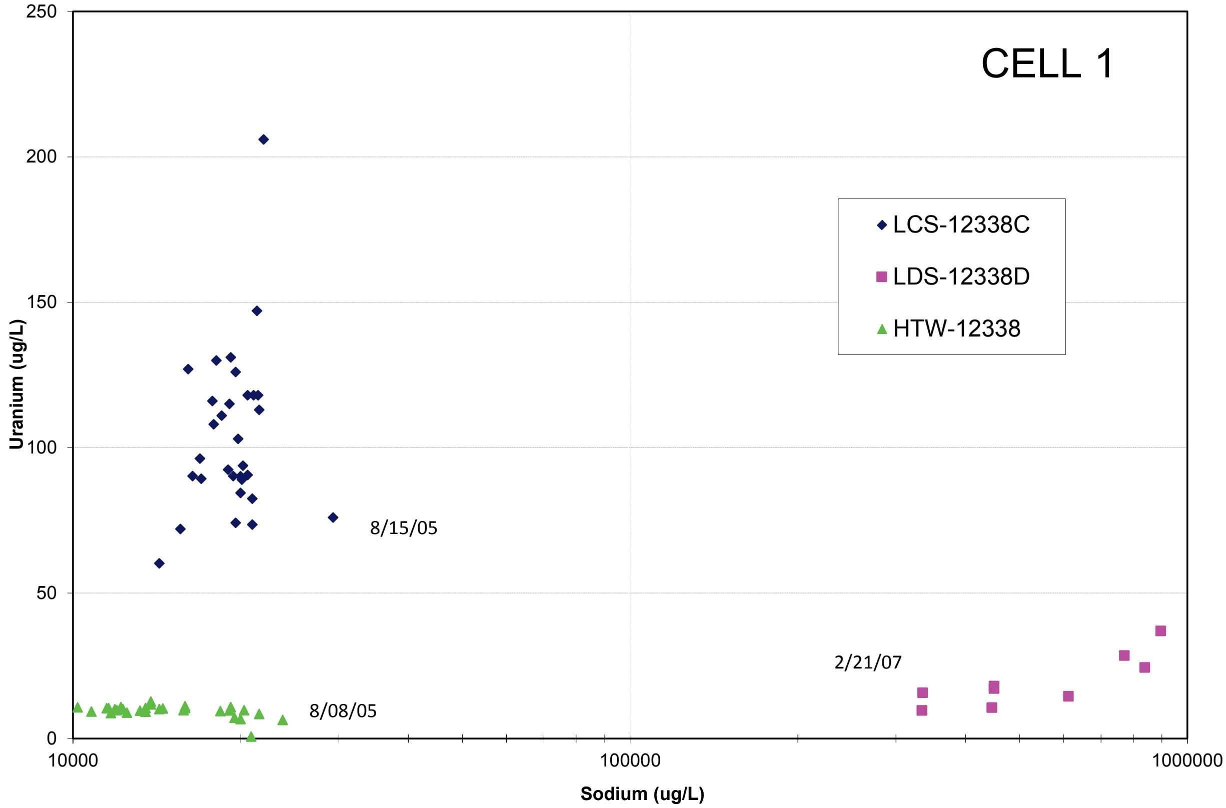


Figure A.5.1-30. Cell 1 Bivariate Plot for Uranium and Sodium

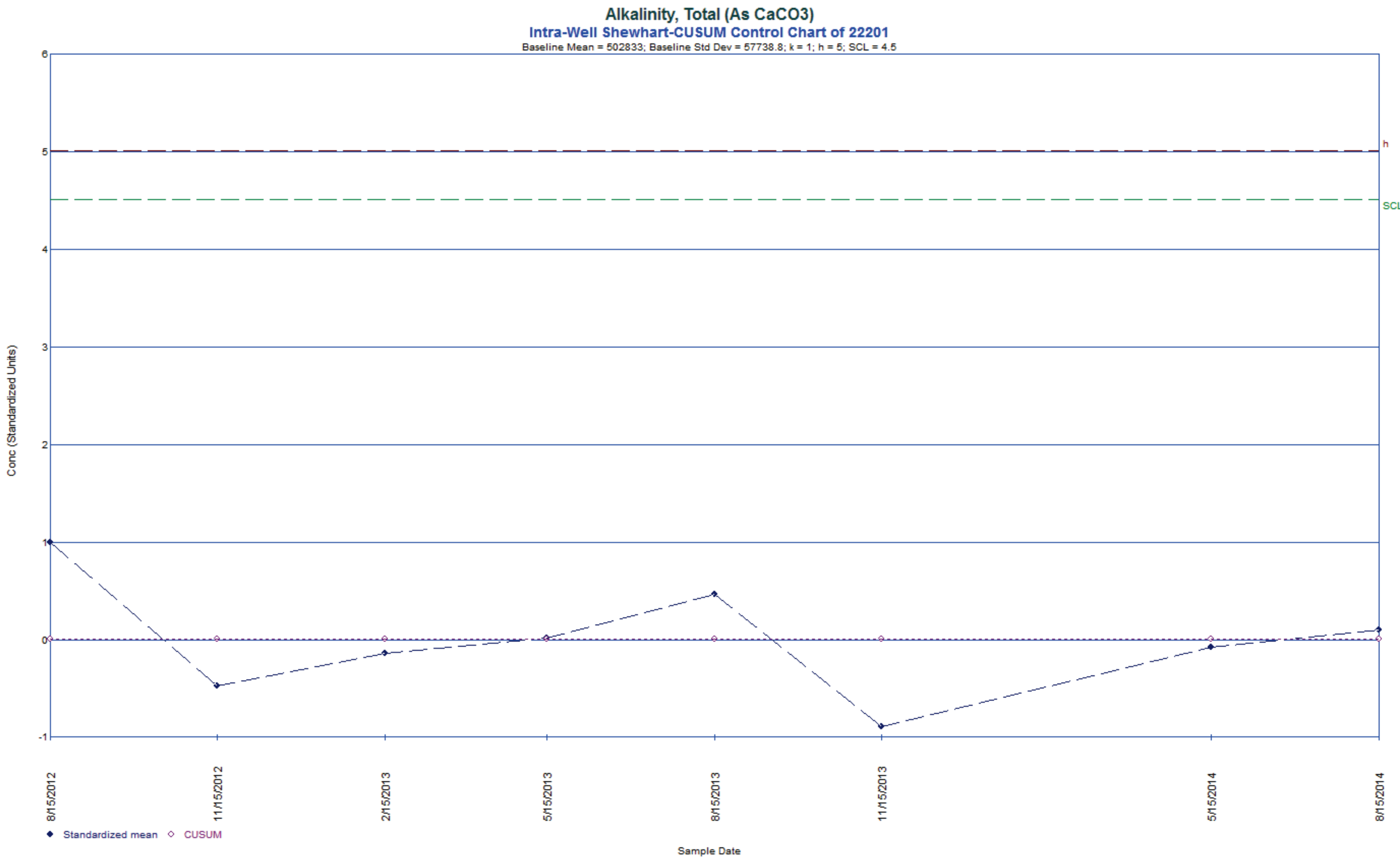


Figure A.5.1-31. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22201)

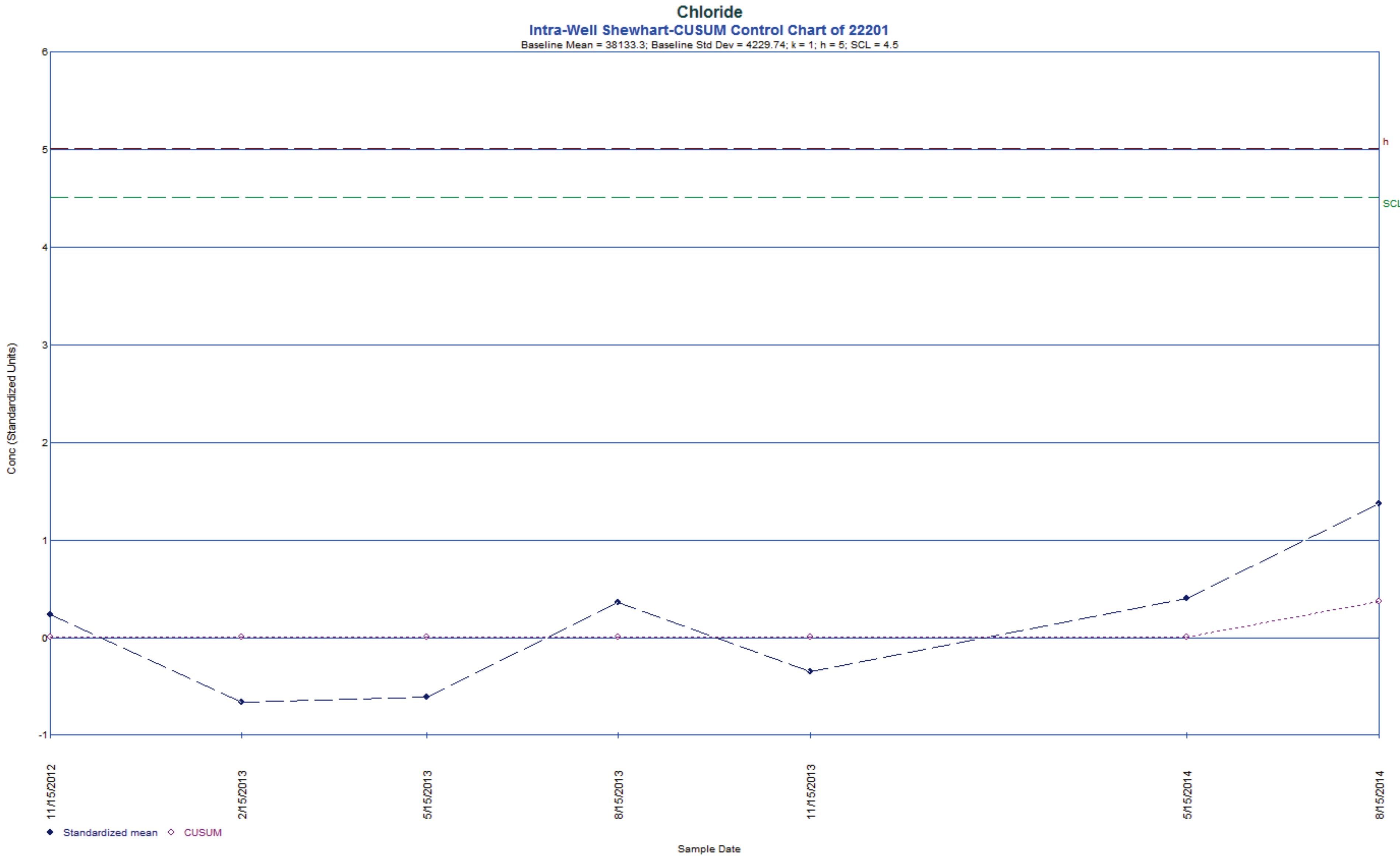


Figure A.5.1-32. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22201)

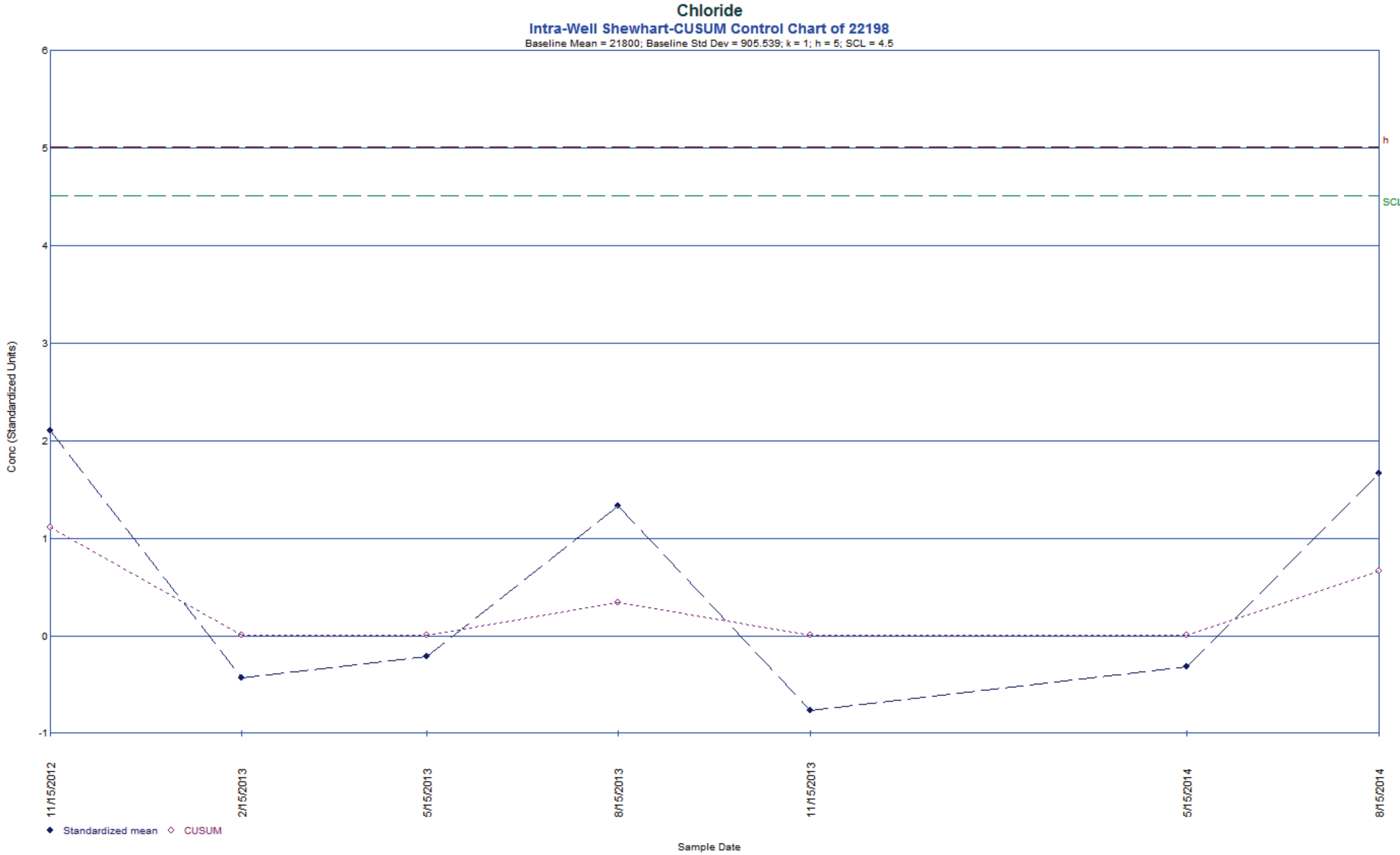


Figure A.5.1-33. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22198)

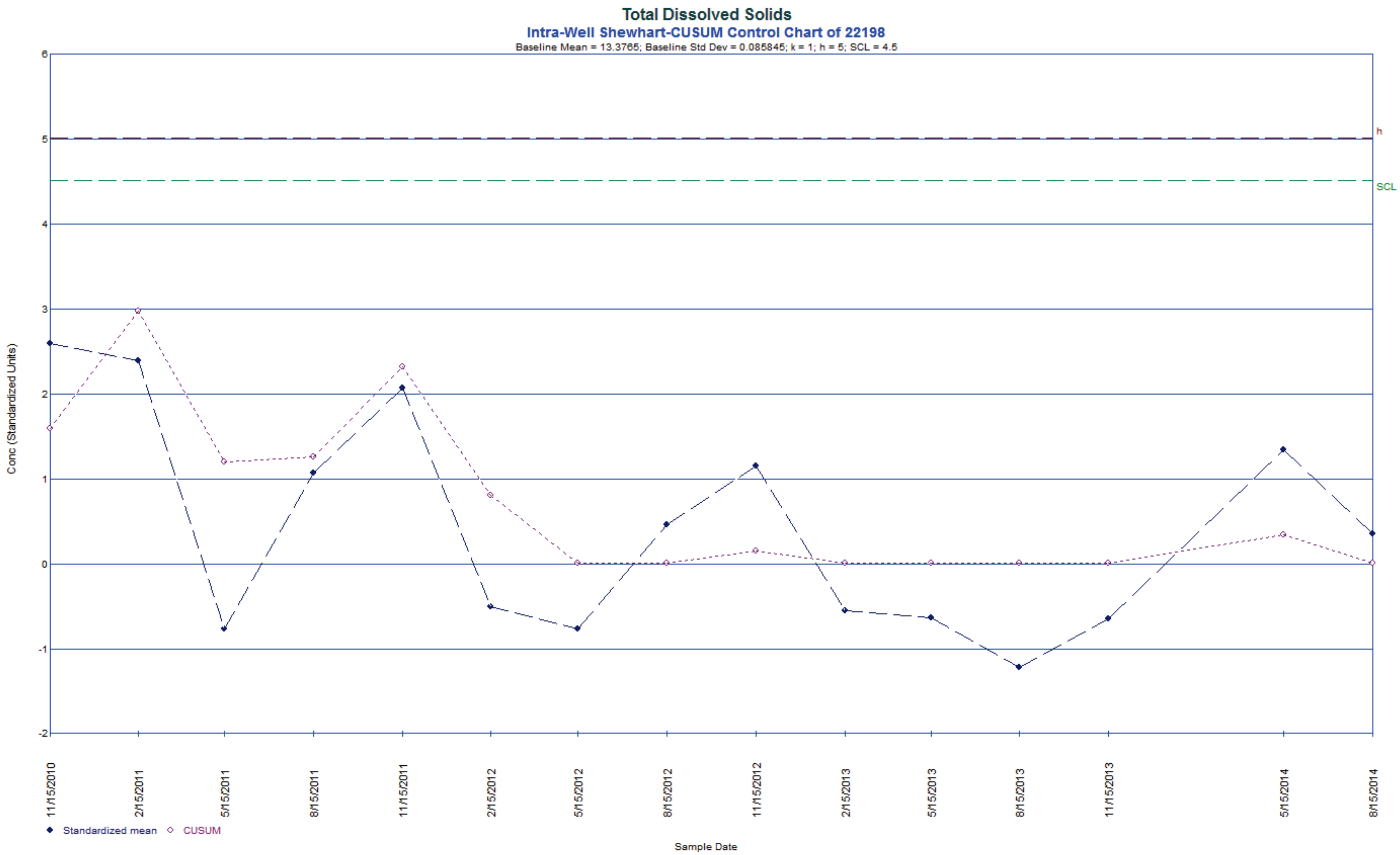


Figure A.5.1-34. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22198)

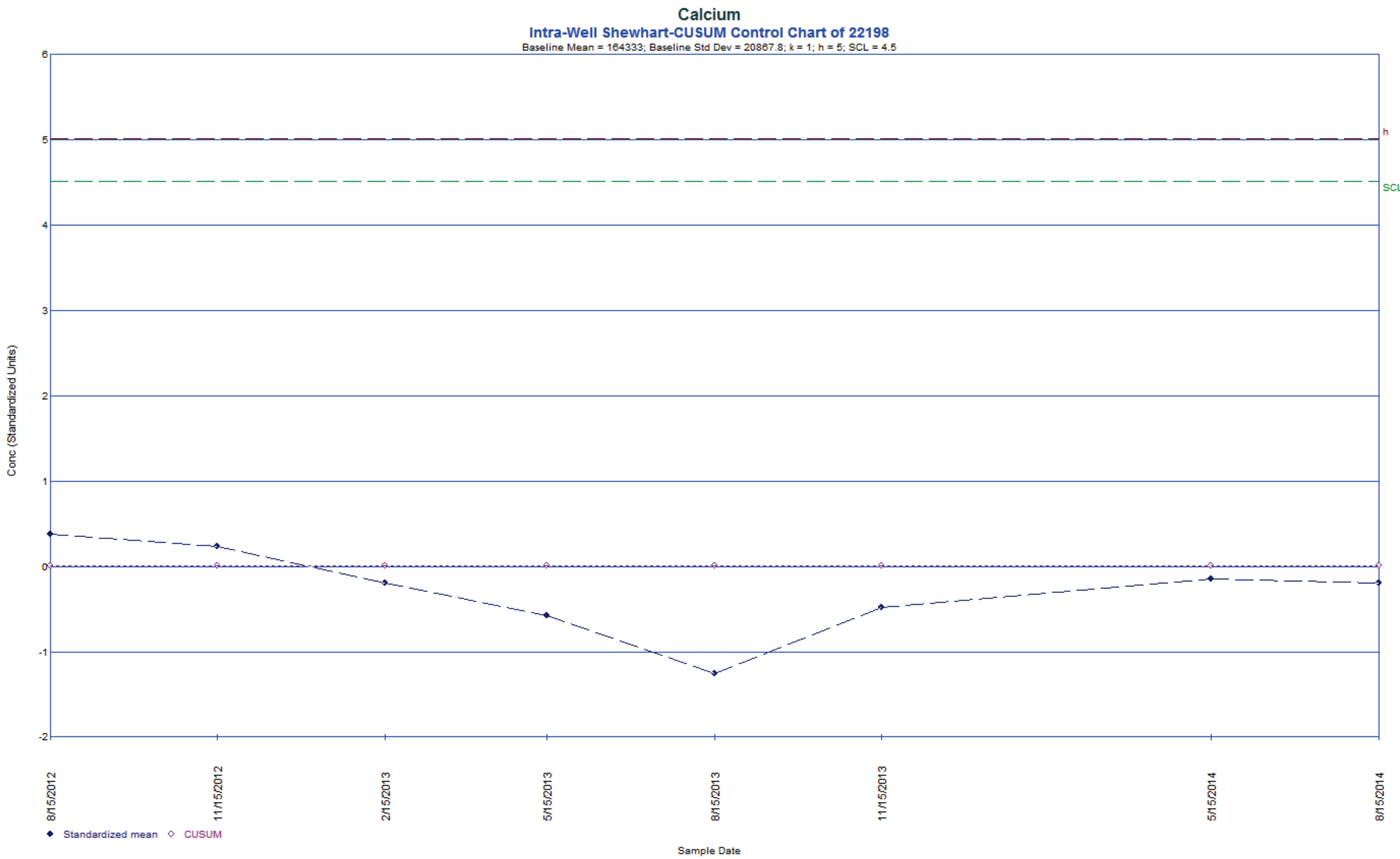


Figure A.5.1-35. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22198)

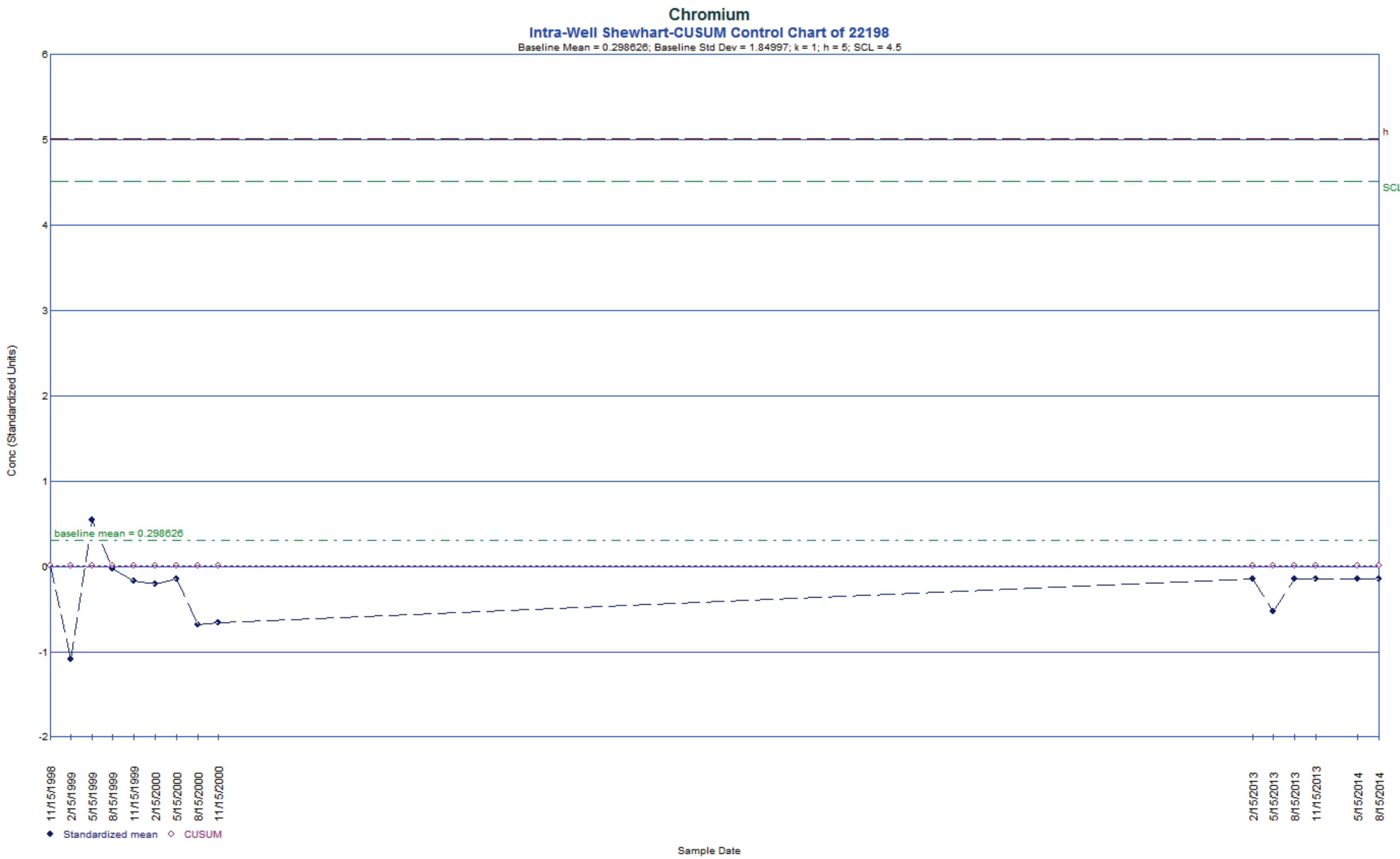


Figure A.5.1-36. Intra-Well Shewhart-CUSUM Control Chart (Chromium 22198)

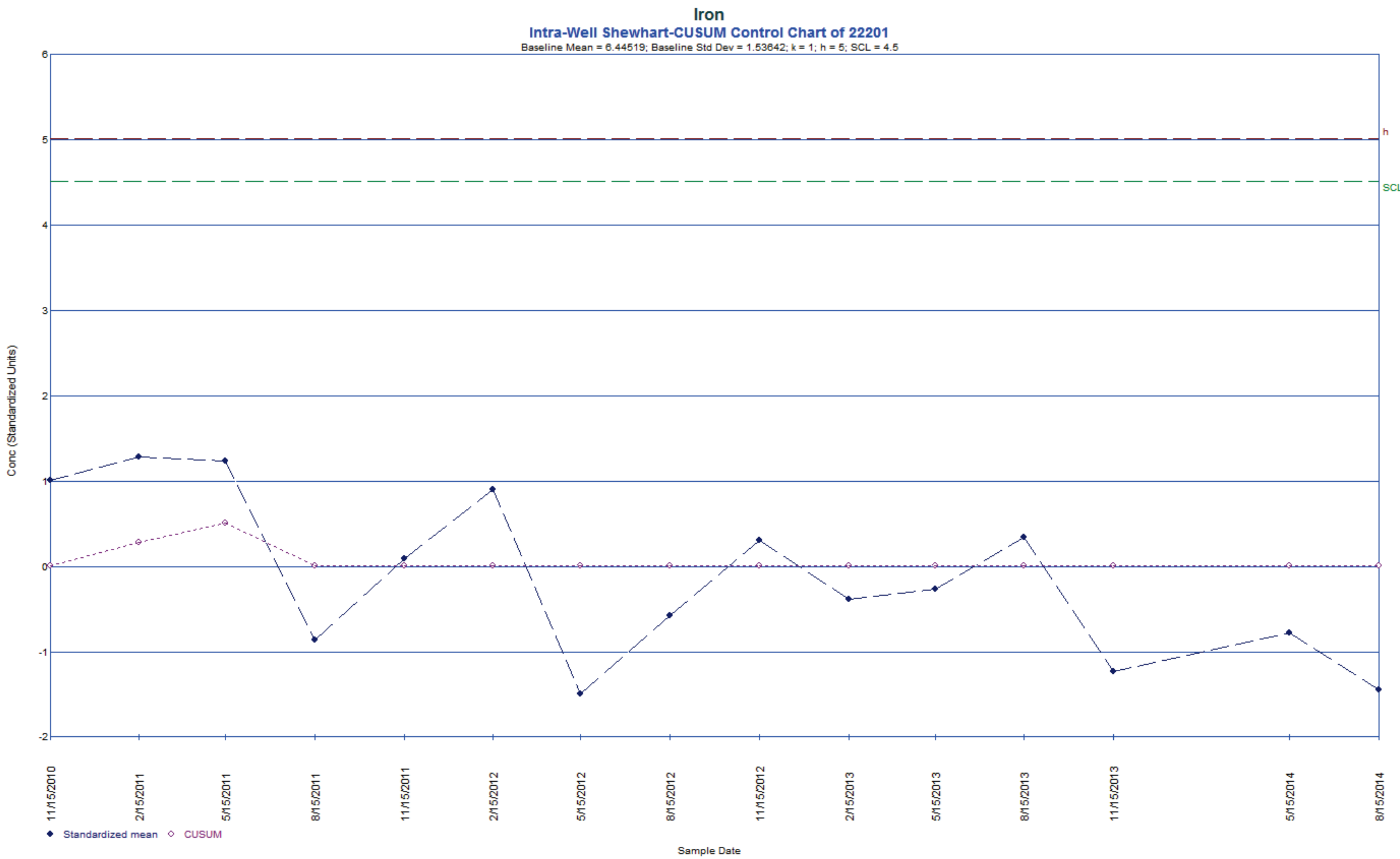


Figure A.5.1-37. Intra-Well Shewhart-CUSUM Control Chart (Iron 22201)

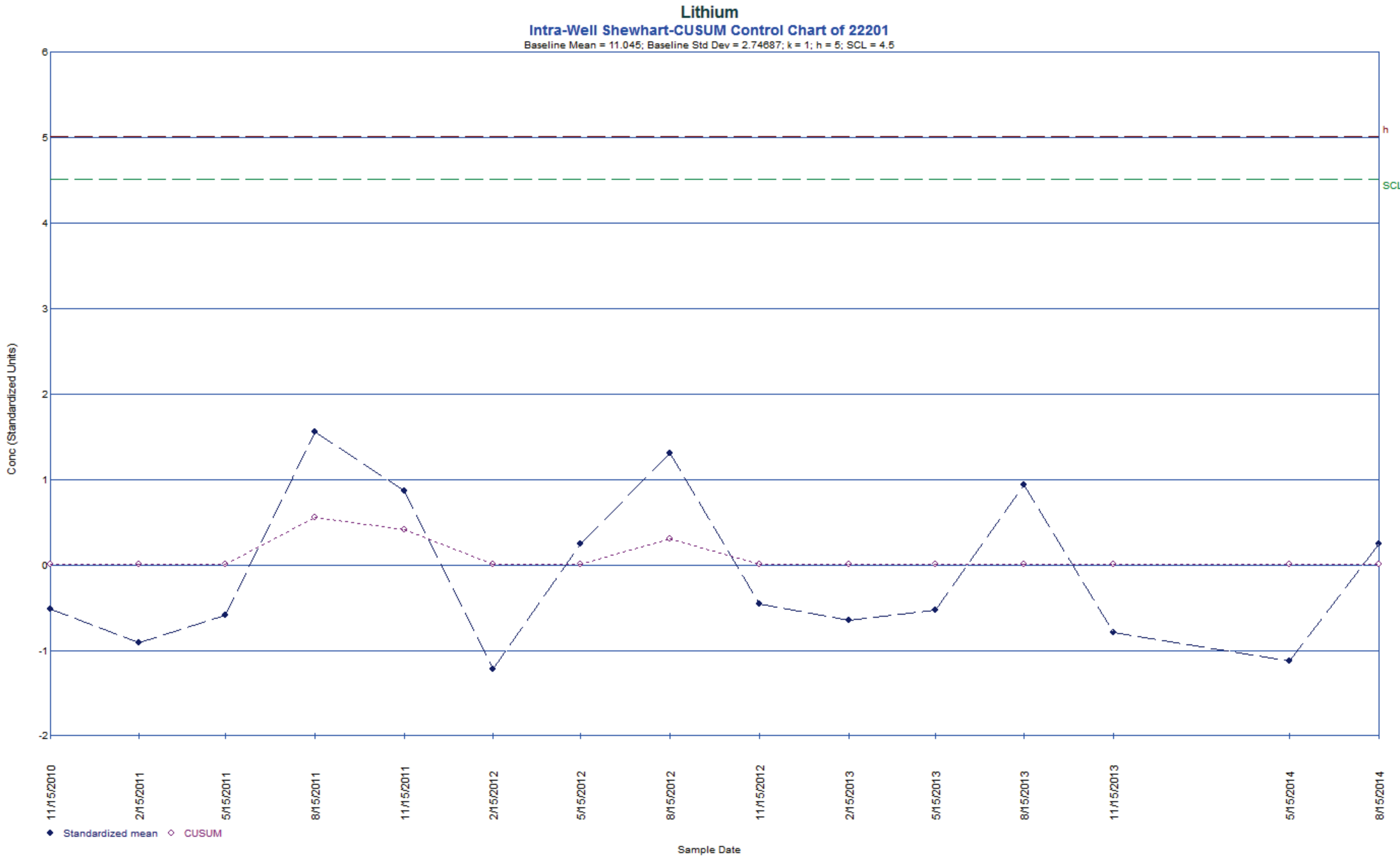


Figure A.5.1-38. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22201)

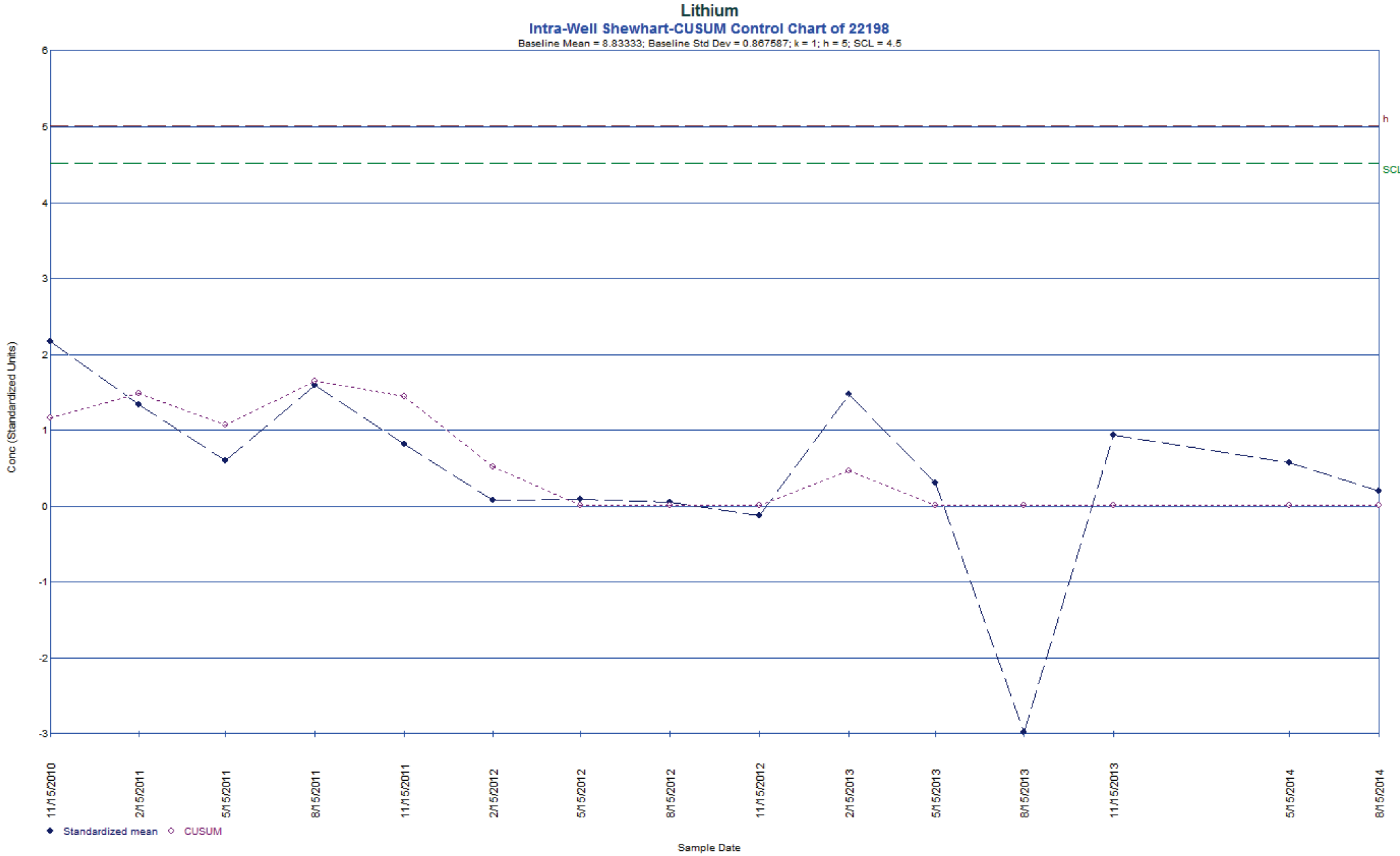


Figure A.5.1-39. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22198)

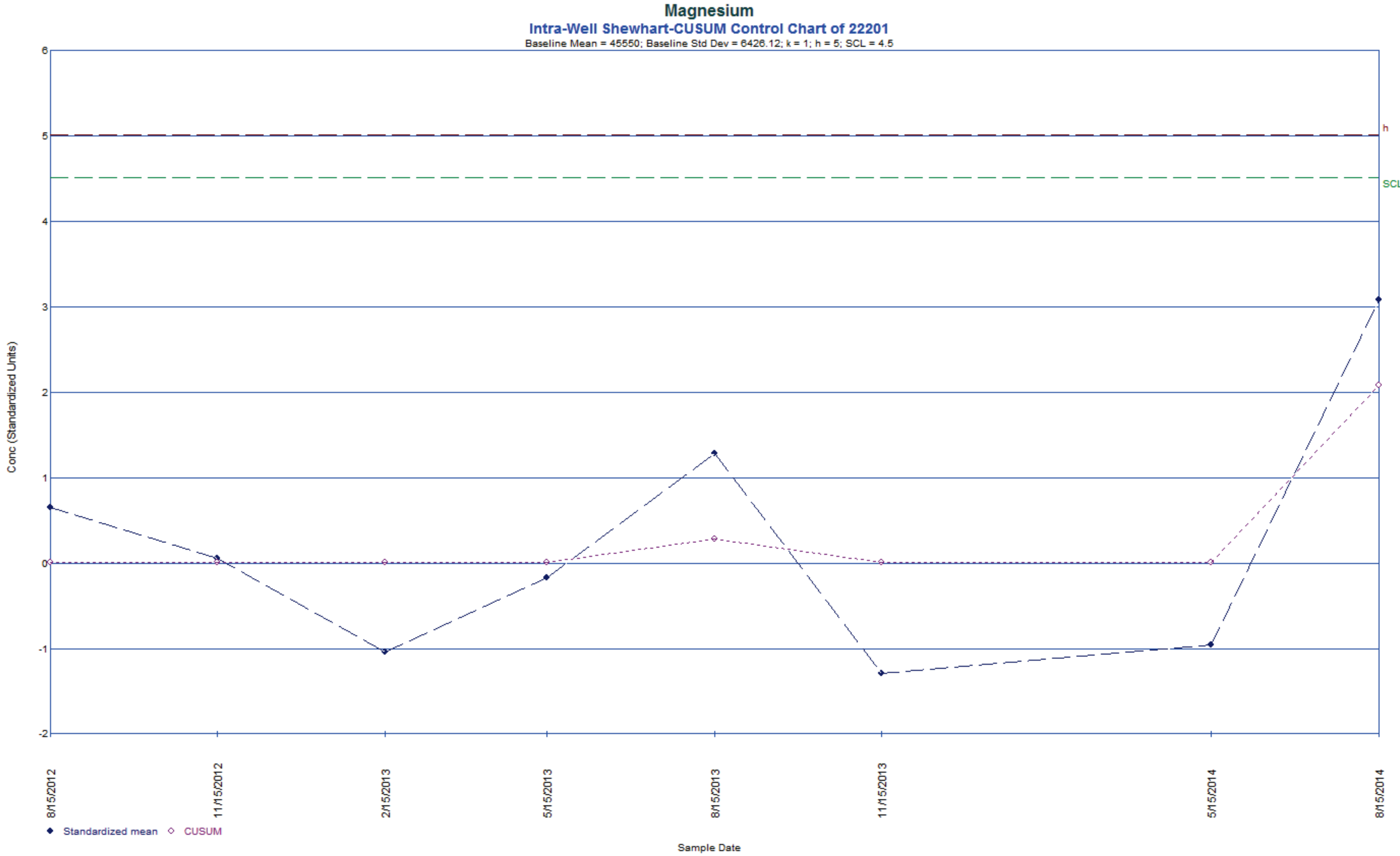


Figure A.5.1-40. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22201)

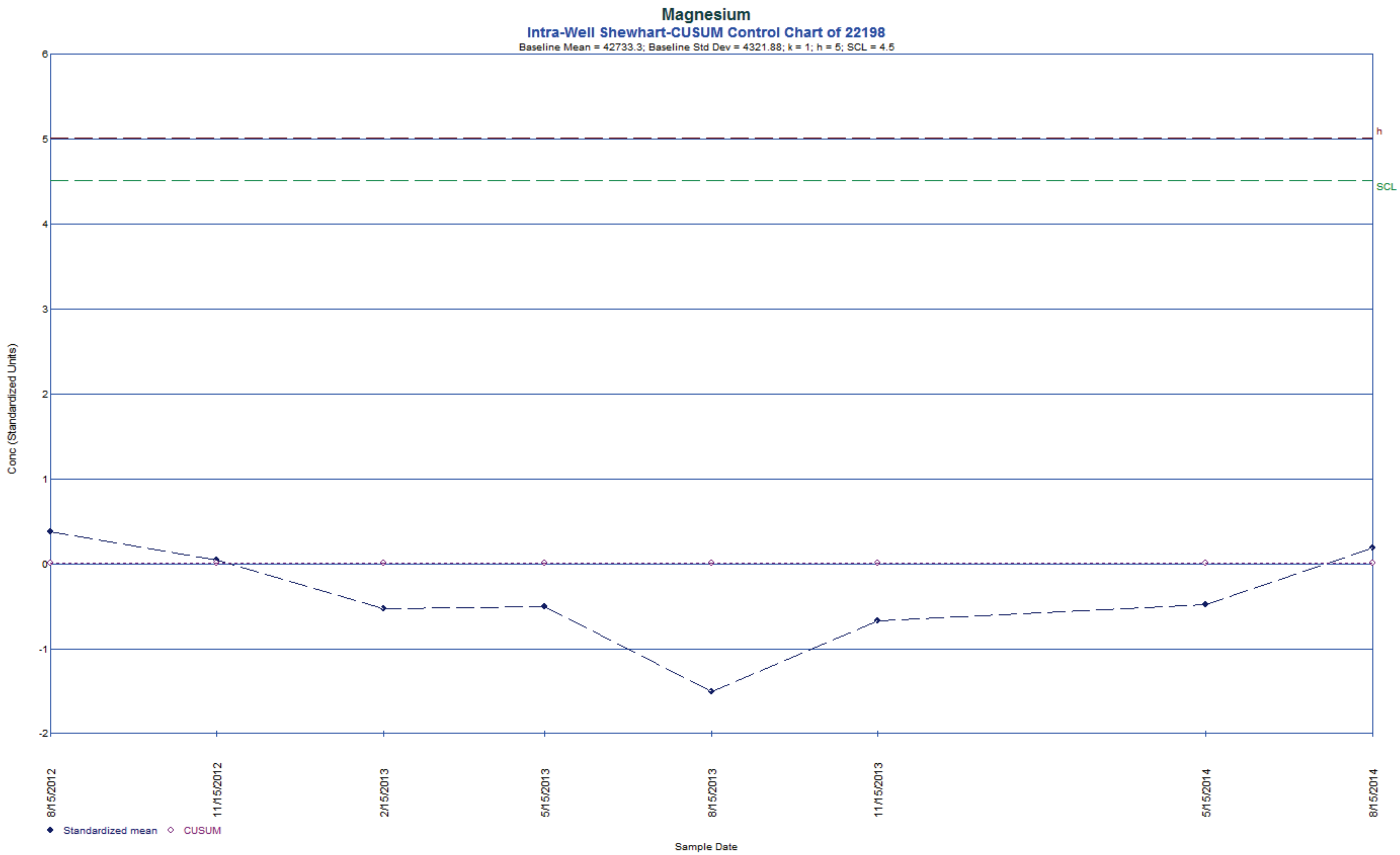


Figure A.5.1-41. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22198)

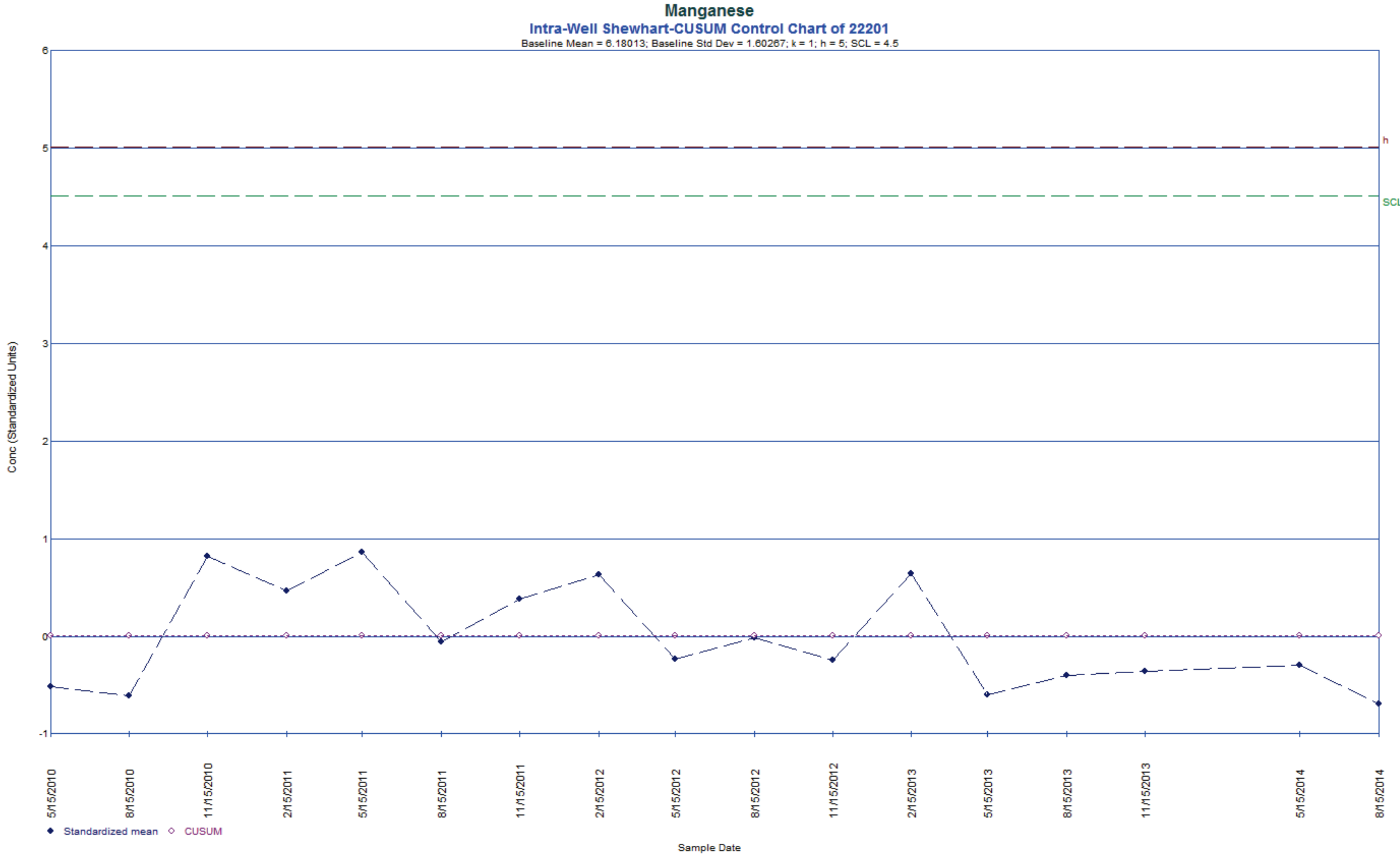


Figure A.5.1-42. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22201)

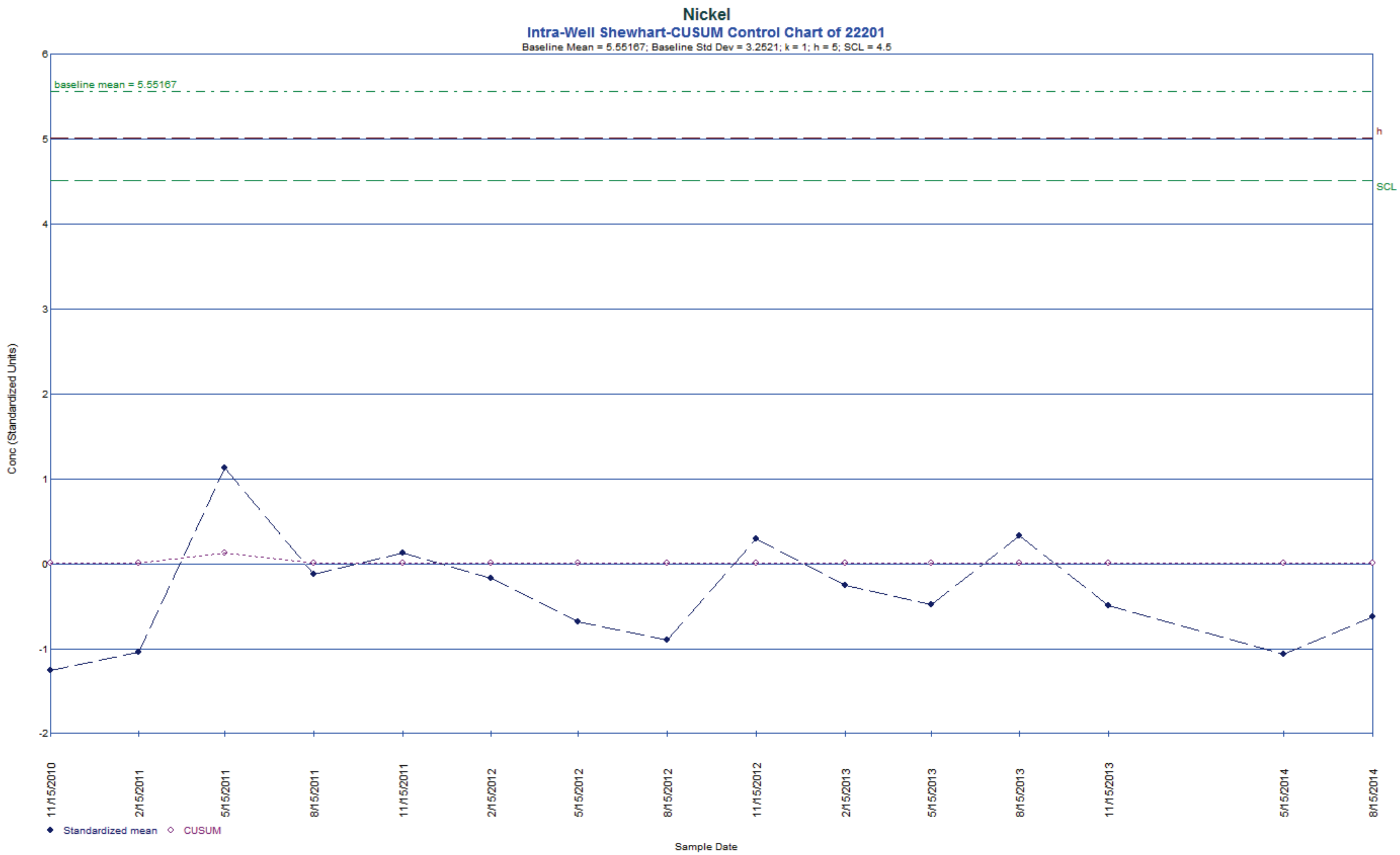


Figure A.5.1-43. Intra-Well Shewhart-CUSUM Control Chart (Nickel 22201)

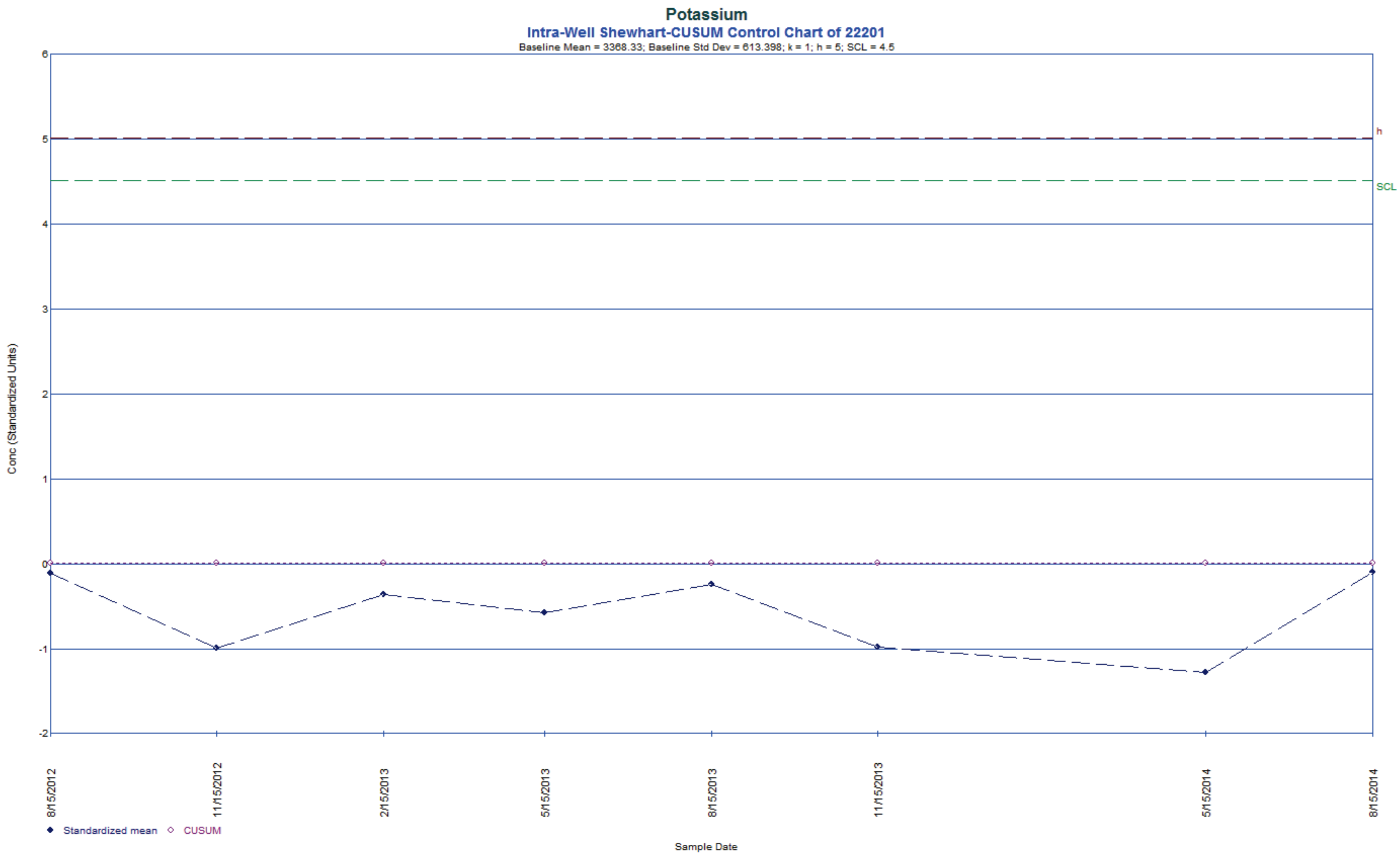


Figure A.5.1-44. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22201)

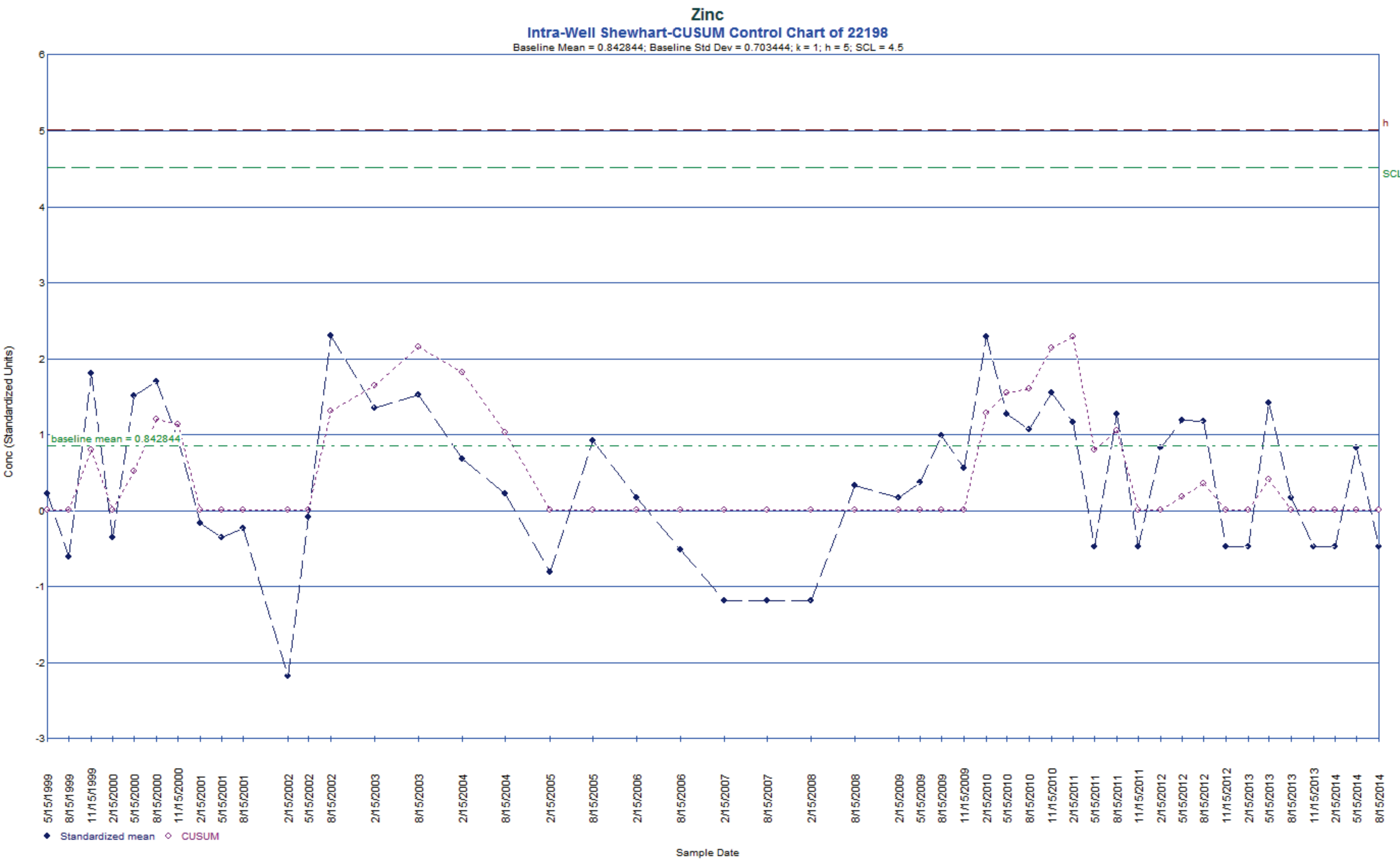


Figure A.5.1-45. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22198)

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Sub-attachment A.5.2

Cell 2

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Contents

Tables

Figures

Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
SCL	Shewhart control limit

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.2-1)
- Annual leachate collection system (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)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.2-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12339 water yield (refer to Figure A.5.2-3)
- Great Miami Aquifer (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 through A.5.2-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.2-30)
- Control charts (refer to Figures A.5.2-31 through A.5.2-44)

A.5.2.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. Summary statistics are provided in Table A.5.2-1.

Based on capacitance probe readings, the LDS tank of Cell 2 was dry during three quarters of 2014. It should be noted that the capacitance probes have the ability of measuring to within hundredths of a foot of water present in the bottom of the tank. So, while water may register via the probes, there may not be enough water present to physically obtain a sample. This was the case in 2014 for the LDS in Cell 2. Therefore, from a sampling ability, the LDS in Cell 2 was considered to be dry all year.

As shown in Table A.5.2-1 and summarized below, five parameters (uranium, chloride, arsenic, boron, and selenium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 2

Parameter	HTW 12339	GMA-U[a] 22200	GMA-D[a] 22199
Total Uranium		Up	
Chloride		Up	
Arsenic			Up
Boron		Up	Up
Selenium		Up	

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

The (uranium-sodium) bivariate plot for the Cell 2 LCS, LDS, and HTW is provided in Figure A.5.2-30. 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, upward concentration trends measured beneath Cell 2 (i.e., in the HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

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 Shewhart-cumulative sum (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 "not in control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart 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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

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

These 14 control charts are presented in Figures A.5.2-31 through A.5.2-44. With the exception of potassium in the upgradient GMA well 22200, all control charts for Cell 2 indicate "in control" conditions. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 2 indicated that water is not mixing between horizons, so the "not in control" condition is attributed to fluctuating ambient conditions beneath the cell and not to cell performance.

Parameter	Monitoring Point[a]	Well Number	Assessment	Figure Number
Total Dissolved Solids	GMA-U	22199	In Control	A.5.2-31
Barium	GMA-U	22200	In Control	A.5.2-32
Barium	GMA-D	22199	In Control	A.5.2-33
Iron	GMA-U	22199	In Control	A.5.2-34
Iron	GMA-U	22200	In Control	A.5.2-35
Lithium	GMA-U	22200	In Control	A.5.2-36
Lithium	GMA-D	22199	In Control	A.5.2-37
Magnesium	GMA-U	22200	In Control	A.5.2-38
Magnesium	GMA-D	22199	In Control	A.5.2-39
Potassium	GMA-U	22200	Not In Control	A.5.2-40
Potassium	GMA-D	22199	In Control	A.5.2-41
Sodium	GMA-U	22200	In Control	A.5.2-42
Zinc	GMA-U	22200	In Control	A.5.2-43
Zinc	GMA-D	22199	In Control	A.5.2-44

[a] 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 semiannually. Only one new Appendix I parameter, silver, was detected in the LCS of Cell 2 in 2014. Detection of silver in the LCS of Cell 2 in 2015 will trigger sampling for silver in the LDS of Cell 2 during the next sampling event.

A.5.2.4 Summary and Conclusions

- Five parameters monitored semiannually have an upward concentration trend in the HTW and/or GMA wells of Cell 2: uranium, chloride, arsenic, boron, and selenium.
- 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. Therefore, upward concentration trends beneath Cell 2 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Fourteen control charts were constructed for Cell 2 parameters. All of the control charts, with the exception of potassium in upgradient well 22200, exhibit "in control" conditions. Separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of

Cell 2 indicated that water is not mixing between horizons, so the “not in control” condition is attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

- One new Appendix I parameter, silver, was detected in the LCS of Cell 2 in 2014. Detection of silver in the LCS of Cell 2 in 2015 will trigger sampling for silver in the LDS of Cell 2 during the subsequent next sampling event.

A.5.2.5 References

DOE (U.S. Department of Energy), 1994. *Fernald Environmental Management Project Fernald, Ohio Remedial Investigation and Feasibility Study*, May.

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12339C	61	61	100	4.51	448	111	87	LogNormal	Up	Detected	
	LDS	12339D	35	35	100	4.08	71	14.5	13.2	Undefined	None	Detected	
	HTW	12339	61	62	98.4	ND	36.9	9.45	5.75	Normal	None	Detected	
	GMA-U	22200	50	68	73.5	ND	1.93	0.300	0.310	Undefined	Up	Not Detected	
	GMA-D	22199	68	70	97.1	ND	12.1	0.720	2.40	Undefined	Down	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12339C	33	33	100	60.5	1480	591	239	Undefined	Up	Detected	
	LDS	12339D	10	10	100	131	347	250	80	Normal	Up	Detected	
	GMA-U	22200	14	14	100	376	426	403	16	Normal	Down	Detected	
	GMA-D	22199	14	14	100	331	378	349	15	Normal	Down	Not Detected	
Chloride (mg/L)	LCS	12339C	33	33	100	3.95	41.2	14.1	5.6	Undefined	Up	Detected	
	LDS	12339D	10	10	100	44	296	102	72	LogNormal	Up	Not Detected	
	GMA-U	22200	14	14	100	31.5	45.7	40.0	3.8	Normal	Up	Not Detected	
	GMA-D	22199	14	14	100	20.8	27.2	23.1	1.7	Normal	Down	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12339C	29	43	67.4	ND	4.1	0.0710	1.14	Undefined	Down	Detected	
	LDS	12339D	12	13	92.3	ND	22.9	4.20	5.75	Undefined	Up	Detected	
	GMA-U	22200	2	14	14.3	ND	0.106	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22199	2	14	14.3	ND	0.0425	Insufficient	Insufficient	Undefined	None	Not Detected	
Sulfate (mg/L)	LCS	12339C	50	50	100	155	1870	1600	350	Undefined	Up	Detected	
	LDS	12339D	18	18	100	2290	13000	4800	2680	LogNormal	Up	Detected	
	HTW	12339	40	40	100	413	850	605	103	Normal	Down	Detected	
	GMA-U	22200	45	45	100	61.1	434	151	98	Undefined	Down	Detected	
	GMA-D	22199	45	45	100	101	540	160	96	Undefined	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12339C	42	42	100	557	3430	3010	930	Undefined	Up	Detected	
	LDS	12339D	12	12	100	1894	18200	8080	4620	Normal	Up	Detected	
	GMA-U	22200	21	21	100	541	857	614	97	Undefined	None	Not Detected	
	GMA-D	22199	21	21	100	520	818	634	77	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12339C	51	61	83.6	ND	6.6	2.68	1.38	Undefined	Up	Detected	
	LDS	12339D	27	35	77.1	ND	11.5	4.25	2.19	LogNormal	None	Detected	26.1(Q3-99)
	GMA-U	22200	56	68	82.4	ND	40.1	1.88	5.54	Undefined	None	Not Detected	
	GMA-D	22199	52	68	76.5	ND	48.1	1.57	6.06	Undefined	None	Not Detected	
Total Organic Halogens (mg/L)	LCS	12339C	33	62	53.2	ND	0.112	0.0225	0.0252	LogNormal	None	Detected	
	LDS	12339D	14	36	38.9	ND	0.069	0.0118	0.0114	Undefined	None	Not Detected	
	GMA-U	22200	22	68	32.4	ND	0.177	0.00473	0.0266	Undefined	Down	Detected	
	GMA-D	22199	15	68	22.0	ND	0.0775	0.00429	0.0126	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12339C	24	38	63.2	ND	0.43	0.0119	0.0906	Undefined	Up	Detected	
	LDS	12339D	4	10	40.0	ND	0.019	0.00564	0.00539	LogNormal	None	Not Detected	
	HTW	12339	4	30	13.3	ND	0.025	0.00250	0.00582	Undefined	None	Not Detected	
	GMA-U	22200	6	21	28.6	ND	0.0355	0.00250	0.00886	Undefined	None	Not Detected	
	GMA-D	22199	7	35	20.0	ND	0.0429	0.00250	0.00953	Undefined	Up	Detected	
Barium (mg/L)	LCS	12339C	33	33	100	0.0297	0.459	0.0750	0.0999	Undefined	None	Detected	
	LDS	12339D	10	10	100	0.0167	0.0325	0.0225	0.0048	Normal	Up	Detected	
	GMA-U	22200	14	14	100	0.0811	0.156	0.115	0.024	Normal	None	Not Detected	
	GMA-D	22199	14	14	100	0.0641	0.131	0.0895	0.0195	Normal	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12339C	62	62	100	0.207	4.78	2.53	1.05	Undefined	Up	Detected	
	LDS	12339D	35	35	100	0.289	2.22	0.422	0.371	Undefined	Up	Detected	
	GMA-U	22200	56	68	82.4	ND	0.105	0.0526	0.0221	Undefined	Up	Detected	
	GMA-D	22199	59	68	86.8	ND	0.0899	0.0514	0.0157	Normal	Up	Detected	
Calcium (mg/L)	LCS	12339C	33	33	100	165	1320	462	285	LogNormal	Up	Detected	
	LDS	12339D	10	10	100	408	546	462	38	Normal	None	Not Detected	
	GMA-U	22200	14	14	100	128	205	142	25	Undefined	None	Not Detected	
	GMA-D	22199	14	14	100	125	193	138	21	Undefined	None	Not Detected	
Chromium (mg/L)	LCS	12339C	11	27	40.7	ND	0.0177	0.00457	0.00435	LogNormal	Up	Detected	
	LDS	12339D	2	5	40.0	ND	0.0155	Insufficient	Insufficient	Normal	None	Insufficient	
	GMA-U	22200	0	6	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	0	6	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Cobalt (mg/L)	LCS	12339C	34	38	89.5	ND	0.306	0.0845	0.0664	LogNormal	None	Detected	
	LDS	12339D	1	10	10.0	ND	0.0035	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-U	22200	0	21	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	0	21	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12339C	22	34	64.7	ND	0.0603	0.00565	0.0120	Undefined	None	Detected	
	LDS	12339D	6	10	60.0	ND	0.167	0.0267	0.0500	LogNormal	None	Not Detected	
	GMA-U	22200	6	14	42.9	ND	0.0144	0.00152	0.00391	Undefined	Down	Detected	
	GMA-D	22199	6	14	42.9	ND	0.01	0.00150	0.00320	Undefined	None	Not Detected	
Iron (mg/L)	LCS	12339C	37	38	97.4	ND	757	295	156	LogNormal	Up	Detected	
	LDS	12339D	10	10	100	0.0774	3.61	1.15	1.19	LogNormal	None	Not Detected	
	GMA-U	22200	21	21	100	3.24	16.8	6.73	3.17	LogNormal	None	Not Detected	
	GMA-D	22199	21	21	100	3.21	5.82	4.13	0.60	Normal	None	Not Detected	7.72(Q2-13)
Lithium (mg/L)	LCS	12339C	30	30	100	0.377	0.984	0.698	0.193	Undefined	Up	Detected	
	LDS	12339D	10	10	100	0.226	1.15	0.548	0.260	Normal	Up	Detected	
	GMA-U	22200	21	21	100	0.00348	0.00562	0.00430	0.00051	Normal	None	Not Detected	
	GMA-D	22199	21	21	100	0.0065	0.00878	0.00740	0.00057	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12339C	33	33	100	32.4	375	235	87	Normal	Up	Detected	
	LDS	12339D	10	10	100	393	1470	713	322	Normal	Up	Detected	
	GMA-U	22200	14	14	100	33.1	50.7	40.4	4.4	Normal	None	Not Detected	
	GMA-D	22199	14	14	100	37.1	42.4	39.8	1.6	Normal	None	Not Detected	54.8(Q3-11), 53.3(Q3-12)
Manganese (mg/L)	LCS	12339C	36	38	94.7	ND	12.7	1.92	3.76	Undefined	None	Detected	
	LDS	12339D	6	10	60.0	ND	0.812	0.356	0.264	LogNormal	None	Not Detected	
	GMA-U	22200	23	23	100	0.204	0.742	0.300	0.139	Undefined	None	Not Detected	
	GMA-D	22199	34	35	97.1	ND	0.697	0.280	0.114	LogNormal	Down	Not Detected	0.791(Q3-06)
Nickel (mg/L)	LCS	12339C	38	38	100	0.00495	0.421	0.06921	0.0834	LogNormal	None	Detected	
	LDS	12339D	9	10	90.0	ND	0.0215	0.00675	0.00681	LogNormal	None	Not Detected	
	GMA-U	22200	0	21	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	6	35	17.1	ND	0.0066	0.000750	0.00147	Undefined	None	Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Potassium (mg/L)	LCS	12339C	33	33	100	3.93	89.6	32.3	18.3	Undefined	Up	Detected	
	LDS	12339D	10	10	100	29.8	108	54.5	23.9	Normal	Up	Detected	
	GMA-U	22200	14	14	100	1.5	2.14	1.81	0.21	Normal	None	Not Detected	
	GMA-D	22199	14	14	100	1.34	1.61	1.48	0.08	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12339C	13	38	34.2	ND	0.0522	0.0109	0.0122	LogNormal	None	Not Detected	
	LDS	12339D	9	10	90.0	ND	0.146	0.0288	0.0425	LogNormal	Up	Not Detected	
	GMA-U	22200	1	21	4.8	ND	0.01135	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-D	22199	0	21	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sodium (mg/L)	LCS	12339C	38	38	100	3.32	42.8	19.8	7.4	Normal	Up	Detected	
	LDS	12339D	10	10	100	664	2450	1230	540	Normal	Up	Detected	
	HTW	12339	30	30	100	39.3	119	51.0	24.1	Undefined	Down	Detected	
	GMA-U	22200	21	21	100	20.4	32.9	27.9	3.6	Normal	None	Not Detected	
	GMA-D	22199	21	21	100	12.6	19.5	15.6	2.1	Normal	Down	Detected	
Zinc (mg/L)	LCS	12339C	28	38	73.7	ND	0.353	0.0731	0.0809	LogNormal	None	Detected	
	LDS	12339D	10	10	100	0.0747	0.284	0.148	0.074	Normal	None	Not Detected	
	GMA-U	22200	17	21	81.0	ND	0.0457	0.0165	0.0115	LogNormal	None	Not Detected	
	GMA-D	22199	22	35	62.9	ND	0.0255	0.00576	0.00444	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least eight samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater Background)	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched Water)
General Chemistry											
Ammonia (mg/L)	17	9	52.9	Yes	0.076	0.2	0.147	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Antimony (mg/L)	17	4	23.5	Yes	0.00053	0.00629	0.0021	0.006 mg/L(1)	-	-	0.0987 mg/L(0)
Cadmium (mg/L)	17	7	41.2	Yes	0.000091	0.00128	0.0004	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Lead (mg/L)	17	5	29.4	Yes	0.0007	0.0275	0.0076	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(3)	0.0114 mg/L(1)
Silver (mg/L)	17	1	5.9	Yes	0.000385	-	-	0.05 mg/L(0)	0.0117 mg/L(0)	0.0031 mg/L(0)	0.264 mg/L(0)
Thallium (mg/L)	17	4	23.5	No	0.00057	0.0107	0.0033	-	-	-	0.0028 mg/L(1)
Vanadium (mg/L)	17	3	17.6	No	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)	28	1	3.6	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 final remediation level (FRL), groundwater background, perched water background, or perched water 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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

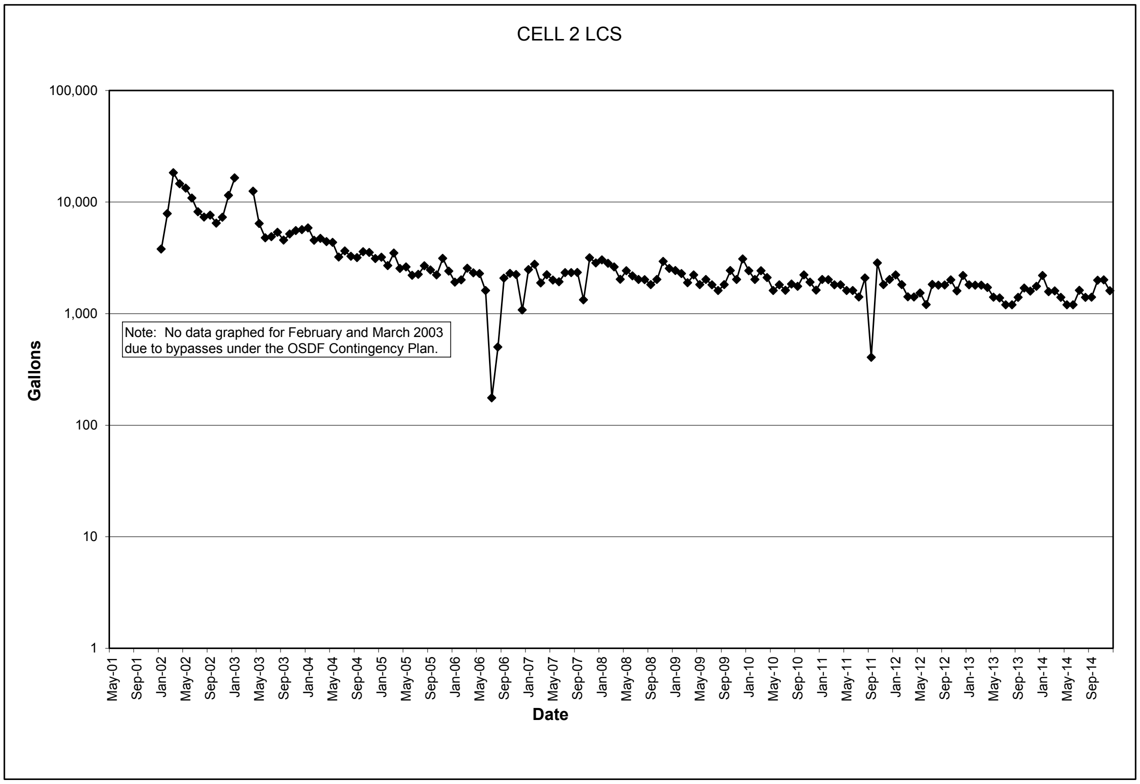


Figure A.5.2-1. Monthly Accumulation Volumes for Cell 2 LCS

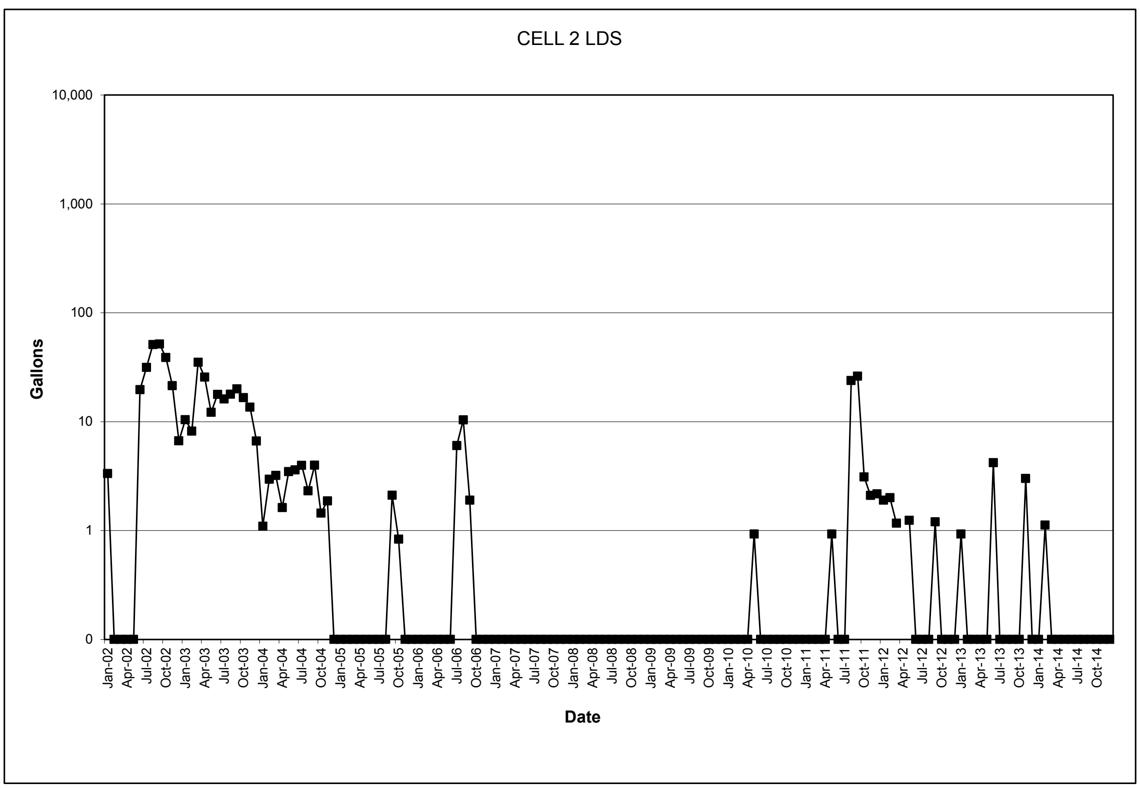
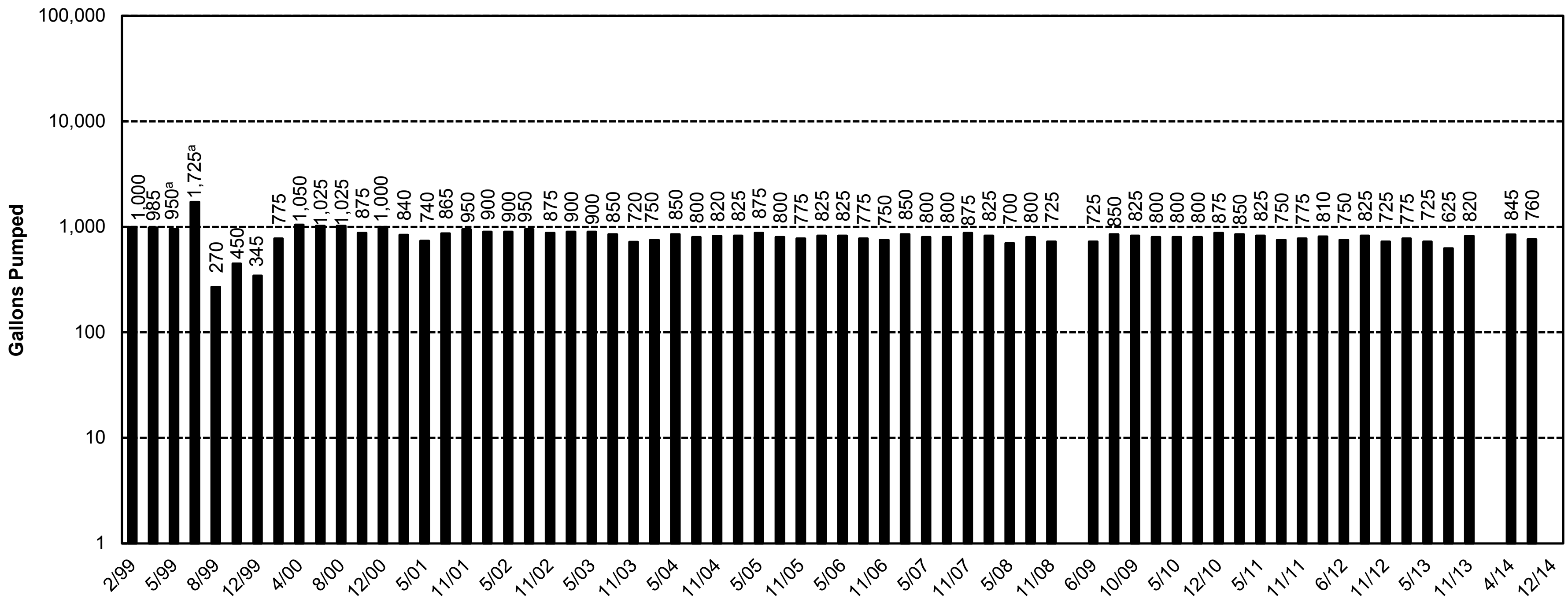


Figure A.5.2-2. Monthly Accumulation Volumes for Cell 2 LDS



12339 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999[a]:	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
2012:	3110	n=4	778
2013:	2945	n=4	736
2014[b]:	1605	n=2	803
Overall:			825

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

[b]Sampling schedule reduced to semi-annual sampling in 2014.

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

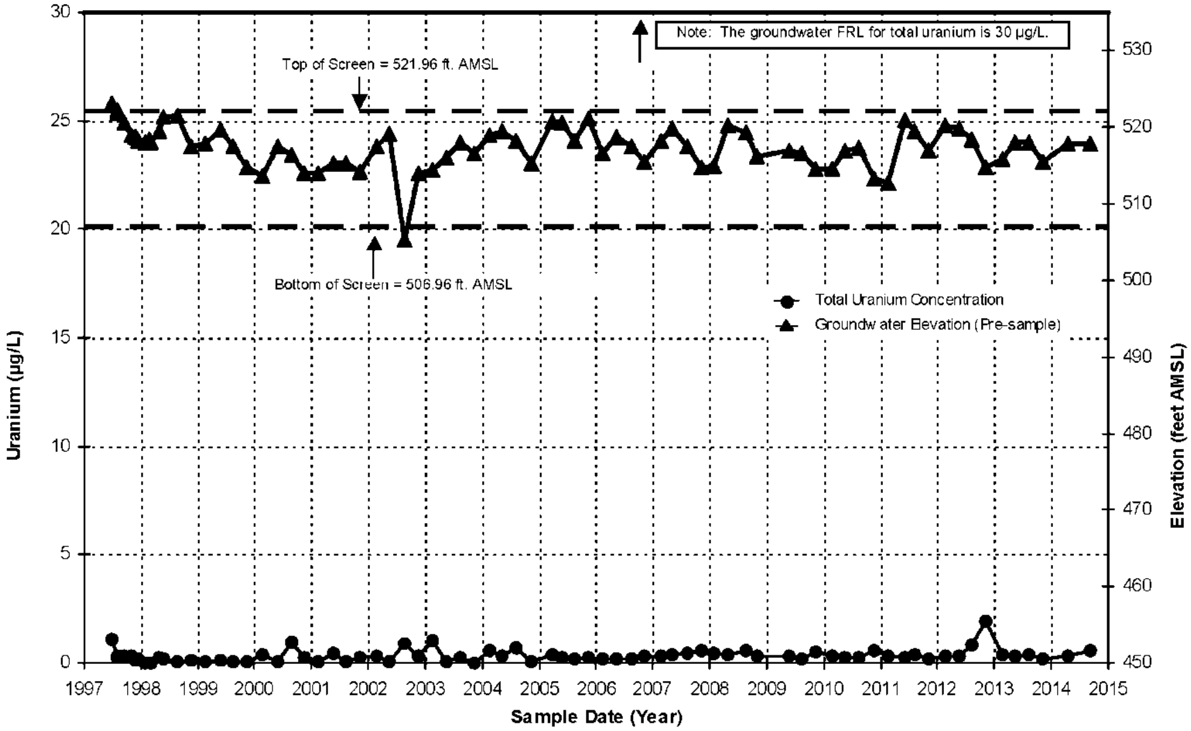


Figure A.5.2-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 2 Upgradient Monitoring Well 22200

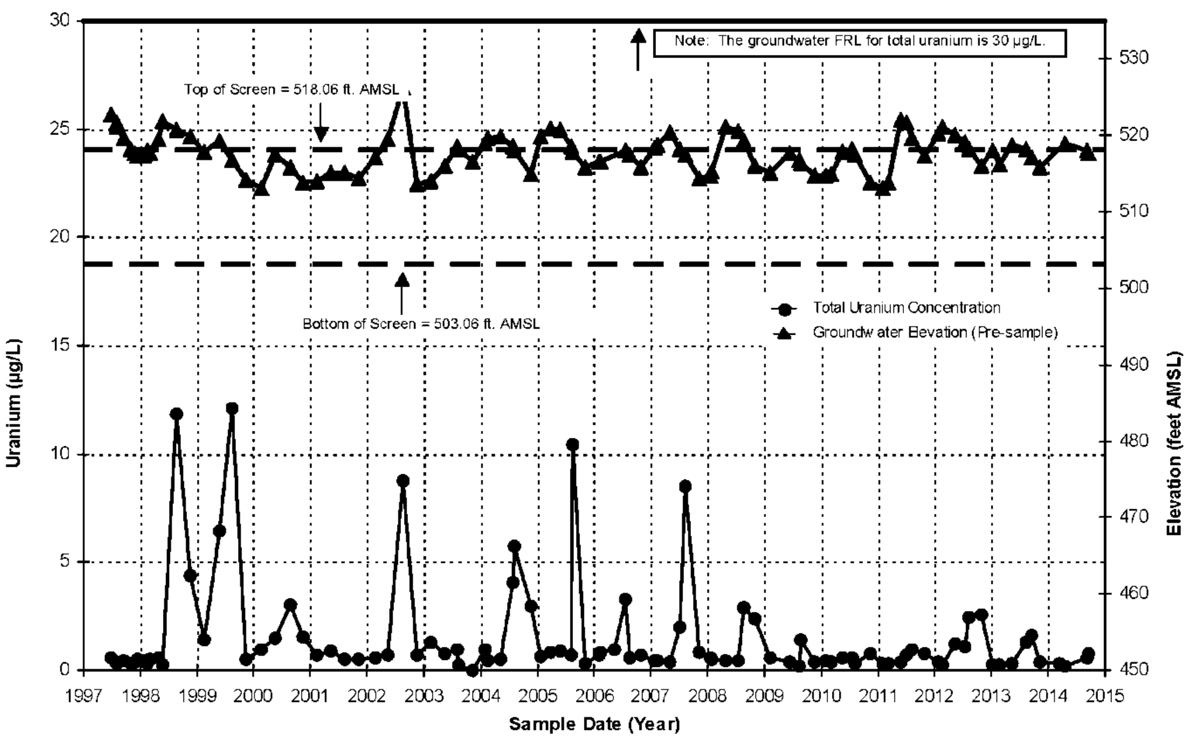


Figure A.5.2-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 2 Downgradient Monitoring Well 22199

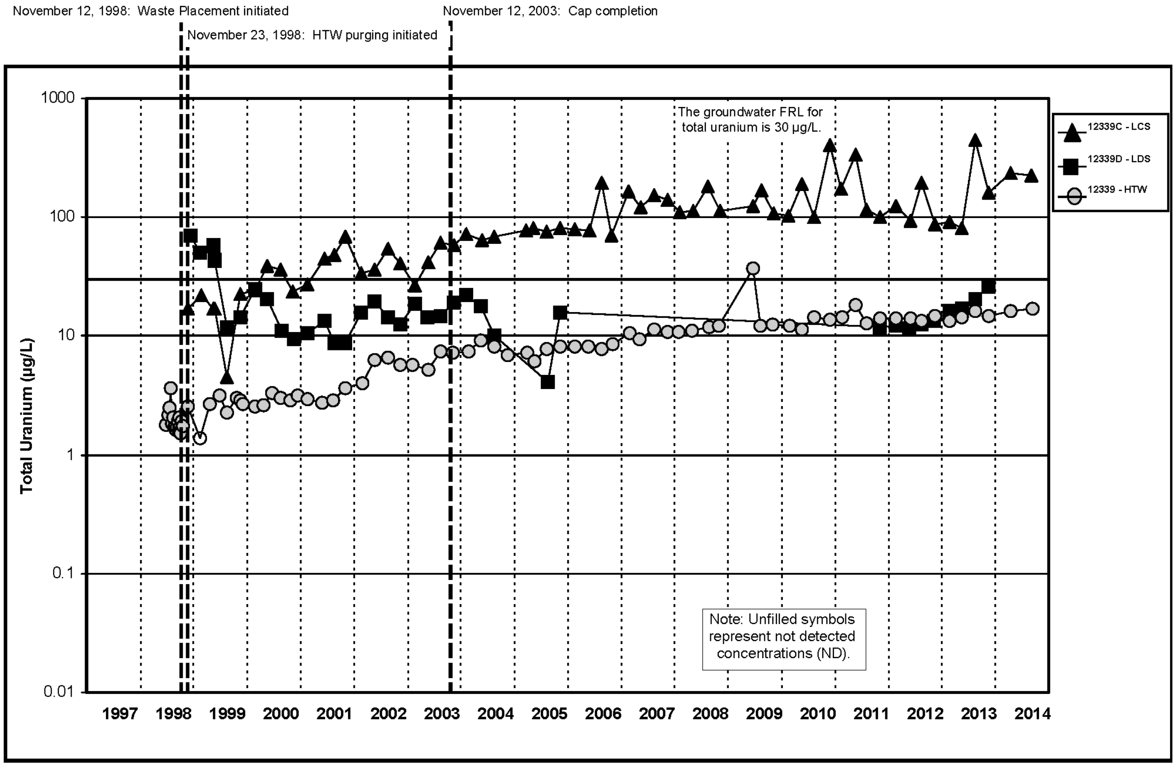


Figure A.5.2-6A. Cell 2 Total Uranium Concentration Versus Time Plot for LCS, LDS, and HTW

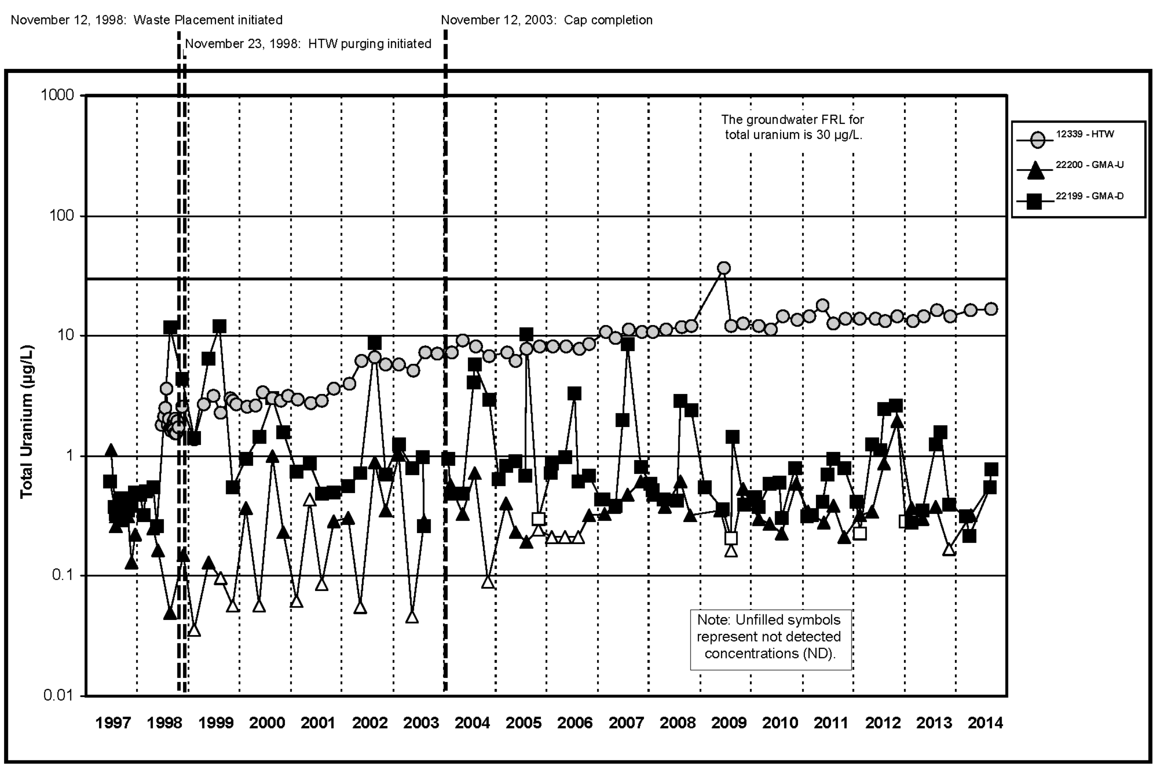


Figure A.5.2-6B. Cell 2 Total Uranium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

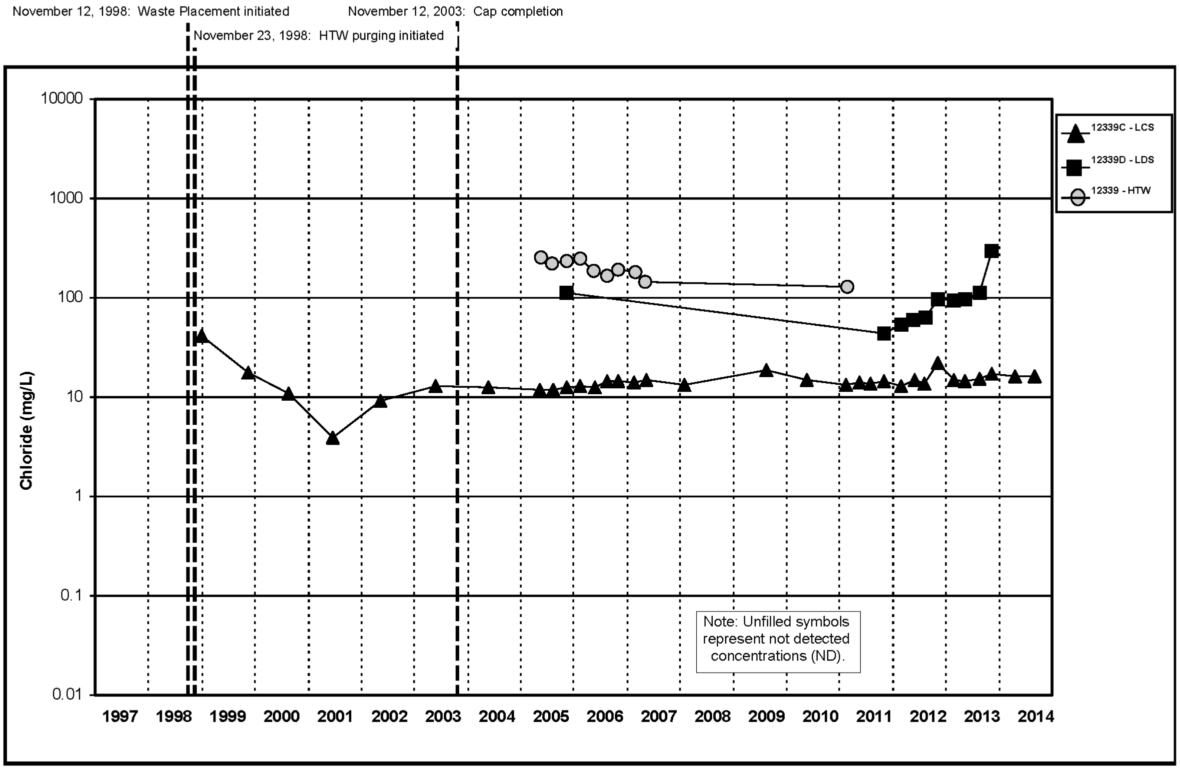


Figure A.5.2-7A. Cell 2 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

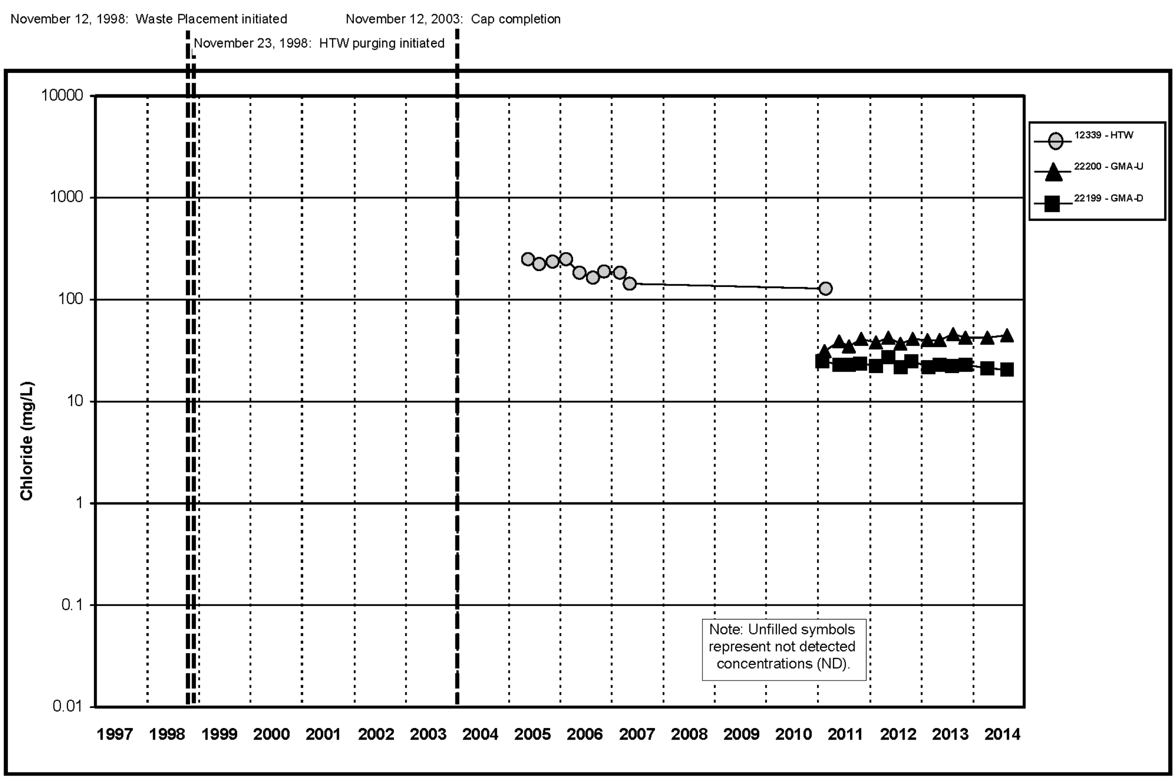


Figure A.5.2-7B. Cell 2 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

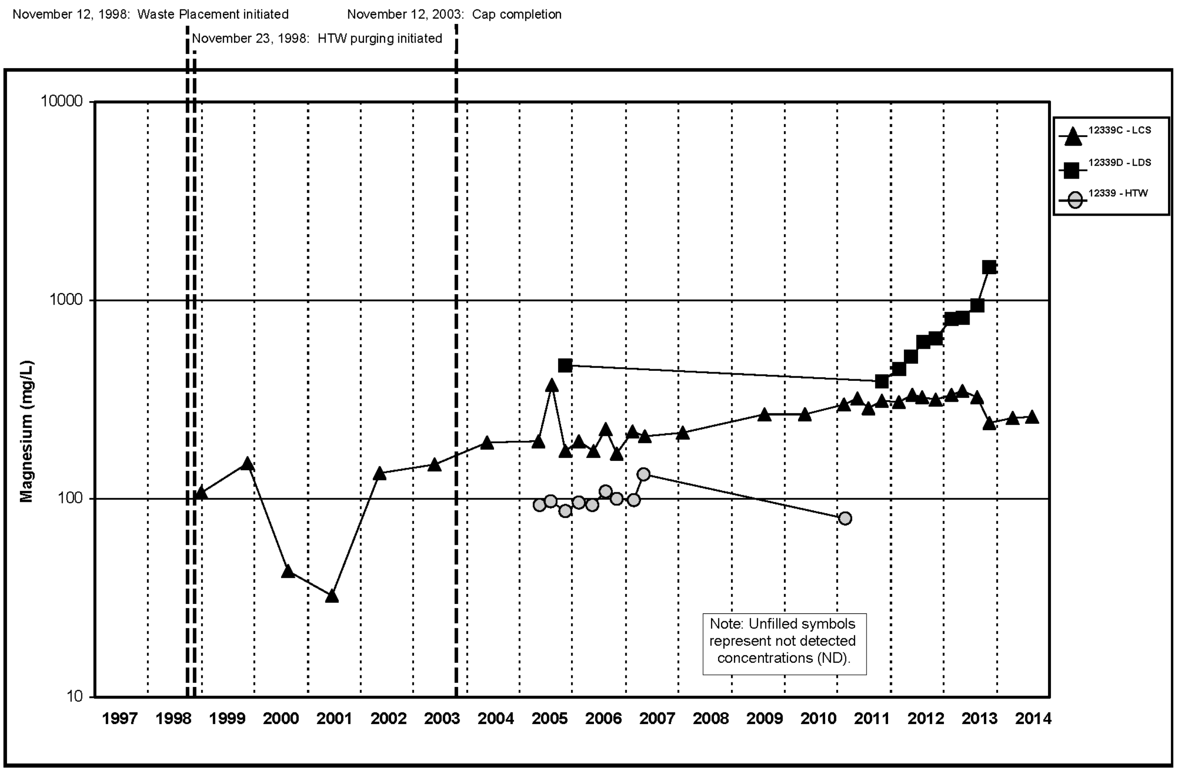


Figure A.5.2-8A. Cell 2 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

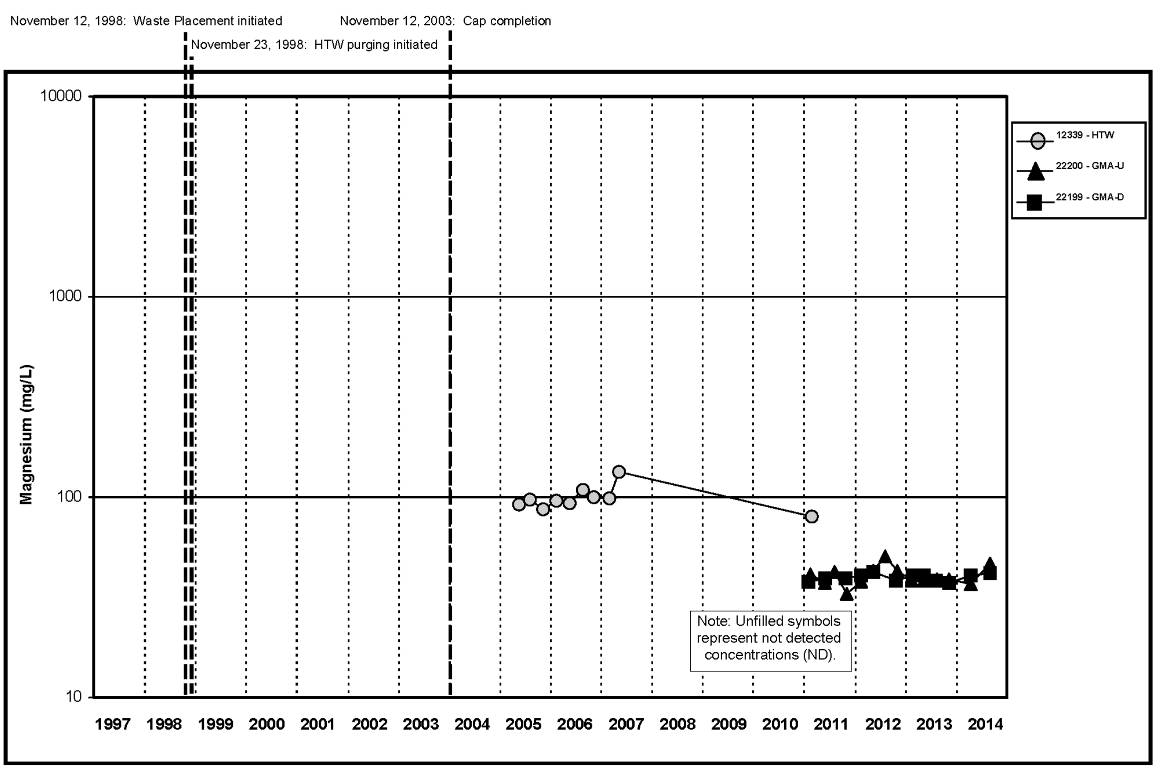


Figure A.5.2-8B. Cell 2 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

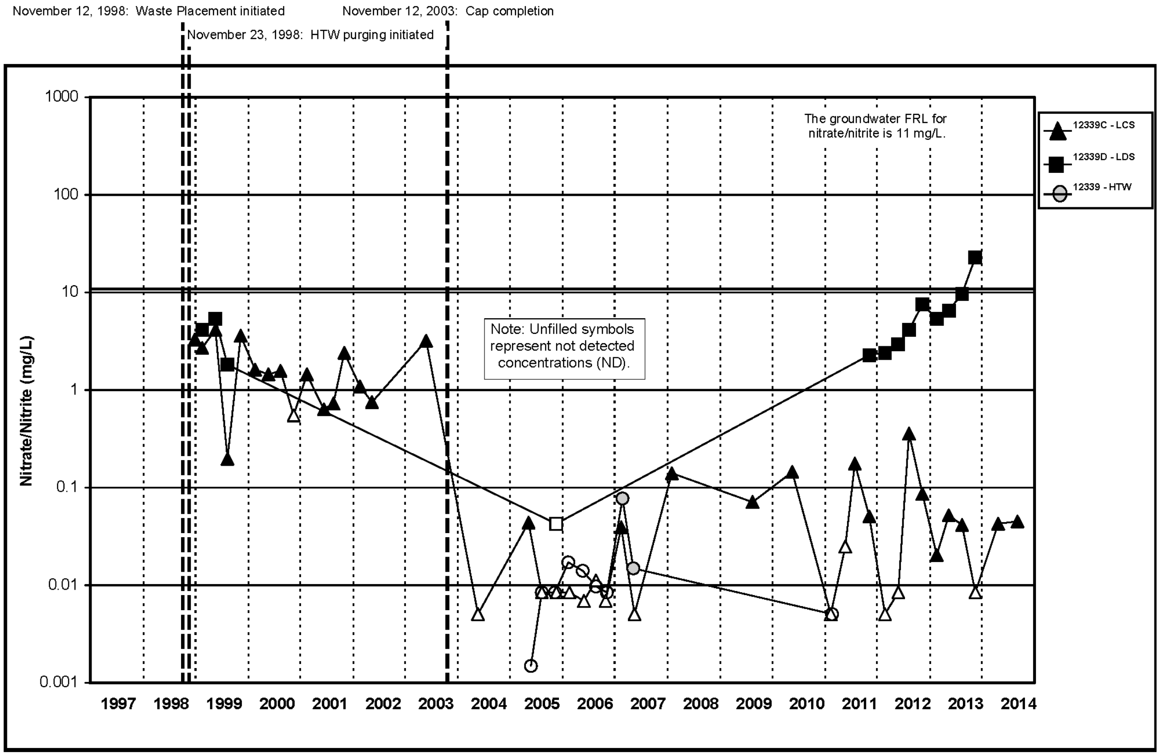


Figure A.5.2-9A. Cell 2 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

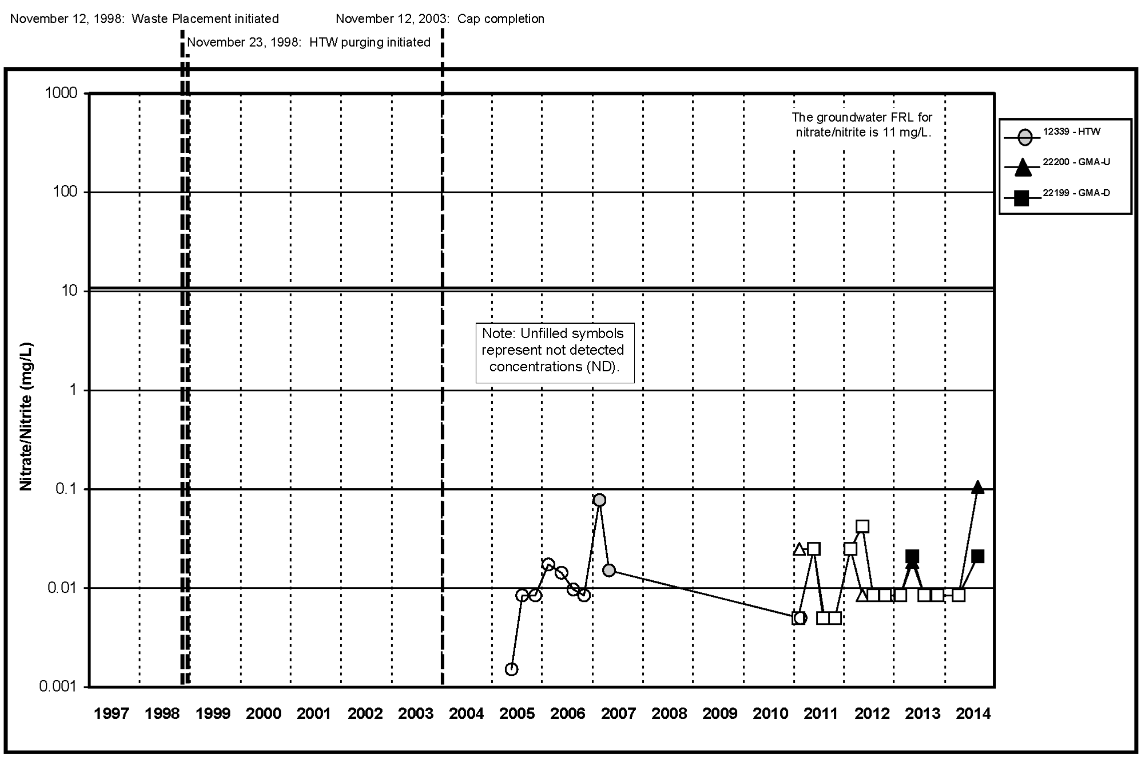


Figure A.5.2-9B. Cell 2 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

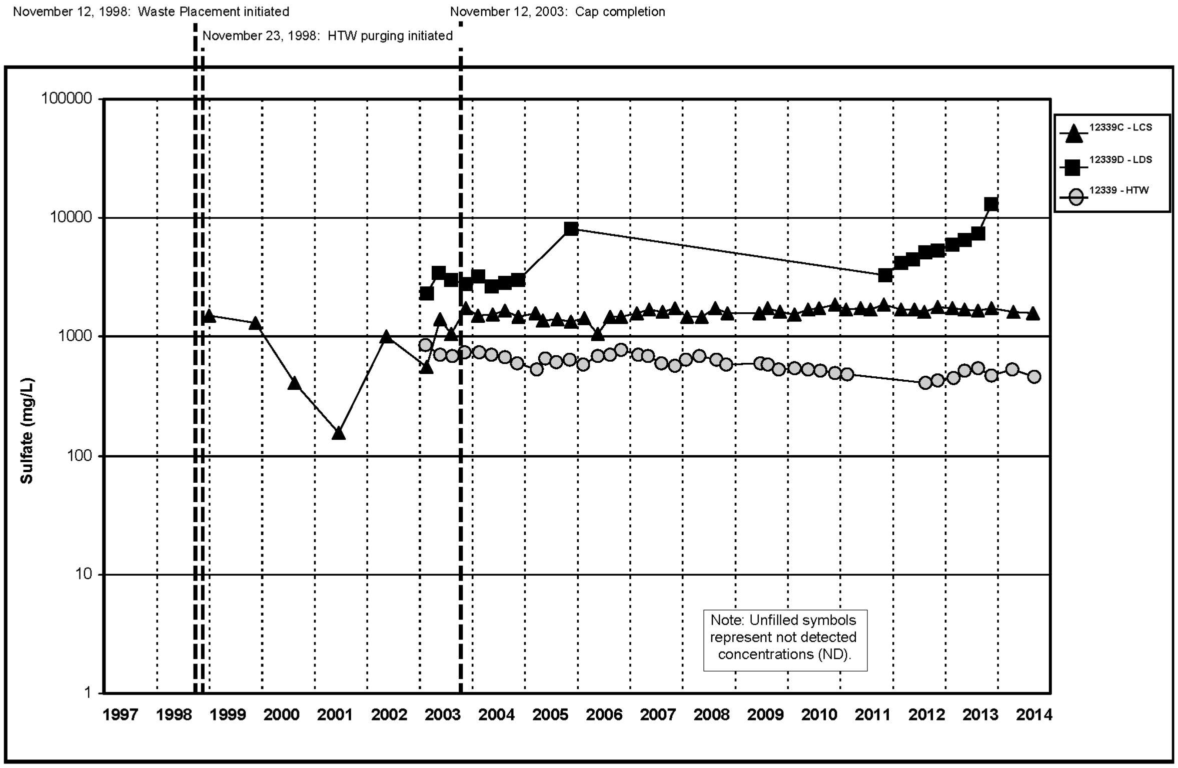


Figure A.5.2-10A. Cell 2 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

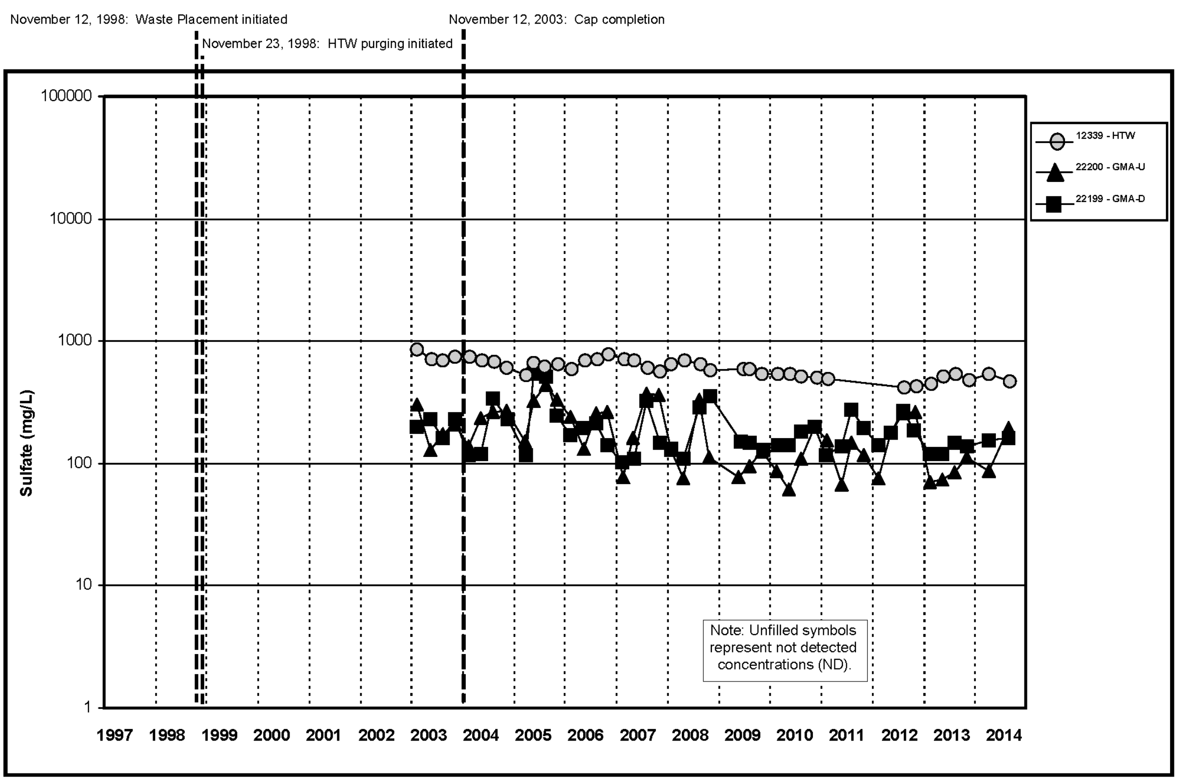


Figure A.5.2-10B. Cell 2 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

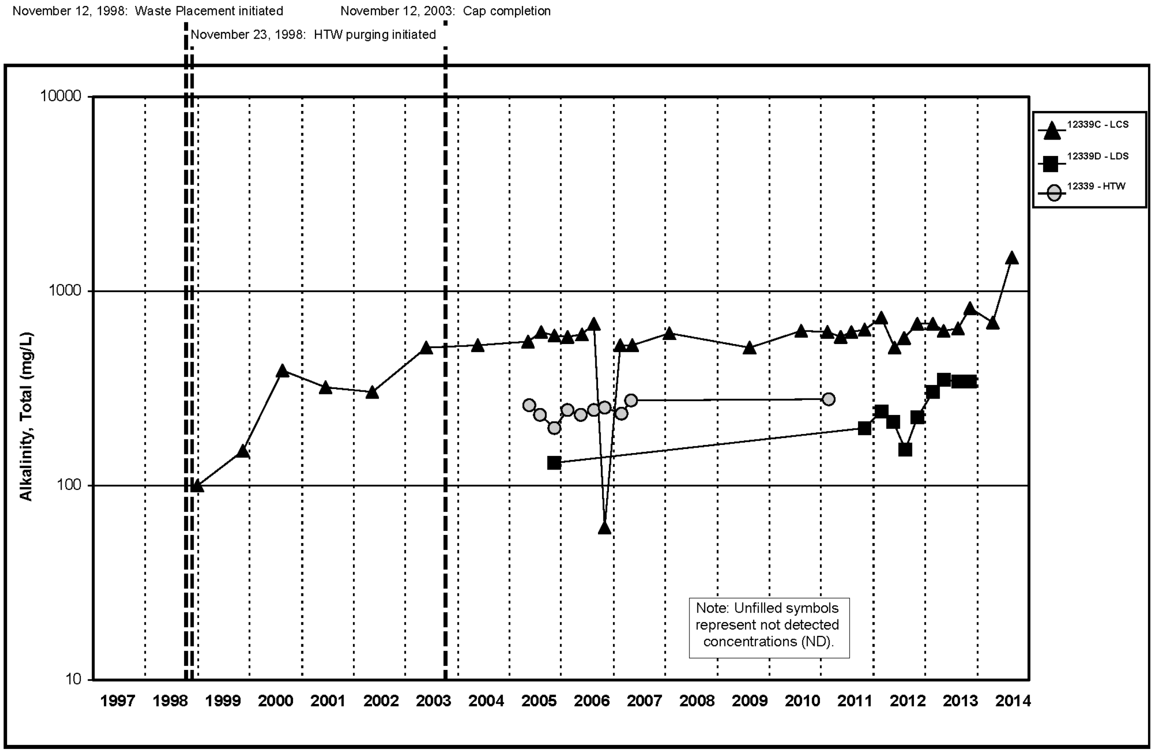


Figure A.5.2-11A. Cell 2 Alkalinity, Total (As $CaCO_3$) Concentration Versus Time Plot for LCS, LDS, and HTW

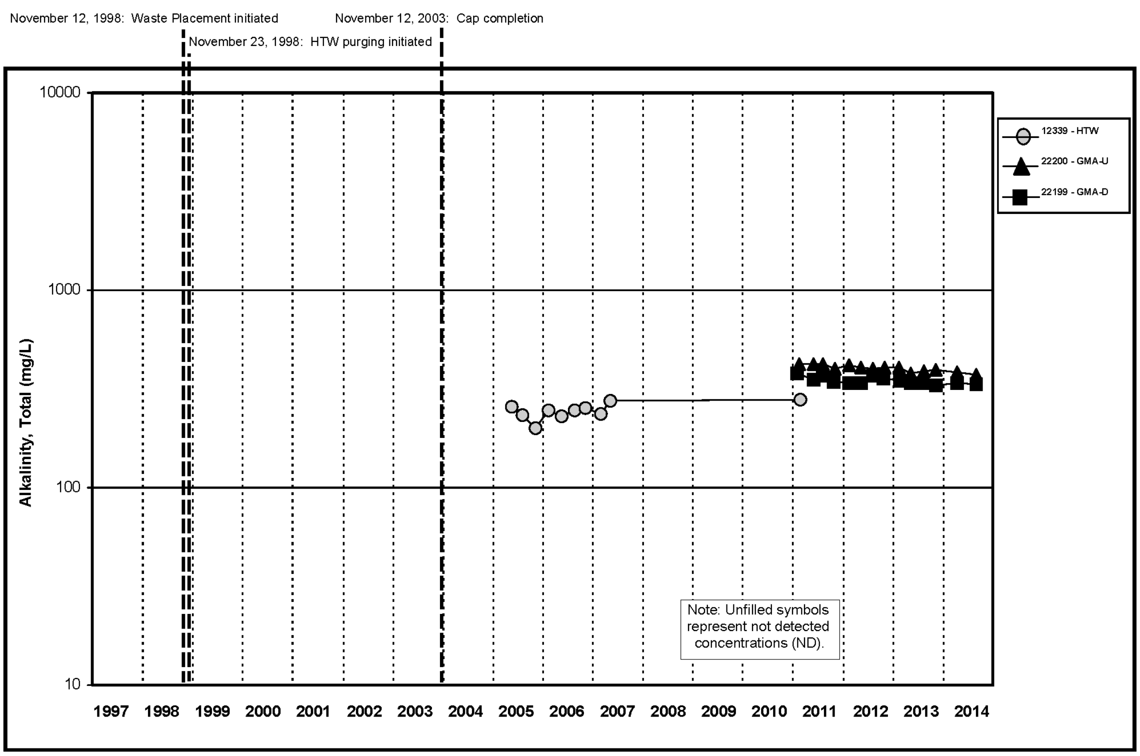


Figure A.5.2-11B. Cell 2 Alkalinity, Total (As $CaCO_3$) Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

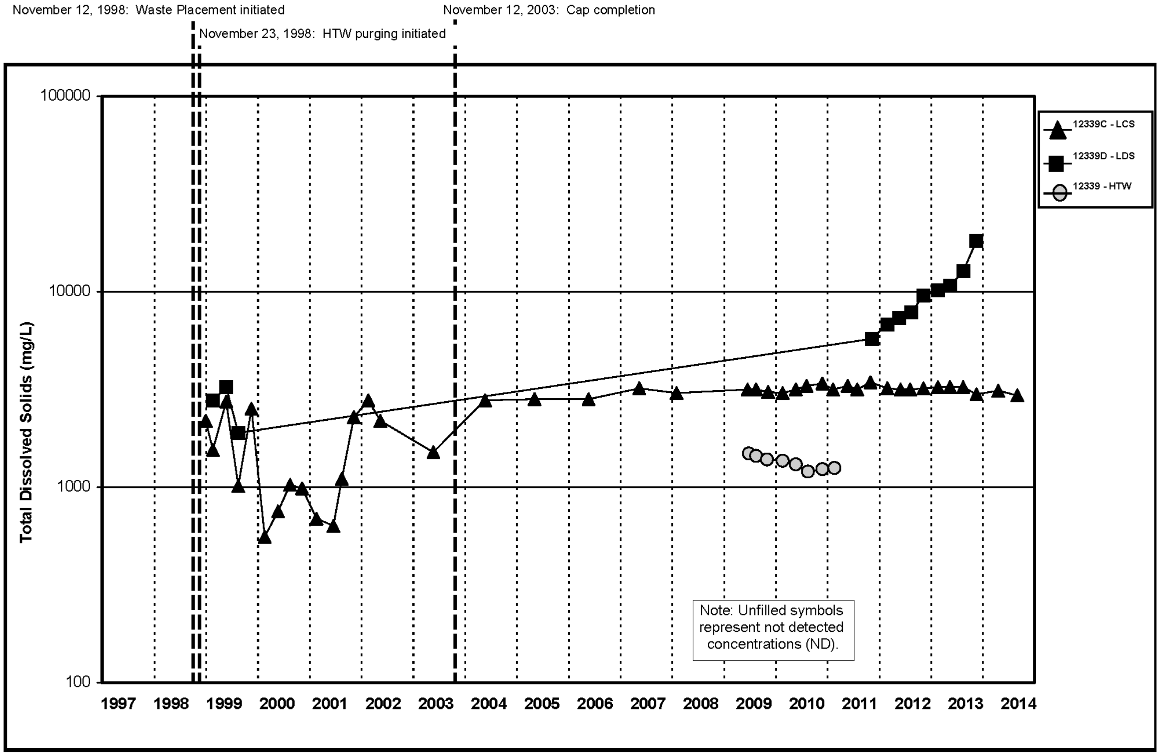


Figure A.5.2-12A. Cell 2 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

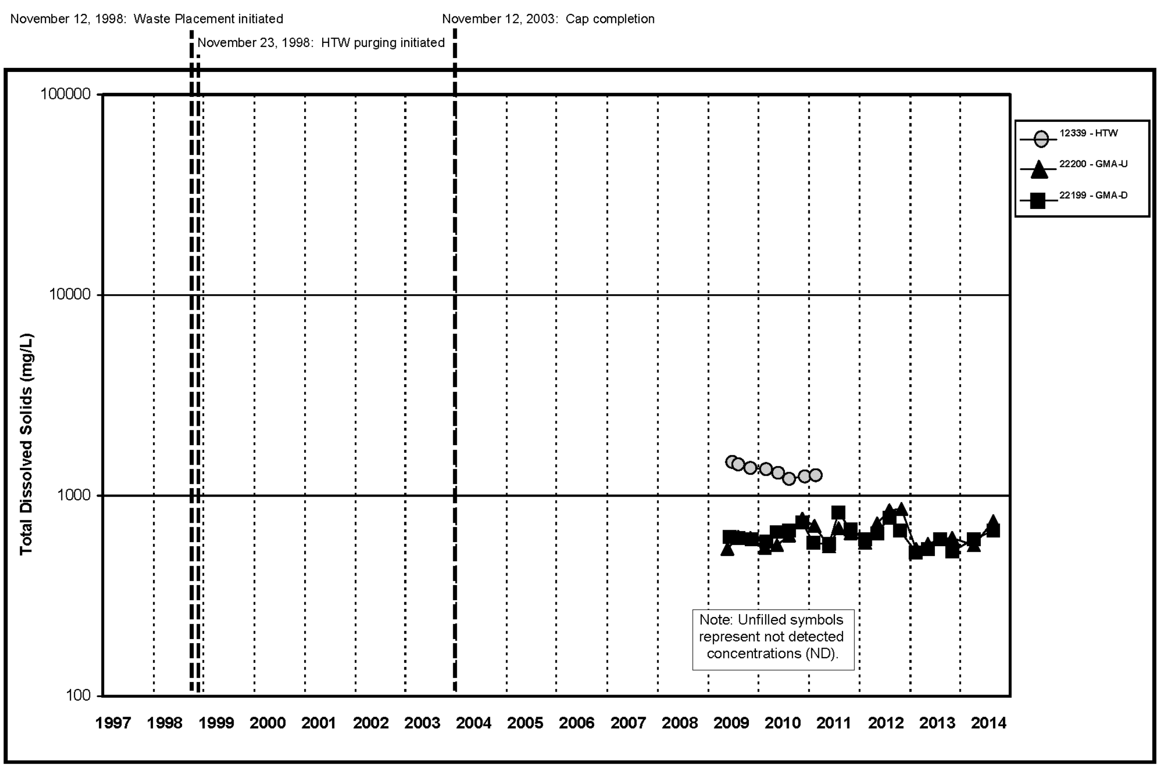


Figure A.5.2-12B. Cell 2 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

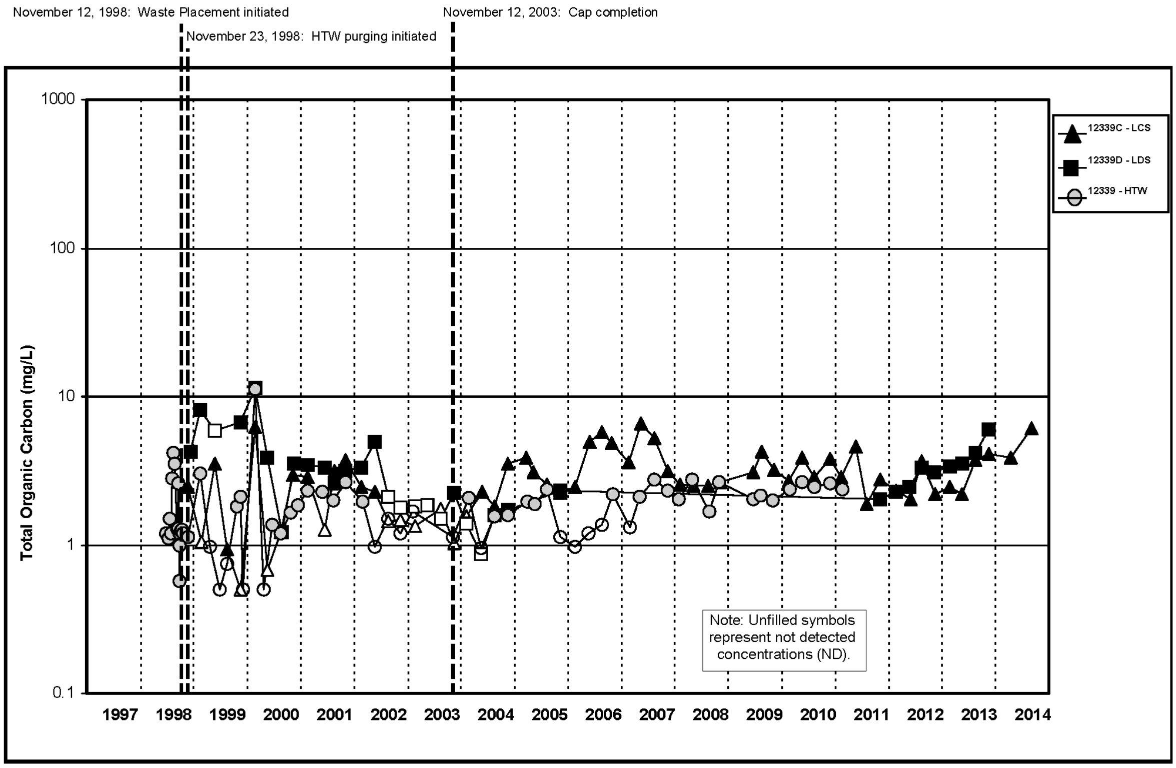


Figure A.5.2-13A. Cell 2 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

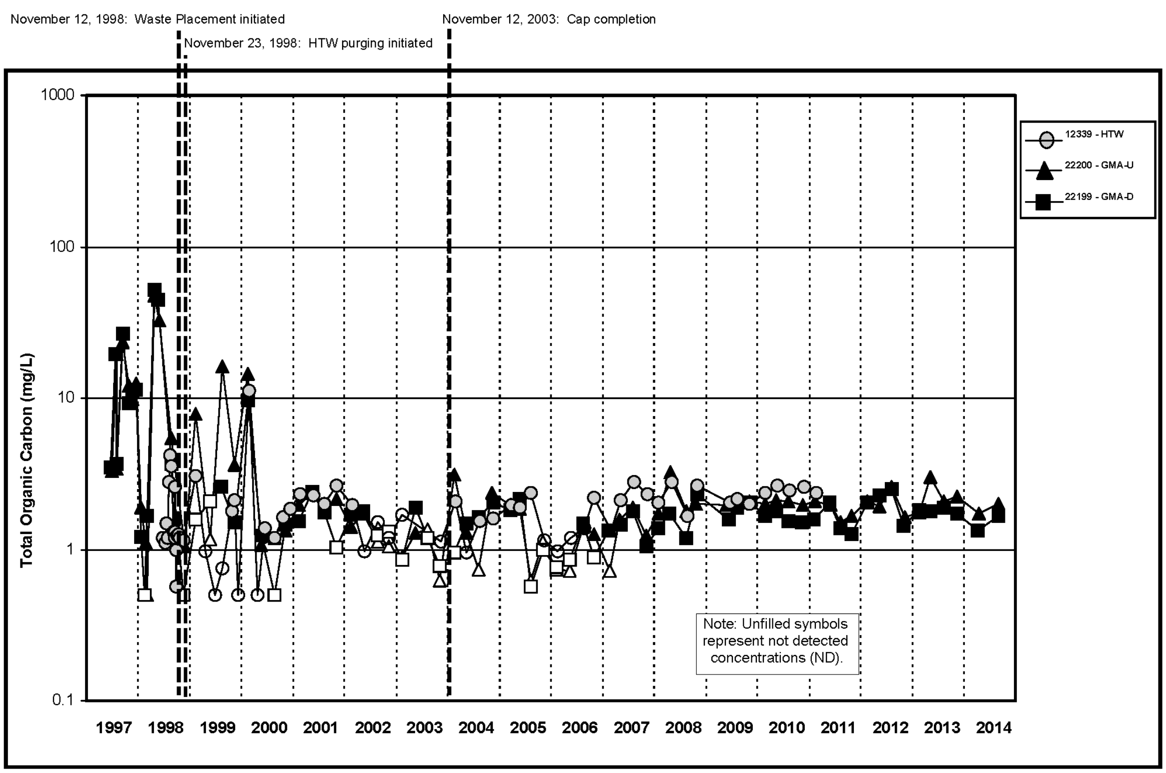


Figure A.5.2-13B. Cell 2 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

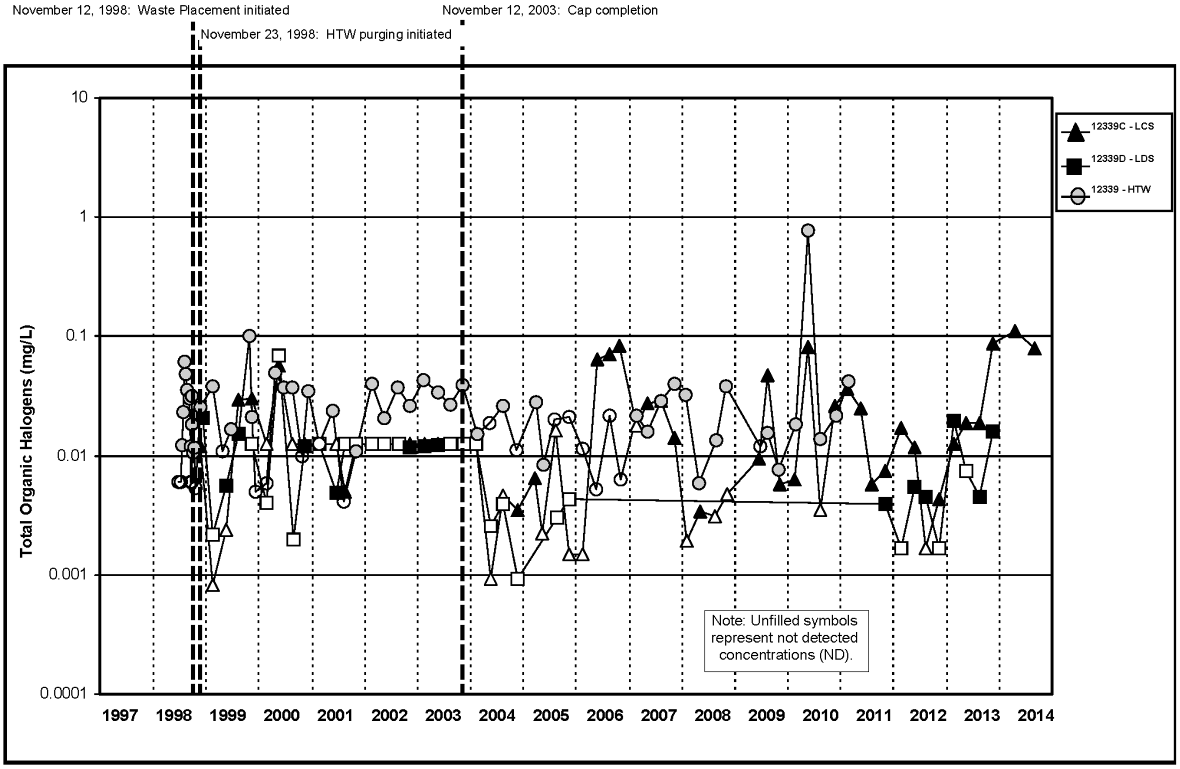


Figure A.5.2-14A. Cell 2 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

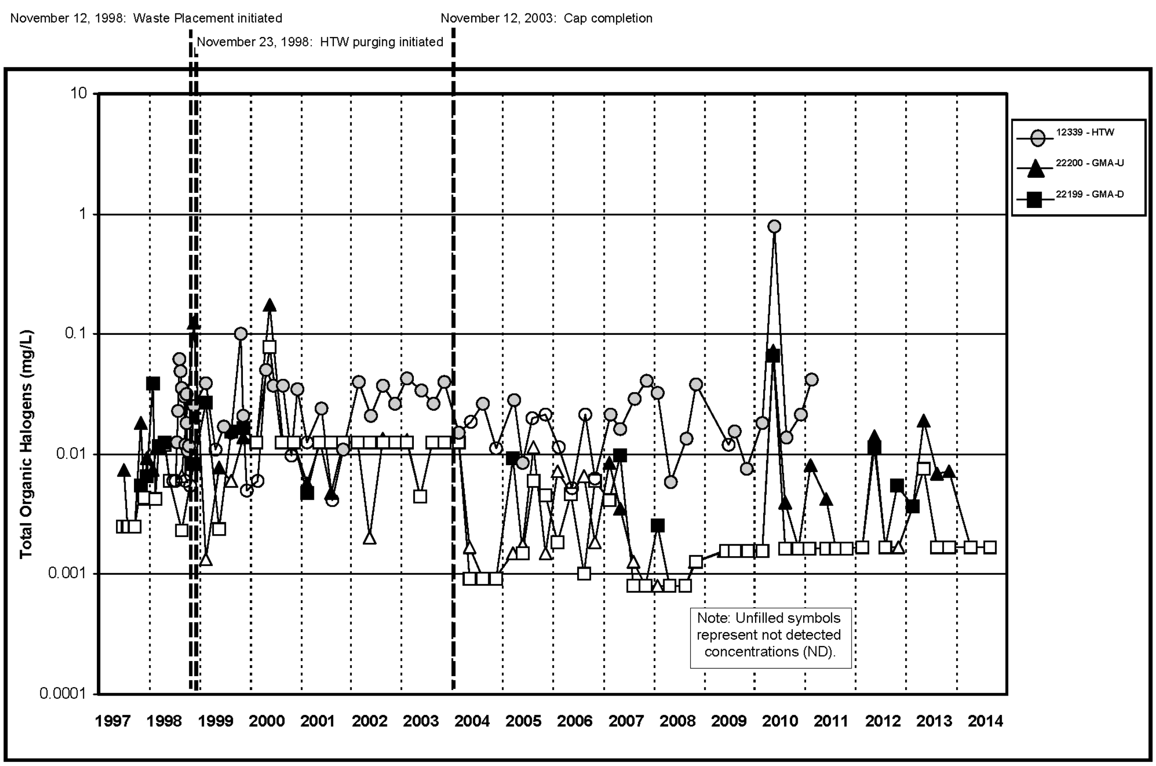


Figure A.5.2-14B. Cell 2 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

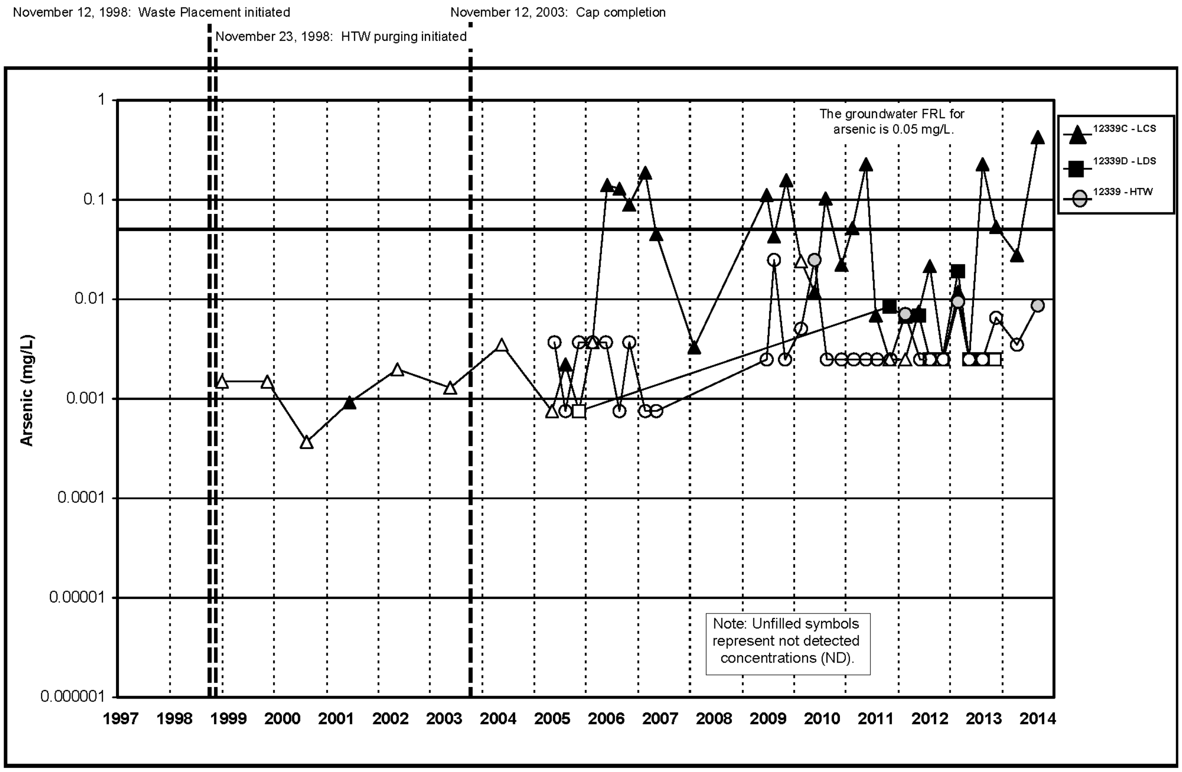


Figure A.5.2-15A. Cell 2 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

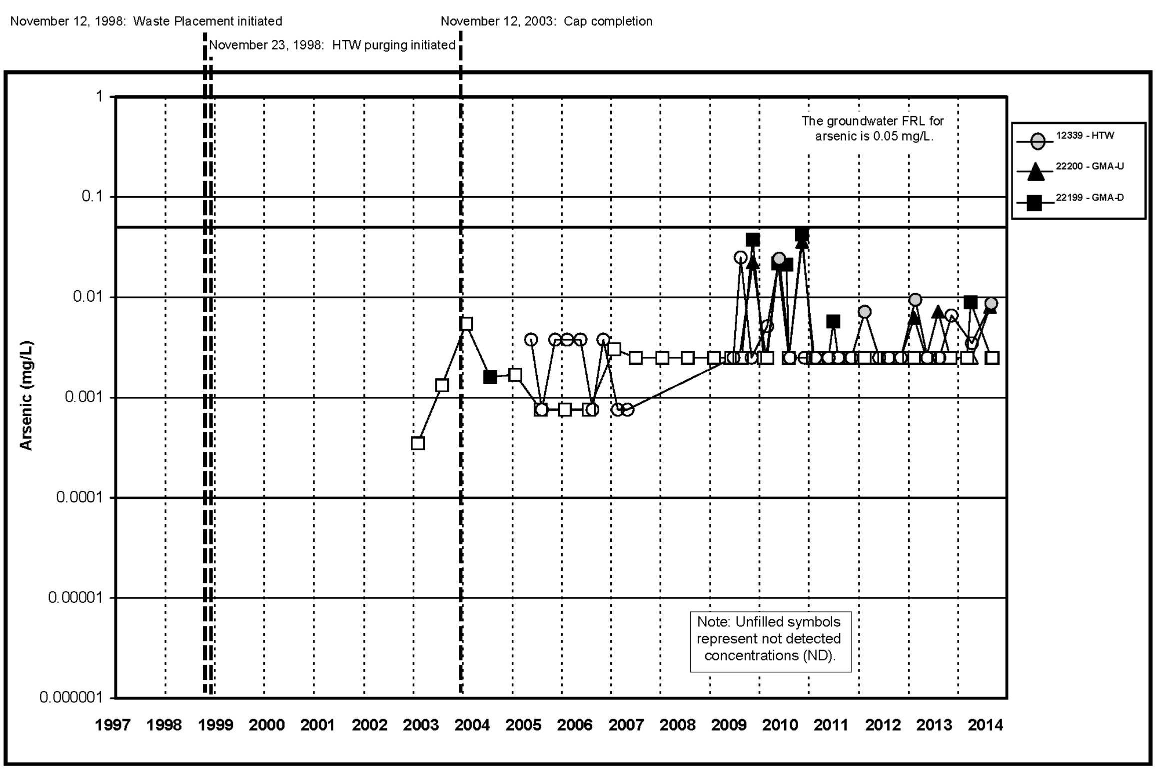


Figure A.5.2-15B. Cell 2 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

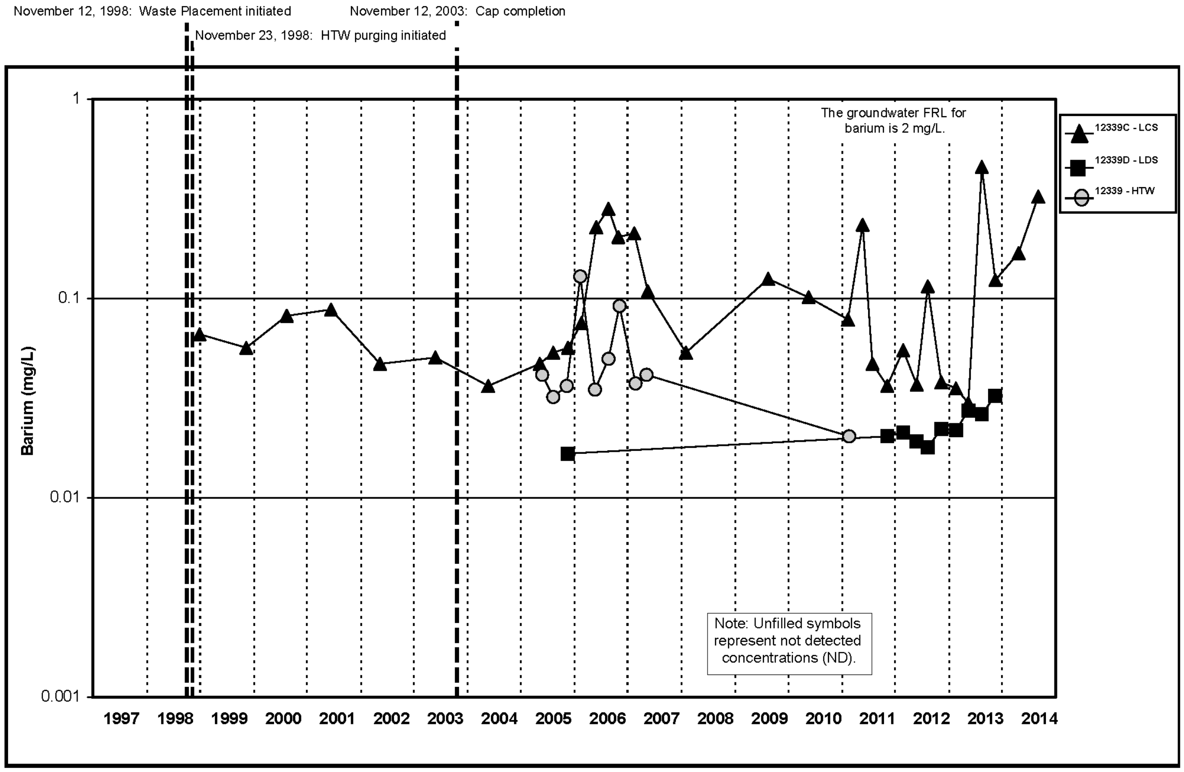


Figure A.5.2-16A. Cell 2 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

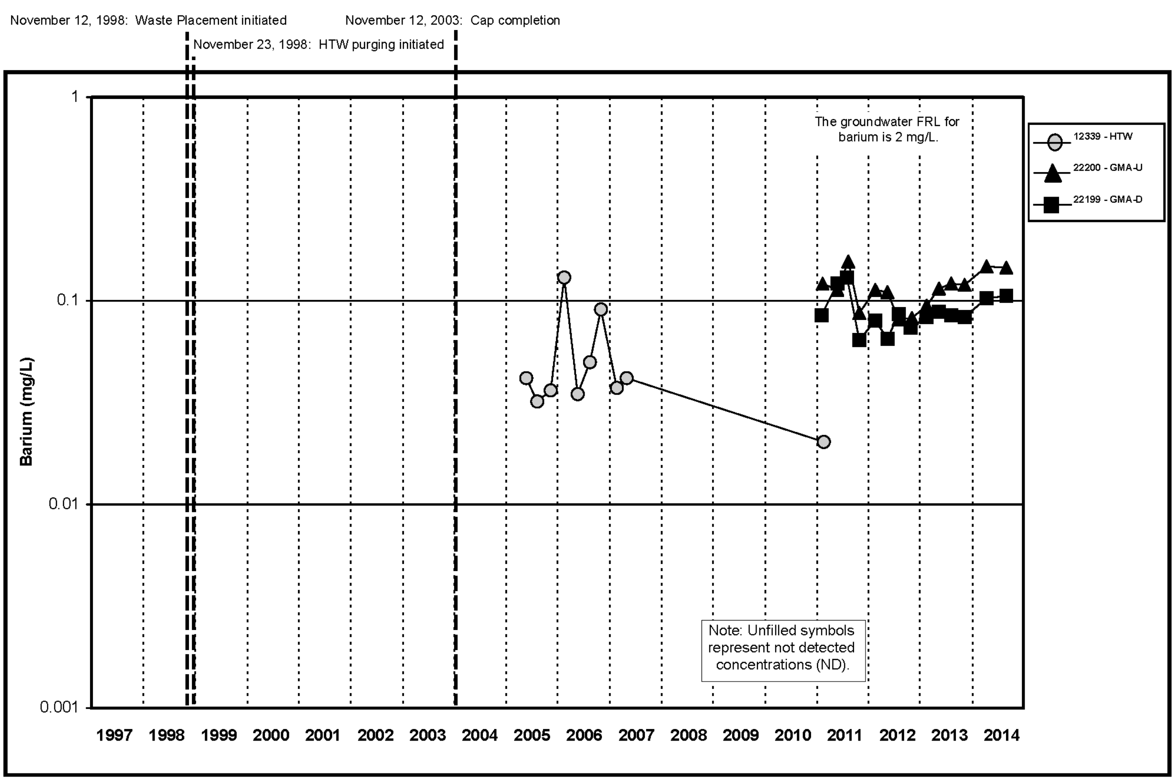


Figure A.5.2-16B. Cell 2 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

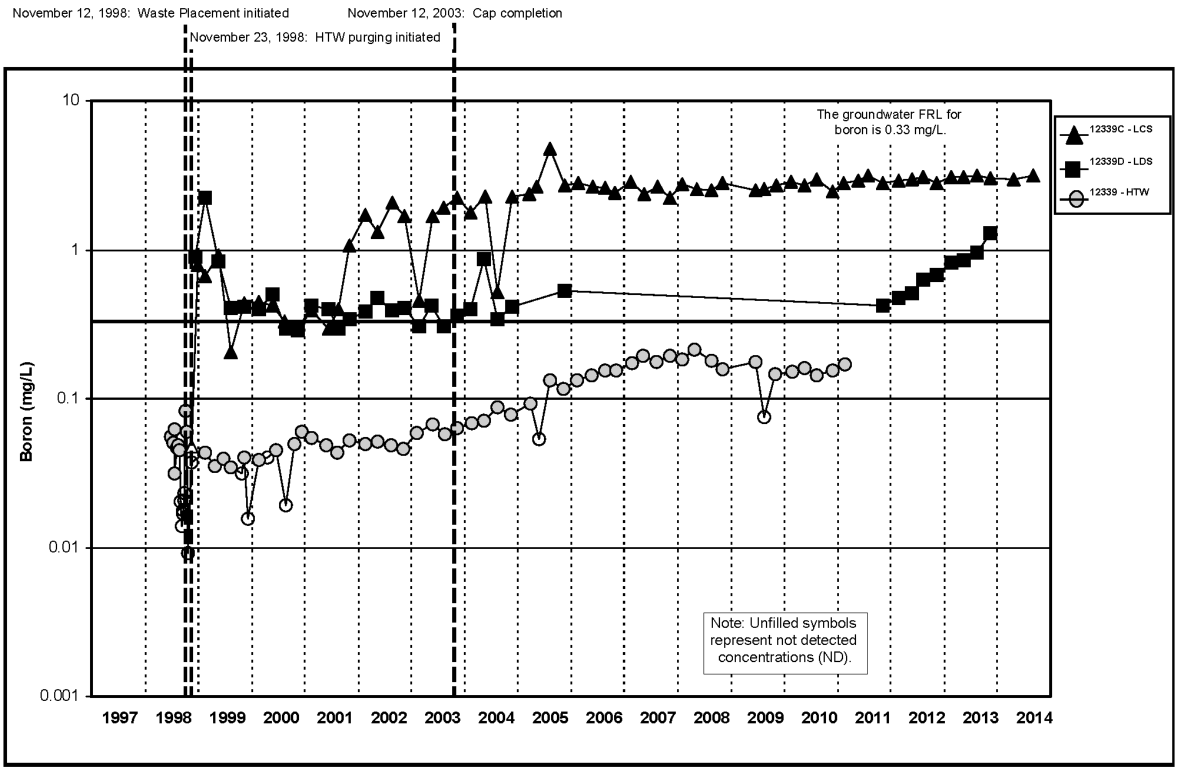


Figure A.5.2-17A. Cell 2 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

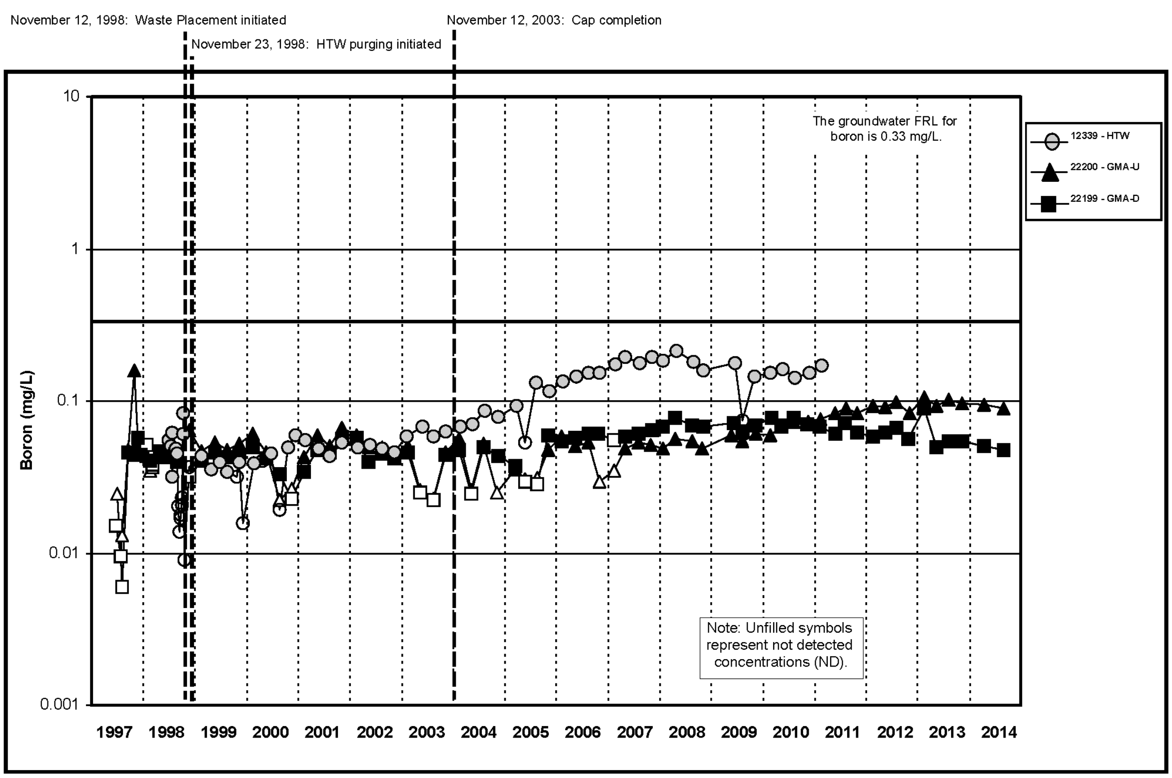


Figure A.5.2-17B. Cell 2 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

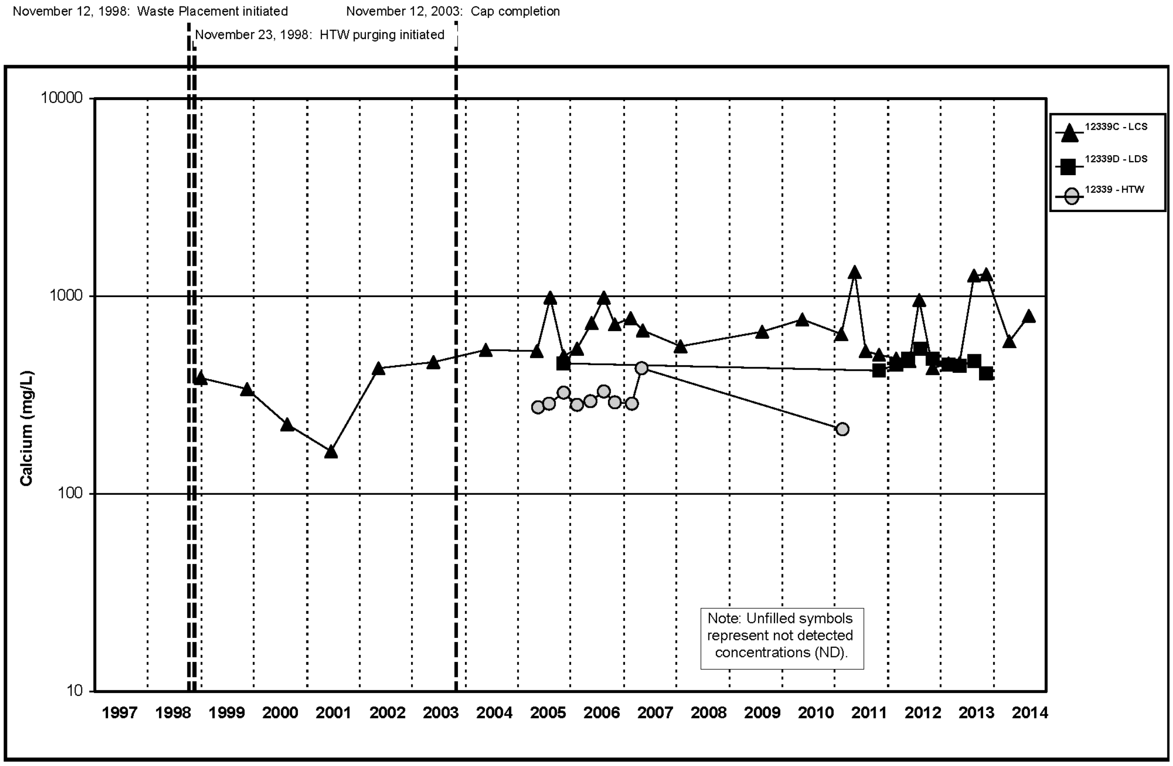


Figure A.5.2-18A. Cell 2 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

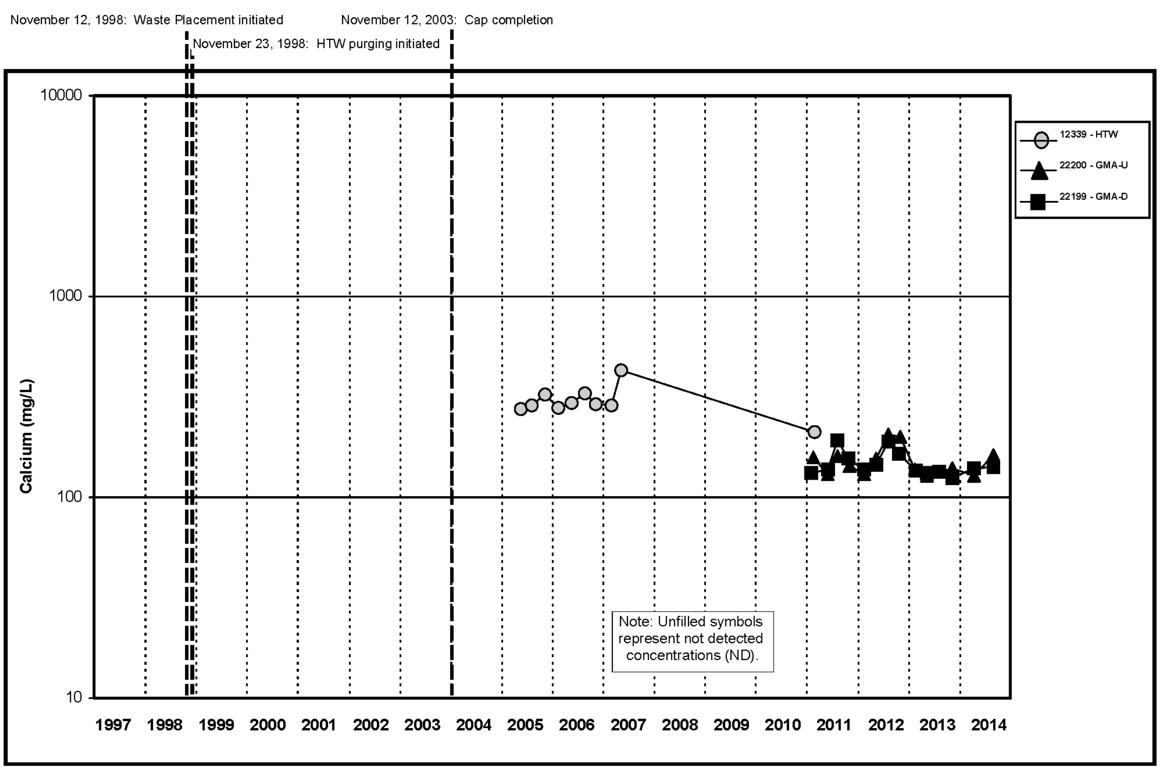


Figure A.5.2-18B. Cell 2 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

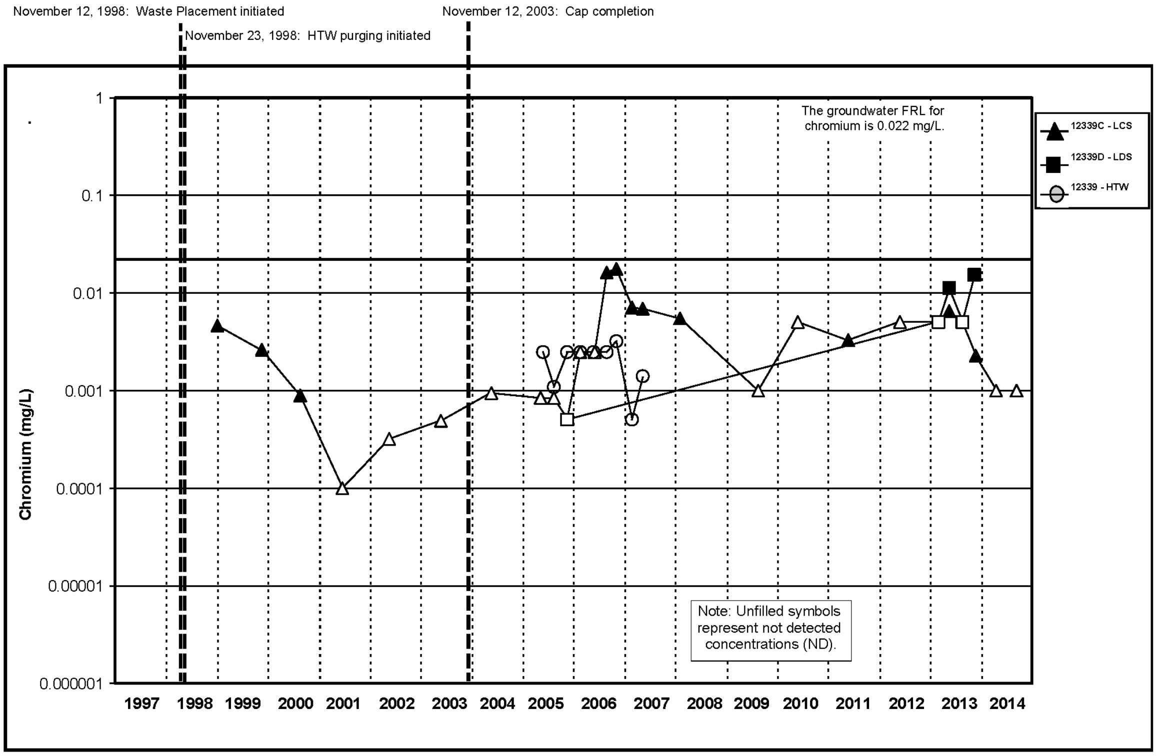


Figure A.5.2-19A. Cell 2 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

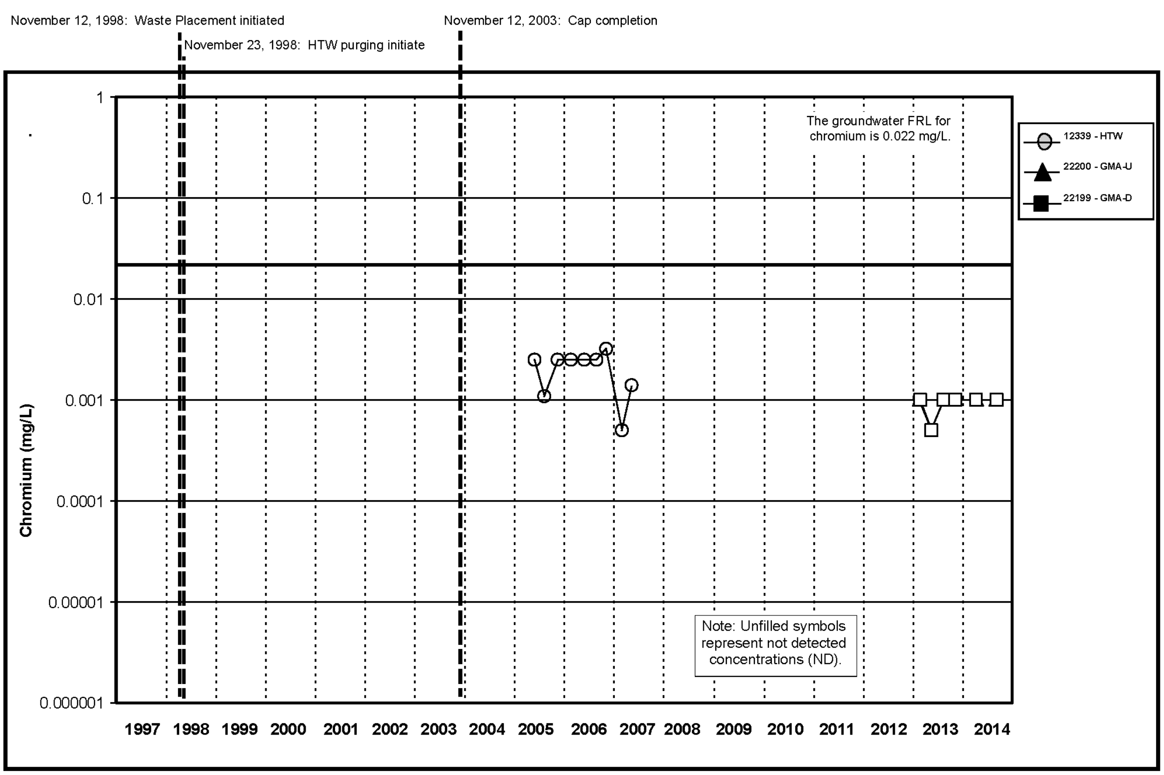


Figure A.5.2-19B. Cell 2 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

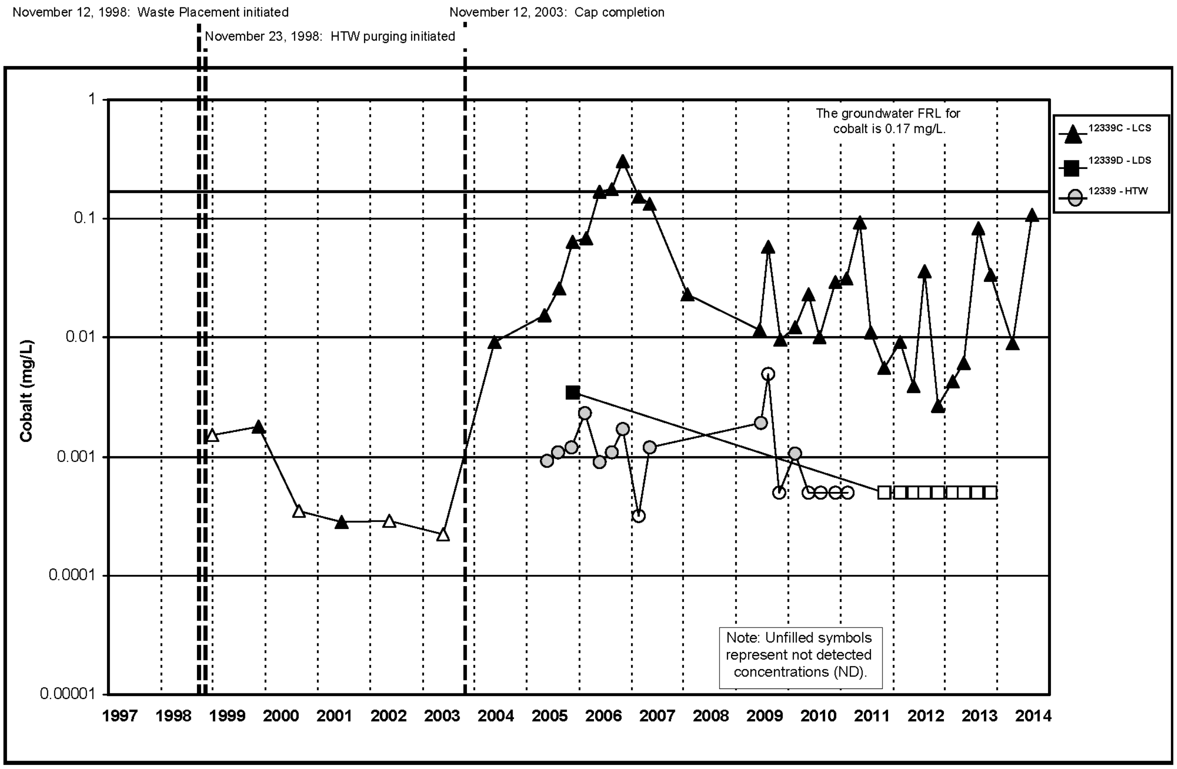


Figure A.5.2-20A. Cell 2 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

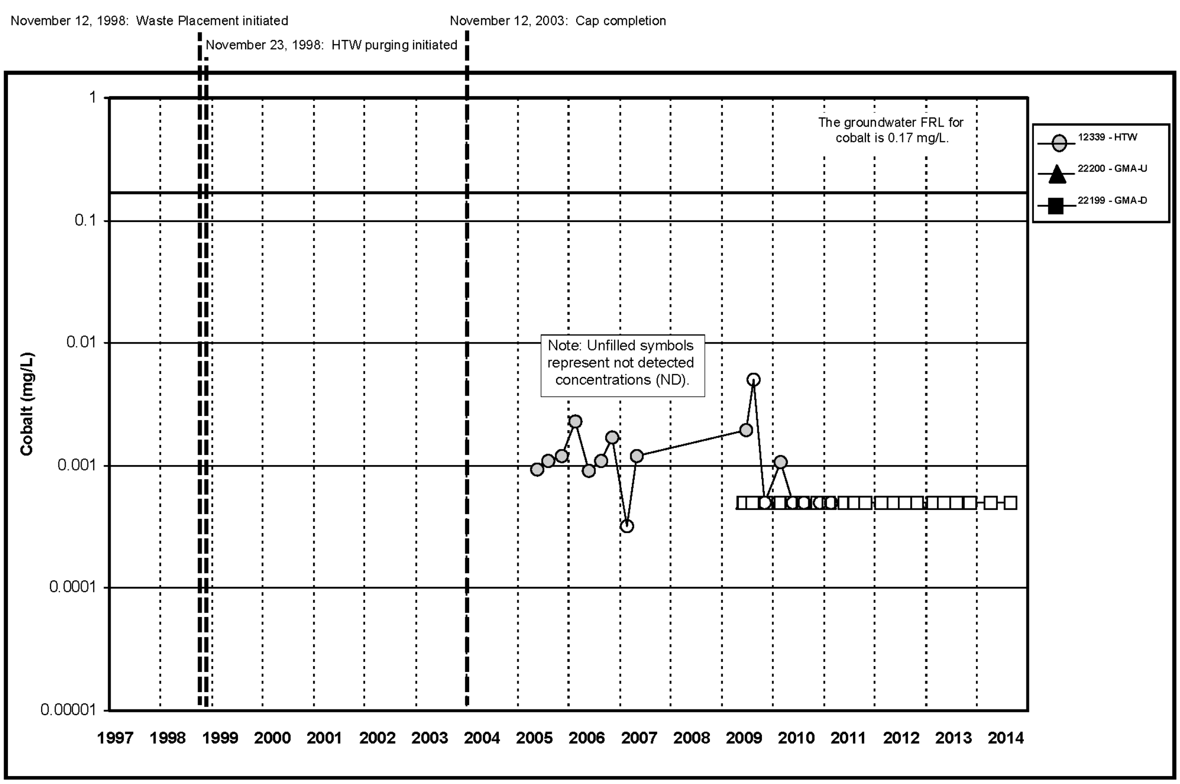


Figure A.5.2-20B. Cell 2 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

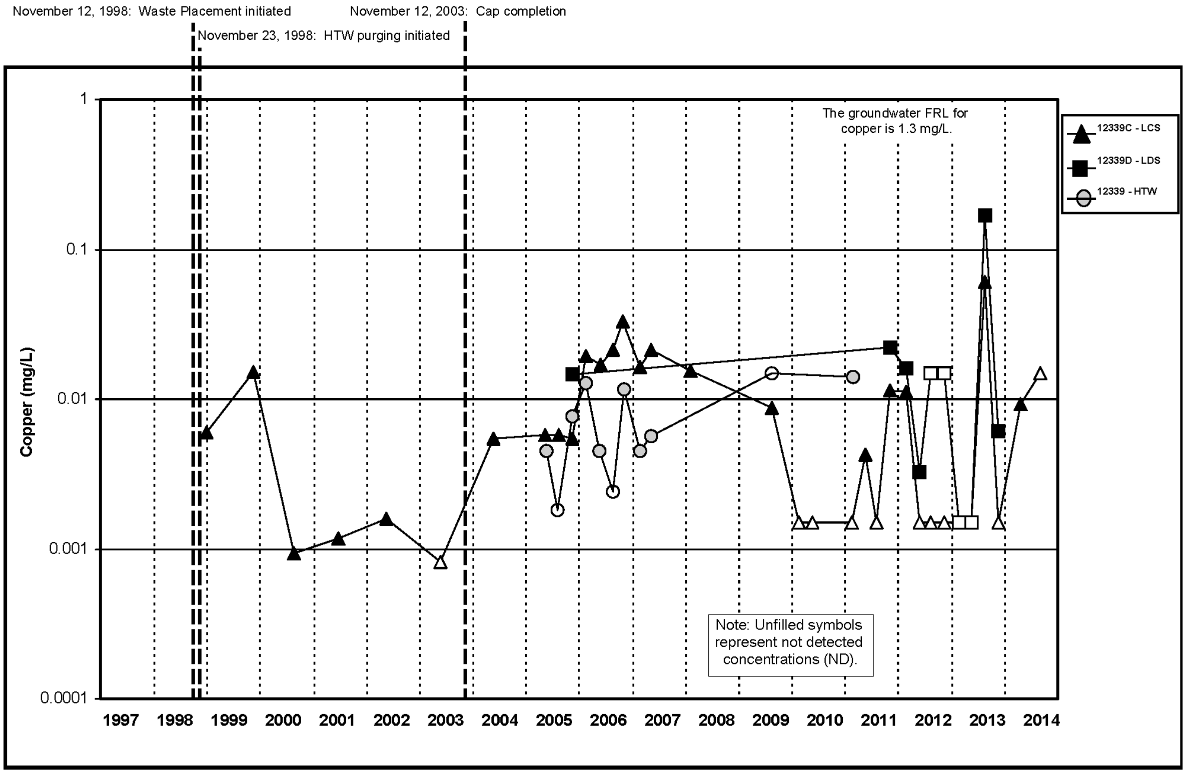


Figure A.5.2-21A. Cell 2 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

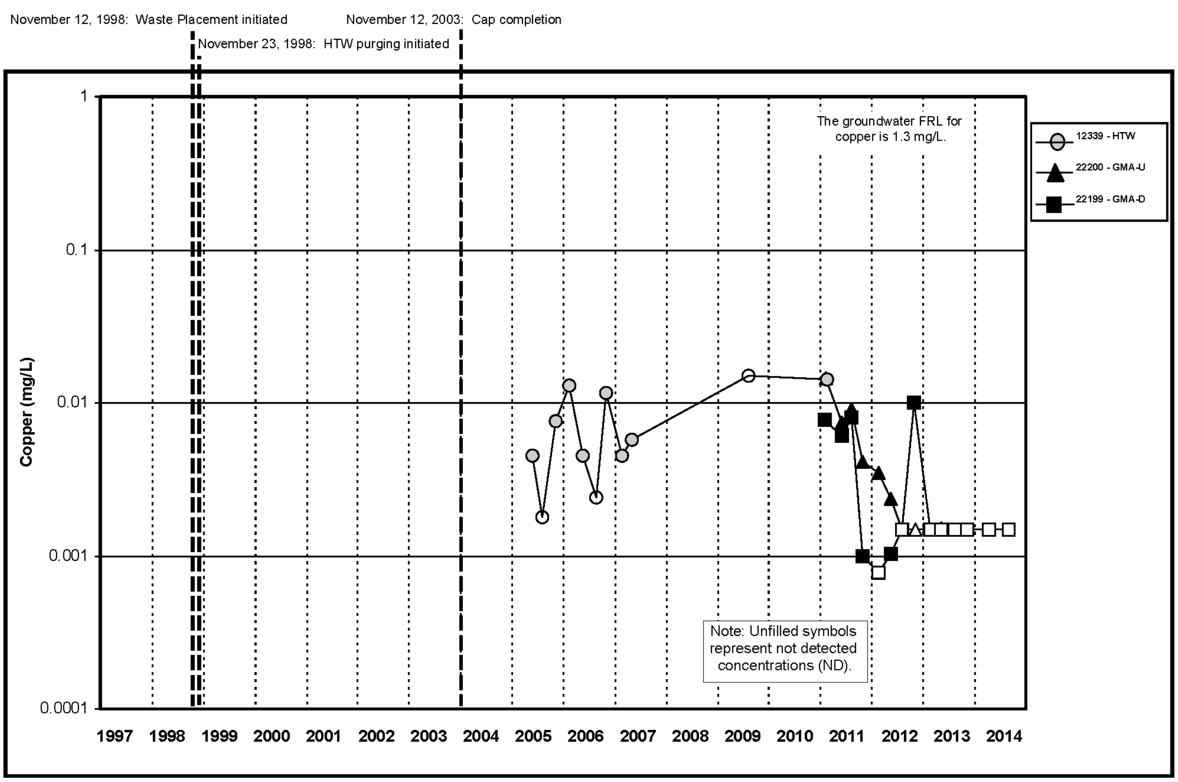


Figure A.5.2-21B. Cell 2 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

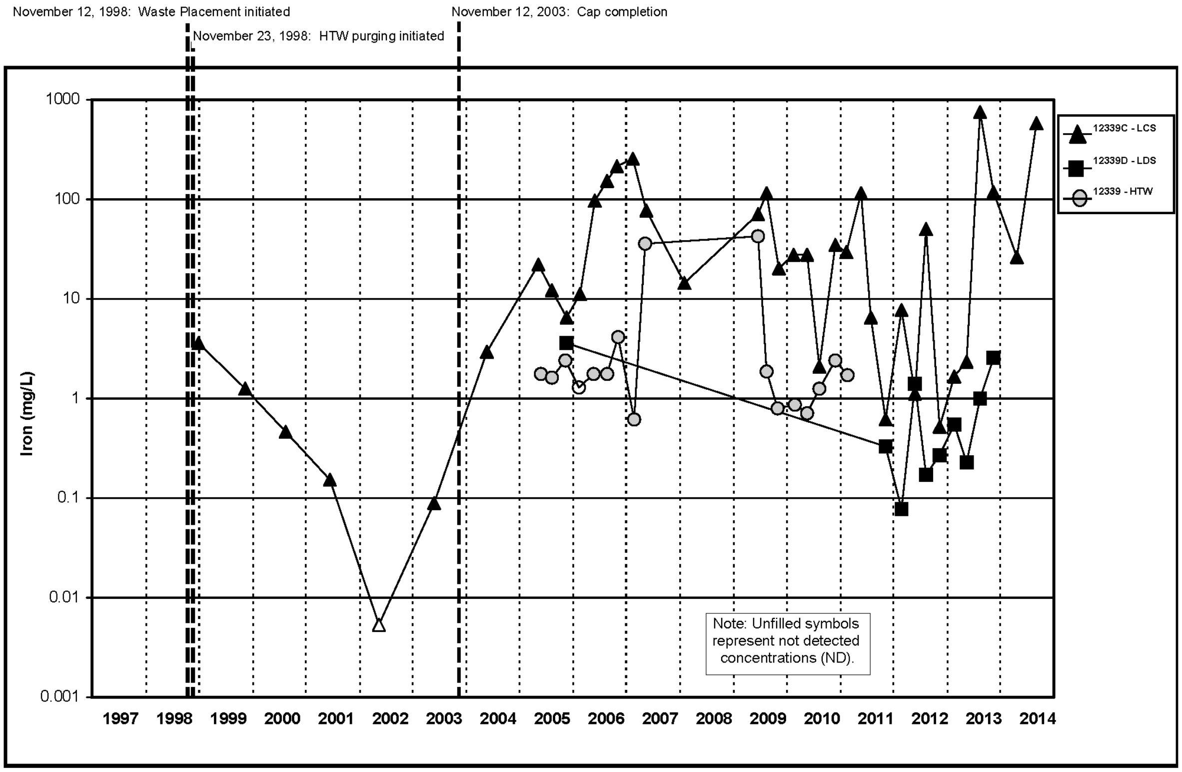


Figure A.5.2-22A. Cell 2 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

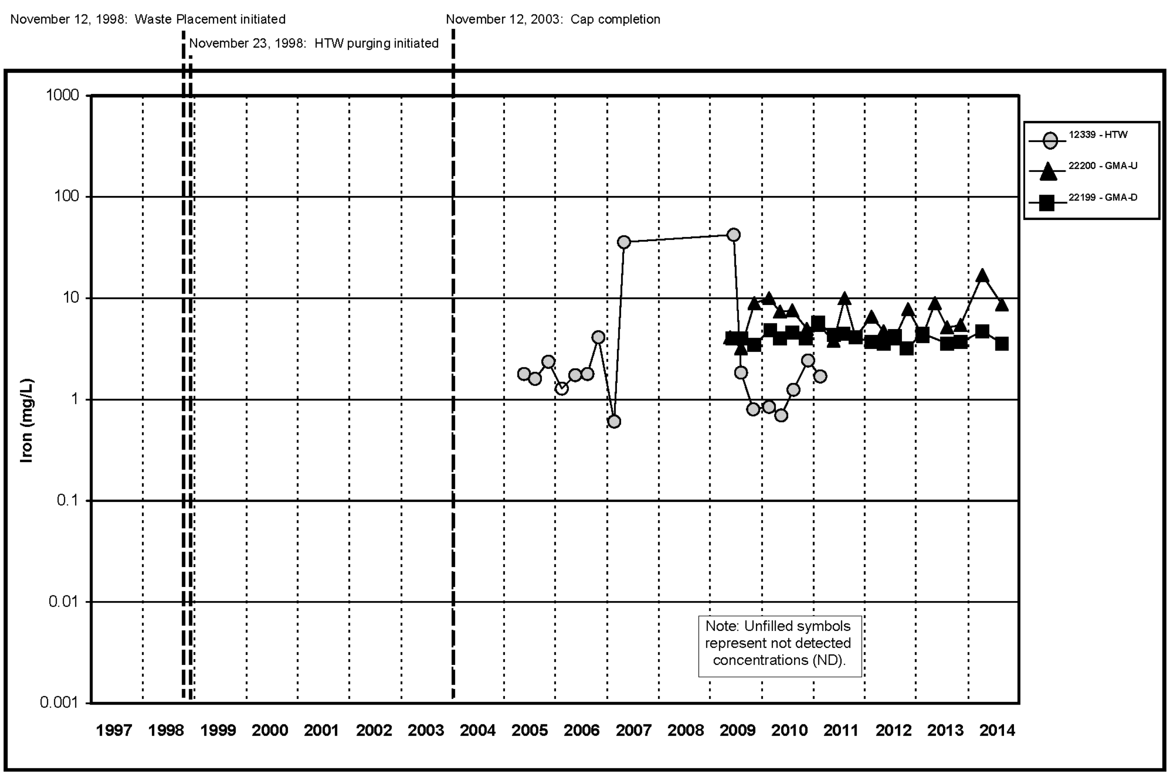


Figure A.5.2-22B. Cell 2 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

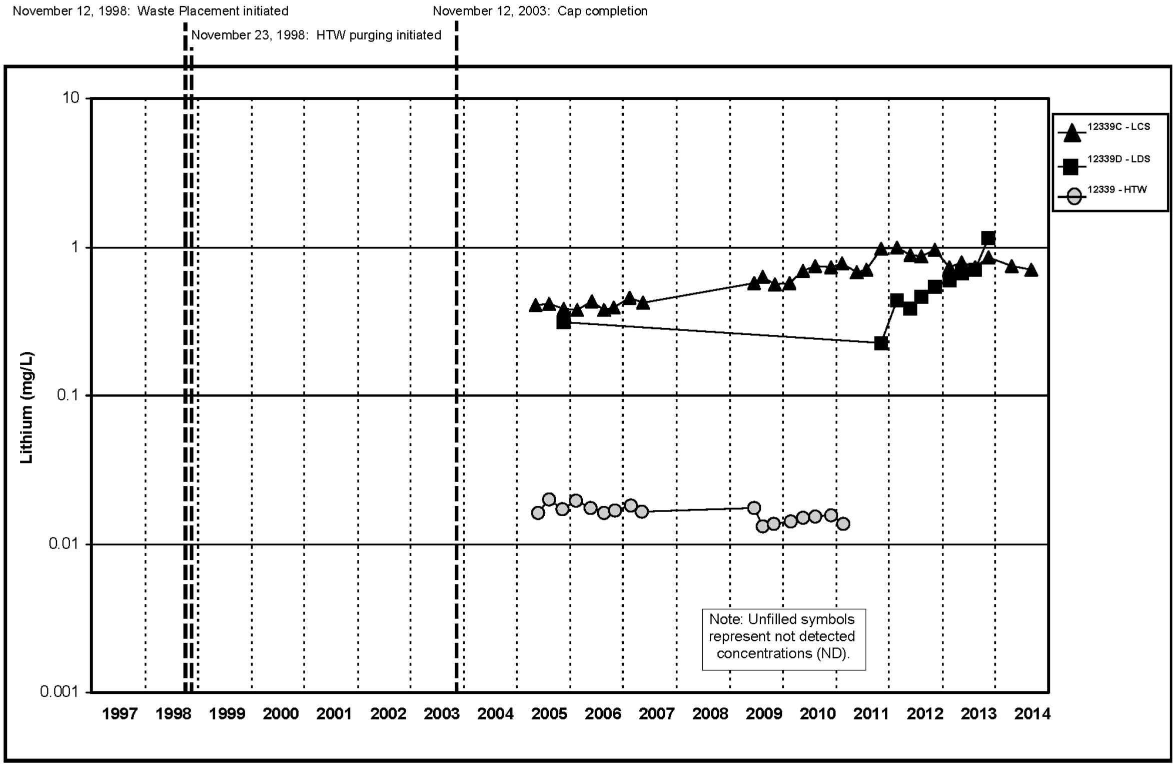


Figure A.5.2-23A. Cell 2 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

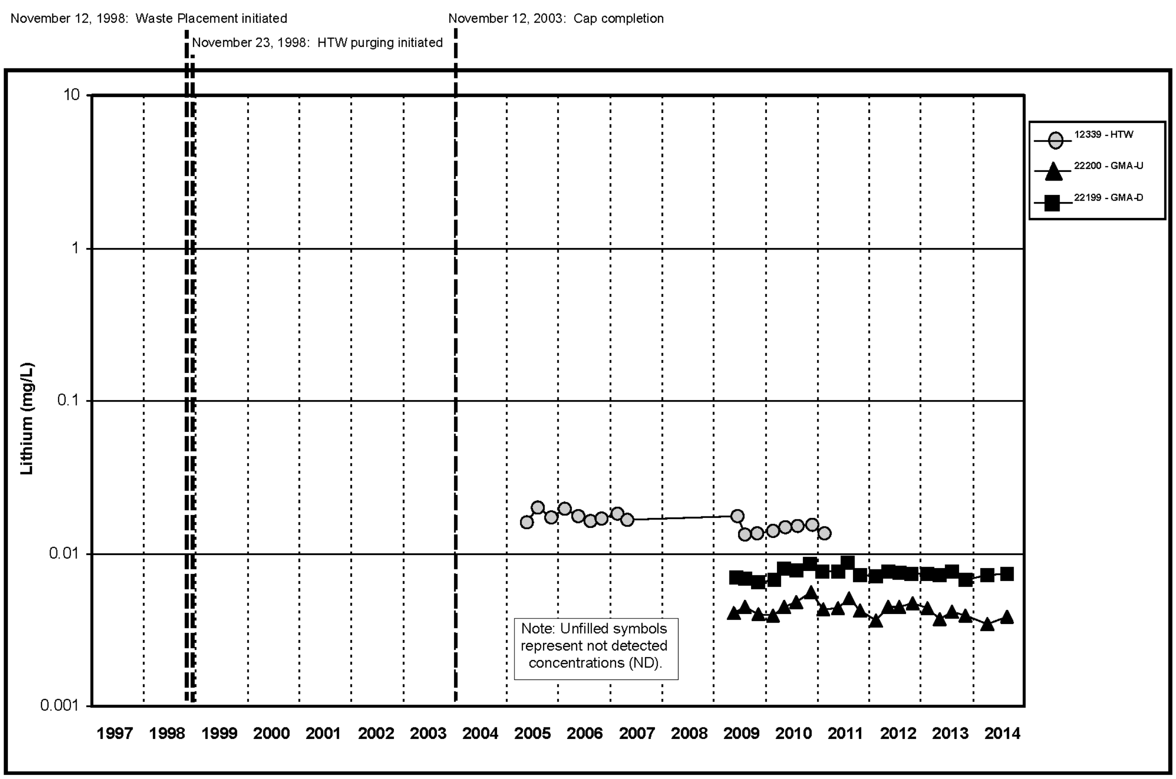


Figure A.5.2-23B. Cell 2 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

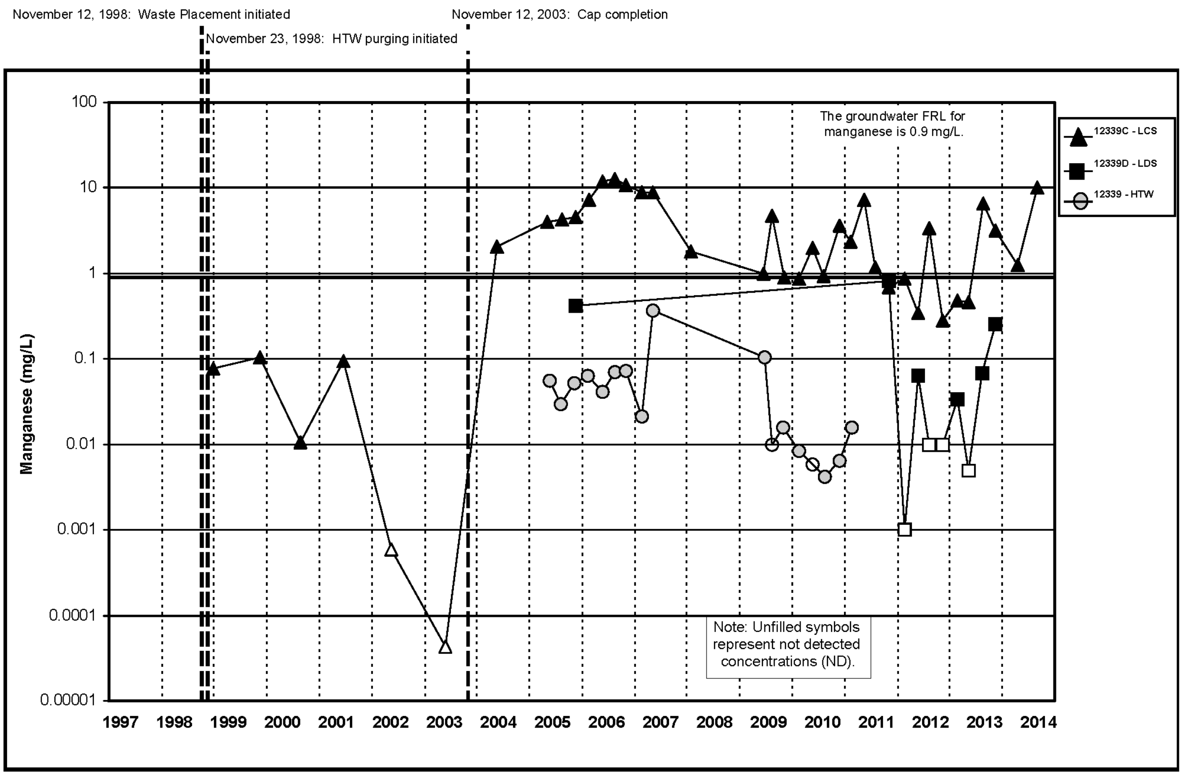


Figure A.5.2-24A. Cell 2 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

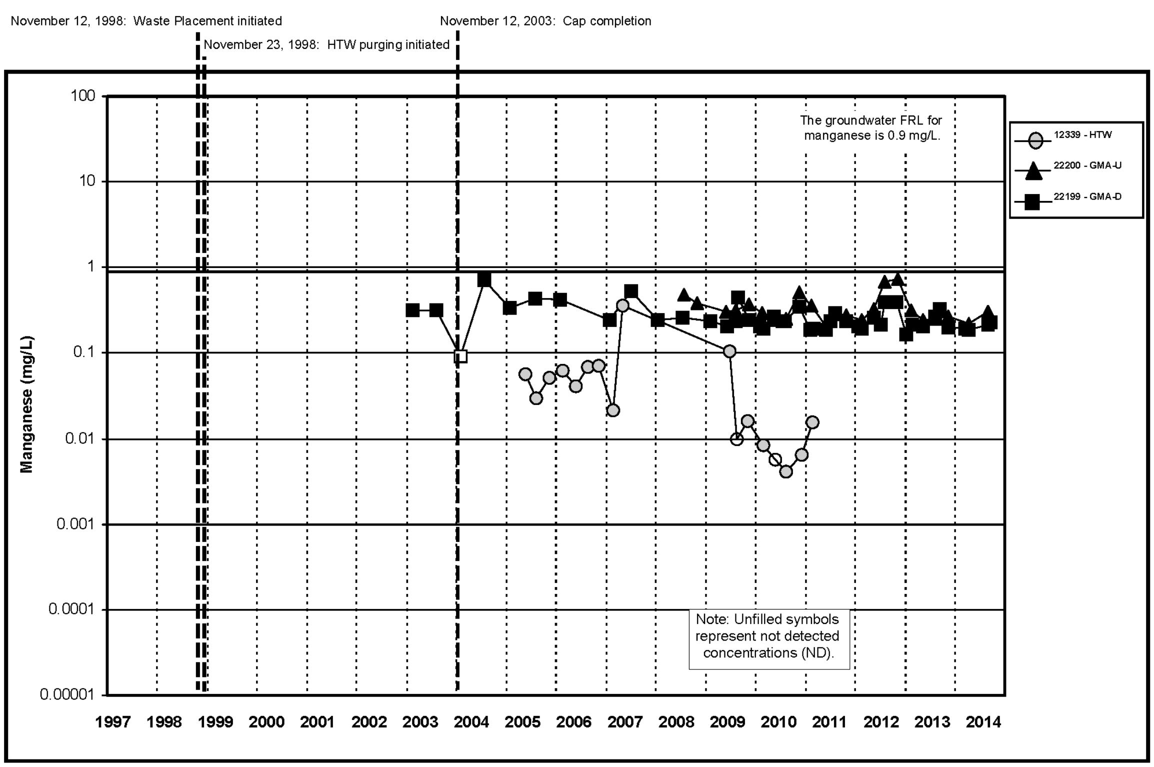


Figure A.5.2-24B. Cell 2 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

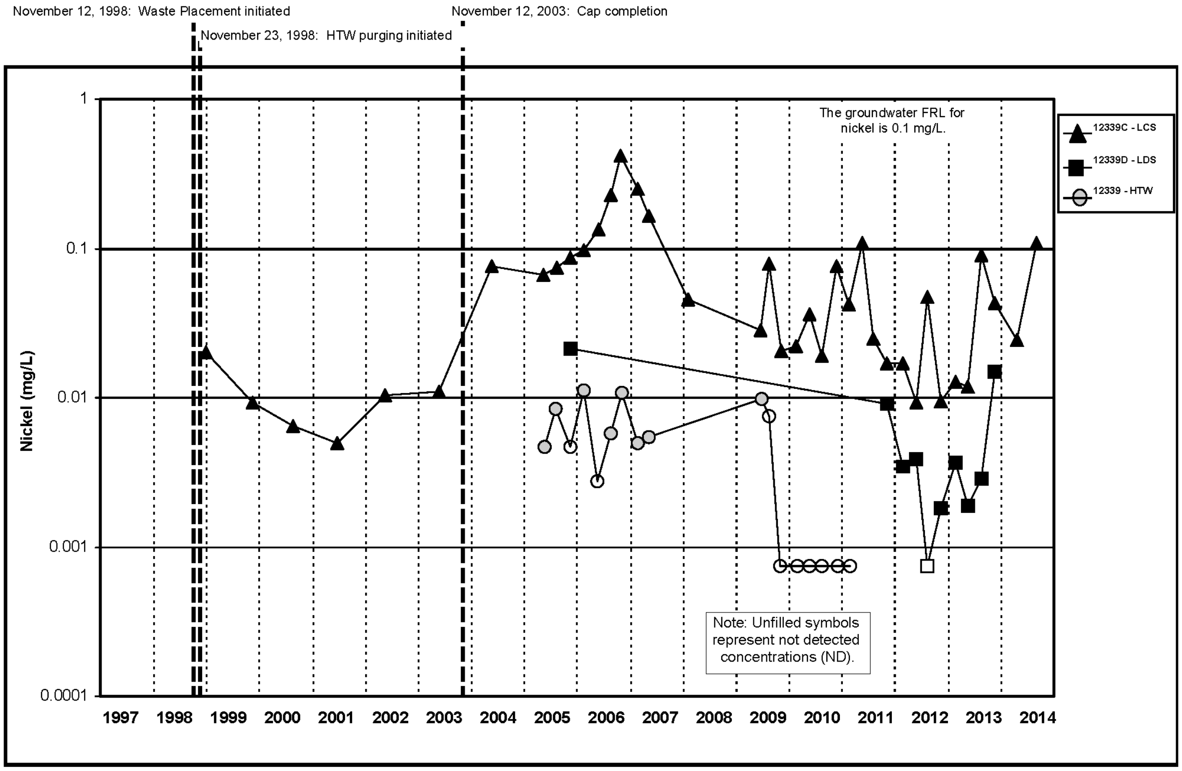


Figure A.5.2-25A. Cell 2 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

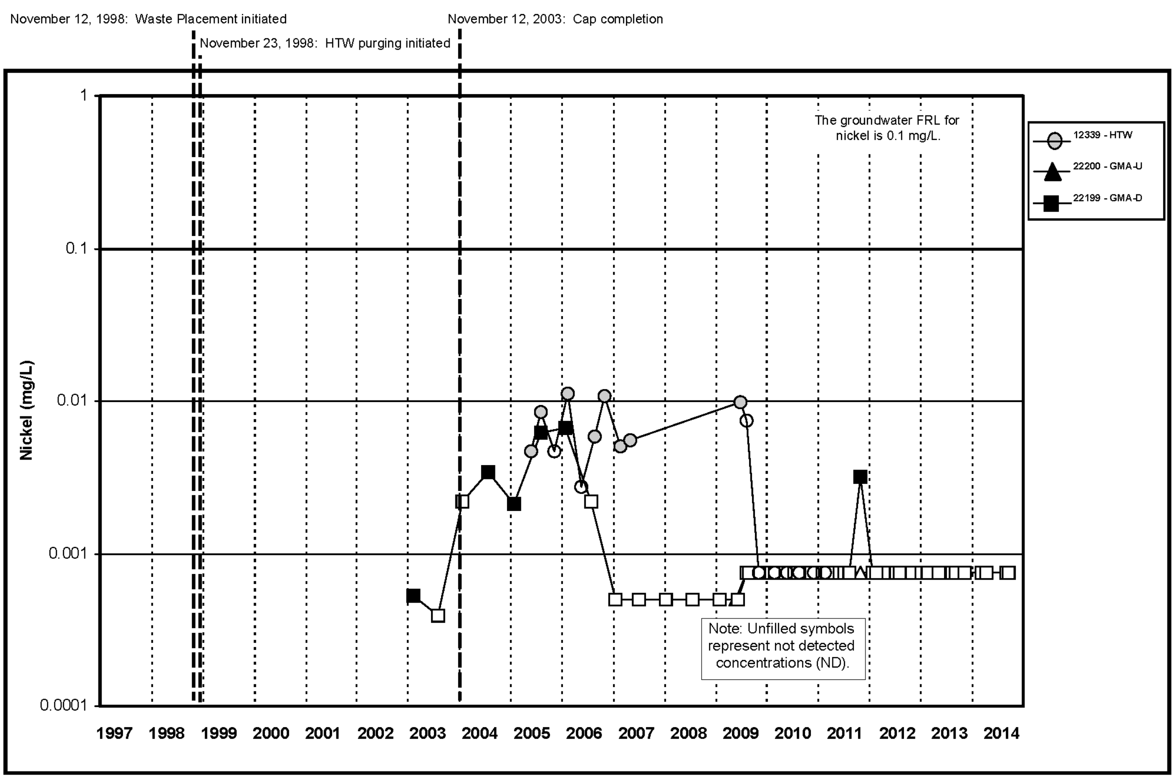


Figure A.5.2-25B. Cell 2 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

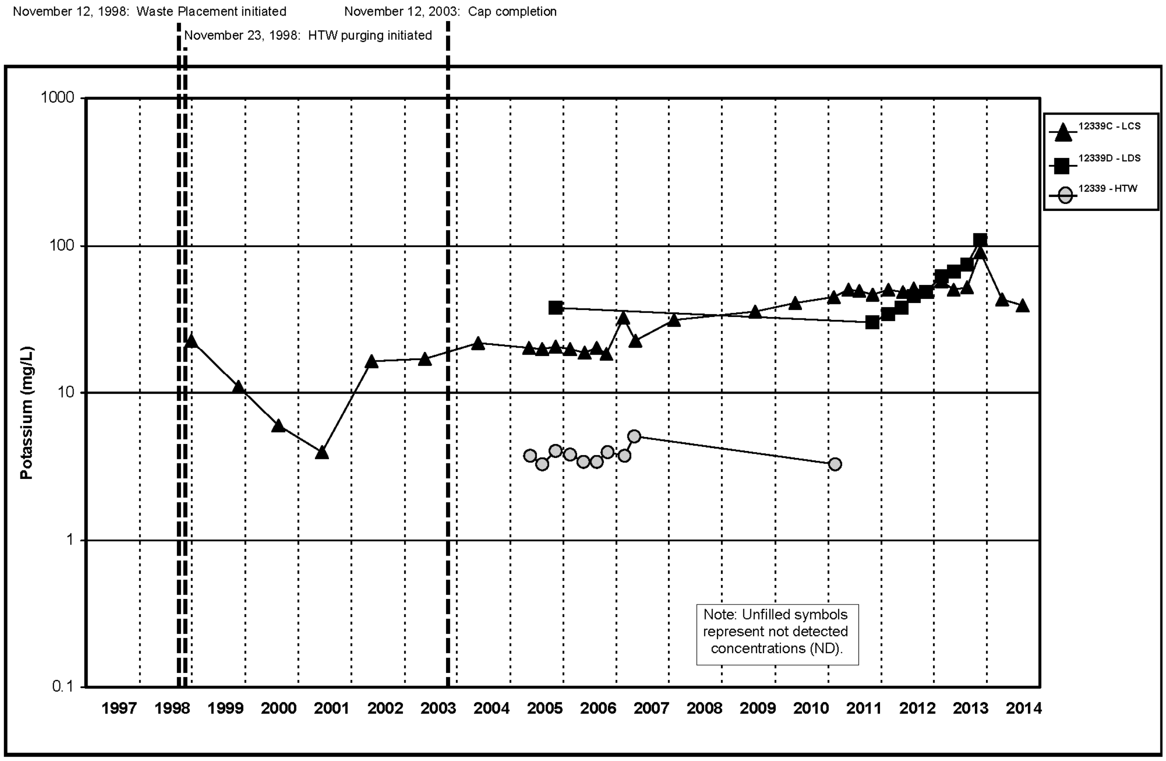


Figure A.5.2-26A. Cell 2 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

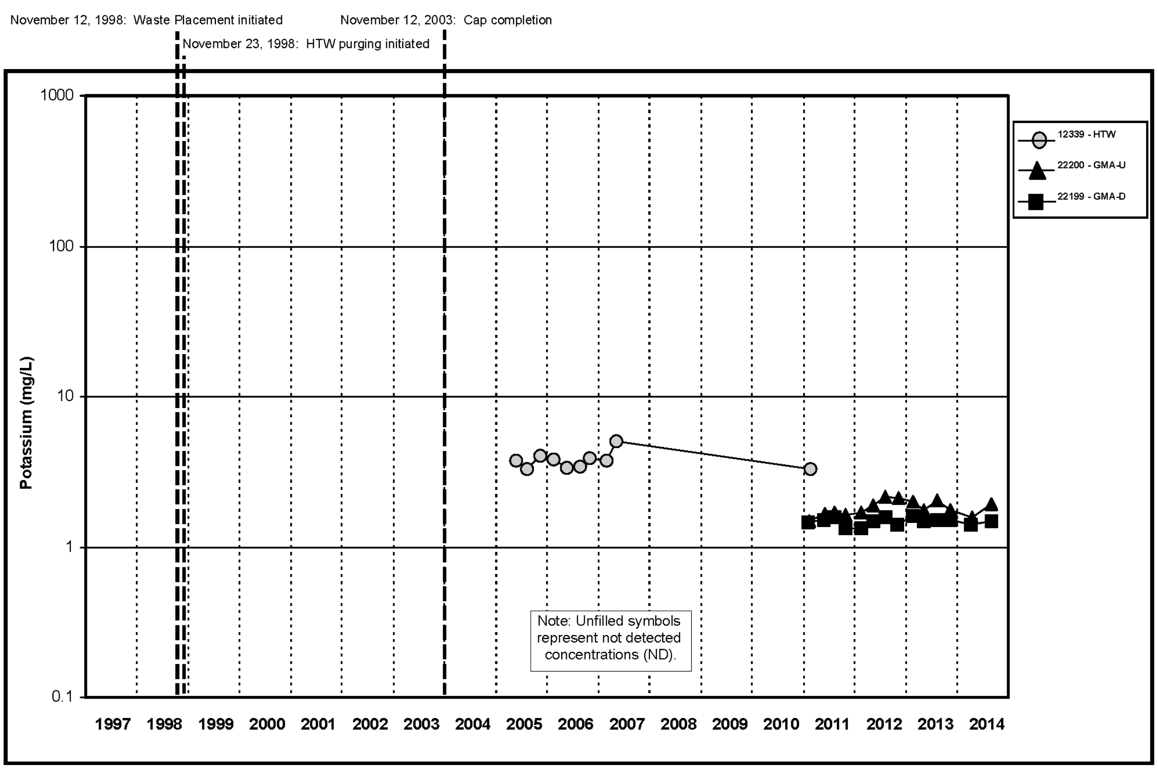


Figure A.5.2-26B. Cell 2 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

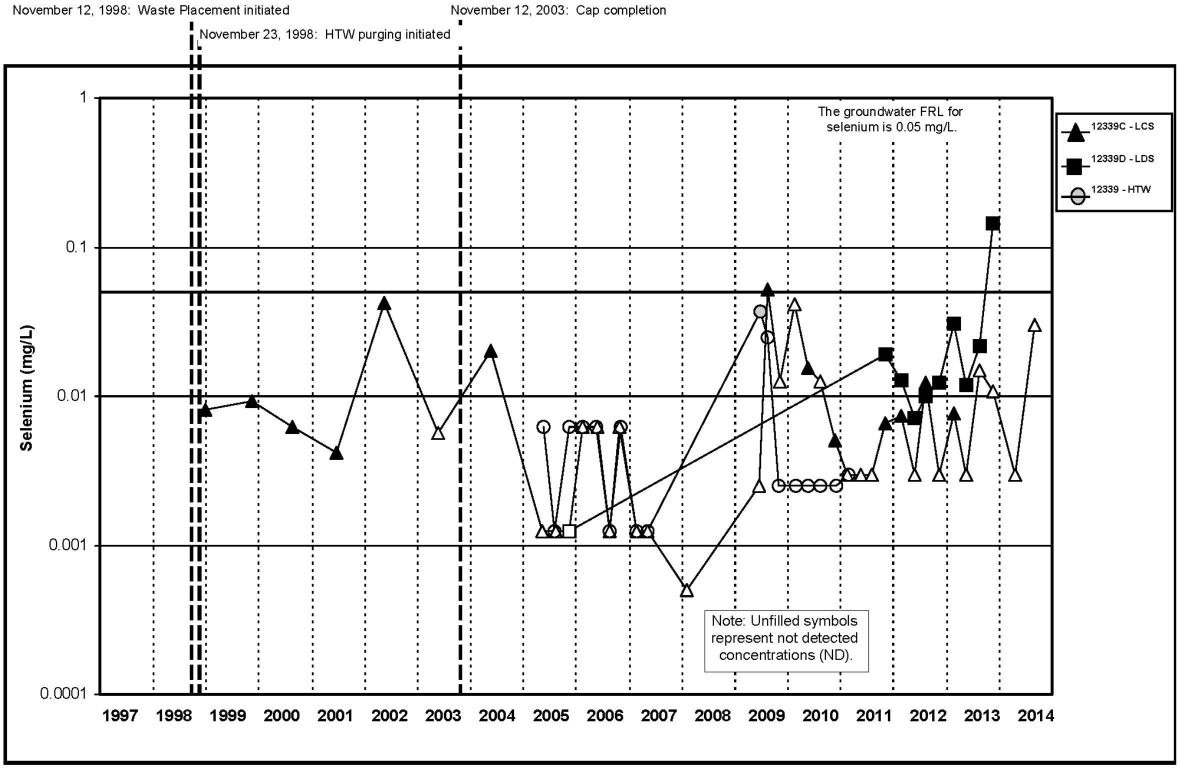


Figure A.5.2-27A. Cell 2 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

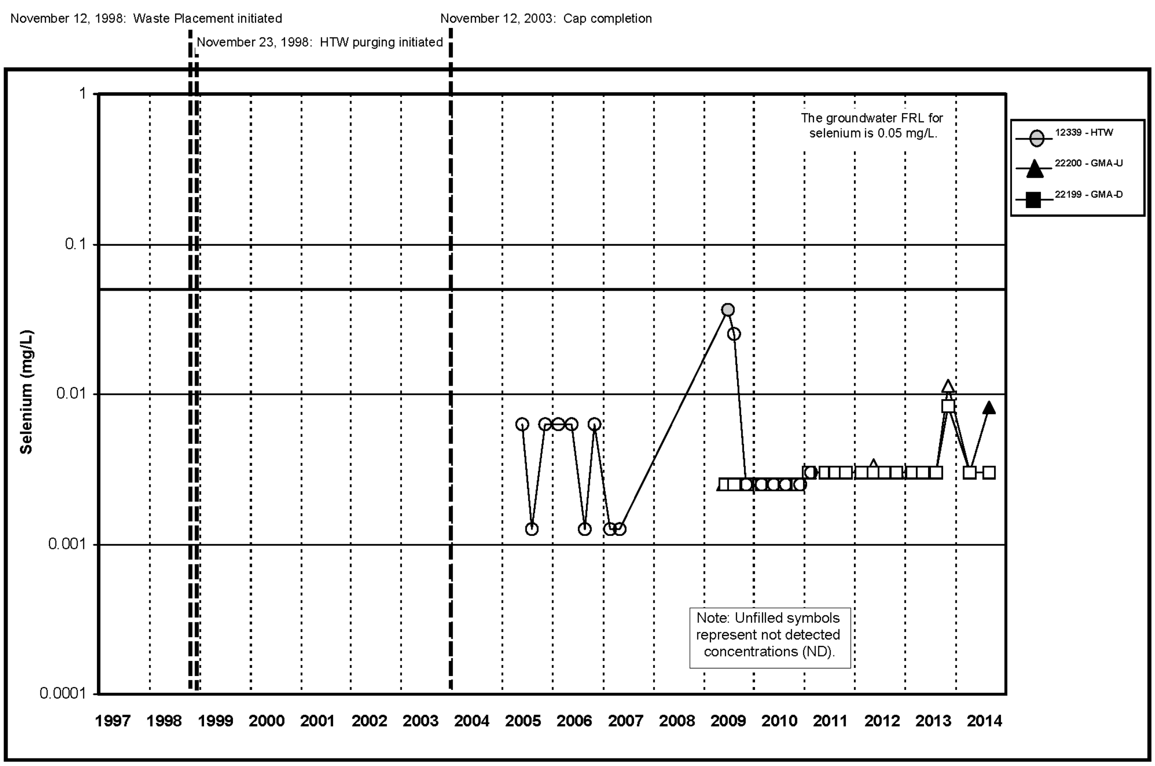


Figure A.5.2-27B. Cell 2 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

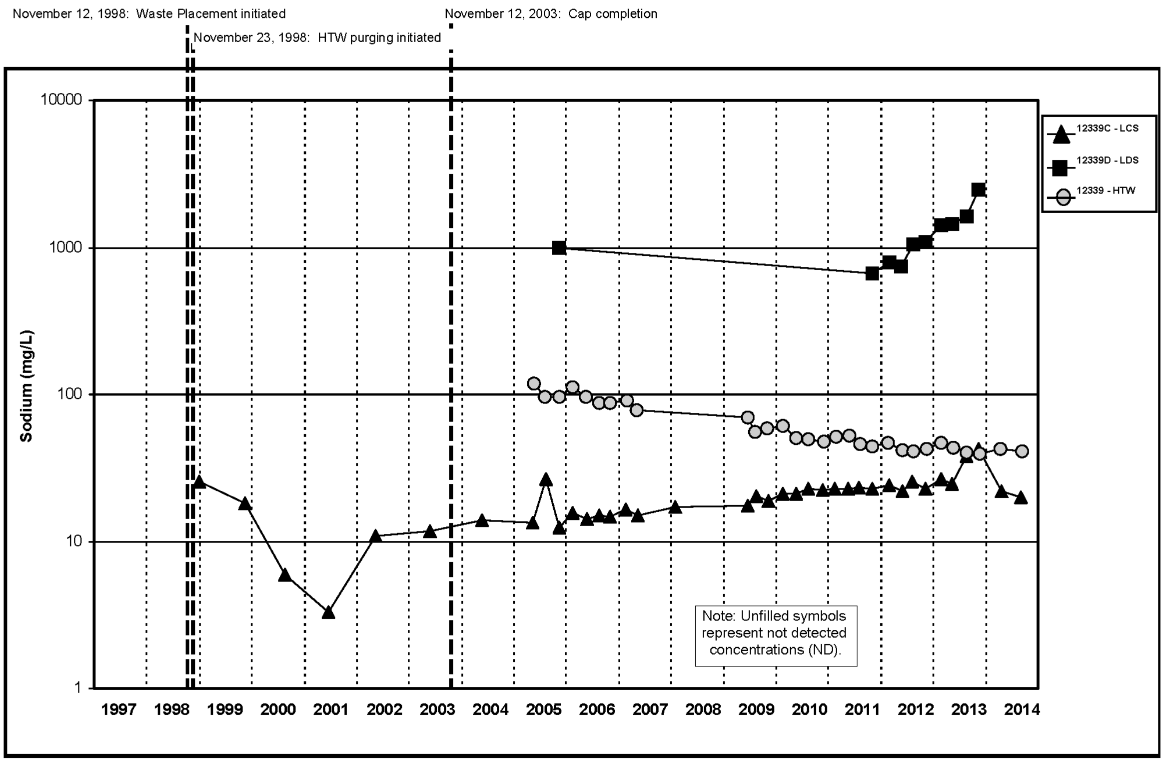


Figure A.5.2-28A. Cell 2 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

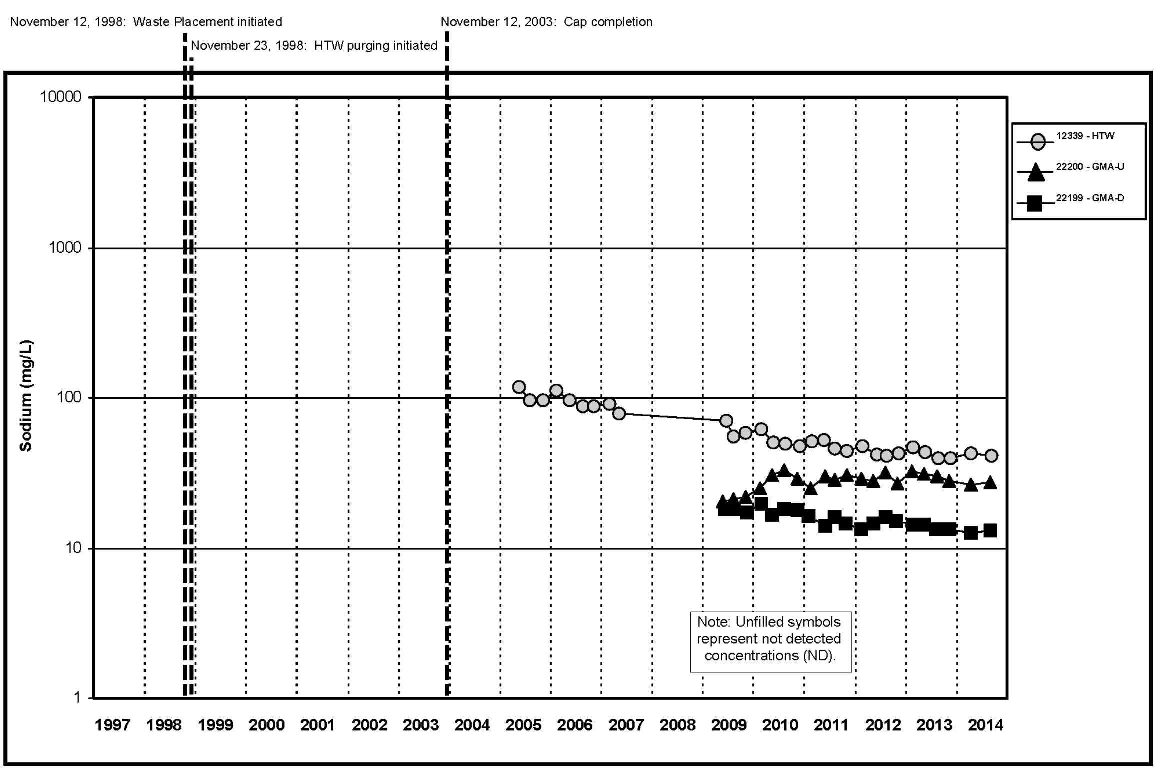


Figure A.5.2-28B. Cell 2 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

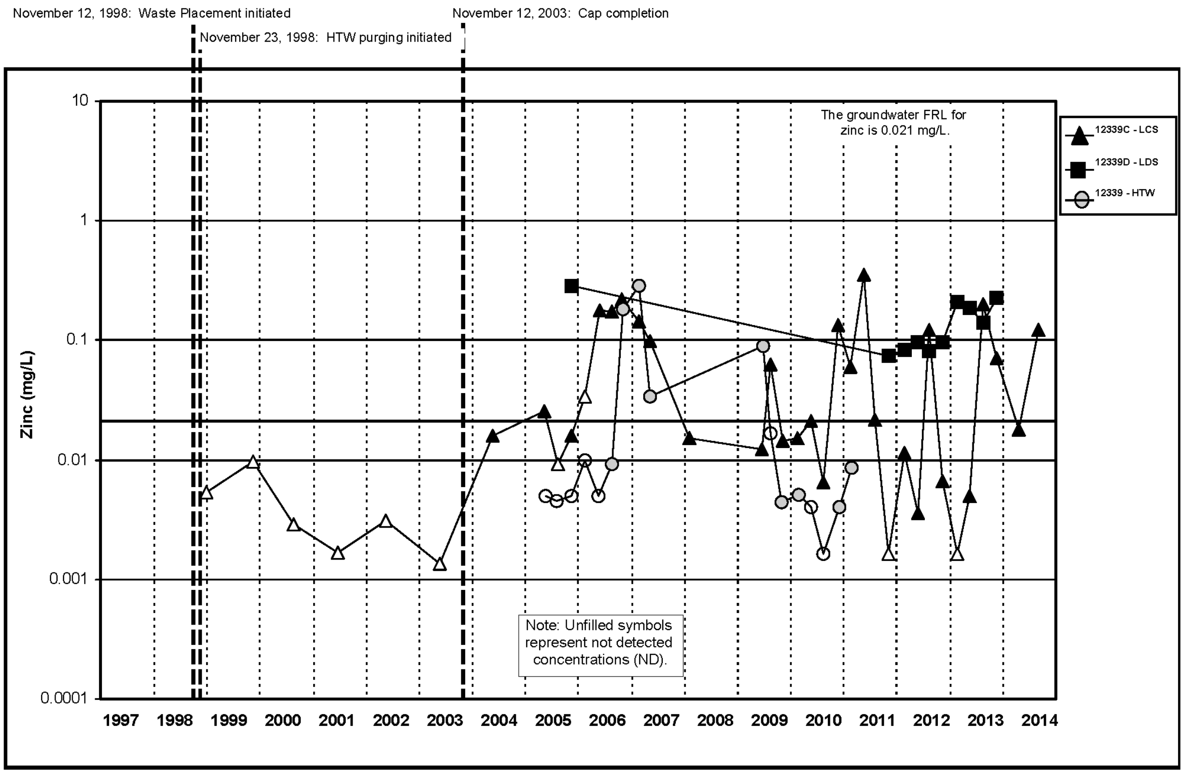


Figure A.5.2-29A. Cell 2 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

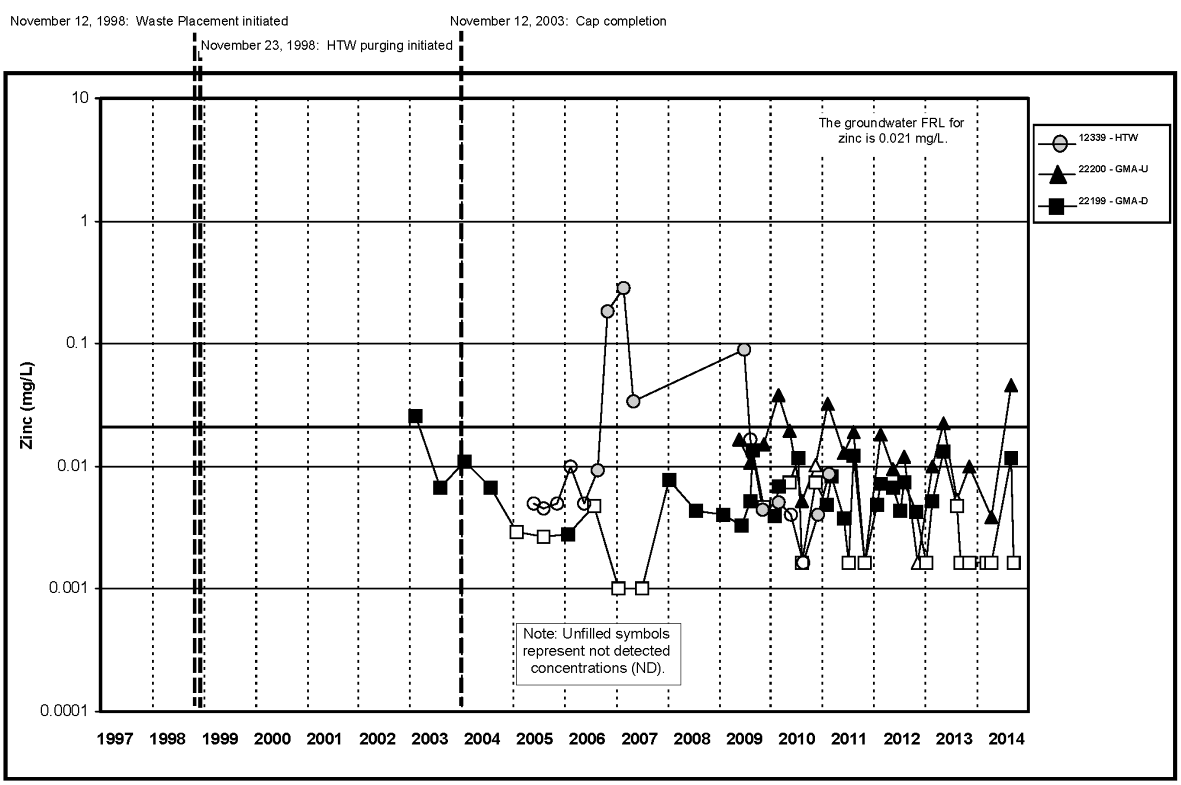


Figure A.5.2-29B. Cell 2 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

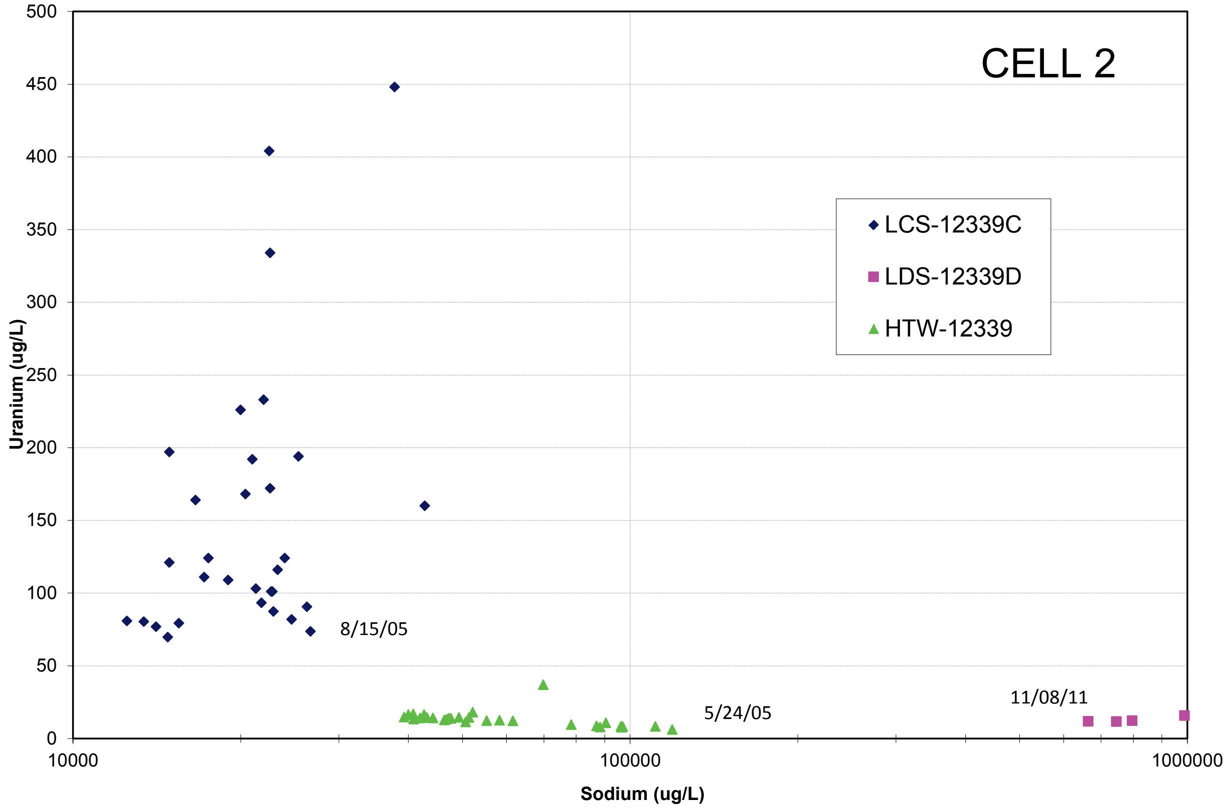


Figure A.5.2-30. Cell 2 Bivariate Plot for Uranium and Sodium

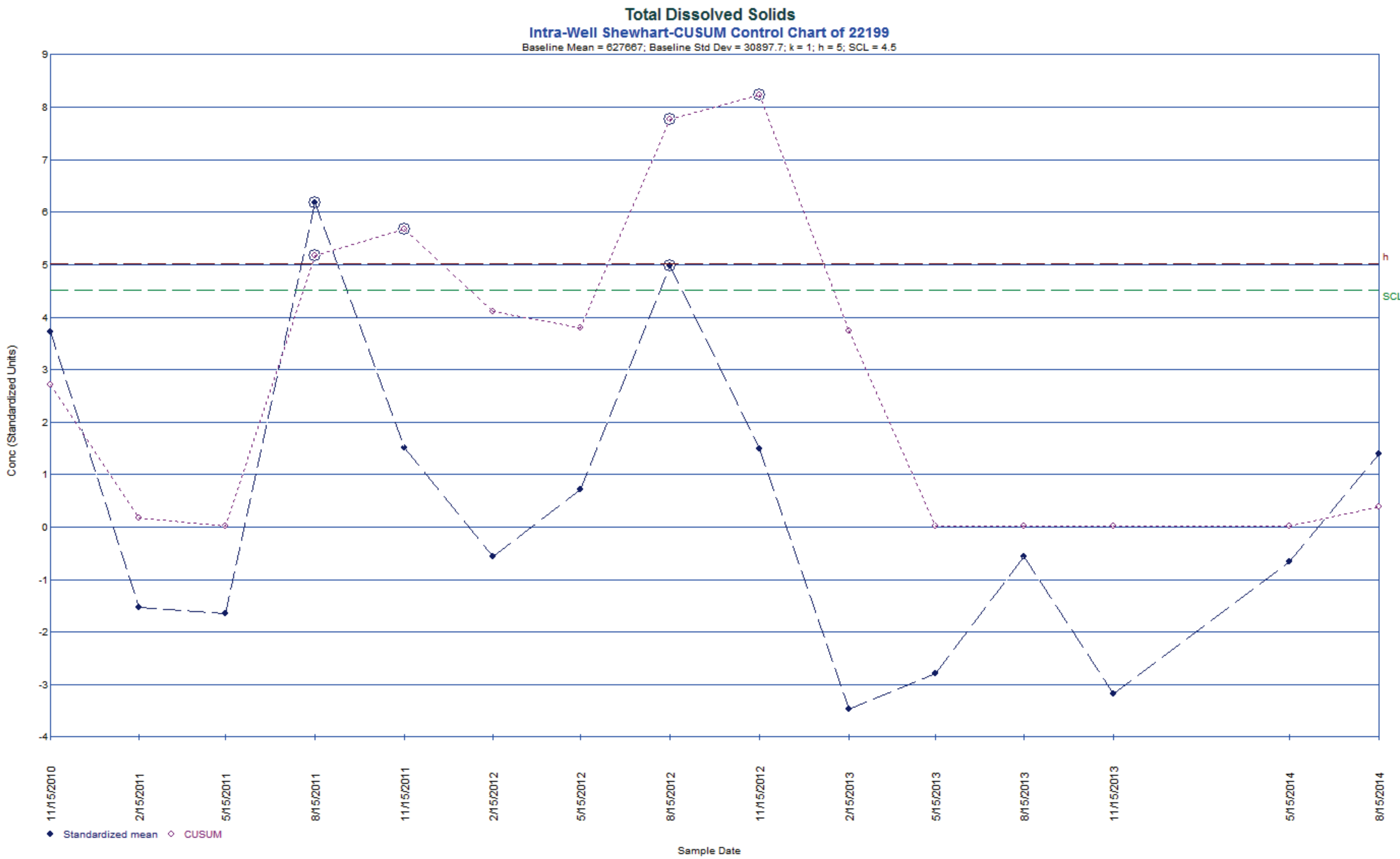


Figure A.5.2-31. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22199)

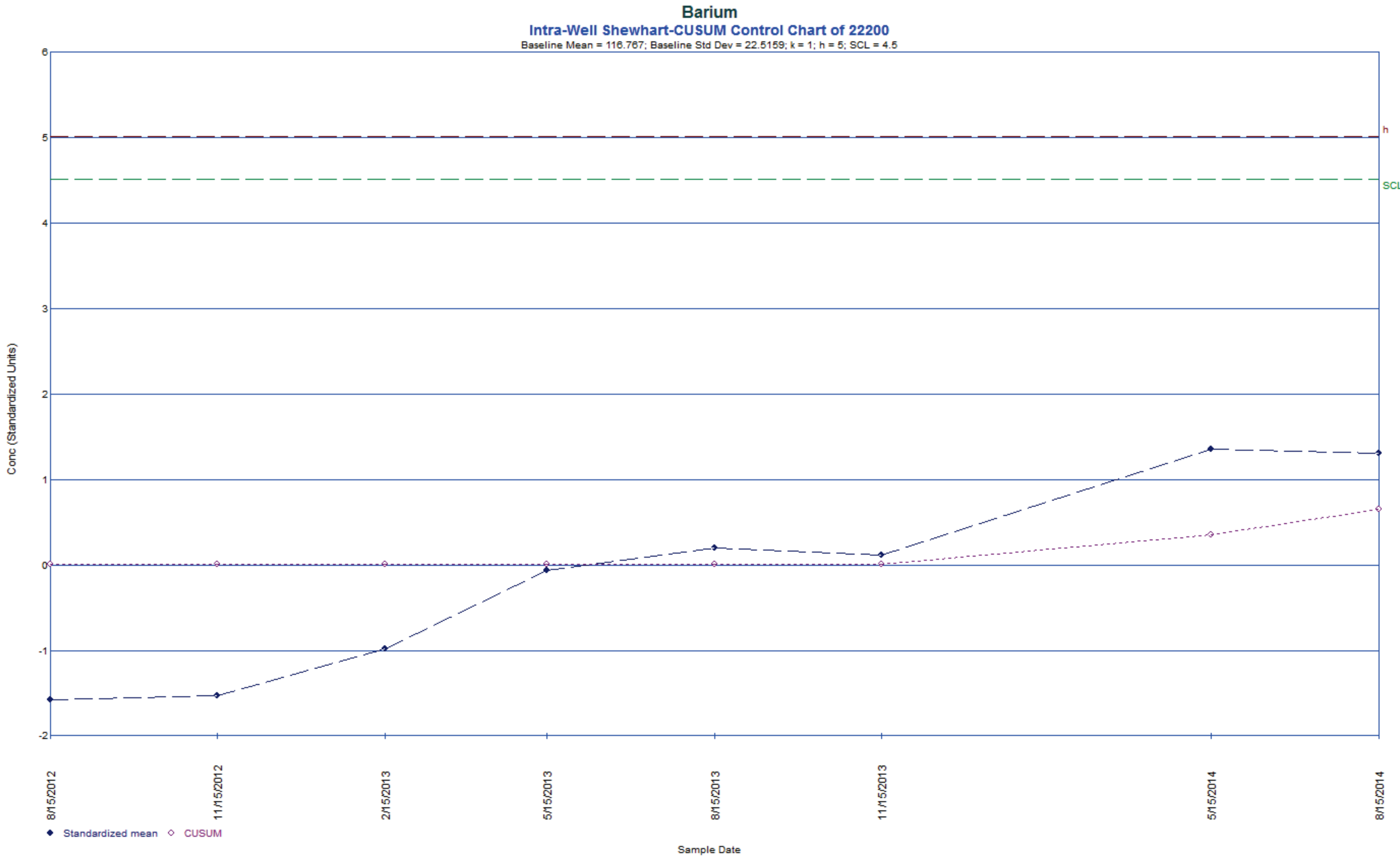


Figure A.5.2-32. Intra-Well Shewhart-CUSUM Control Chart (Barium 22200)

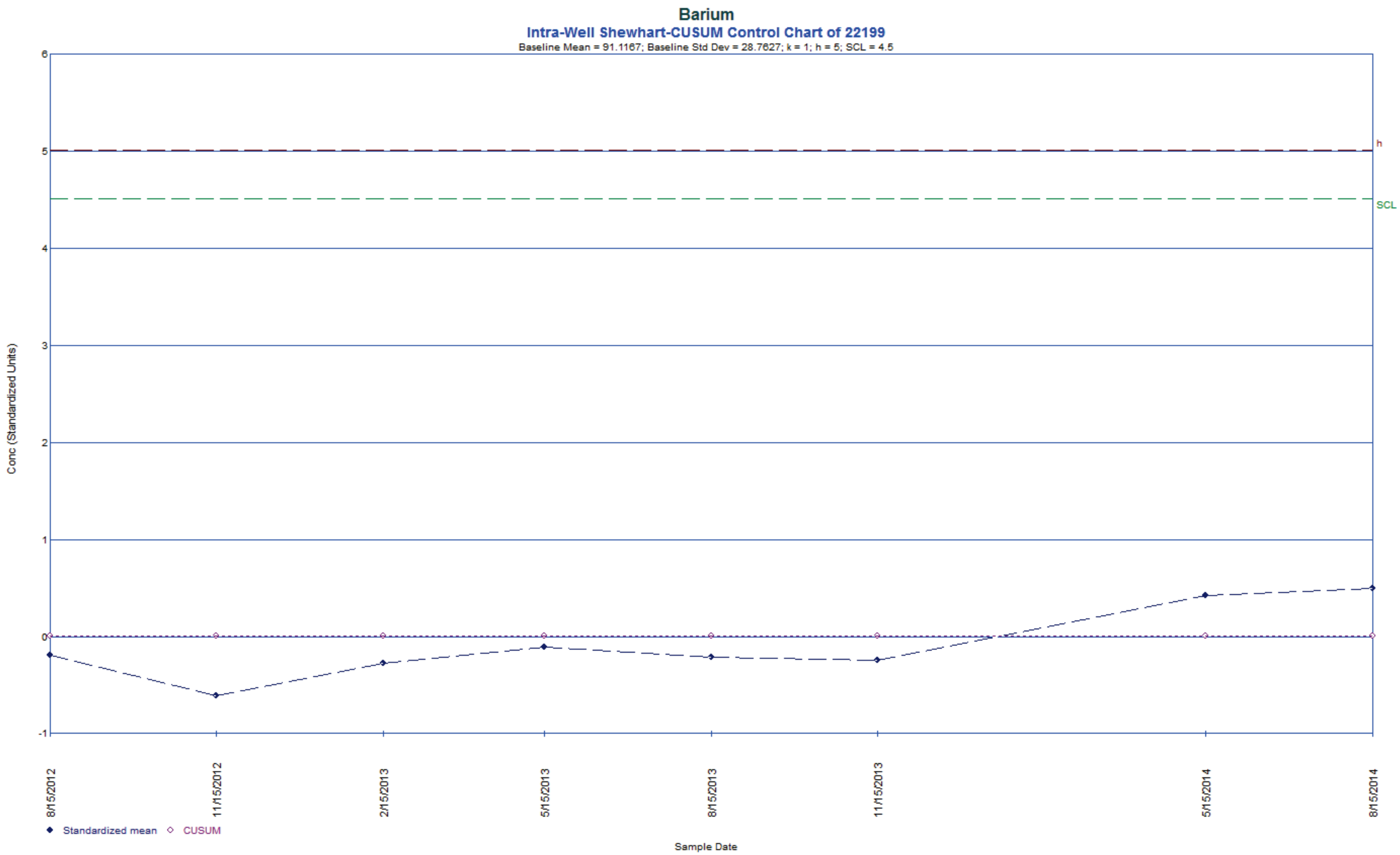


Figure A.5.2-33. Intra-Well Shewhart-CUSUM Control Chart (Barium 22199)

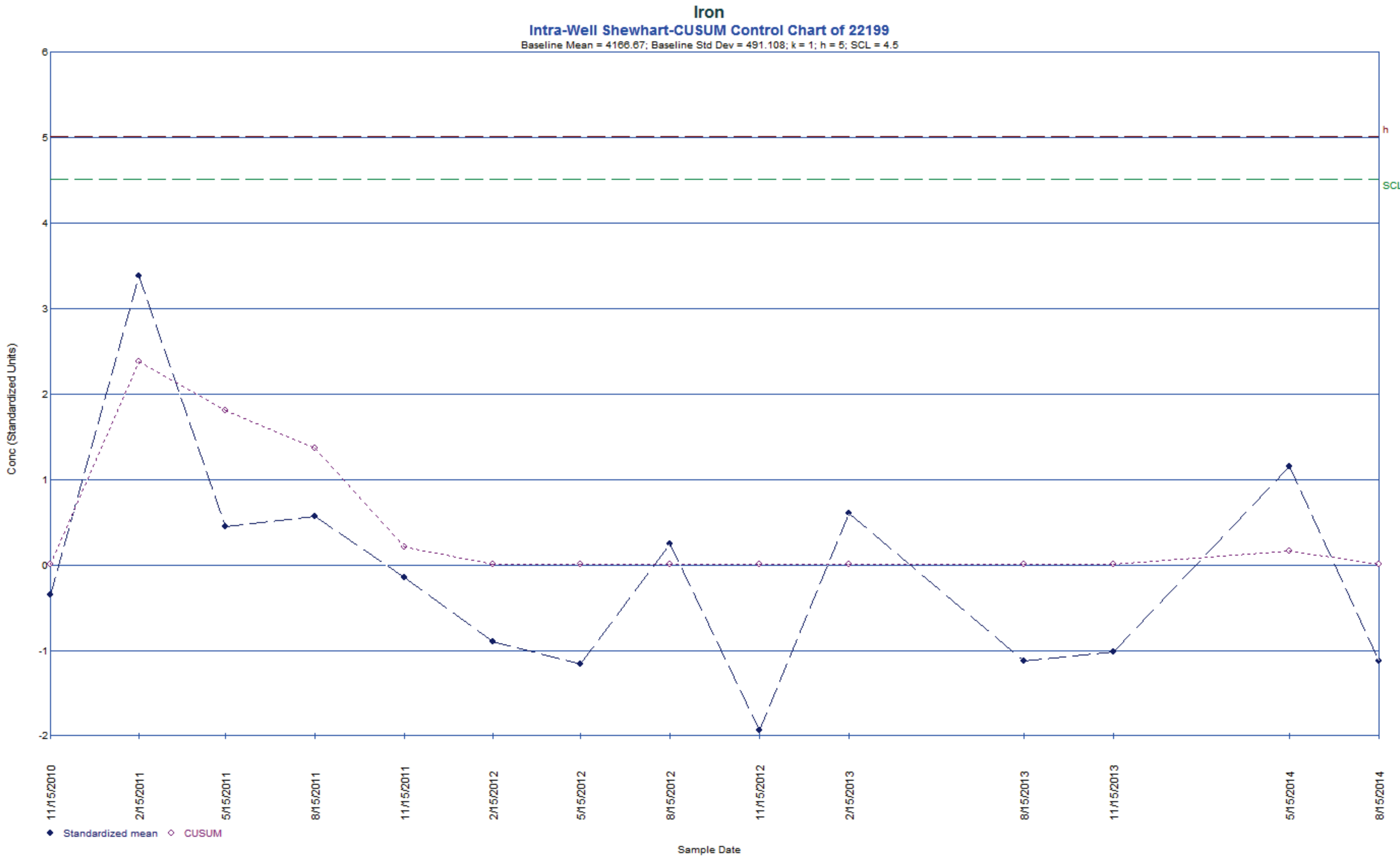


Figure A.5.2-34. Intra-Well Shewhart-CUSUM Control Chart (Iron 22199)

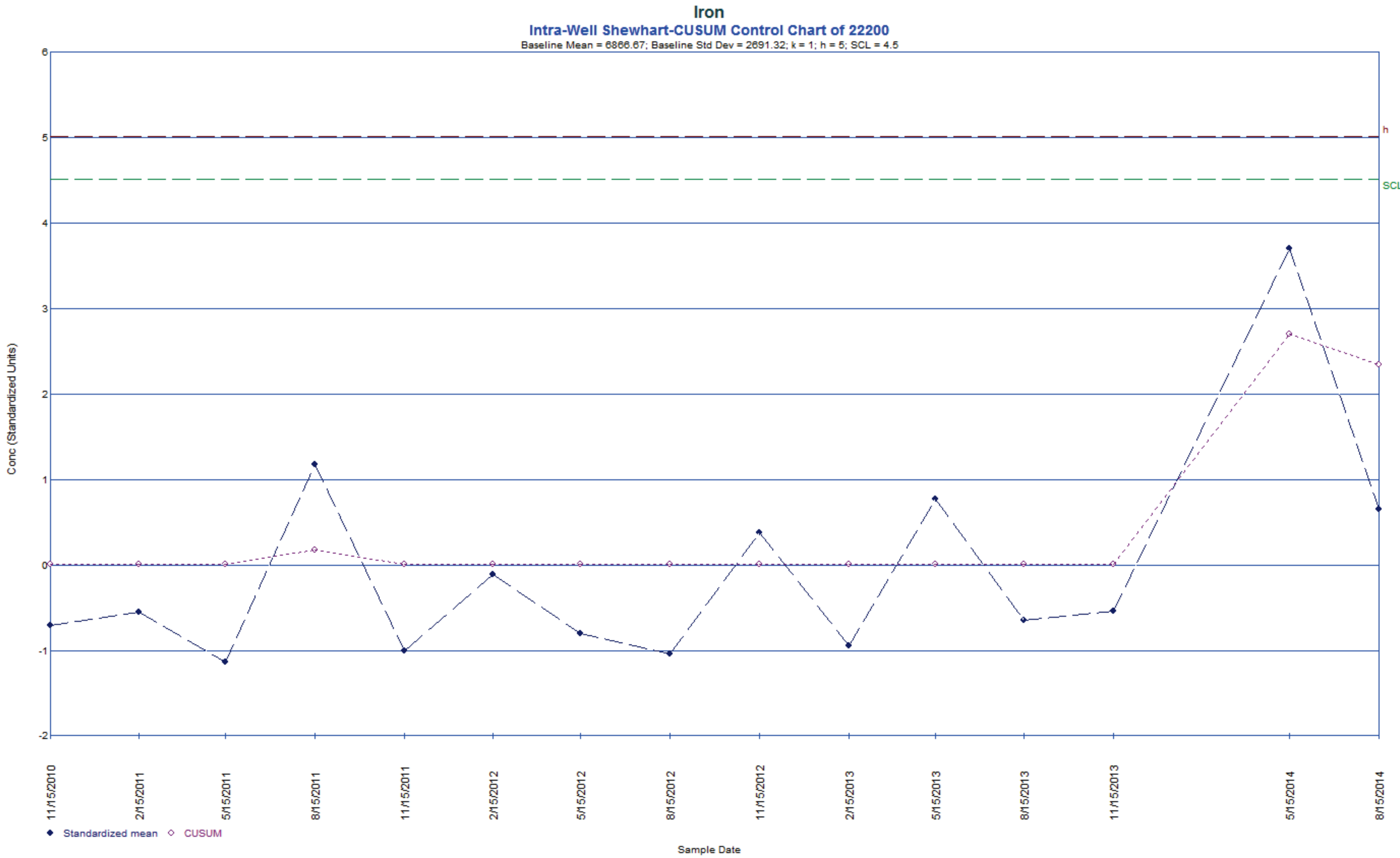


Figure A.5.2-35. Intra-Well Shewhart-CUSUM Control Chart (Iron 22200)

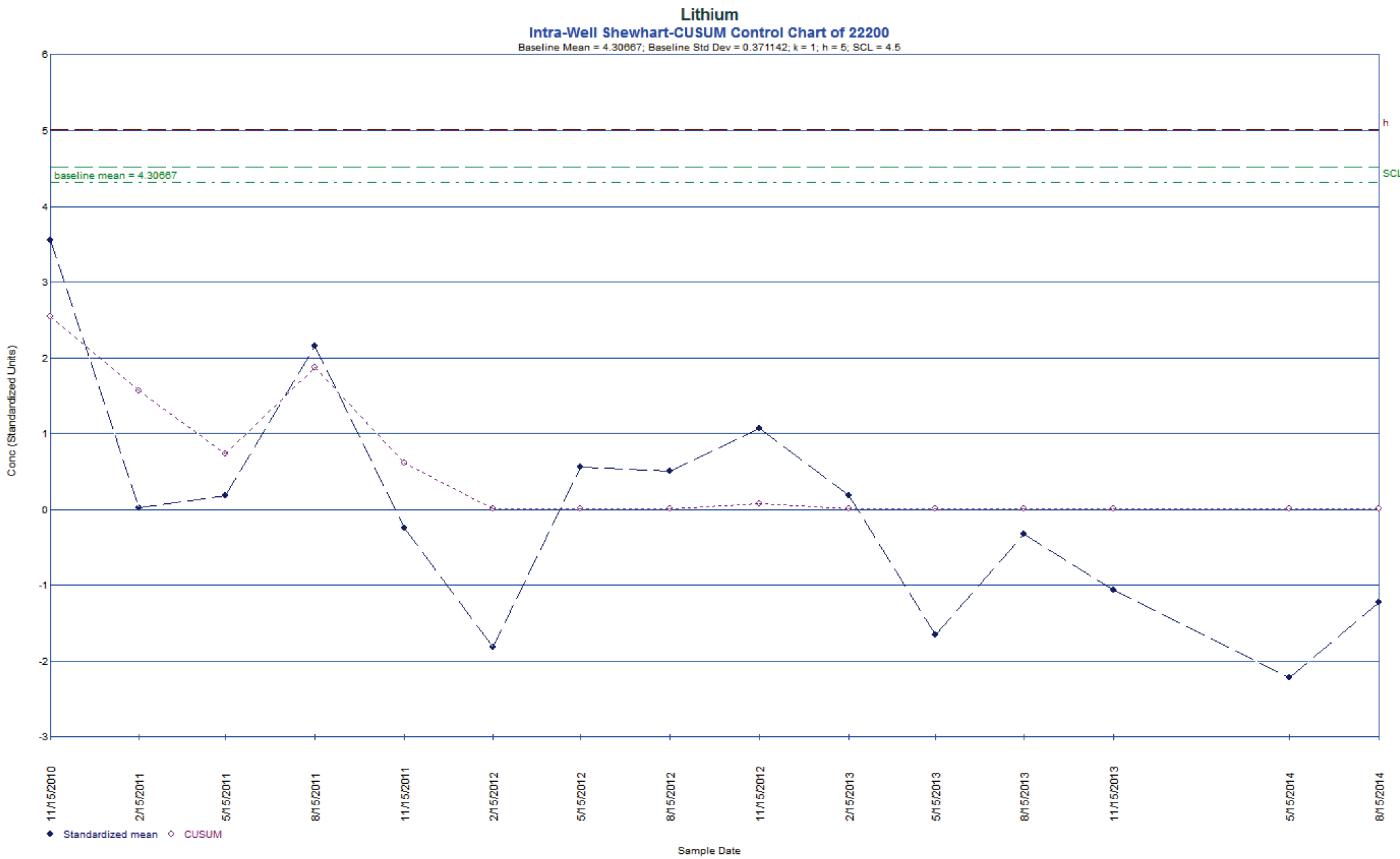


Figure A.5.2-36. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22200)

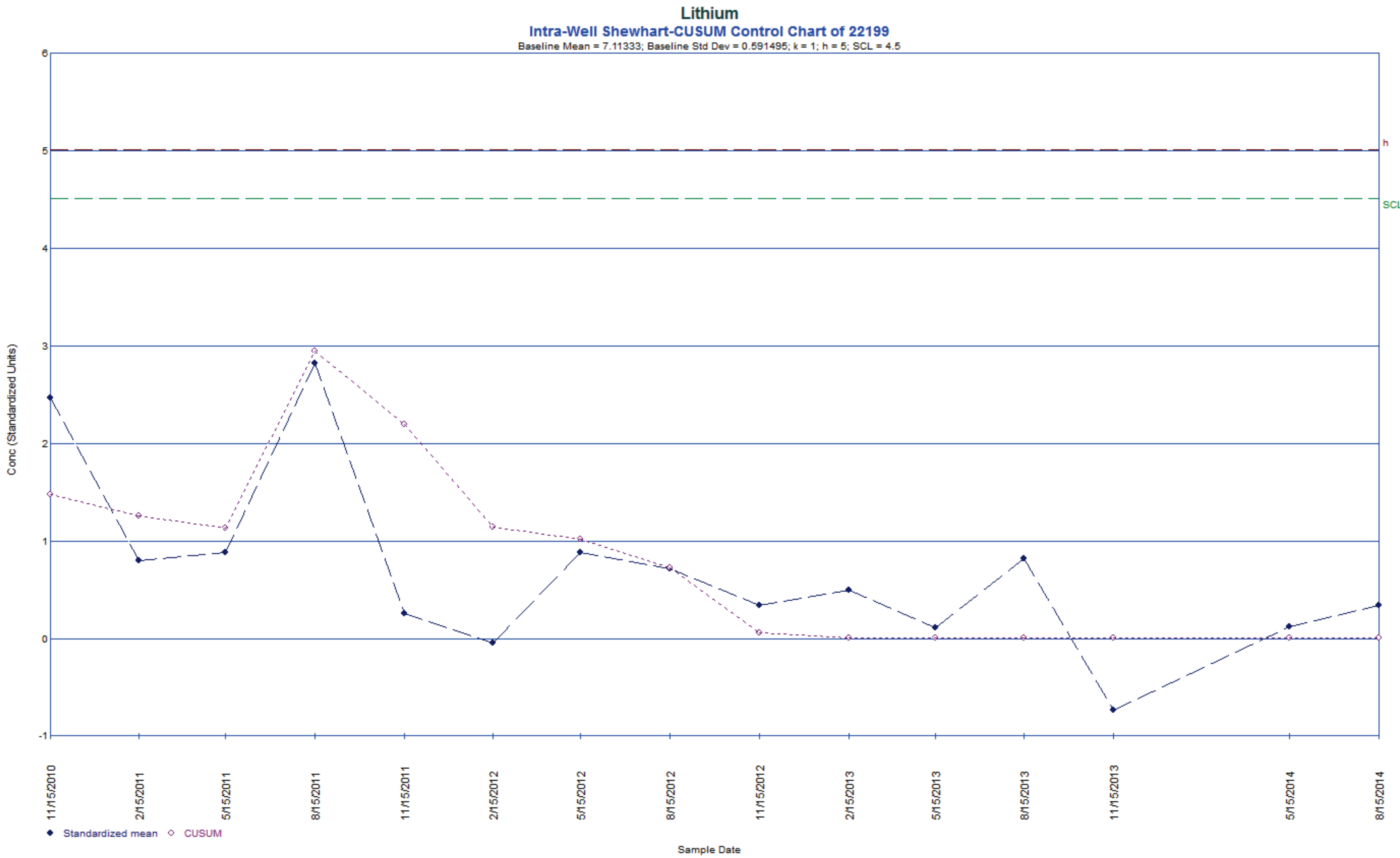


Figure A.5.2-37. Intrra-Well Shewhart-CUSUM Control Chart (Lithium 22199)

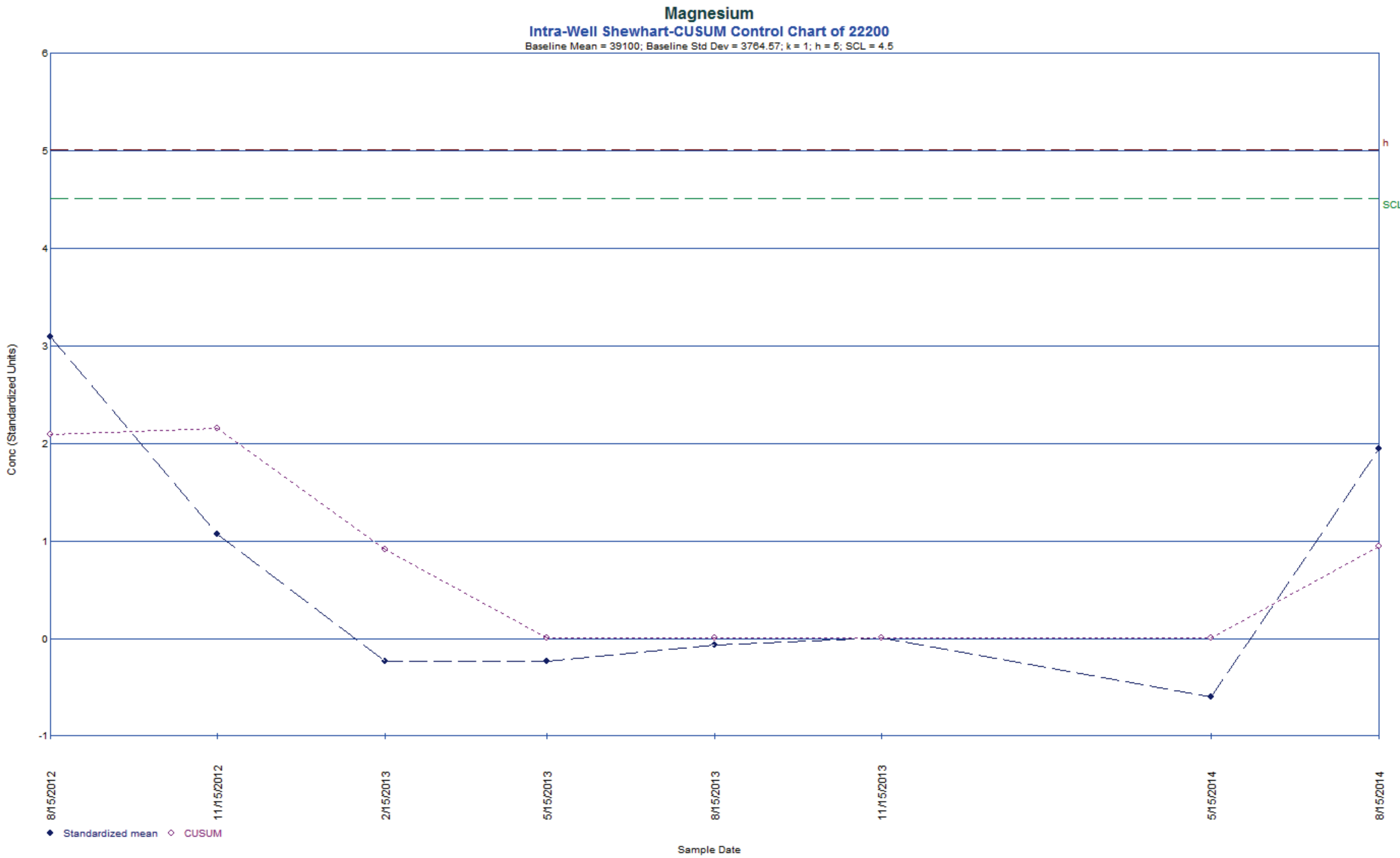


Figure A.5.2-38. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22200)

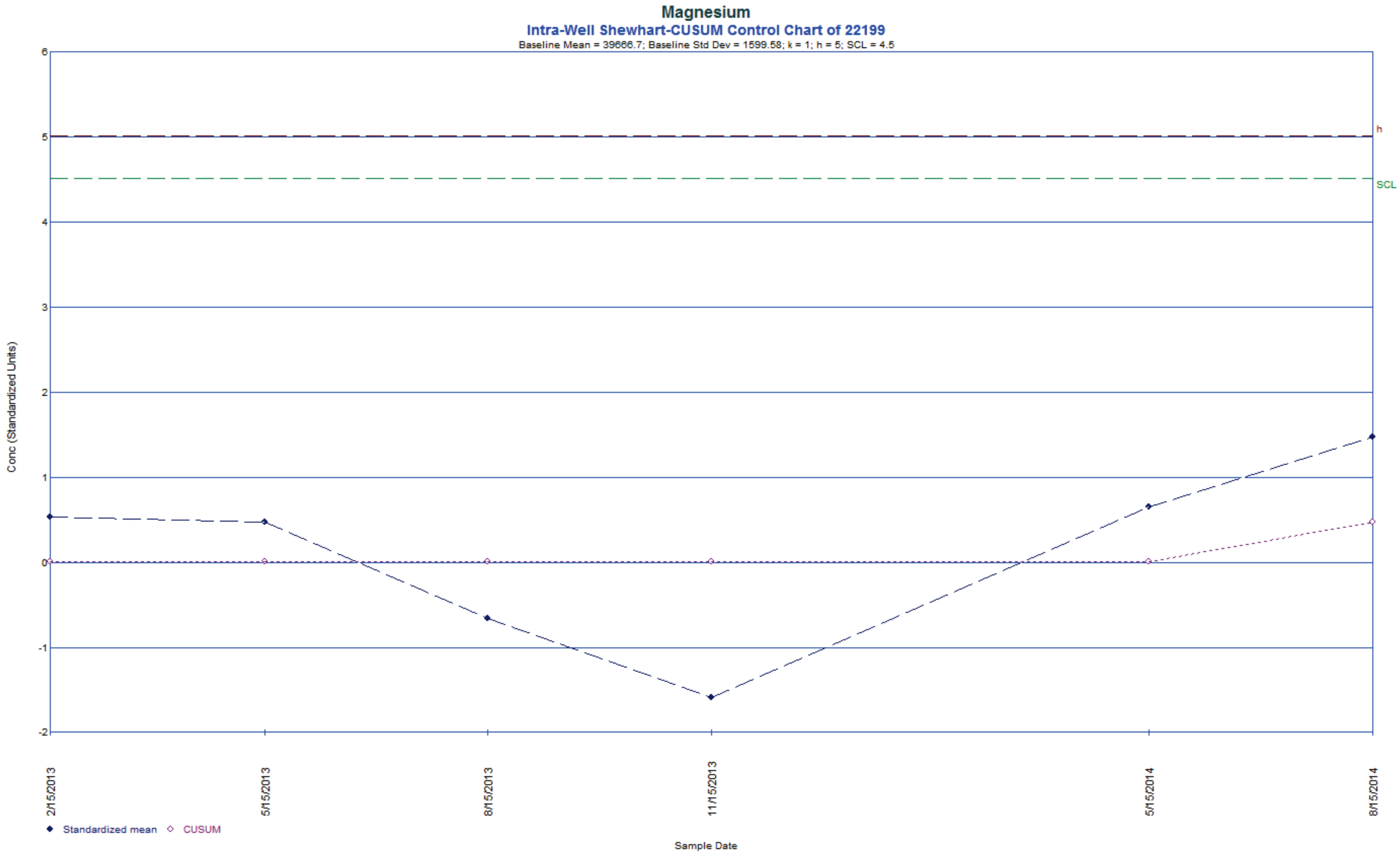


Figure A.5.2-39. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22199)

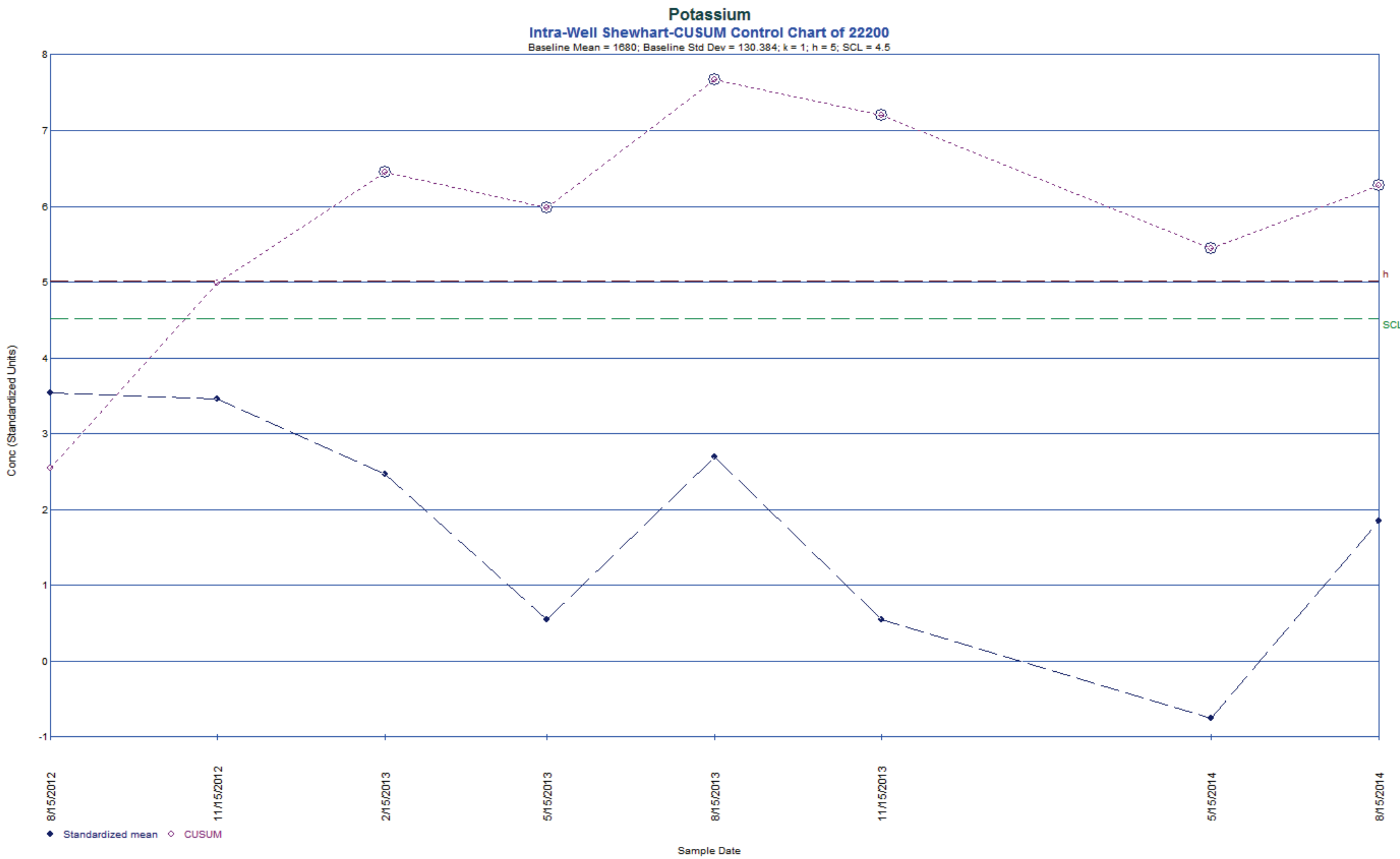


Figure A.5.2-40. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22200)

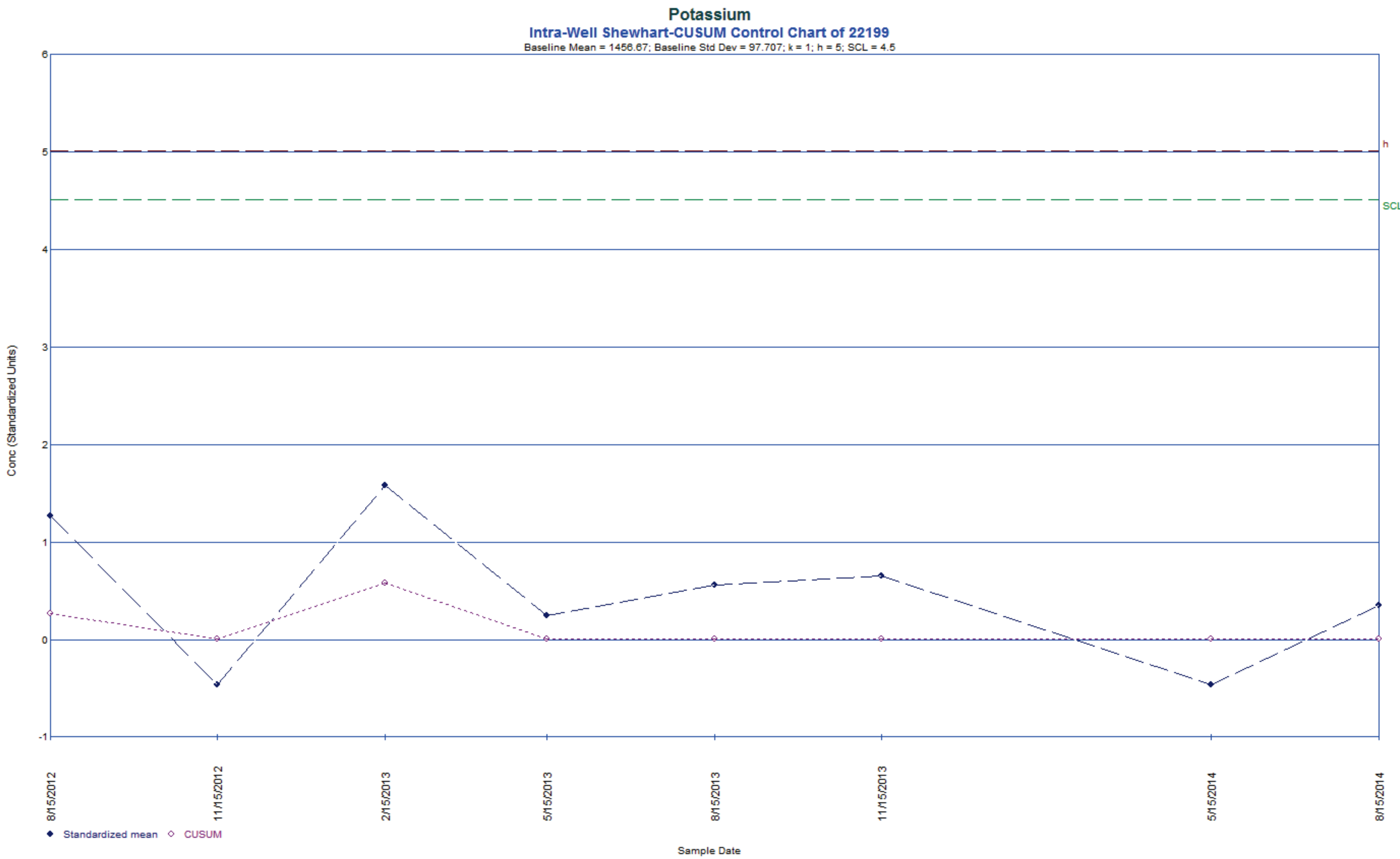


Figure A.5.2-41. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22199)

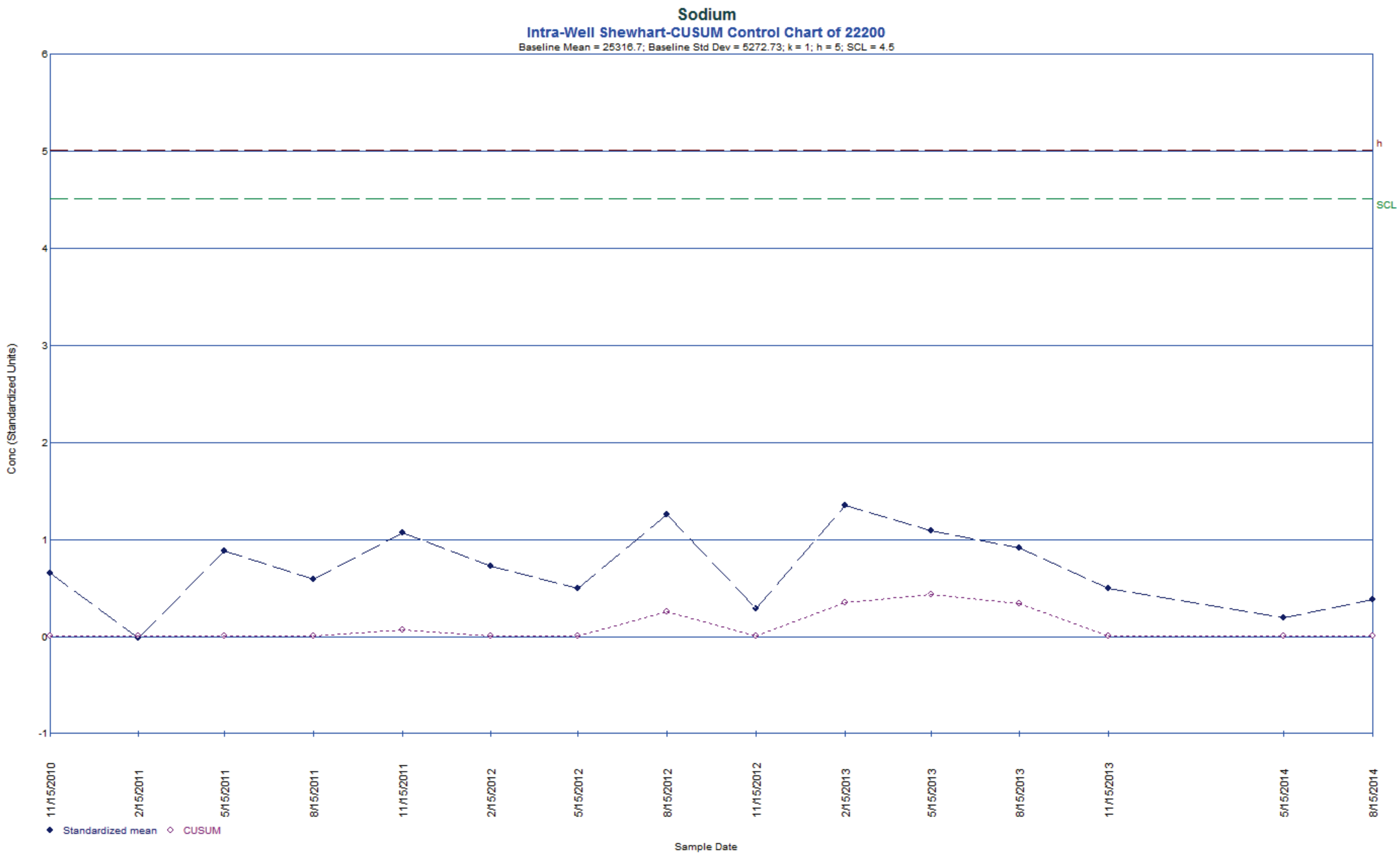


Figure A.5.2-42. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22200)

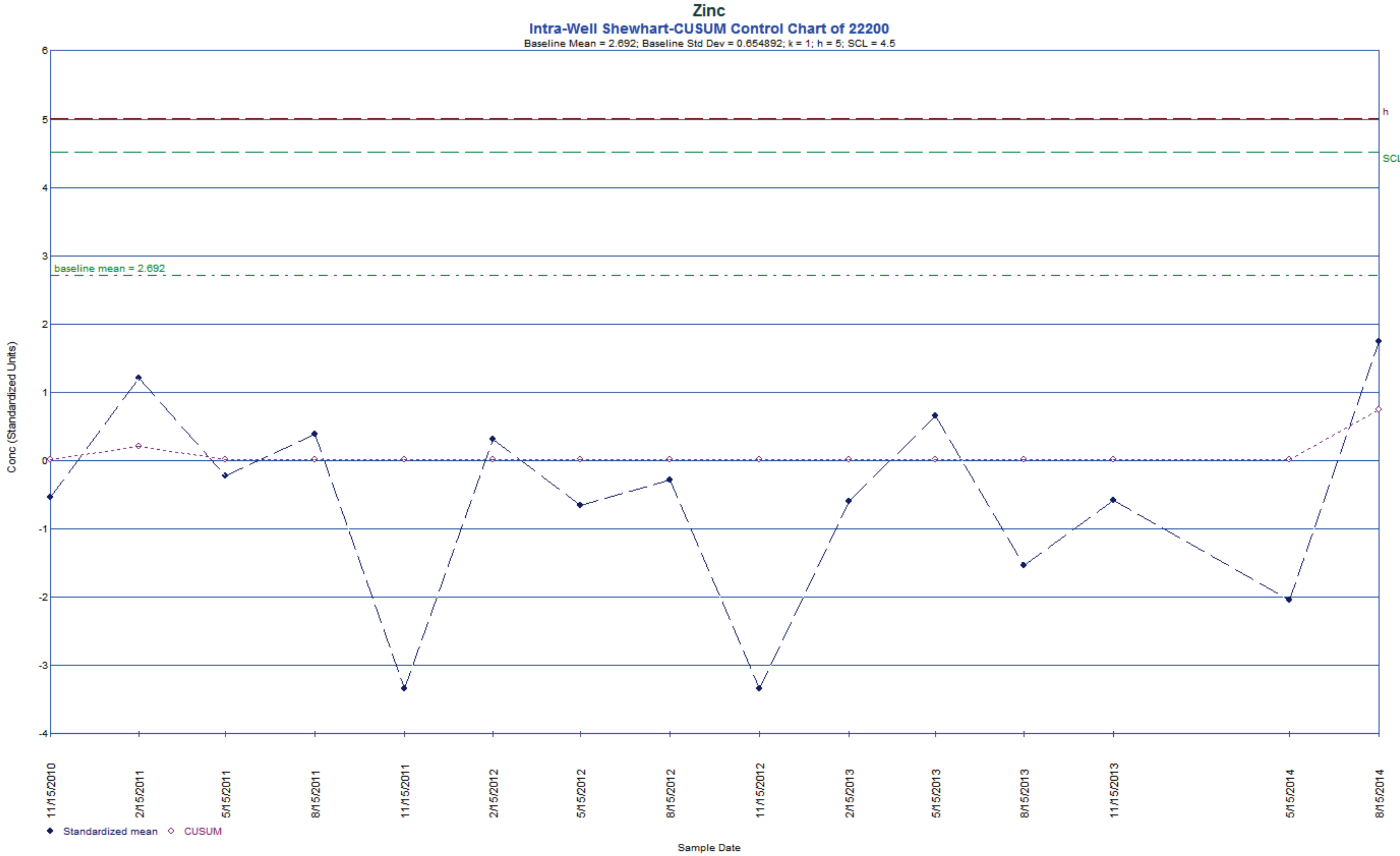


Figure A.5.2-43. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22200)

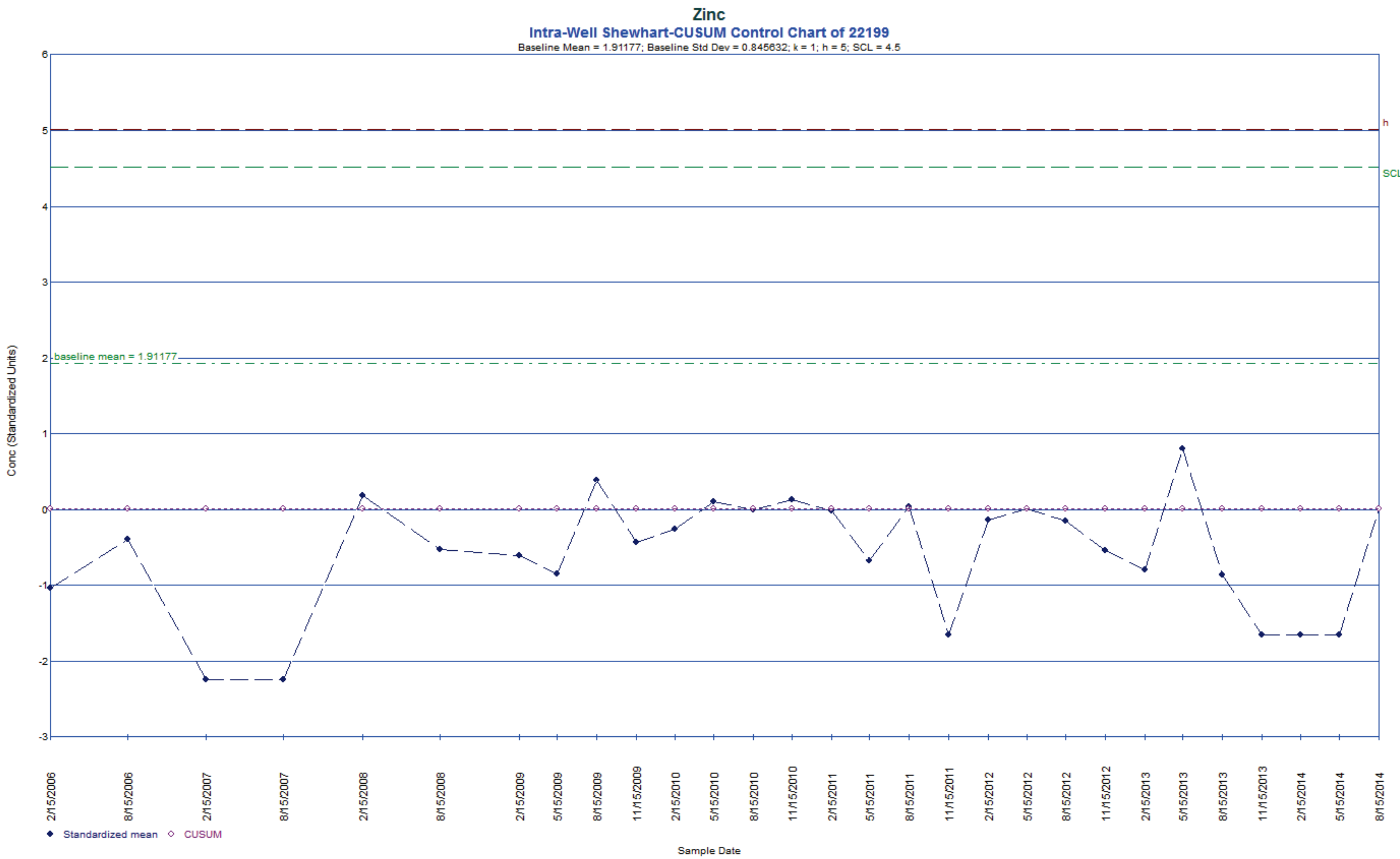


Figure A.5.2-44. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22199)

Sub-attachment A.5.3

Cell 3

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Contents

Tables

Figures

Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
PCB	polychlorinated biphenyl
SCL	Shewhart control limit
TOC	total organic carbon

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.3-1)
- Annual leachate collection system (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)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.3-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12340 water yield (refer to Figure A.5.3-3)
- Great Miami Aquifer (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 through A.5.3-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.3-30)
- Control charts (refer to Figures A.5.3-31 through A.5.3-47)

A.5.3.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. Summary statistics are provided in Table A.5.3-1.

Based on capacitance probe readings, the LDS tank of Cell 3 was dry during three quarters of 2014. It should be noted that the capacitance probes have the ability of measuring to within hundredths of a foot of water present in the bottom of the tank. So, while water may register via the probes, there may not be enough water present to physically obtain a sample. This was the case in 2014 for the LDS in Cell 3. Therefore, from a sampling ability, the LDS in Cell 3 was considered to be dry all year.

As shown in Table A.5.3-1, and summarized below, five parameters (uranium, total organic carbon [TOC], arsenic, boron, and sodium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 3

Parameter	HTW 12340	GMA-U[a] 22203	GMA-D[a] 22204
Total Uranium	Up	Up	Up
Total Organic Carbon		Up	Up
Arsenic			Up
Boron		Up	Up
Sodium		Up	

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

The (uranium-sodium) bivariate plot for the Cell 3 LCS, LDS, and HTW is provided in Figure A.5.3-30. 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, upward concentration trends measured beneath Cell 3 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

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 Shewhart-cumulative sum (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 "not in control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart control limit (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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.3-1 in gray shading, 11 parameters in the HTW and GMA wells of Cell 3 meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 17 control charts.

These 17 control charts are presented in Figures A.5.3-31 through A.5.3-47. All of the control charts for Cell 3 exhibit "in control" conditions.

Parameter	Monitoring Point[a]	Well Number	Assessment	Figure Number
Alkalinity	GMA-D	22204	In Control	A.5.3-31
Chloride	GMA-U	22203	In Control	A.5.3-32
Total Dissolved Solids	GMA-D	22204	In Control	A.5.3-33
Barium	GMA-U	22203	In Control	A.5.3-34
Barium	GMA-D	22204	In Control	A.5.3-35
Calcium	GMA-U	22203	In Control	A.5.3-36
Calcium	GMA-D	22204	In Control	A.5.3-37
Iron	GMA-U	22203	In Control	A.5.3-38
Lithium	GMA-U	22203	In Control	A.5.3-39
Magnesium	GMA-U	22203	In Control	A.5.3-40
Magnesium	GMA-D	22204	In Control	A.5.3-41
Manganese	GMA-U	22203	In Control	A.5.3-42
Manganese	GMA-D	22204	In Control	A.5.3-43
Potassium	GMA-U	22203	In Control	A.5.3-44
Potassium	GMA-D	22204	In Control	A.5.3-45
Zinc	GMA-U	22203	In Control	A.5.3-46
Zinc	GMA-D	22204	In Control	A.5.3-47

[a] 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 semiannually. No new Appendix I or polychlorinated biphenyl (PCB) parameters were detected in the LCS of Cell 3 in 2014.

A.5.3.4 Summary and Conclusions

- The LDS of Cell 3 has been dry since 2007.
- Five parameters monitored semiannually have an upward concentration trend in the HTW and/or GMA wells of Cell 3: uranium, TOC, arsenic, boron, 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. Therefore, upward concentration trends beneath Cell 3 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Seventeen control charts were constructed for Cell 3 parameters. All of the control charts exhibit "in control" conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 3 in 2014.

A.5.3.5 References

DOE (U.S. Department of Energy), 1994. *Fernald Environmental Management Project Fernald, Ohio Remedial Investigation and Feasibility Study*, May.

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12340C	58	58	100	9.35	113	69.7	27.9	Normal	Up	Detected	
	LDS	12340D	21	21	100	8.90	72.4	19.7	13.0	Normal	Down	Not Detected	
	HTW	12340	61	61	100	3.89	58.5	19.7	8.3	Undefined	Up	Detected	
	GMA-U	22203	60	63	95.2	ND	9.51	2.30	2.12	LogNormal	Up	Detected	
	GMA-D	22204	64	65	98.5	ND	22.9	6.18	5.17	LogNormal	Up	Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12340C	33	33	100	72.0	1080	483	179	Undefined	None	Detected	
	LDS	12340D	9	9	100	108	267	161	54	Normal	None	Not Detected	693(Q4-05)
	GMA-U	22203	14	14	100	360	451	396	22	Normal	Down	Not Detected	
	GMA-D	22204	14	14	100	356	381	369	9	Normal	None	Not Detected	269(Q1-12)
Chloride (mg/L)	LCS	12340C	33	33	100	4.70	70.5	41.1	15.5	Undefined	Up	Detected	
	LDS	12340D	9	9	100	54.1	74.2	61.8	6.5	Normal	None	Not Detected	
	GMA-U	22203	14	14	100	21.5	44.0	34.1	5.3	Normal	None	Not Detected	
	GMA-D	22204	14	14	100	19.0	22.3	20.5	0.9	Normal	Down	Detected	26.1(Q2-12)
Nitrate, Nitrite (mg/L)	LCS	12340C	29	40	72.5	ND	2.20	0.274	0.586	Undefined	None	Detected	
	LDS	12340D	6	9	66.7	ND	5.71	1.06	1.92	LogNormal	None	Not Detected	
	GMA-U	22203	3	14	21.4	ND	0.273	0.0085	Insufficient	Undefined	None	Not Detected	
	GMA-D	22204	1	14	7.1	ND	0.0425	Insufficient	Insufficient	Undefined	None	Not Detected	
Sulfate (mg/L)	LCS	12340C	50	50	100	26.1	2650	1780	560	Undefined	Up	Detected	
	LDS	12340D	19	19	100	112	2510	1250	700	Undefined	Down	Not Detected	
	HTW	12340	40	40	100	352	958	661	156	Normal	Down	Detected	
	GMA-U	22203	45	45	100	64.2	735	232	146	LogNormal	Down	Detected	4,020(Q3-12)
	GMA-D	22204	45	45	100	232	779	478	147	Normal	Down	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12340C	39	39	100	233	3570	3210	1140	Undefined	Up	Detected	
	LDS	12340D	0	0	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-U	22203	21	21	100	524	1190	614	167	Undefined	None	Not Detected	
	GMA-D	22204	21	21	100	724	1530	1060	210	LogNormal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12340C	45	57	79.0	ND	4.21	2.08	0.71	Normal	Up	Detected	17.4(Q4-99)
	LDS	12340D	17	21	81.0	ND	8.02	5.77	2.26	Undefined	None	Not Detected	
	GMA-U	22203	49	63	77.8	ND	2.90	1.65	0.53	Normal	Up	Not Detected	14.1(Q4-00), 5.66(Q1-00)
	GMA-D	22204	46	63	73.0	ND	2.92	1.53	0.52	Normal	Up	Detected	8.83(Q1-00)
Total Organic Halogens (mg/L)	LCS	12340C	25	58	43.1	ND	0.141	0.0125	0.487	Undefined	Down	Detected	
	LDS	12340D	10	21	47.6	ND	0.0838	0.0251	0.0187	LogNormal	None	Not Detected	
	GMA-U	22203	29	63	46.0	ND	0.213	0.00610	0.0278	Undefined	None	Detected	
	GMA-D	22204	13	63	20.6	ND	0.165	0.00364	0.0208	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12340C	9	38	23.7	ND	0.131	0.00250	0.0261	Undefined	None	Detected	
	LDS	12340D	1	9	11.1	ND	0.00850	Insufficient	Insufficient	Undefined	None	Not Detected	
	HTW	12340	4	30	13.3	ND	0.0250	0.00250	0.00528	Undefined	None	Not Detected	
	GMA-U	22203	4	21	19.0	ND	0.0372	0.00250	0.00838	Undefined	None	Not Detected	
	GMA-D	22204	7	35	20.0	ND	0.0382	0.00250	0.00932	Undefined	Up	Detected	
Barium (mg/L)	LCS	12340C	33	33	100	0.0276	0.118	0.0358	0.0181	Undefined	Down	Detected	
	LDS	12340D	9	9	100	0.0135	0.0386	0.0197	0.0078	LogNormal	None	Not Detected	
	GMA-U	22203	14	14	100	0.0638	0.141	0.0994	0.0231	Normal	None	Not Detected	
	GMA-D	22204	14	14	100	0.0327	0.0592	0.0419	0.0079	Normal	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Boron (mg/L)	LCS	12340C	58	59	98.3	ND	9.19	4.50	2.00	Undefined	Up	Detected	
	LDS	12340D	20	21	95.2	ND	0.557	0.128	0.149	Undefined	Down	Detected	
	GMA-U	22203	52	63	82.5	ND	0.0870	0.0460	0.0163	Normal	Up	Detected	
	GMA-D	22204	55	63	87.3	ND	0.0887	0.0460	0.0164	Normal	None	Detected	
Calcium (mg/L)	LCS	12340C	33	33	100	50.3	1200	616	213	Undefined	Up	Detected	
	LDS	12340D	9	9	100	121	363	199	71	Normal	None	Not Detected	
	GMA-U	22203	14	14	100	135	264	174	39	LogNormal	None	Not Detected	
	GMA-D	22204	14	14	100	179	365	262	57	Normal	None	Not Detected	
Chromium (mg/L)	LCS	12340C	9	27	33.3	ND	0.00654	0.00130	0.00190	Undefined	None	Not Detected	
	LDS	12340D	2	9	22.2	ND	0.00280	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22203	1	6	16.7	ND	0.00295	Insufficient	Insufficient	LogNormal	None	Not Detected	
	GMA-D	22204	0	6	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Cobalt (mg/L)	LCS	12340C	20	38	52.6	ND	0.0666	0.00104	0.0169	Undefined	None	Detected	
	LDS	12340D	8	9	88.9	ND	0.00110	0.000710	0.000260	Normal	None	Not Detected	
	GMA-U	22203	1	21	4.8	ND	0.00130	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22204	5	21	23.8	ND	0.00176	0.000500	0.000446	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12340C	23	34	67.6	ND	0.0311	0.00548	0.00686	Undefined	None	Not Detected	
	LDS	12340D	6	9	66.7	ND	0.0160	0.00810	0.00490	Normal	None	Not Detected	
	GMA-U	22203	9	14	64.3	ND	0.0102	0.00209	0.00327	Undefined	Down	Not Detected	
	GMA-D	22204	7	14	50.0	ND	0.0119	0.00191	0.00370	Undefined	Down	Not Detected	
Iron (mg/L)	LCS	12340C	36	38	94.7	ND	16.6	0.716	3.44	Undefined	Down	Detected	
	LDS	12340D	8	9	88.9	ND	2.14	1.22	0.53	Normal	None	Not Detected	
	GMA-U	22203	21	21	100	2.85	33.2	9.59	7.10	LogNormal	None	Not Detected	
	GMA-D	22204	21	21	100	3.15	11.3	5.14	2.02	LogNormal	Down	Not Detected	
Lithium (mg/L)	LCS	12340C	30	30	100	0.683	1.02	0.790	0.091	Undefined	None	Detected	
	LDS	12340D	9	9	100	0.0313	0.0645	0.0427	0.0106	Normal	Down	Not Detected	
	GMA-U	22203	21	21	100	0.00577	0.0159	0.00849	0.00249	LogNormal	None	Not Detected	
	GMA-D	22204	21	21	100	0.00694	0.0102	0.00815	0.00104	Undefined	None	Not Detected	
Magnesium (mg/L)	LCS	12340C	33	33	100	10.2	380	208	80	Undefined	Up	Detected	
	LDS	12340D	9	9	100	87.2	138	110	15	Normal	None	Not Detected	
	GMA-U	22203	14	14	100	32.5	58.1	42.0	7.0	Normal	None	Not Detected	
	GMA-D	22204	14	14	100	40.4	66.6	52.4	8.5	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12340C	37	38	97.4	ND	7.27	0.160	2.50	Undefined	None	Detected	
	LDS	12340D	8	9	88.9	ND	0.146	0.0256	0.0463	LogNormal	None	Not Detected	
	GMA-U	22203	23	23	100	0.178	0.708	0.379	0.152	LogNormal	None	Not Detected	
	GMA-D	22204	34	35	97.1	ND	3.01	1.38	0.49	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12340C	38	38	100	0.00210	0.102	0.00884	0.0331	Undefined	Down	Detected	
	LDS	12340D	9	9	100	0.00340	0.00970	0.00620	0.00190	Normal	None	Not Detected	
	GMA-U	22203	3	21	14.3	ND	0.00668	0.000750	Insufficient	Undefined	None	Detected	
	GMA-D	22204	12	35	34.3	ND	0.0127	0.000750	0.00276	Undefined	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Potassium (mg/L)	LCS	12340C	33	33	100	0.575	35.0	28.5	9.7	Undefined	Up	Detected	
	LDS	12340D	9	9	100	9.47	15.7	11.8	1.8	Normal	None	Not Detected	
	GMA-U	22203	14	14	100	2.12	3.50	2.72	0.41	Normal	None	Not Detected	
	GMA-D	22204	14	14	100	1.82	3.07	2.46	0.38	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12340C	8	38	21.0	ND	0.0392	0.00609	0.00691	LogNormal	Up	Not Detected	
	LDS	12340D	0	9	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-U	22203	1	21	4.8	ND	0.00617	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22204	0	21	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sodium (mg/L)	LCS	12340C	38	38	100	4.35	49.9	26.9	8.8	Undefined	Up	Detected	
	LDS	12340D	9	9	100	263	344	315	27	Normal	None	Not Detected	
	HTW	12340	30	30	100	27.1	74.1	39.3	14.9	Undefined	Down	Detected	
	GMA-U	22203	21	21	100	18.5	30.7	23.1	3.6	Normal	Up	Detected	
	GMA-D	22204	21	21	100	11.8	20.5	16.0	2.5	Normal	Down	Detected	
Zinc (mg/L)	LCS	12340C	25	38	65.8	ND	0.0668	0.0178	0.0128	LogNormal	None	Not Detected	
	LDS	12340D	8	9	88.9	ND	0.499	0.161	0.175	LogNormal	None	Not Detected	
	GMA-U	22203	13	21	61.9	ND	0.0130	0.00651	0.00376	Normal	None	Not Detected	
	GMA-D	22204	27	35	77.1	ND	0.0405	0.0100	0.0082	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least eight samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched
General Chemistry											
Ammonia (mg/L)	17	6	35.3	Yes	0.0242	0.274	0.110	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	17	1	5.9	No	0.000200	-	-	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	17	3	17.6	No	0.000065	0.000440	0.000200	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Lead (mg/L)	17	2	11.8	No	0.00146	0.0266	0.0140	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(1)	0.0114 mg/L(1)
Thallium (mg/L)	17	1	5.9	No	0.00210	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	17	3	17.6	No	0.00340	0.00959	0.00560	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)	27	3	11.1	Yes	3.84	12.4	8.71	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	0.790	0.570	280 ug/L(0)	-	-	-
1,1-Dichloroethene (ug/L)	34	10	29.4	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	25	1	4.0	No	2.94	-	-	-	-	-	-
Bromodichloromethane (ug/L)	26	1	3.8	No	0.5	-	-	100 ug/L(0)	-	-	-
Chlorodibromomethane (ug/L)	11	1	9.1	No	1.0	-	-	-	-	-	-
Trans-1,3-dichloropropene (ug/L)	10	1	10.0	No	1.0	-	-	-	-	-	-
Vinyl chloride (ug/L)	26	2	7.7	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, perched water background, or perched water 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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

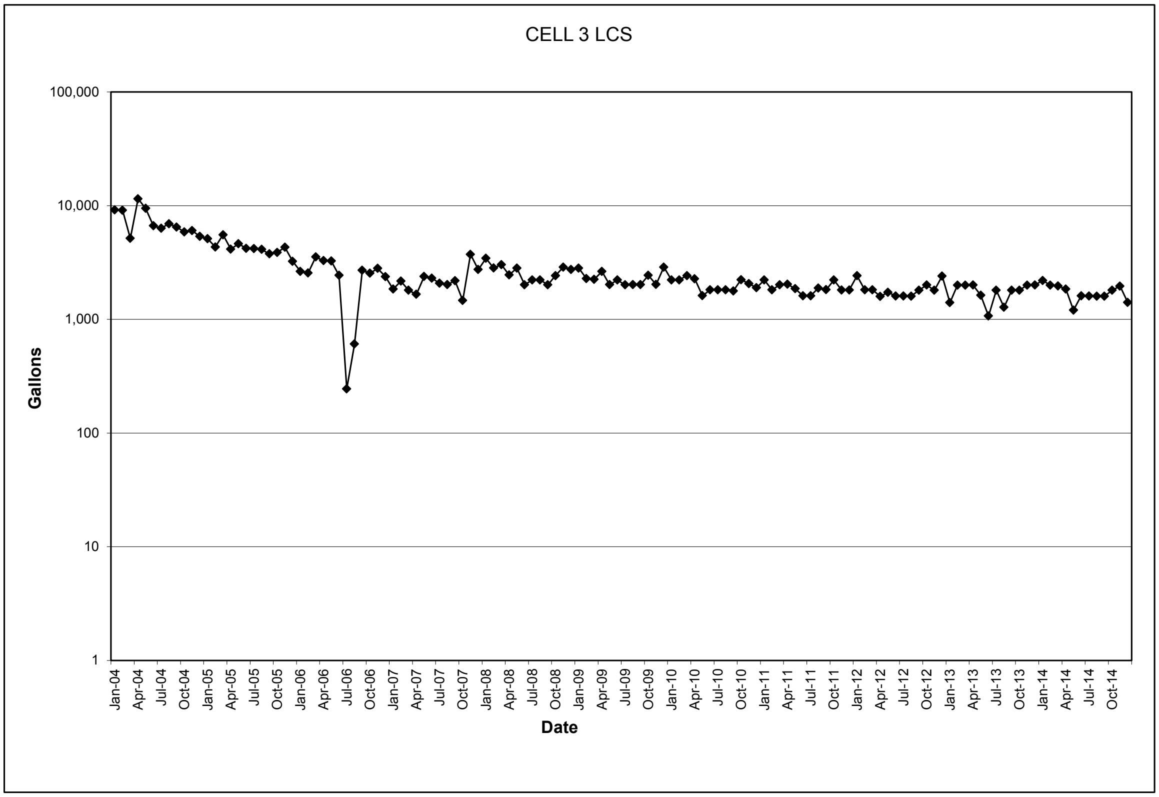


Figure A.5.3-1. Monthly Accumulation Volumes for Cell 3 LCS

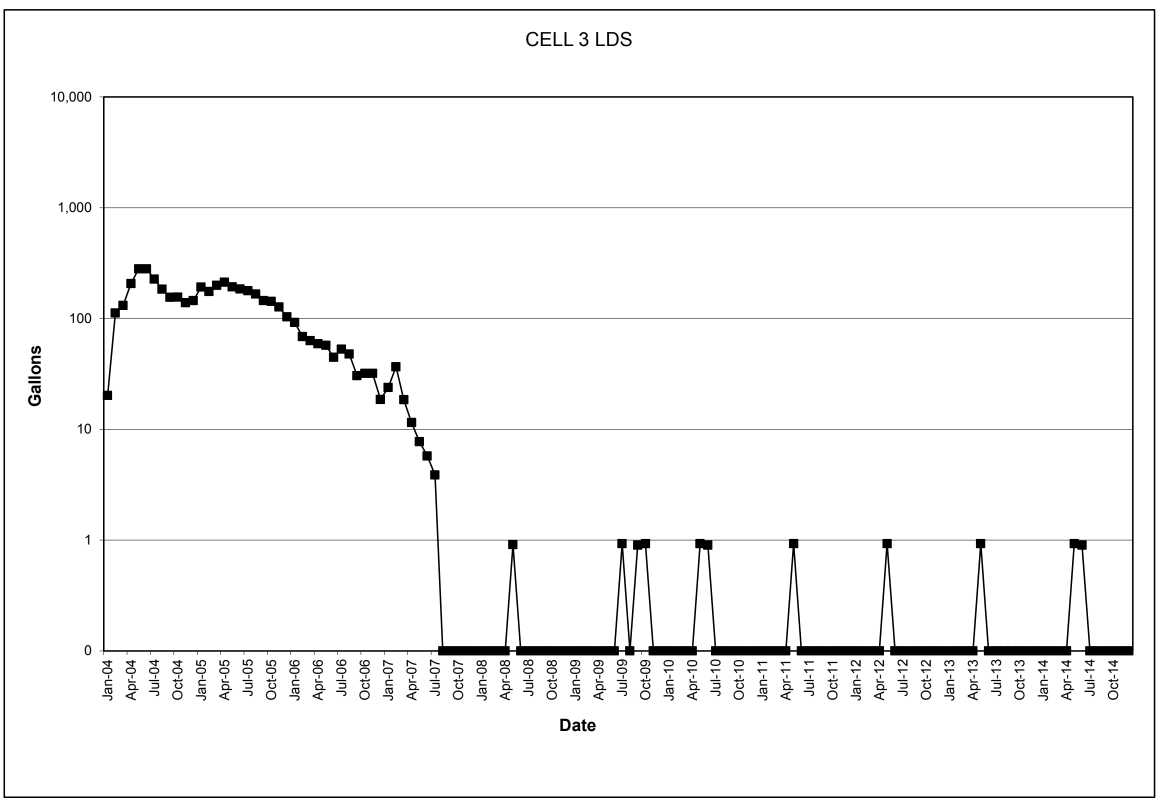
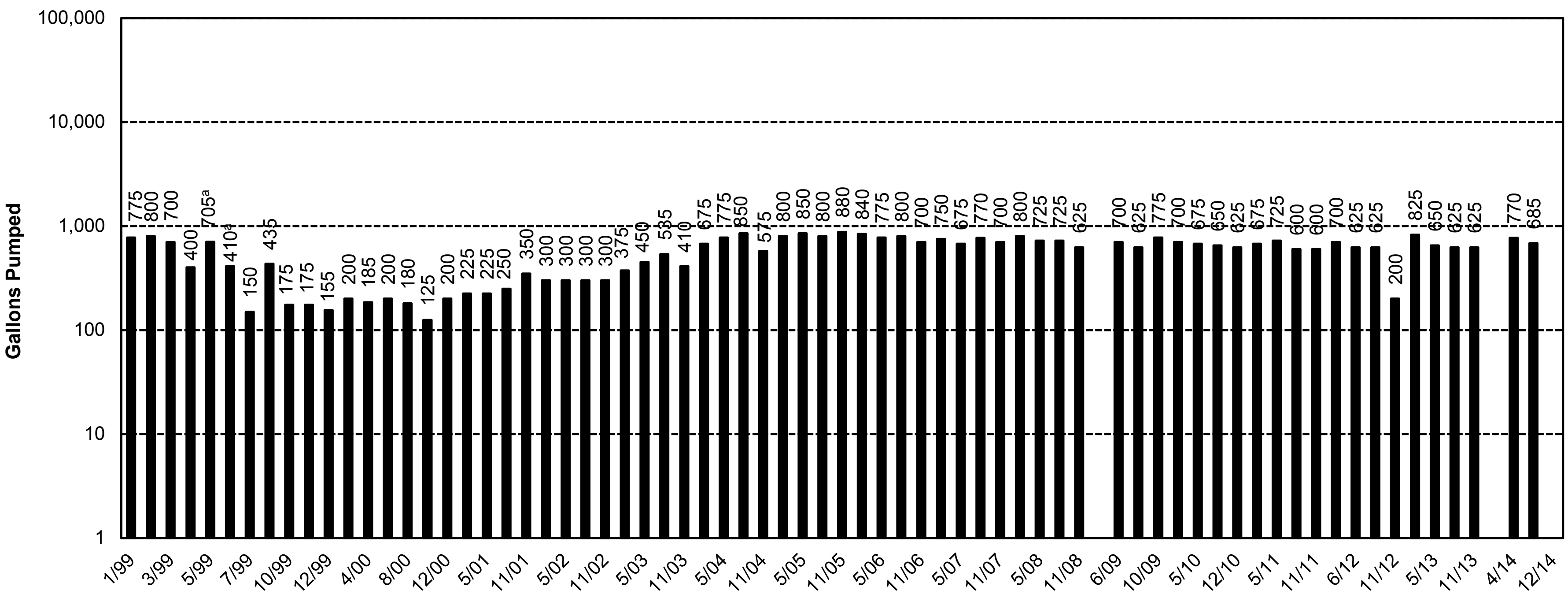


Figure A.5.3-2. Monthly Accumulation Volumes for Cell 3 LDS



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
2012:	2150	n=4	538
2013:	2725	n=4	681
2014[b]:	1455	n=2	728
Overall:			554

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

[b]Sampling schedule reduced to semi-annual sampling in 2014.

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

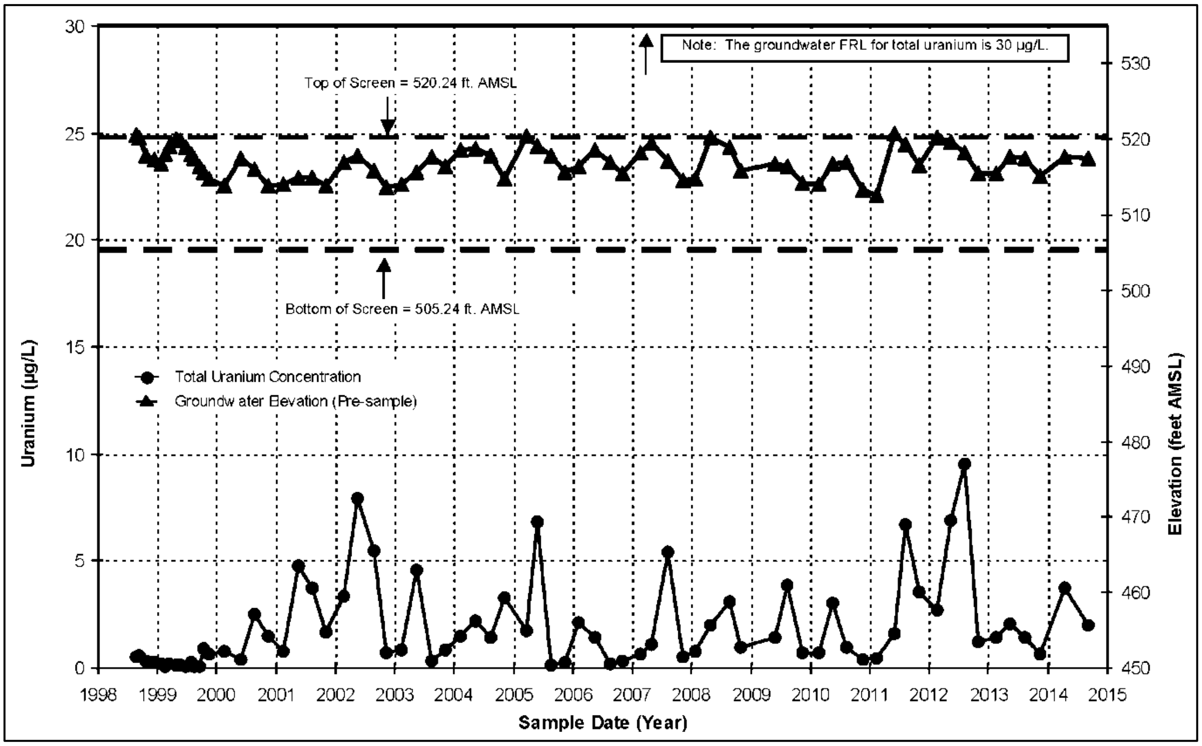


Figure A.5.3-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 3 Upgradient Monitoring Well 22203

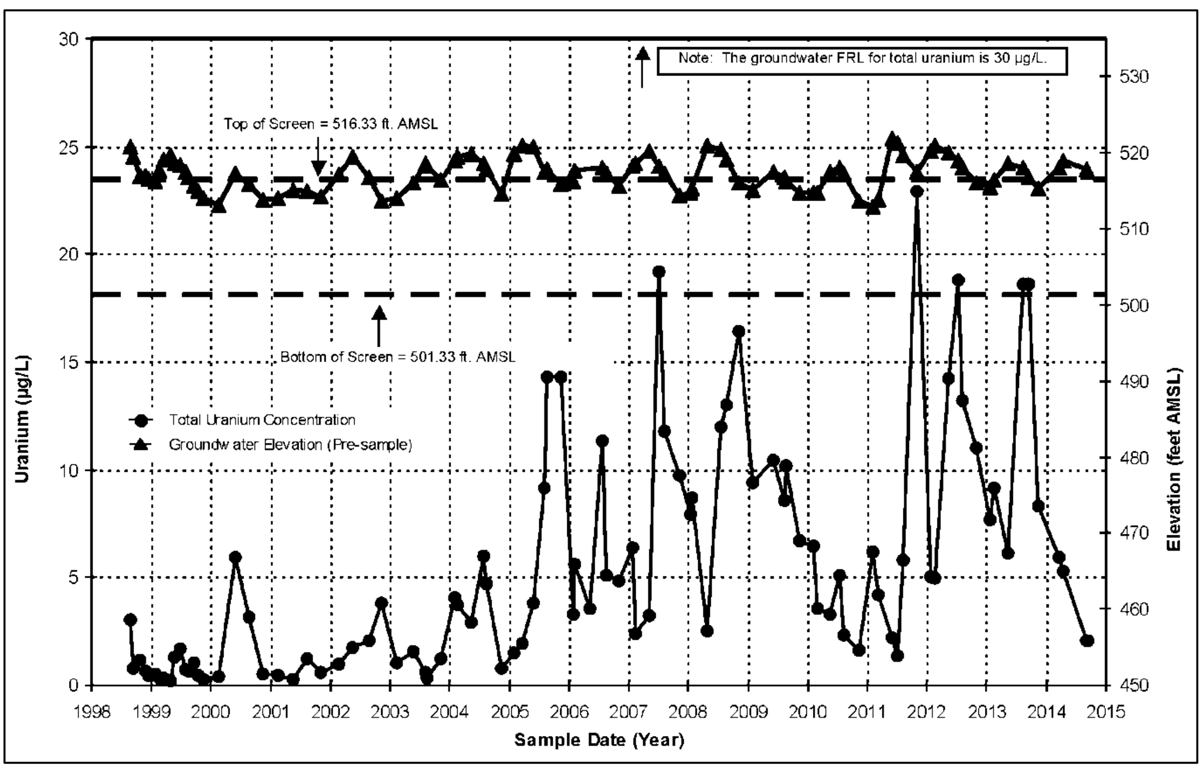


Figure A.5.3-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 3 Downgradient Monitoring Well 22204

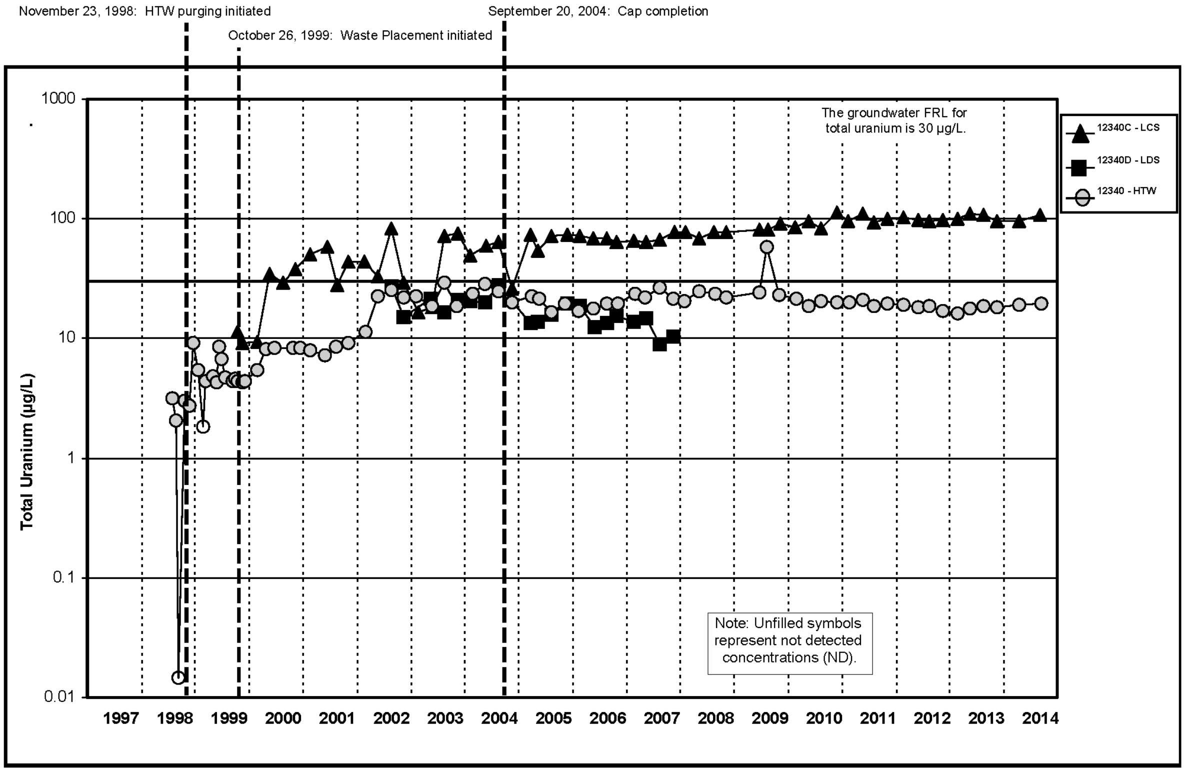


Figure A.5.3-6A. Cell 3 Uranium, Total Concentration Versus Time Plot for LCS, LDS, and HTW

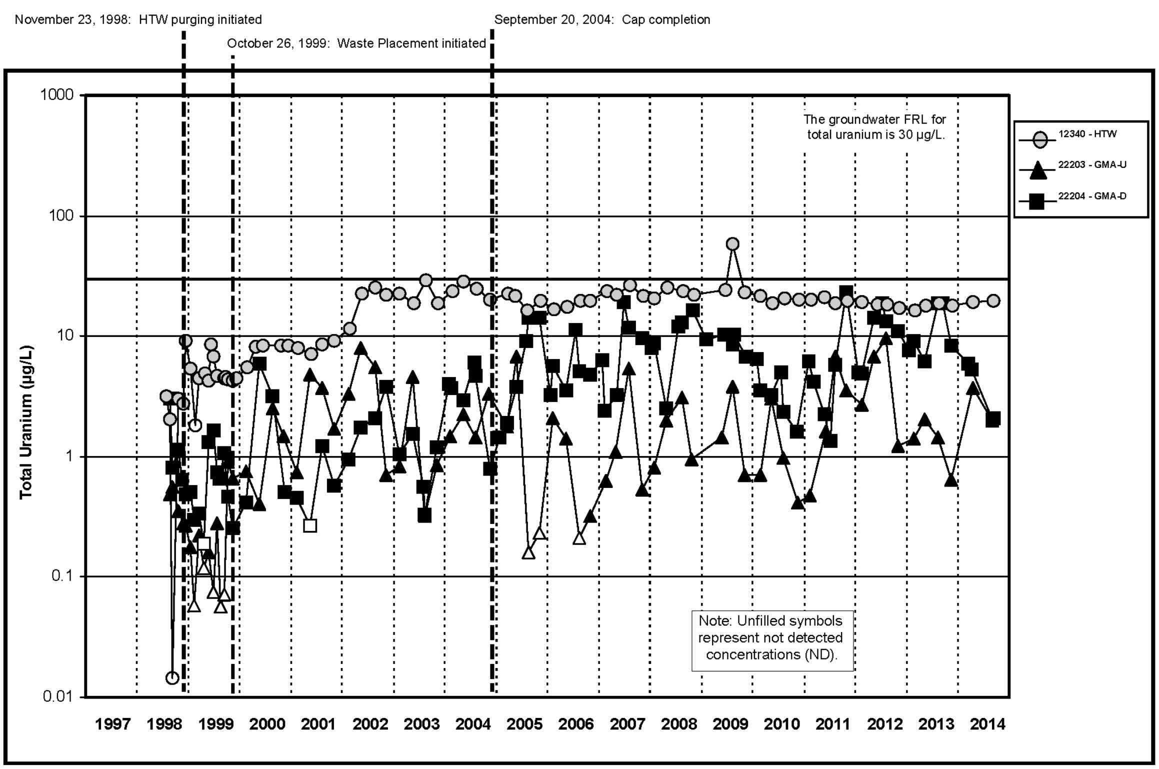


Figure A.5.3-6B. Cell 3 Uranium, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

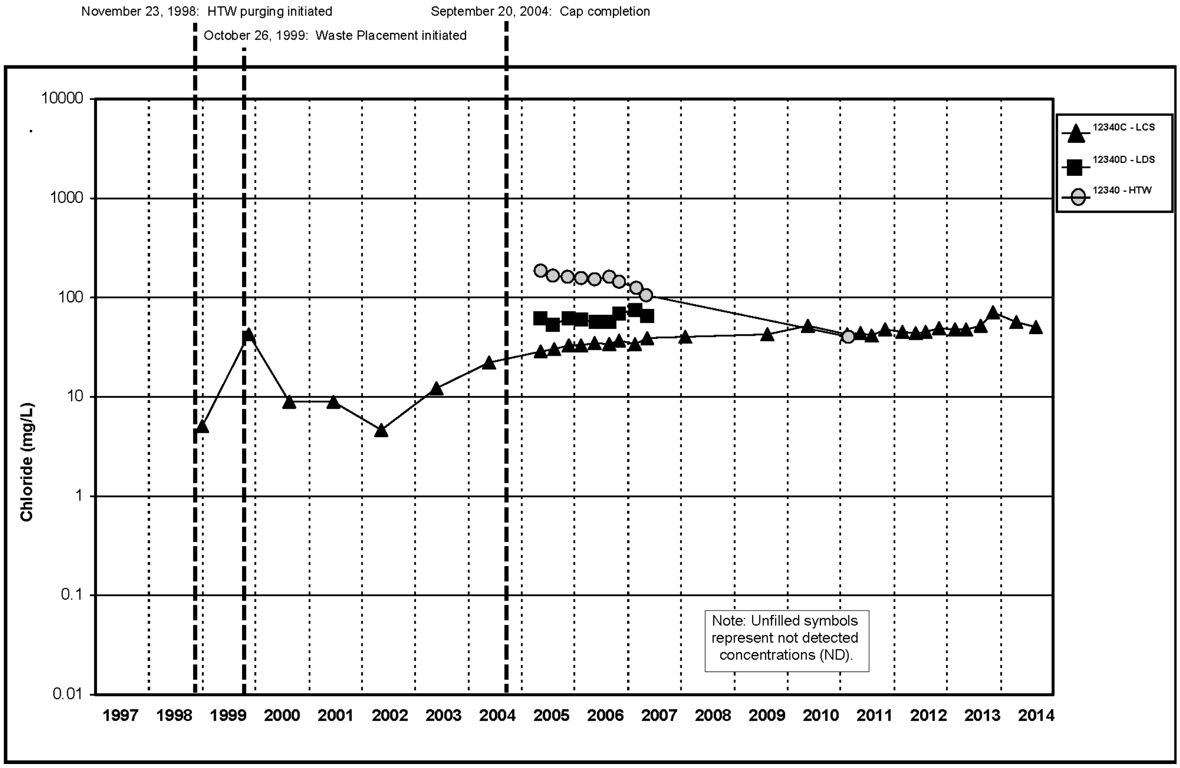


Figure A.5.3-7A. Cell 3 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

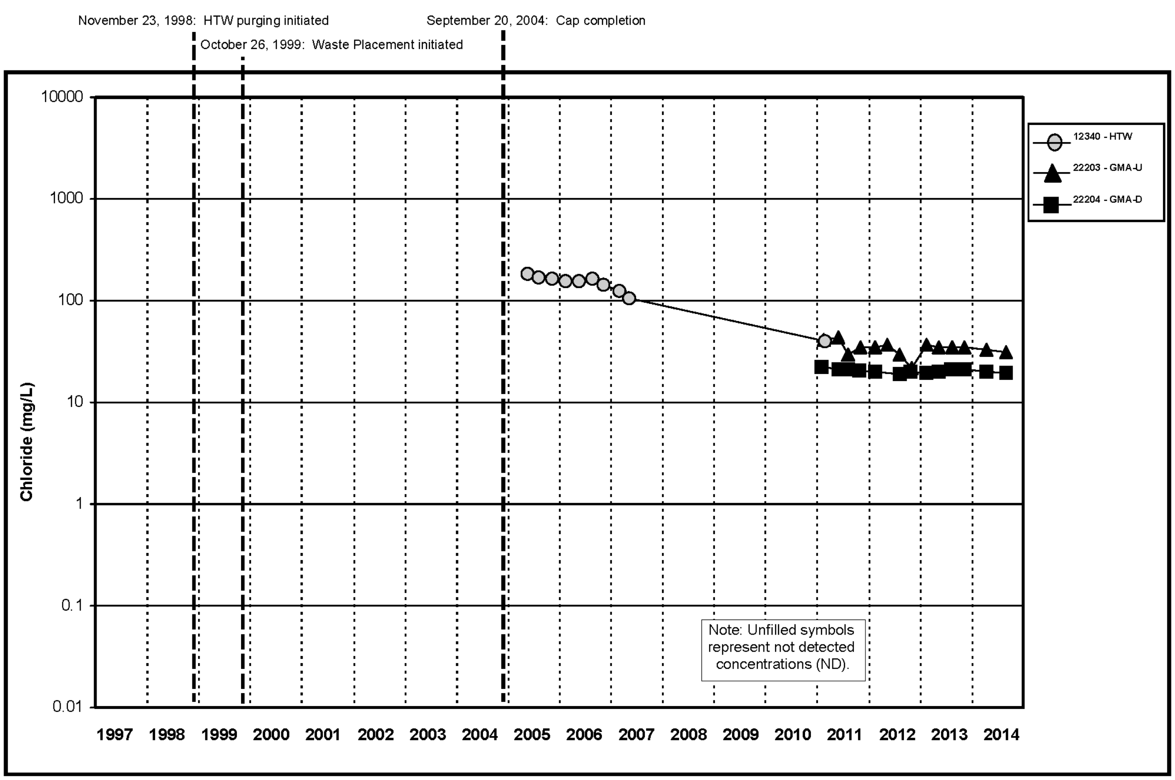


Figure A.5.3-7B. Cell 3 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

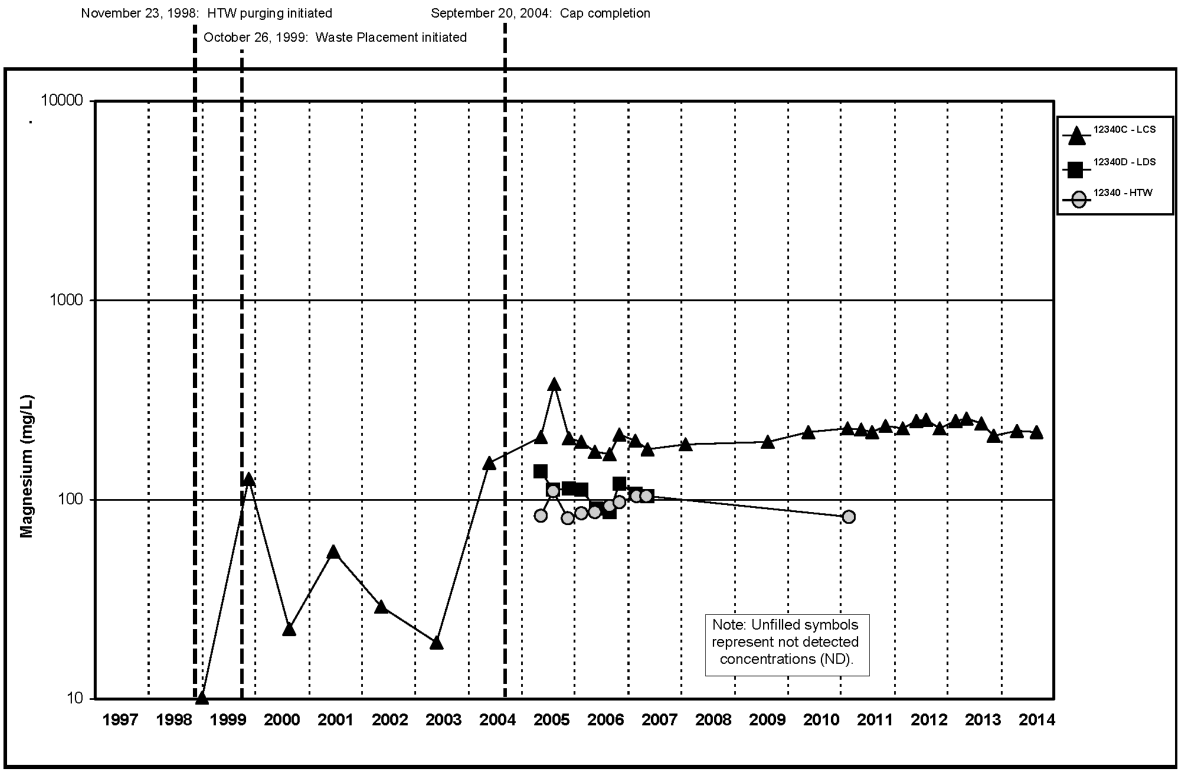


Figure A.5.3-8A. Cell 3 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

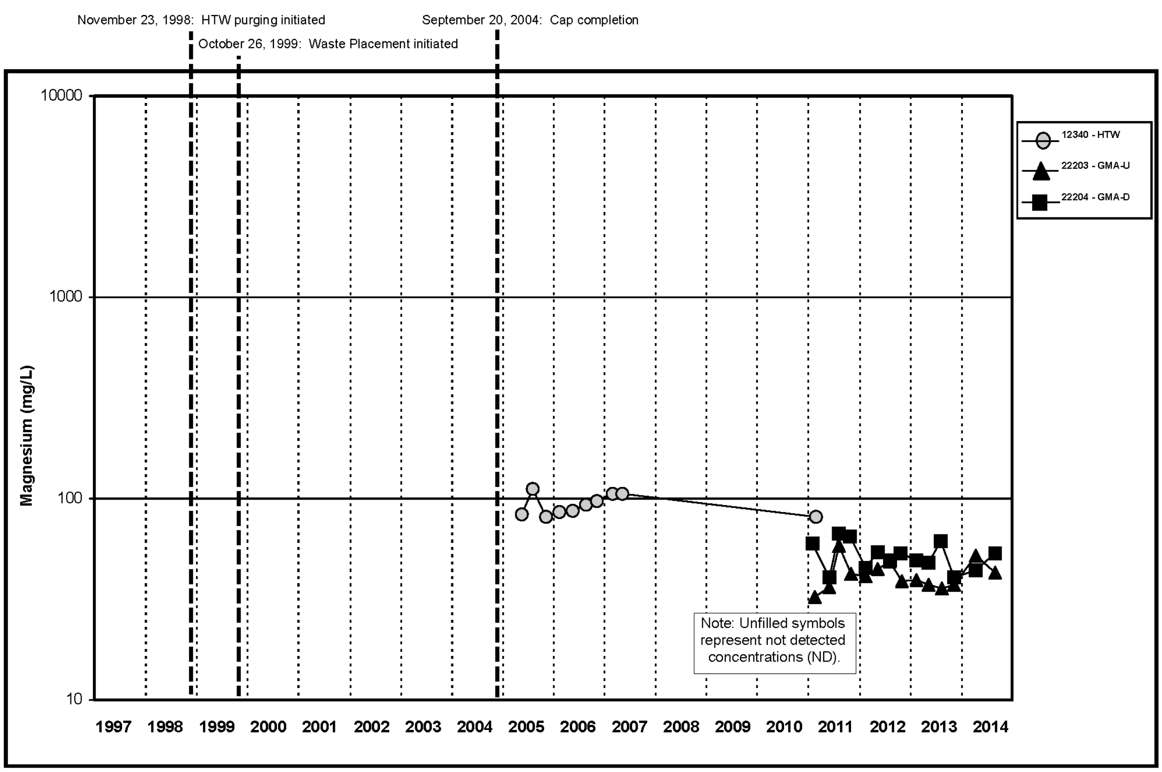


Figure A.5.3-8B. Cell 3 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

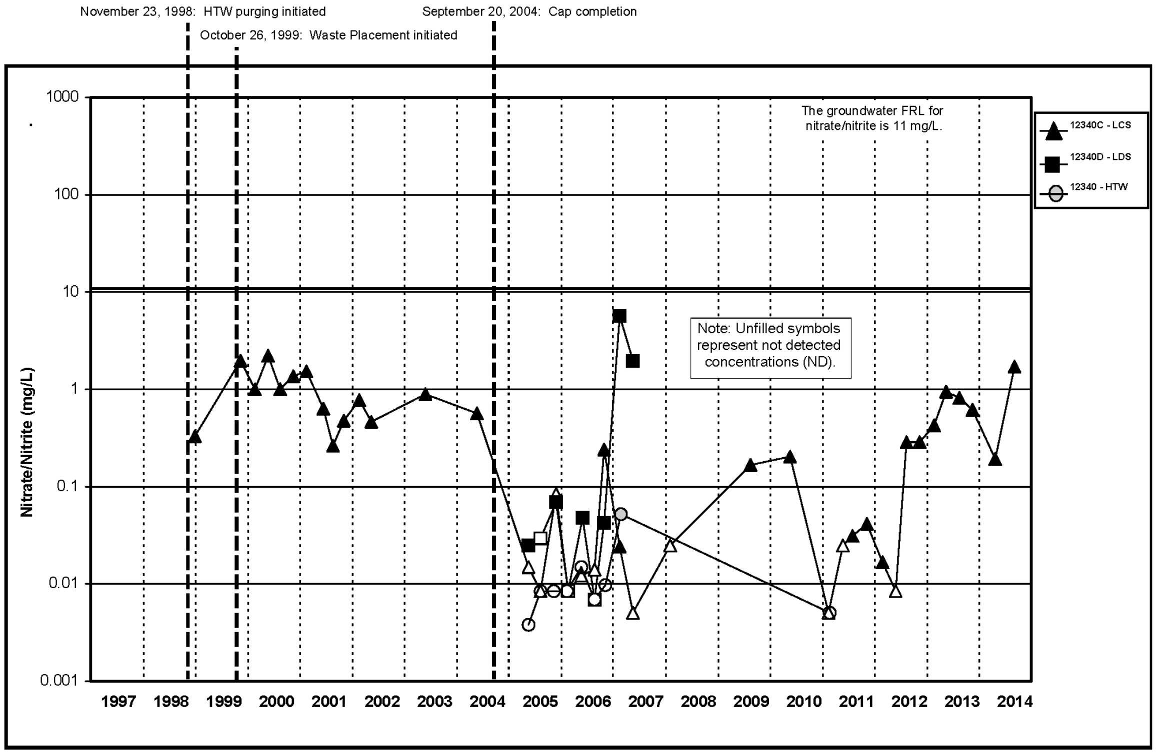


Figure A.5.3-9A. Cell 3 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

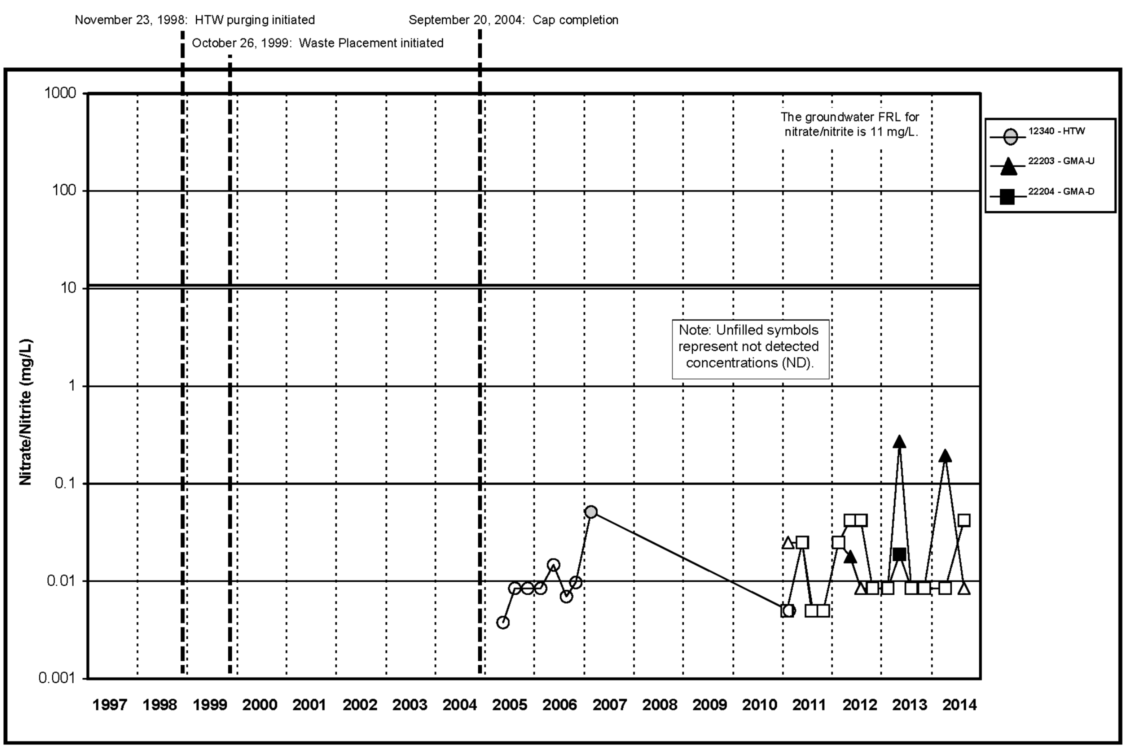


Figure A.5.3-9B. Cell 3 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW GMA-U Well, and GMA-D Well

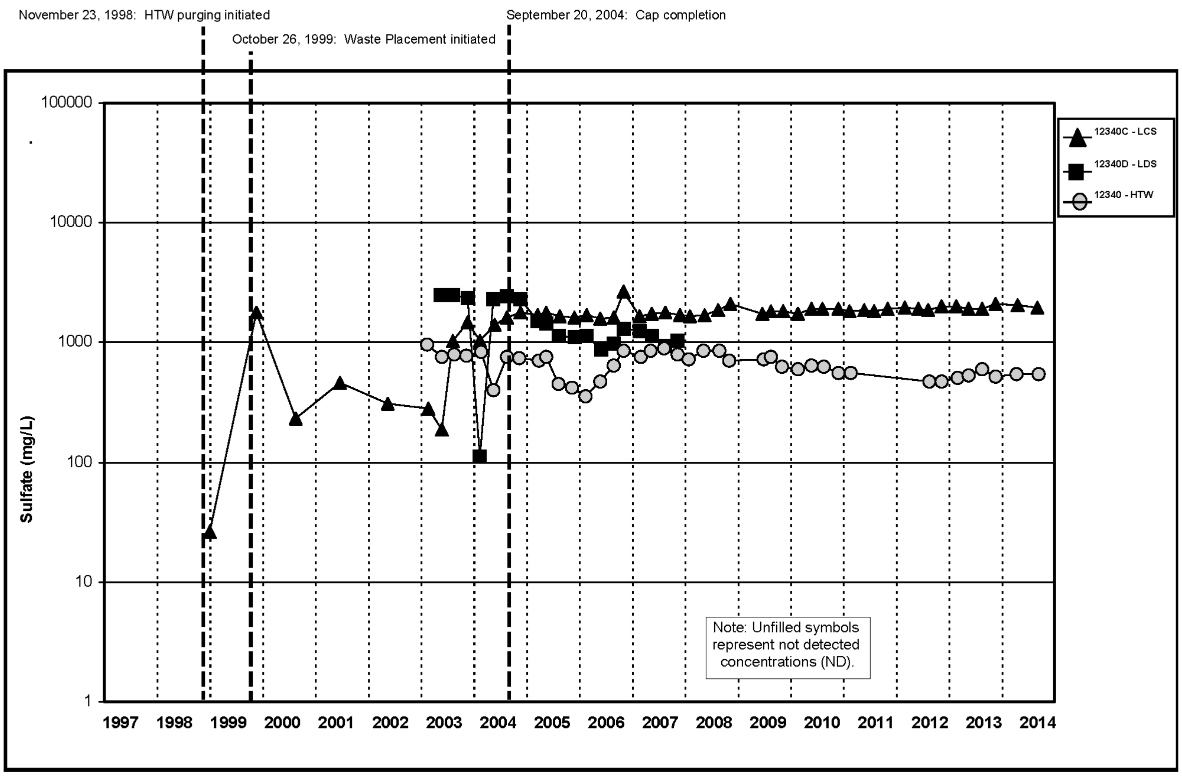


Figure A.5.3-10A. Cell 3 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

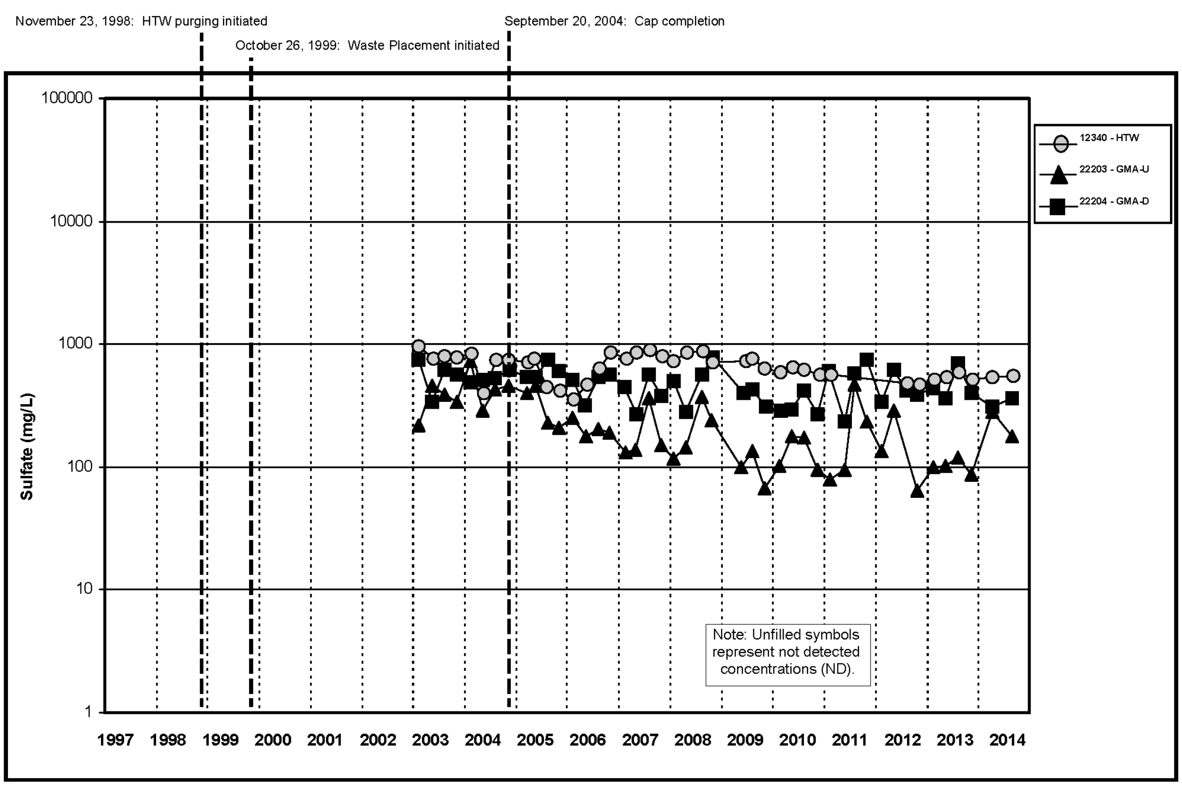


Figure A.5.3-10B. Cell 3 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

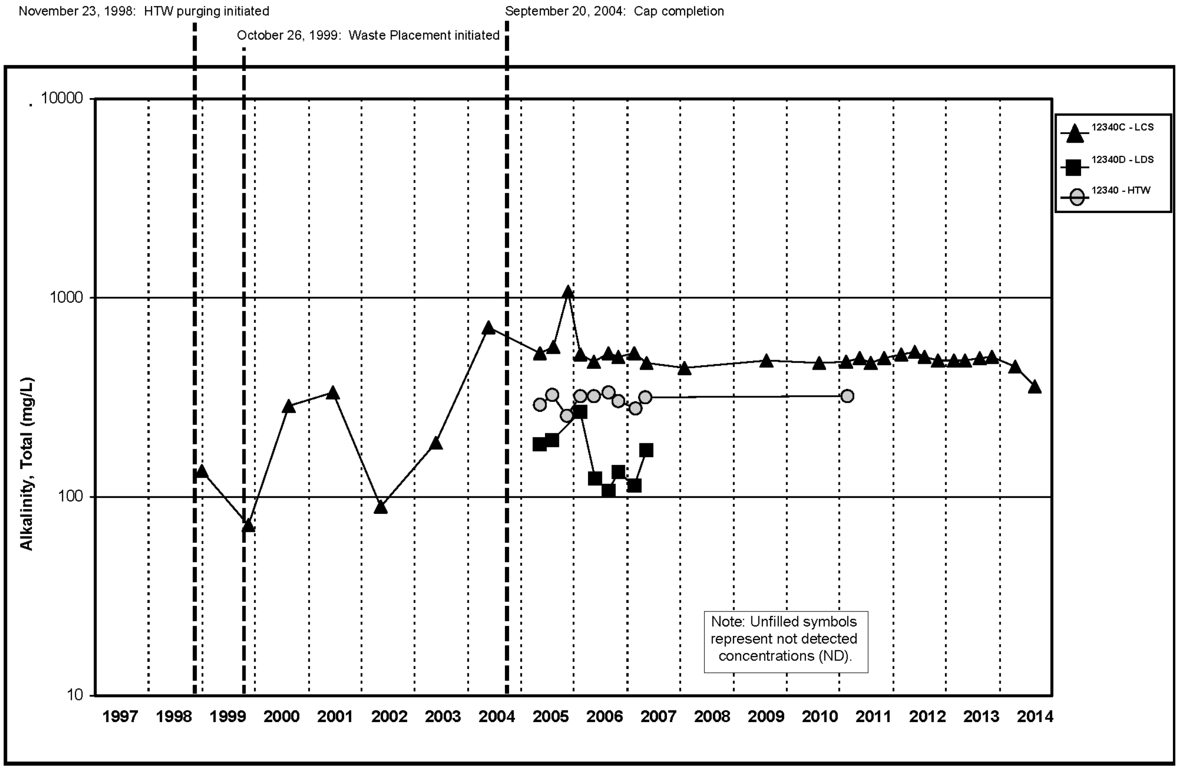


Figure A.5.3-11A. Cell 3 Alkalinity, Total Concentration Versus Time Plot for LCS, LDS, and HTW

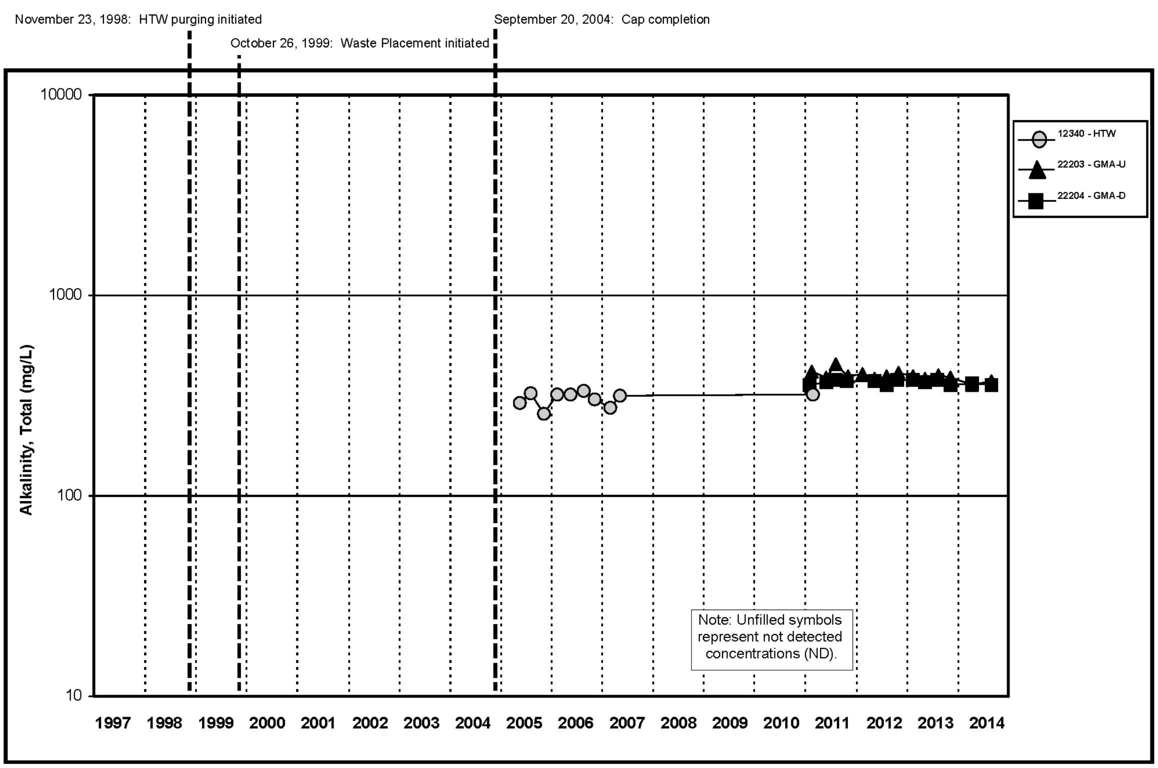


Figure A.5.3-11B. Cell 3 Alkalinity, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

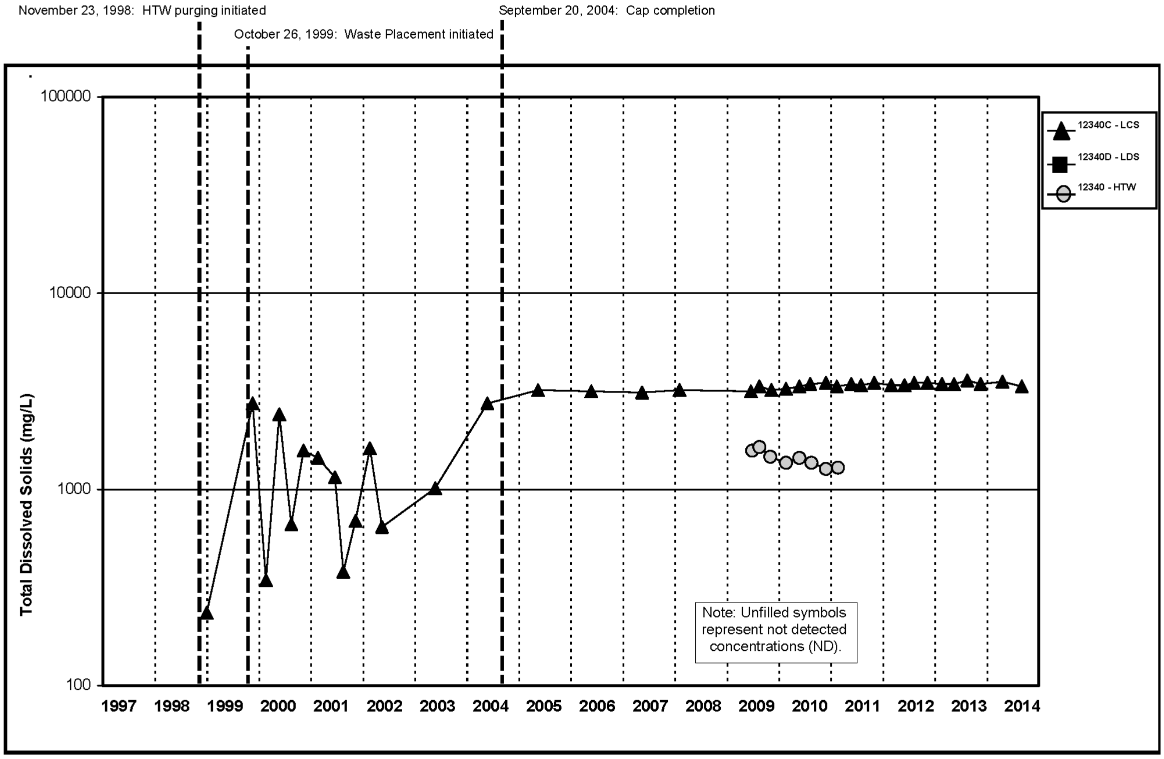


Figure A.5.3-12A. Cell 3 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

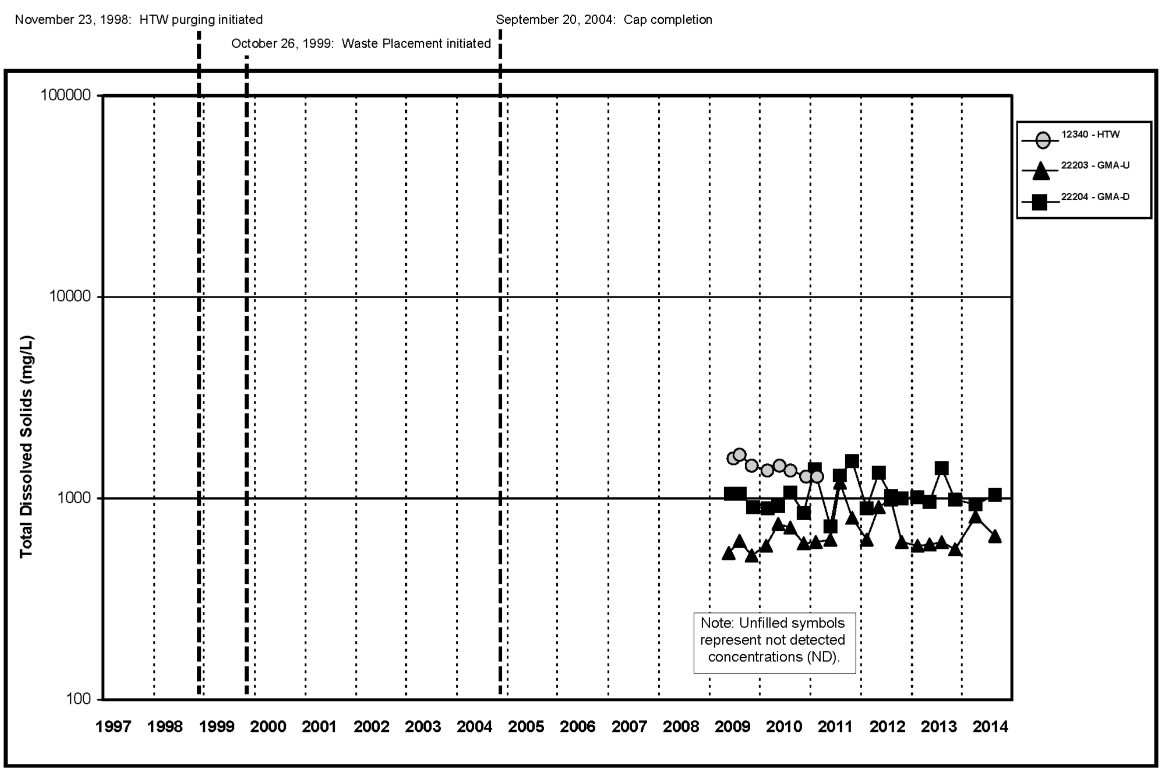


Figure A.5.3-12B. Cell 3 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

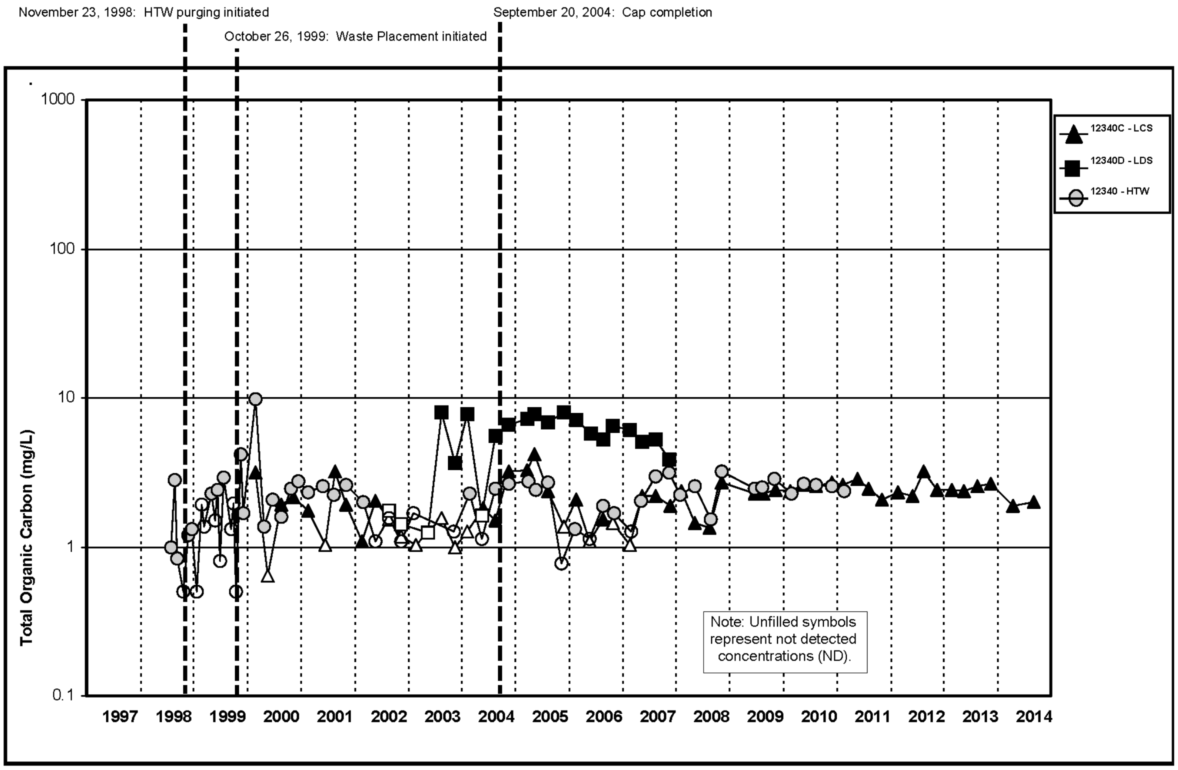


Figure A.5.3-13A. Cell 3 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

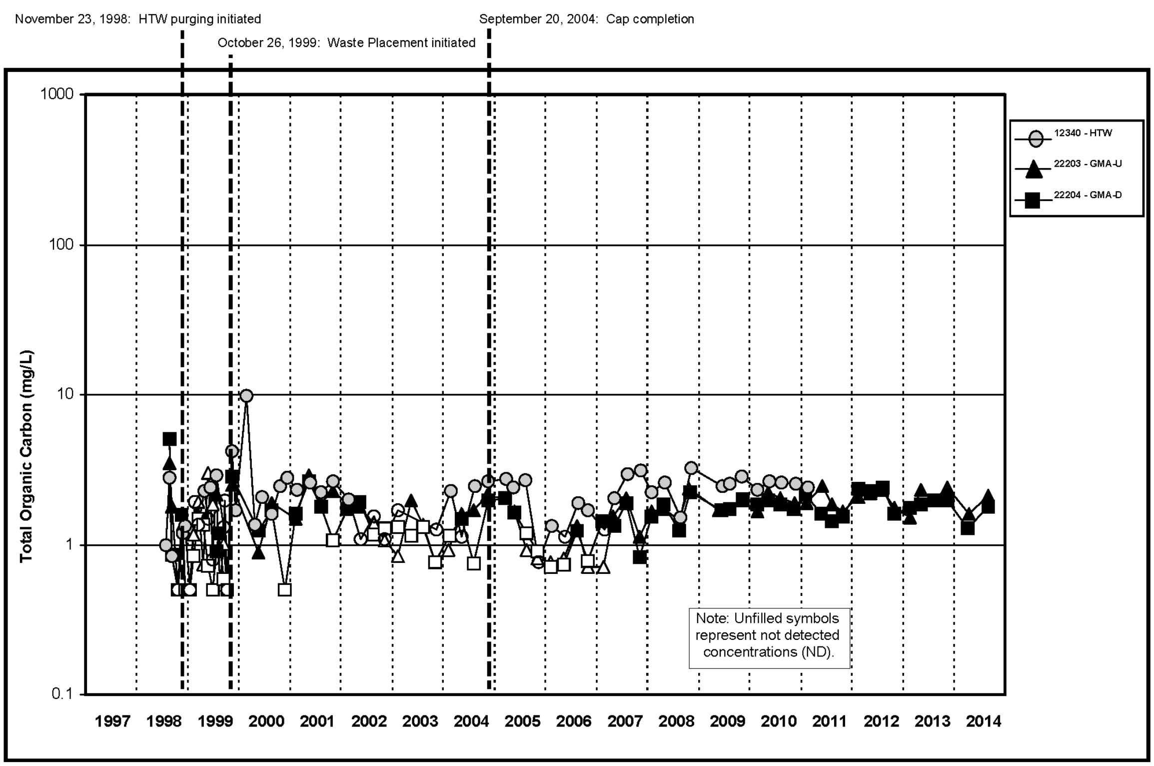


Figure A.5.3-13B. Cell 3 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

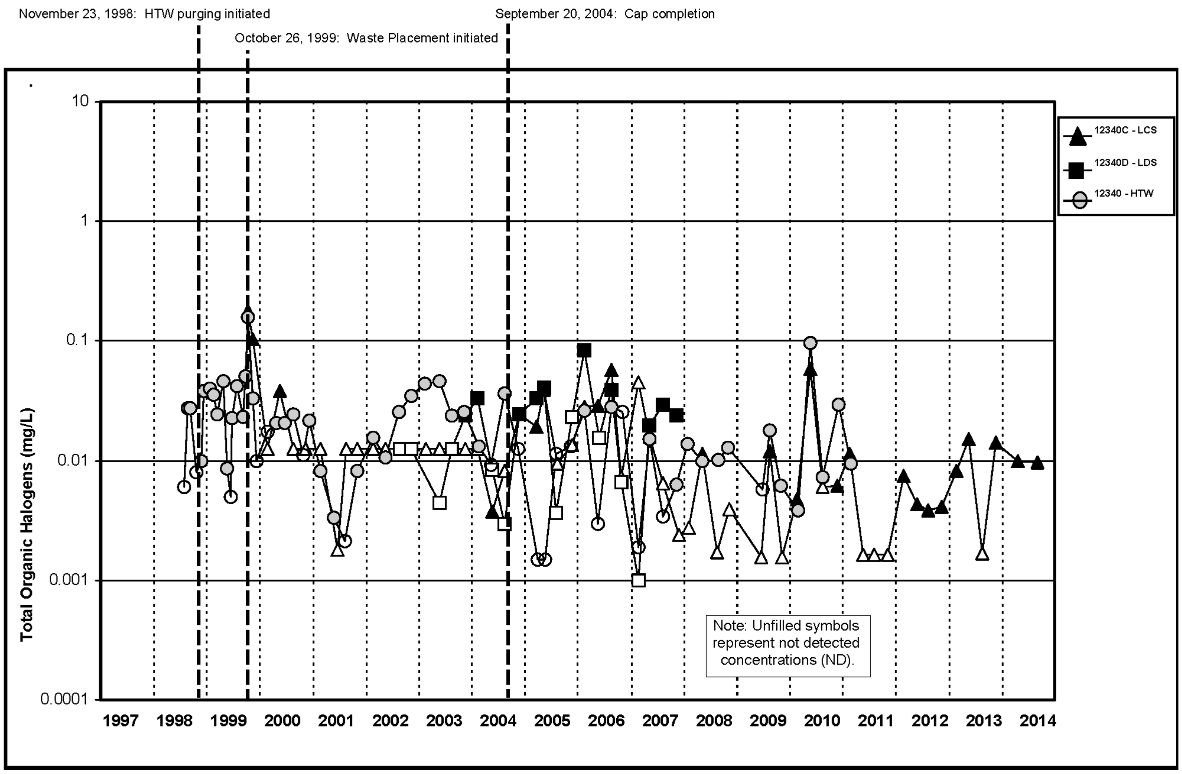


Figure A.5.3-14A. Cell 3 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

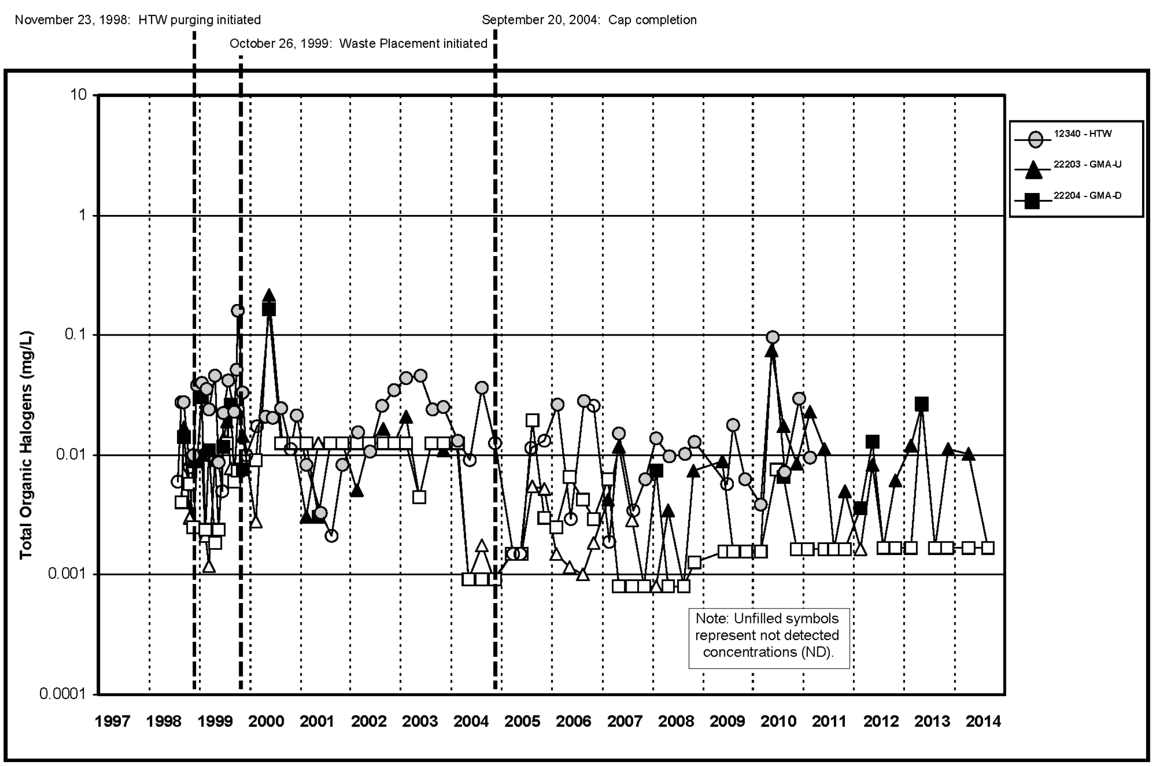


Figure A.5.3-14B. Cell 3 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

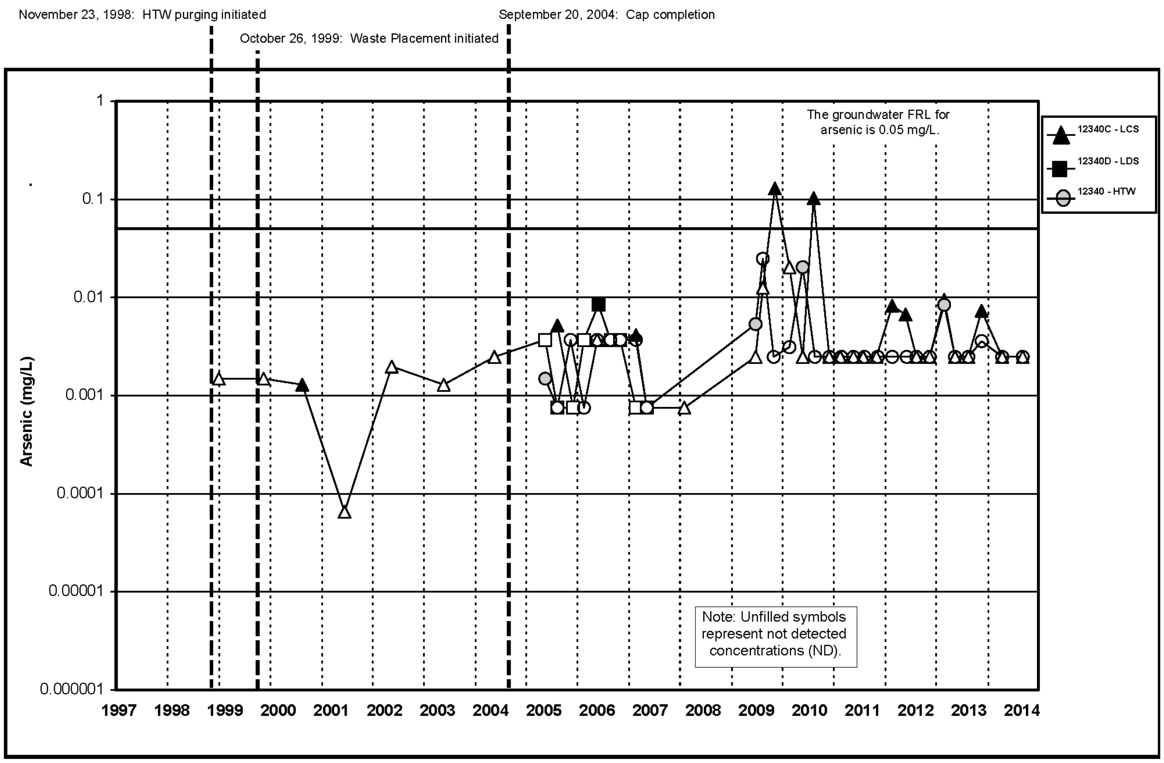


Figure A.5.3-15A. Cell 3 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

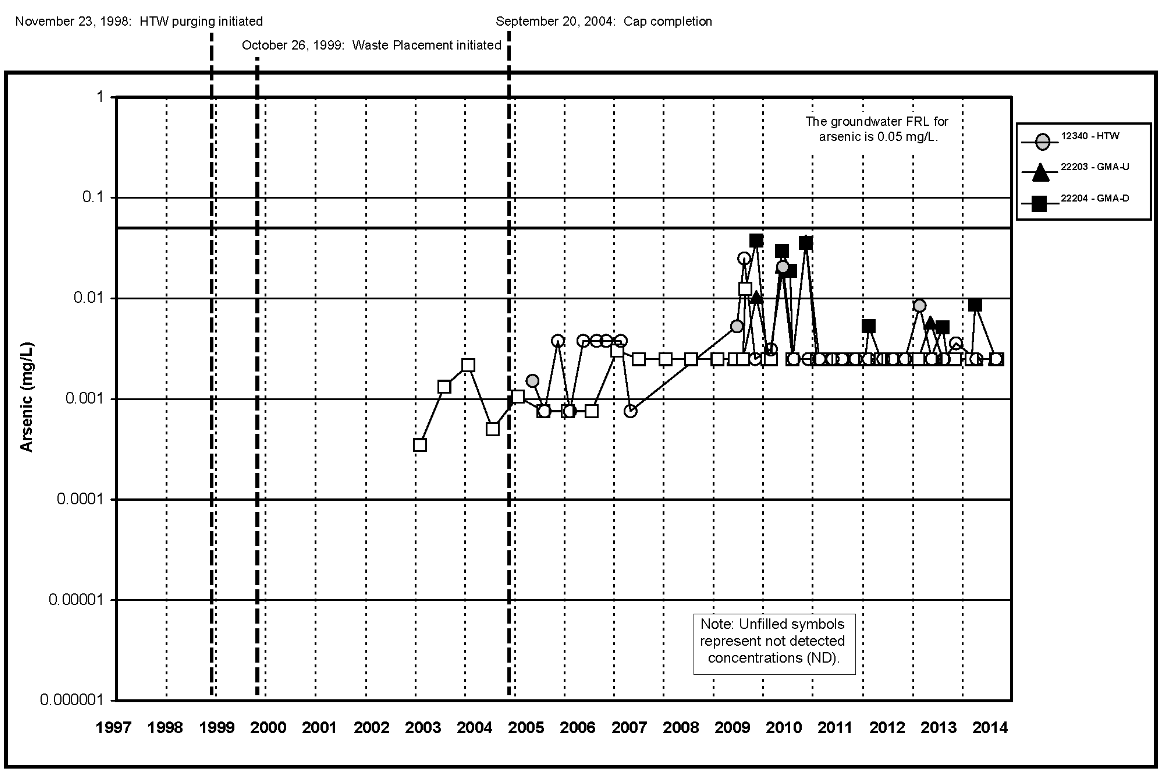


Figure A.5.3-15B. Cell 3 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

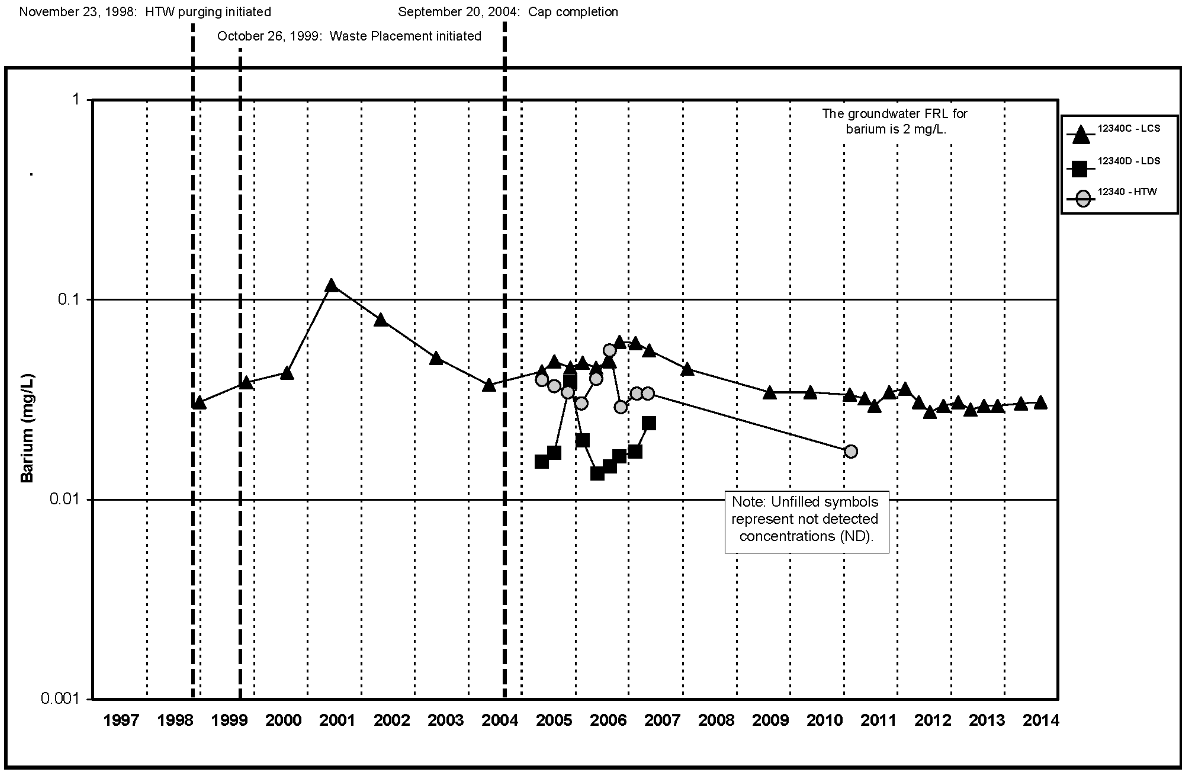


Figure A.5.3-16A. Cell 3 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

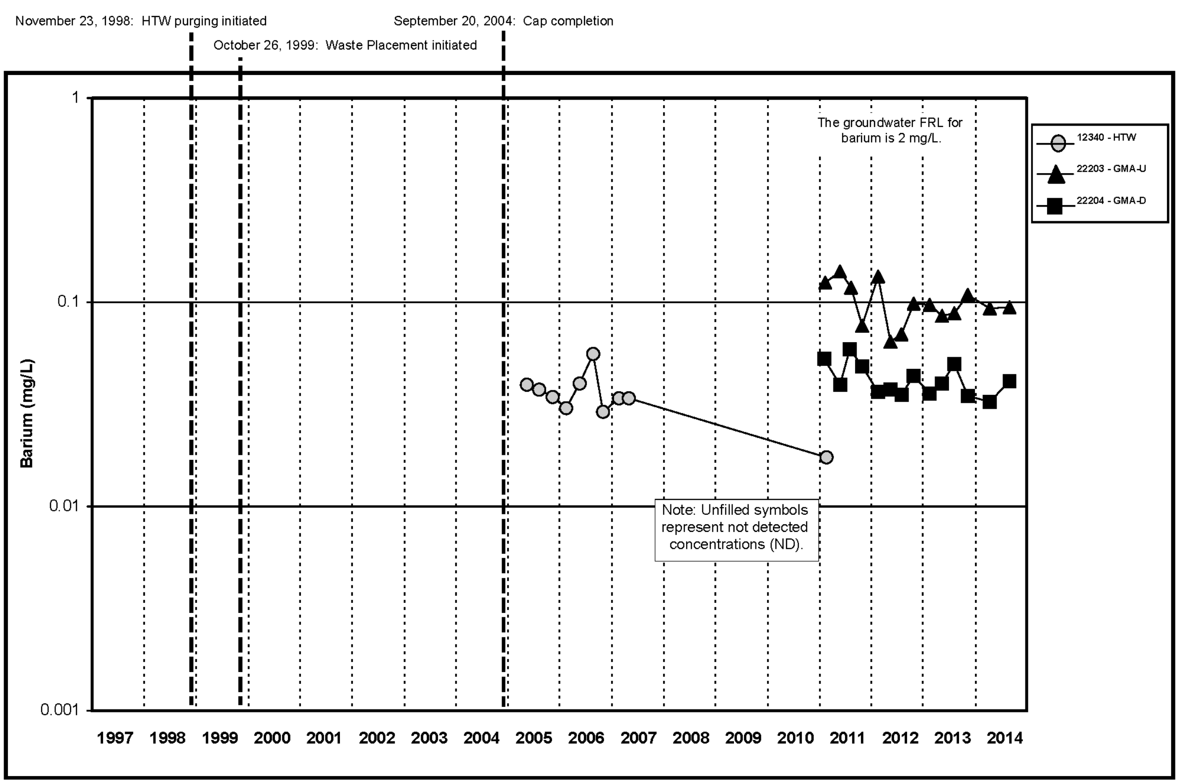


Figure A.5.3-16B. Cell 3 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

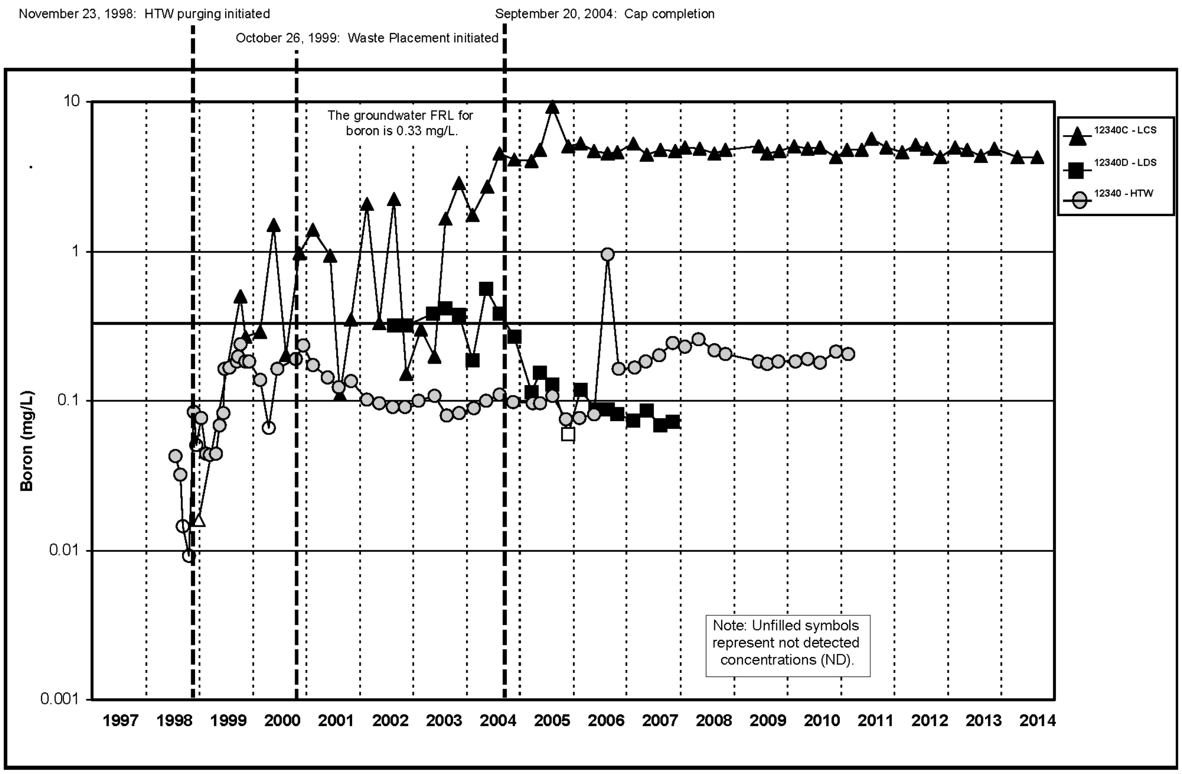


Figure A.5.3-17A. Cell 3 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

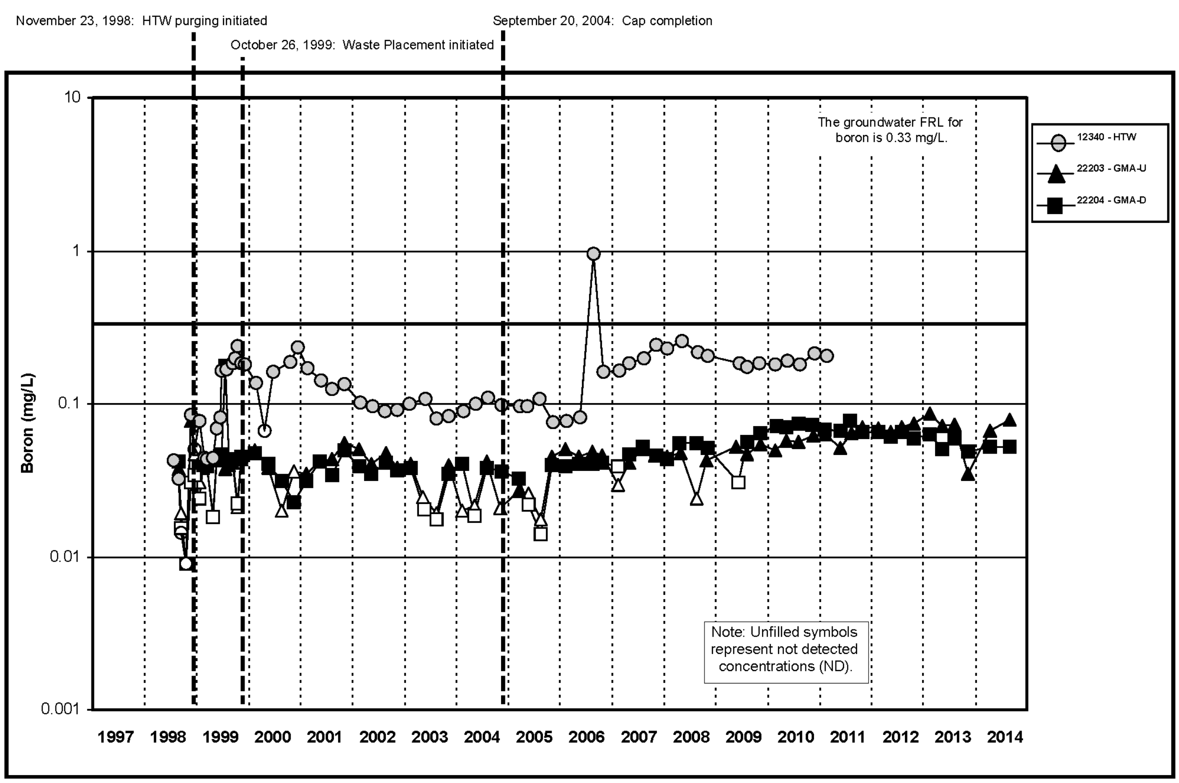


Figure A.5.3-17B. Cell 3 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

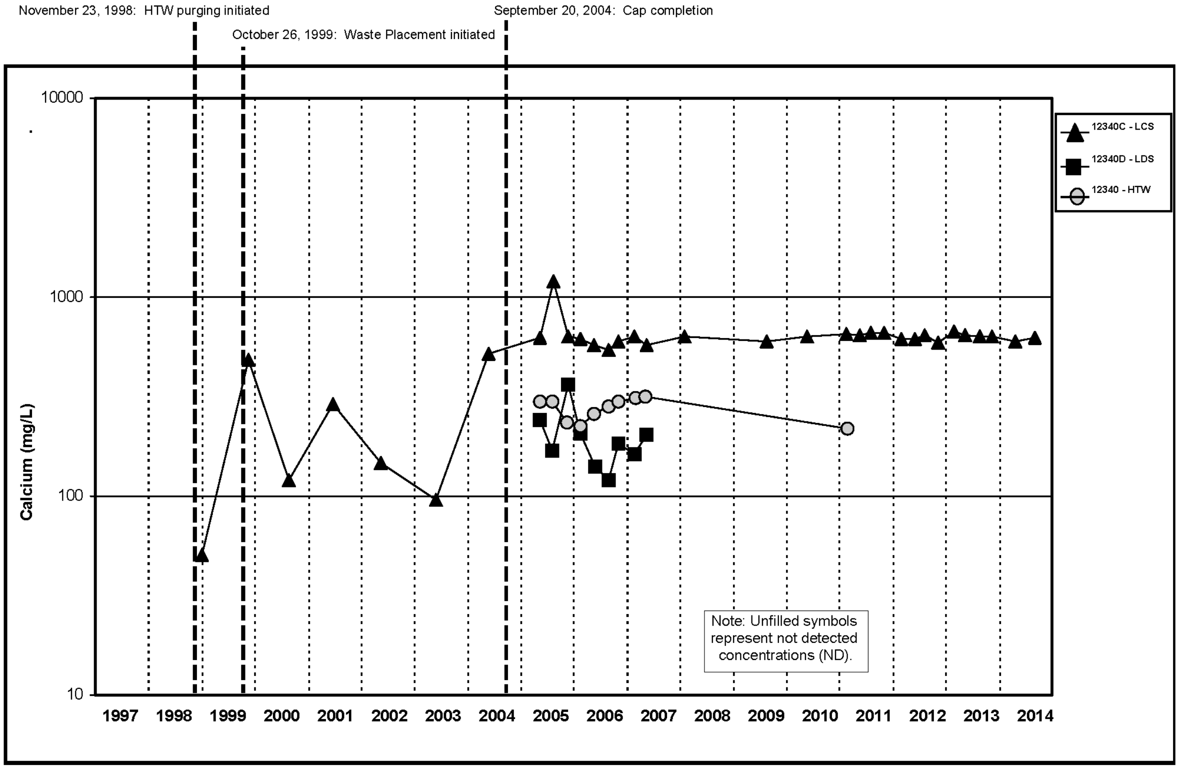


Figure A.5.3-18A. Cell 3 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

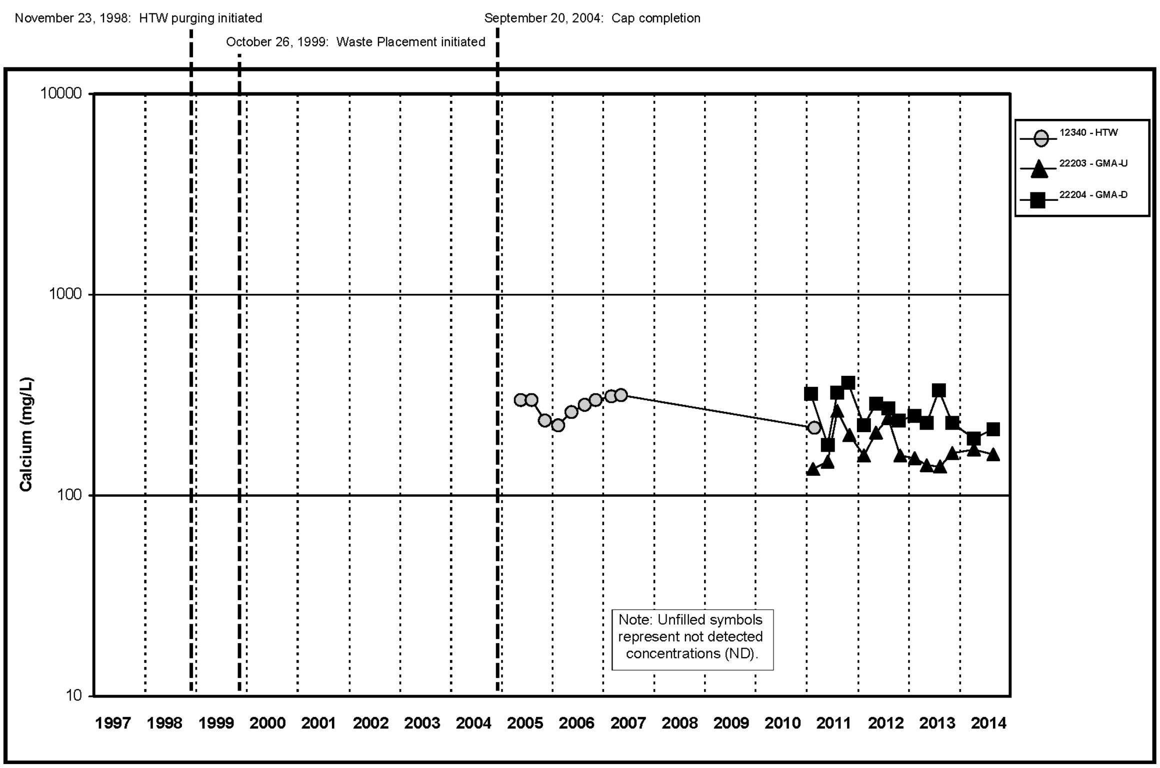


Figure A.5.3-18B. Cell 3 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

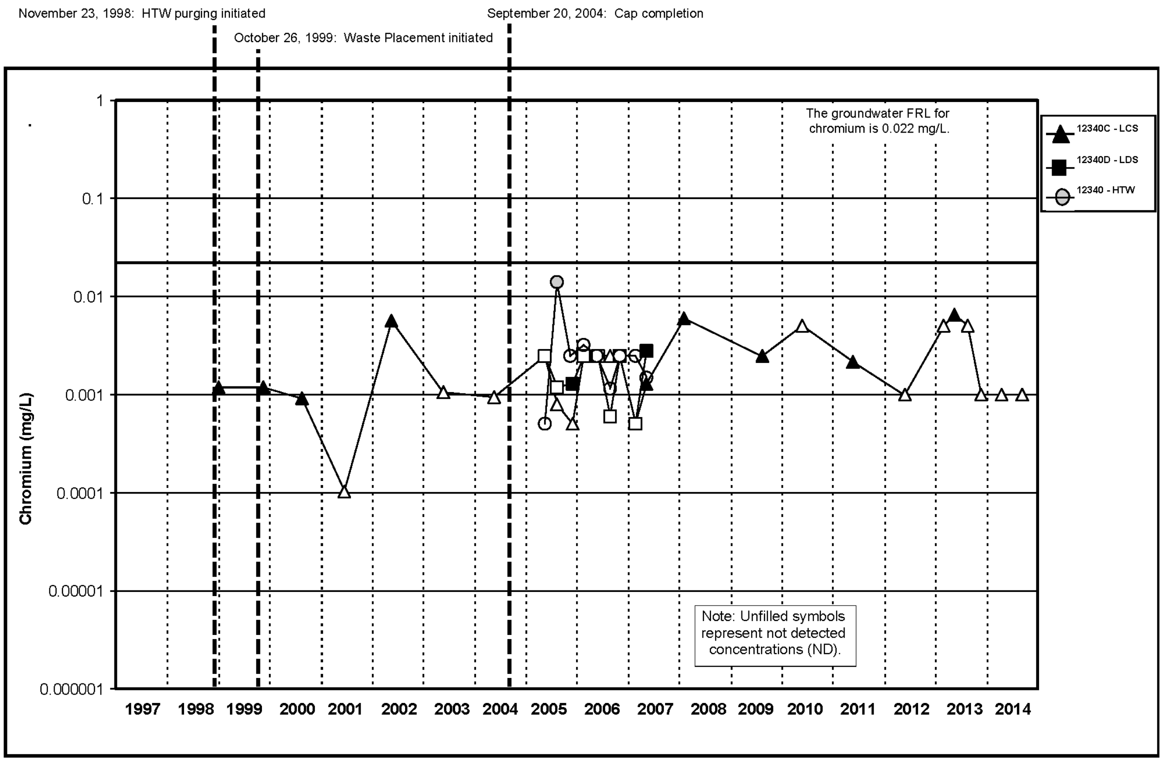


Figure A.5.3-19A. Cell 3 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

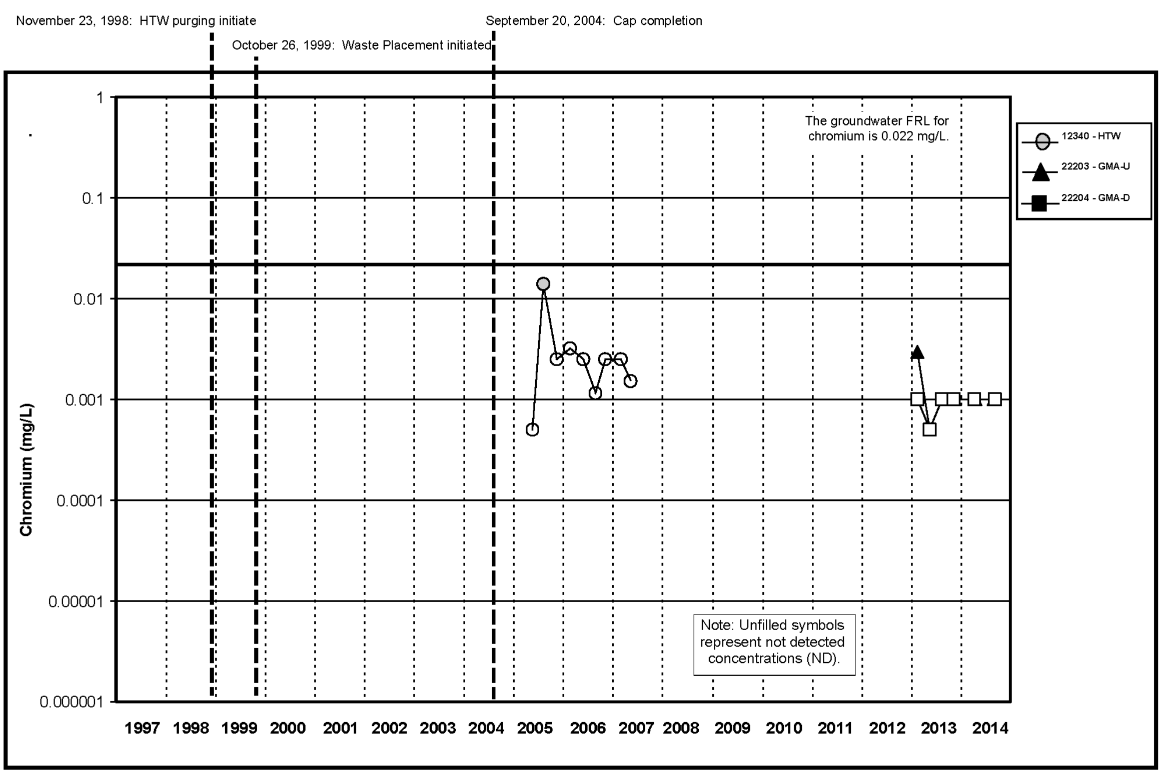


Figure A.5.3-19B. Cell 3 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

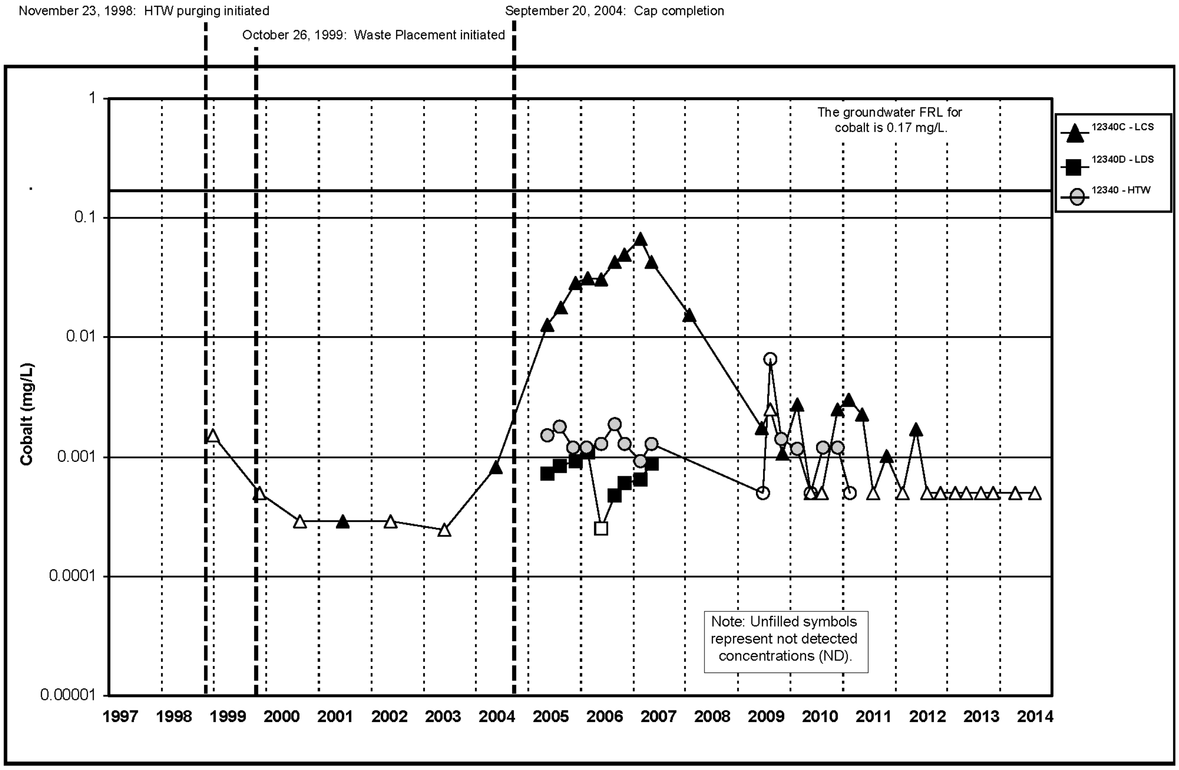


Figure A.5.3-20A. Cell 3 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

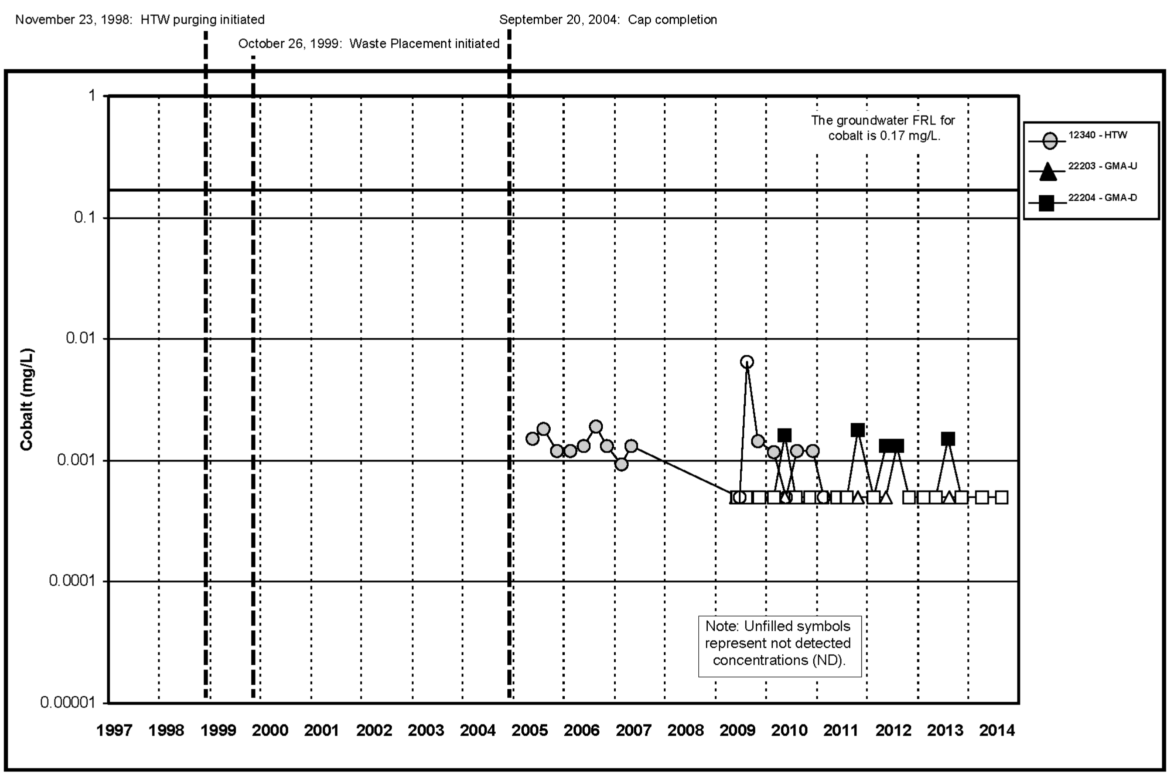


Figure A.5.3-20B. Cell 3 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

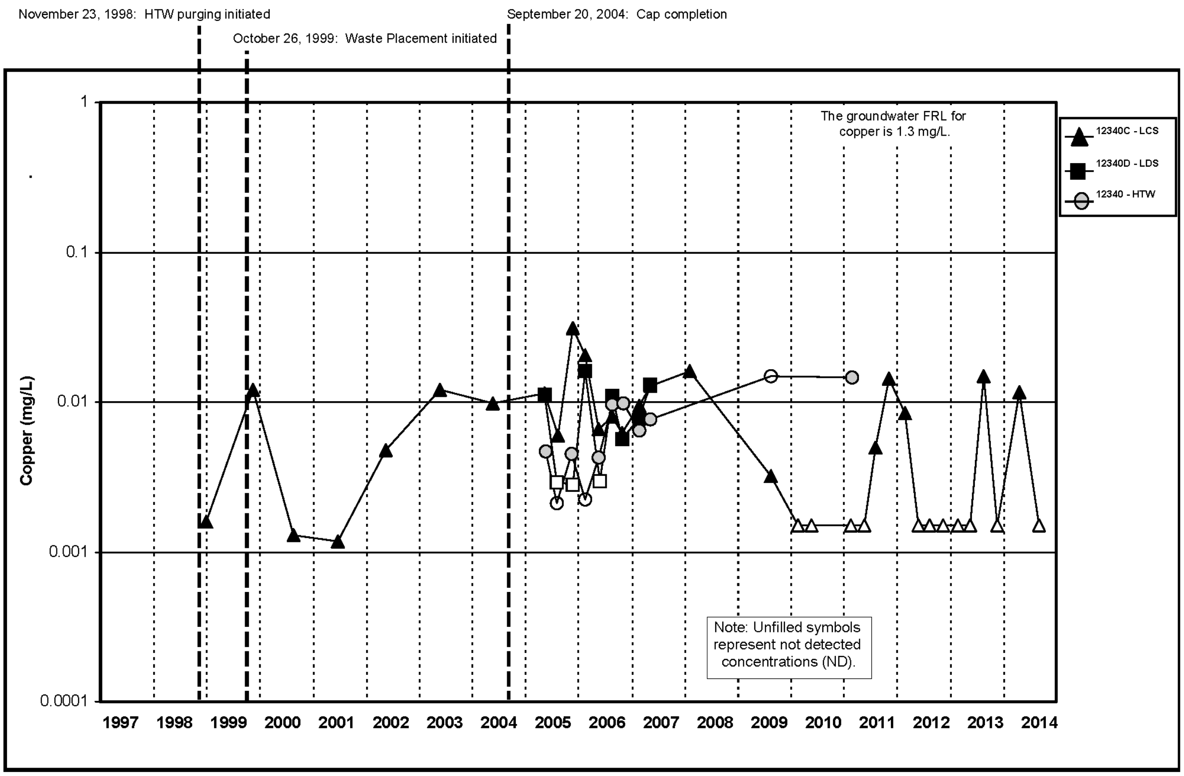


Figure A.5.3-21A. Cell 3 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

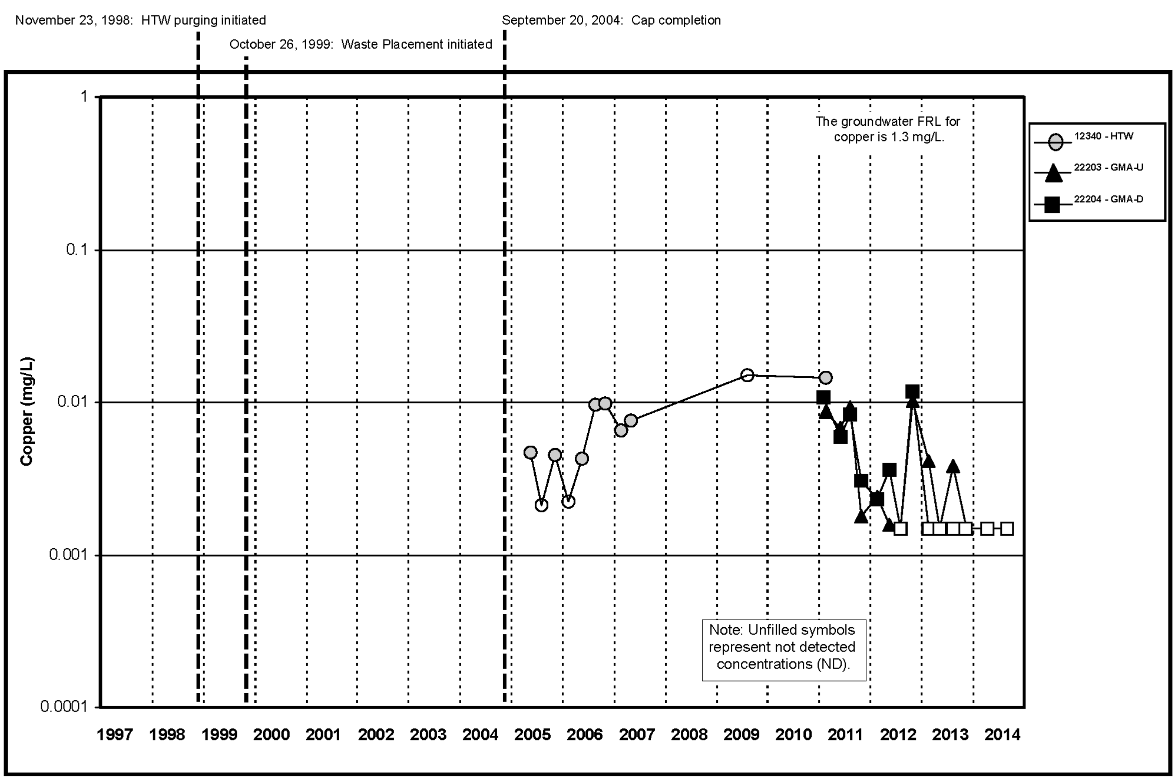


Figure A.5.3-21B. Cell 3 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

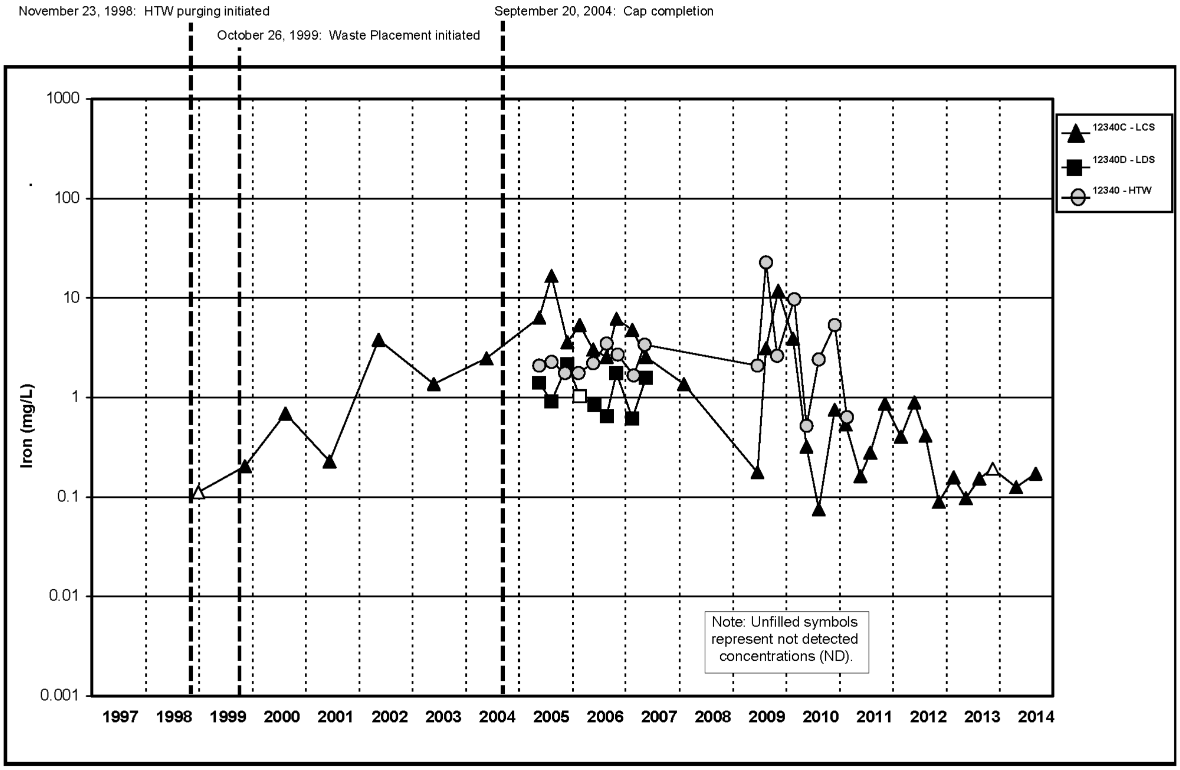


Figure A.5.3-22A. Cell 3 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

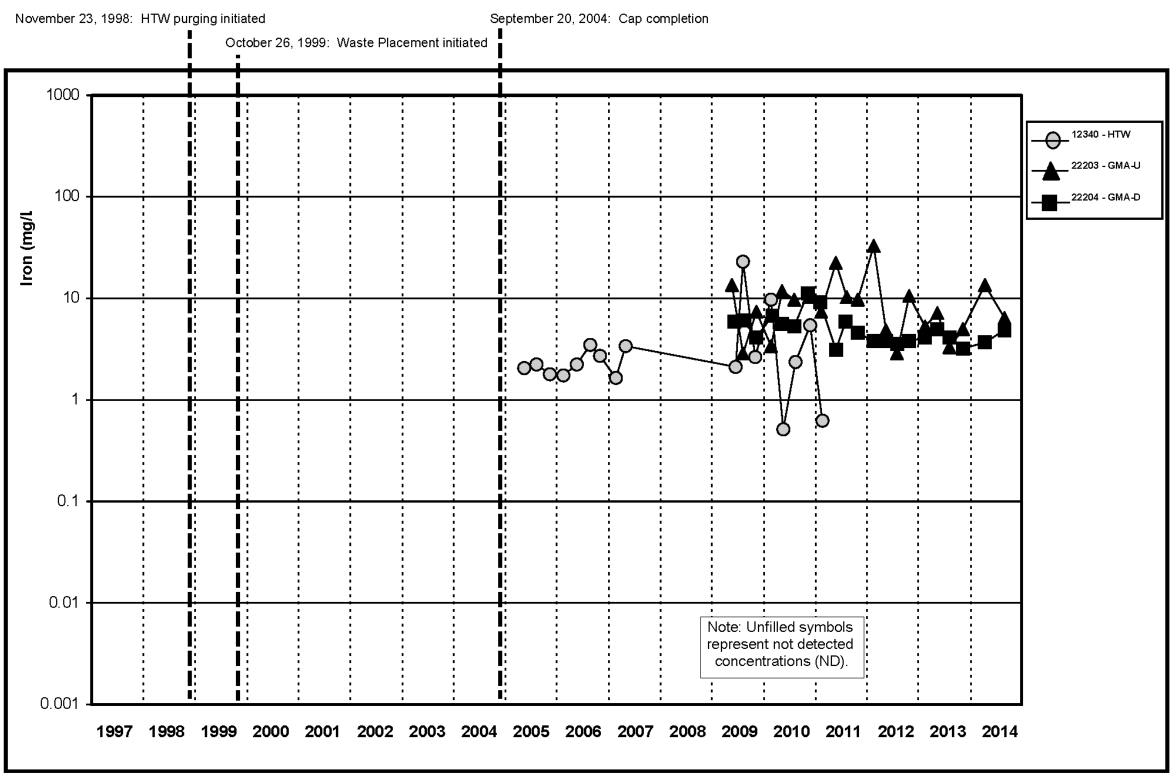


Figure A.5.3-22B. Cell 3 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

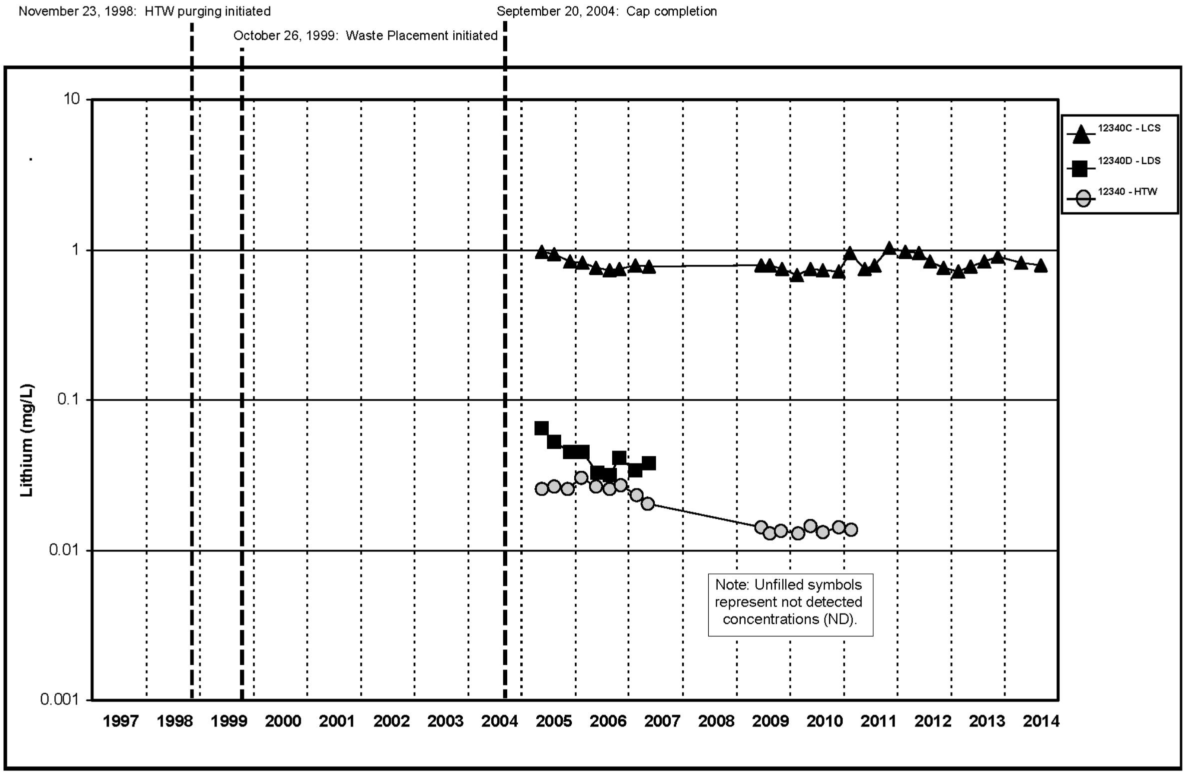


Figure A.5.3-23A. Cell 3 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

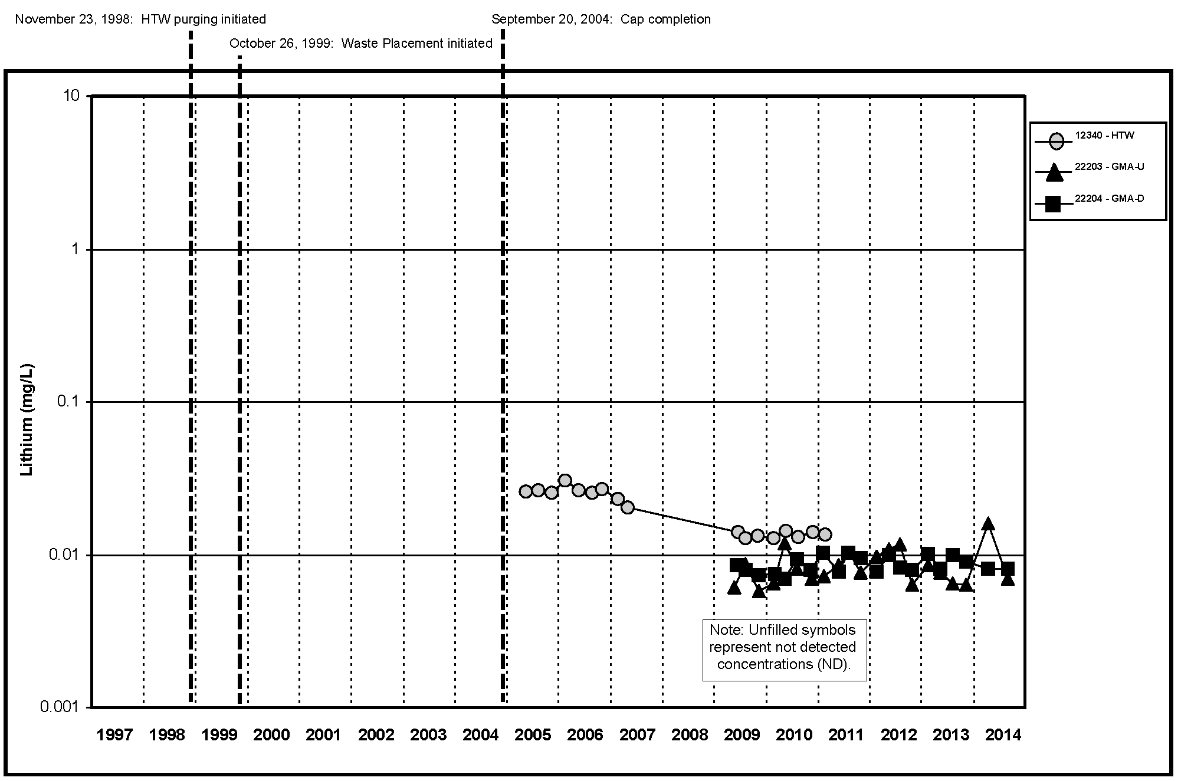


Figure A.5.3-23B. Cell 3 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

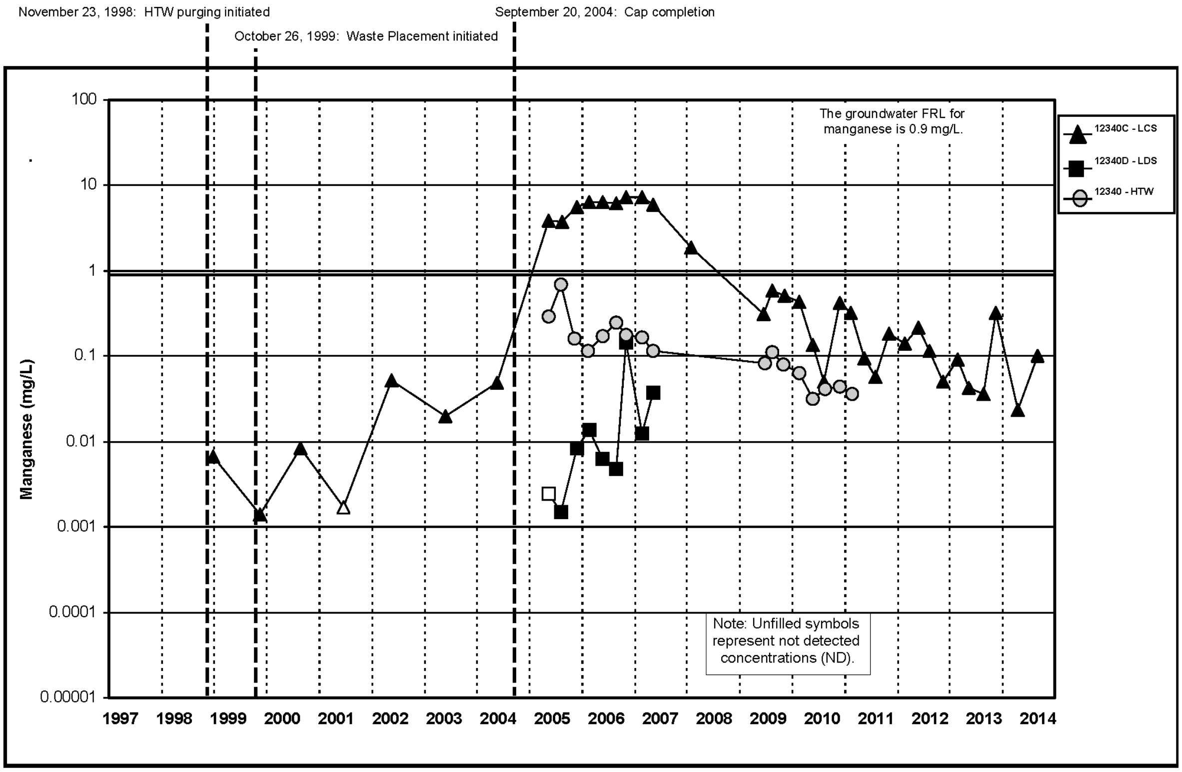


Figure A.5.3-24A. Cell 3 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

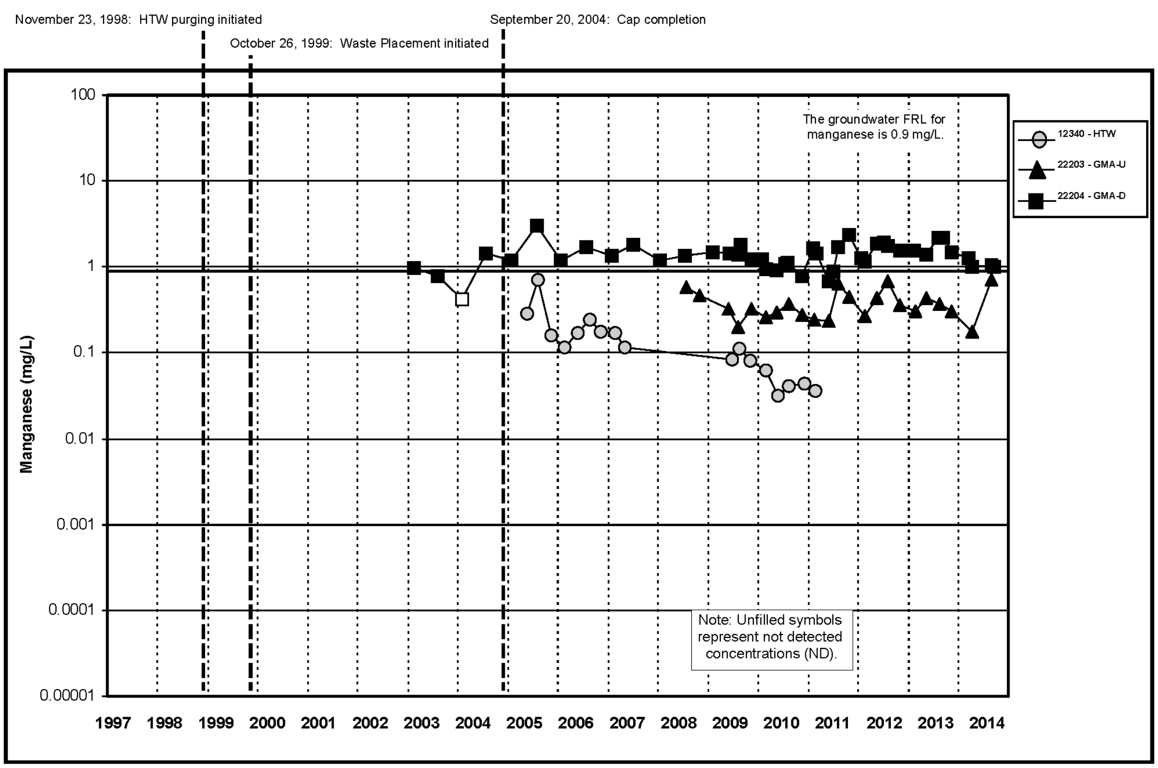


Figure A.5.3-24B. Cell 3 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

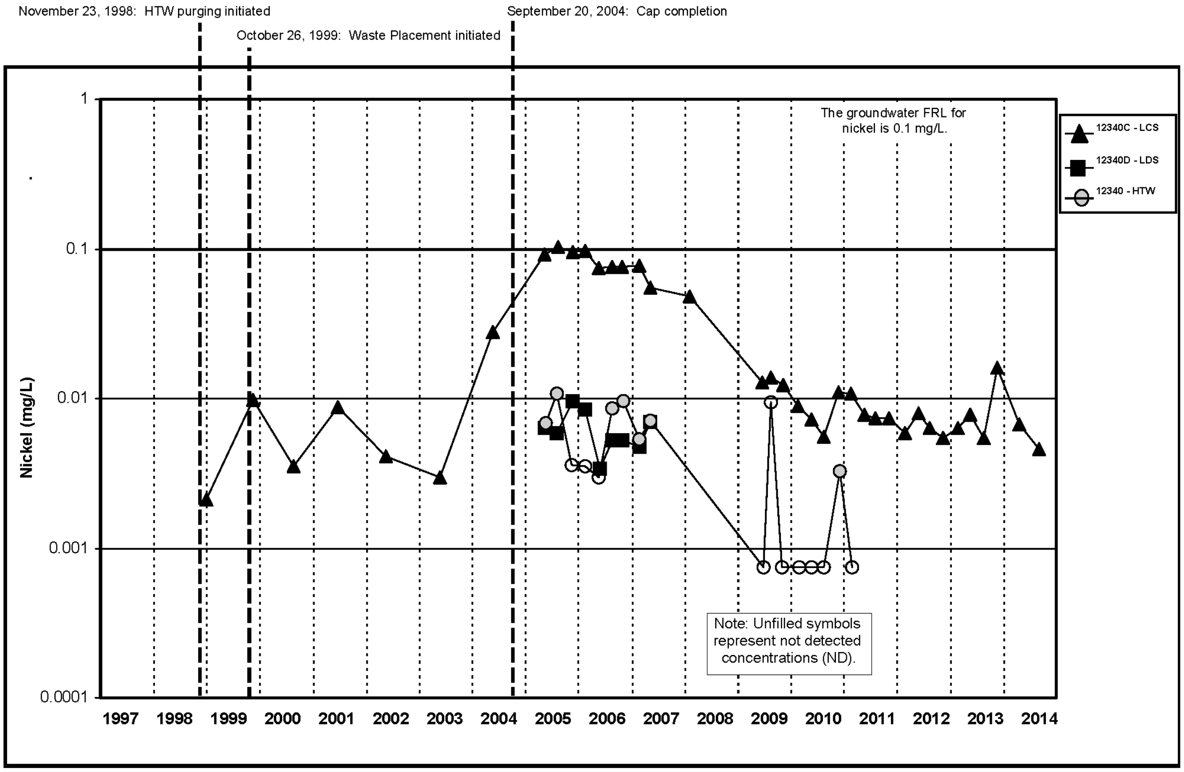


Figure A.5.3-25A. Cell 3 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

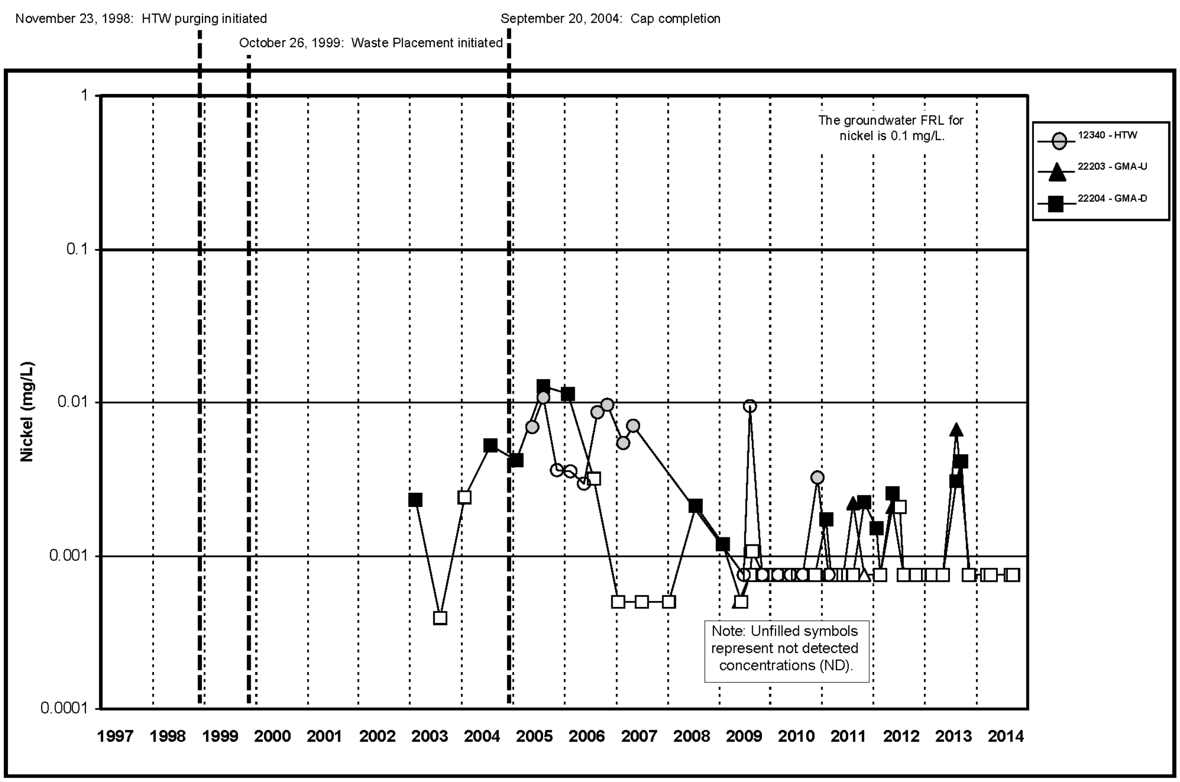


Figure A.5.3-25B. Cell 3 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

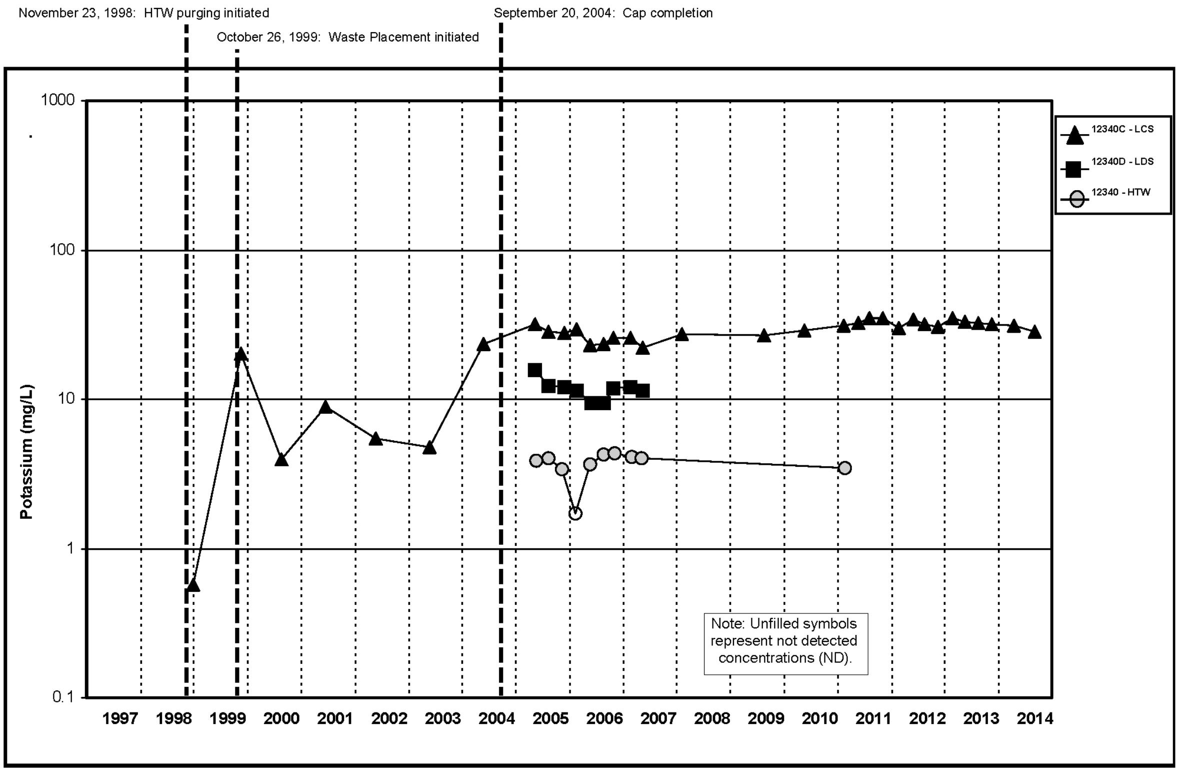


Figure A.5.3-26A. Cell 3 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

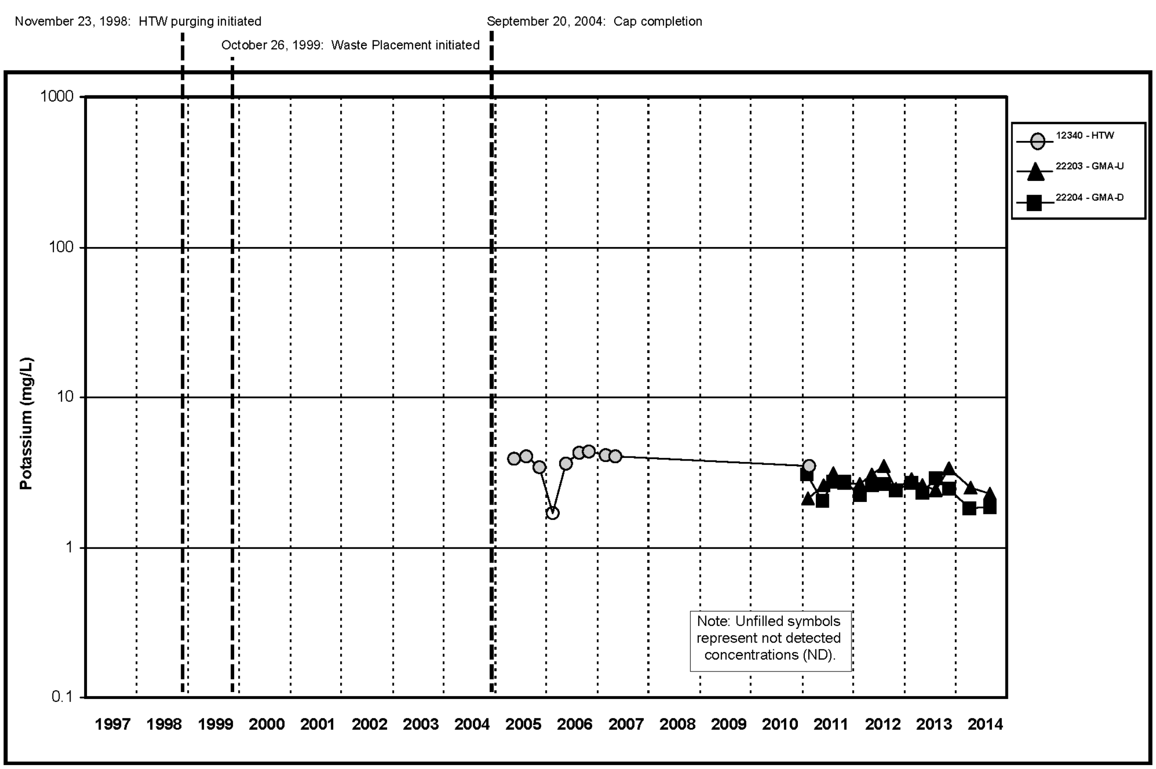


Figure A.5.3-26B. Cell 3 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

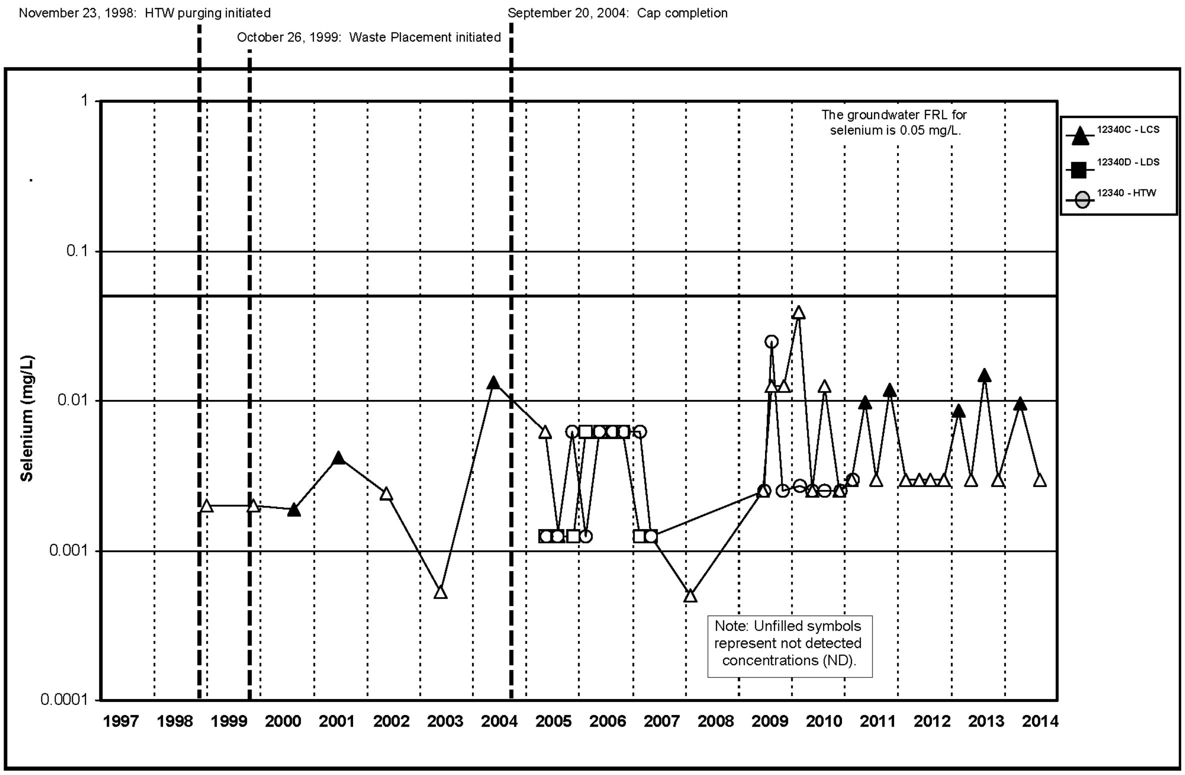


Figure A.5.3-27A. Cell 3 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

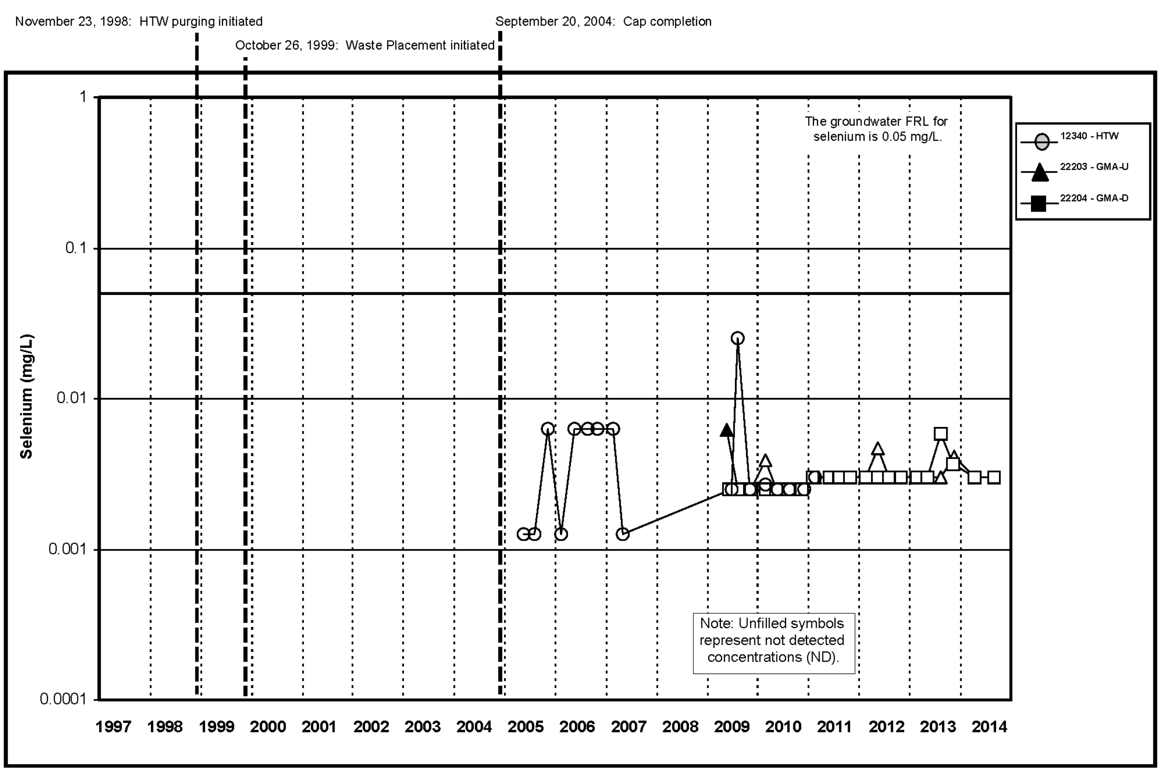


Figure A.5.3-27B. Cell 3 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

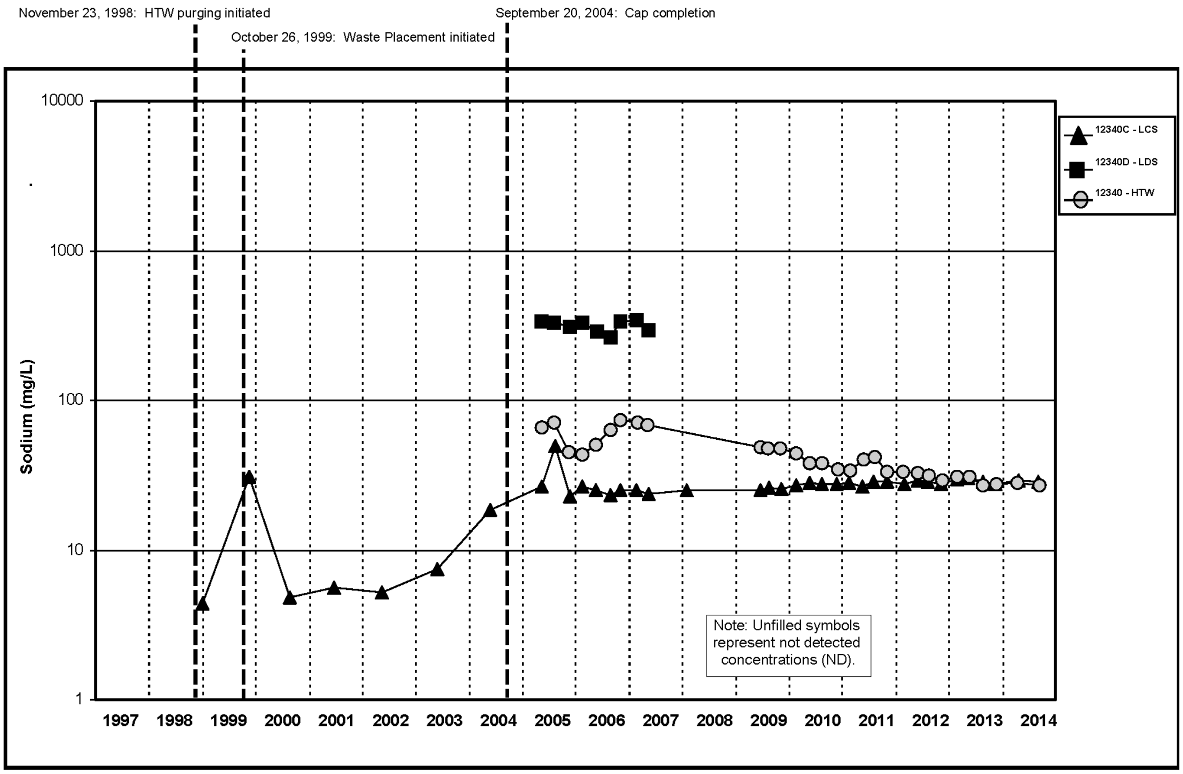


Figure A.5.3-28A. Cell 3 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

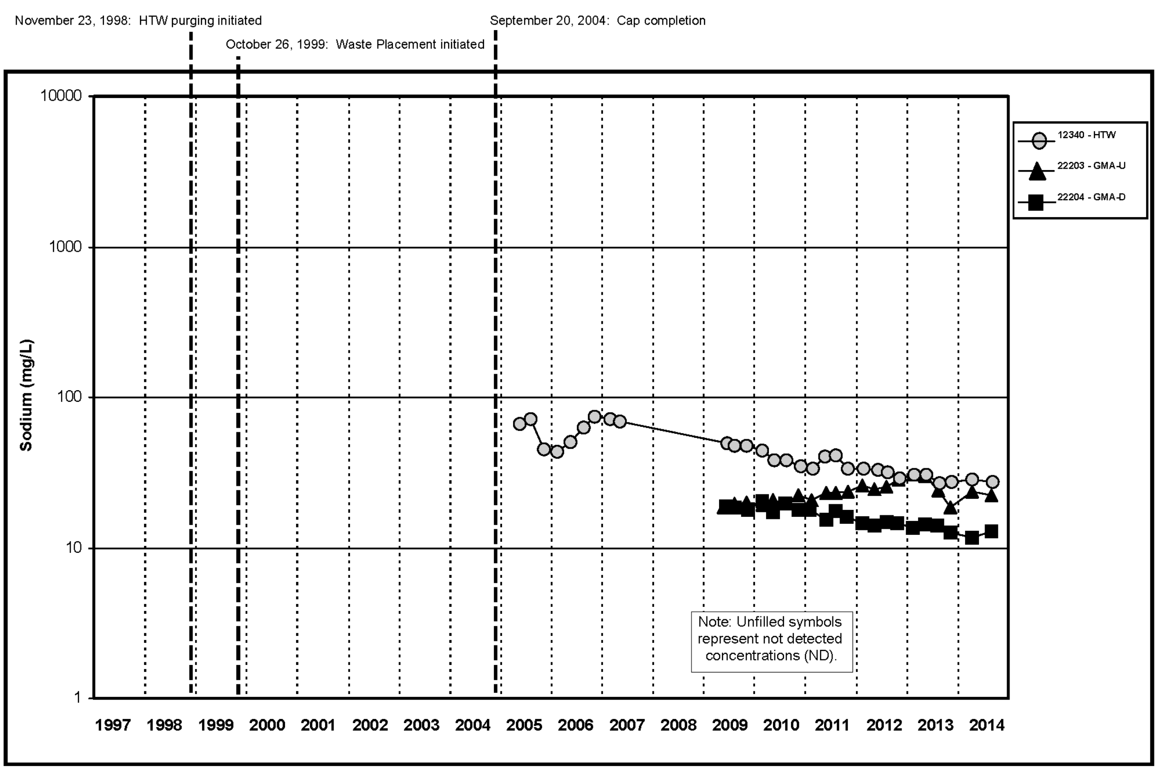


Figure A.5.3-28B. Cell 3 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

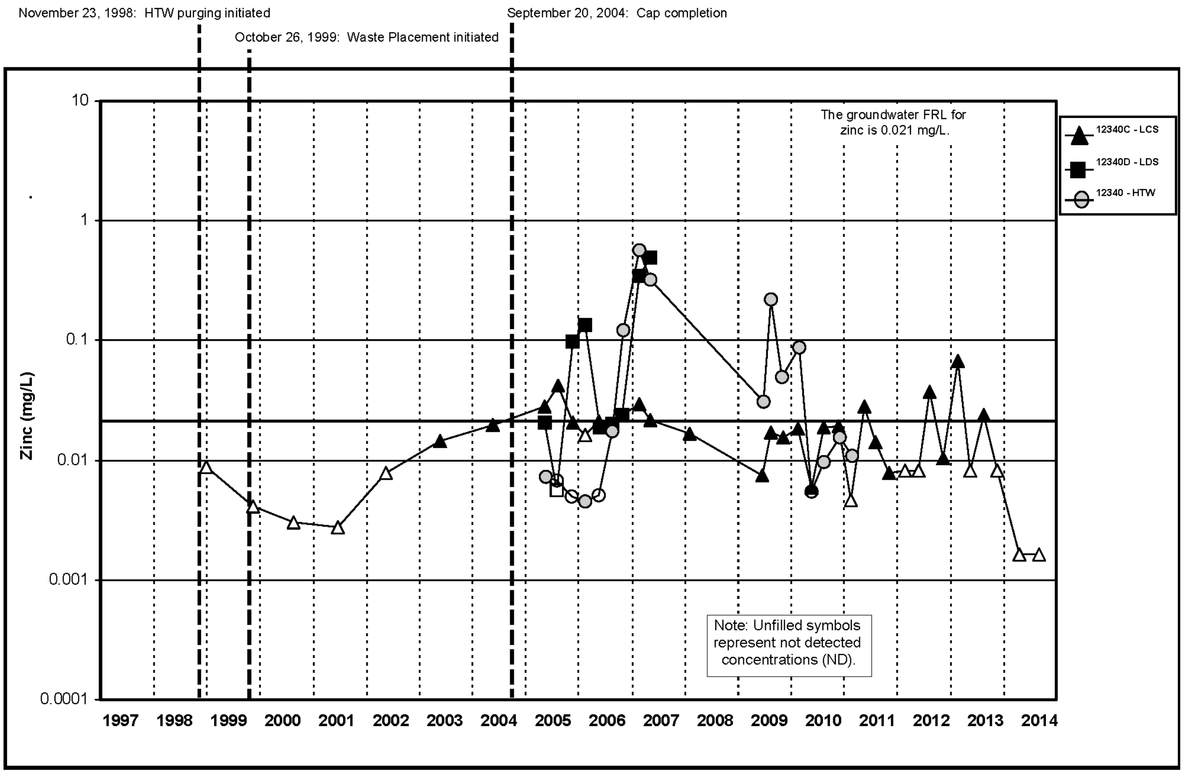


Figure A.5.3-29A. Cell 3 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

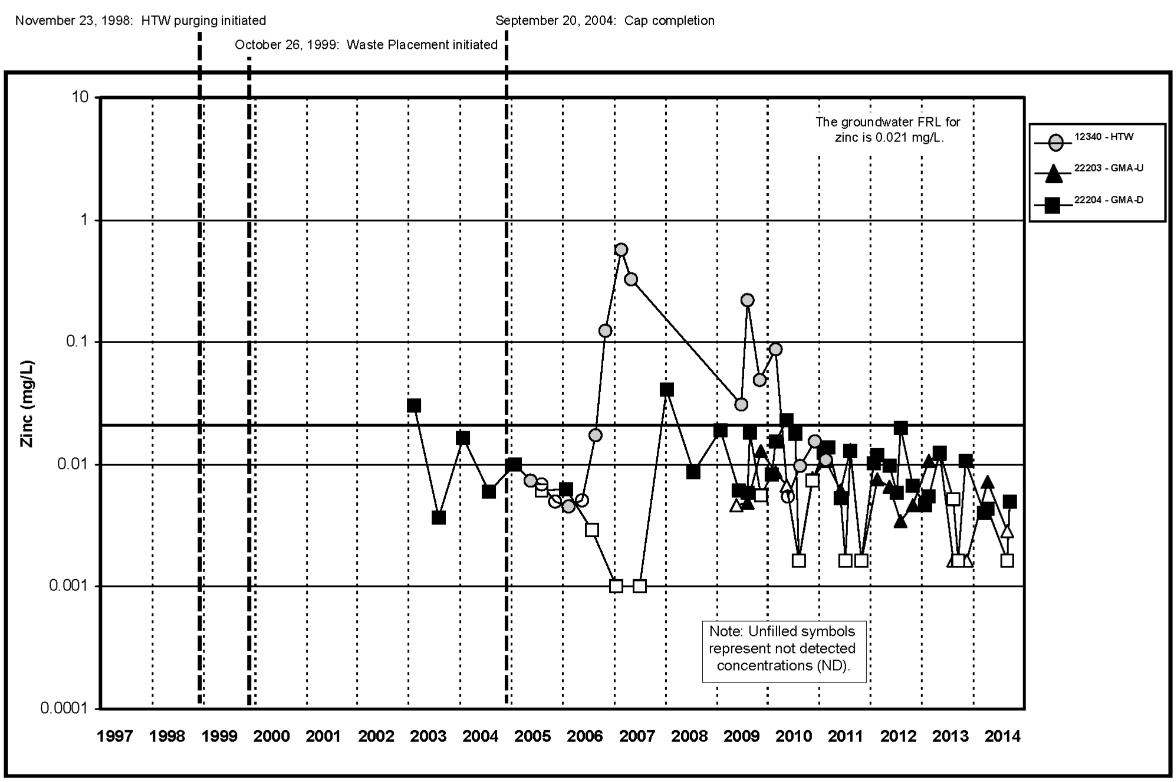


Figure A.5.3-29B. Cell 3 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

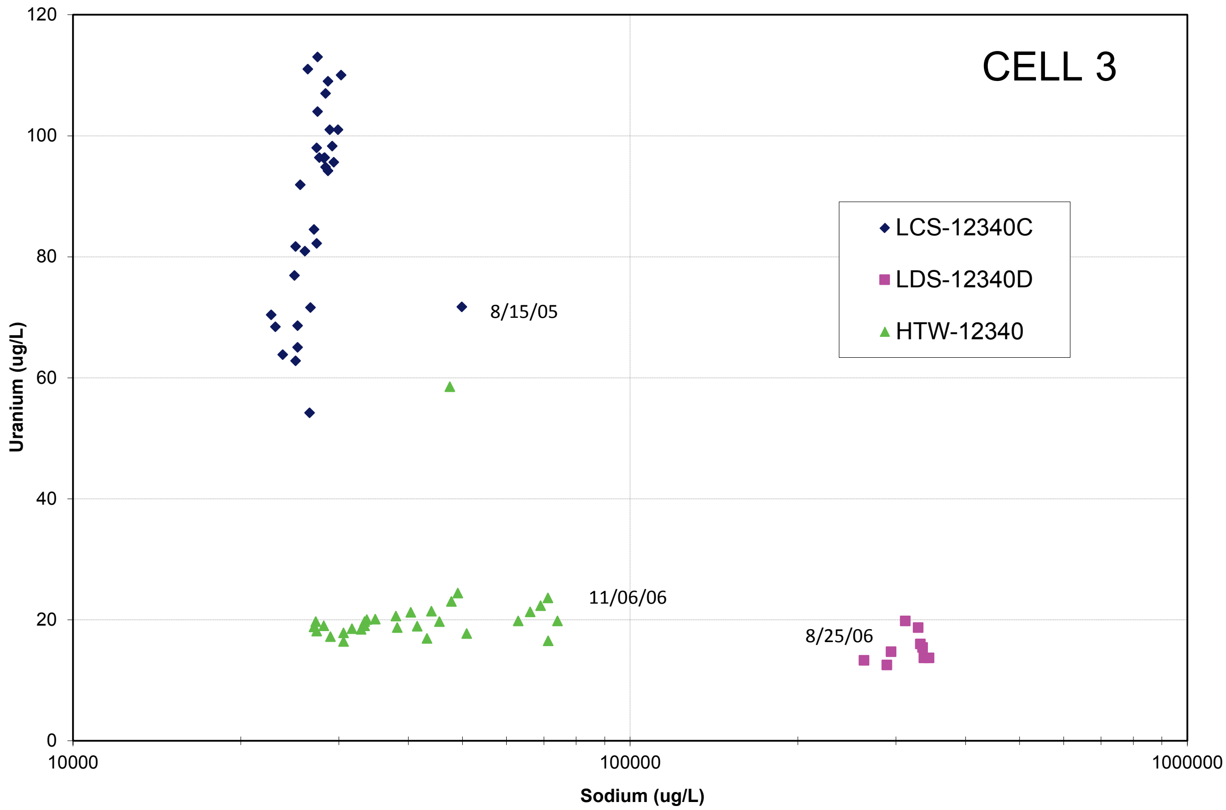


Figure A.5.3-30. Cell 3 Bivariate Plot for Uranium and Sodium

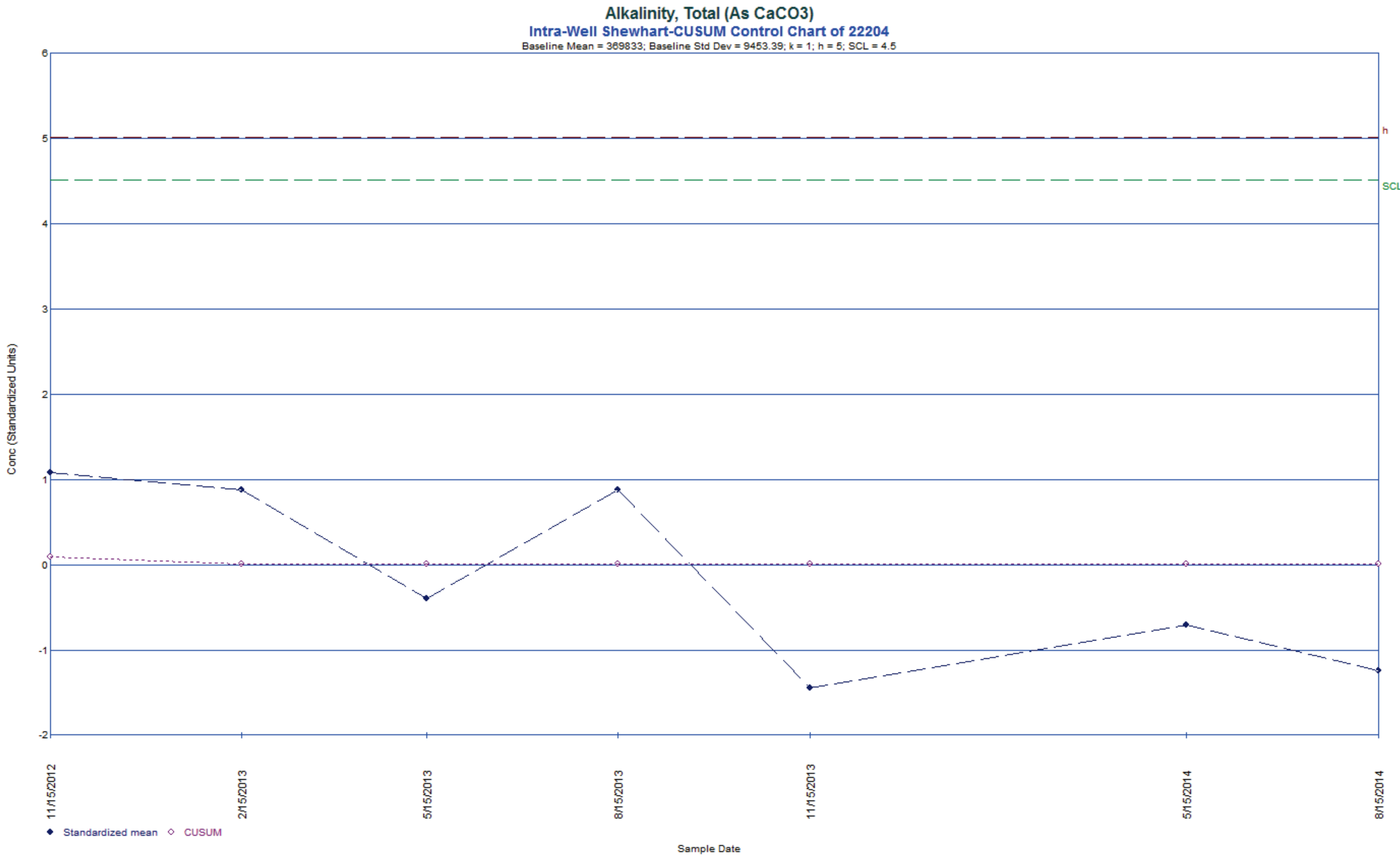


Figure A.5.3-31. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22204)

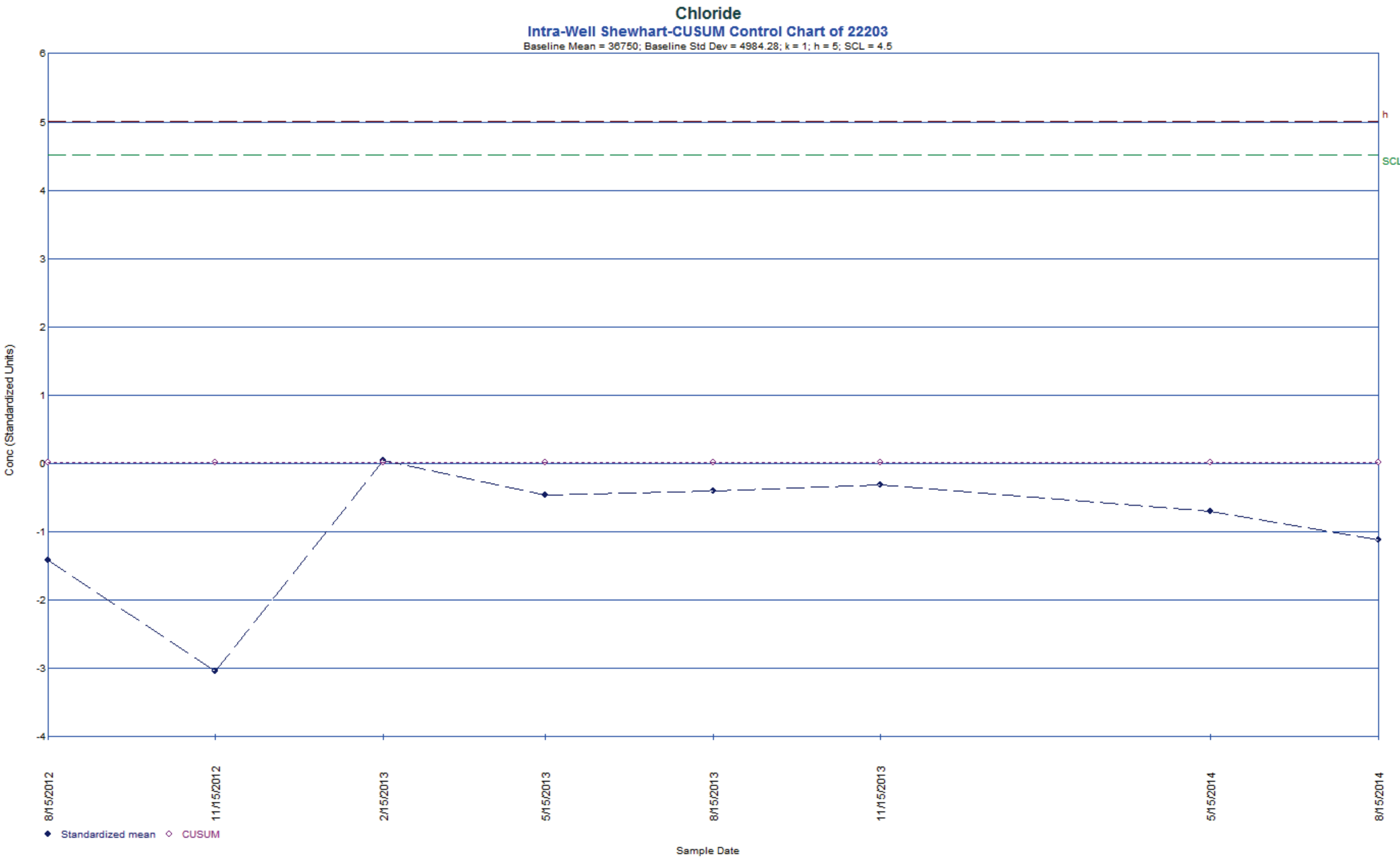


Figure A.5.3-32. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22203)

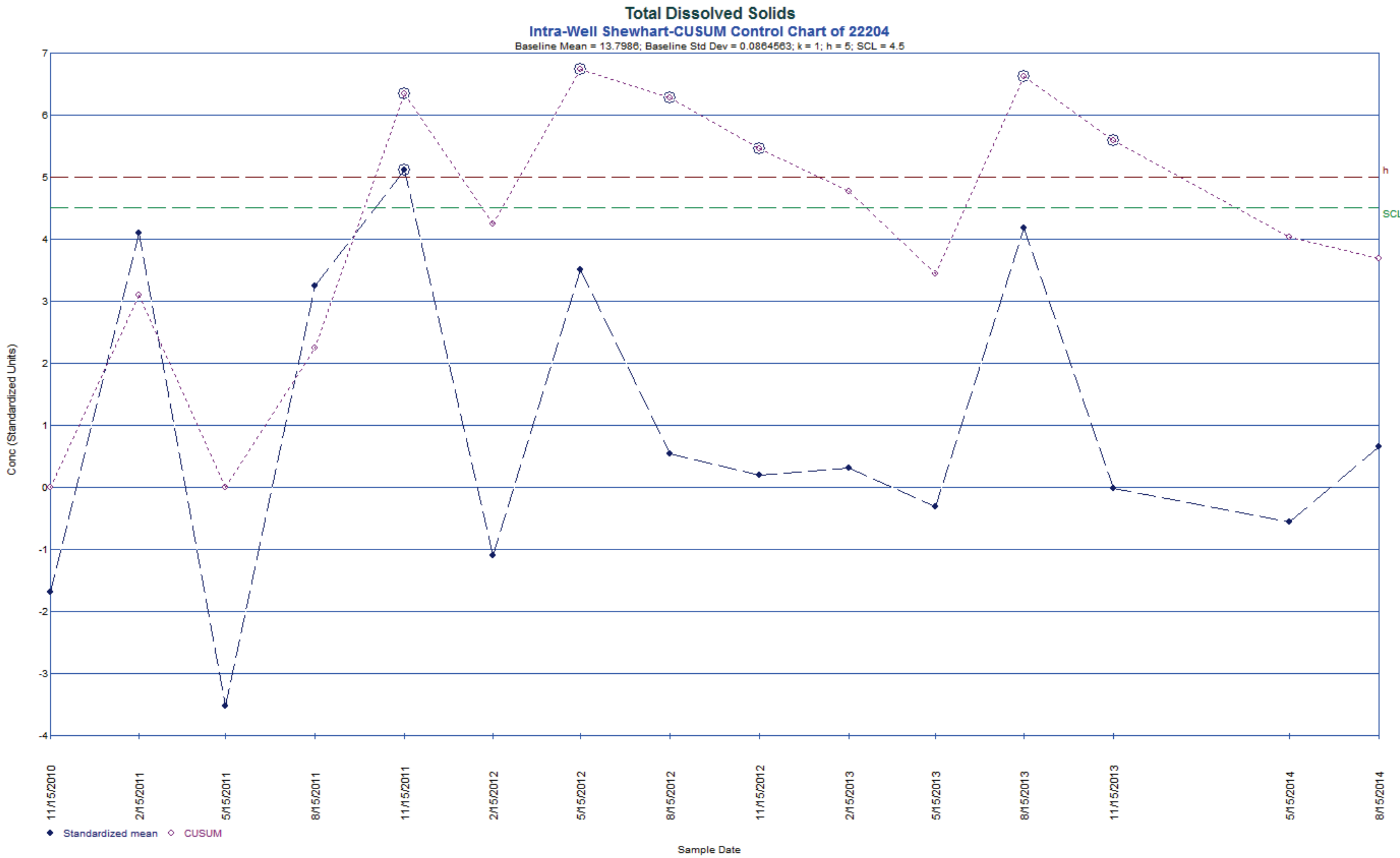


Figure A.5.3-33. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22204)

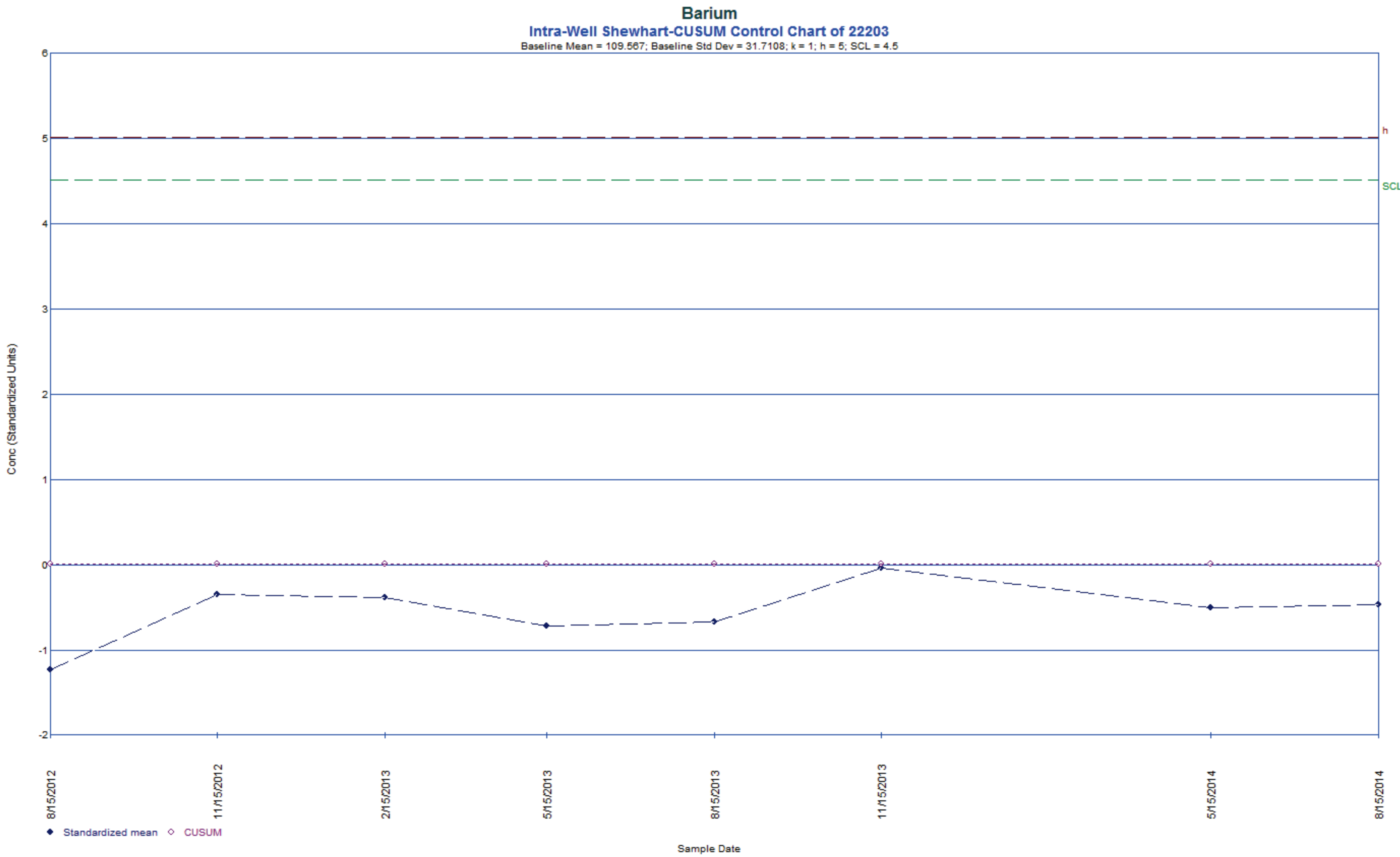


Figure A.5.3-34. Intra-Well Shewhart-CUSUM Control Chart (Barium 22203)

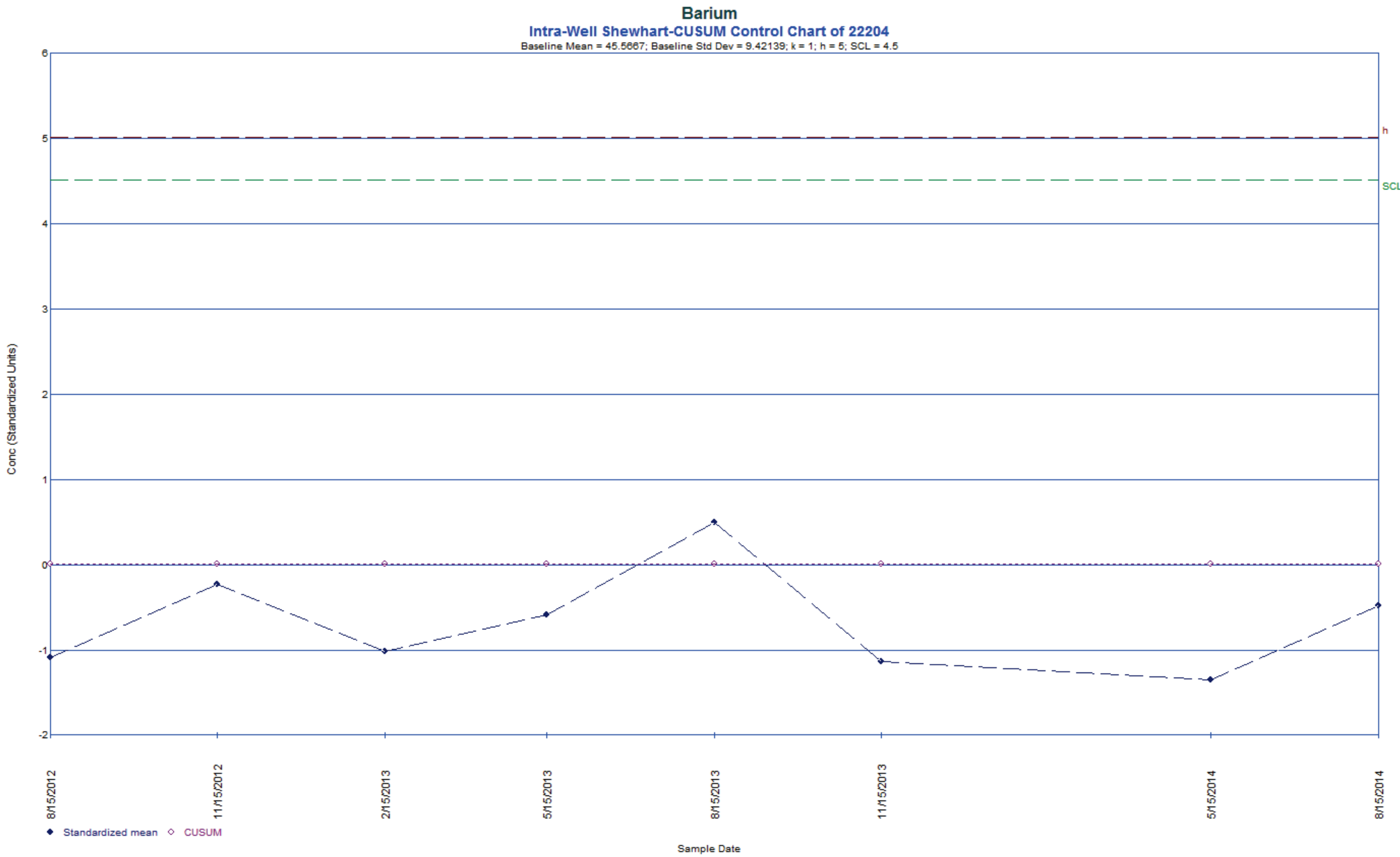


Figure A.5.3-35. Intra-Well Shewhart-CUSUM Control Chart (Barium 22204)

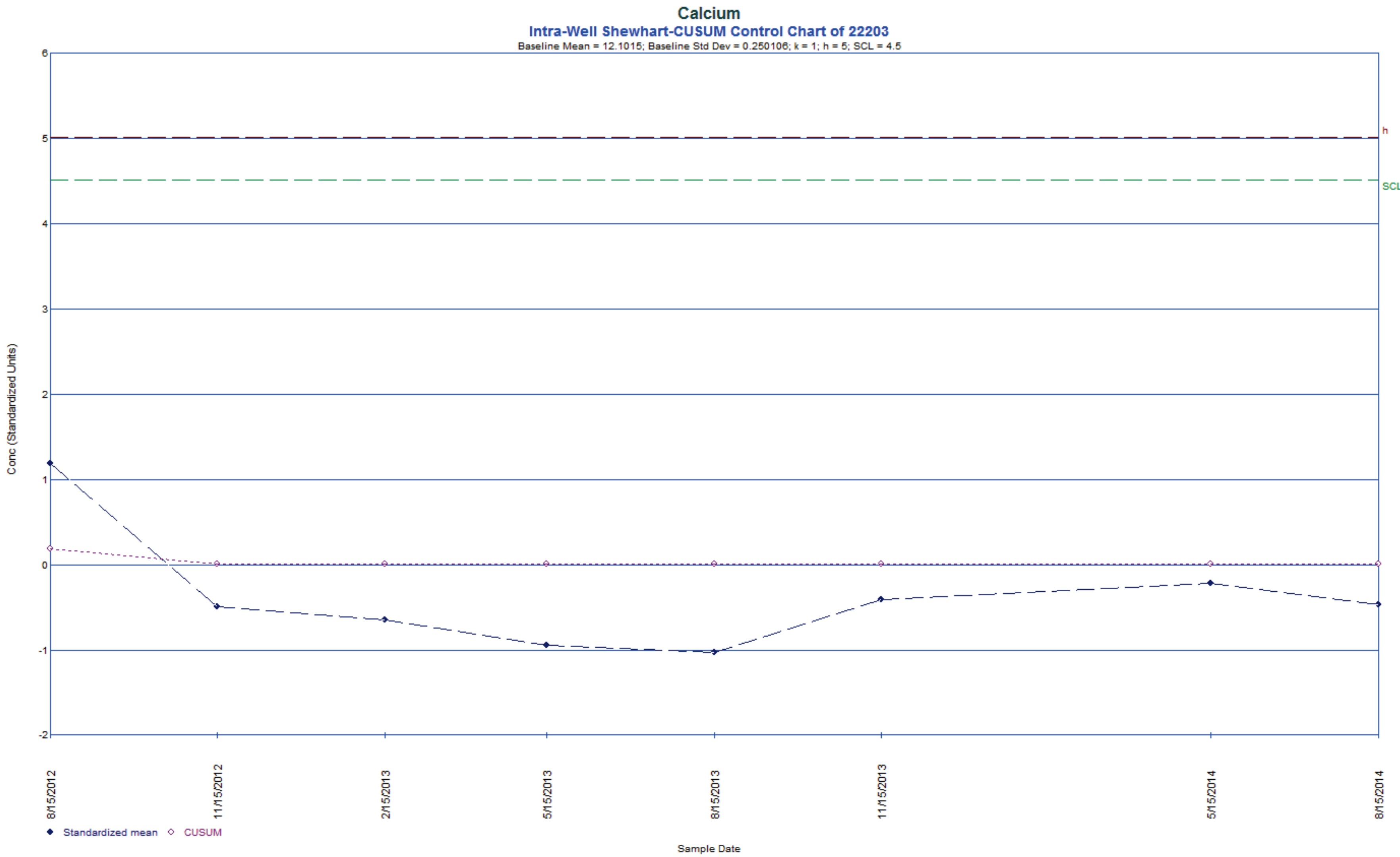


Figure A.5.3-36. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22203)

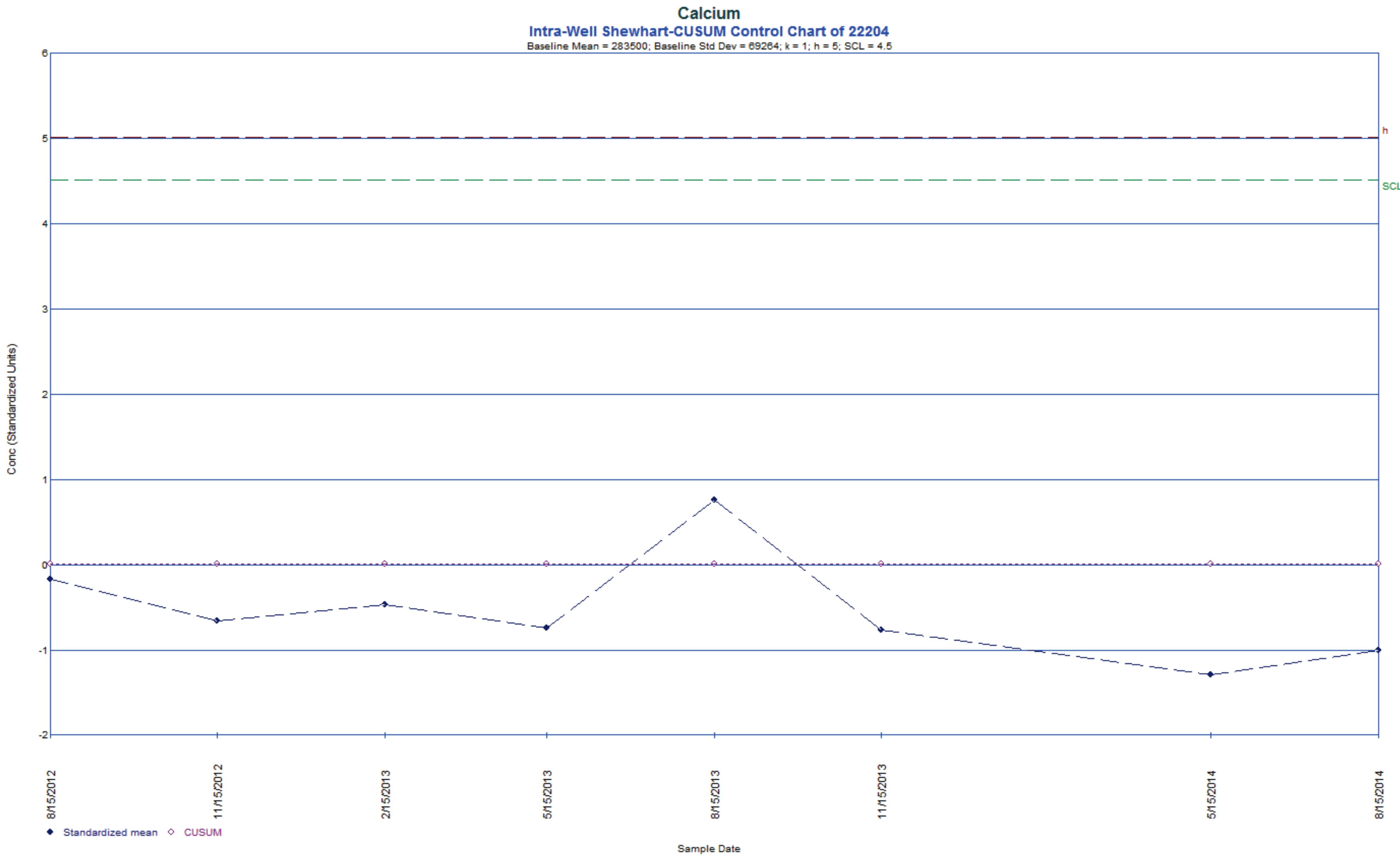


Figure A.5.3-37. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22204)

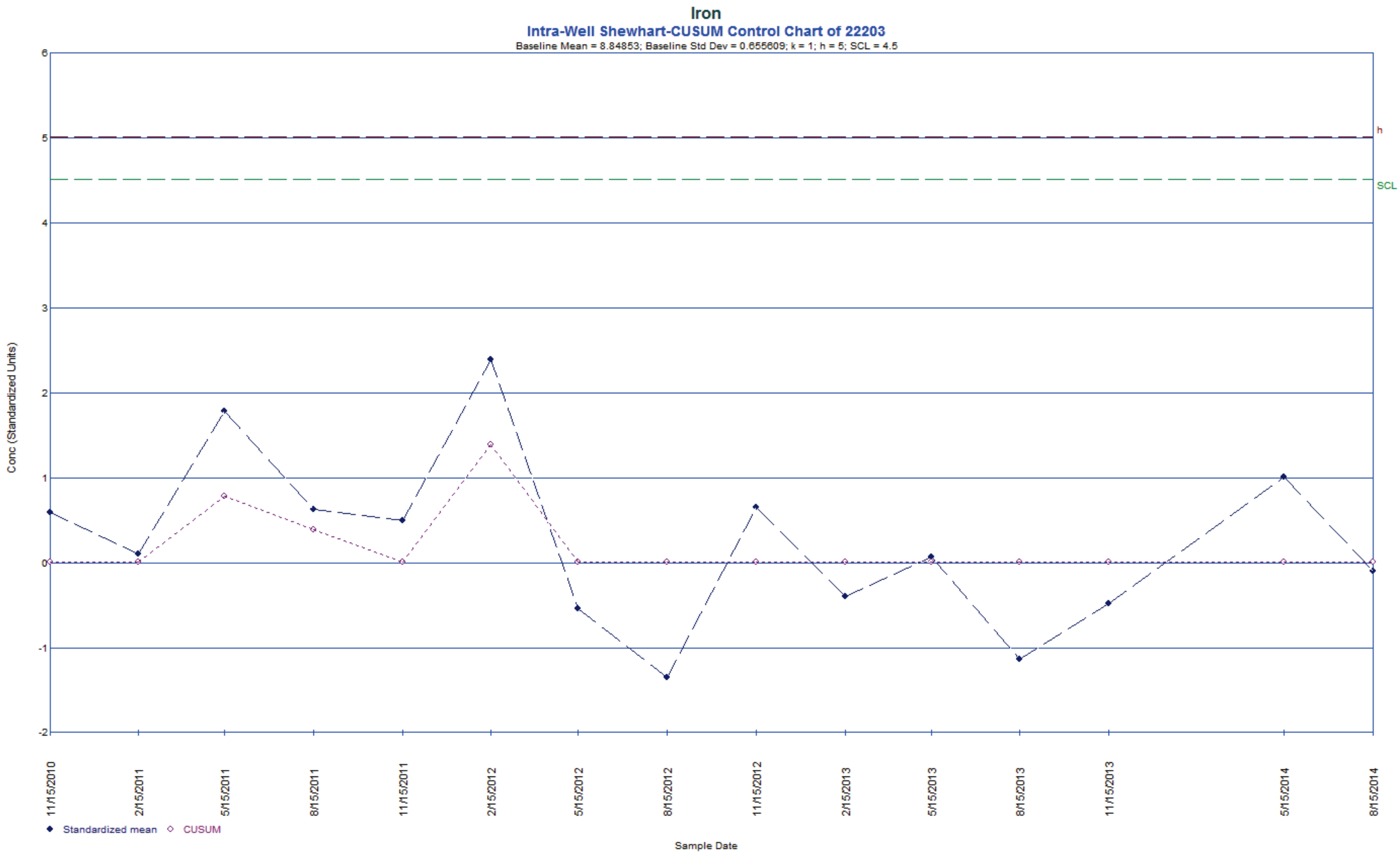


Figure A.5.3-38. Intra-Well Shewhart-CUSUM Control Chart (Iron 22203)

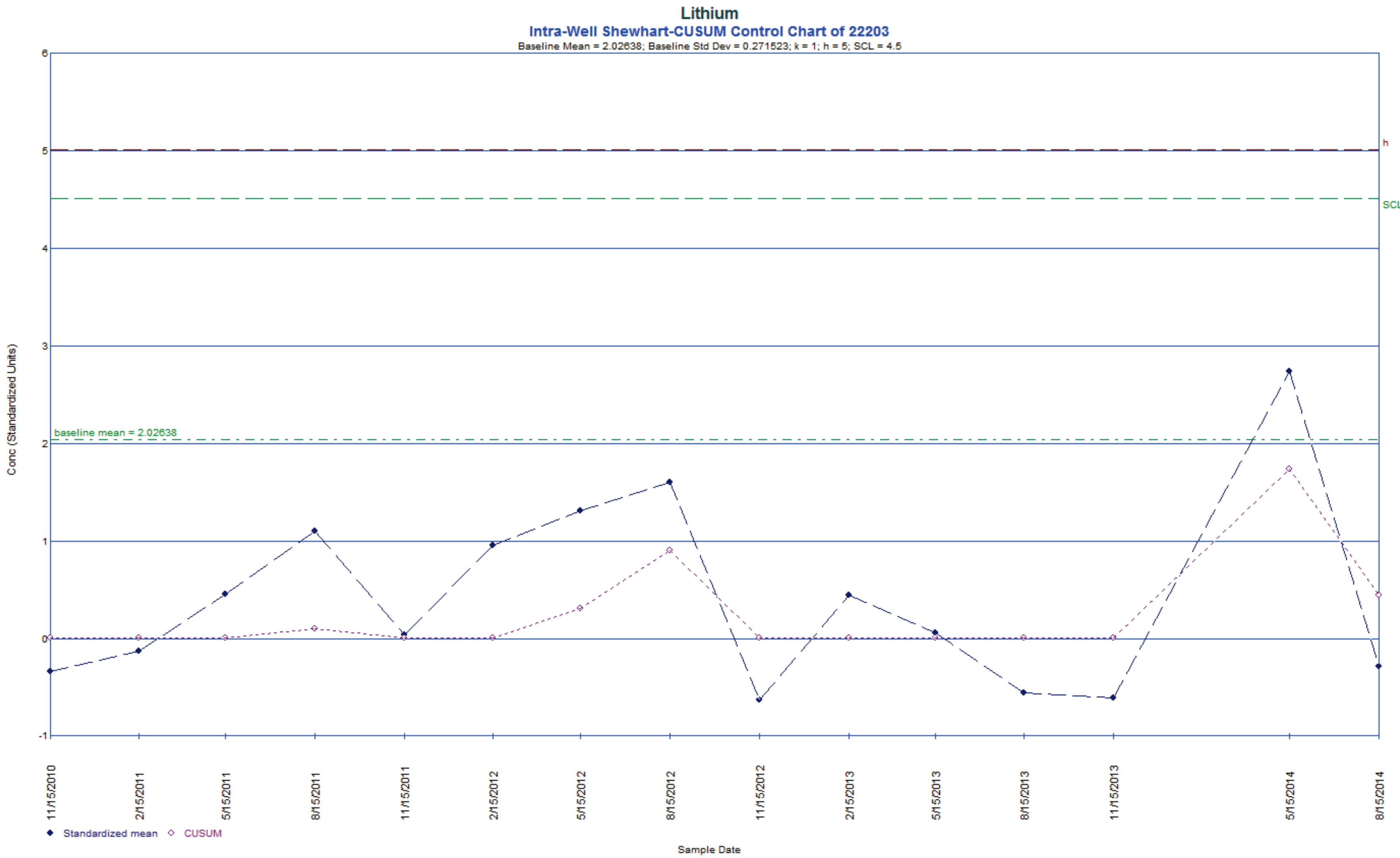


Figure A.5.3-39. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22203)

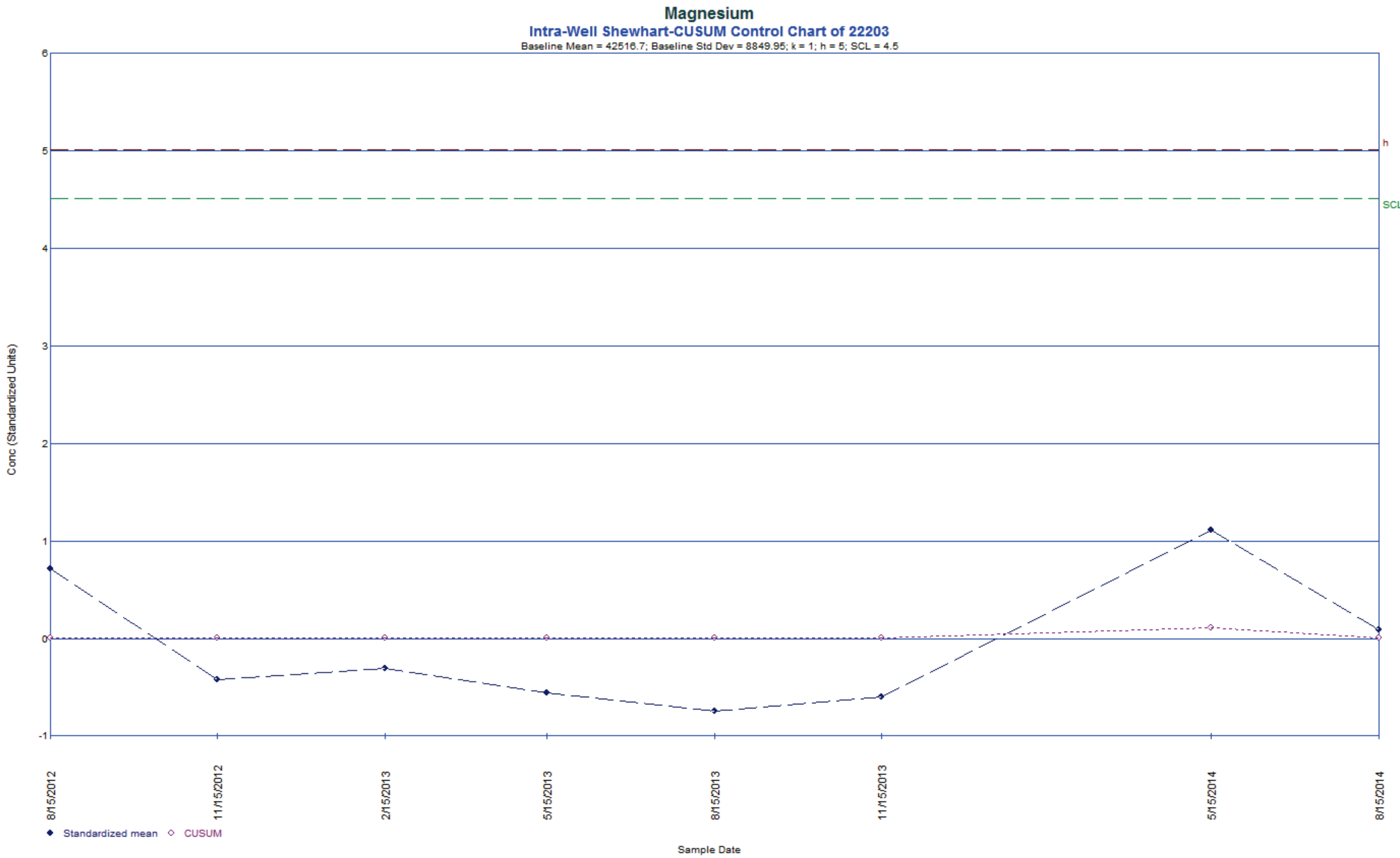


Figure A.5.3-40. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22203)

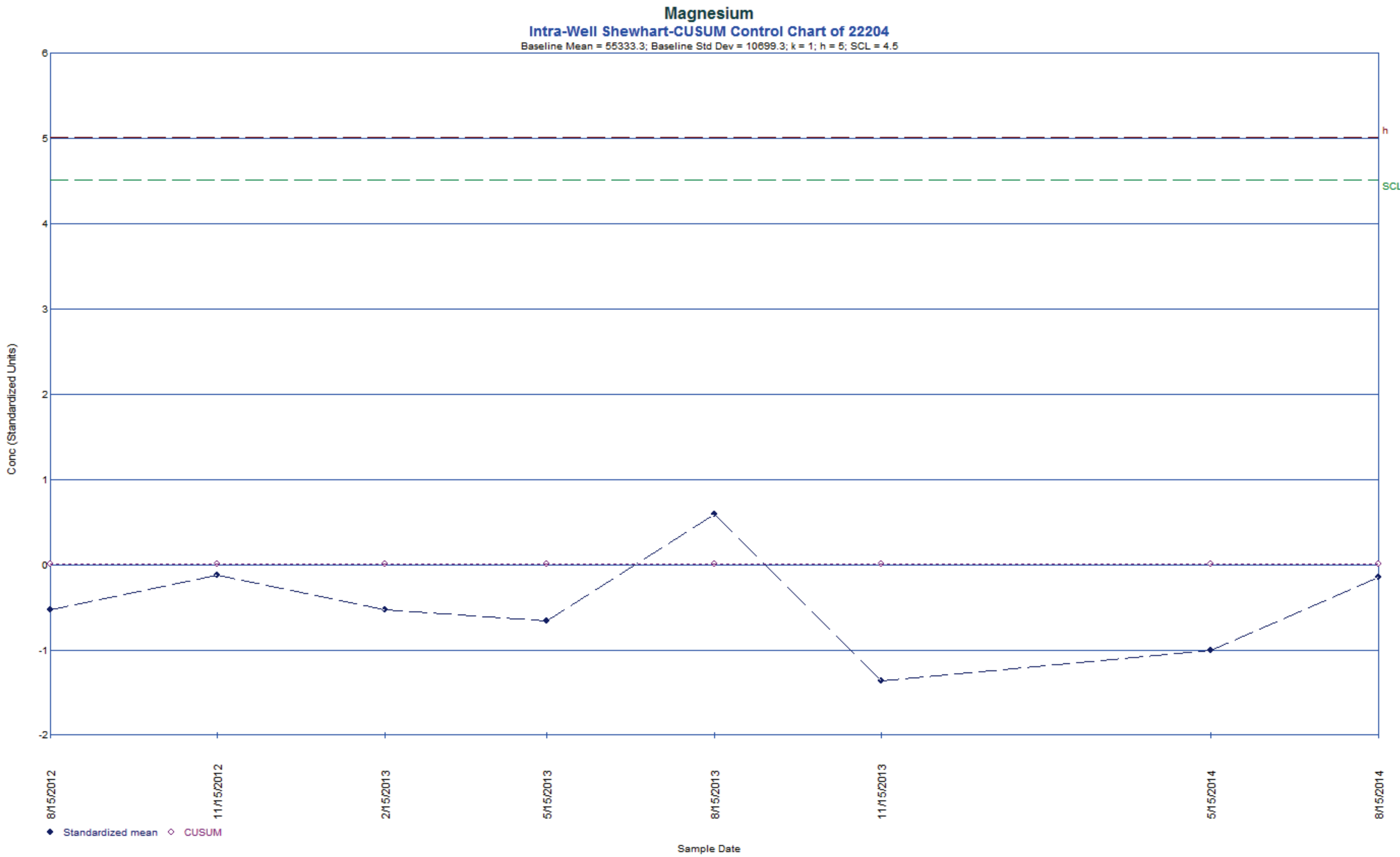


Figure A.5.3-41. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22204)

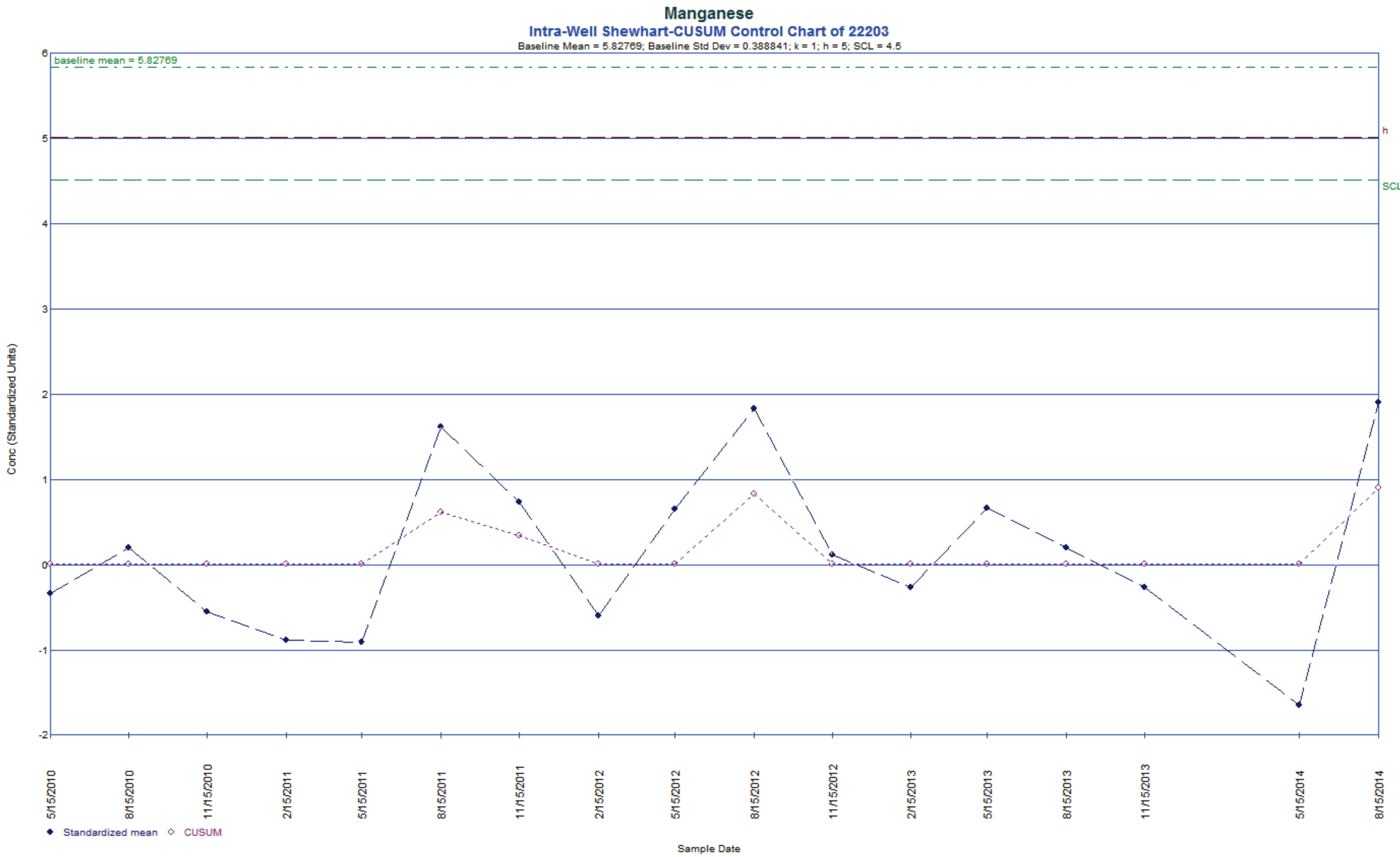


Figure A.5.3-42. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22203)

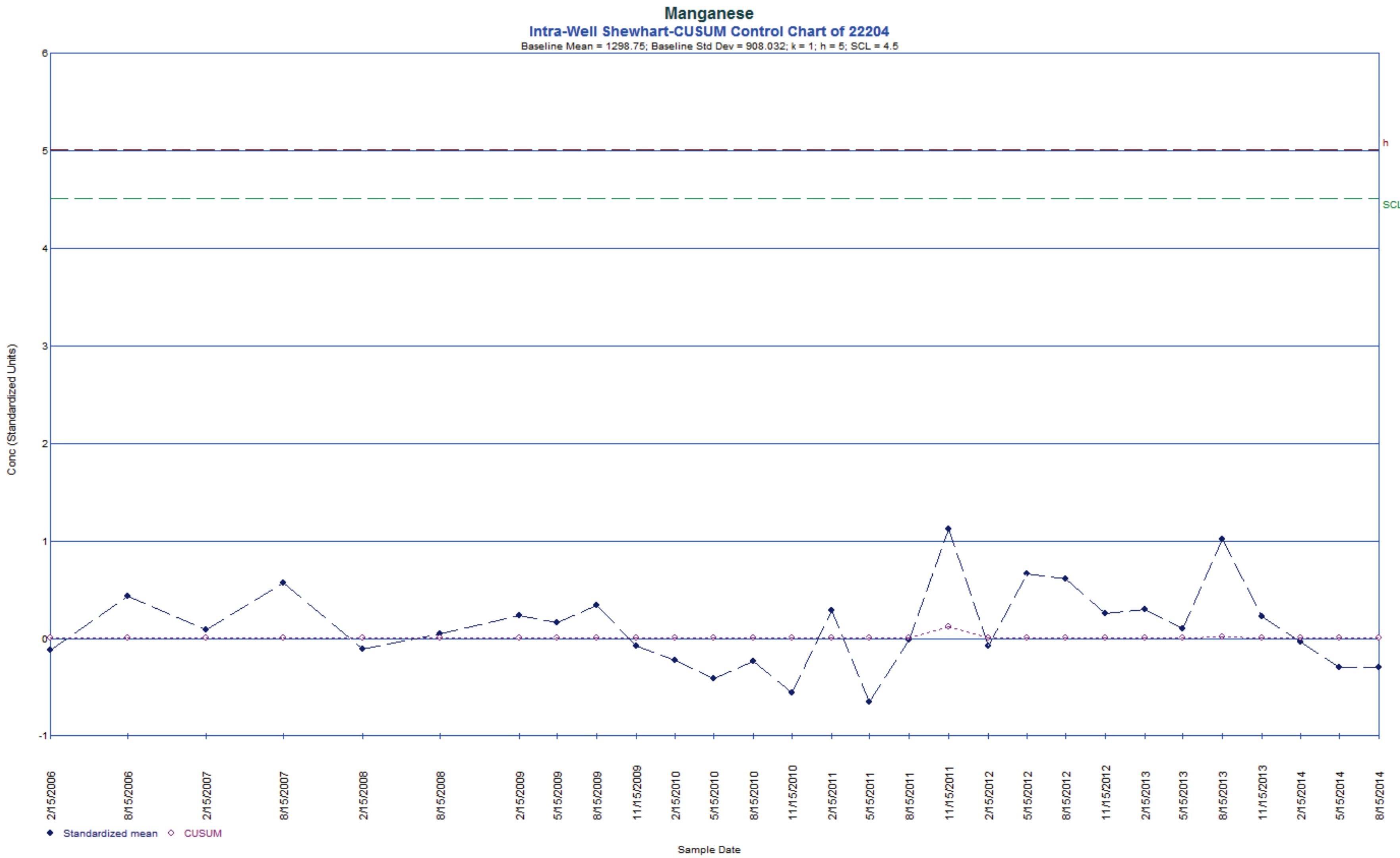


Figure A.5.3-43. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22204)

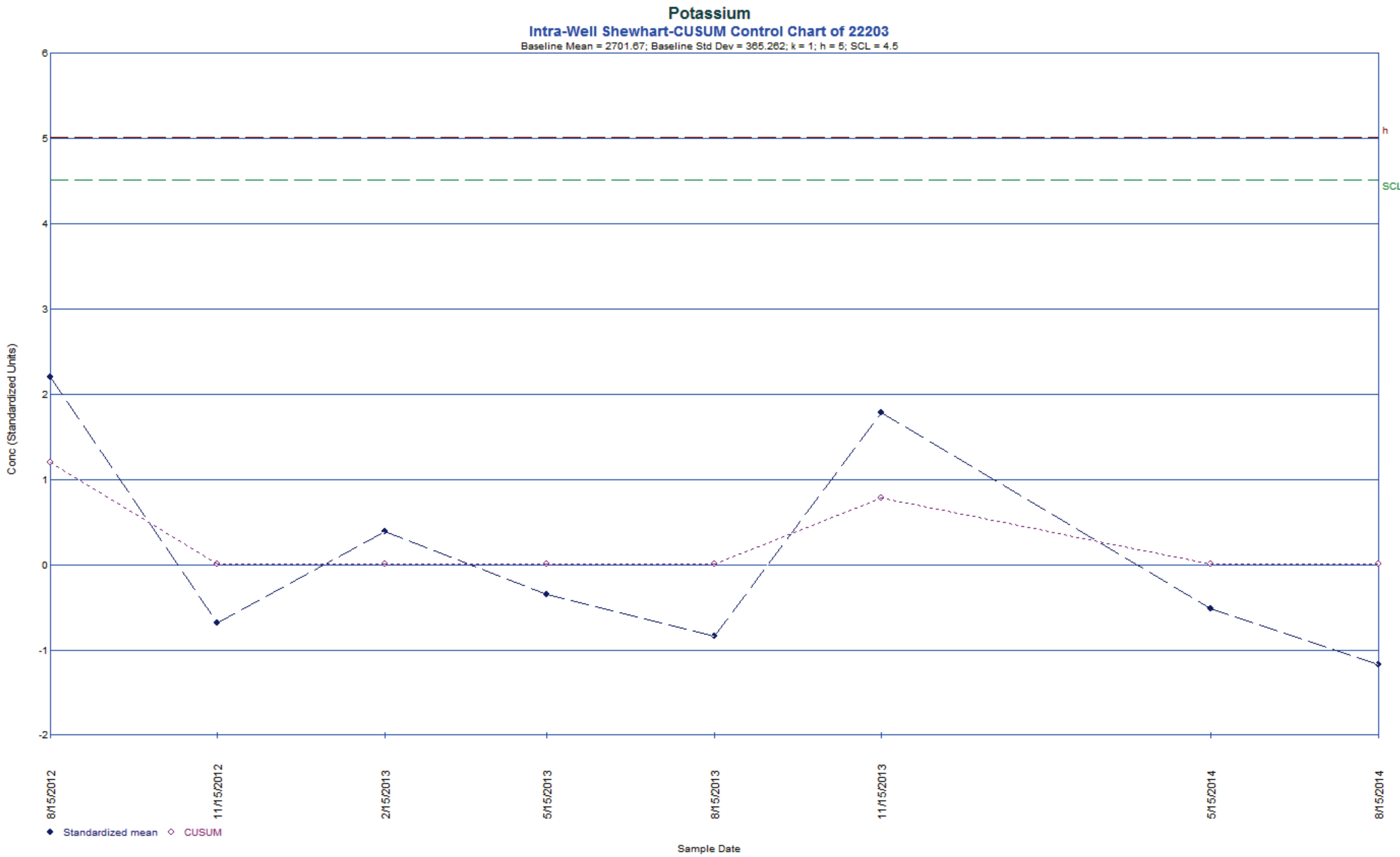


Figure A.5.3-44. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22203)

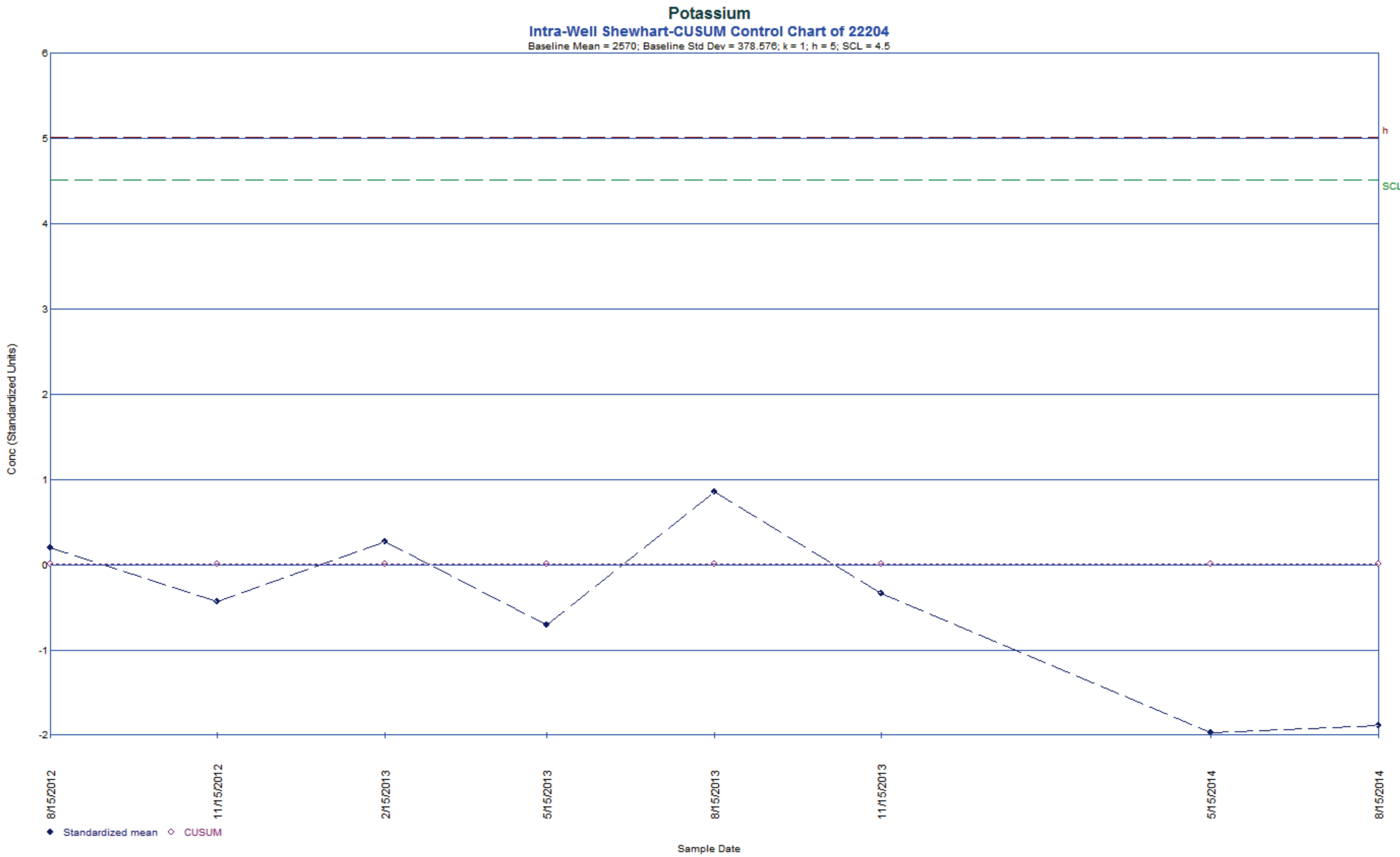


Figure A.5.3-45. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22204)

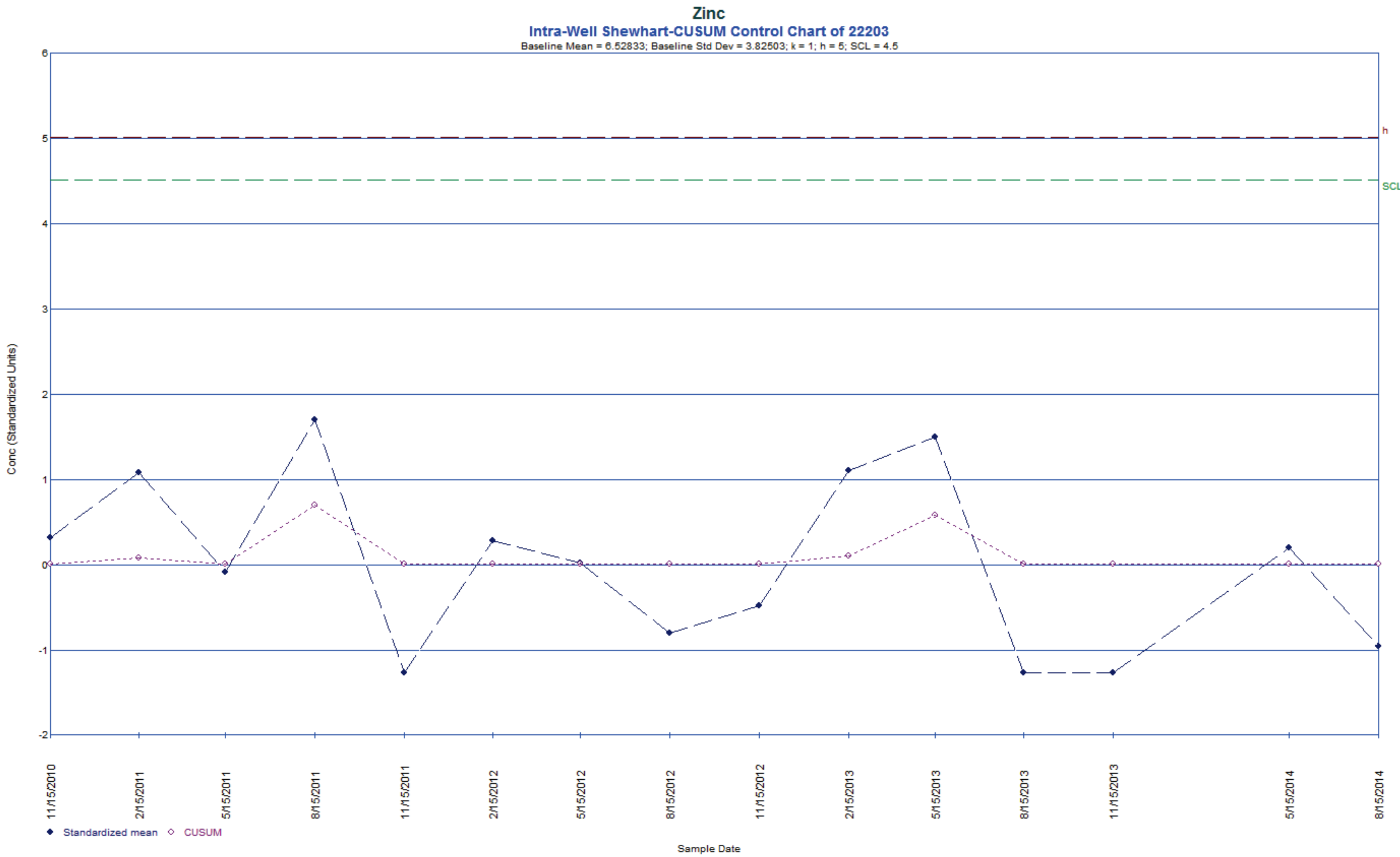


Figure A.5.3-46. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22203)

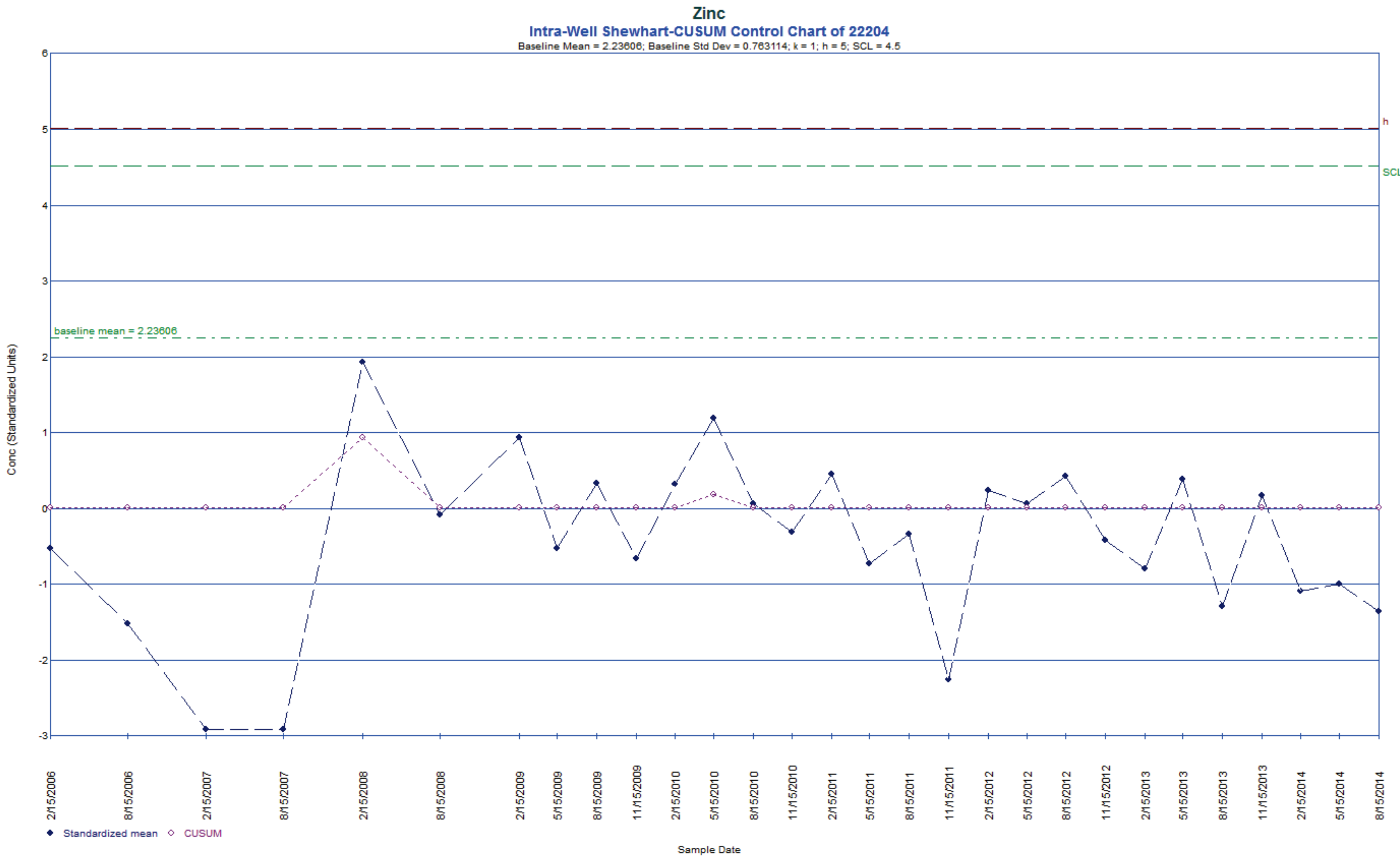


Figure A.5.3-47. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22204)

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Sub-attachment A.5.4

Cell 4

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Contents

Tables

Figures

Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
PCB	polychlorinated biphenyl
SCL	Shewhart control limit
TOC	total organic carbon

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.4-1)
- Annual leachate collection system (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)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.4-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12341 water yield (refer to Figure A.5.4-3)
- Great Miami Aquifer (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 through A.5.4-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.4-30)
- Control charts (refer to Figures A.5.4-31 through A.5.4-46)

A.5.4.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. The LDS of Cell 4 has been dry since 2012. Summary statistics are provided in Table A.5.4-1.

Based on capacitance probe readings, the LDS tank of Cell 4 was dry during three quarters of 2014. It should be noted that the capacitance probes have the ability of measuring to within hundredths of a foot of water present in the bottom of the tank. So, while water may register via the probes, there may not be enough water present to physically obtain a sample. This was the case in 2014 for the LDS in Cell 4. Therefore, from a sampling ability, the LDS in Cell 4 was considered to be dry all year.

As shown in Table A.5.4-1, and summarized below, five parameters (uranium, total organic carbon (TOC), boron, selenium, and sodium) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 4

Parameter	HTW 12341	GMA-U[a] 22206	GMA-D[a] 22205
Total Uranium		Up	
Total Organic Carbon		Up	Up
Boron			Up
Selenium			Up
Sodium		Up	

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

The (uranium-sodium) bivariate plot for the Cell 4 LCS, LDS, and HTW is provided in Figure A.5.4-30. 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, upward concentration trends measured beneath Cell 4 (i.e., in the HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

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 Shewhart-cumulative sum (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 "not in control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart control limit (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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.4-1 in gray shading, 13 parameters in the HTW and/or GMA wells of Cell 4 (uranium, alkalinity, chloride, nitrate + nitrate as nitrogen, sulfate, total organic halogens, arsenic, barium, iron, magnesium, manganese, potassium, and zinc) meet the criteria for control charts (i.e., eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 16 control charts.

These 17 control charts are presented in Figures A.5.4-31 through A.5.4-47. All of the control charts for Cell 4 (with the exception of zinc in GMA well 22205) exhibit “in control” conditions. 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 “not in control” condition is attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

Parameter	Monitoring Point[a]	Well Number	Assessment	Figure Number
Total Uranium	GMA-D	22205	In Control	A.5.4-31
Alkalinity	GMA-U	22206	In Control	A.5.4-32
Chloride	GMA-U	22206	In Control	A.5.4-33
Nitrate + Nitrite as Nitrogen	GMA-D	22205	In Control	A.5.4-34
Sulfate	GMA-D	22205	In Control	A.5.4-35
Total Organic Halogens	GMA-U	22206	In Control	A.5.4-36
Arsenic	HTW	12341	In Control	A.5.4-37
Barium	GMA-U	22206	In Control	A.5.4-38
Barium	GMA-D	22205	In Control	A.5.4-39
Iron	GMA-U	22206	In Control	A.5.4-40
Iron	GMA-D	22205	In Control	A.5.4-41
Magnesium	GMA-U	22206	In Control	A.5.4-42
Magnesium	GMA-D	22205	In Control	A.5.4-43
Manganese	GMA-U	22206	In Control	A.5.4-44
Potassium	GMA-U	22206	In Control	A.5.4-45
Sodium	HTW	12341	In Control	A.5.4-46
Zinc	GMA-D	22205	Not in Control	A.5.4-47

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

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 biannually. No new Appendix I or polychlorinated biphenyl (PCB) parameters were detected in the LCS of Cell 4 in 2014.

A.5.4.4 Summary and Conclusions

- The LDS of Cell 4 has been dry since 2012.
- Five parameters monitored biannually have an upward concentration in the HTW and/or GMA wells of Cell 4: uranium, TOC, boron, selenium, and sodium.
- 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. Therefore, upward concentration trends beneath Cell 4 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.

- Seventeen control charts were constructed for Cell 4 parameters. All but one (i.e., zinc in well 22205) exhibit "in control" conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 4 in 2014.

A.5.4.5 References

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12341C	44	44	100	4.41	171	88.6	31.8	Undefined	None	Detected	
	LDS	12341D	34	34	100	5.74	21.3	14.2	2.9	Normal	None	Detected	
	HTW	12341	49	49	100	4.56	7.89	5.51	0.82	Undefined	Down	Not Detected	
	GMA-U	22206	46	50	92.0	ND	4.67	1.31	1.06	LogNormal	Up	Not Detected	
	GMA-D	22205	52	52	100	0.525	12.1	2.63	2.52	LogNormal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12341C	29	29	100	48.0	583	347	121	Undefined	None	Detected	
	LDS	12341D	13	13	100	142	450	305	106	Normal	None	Not Detected	
	GMA-U	22206	14	14	100	346	404	380	17	Normal	None	Not Detected	
	GMA-D	22205	14	14	100	380	426	398	15	Normal	Down	Not Detected	
Chloride (mg/L)	LCS	12341C	28	29	96.6	ND	190	117	39	Undefined	Up	Detected	
	LDS	12341D	13	13	100	62.8	298	75.8	65.8	Undefined	None	Not Detected	
	GMA-U	22206	14	14	100	21.6	59.1	34.6	8.3	LogNormal	None	Not Detected	
	GMA-D	22205	14	14	100	18.6	25.5	20.8	1.9	Normal	Down	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12341C	24	33	72.7	ND	6.34	0.985	1.49	Undefined	None	Detected	
	LDS	12341D	5	13	38.5	ND	2.28	1.01	0.78	LogNormal	Up	Detected	
	GMA-U	22206	2	14	14.3	ND	0.0250	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22205	3	14	21.4	ND	0.0425	0.0164	Insufficient	LogNormal	None	Not Detected	
Sulfate (mg/L)	LCS	12341C	44	44	100	140	3940	2530	840	Undefined	Up	Detected	
	LDS	12341D	34	34	100	1470	4490	2480	850	LogNormal	Up	Detected	7,870(Q2-11)
	HTW	12341	40	40	100	153	441	226	80	Undefined	Up	Detected	
	GMA-U	22206	45	45	100	90.4	559	234	113	LogNormal	Down	Detected	3,720(Q3-12)
	GMA-D	22205	45	45	100	199	535	335	80	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12341C	32	32	100	351	5370	4760	1480	Undefined	Up	Detected	
	LDS	12341D	11	11	100	4810	7140	5920	890	Normal	Up	Detected	
	GMA-U	22206	21	21	100	559	877	624	92	Undefined	None	Not Detected	
	GMA-D	22205	21	21	100	753	1180	939	111	Normal	None	Detected	
Total Organic Carbon (mg/L)	LCS	12341C	37	44	84.1	ND	5.39	2.36	0.95	Undefined	None	Not Detected	
	LDS	12341D	31	34	91.2	ND	8.00	4.52	1.52	Normal	Down	Detected	
	GMA-U	22206	39	50	78.0	ND	2.39	1.51	0.48	Normal	Up	Detected	9.84(Q2-03)
	GMA-D	22205	39	50	78.0	ND	2.74	1.60	0.48	Normal	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12341C	31	44	70.4	ND	0.0395	0.0162	0.0103	Normal	None	Not Detected	0.060(Q2-10)
	LDS	12341D	26	34	76.5	ND	0.0445	0.0206	0.0113	Normal	None	Not Detected	0.070(Q2-10)
	GMA-U	22206	21	50	42.0	ND	0.0640	0.00774	0.0105	LogNormal	None	Not Detected	
	GMA-D	22205	11	50	22.0	ND	0.0340	0.00253	0.00590	Undefined	None	Detected	
Arsenic (mg/L)	LCS	12341C	10	34	29.4	ND	0.126	0.00375	0.0251	Undefined	None	Detected	
	LDS	12341D	6	20	30.0	ND	0.0274	0.00682	0.00761	LogNormal	None	Not Detected	
	HTW	12341	12	30	40.0	ND	0.0119	0.00445	0.00244	LogNormal	None	Not Detected	0.0938(Q3-09), 0.0307(Q2-10)
	GMA-U	22206	5	21	23.8	ND	0.0365	0.00250	0.00897	Undefined	Down	Detected	
	GMA-D	22205	5	35	14.3	ND	0.0344	0.00250	0.00862	Undefined	Down	Detected	
Barium (mg/L)	LCS	12341C	29	29	100	0.0145	0.0339	0.0233	0.0056	Normal	Down	Detected	0.058(Q2-04), 0.0543(Q4-02)
	LDS	12341D	13	13	100	0.0167	0.0775	0.0388	0.0201	Normal	Down	Detected	
	GMA-U	22206	14	14	100	0.0554	0.0782	0.0670	0.0065	Normal	None	Not Detected	
	GMA-D	22205	14	14	100	0.0478	0.0703	0.0616	0.0066	Normal	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Boron (mg/L)	LCS	12341C	44	44	100	0.0626	1.93	0.875	0.306	Undefined	None	Detected	
	LDS	12341D	34	34	100	0.415	1.81	0.634	0.310	Undefined	None	Detected	
	GMA-U	22206	45	50	90.0	ND	0.0617	0.0417	0.0092	Undefined	None	Not Detected	
	GMA-D	22205	43	50	86.0	ND	0.0807	0.0443	0.0153	Normal	Up	Detected	
Calcium (mg/L)	LCS	12341C	29	29	100	52.9	1110	556	167	Undefined	None	Not Detected	
	LDS	12341D	13	13	100	284	578	424	88	Normal	None	Not Detected	
	GMA-U	22206	14	14	100	141	217	157	28	Undefined	None	Not Detected	
	GMA-D	22205	14	14	100	193	268	226	20	Normal	Down	Detected	
Chromium (mg/L)	LCS	12341C	6	23	26.1	ND	0.0137	0.00350	0.00302	LogNormal	None	Not Detected	
	LDS	12341D	3	10	30.0	ND	0.00640	0.00250	Insufficient	Undefined	Up	Not Detected	
	GMA-U	22206	1	6	16.7	ND	0.00401	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22205	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Cobalt (mg/L)	LCS	12341C	13	34	38.2	ND	0.00570	0.000500	0.00136	Undefined	Down	Detected	
	LDS	12341D	11	20	55.0	ND	0.00640	0.00150	0.00181	Undefined	Down	Detected	
	GMA-U	22206	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22205	4	21	19.0	ND	0.00211	0.000500	0.000494	Undefined	None	Detected	
Copper (mg/L)	LCS	12341C	16	30	53.3	ND	0.132	0.00750	0.0239	Undefined	None	Not Detected	
	LDS	12341D	10	15	66.7	ND	0.0259	0.0115	0.0080	Normal	None	Not Detected	
	GMA-U	22206	8	14	57.1	ND	0.0712	0.00195	0.0183	Undefined	Down	Not Detected	
	GMA-D	22205	7	14	50.0	ND	0.0183	0.00150	0.00515	Undefined	Down	Not Detected	
Iron (mg/L)	LCS	12341C	23	34	67.6	ND	4.18	0.0697	1.22	Undefined	Down	Detected	
	LDS	12341D	16	20	80.0	ND	27.8	9.02	6.39	LogNormal	Down	Detected	
	GMA-U	22206	21	21	100	0.986	22.8	8.82	4.84	Normal	None	Not Detected	
	GMA-D	22205	21	21	100	2.30	9.37	6.04	1.45	Normal	None	Not Detected	12.2(Q2-13)
Lithium (mg/L)	LCS	12341C	30	30	100	0.0818	0.187	0.134	0.030	Normal	Up	Detected	
	LDS	12341D	19	19	100	0.0951	0.331	0.174	0.066	Normal	Up	Detected	
	GMA-U	22206	21	21	100	0.0110	0.0175	0.0135	0.0019	Normal	Down	Detected	
	GMA-D	22205	21	21	100	0.00685	0.0102	0.00818	0.00083	Normal	None	Detected	0.0167(Q3-11)
Magnesium (mg/L)	LCS	12341C	29	29	100	15.0	732	557	183	Undefined	Up	Detected	
	LDS	12341D	13	13	100	159	548	189	158	Undefined	Up	Detected	
	GMA-U	22206	14	14	100	30.2	43.8	35.7	4.4	Normal	None	Not Detected	
	GMA-D	22205	14	14	100	45.2	63.2	51.8	4.8	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12341C	15	34	44.1	ND	2.14	0.0100	0.411	Undefined	Down	Detected	
	LDS	12341D	12	20	60.0	ND	1.85	0.955	0.496	LogNormal	Down	Detected	
	GMA-U	22206	23	23	100	0.311	0.708	0.443	0.105	LogNormal	None	Not Detected	
	GMA-D	22205	34	35	97.1	ND	1.10	0.620	0.180	Normal	Down	Not Detected	
Nickel (mg/L)	LCS	12341C	29	34	85.3	ND	0.0474	0.00890	0.0116	LogNormal	Down	Detected	
	LDS	12341D	18	20	90.0	ND	0.0474	0.0178	0.0118	Normal	None	Detected	
	GMA-U	22206	2	21	9.5	ND	0.0249	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22205	11	35	31.4	ND	0.0135	0.000750	0.00252	Undefined	None	Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Potassium (mg/L)	LCS	12341C	29	29	100	3.81	78.4	21.9	11.7	Undefined	None	Not Detected	
	LDS	12341D	13	13	100	31	137	36.5	30.3	Undefined	None	Detected	
	GMA-U	22206	14	14	100	3.69	4.39	3.97	0.21	Normal	None	Not Detected	
	GMA-D	22205	14	14	100	2.25	3.22	2.64	0.24	Normal	Down	Not Detected	
Selenium (mg/L)	LCS	12341C	9	34	26.5	ND	0.0855	0.00771	0.0147	LogNormal	None	Not Detected	0.231(Q4-09)
	LDS	12341D	2	20	10	ND	0.0670	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22206	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22205	1	21	4.8	ND	0.0122	Insufficient	Insufficient	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12341C	34	34	100	22.0	117	53.2	15.2	Undefined	Up	Detected	
	LDS	12341D	20	20	100	307	623	458	87	Normal	Up	Detected	
	HTW	12341	30	30	100	14.1	18.1	15.4	0.9	Normal	None	Not Detected	
	GMA-U	22206	21	21	100	12.3	21.9	16.2	3.0	Normal	Up	Detected	
	GMA-D	22205	21	21	100	14.0	22.2	18.1	2.3	Normal	None	Detected	
Zinc (mg/L)	LCS	12341C	14	34	41.2	ND	0.0446	0.00825	0.00970	Undefined	None	Not Detected	
	LDS	12341D	17	20	85.0	ND	0.775	0.311	0.251	LogNormal	None	Detected	
	GMA-U	22206	13	21	61.9	ND	0.0499	0.00760	0.0104	Undefined	None	Not Detected	
	GMA-D	22205	20	35	57.1	ND	0.0117	0.00441	0.00268	LogNormal	None	Not Detected	

Note 1: 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 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Background[a,b,e] (Number of Samples Greater than Groundwater	Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched Water)
General Chemistry											
Ammonia (mg/L)	13	7	53.8	Yes	0.0268	0.133	0.0730	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganic											
Lead (mg/L)	13	1	7.70	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)	19	6	31.6	Yes	1.21	37.8	15.5	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 final remediation level (FRL), groundwater background, perched water background, or perched water 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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

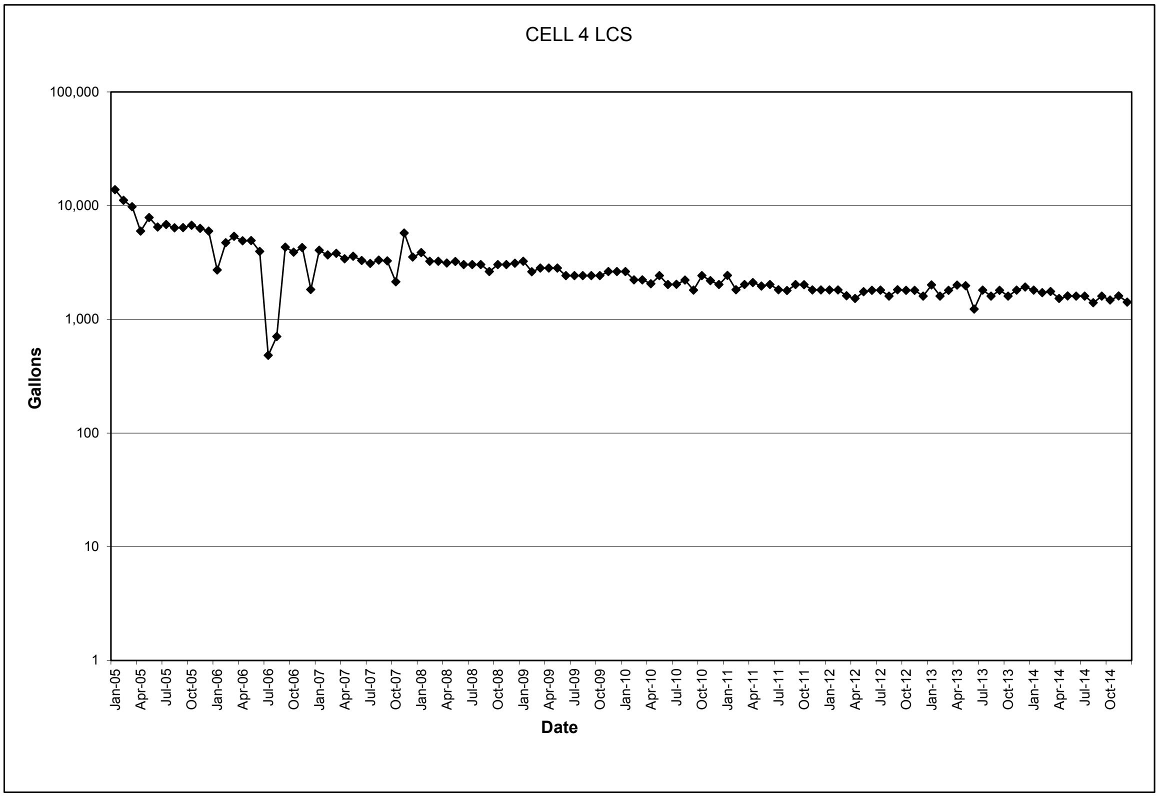


Figure A.5.4-1. Monthly Accumulation Volumes For Cell 4 LCS

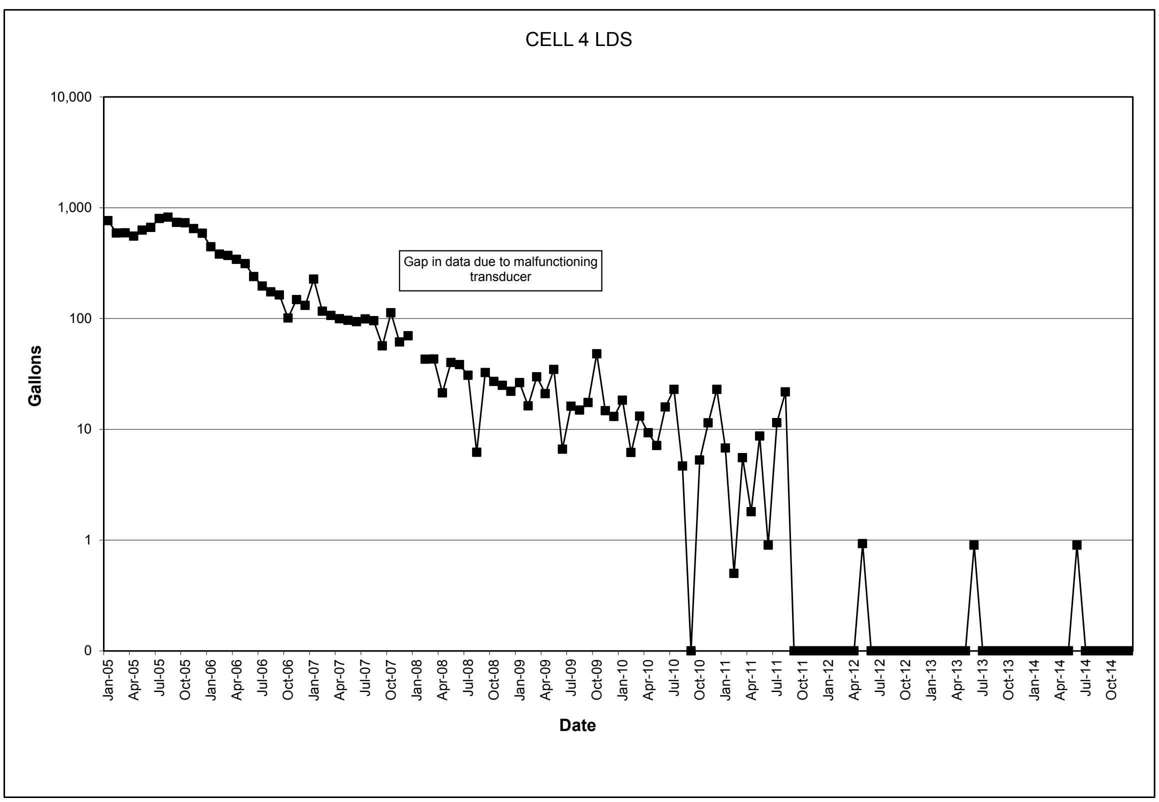
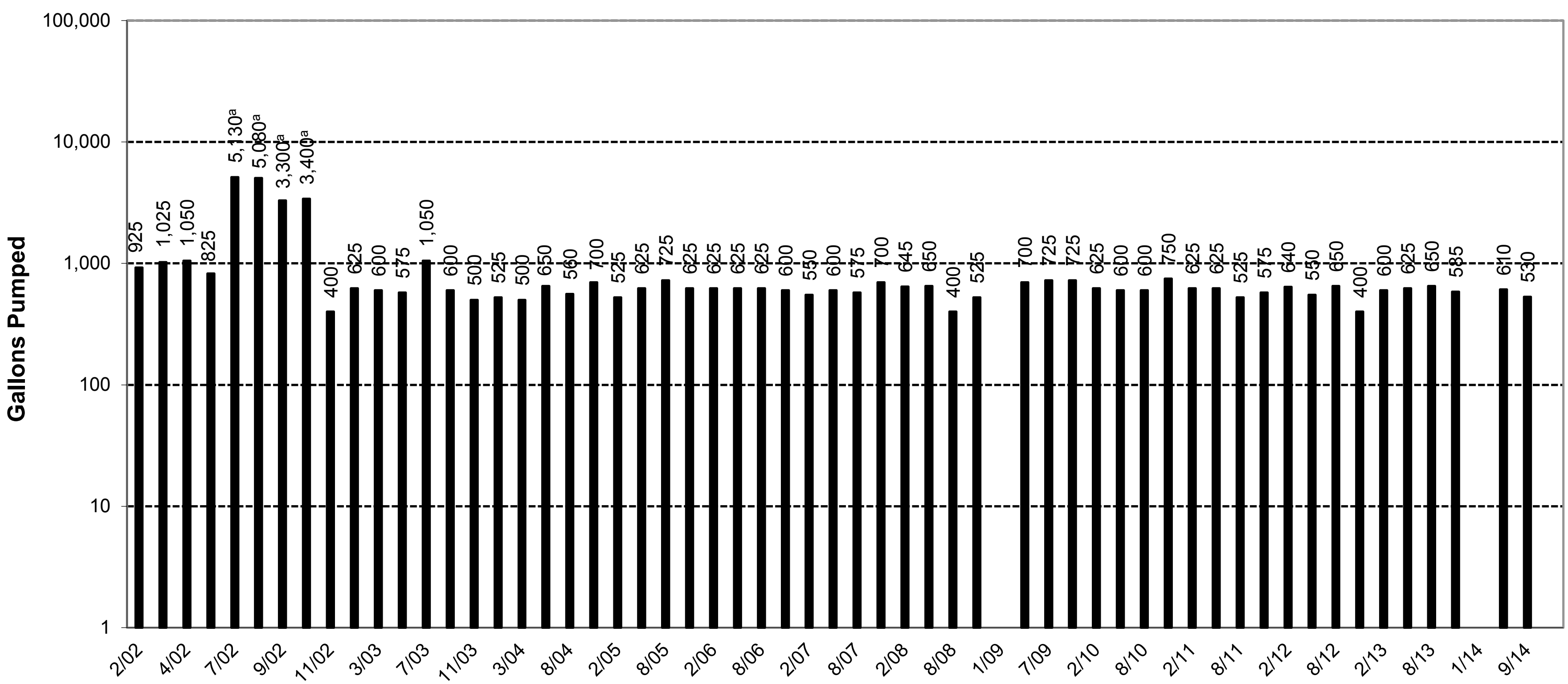


Figure A.5.4-2. Monthly Accumulation Volumes For Cell 4 LDS



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
2012:	2240	n=4	560
2013:	2460	n=4	615
2014[b]:	1140	n=2	570
Overall:			887

[a]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.

[b]Sampling schedule reduced to semiannual sampling in 2014.

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

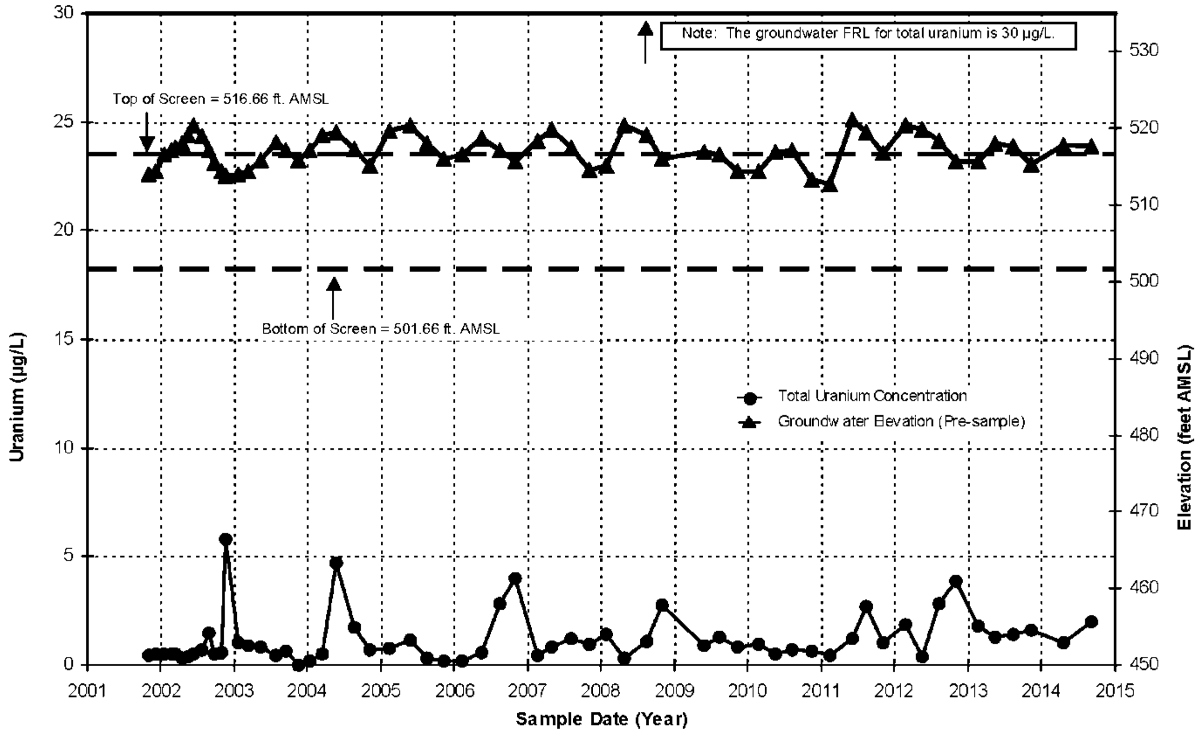


Figure A.5.4-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 4 Upgradient Monitoring Well 22206

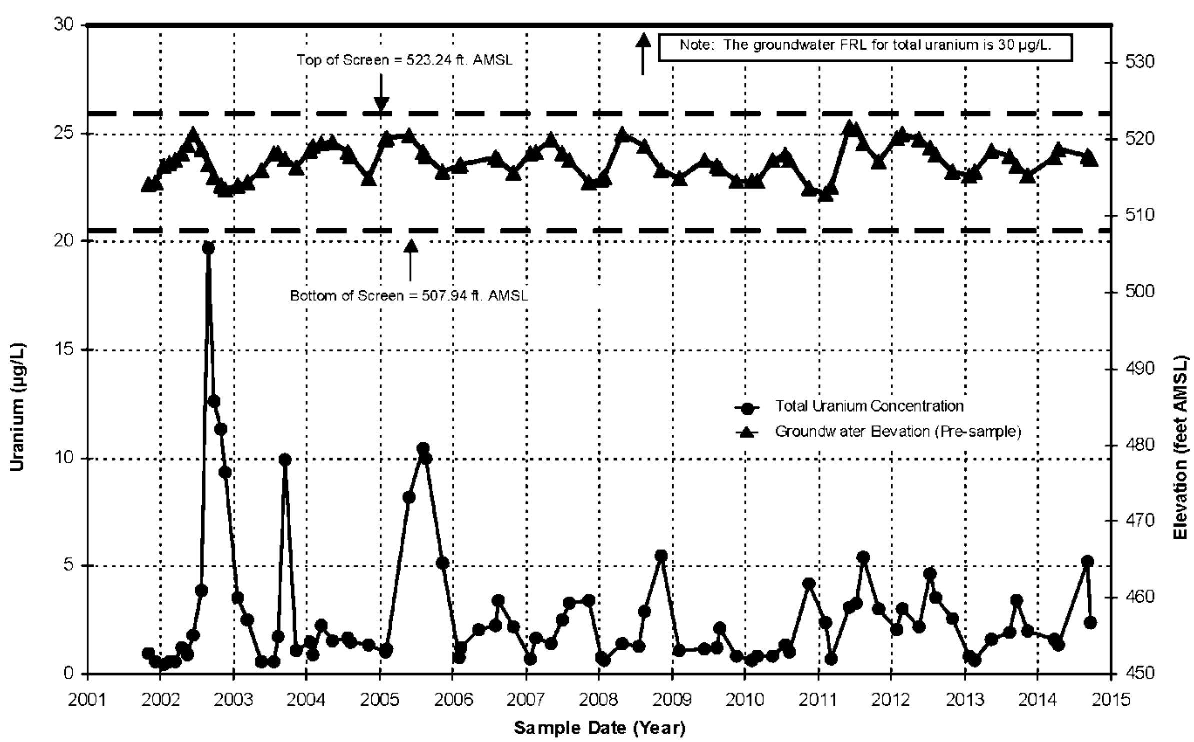


Figure A.5.4-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 4 Downgradient Monitoring Well 22505

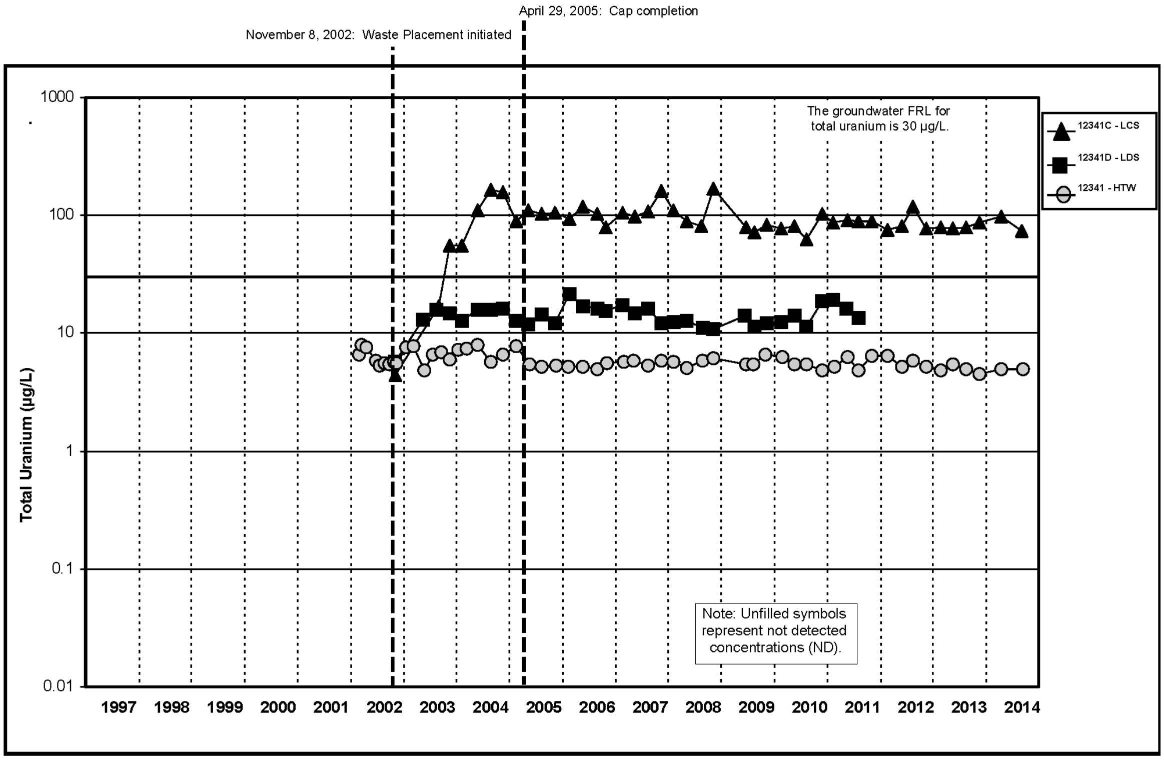


Figure A.5.4-6A. Cell 4 Uranium, Total Concentration Versus Time Plot for LCS, LDS, and HTW

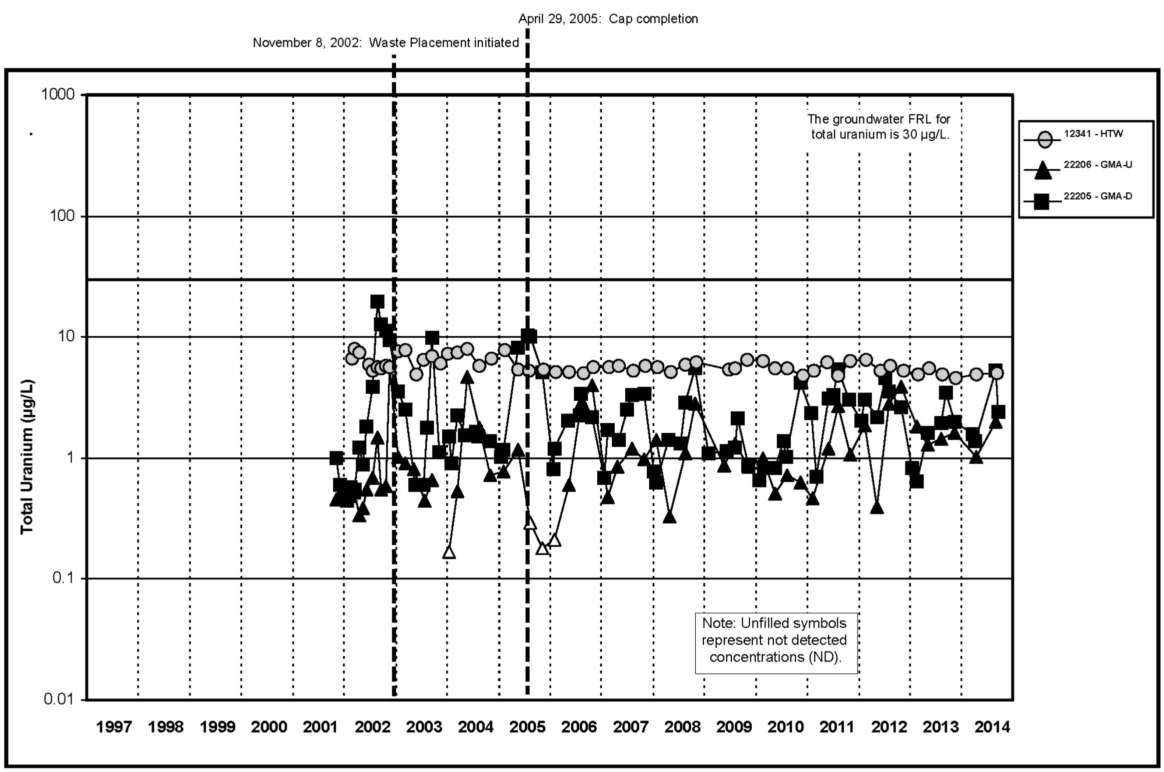


Figure A.5.4-6B. Cell 4 Uranium, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

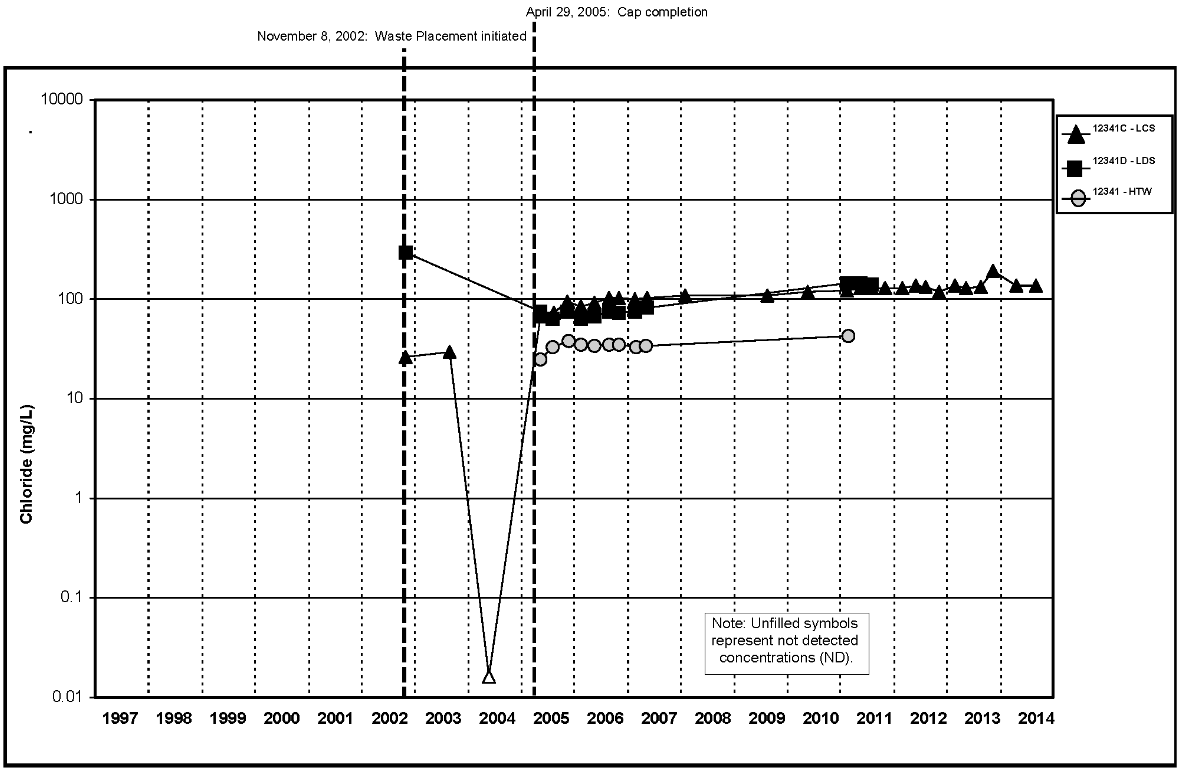


Figure A.5.4-7A. Cell 4 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

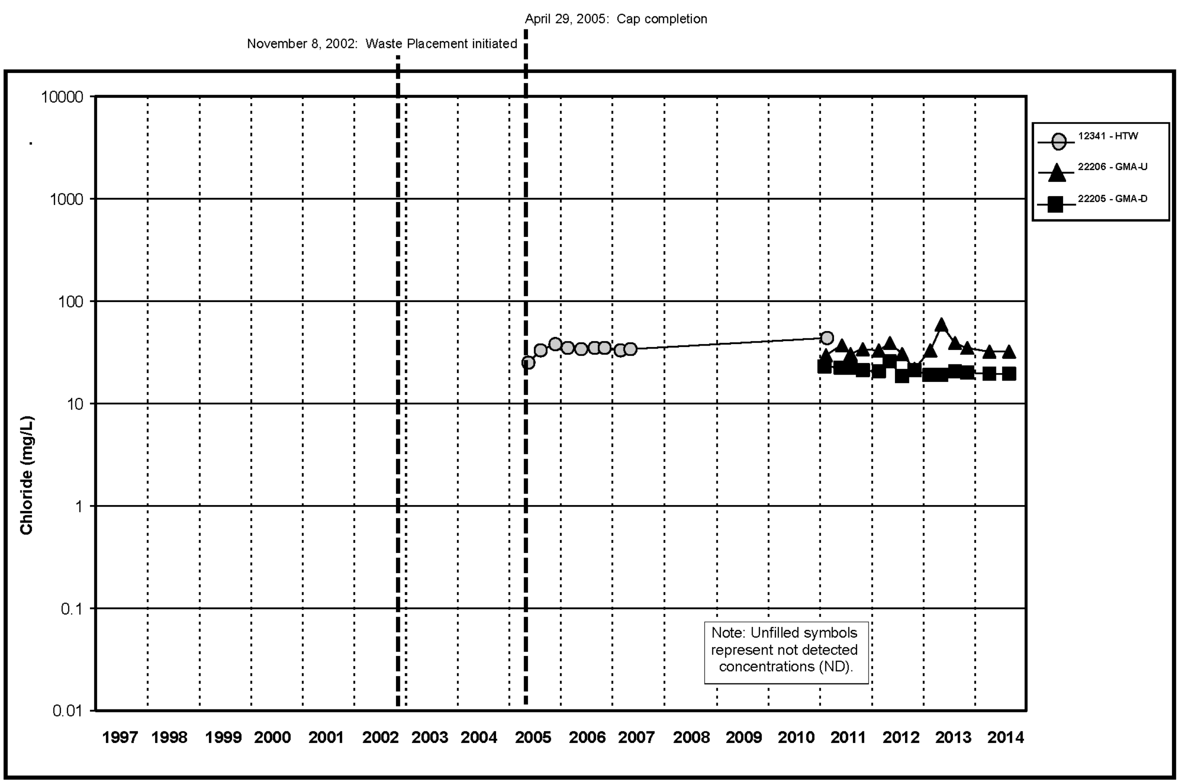


Figure A.5.4-7B. Cell 4 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

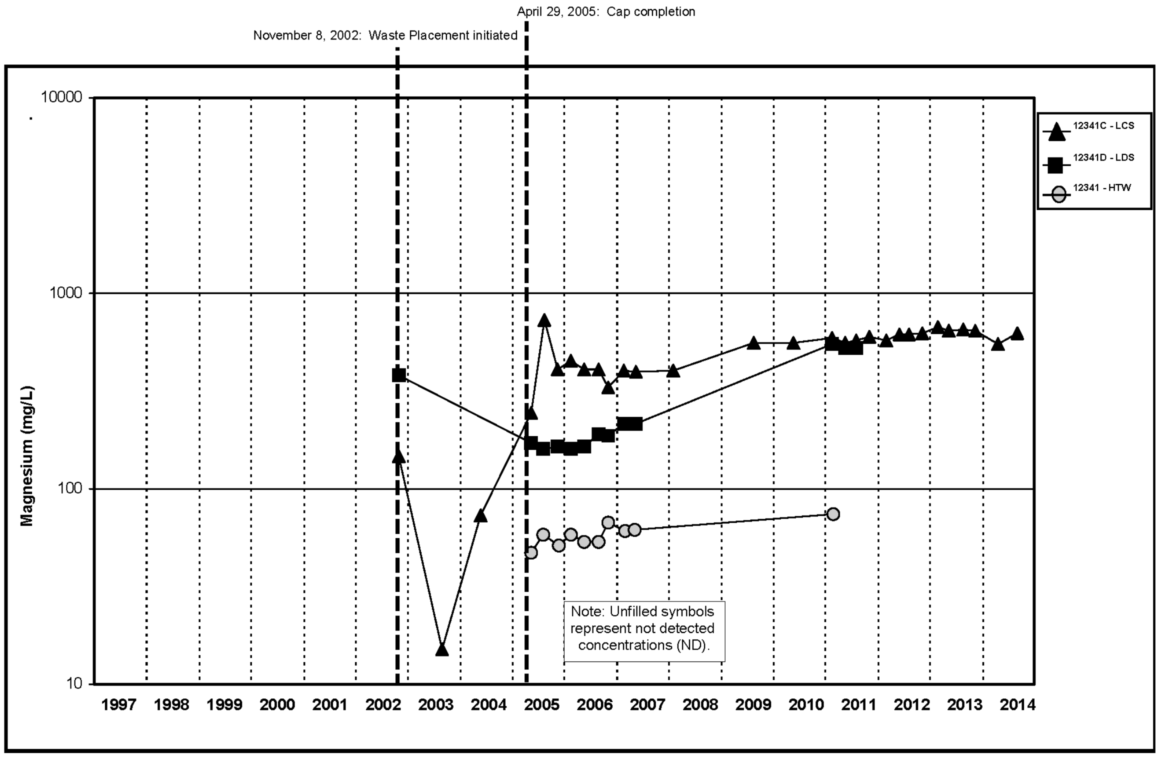


Figure A.5.4-8A. Cell 4 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

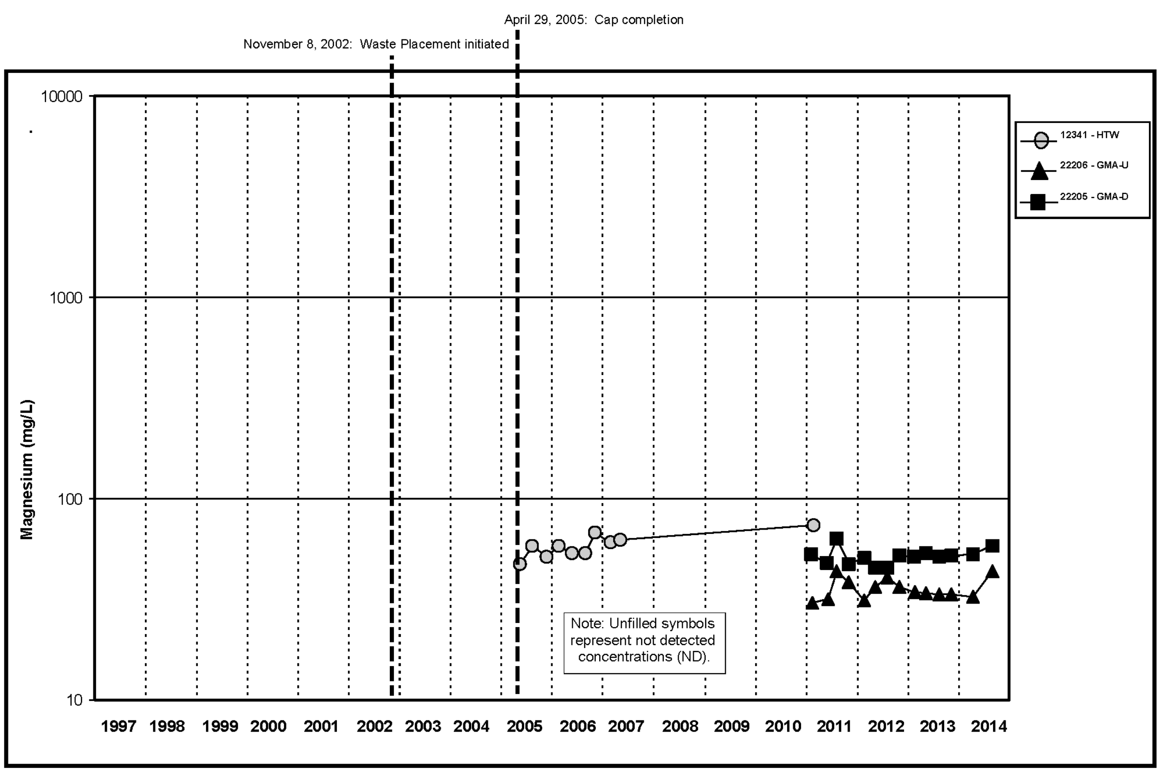


Figure A.5.4-8B. Cell 4 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

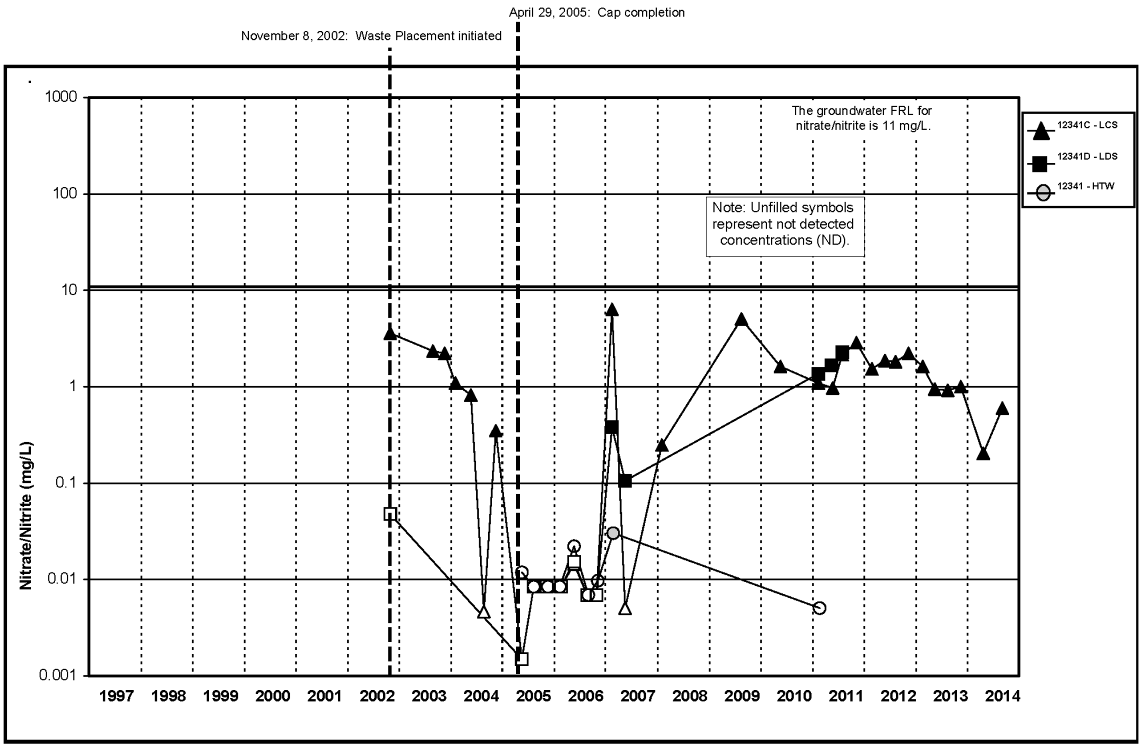


Figure A.5.4-9A. Cell 4 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

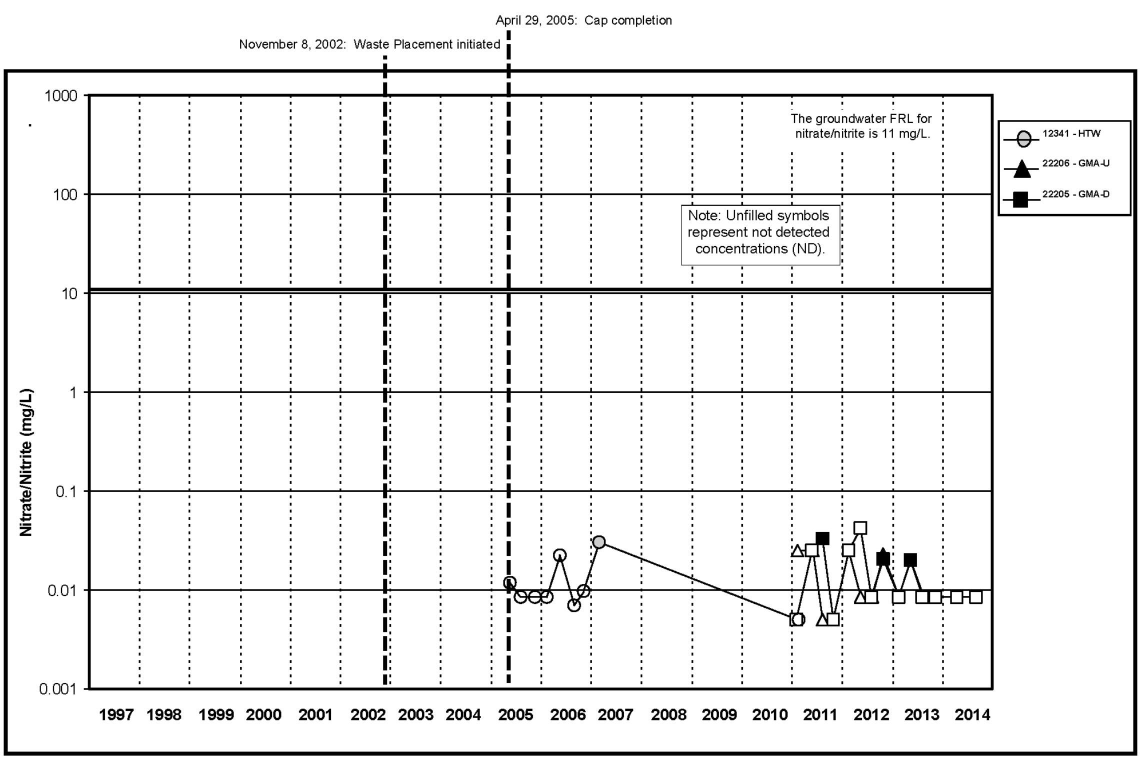


Figure A.5.4-9B. Cell 4 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

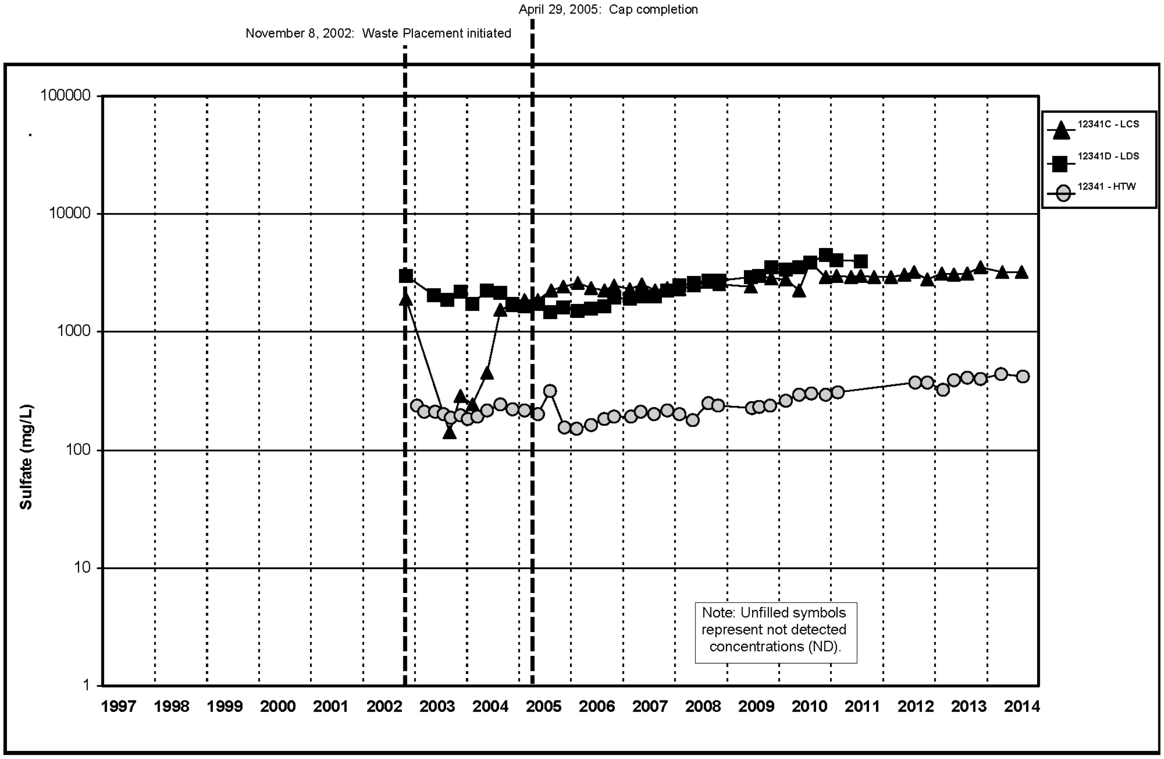


Figure A.5.4-10A. Cell 4 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

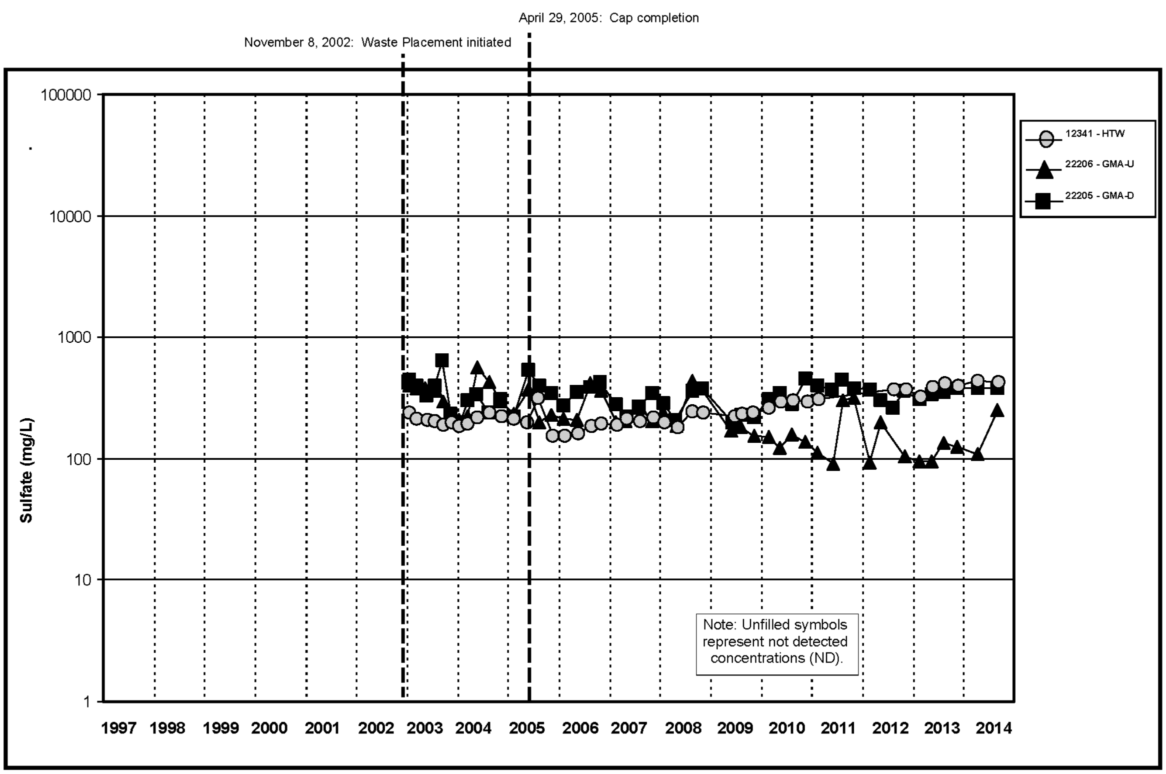


Figure A.5.4-10B. Cell 4 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

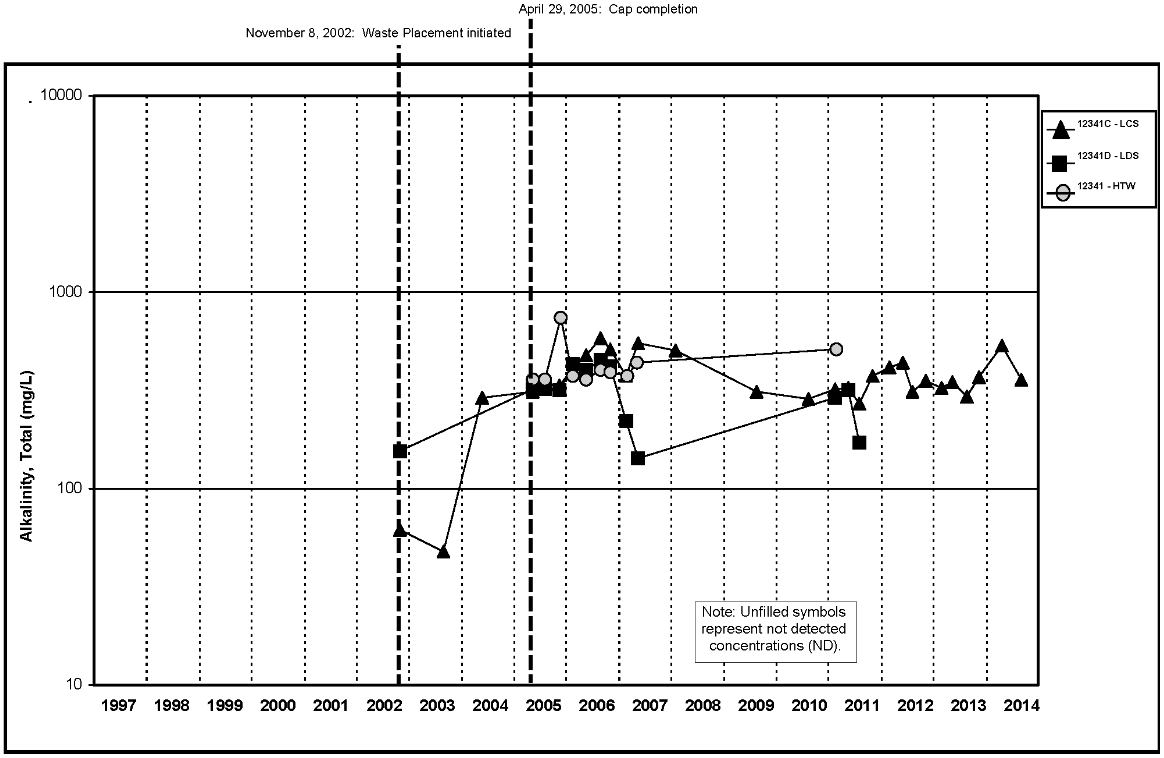


Figure A.5.4-11A. Cell 4 Alkalinity, Total Concentration Versus Time Plot for LCS, LDS, and HTW

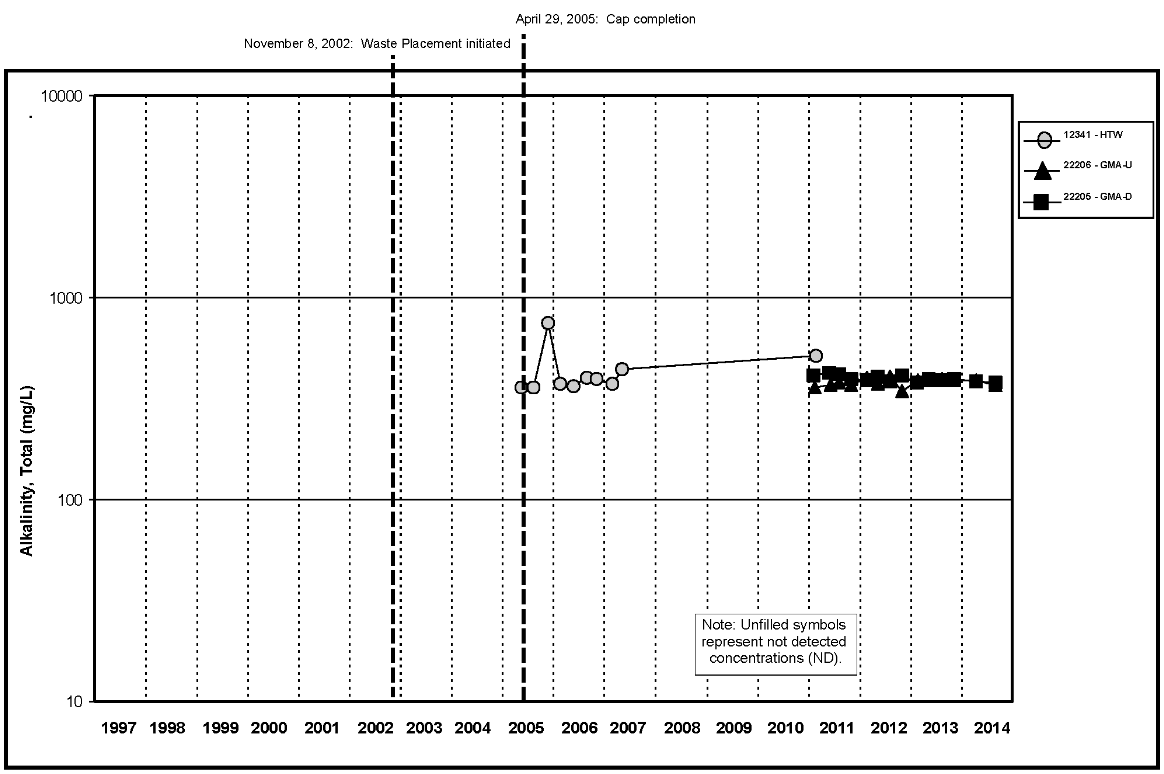


Figure A.5.4-11B. Cell 4 Alkalinity, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

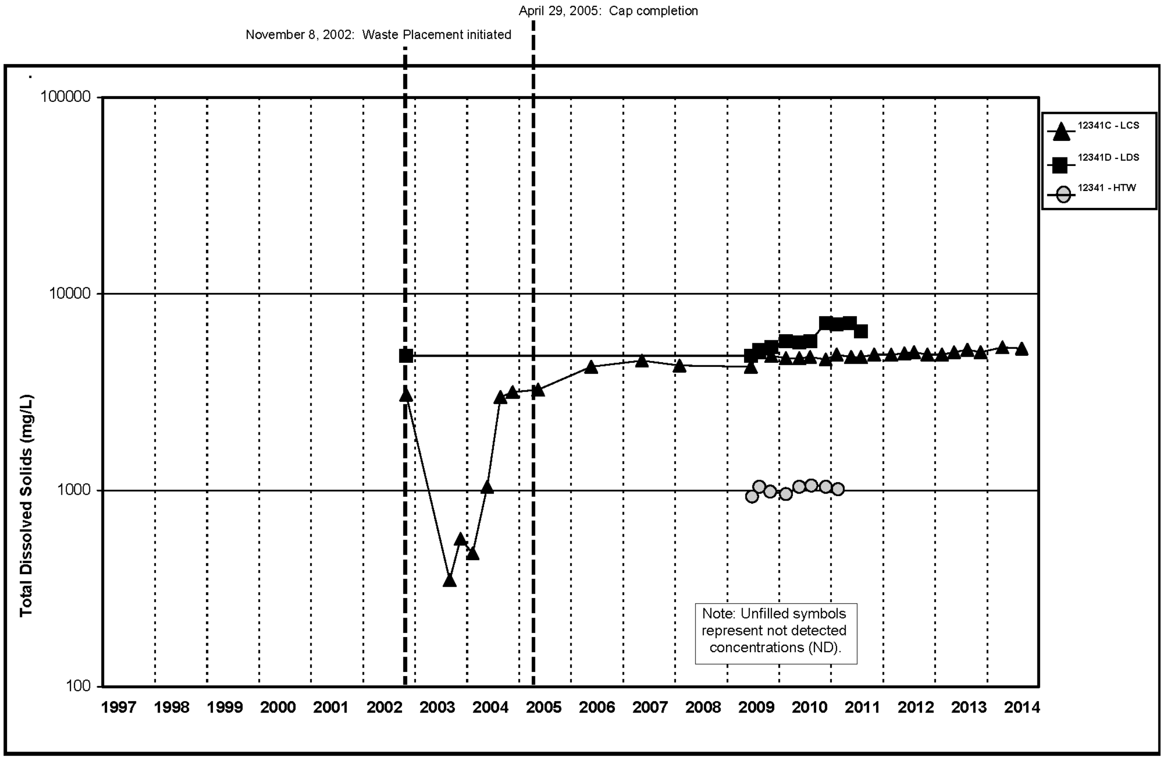


Figure A.5.4-12A. Cell 4 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

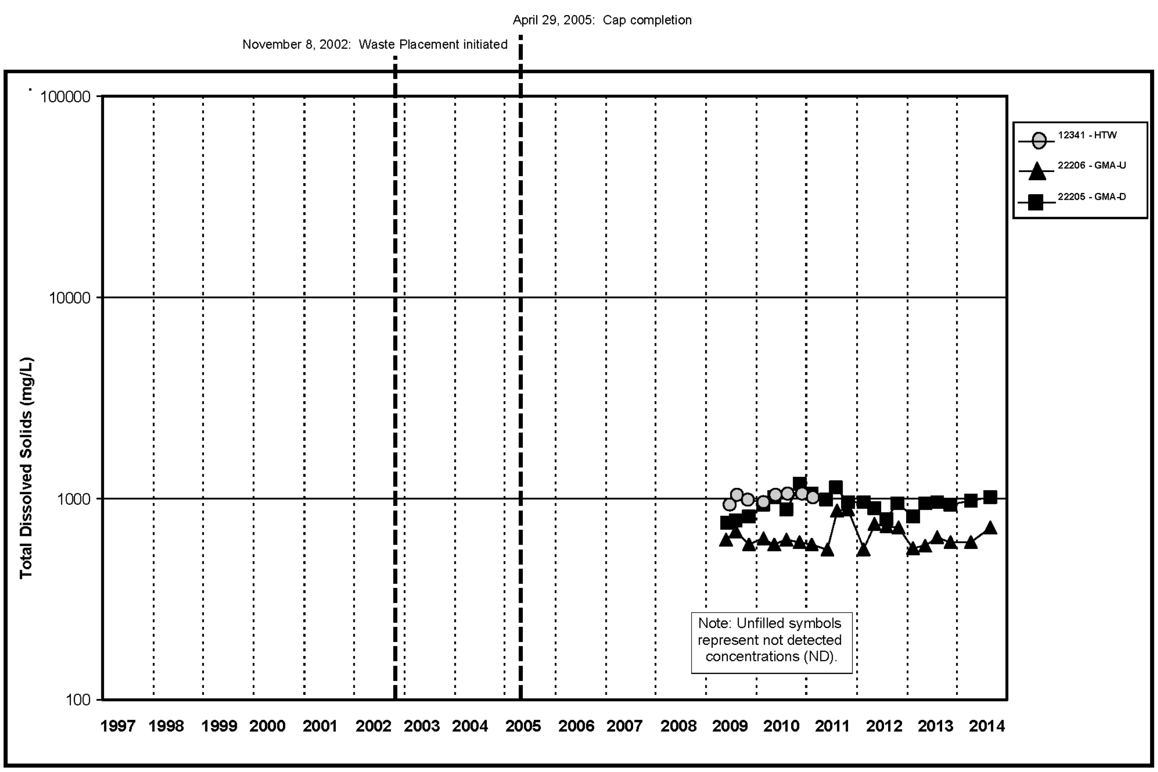


Figure A.5.4-12B. Cell 4 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

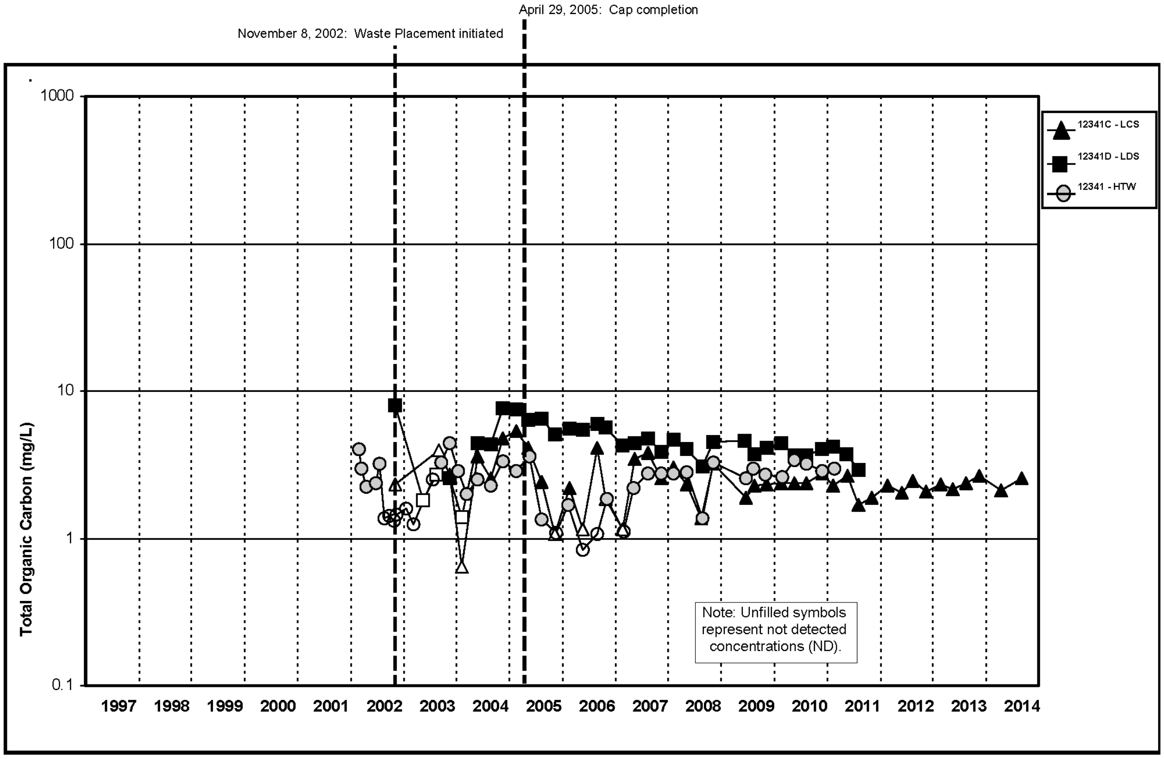


Figure A.5.4-13A. Cell 4 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

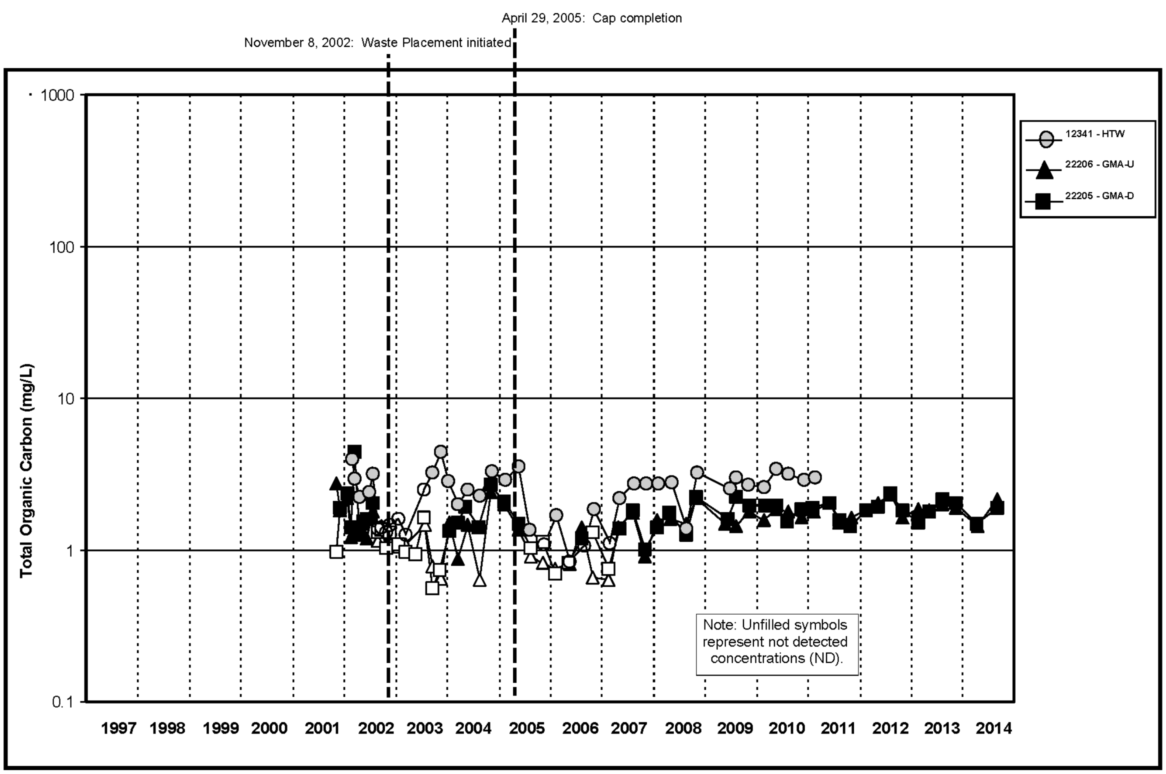


Figure A.5.4-13B. Cell 4 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

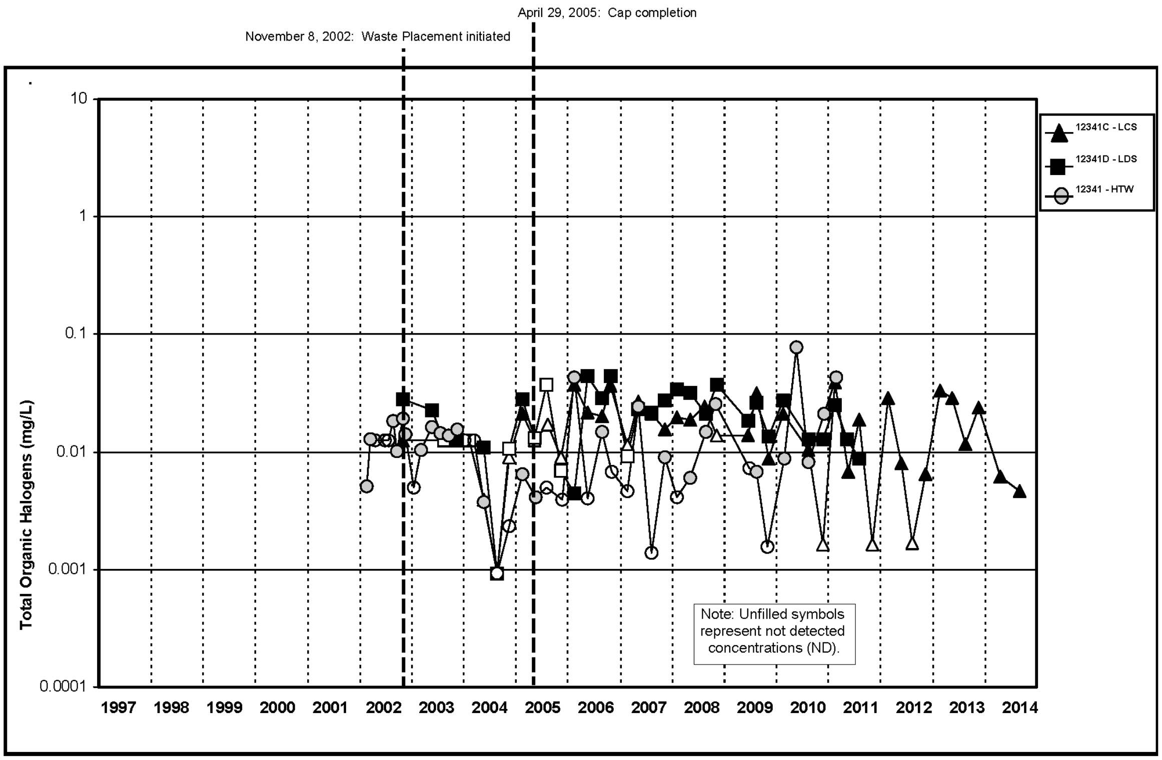


Figure A.5.4-14A. Cell 4 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

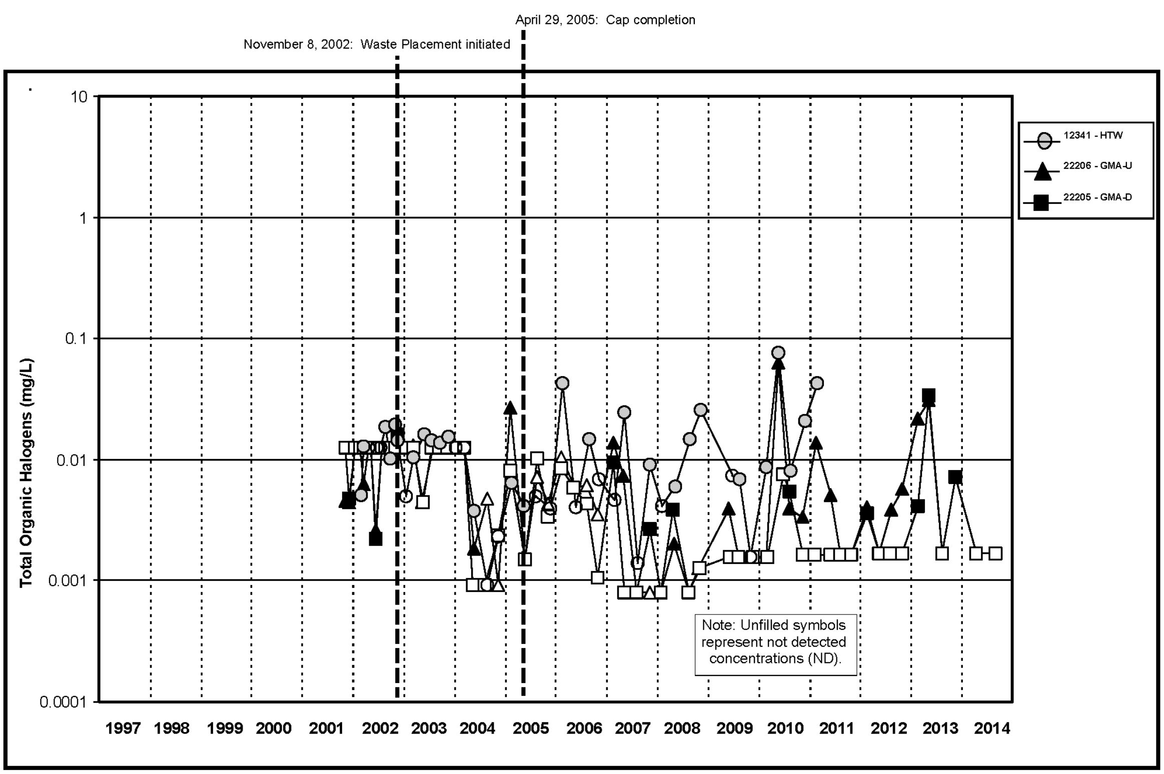


Figure A.5.4-14B. Cell 4 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

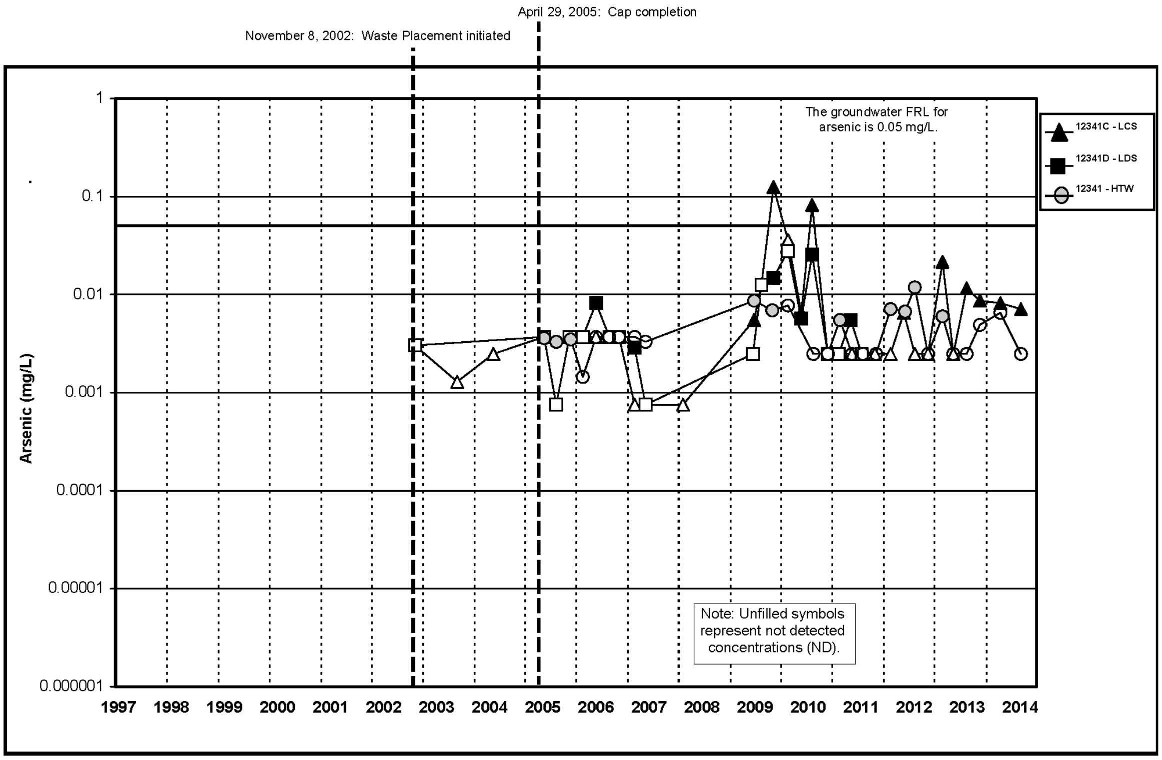


Figure A.5.4-15A. Cell 4 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

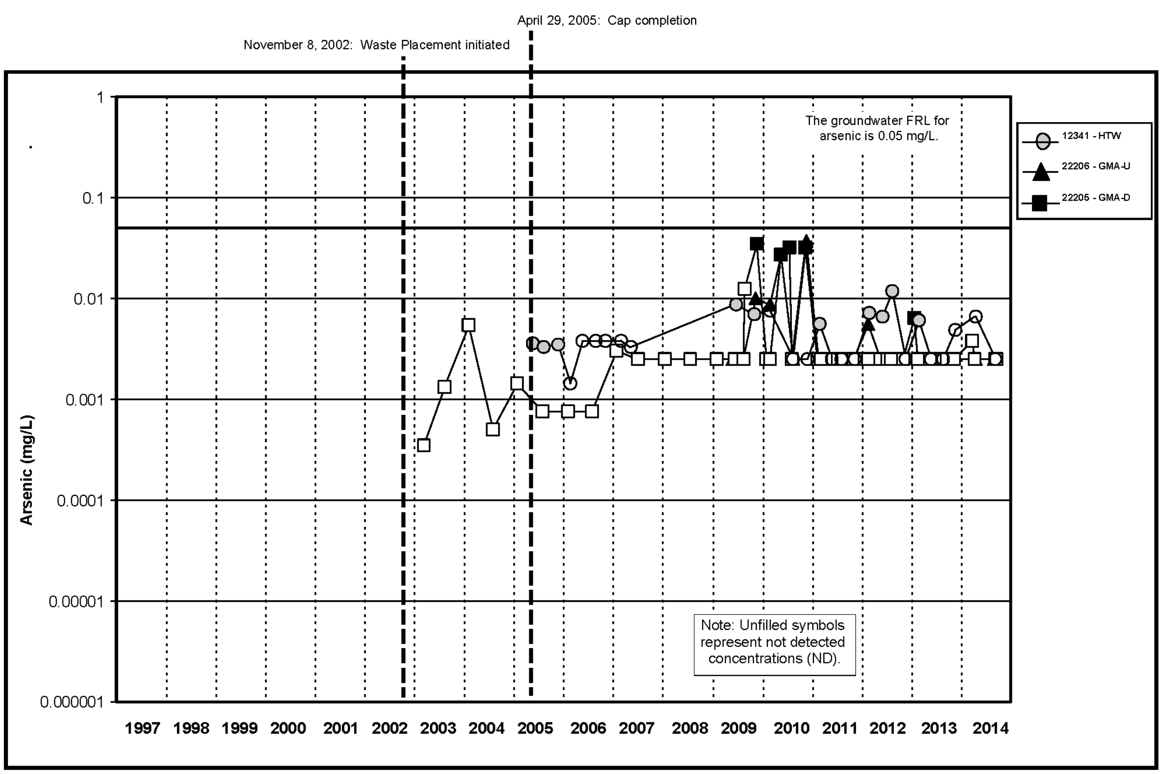


Figure A.5.4-15B. Cell 4 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

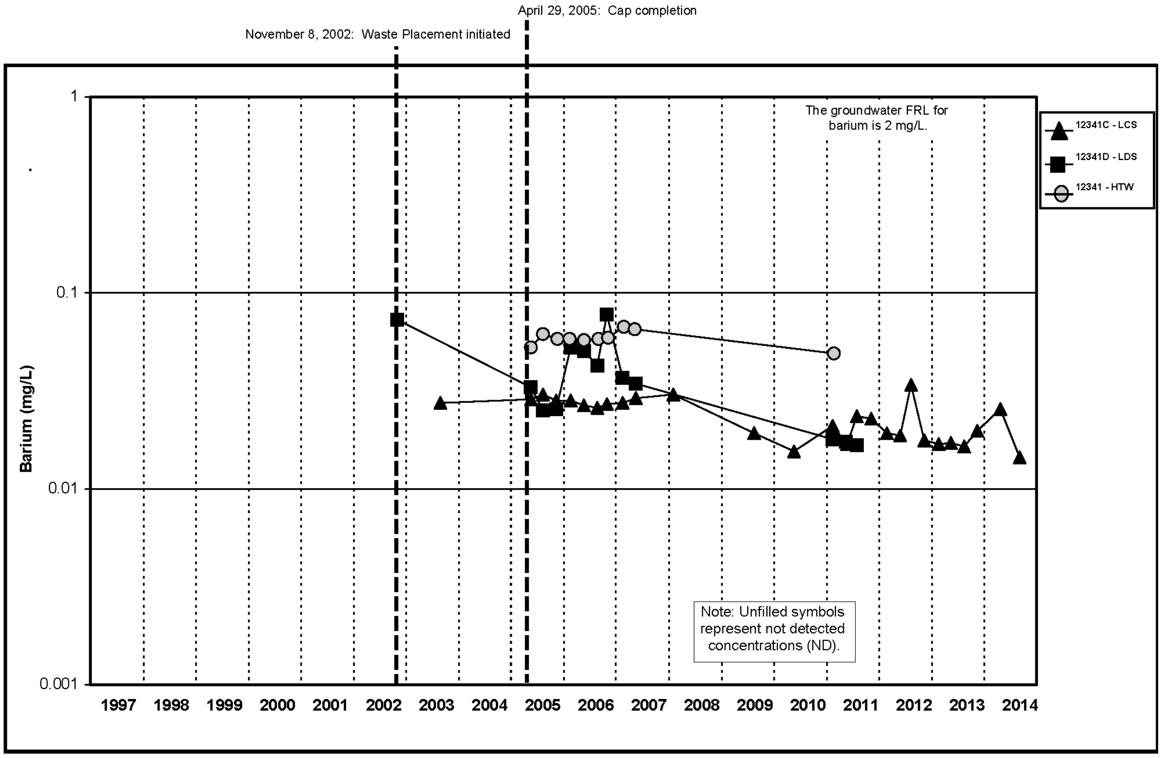


Figure A.5.4-16A. Cell 4 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

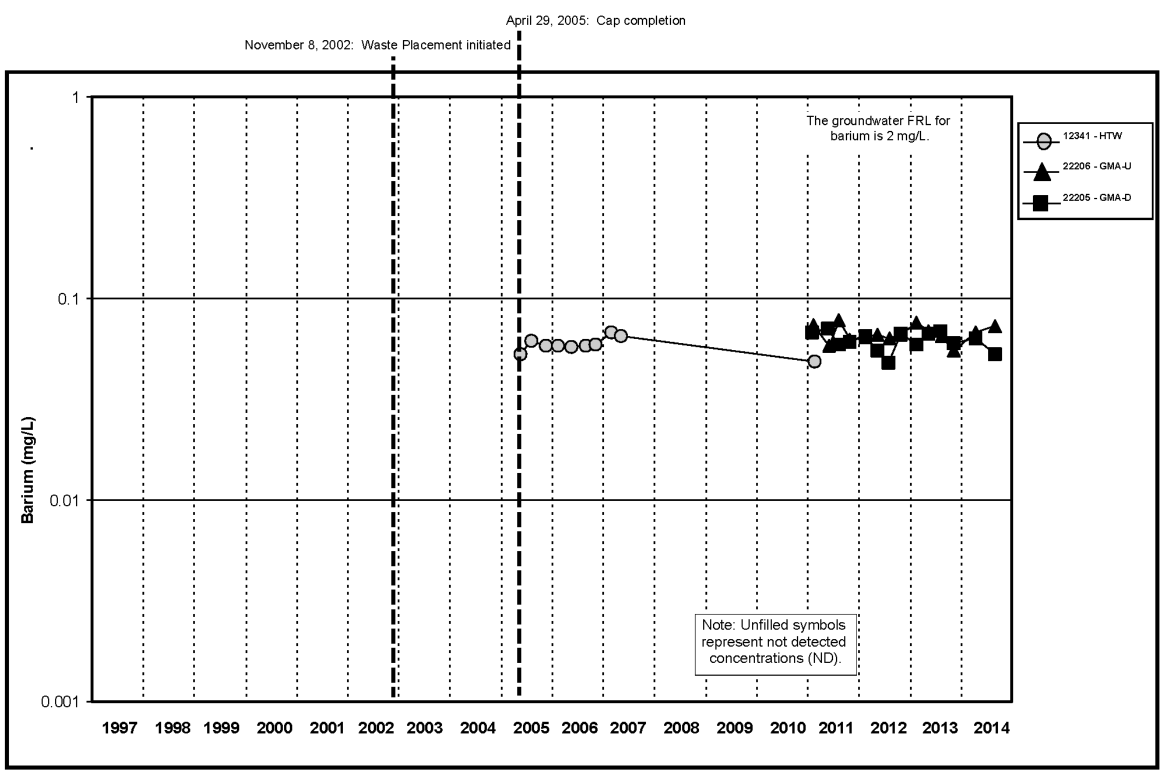


Figure A.5.4-16B. Cell 4 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

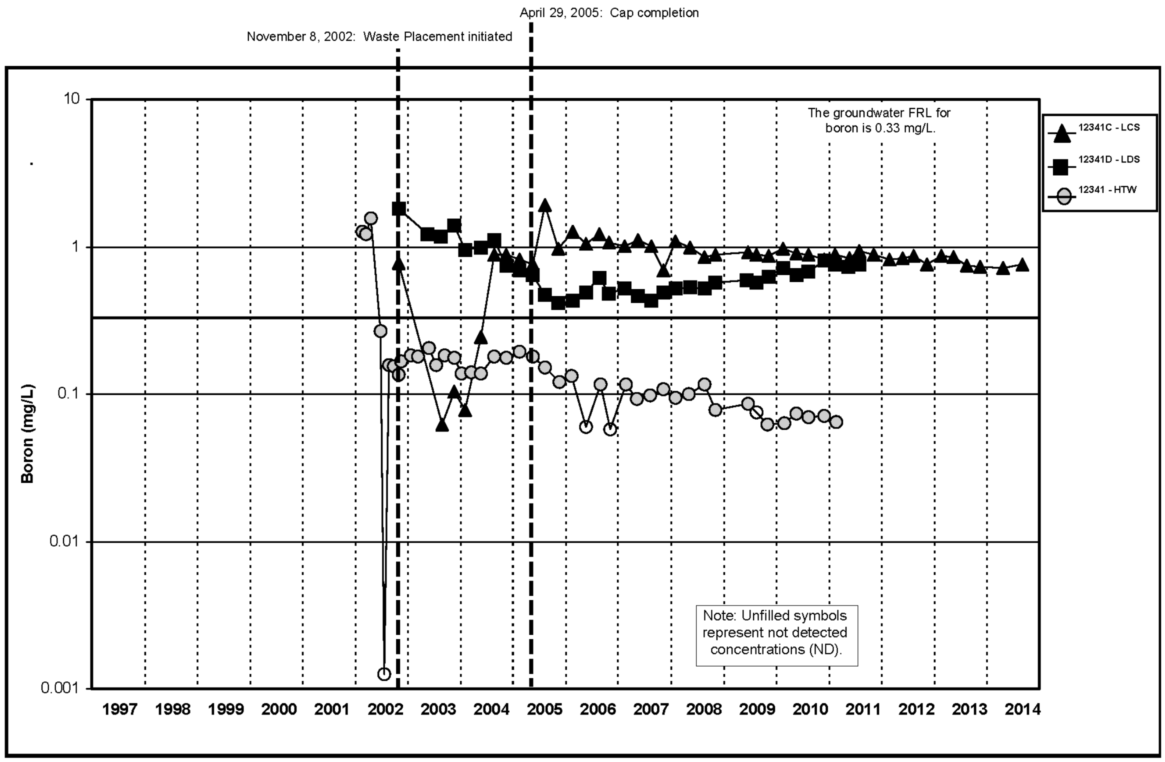


Figure A.5.4-17A. Cell 4 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

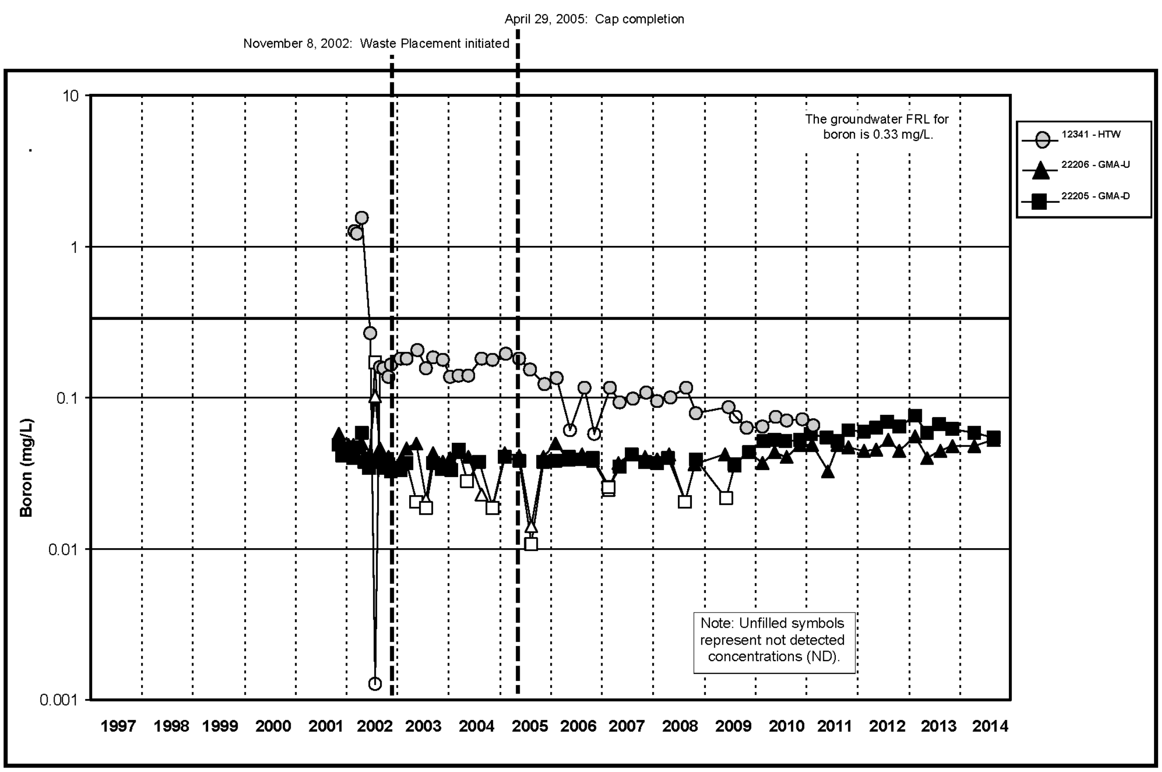


Figure A.5.4-17B. Cell 4 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

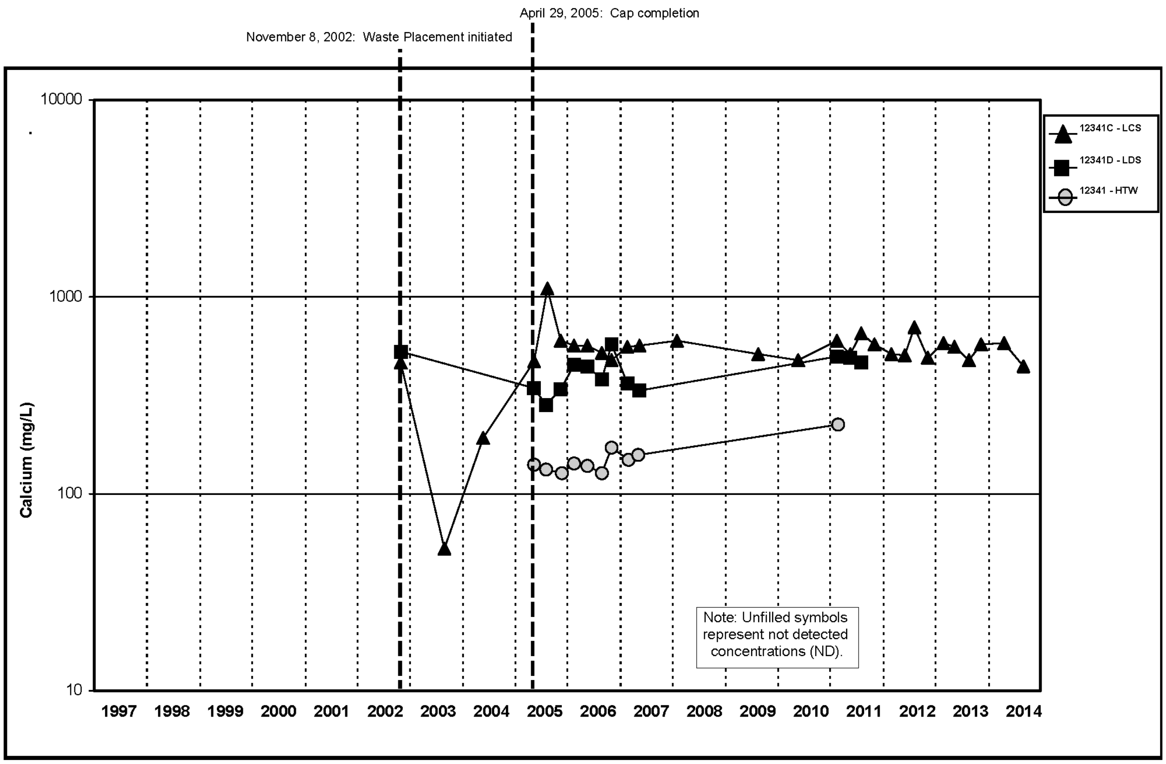


Figure A.5.4-18A. Cell 4 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

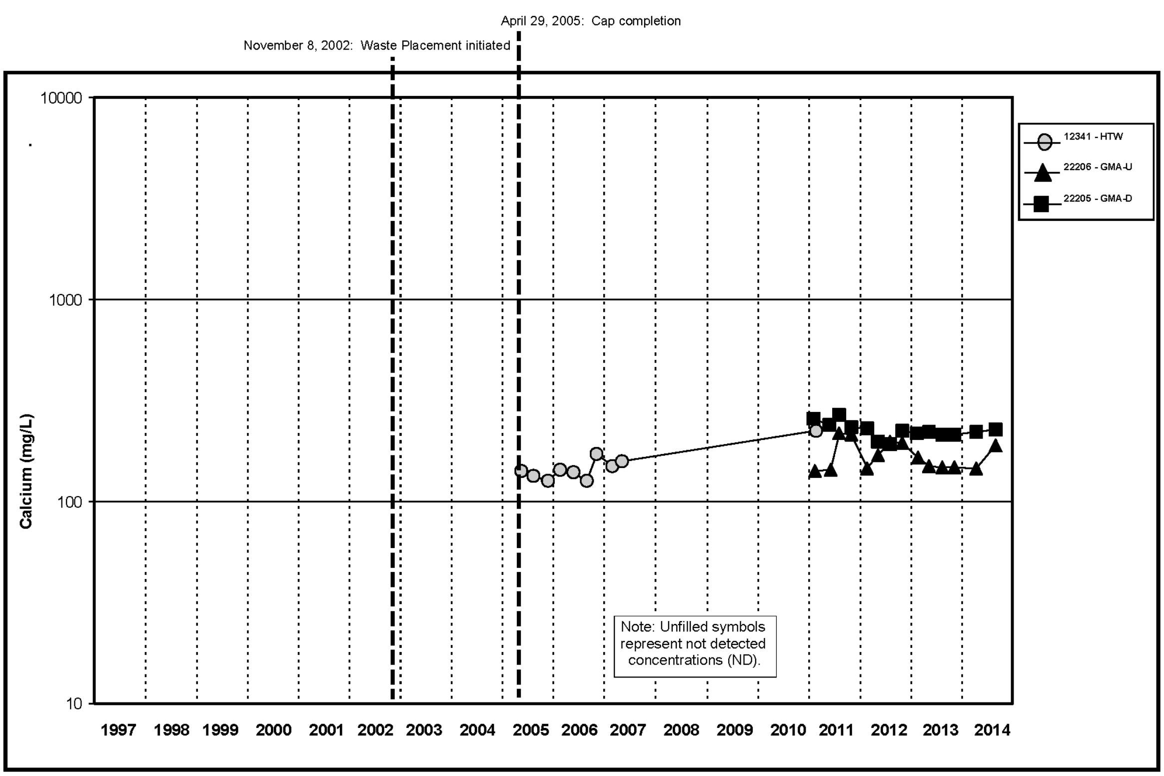


Figure A.5.4-18B. Cell 4 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

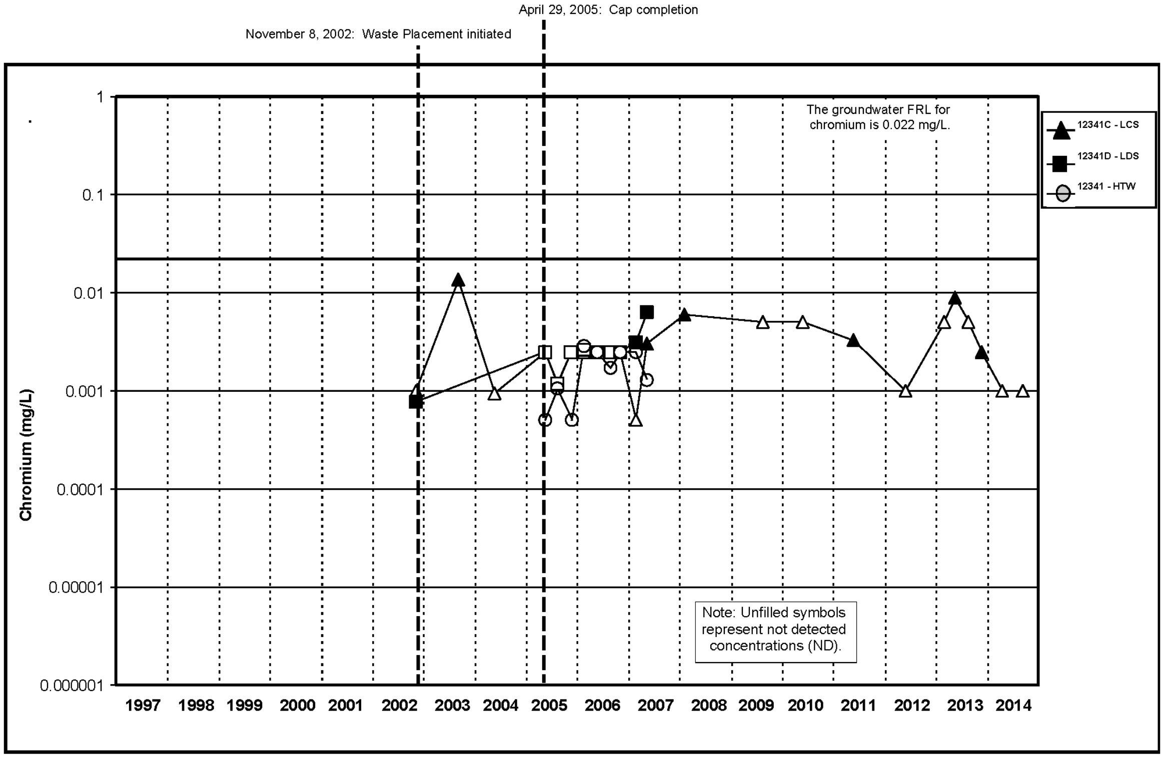


Figure A.5.4-19A. Cell 4 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

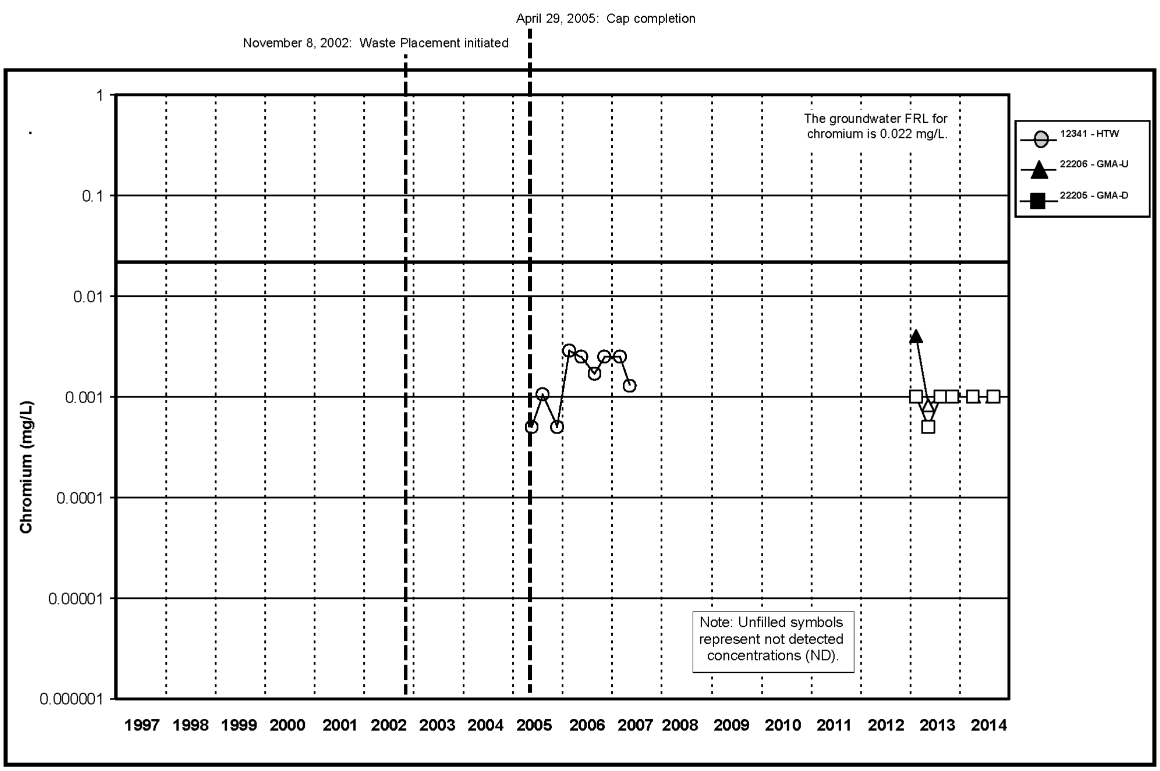


Figure A.5.4-19B. Cell 4 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

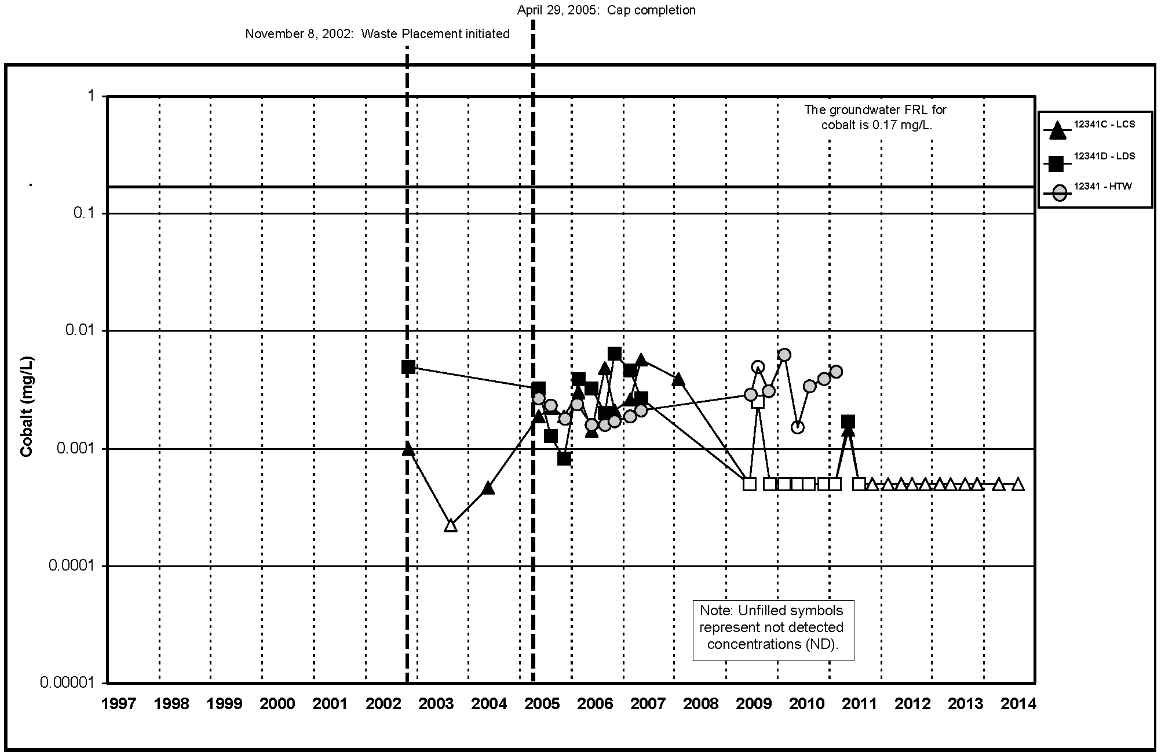


Figure A.5.4-20A. Cell 4 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

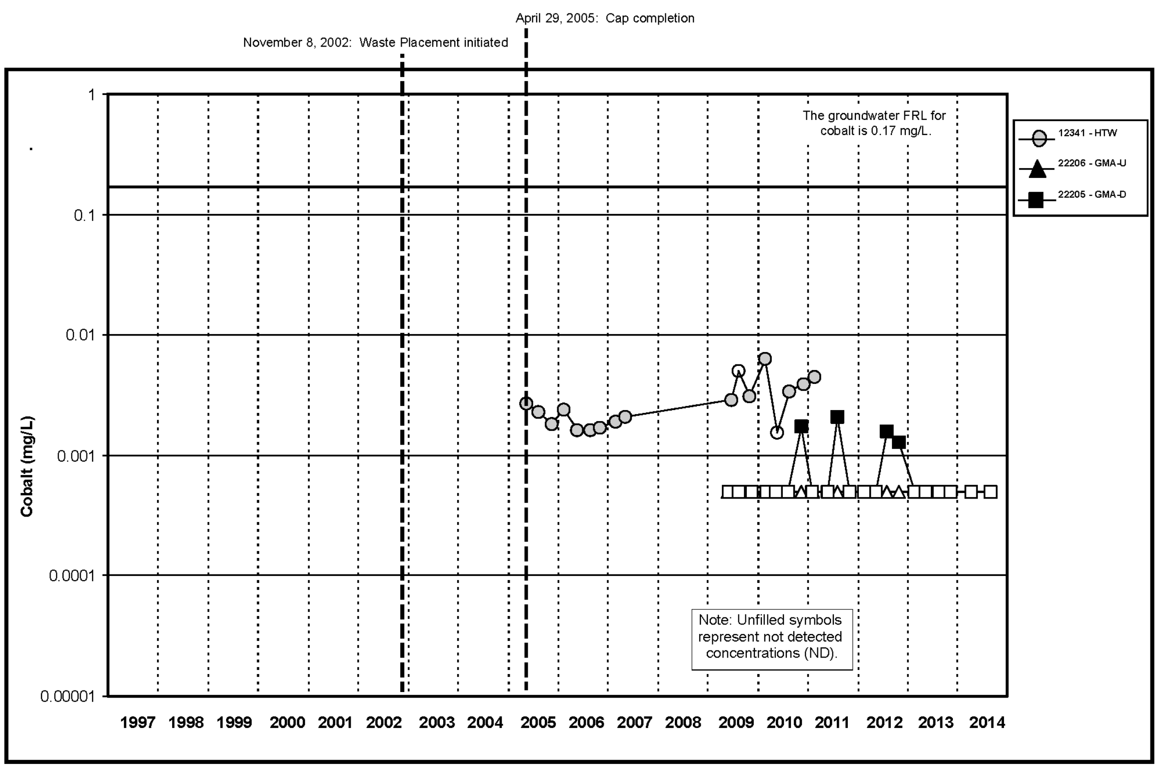


Figure A.5.4-20B. Cell 4 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

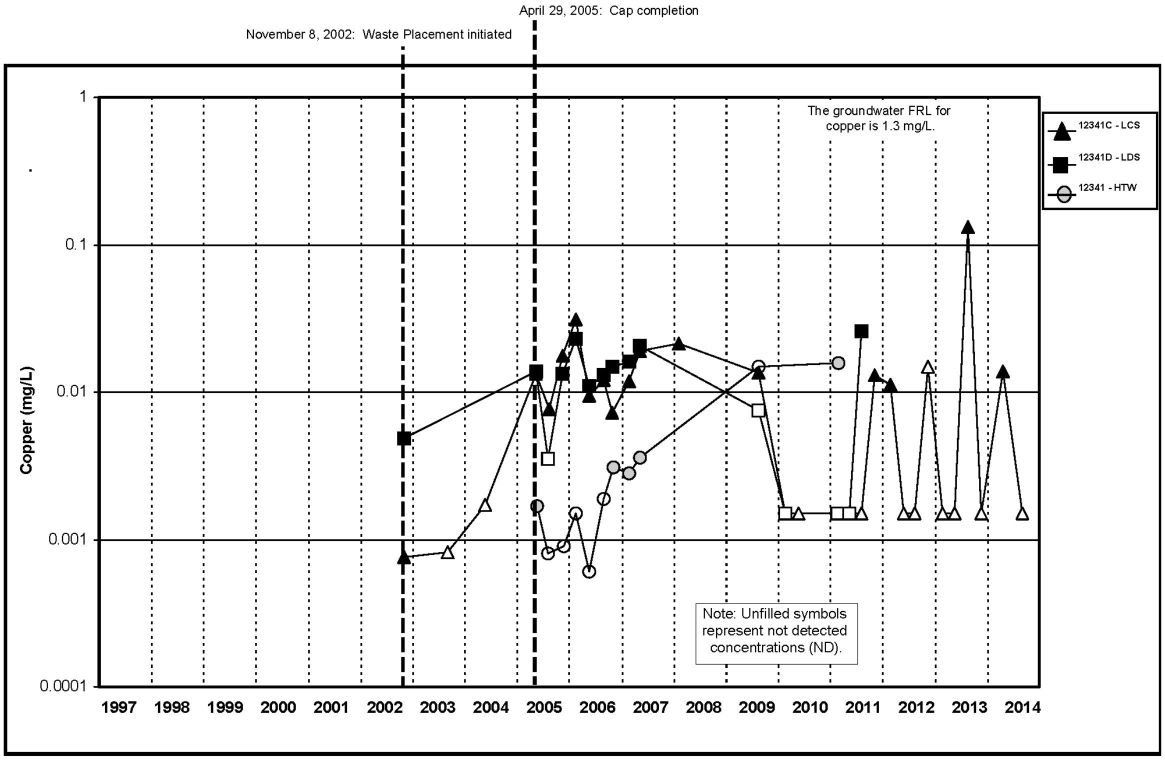


Figure A.5.4-21A. Cell 4 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

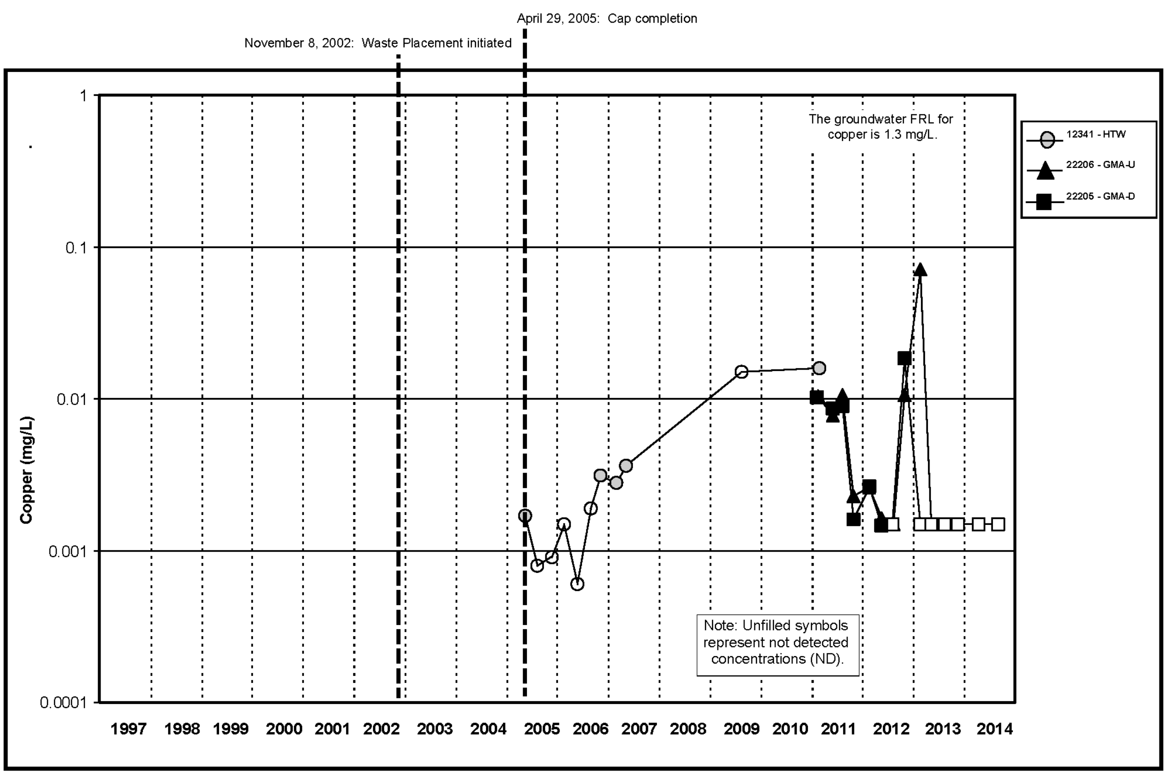


Figure A.5.4-21B. Cell 4 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

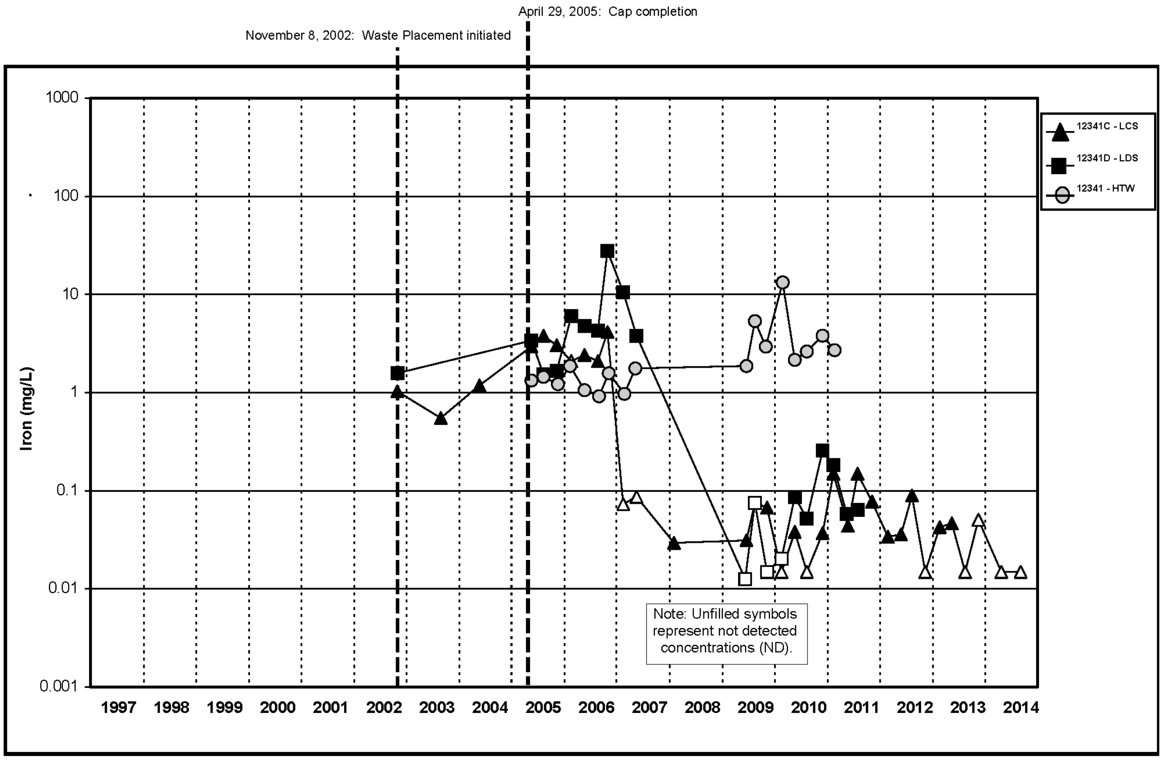


Figure A.5.4-22A. Cell 4 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

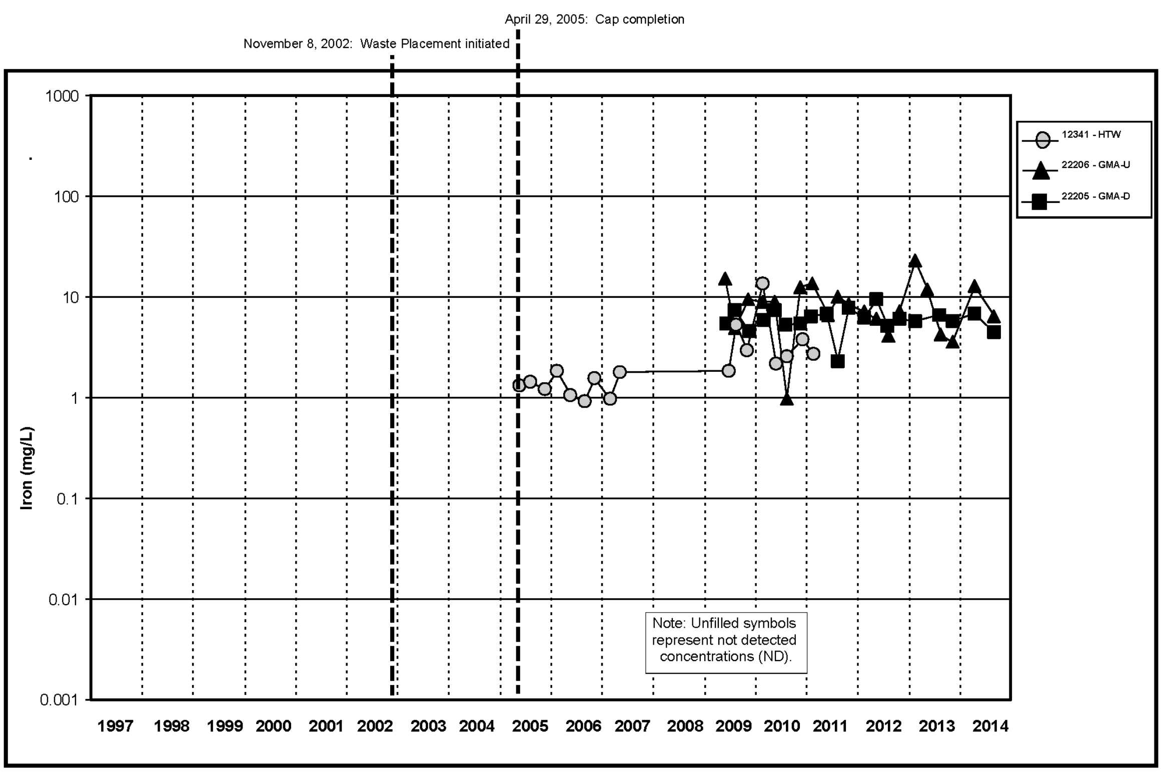


Figure A.5.4-22B. Cell 4 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

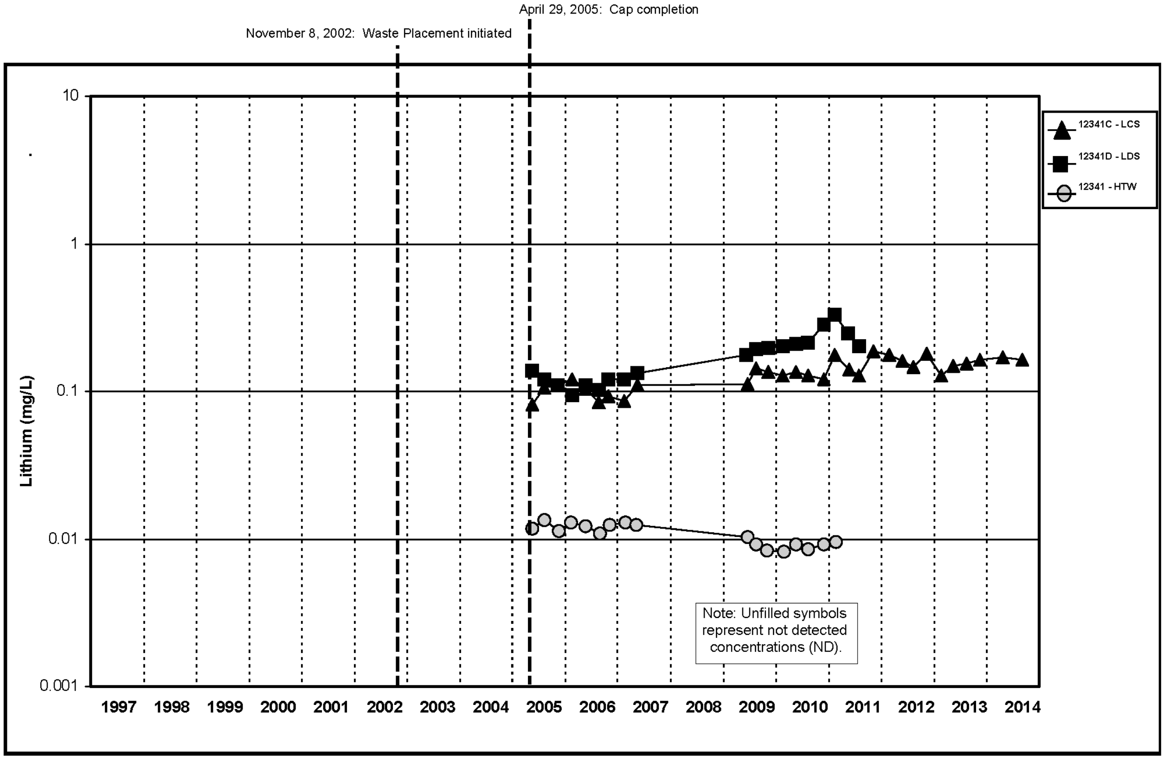


Figure A.5.4-23A. Cell 4 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

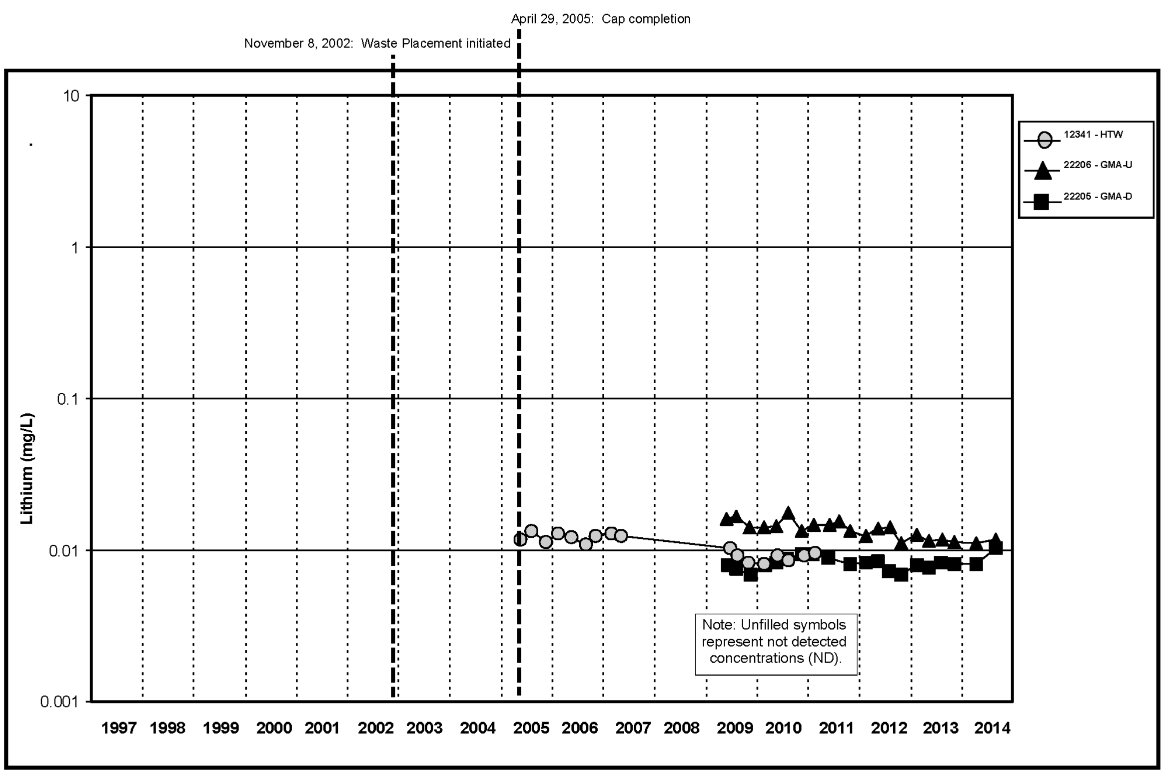


Figure A.5.4-23B. Cell 4 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

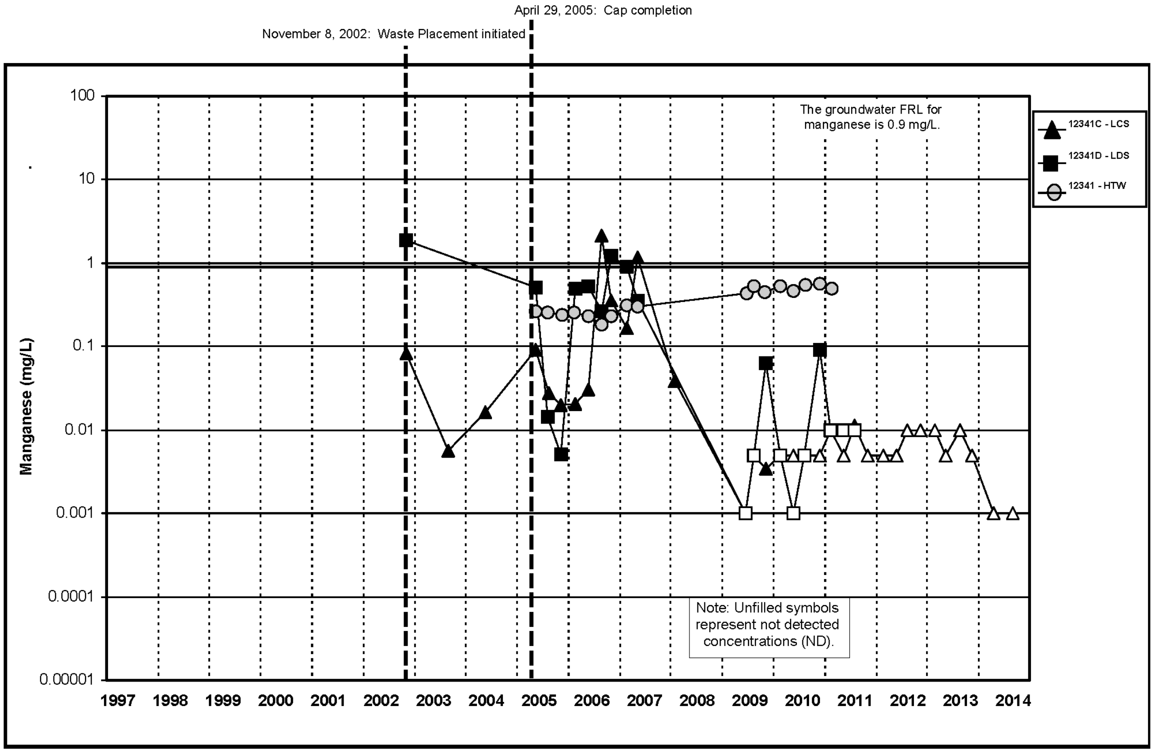


Figure A.5.4-24A. Cell 4 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

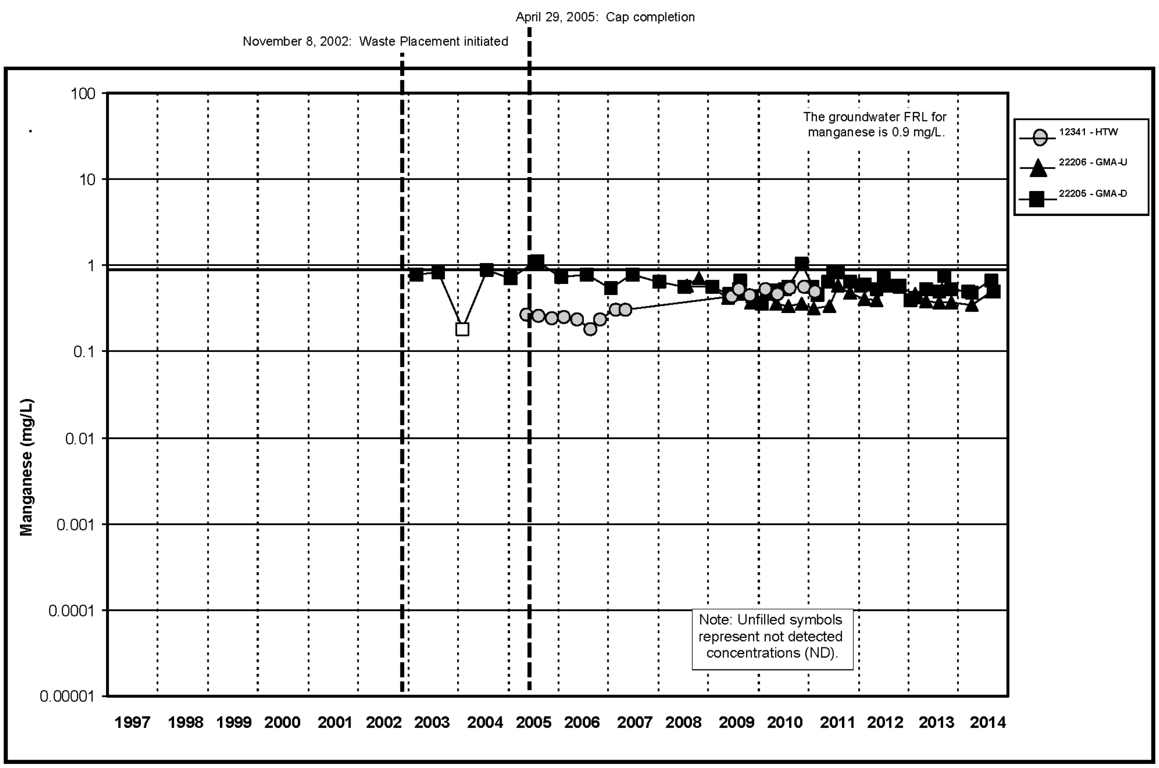


Figure A.5.4-24B. Cell 4 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

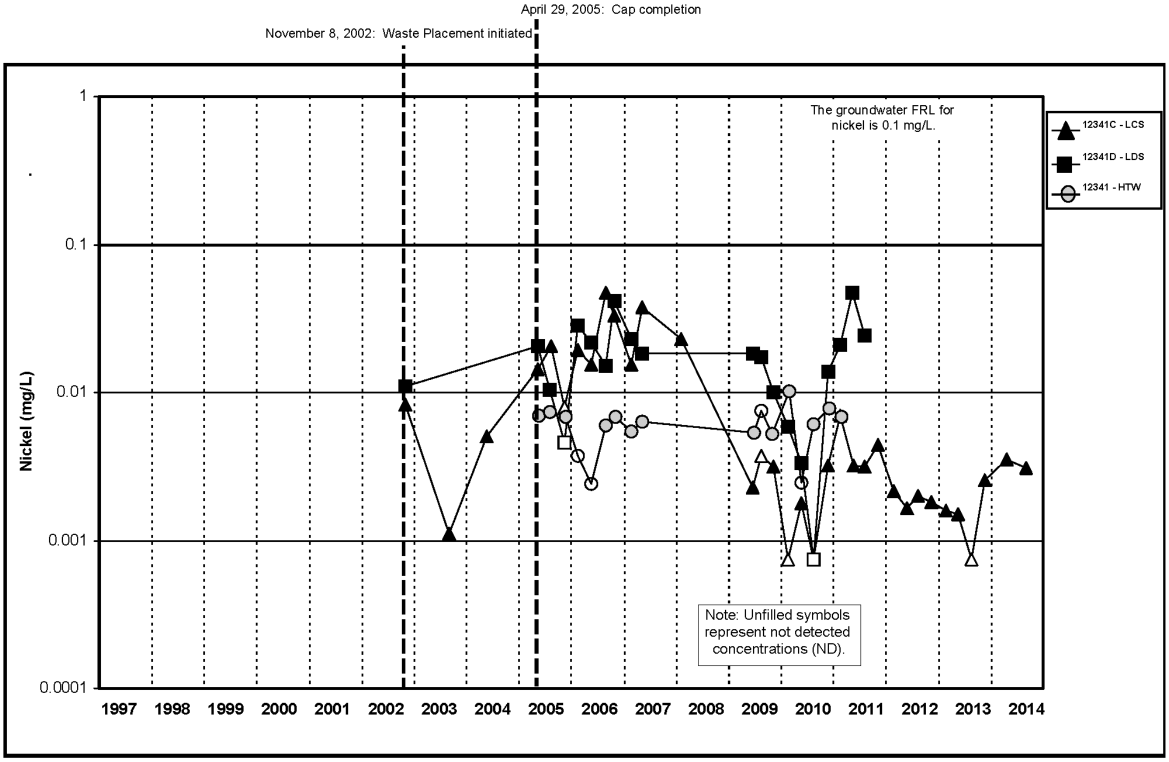


Figure A.5.4-25A. Cell 4 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

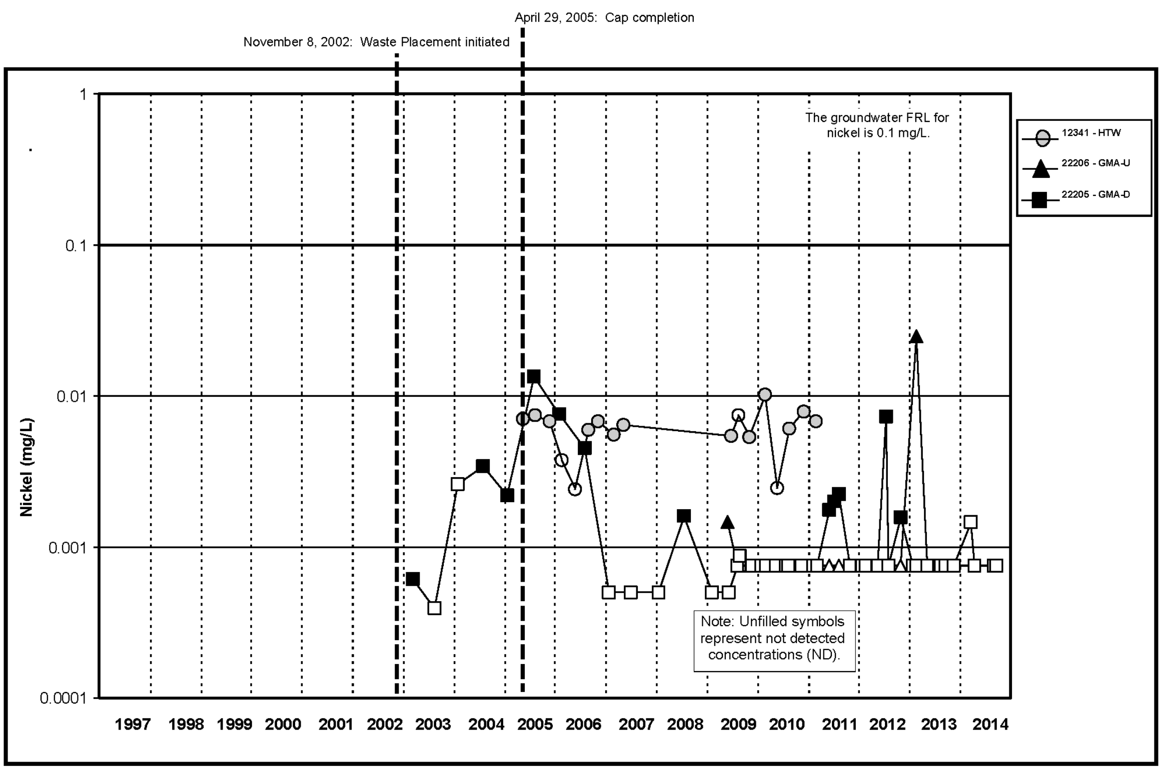


Figure A.5.4-25B. Cell 4 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

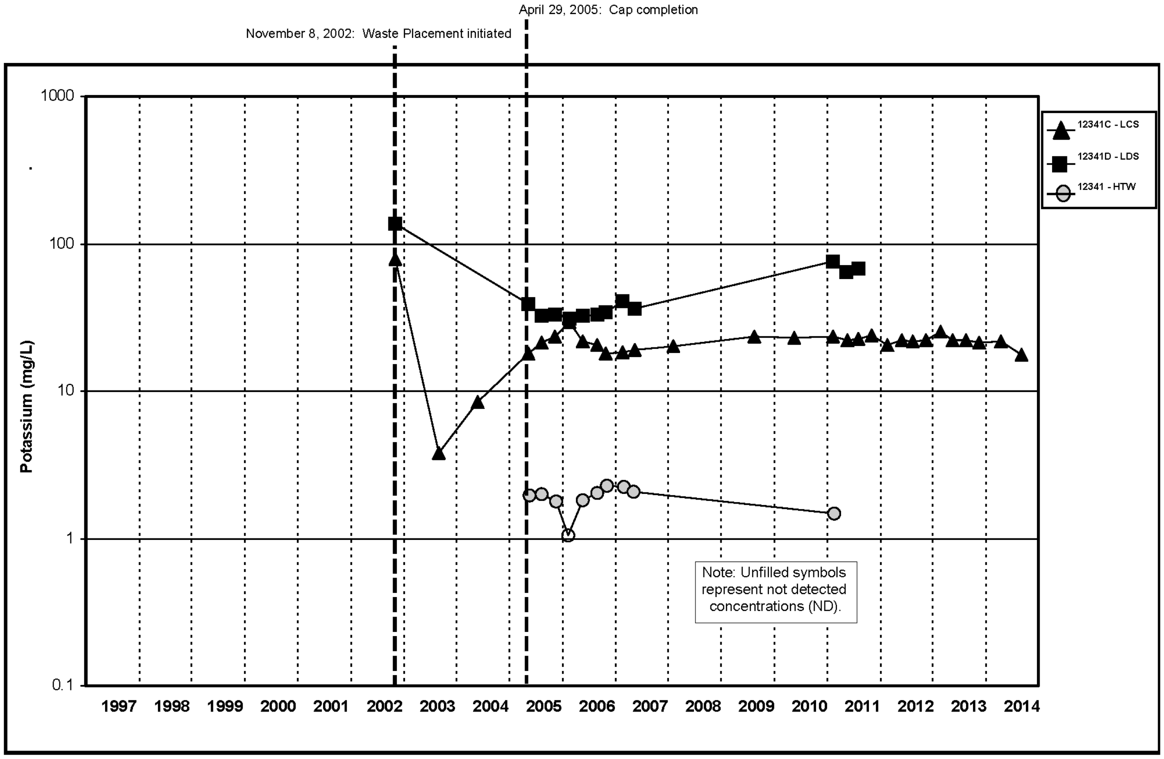


Figure A.5.4-26A. Cell 4 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

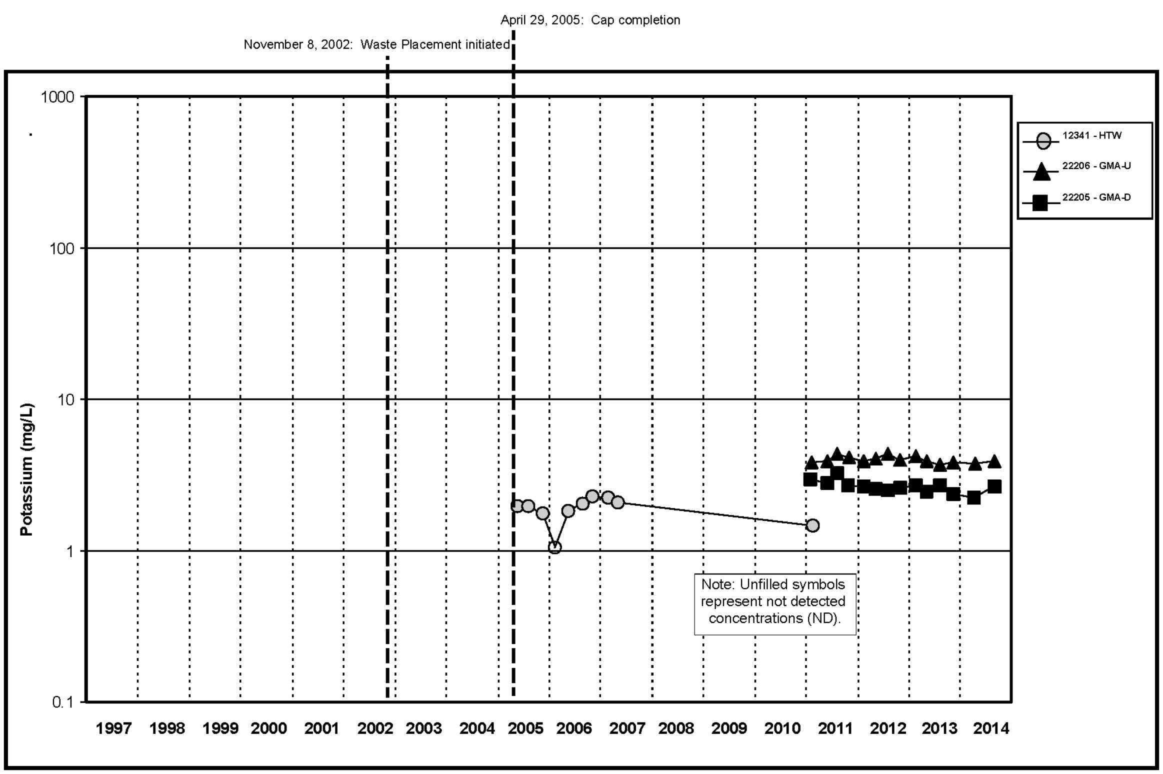


Figure A.5.4-26B. Cell 4 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

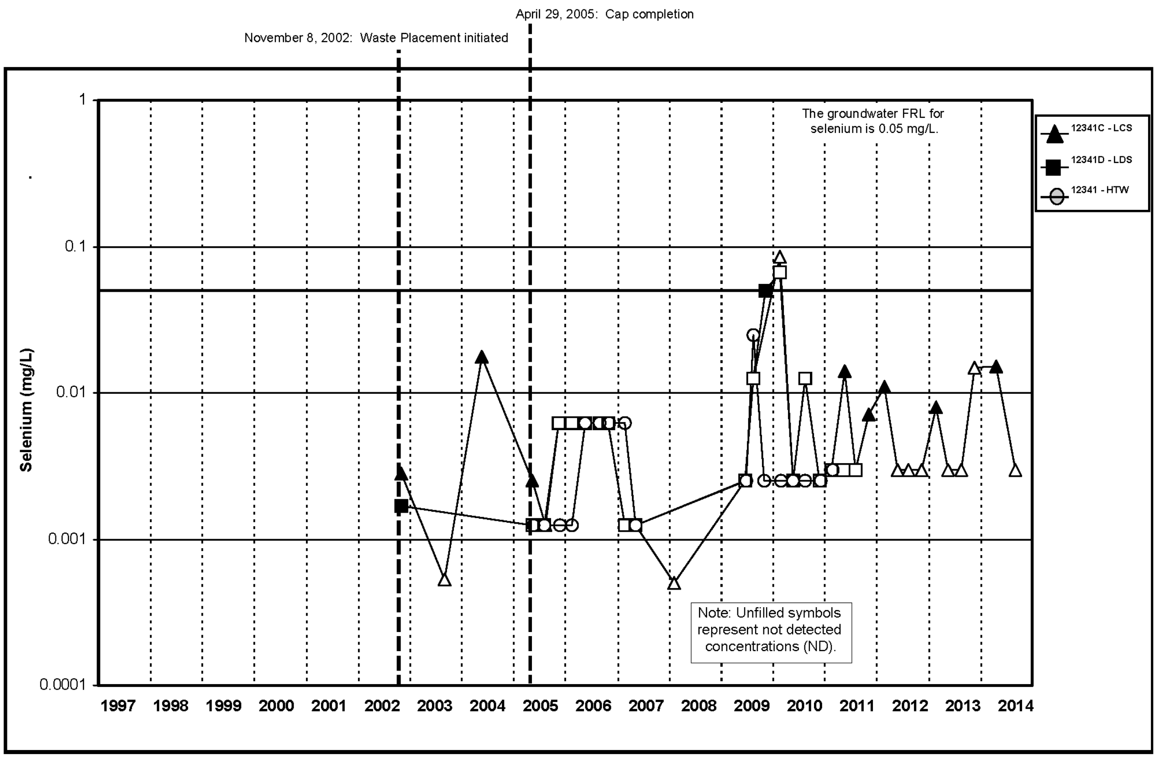


Figure A.5.4-27A. Cell 4 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

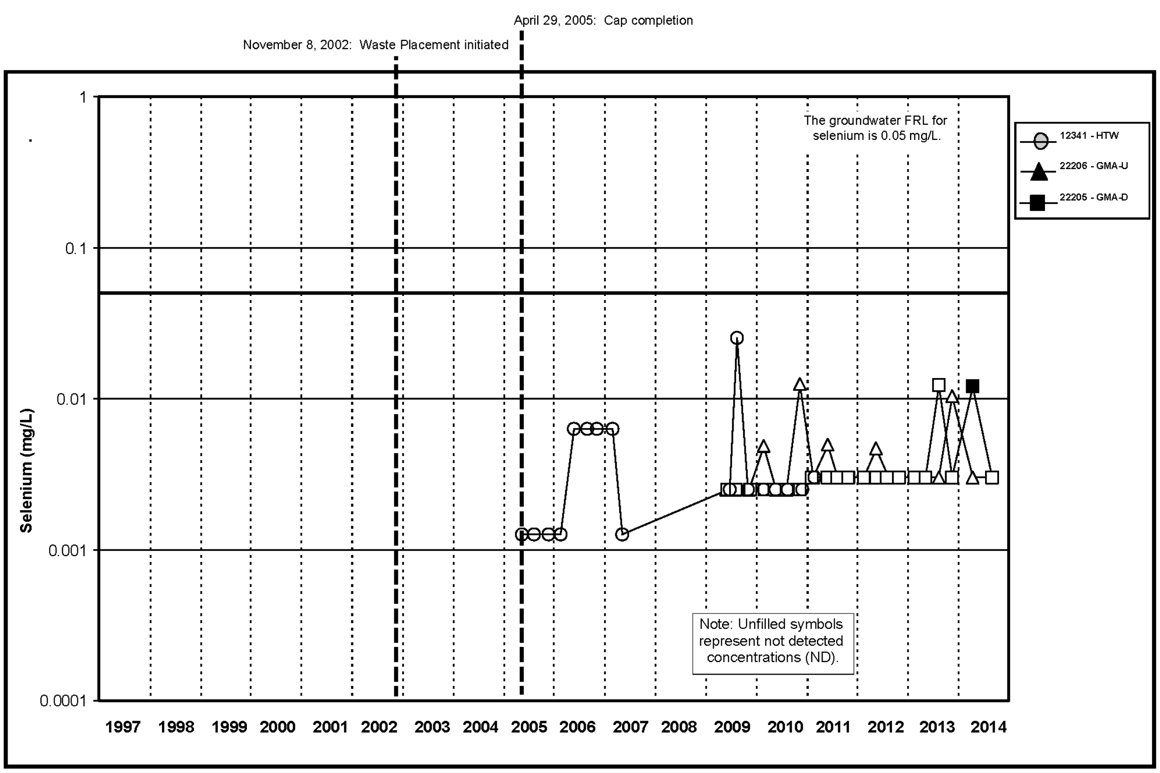


Figure A.5.4-27B. Cell 4 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

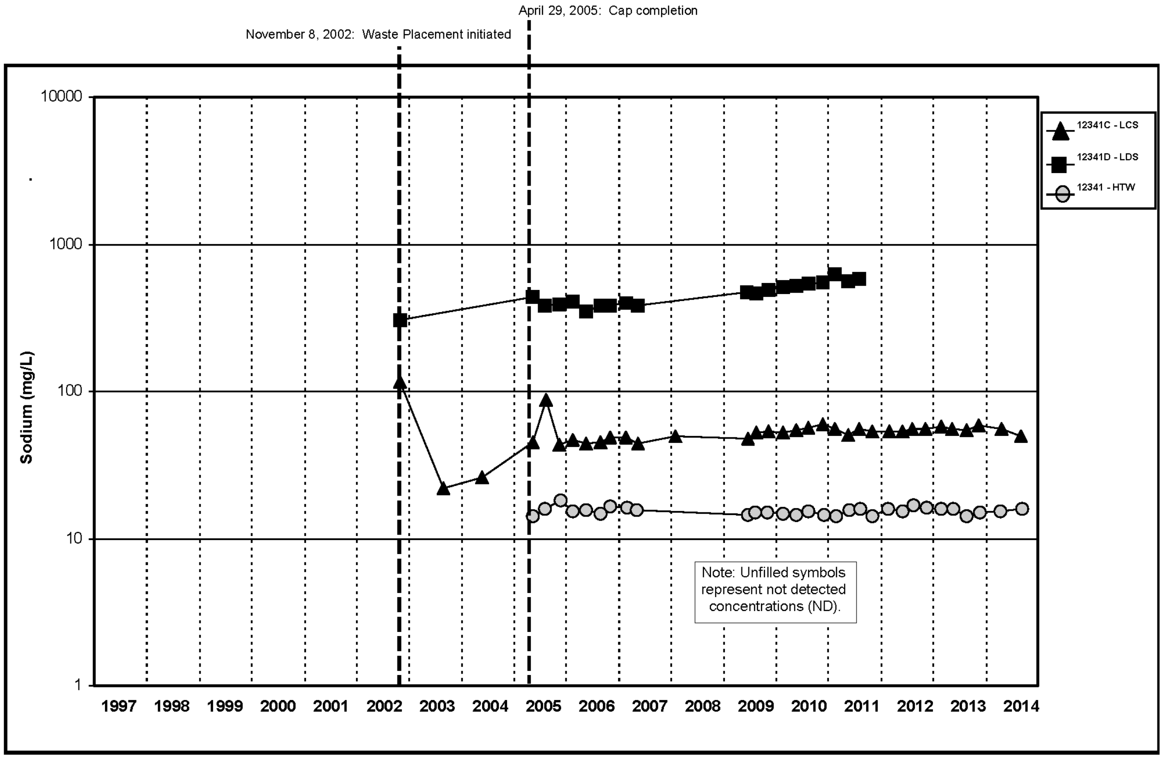


Figure A.5.4-28A. Cell 4 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

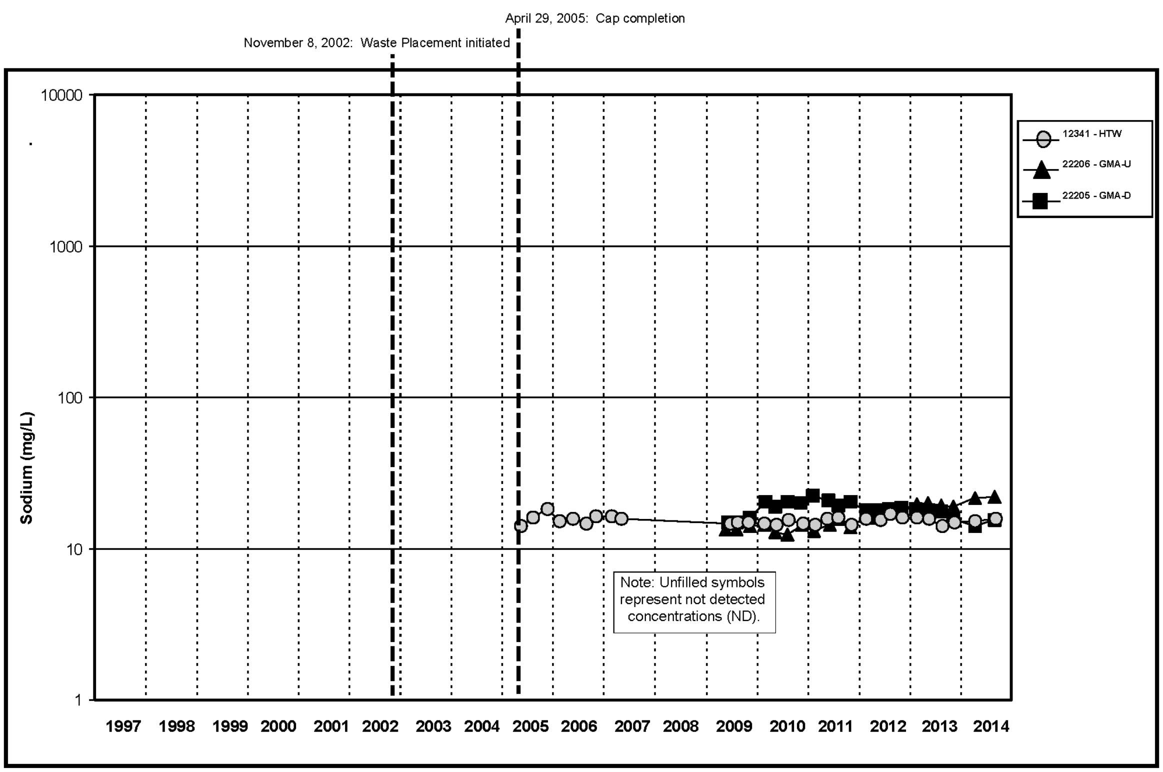


Figure A.5.4-28B. Cell 4 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

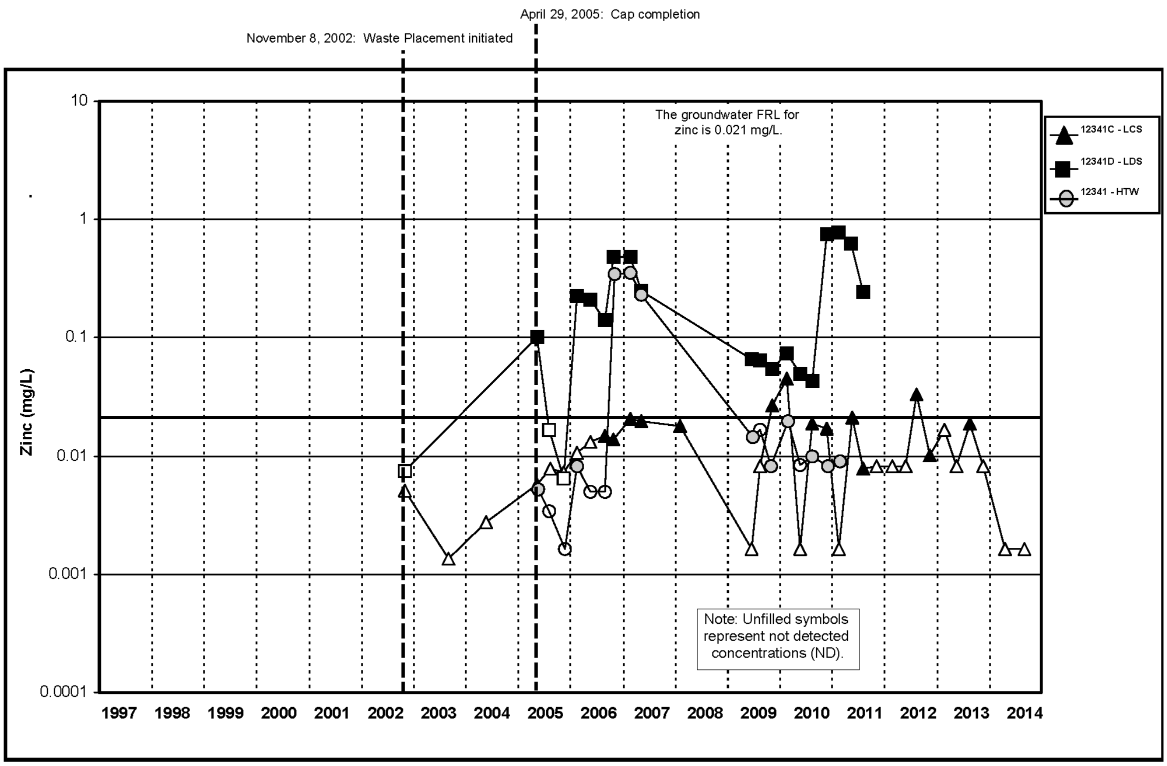


Figure A.5.4-29A. Cell 4 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

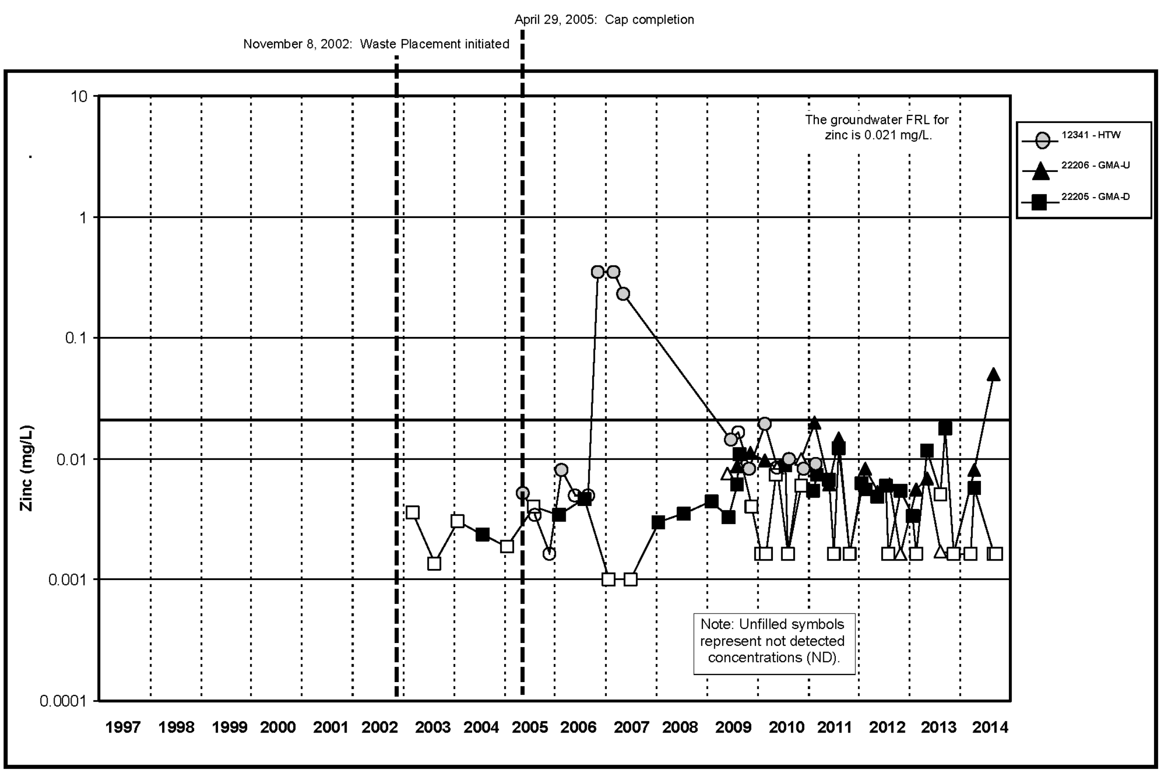


Figure A.5.4-29B. Cell 4 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

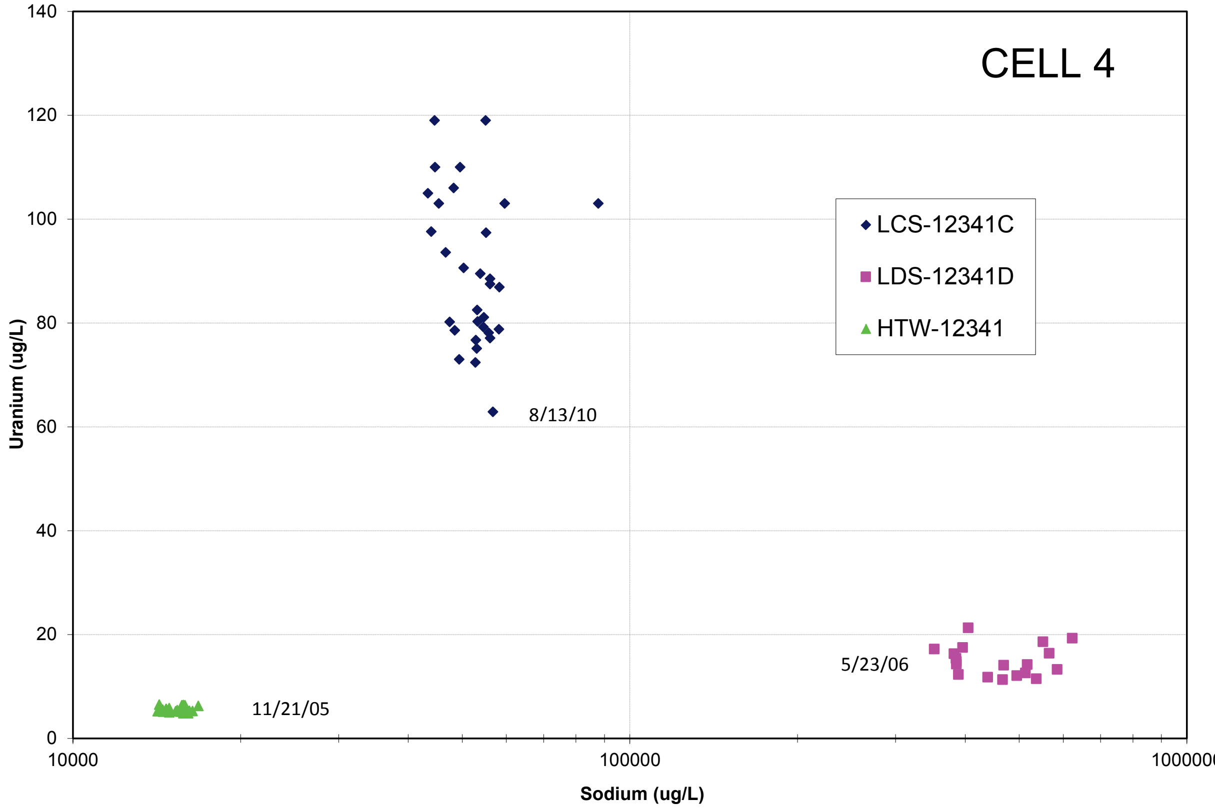


Figure A.5.4-30. Cell 4 Bivariate Plot for Uranium and Sodium

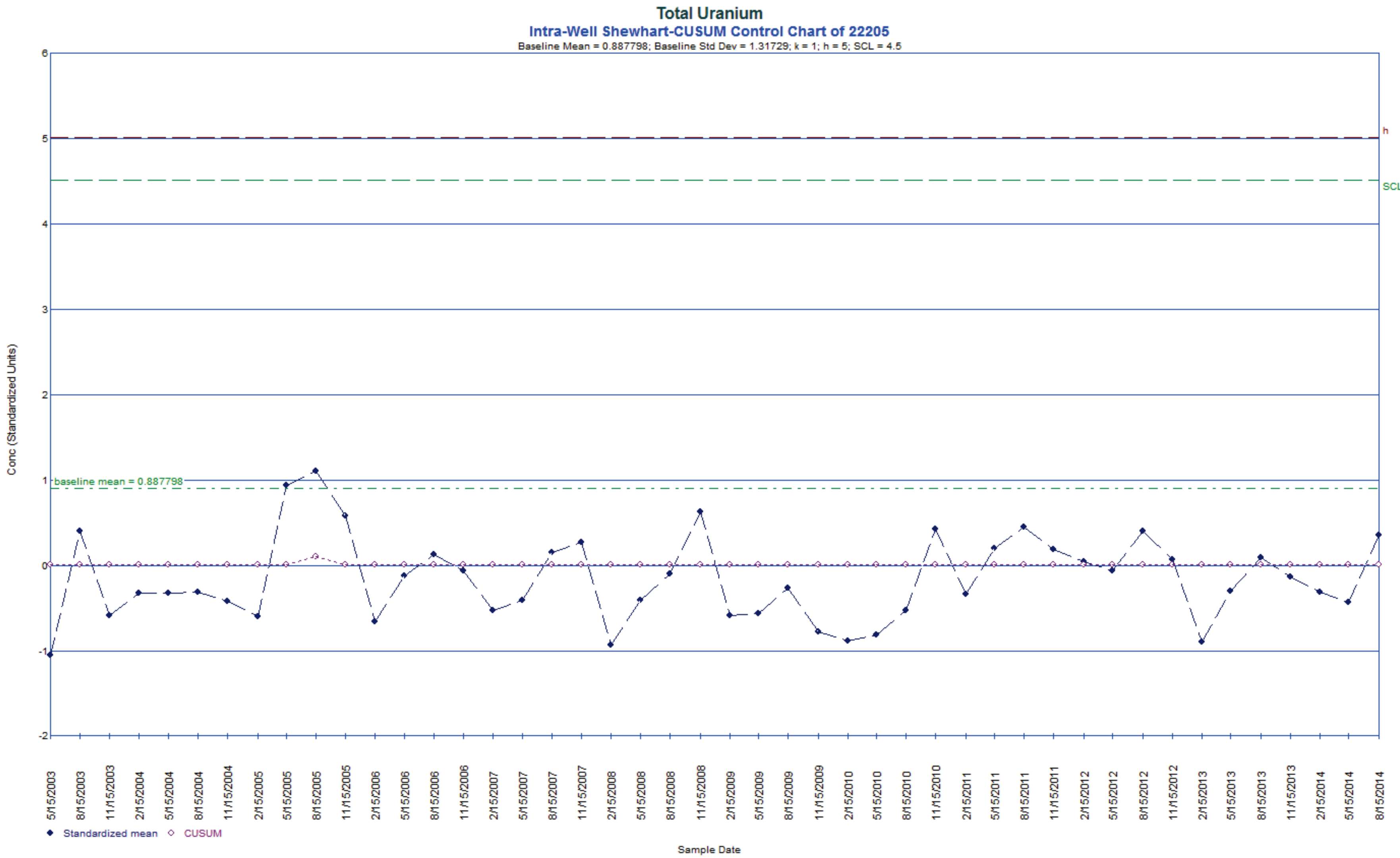


Figure A.5.4-31. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22205)

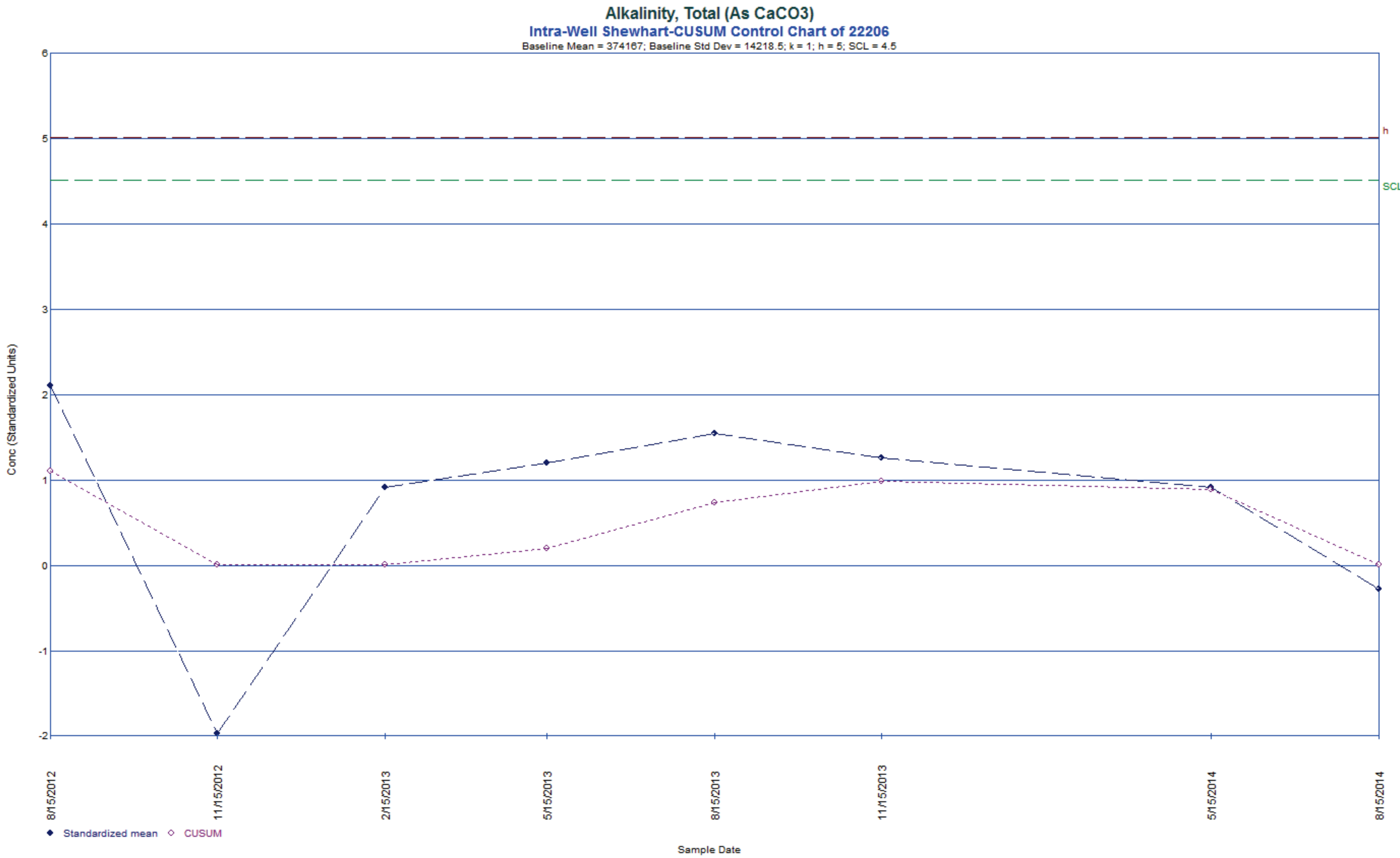


Figure A.5.4-32. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22206)

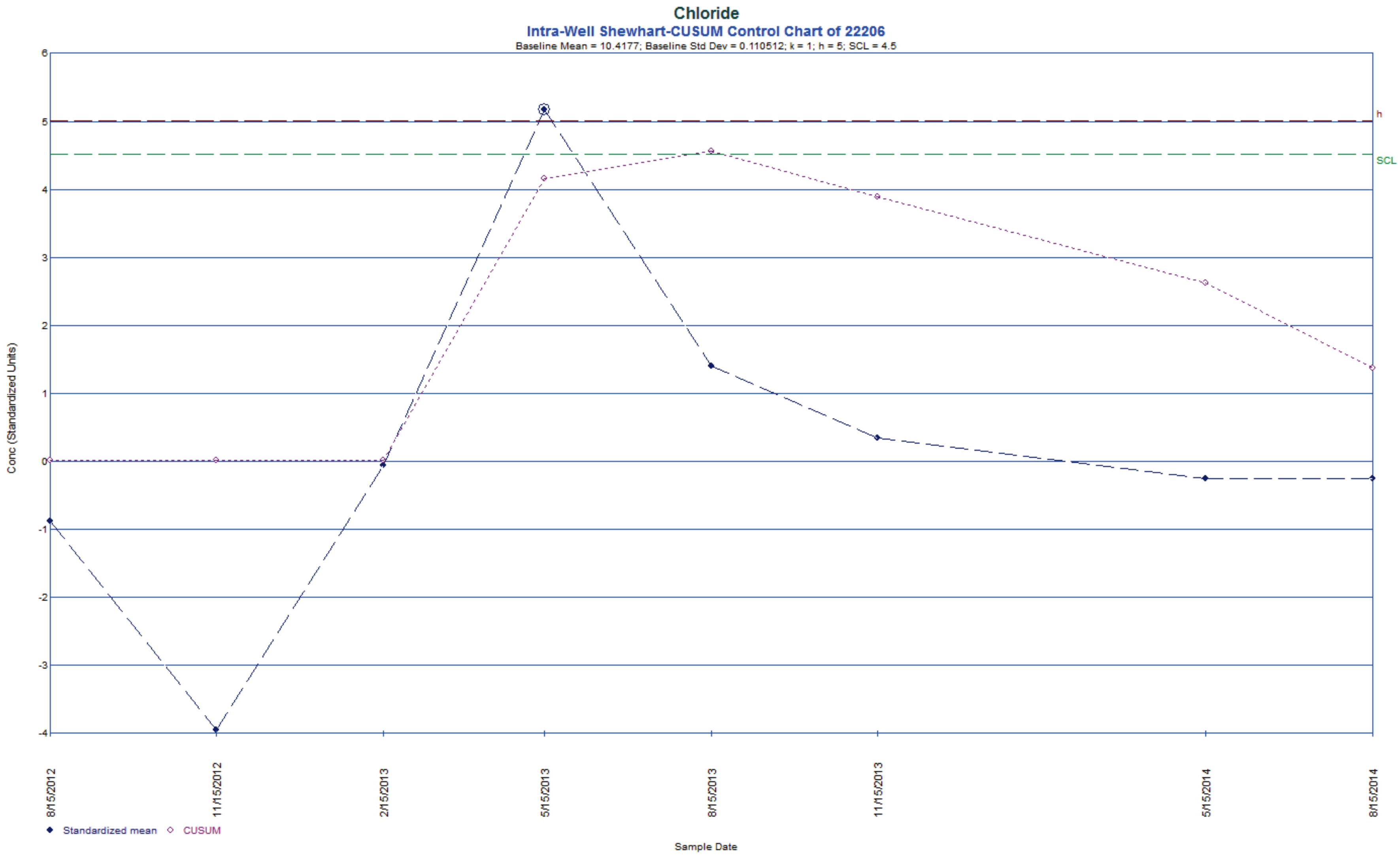


Figure A.5.4-33. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22206)

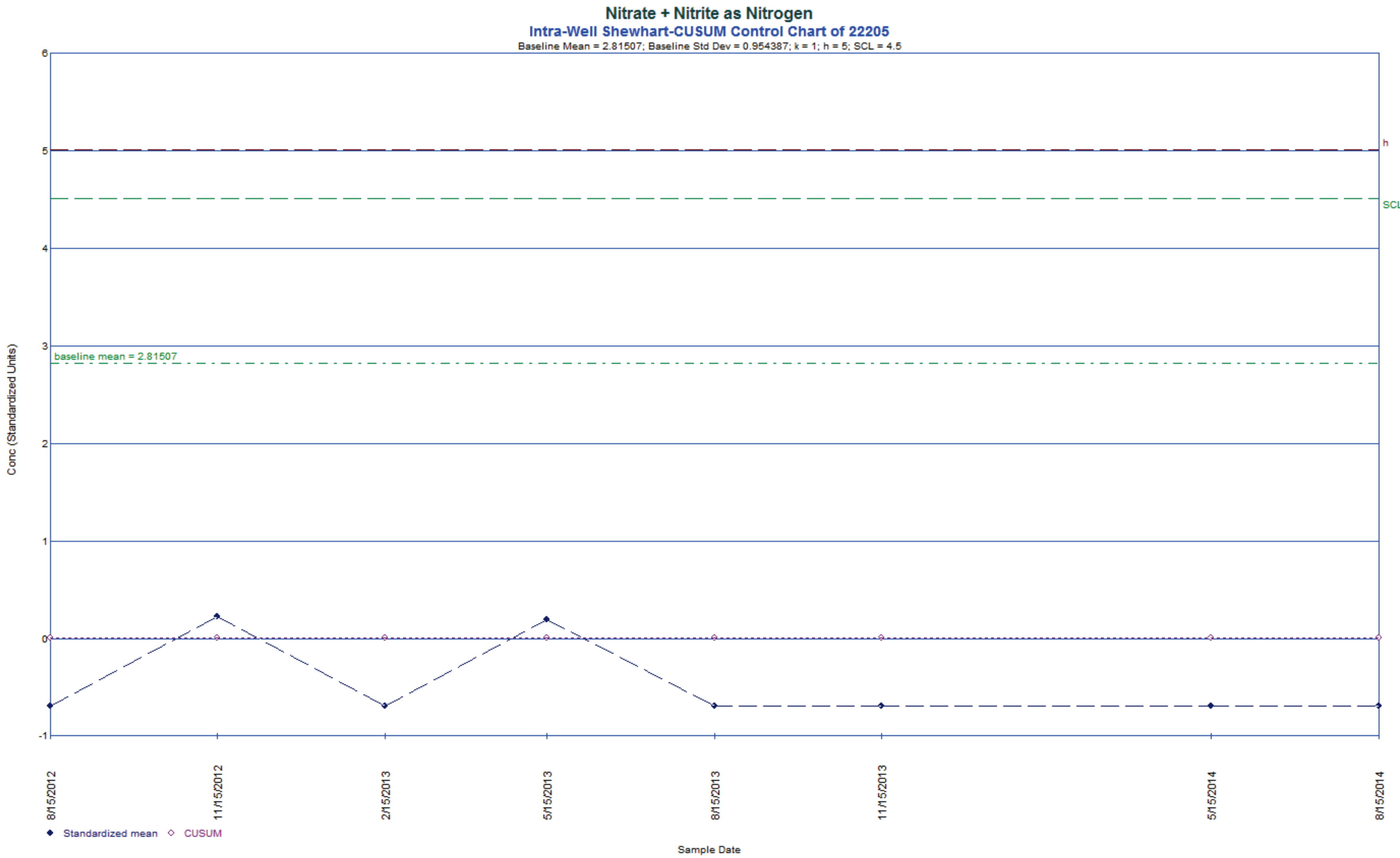


Figure A.5.4-34. Intra-Well Shewhart-CUSUM Control Chart (Nitrate + Nitrite as Nitrogen 22205)

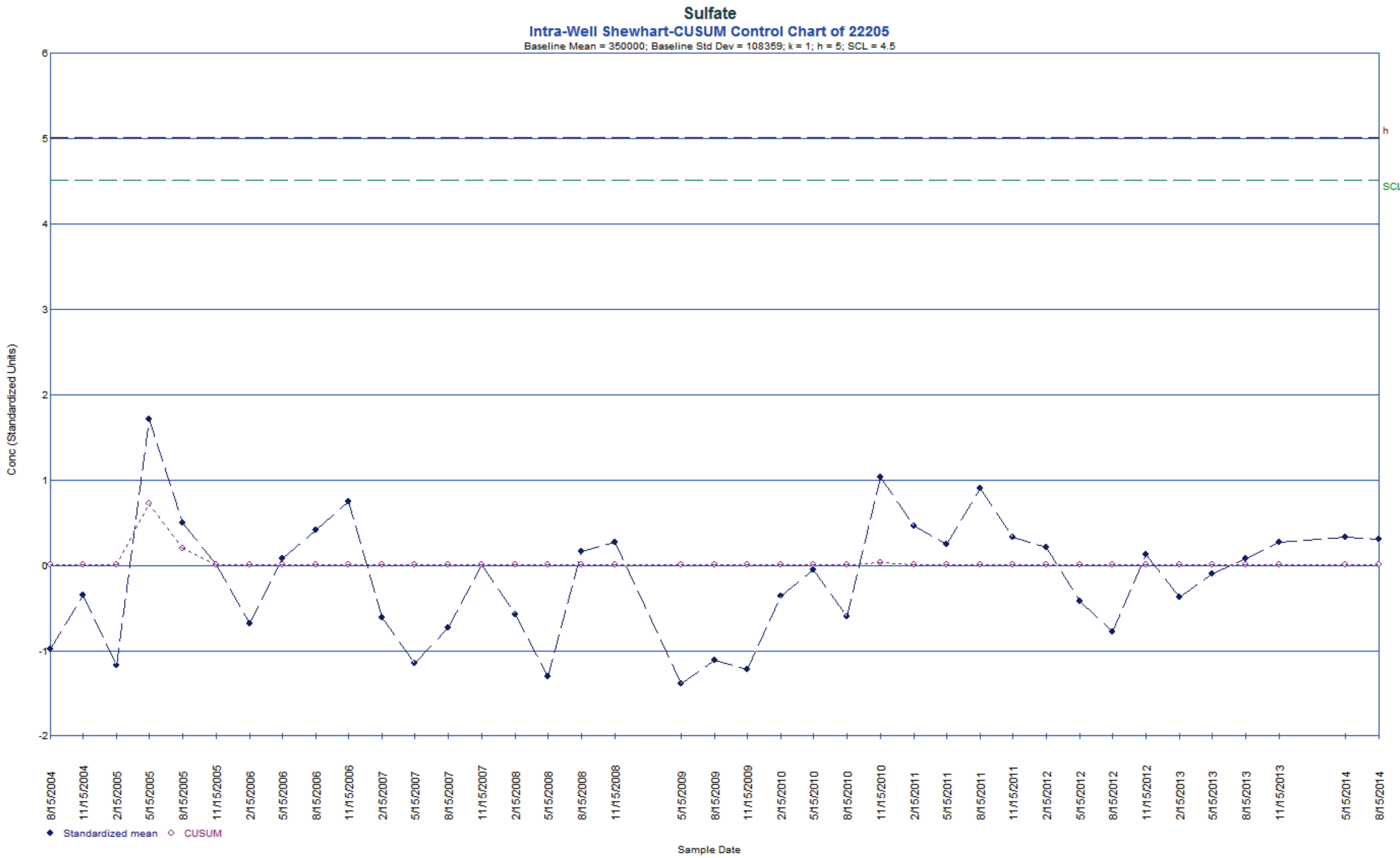


Figure A.5.4-35. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22205)

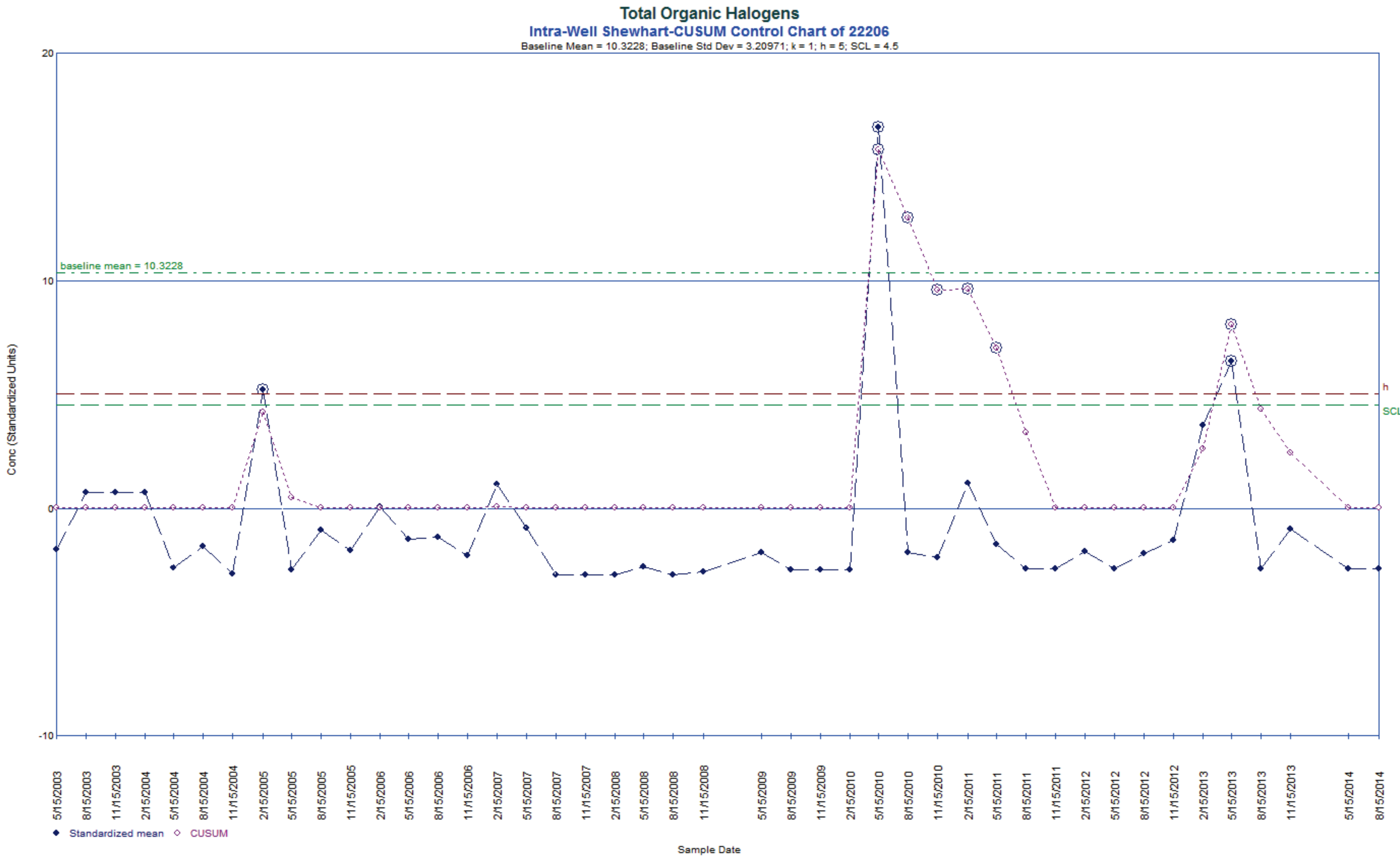


Figure A.5.4-36. Intra-Well Shewhart-CUSUM Control Chart (Total Organic Halogens 22206)

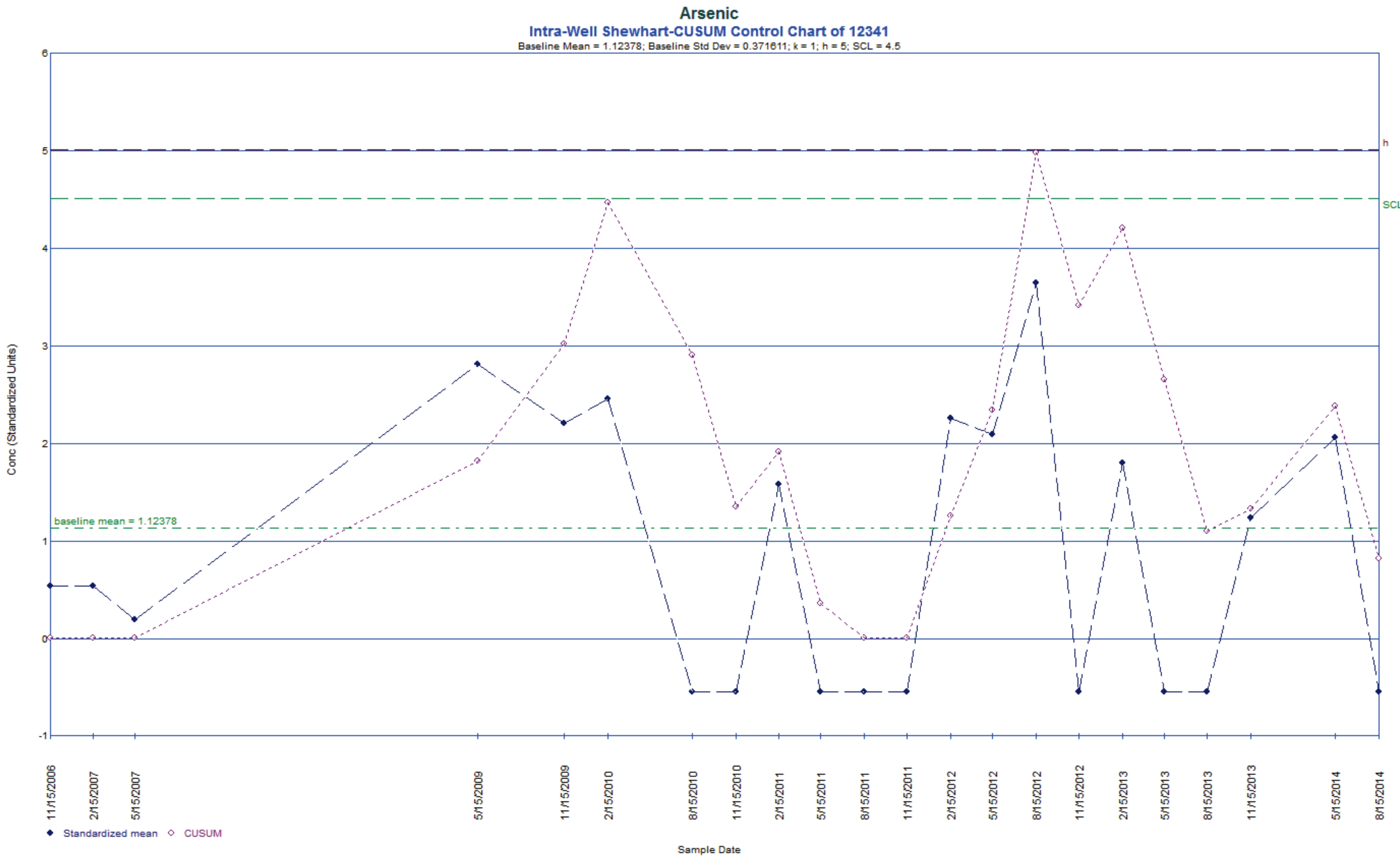


Figure A.5.4-37. Intra-Well Shewhart-CUSUM Control Chart (Arsenic 12341)

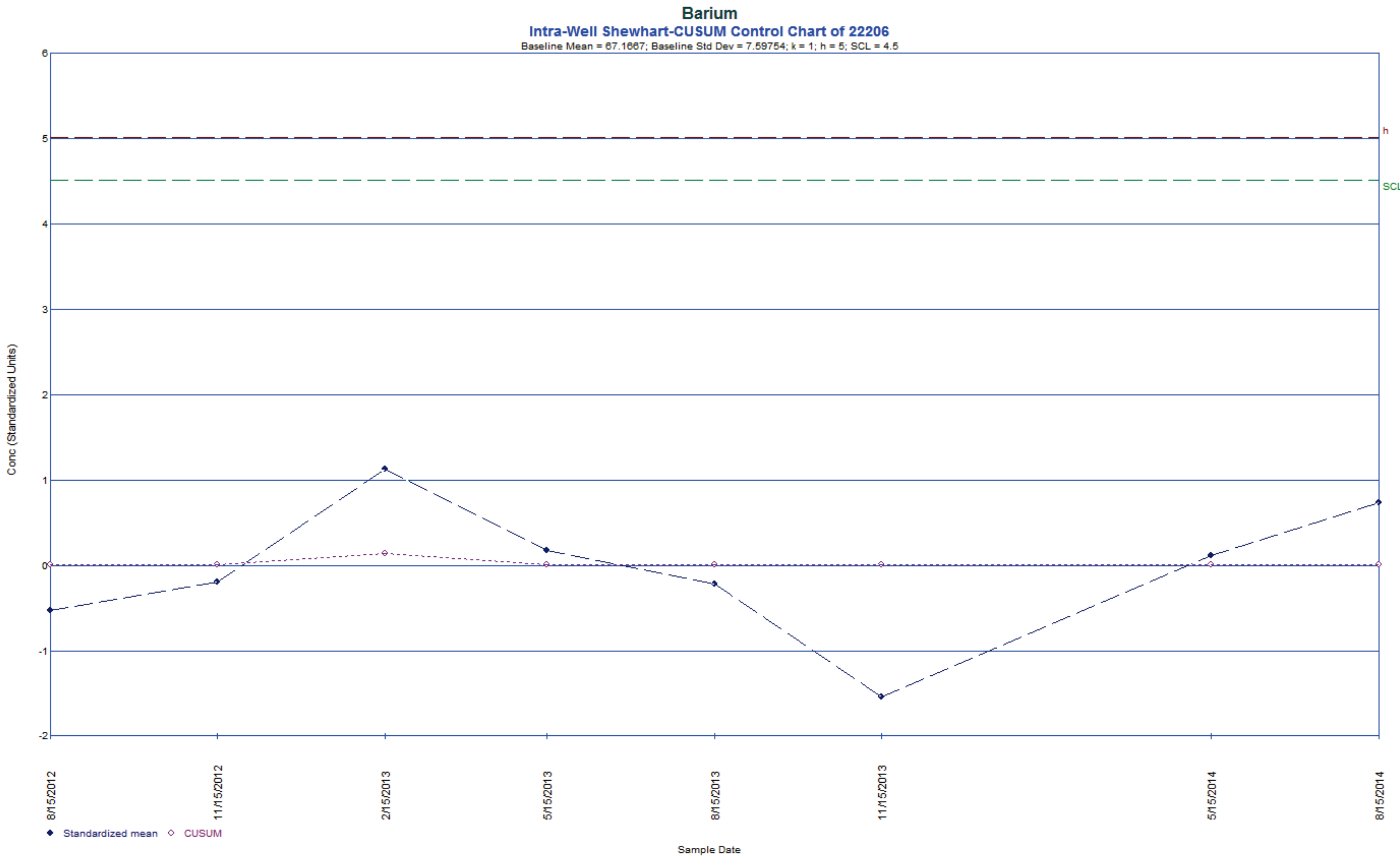


Figure A.5.4-38. Intra-Well Shewhart-CUSUM Control Chart (Barium 22206)

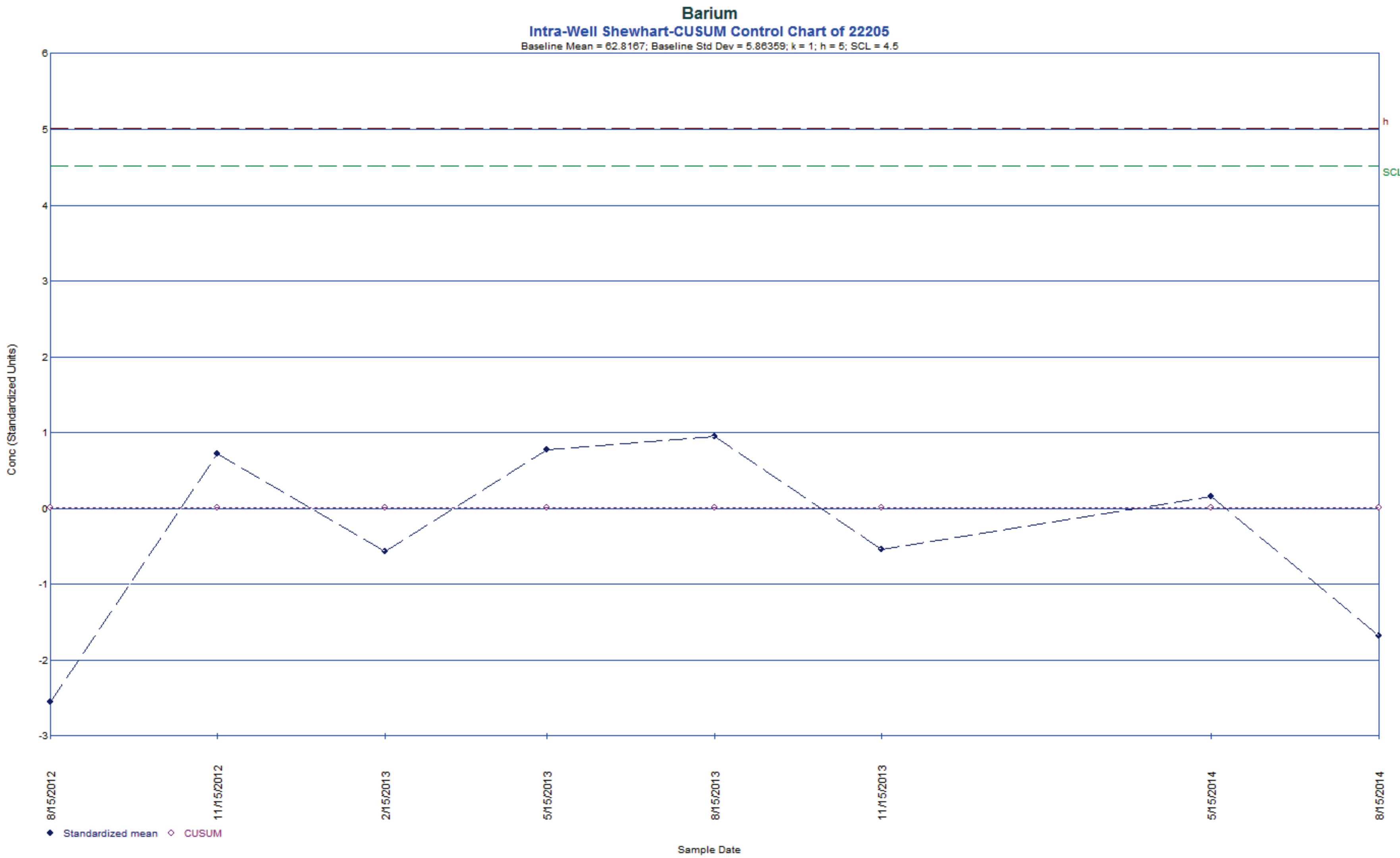


Figure A.5.4-39. Intra-Well Shewhart-CUSUM Control Chart (Barium 22205)

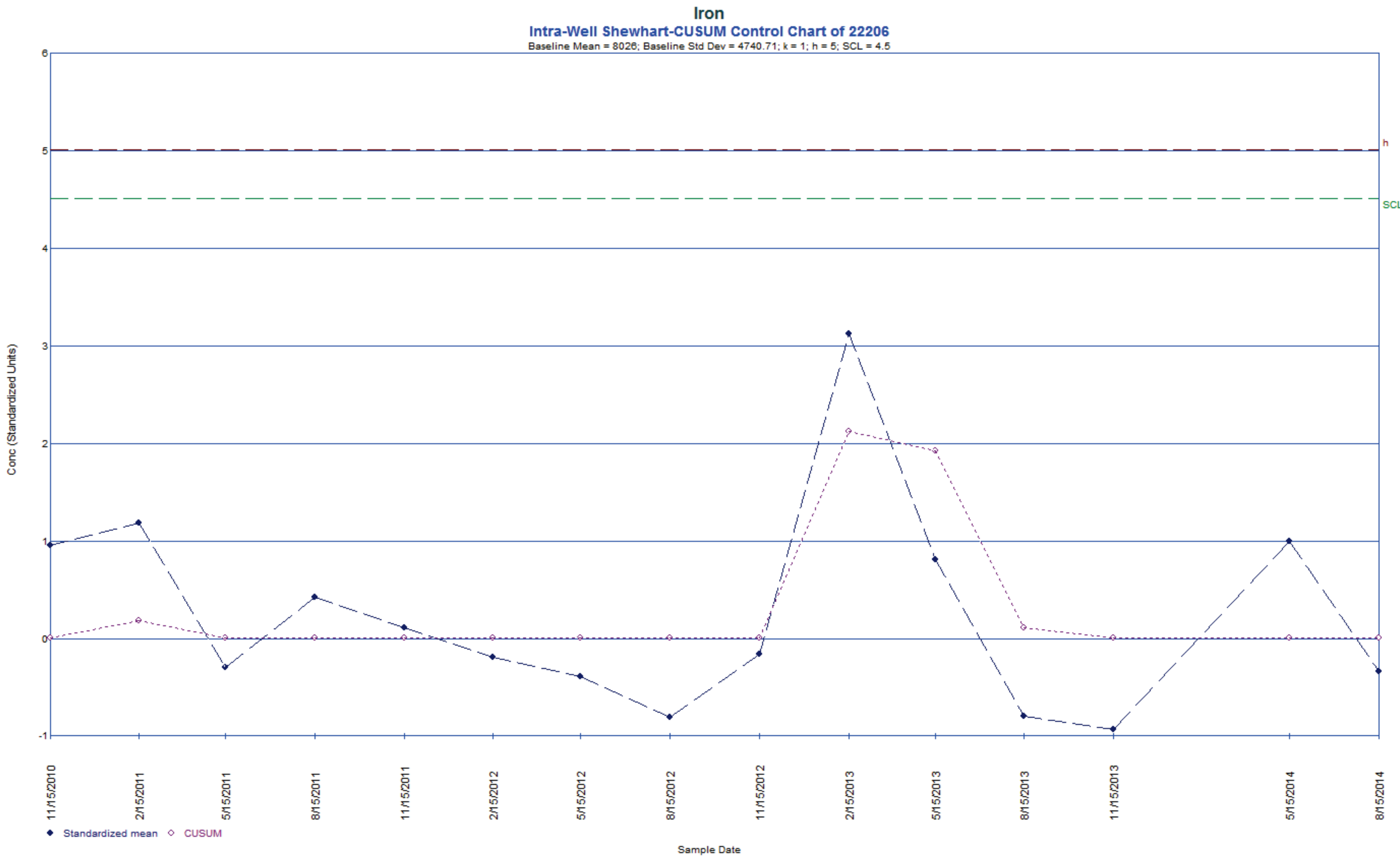


Figure A.5.4-40. Intra-Well Shewhart-CUSUM Control Chart (Iron 22206)

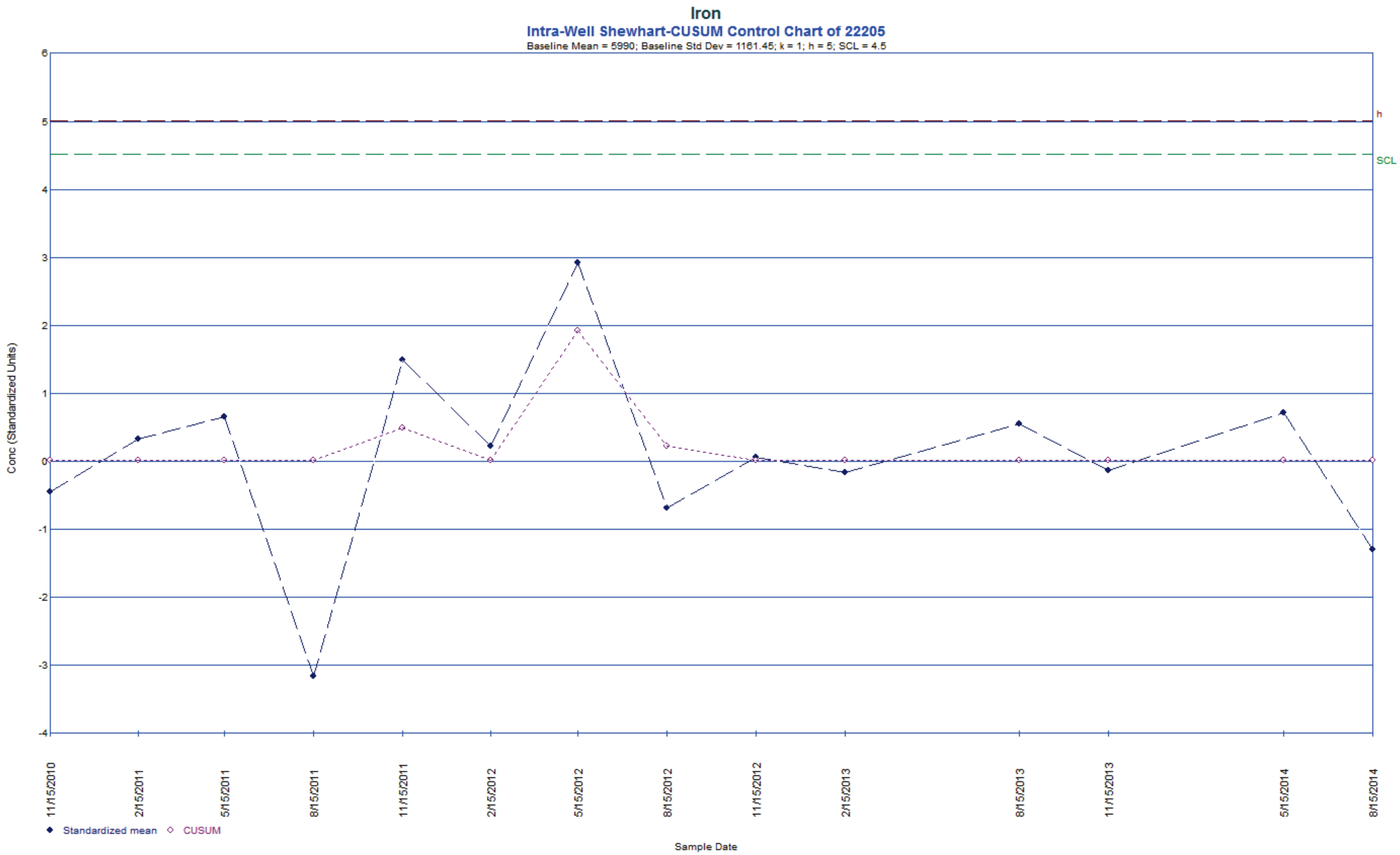


Figure A.5.4-41. Intra-Well Shewhart-CUSUM Control Chart (Iron 22205)

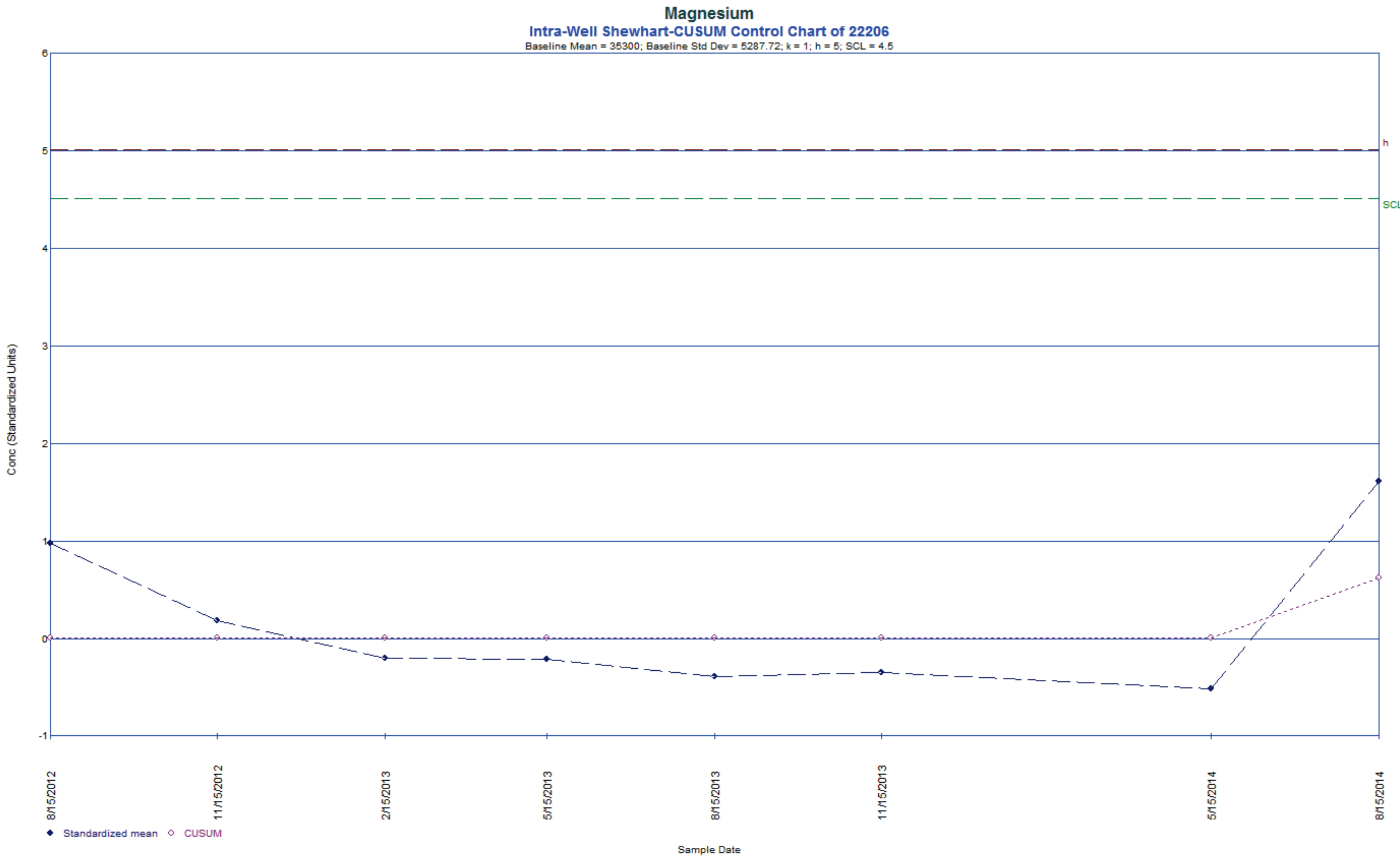


Figure A.5.4-42. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22206)

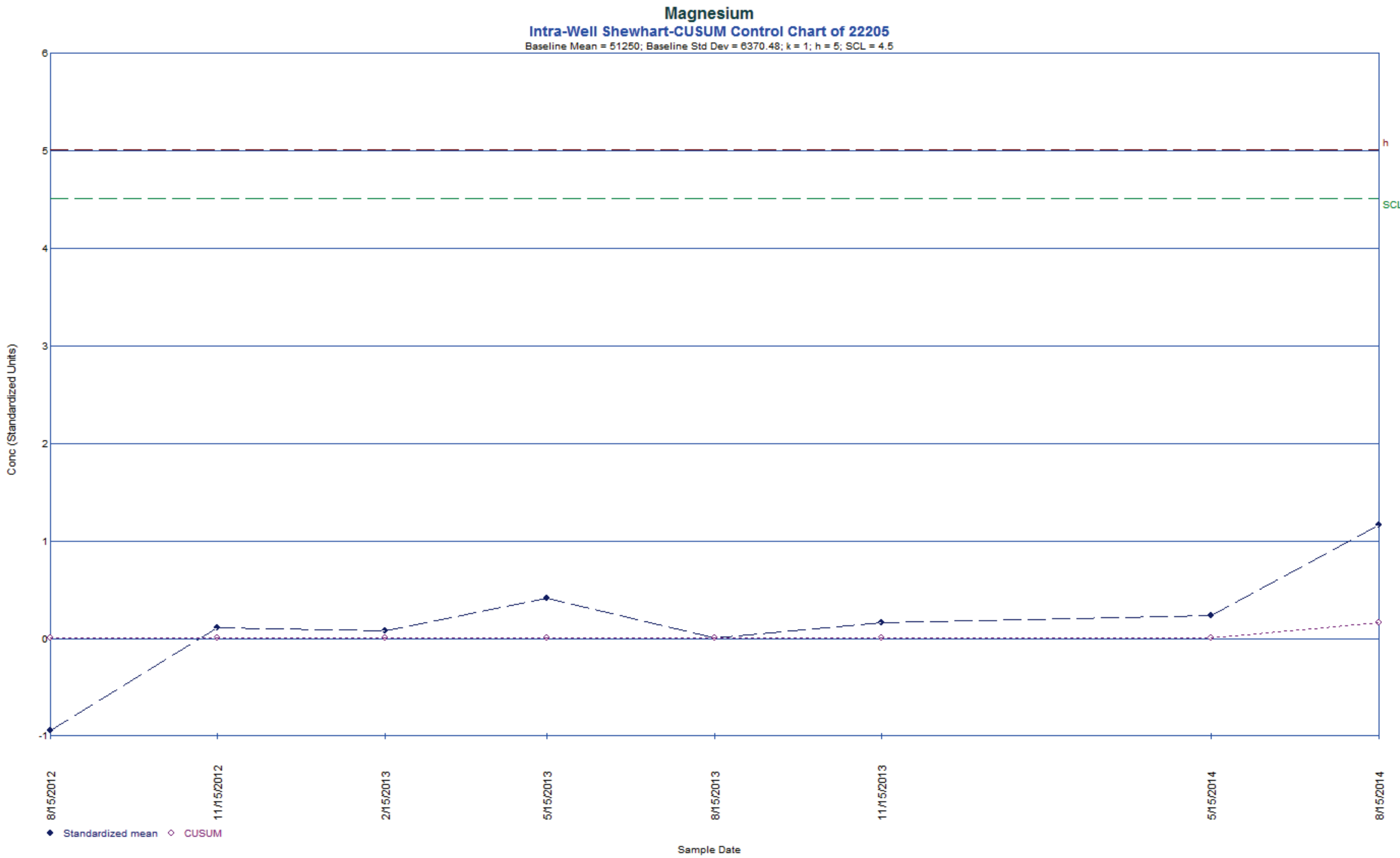


Figure A.5.4-43. Intra-Well Shewhart CUSUM Control Chart (Magnesium 22205)

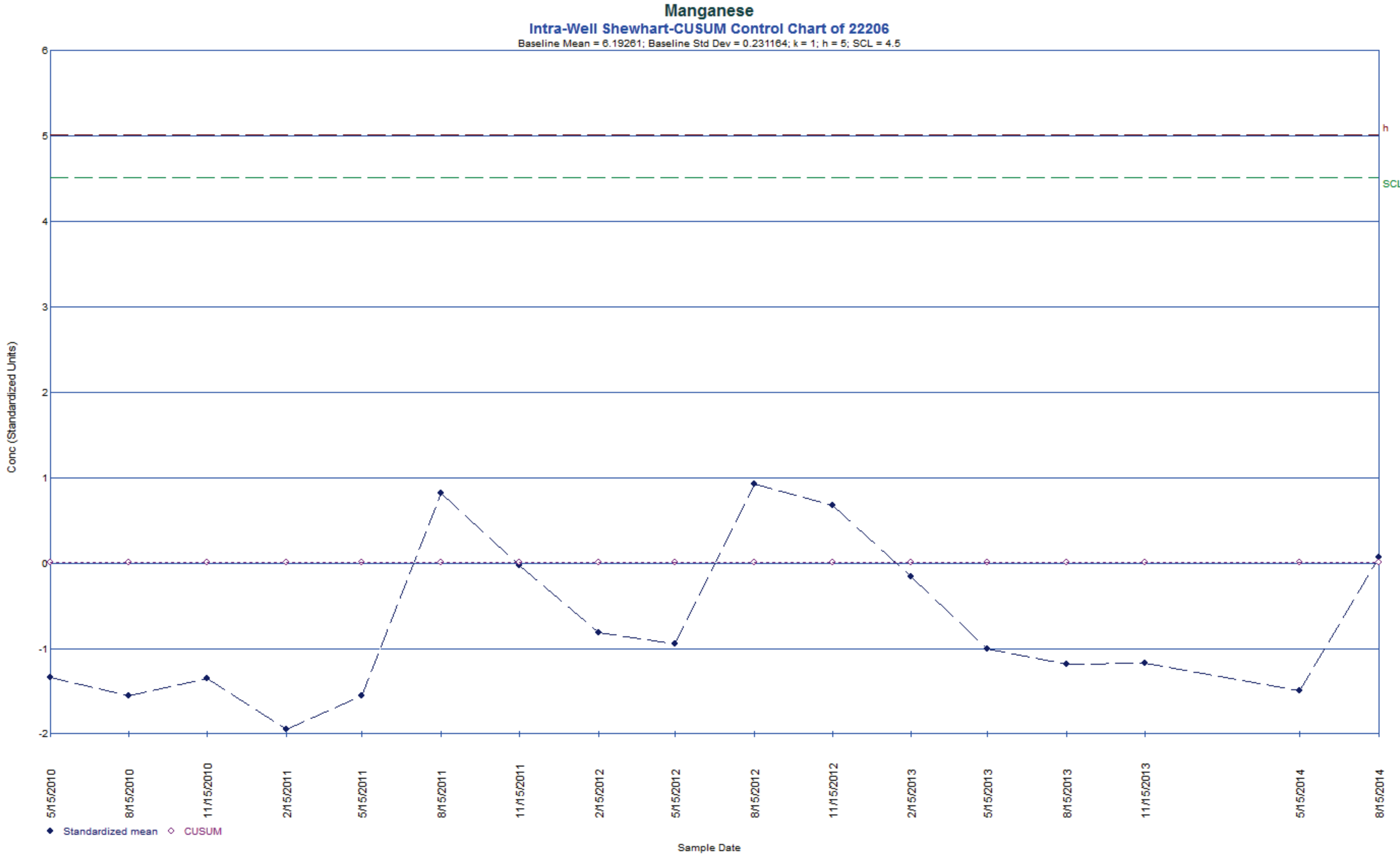


Figure A.5.4 44. Intra-Well Shewhart CUSUM Control Chart (Manganese 22206)

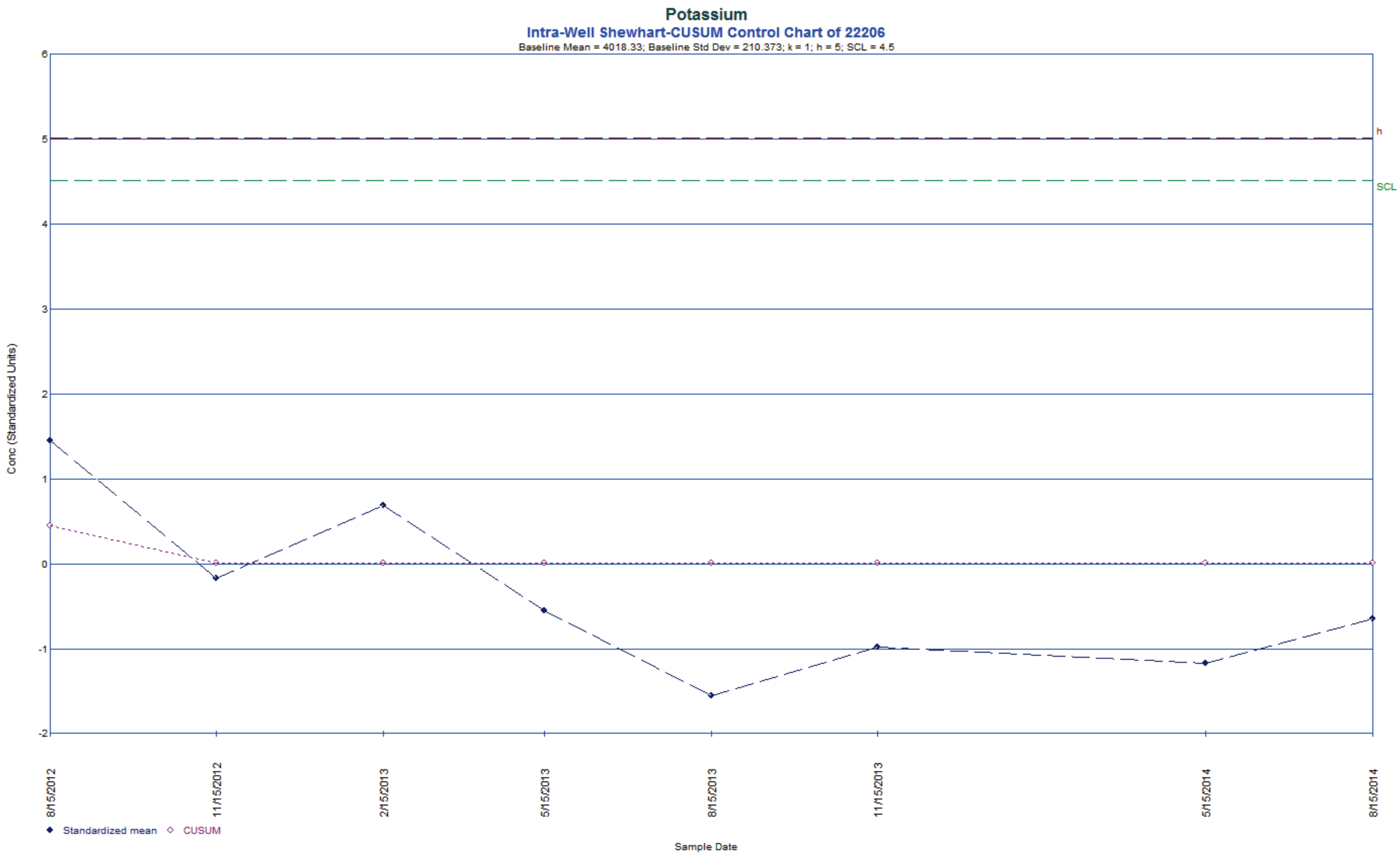


Figure A.5.4-45. Intra-Well Shewhart CUSUM Control Chart (Potassium 22206)

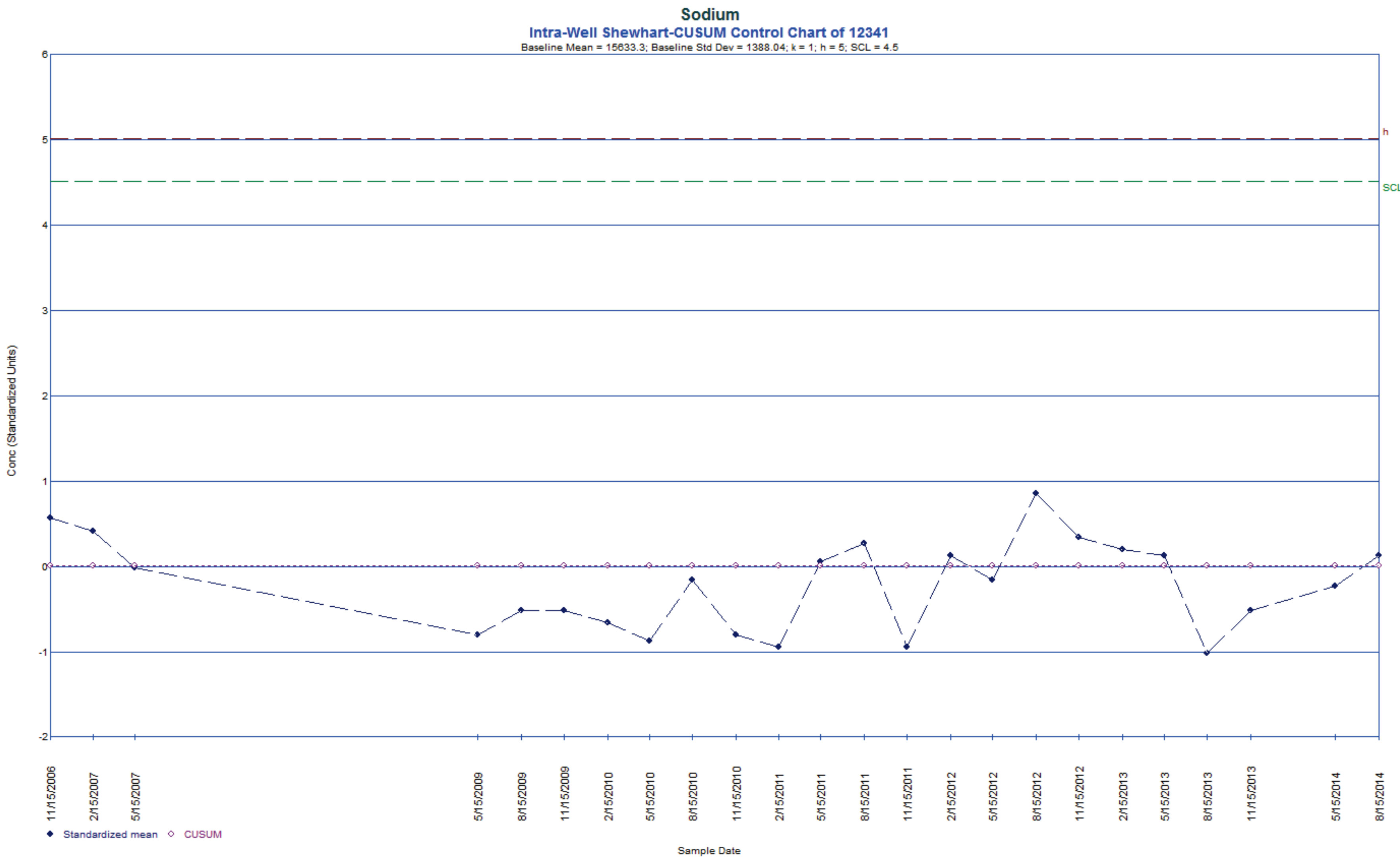


Figure A.5.4-46. Intra-Well Shewhart CUSUM Control Chart (Sodium 12341)

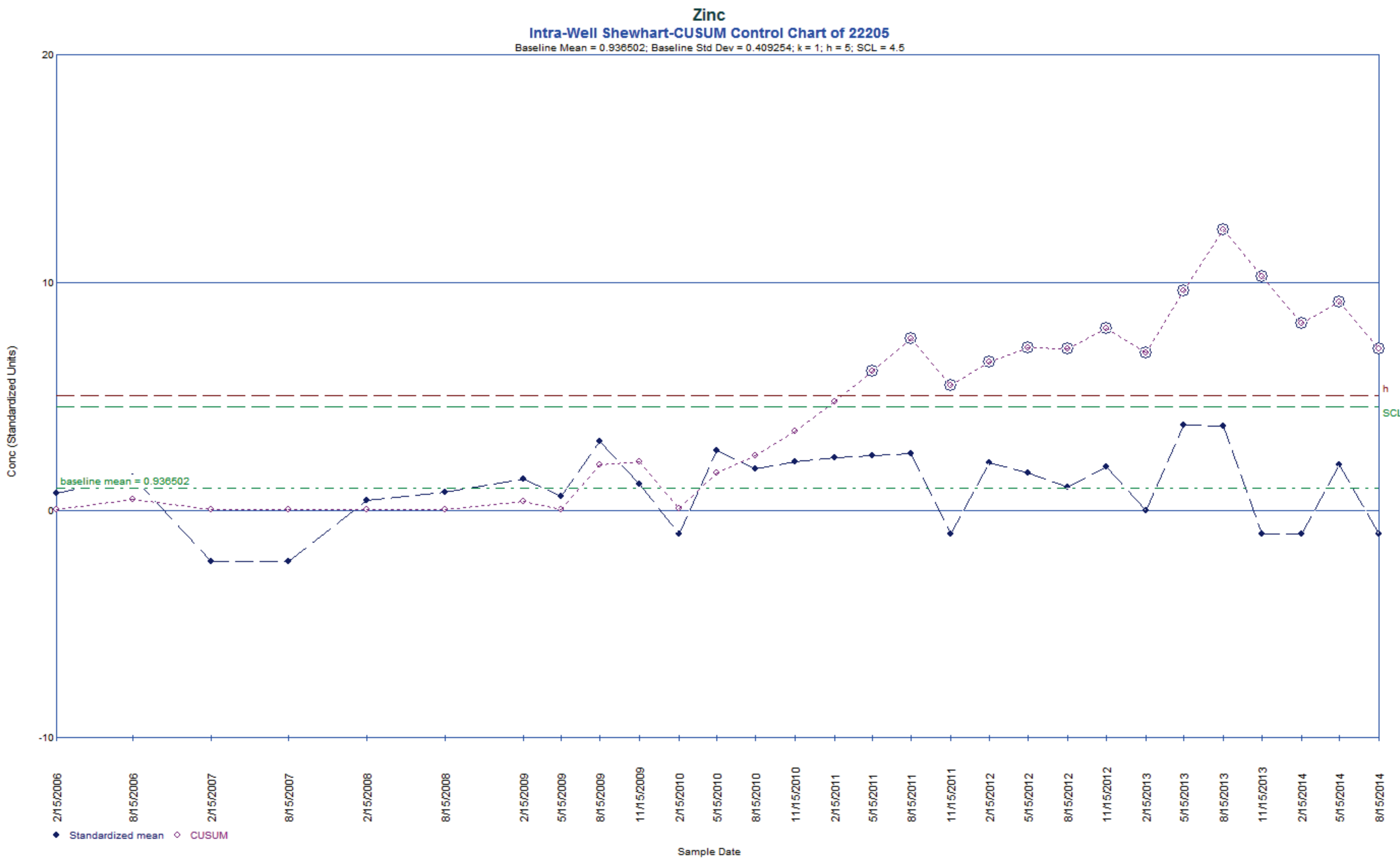


Figure A.5.4-47. Intra-Well Shewhart CUSUM Control Chart (Zinc 22205)

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Sub-attachment A.5.5

Cell 5

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Contents

Tables

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Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
PCB	polychlorinated biphenyl
SCL	Shewhart control limit
TDS	total dissolved solids
TOC	total organic carbon

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.5-1)
- Annual leachate collection system (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)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.5-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12342 water yield (refer to Figure A.5.5-3)
- Great Miami Aquifer (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 through A.5.5-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.5-30)
- Control charts (refer to Figures A.5.5-31 through A.5.5-41)

A.5.5.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring took place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF was operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. Summary statistics are provided in Table A.5.5-1.

Based on capacitance probe readings, the LDS tank of Cell 5 was not dry during 2014. It should be noted that the capacitance probes have the ability of measuring to within hundredths of a foot of water present in the bottom of the tank. So, while water may register via the probes, there may not be enough water present to physically obtain a sample. This was the case in 2014 for the LDS in Cell 5. Therefore, from a sampling ability, the LDS in Cell 5 were considered to be dry all year.

As shown in Table A.5.5-1, and summarized below, 13 parameters (alkalinity, chloride, sulfate, total organic carbon [TOC], arsenic, barium, boron, iron, lithium, magnesium, manganese, potassium, and selenium) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 5

Parameter	HTW 12342	GMA-U[a] 22207	GMA-D[a] 22208
Alkalinity		Up	
Chloride		Up	
Sulfate	Up		
TOC		Up	Up
Arsenic			Up
Barium		Up	
Boron		Up	Up
Iron			Up
Lithium		Up	
Magnesium		Up	
Manganese			Up
Potassium		Up	
Selenium		Up	Up

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

The (uranium-sodium) bivariate plot for the Cell 5 LCS, LDS, and HTW is provided in Figure A.5.5-30. 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, upward concentration trends measured beneath Cell 5 (i.e., in the HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

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 Shewhart-cumulative sum (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 “not in control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart control limit (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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.5-1 in gray shading, 10 parameters in the HTW and/or GMA wells of Cell 5 meet the criteria for control charts (i.e., eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 11 control charts.

Parameter	Monitoring Point[a]	Well Number	Assessment	Figure Number
Nitrate/Nitrite	GMA-U	22207	In Control	A.5.5-31
Total Dissolved Solids	GMA-D	22208	Not in Control	A.5.5-32
Barium	GMA-D	22208	In Control	A.5.5-33
Calcium	GMA-U	22207	Not In Control	A.5.5-34
Calcium	GMA-D	22208	In Control	A.5.5-35
Iron	GMA-U	22207	In Control	A.5.5-36
Lithium	GMA-D	22208	In Control	A.5.5-37
Manganese	GMA-U	22207	In Control	A.5.5-38
Potassium	GMA-D	22208	In Control	A.5.5-39
Sodium	GMA-D	22208	In Control	A.5.5-40
Zinc	GMA-D	22208	In Control	A.5.5-41

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

These 11 control charts are presented in Figures A.5.5-31 through A.5.5-41. All of the control charts, with the exception of two, exhibit "in control" conditions. The two exceptions are total dissolved solids (TDS) in the GMA-downgradient well and calcium in the GMA-upgradient well. 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 "Not in Control" conditions beneath the facility (i.e., HTW and GMA wells) 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 semiannually. No new Appendix I of polychlorinated biphenyl (PCB) parameters were detected in the LCS of Cell 5 in 2014.

A.5.5.4 Summary and Conclusions

- Thirteen parameters monitored semiannually have an upward concentration trend in the HTW and/or GMA wells of Cell 5: alkalinity, chloride, sulfate, TOC, arsenic, barium, boron, iron, lithium, magnesium, manganese, potassium, and selenium.
- 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. Therefore, upward concentration trends beneath Cell 5 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.

- Eleven control charts were constructed for Cell 5 parameters. Nine of the 11 control charts exhibit “in control” conditions. The control charts for TDS in the GMA-D well and calcium in the GMA-U well exhibited a “not in control” condition.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 5 in 2014.

A.5.5.5 References

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities -Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12342C	46	46	100	3.39	285	120	46	Undefined	None	Detected	
	LDS	12342D	40	40	100	2.93	27.1	15.6	5.2	Normal	Down	Detected	
	HTW	12342	49	49	100	7.45	19.2	9.3	2.3	Undefined	None	Detected	
	GMA-U	22207	42	50	84.0	ND	0.631	0.317	0.137	LogNormal	Down	Detected	2.39(Q3-02)
	GMA-D	22208	44	52	84.6	ND	2.10	0.372	0.275	Undefined	None	Not Detected	
Alkalinity as $CaCO_3$ (mg/L)	LCS	12342C	29	29	100	58.0	563	457	110	Undefined	None	Detected	
	LDS	12342D	20	20	100	73.8	651	199	222	Undefined	Down	Detected	
	GMA-U	22207	14	14	100	337	395	366	17	Normal	Up	Detected	
	GMA-D	22208	14	14	100	375	430	401	19	Normal	Down	Detected	
Chloride (mg/L)	LCS	12342C	29	29	100	16.9	167	99.4	30.6	Undefined	Up	Detected	
	LDS	12342D	20	20	100	6.20	130	47.2	22.6	Undefined	Up	Detected	
	GMA-U	22207	14	14	100	20.5	41.5	32.2	5.7	Normal	Up	Not Detected	
	GMA-D	22208	14	14	100	18.7	31.9	23.3	3.9	Normal	Down	Detected	
Nitrate, Nitrite (mg/L)	LCS	12342C	28	35	80.0	ND	4.18	1.42	0.92	Undefined	Up	Detected	
	LDS	12342D	12	20	60.0	ND	5.77	0.354	1.47	Undefined	Up	Detected	
	GMA-U	22207	2	14	14.3	ND	0.0425	Insufficient	Insufficient	LogNormal	None	Not Detected	
	GMA-D	22208	2	14	14.3	ND	0.0500	Insufficient	Insufficient	Undefined	None	Not Detected	
Sulfate (mg/L)	LCS	12342C	46	46	100	218	5910	2900	1350	Undefined	Up	Detected	
	LDS	12342D	40	40	100	1130	6100	2160	1030	LogNormal	Up	Detected	
	HTW	12342	40	40	100	101	420	325	115	Undefined	Up	Detected	
	GMA-U	22207	45	45	100	97.8	770	243	132	Normal	Down	Detected	
	GMA-D	22208	45	45	100	221	671	389	94	Normal	None	Detected	
Total Dissolved Solids (mg/L)	LCS	12342C	34	34	100	436	6810	5630	2130	Undefined	Up	Detected	
	LDS	12342D	18	18	100	2080	7690	4770	1260	Normal	Up	Detected	
	GMA-U	22207	21	21	100	552	770	640	59	Normal	None	Detected	987(Q4-09)
	GMA-D	22208	21	21	100	882	1290	1020	110	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12342C	37	45	82.2	ND	4.21	1.98	0.79	Normal	None	Not Detected	
	LDS	12342D	37	40	92.5	ND	10.7	5.85	2.19	Normal	None	Detected	
	GMA-U	22207	39	50	78.0	ND	2.66	1.49	0.49	Normal	Up	Detected	4.15(Q4-03)
	GMA-D	22208	40	50	80.0	ND	2.68	1.50	0.47	Normal	Up	Detected	8.93(Q4-01)
Total Organic Halogens (mg/L)	LCS	12342C	27	46	58.7	ND	0.0604	0.0112	0.0123	Undefined	None	Not Detected	
	LDS	12342D	30	40	75.0	ND	0.0717	0.0296	0.0188	Normal	None	Not Detected	
	GMA-U	22207	17	50	34.0	ND	0.0470	0.00430	0.00802	Undefined	None	Detected	
	GMA-D	22208	13	50	26.0	ND	0.0260	0.00349	0.00531	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12342C	10	34	29.4	ND	0.140	0.00375	0.0317	Undefined	None	Not Detected	
	LDS	12342D	3	27	11.1	ND	0.0187	0.00250	Insufficient	Undefined	None	Not Detected	
	HTW	12342	11	30	36.7	ND	0.0528	0.00368	0.00961	Undefined	None	Not Detected	
	GMA-U	22207	8	21	38.1	ND	0.0363	0.00250	0.00871	Undefined	None	Not Detected	
	GMA-D	22208	6	35	17.1	ND	0.0390	0.0025	0.00933	Undefined	Up	Detected	
Barium (mg/L)	LCS	12342C	29	29	100	0.0155	0.0707	0.0249	0.0135	Undefined	Down	Detected	
	LDS	12342D	20	20	100	0.00698	0.0659	0.0190	0.0135	LogNormal	Down	Detected	
	GMA-U	22207	14	14	100	0.0622	0.144	0.0829	0.0230	LogNormal	Up	Detected	
	GMA-D	22208	14	14	100	0.0417	0.0617	0.0482	0.0053	Normal	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12342C	44	46	95.6	ND	1.59	0.746	0.295	Undefined	None	Detected	
	LDS	12342D	40	40	100	0.202	1.20	0.398	0.272	Undefined	None	Detected	
	GMA-U	22207	45	50	90.0	ND	0.0482	0.0388	0.0083	Undefined	Up	Not Detected	
	GMA-D	22208	44	50	88.0	ND	0.0478	0.0334	0.0100	Undefined	Up	Detected	
Calcium (mg/L)	LCS	12342C	29	29	100	163	990	510	141	Undefined	None	Not Detected	
	LDS	12342D	20	20	100	222	386	319	42	Normal	None	Not Detected	
	GMA-U	22207	14	14	100	124	187	155	15	Normal	None	Not Detected	
	GMA-D	22208	14	14	100	202	285	237	23	Normal	None	Not Detected	
Chromium (mg/L)	LCS	12342C	4	23	17.4	ND	0.0125	0.00318	0.00299	LogNormal	None	Not Detected	
	LDS	12342D	3	14	21.4	ND	0.0252	0.00502	Insufficient	LogNormal	Up	Not Detected	
	GMA-U	22207	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22208	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Cobalt (mg/L)	LCS	12342C	13	34	38.2	ND	0.0116	0.000500	0.00278	Undefined	Down	Detected	
	LDS	12342D	10	27	37.0	ND	0.0034	0.000500	0.000834	Undefined	Down	Detected	
	GMA-U	22207	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22208	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12342C	18	30	60.0	ND	0.147	0.0104	0.0294	Undefined	None	Not Detected	
	LDS	12342D	10	22	45.4	ND	0.0209	0.00475	0.00611	Undefined	None	Not Detected	
	GMA-U	22207	6	14	42.9	ND	0.00993	0.00150	0.00290	Undefined	None	Detected	
	GMA-D	22208	6	14	42.9	ND	0.00925	0.00150	0.00291	Undefined	Down	Detected	
Iron (mg/L)	LCS	12342C	28	34	82.4	ND	4.61	0.244	1.47	Undefined	Down	Detected	
	LDS	12342D	25	27	92.6	ND	3.67	0.603	1.06	Undefined	Down	Detected	
	GMA-U	22207	21	21	100	5.54	21.4	9.83	4.68	LogNormal	None	Not Detected	73.6(Q2-14), 42.3(Q1-13)
	GMA-D	22208	21	21	100	4.92	9.30	7.34	1.02	Normal	Up	Detected	
Lithium (mg/L)	LCS	12342C	30	30	100	0.107	0.576	0.218	0.091	LogNormal	Up	Detected	
	LDS	12342D	26	26	100	0.0484	0.308	0.142	0.073	Normal	Up	Detected	
	GMA-U	22207	21	21	100	0.00642	0.0165	0.0130	0.0035	Undefined	Up	Detected	
	GMA-D	22208	21	21	100	0.00659	0.00932	0.00802	0.00066	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12342C	29	29	100	57.7	959	796	283	Undefined	Up	Detected	
	LDS	12342D	20	20	100	104	655	226	184	Undefined	Up	Detected	
	GMA-U	22207	14	14	100	26.1	36.4	32.1	3.4	Normal	Up	Detected	
	GMA-D	22208	14	14	100	47.7	66.4	57.2	5.4	Normal	None	Detected	
Manganese (mg/L)	LCS	12342C	14	34	41.2	ND	2.96	0.00600	0.853	Undefined	Down	Detected	
	LDS	12342D	17	27	63	ND	0.783	0.159	0.164	LogNormal	Down	Not Detected	
	GMA-U	22207	21	21	100	0.256	0.428	0.329	0.046	Normal	None	Not Detected	0.650(Q4-09)
	GMA-D	22208	34	35	97.1	ND	0.541	0.401	0.062	Normal	Up	Detected	0.000425(Q1-04)
Nickel (mg/L)	LCS	12342C	28	34	82.4	ND	0.0452	0.00420	0.0147	Undefined	Down	Detected	
	LDS	12342D	21	27	77.8	ND	0.0230	0.00686	0.00612	LogNormal	Down	Detected	
	GMA-U	22207	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22208	8	35	22.9	ND	0.00690	0.000750	0.00150	Undefined	None	Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Potassium (mg/L)	LCS	12342C	29	29	100	6.22	65.5	28.8	9.4	Undefined	Up	Detected	
	LDS	12342D	20	20	100	10.0	47.4	26.0	12.8	Undefined	Up	Detected	
	GMA-U	22207	14	14	100	2.75	3.52	3.19	0.27	Normal	Up	Detected	
	GMA-D	22208	14	14	100	2.90	3.53	3.26	0.17	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12342C	11	34	32.4	ND	0.212	0.00625	0.0378	Undefined	None	Not Detected	
	LDS	12342D	4	27	14.8	ND	0.0525	0.00300	0.0128	Undefined	None	Not Detected	
	GMA-U	22207	1	21	4.8	ND	0.00730	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-D	22208	2	21	9.5	ND	0.0107	Insufficient	Insufficient	Undefined	Up	Not Detected	
Sodium (mg/L)	LCS	12342C	33	34	97.1	16.4	108	69.7	16.7	Undefined	None	Not Detected	
	LDS	12342D	27	27	100	84.6	808	432	137	Normal	Up	Detected	
	HTW	12342	30	30	100	17.0	33.6	27.0	4.7	Undefined	None	Detected	
	GMA-U	22207	21	21	100	13.0	19.1	15.1	1.4	Normal	None	Detected	
	GMA-D	22208	21	21	100	14.3	17.9	16.4	1.0	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12342C	11	34	32.4	ND	0.0400	0.00825	0.00846	Undefined	None	Not Detected	
	LDS	12342D	20	27	74.1	ND	0.131	0.0311	0.0271	LogNormal	None	Not Detected	
	GMA-U	22207	8	21	38.1	ND	0.0123	0.00286	0.00351	Undefined	None	Not Detected	
	GMA-D	22208	18	35	51.4	ND	0.0124	0.00394	0.00246	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least eight samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater Background)	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched Water)
General Chemistry											
Ammonia (mg/L)	13	5	38.5	Yes	0.020	0.815	0.240	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	13	1	7.7	No	0.000038	-	-	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	21	9	42.9	Yes	2.04	21.2	11.5	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)	21	1	4.8	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	2.70	-	-	-	-	-	-
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	-	-	-	-	-	-

[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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.
[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).
[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.
[f]Maximum Perched Water - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

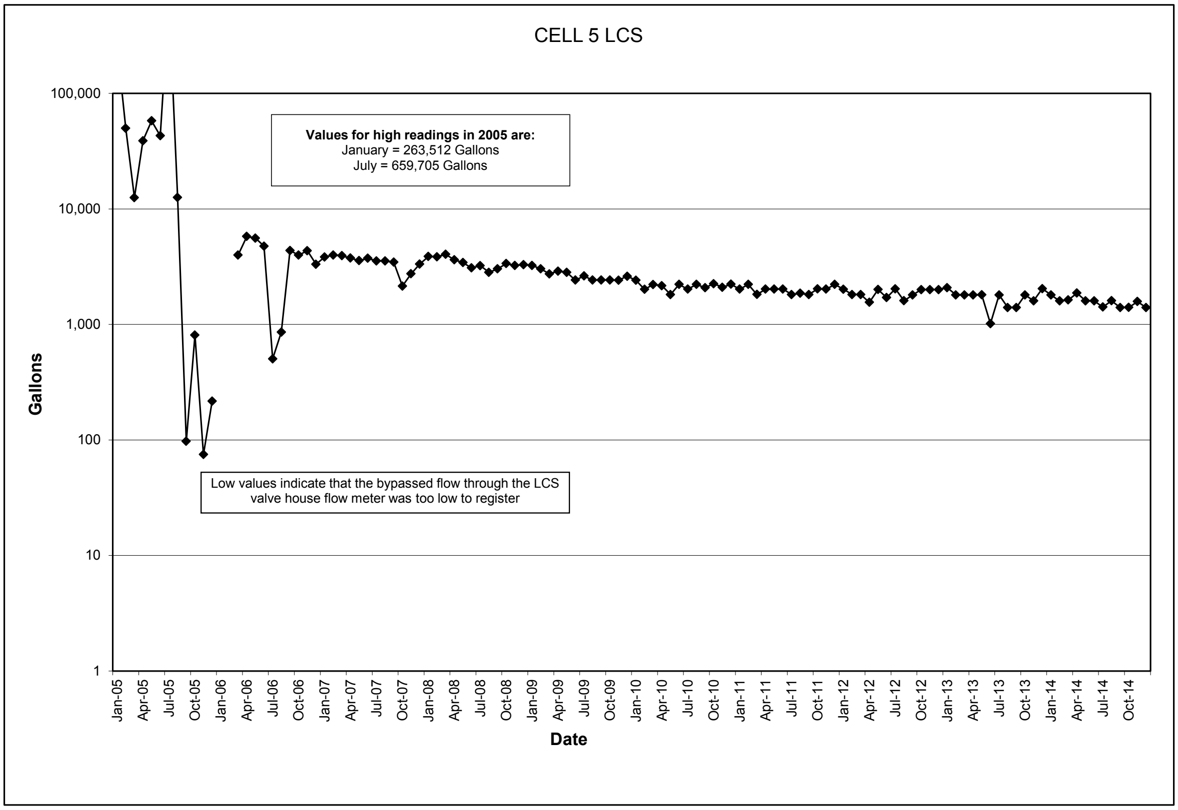


Figure A.5.5-1. Monthly Accumulation Volumes for Cell 5 LCS

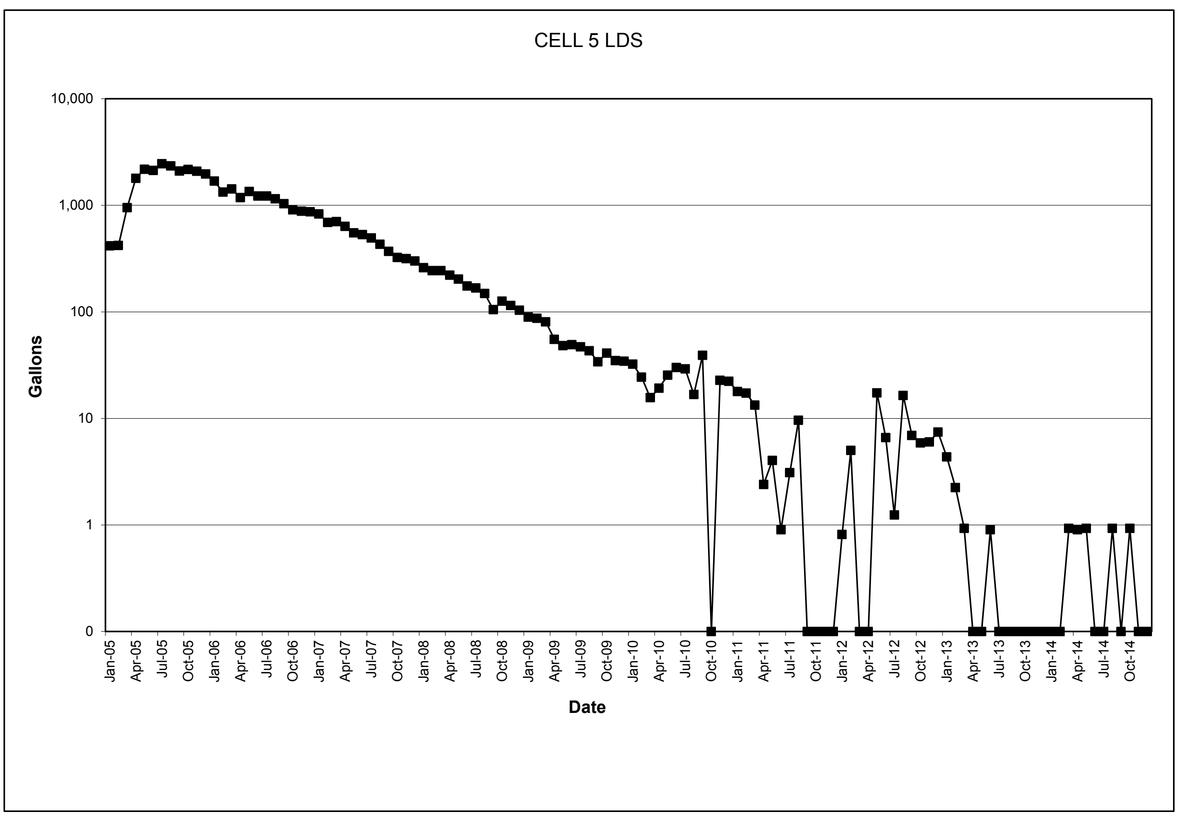
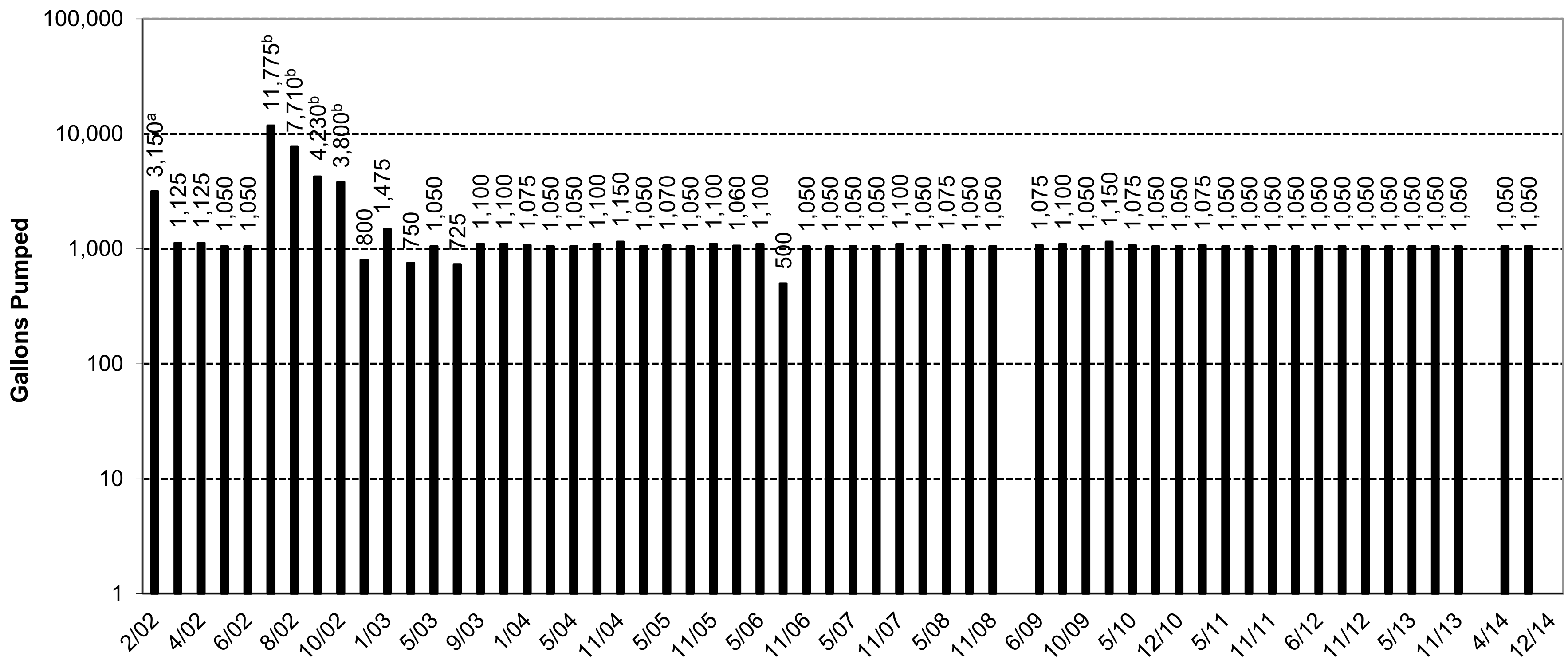


Figure A.5.5-2. Monthly Accumulation Volumes for Cell 5 LDS



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
2012:	4200	n=4	1050
2013:	4200	n=4	1050
2014[c]:	2100	n=2	1050
Overall:			1486

[a]Excess water was pumped from this well in February 2002 for well development.

[b]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.

[c]Sampling schedule reduced to semi-annual sampling in 2014.

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

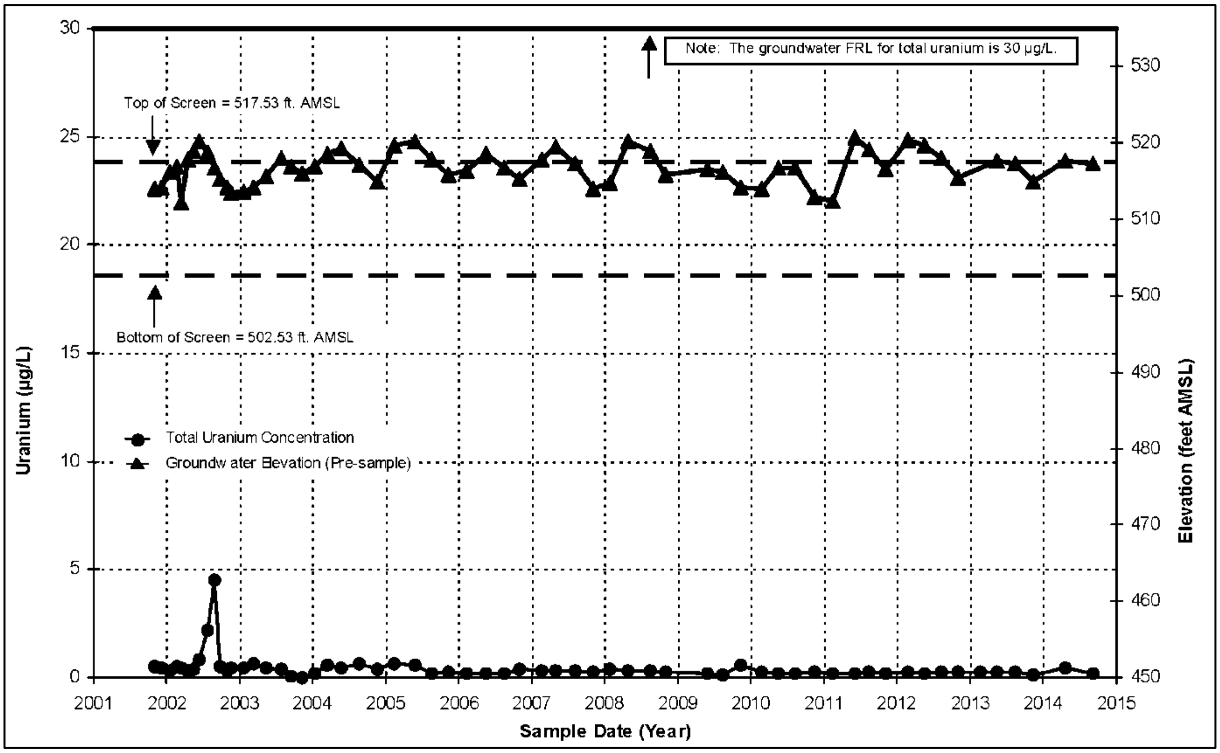


Figure A.5.5-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 5 Upgradient Monitoring Well 22207

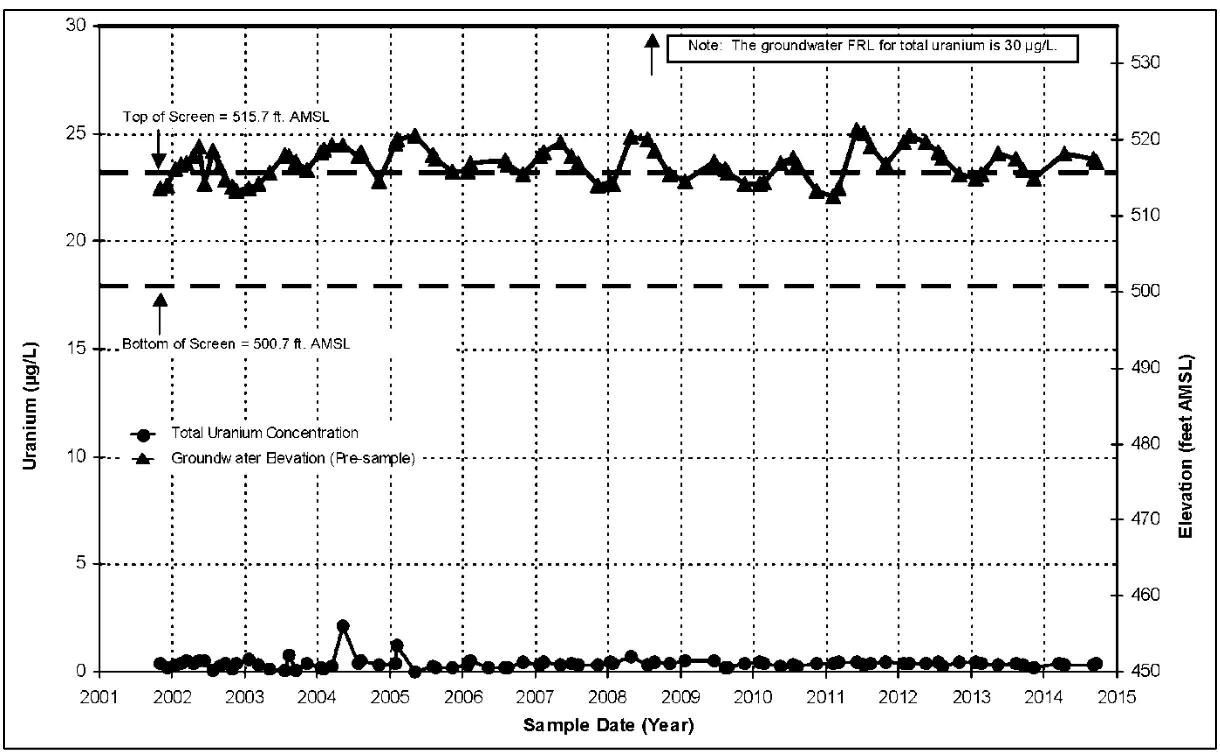


Figure A.5.5-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 5 Downgradient Monitoring Well 22208

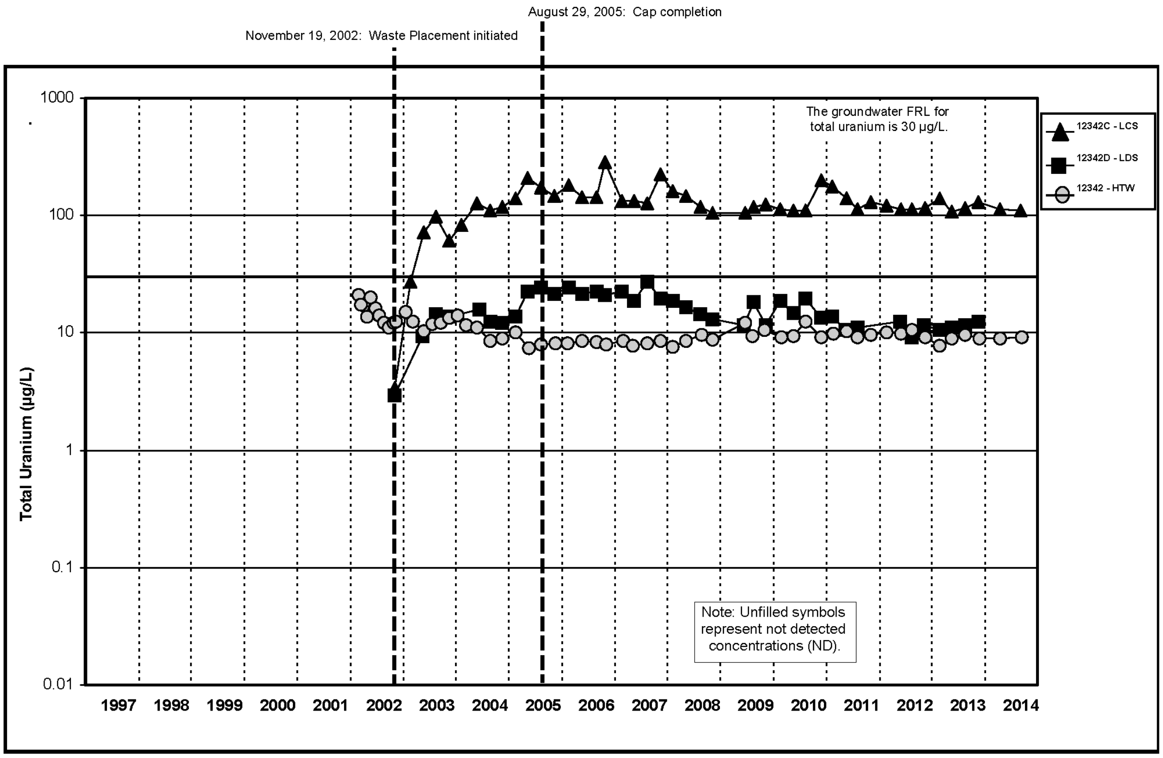


Figure A.5.5-6A. Cell 5 Uranium, Total Concentration Versus Time Plot for LCS, LDS, and HTW

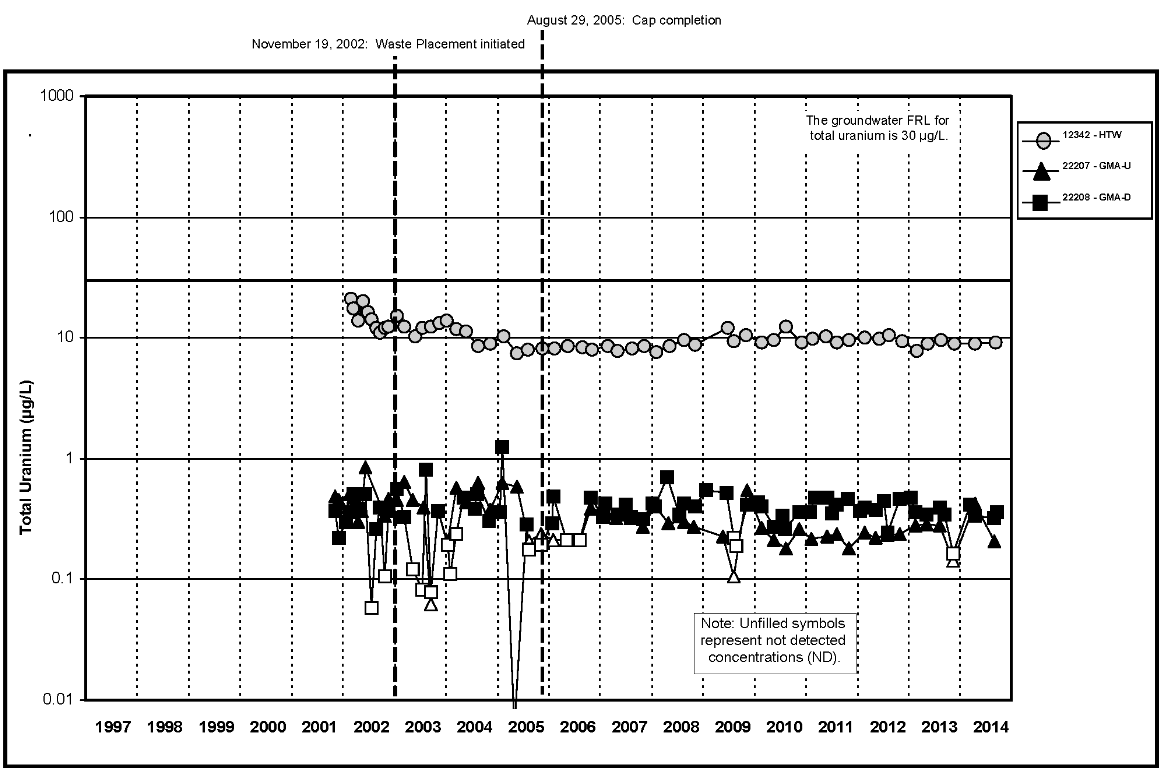


Figure A.5.5-6B. Cell 5 Uranium, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

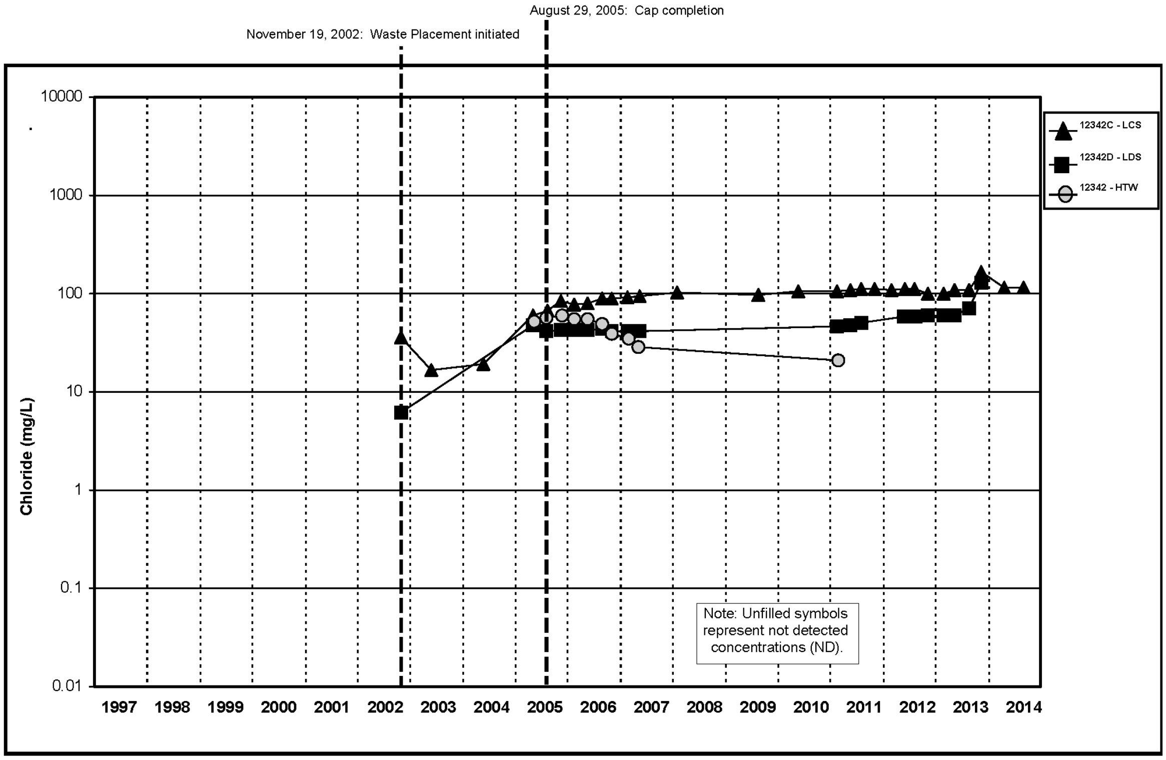


Figure A.5.5-7A. Cell 5 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

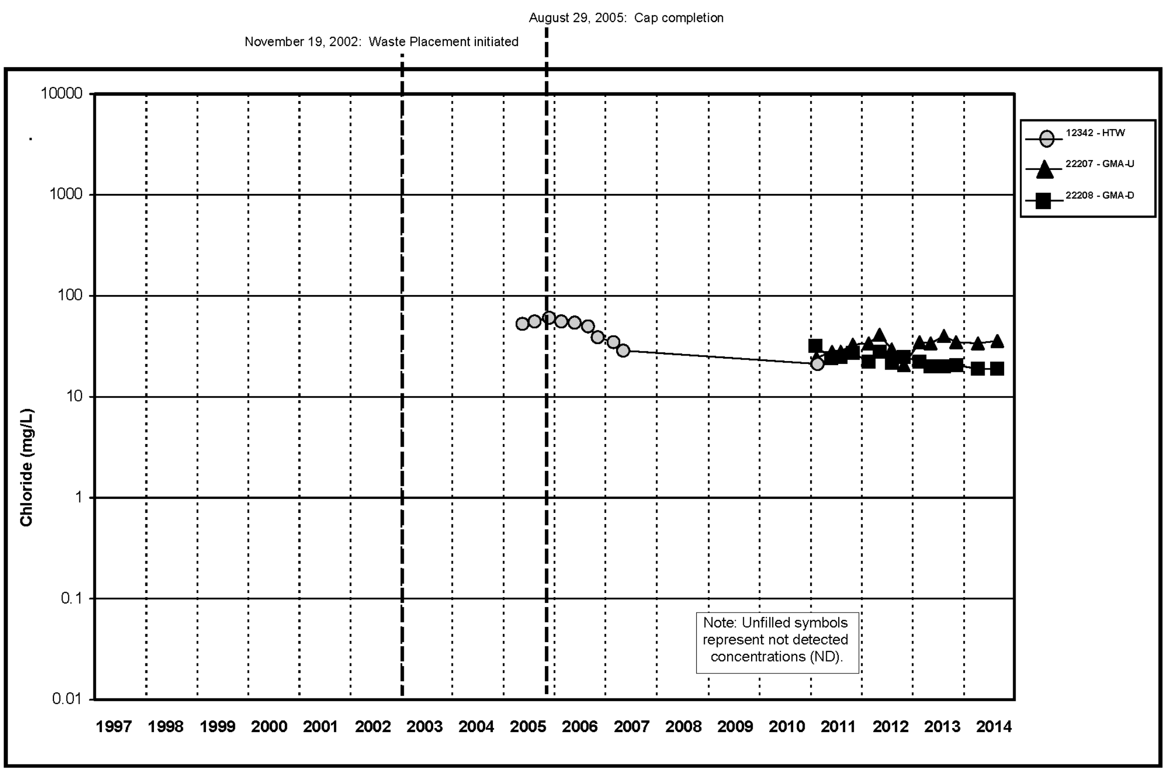


Figure A.5.5-7B. Cell 5 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

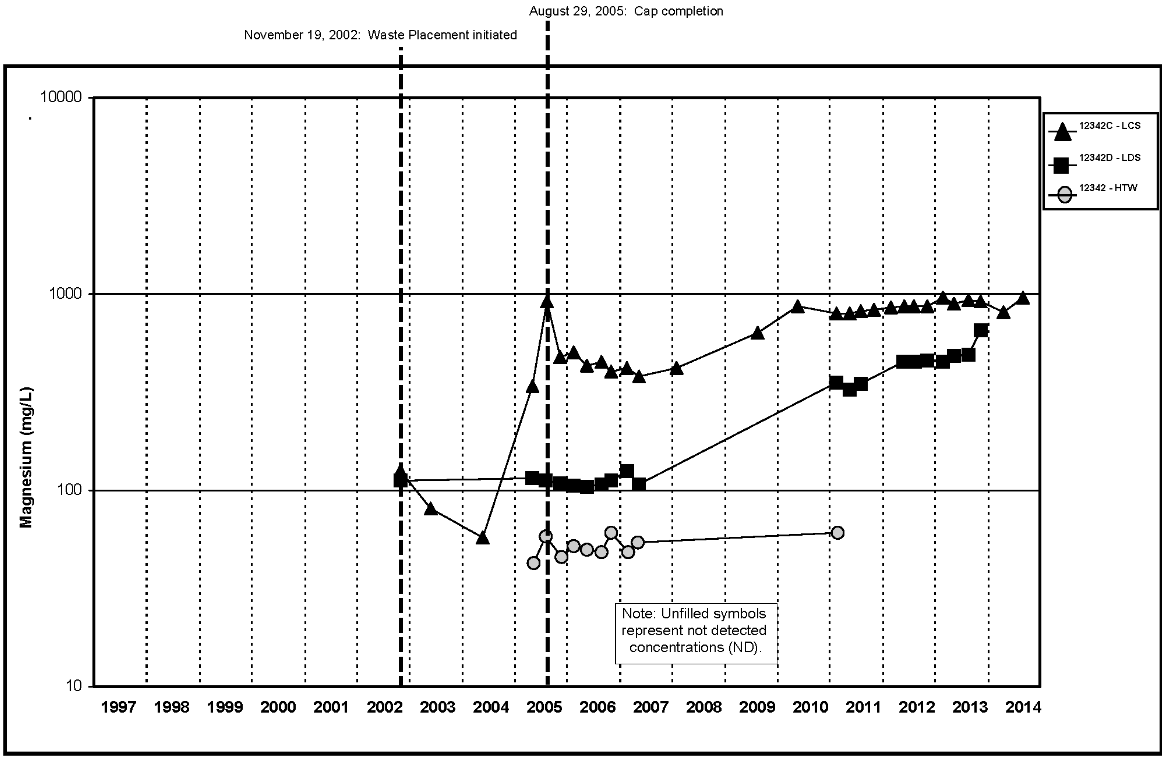


Figure A.5.5-8A. Cell 5 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

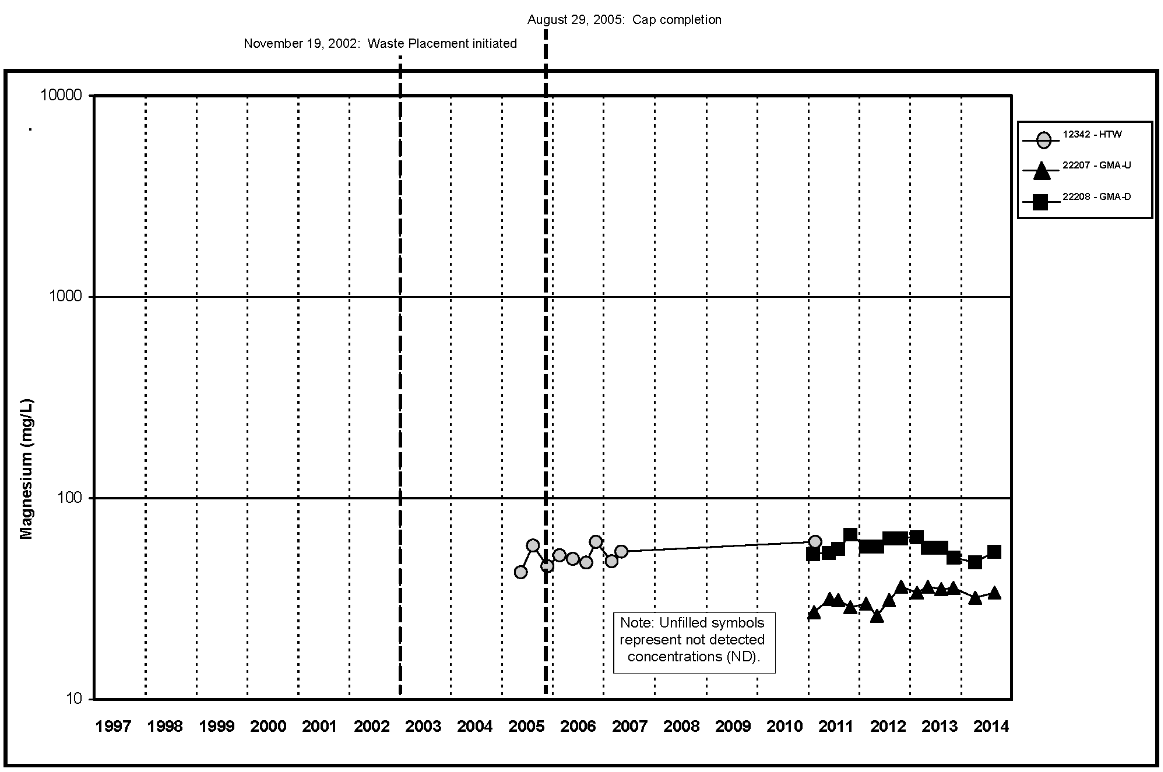


Figure A.5.5-8B. Cell 5 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

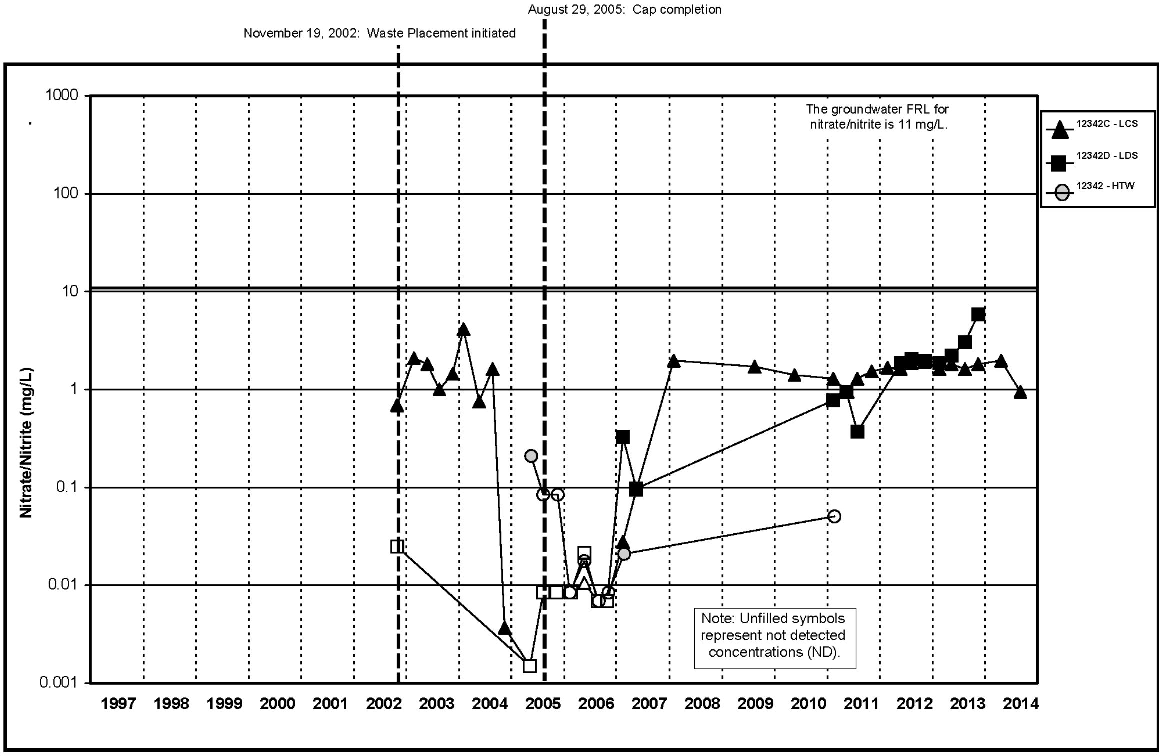


Figure A.5.5-9A. Cell 5 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

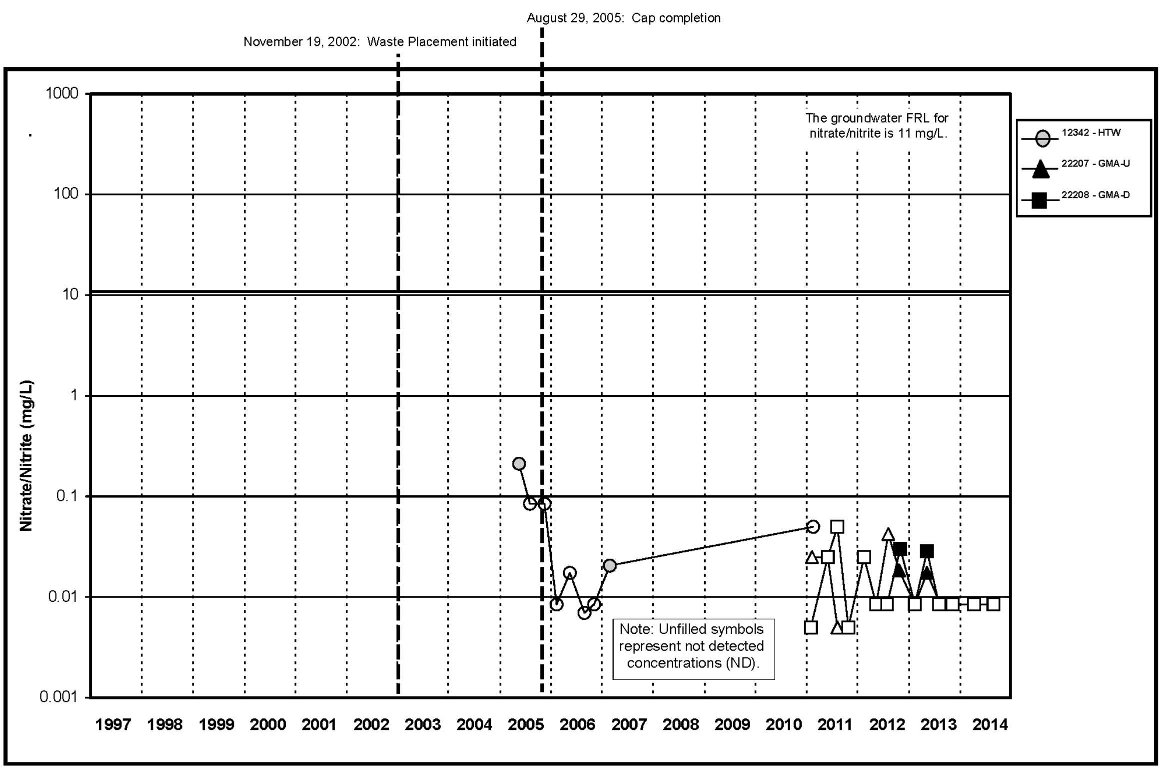


Figure A.5.5-9B. Cell 5 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

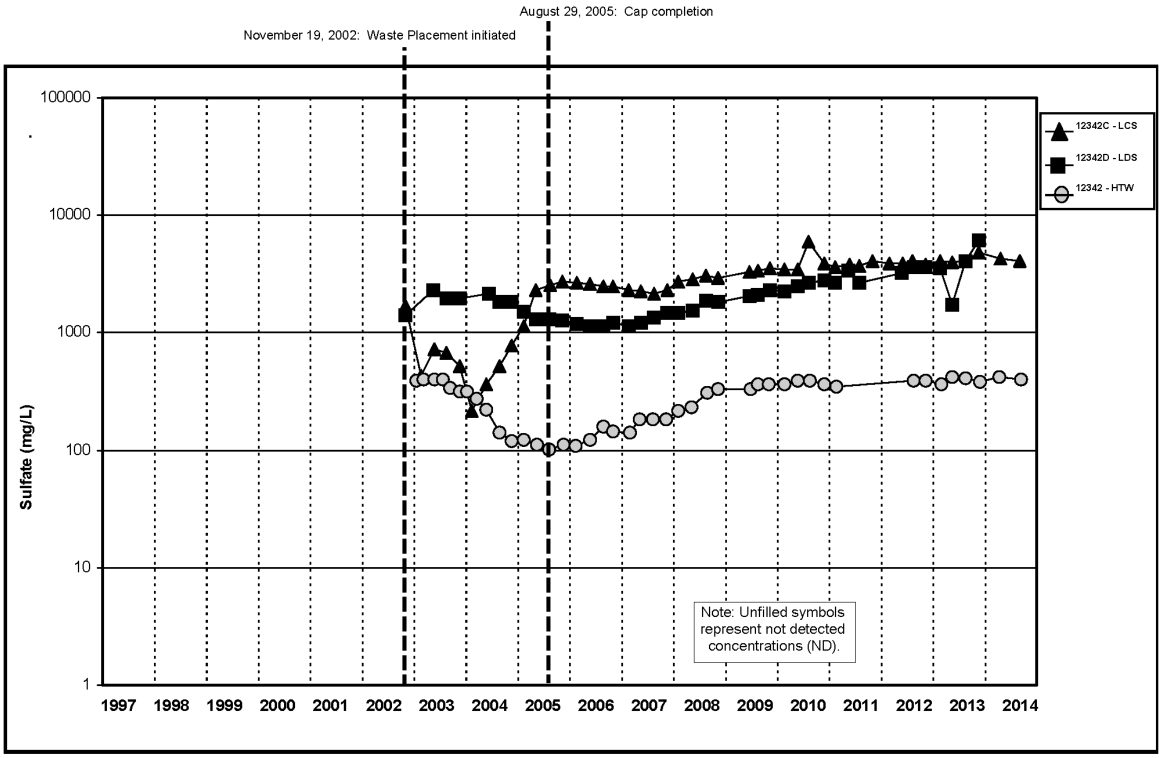


Figure A.5.5-10A. Cell 5 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

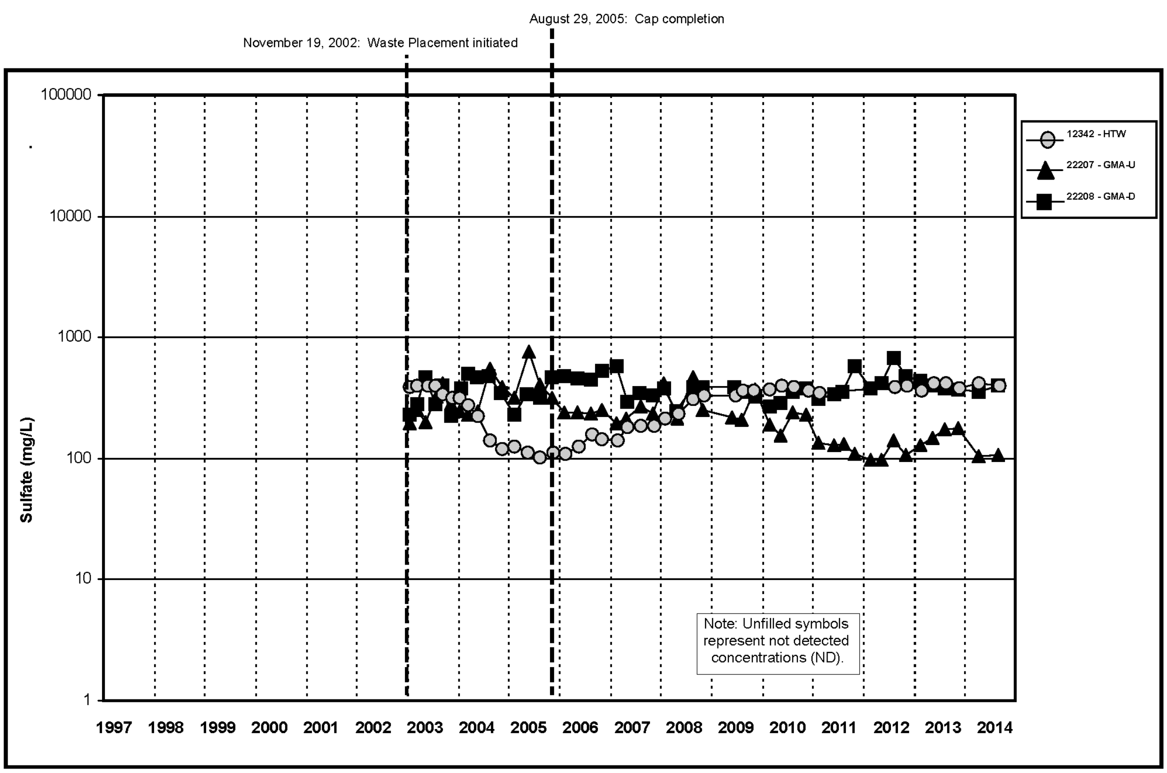


Figure A.5.5-10B. Cell 5 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

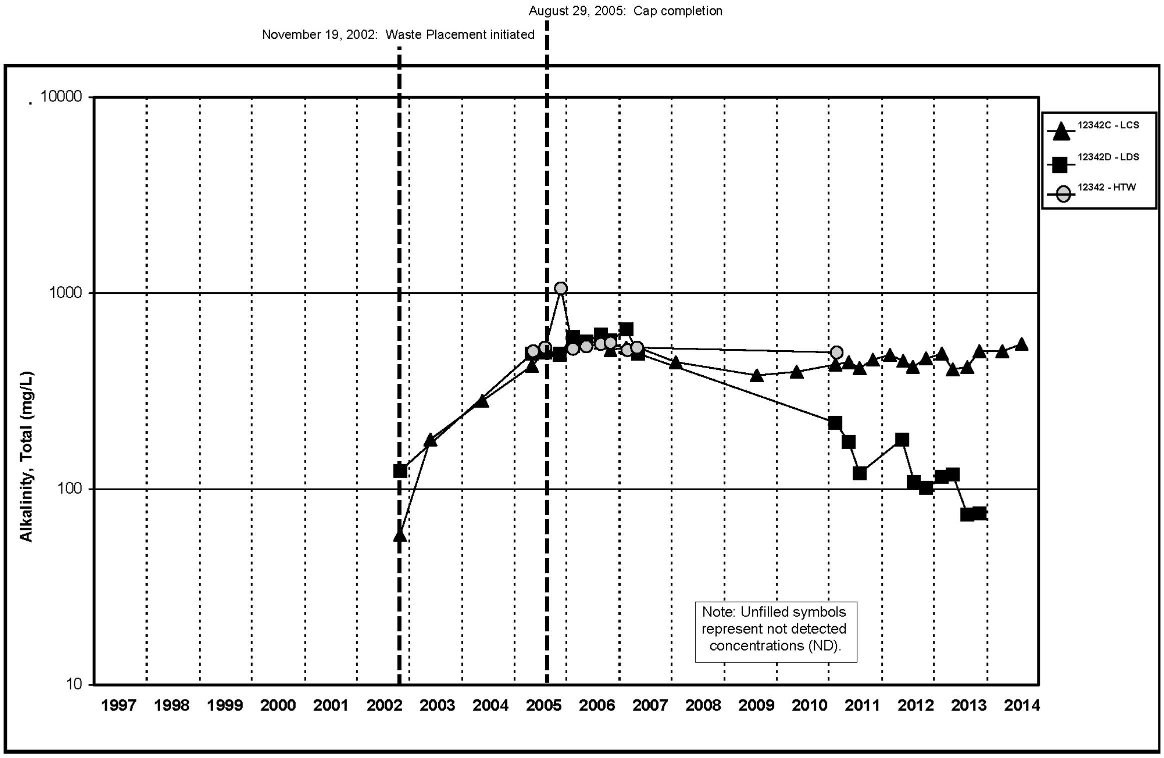


Figure A.5.5-11A. Cell 5 Alkalinity, Total Concentration Versus Time Plot for LCS, LDS, and HTW

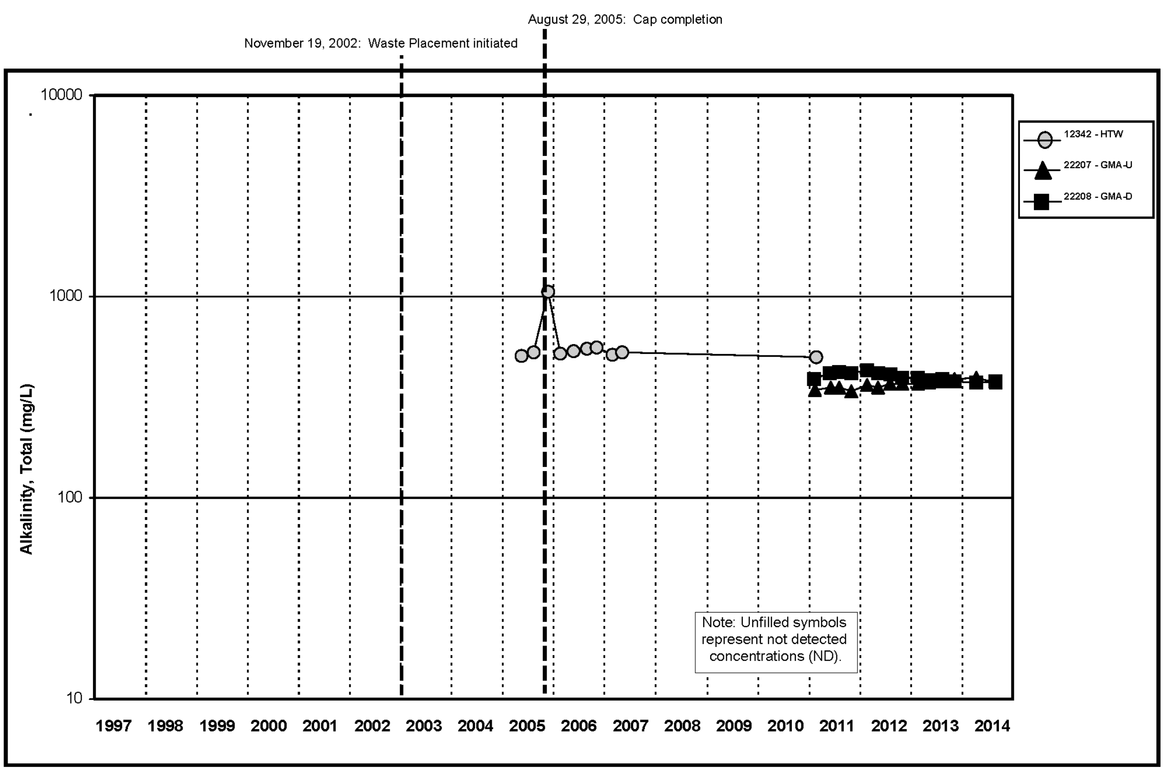


Figure A.5.5-11B. Cell 5 Alkalinity, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

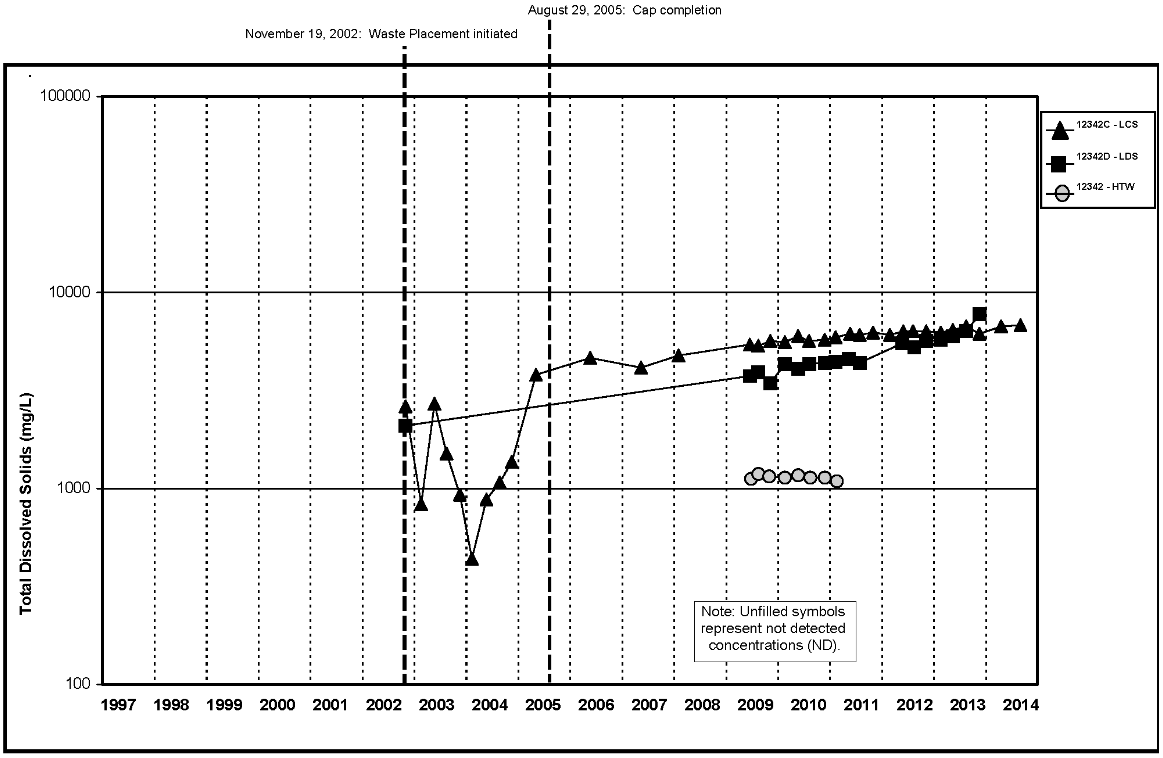


Figure A.5.5-12A. Cell 5 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

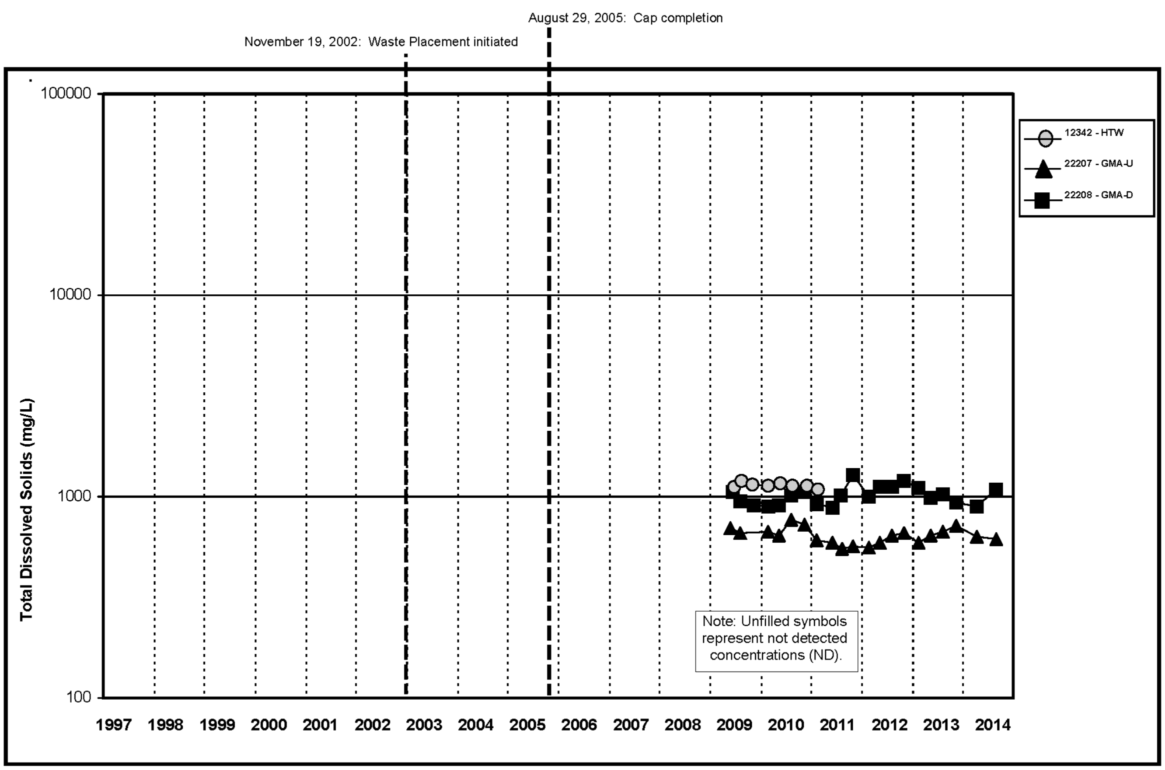


Figure A.5.5-12B. Cell 5 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

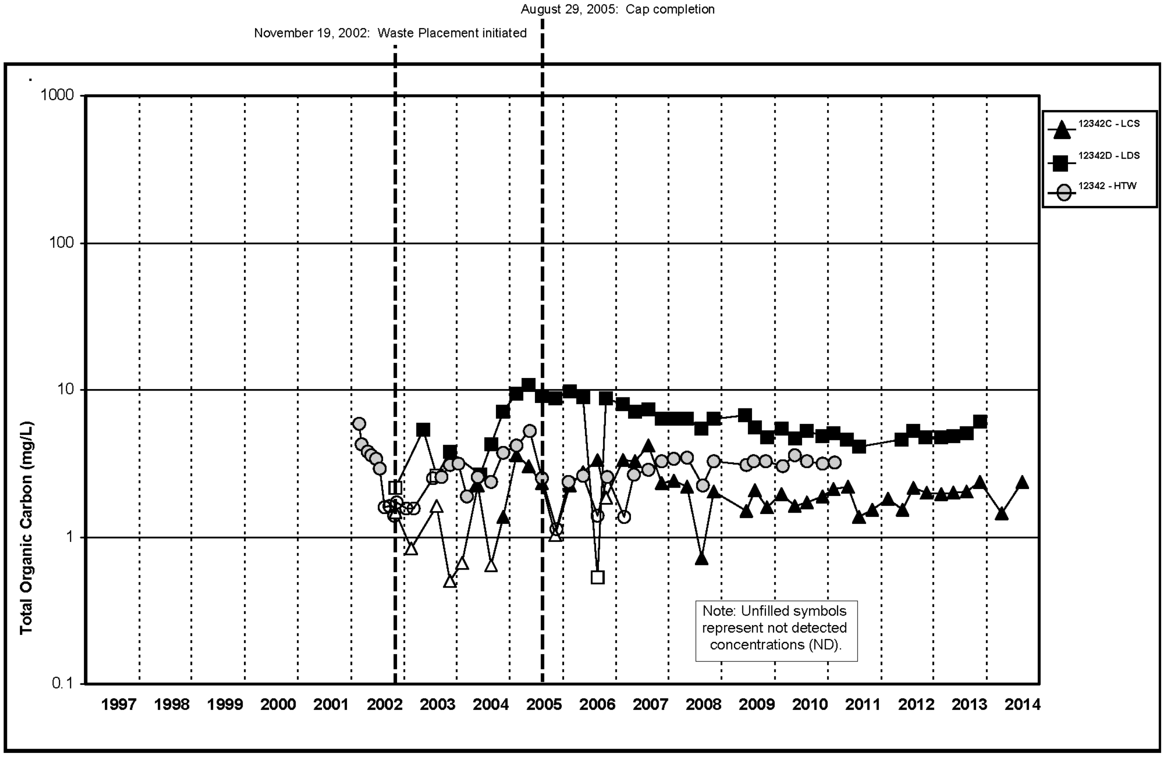


Figure A.5.5-13A. Cell 5 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

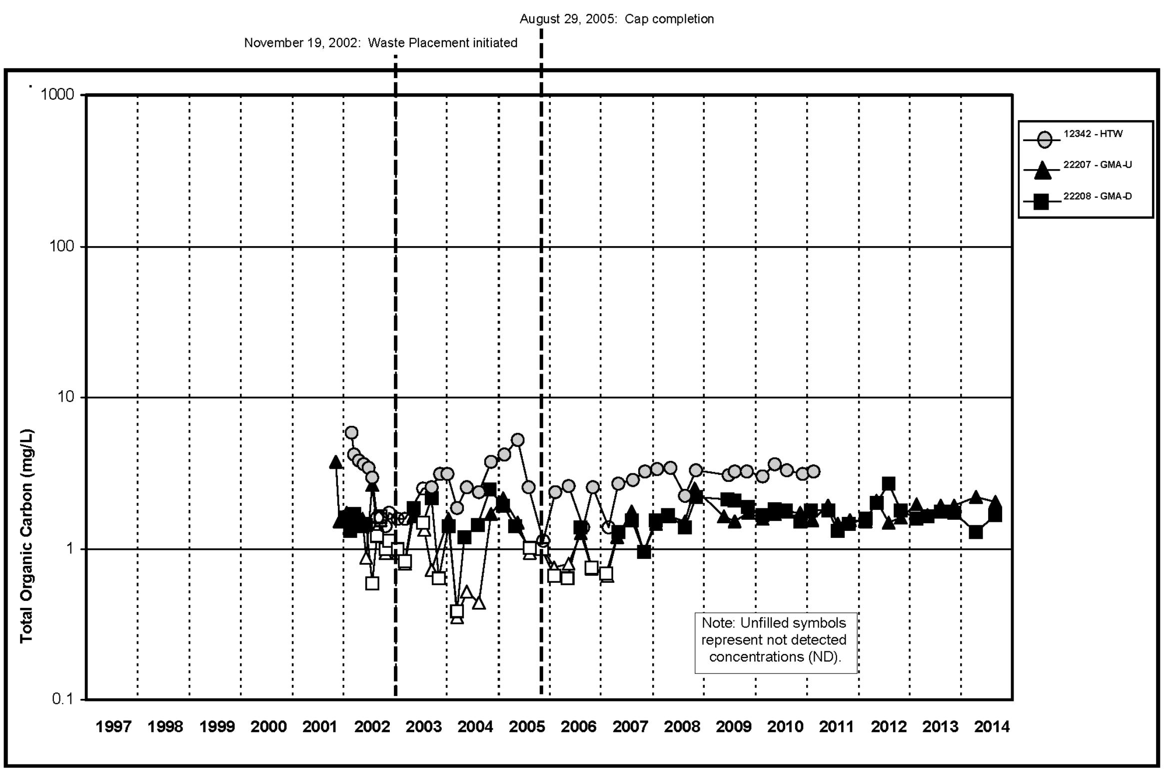


Figure A.5.5-13B. Cell 5 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

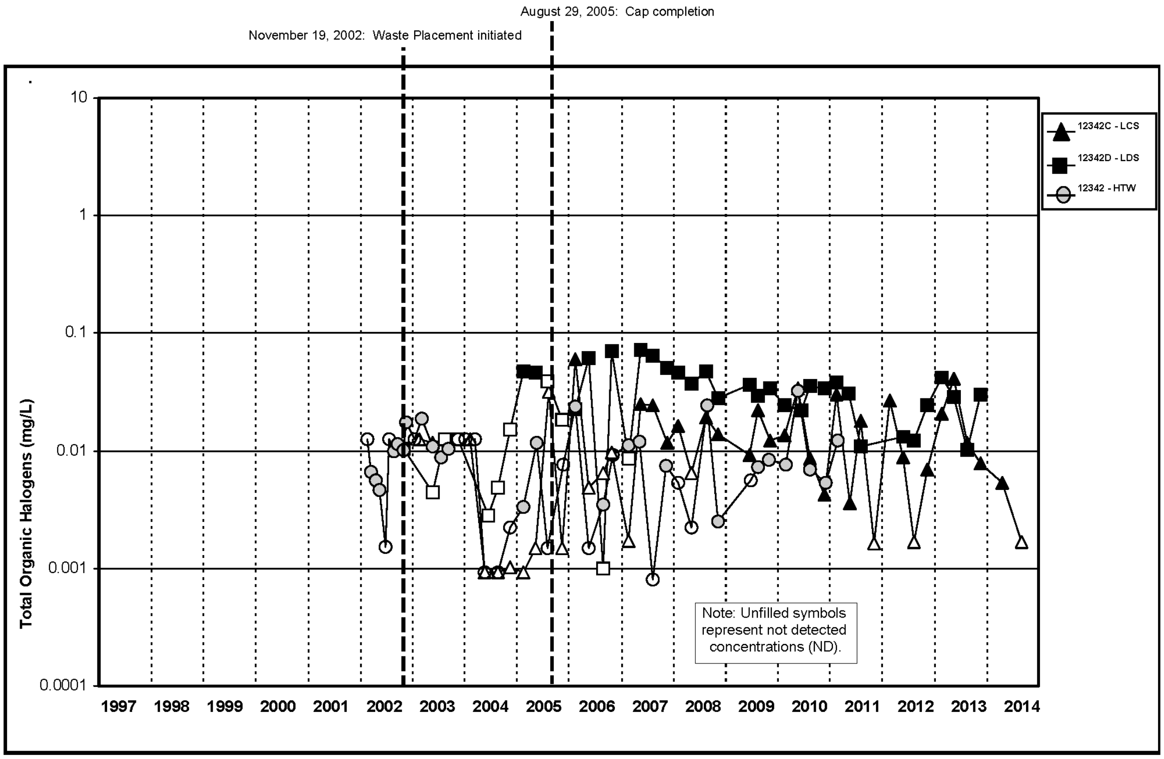


Figure A.5.5-14A. Cell 5 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

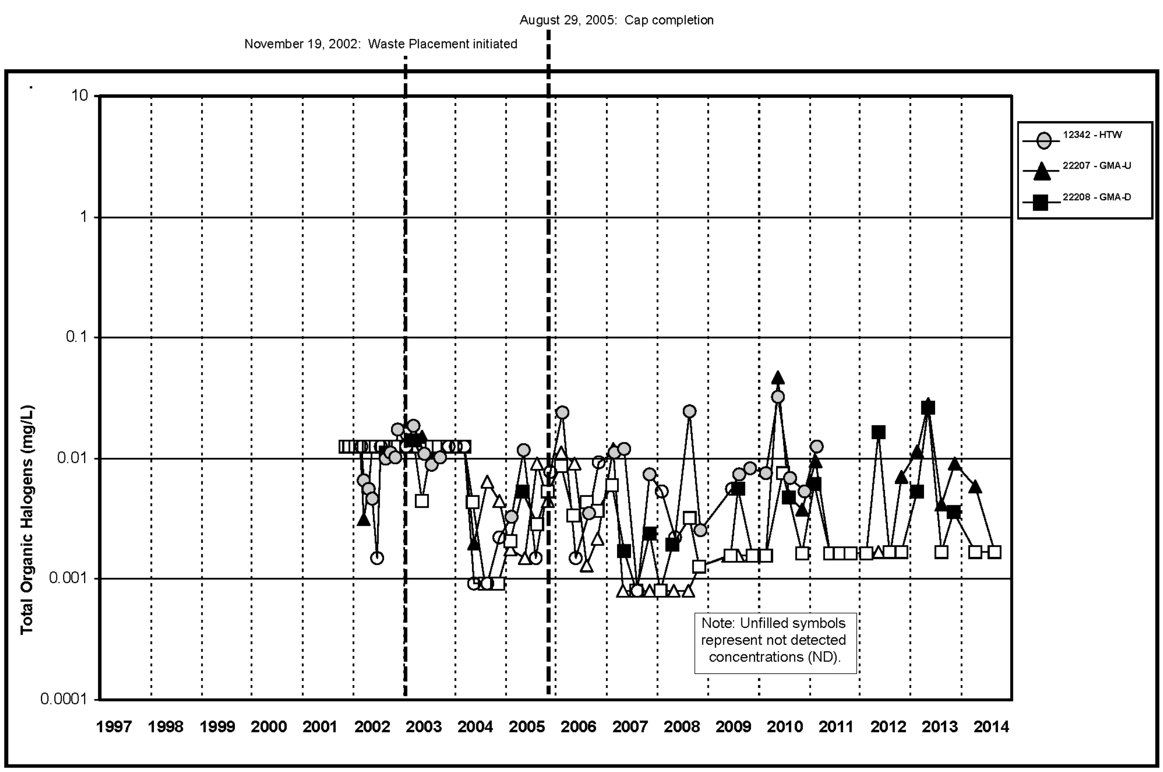


Figure A.5.5-14B. Cell 5 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

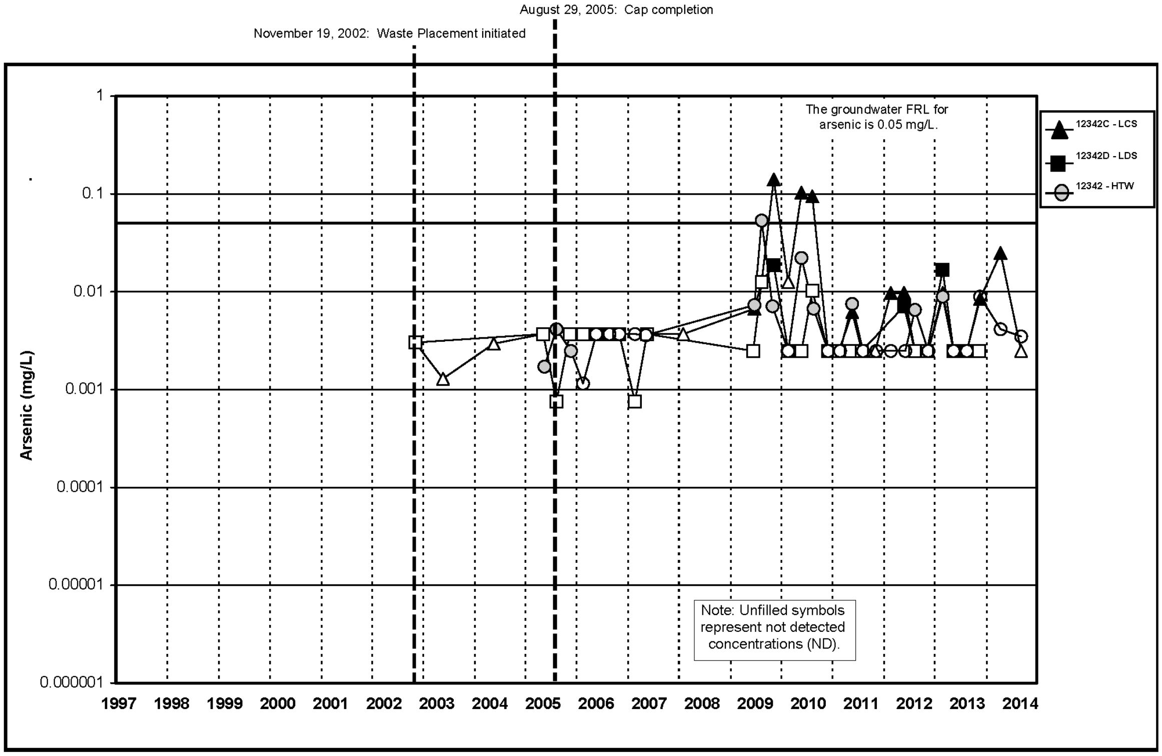


Figure A.5.5-15A. Cell 5 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

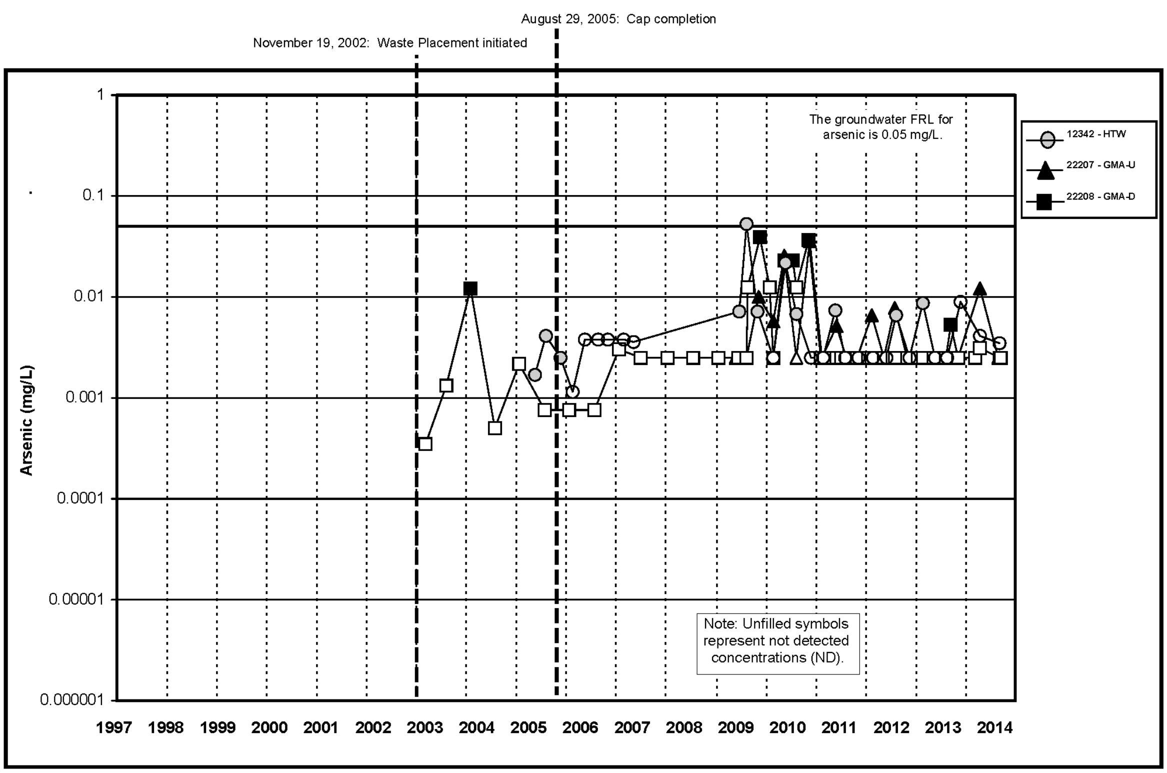


Figure A.5.5-15B. Cell 5 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

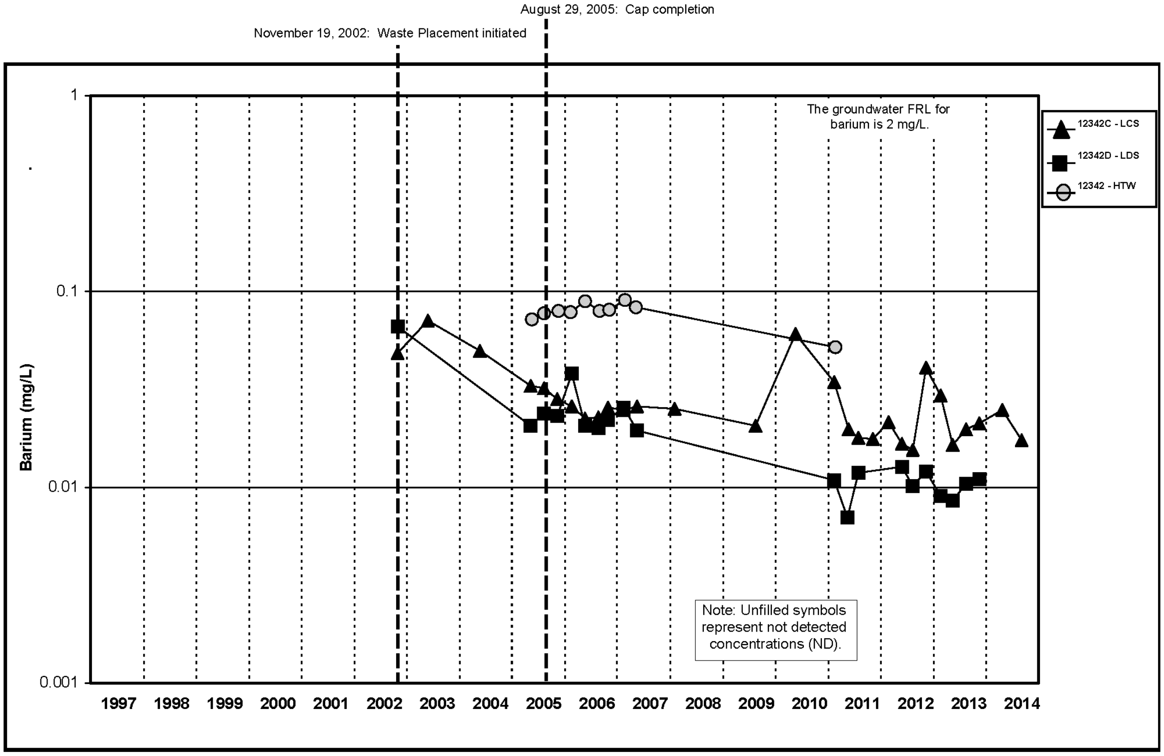


Figure A.5.5-16A. Cell 5 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

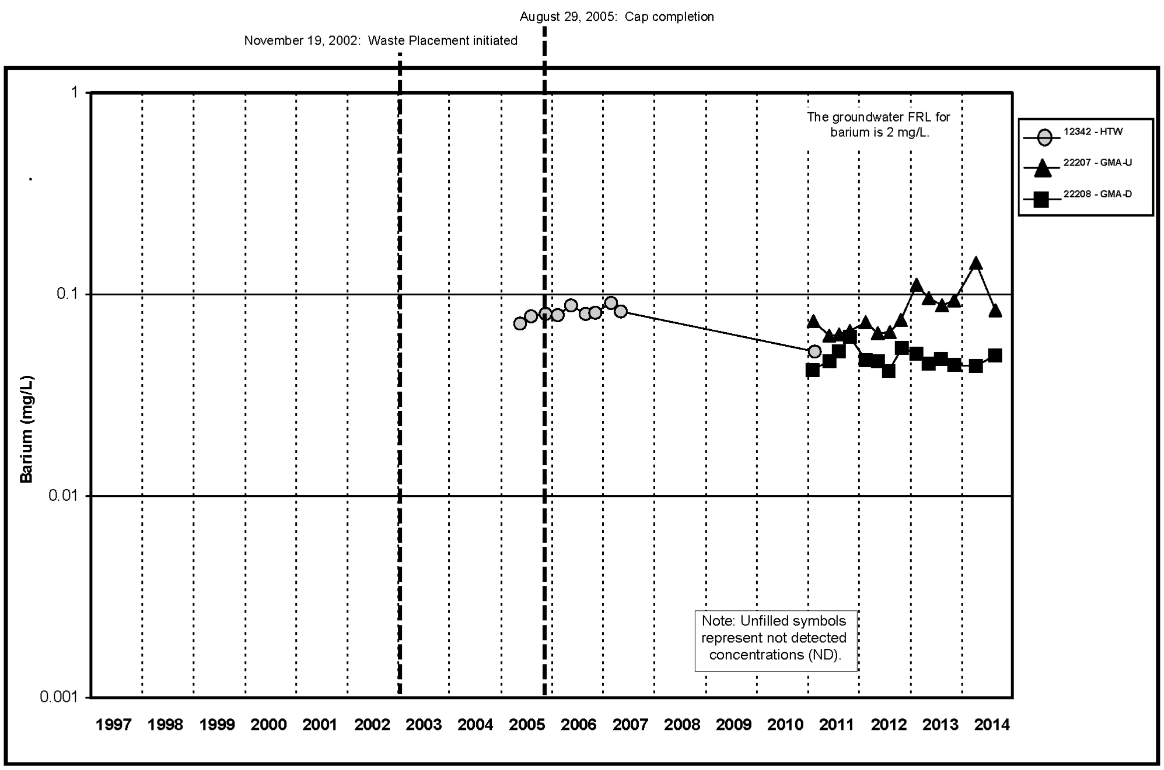


Figure A.5.5-16B. Cell 5 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

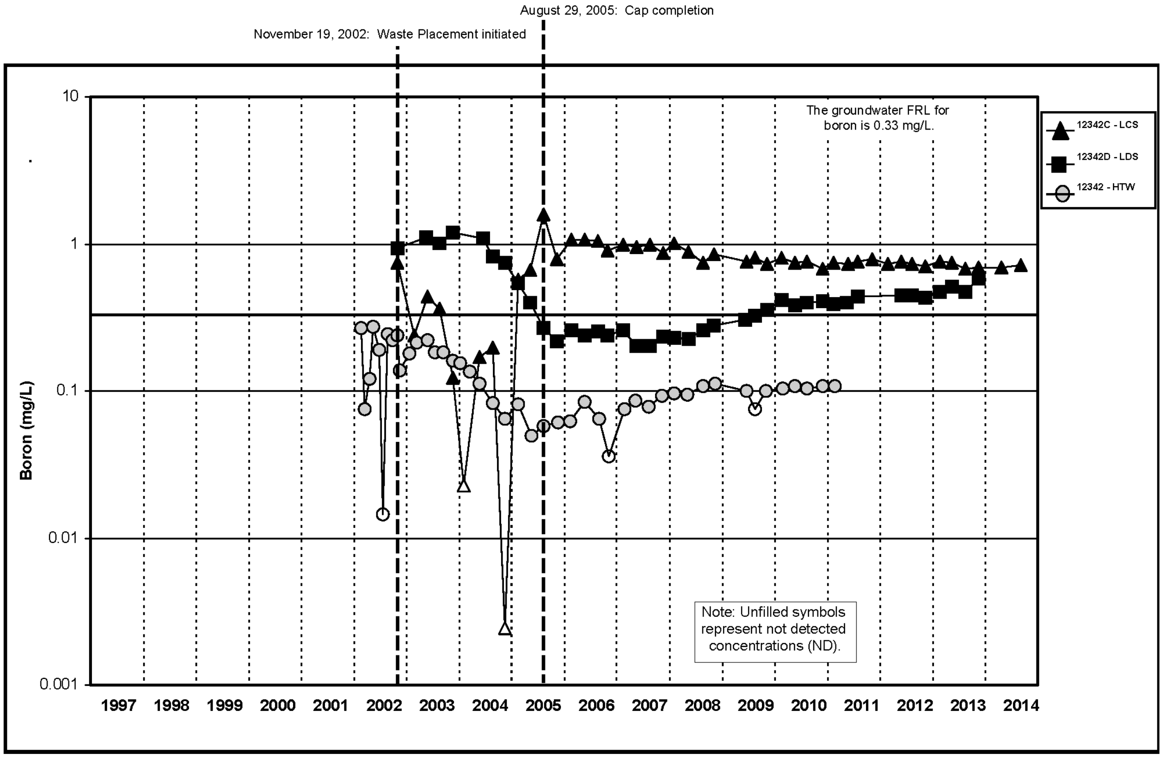


Figure A.5.5-17A. Cell 5 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

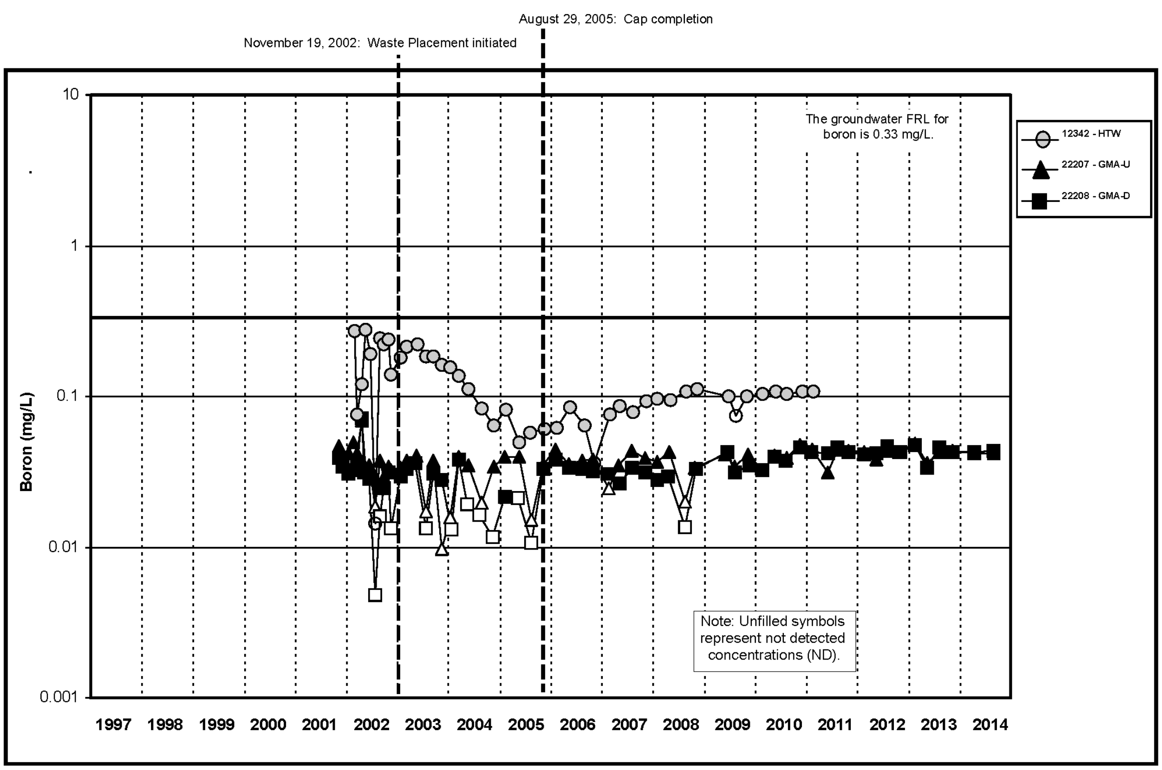


Figure A.5.5-17B. Cell 5 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

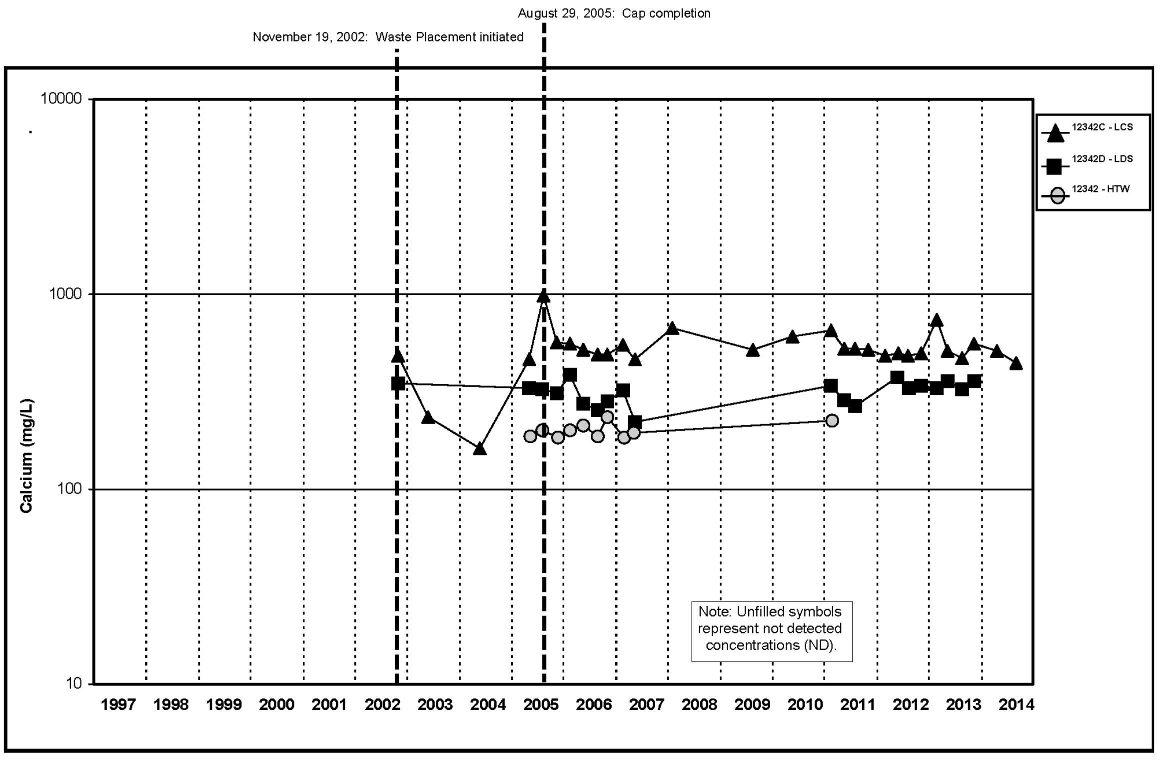


Figure A.5.5-18A. Cell 5 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

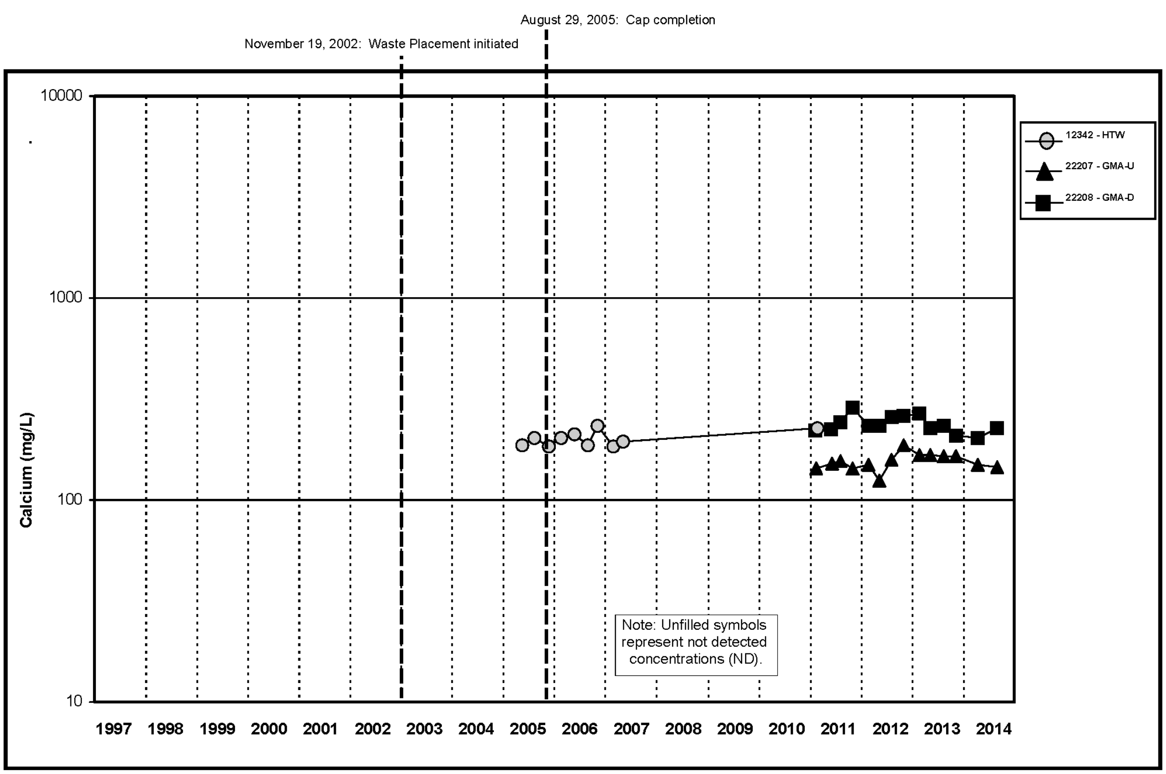


Figure A.5.5-18B. Cell 5 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

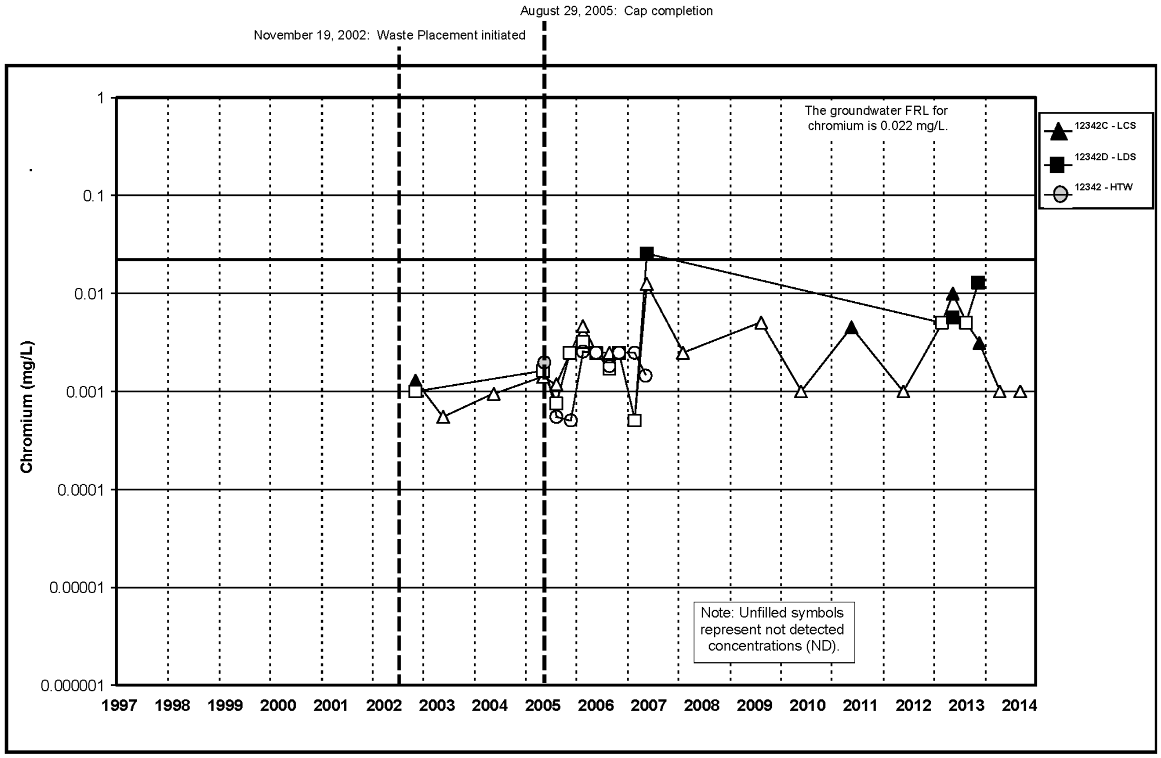


Figure A.5.5-19A. Cell 5 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

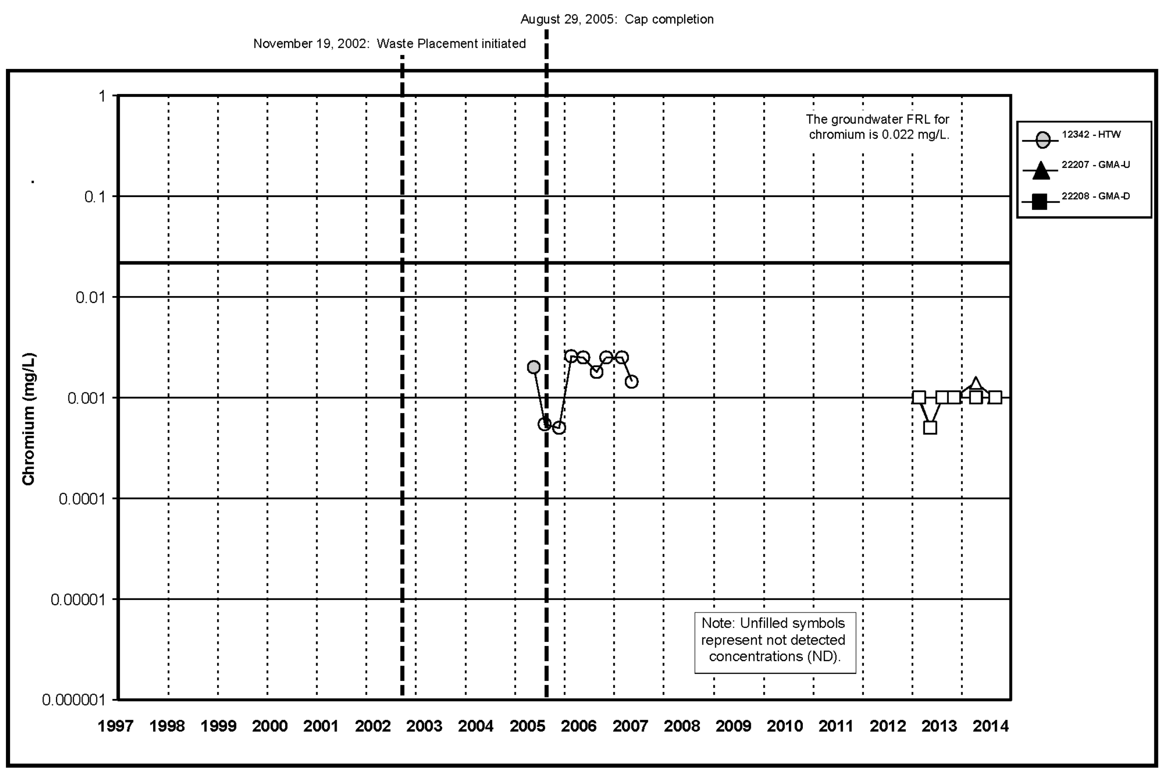


Figure A.5.5-19B. Cell 5 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

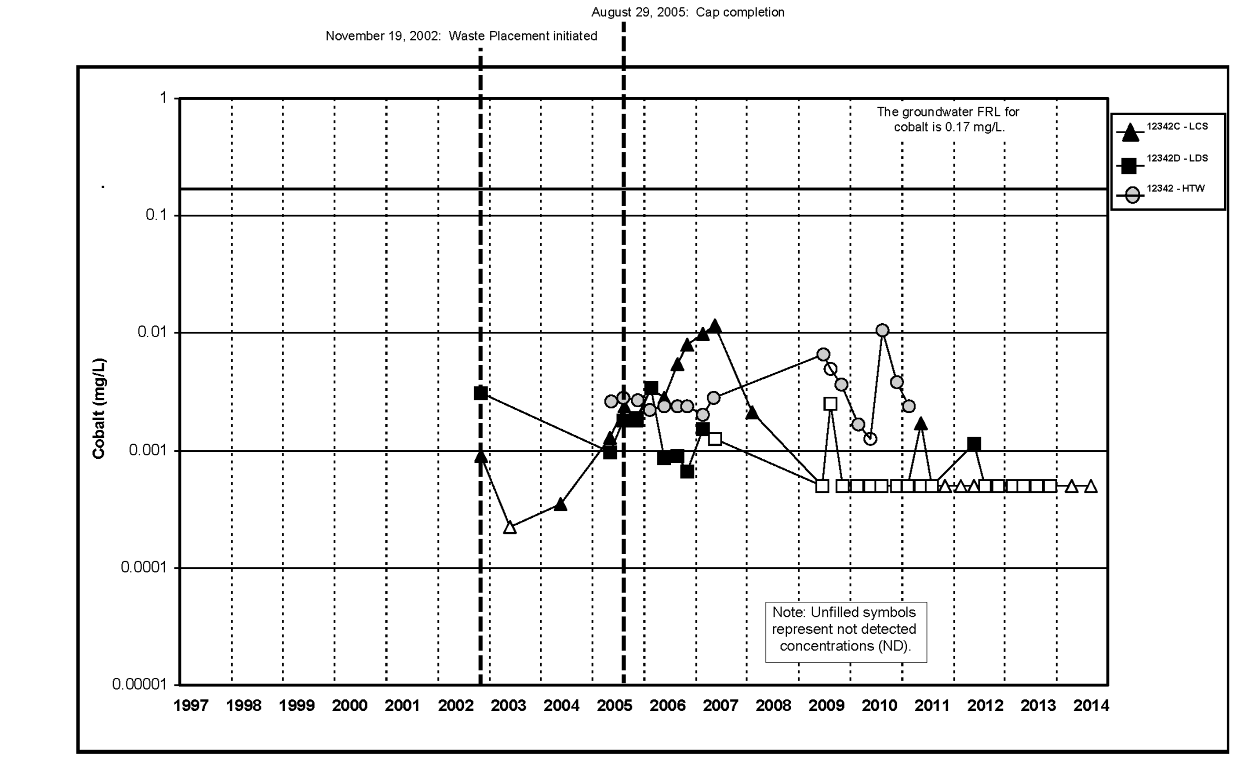


Figure A.5.5-20A. Cell 5 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

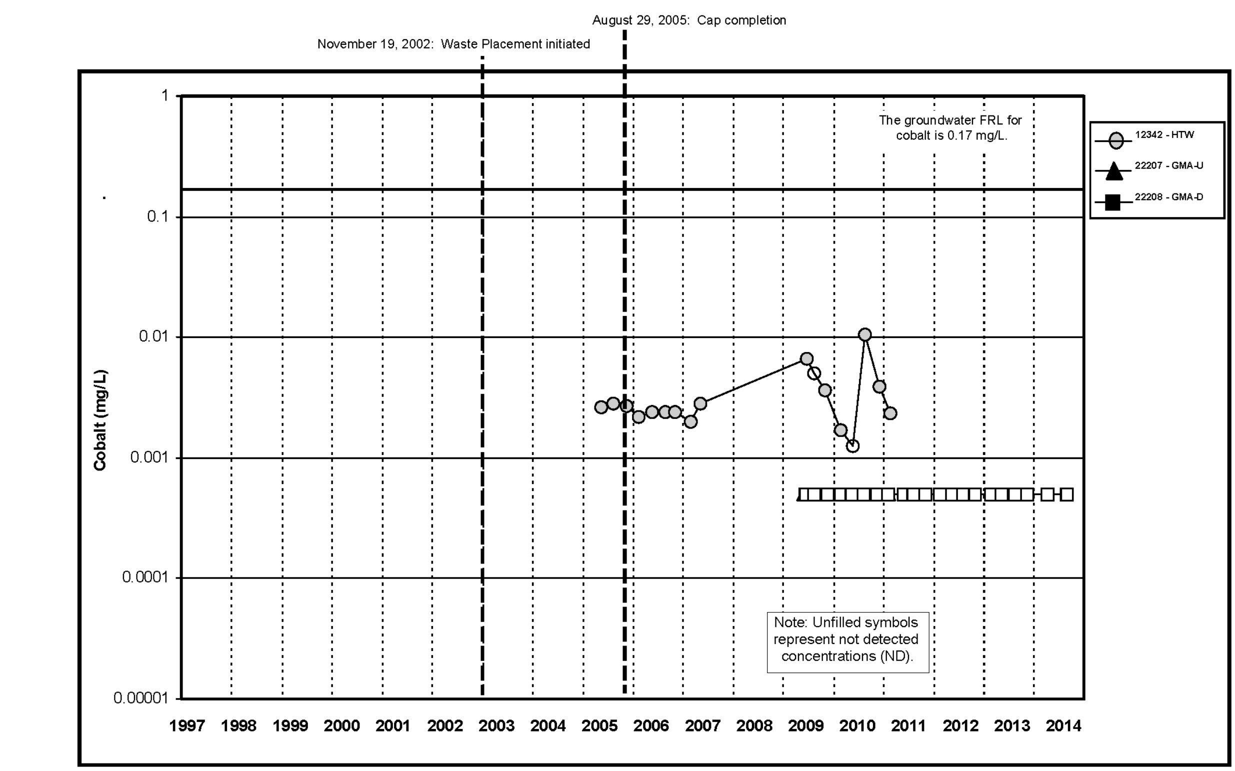


Figure A.5.5-20B. Cell 5 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

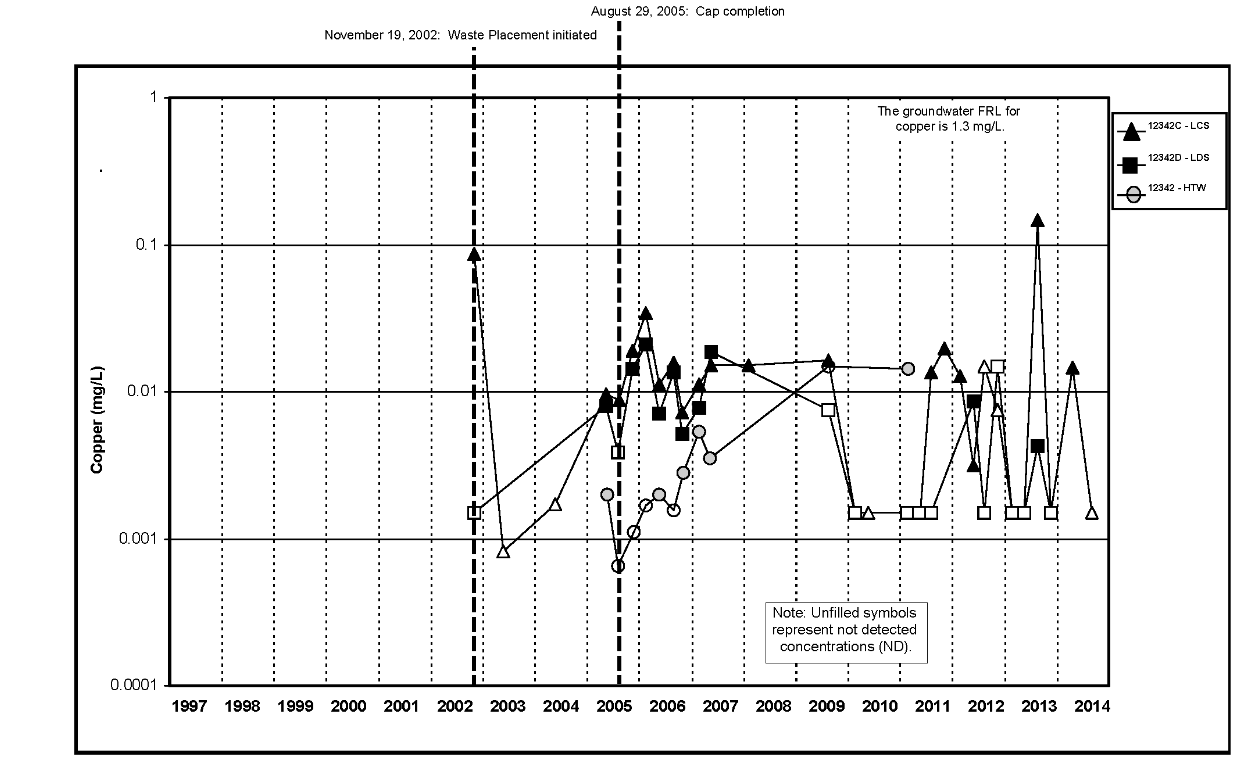


Figure A.5.5-21A. Cell 5 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

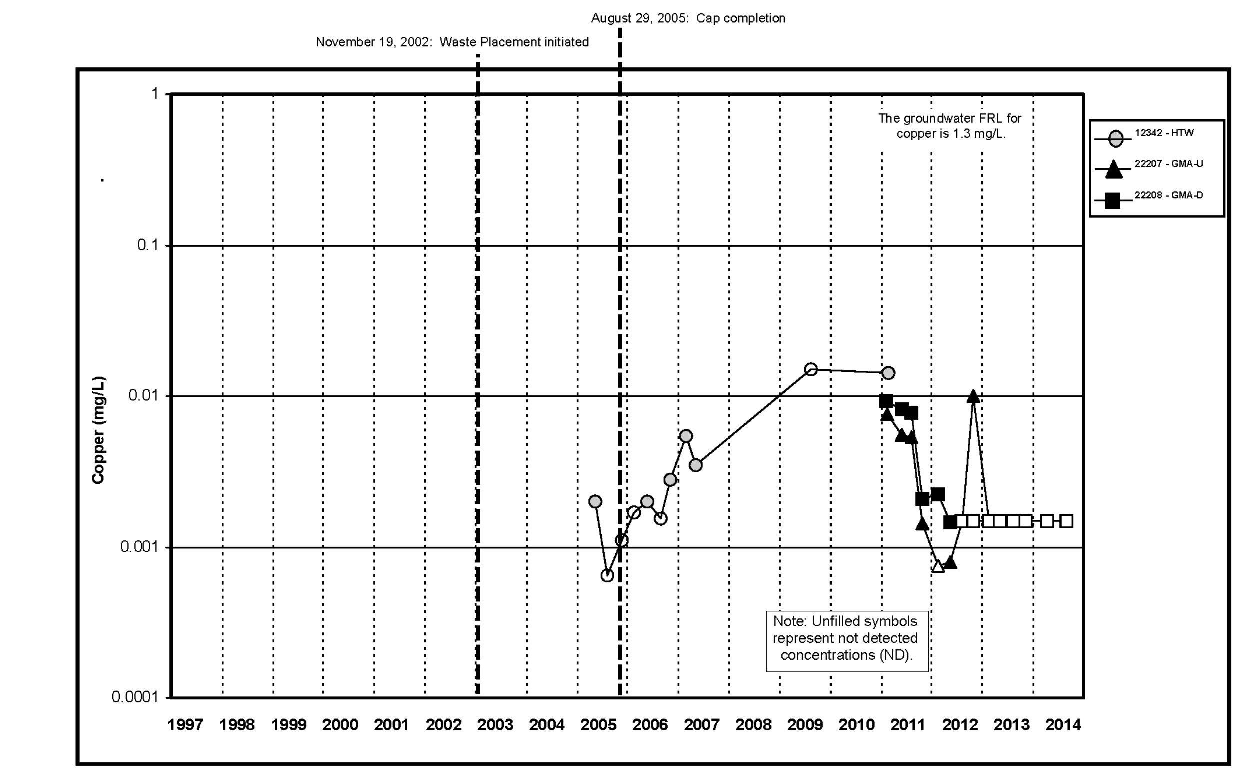


Figure A.5.5-21B. Cell 5 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

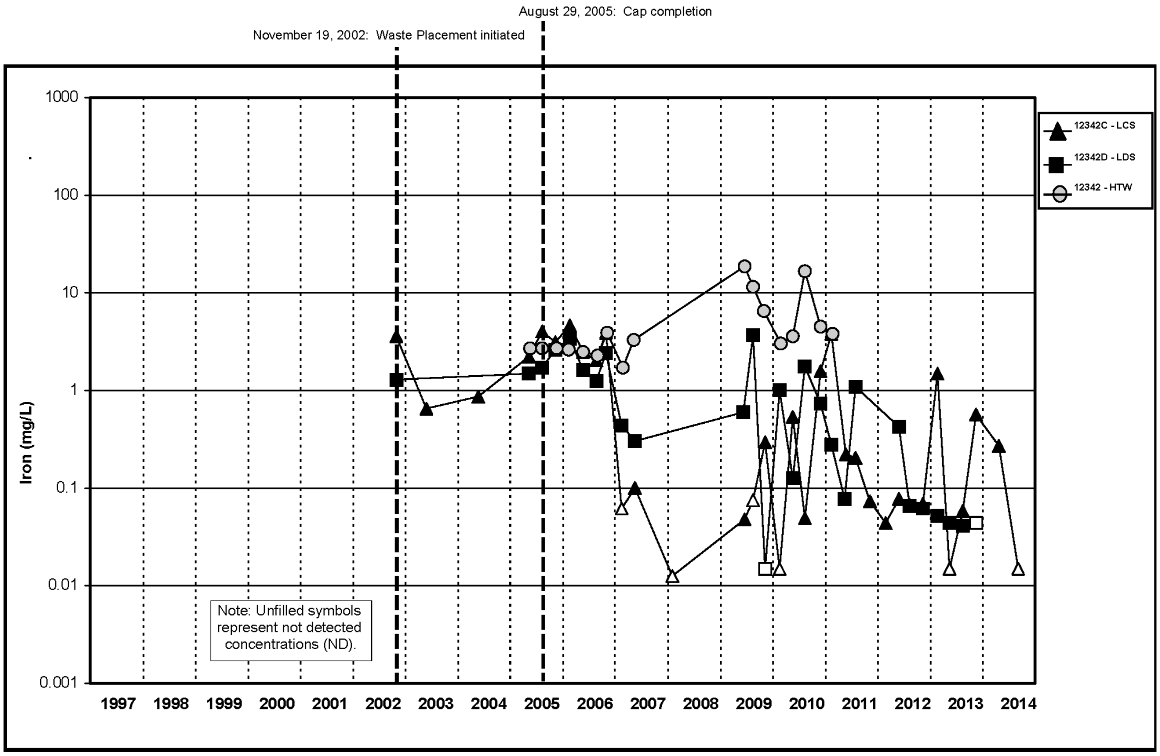


Figure A.5.5-22A. Cell 5 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

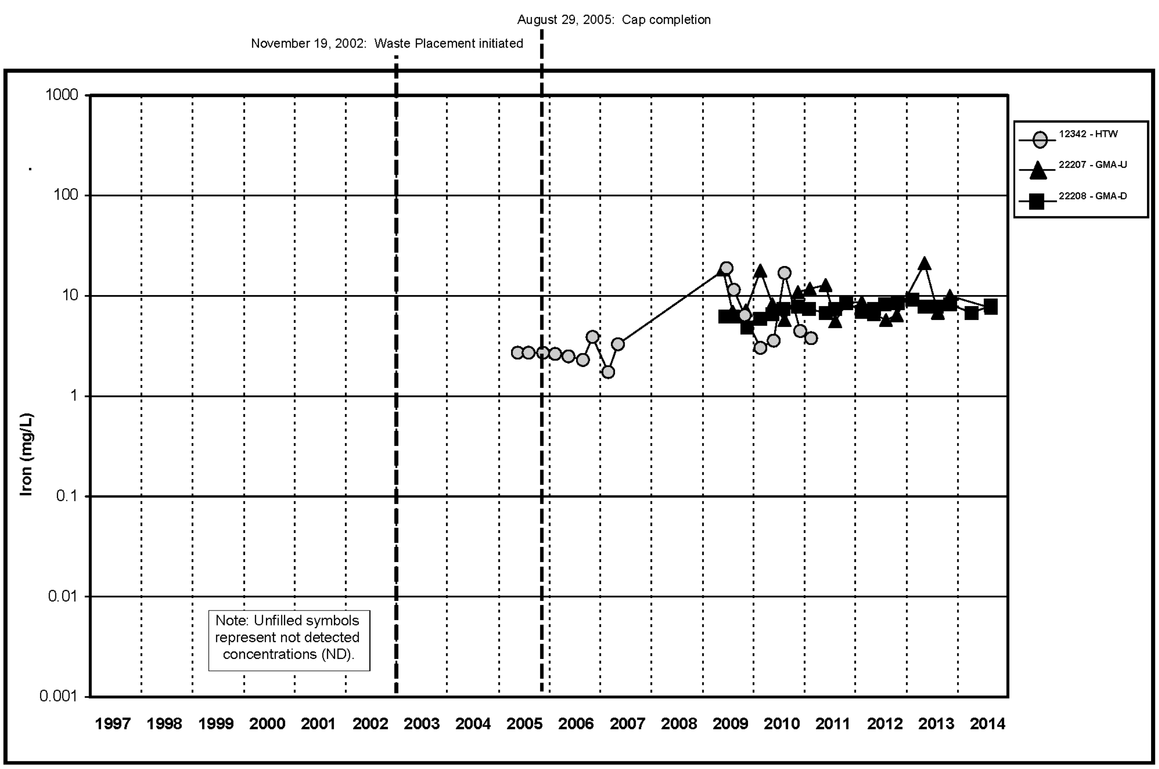


Figure A.5.5-22B. Cell 5 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

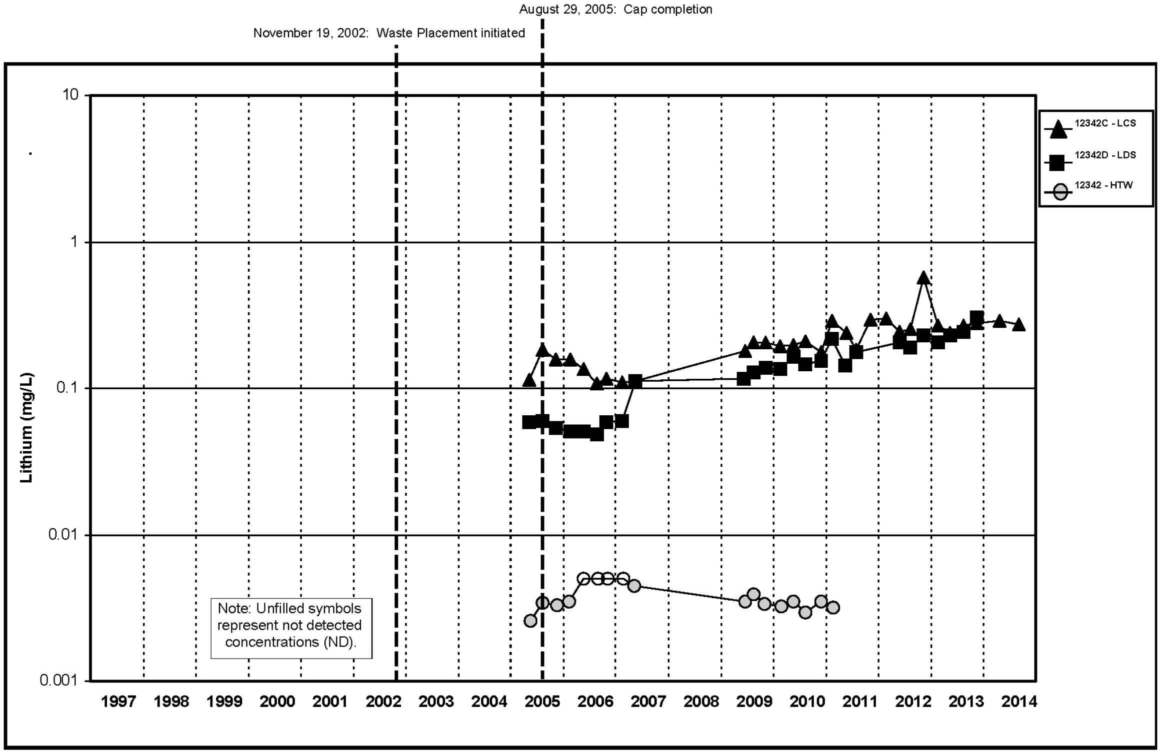


Figure A.5.5-23A. Cell 5 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

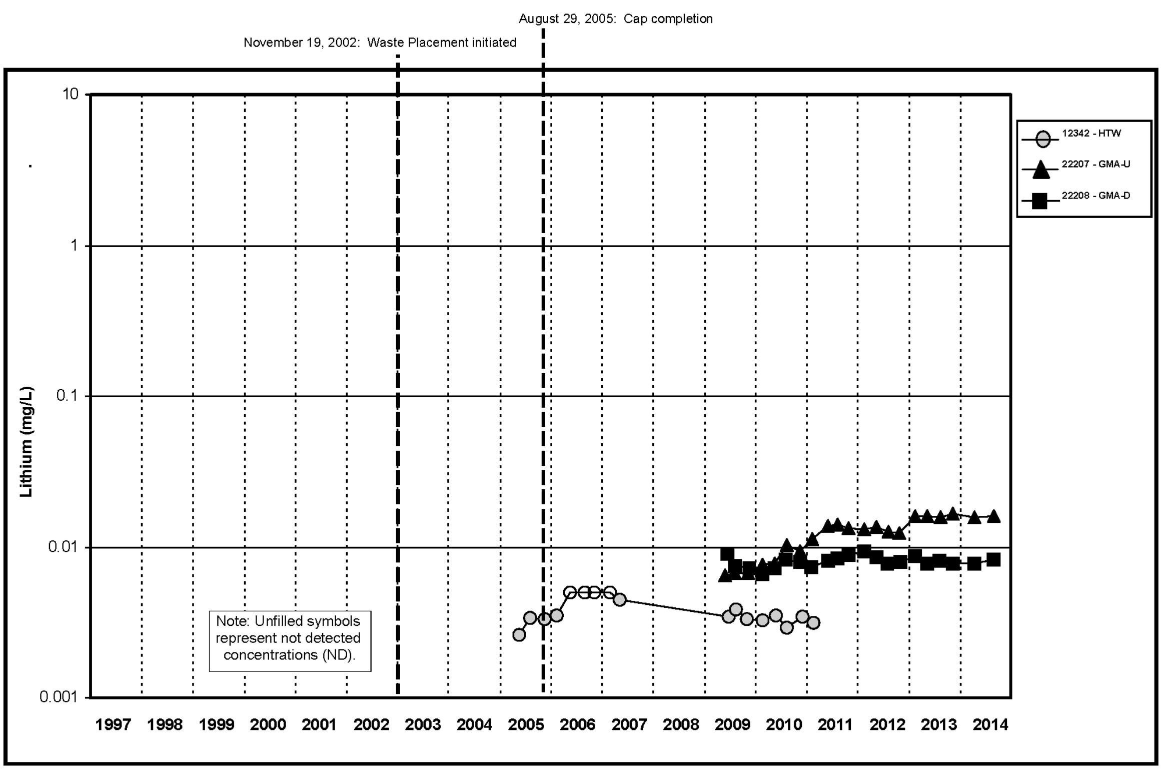


Figure A.5.5-23B. Cell 5 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

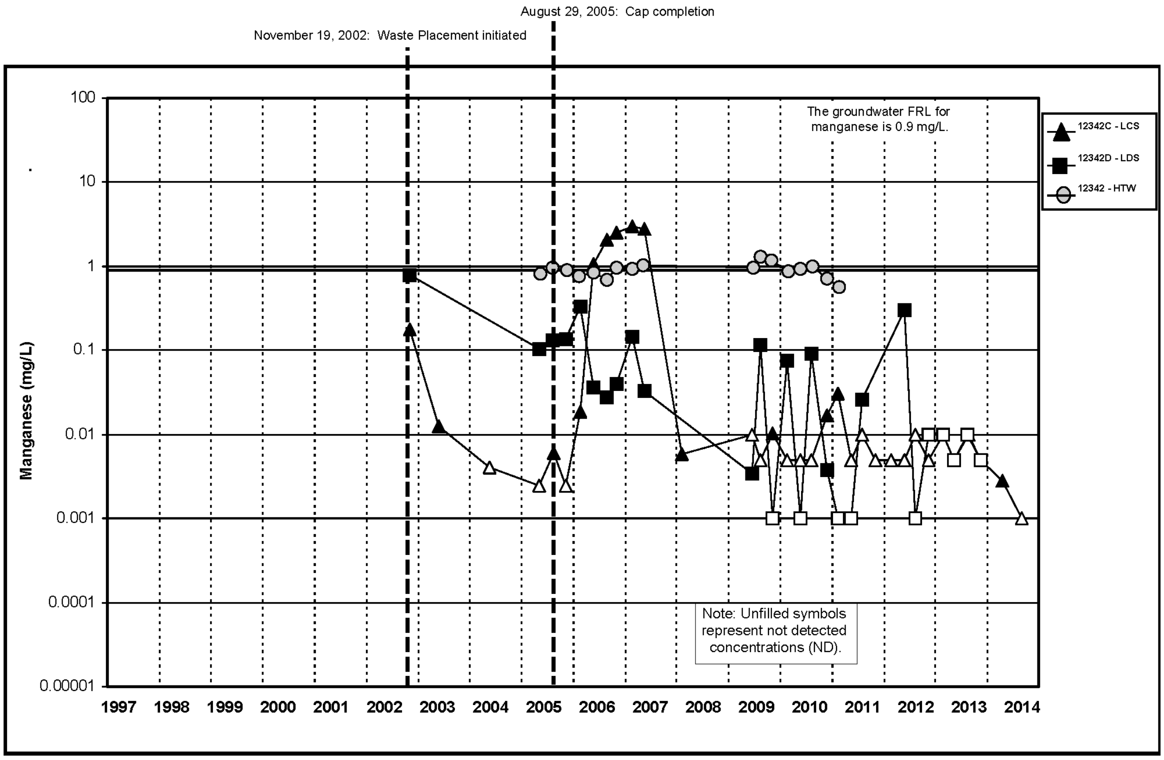


Figure A.5.5-24A. Cell 5 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

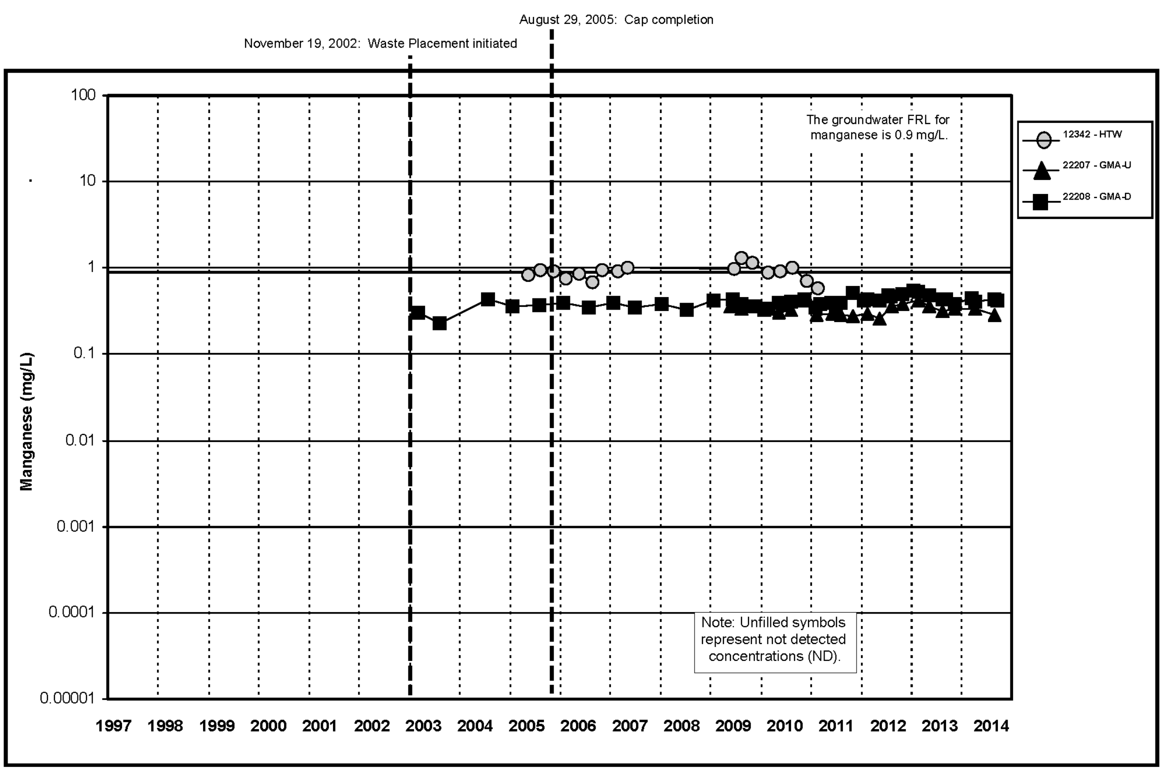


Figure A.5.5-24B. Cell 5 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

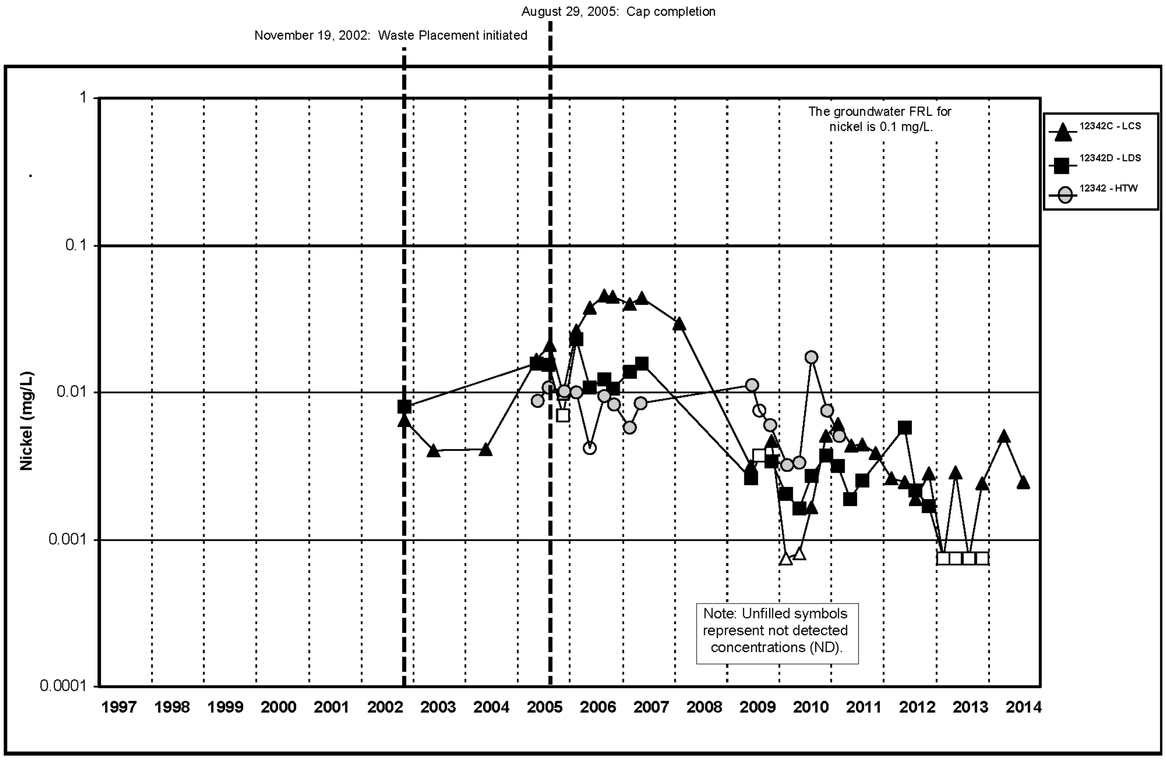


Figure A.5.5-25A. Cell 5 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

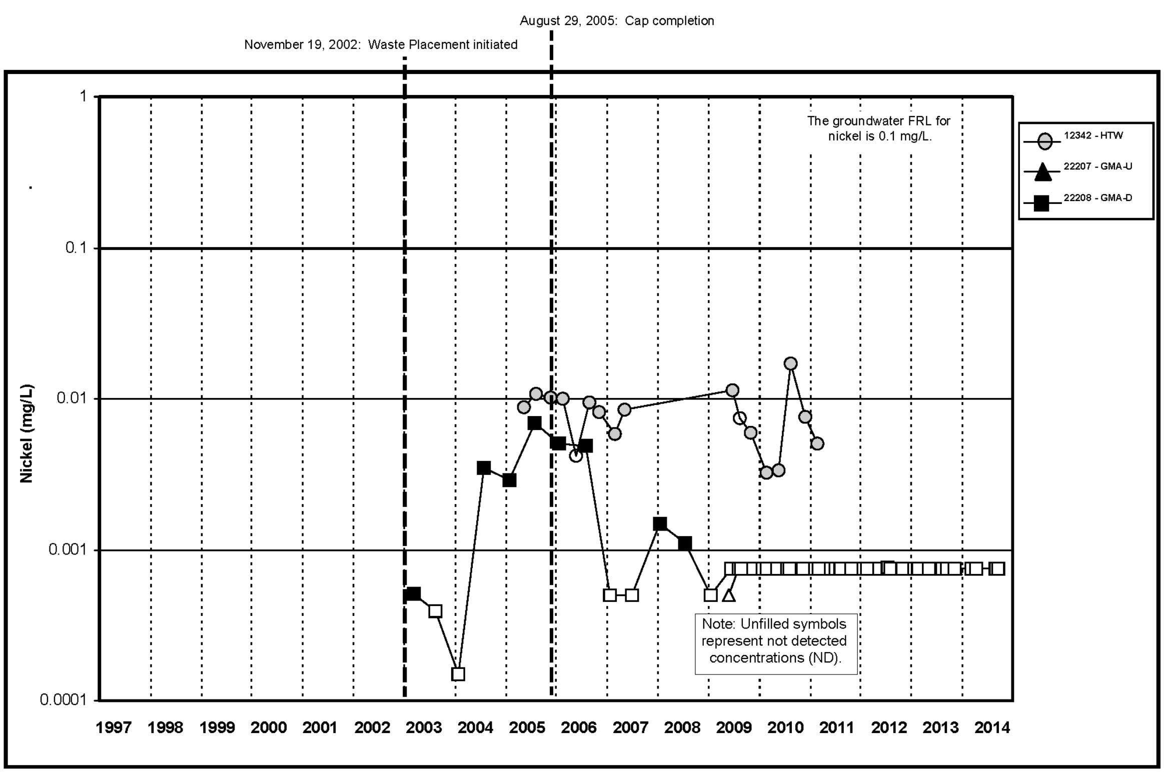


Figure A.5.5-25B. Cell 5 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

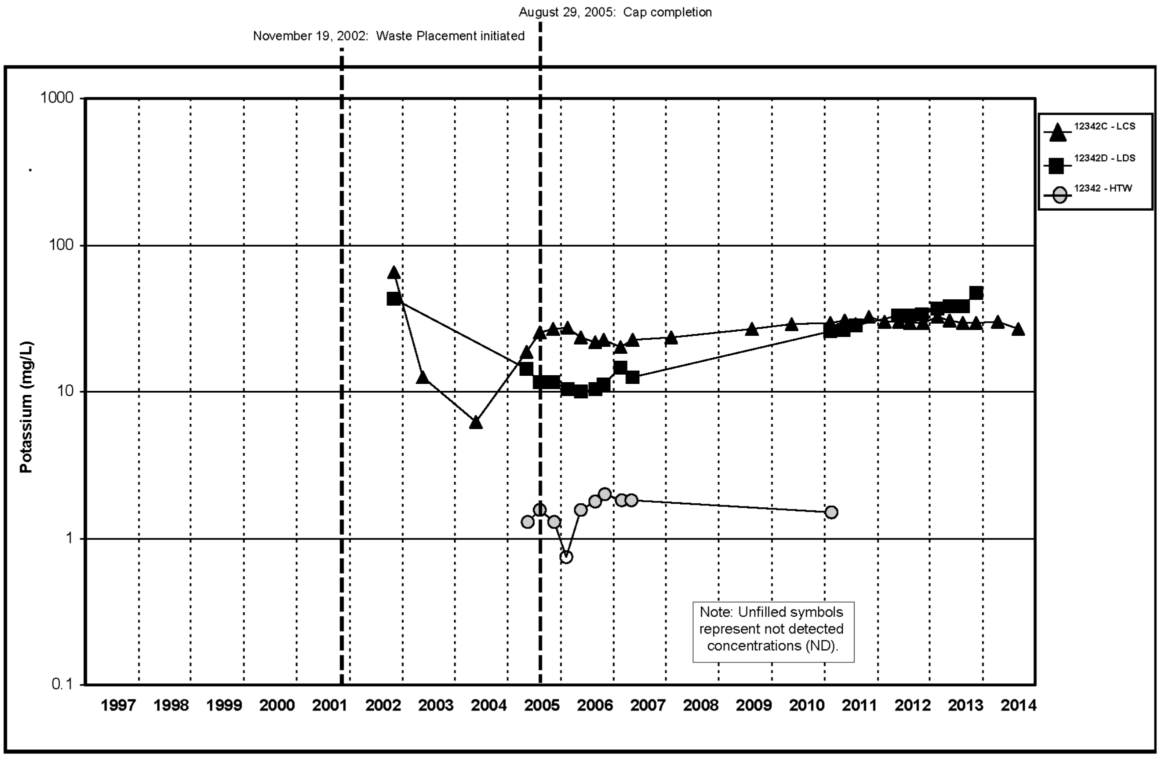


Figure A.5.5-26A. Cell 5 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

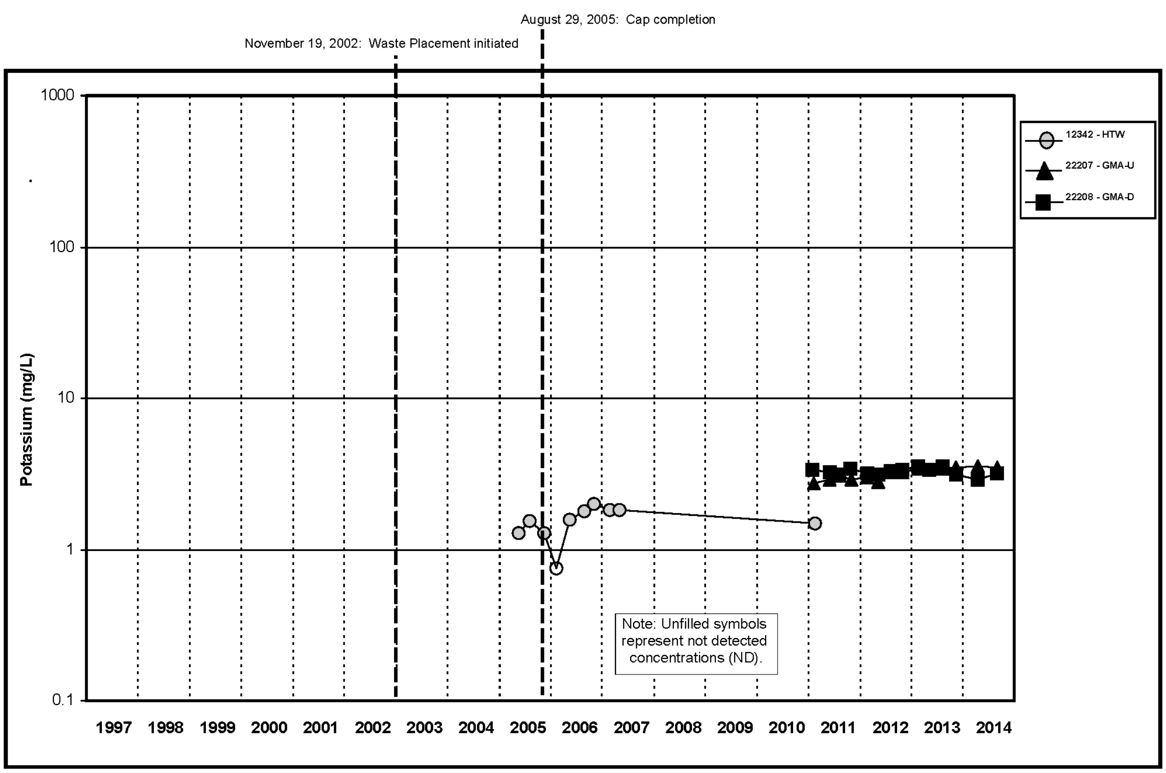


Figure A.5.5-26B. Cell 5 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

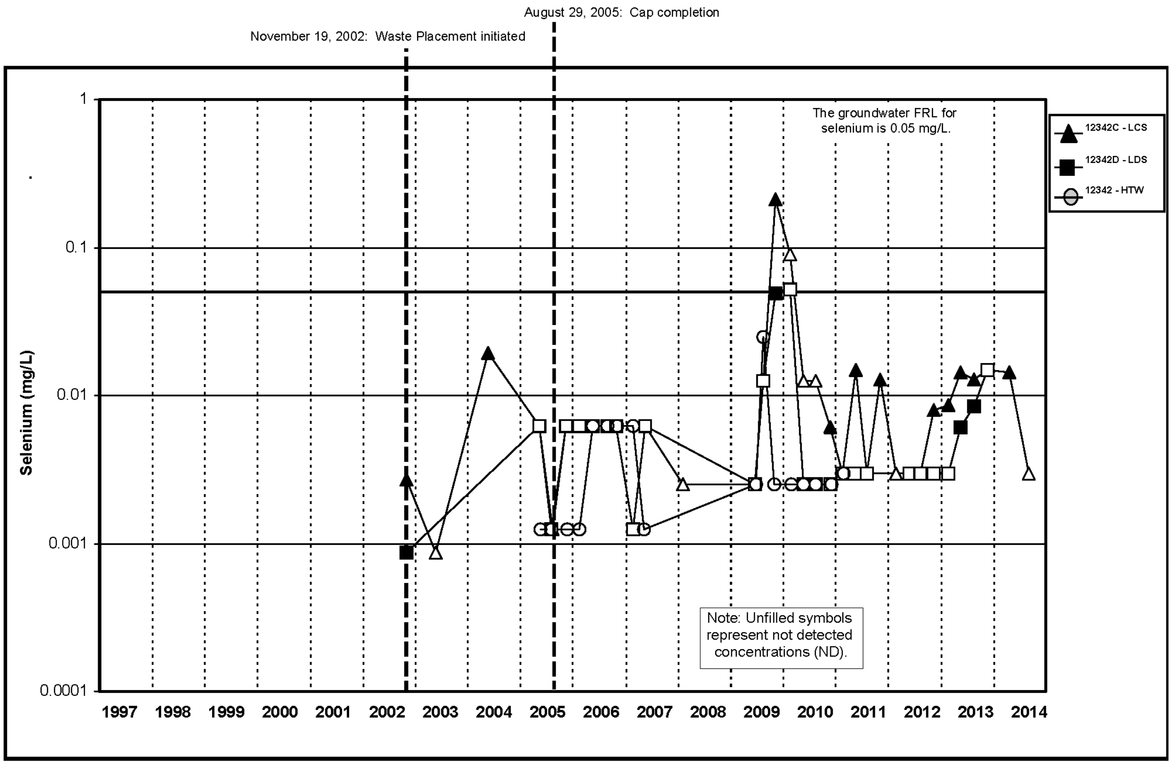


Figure A.5.5-27A. Cell 5 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

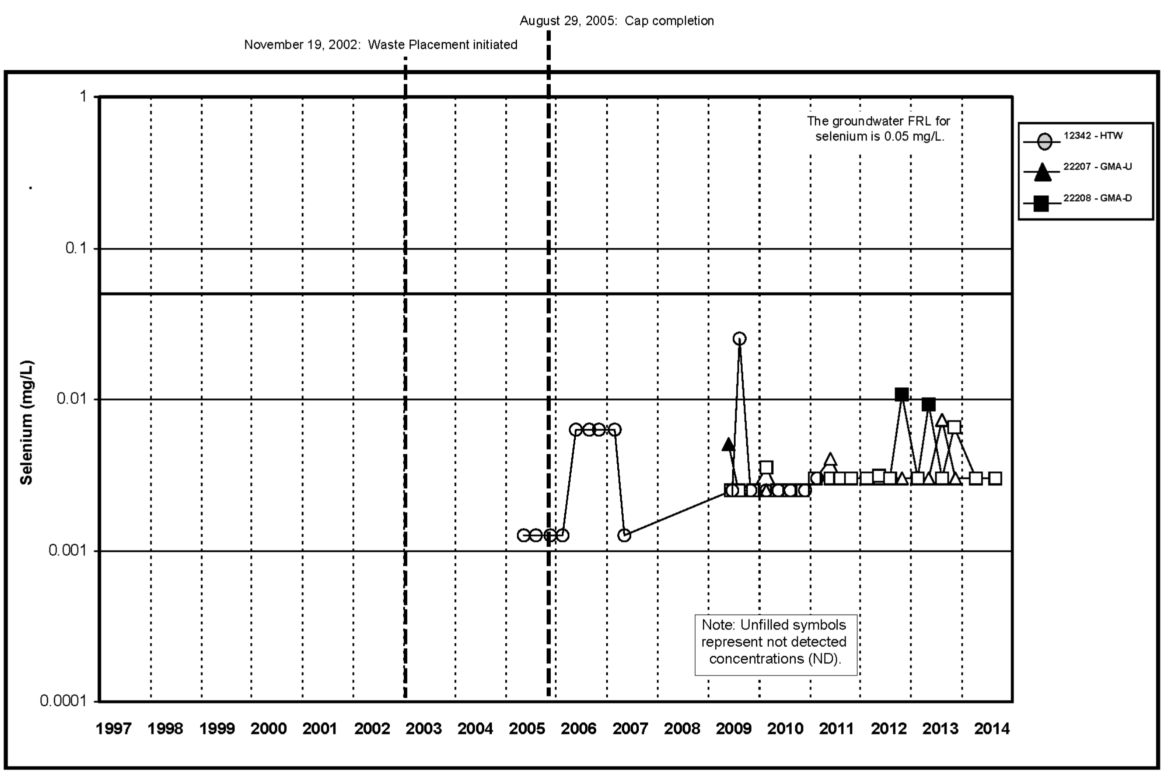


Figure A.5.5-27B. Cell 5 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

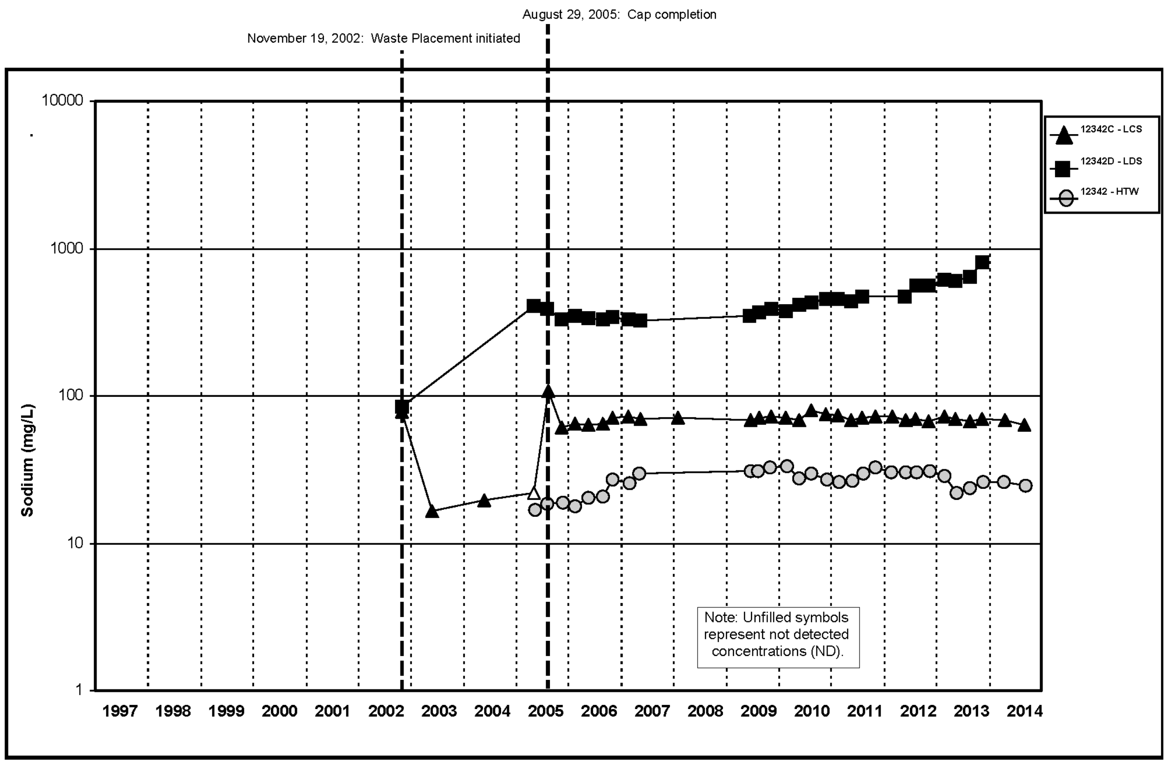


Figure A.5.5-28A. Cell 5 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

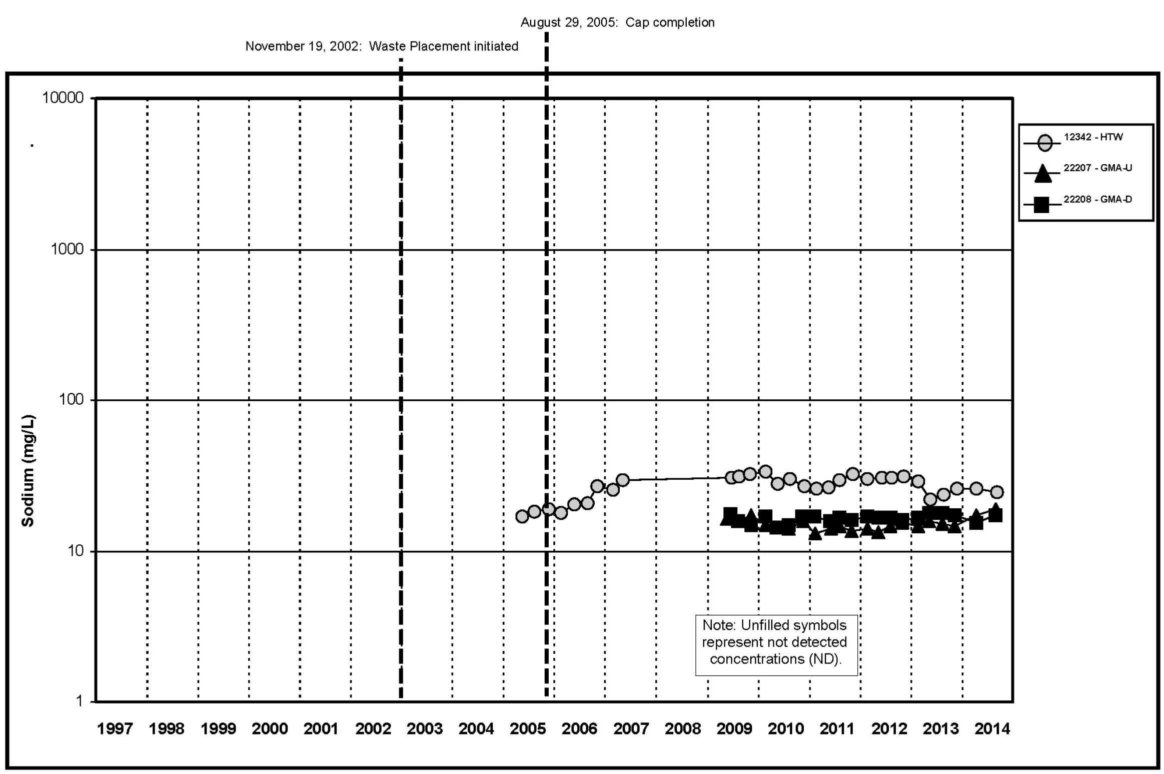


Figure A.5.5-28B. Cell 5 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

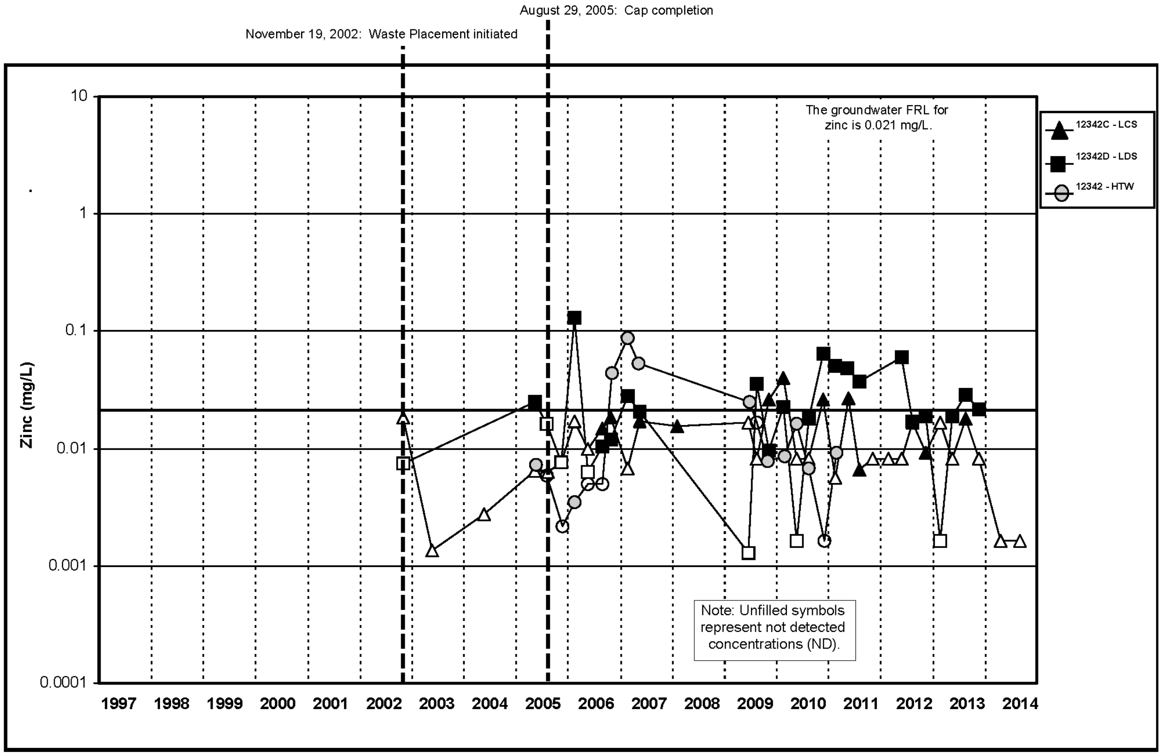


Figure A.5.5-29A. Cell 5 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

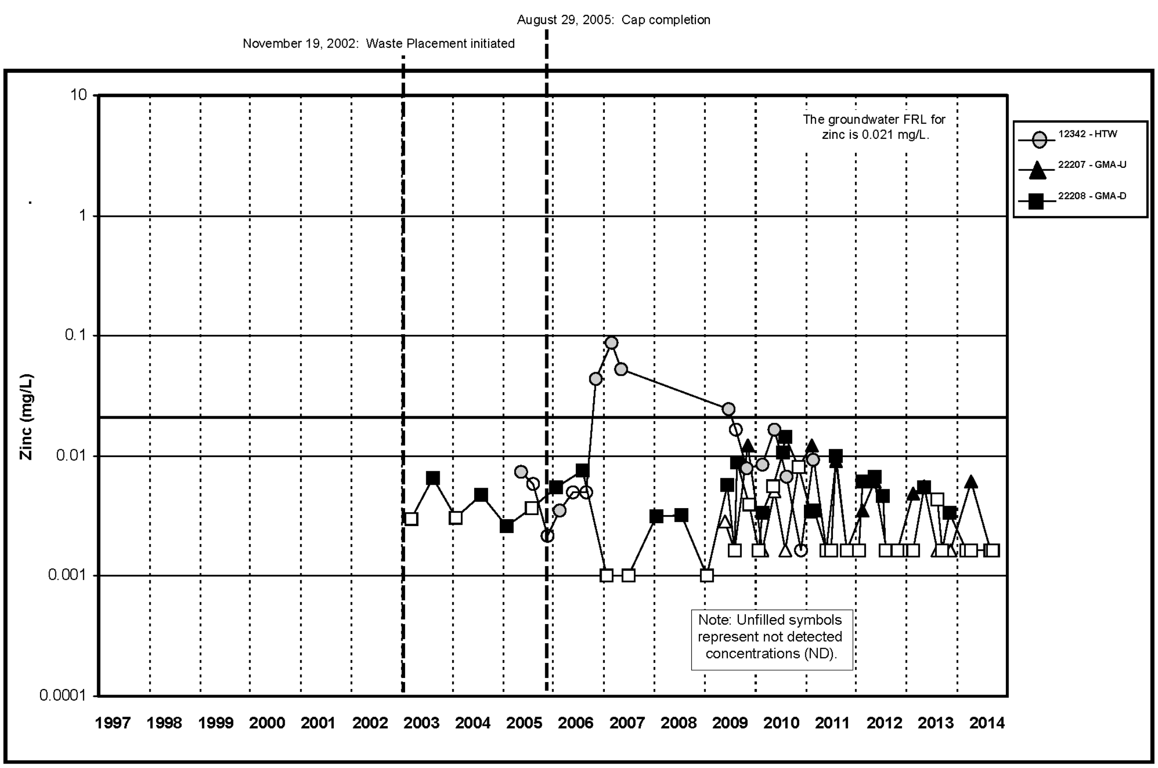


Figure A.5.5-29B. Cell 5 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

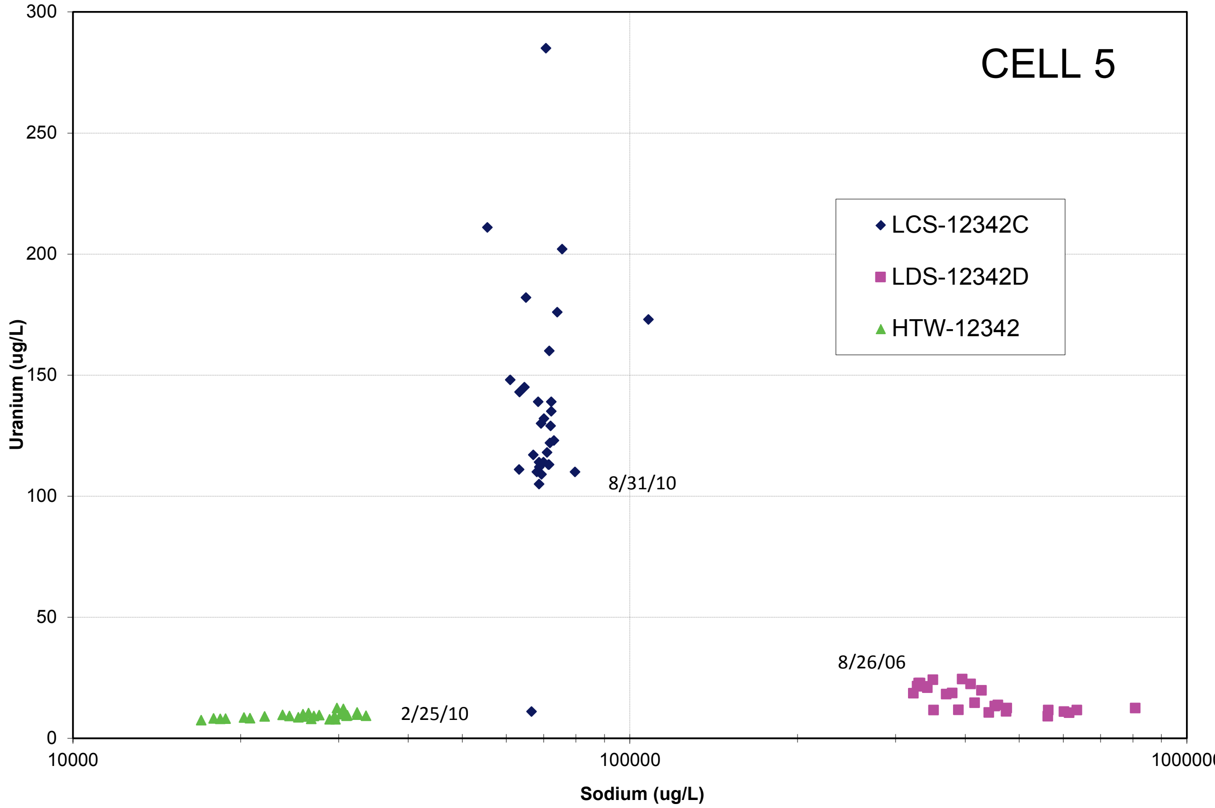


Figure A.5.5-30. Cell 5 Bivariate Plot for Uranium and Sodium

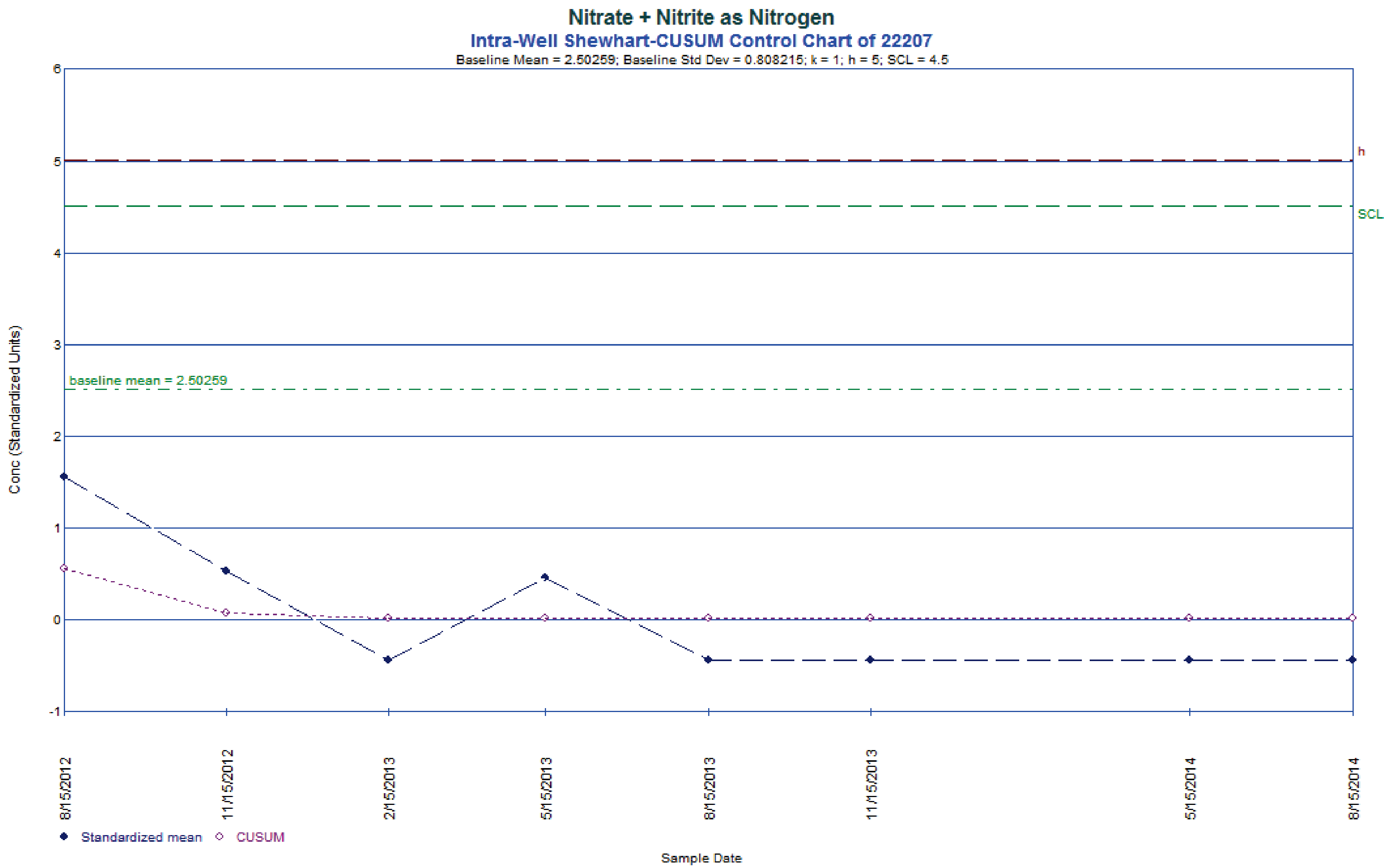


Figure A.5.5-31. Intra-Well Shewhart-CUSUM Control Chart (Nitrate + Nitrite as Nitrogen 22207)

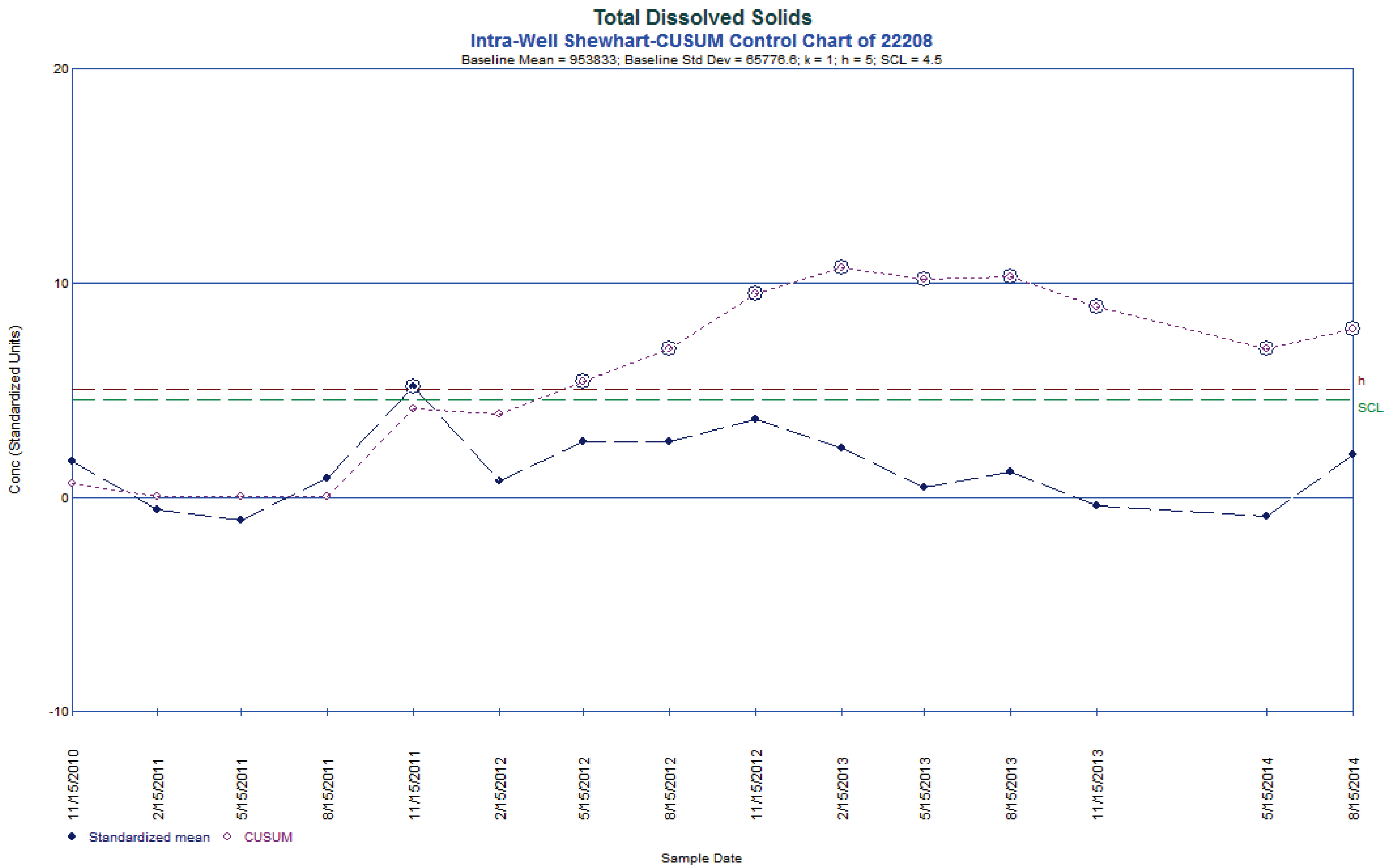


Figure A.5.5-32. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22208)

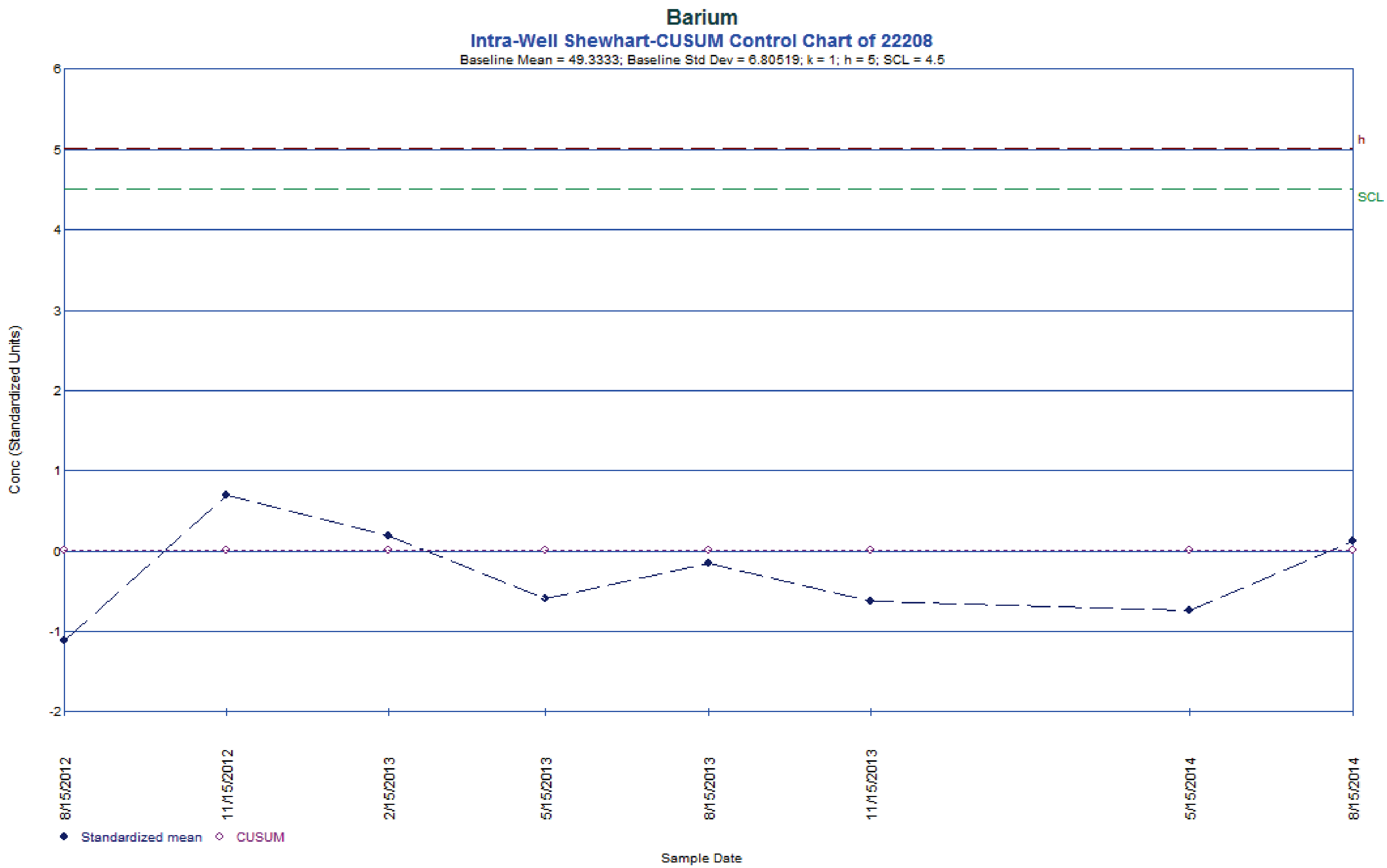


Figure A.5.5-33. Intra-Well Shewhart-CUSUM Control Chart (Barium 22208)

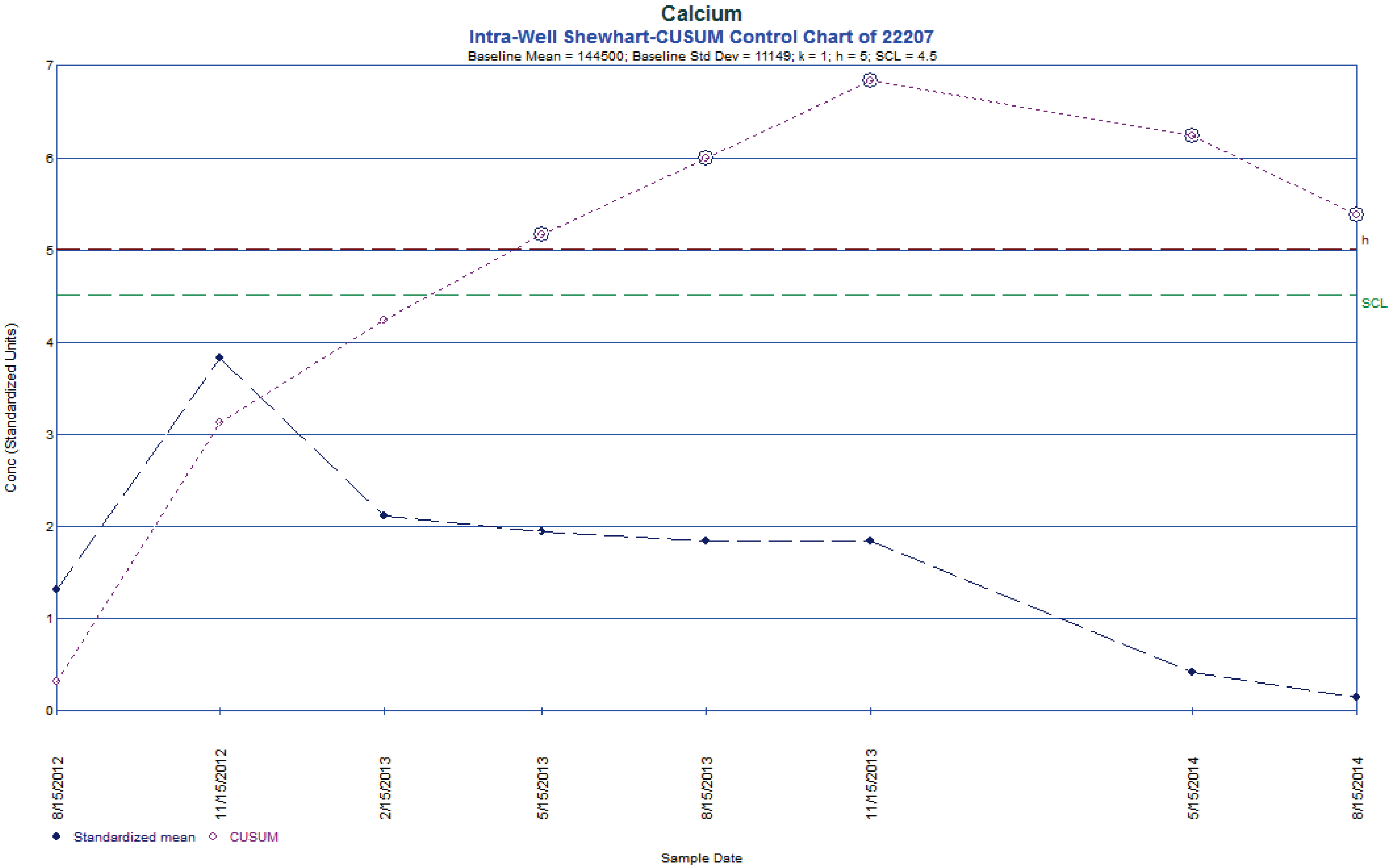


Figure A.5.5-34. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22207)

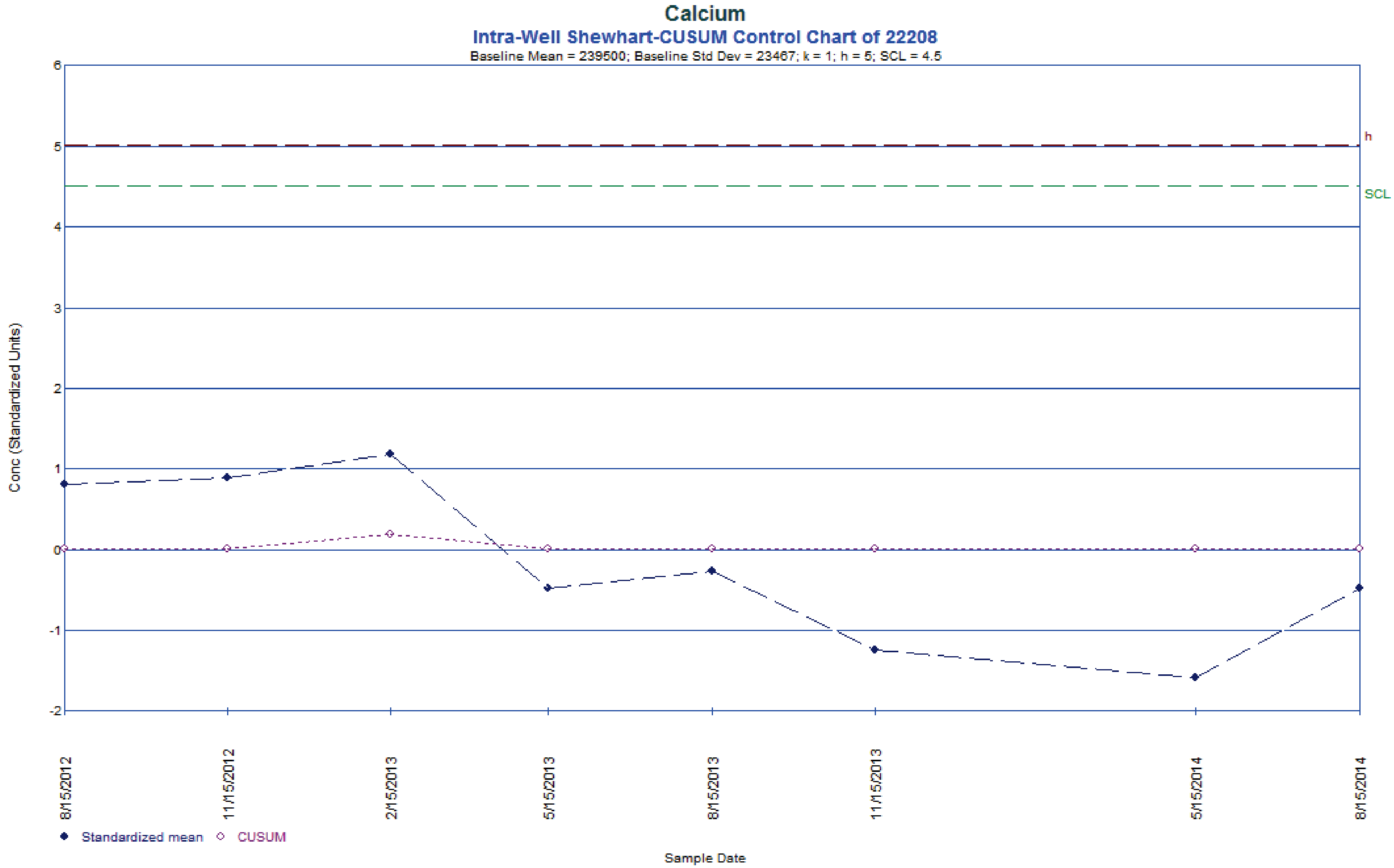


Figure A.5.5-35. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22208)

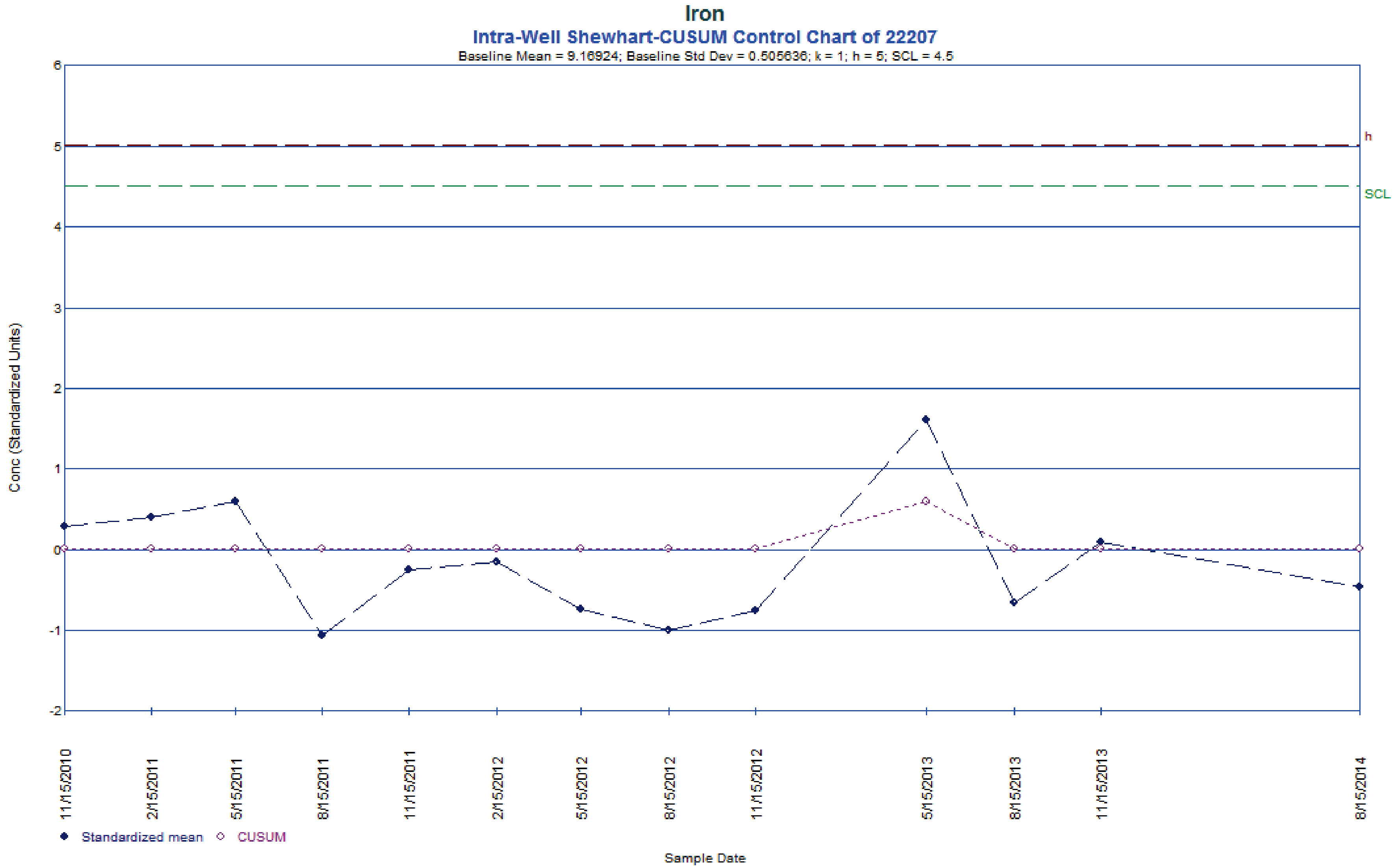


Figure A.5.5-36. Intra-Well Shewhart-CUSUM Control Chart (Iron 22207)

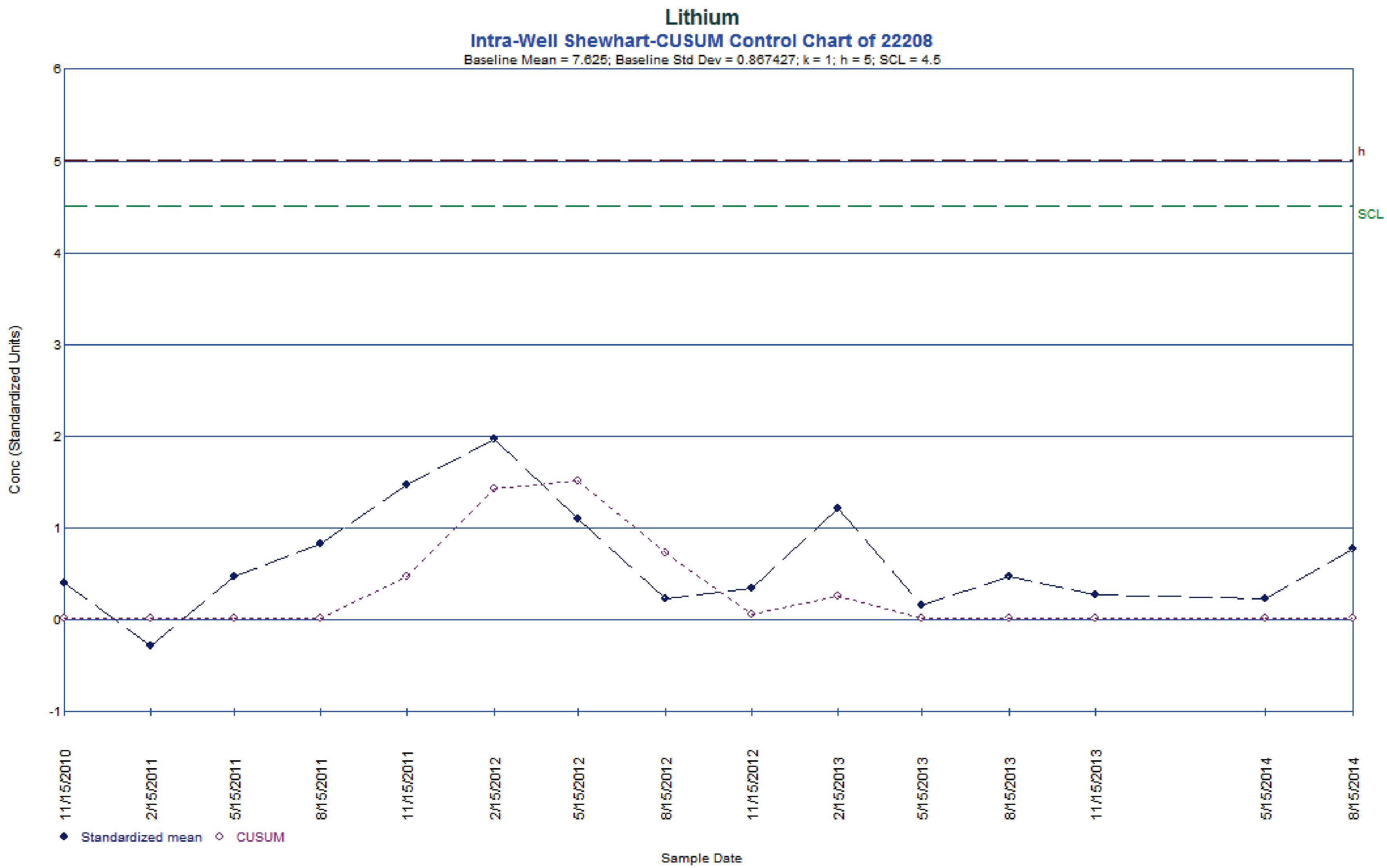


Figure A.5.5-37. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22208)

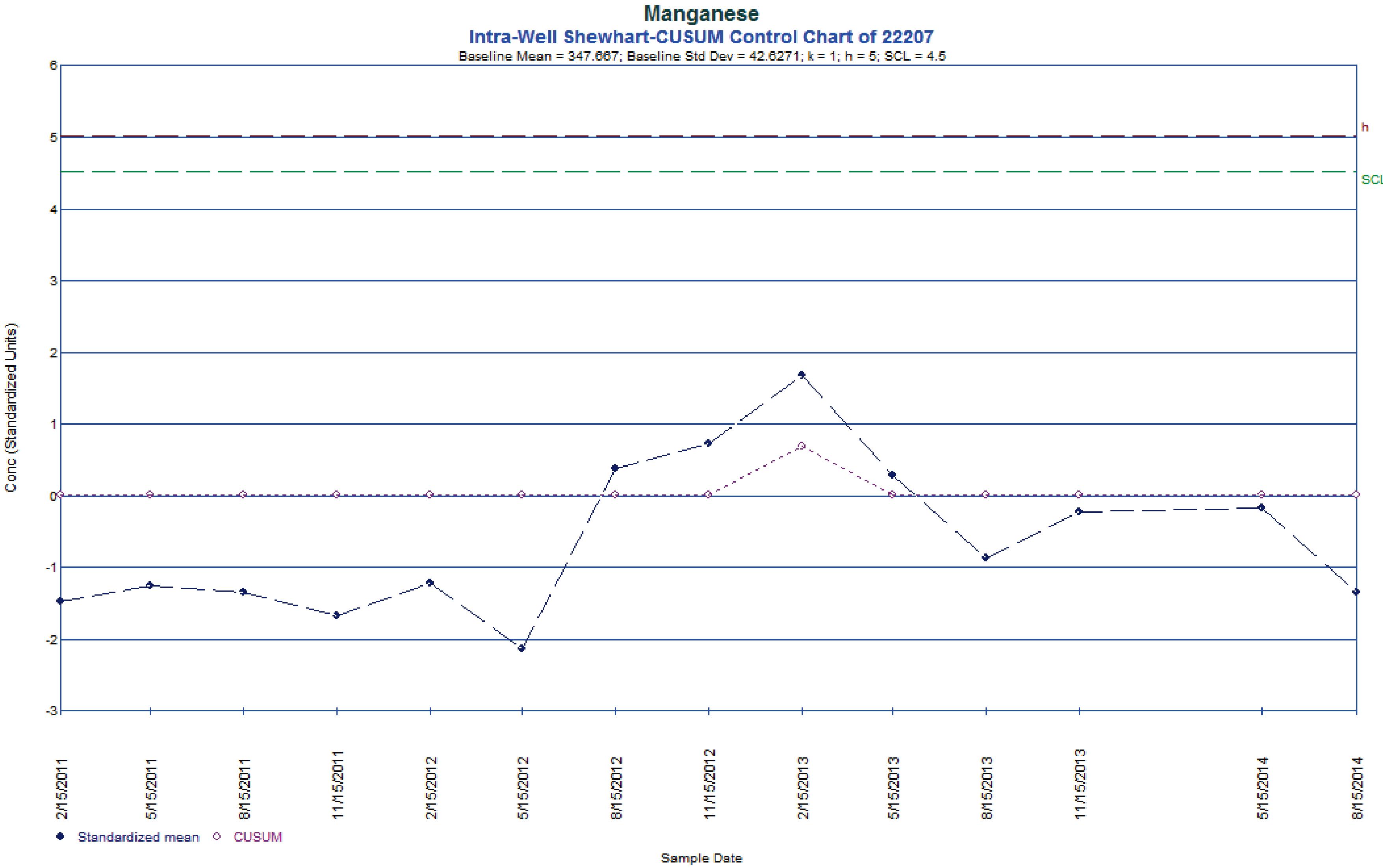


Figure A.5.5-38. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22207)

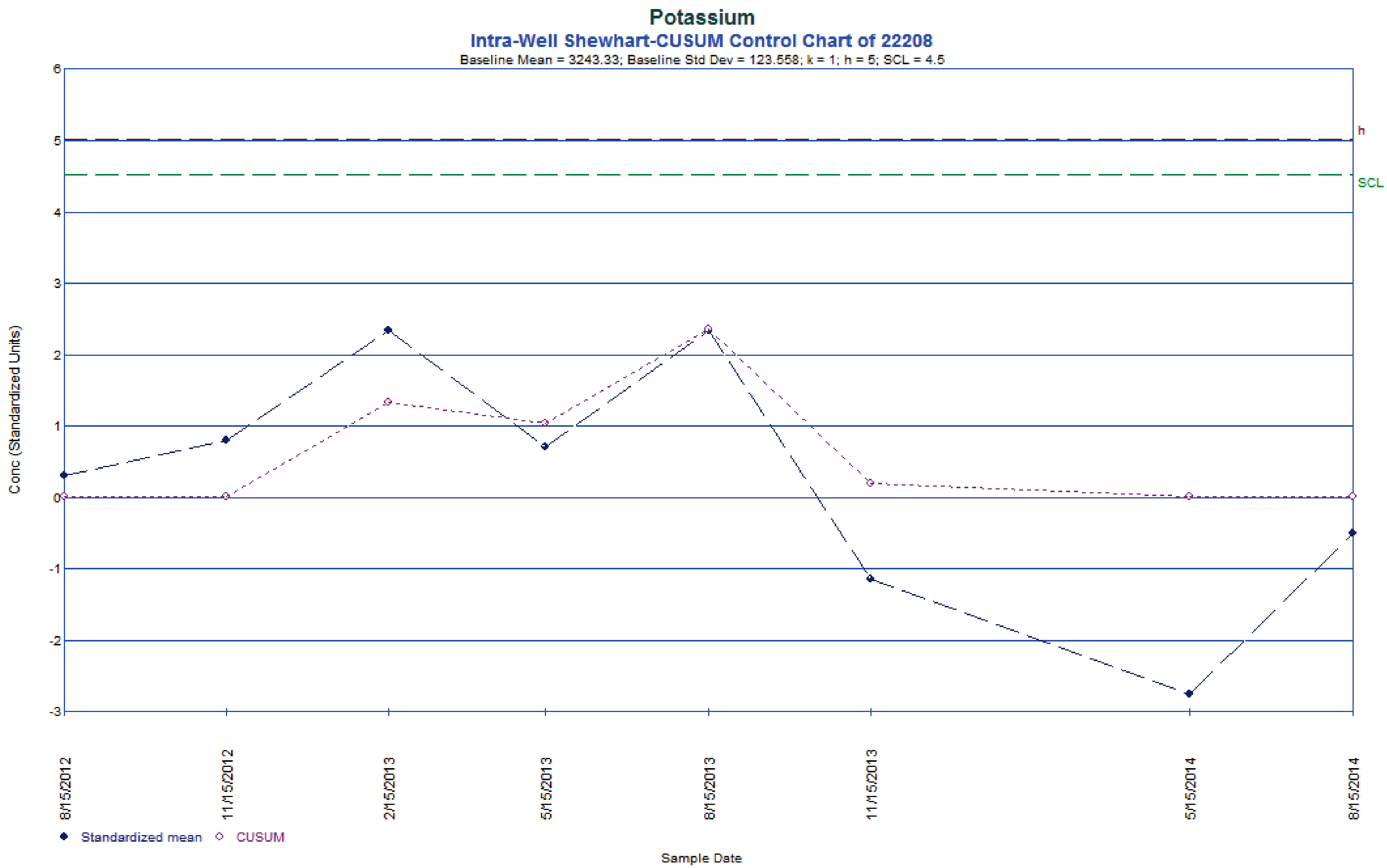


Figure A.5.5-39. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22208)

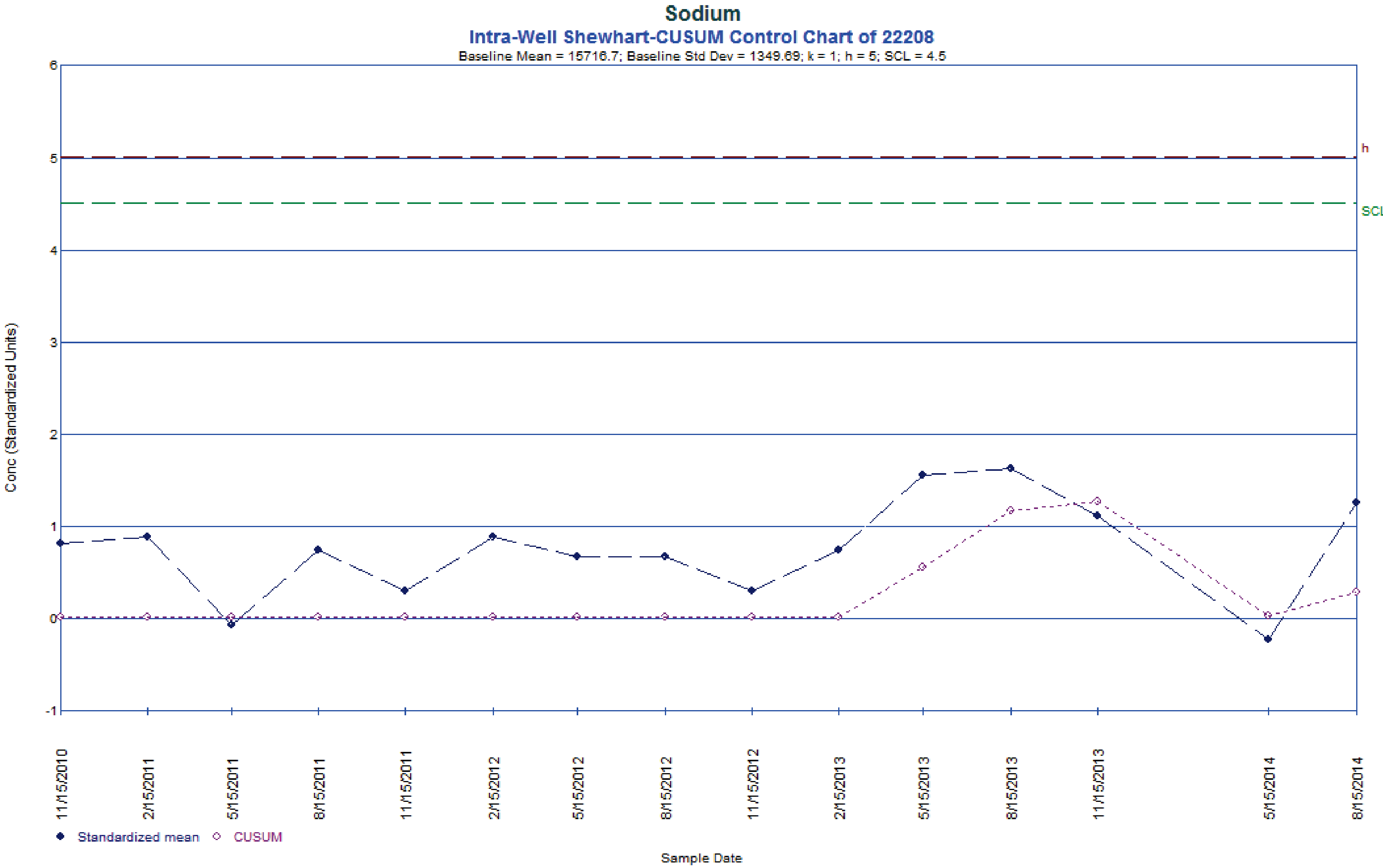


Figure A.5.5-40. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22208)

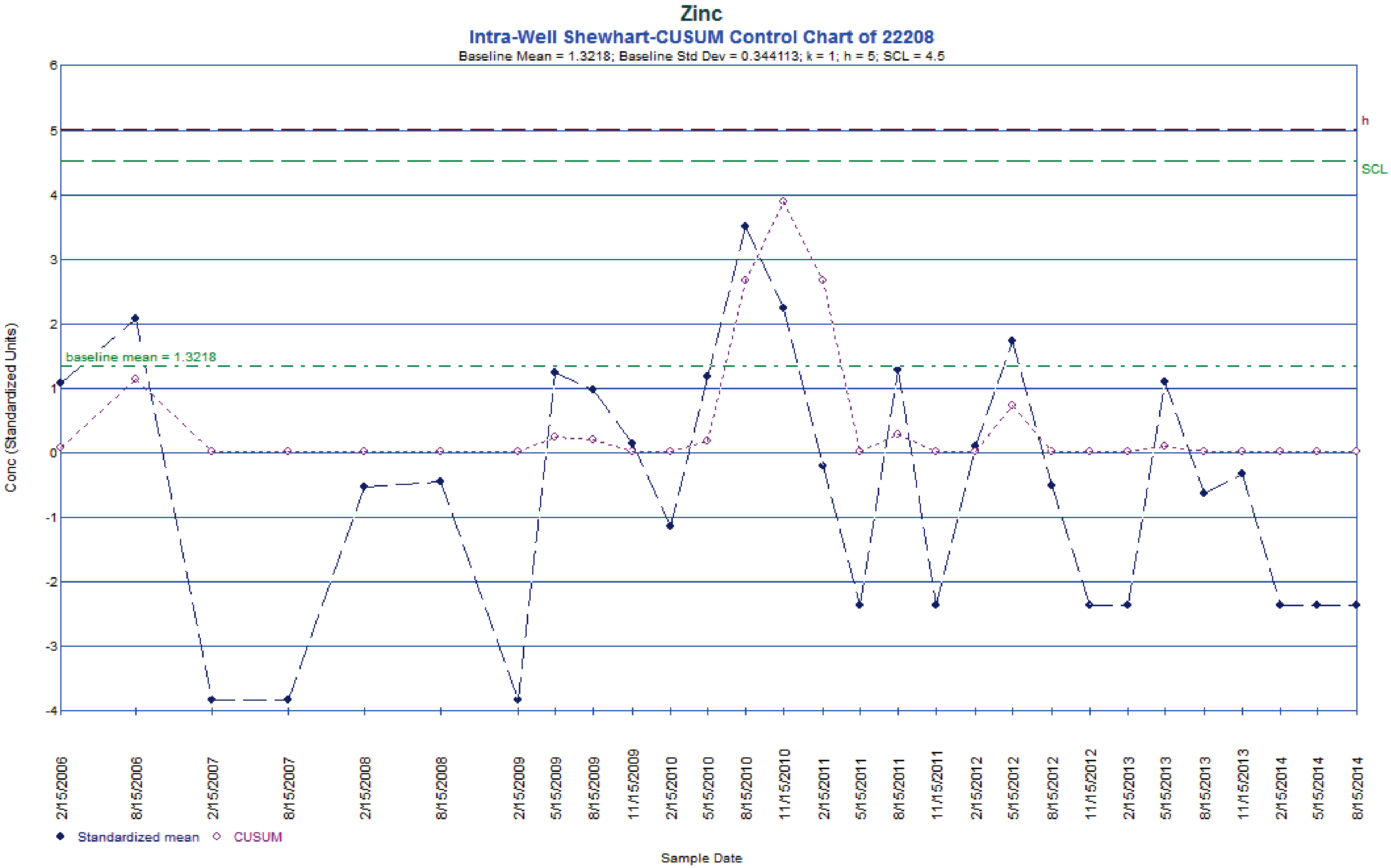


Figure A.5.5-41. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22208)

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Sub-attachment A.5.6

Cell 6

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Contents

Tables

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Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
PCB	polychlorinated biphenyl
SCL	Shewhart control limit
TDS	total dissolved solids
TOC	total organic carbon

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.6-1)
- Annual leachate collection system (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)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.6-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12343 water yield (refer to Figure A.5.6-3)
- Great Miami Aquifer (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 through A.5.6-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.6-30)
- Control charts (refer to Figures A.5.6-31 through A.5.6-40)

A.5.6.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF was operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. Summary statistics are provided in Table A.5.6-1.

As shown in Table A.5.6-1, and summarized below, 10 parameters (uranium, alkalinity, chloride, sulfate, total dissolved solids [TDS], total organic carbon [TOC], boron, iron, magnesium, and selenium) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

The (uranium-sodium) bivariate plot for the Cell 6 LCS, LDS, and HTW is provided in Figure A.5.6-30. 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 concentration trends measured beneath Cell 6 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 6

Parameter	HTW 12343	GMA-U[a] 22209	GMA-D[a] 22210
Total Uranium	Up		Up
Alkalinity		Up	
Chloride		Up	
Sulfate	Up		Up
Total Dissolved Solids			Up
Total Organic Carbon		Up	Up
Boron		Up	Up
Iron			Up
Magnesium		Up	
Selenium			Up

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

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 Shewhart-cumulative sum (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 “not in control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart control limit (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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.6-1 in gray shading, seven parameters in the HTW and/or GMA wells of Cell 6 (alkalinity, barium, calcium, iron, lithium, magnesium, and potassium) meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 10 control charts.

Control charts are presented in Figures A.5.6-31 through A.5.6-41. All of the control charts (with the exception of barium in the GMA-U well) exhibit “in control” conditions.

Parameter	Monitoring Point[a]	Well Number	Assessment	Figure Number
Alkalinity	GMA-D	22210	In Control	A.5.6-31
Barium	GMA-U	22209	Not In Control	A.5.6-32
Barium	GMA-D	22210	In Control	A.5.6-33
Calcium	GMA-D	22210	In Control	A.5.6-34
Iron	GMA-U	22209	In Control	A.5.6-35
Lithium	GMA-U	22209	In Control	A.5.6-36
Lithium	GMA-D	22210	In Control	A.5.6-37
Magnesium	GMA-D	22210	In Control	A.5.6-38
Potassium	GMA-U	22209	In Control	A.5.6-39
Potassium	GMA-D	22210	In Control	A.5.6-40

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

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 semiannually. No new Appendix I or polychlorinated biphenyl (PCB) parameters were detected in the LCS of Cell 6 in 2014. In 2013, cadmium was detected in the LCS of Cell 6 for the first time. Cadmium was not detected in the LCS of Cell 6 in 2014.

A.5.6.4 Summary and Conclusions

- Ten parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 6: uranium, alkalinity, chloride, sulfate, TDS, TOC, boron, iron, magnesium, and selenium.
- 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. Therefore, upward concentration trends beneath Cell 6 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Ten control charts were constructed for Cell 6 parameters. With the exception of barium in the GMA-U well, all of the control charts exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 6 in 2014. In 2013, cadmium was detected in the LCS of Cell 6 for the first time. Cadmium was not detected in the LCS of Cell 6 in 2014.

A.5.6.5 References

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities -Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12343C	42	42	100	43.3	197	128	30	Normal	Down	Detected	
	LDS	12343D	42	42	100	3.10	43.7	25.4	9.4	Normal	Up	Detected	
	HTW	12343	42	42	100	6.32	24.2	12.0	3.3	LogNormal	Up	Detected	
	GMA-U	22209	42	46	91.3	ND	2.43	0.492	0.427	Undefined	Down	Not Detected	
	GMA-D	22210	46	48	95.8	ND	0.994	0.654	0.177	Normal	Up	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12343C	28	28	100	364	568	460	51	Normal	Down	Not Detected	64(Q4-03)
	LDS	12343D	24	24	100	142	549	230	133	Undefined	Down	Detected	
	GMA-U	22209	15	15	100	225	366	346	37	Undefined	Up	Detected	
	GMA-D	22210	14	14	100	389	428	410	12	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12343C	28	28	100	20.1	183	124	34	Undefined	Up	Detected	
	LDS	12343D	24	24	100	51.5	203	138	55	Undefined	Up	Detected	
	GMA-U	22209	15	15	100	17.9	41.0	30.0	7.2	Normal	Up	Detected	
	GMA-D	22210	14	14	100	22.2	34.6	27.0	3.5	Normal	Down	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12343C	24	31	77.4	ND	4.67	2.50	1.39	Undefined	Up	Detected	
	LDS	12343D	16	24	66.7	ND	4.10	1.41	1.29	Undefined	Up	Detected	
	GMA-U	22209	2	15	13.3	ND	0.500	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22210	1	14	7.1	ND	0.0250	Insufficient	Insufficient	Undefined	None	Not Detected	
Sulfate (mg/L)	LCS	12343C	42	42	100	491	4800	2720	1060	Normal	Up	Detected	
	LDS	12343D	42	42	100	1300	5020	2750	1080	Undefined	Up	Detected	
	HTW	12343	36	37	97.3	ND	656	468	88	Normal	Up	Detected	
	GMA-U	22209	45	45	100	2.07	406	174	71	Undefined	None	Not Detected	
	GMA-D	22210	45	45	100	127	578	302	90	Undefined	Up	Detected	
Total Dissolved Solids (mg/L)	LCS	12343C	30	30	100	267	6430	5670	1740	Undefined	Up	Detected	
	LDS	12343D	22	22	100	3690	7850	5910	1020	Normal	Up	Detected	
	GMA-U	22209	21	21	100	550	718	637	45	Normal	Down	Not Detected	876(Q3-11)
	GMA-D	22210	21	21	100	827	1020	940	49	Normal	Up	Detected	
Total Organic Carbon (mg/L)	LCS	12343C	39	42	92.9	ND	3.55	2.10	0.55	Normal	None	Not Detected	14.6(Q4-03)
	LDS	12343D	40	42	95.2	ND	10.4	4.40	2.06	Normal	Down	Detected	
	GMA-U	22209	34	46	73.9	ND	2.28	1.34	0.47	Normal	Up	Detected	
	GMA-D	22210	35	46	76.1	ND	2.50	1.42	0.49	Normal	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12343C	29	42	69.0	ND	0.0600	0.0148	0.0120	LogNormal	None	Not Detected	
	LDS	12343D	33	42	78.6	ND	0.0446	0.0228	0.0118	Normal	None	Not Detected	0.091(Q2-10)
	GMA-U	22209	14	46	30.4	ND	0.0432	0.00323	0.00975	Undefined	None	Detected	
	GMA-D	22210	12	46	26.1	ND	0.059	0.00305	0.00939	Undefined	None	Not Detected	
Arsenic (mg/L)	LCS	12343C	10	33	30.3	ND	0.0930	0.00375	0.0238	Undefined	None	Detected	
	LDS	12343D	9	31	29.0	ND	0.0230	0.00375	0.00470	Undefined	None	Not Detected	
	HTW	12343	3	29	10.3	ND	0.0330	0.00250	Insufficient	Undefined	None	Not Detected	
	GMA-U	22209	6	21	28.6	ND	0.0396	0.00250	0.0105	Undefined	None	Detected	
	GMA-D	22210	7	31	22.6	ND	0.0381	0.00250	0.00955	Undefined	None	Detected	
Barium (mg/L)	LCS	12343C	28	28	100	0.0131	0.0868	0.0263	0.0181	Undefined	Down	Detected	
	LDS	12343D	24	24	100	0.0127	0.0670	0.0241	0.0123	LogNormal	Down	Detected	
	GMA-U	22209	14	14	100	0.0738	0.112	0.0927	0.0111	Normal	None	Not Detected	
	GMA-D	22210	14	14	100	0.0325	0.0459	0.0375	0.0039	Normal	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12343C	42	42	100	0.0566	1.37	0.748	0.220	Undefined	Down	Detected	
	LDS	12343D	42	42	100	0.289	2.38	0.406	0.336	Undefined	None	Detected	
	GMA-U	22209	41	46	89.1	ND	0.0484	0.0371	0.0078	Undefined	Up	Detected	
	GMA-D	22210	43	46	93.5	ND	0.0468	0.0346	0.0066	Normal	Up	Detected	0.0086(Q3-05)
Calcium (mg/L)	LCS	12343C	28	28	100	225	996	498	131	Undefined	None	Not Detected	
	LDS	12343D	24	24	100	302	523	416	65	Normal	Up	Detected	
	GMA-U	22209	14	14	100	136	242	150	34	Undefined	None	Not Detected	
	GMA-D	22210	14	14	100	209	239	223	8	Normal	None	Not Detected	
Chromium (mg/L)	LCS	12343C	5	22	22.7	ND	0.0125	0.00360	0.00306	LogNormal	Up	Not Detected	
	LDS	12343D	5	19	26.3	ND	0.0146	0.00488	0.00421	LogNormal	Up	Not Detected	
	GMA-U	22209	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	2	6	33.3	ND	0.00244	Insufficient	Insufficient	LogNormal	None	Not Detected	
Cobalt (mg/L)	LCS	12343C	11	33	33.3	ND	0.00290	0.000500	0.000701	Undefined	Down	Detected	
	LDS	12343D	10	31	32.3	ND	0.0105	0.000500	0.00181	Undefined	Down	Detected	
	GMA-U	22209	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12343C	18	29	62.1	ND	0.144	0.00820	0.0260	Undefined	None	Not Detected	
	LDS	12343D	14	26	53.8	ND	0.126	0.00905	0.0240	Undefined	None	Not Detected	
	GMA-U	22209	6	14	42.9	ND	0.0101	0.00150	0.00300	Undefined	None	Not Detected	
	GMA-D	22210	6	14	42.9	ND	0.0109	0.00150	0.00314	Undefined	Down	Detected	
Iron (mg/L)	LCS	12343C	13	33	39.4	ND	4.48	0.0150	1.41	Undefined	Down	Detected	
	LDS	12343D	21	31	67.7	ND	3.69	0.0778	1.02	Undefined	Down	Detected	
	GMA-U	22209	21	21	100	2.24	7.84	4.45	1.15	LogNormal	None	Not Detected	
	GMA-D	22210	21	21	100	1.57	7.23	2.91	1.31	LogNormal	Up	Detected	
Lithium (mg/L)	LCS	12343C	30	30	100	0.0234	0.271	0.168	0.071	Normal	Up	Detected	
	LDS	12343D	30	30	100	0.0703	0.205	0.140	0.044	Undefined	Up	Detected	
	GMA-U	22209	21	21	100	0.00486	0.00739	0.00589	0.00064	Normal	None	Not Detected	
	GMA-D	22210	21	21	100	0.00631	0.00865	0.00739	0.00063	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12343C	28	28	100	92.4	896	743	271	Undefined	Up	Detected	
	LDS	12343D	24	24	100	130	635	441	187	Undefined	Up	Detected	
	GMA-U	22209	14	14	100	27.0	39.7	32.7	3.6	Normal	Up	Detected	55.4(Q3-13)
	GMA-D	22210	14	14	100	50.6	58.3	54.0	2.3	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12343C	9	33	27.3	ND	1.41	0.00500	0.259	Undefined	Down	Detected	
	LDS	12343D	11	31	35.5	ND	3.24	0.00810	0.580	Undefined	None	Not Detected	
	GMA-U	22209	21	21	100	0.243	0.748	0.273	0.116	Undefined	None	Not Detected	
	GMA-D	22210	31	31	100	0.0735	0.420	0.211	0.089	Normal	None	Detected	
Nickel (mg/L)	LCS	12343C	22	33	66.7	ND	0.0319	0.00335	0.00947	Undefined	Down	Detected	
	LDS	12343D	25	31	80.6	ND	0.0580	0.0164	0.0156	LogNormal	None	Detected	
	GMA-U	22209	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	28	31	90.3	ND	0.00990	0.00349	0.00238	LogNormal	None	Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Potassium (mg/L)	LCS	12343C	28	28	100	9.00	75.5	28.7	11.4	Undefined	Up	Detected	
	LDS	12343D	24	24	100	24.5	69.8	51.0	15.9	Undefined	Up	Detected	
	GMA-U	22209	14	14	100	3.00	3.78	3.30	0.23	Normal	None	Not Detected	
	GMA-D	22210	14	14	100	3.06	3.62	3.36	0.14	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12343C	12	33	36.4	ND	0.140	0.0123	0.0255	LogNormal	Up	Not Detected	
	LDS	12343D	7	31	22.6	ND	0.0545	0.00770	0.0104	LogNormal	None	Not Detected	0.193(Q4-13)
	GMA-U	22209	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	2	21	9.5	ND	0.00770	Insufficient	Insufficient	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12343C	33	33	100	23.1	107	68.4	16.0	Undefined	Up	Not Detected	
	LDS	12343D	31	31	100	109	702	446	114	Undefined	Up	Detected	
	HTW	12343	29	29	100	32.7	66.0	45.6	11.1	Undefined	Down	Detected	
	GMA-U	22209	21	21	100	14.5	22.5	17.7	2.1	Normal	Down	Detected	
	GMA-D	22210	21	21	100	16.2	20.4	18.0	1.0	Normal	Down	Detected	
Zinc (mg/L)	LCS	12343C	10	33	30.3	ND	0.0432	0.0122	0.0088	LogNormal	None	Not Detected	
	LDS	12343D	23	31	74.2	ND	2.61	0.308	0.516	LogNormal	Up	Detected	
	GMA-U	22209	8	21	38.1	ND	0.0133	0.00304	0.00351	Undefined	None	Not Detected	
	GMA-D	22210	25	31	80.6	ND	0.0244	0.0100	0.0061	LogNormal	Down	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least eight samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater Background)	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched Water)
General Chemistry											
Ammonia (mg/L)	12	5	41.7	Yes	0.0198	1	0.263	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganic											
Cadmium	12	1	8.3	No	0.000176	-	-	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Mercury (mg/L)	18	1	5.6	No	0.000338	-	-	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Vanadium (mg/L)	12	1	8.3	No	0.000880	-	-	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)	18	5	27.8	No	1.83	21.4	10.1	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	-	-	-	-	-	-

[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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

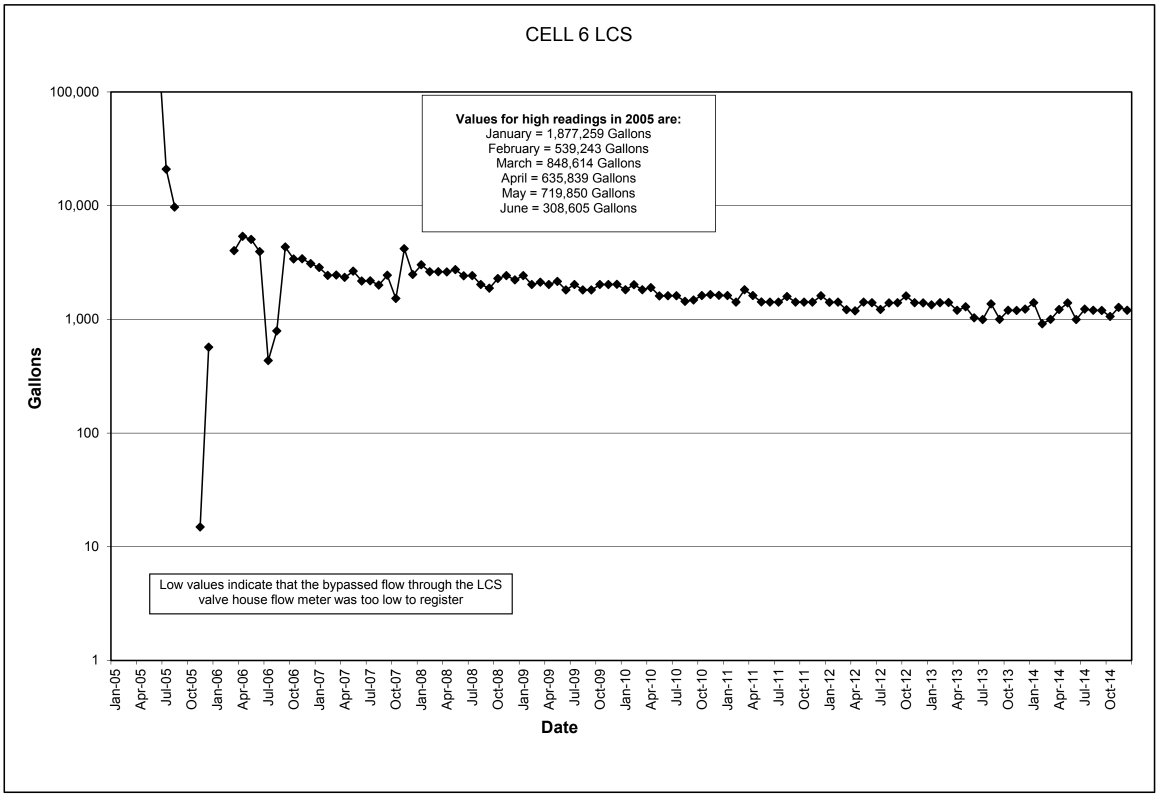


Figure A.5.6-1. Monthly Accumulation Volumes for Cell 6 LCS

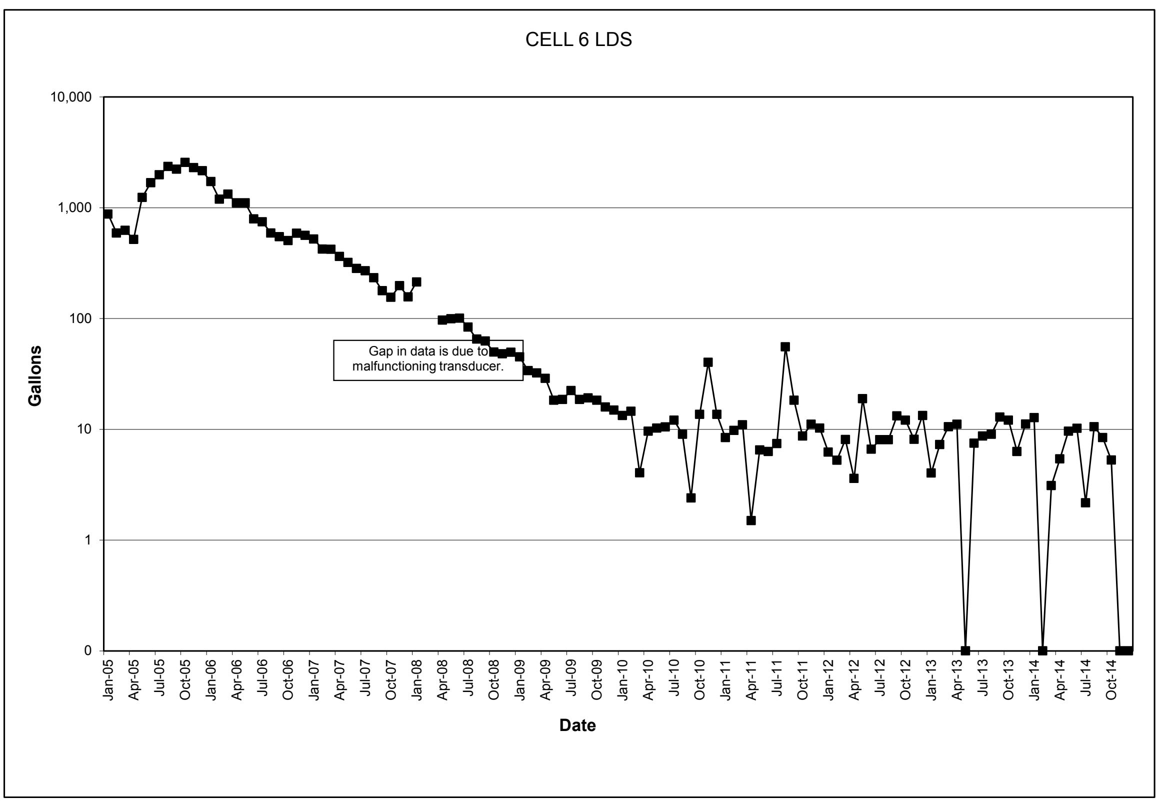
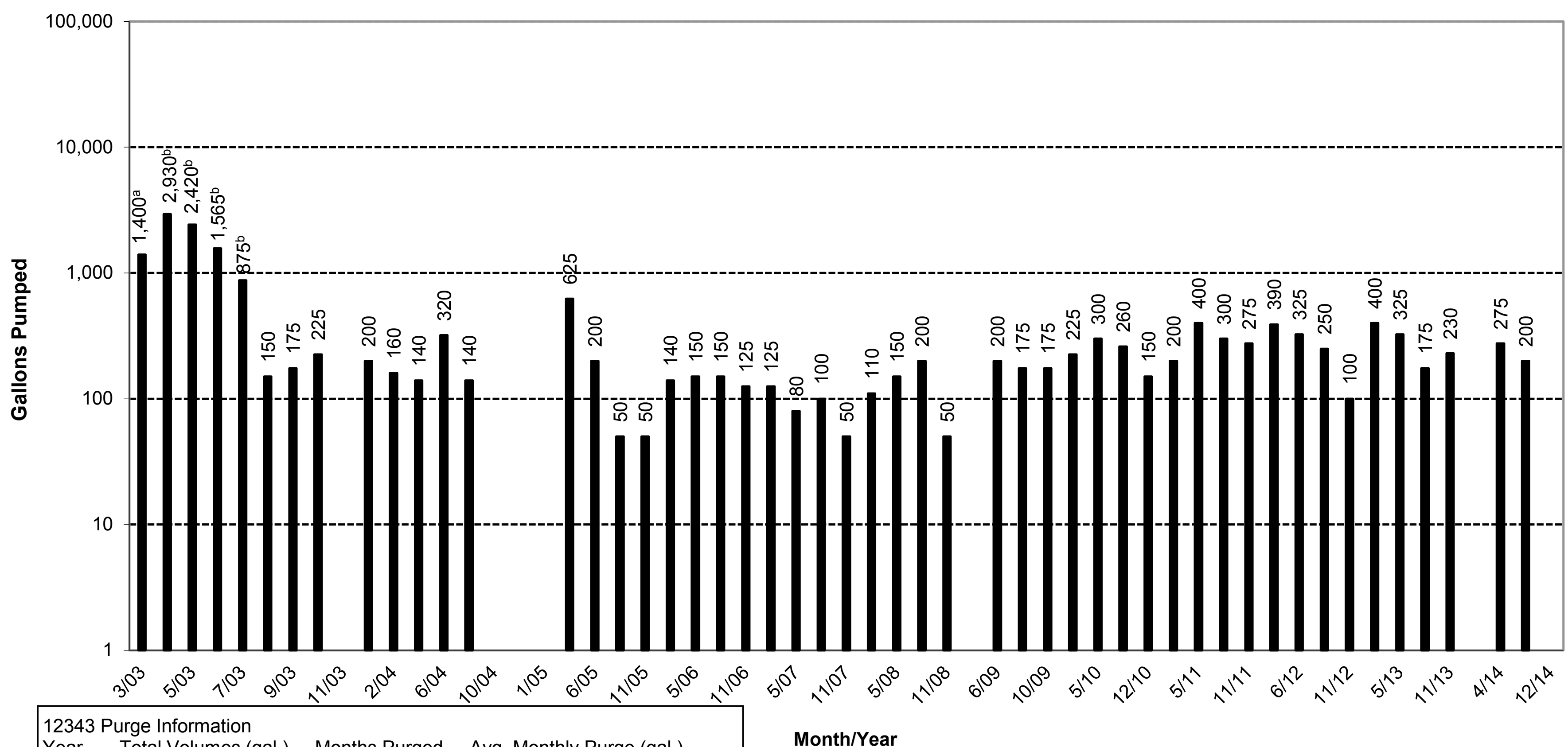


Figure A.5.6-2. Monthly Accumulation Volumes for Cell 6 LDS



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
2012:	1065	n=4	266
2013:	1130	n=4	283
2014[c]:	475	n=2	238
Overall:			340

[a]Excess water was pumped from this well in March 2003 for well development.

[b]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.

[c]Sampling schedule reduced to semi-annual sampling in 2014.

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

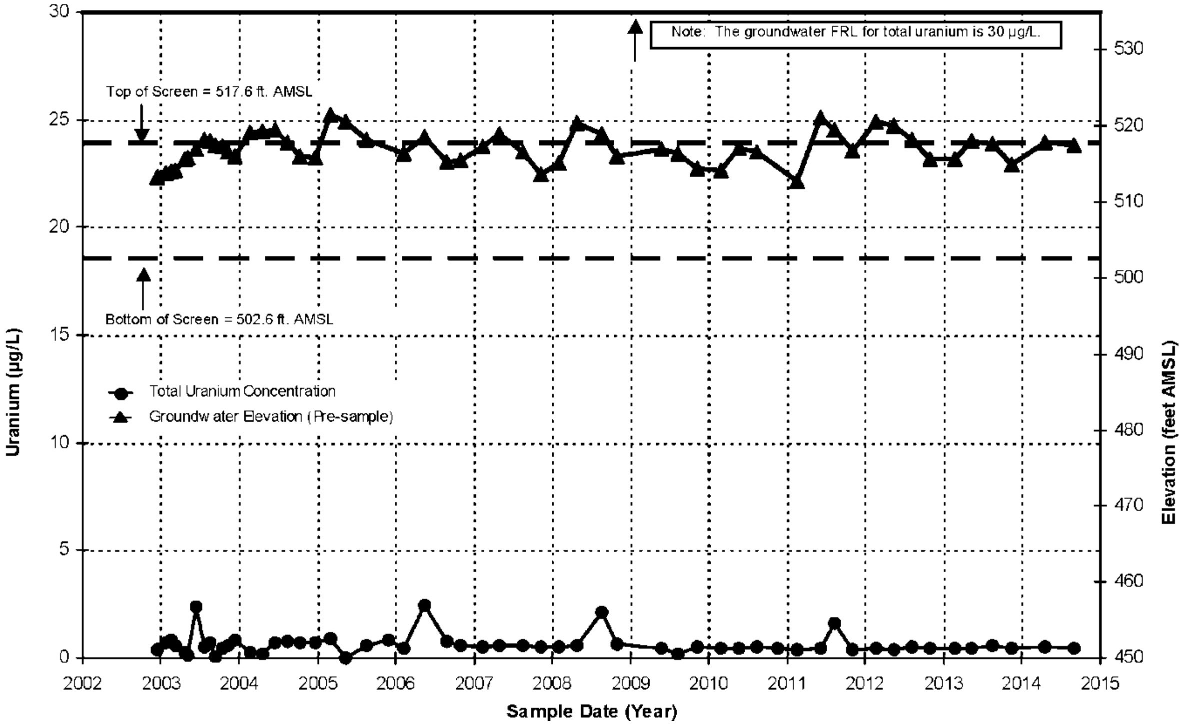


Figure A.5.6-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 6 Upgradient Monitoring Well 22209

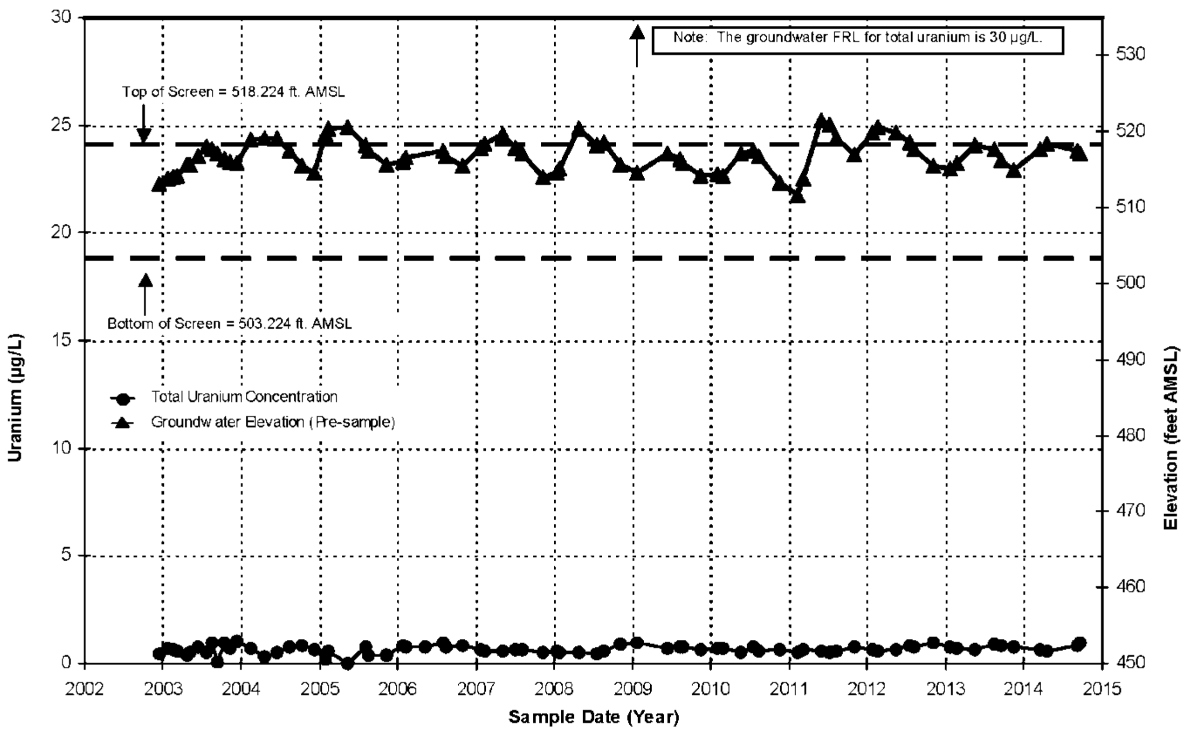


Figure A.5.6-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 6 Downgradient Monitoring Well 22210

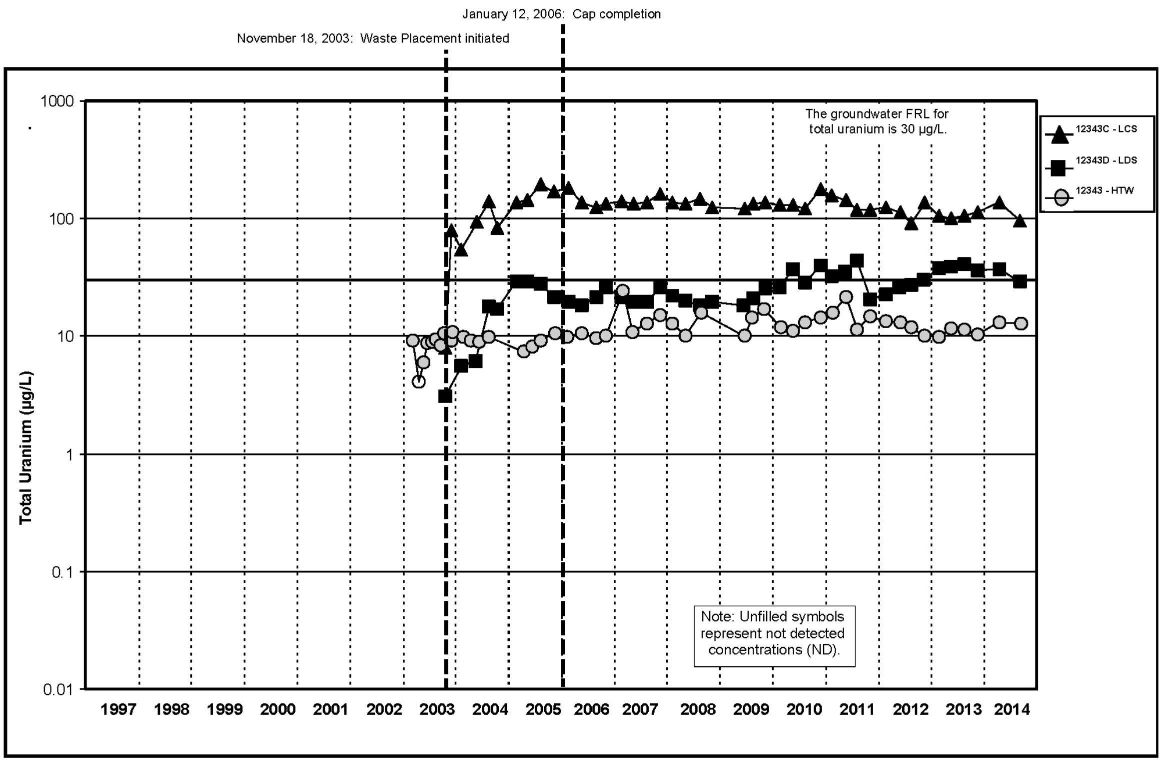


Figure A.5.6-6A. Cell 6 Uranium, Total Concentration Versus Time Plot for LCS, LDS, and HTW

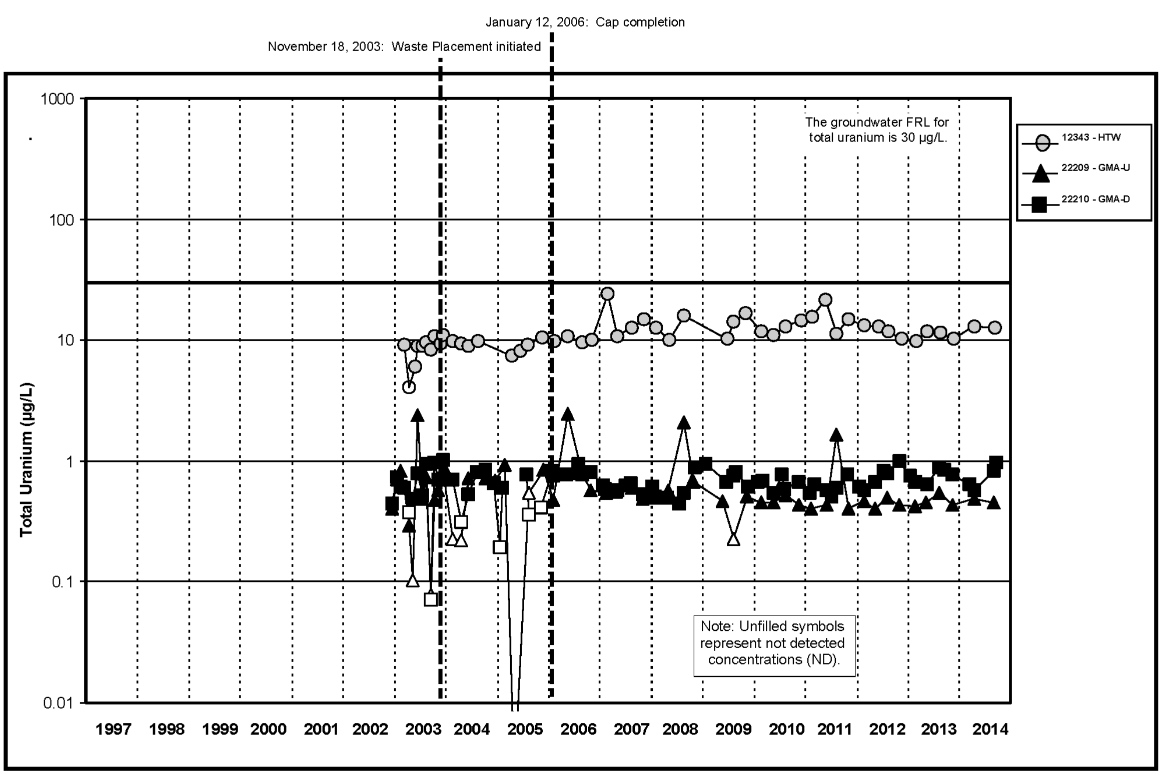


Figure A.5.6-6B. Cell 6 Uranium, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

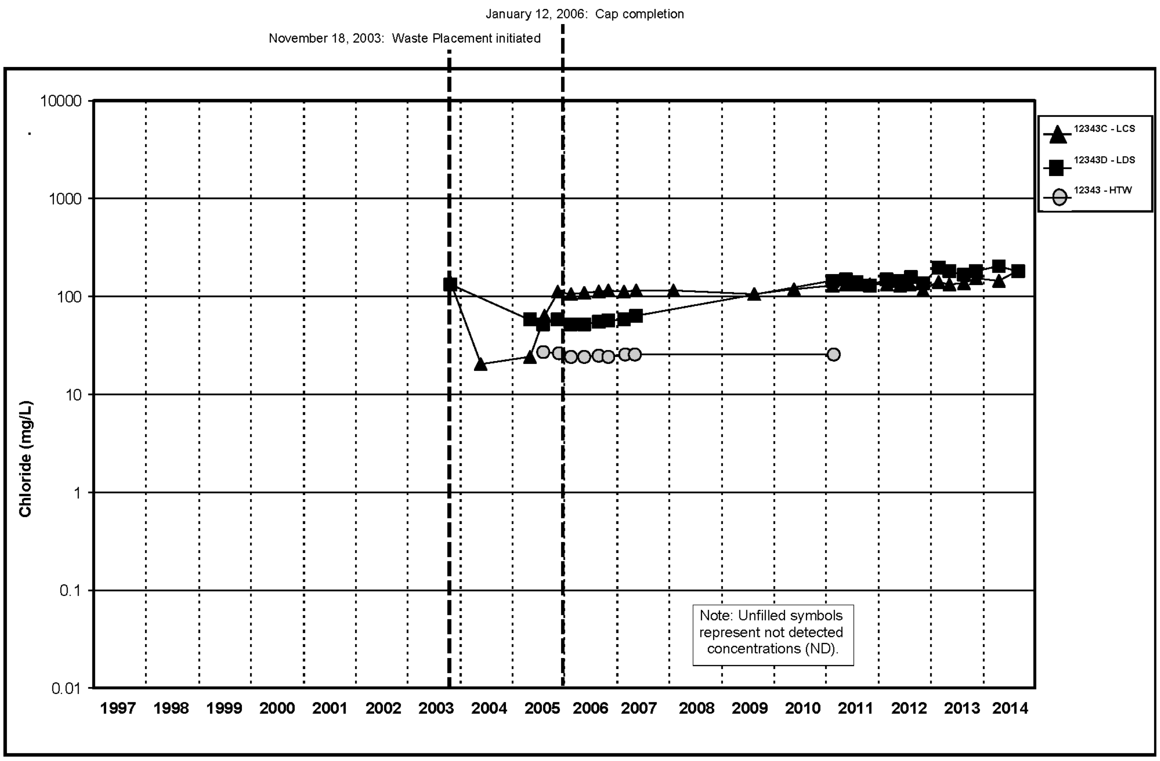


Figure A.5.6-7A. Cell 6 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

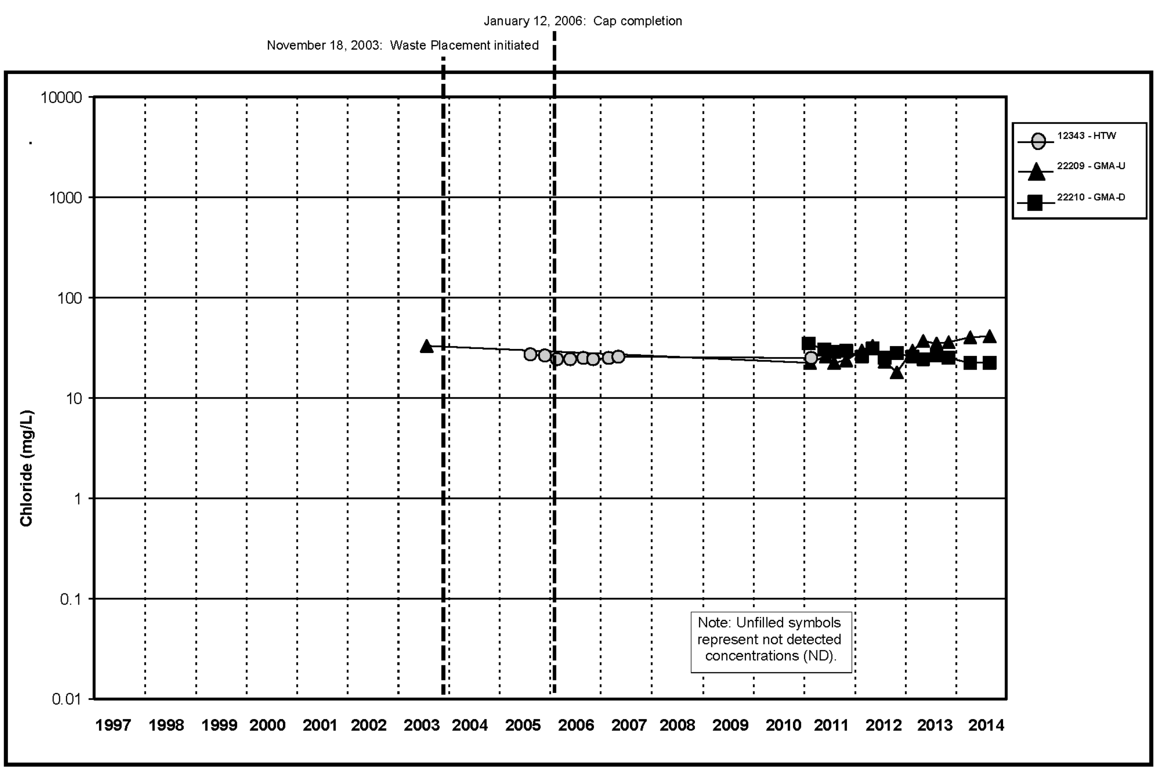


Figure A.5.6-7B. Cell 6 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

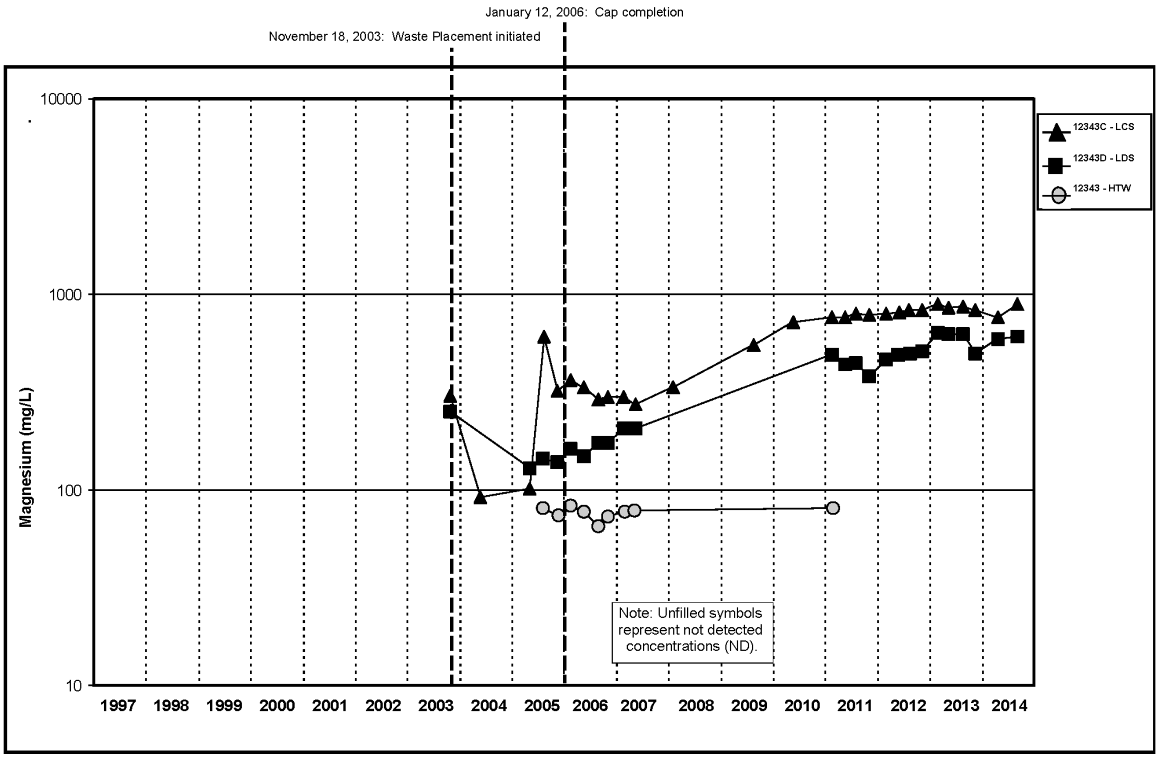


Figure A.5.6-8A. Cell 6 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

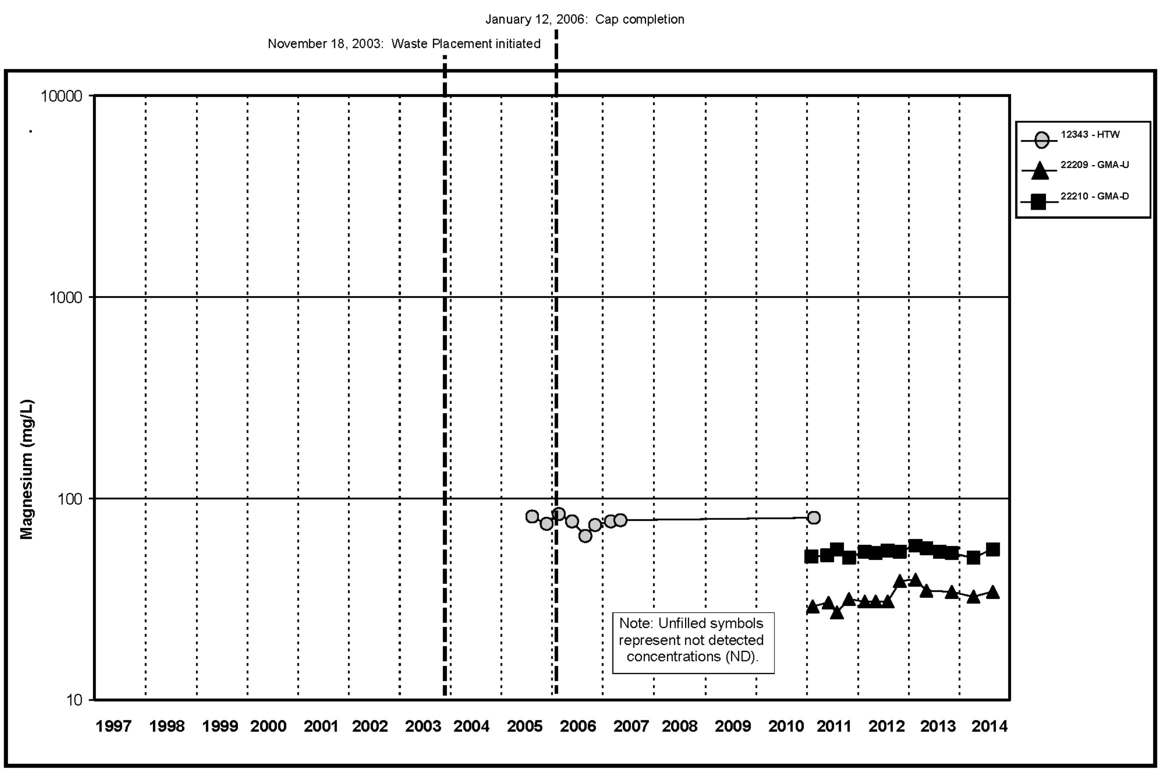


Figure A.5.6-8B. Cell 6 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

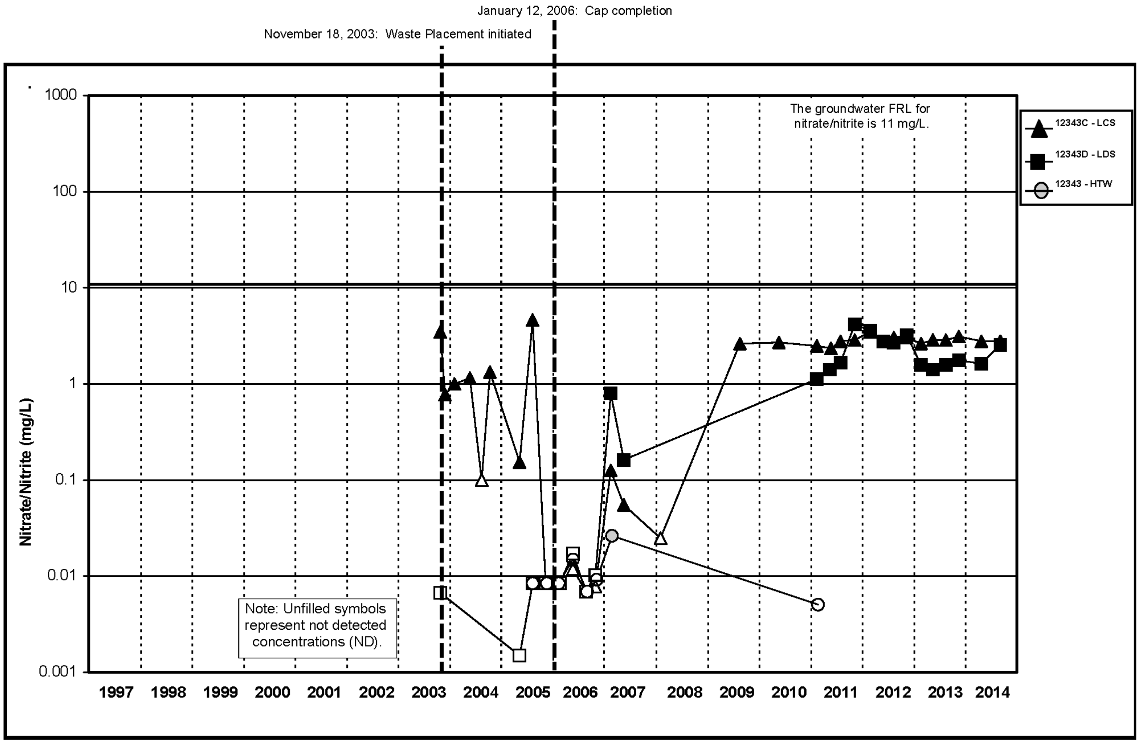


Figure A.5.6-9A. Cell 6 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

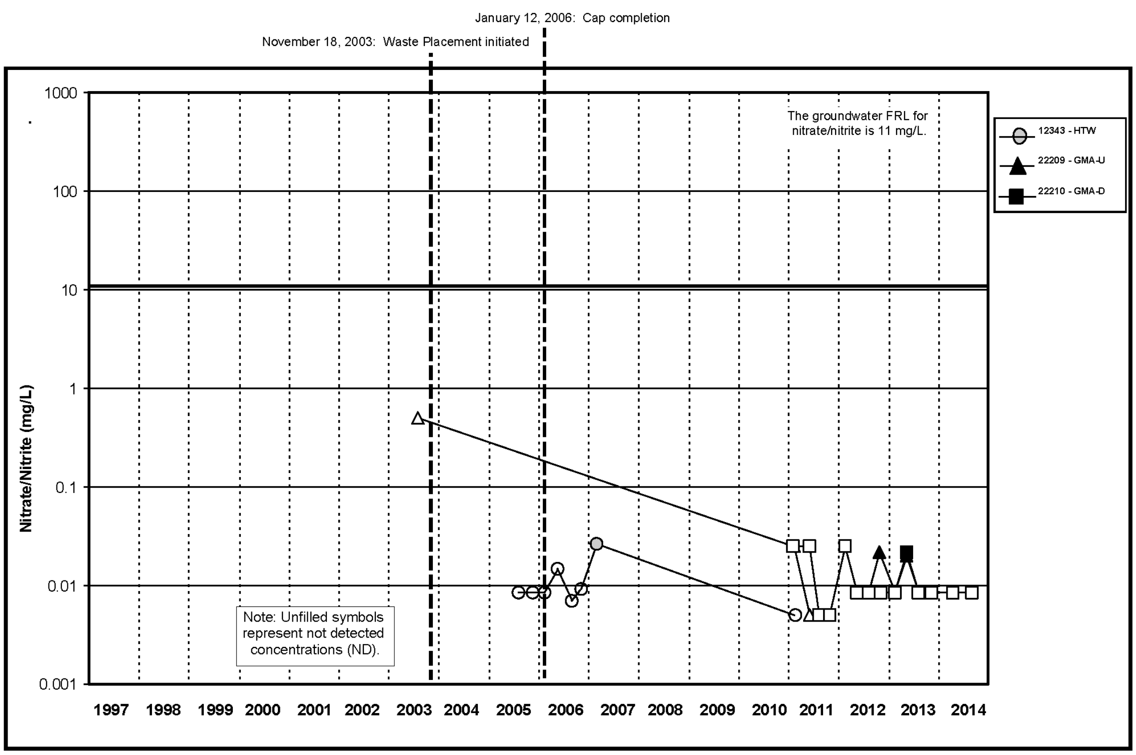


Figure A.5.6-9B. Cell 6 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

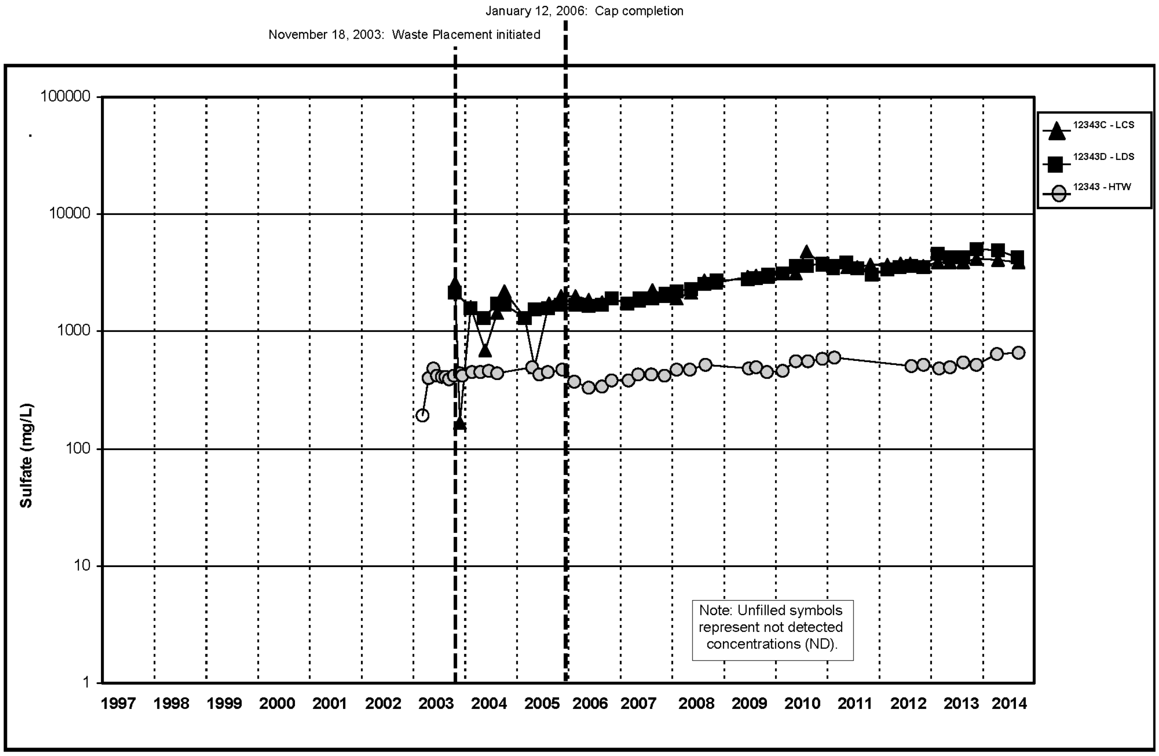


Figure A.5.6-10A. Cell 6 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

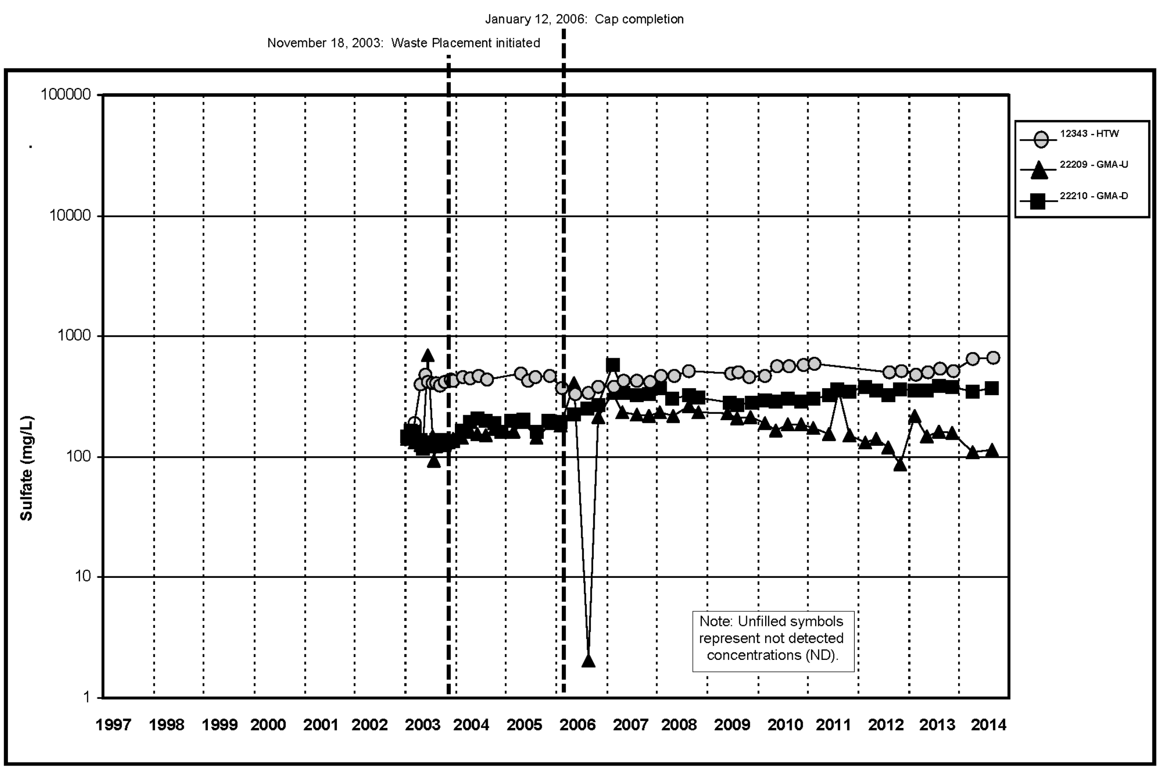


Figure A.5.6-10B. Cell 6 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

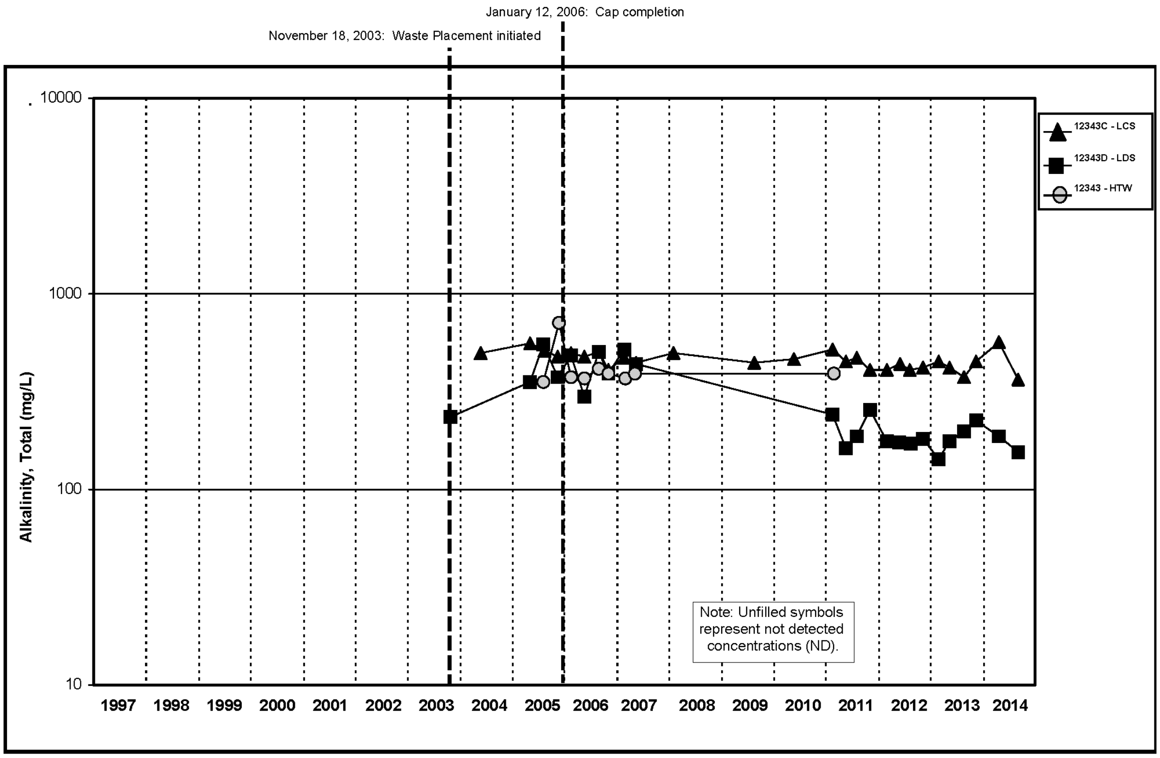


Figure A.5.6-11A. Cell 6 Alkalinity, Total Concentration Versus Time Plot for LCS, LDS, and HTW

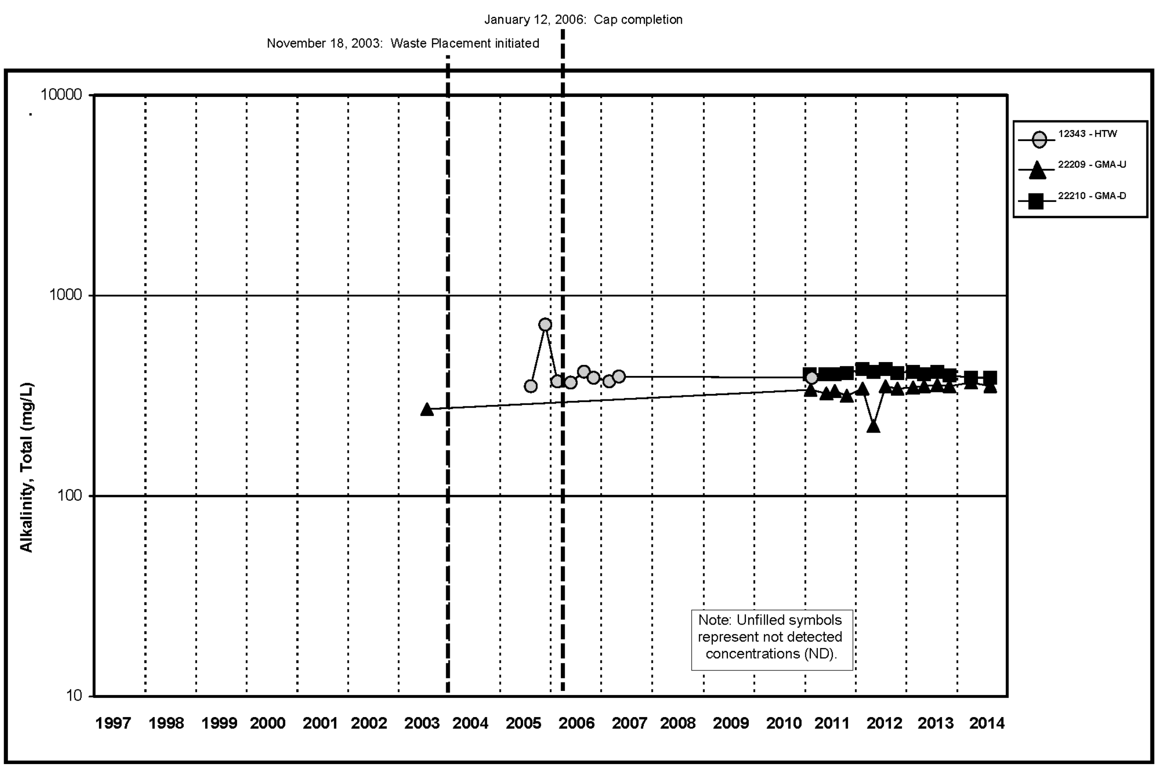


Figure A.5.6-11B. Cell 6 Alkalinity, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

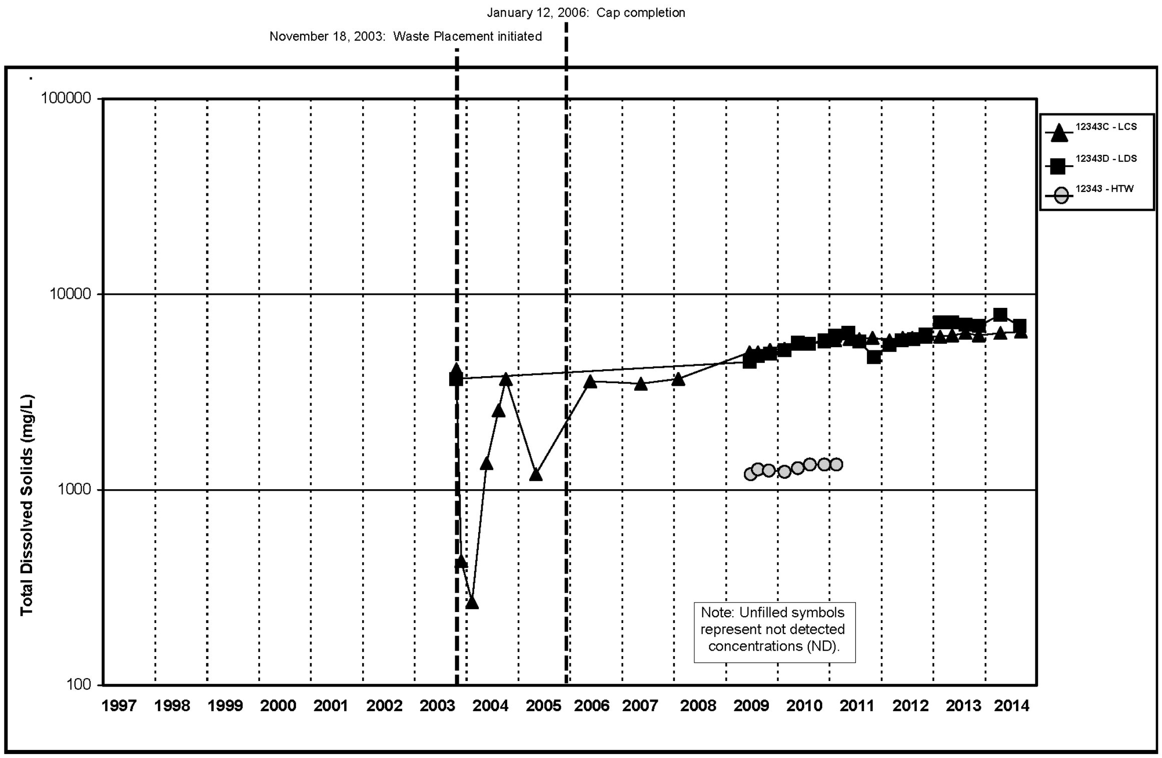


Figure A.5.6-12A. Cell 6 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

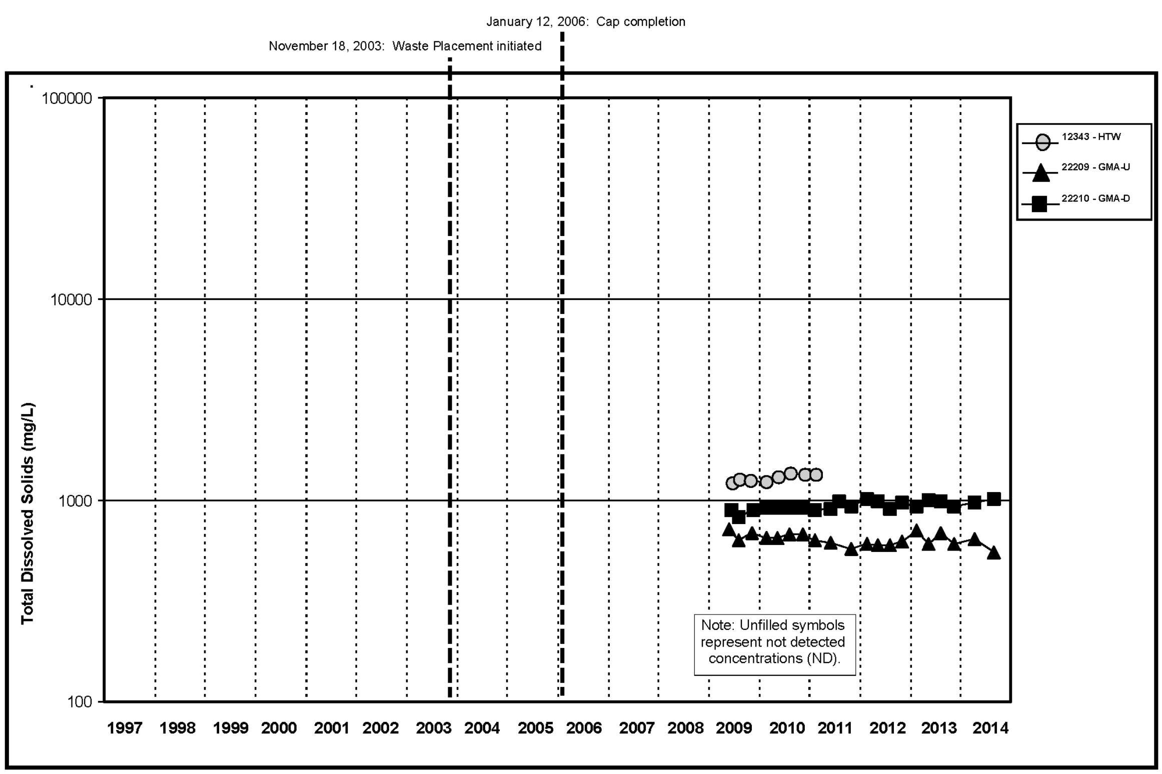


Figure A.5.6-12B. Cell 6 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

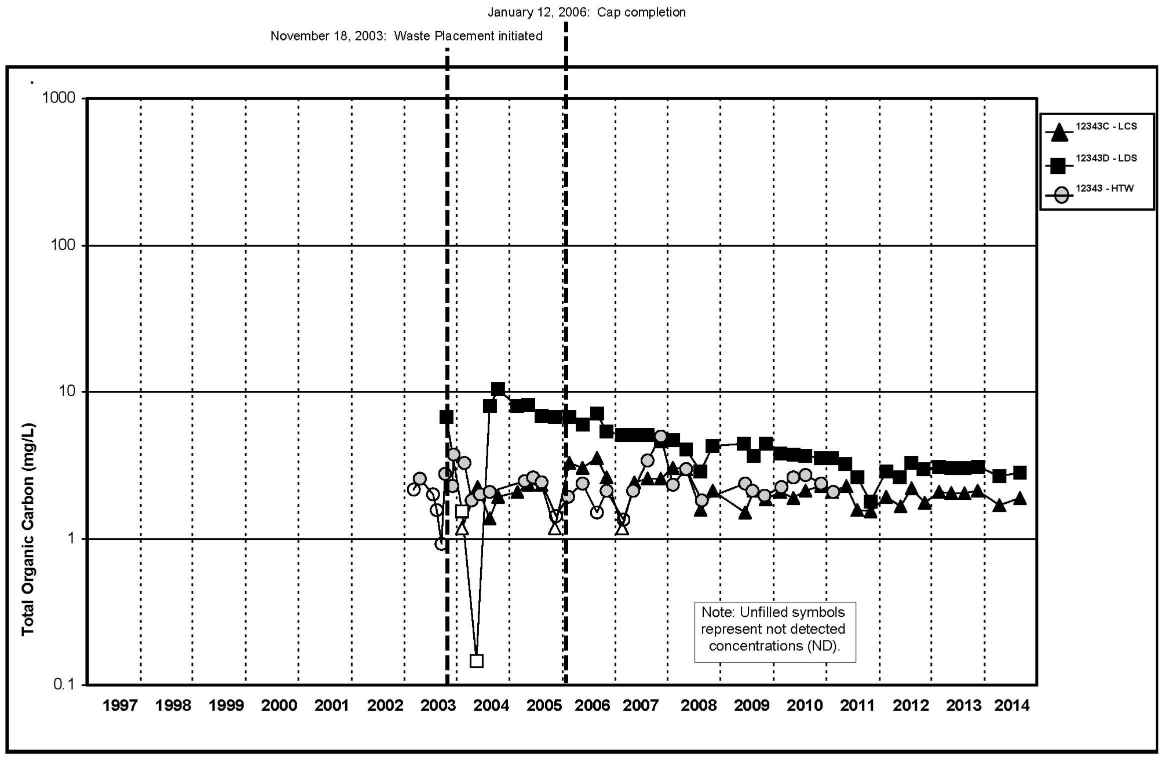


Figure A.5.6-13A. Cell 6 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

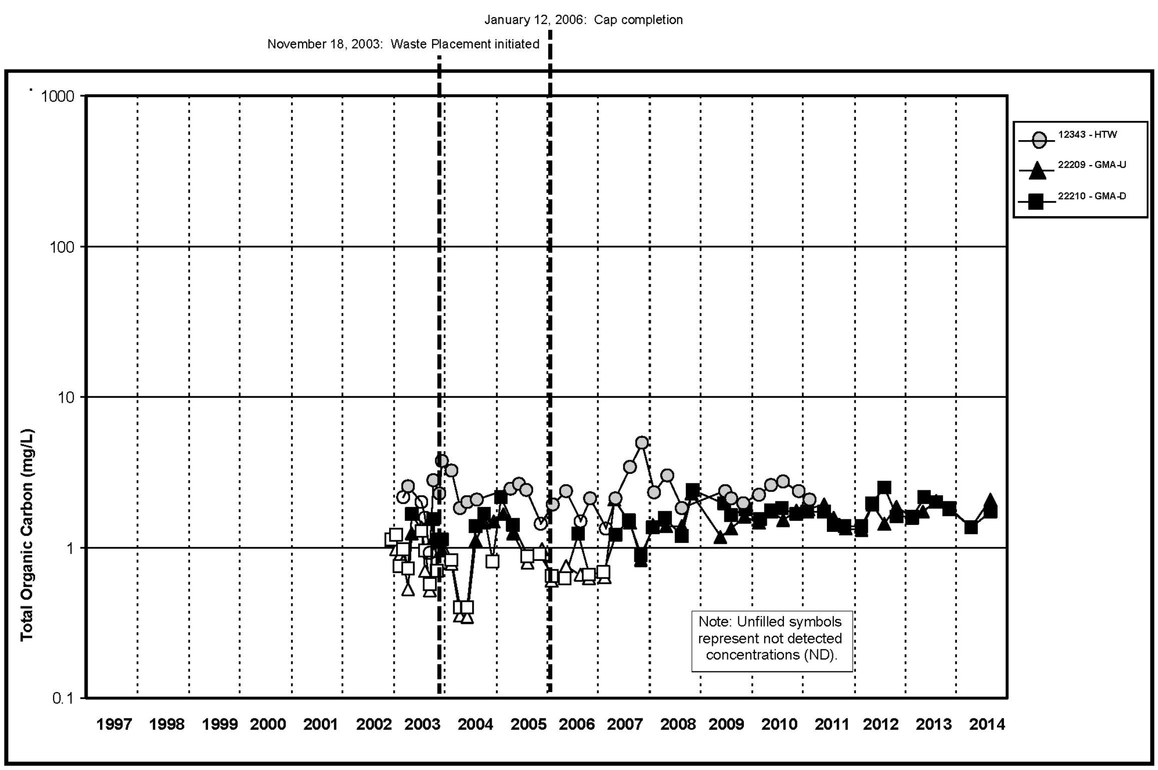


Figure A.5.6-13B. Cell 6 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

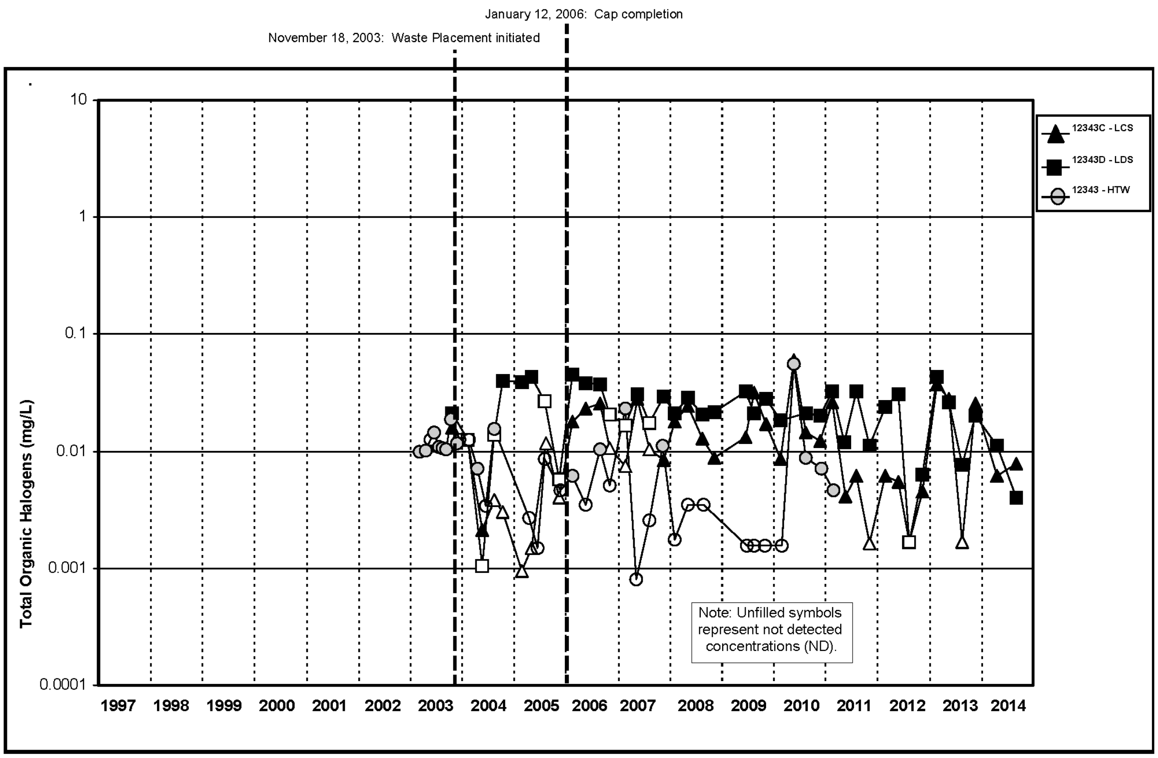


Figure A.5.6-14A. Cell 6 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

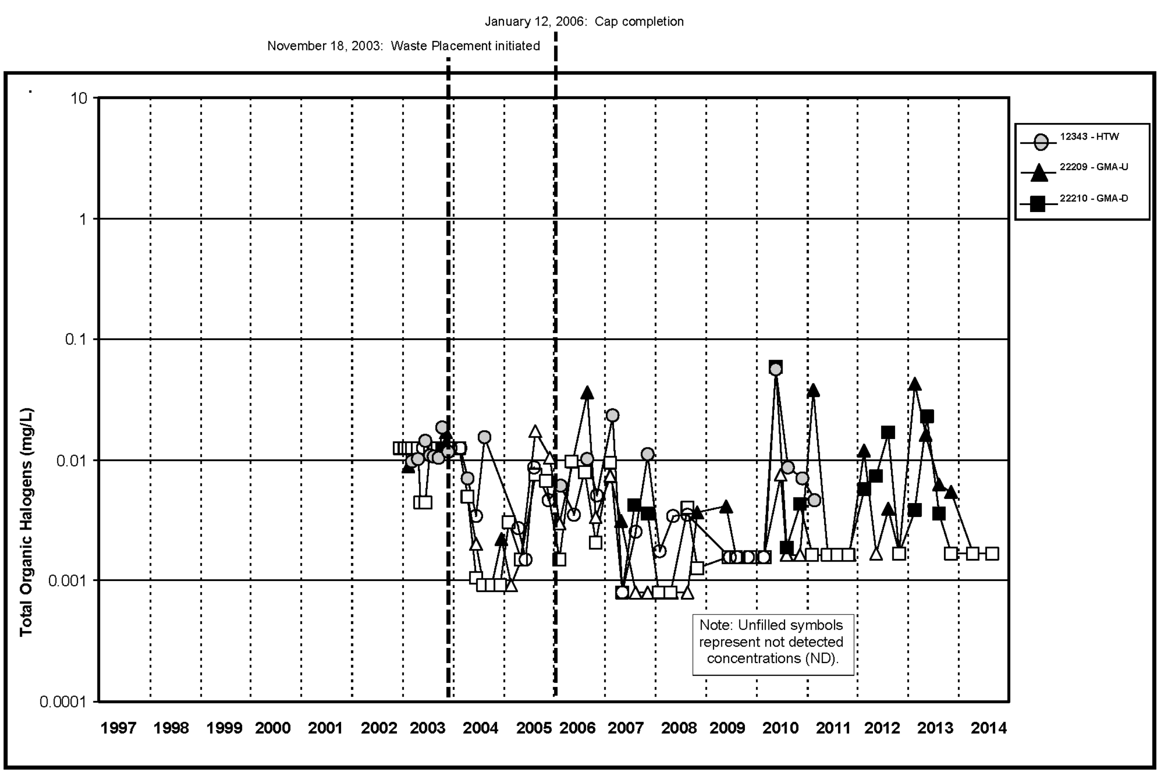


Figure A.5.6-14B. Cell 6 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

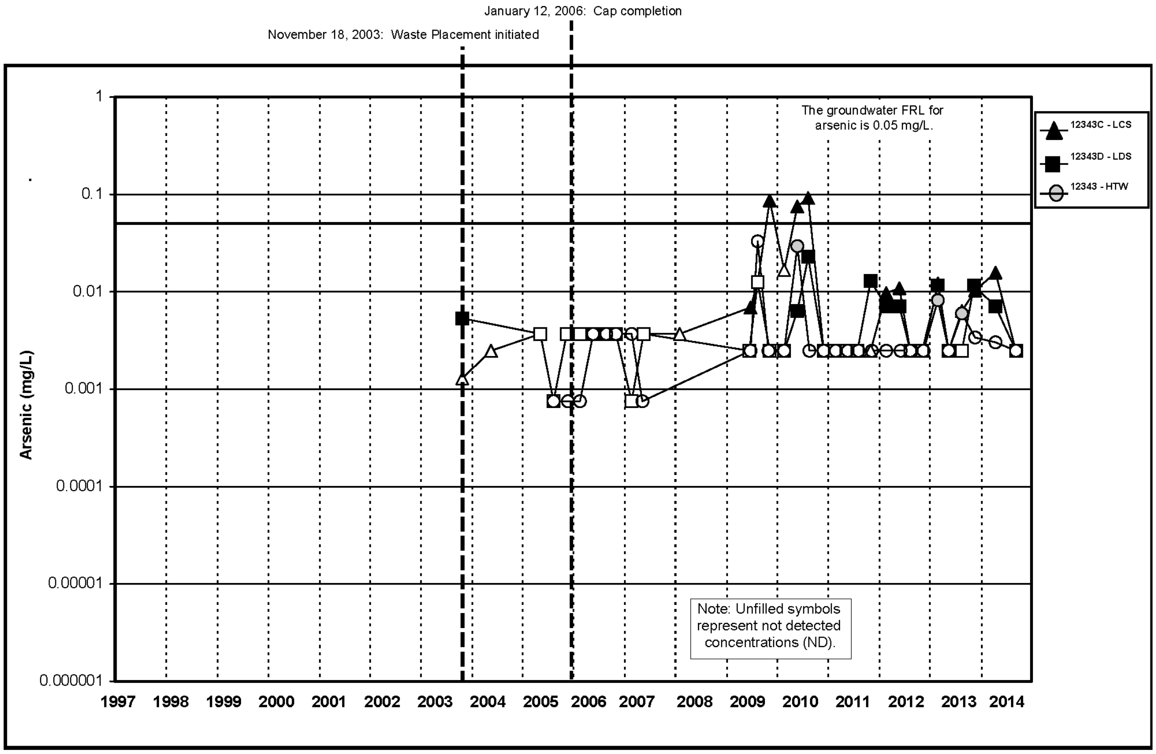


Figure A.5.6-15A. Cell 6 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

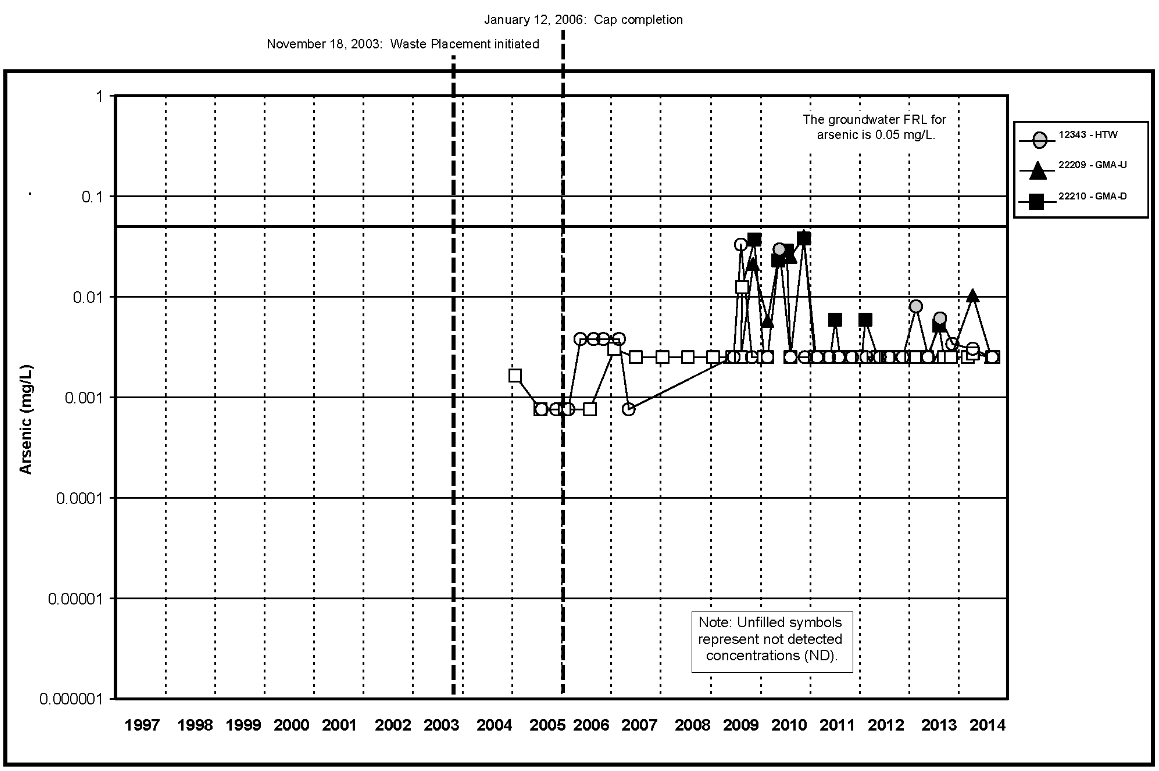


Figure A.5.6-15B. Cell 6 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

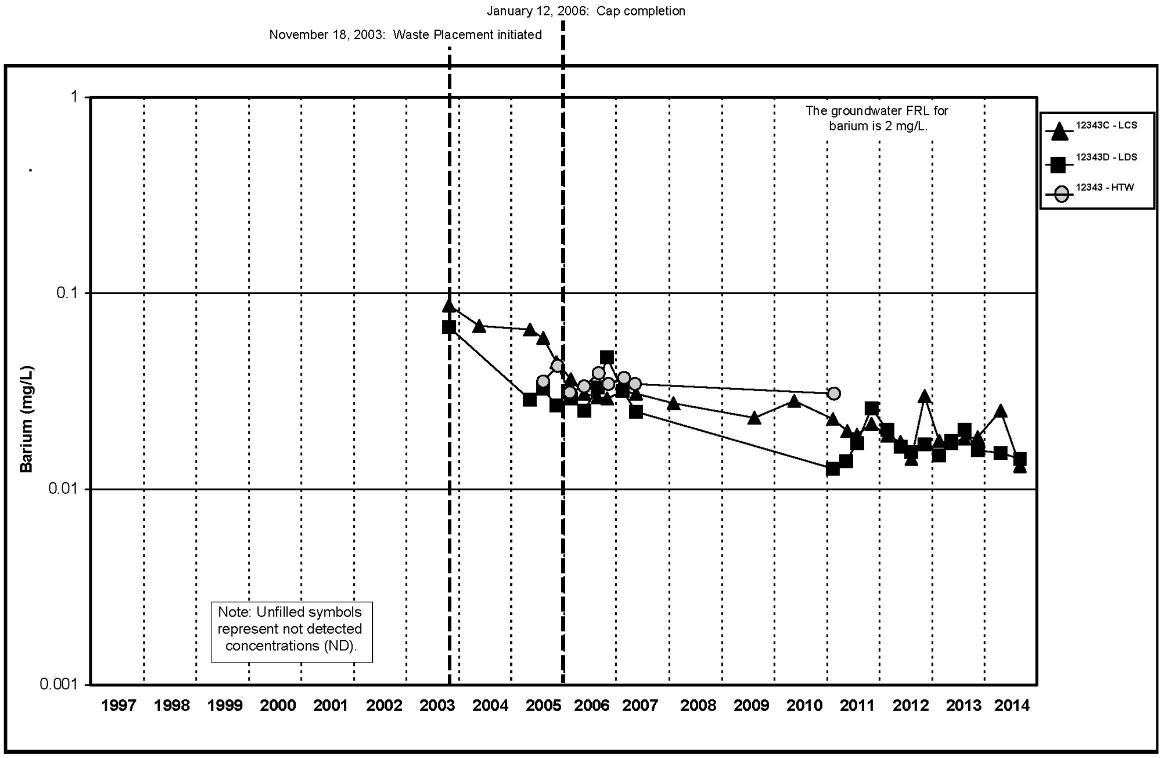


Figure A.5.6-16A. Cell 6 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

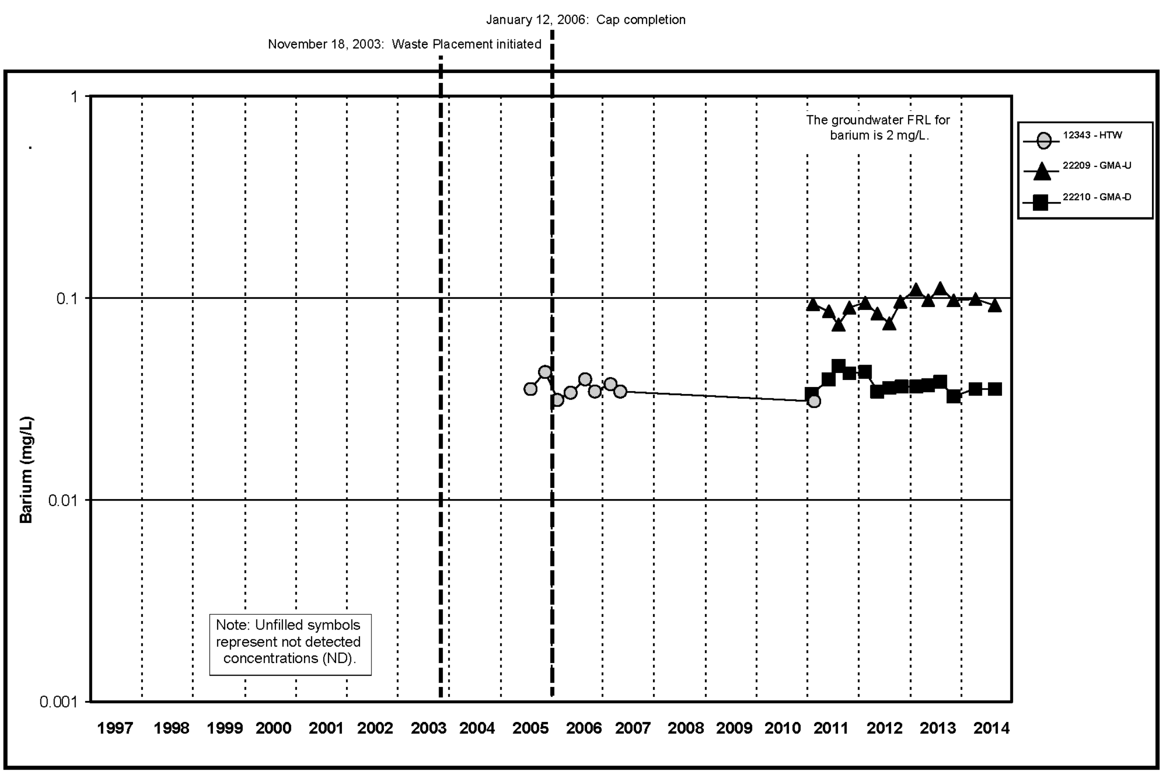


Figure A.5.6-16B. Cell 6 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

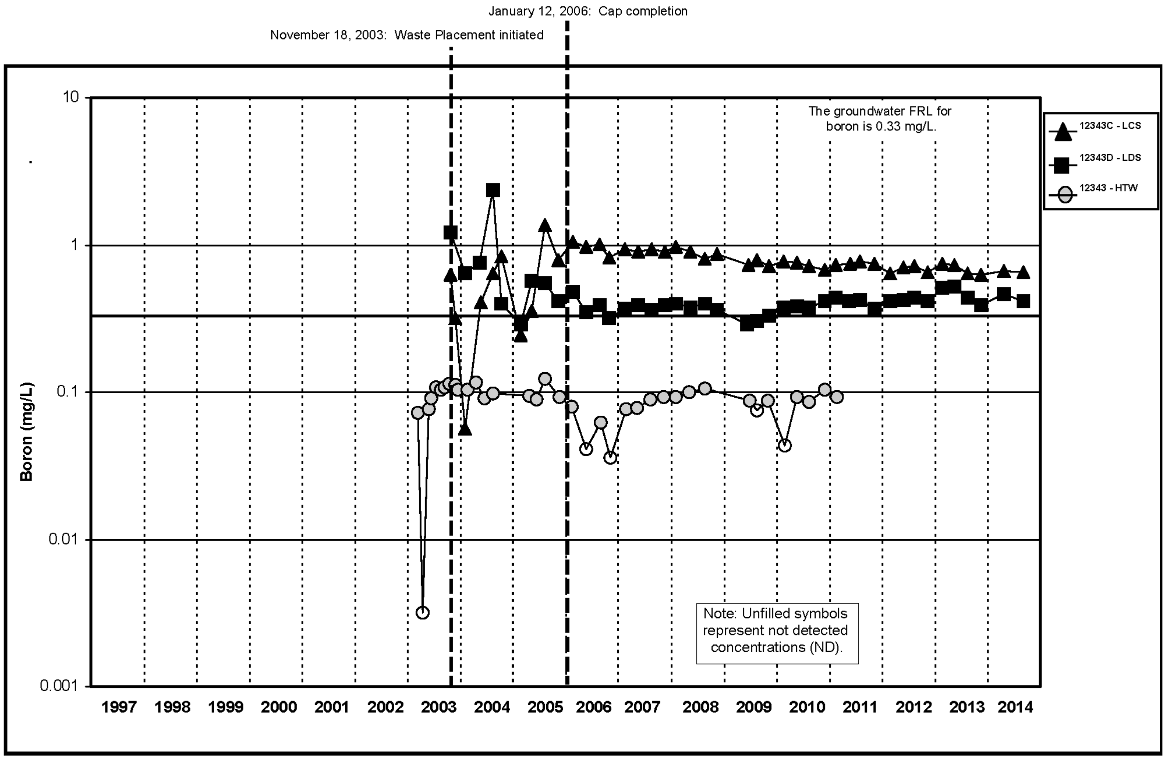


Figure A.5.6-17A. Cell 6 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

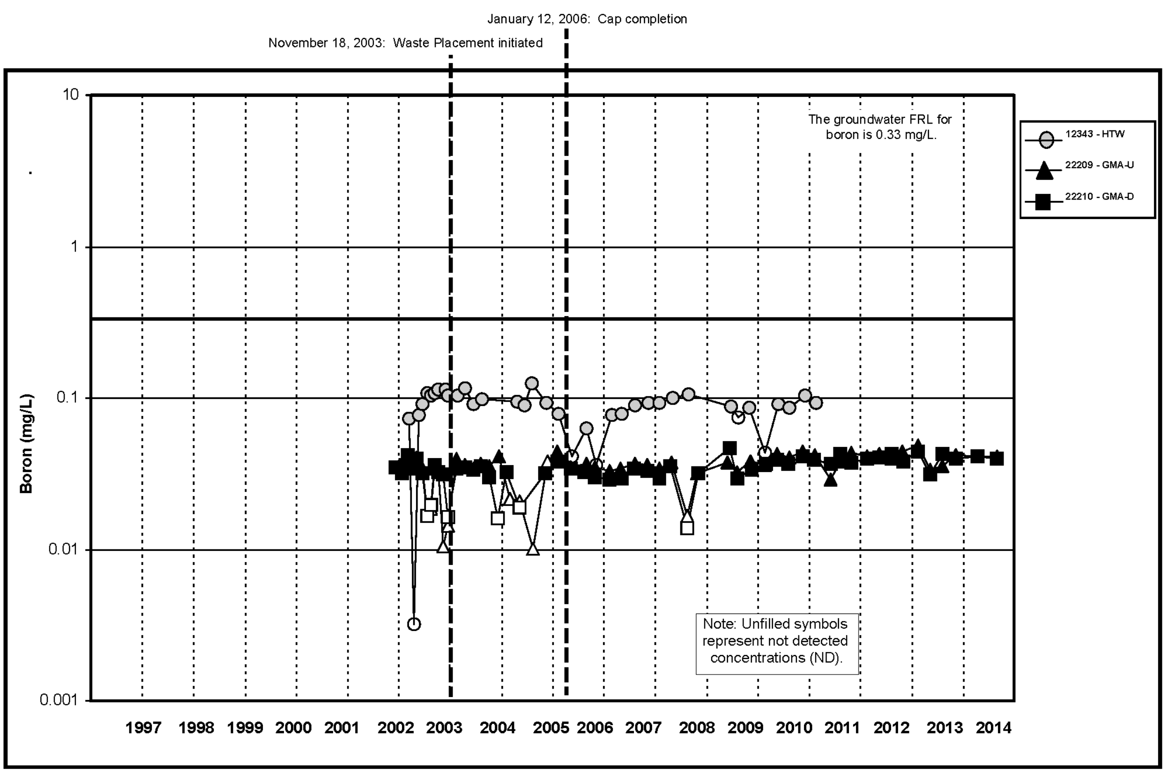


Figure A.5.6-17B. Cell 6 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

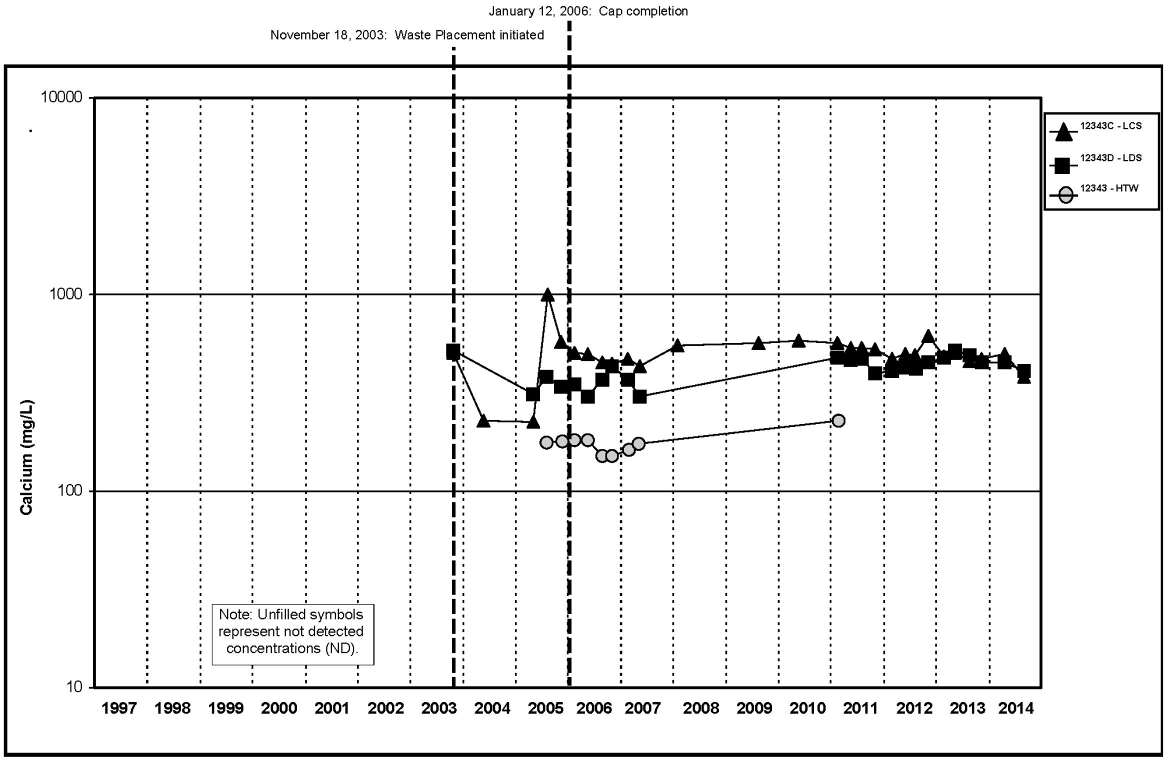


Figure A.5.6-18A. Cell 6 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

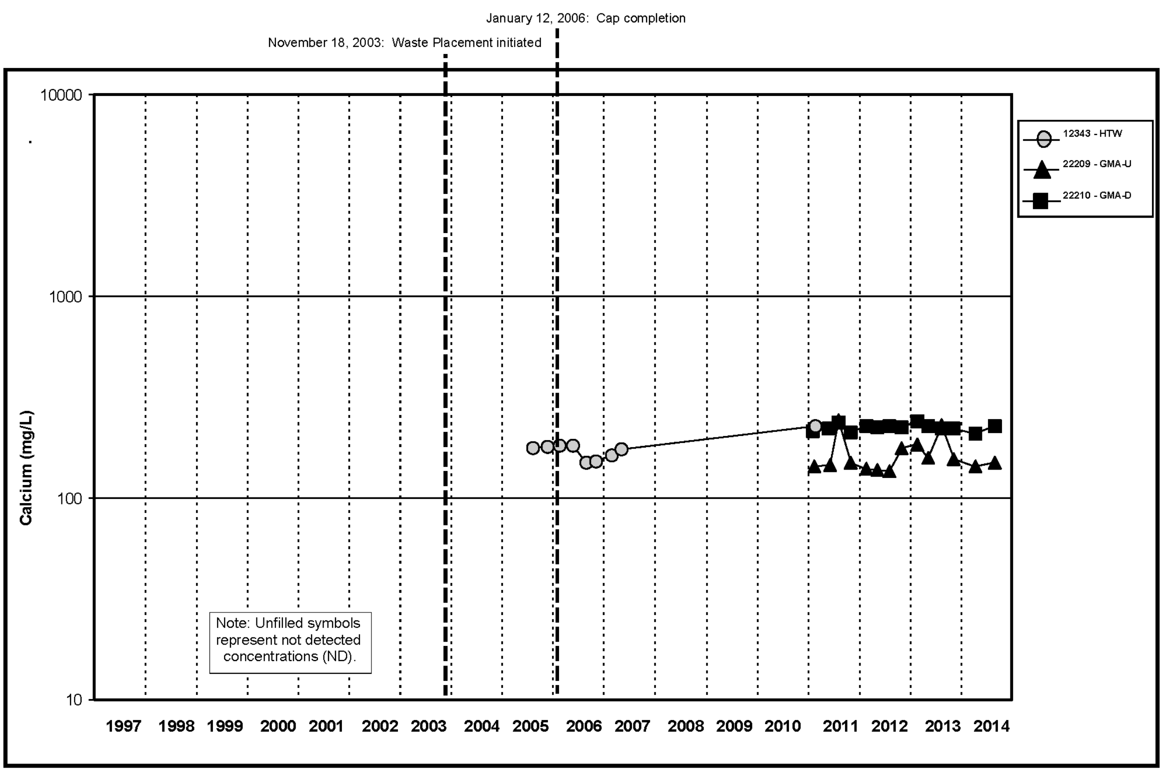


Figure A.5.6-18B. Cell 6 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

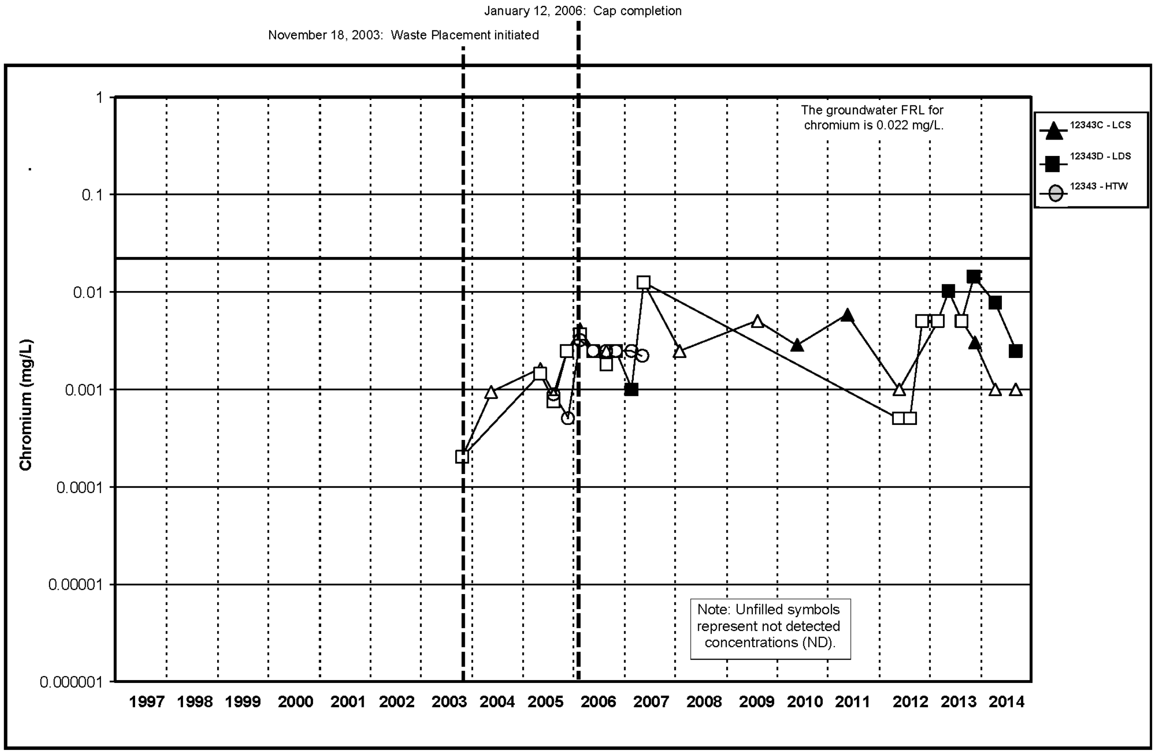


Figure A.5.6-19A. Cell 6 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

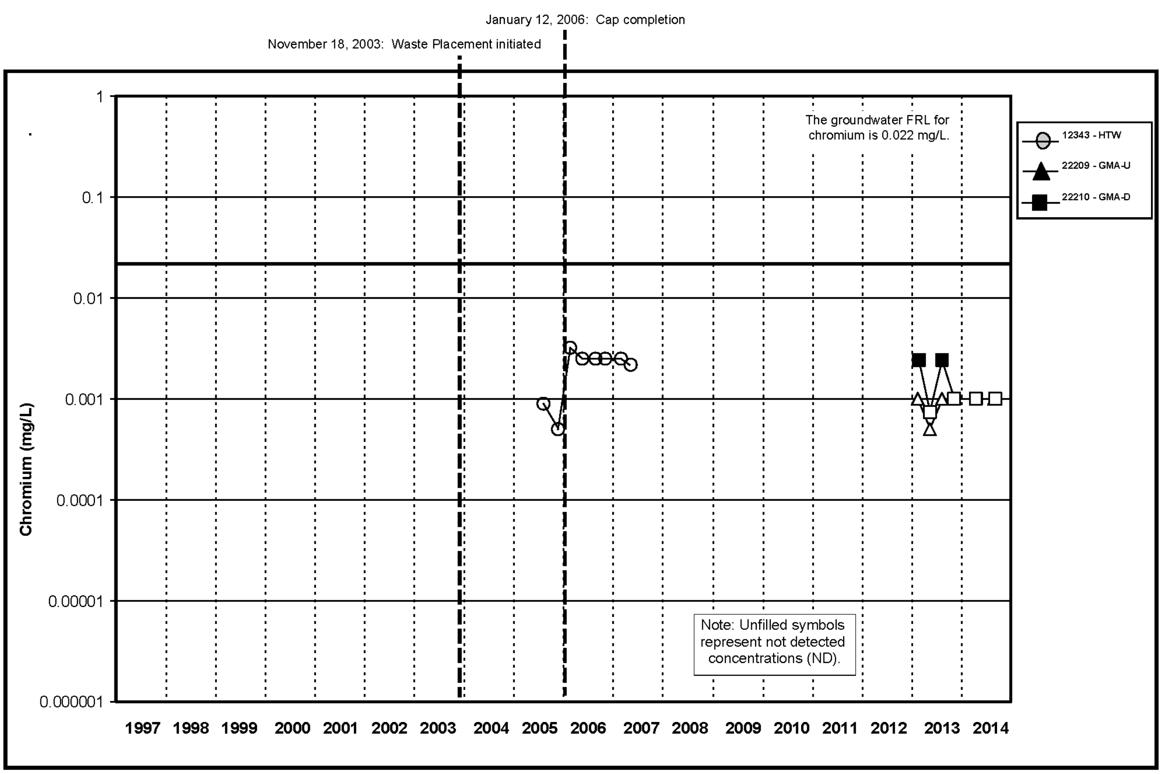


Figure A.5.6-19B. Cell 6 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

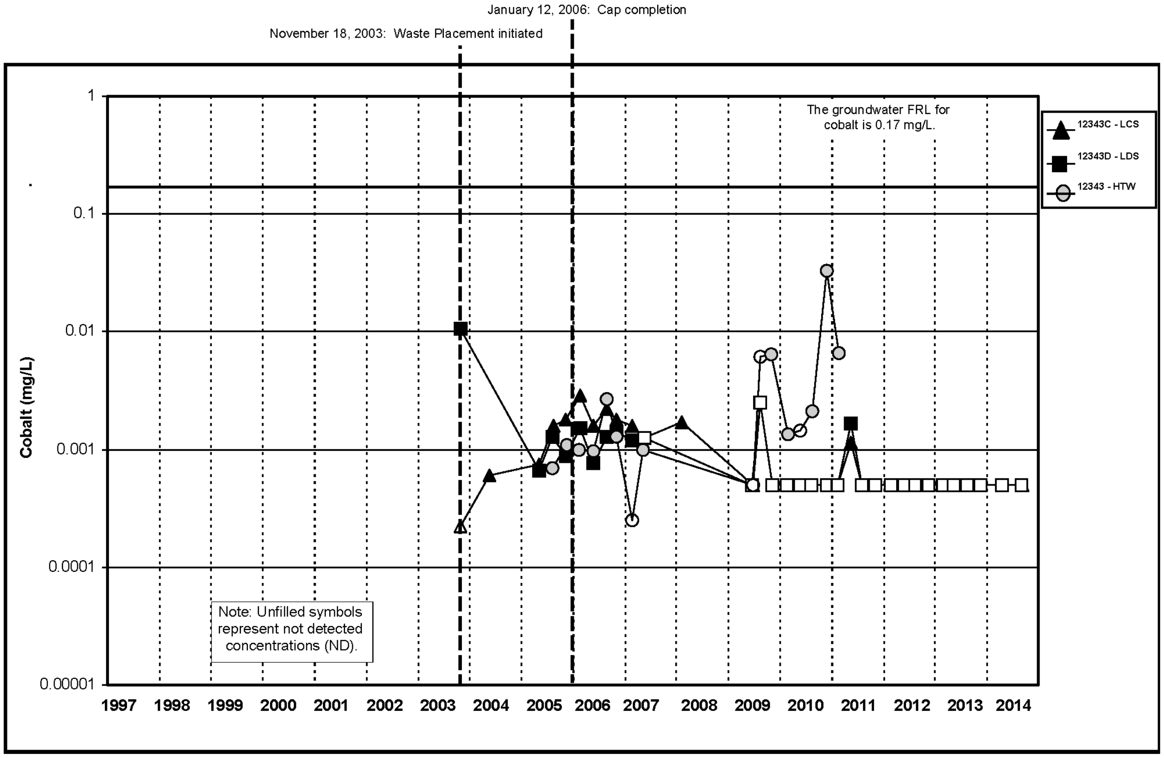


Figure A.5.6-20A. Cell 6 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

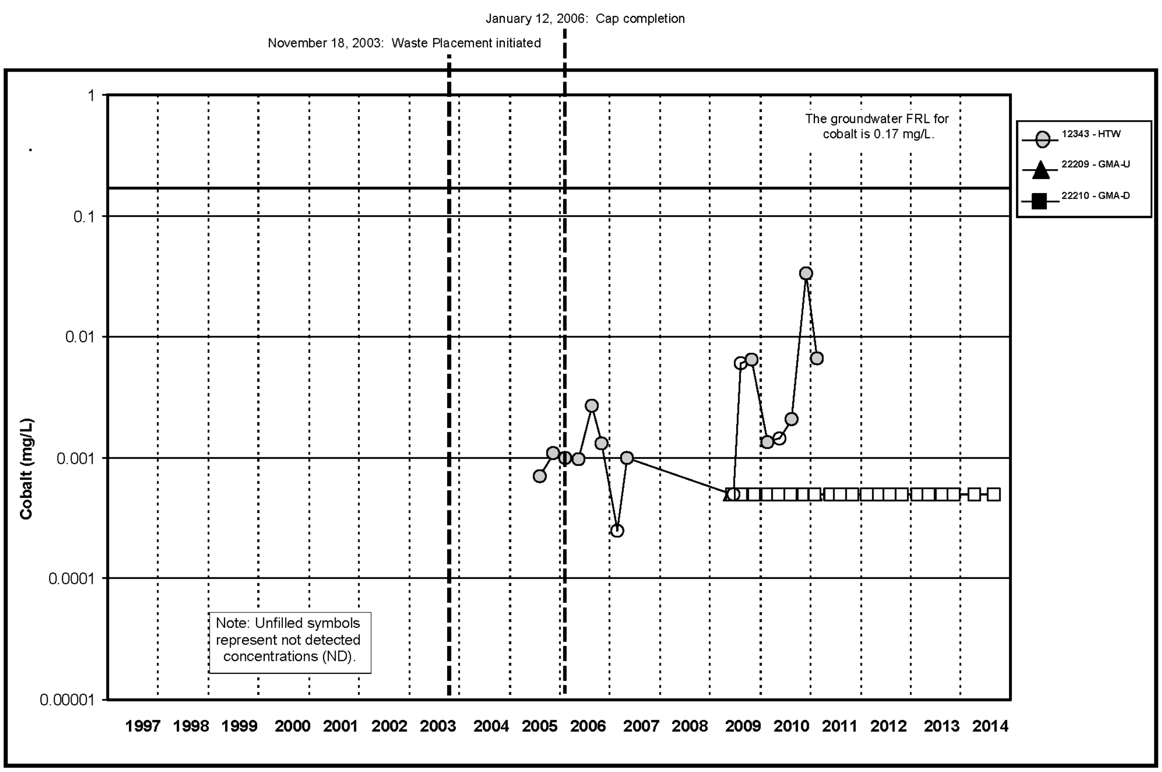


Figure A.5.6-20B. Cell 6 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

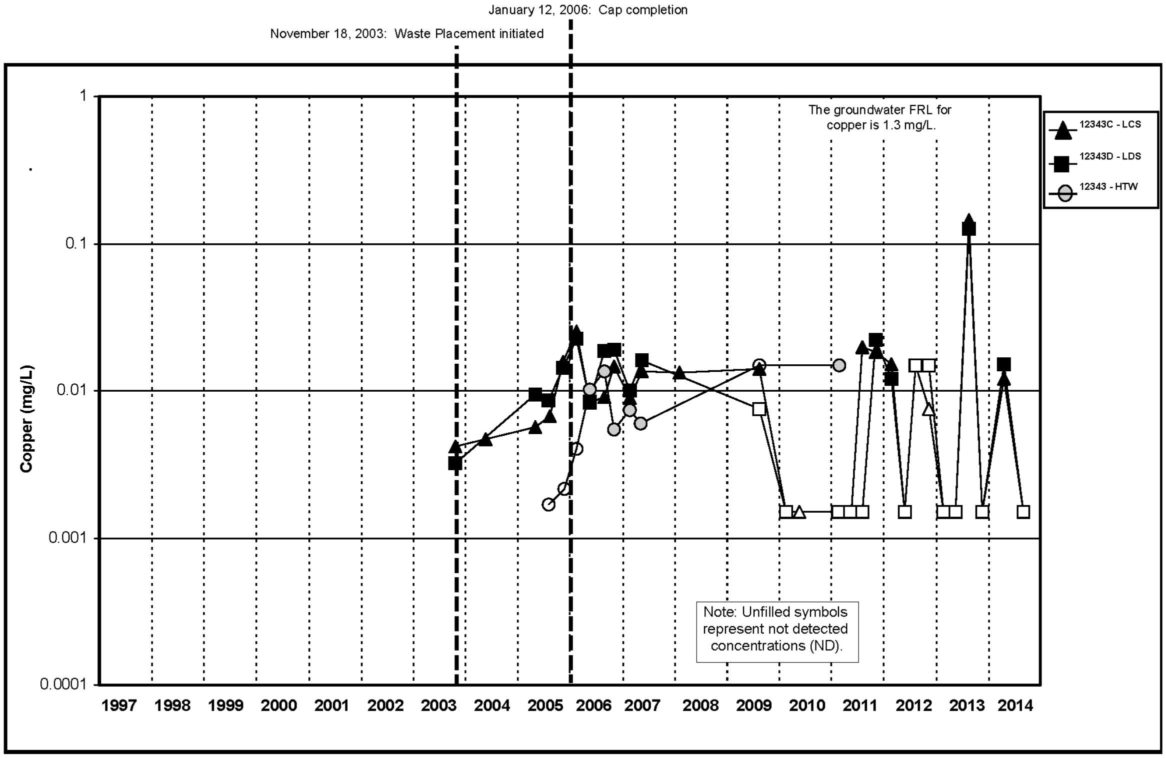


Figure A.5.6-21A. Cell 6 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

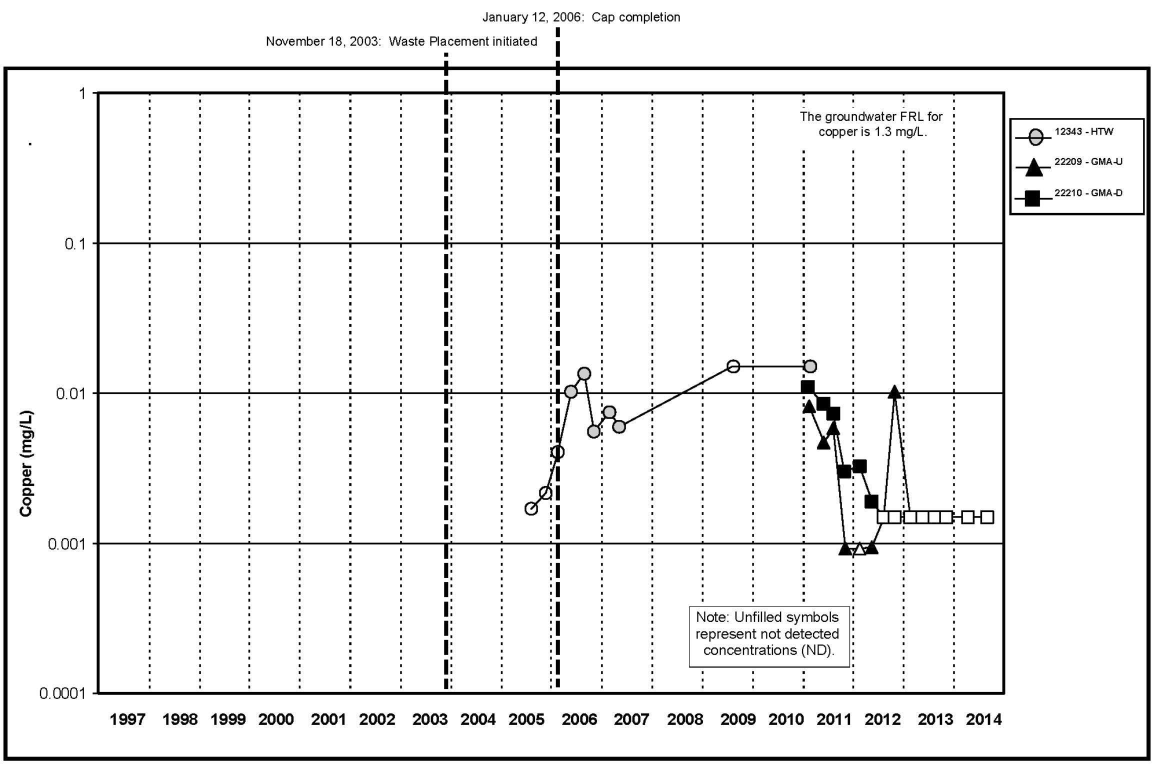


Figure A.5.6-21B. Cell 6 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

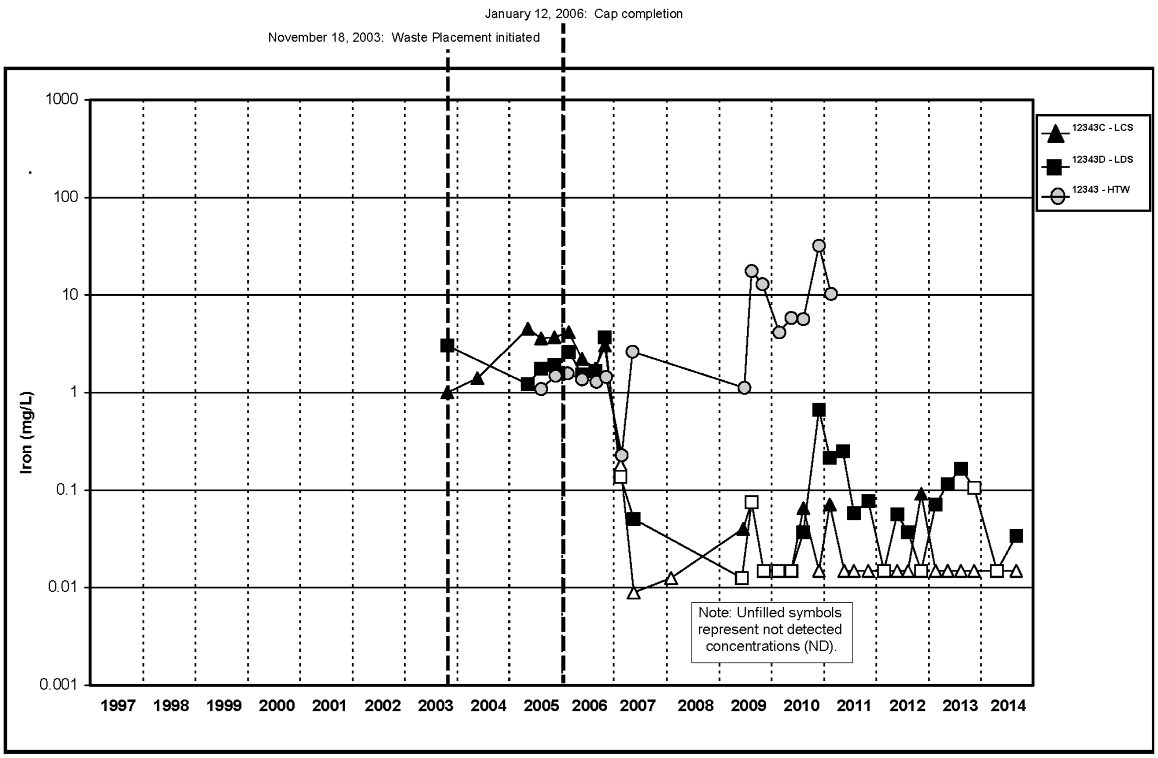


Figure A.5.6-22A. Cell 6 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

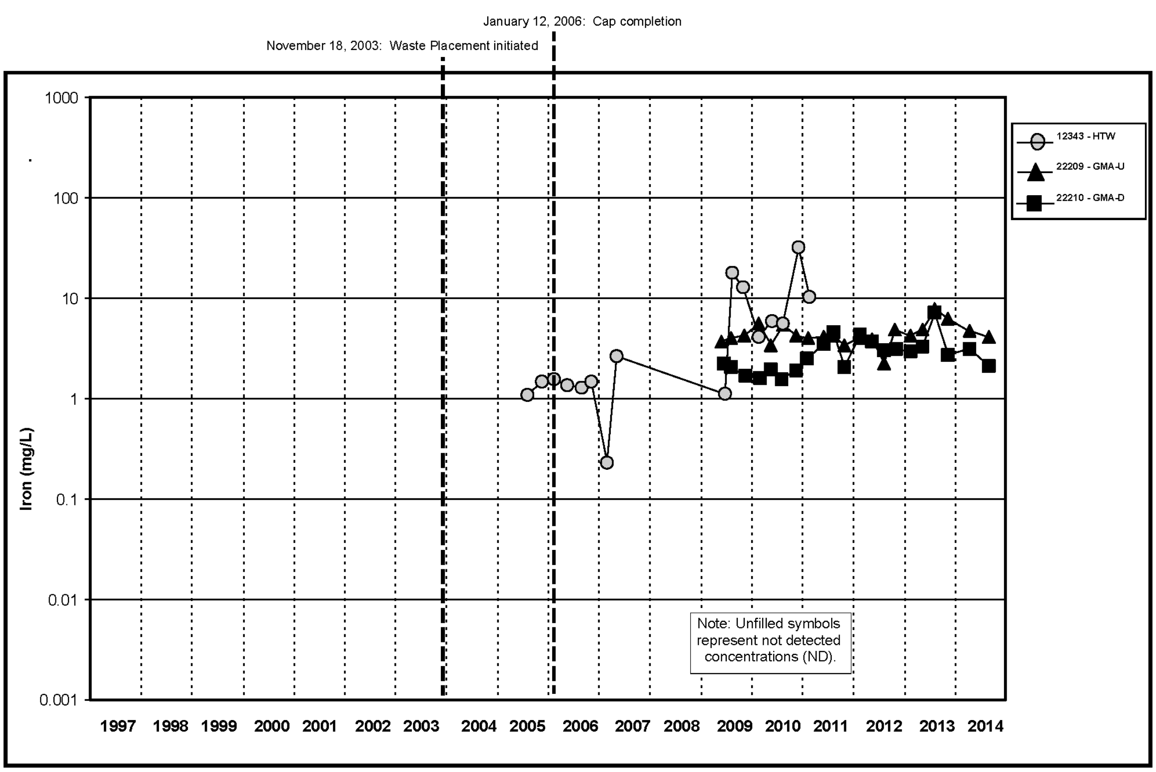


Figure A.5.6-22B. Cell 6 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

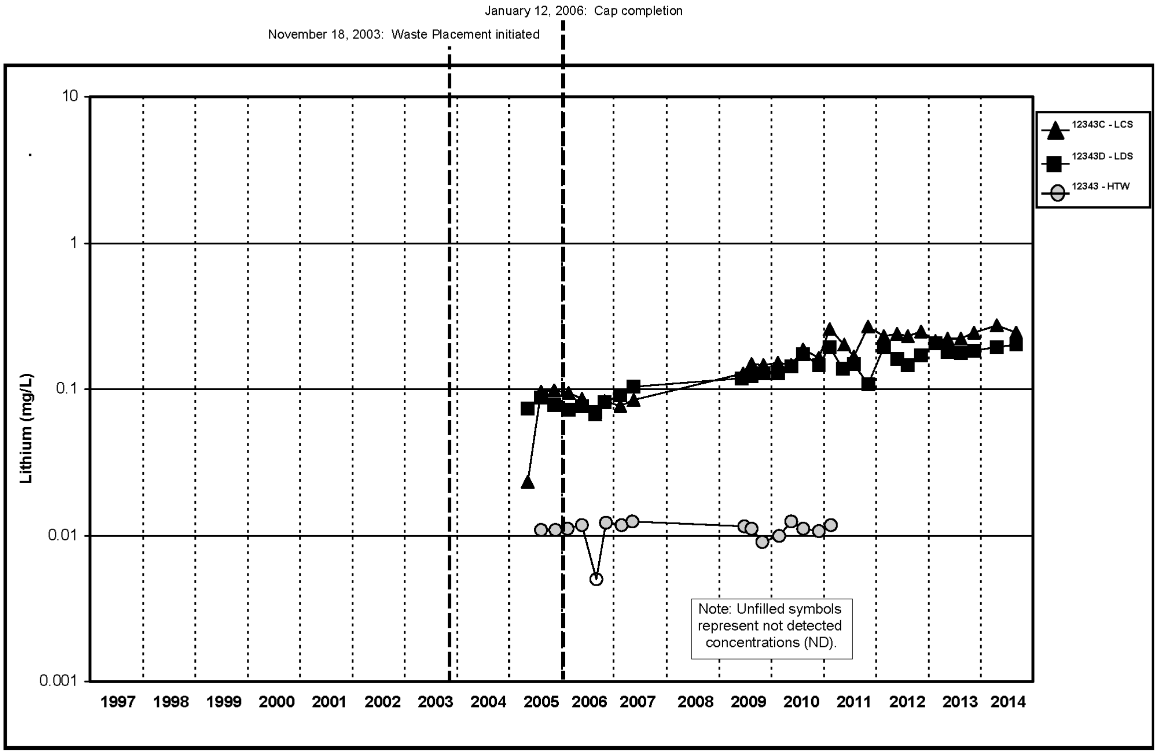


Figure A.5.6-23A. Cell 6 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

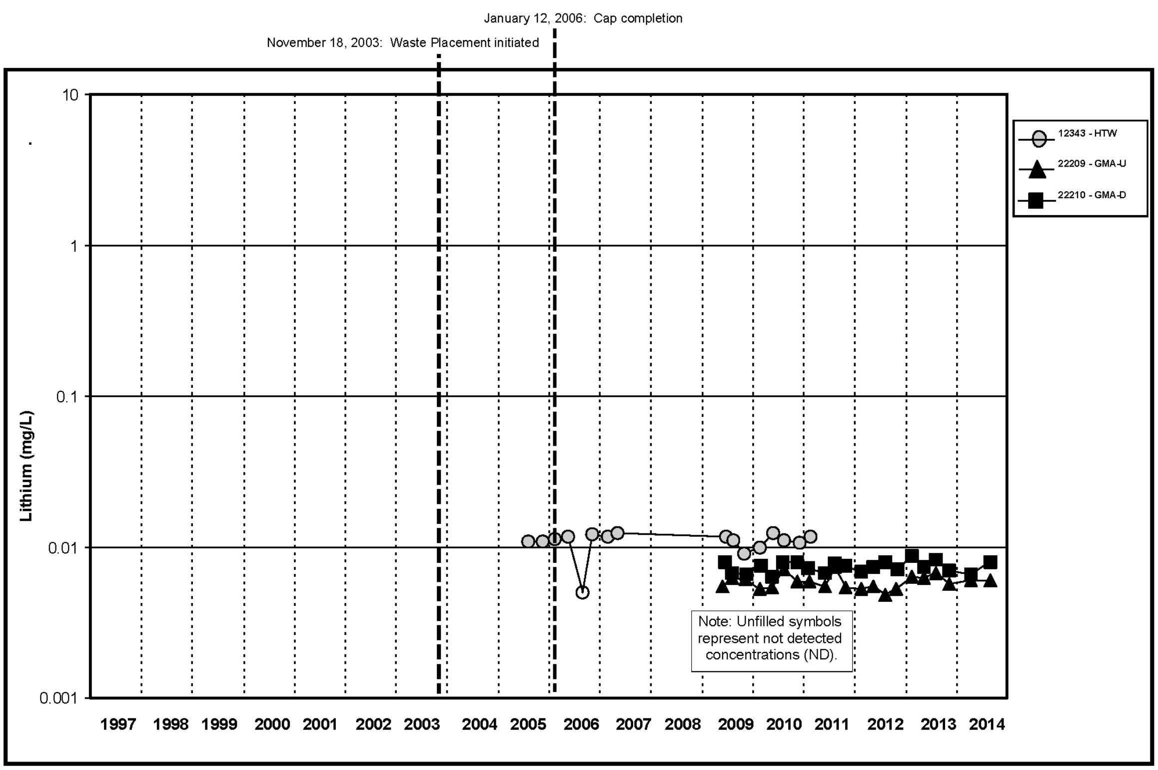


Figure A.5.6-23B. Cell 6 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

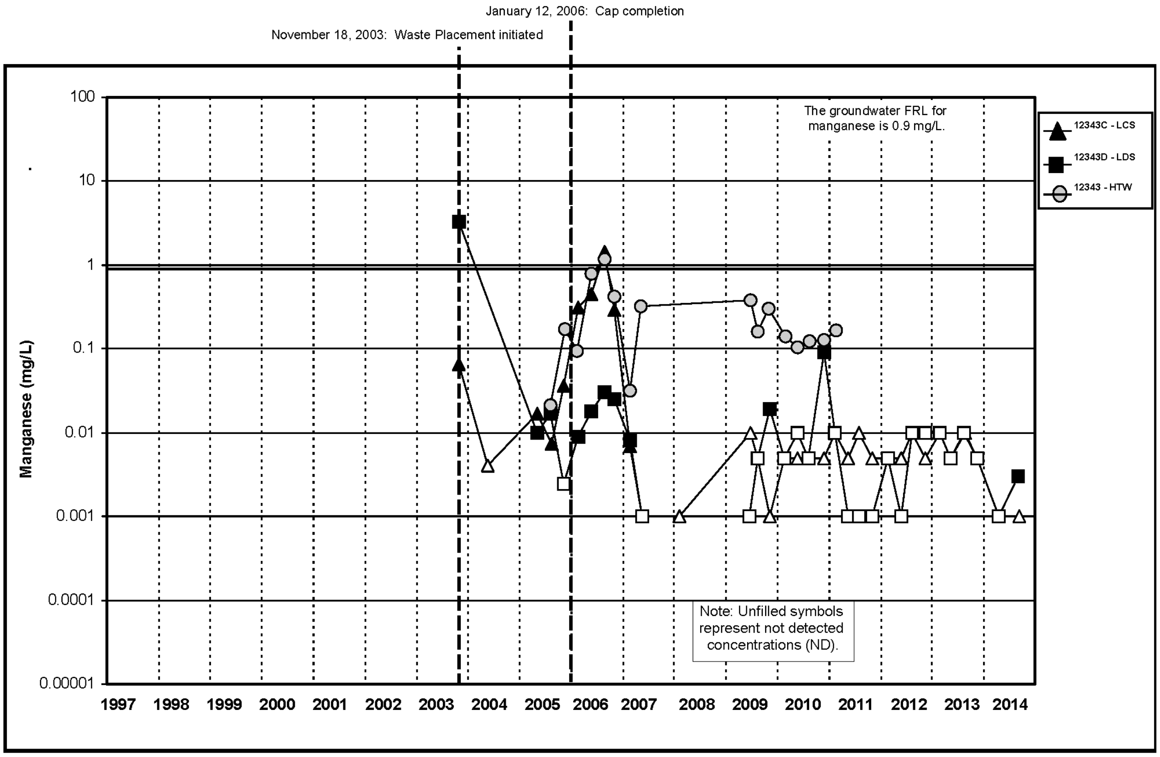


Figure A.5.6-24A. Cell 6 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

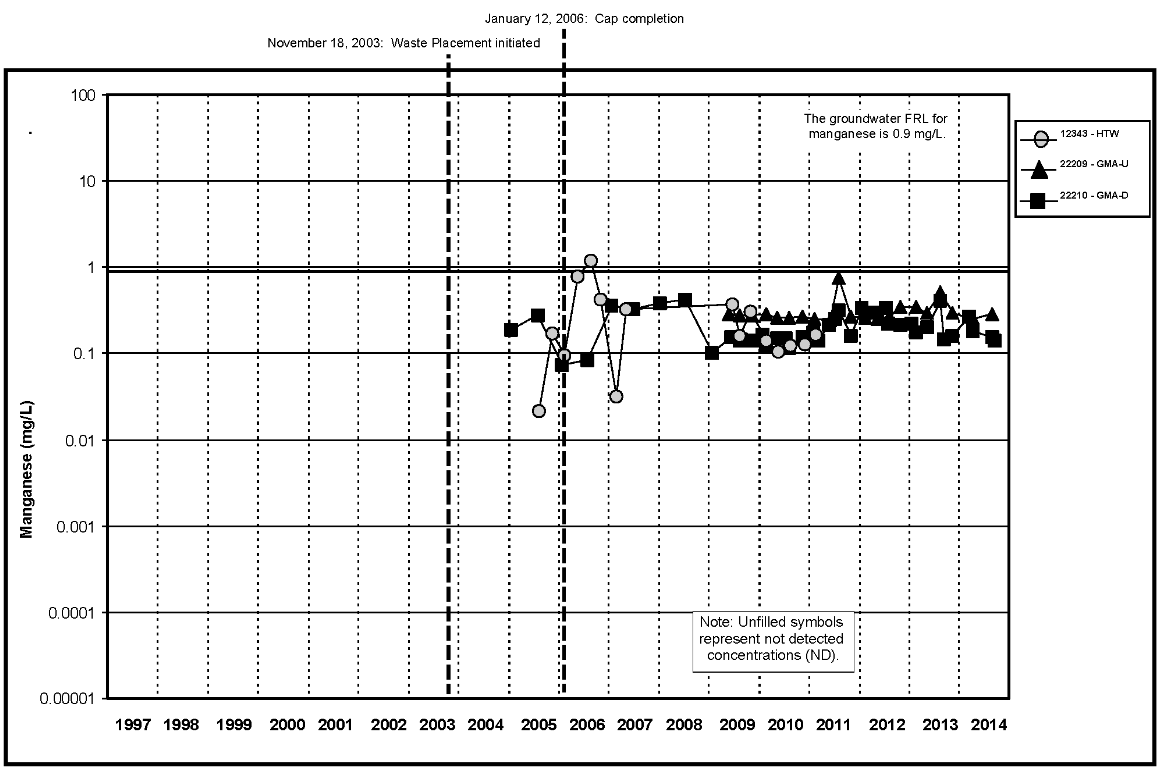


Figure A.5.6-24B. Cell 6 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

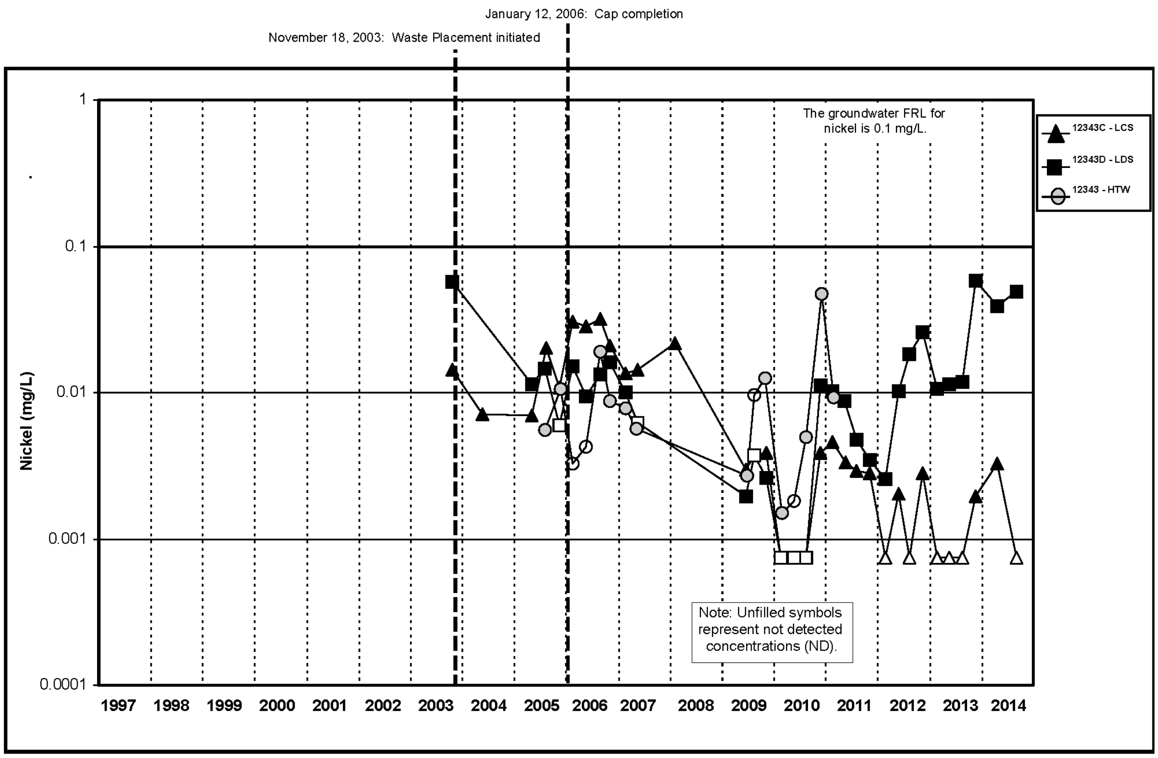


Figure A.5.6-25A. Cell 6 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

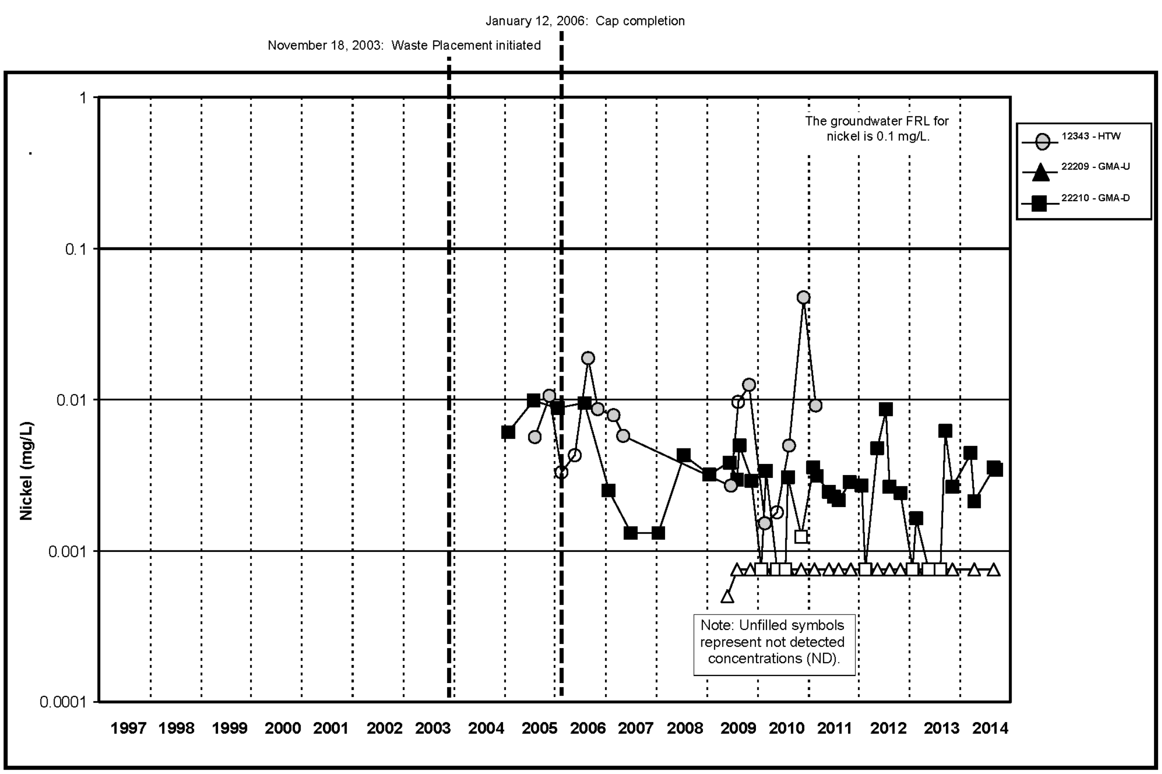


Figure A.5.6-25B. Cell 6 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

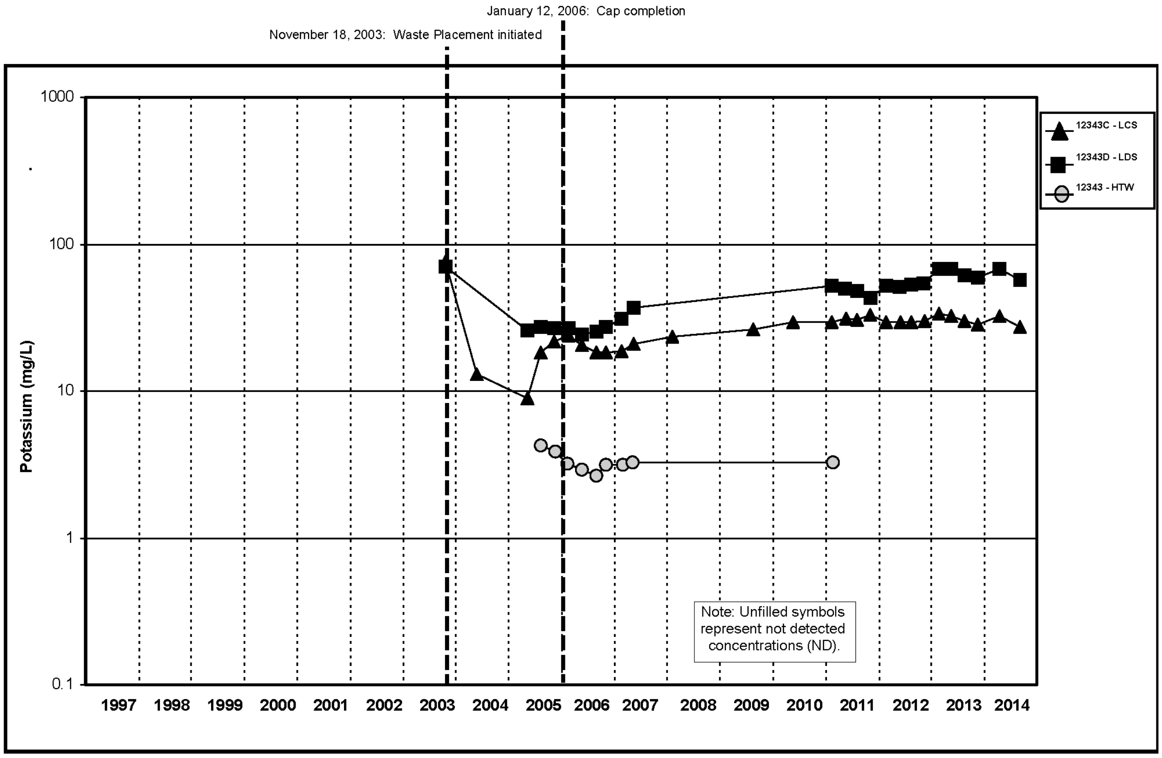


Figure A.5.6-26A. Cell 6 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

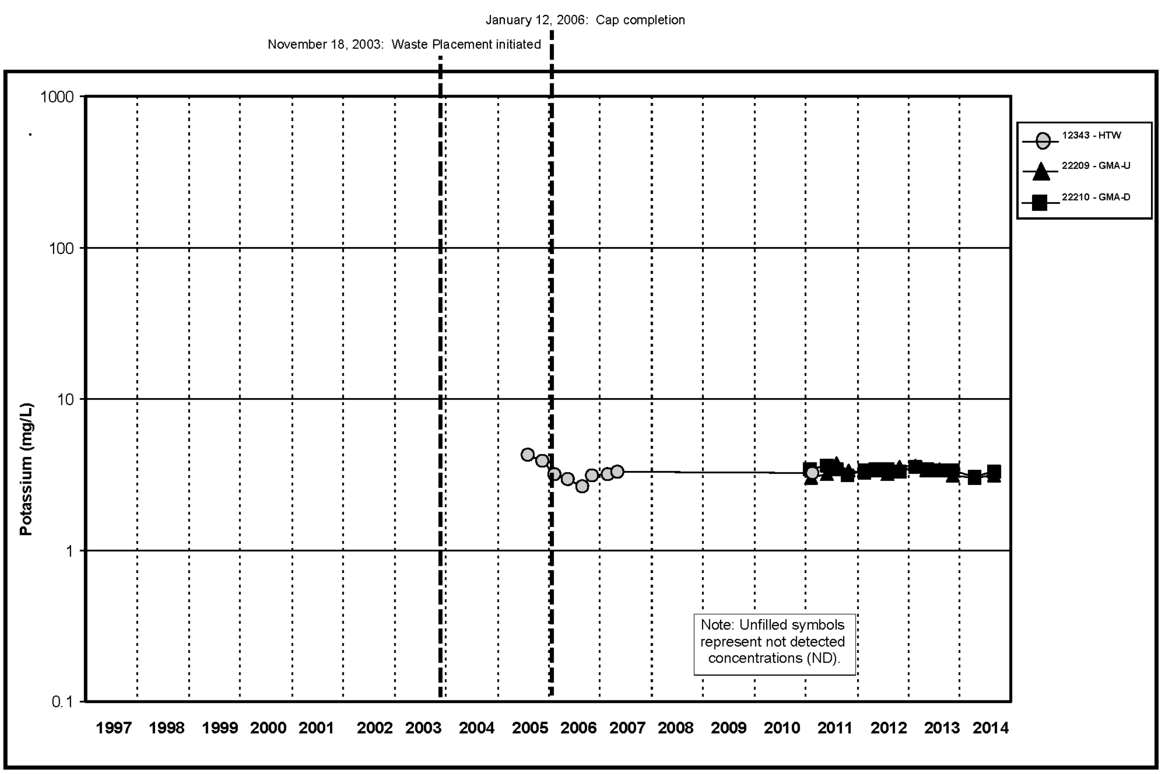


Figure A.5.6-26B. Cell 6 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

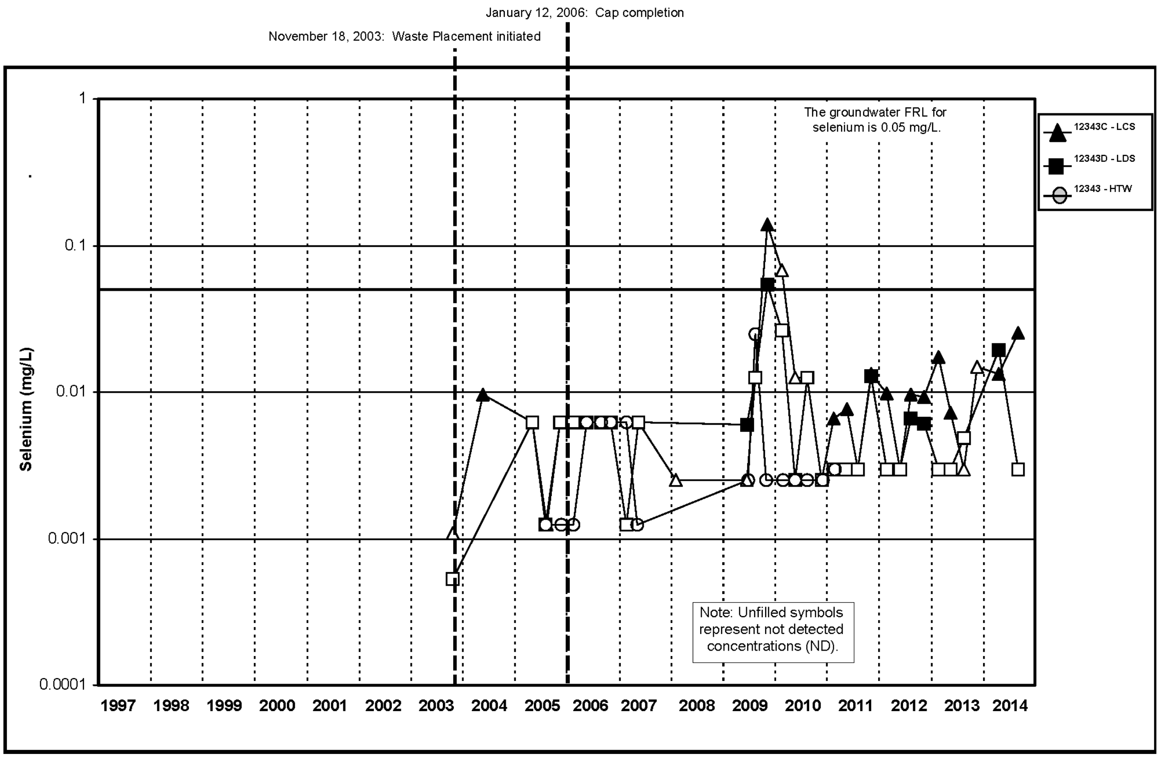


Figure A.5.6-27A. Cell 6 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

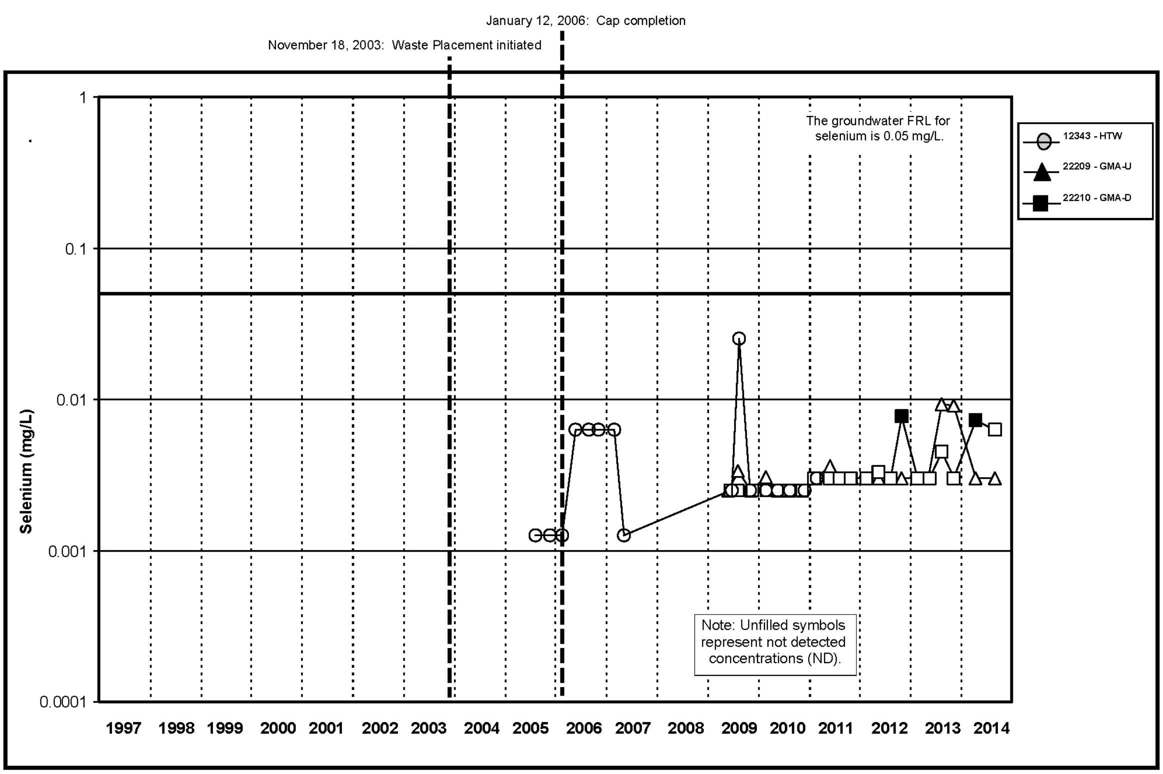


Figure A.5.6-27B. Cell 6 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

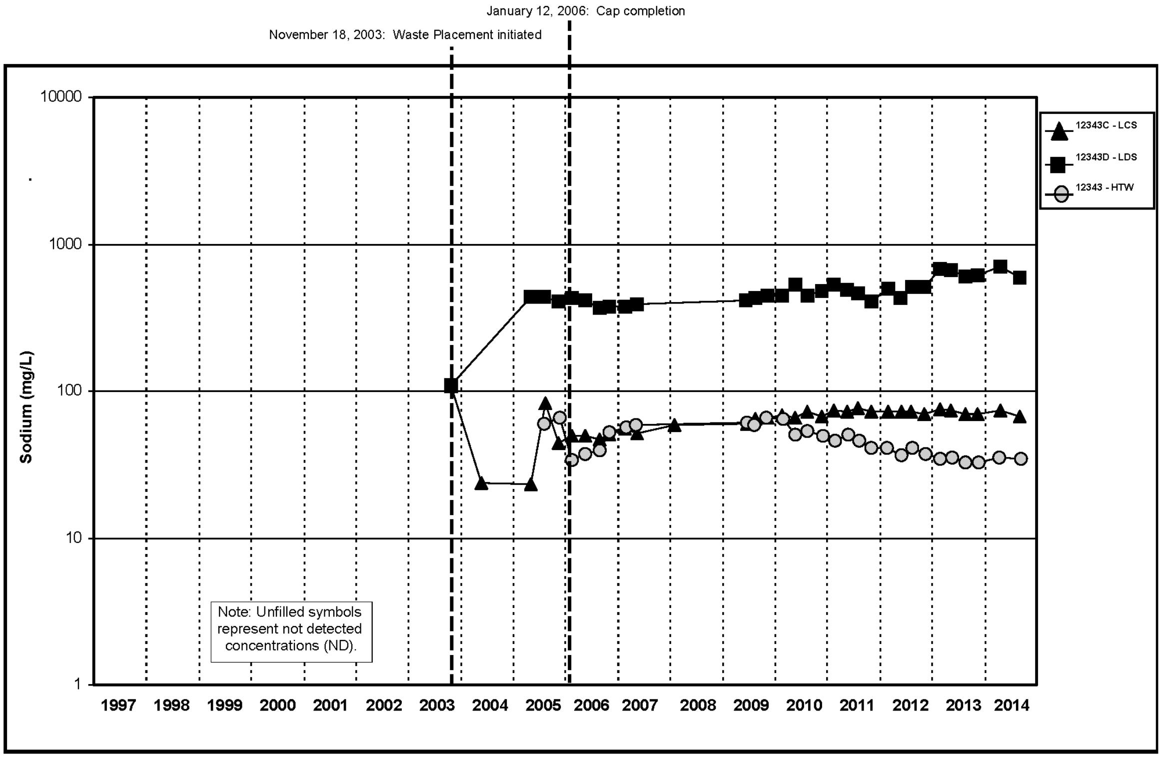


Figure A.5.6-28A. Cell 6 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

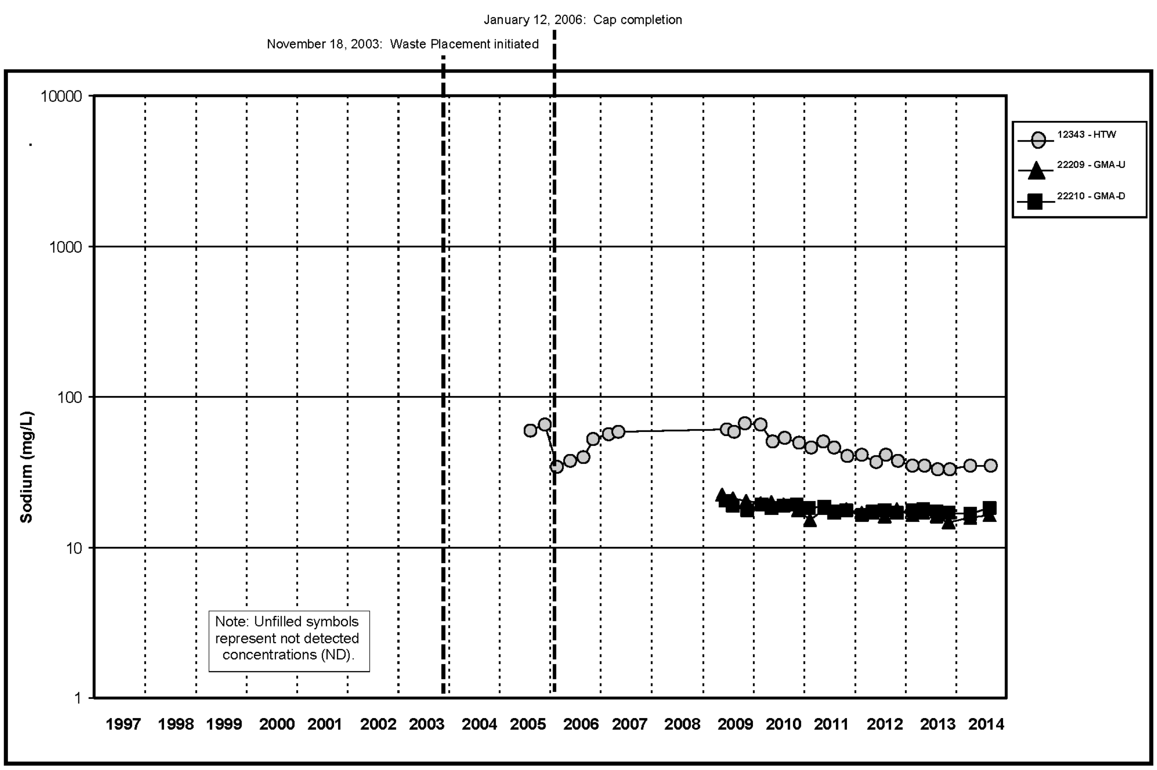


Figure A.5.6-28B. Cell 6 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

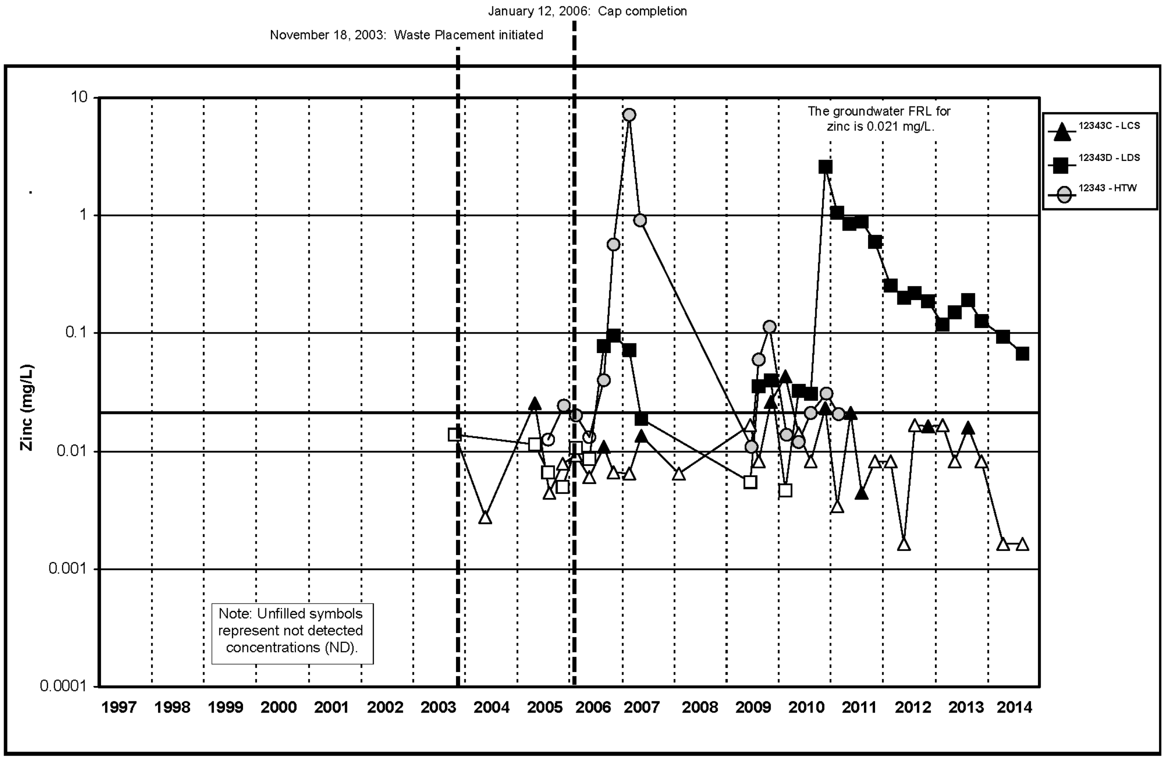


Figure A.5.6-29A. Cell 6 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

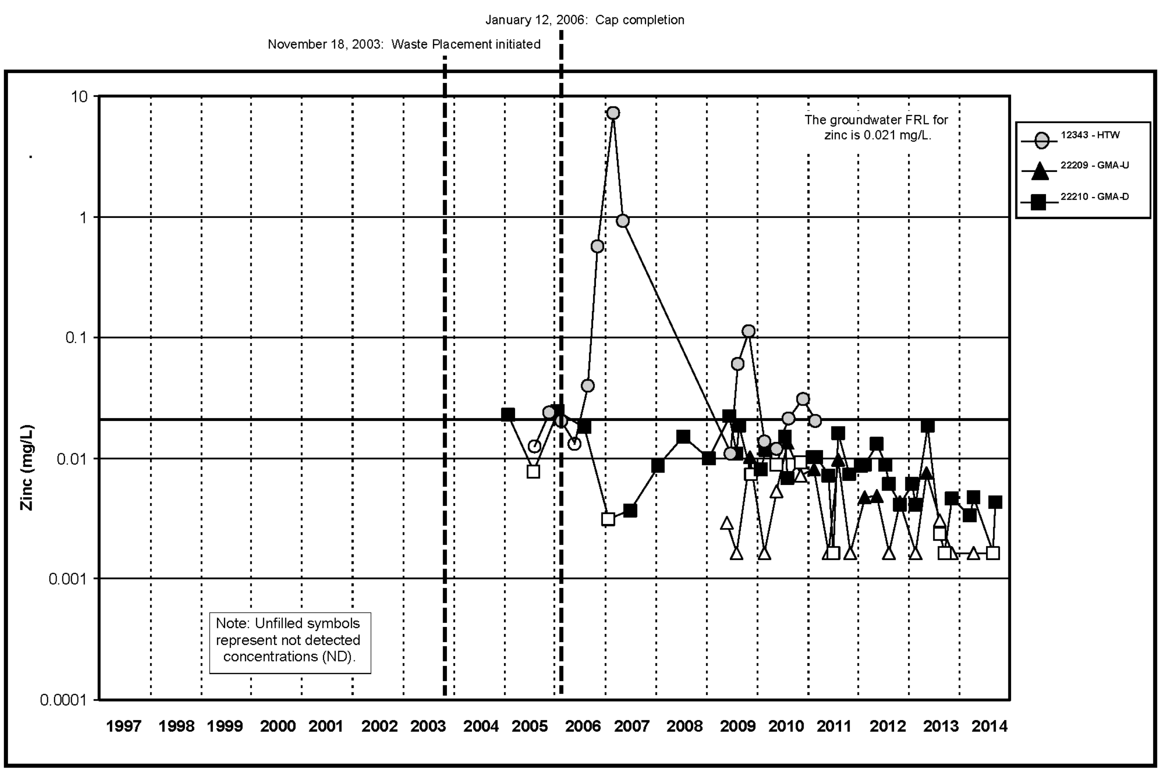


Figure A.5.6-29B. Cell 6 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

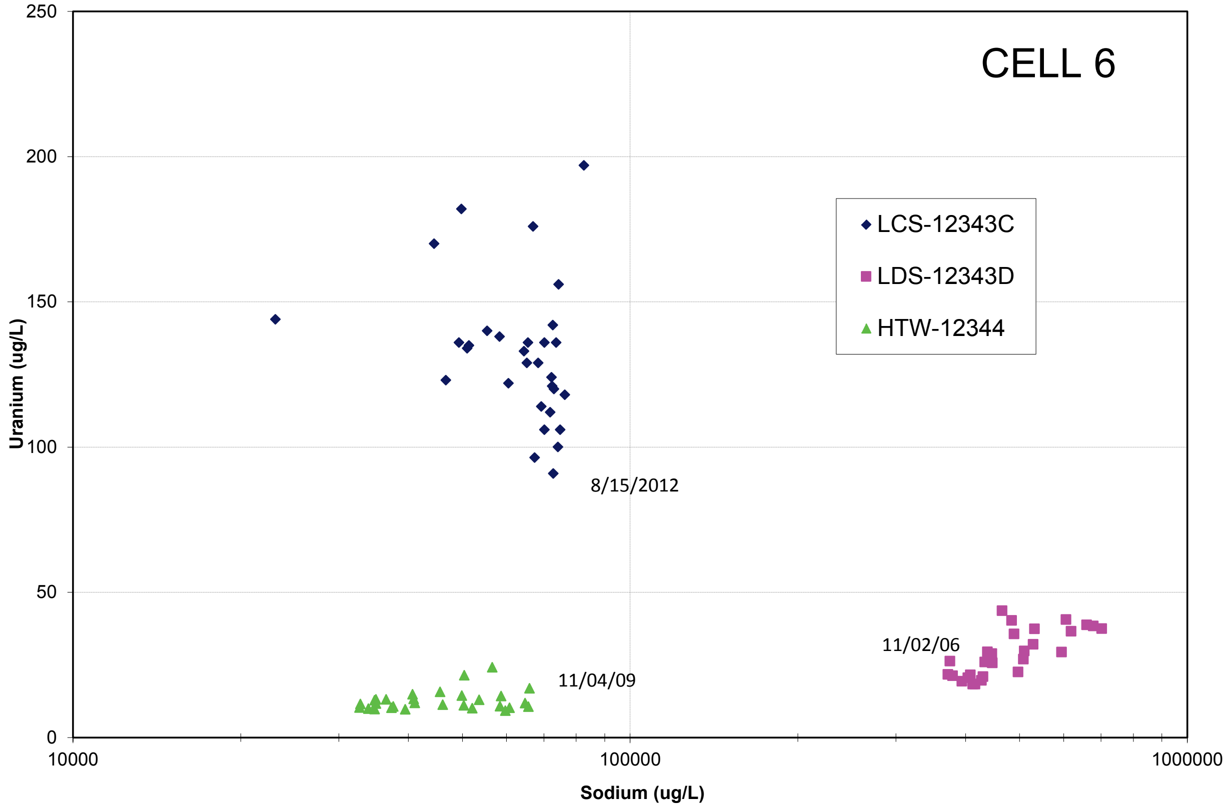


Figure A.5.6-30. Cell 6 Bivariate Plot for Uranium and Sodium

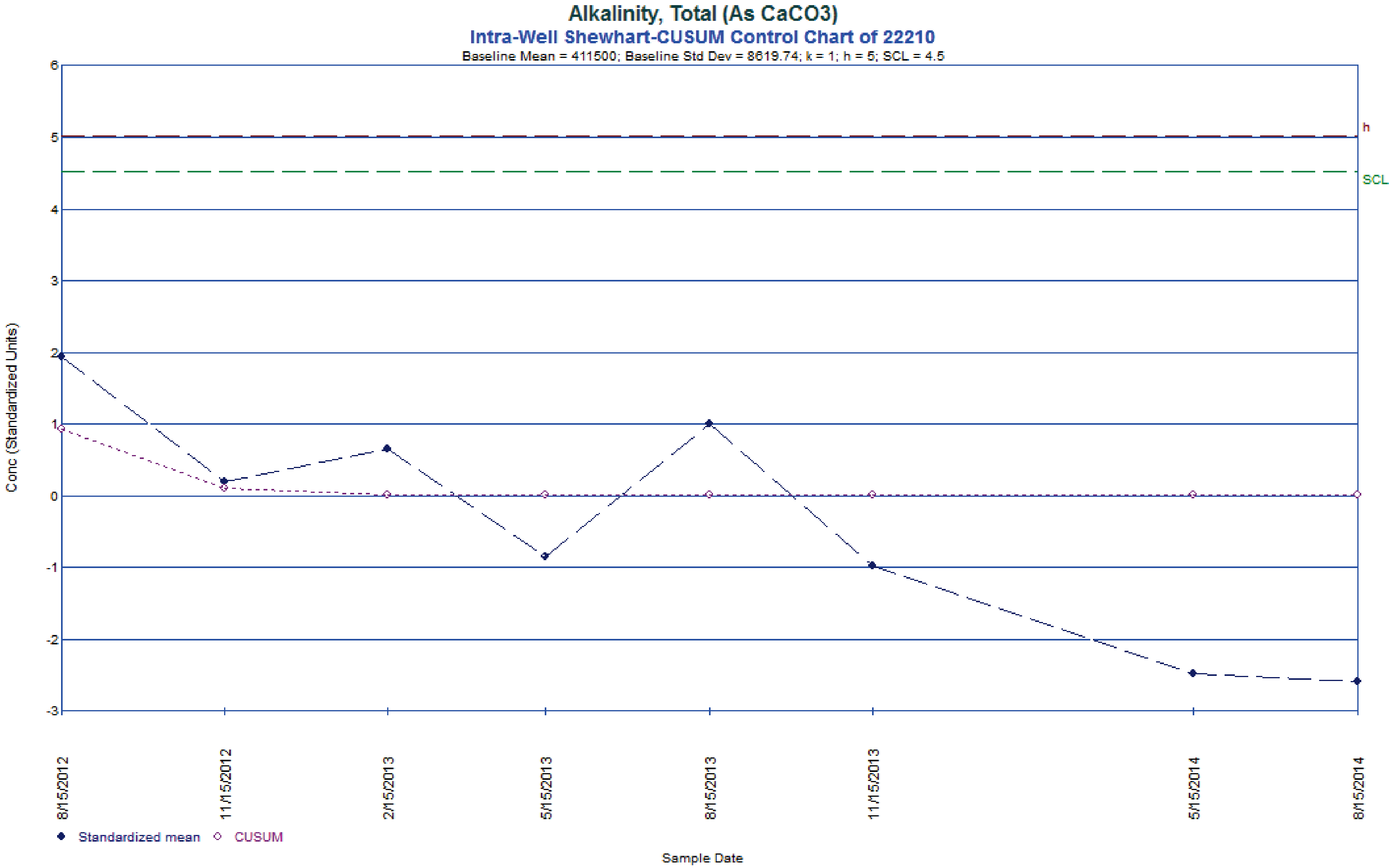


Figure A.5.6-31. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22210)

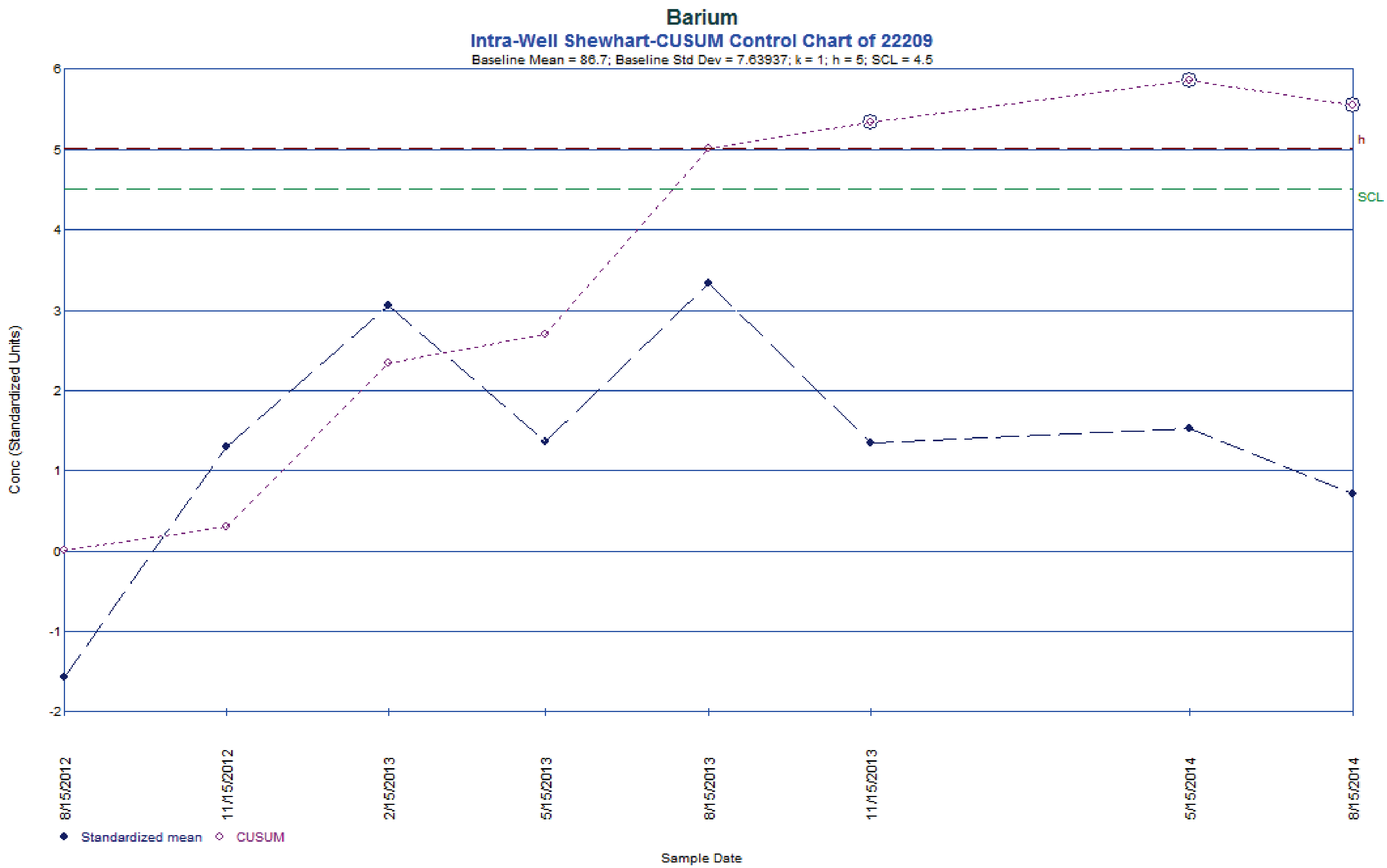


Figure A.5.6-32. Intra-Well Shewhart-CUSUM Control Chart (Barium 22209)

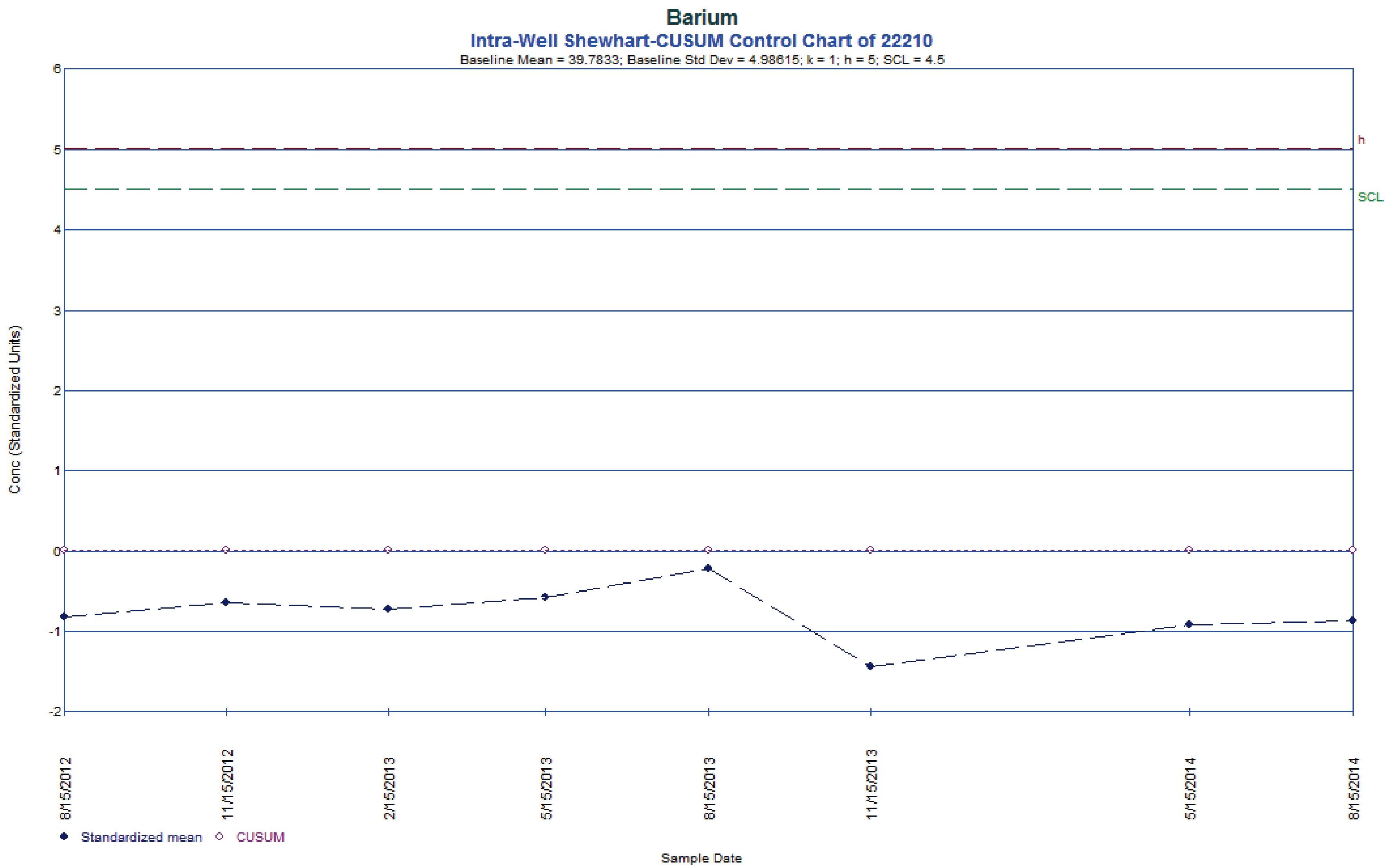


Figure A.5.6-33. Intra-Well Shewhart-CUSUM Control Chart (Barium 22210)

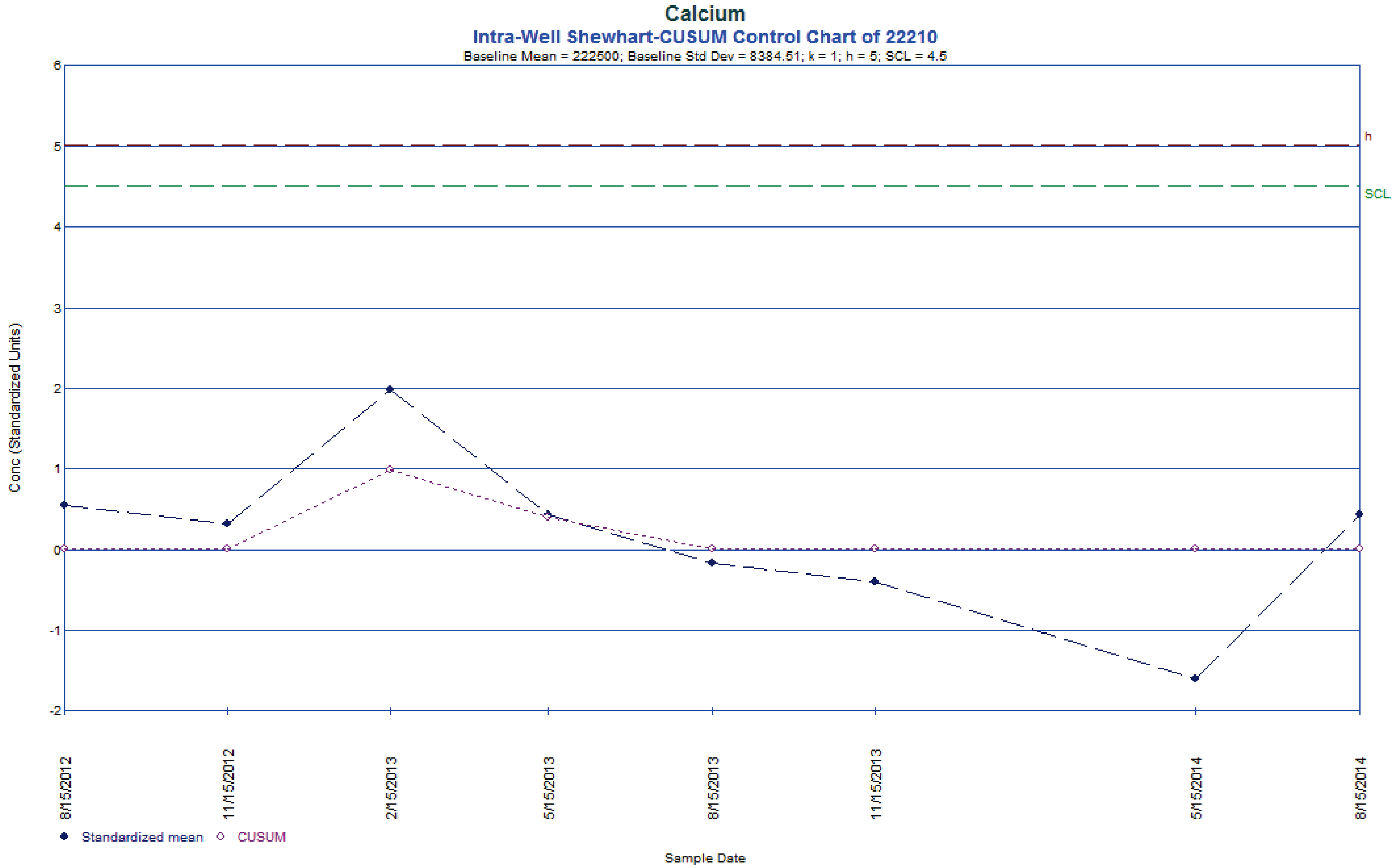


Figure A.5.6-34. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22210)

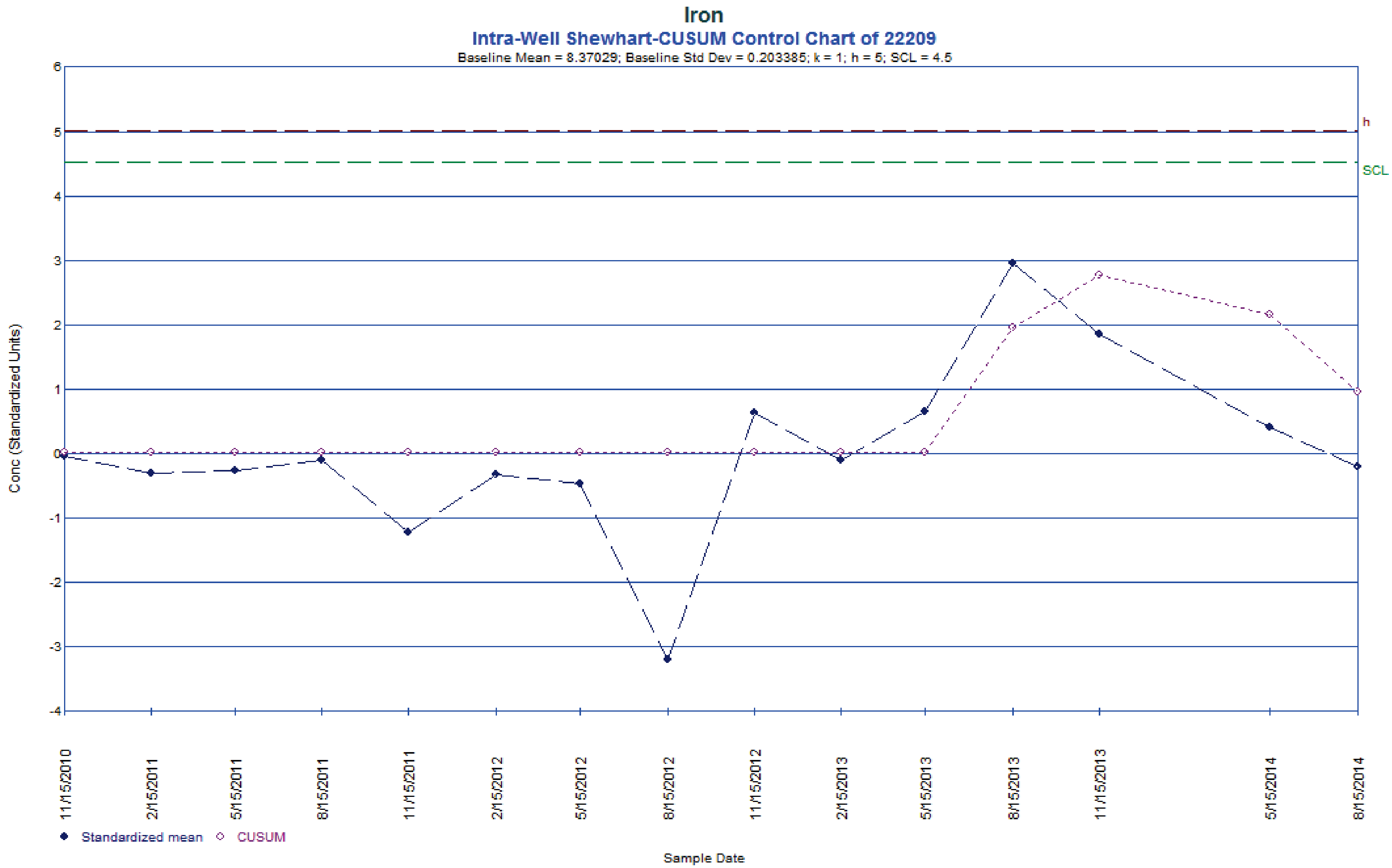


Figure A.5.6-35. Intra-Well Shewhart-CUSUM Control Chart (Iron 22209)

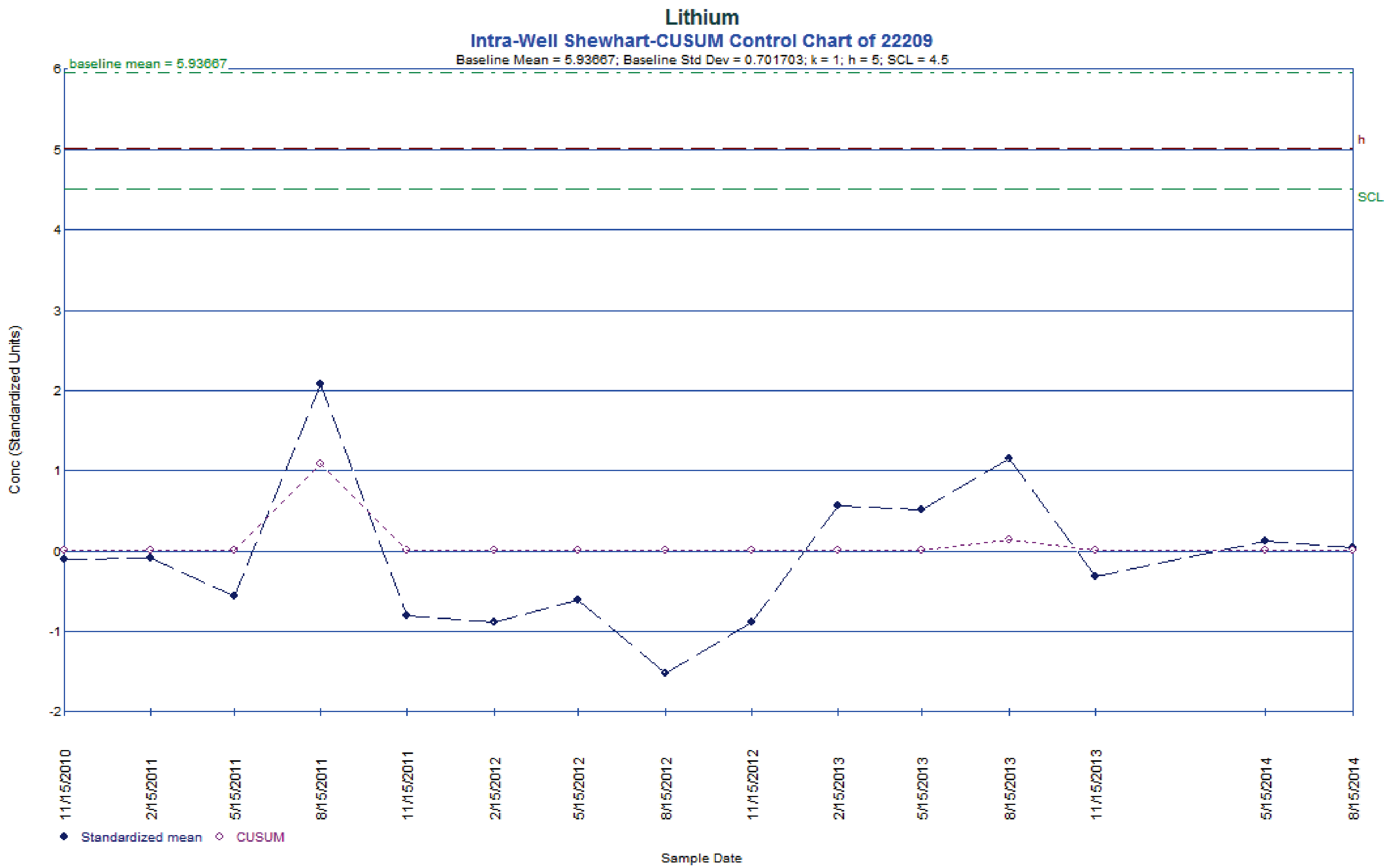


Figure A.5.6-36. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22209)

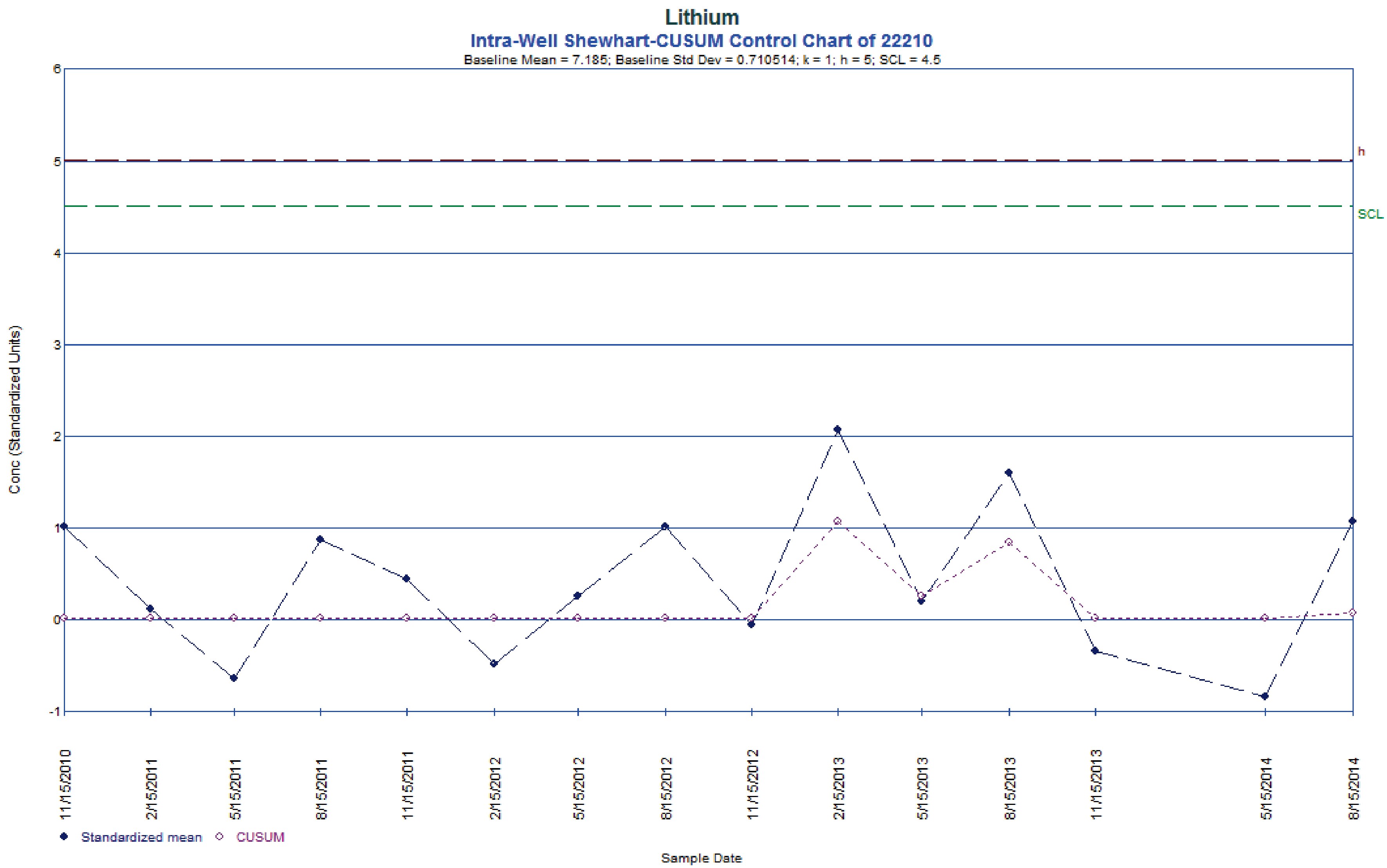


Figure A.5.6-37. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22210)

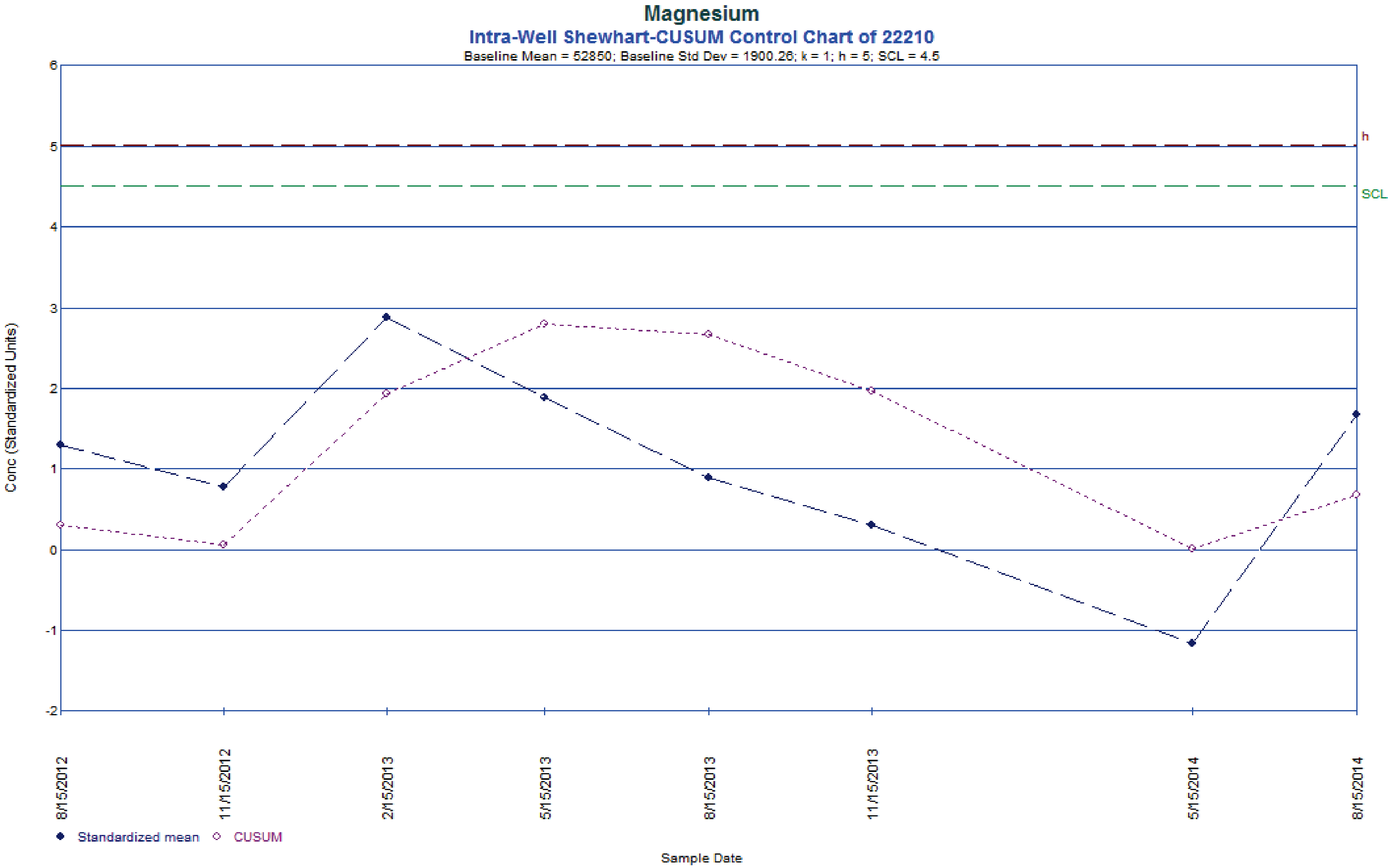


Figure A.5.6-38. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22210)

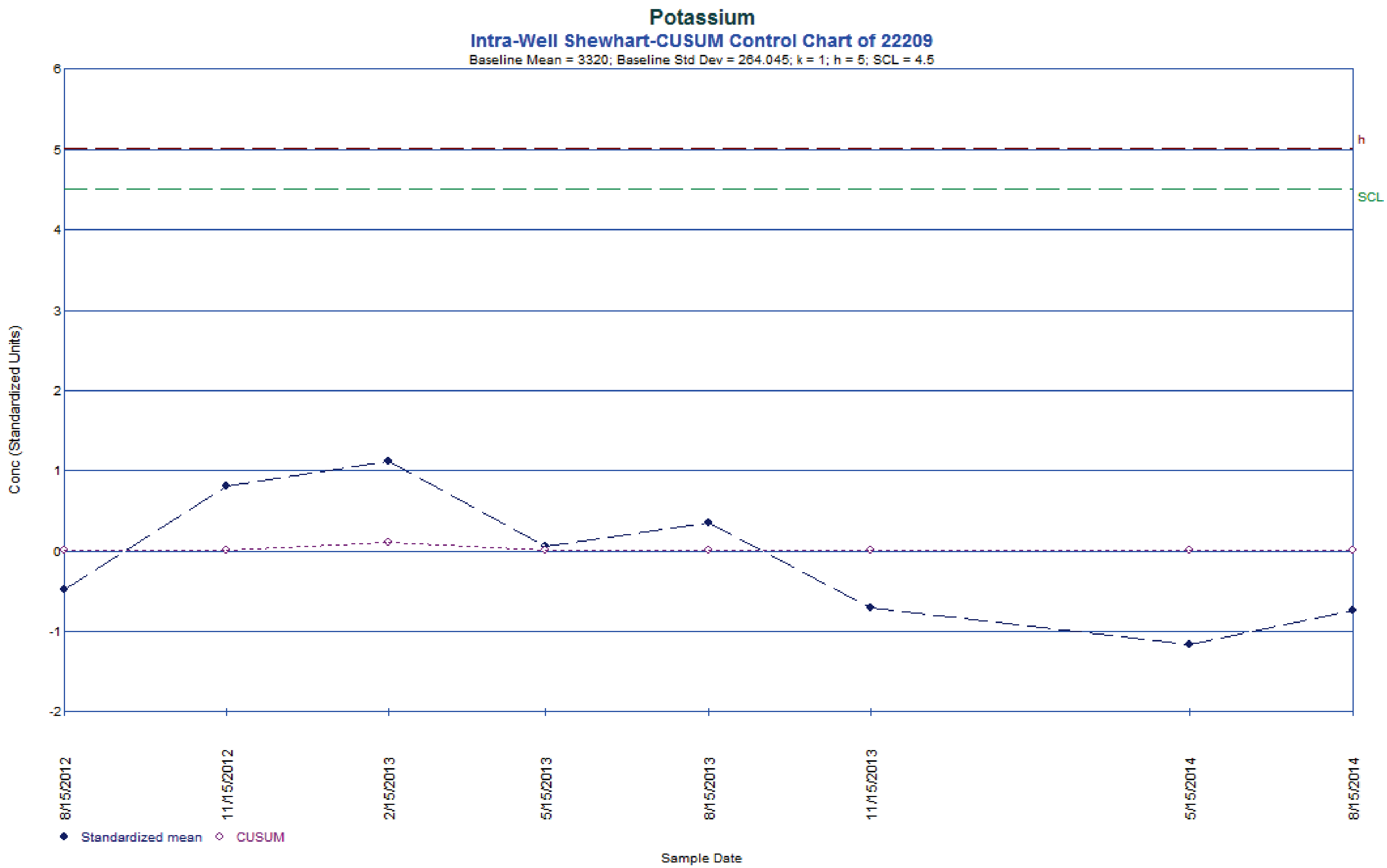


Figure A.5.6-39. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22209)

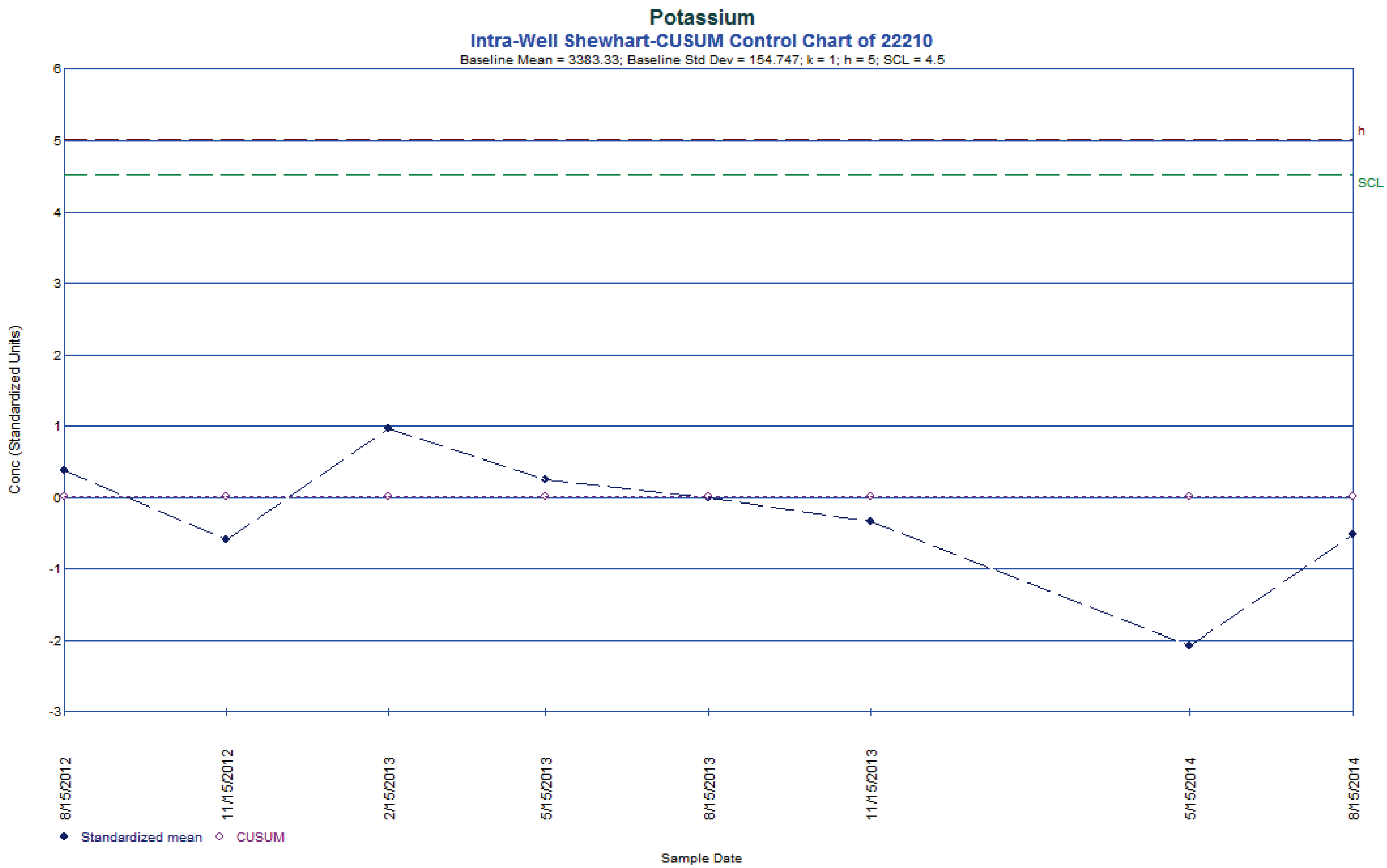


Figure A.5.6-40. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22210)

Sub-attachment A.5.7

Cell 7

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Contents

Tables

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Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system
LDS	leak detection system
OSDF	On-Site Disposal Facility
PCB	polychlorinated biphenyl
SCL	Shewhart control limit
TOC	total organic carbon

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.7-1)
- Annual leachate collection system (LCS) sample summary information for detected parameters (refer to Table A.5.7-2)
- LCS monthly accumulation volumes (refer to Figure A.5.7-1)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.7-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12344 water yield (refer to Figure A.5.7-3)
- Great Miami Aquifer (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 through A.5.7-29B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.7-30)
- Control charts (refer to Figures A.5.7-31 through A.5.7-45)

A.5.7.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. The Cell 7 LDS was dry all of 2012 and 2013, but contained enough water to be sampled in 2014. Summary statistics are provided in Table A.5.7-1.

As shown in Table A.5.7-1, and summarized below, seven of the 24 constituents sampled semiannually in the LCS, LDS, HTW, and GMA wells (uranium, alkalinity, chloride, sulfate, total organic carbon [TOC], boron, and selenium) have upward concentration trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

The (uranium-sodium) bivariate plot for the Cell 7 LCS, LDS, and HTW is provided in Figure A.5.7-30. 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 beneath Cell 7 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 7

Parameter	HTW 12344	GMA-U[a] 22212	GMA-D[a] 22211
Total Uranium	Up		
Alkalinity		Up	
Chloride		Up	
Sulfate			Up
Total Organic Carbon		Up	Up
Boron		Up	Up
Selenium		Up	Up

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

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 Shewhart-cumulative sum (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 "not in control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart control limit (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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.7-1 in gray shading, 11 constituents in the HTW and GMA wells of Cell 7 (alkalinity, chloride, total dissolved solids, barium, calcium, iron, lithium, magnesium, potassium, sodium, and zinc) meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 15 control charts.

Parameter	Monitoring Point[a]	Monitoring Well	Assessment	Figure Number
Alkalinity	GMA-D	22211	In Control	A.5.7-31
Chloride	GMA-D	22211	In Control	A.5.7-32
Total Dissolved Solids	GMA-D	22211	In Control	A.5.7-33
Barium	GMA-U	22212	In Control	A.5.7-34
Barium	GMA-D	22211	In Control	A.5.7-35
Calcium	GMA-U	22212	In Control	A.5.7-36
Calcium	GMA-D	22211	In Control	A.5.7-37
Iron	GMA-U	22212	In Control	A.5.7-38
Lithium	GMA-D	22211	In Control	A.5.7-39
Magnesium	GMA-U	22212	In Control	A.5.7-40
Magnesium	GMA-D	22211	In Control	A.5.7-41
Potassium	GMA-U	22212	In Control	A.5.7-42
Potassium	GMA-D	22211	In Control	A.5.7-43
Sodium	GMA-D	22211	In Control	A.5.7-44
Zinc	GMA-D	22211	In Control	A.5.7-45

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

The control charts are presented in Figures A.5.7-31 through A.5.7-45. All of the control charts exhibit “in control” conditions.

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 semiannually. No new Appendix I or polychlorinated biphenyl (PCB) parameters were detected in the LCS of Cell 7 in 2014.

A.5.7.4 Cell 7 LDS Sampling

In addition to the 24 parameters being sampled for quarterly in the LCS, LDS, and GMA wells, the Cell 7 LDS is also being sampled for 1,1-dichloroethene.

The constituent 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, triggering sampling in the LDS beginning in 2011. 1,1-dichloroethene has not been detected in the LCS of Cell 7 since 2011.

Sampled for twice in the LDS of Cell 7 in 2011, 1,1-dichloroethene was not detected in the LDS of Cell 7. The LDS of Cell 7 was dry in 2012 and 2013. In 2014, the LDS was sampled twice, and 1,1-dichloroethene was not detected.

A.5.7.5 Summary and Conclusions

- The Cell 7 LDS was dry in 2012 and 2013, but contained enough water to be sampled in 2014.
- Seven parameters monitored semiannually have an upward concentration trend in the HTW and/or GMA wells of Cell 7: uranium, alkalinity, chloride, sulfate, TOC, boron, and selenium.
- 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. Therefore, upward

concentration trends beneath Cell 7 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.

- Fifteen control charts were constructed for Cell 7 parameters. All of the control charts exhibit "in control" conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 7 in 2014.
- In 2014, the LDS was sampled twice; 1,1-dichloroethene was not detected.

A.5.7.6 References

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities -Unified Guidance*, EPA 530/R-09-007, March.

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trand[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12344C	39	39	100	4.72	355	167	54	Undefined	Down	Detected	
	LDS	12344D	29	29	100	12.2	169	29.8	27.3	Normal	None	Not Detected	
	HTW	12344	39	39	100	2.00	12.1	3.56	2.05	Undefined	Up	Detected	
	GMA-U	22212	38	41	92.7	ND	5.53	0.440	1.04	Undefined	None	Not Detected	
	GMA-D	22211	42	43	97.7	ND	2.62	0.330	0.572	Undefined	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12344C	27	27	100	86.0	822	480	151	Undefined	Up	Detected	
	LDS	12344D	15	15	100	155	586	370	118	Normal	None	Not Detected	
	GMA-U	22212	14	14	100	316	351	340	11	Normal	Up	Not Detected	
	GMA-D	22211	14	14	100	284	423	374	34	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12344C	27	27	100	26.7	204	146	48	Undefined	Up	Detected	
	LDS	12344D	15	15	100	43.0	296	58.8	86.8	Undefined	None	Detected	
	GMA-U	22212	14	14	100	18.3	41.4	30.3	6.2	Normal	Up	Not Detected	
	GMA-D	22211	14	14	100	18.8	31.7	24.6	3.6	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12344C	23	28	82.1	ND	10.7	3.94	2.65	Undefined	Up	Detected	
	LDS	12344D	12	15	80.0	ND	13.0	10.8	4.7	LogNormal	Up	Detected	
	GMA-U	22212	2	14	14.3	ND	0.0250	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22211	3	14	21.4	ND	0.0376	0.00850	Insufficient	Undefined	None	Not Detected	
Sulfate (mg/L)	LCS	12344C	39	39	100	122	5070	3280	1230	Undefined	Up	Detected	
	LDS	12344D	29	29	100	1280	7190	1750	1470	Undefined	Up	Detected	
	HTW	12344	34	34	100	80.4	765	309	234	Undefined	Up	Detected	
	GMA-U	22212	41	41	100	96.6	731	219	125	LogNormal	None	Detected	
	GMA-D	22211	41	41	100	152	572	333	116	Normal	Up	Detected	3640(Q3-12)
Total Dissolved Solids (mg/L)	LCS	12344C	27	27	100	960	7200	6160	1660	Undefined	Up	Detected	
	LDS	12344D	13	13	100	2590	12,300	5560	3040	LogNormal	Up	Not Detected	
	GMA-U	22212	21	21	100	519	1510	647	249	Undefined	Down	Not Detected	
	GMA-D	22211	21	21	100	602	1350	998	199	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12344C	35	39	89.7	ND	5.55	2.30	0.78	LogNormal	None	Not Detected	
	LDS	12344D	29	29	100	2.99	8.99	5.78	1.48	Normal	None	Detected	
	GMA-U	22212	36	41	87.8	ND	2.24	1.49	0.47	Undefined	Up	Detected	
	GMA-D	22211	35	41	85.4	ND	2.18	1.49	0.50	Undefined	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12344C	29	39	74.4	ND	0.0414	0.0124	0.0115	Undefined	None	Detected	
	LDS	12344D	22	29	75.9	ND	0.0640	0.0290	0.0135	Normal	None	Not Detected	
	GMA-U	22212	15	41	36.6	ND	0.0500	0.00405	0.00804	Undefined	None	Not Detected	
	GMA-D	22211	13	41	31.7	ND	0.0540	0.00181	0.00894	Undefined	None	Not Detected	
Arsenic (mg/L)	LCS	12344C	11	32	34.4	ND	0.179	0.00375	0.0395	Undefined	None	Not Detected	
	LDS	12344D	6	22	27.3	ND	0.048	0.00680	0.0106	LogNormal	None	Not Detected	
	HTW	12344	2	27	7.4	ND	0.0298	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22212	5	21	23.8	ND	0.0394	0.00250	0.00972	Undefined	None	Not Detected	
	GMA-D	22211	8	31	25.8	ND	0.0323	0.00250	0.00781	Undefined	None	Detected	
Barium (mg/L)	LCS	12344C	27	27	100	0.0187	0.112	0.0280	0.0261	Undefined	Down	Detected	
	LDS	12344D	15	15	100	0.0197	0.0891	0.0306	0.0181	Undefined	Down	Not Detected	
	GMA-U	22212	14	14	100	0.0508	0.104	0.0805	0.0164	Normal	None	Not Detected	
	GMA-D	22211	14	14	100	0.0429	0.0693	0.0556	0.0077	Normal	None	Not Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trand[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Boron (mg/L)	LCS	12344C	39	39	100	0.0625	1.35	1.14	0.33	Undefined	None	Not Detected	
	LDS	12344D	29	29	100	0.168	2.10	0.322	0.401	Undefined	Up	Detected	
	GMA-U	22212	39	41	95.1	ND	0.0486	0.0360	0.0065	Normal	Up	Detected	
	GMA-D	22211	38	41	92.7	ND	0.0433	0.0303	0.0069	Undefined	Up	Detected	
Calcium (mg/L)	LCS	12344C	27	27	100	153	759	565	143	Undefined	None	Detected	
	LDS	12344D	15	15	100	155	474	321	116	Normal	None	Detected	
	GMA-U	22212	14	14	100	140	171	152	11	LogNormal	None	Not Detected	377(Q3-11)
	GMA-D	22211	14	14	100	153	263	211	35	Normal	None	Not Detected	
Chromium (mg/L)	LCS	12344C	5	21	23.8	ND	0.0292	0.00426	0.00605	LogNormal	None	Not Detected	
	LDS	12344D	1	12	8.3	ND	0.0125	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22212	6	6	100	0.00486	0.0294	0.0134	0.0087	Normal	None	Not Detected	
	GMA-D	22211	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Cobalt (mg/L)	LCS	12344C	13	32	40.6	ND	0.00800	0.0005	0.00193	Undefined	Down	Detected	
	LDS	12344D	10	22	45.4	ND	0.00250	0.000560	0.000514	Undefined	None	Not Detected	
	GMA-U	22212	1	21	4.8	ND	0.00138	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22211	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12344C	19	32	59.4	ND	0.154	0.00875	0.0268	Undefined	None	Not Detected	
	LDS	12344D	15	22	68.2	ND	0.0239	0.00854	0.00666	LogNormal	Down	Not Detected	
	GMA-U	22212	6	14	42.9	ND	0.00993	0.00150	0.00354	Undefined	None	Not Detected	
	GMA-D	22211	5	14	35.7	ND	0.00956	0.0015	0.00296	Undefined	None	Detected	
Iron (mg/L)	LCS	12344C	30	32	93.8	ND	18.7	5.16	4.32	LogNormal	Down	Detected	
	LDS	12344D	18	22	81.8	ND	2.74	0.732	0.830	Undefined	Down	Detected	
	GMA-U	22212	21	21	100	3.76	22.2	8.64	4.99	LogNormal	None	Not Detected	
	GMA-D	22211	21	21	100	2.75	11.2	7.52	2.03	Normal	Down	Not Detected	
Lithium (mg/L)	LCS	12344C	30	30	100	0.0188	0.393	0.217	0.105	Normal	Up	Detected	0.695(Q4-12)
	LDS	12344D	21	21	100	0.0529	0.422	0.131	0.083	LogNormal	Up	Detected	
	GMA-U	22212	21	21	100	0.00474	0.00892	0.00534	0.00106	Undefined	Down	Not Detected	
	GMA-D	22211	21	21	100	0.00555	0.00930	0.00704	0.00095	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12344C	27	27	100	60.5	1030	748	318	Undefined	Up	Detected	
	LDS	12344D	15	15	100	61.1	946	95.9	266	Undefined	Up	Detected	
	GMA-U	22212	14	14	100	28.6	37.2	33.9	2.2	Normal	None	Not Detected	54.6(Q3-11)
	GMA-D	22211	14	14	100	34.6	64.7	51.0	9.2	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12344C	14	32	43.8	ND	0.991	0.0100	0.236	Undefined	Down	Detected	
	LDS	12344D	15	22	68.2	ND	1.20	0.0460	0.254	LogNormal	None	Not Detected	
	GMA-U	22212	21	21	100	0.219	1.23	0.270	0.228	Undefined	None	Not Detected	
	GMA-D	22211	31	31	100	0.256	0.680	0.452	0.114	Normal	None	Detected	
Nickel (mg/L)	LCS	12344C	26	32	81.2	ND	0.0265	0.00717	0.00735	LogNormal	Down	Detected	
	LDS	12344D	18	22	81.8	ND	0.0262	0.00932	0.00629	LogNormal	None	Detected	
	GMA-U	22212	7	21	33.3	ND	0.00493	0.000750	0.00122	Undefined	None	Not Detected	
	GMA-D	22211	5	31	16.1	ND	0.00520	0.00075	0.000948	Undefined	None	Detected	

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

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trand[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Potassium (mg/L)	LCS	12344C	27	27	100	8.12	61.4	47.2	13.3	Undefined	Up	Detected	
	LDS	12344D	15	15	100	13.2	123	29.5	36.8	Undefined	None	Detected	
	GMA-U	22212	14	14	100	3.05	3.81	3.50	0.23	Normal	None	Not Detected	4.81(Q3-11)
	GMA-D	22211	14	14	100	2.62	3.65	3.09	0.32	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12344C	9	32	28.1	ND	0.0605	0.00809	0.0108	LogNormal	Up	Not Detected	0.171(Q4-09)
	LDS	12344D	4	22	18.2	ND	0.0477	0.00753	0.0107	LogNormal	None	Not Detected	
	GMA-U	22212	3	21	14.3	ND	0.0114	0.00300	Insufficient	Undefined	Up	Detected	
	GMA-D	22211	1	21	4.8	ND	0.00786	Insufficient	Insufficient	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12344C	32	32	100	18.1	110	91.1	24.4	Undefined	Up	Detected	
	LDS	12344D	22	22	100	186	1490	534	294	Undefined	None	Detected	
	HTW	12344	27	27	100	19.8	37.4	32.1	6.2	Undefined	Up	Detected	
	GMA-U	22212	21	21	100	15.5	27.0	20.5	3.5	Normal	Down	Detected	
	GMA-D	22211	21	21	100	11.1	19.2	15.5	2.4	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12344C	16	32	50	ND	0.154	0.0165	0.0346	Undefined	Down	Not Detected	
	LDS	12344D	19	22	86.4	ND	5.16	0.0272	1.36	Undefined	Up	Detected	
	GMA-U	22212	11	21	52.4	ND	0.0468	0.00401	0.00984	Undefined	None	Not Detected	
	GMA-D	22211	17	31	54.8	ND	0.0205	0.00419	0.00370	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least eight samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater Background)	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximumed Perched Water)
General Chemistry											
Ammonia (mg/L)	11	6	54.5	Yes	0.026	0.254	0.117	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	11	2	18.2	No	0.000170	0.000250	0.000200	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	11	1	9.1	No	0.000200	-	-	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Lead (mg/L)	11	1	9.1	No	0.00610	-	-	0.015 mg/L(0)	0.022 mg/L(0)	0.0016 mg/L(1)	0.0114 mg/L(0)
Thallium (mg/L)	11	1	9.1	No	0.000460	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	11	1	9.1	No	0.00510	-	-	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)	19	7	36.8	Yes	0.86	28.7	11.9	94 pCi/L(0)	22 pCi/L(1)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethene (ug/L)	17	3	17.6	No	0.455	0.720	0.558	7 ug/L(0)	-	-	-
Acetone (ug/L)	9	1	11.1	No	3.50	-	-	-	-	-	-
alpha-Chlordane (ug/L)	17	1	5.9	No	0.0113	-	-	2.0 ug/L(0)	-	-	-
Total Xylenes (ug/L)	9	1	11.1	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the final remediation level (FRL), groundwater background, perched water background, or perched water 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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

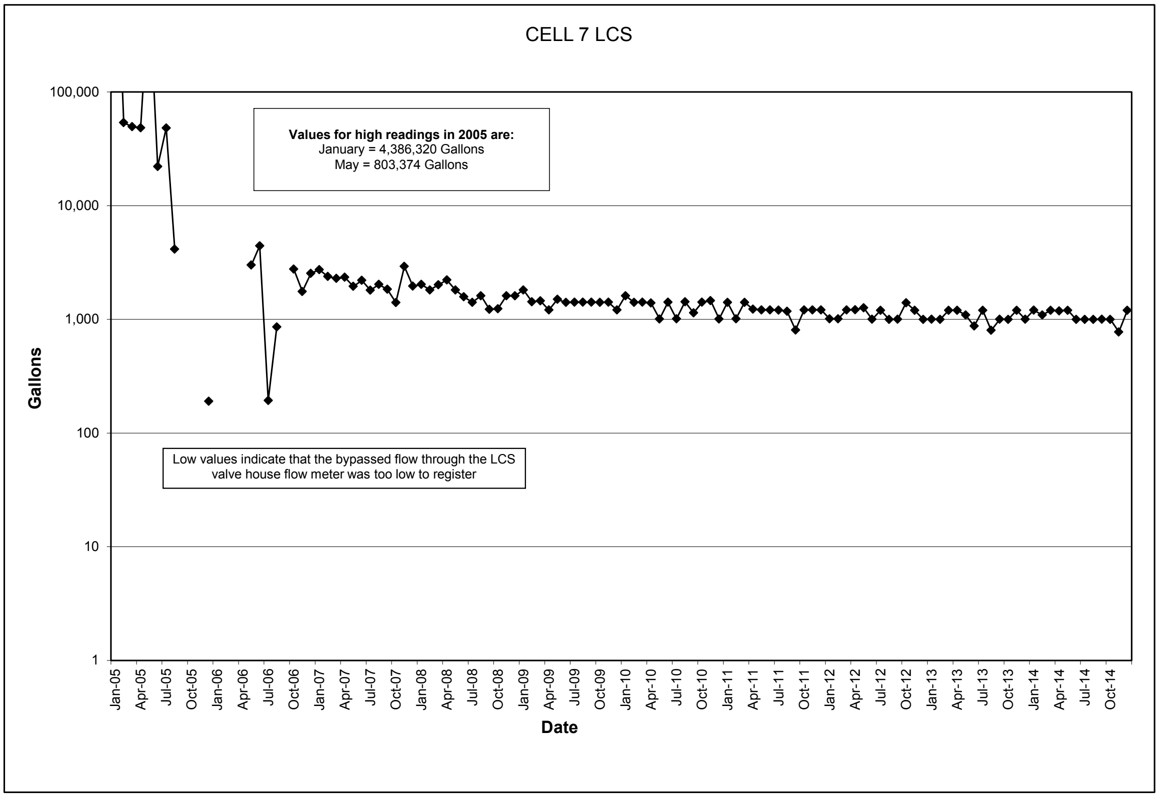


Figure A.5.7-1. Monthly Accumulation Volumes for Cell 7 LCS

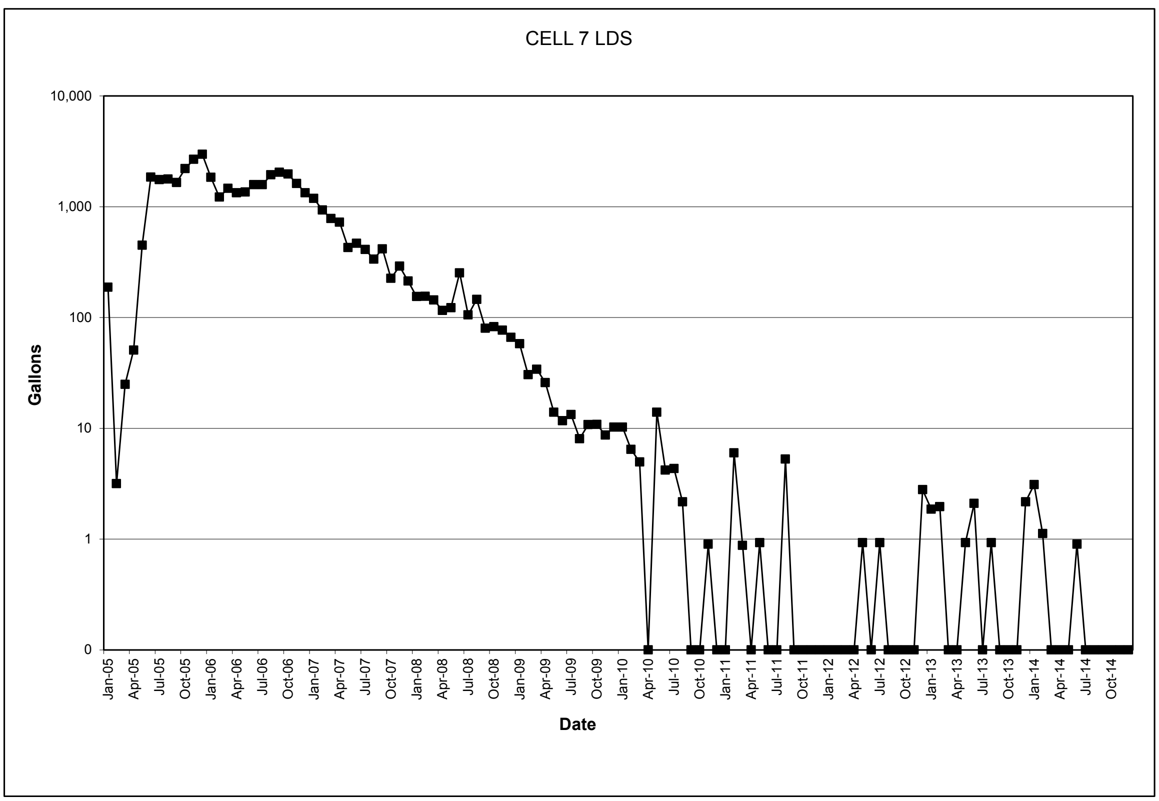
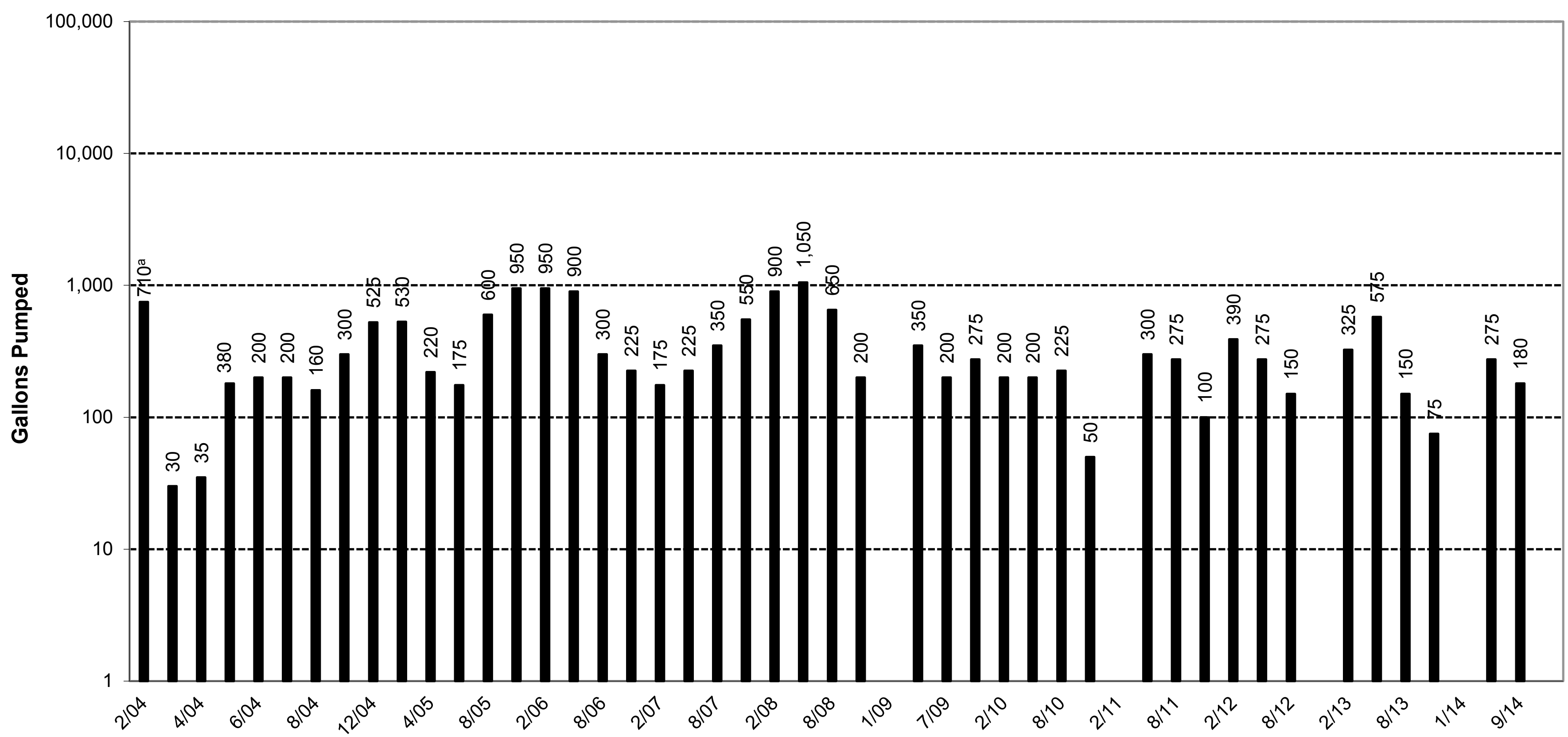


Figure A.5.7-2. Monthly Accumulation Volumes for Cell 7 LDS



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
2012:	815	n=4	204
2013:	1125	n=4	281
2014[b]:	455	n=2	228
Overall:			338

[a]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.

[b]Sampling schedule reduced to semi-annual sampling in 2014.

Figure A.5.7-3. OSDF Horizontal Till Well 12343 (Cell 7) Water Yield

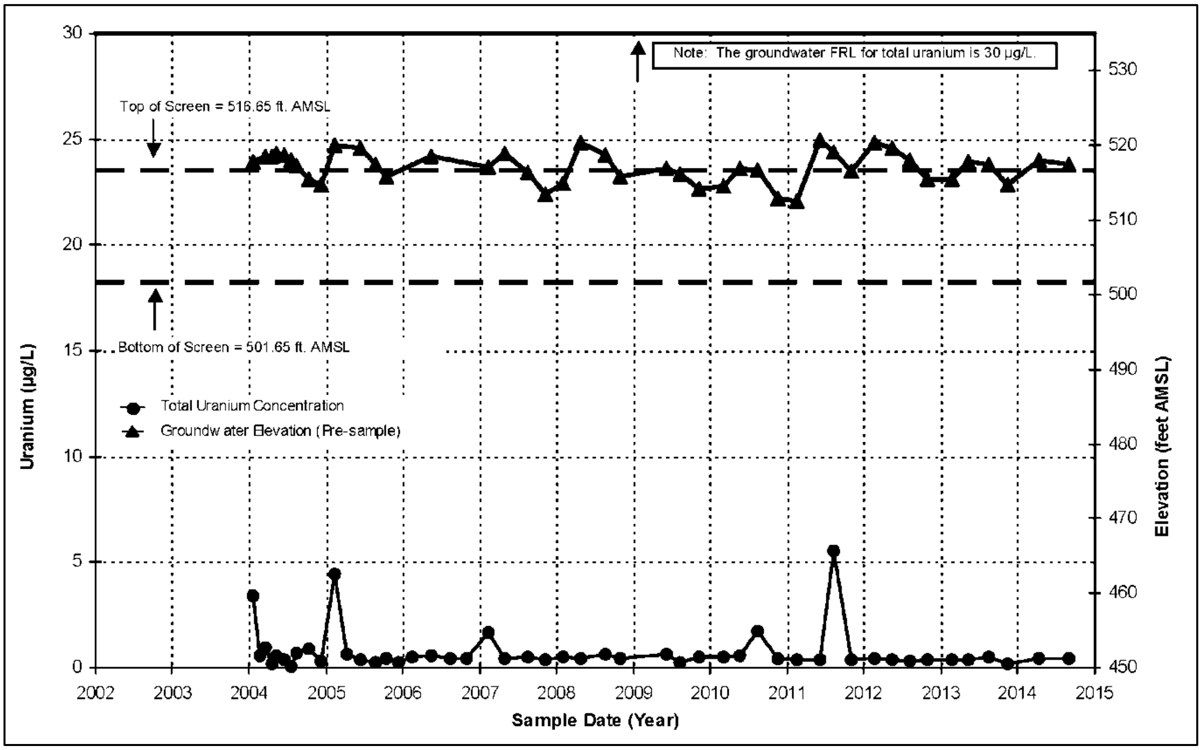


Figure A.5.7-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 7 Upgradient Monitoring Well 22212

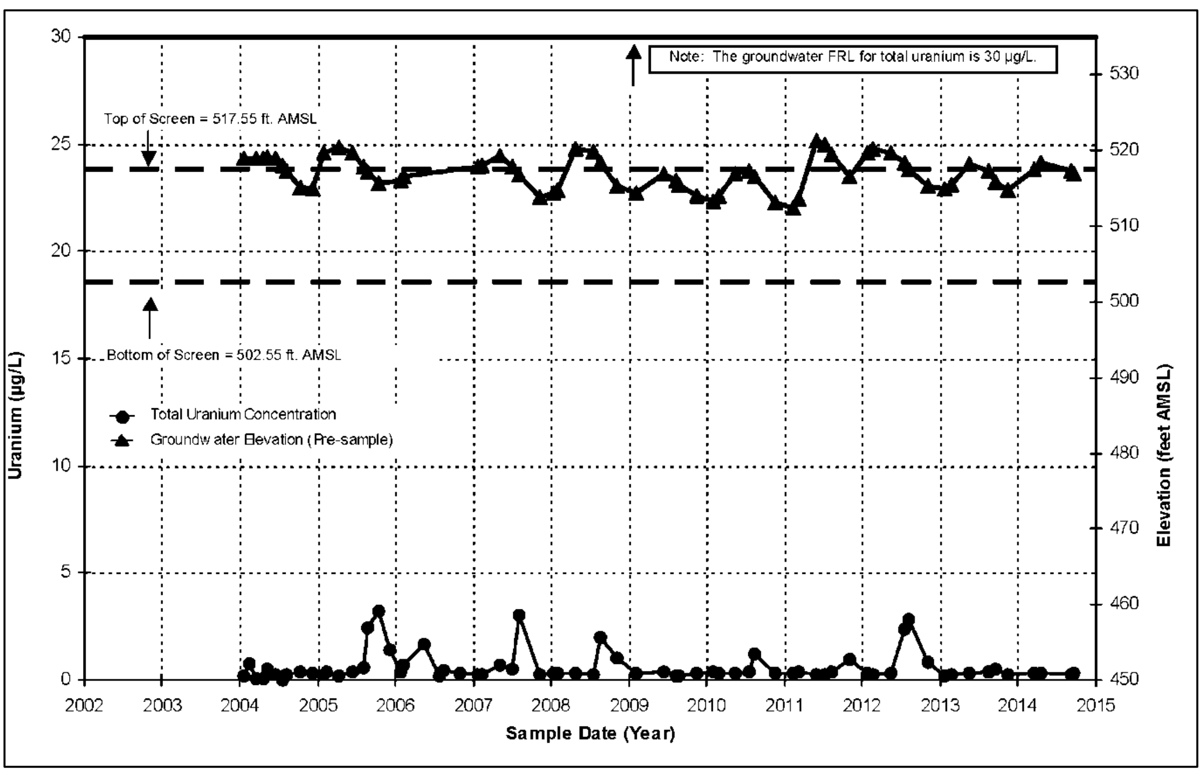


Figure A.5.7-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 7 Downgradient Monitoring Well 22211

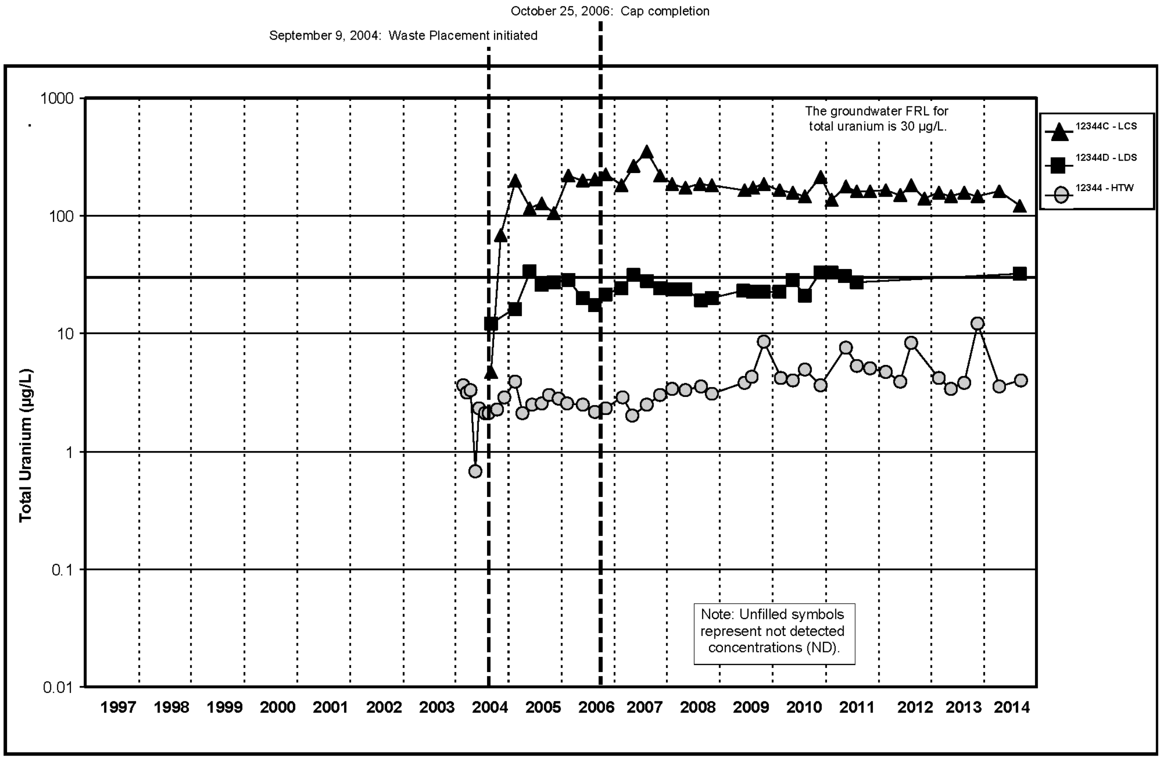


Figure A.5.7-6A. Cell 7 Uranium, Total Concentration Versus Time Plot for LCS, LDS, and HTW

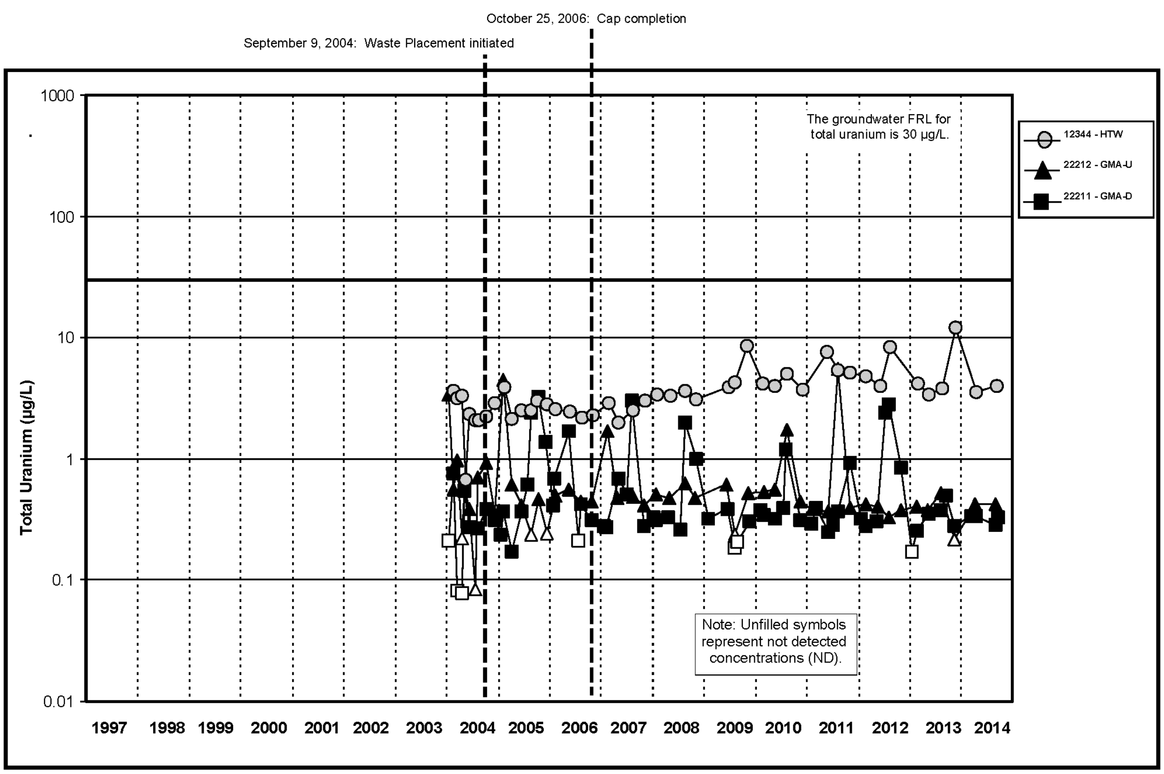


Figure A.5.7-6B. Cell 7 Uranium, Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

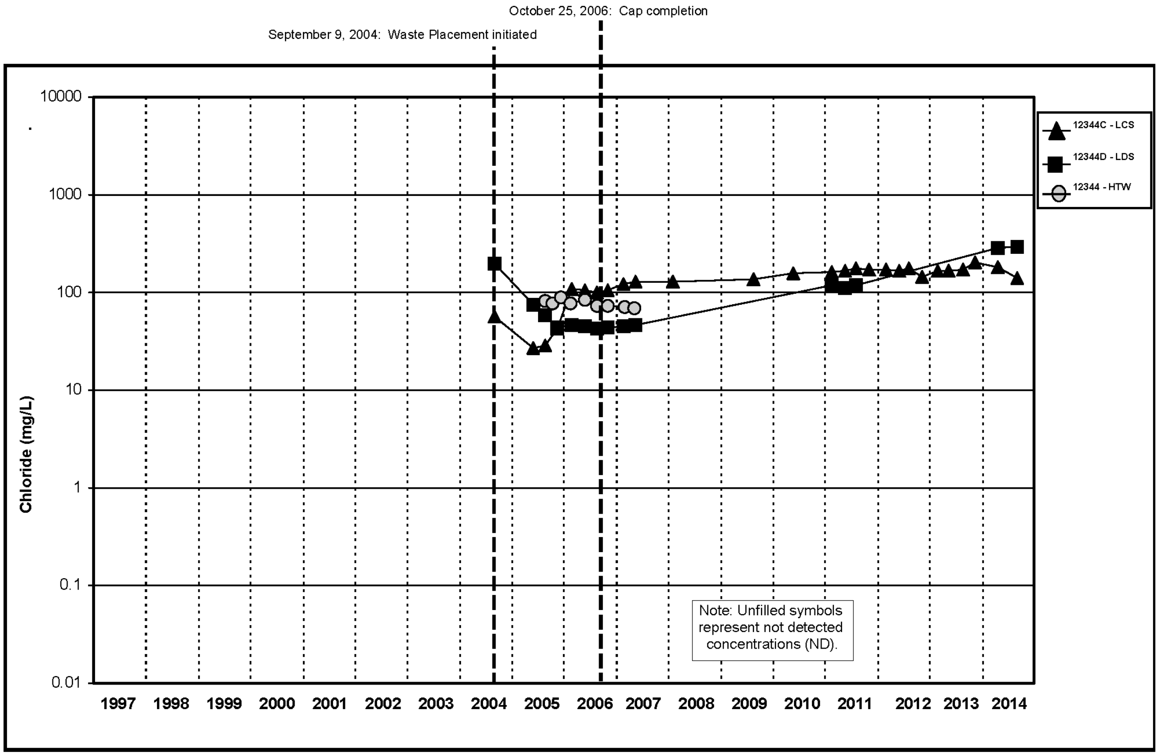


Figure A.5.7-7A. Cell 7 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

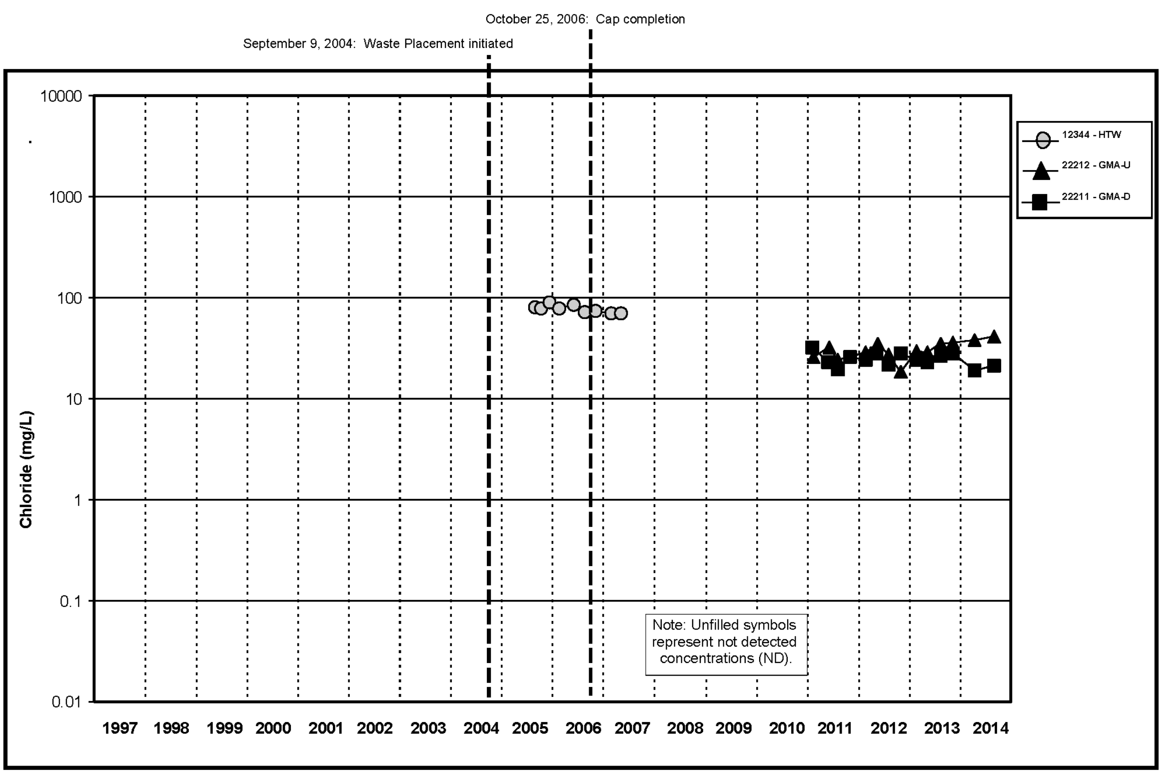


Figure A.5.7-7B. Cell 7 Chloride Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

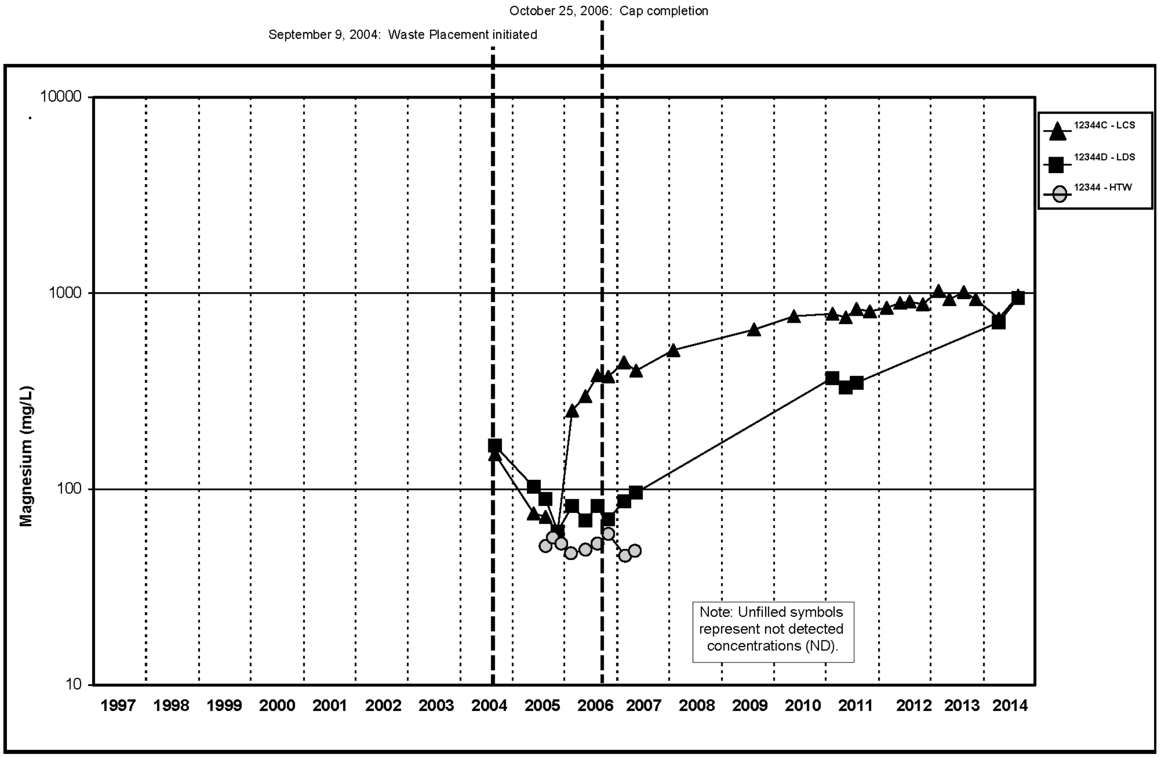


Figure A.5.7-8A. Cell 7 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

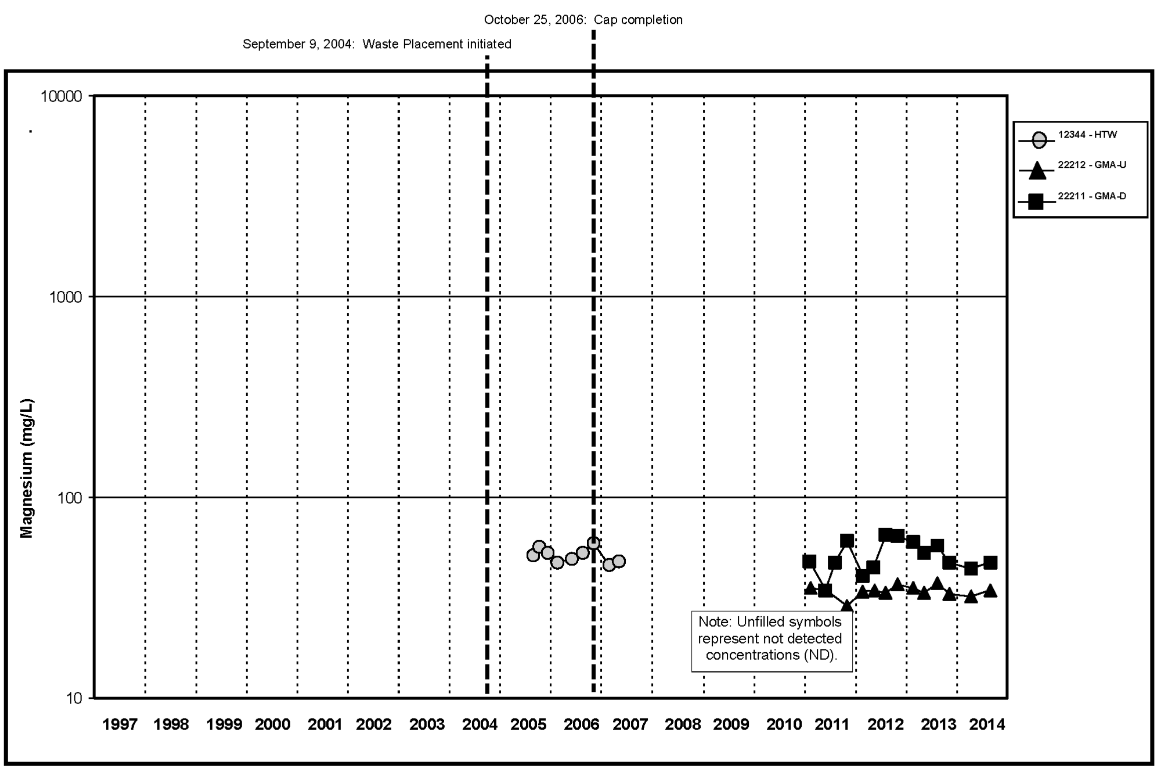


Figure A.5.7-8B. Cell 7 Magnesium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

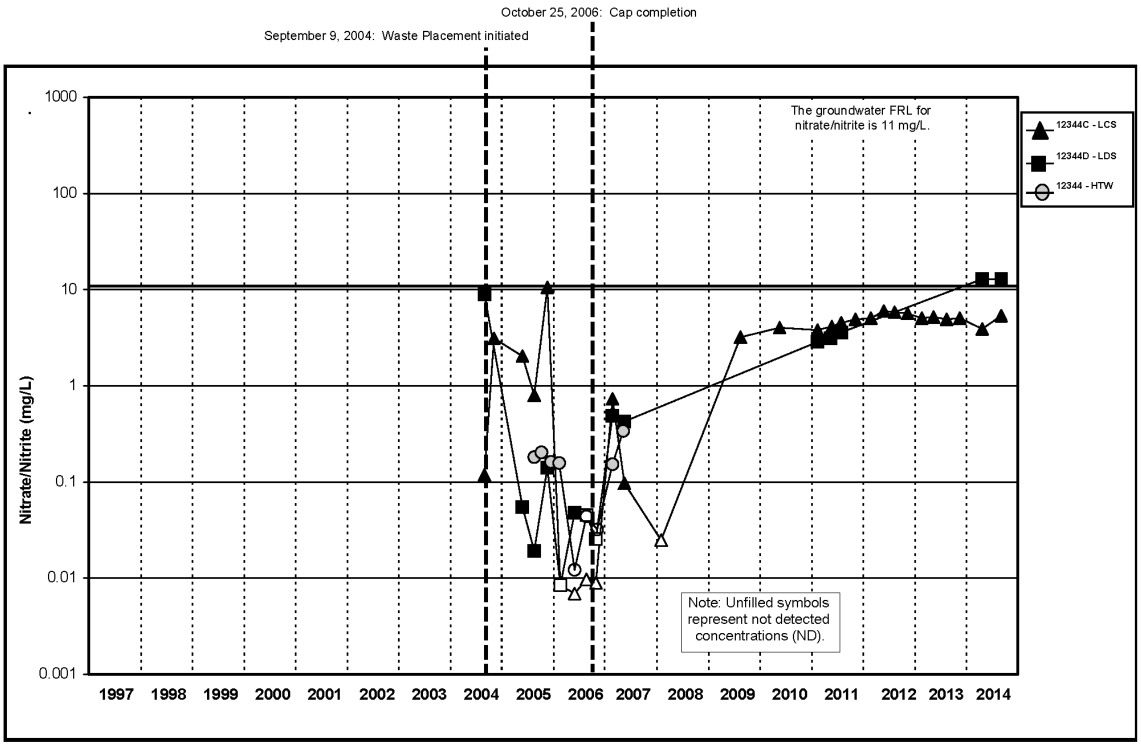


Figure A.5.7-9A. Cell 7 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

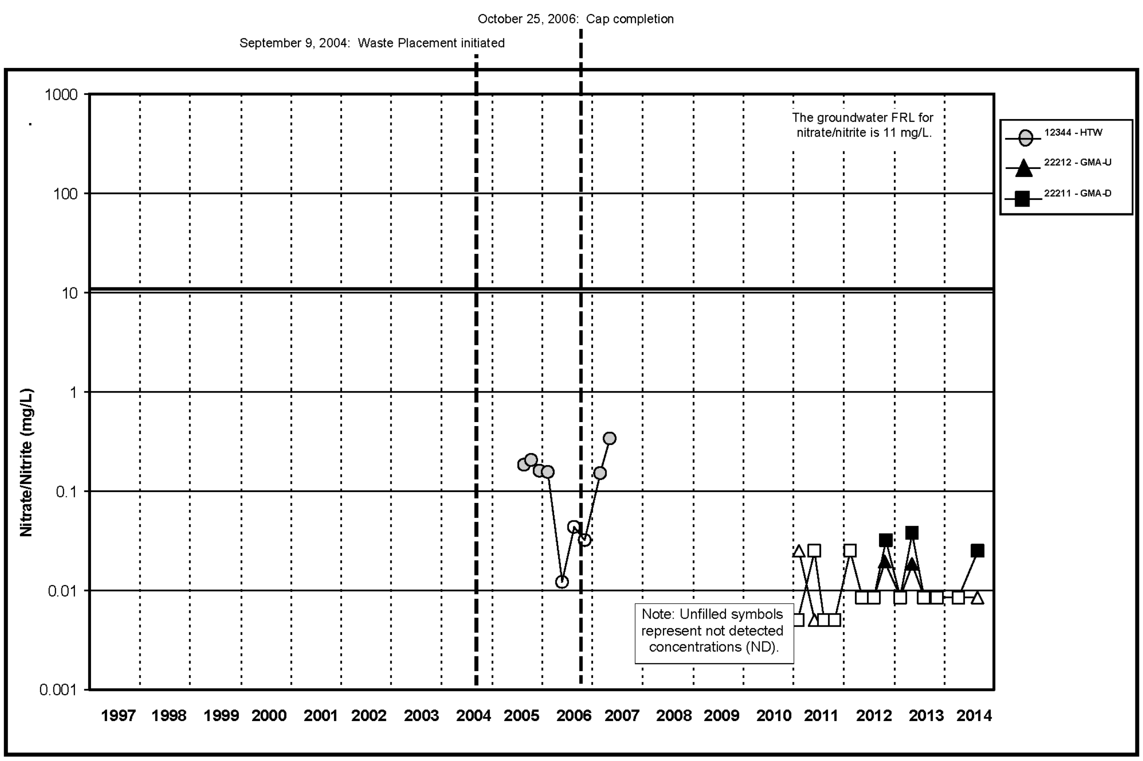


Figure A.5.7-9B. Cell 7 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

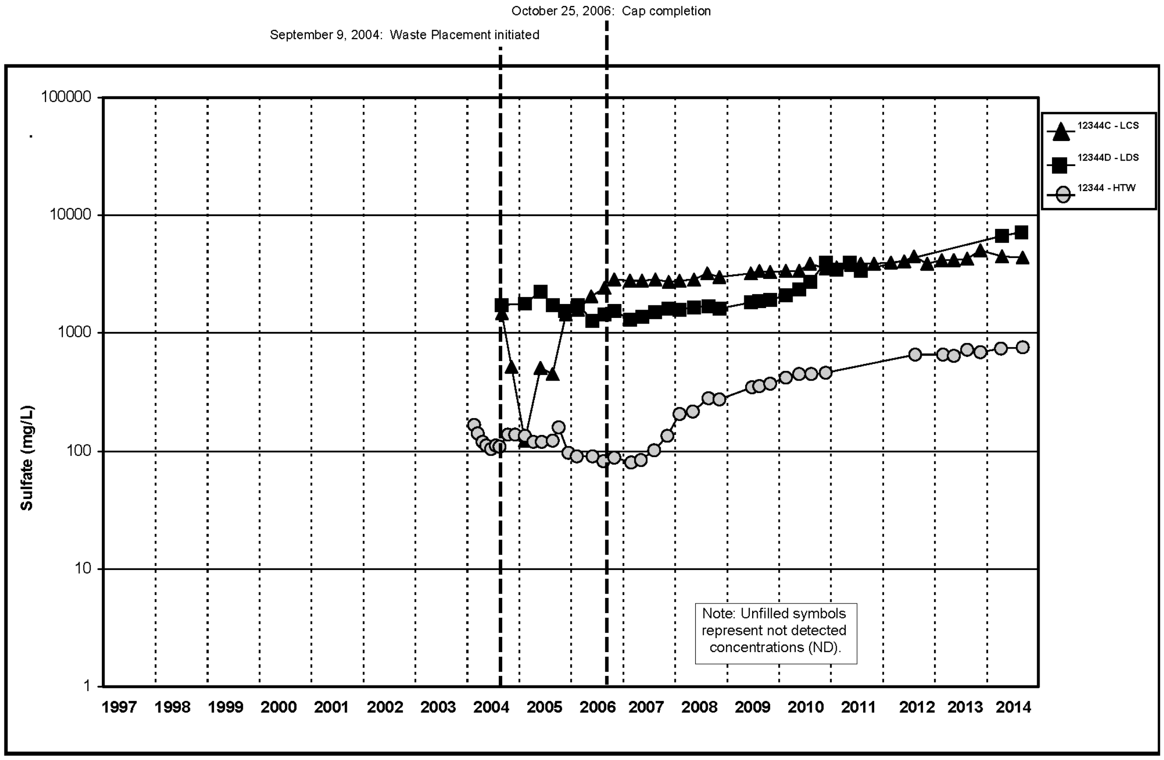


Figure A.5.7-10A. Cell 7 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

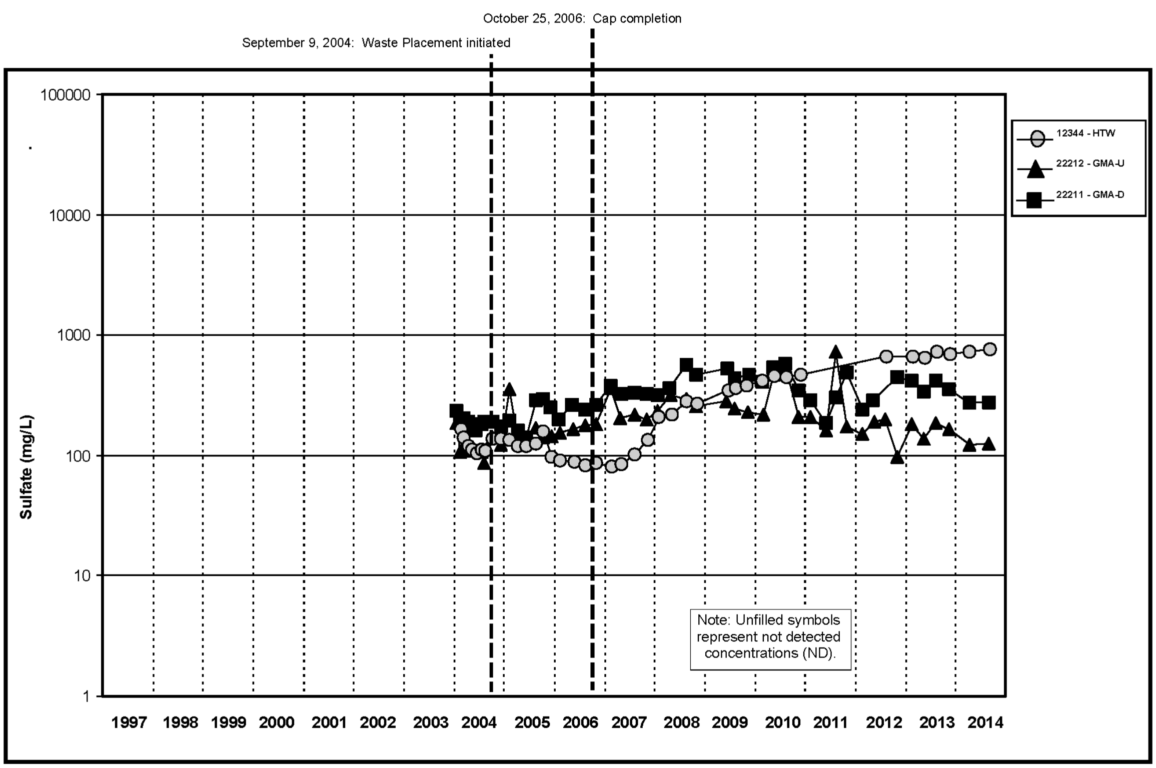


Figure A.5.7-10B. Cell 7 Sulfate Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

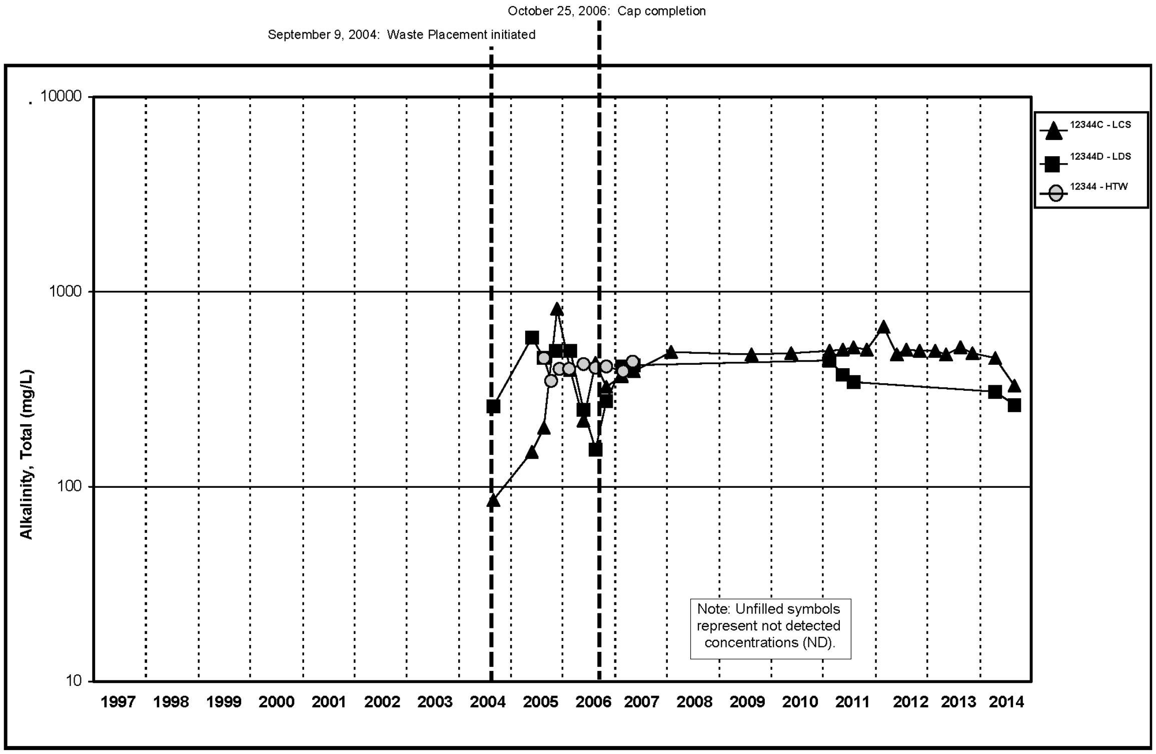


Figure A.5.7-11A. Cell 7 Alkalinity Total Concentration Versus Time Plot for LCS, LDS, and HTW

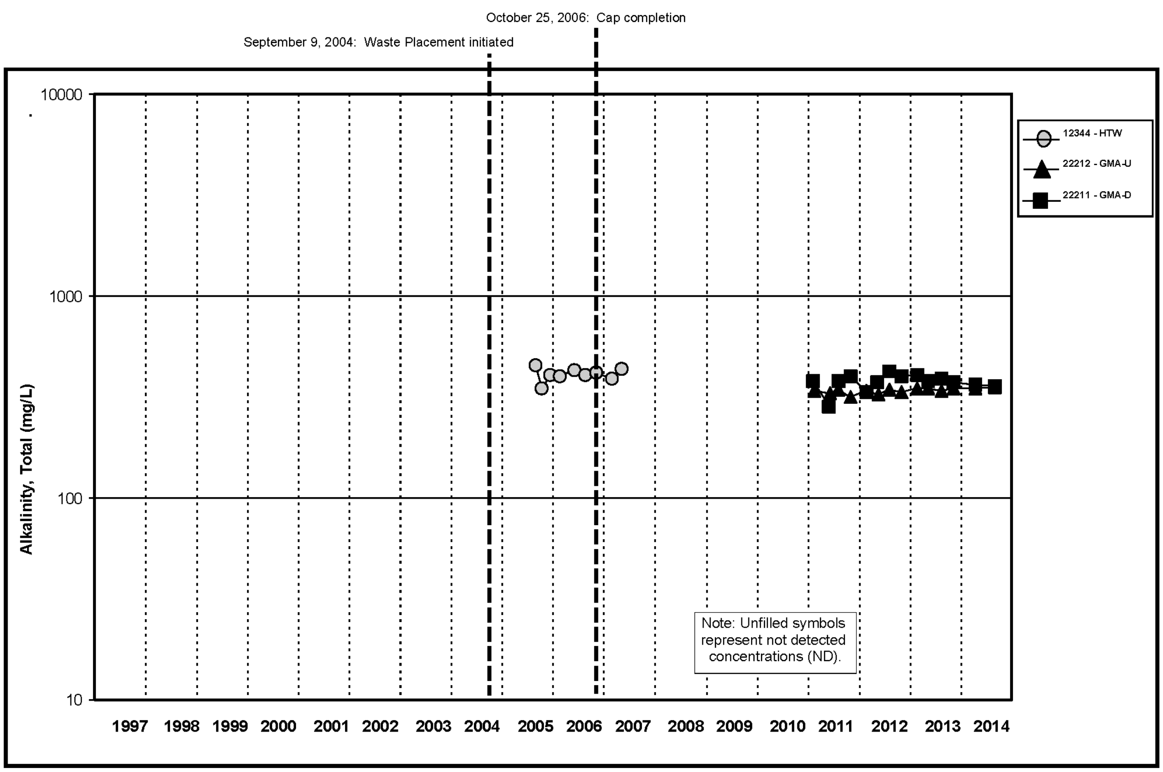


Figure A.5.7-11B. Cell 7 Alkalinity Total Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

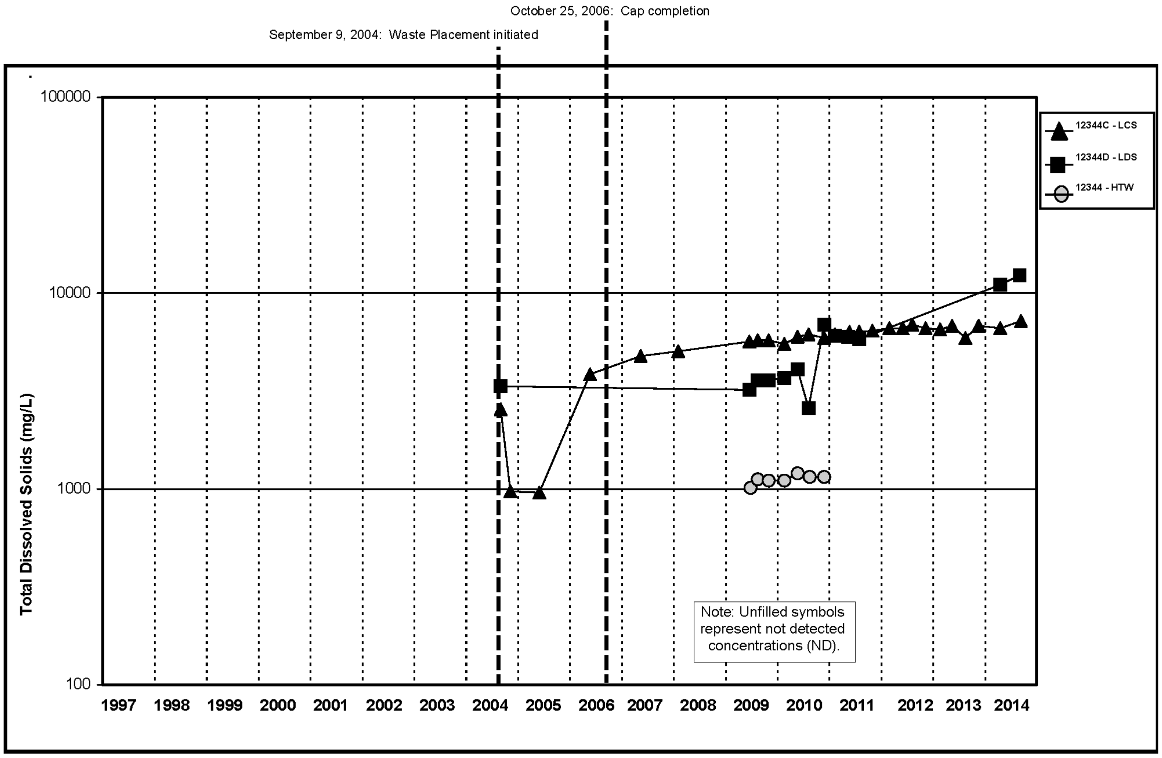


Figure A.5.7-12A. Cell 7 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

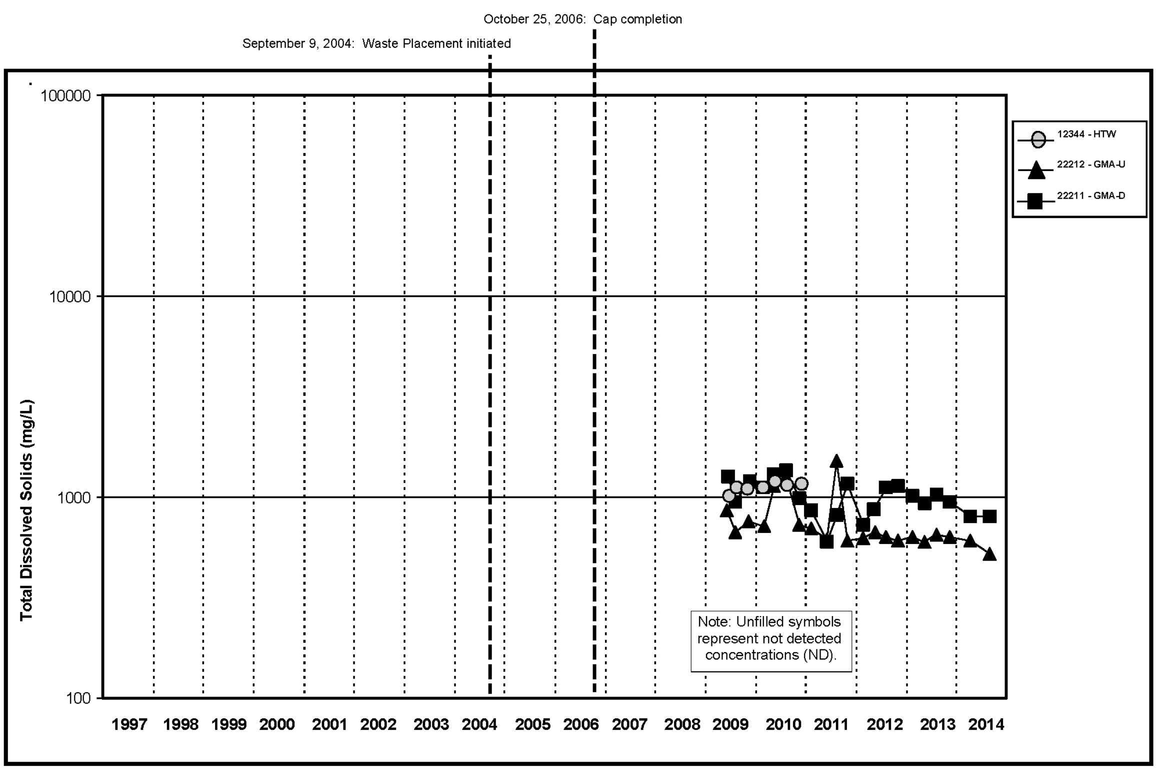


Figure A.5.7-12B. Cell 7 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

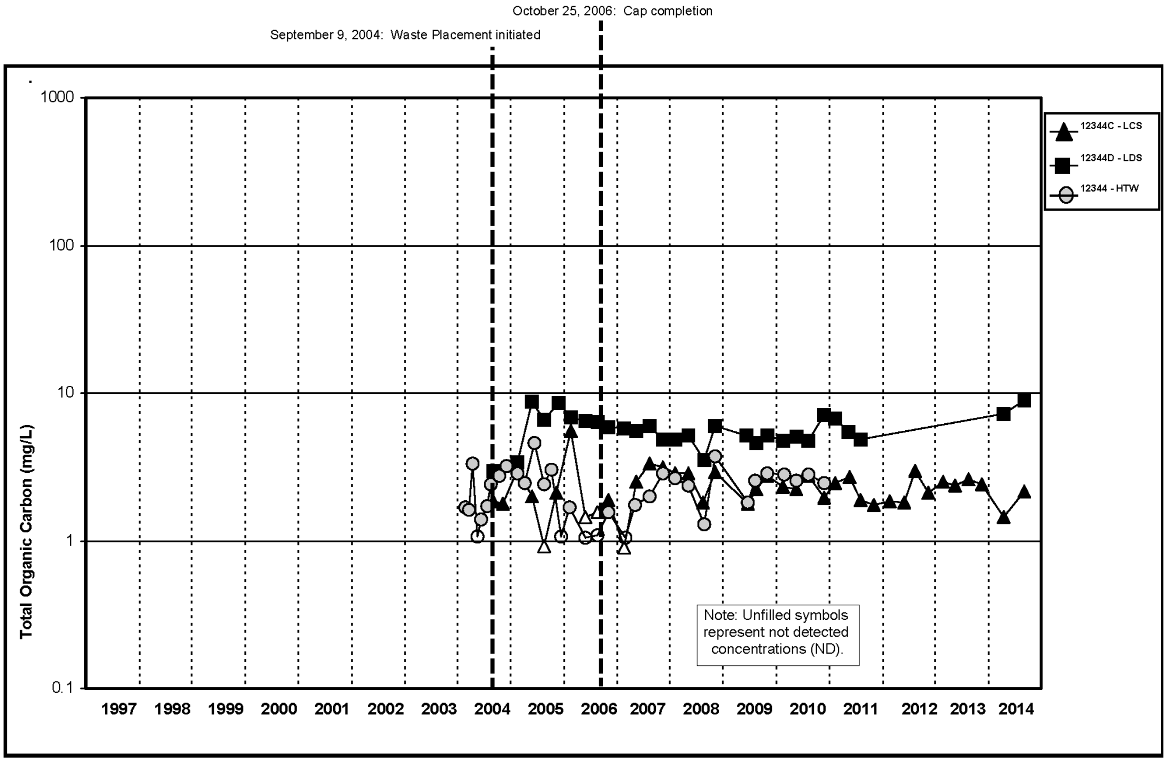


Figure A.5.7-13A. Cell 7 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

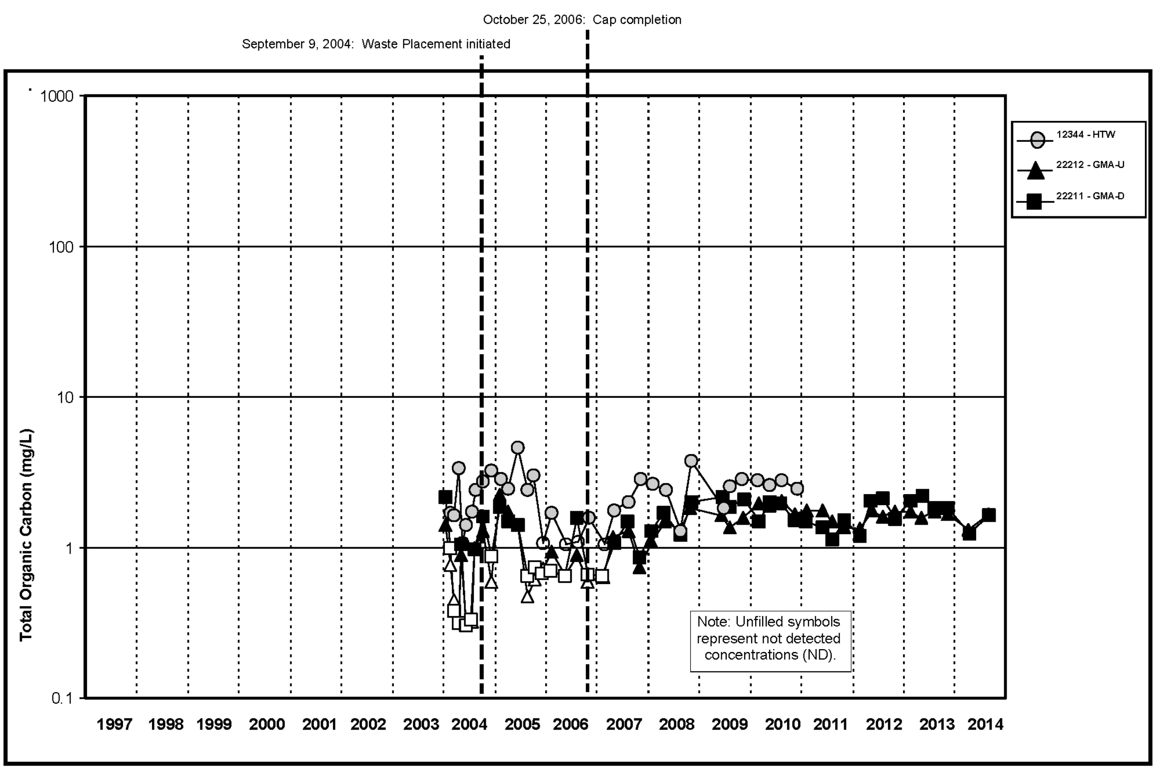


Figure A.5.7-13B. Cell 7 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

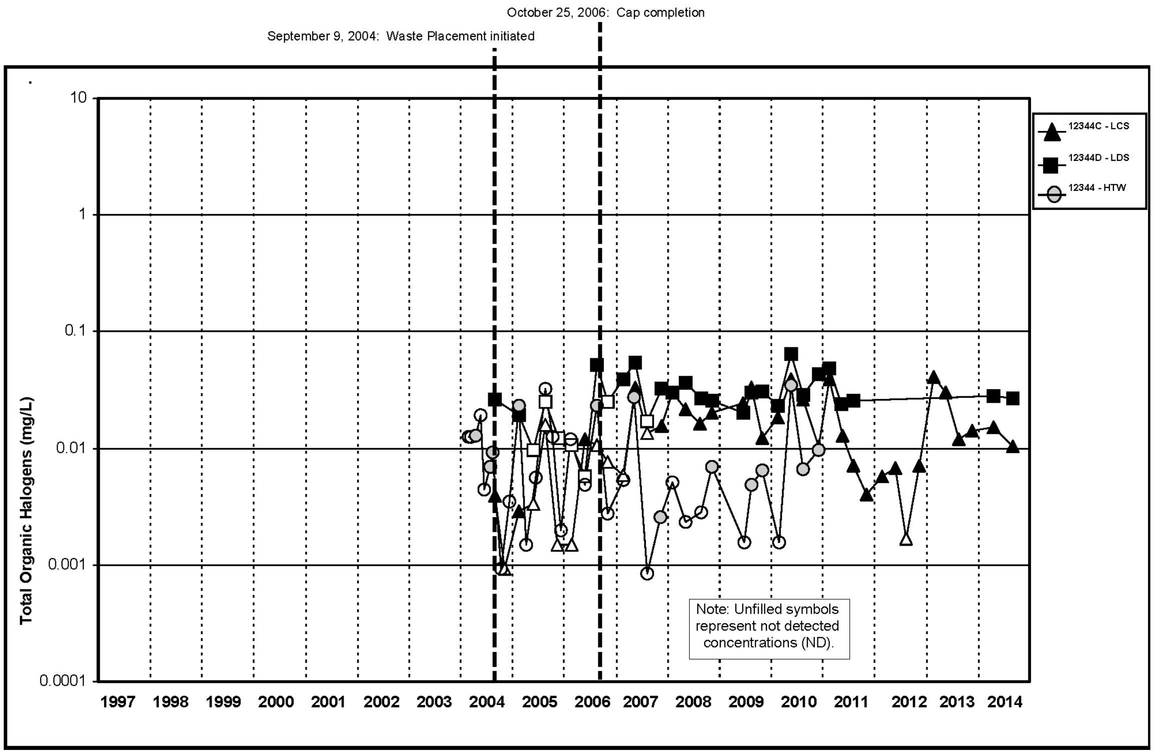


Figure A.5.7-14A. Cell 7 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

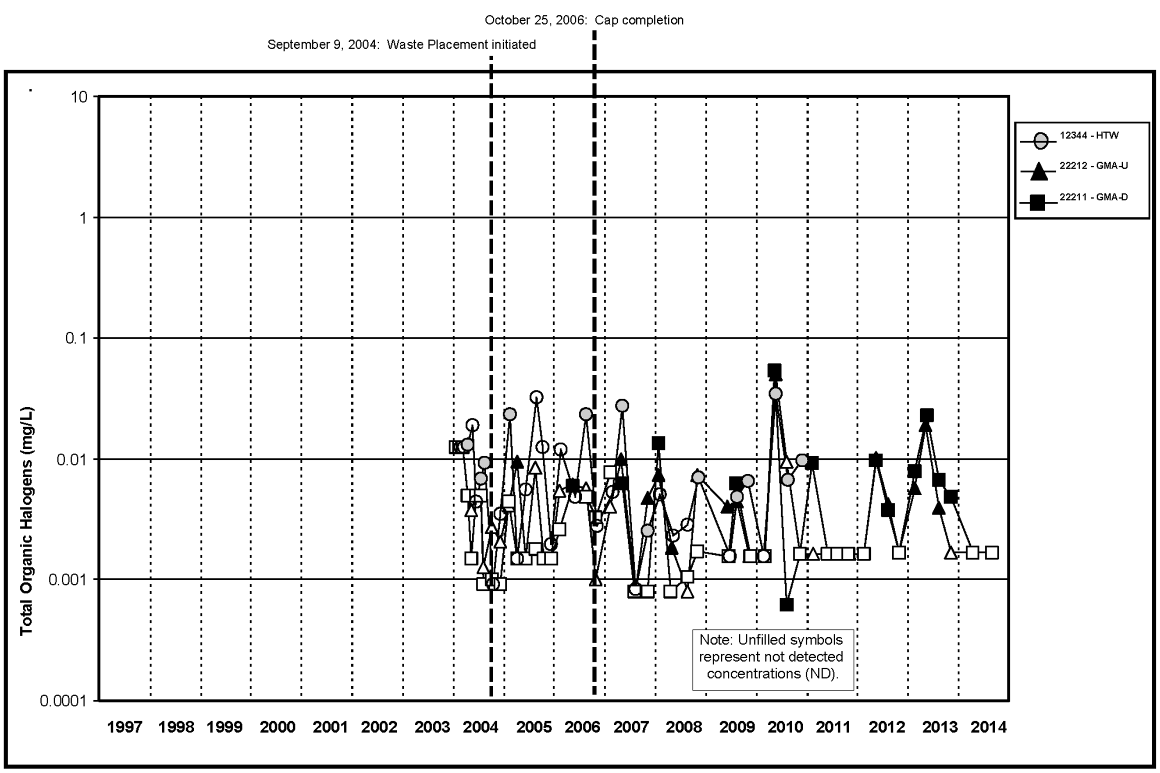


Figure A.5.7-14B. Cell 7 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

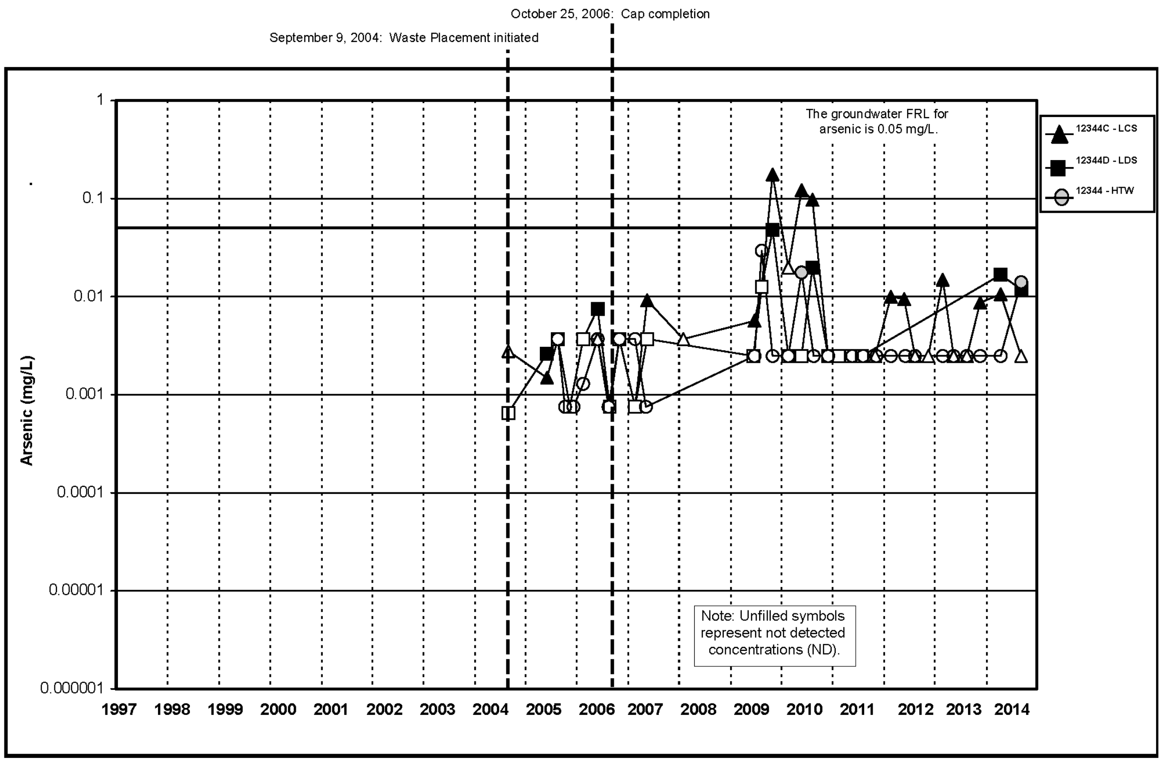


Figure A.5.7-15A. Cell 7 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

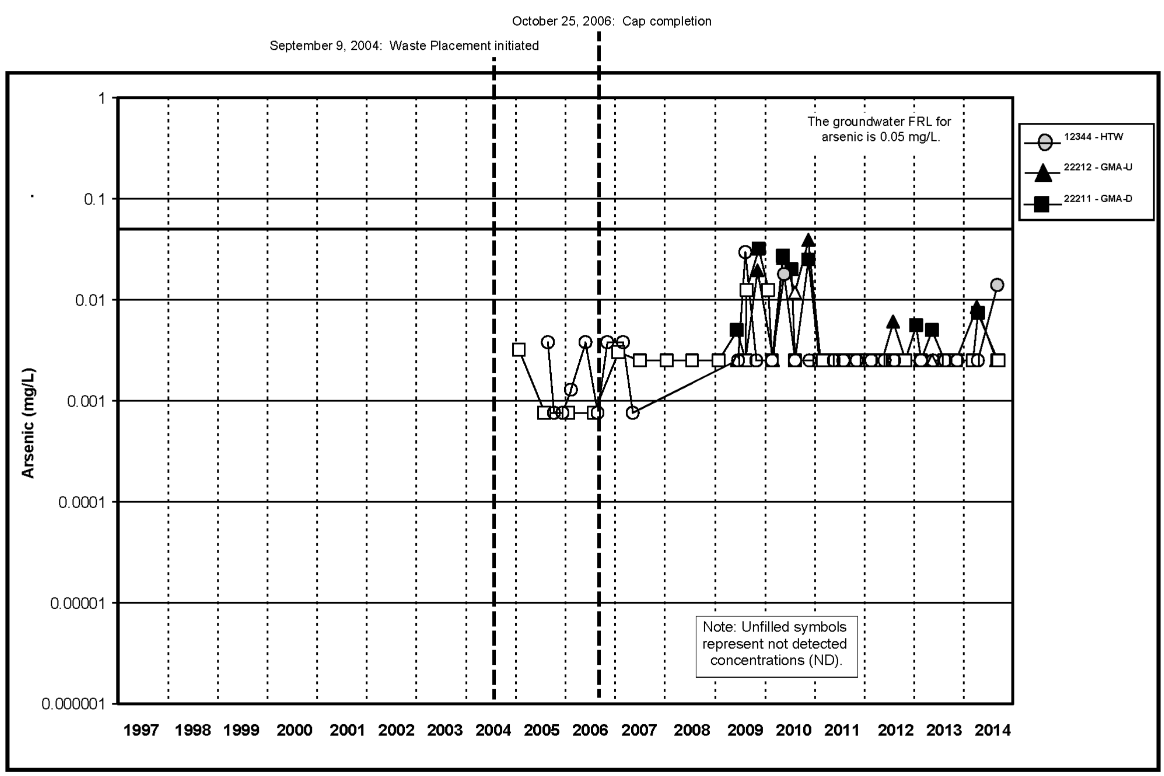


Figure A.5.7-15B. Cell 7 Arsenic Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

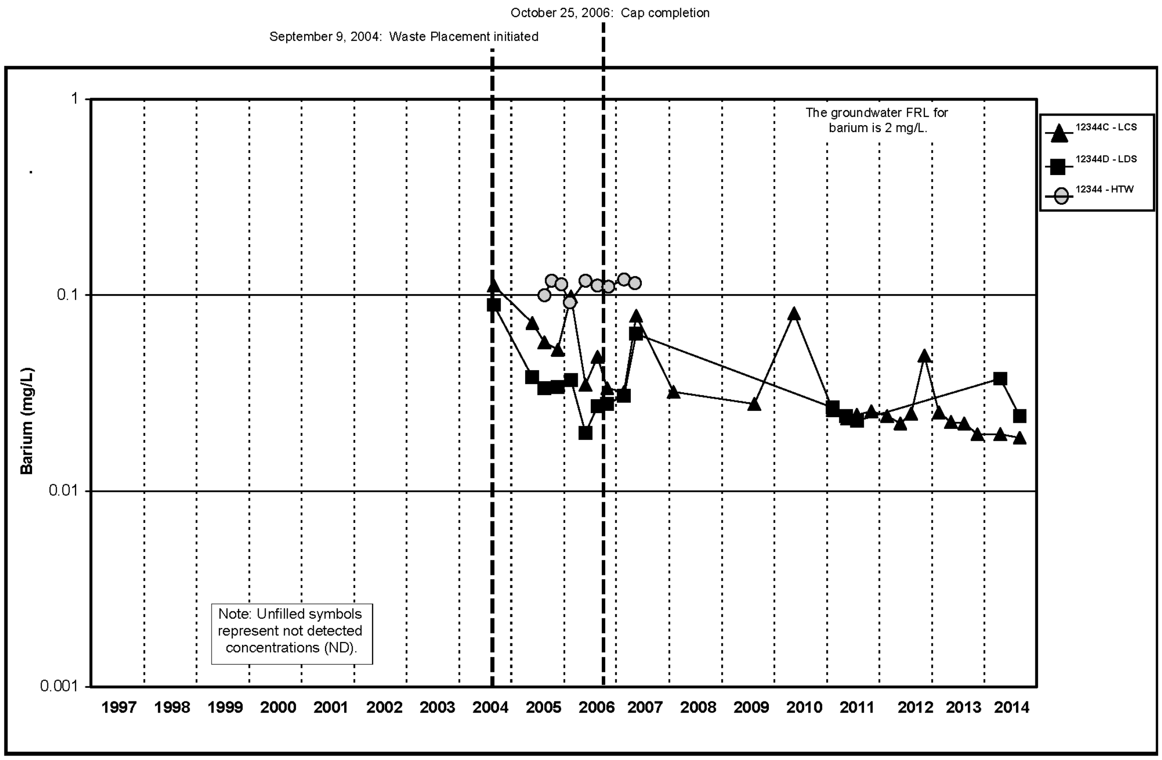


Figure A.5.7-16A. Cell 7 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

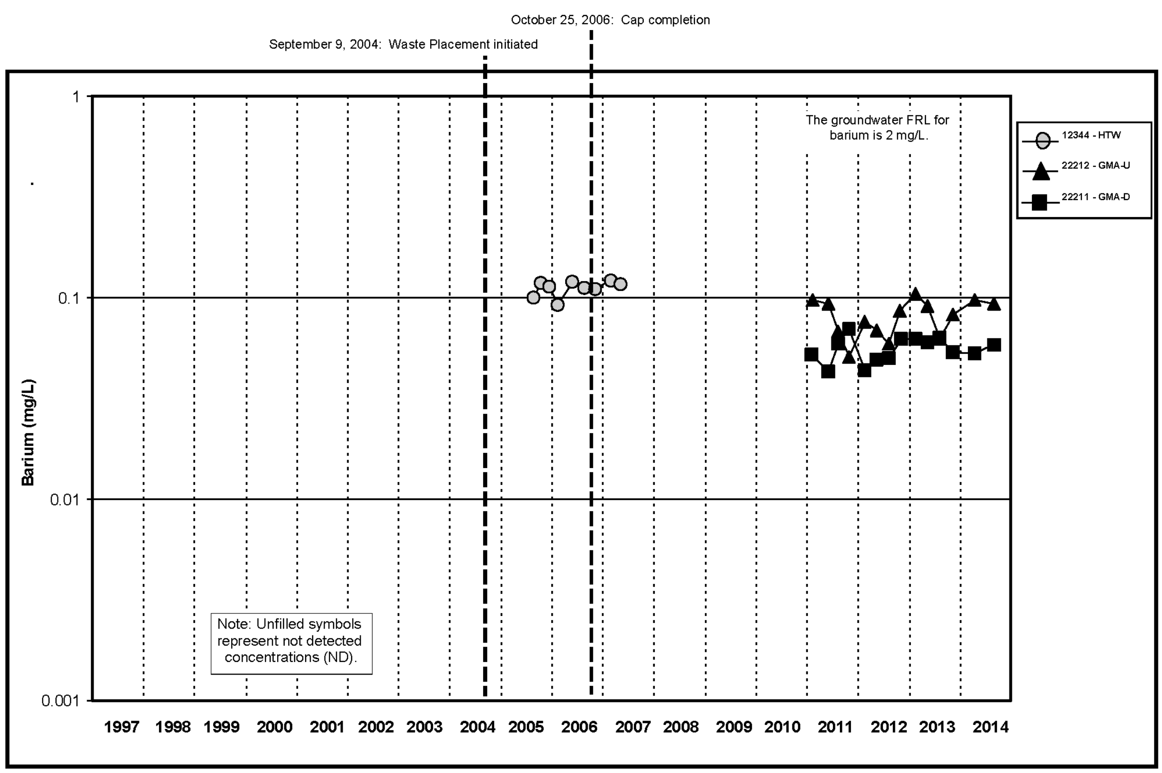


Figure A.5.7-16B. Cell 7 Barium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

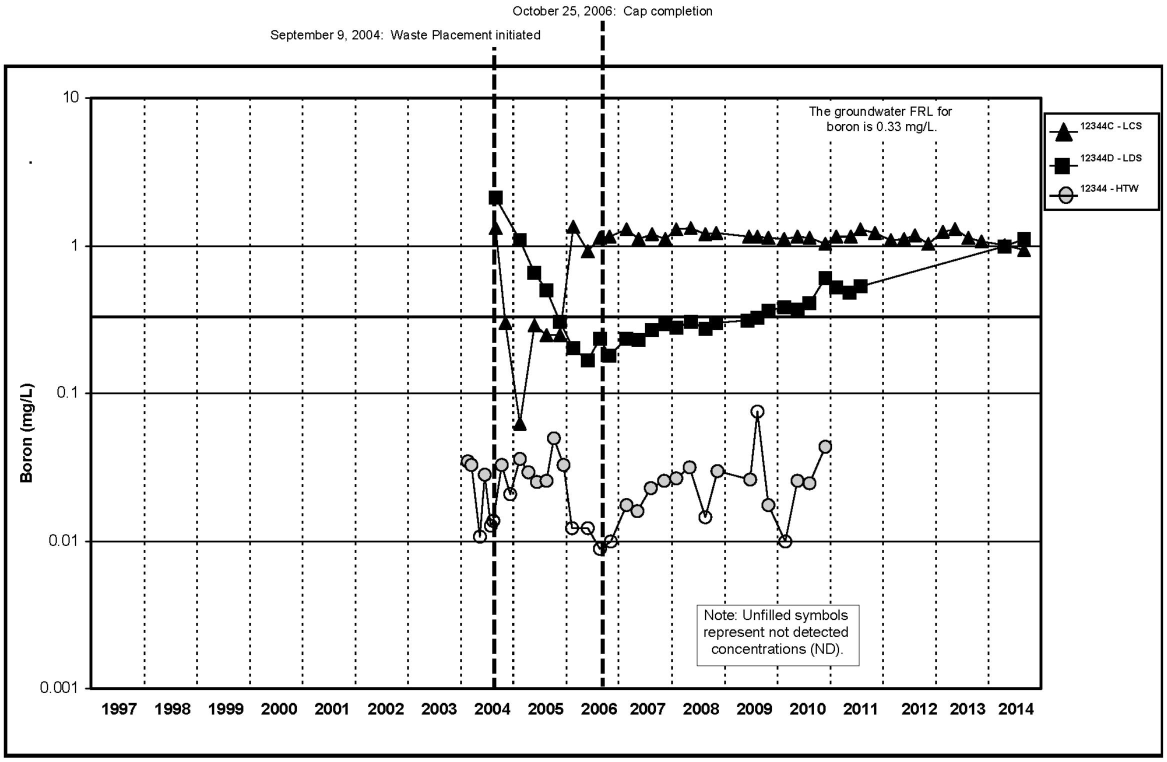


Figure A.5.7-17A. Cell 7 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

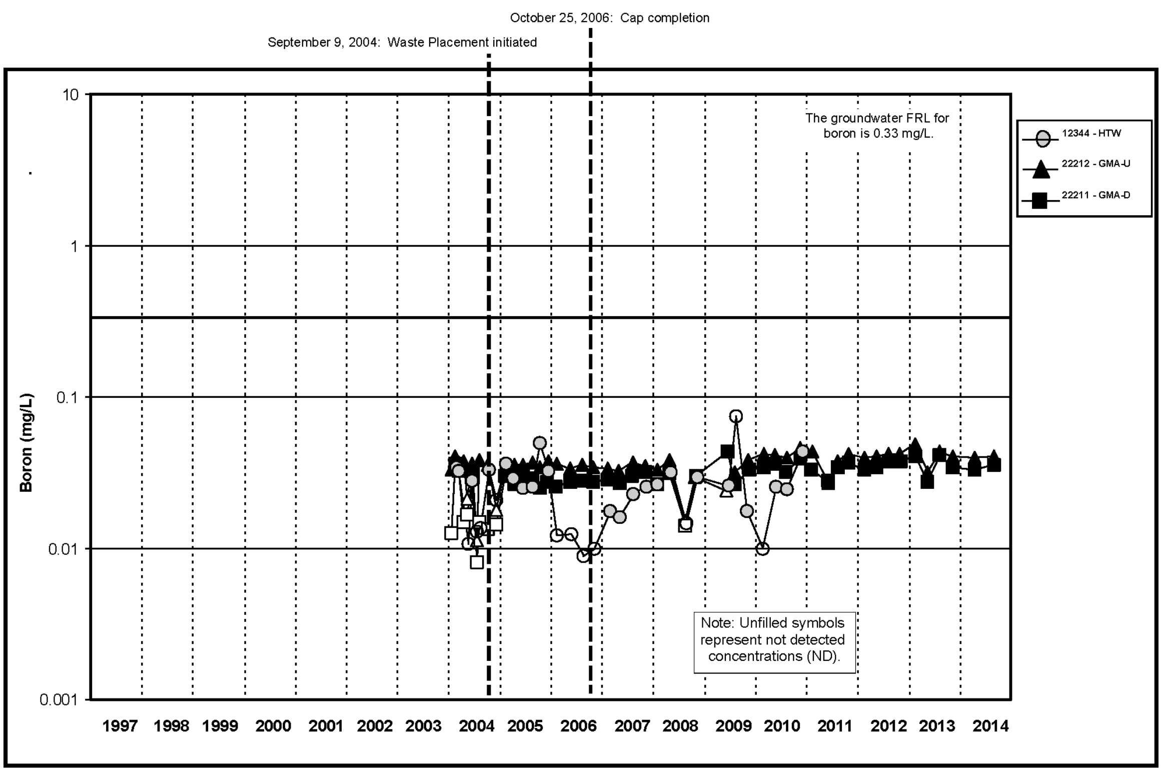


Figure A.5.7-17B. Cell 7 Boron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

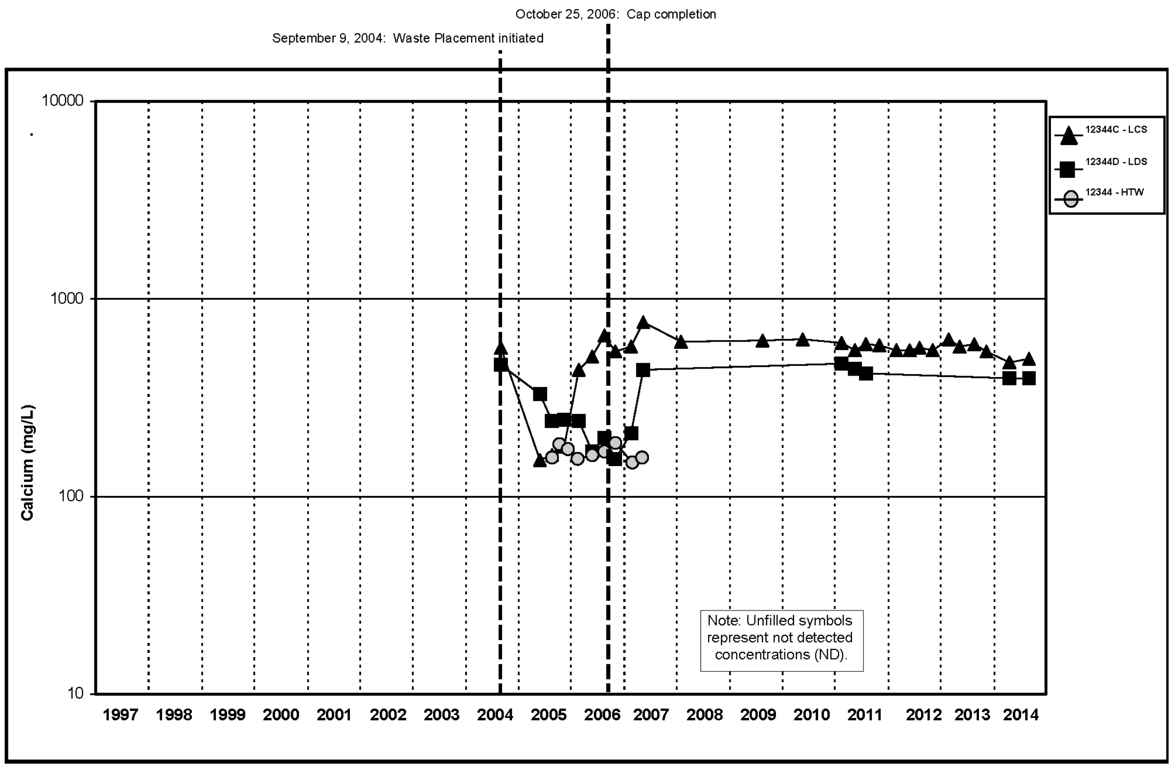


Figure A.5.7-18A. Cell 7 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

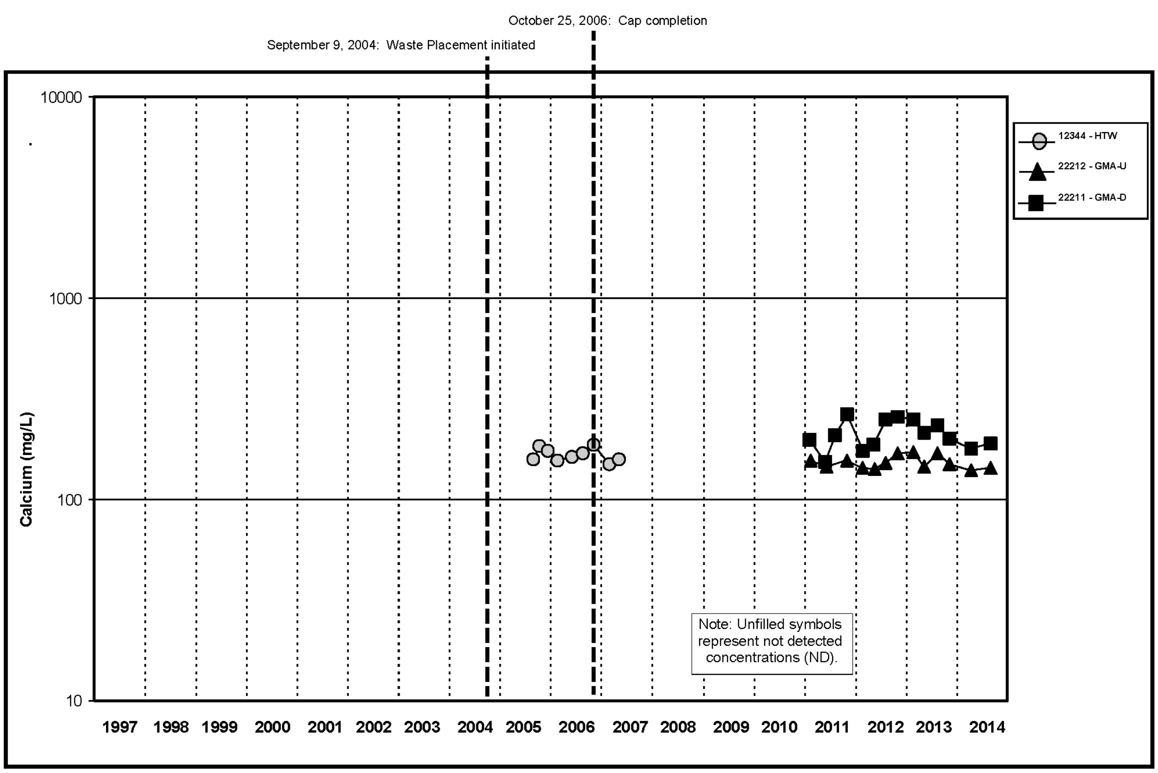


Figure A.5.7-18B. Cell 7 Calcium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

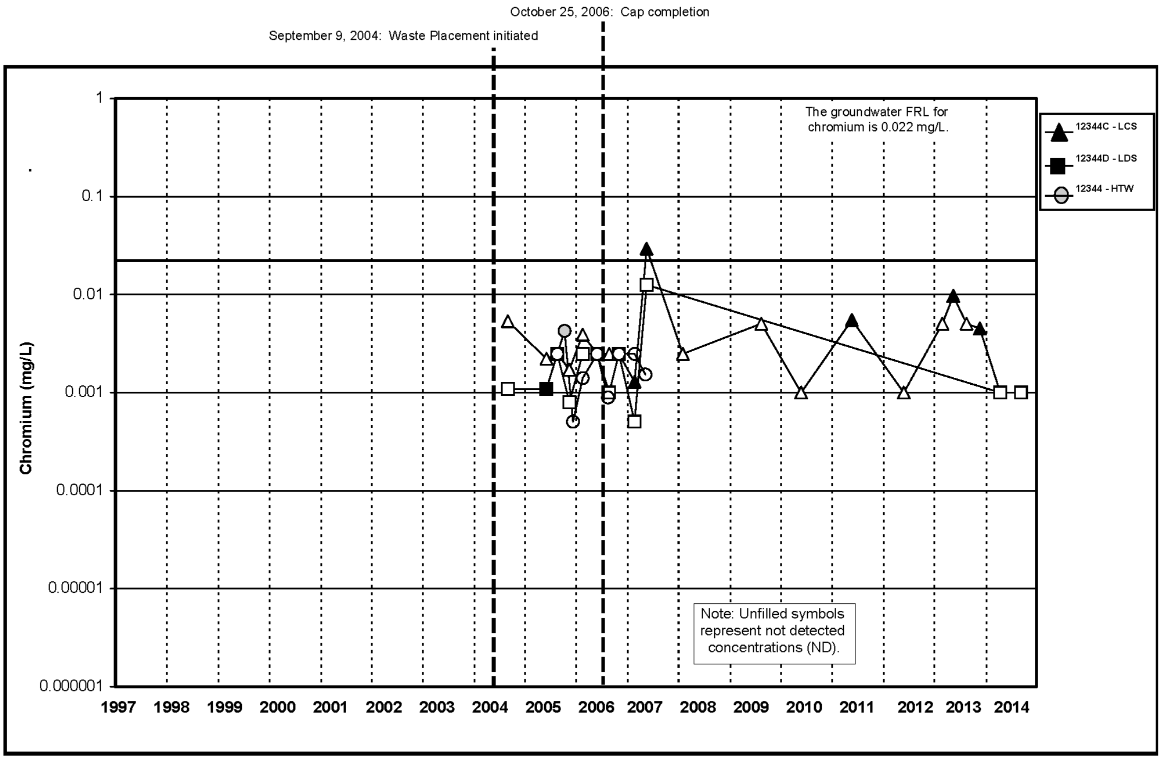


Figure A.5.7-19A. Cell 7 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

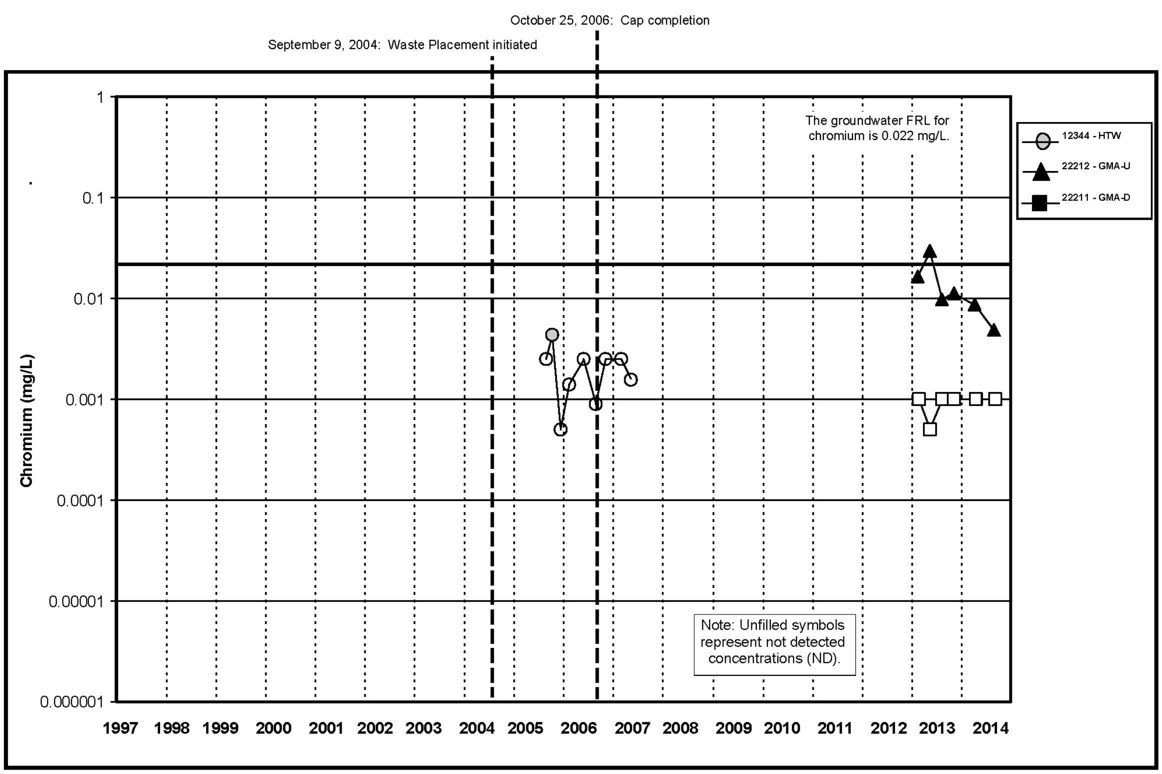


Figure A.5.7-19B. Cell 7 Chromium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

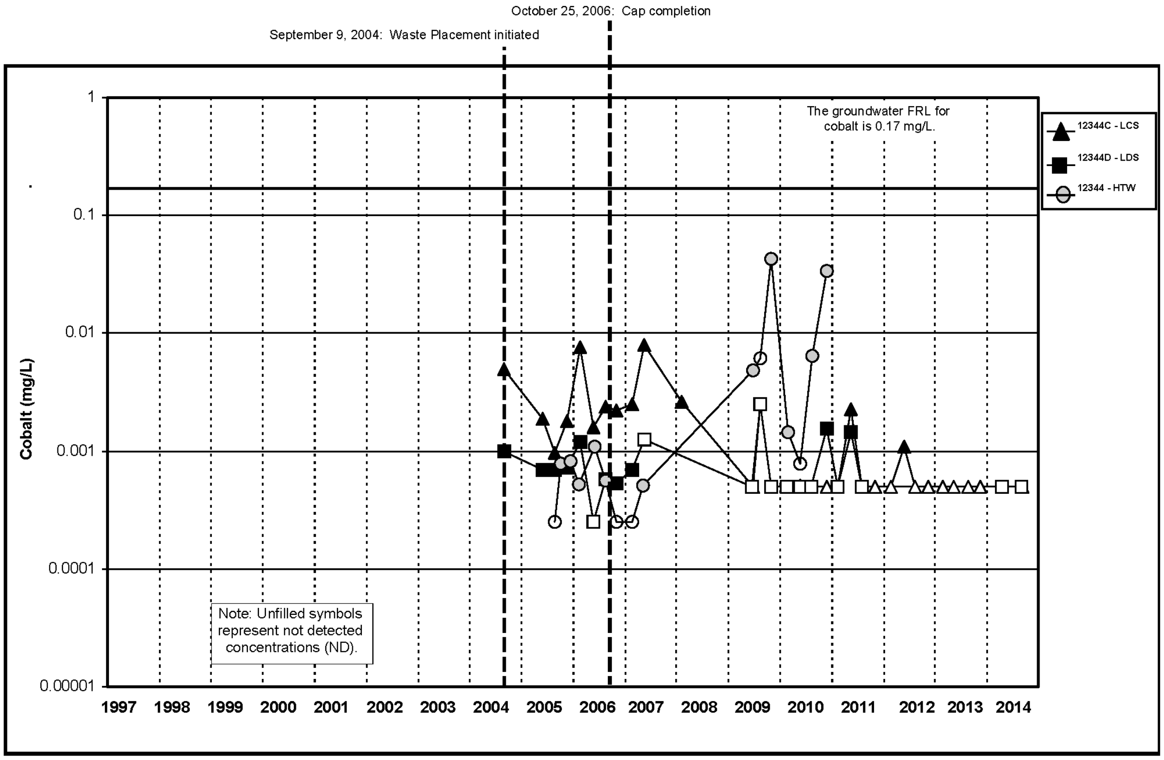


Figure A.5.7-20A. Cell 7 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

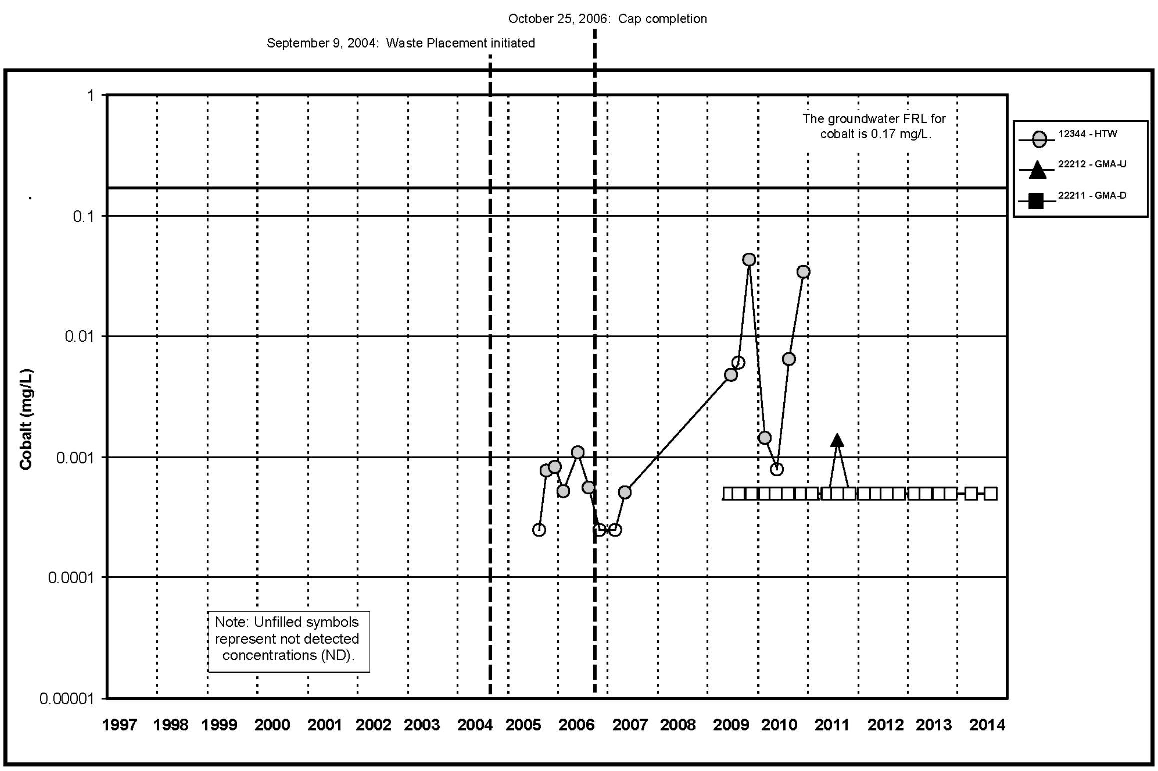


Figure A.5.7-20B. Cell 7 Cobalt Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

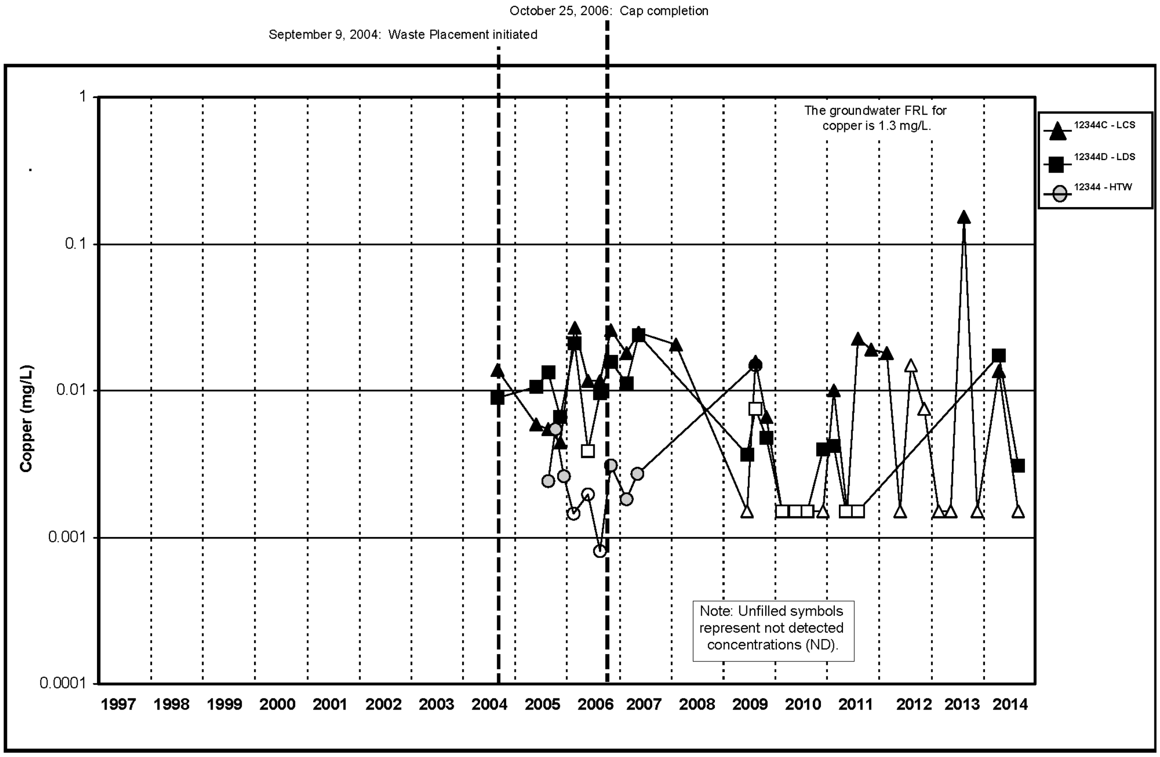


Figure A.5.7-21A. Cell 7 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

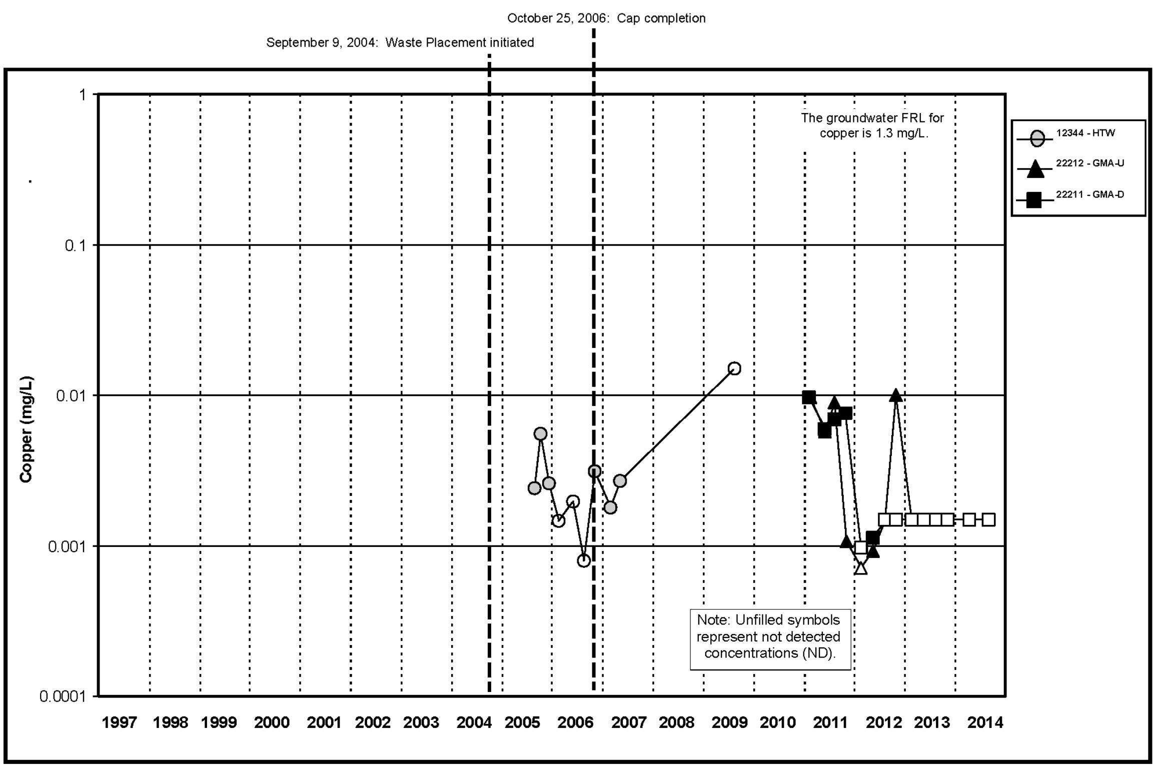


Figure A.5.7-21B. Cell 7 Copper Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

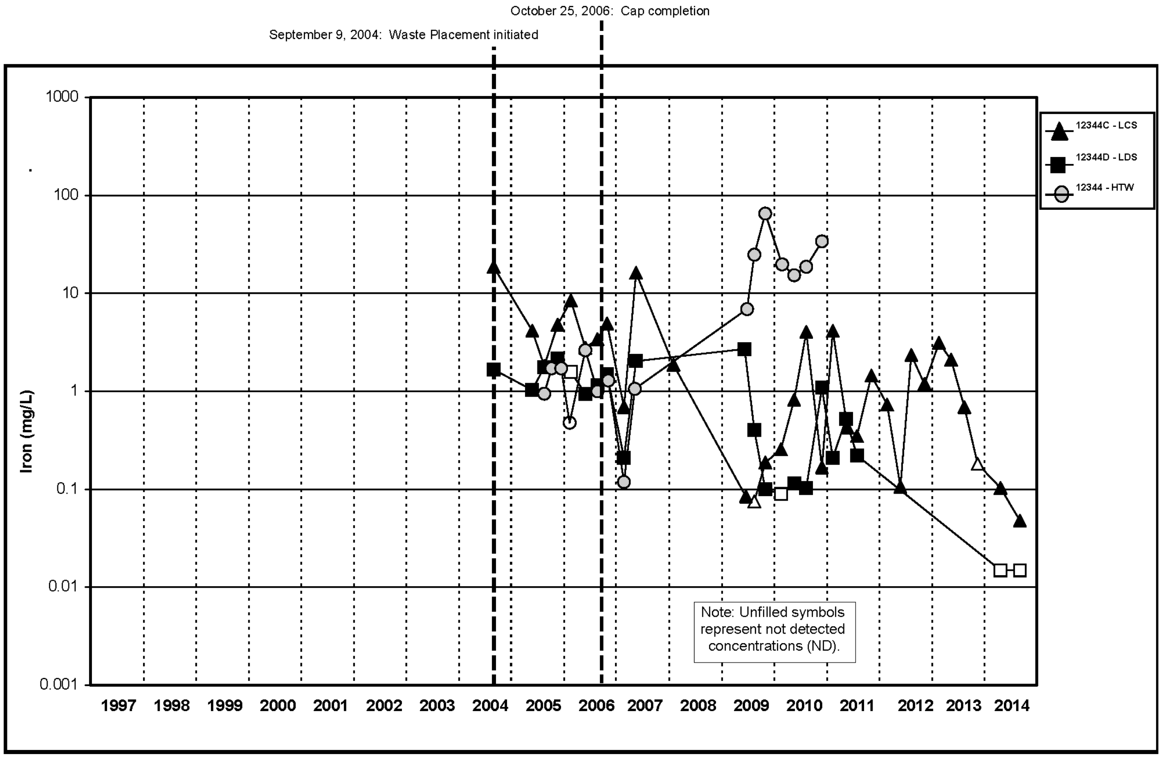


Figure A.5.7-22A. Cell 7 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

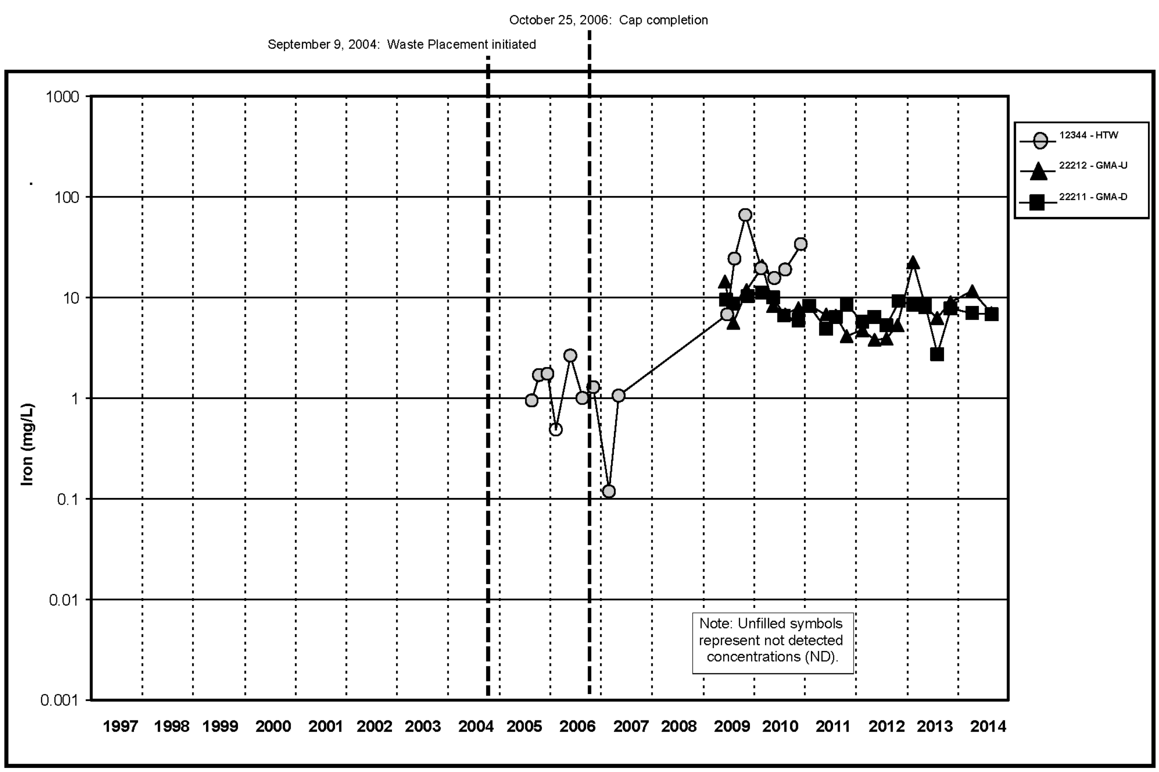


Figure A.5.7-22B. Cell 7 Iron Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

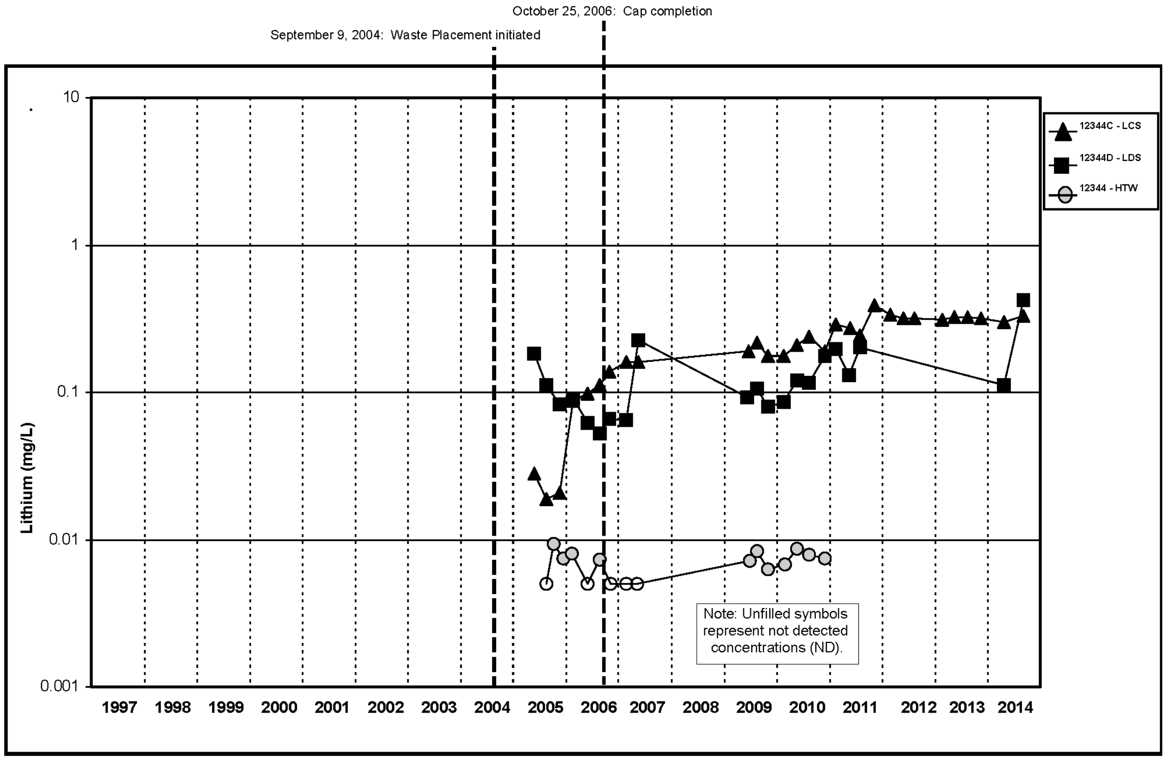


Figure A.5.7-23A. Cell 7 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

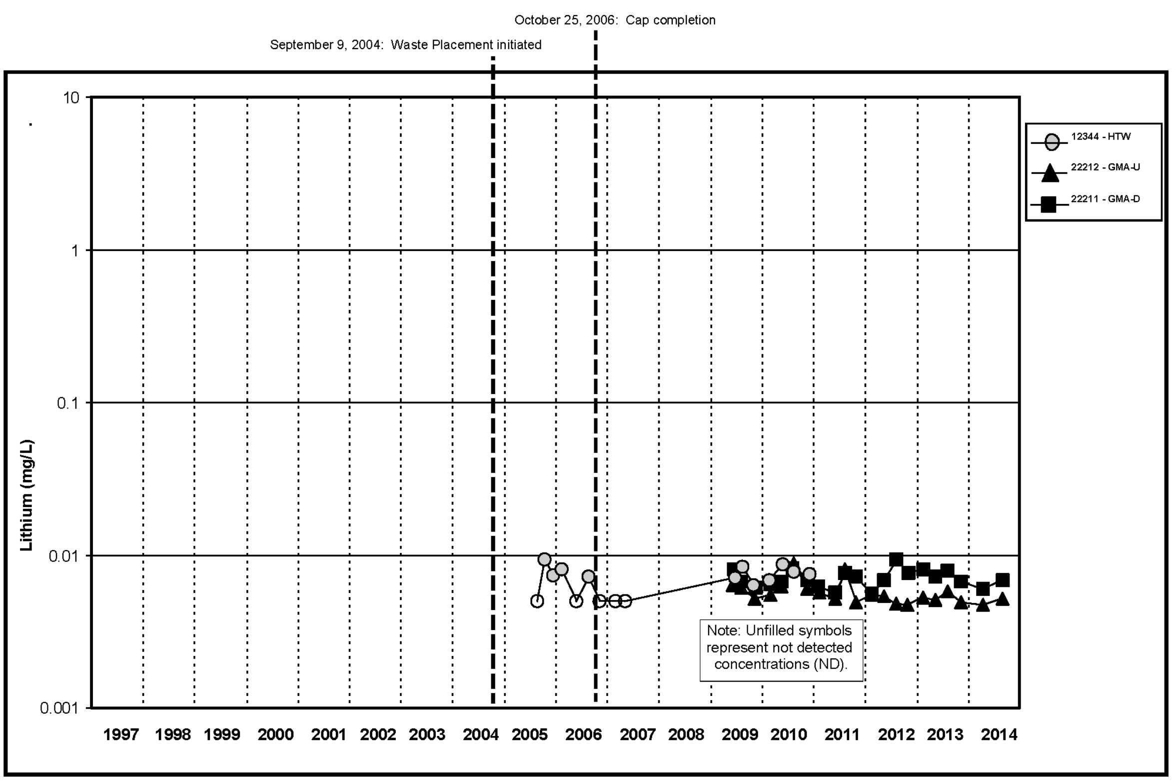


Figure A.5.7-23B. Cell 7 Lithium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

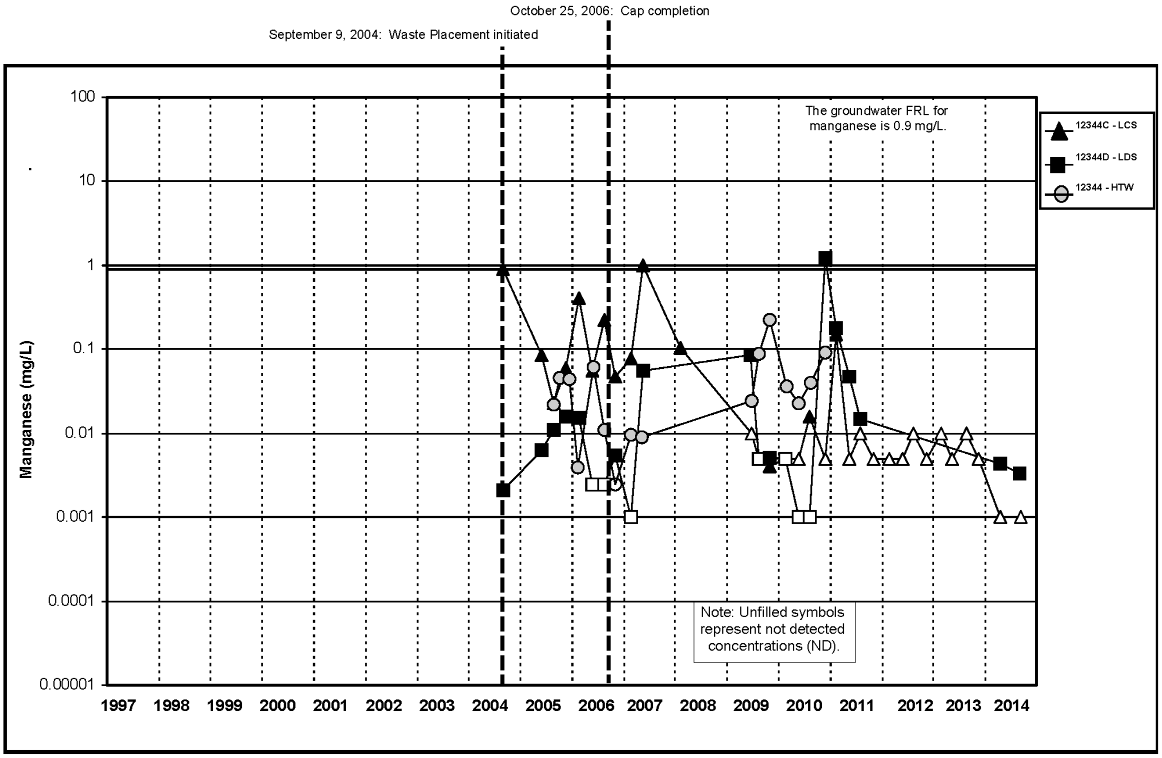


Figure A.5.7-24A. Cell 7 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

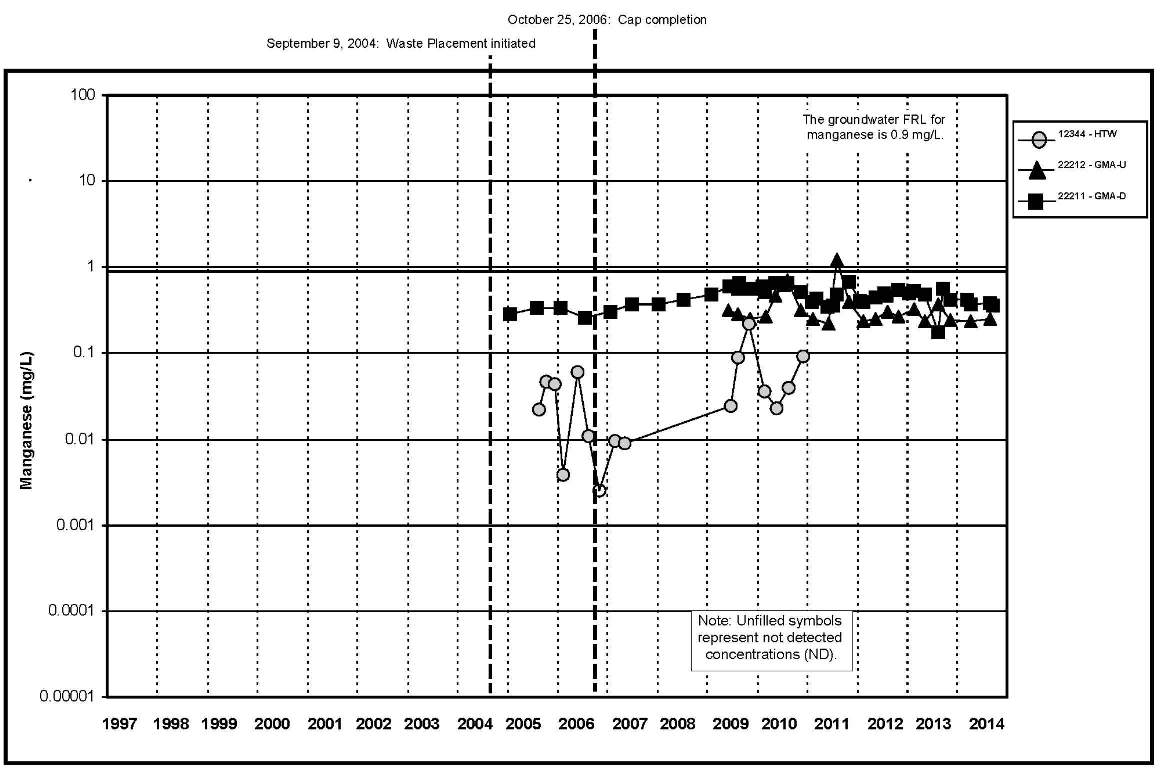


Figure A.5.7-24B. Cell 7 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

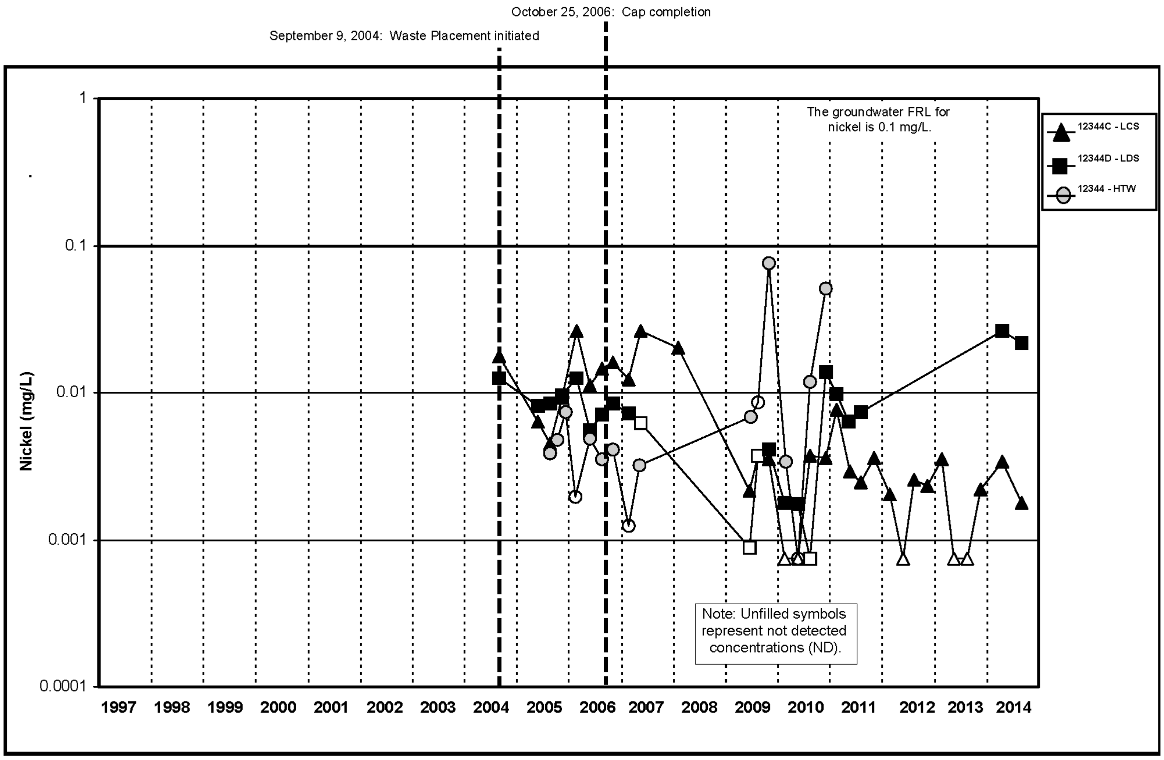


Figure A.5.7-25A. Cell 7 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

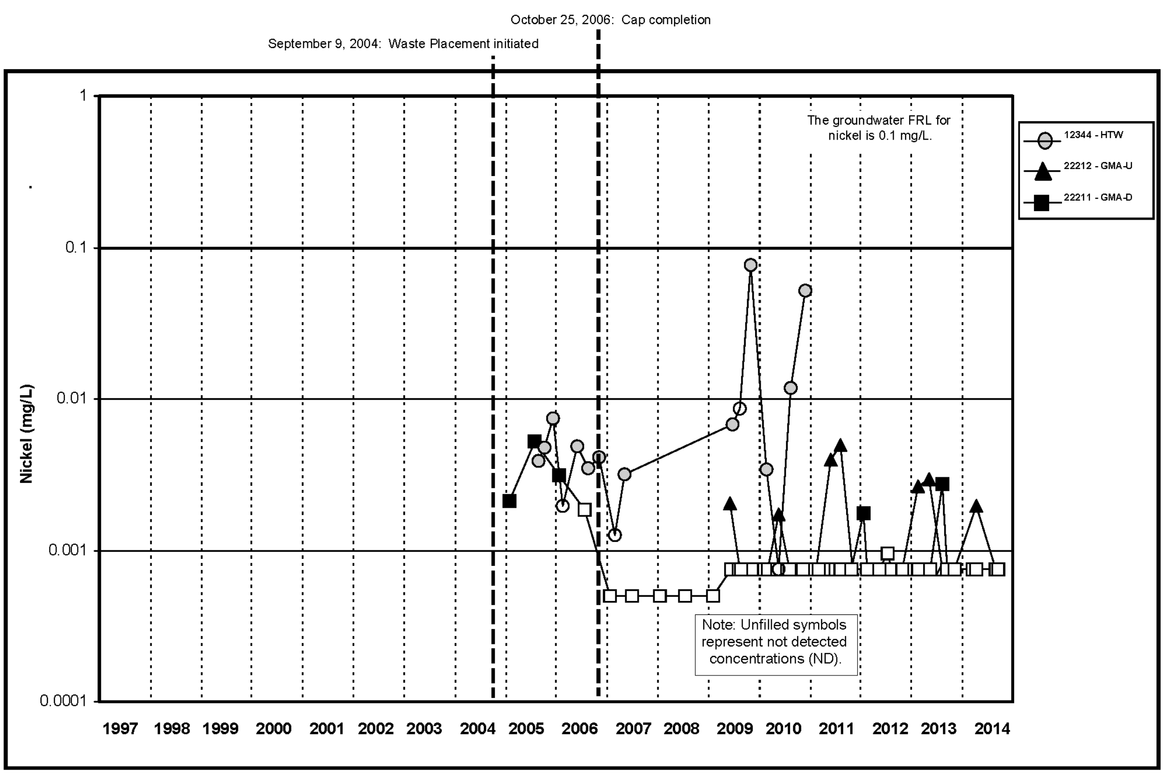


Figure A.5.7-25B. Cell 7 Nickel Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

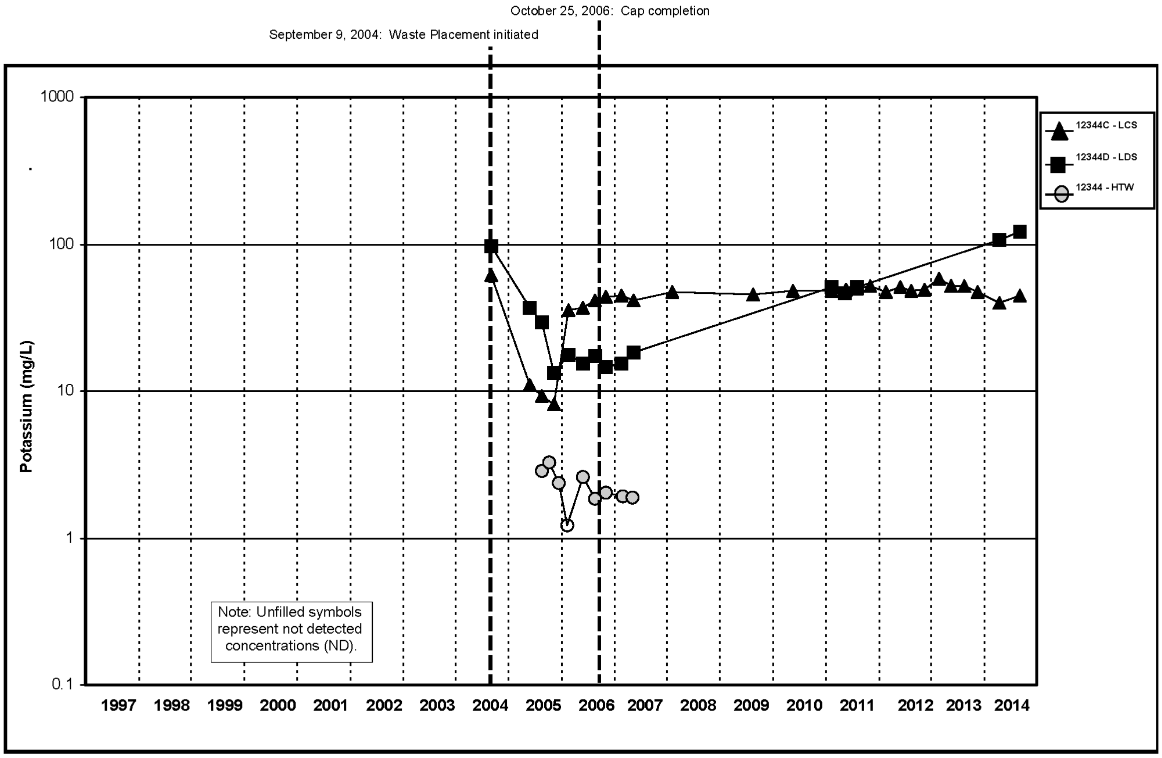


Figure A.5.7-26A. Cell 7 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

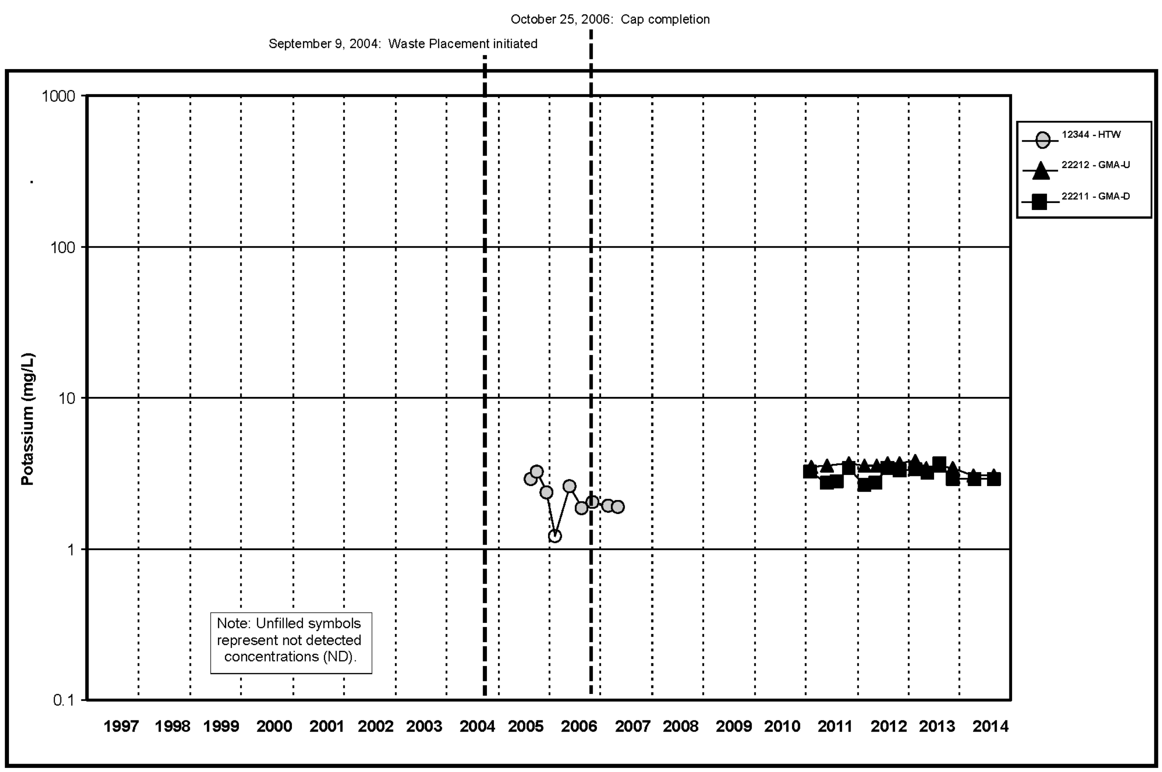


Figure A.5.7-26B. Cell 7 Potassium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

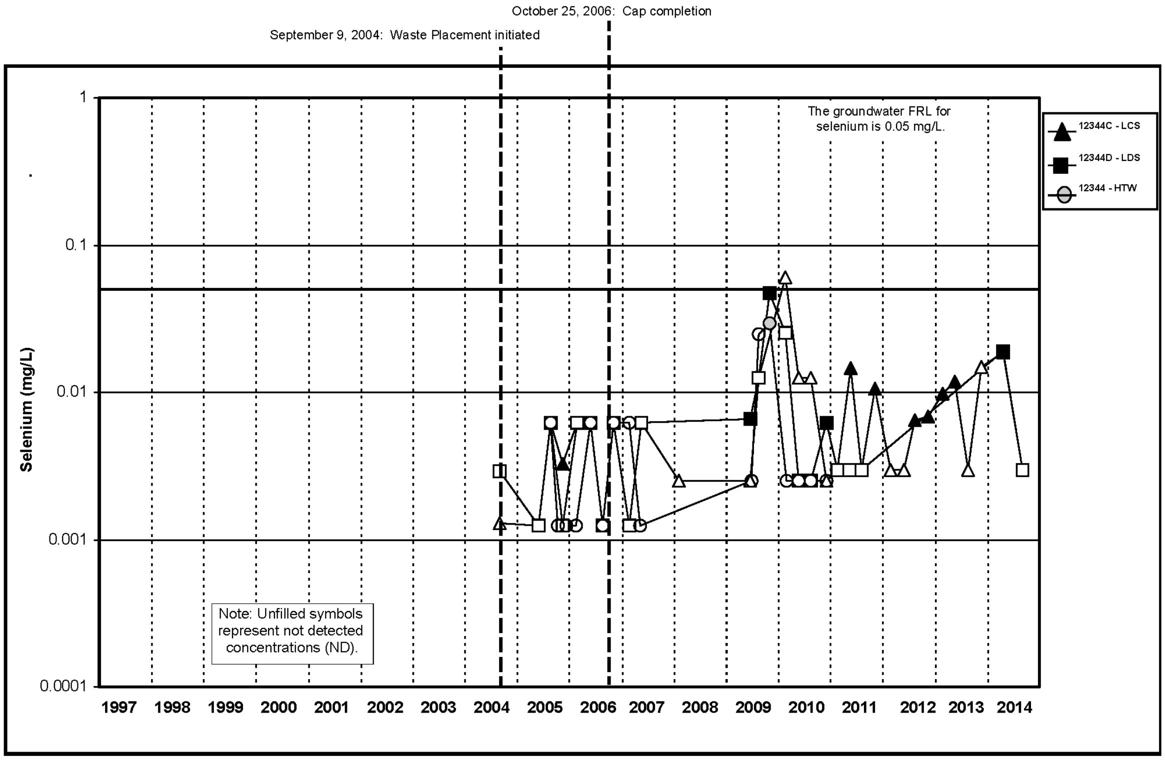


Figure A.5.7-27A. Cell 7 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

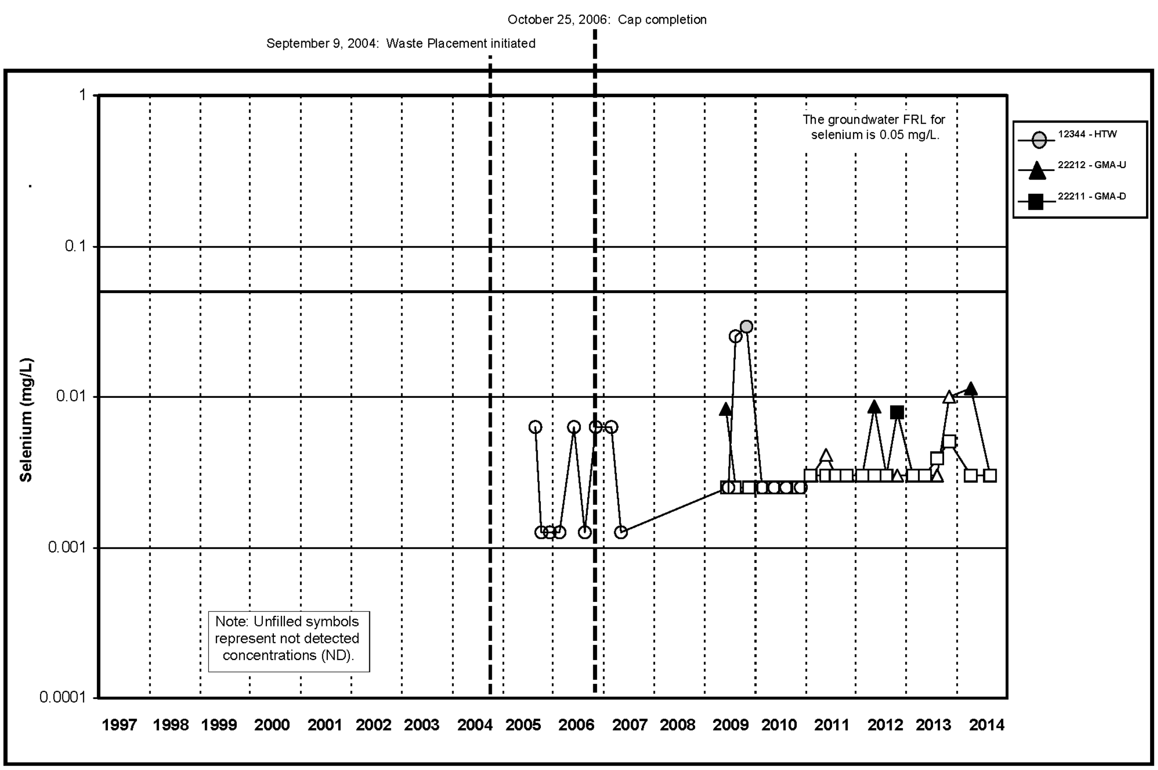


Figure A.5.7-27B. Cell 7 Selenium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

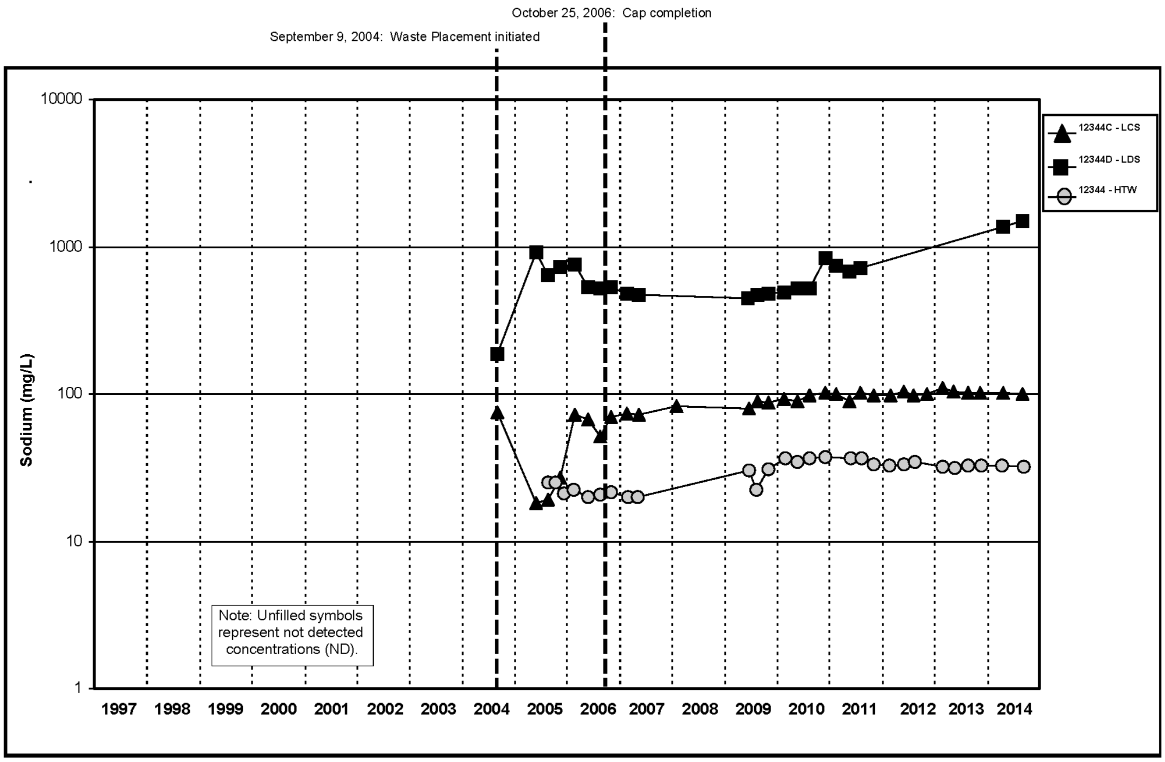


Figure A.5.7-28A. Cell 7 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

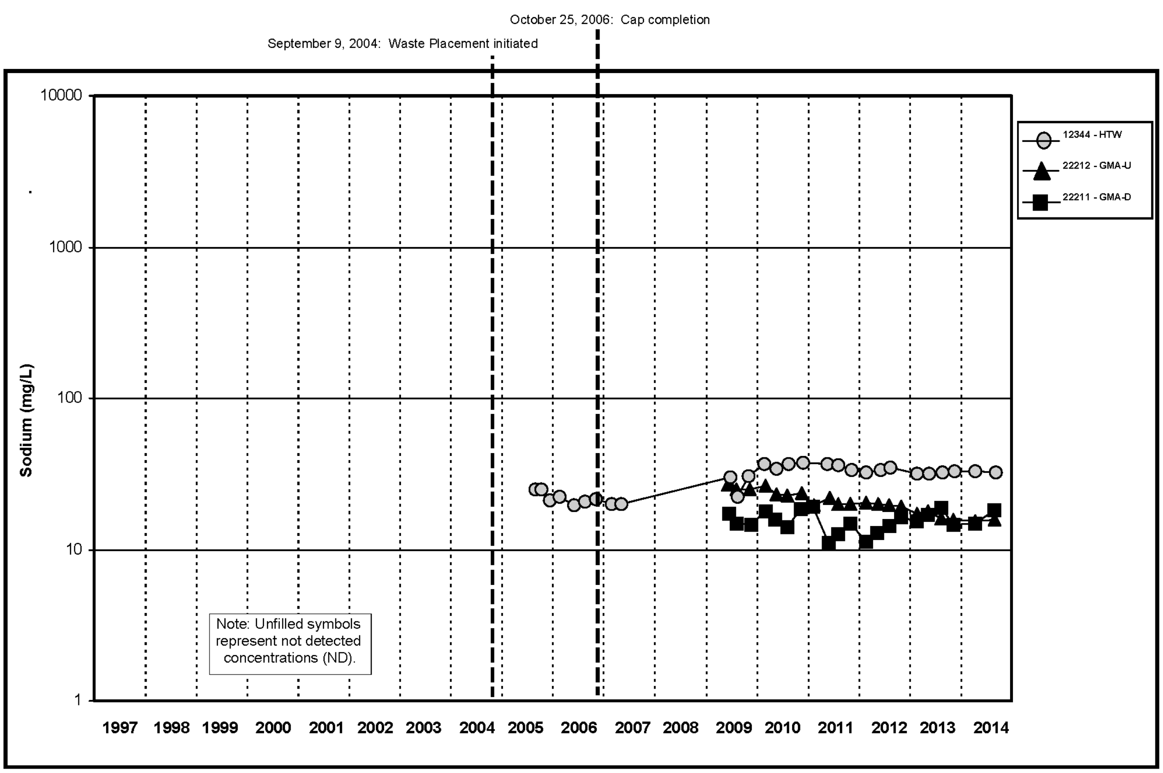


Figure A.5.7-28B. Cell 7 Sodium Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

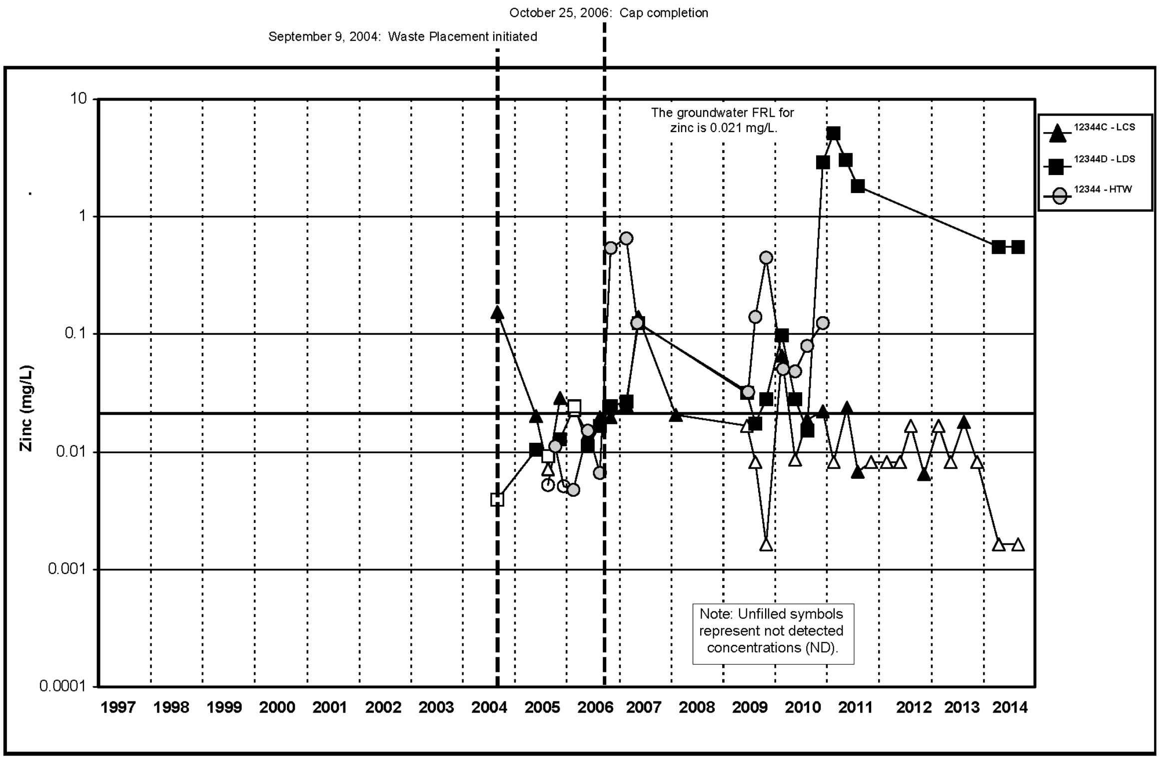


Figure A.5.7-29A. Cell 7 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

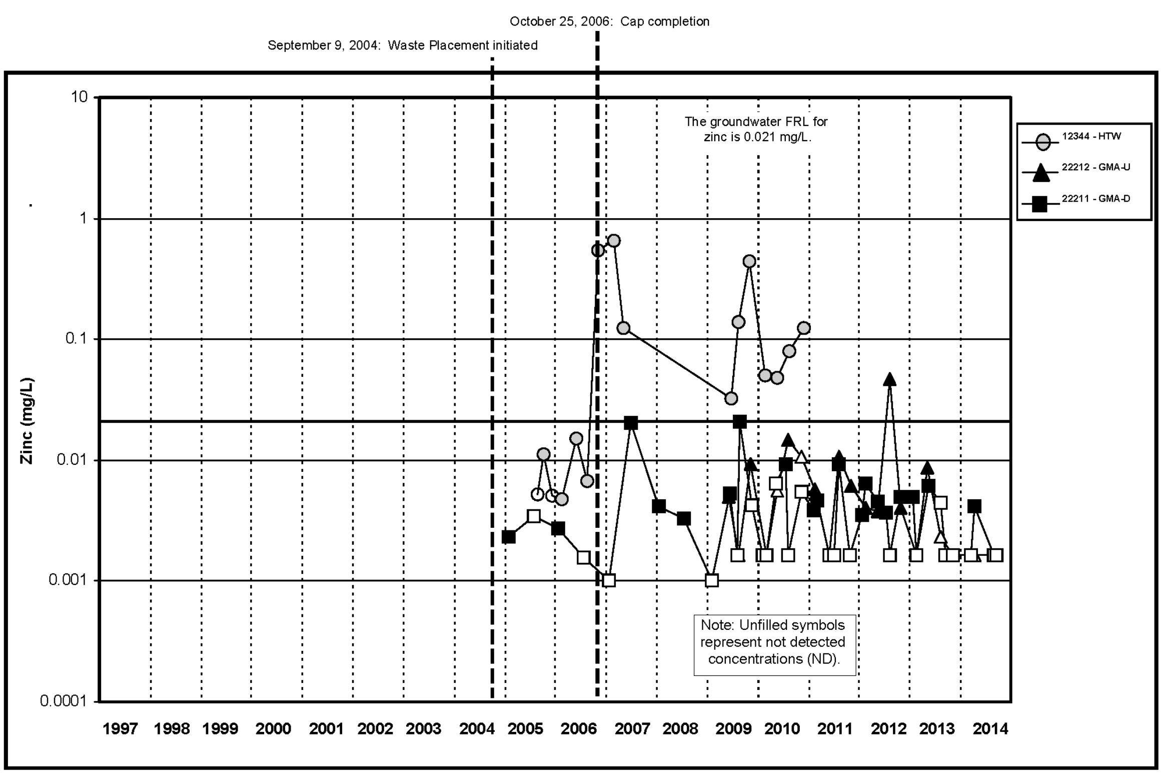


Figure A.5.7-29B. Cell 7 Zinc Concentration Versus Time Plot for HTW, GMA-U Well, and GMA-D Well

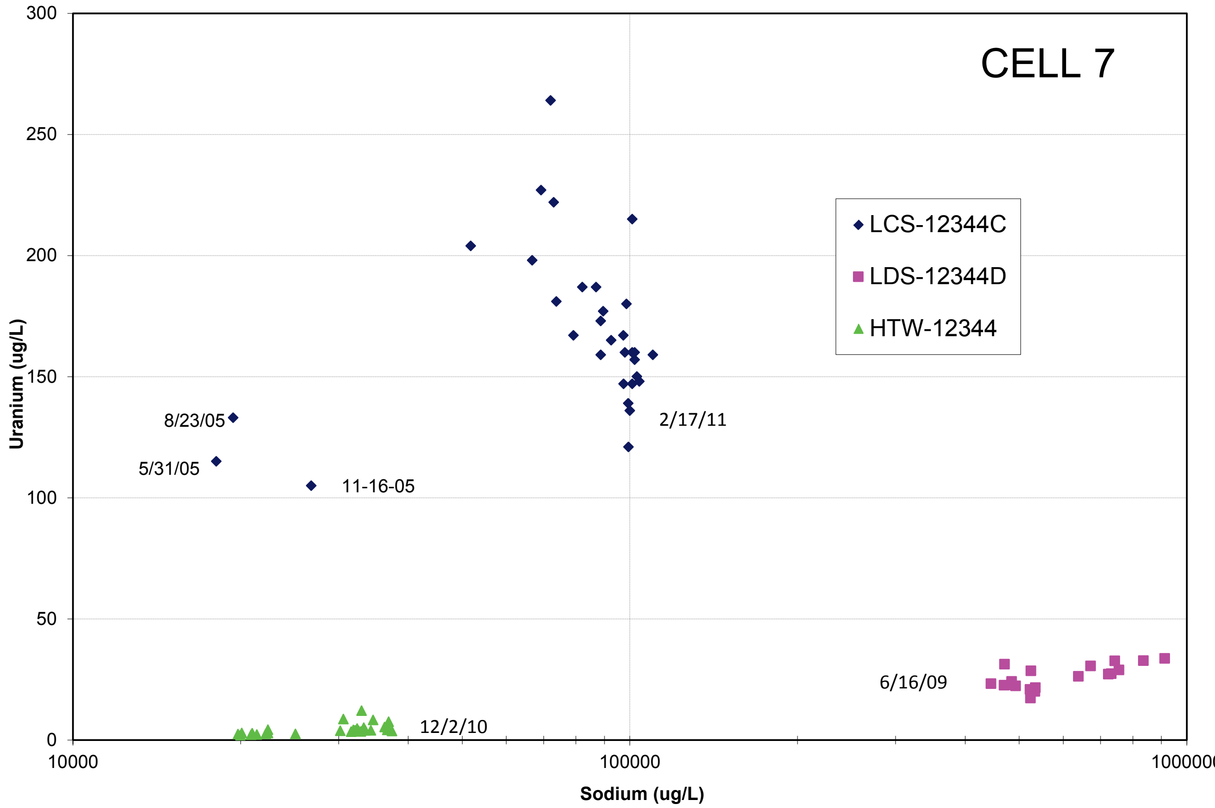


Figure A.5.7-30. Cell 7 Bivariate Plot for Uranium and Sodium

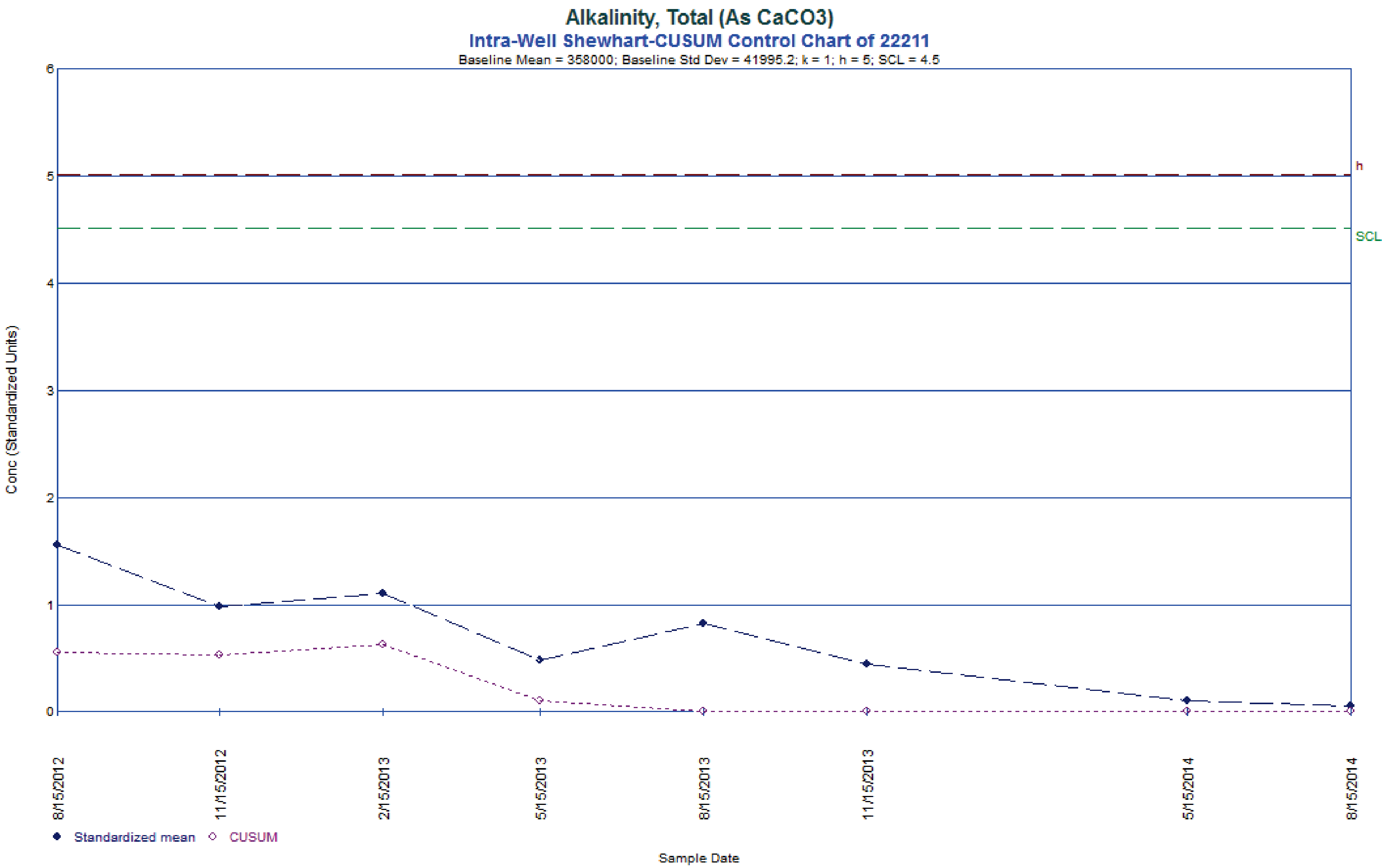


Figure A.5.7-31. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22211)

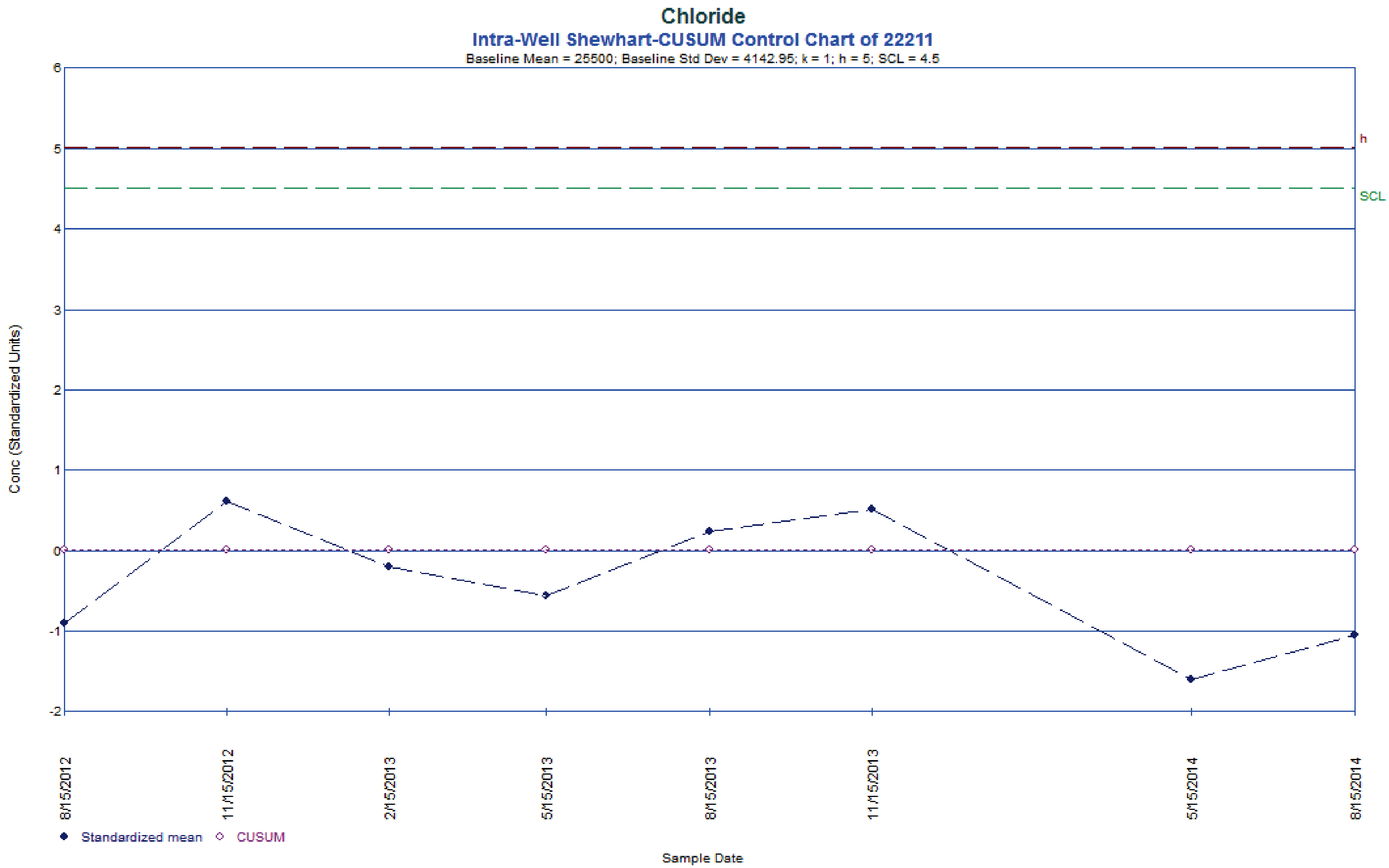


Figure A.5.7-32. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22211)

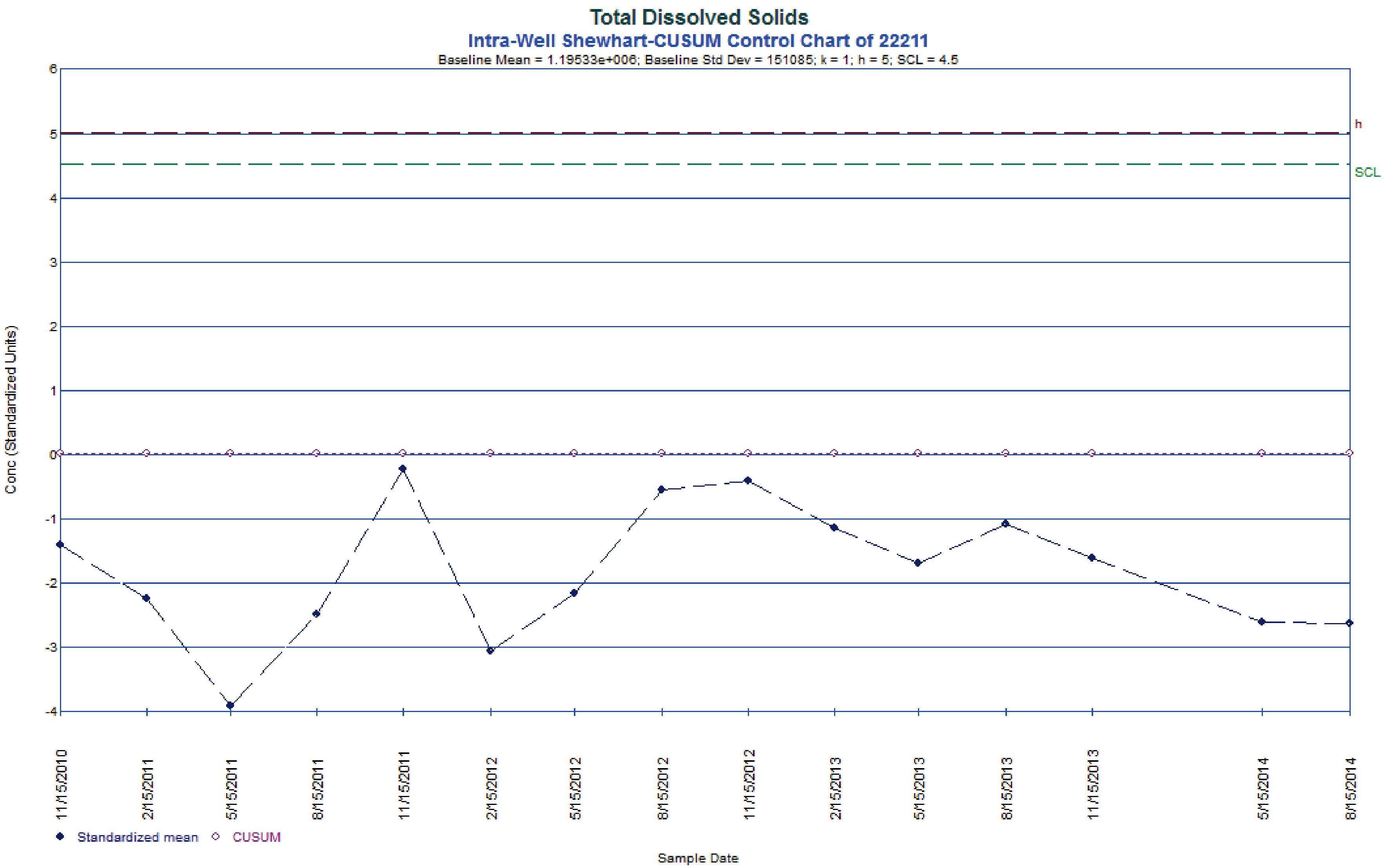


Figure A.5.7-33. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22211)

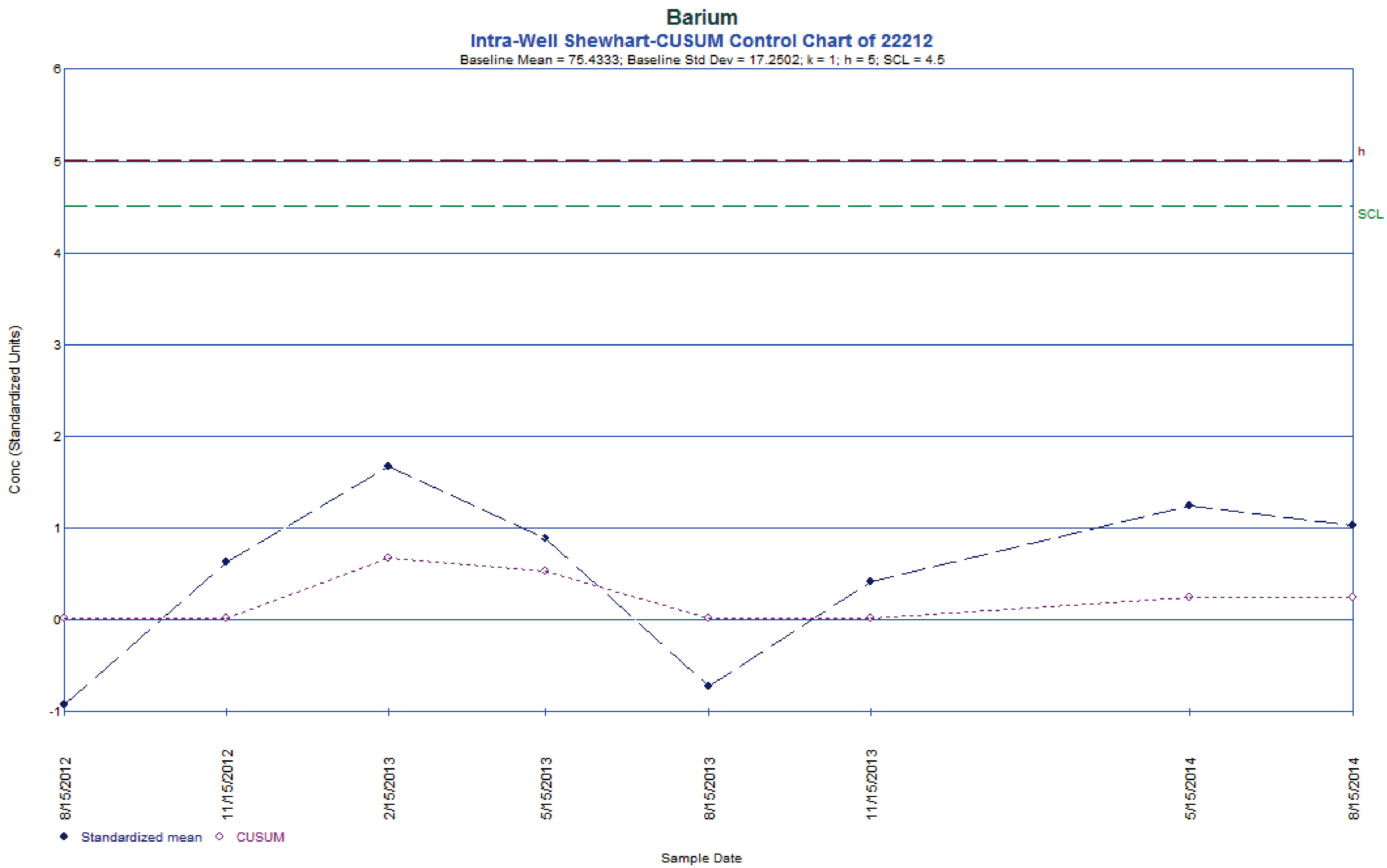


Figure A.5.7-34. Intra-Well Shewhart-CUSUM Control Chart (Barium 22212)

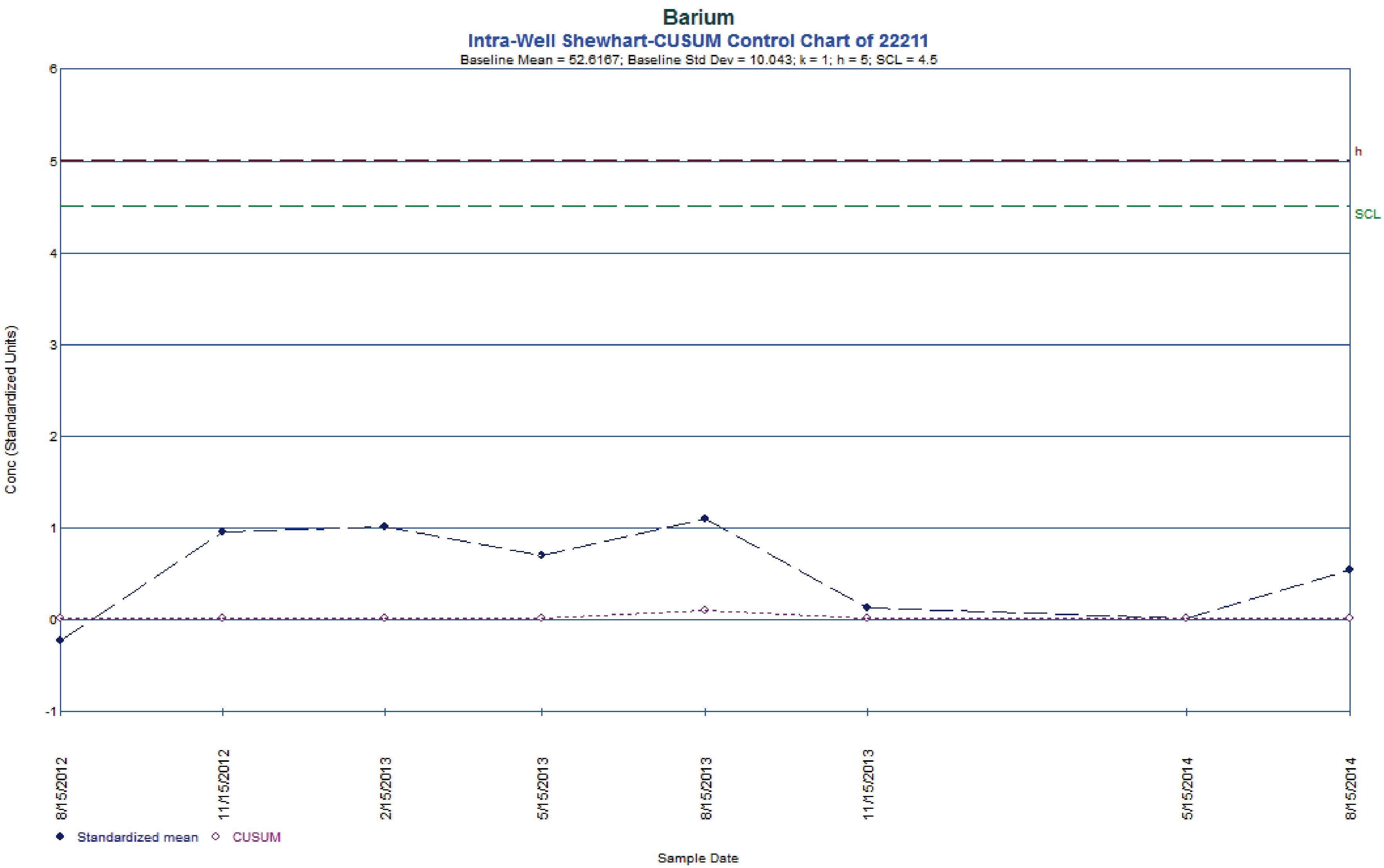


Figure A.5.7-35. Intra-Well Shewhart-CUSUM Control Chart (Barium 22211)

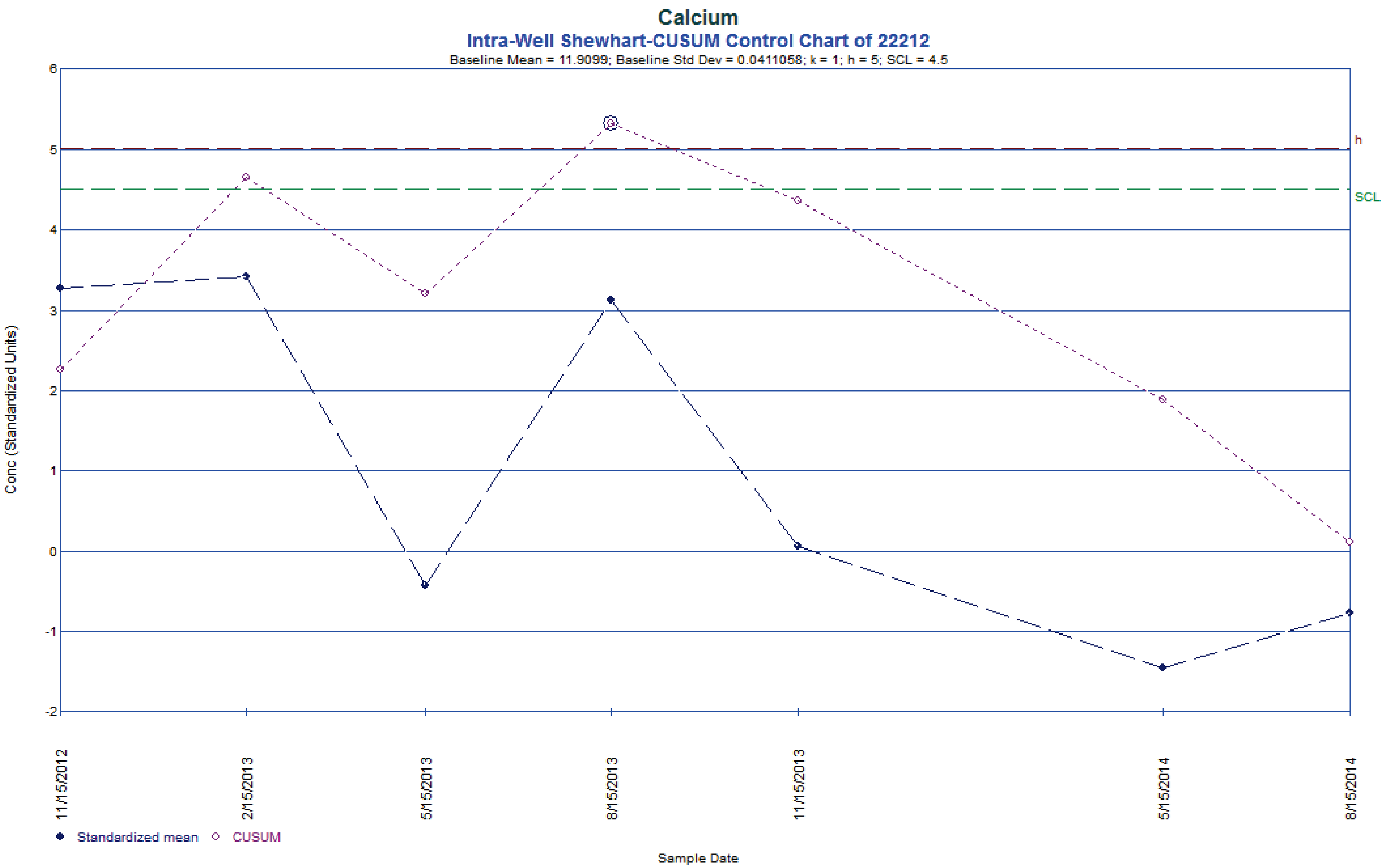


Figure A.5.7-36. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22212)

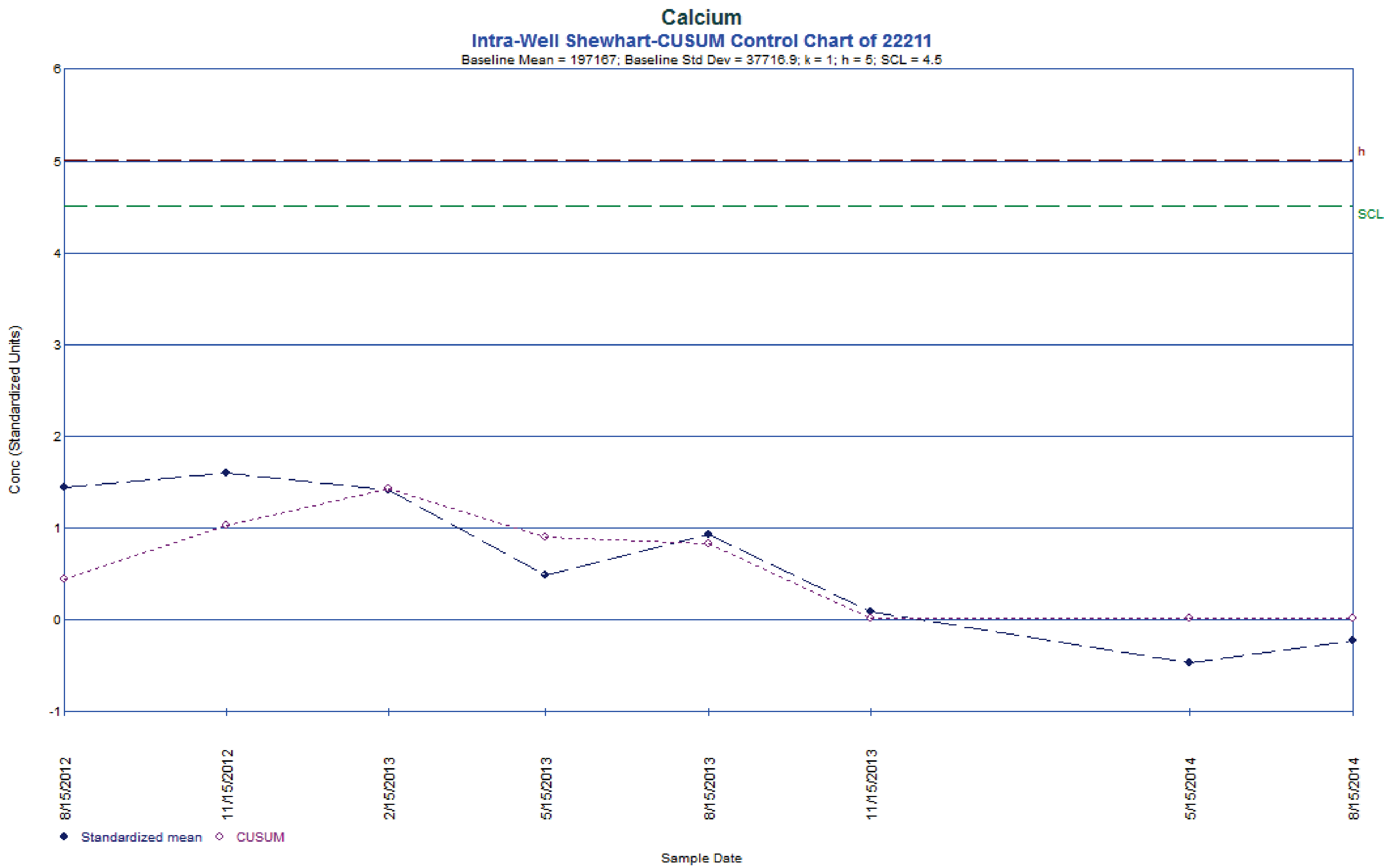


Figure A.5.7-37. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22211)

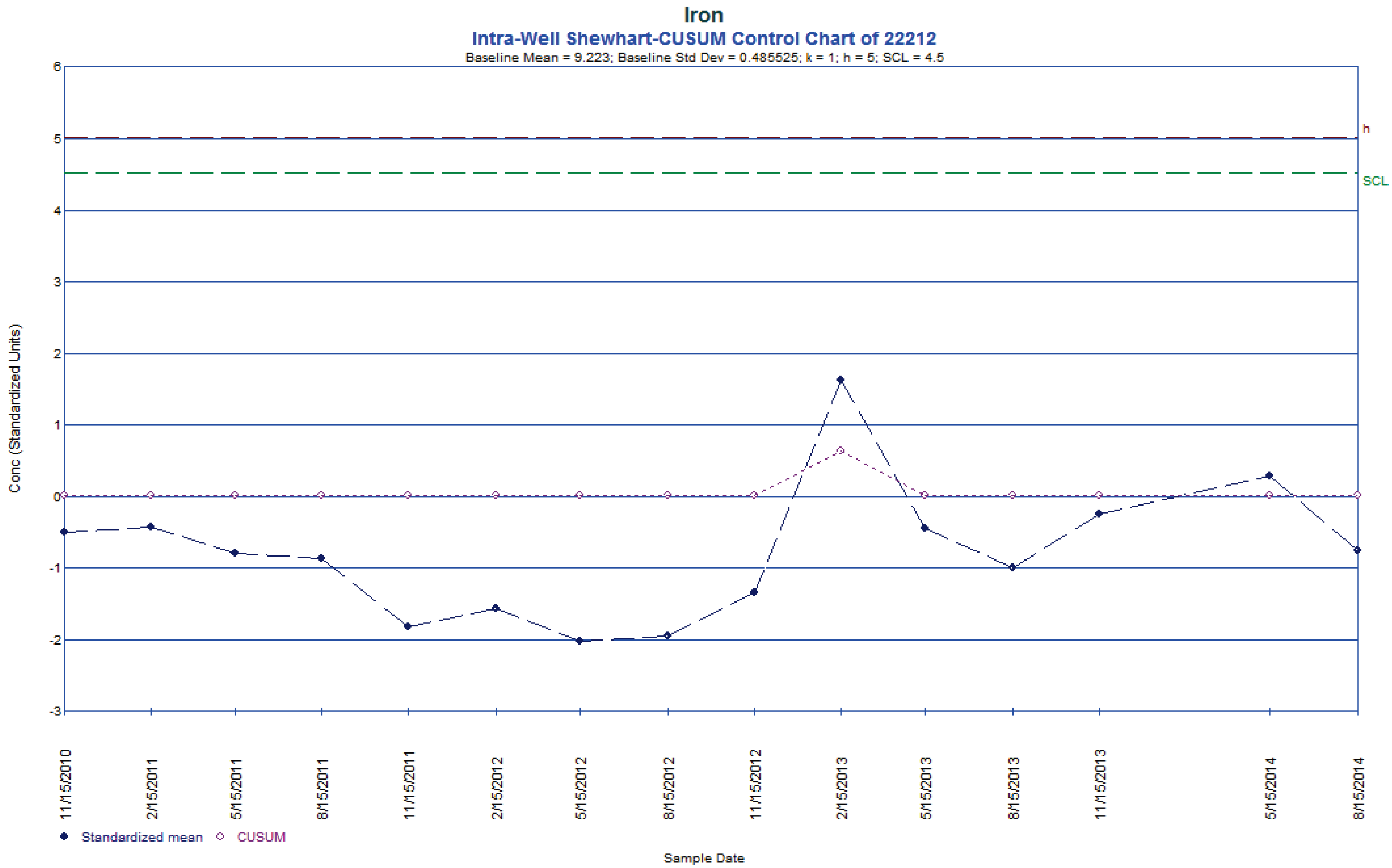


Figure A.5.7-38. Intra-Well Shewhart-CUSUM Control Chart (Iron 22212)

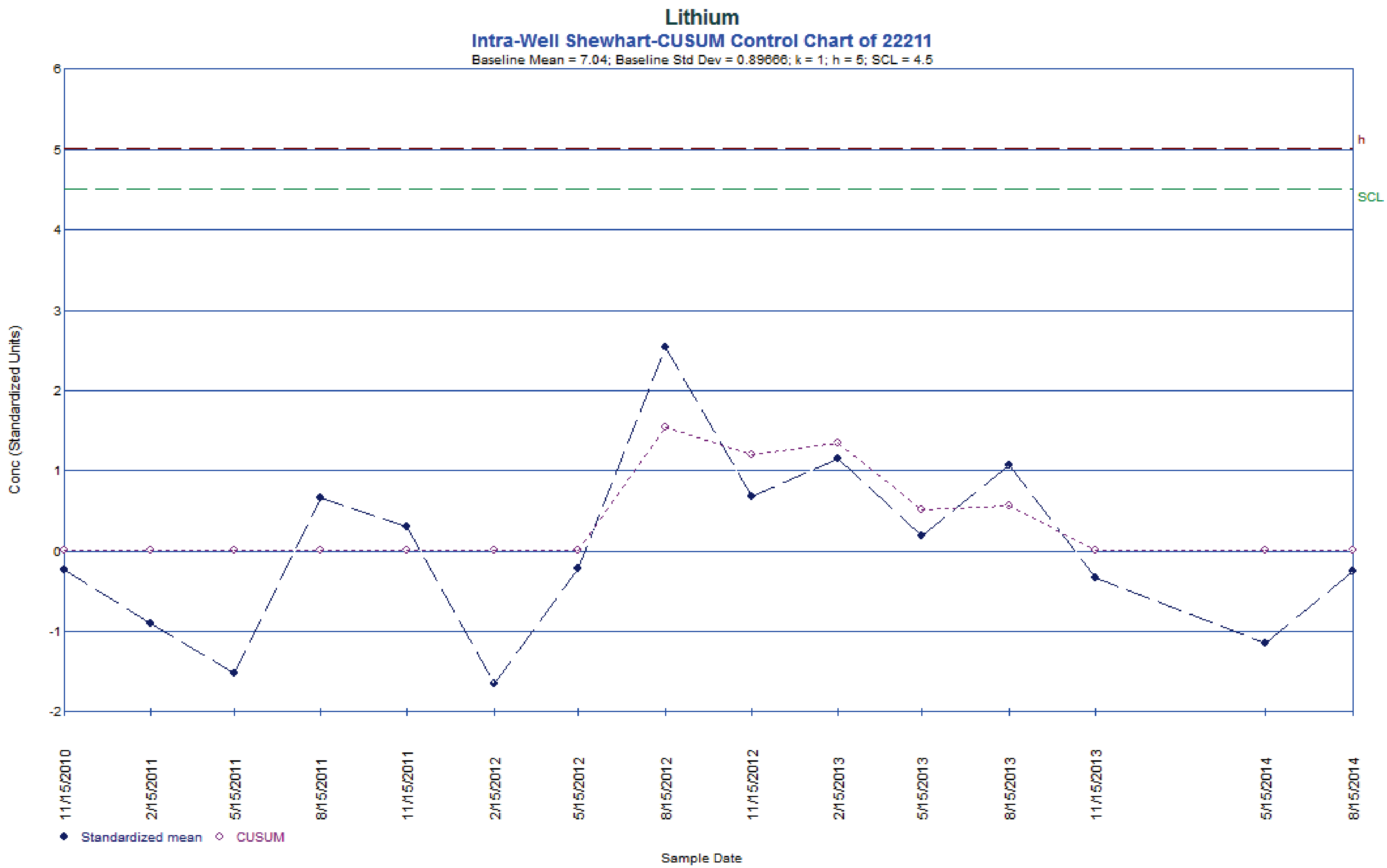


Figure A.5.7-39. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22211)

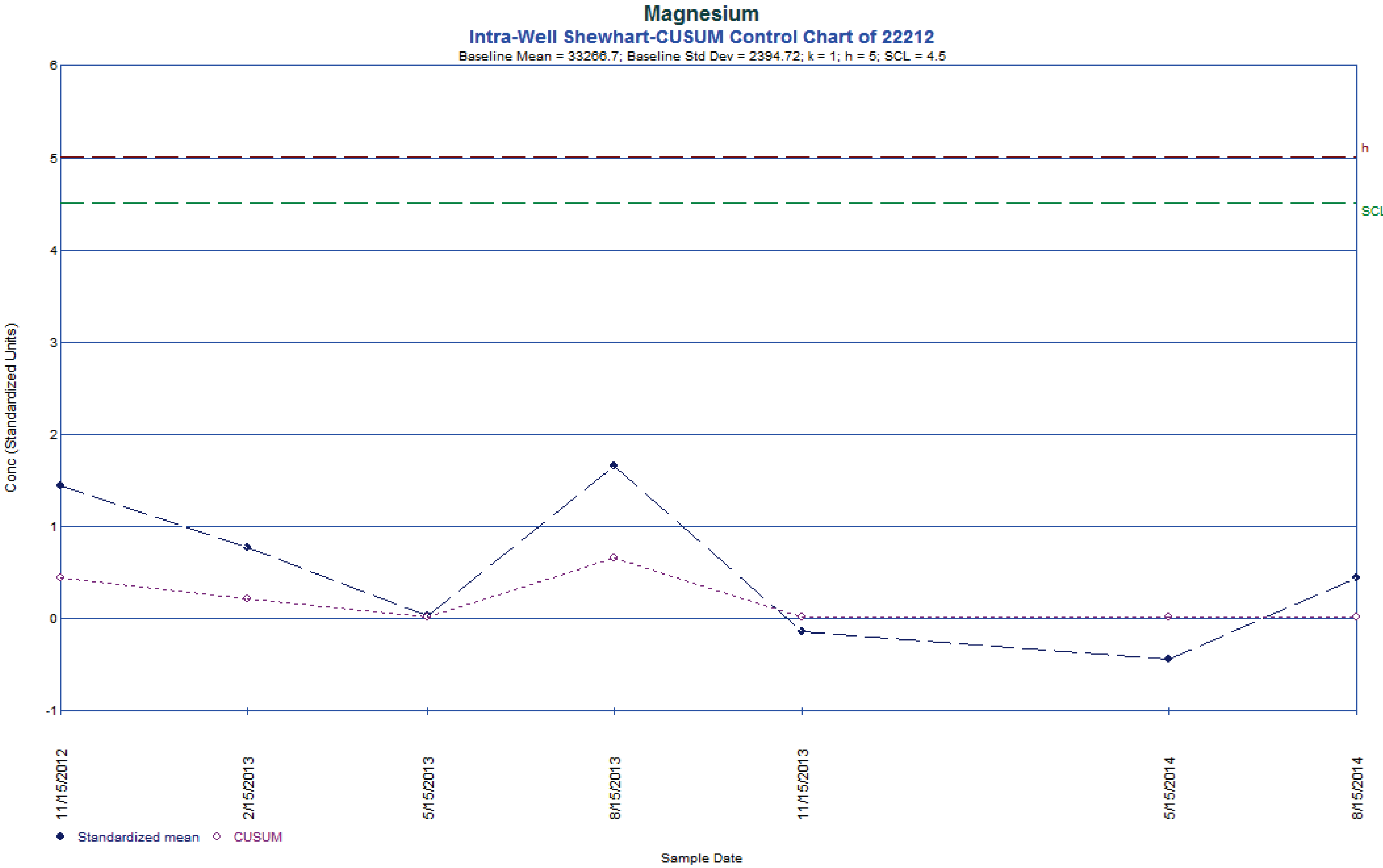


Figure A.5.7-40. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22212)

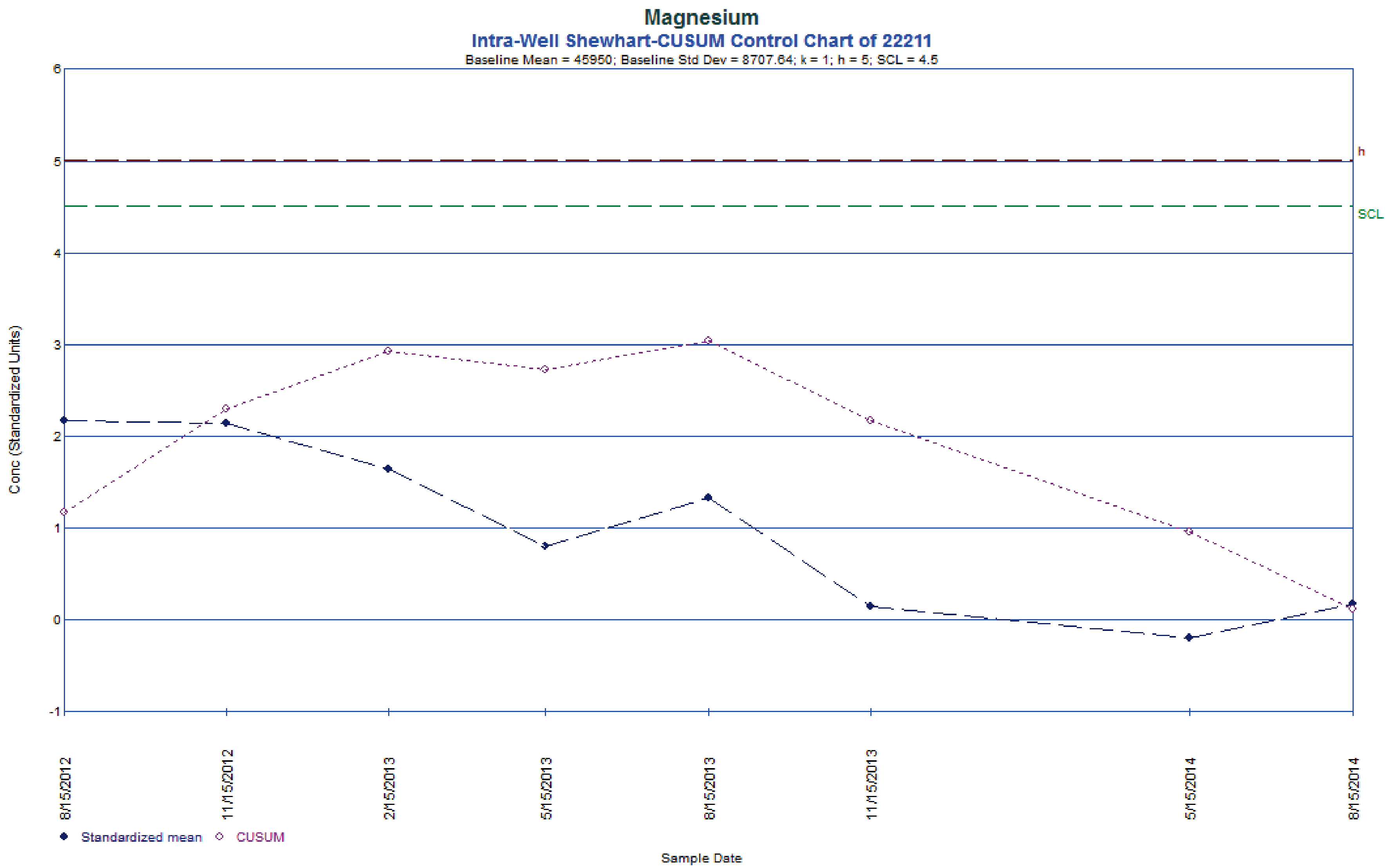


Figure A.5.7-41. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22211)

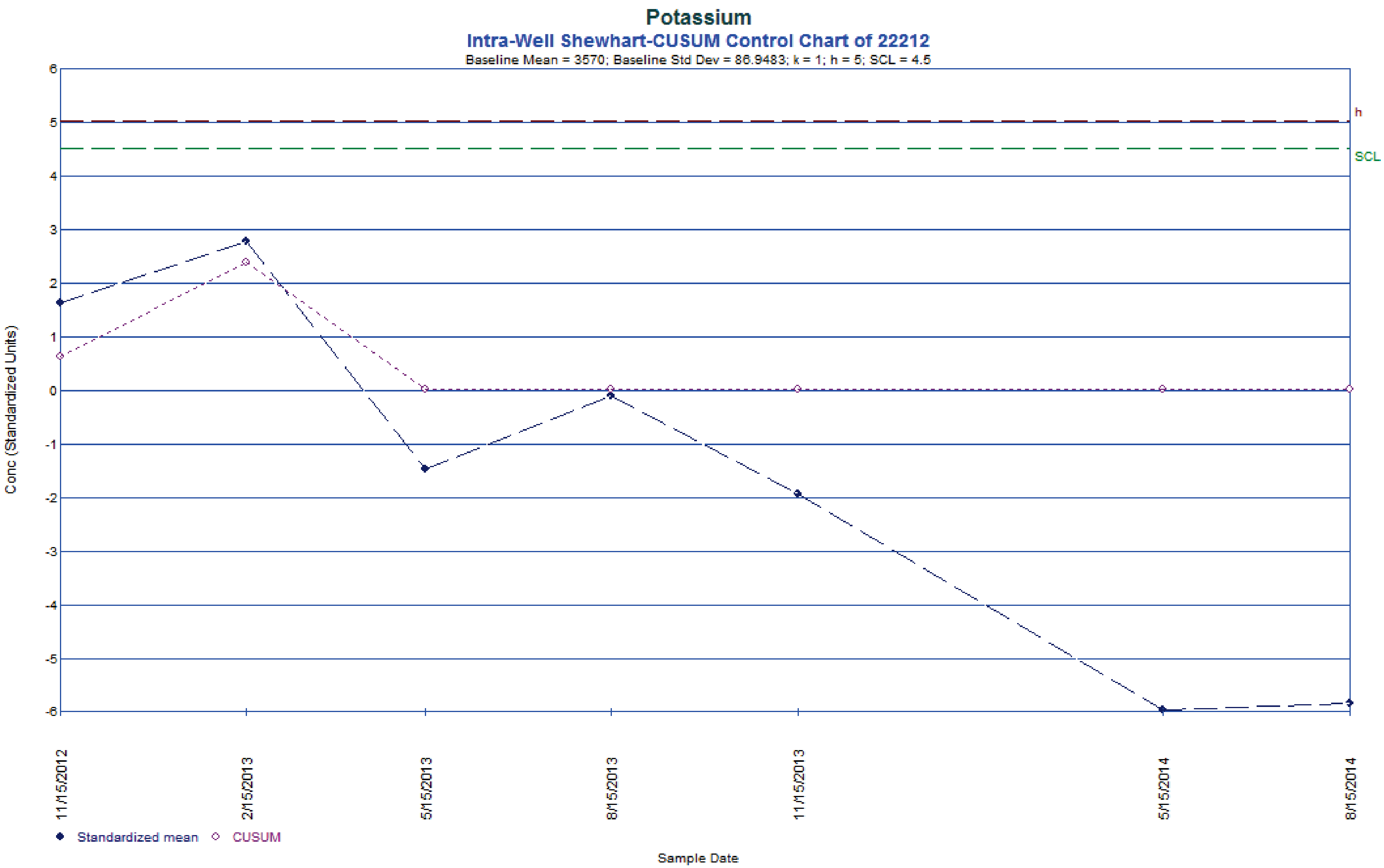


Figure A.5.7-42. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22212)

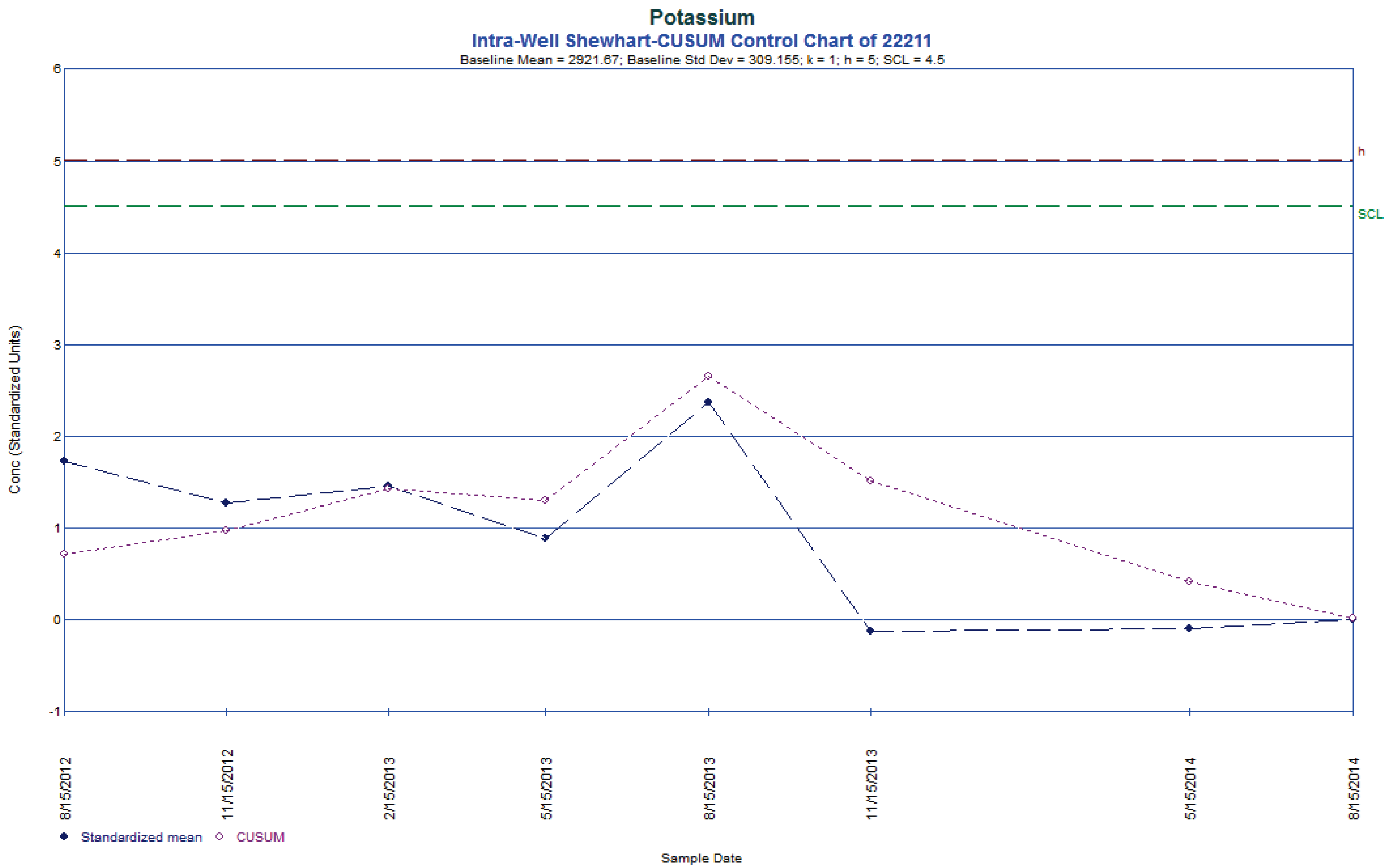


Figure A.5.7-43. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22211)

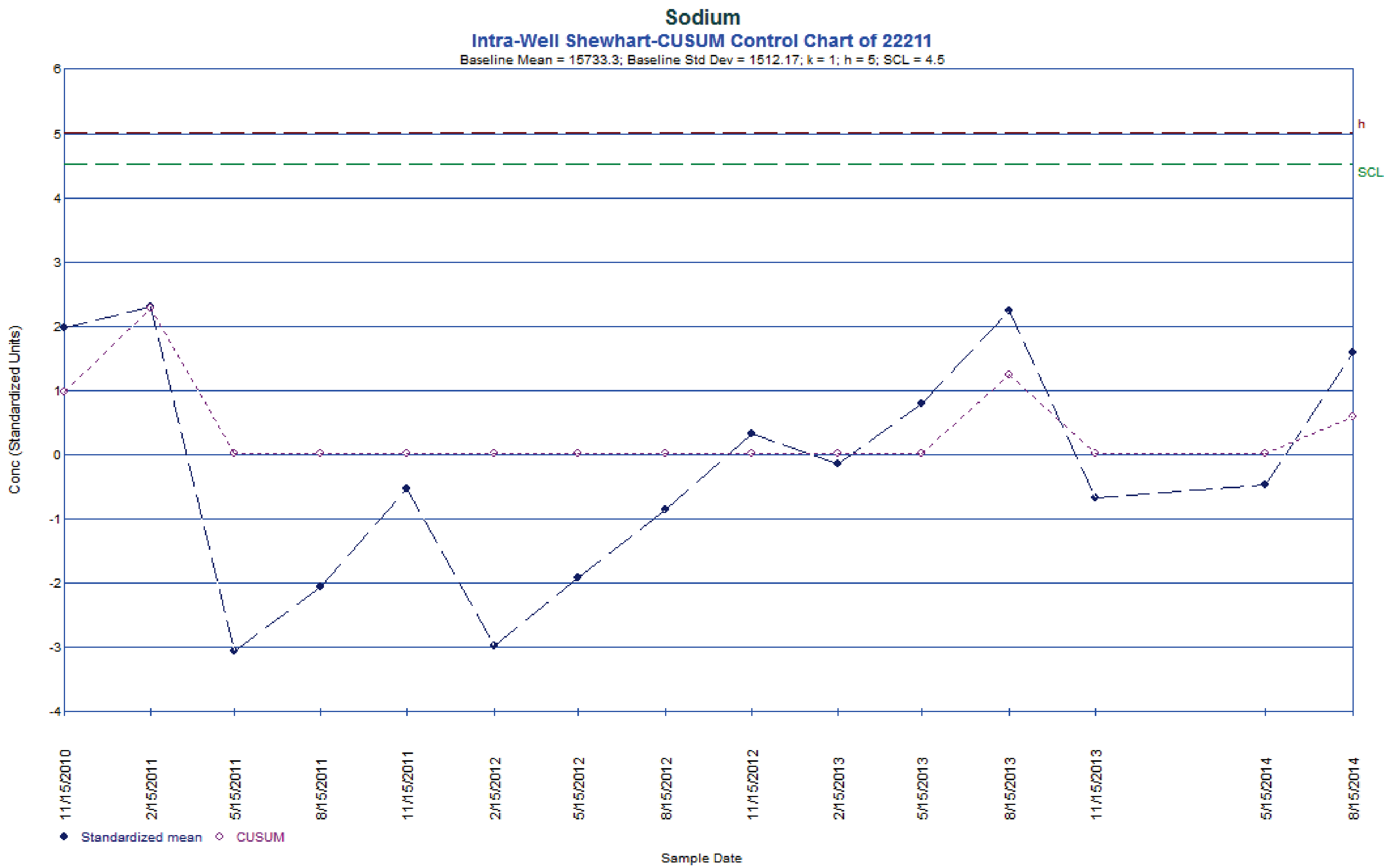


Figure A.5.7-44. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22211)

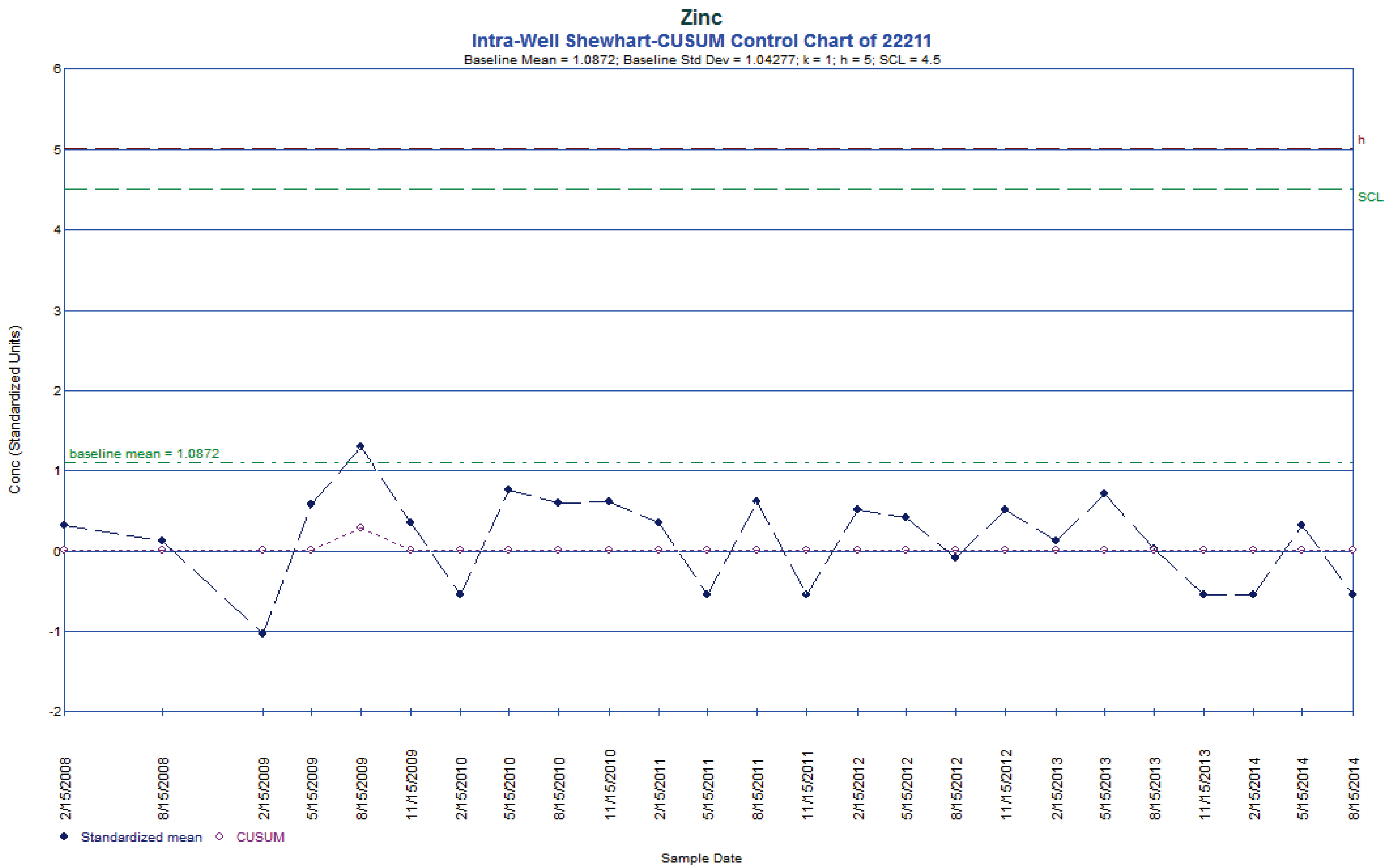


Figure A.5.7-45. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22211)

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Sub-attachment A.5.8

Cell 8

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Contents

Tables

Figures

Abbreviations

CUSUM	Shewhart-cumulative sum
EPA	U.S. Environmental Protection Agency
GMA	Great Miami Aquifer
HTW	horizontal till well
LCS	leachate collection system\
LDS	leak detection system
OSDF	On-Site Disposal Facility
SCL	Shewhart control limit
TDS	total dissolved solids
TOC	total organic carbon

The following information is provided in this sub-attachment:

- Semiannual monitoring summary statistics (refer to Table A.5.8-1)
- Annual leachate collection system (LCS) sample summary information for detected parameters (refer to Table A.5.8-2)
- LCS monthly accumulation volumes (refer to Figure A.5.8-1)
- Leak detection system (LDS) monthly accumulation volumes (refer to Figure A.5.8-2)
- On-Site Disposal Facility (OSDF) horizontal till well (HTW) 12345 water yield (refer to Figure A.5.8-3)
- Great Miami Aquifer (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 through A.5.8-31B)
- A bivariate plots (refer to Figure A.5.8-32 and A.5.8-33)
- Control charts (refer to Figures A.5.8-34 through A.5.8-55)

A.5.8.1 Water Quality Monitoring Results

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.

Until 2014, quarterly water quality monitoring occurred in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. With U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency concurrence, the U.S. Department of Energy changed from a quarterly sampling frequency to a semiannual sampling frequency at the start of 2014.

In 2014, 24 parameters were sampled biannually in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled biannually for arsenic, uranium, sodium, and sulfate. The Cell 8 HTW has been dry since the third quarter of 2008. In Cell 8, the LCS, LDS, and GMA wells are also sampled for technetium-99. Summary statistics are provided in Table A.5.8-1.

As shown in Table A.5.8-1, and summarized below, nine of the 24 parameters monitored semiannually in the LCS, LDS, HTW, and GMA wells, (uranium, chloride, sulfate, total dissolved solids [TDS], total organic carbon [TOC], boron, manganese, selenium, and sodium) 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).

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 8

Parameter	HTW 12345	GMA-U[a] 22213	GMA-D[a] 22214	GMA-SW[a] 22215	GMA-SE[a] 22217
Total Uranium		Up		Up	
Chloride			Up		
Sulfate		Up		Up	
Total Dissolved Solids				Up	
Total Organic Carbon		Up	Up	Up	
Boron		Up		Up	
Manganese				Up	
Selenium			Up	Up	
Sodium			Up	Up	

[a] GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; GMA-SE = southeast Great Miami Aquifer.
No entry indicates that the trend was not up.

Two bivariate plots are used to illustrate that the LCS, LDS, and HTW of Cell 8 have separate and distinct chemical signatures. A (uranium-sodium) bivariate plot for the Cell 8 LCS, LDS, and HTW is provided in Figure A.5.8-32 and a (uranium-sulfate) bivariate plot for the Cell 8 LCS, LDS, and HTW is provided in Figure A.5.8-33. 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. Therefore, the increasing concentrations measured beneath Cell 8 (i.e., HTW and or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and are not related to cell performance.

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 Shewhart-cumulative sum (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 “not in control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewhart 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 Shewhart control limit (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. When interpreting the control charts in this report, the SCL limit of 4.5 can be ignored.

As shown in Table A.5.8-1 in gray shading, 14 parameters in the HTW and/or GMA wells of Cell 8 (uranium, alkalinity, chloride, nitrate + nitrite as nitrogen, sulfate, TDS, total organic carbon, barium, boron, calcium, iron, magnesium, manganese, and potassium) meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 22 control charts.

Parameter	Monitoring Point[a]	Monitoring Well	Assessment	Figure Number
Uranium	HTW	12345	In Control	A.5.8-34
Uranium	GMA-SE	22217	In Control	A.5.8-35
Alkalinity	GMA-SW	22215	In Control	A.5.8-36
Alkalinity	GMA-SE	22217	In Control	A.5.8-37
Chloride	GMA-U	22213	In Control	A.5.8-38
Chloride	GMA-SW	22215	In Control	A.5.8-39
Nitrate+Nitrite as Nitrogen	GMA-SE	22217	In Control	A.5.8-40
Sulfate	GMA-SE	22217	In Control	A.5.8-41
Total Dissolved Solids	GMA-SE	22217	In Control	A.5.8-42
Total Organic Carbon	HTW	12345	In Control	A.5.8-43
Barium	GMA-D	22214	In Control	A.5.8-44
Barium	GMA-SW	22215	In Control	A.5.8-45
Boron	GMA-SE	22217	In Control	A.5.8-46
Calcium	GMA-SE	22217	In Control	A.5.8-47
Iron	GMA-U	22213	In Control	A.5.8-48
Iron	GMA-D	22214	In Control	A.5.8-49
Magnesium	GMA-SE	22217	In Control	A.5.8-50
Manganese	GMA-U	22213	In Control	A.5.8-51
Manganese	GMA-D	22214	In Control	A.5.8-52
Manganese	GMA-SE	22217	In Control	A.5.8-53
Potassium	GMA-D	22214	In Control	A.5.8-54
Potassium	GMA-SE	22217	In Control	A.5.8-55

[a] GMA-D = downgradient Great Miami Aquifer; GMA-U = upgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; GMA-SE = southeast Great Miami Aquifer, HTW = horizontal till well.

The control charts are presented in Figures A.5.8-34 through A.5.8-55 and all exhibit "in control" conditions.

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 semiannually. One new Appendix I parameter was detected (lead) in the LCS of Cell 8 in 2014. Detection of lead in the LCS of Cell 8 in 2015 will trigger sampling for lead in the LDS of Cell 8 during the next sampling event.

A.5.8.4 Cell 8 LDS Sampling

In addition to the 24 parameters being sampled for quarterly in the LCS, LDS, and GMA wells, the Cell 8 LDS is also being sampled for cadmium and 1,1-dichloroethene based on previous sampling results in the Cell 8 LCS.

Cadmium:
Cadmium was detected for the first time in the LCS of Cell 8 in 2011. It was detected again in the LCS of Cell 8 in 2012. Cadmium was not detected in either the LCS or LDS of Cell 8 in 2013 or 2014.

1,1-Dichloroethene:
1,1-dichloroethene was detected for the first time in the LCS of Cell 8 in 2009. In 2010, it was detected again in the LCS of Cell 8, triggering sampling in the LDS beginning in 2011. Sampled for twice in 2011, it was not detected in the Cell8 LDS. Sampled for once in 2012 (during the first three quarters of 2012 the LDS of Cell 8 was dry) 1,1-dichloroethene was not detected in the LDS of Cell 8. It was not detected in the LDS of Cell 8 in 2013 or 2014. 1,1-dichloroethene has not been detected in the LCS of Cell 8 since 2011.

A.5.8.5 Summary and Conclusions

- The HTW of Cell 8 has been dry since the third quarter of 2008.
- Nine parameters monitored semiannually are increasing in either the HTW and/or GMA wells of Cell 8 (uranium, chloride, sulfate, TDS, TOC, boron, manganese, selenium, and sodium).
- 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-two control charts were constructed for Cell 8 parameters. All of the control charts exhibit “in control” conditions.
- One new Appendix I parameter (lead) was detected in the LCS of Cell 8 in 2014. Detection of lead in the LCS of Cell 8 in 2015 will trigger sampling for lead in the LDS of Cell 8 during the subsequent next sampling event.
- Cadmium was not detected in either the LCS or LDS of Cell 8 in 2014.
- Sampling for 1,1-dichloroethene continues in the LDS of Cell 8, due to two prior detects in the LCS. 1,1-dichloroethene was not detected in the LDS of Cell 8 in 2014.

A.5.8.6 References

EPA (U.S. Environmental Protection Agency), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities -Unified Guidance*, EPA 530/R-09-007, March.

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Table A.5.8-1. Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Uranium (µg/L)	LCS	12345C	38	38	100	1.51	335	178	63	Normal	Up	Detected	
	LDS	12345D	33	33	100	9.38	64.4	23.5	12.0	LogNormal	Up	Detected	
	HTW	12345	16	16	100	3.67	7.30	5.02	0.99	Normal	None	Not Detected	
	GMA-U	22213	35	41	85.4	ND	0.717	0.387	0.129	Normal	Up	Detected	
	GMA-D	22214	42	43	97.7	ND	2.37	0.454	0.527	Undefined	None	Not Detected	
	GMA-SW	22215	32	35	91.4	ND	16.4	0.486	2.89	Undefined	Up	Not Detected	
	GMA-SE	22217	31	31	100	0.898	18.3	8.02	4.44	Normal	None	Not Detected	
Alkalinity as $CaCO_3$ (mg/L)	LCS	12345C	27	27	100	64.9	466	307	129	Undefined	None	Detected	
	LDS	12345D	19	19	100	170	487	255	107	Undefined	None	Not Detected	
	GMA-U	22213	14	14	100	230	368	332	31	Undefined	None	Not Detected	
	GMA-D	22214	14	14	100	212	354	288	48	Normal	Down	Not Detected	
	GMA-SW	22215	14	14	100	330	368	344	10	Normal	None	Not Detected	
	GMA-SE	22217	14	14	100	300	396	336	26	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12345C	27	27	100	18.9	414	292	126	Undefined	Up	Detected	
	LDS	12345D	19	19	100	34.5	248	103	62	LogNormal	Up	Detected	
	GMA-U	22213	14	14	100	25.2	52.0	35.8	8.2	Normal	None	Not Detected	
	GMA-D	22214	14	14	100	22.8	35.9	30.0	3.7	Normal	Up	Not Detected	
	GMA-SW	22215	14	14	100	30.2	43.6	36.3	3.8	Normal	None	Not Detected	
	GMA-SE	22217	14	14	100	23.1	40.5	31.7	4.9	Normal	None	Detected	
Nitrate, Nitrite (mg/L)	LCS	12345C	26	27	96.3	ND	74.6	30.9	18.3	Normal	None	Detected	
	LDS	12345D	13	19	68.4	ND	13.6	1.07	3.65	Undefined	Up	Detected	
	GMA-U	22213	0	14	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	1	14	7.1	ND	0.05	Insufficient	Insufficient	Undefined	Down	Detected	
	GMA-SW	22215	1	14	7.1	ND	0.025	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-SE	22217	4	14	28.6	ND	0.085	0.0236	0.0221	LogNormal	None	Not Detected	
Sulfate (mg/L)	LCS	12345C	38	38	100	146	4020	2580	990	Undefined	Up	Detected	
	LDS	12345D	33	33	100	1730	9210	3800	1830	LogNormal	Up	Detected	
	HTW	12345	15	15	100	95.5	152	116	18	Normal	None	Detected	
	GMA-U	22213	41	41	100	90.233333	284	196	59	Undefined	Up	Detected	
	GMA-D	22214	41	41	100	113	457	247	75	LogNormal	None	Detected	
	GMA-SW	22215	34	35	97.1	ND	911	222	185	LogNormal	Up	Detected	
	GMA-SE	22217	31	31	100	163	1320	434	211	LogNormal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12345C	26	26	100	882	5580	5210	1270	Undefined	Up	Detected	
	LDS	12345D	18	18	100	3860	13,500	7500	2310	Normal	Up	Detected	
	GMA-U	22213	21	21	100	599	843	722	76	Normal	Down	Detected	
	GMA-D	22214	21	21	100	446	872	670	124	Normal	None	Detected	
	GMA-SW	22215	21	21	100	457	1800	740	329	Undefined	Up	Not Detected	
	GMA-SE	22217	21	21	100	699	1550	1030	220	Normal	None	Not Detected	

Table A.5.8-1 (continued). Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Total Organic Carbon (mg/L)	LCS	12345C	35	38	92.1	ND	5.31	2.30	0.78	LogNormal	None	Not Detected	
	LDS	12345D	32	33	97.0	ND	5.45	3.19	0.95	Normal	None	Detected	
	GMA-U	22213	36	41	87.8	ND	2.23	1.35	0.44	Normal	Up	Detected	
	GMA-D	22214	35	41	85.4	ND	2.03	1.35	0.40	Undefined	Up	Not Detected	
	GMA-SW	22215	30	35	85.7	ND	2.83	1.43	0.51	Normal	Up	Detected	
	GMA-SE	22217	30	31	96.8	ND	2.33	1.60	0.35	Normal	None	Not Detected	
Total Organic Halogens (mg/L)	LCS	12345C	26	38	68.4	ND	0.08	0.0178	0.0198	Undefined	Up	Detected	
	LDS	12345D	24	33	72.7	ND	0.0794	0.0164	0.0145	LogNormal	Up	Not Detected	
	GMA-U	22213	7	41	17.1	ND	0.056	0.00166	0.00946	Undefined	None	Not Detected	
	GMA-D	22214	9	41	22.0	ND	0.059	0.00166	0.0101	Undefined	None	Not Detected	
	GMA-SW	22215	10	35	28.6	ND	0.046	0.00166	0.00905	Undefined	None	Not Detected	
	GMA-SE	22217	11	31	35.5	ND	0.073	0.00166	0.0133	Undefined	None	Not Detected	
Arsenic (mg/L)	LCS	12345C	8	30	26.7	ND	0.142	0.00312	0.0374	Undefined	None	Not Detected	
	LDS	12345D	7	24	29.2	ND	0.0912	0.00952	0.0195	LogNormal	None	Not Detected	
	HTW	12345	0	7	0	ND	NA	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22213	7	21	33.3	ND	0.0406	0.00250	0.00980	Undefined	None	Not Detected	
	GMA-D	22214	8	31	25.8	ND	0.0457	0.00250	0.0108	Undefined	None	Detected	
	GMA-SW	22215	6	21	28.6	ND	0.043	0.00250	0.0112	Undefined	None	Detected	
	GMA-SE	22217	5	21	23.8	ND	0.0344	0.0025	0.00796	Undefined	None	Not Detected	
Barium (mg/L)	LCS	12345C	25	25	100	0.0178	0.103	0.0417	0.0238	LogNormal	Down	Detected	
	LDS	12345D	17	17	100	0.0146	0.0837	0.0322	0.0180	LogNormal	Down	Detected	
	GMA-U	22213	14	14	100	0.0945	0.132	0.106	0.011	Normal	Down	Not Detected	
	GMA-D	22214	14	14	100	0.0409	0.105	0.0731	0.0176	Normal	None	Not Detected	
	GMA-SW	22215	14	14	100	0.0409	0.122	0.0813	0.0197	Normal	None	Not Detected	
	GMA-SE	22217	14	14	100	0.0211	0.0844	0.0284	0.0195	Undefined	None	Not Detected	
Boron (mg/L)	LCS	12345C	38	38	100	0.0681	0.776	0.660	0.192	Undefined	Up	Detected	
	LDS	12345D	33	33	100	0.582	2.4	1.15	0.46	LogNormal	None	Detected	
	GMA-U	22213	38	41	92.7	ND	0.0463	0.0361	0.0068	Undefined	Up	Not Detected	
	GMA-D	22214	39	41	95.1	ND	0.0393	0.0294	0.0059	Undefined	None	Not Detected	
	GMA-SW	22215	33	35	94.3	ND	0.0746	0.0342	0.0093	Undefined	Up	Not Detected	
	GMA-SE	22217	29	31	93.6	ND	0.0382	0.0277	0.0056	Normal	None	Not Detected	
Calcium (mg/L)	LCS	12345C	25	25	100	65.4	874	613	219	Undefined	Up	Detected	
	LDS	12345D	17	17	100	279	678	486	94	Normal	None	Detected	
	GMA-U	22213	14	14	100	142	186	160	11	Normal	Down	Not Detected	
	GMA-D	22214	14	14	100	104	230	162	33	Normal	Down	Detected	
	GMA-SW	22215	14	14	100	127	446	188	96	Undefined	None	Not Detected	
	GMA-SE	22217	14	14	100	171	334	232	45	Normal	None	Not Detected	
Chromium (mg/L)	LCS	12345C	5	19	26.3	ND	0.0269	0.00405	0.00585	LogNormal	None	Not Detected	
	LDS	12345D	4	13	30.8	ND	0.0337	0.00577	0.00886	LogNormal	None	Not Detected	
	GMA-U	22213	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	2	6	33.3	ND	0.00277	Insufficient	Insufficient	Normal	None	Not Detected	
	GMA-SW	22215	0	6	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SE	22217	4	6	66.7	ND	0.0112	0.00485	0.00351	Normal	None	Not Detected	

Table A.5.8-1 (continued). Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Cobalt (mg/L)	LCS	12345C	10	30	33.3	ND	0.0029	0.000500	0.000731	Undefined	Down	Detected	
	LDS	12345D	7	24	29.2	ND	0.0025	0.000500	0.000747	Undefined	Down	Detected	
	GMA-U	22213	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SW	22215	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SE	22217	14	21	66.7	ND	0.00216	0.00111	0.00049	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12345C	16	30	53.3	ND	0.12	0.00445	0.0218	Undefined	None	Not Detected	
	LDS	12345D	12	24	50.0	ND	0.16	0.00677	0.0326	Undefined	None	Not Detected	
	GMA-U	22213	5	14	35.7	ND	0.0111	0.00150	0.00299	Undefined	None	Detected	
	GMA-D	22214	5	14	35.7	ND	0.0105	0.00150	0.00300	Undefined	None	Detected	
	GMA-SW	22215	5	14	35.7	ND	0.0102	0.00150	0.00345	Undefined	None	Detected	
	GMA-SE	22217	6	14	42.9	ND	0.0127	0.0015	0.00354	Undefined	Down	Detected	
Iron (mg/L)	LCS	12345C	19	30	63.3	ND	3.91	0.0764	0.939	Undefined	Down	Detected	
	LDS	12345D	20	24	83.3	ND	6.2	1.45	1.76	LogNormal	None	Detected	
	GMA-U	22213	21	21	100	0.551	2.83	1.97	0.59	Normal	None	Not Detected	
	GMA-D	22214	21	21	100	2.11	6.69	3.77	1.09	Normal	None	Not Detected	
	GMA-SW	22215	21	21	100	4.78	10.4	6.48	1.51	LogNormal	None	Detected	17.4(Q4-09)
	GMA-SE	22217	20	21	95.2	ND	10.3	3.40	2.81	LogNormal	Down	Detected	
Lithium (mg/L)	LCS	12345C	29	29	100	0.0073	0.322	0.112	0.064	Undefined	Up	Detected	
	LDS	12345D	23	23	100	0.0702	0.516	0.257	0.117	Normal	Up	Detected	
	GMA-U	22213	21	21	100	0.00434	0.00728	0.00541	0.00069	Normal	Down	Not Detected	
	GMA-D	22214	21	21	100	0.00372	0.00718	0.00524	0.00088	LogNormal	None	Detected	
	GMA-SW	22215	21	21	100	0.00467	0.00828	0.00544	0.00088	Undefined	None	Not Detected	
	GMA-SE	22217	21	21	100	0.00488	0.00799	0.00628	0.00093	Normal	Down	Not Detected	
Magnesium (mg/L)	LCS	12345C	25	25	100	21.9	681	544	225	Undefined	Up	Detected	
	LDS	12345D	17	17	100	148	1260	598	375	Undefined	Up	Up	
	GMA-U	22213	14	14	100	31.7	42.0	36.1	2.6	Normal	Down	Detected	
	GMA-D	22214	14	14	100	24.2	48.4	37.6	6.7	Normal	Down	Not Detected	
	GMA-SW	22215	14	14	100	32.5	74.5	40.0	11.6	Undefined	None	Not Detected	
	GMA-SE	22217	14	14	100	38.5	63.3	47.8	7.4	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12345C	13	30	43.3	ND	0.328	0.00782	0.0663	Undefined	None	Not Detected	
	LDS	12345D	17	24	70.8	ND	0.687	0.0760	0.148	LogNormal	None	Not Detected	
	GMA-U	22213	21	21	100	0.217	0.298	0.252	0.022	Normal	None	Not Detected	
	GMA-D	22214	31	31	100	0.202	0.764	0.406	0.149	LogNormal	None	Not Detected	
	GMA-SW	22215	21	21	100	0.228	1.94	0.337	0.437	Undefined	Up	Not Detected	
	GMA-SE	22217	21	21	100	0.196	1.57	0.975	0.389	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12345C	23	30	76.7	ND	0.018	0.00534	0.00428	LogNormal	Down	Detected	
	LDS	12345D	22	24	91.7	ND	0.0506	0.0137	0.0100	LogNormal	None	Detected	
	GMA-U	22213	1	21	4.8	ND	0.00176	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22214	5	31	16.1	ND	0.0063	0.00075	0.00110	Undefined	None	Detected	
	GMA-SW	22215	2	21	9.5	ND	0.00524	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-SE	22217	16	21	76.2	ND	0.0228	0.00545	0.00572	Undefined	None	Not Detected	

Table A.5.8-1 (continued). Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard Deviation[d]	Distribution Type[d,e]	Trend[d,f]	Serial Correlation[d,g]	Outliers[h,i]
Potassium (mg/L)	LCS	12345C	25	25	100	4.86	32.3	25.3	7.1	Undefined	Up	Not Detected	
	LDS	12345D	17	17	100	38.0	170	89.4	36.8	Normal	Up	Detected	
	GMA-U	22213	14	14	100	3.36	4.14	3.76	0.21	Normal	Down	Detected	
	GMA-D	22214	14	14	100	2.32	3.07	2.65	0.24	Normal	None	Not Detected	
	GMA-SW	22215	14	14	100	2.3	5.01	3.52	0.64	Undefined	None	Not Detected	
	GMA-SE	22217	14	14	100	2.77	4.09	3.30	0.38	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12345C	6	30	20.0	ND	0.151	0.0115	0.0298	LogNormal	None	Not Detected	
	LDS	12345D	6	24	25.0	ND	0.075	0.0116	0.0166	LogNormal	Up	Not Detected	
	GMA-U	22213	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	2	21	9.5	ND	0.0125	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-SW	22215	2	21	9.5	ND	0.0098	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-SE	22217	0	21	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sodium (mg/L)	LCS	12345C	30	30	100	16.8	128	108	35	Undefined	Up	Detected	
	LDS	12345D	24	24	100	76.6	1200	526	270	Normal	Up	Detected	
	HTW	12345	7	7	100	277	385	334	45	Normal	Down	Not Detected	
	GMA-U	22213	21	21	100	19.4	30.3	24.2	3.9	Undefined	Down	Detected	
	GMA-D	22214	21	21	100	9.83	13.6	11.6	1.1	Normal	Up	Not Detected	
	GMA-SW	22215	21	21	100	13.5	$26.0	18.2	3.1	Normal	Up	Detected	
	GMA-SE	22217	21	21	100	11.5	17.6	14.1	1.8	Normal	None	Detected	
Technetium-99 (pCi/L)	LCS	12345C	19	32	59.4	ND	101	27.1	26.4	LogNormal	None	Detected	
	LDS	12345D	5	24	20.8	ND	13.5	2.66	3.96	LogNormal	None	Not Detected	
	GMA-U	22213	6	32	18.8	ND	24.8	0.702	5.01	Undefined	None	Detected	
	GMA-D	22214	4	32	12.5	ND	11.8	0.0852	2.81	Undefined	None	Detected	
	GMA-SW	22215	0	26	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SE	22217	0	22	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Zinc (mg/L)	LCS	12345C	13	30	43.3	ND	0.0622	0.0134	0.0136	LogNormal	None	Detected	
	LDS	12345D	20	24	83.3	ND	0.333	0.108	0.102	Undefined	Up	Detected	
	GMA-U	22213	9	21	42.9	ND	0.0221	0.00307	0.00480	Undefined	Down	Not Detected	
	GMA-D	22214	14	31	45.2	ND	0.00705	0.00260	0.00186	Undefined	None	Not Detected	
	GMA-SW	22215	11	21	52.4	ND	0.0158	0.00421	0.00384	Undefined	None	Not Detected	
	GMA-SE	22217	11	21	52.4	ND	0.0184	0.00399	0.00510	Undefined	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with at least eight samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[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.

[d]Insufficient is used for 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.

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.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 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 2014	Minimum Detected Concentration[a,b,c]	Maximum Detected Concentration[a,b,c]	Average Detected Concentration[a,b,c]	Groundwater FRL[d] (Number of Samples Above FRL)	Groundwater Background[a,b,e] (Number of Samples Greater than Groundwater Background)	Perched Water Background[a,b,e] (Number of Samples Greater Than Perched Water Background)	Maximum Perched Water Detected Concentration [a,b,f] (Number of Samples Greater than Maximum Perched Water)
General Chemistry											
Ammonia (mg/L)	11	5	45.5	Yes	0.030	0.184	0.099	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Cadmium (mg/L)	11	2	18.8	No	0.000127	0.000164	0.000100	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Lead (mg/L)	11	1	9.1	Yes	0.00141	-	-	0.015 mg/L(0)	0.022 mg/L(0)	0.0016 mg/L(0)	0.0114 mg/L(0)
Thallium (mg/L)	11	1	9.1	No	0.000570	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	11	1	9.1	No	0.0160	-	-	0.038 mg/L(0)	0.012 mg/L(1)	0.005 mg/L(1)	0.299 mg/L(0)
Organics											
1,1-Dichloroethene	22	3	13.6	No	0.86	2.11	1.65	7 ug/L(0)	-	-	-
Acetone	9	1	11.1	No	2.31	-	-	-	-	-	-
Aroclor - 1260	9	1	11.1	No	0.058	-	-	-	-	-	-
Tetrachloroethene	22	7	31.8	No	0.380	1.24	0.732	-	-	-	-
Trichloroethene	22	3	13.6	No	0.246	1.11	0.587	5 ug/L(0)	-	-	-

Note: Shading indicates that at least one detected sample is greater than the final remediation level (FRL), groundwater background, perched water background, or perched water 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 minumum and maximum are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "Average Detected Concentration" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4 (DOE 1996).

[e]From the Characterization of Background Water Quality for Streams and Groundwater (DOE 1994) which was developed for Operable Unit 5 RI/FS documents.

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

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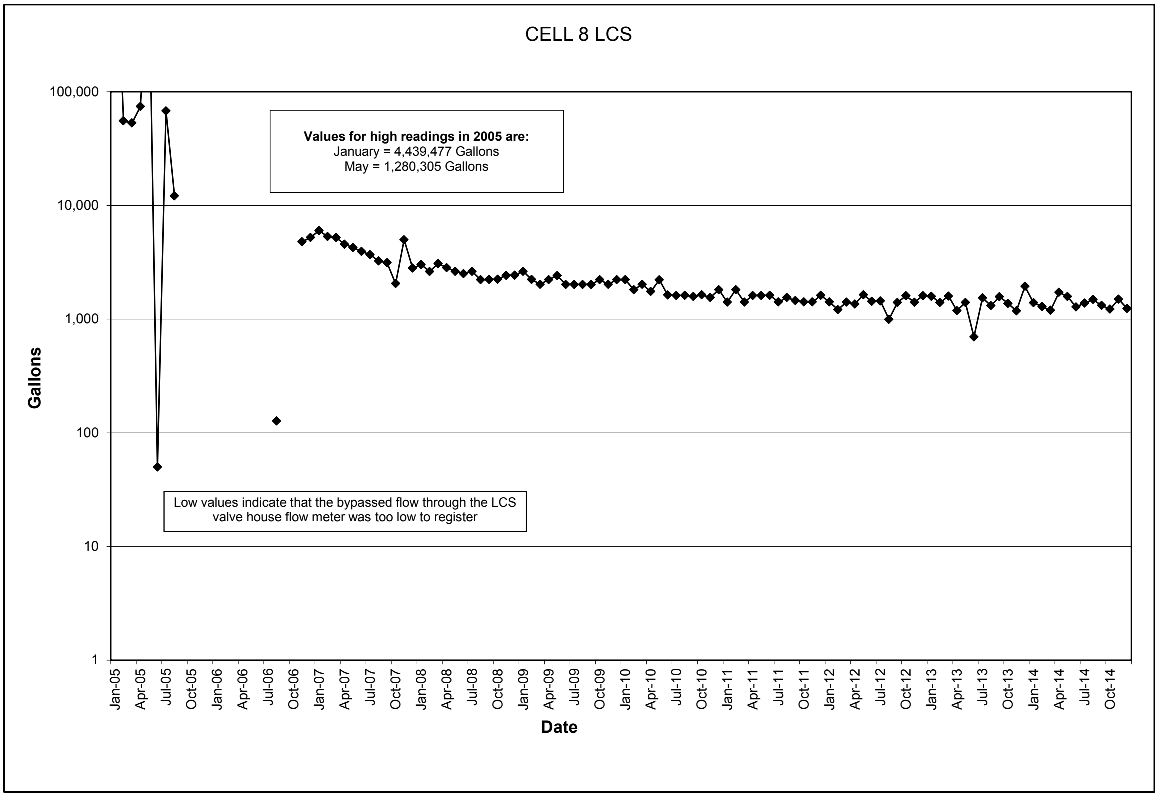


Figure A.5.8-1. Monthly Accumulation Volumes for Cell 8 LCS

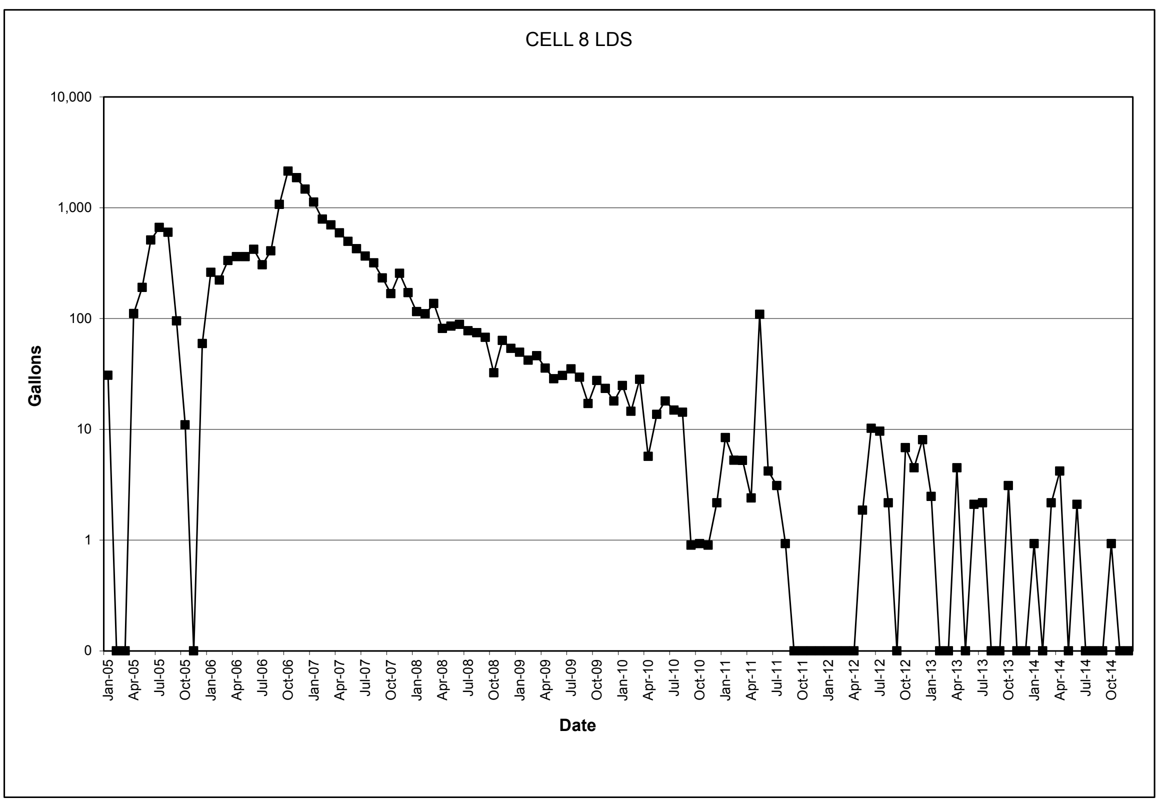
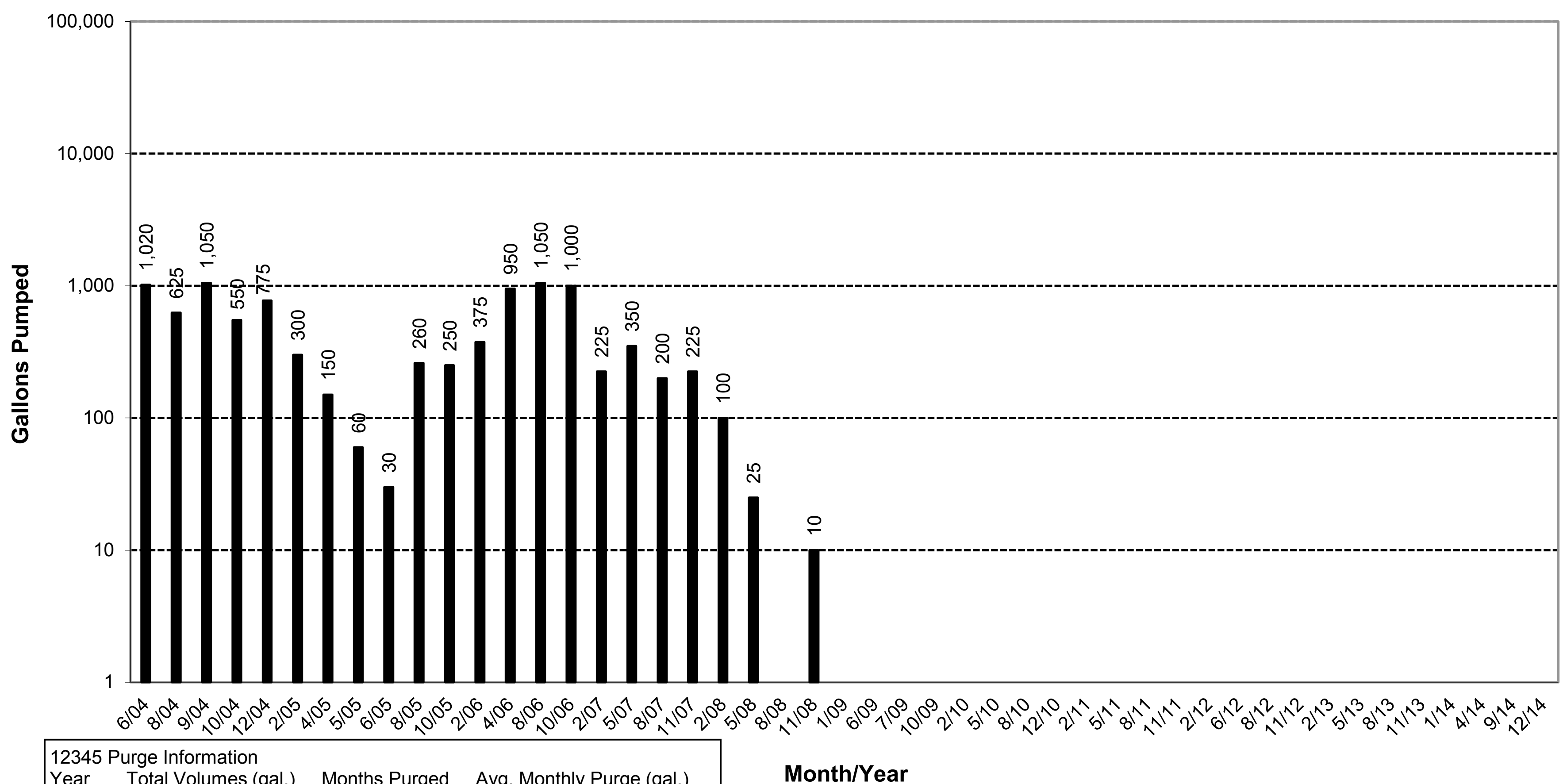


Figure A.5.8-2. Monthly Accumulation Volumes for Cell 8 LDS



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
2012:	0	n=4	0
2013:	0	n=4	0
2014[a]:	0	n=2	0
Overall:			218

[a]Sampling schedule reduced to semi-annual sampling in 2014.

Figure A.5.8-3. OSDF Horizontal Till Well 12343 (Cell 8) Water Yield

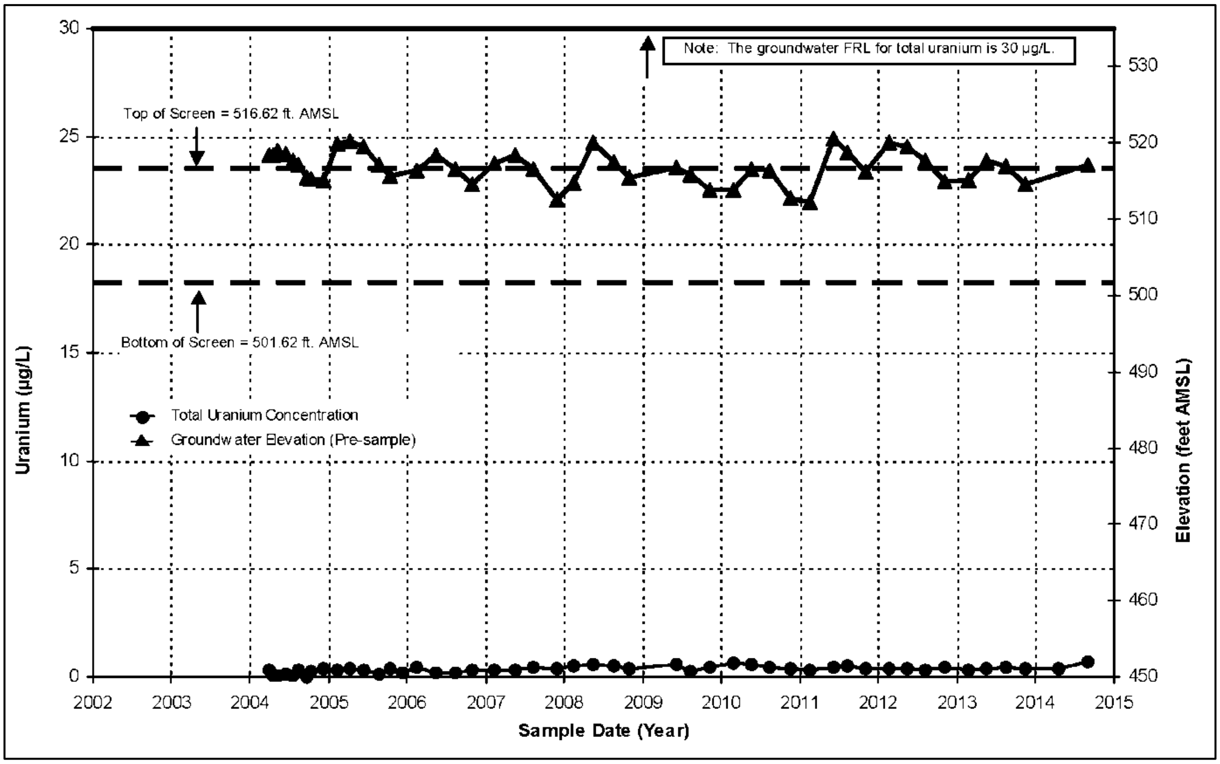


Figure A.5.8-4. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 8 Upgradient Monitoring Well 22213

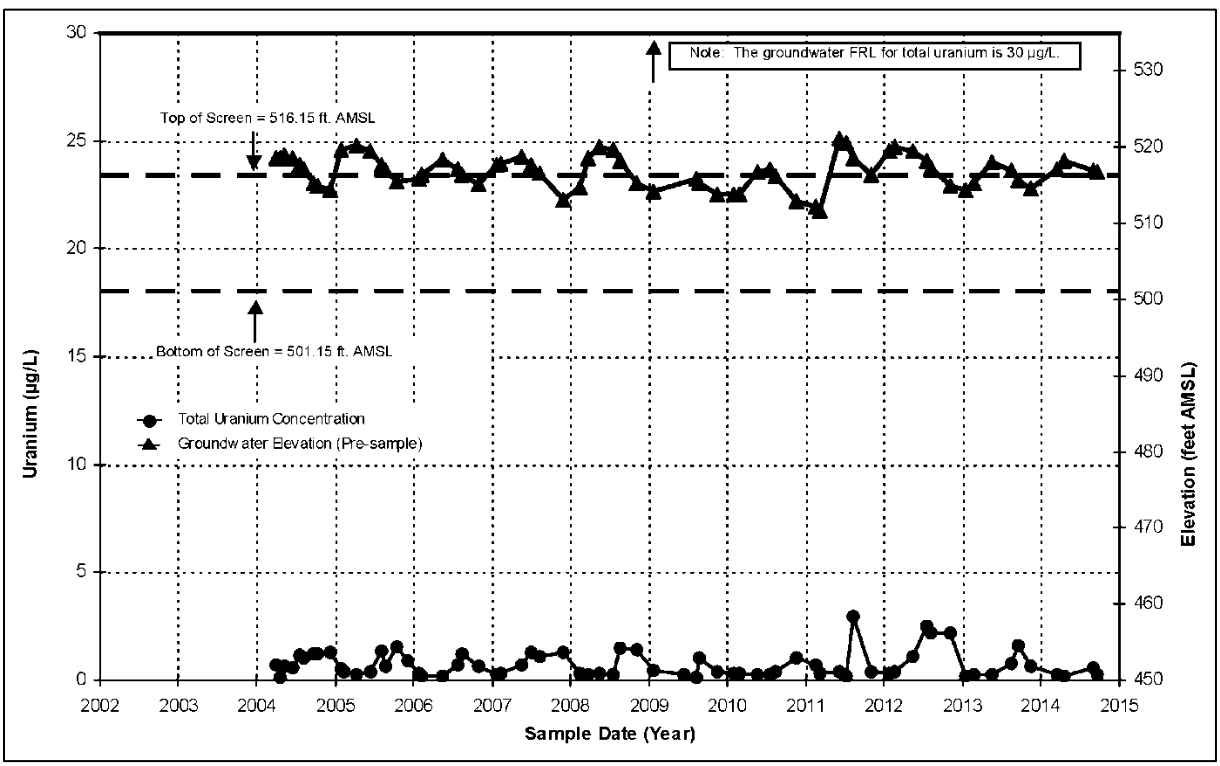


Figure A.5.8-5. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 8 Downgradient Monitoring Well 22214

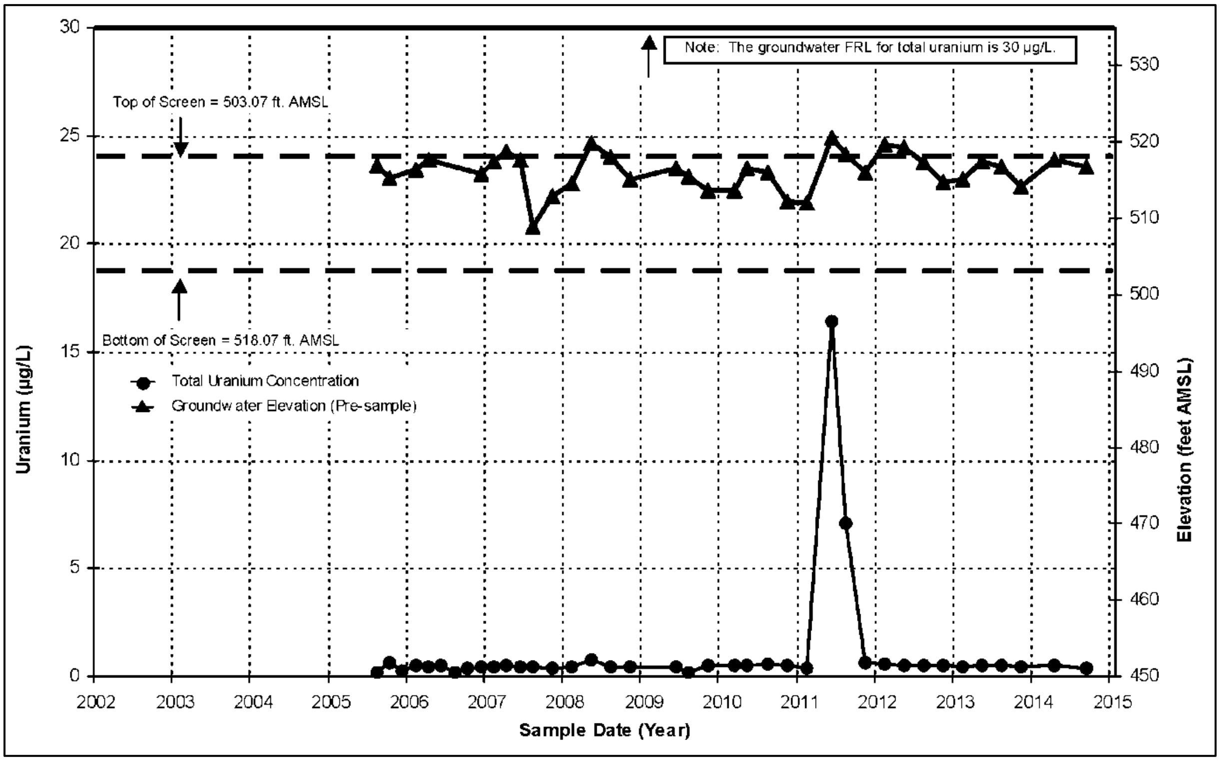


Figure A.5.8-6. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 8 Downgradient Monitoring Well 22215

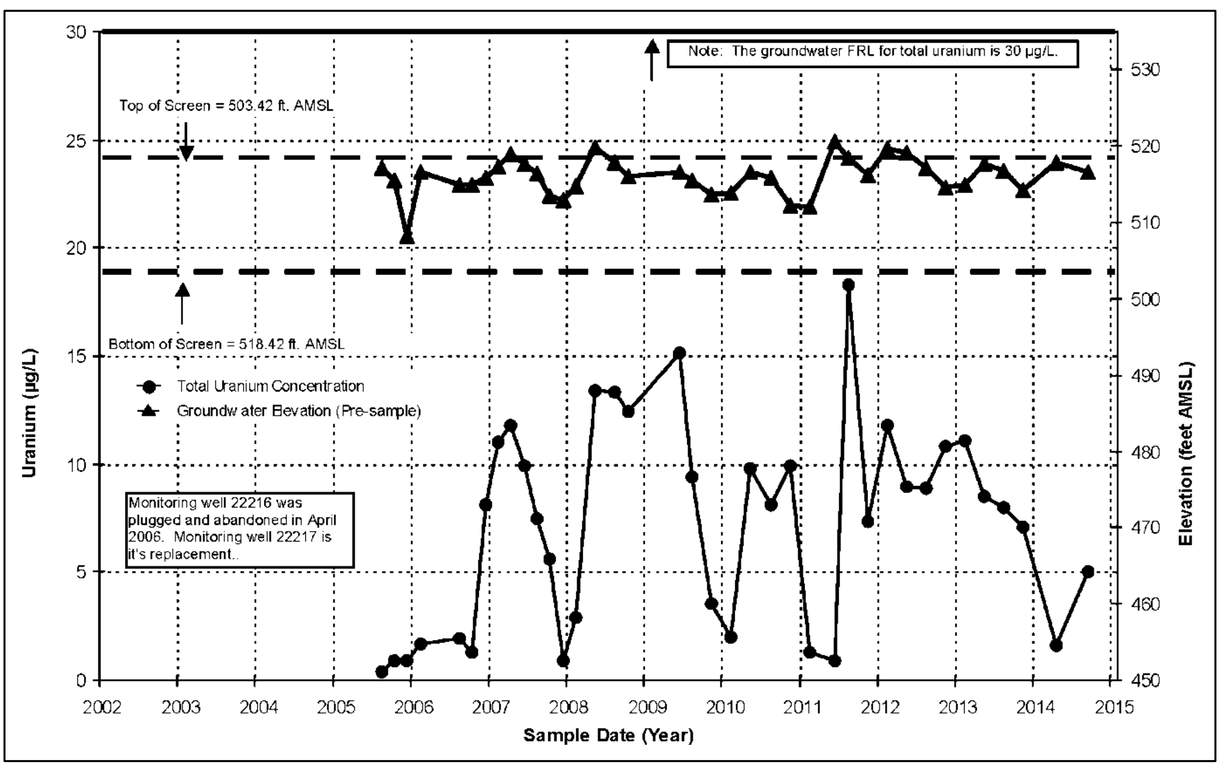


Figure A.5.8-7. Total Uranium Concentration and Groundwater Elevation Versus Time Plot for Cell 8 Downgradient Monitoring Well 22216/22217

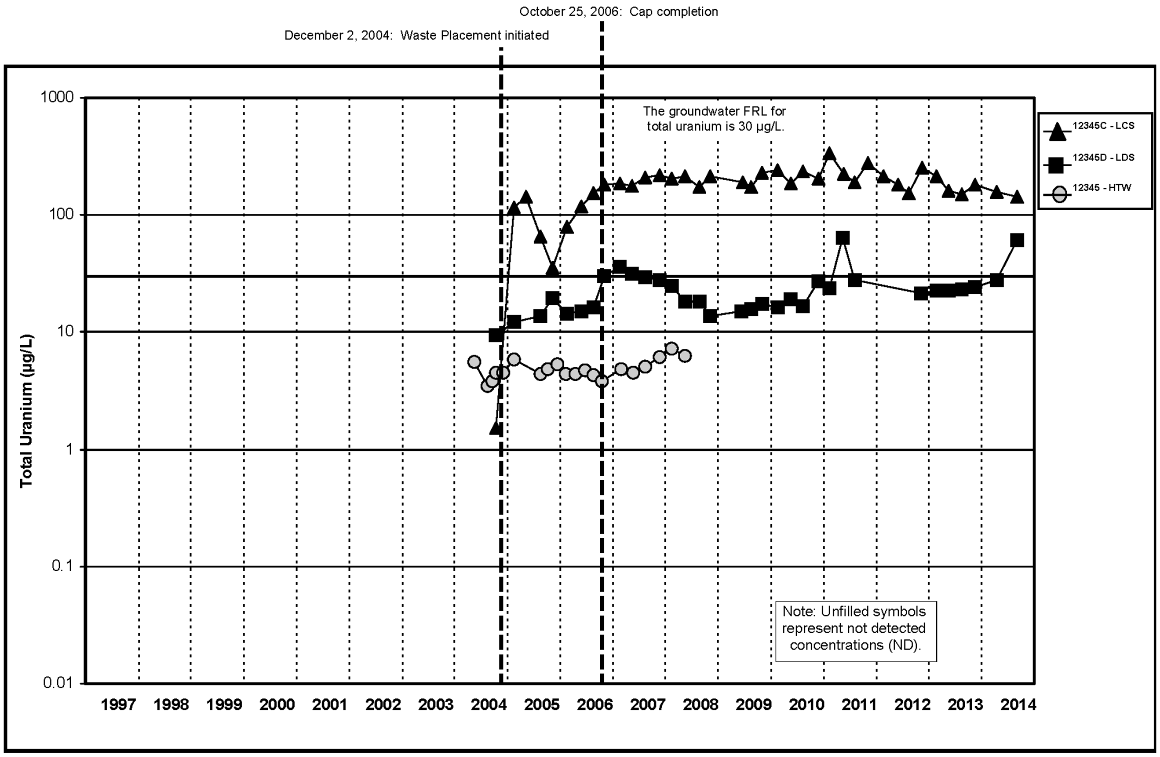


Figure A.5.8-8A. Cell 8 Uranium Total Concentration Versus Time Plot for LCS, LDS, and HTW

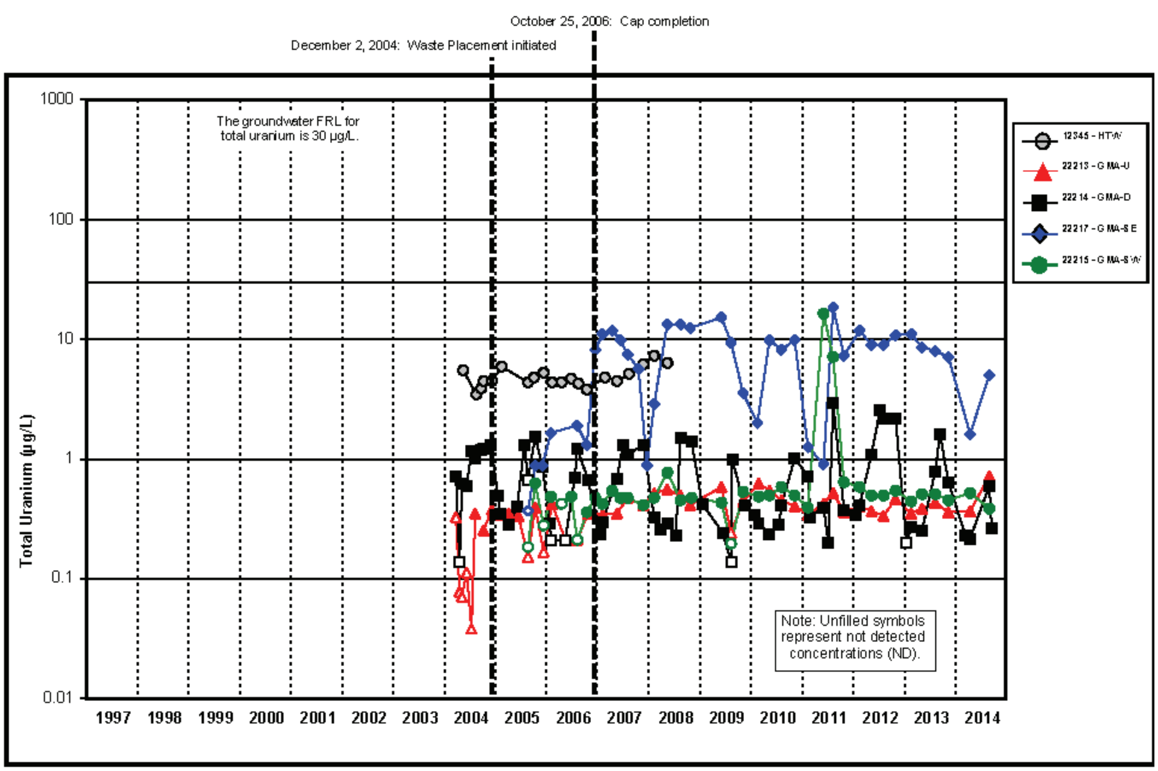


Figure A.5.8-8B. Cell 8 Uranium Total Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

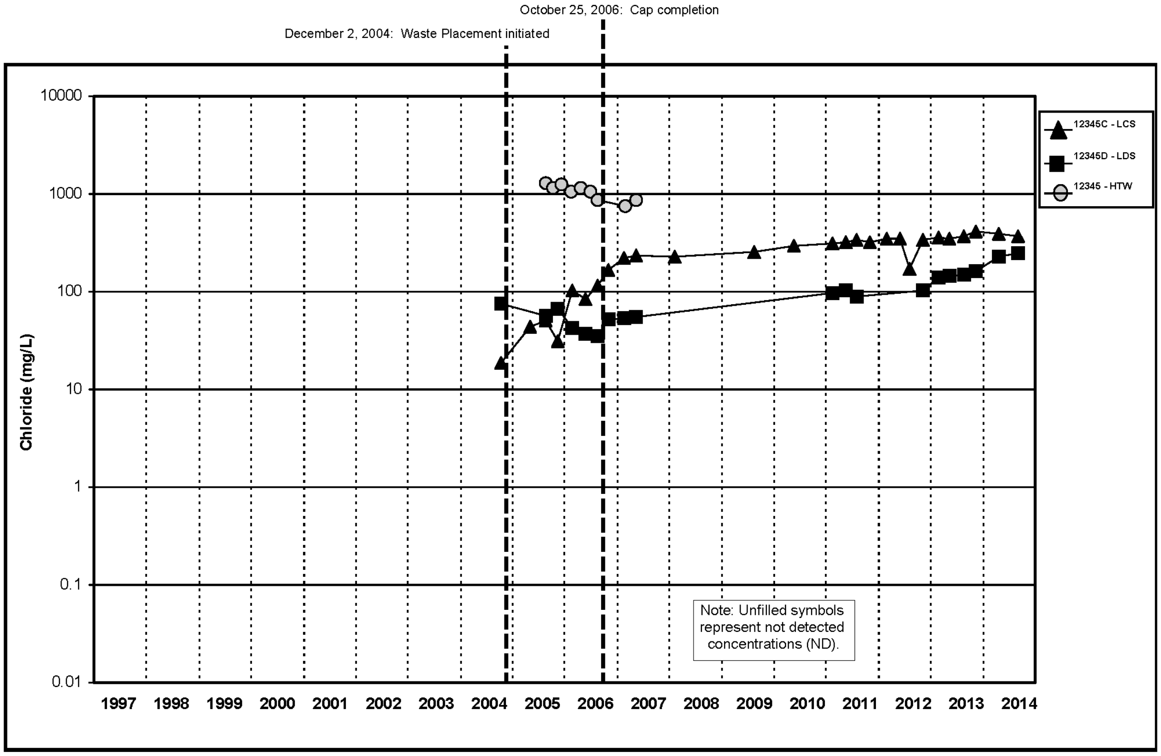


Figure A.5.8-9A. Cell 8 Chloride Concentration Versus Time Plot for LCS, LDS, and HTW

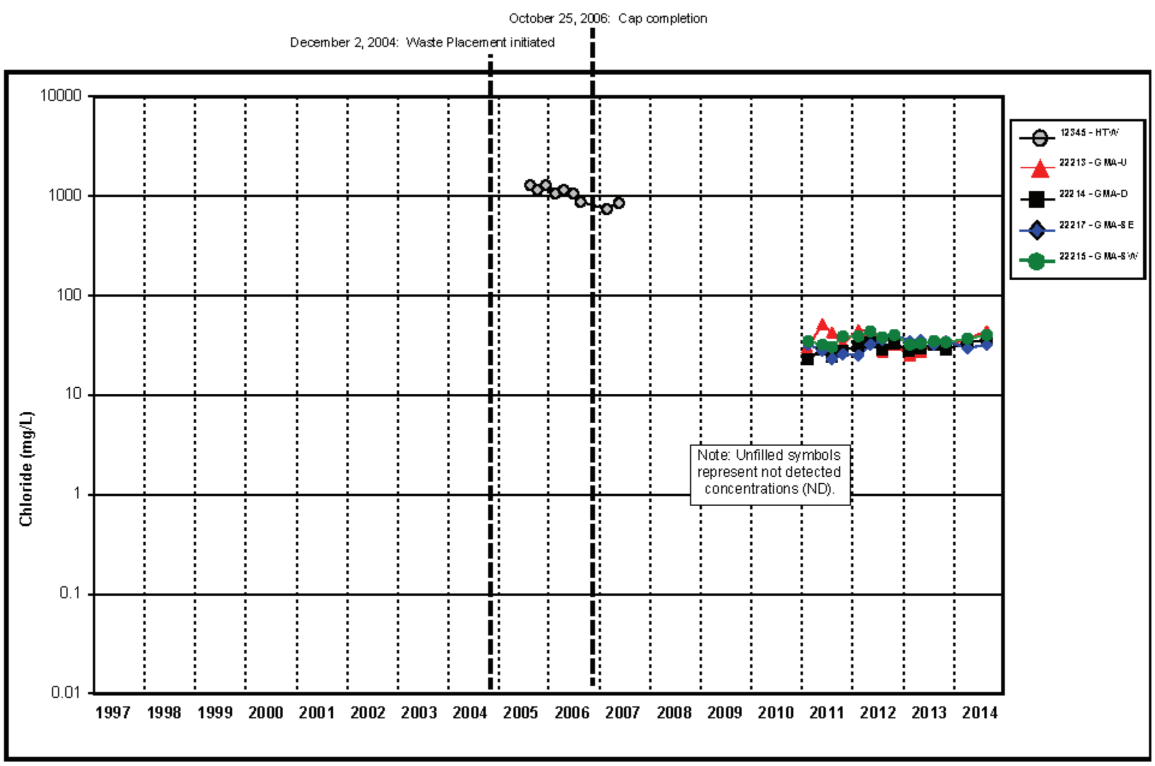


Figure A.5.8-9B. Cell 8 Chloride Concentration Versus Time Plot for HTW, HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

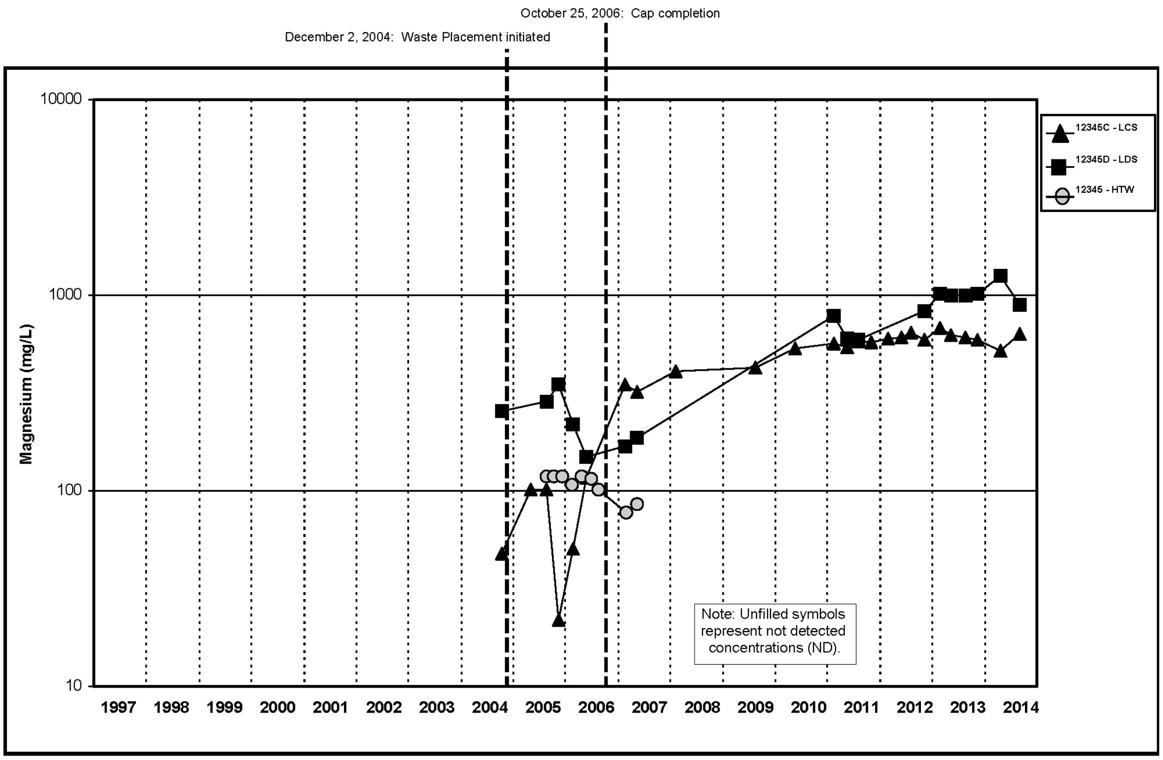


Figure A.5.8-10A. Cell 8 Magnesium Concentration Versus Time Plot for LCS, LDS, and HTW

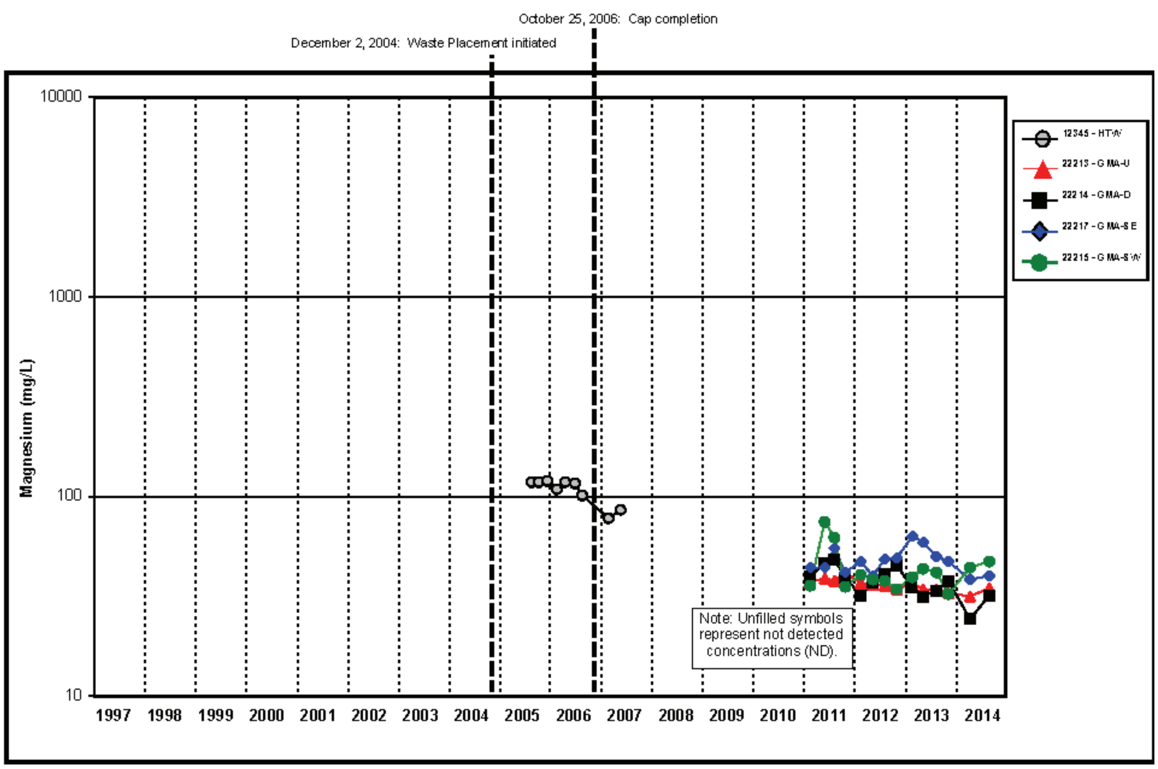


Figure A.5.8-10B. Cell 8 Magnesium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

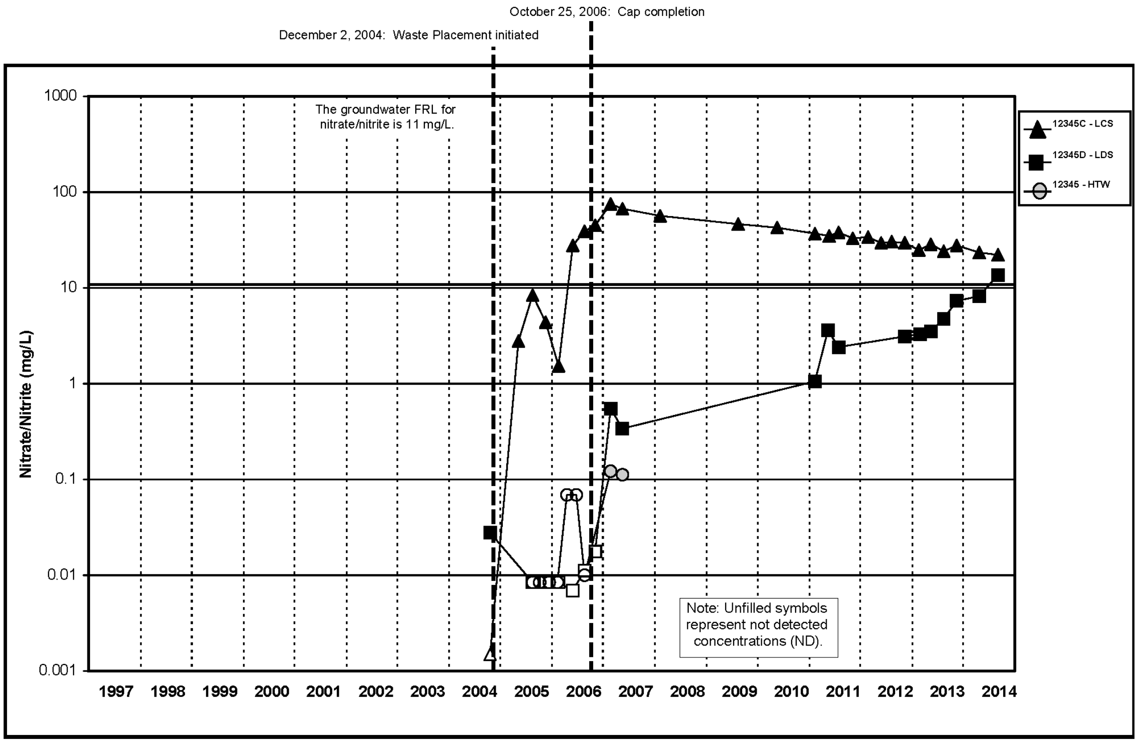


Figure A.5.8-11A. Cell 8 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for LCS, LDS, and HTW

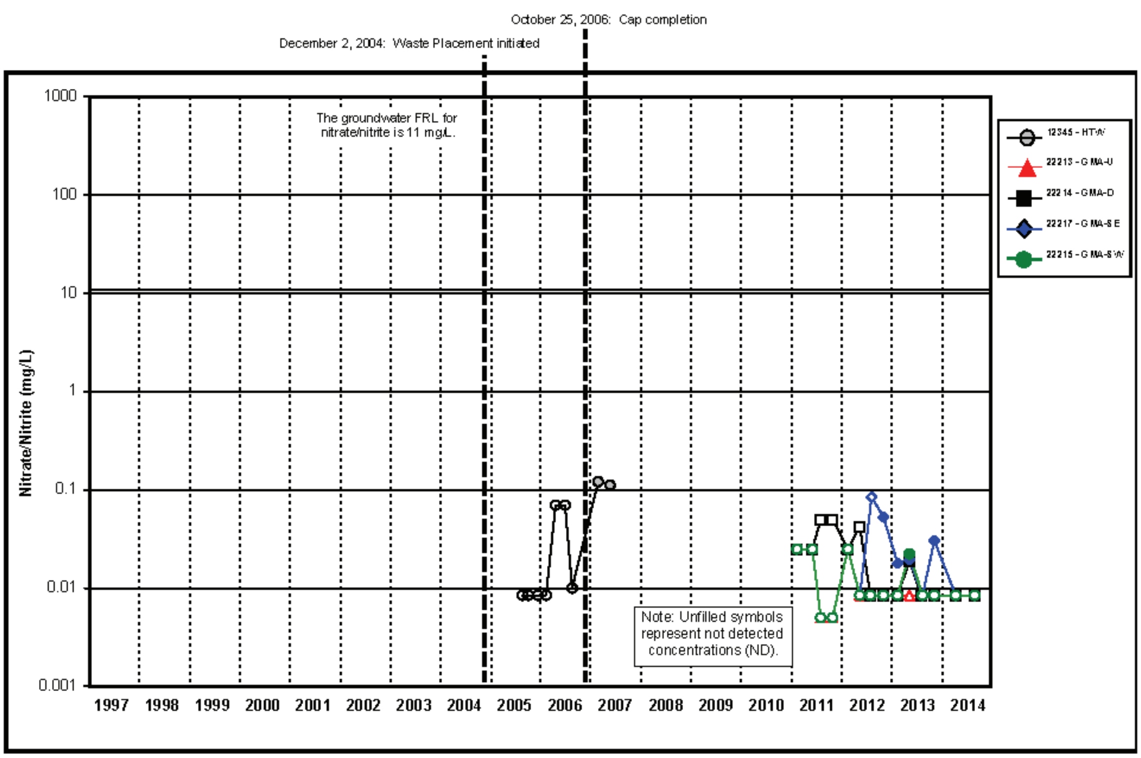


Figure A.5.8-11B. Cell 8 Nitrate + Nitrite as Nitrogen Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

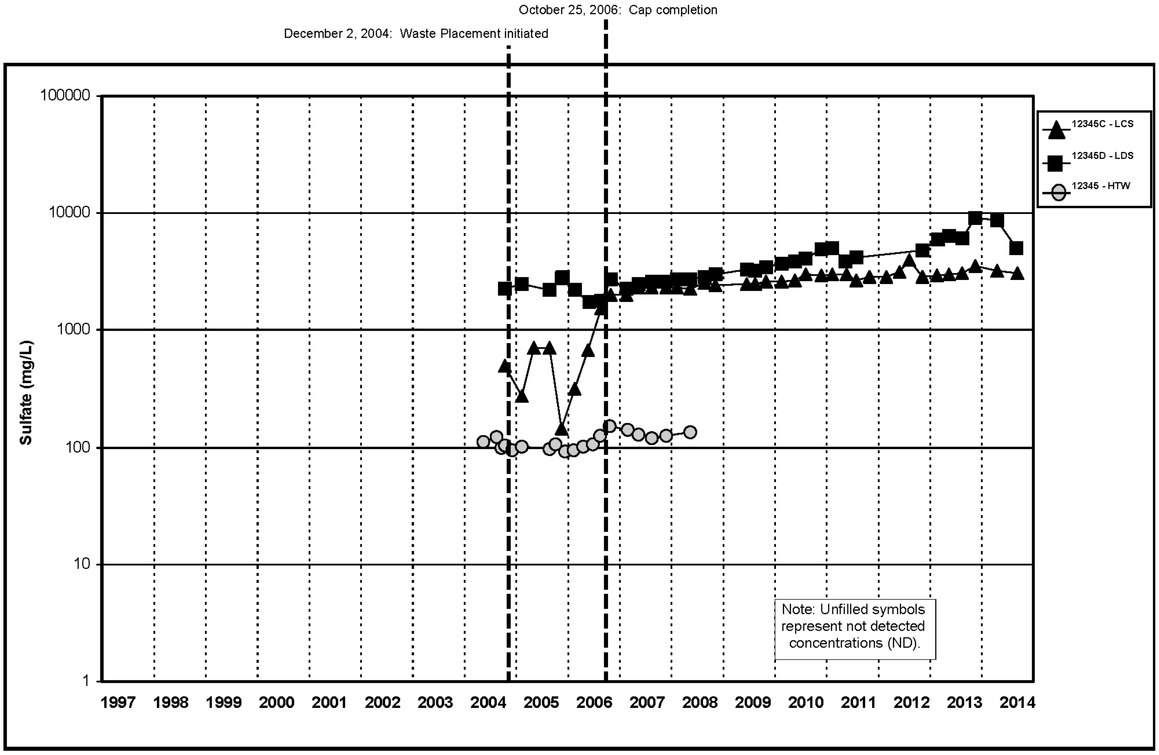


Figure A.5.8-12A. Cell 8 Sulfate Concentration Versus Time Plot for LCS, LDS, and HTW

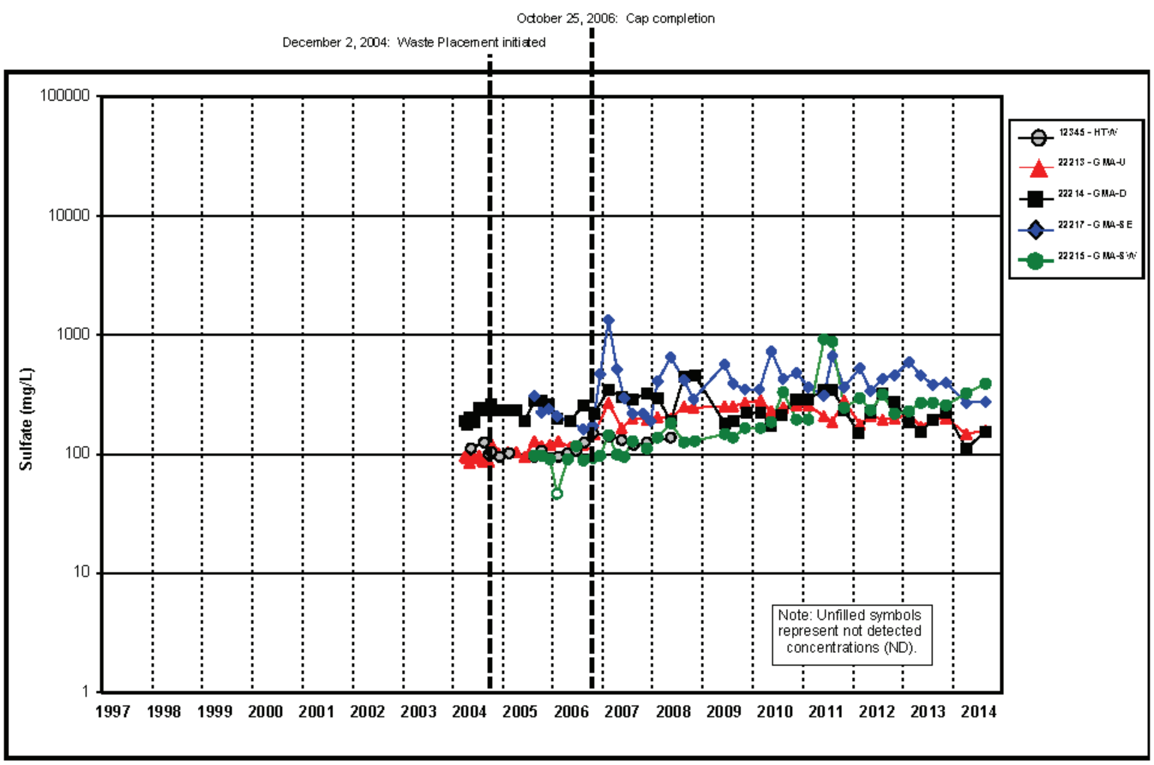


Figure A.5.8-12B. Cell 8 Sulfate Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

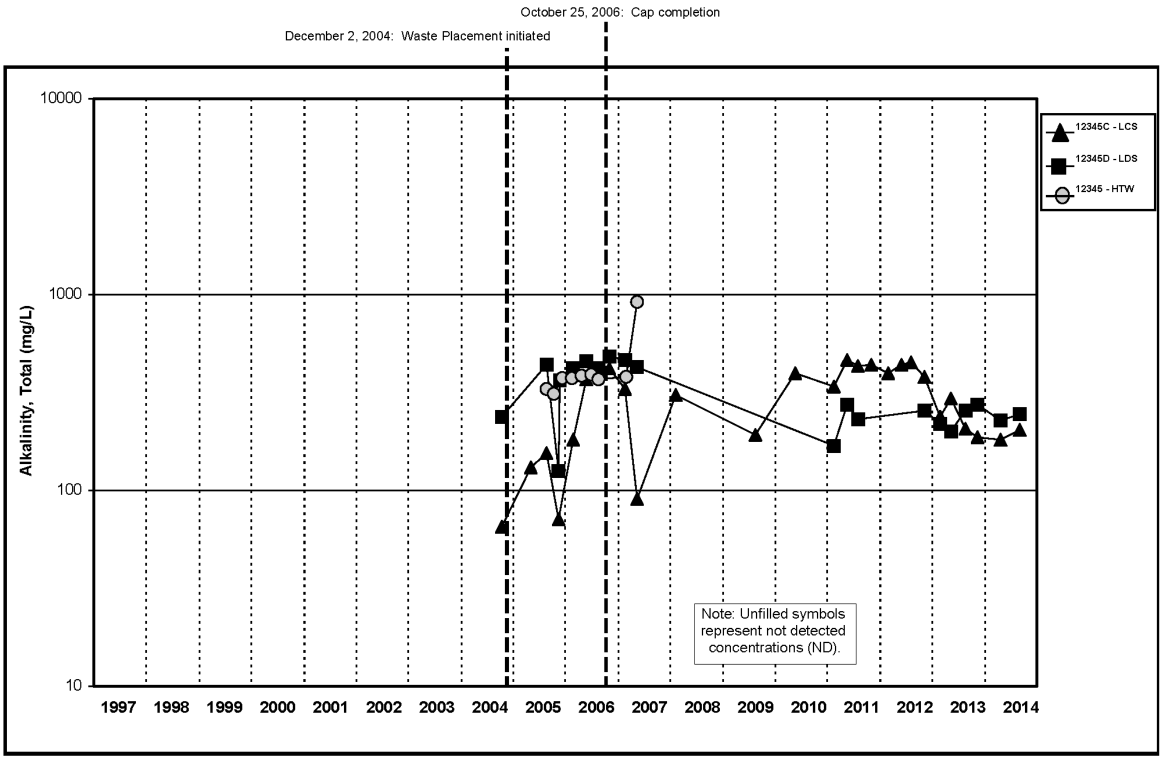


Figure A.5.8-13A. Cell 8 Alkalinity Total Concentration Versus Time Plot for LCS, LDS, and HTW

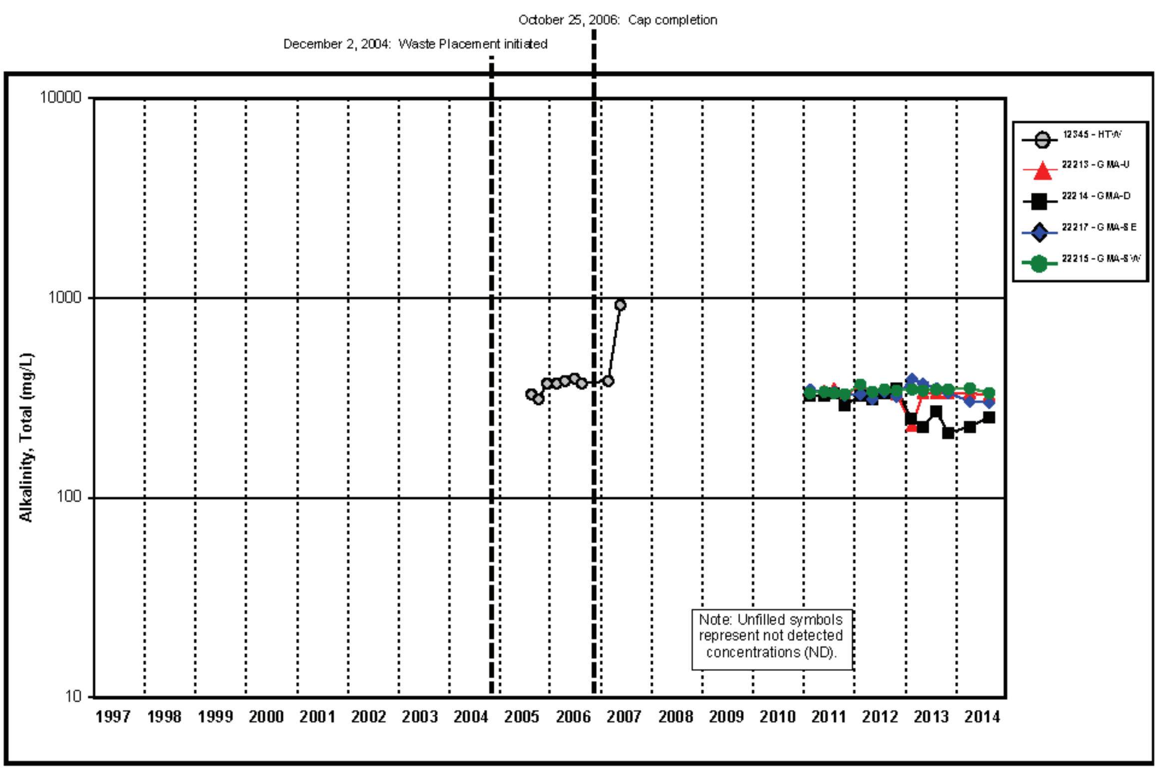


Figure A.5.8-13B. Cell 8 Alkalinity, Total Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

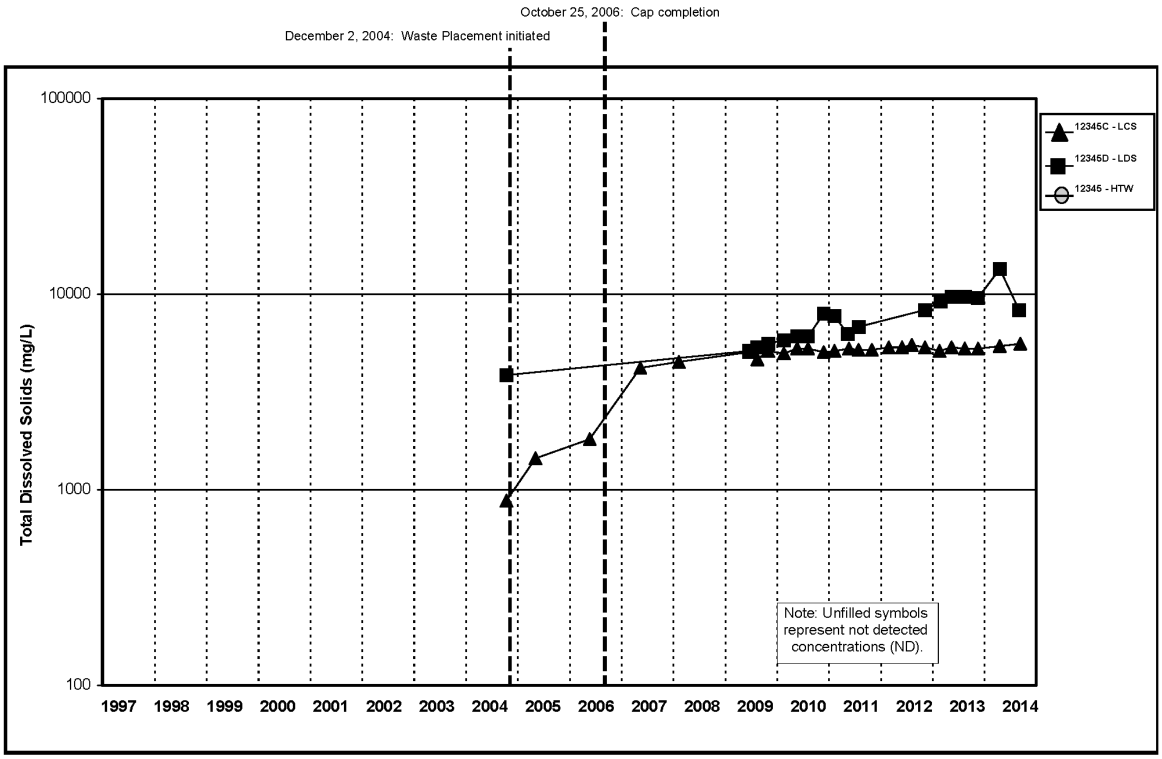


Figure A.5.8-14A. Cell 8 Total Dissolved Solids Concentration Versus Time Plot for LCS, LDS, and HTW

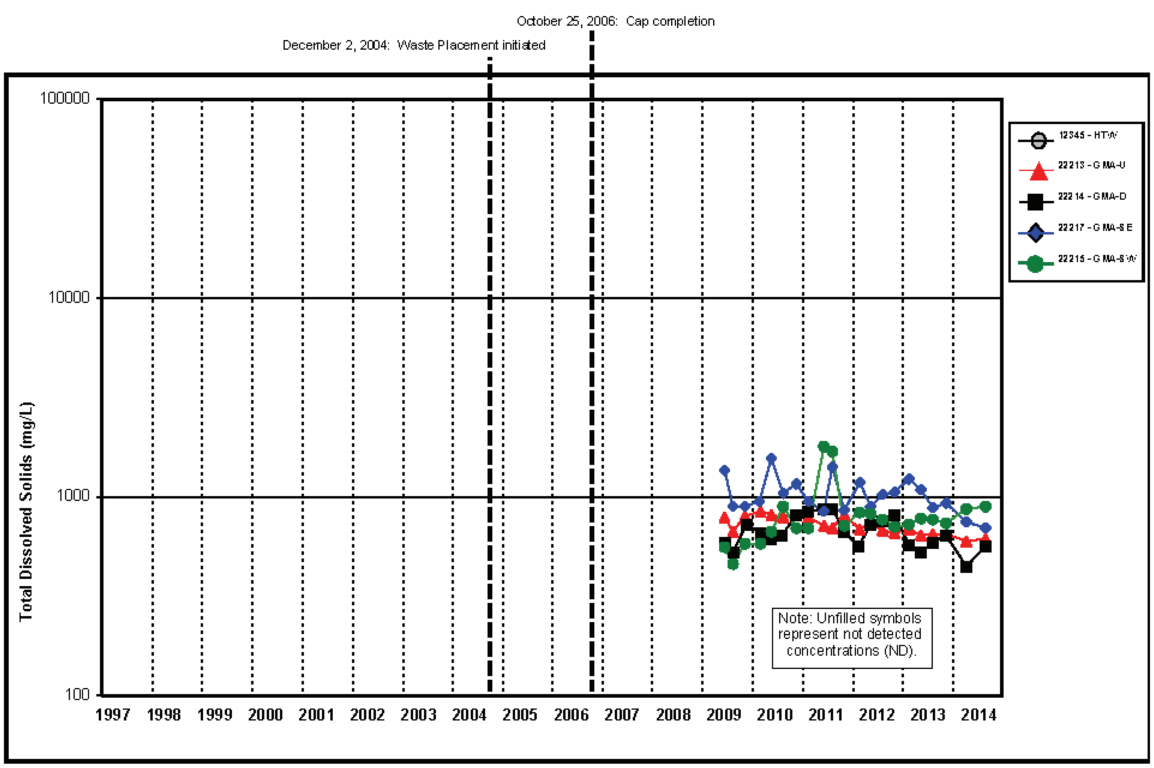


Figure A.5.8-14B. Cell 8 Total Dissolved Solids Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

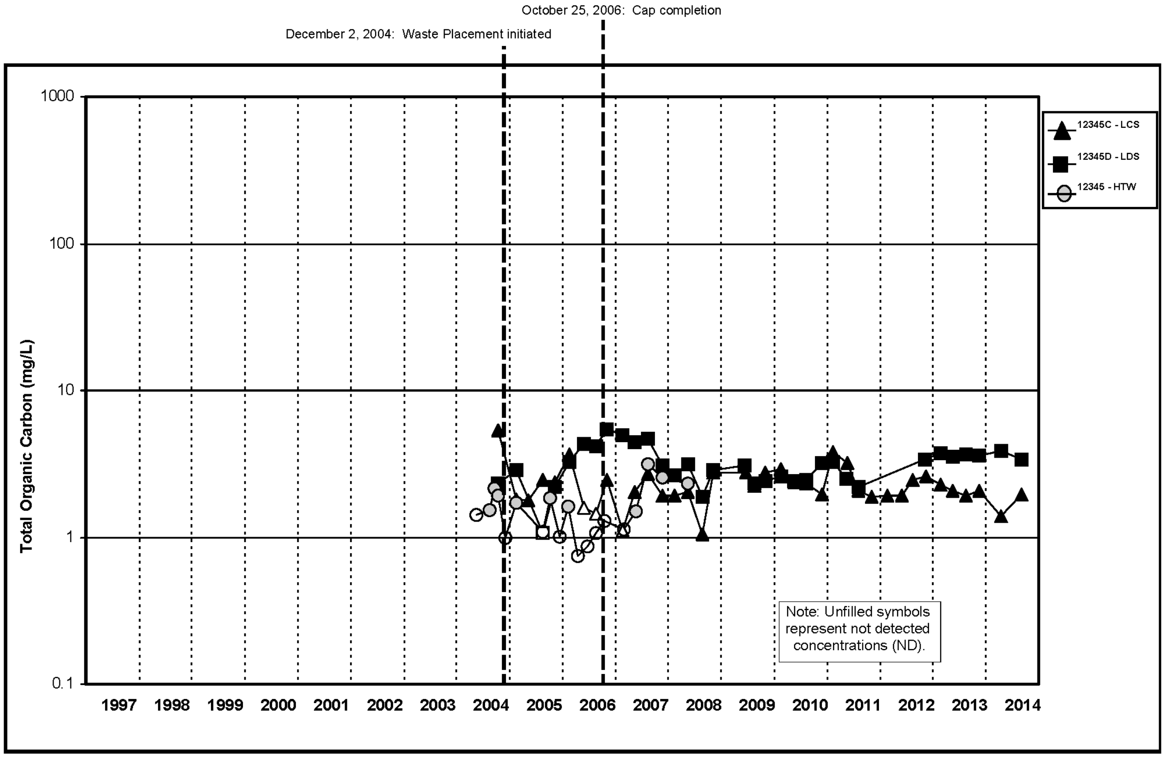


Figure A.5.8-15A. Cell 8 Total Organic Carbon Concentration Versus Time Plot for LCS, LDS, and HTW

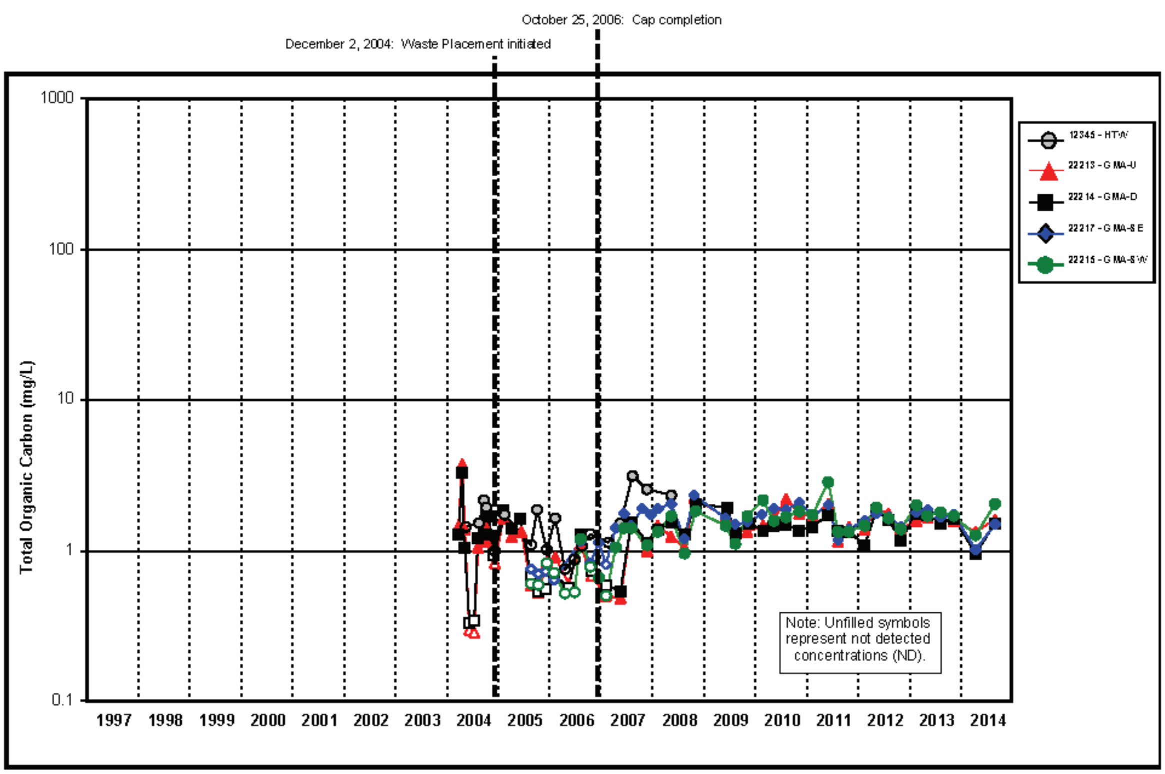


Figure A.5.8-15B. Cell 8 Total Organic Carbon Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

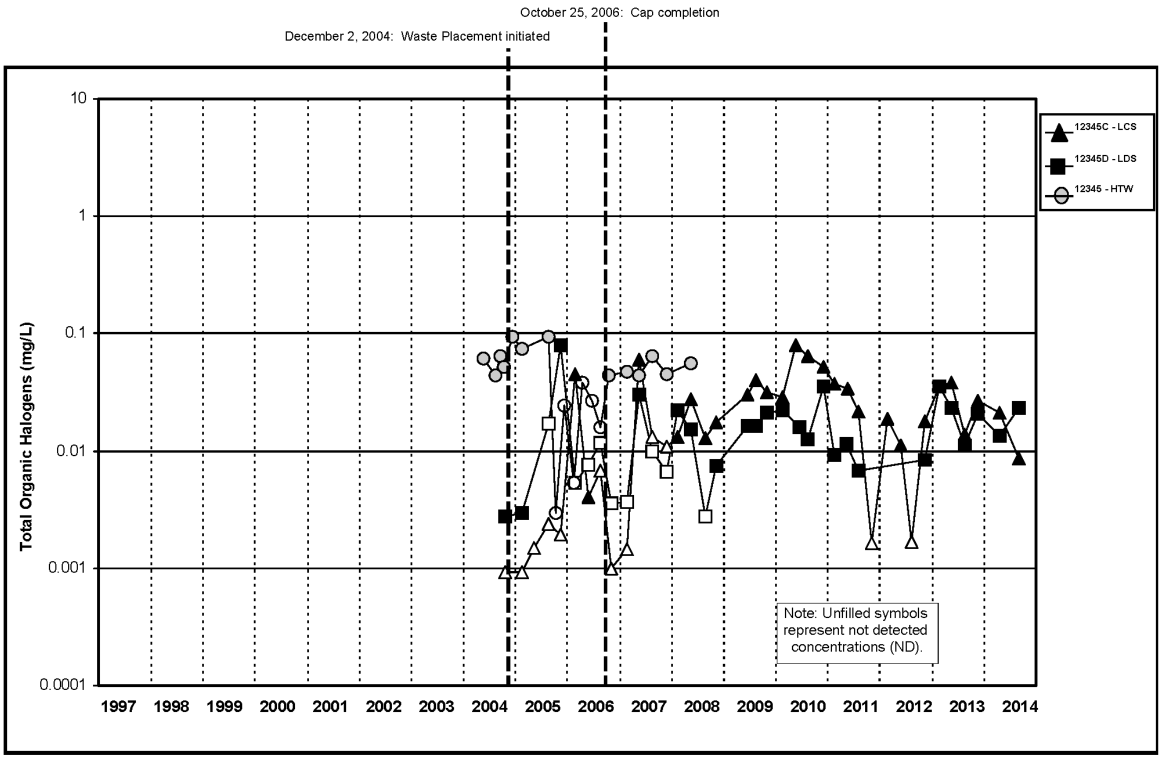


Figure A.5.8-16A. Cell 8 Total Organic Halogens Concentration Versus Time Plot for LCS, LDS, and HTW

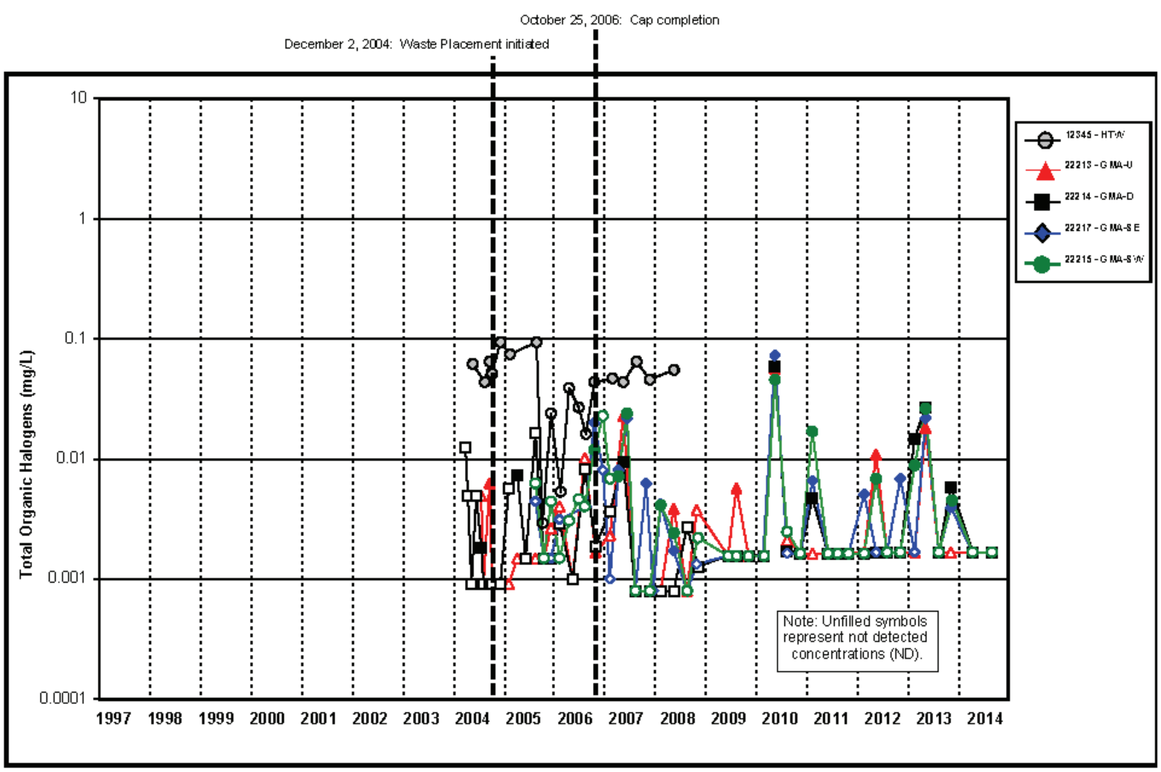


Figure A.5.8-16B. Cell 8 Total Organic Halogens Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

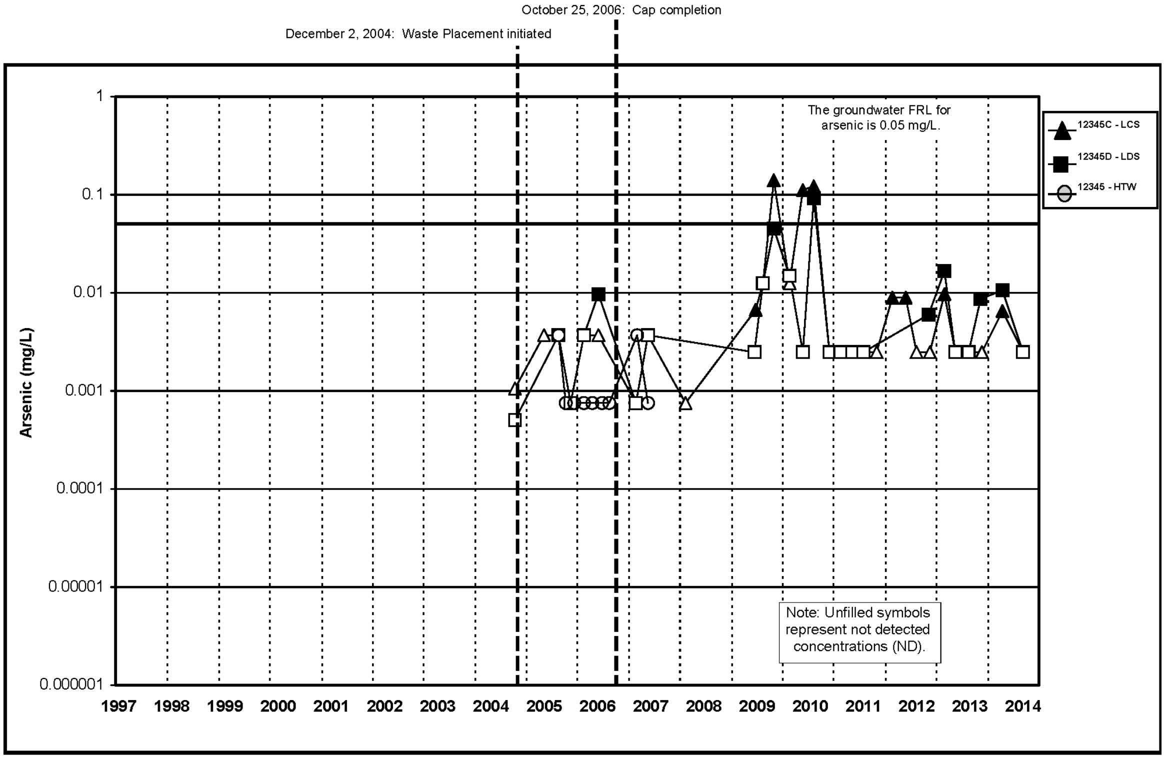


Figure A.5.8-17A. Cell 8 Arsenic Concentration Versus Time Plot for LCS, LDS, and HTW

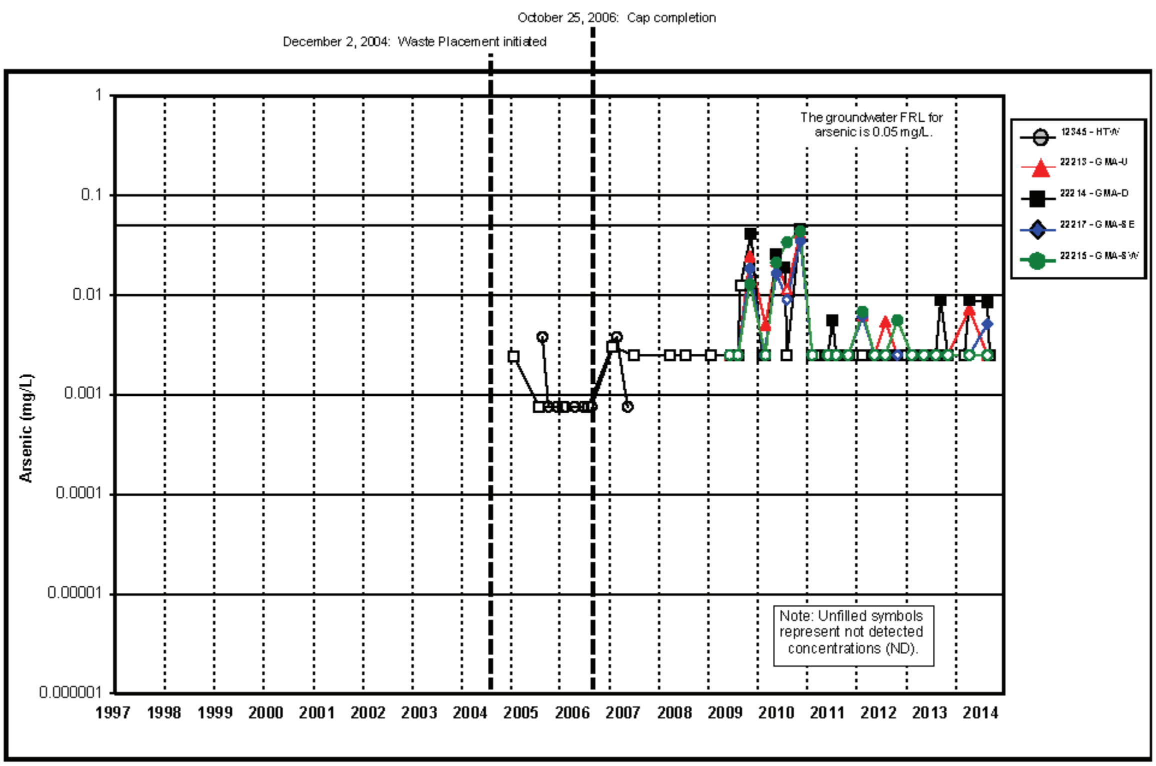


Figure A.5.8-17B. Cell 8 Arsenic Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

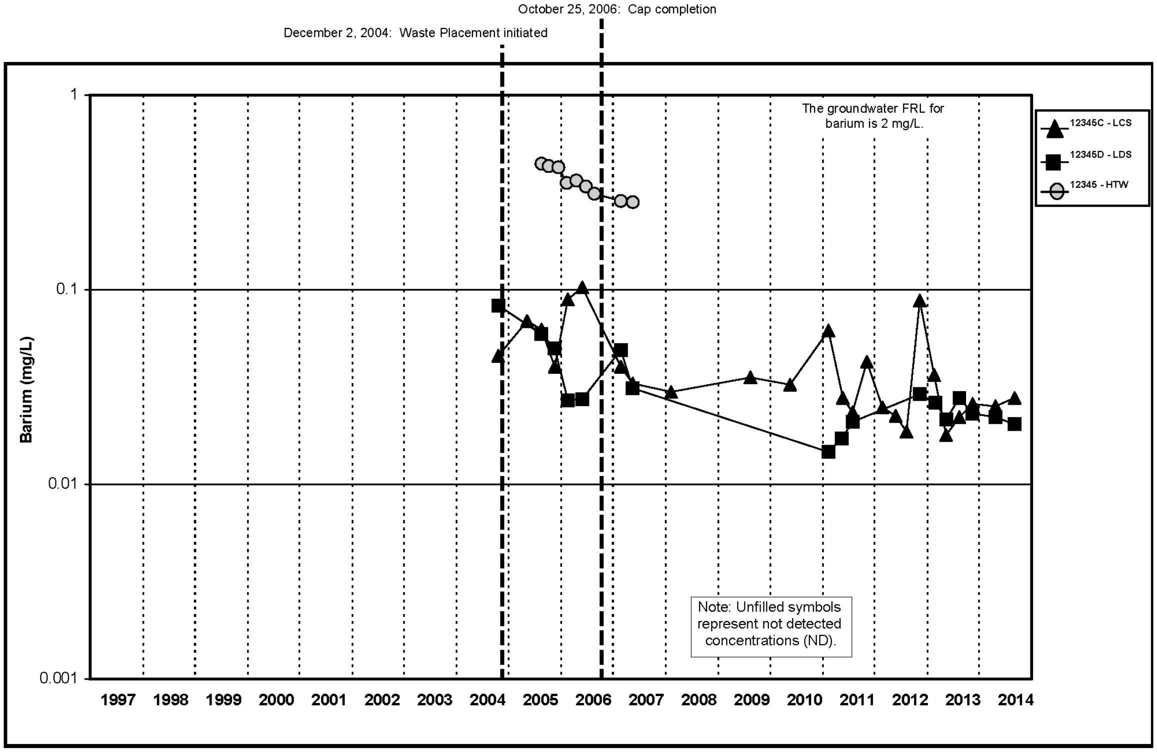


Figure A.5.8-18A. Cell 8 Barium Concentration Versus Time Plot for LCS, LDS, and HTW

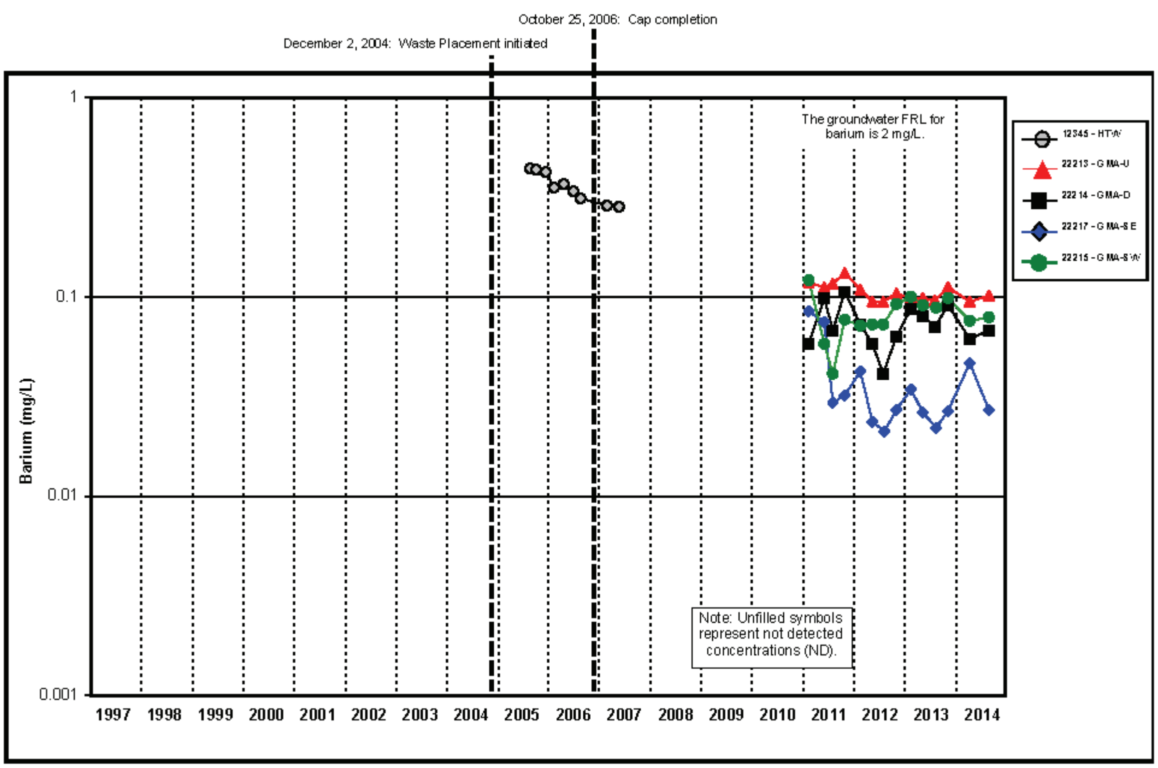


Figure A.5.8-18B. Cell 8 Barium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

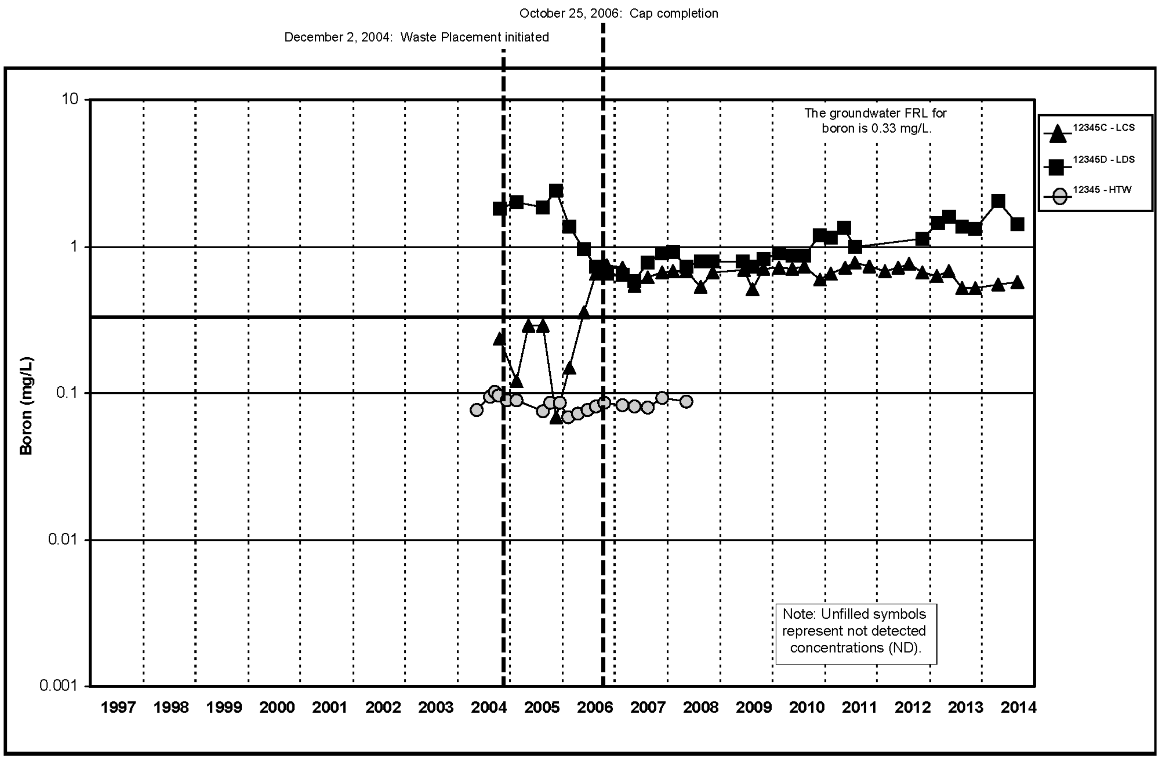


Figure A.5.8-19A. Cell 8 Boron Concentration Versus Time Plot for LCS, LDS, and HTW

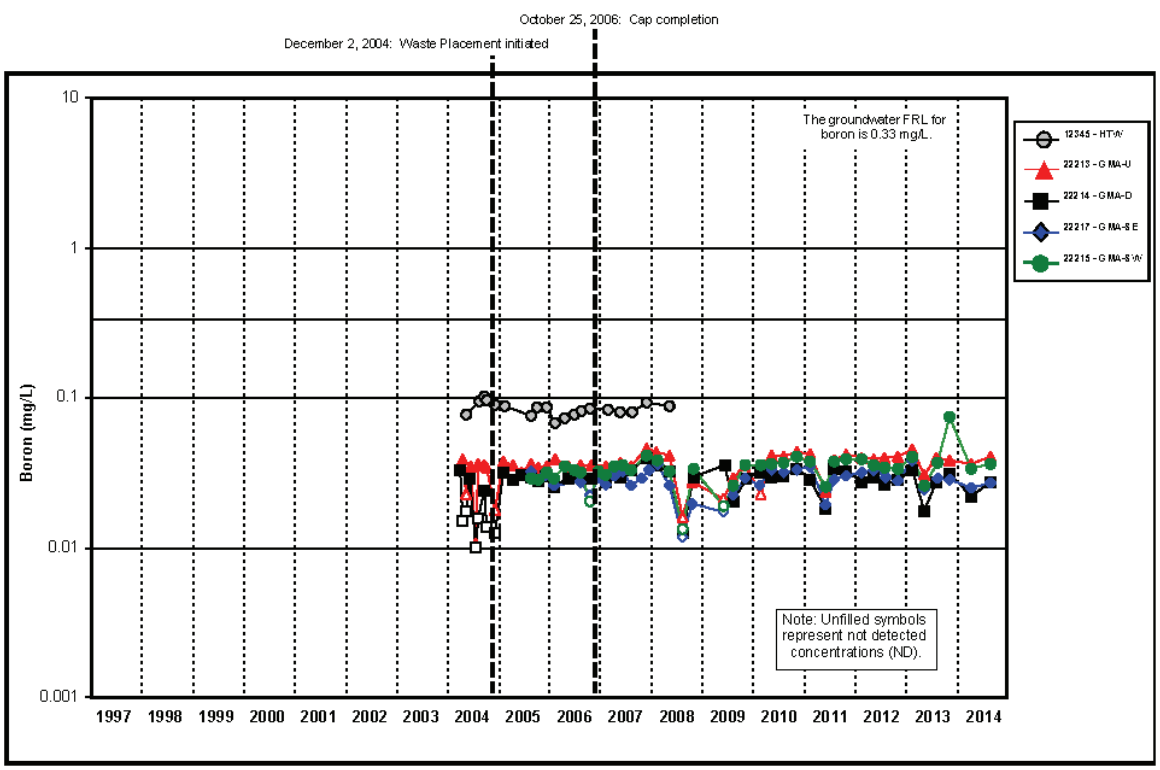


Figure A.5.8-19B. Cell 8 Boron Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

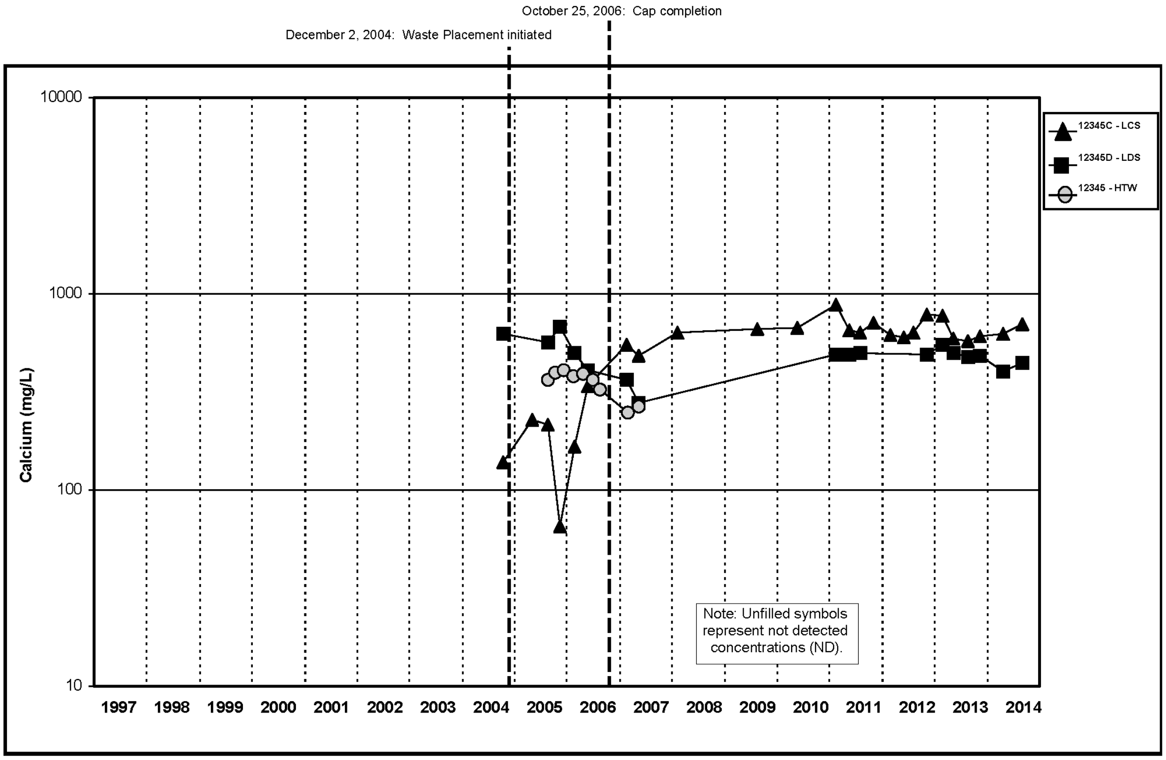


Figure A.5.8-20A. Cell 8 Calcium Concentration Versus Time Plot for LCS, LDS, and HTW

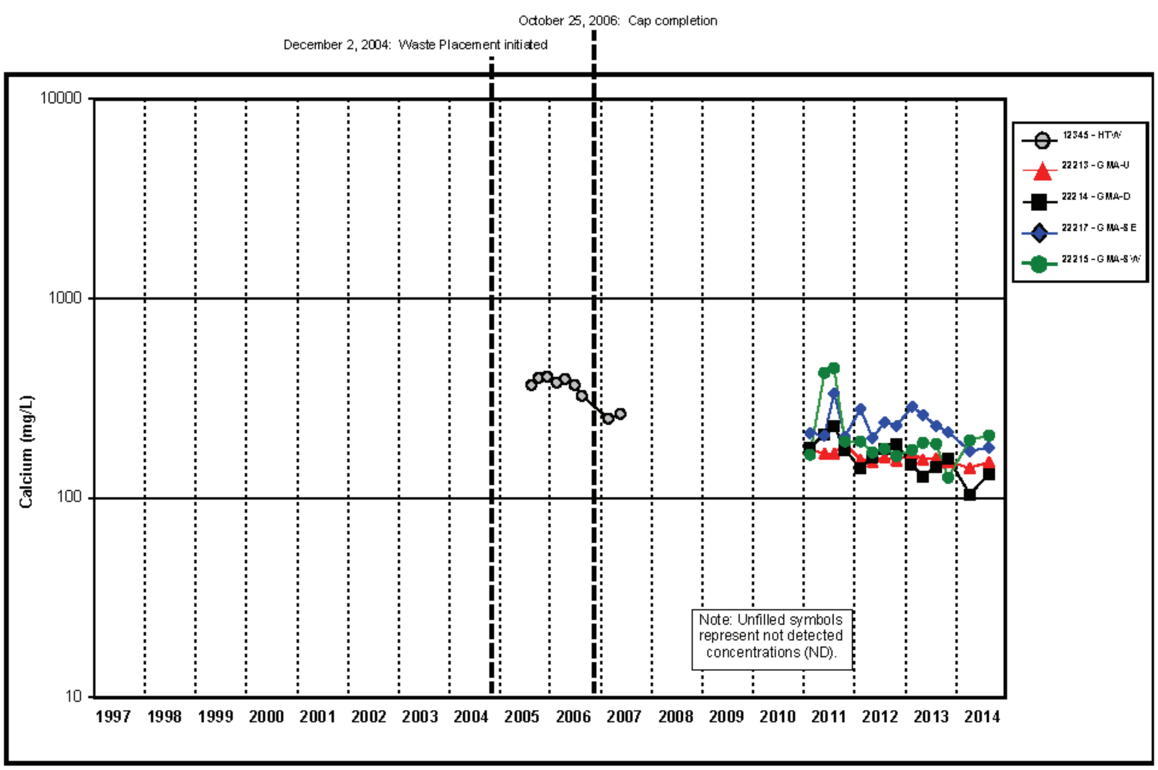


Figure A.5.8-20B. Cell 8 Calcium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

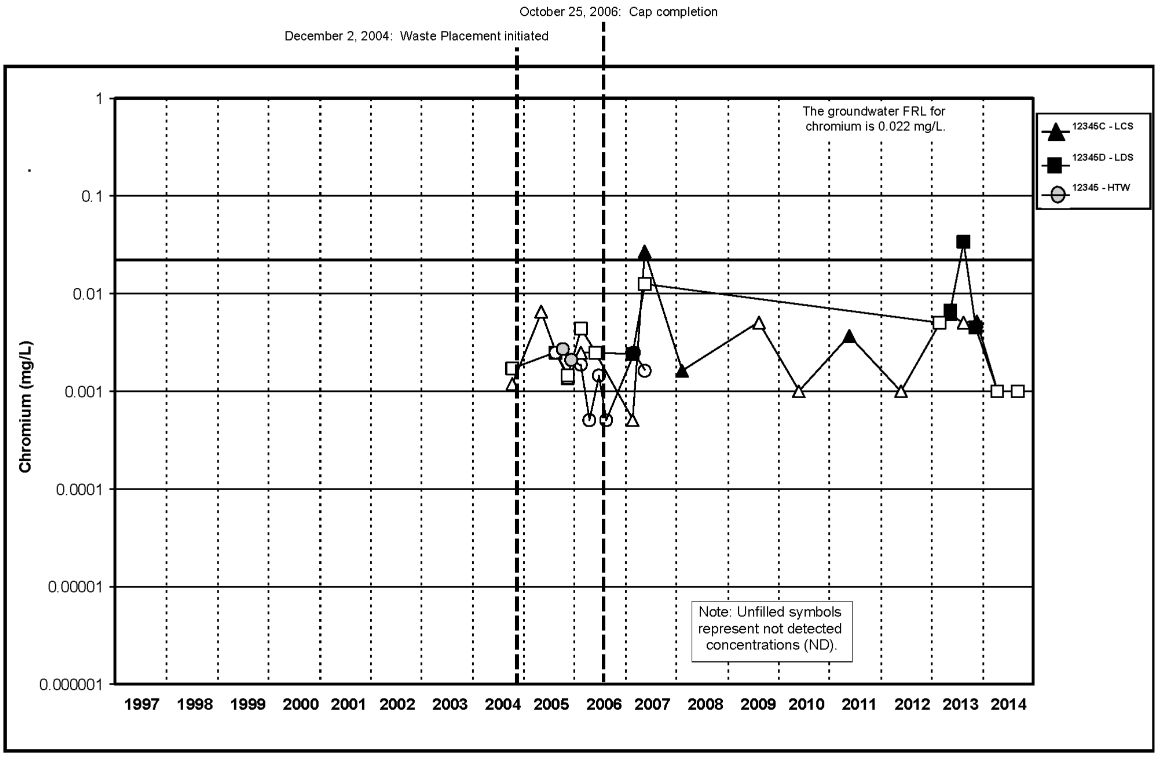


Figure A.5.8-21A. Cell 8 Chromium Concentration Versus Time Plot for LCS, LDS, and HTW

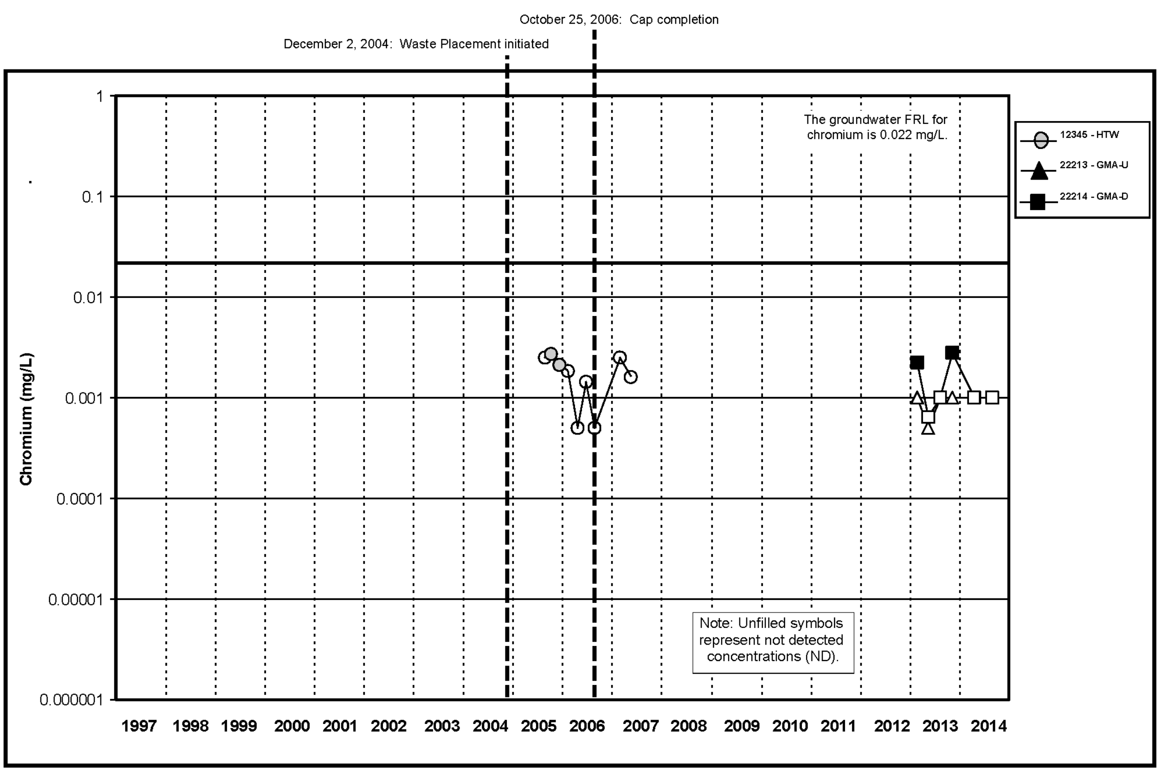


Figure A.5.8-21B. Cell 8 Chromium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

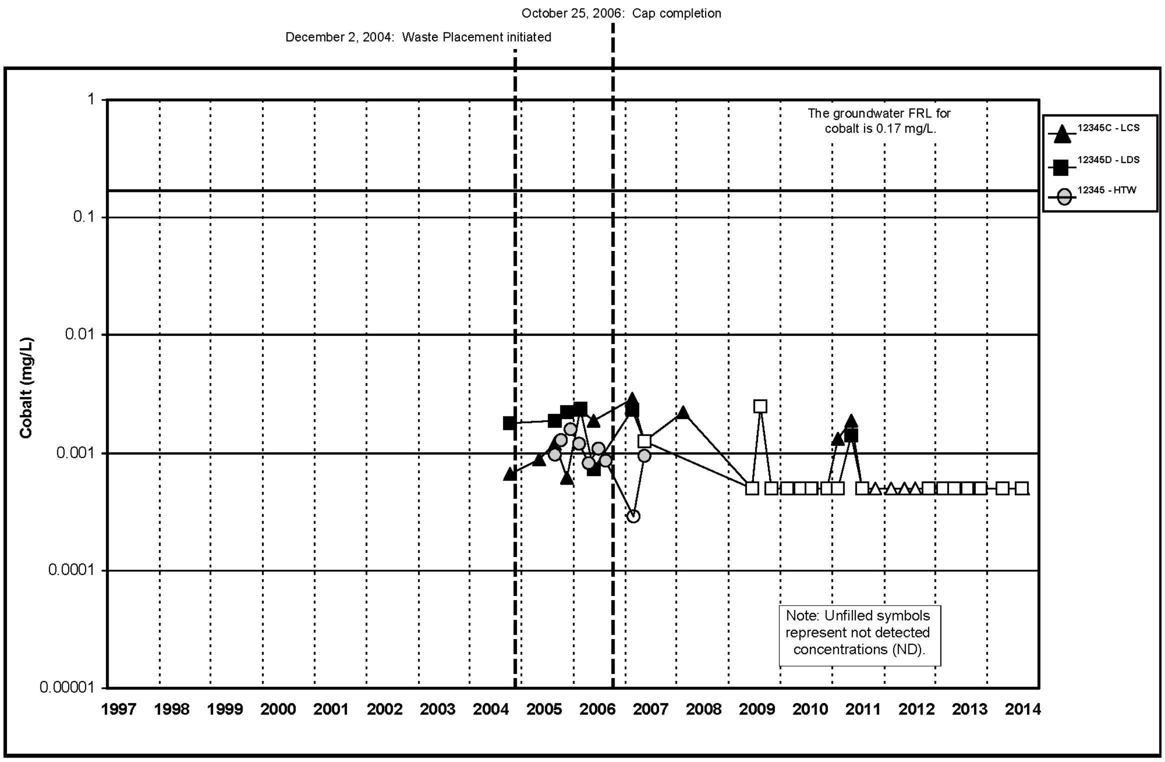


Figure A.5.8-22A. Cell 8 Cobalt Concentration Versus Time Plot for LCS, LDS, and HTW

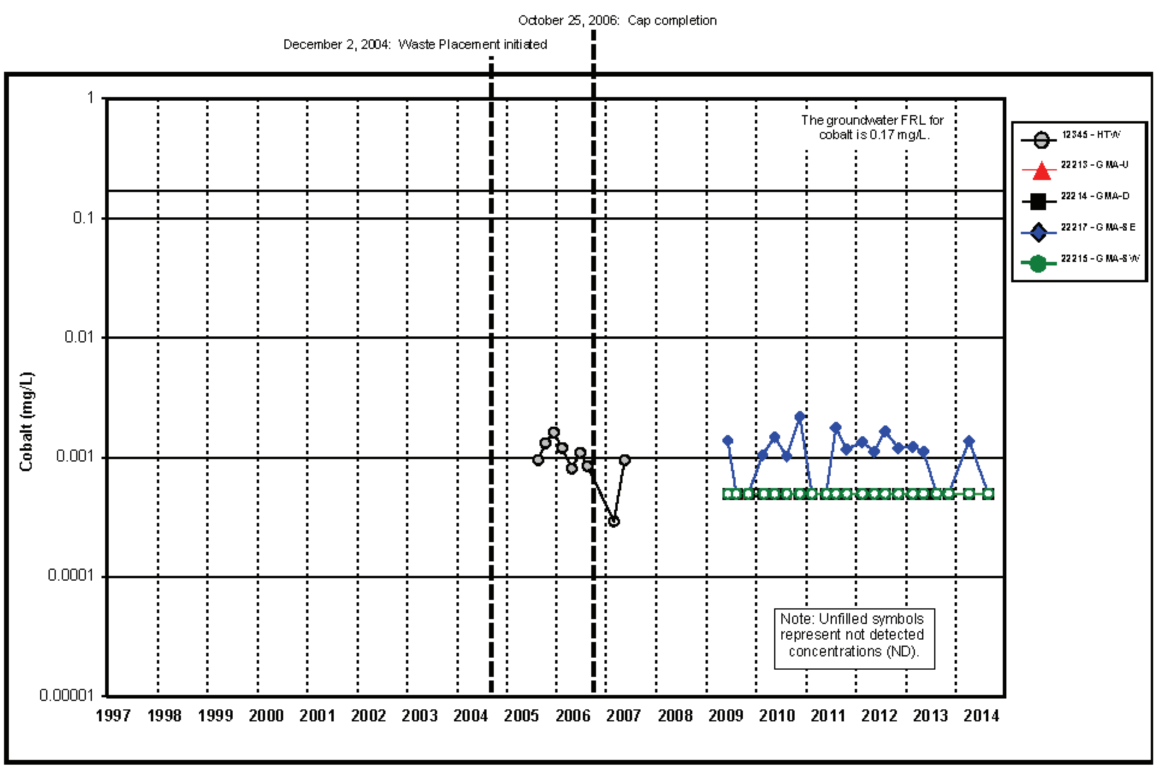


Figure A.5.8-22B. Cell 8 Cobalt Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

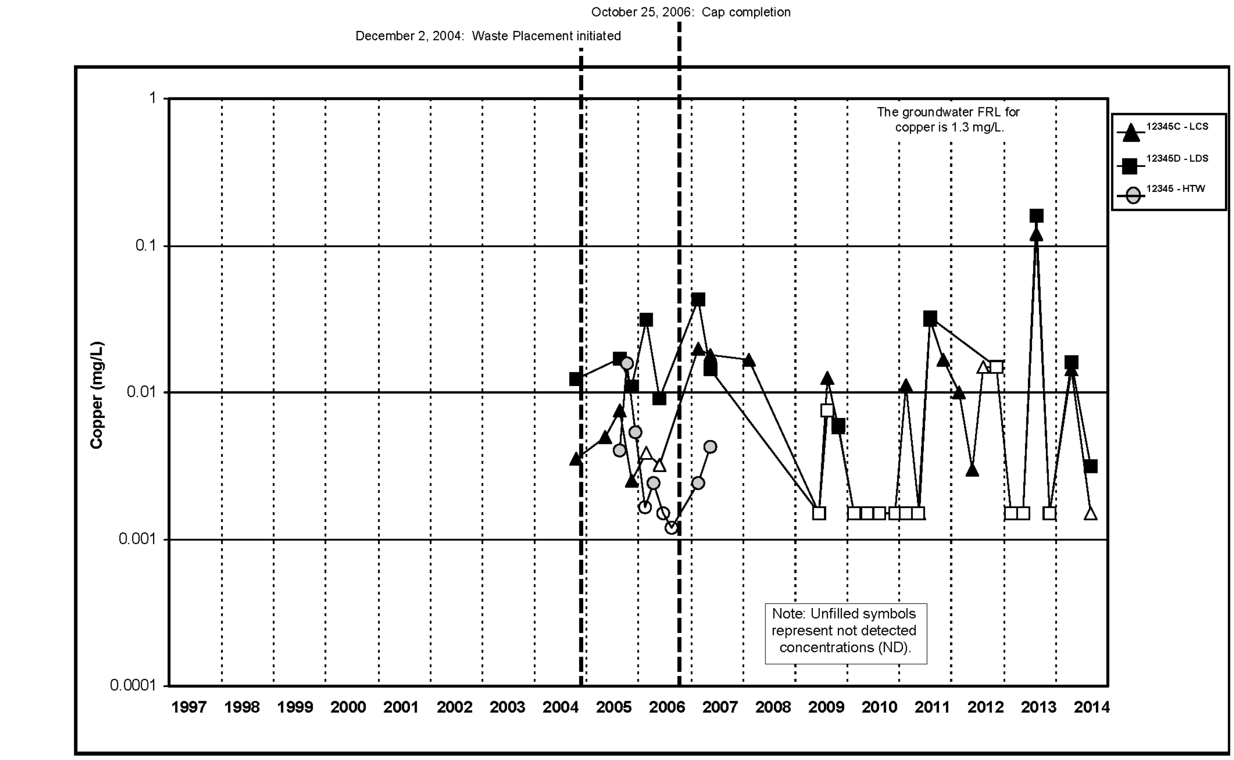


Figure A.5.8-23A. Cell 8 Copper Concentration Versus Time Plot for LCS, LDS, and HTW

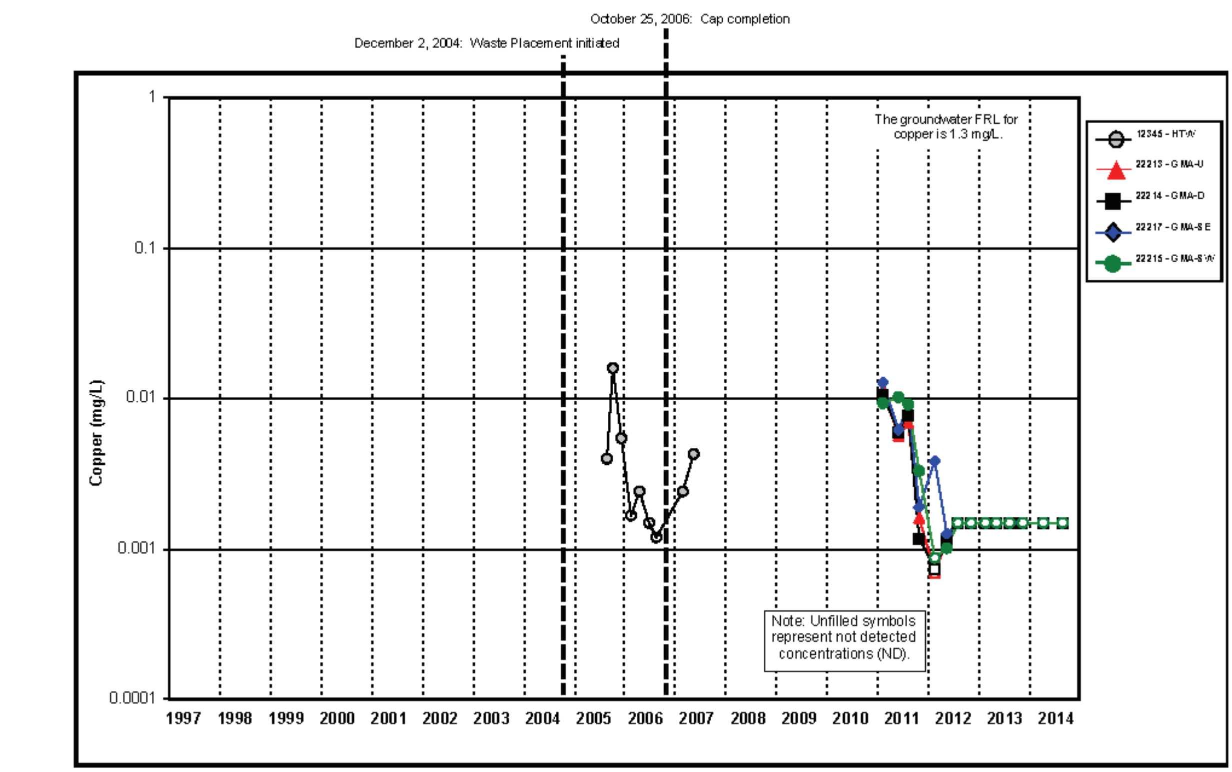


Figure A.5.8-23B. Cell 8 Copper Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

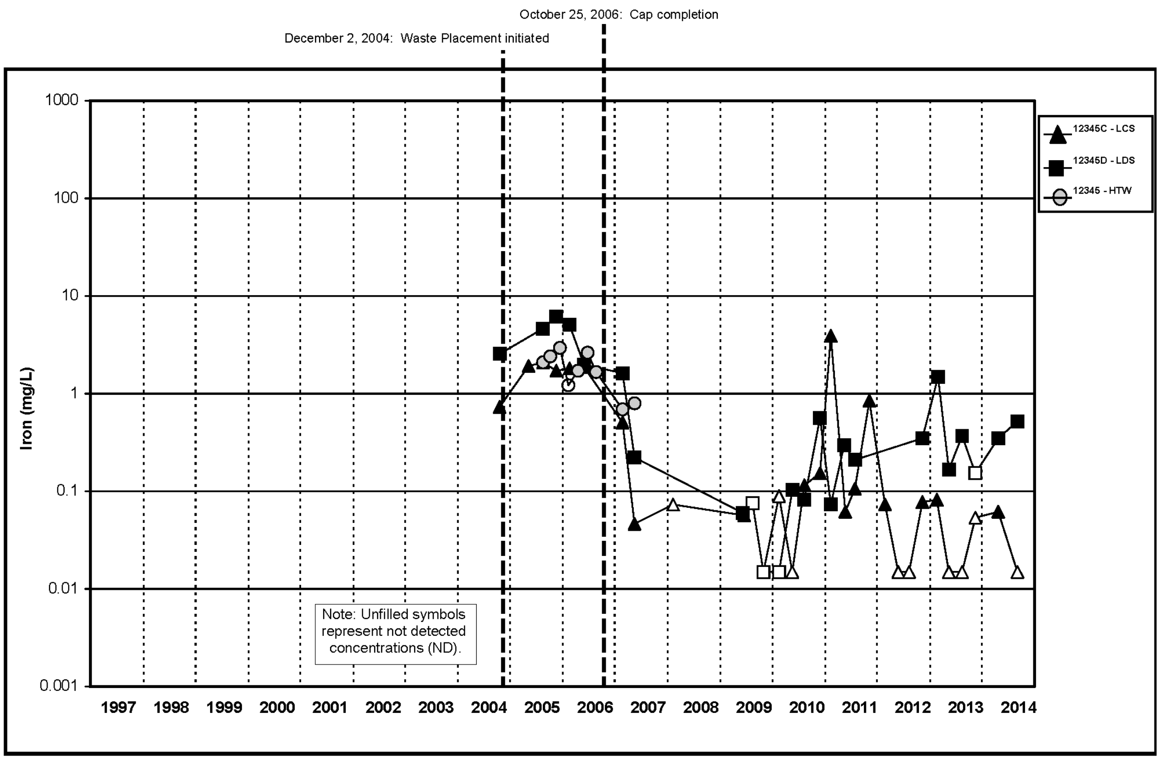


Figure A.5.8-24A. Cell 8 Iron Concentration Versus Time Plot for LCS, LDS, and HTW

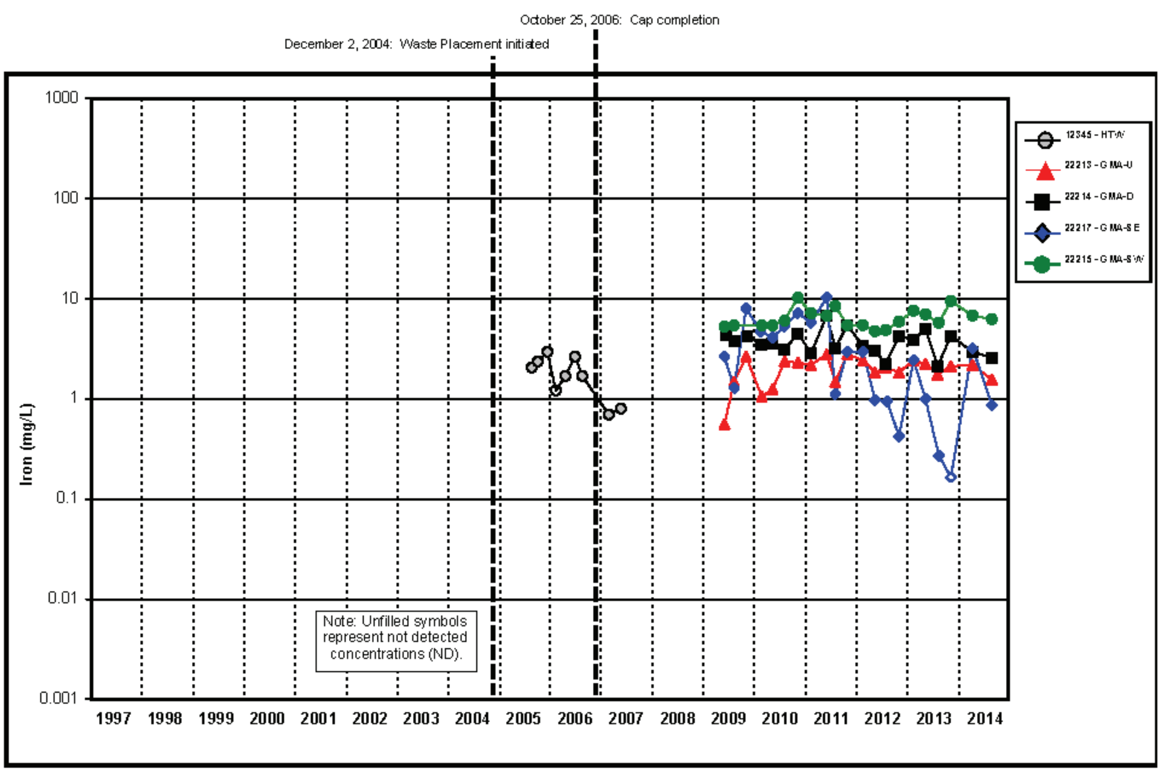


Figure A.5.8-24B. Cell 8 Iron Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

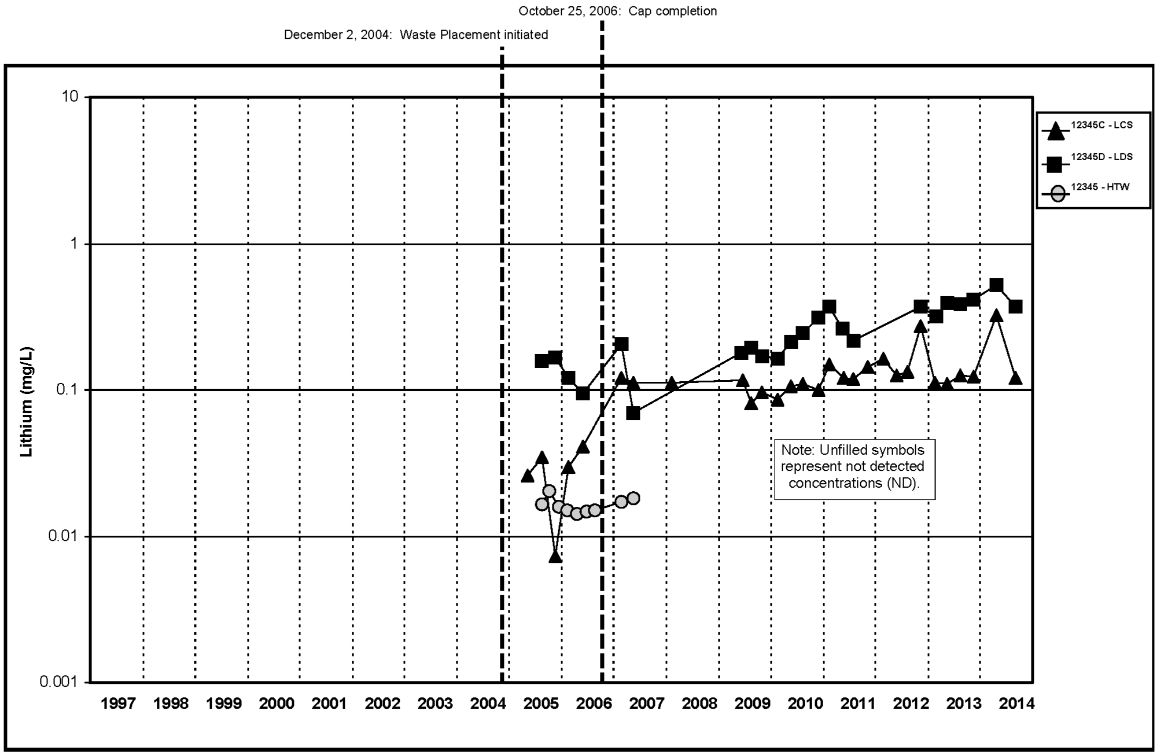


Figure A.5.8-25A. Cell 8 Lithium Concentration Versus Time Plot for LCS, LDS, and HTW

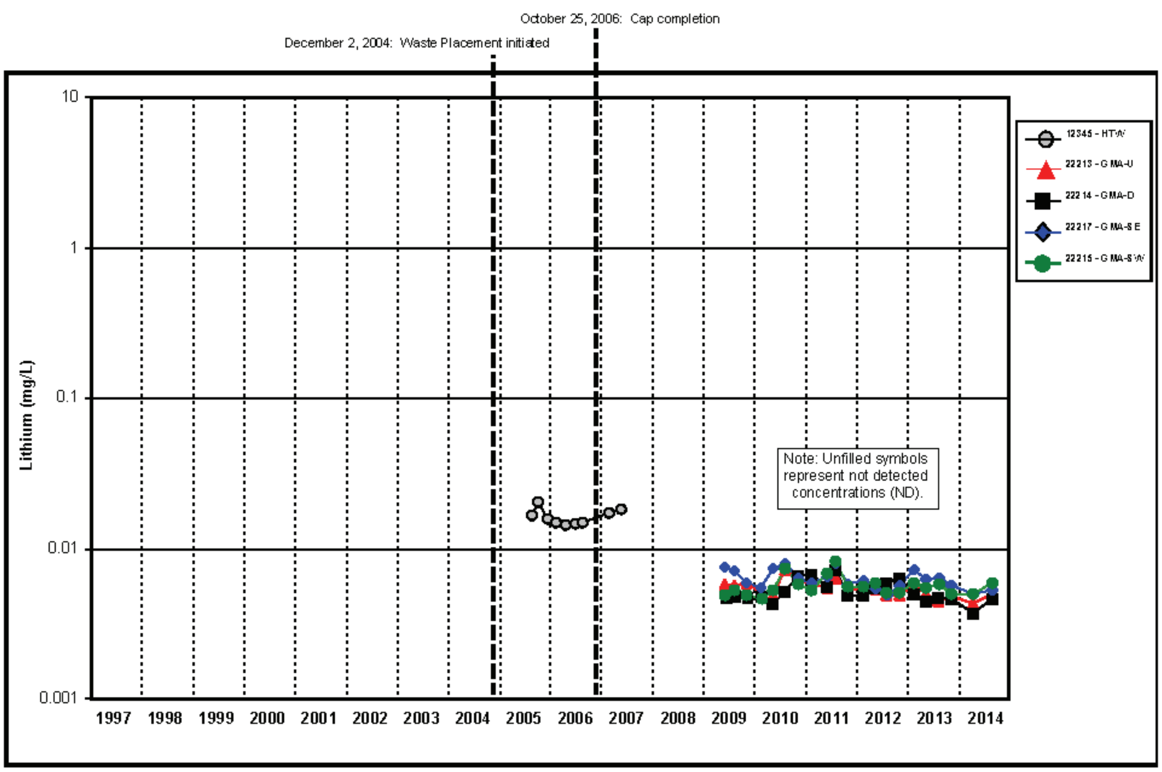


Figure A.5.8-25B. Cell 8 Lithium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

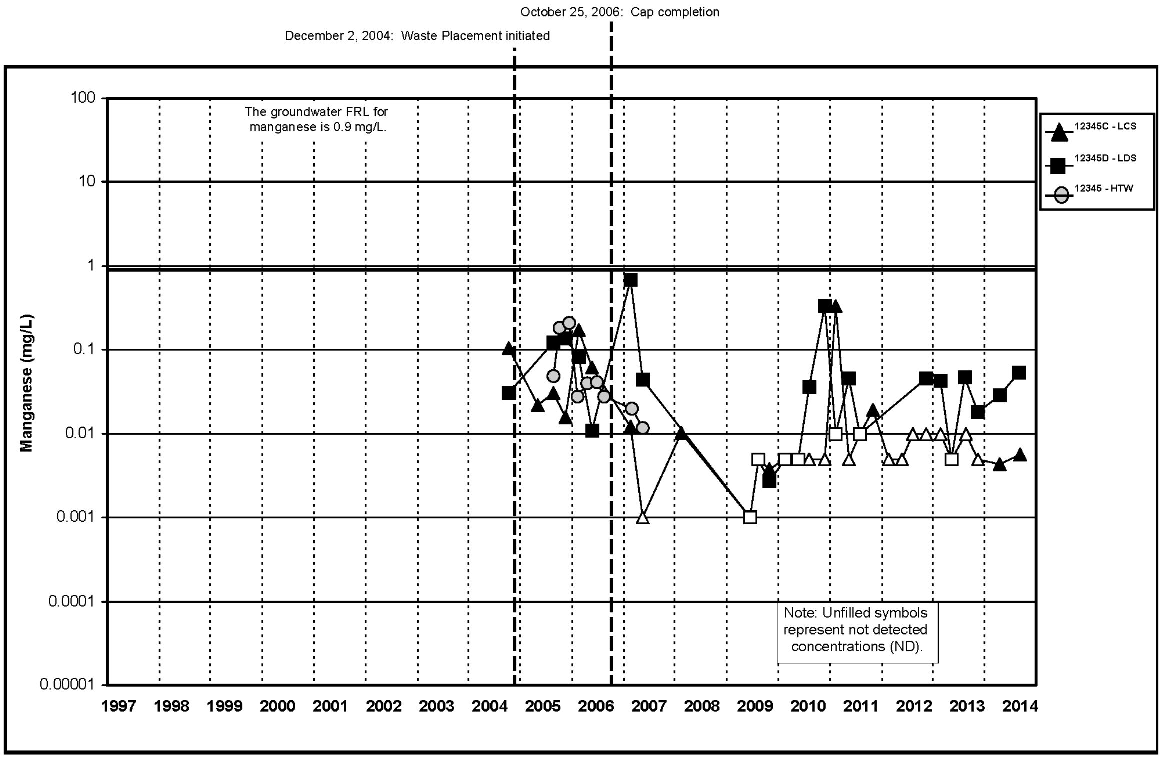


Figure A.5.8-26A. Cell 8 Manganese Concentration Versus Time Plot for LCS, LDS, and HTW

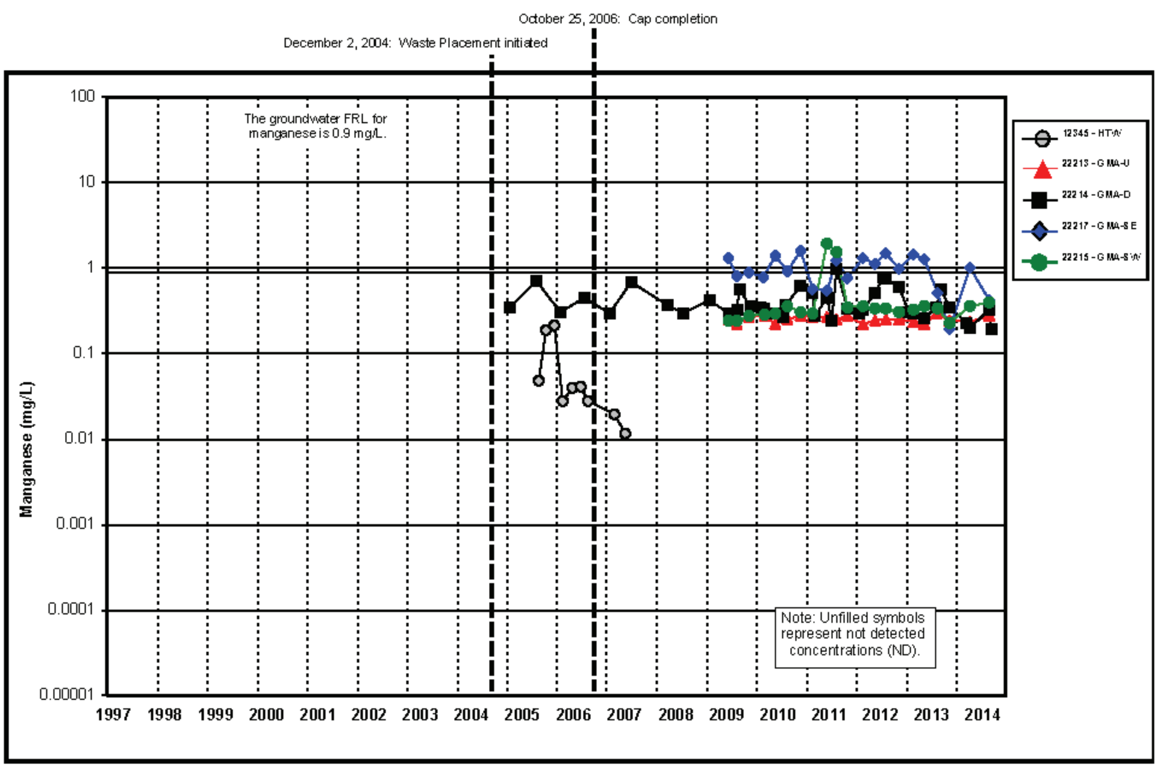


Figure A.5.8-26B. Cell 8 Manganese Concentration Versus Time Plot for HTW, GMA-U Well, GMA-D, GMA-SE, and GMA-SW Wells

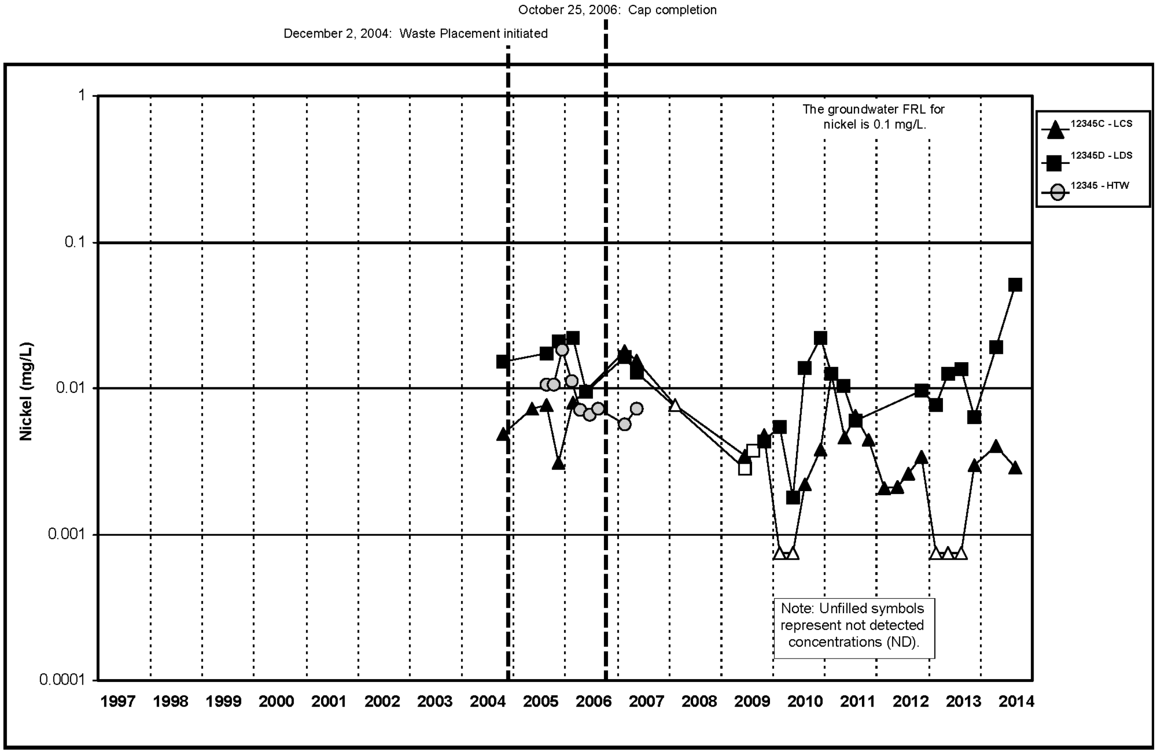


Figure A.5.8-27A. Cell 8 Nickel Concentration Versus Time Plot for LCS, LDS, and HTW

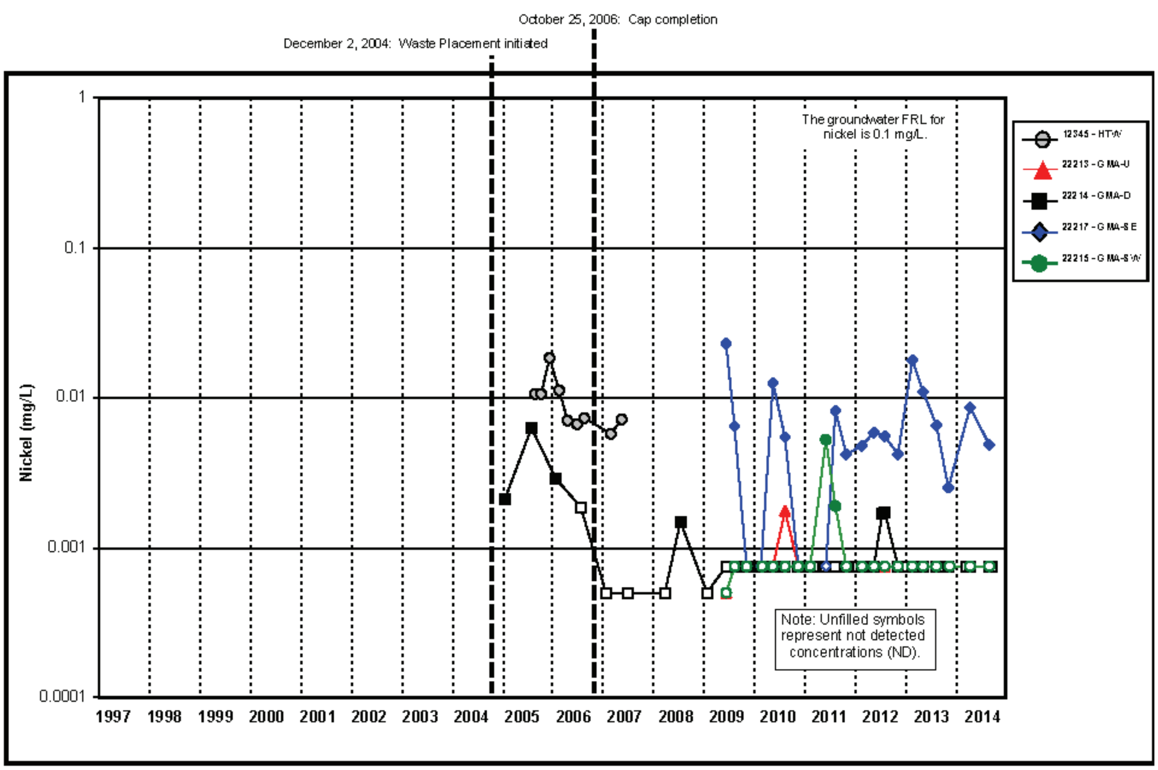


Figure A.5.8-27B. Cell 8 Nickel Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

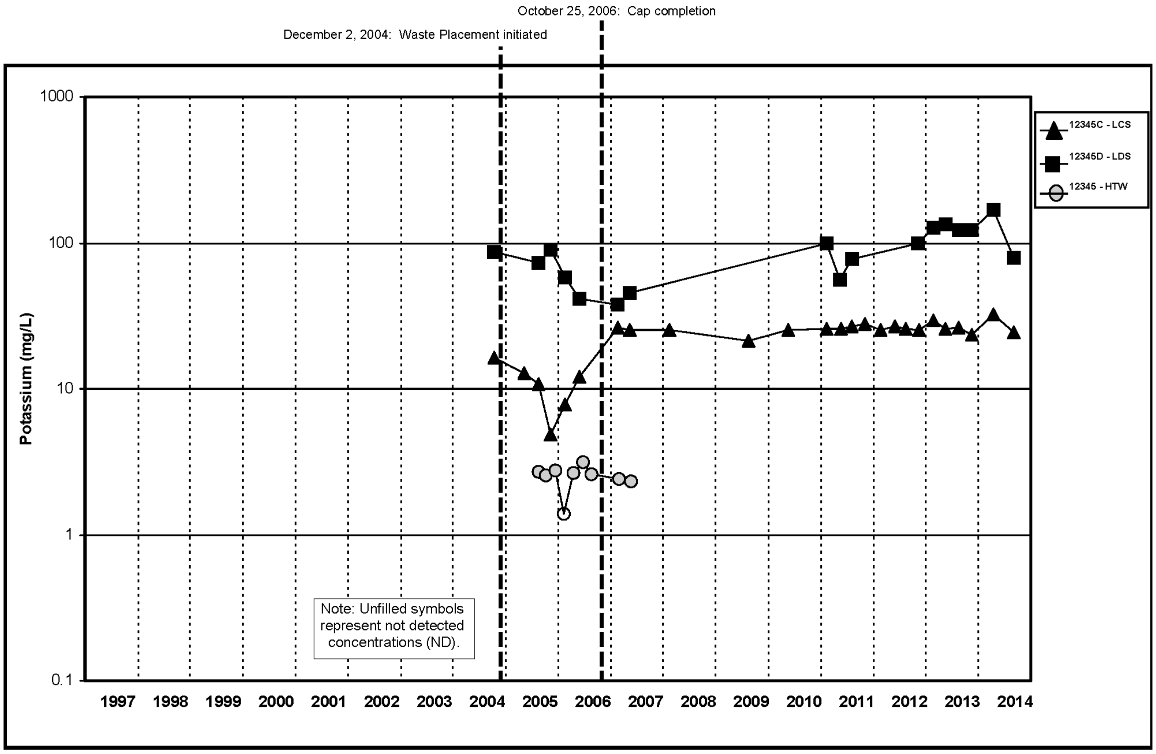


Figure A.5.8-28A. Cell 8 Potassium Concentration Versus Time Plot for LCS, LDS, and HTW

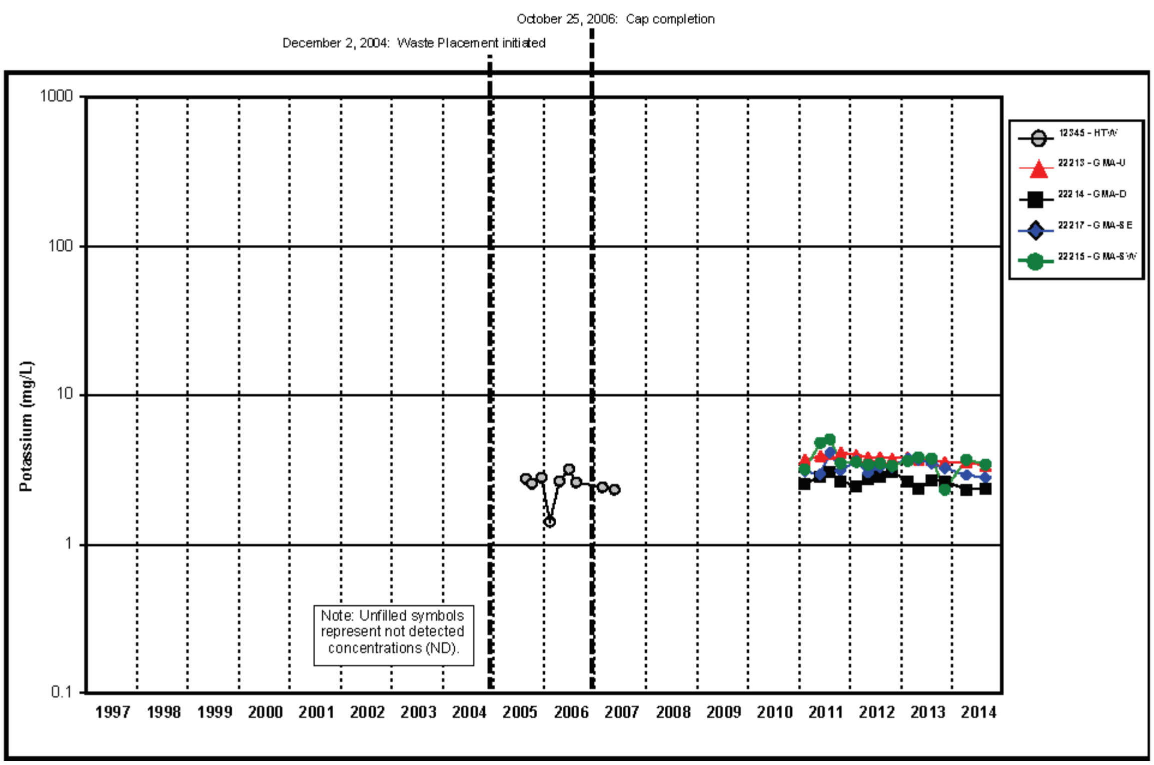


Figure A.5.8-28B. Cell 8 Potassium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

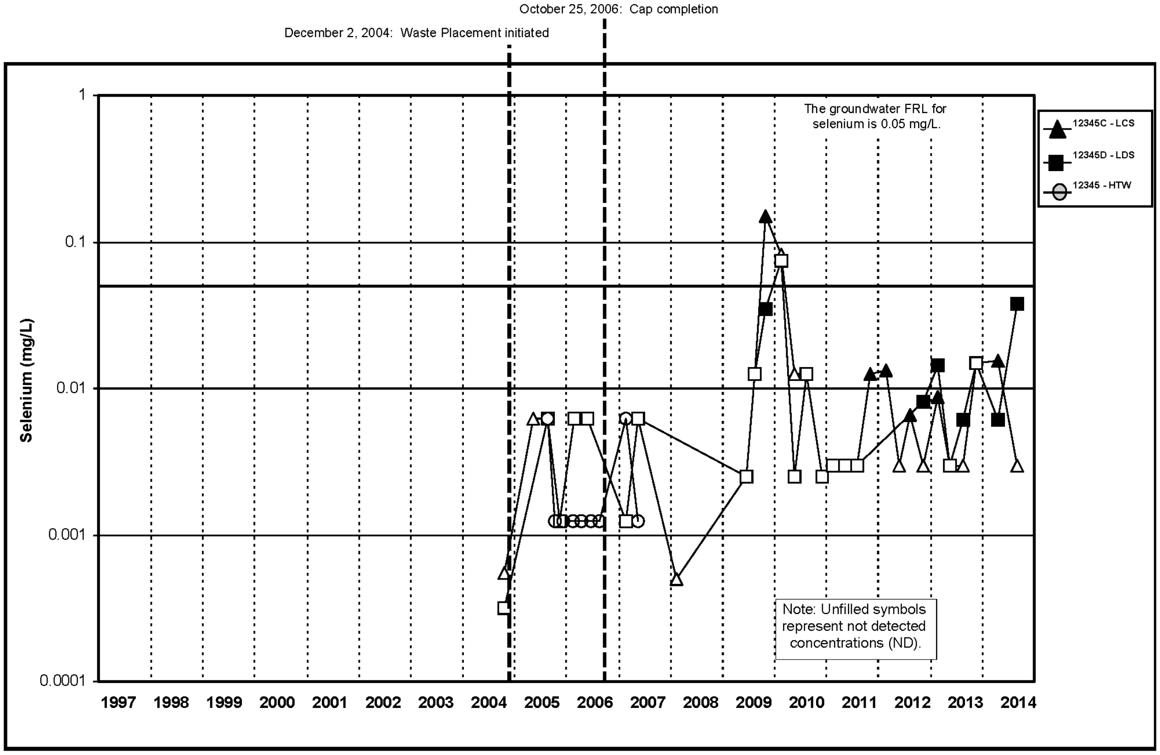


Figure A.5.8-29A. Cell 8 Selenium Concentration Versus Time Plot for LCS, LDS, and HTW

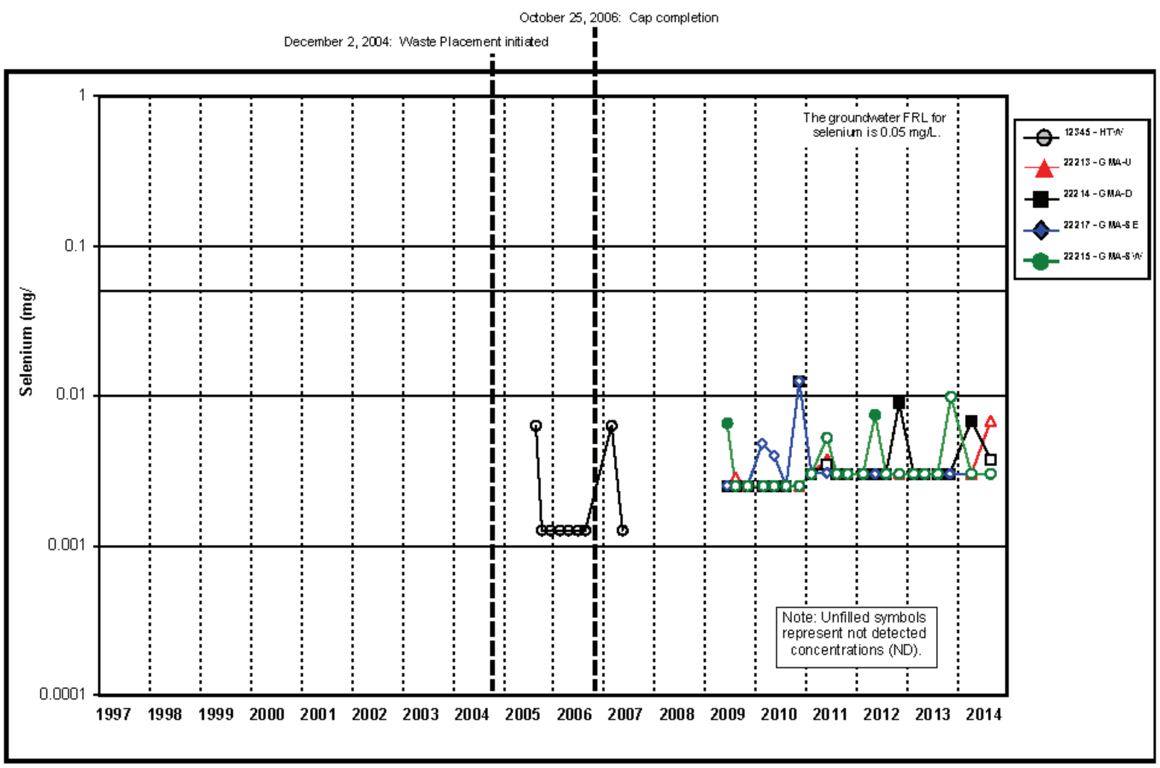


Figure A.5.8-29B. Cell 8 Selenium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

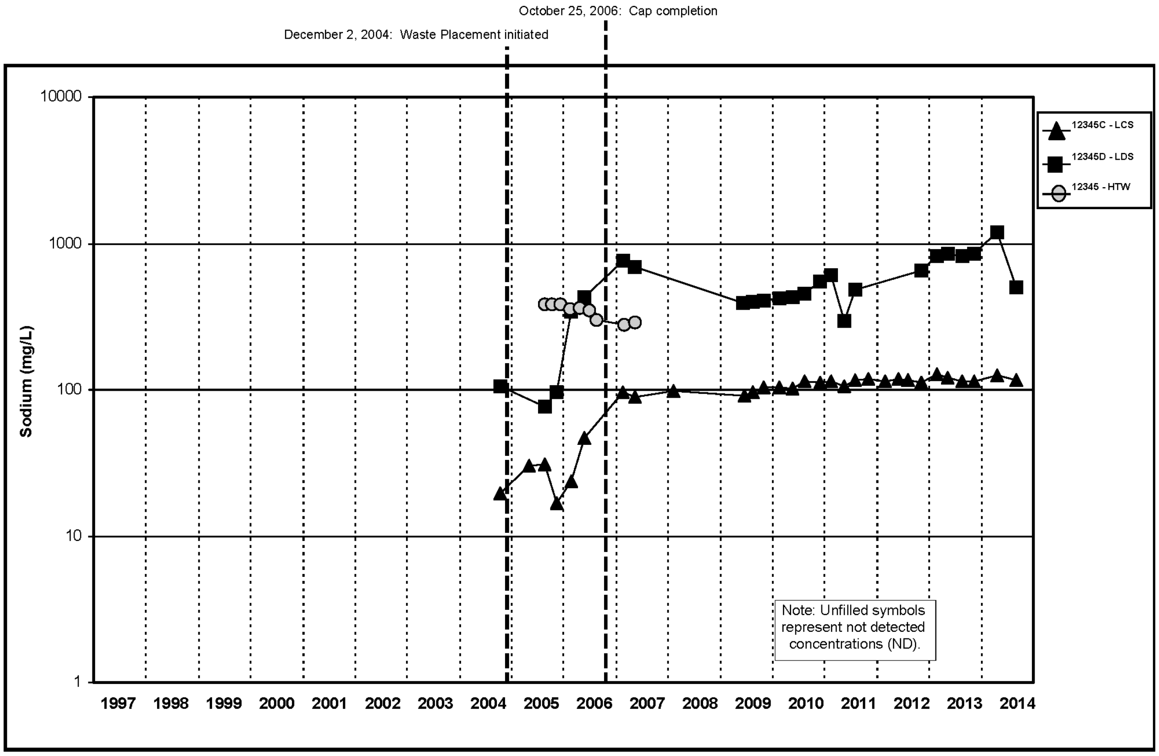


Figure A.5.8-30A. Cell 8 Sodium Concentration Versus Time Plot for LCS, LDS, and HTW

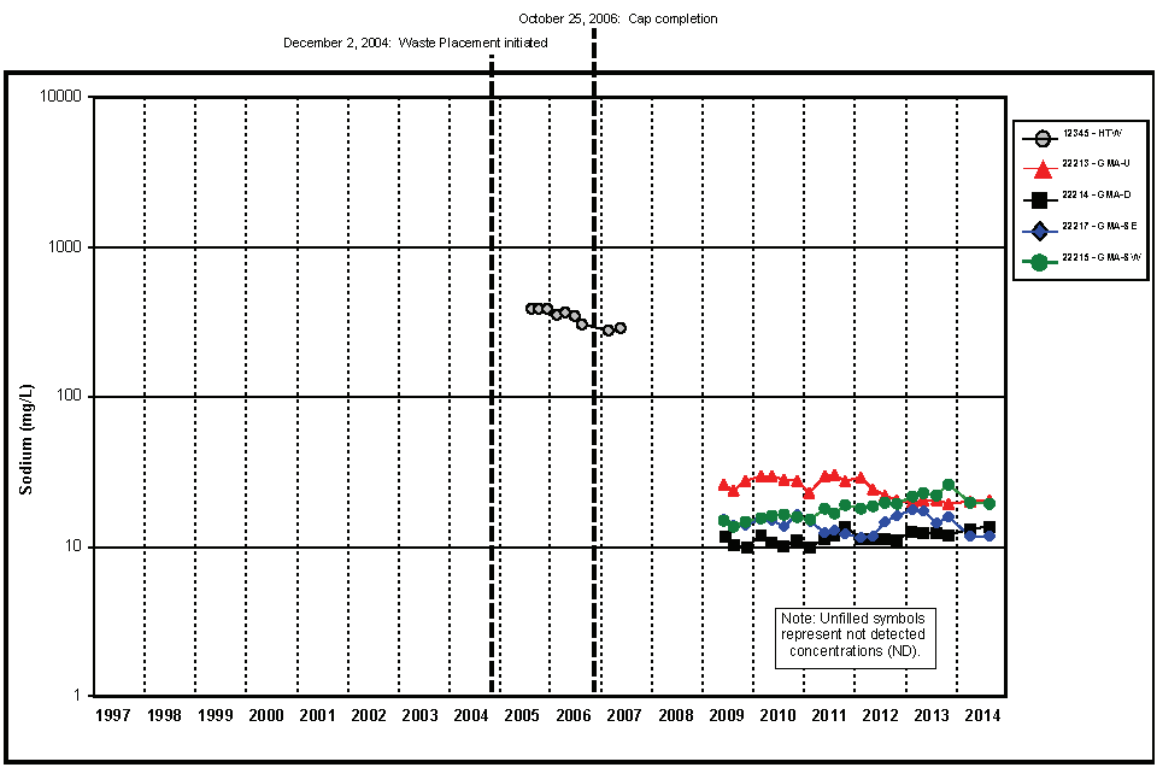


Figure A.5.8-30B. Cell 8 Sodium Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

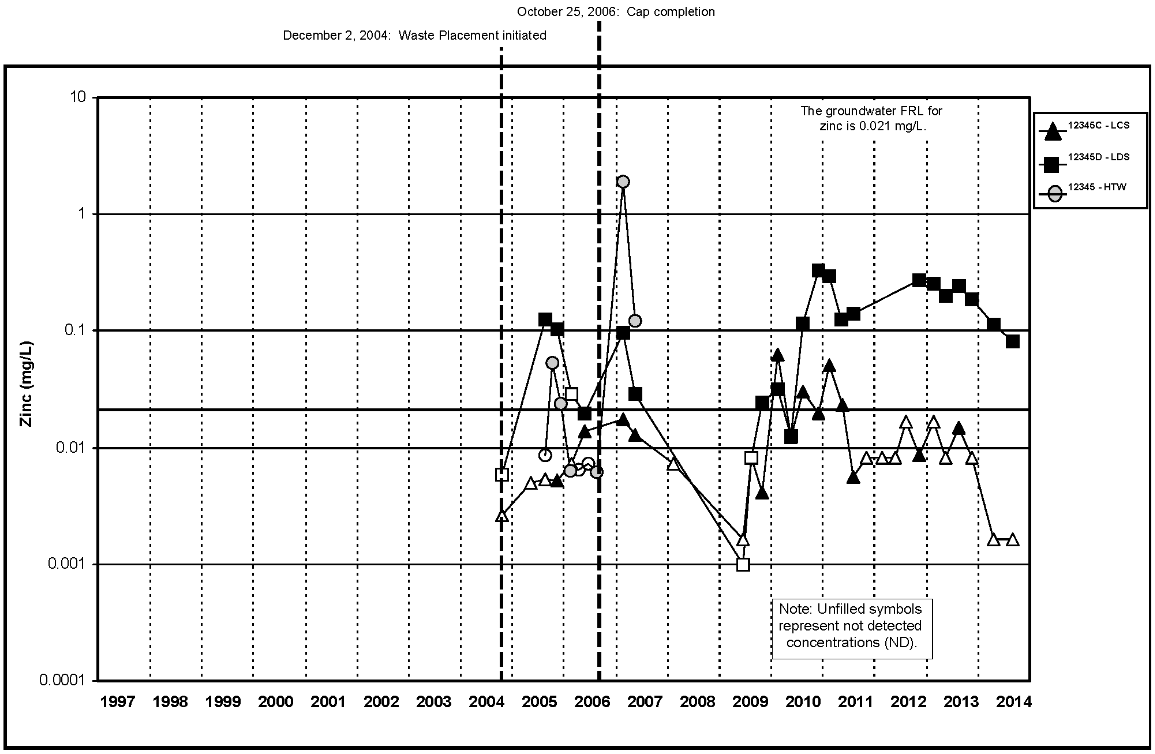


Figure A.5.8-31A. Cell 8 Zinc Concentration Versus Time Plot for LCS, LDS, and HTW

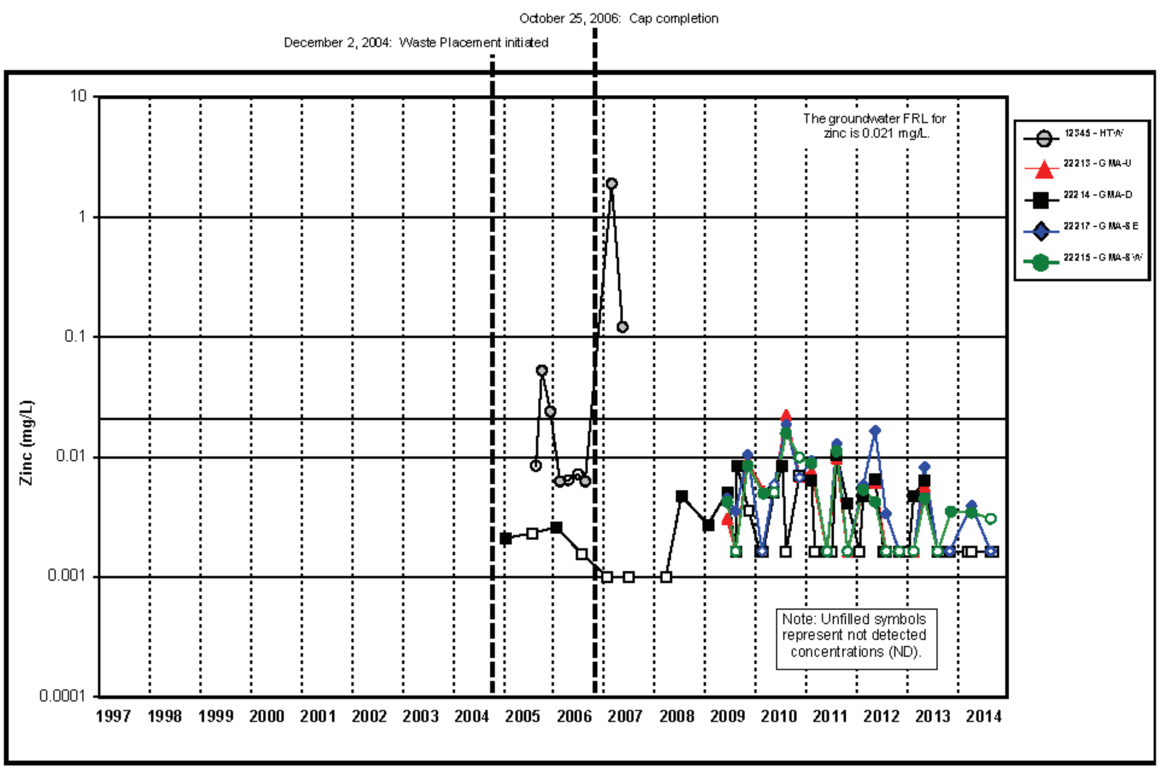


Figure A.5.8-31B. Cell 8 Zinc Concentration Versus Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

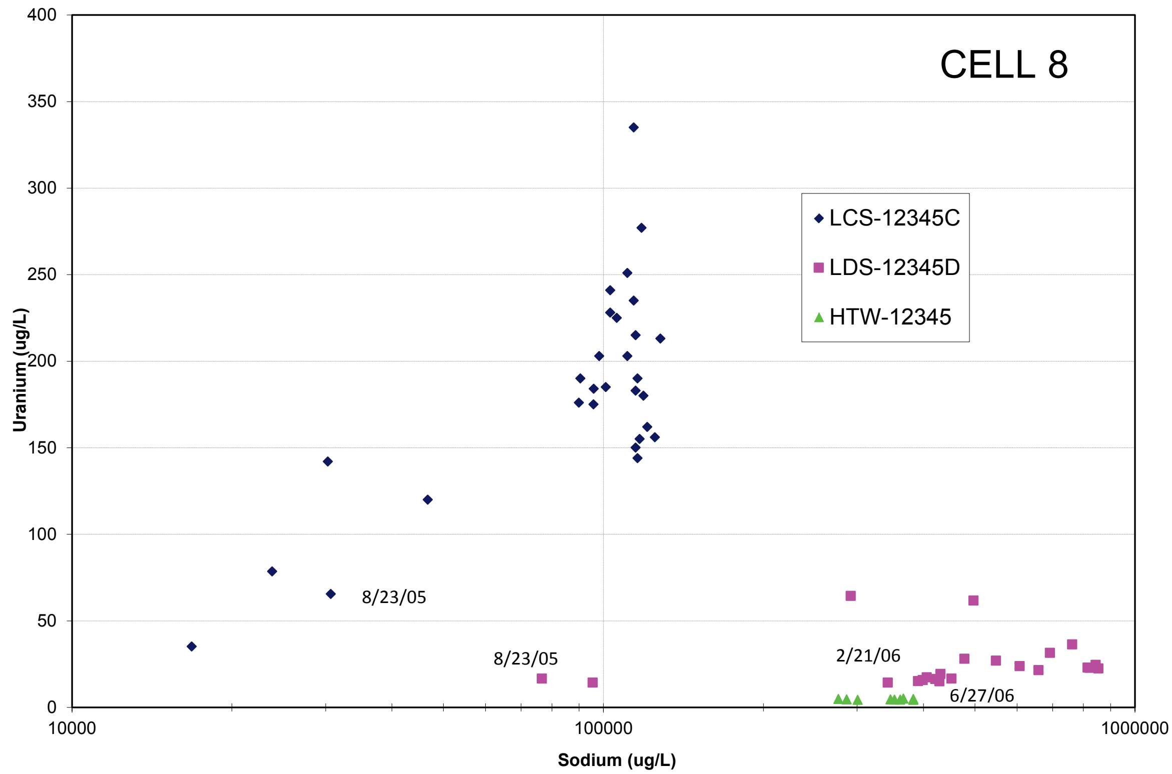


Figure A.5.8-32. Cell 8 Bivariate Plot for Uranium and Sodium

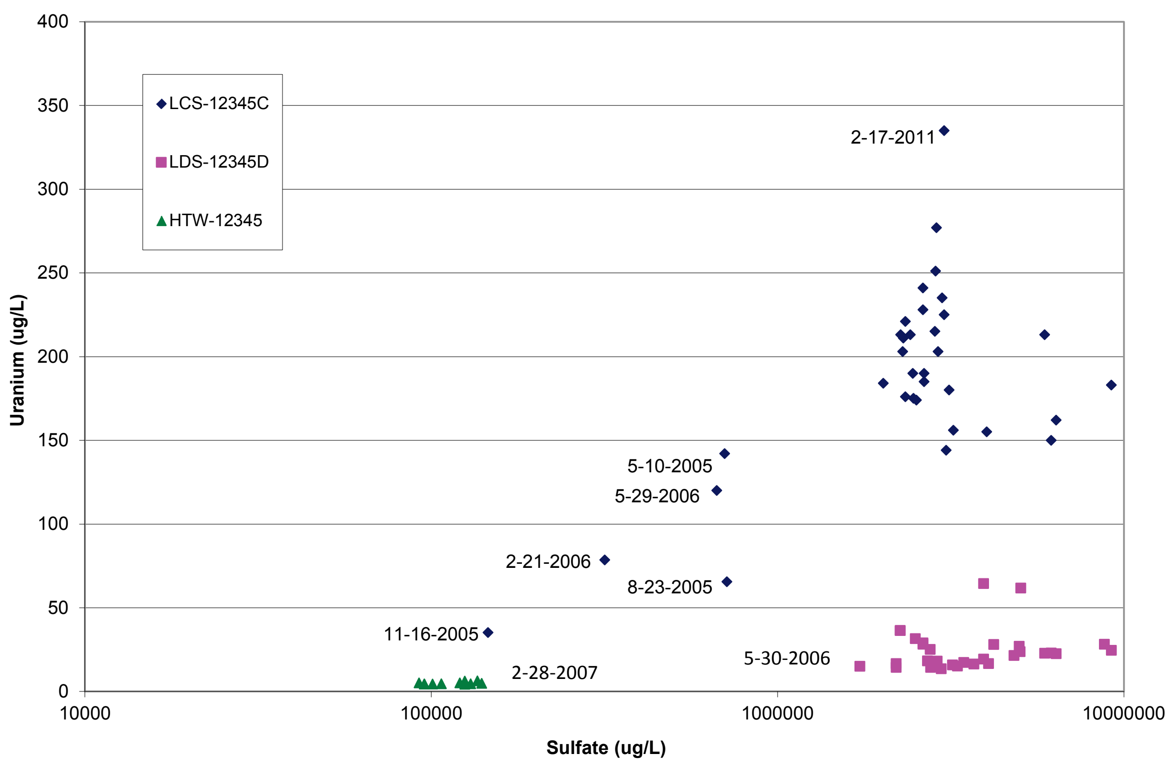


Figure A.5.8-33. Cell 8 Bivariate Plot for Uranium and Sulfate

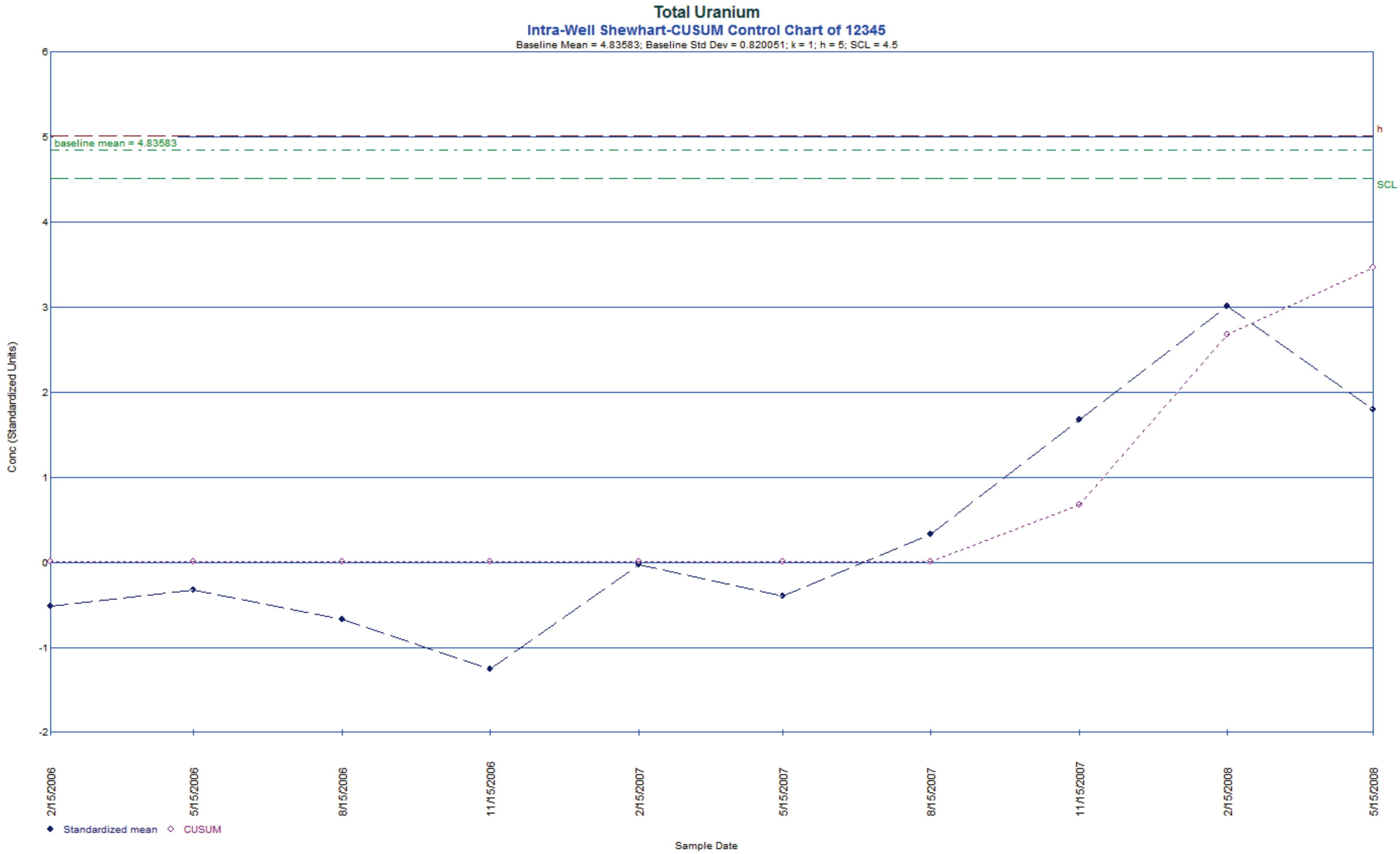


Figure A.5.8-34. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 12345)

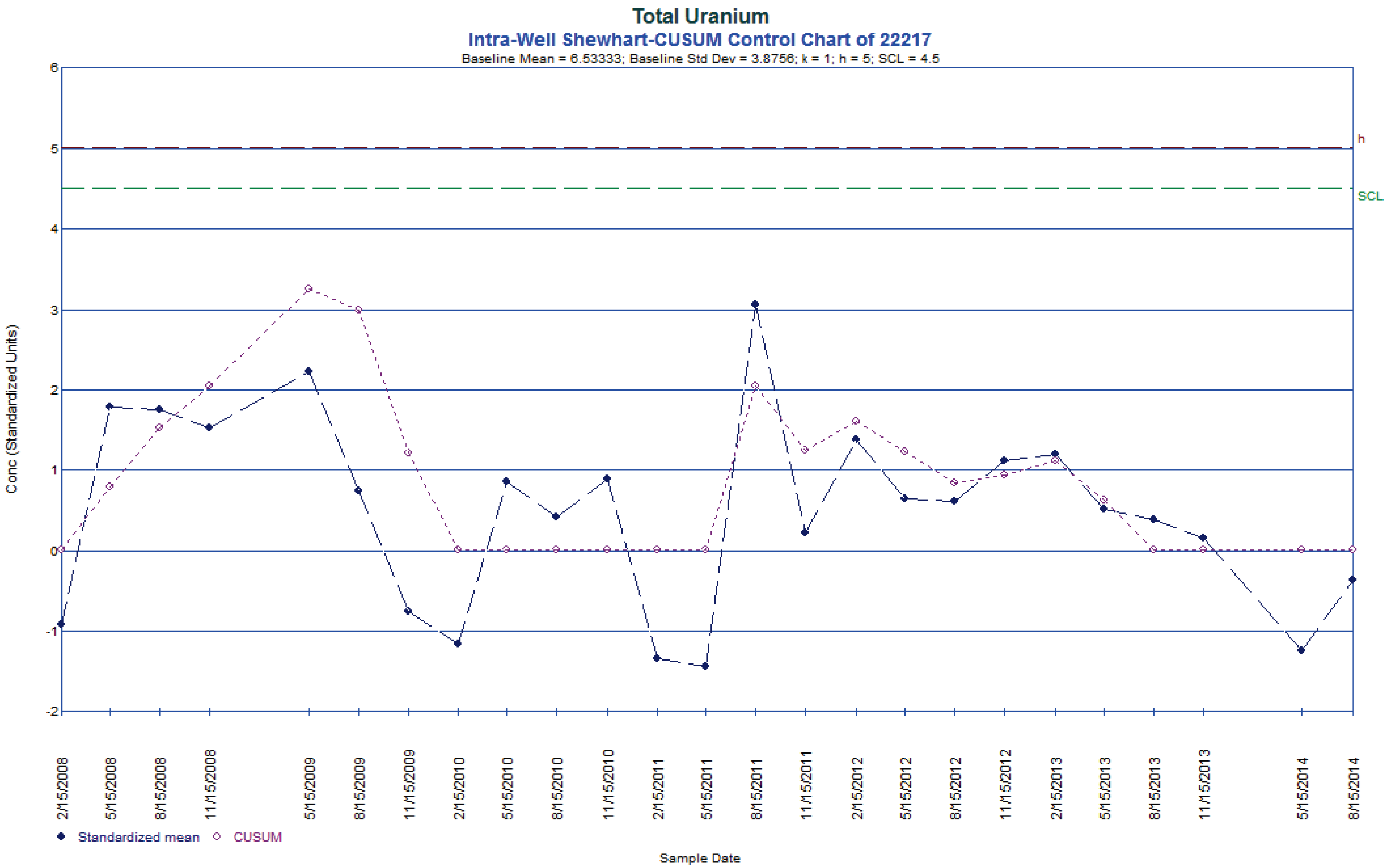


Figure A.5.8-35. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22217)

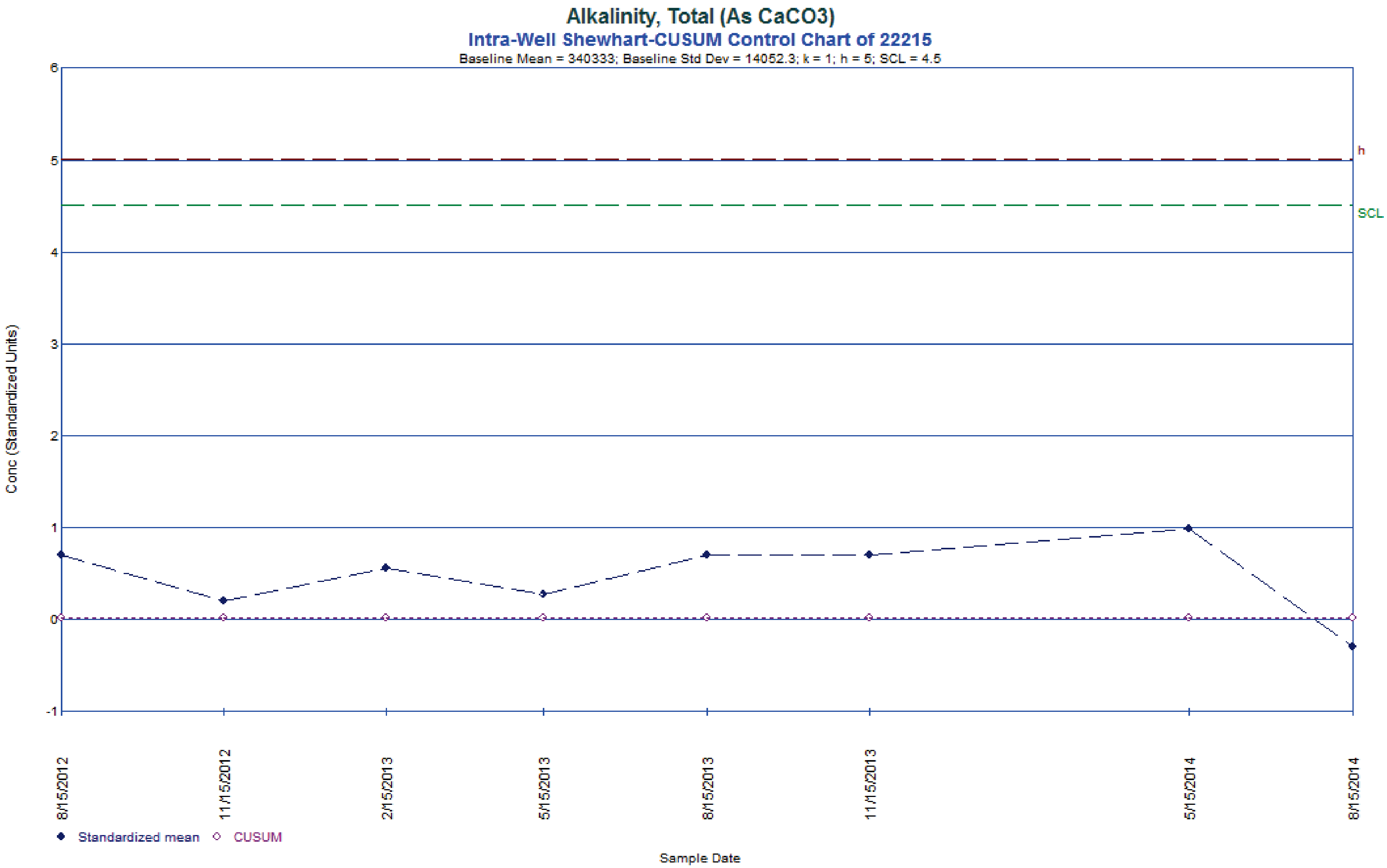


Figure A.5.8-36. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22215)

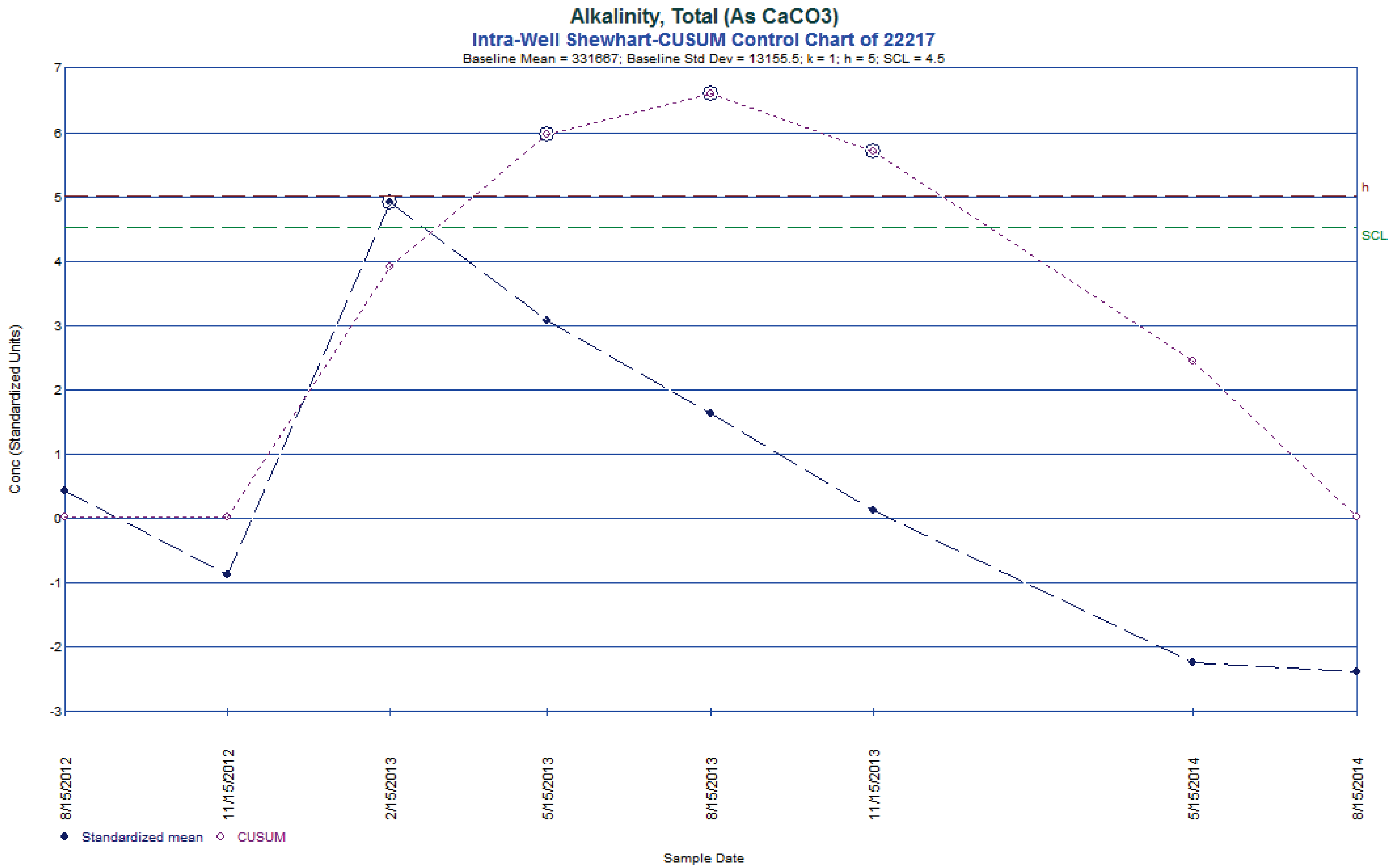


Figure A.5.8-37. Intra-Well Shewhart-CUSUM Control Chart (Alkalinity 22217)

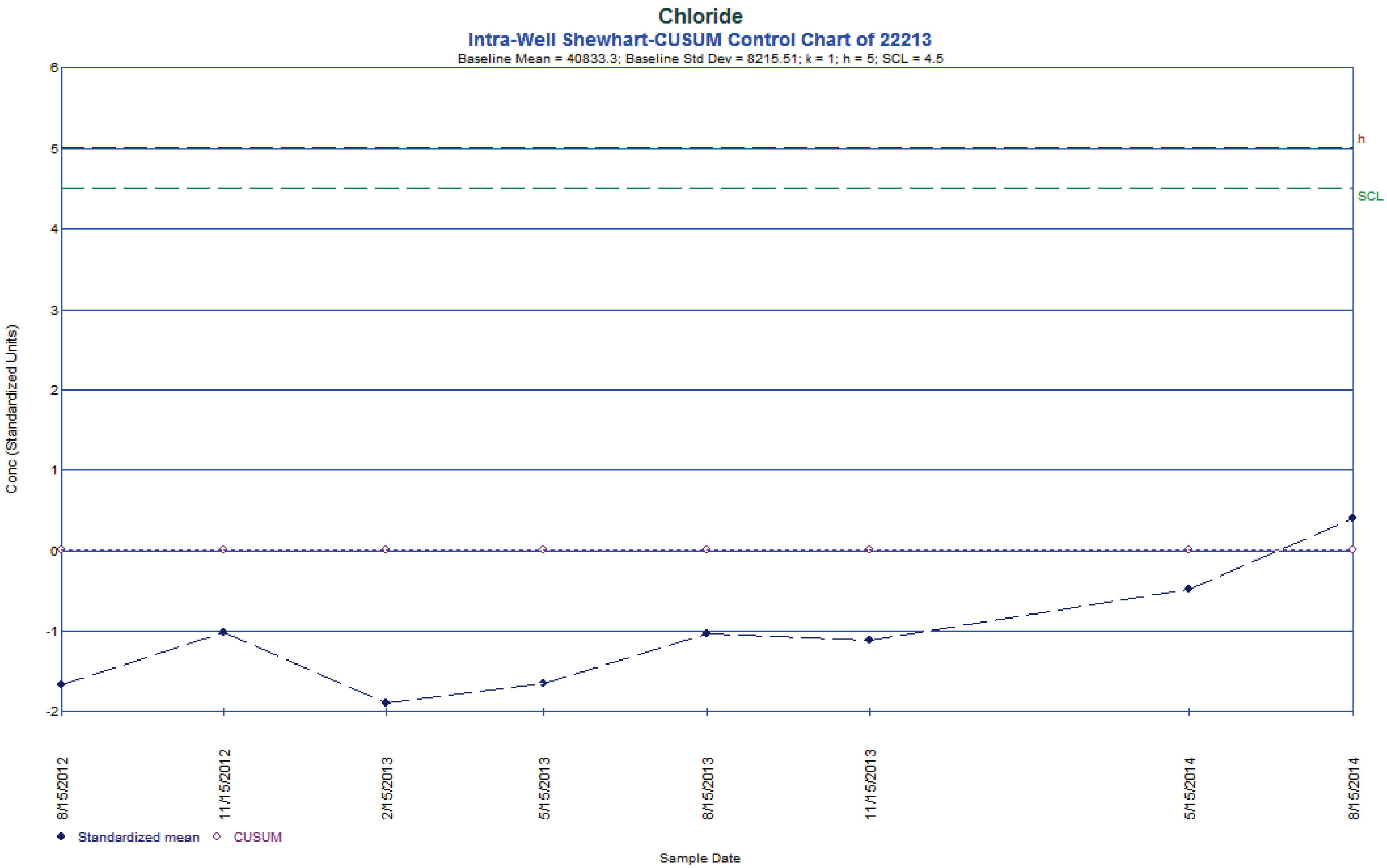


Figure A.5.8-38. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22213)

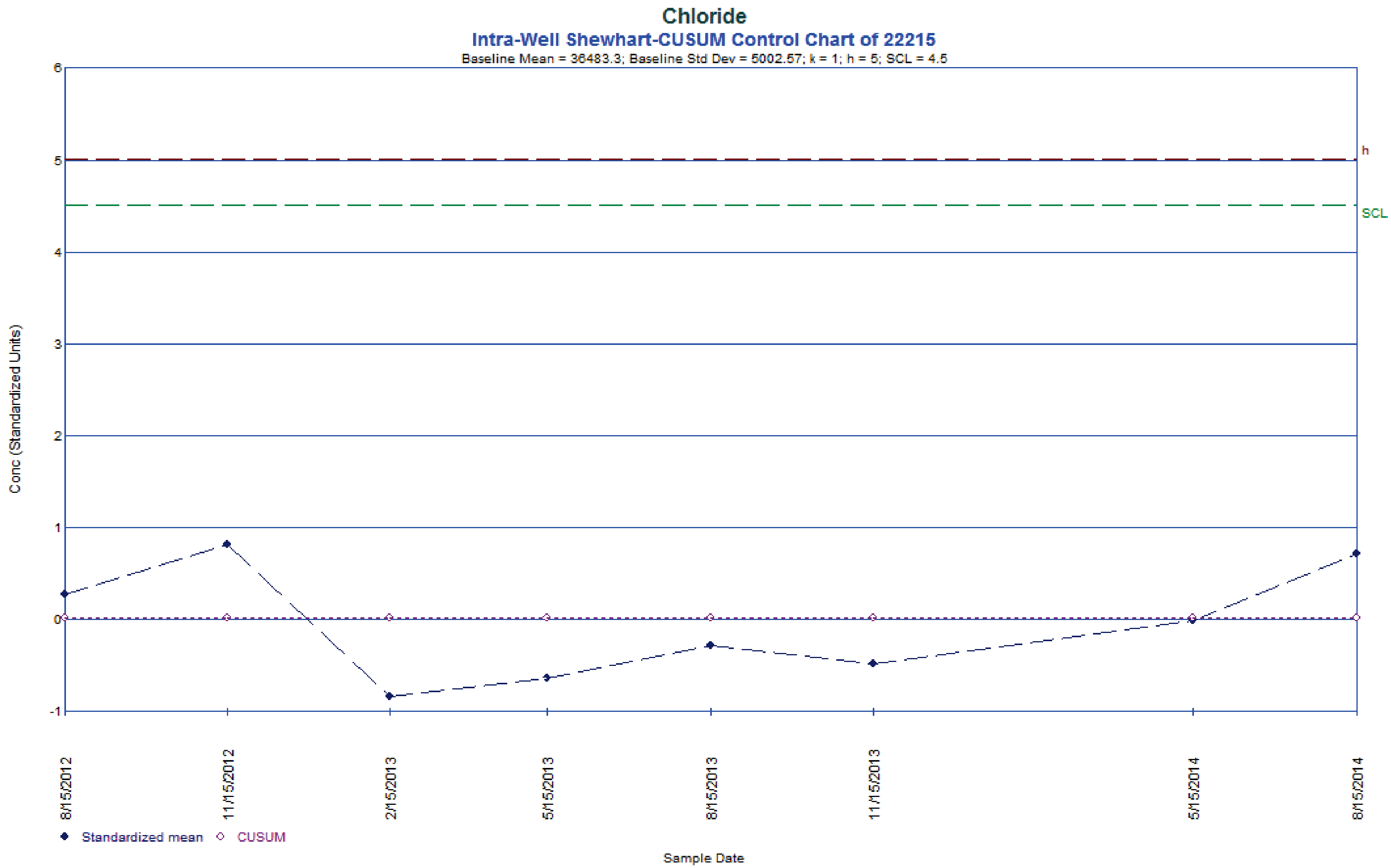


Figure A.5.8-39. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22215)

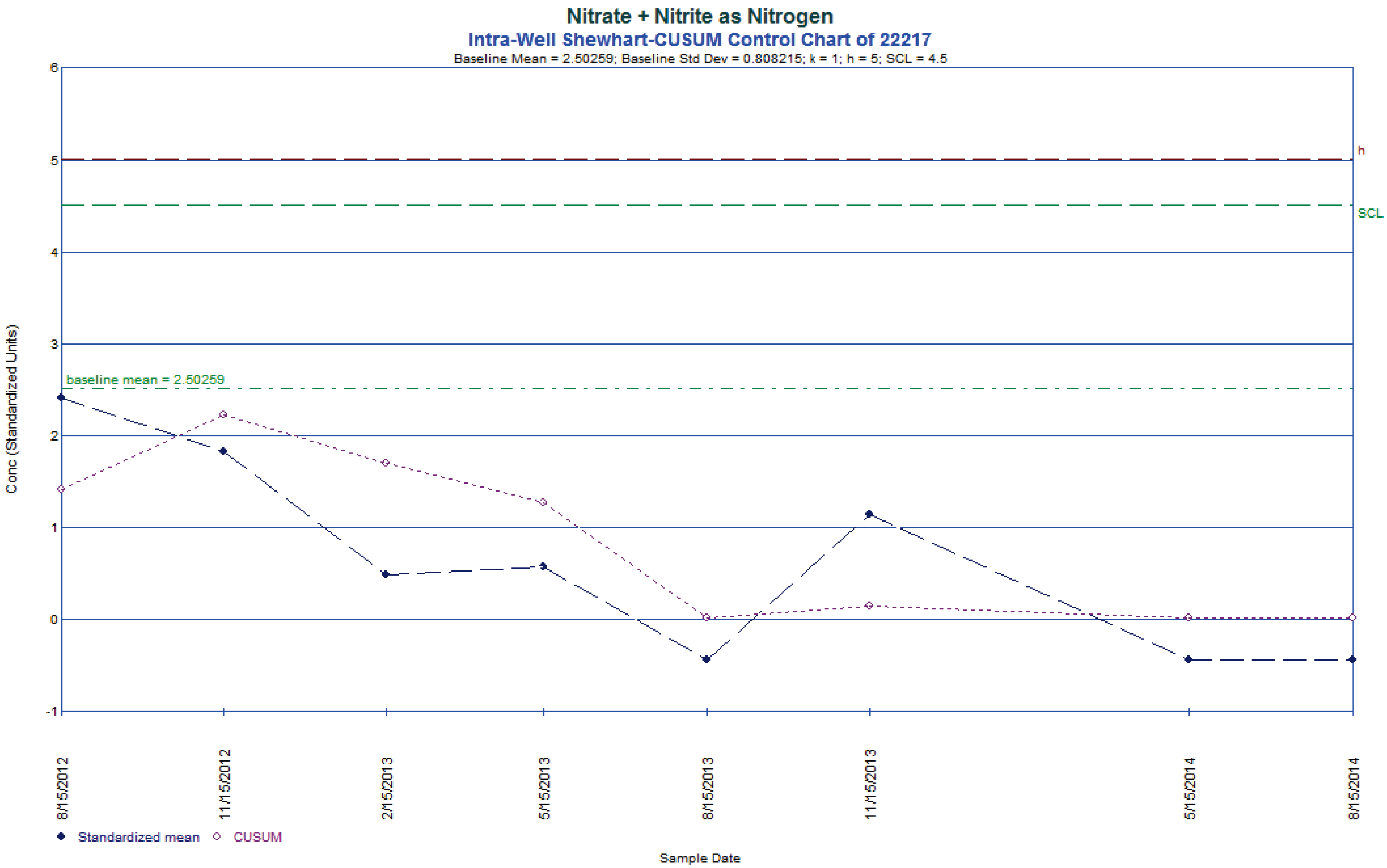


Figure A.5.8-40. Intra-Well Shewhart-CUSUM Control Chart (Nitrate + Nitrite as Nitrogen 22217)

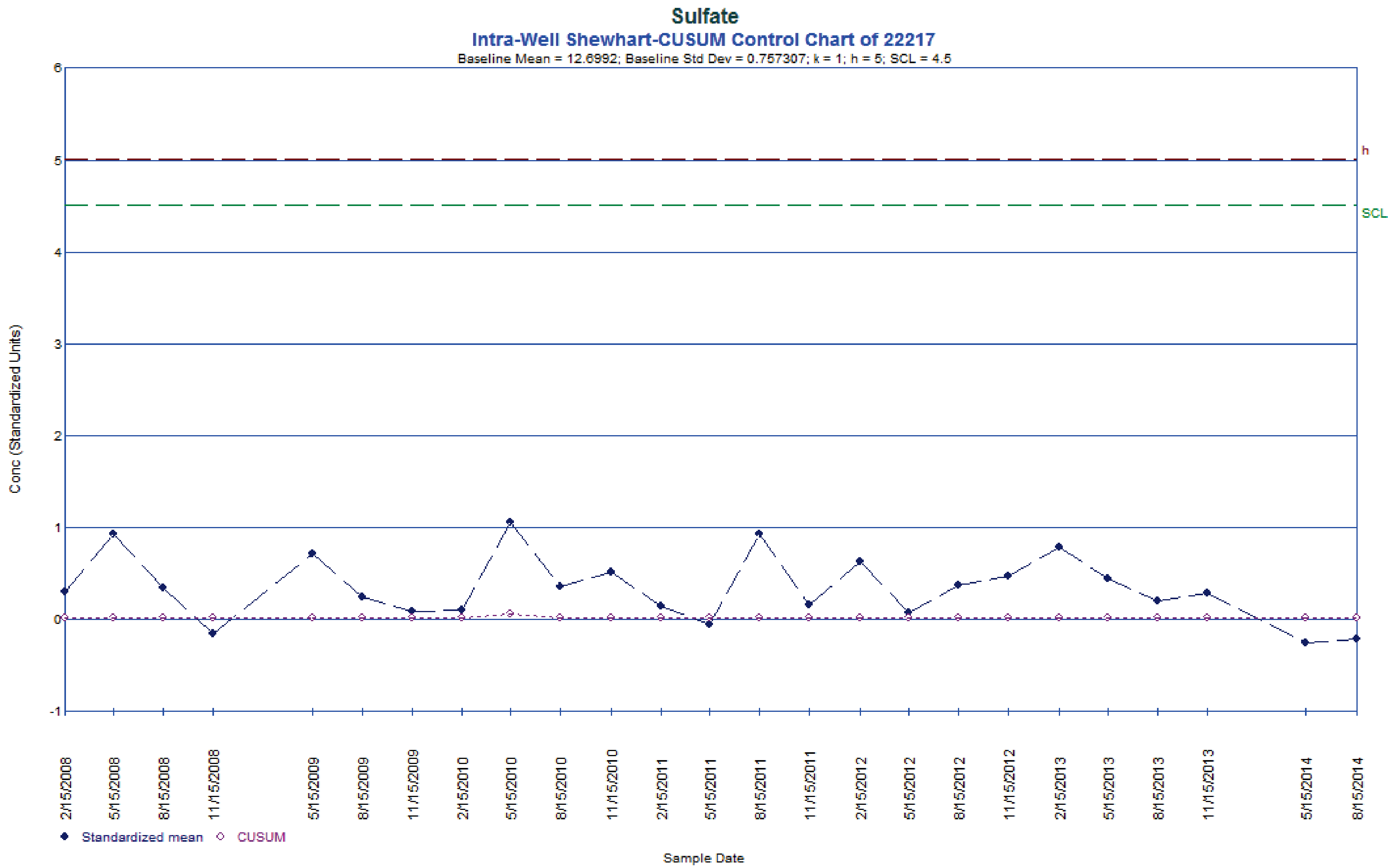


Figure A.5.8-41. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22217)

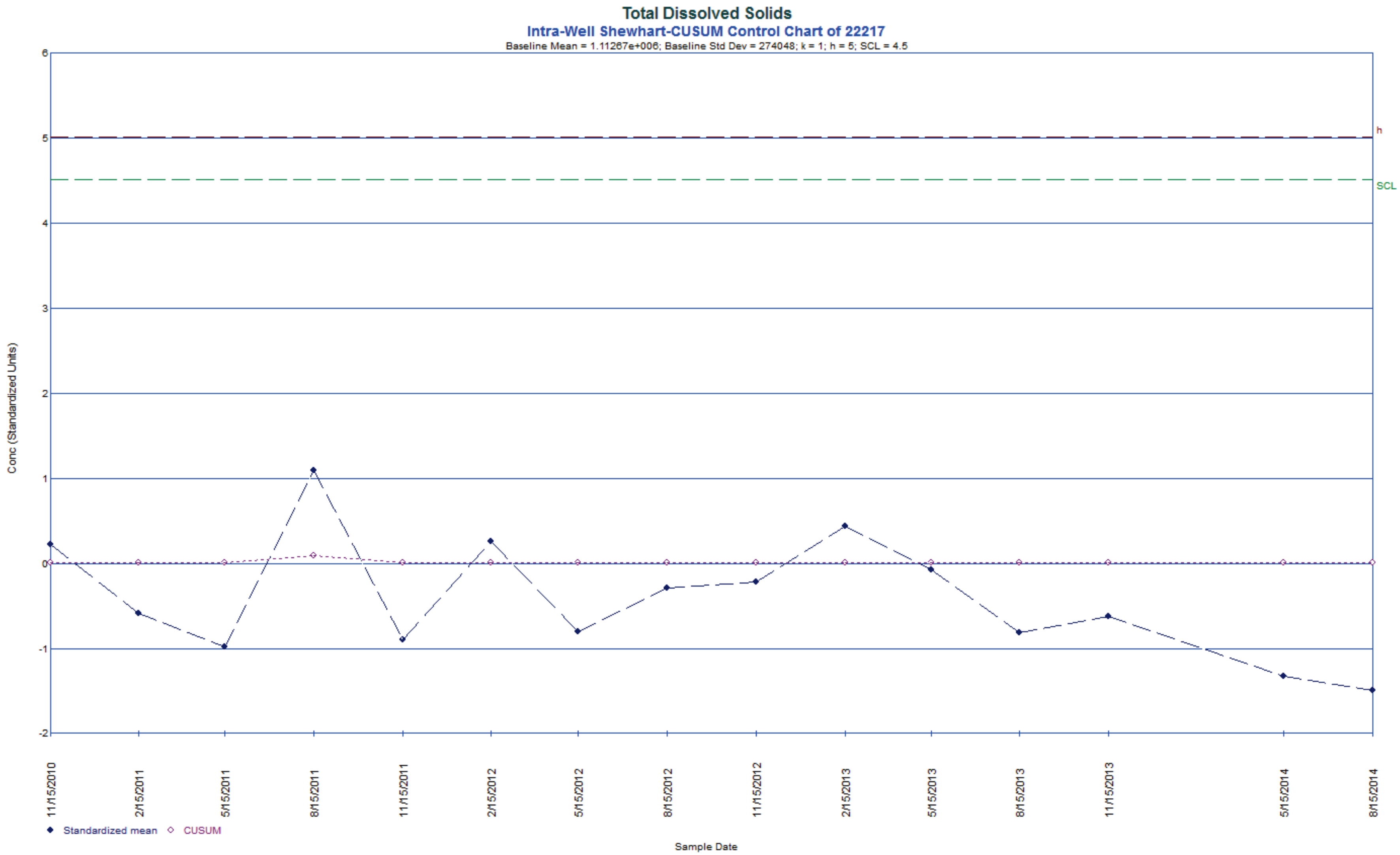


Figure A.5.8-42. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22217)

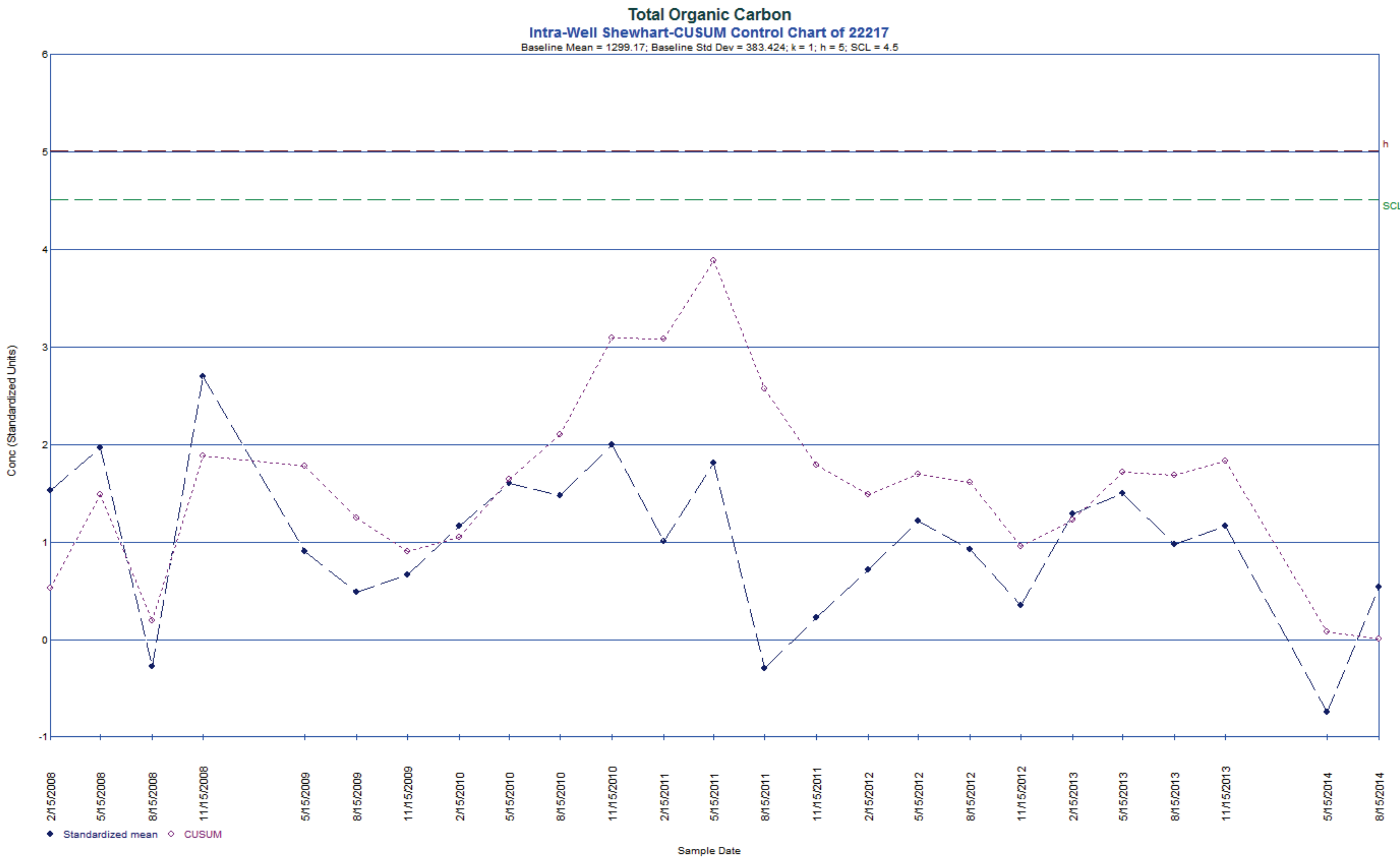


Figure A.5.8-43. Intra-Well Shewhart-CUSUM Control Chart (Total Organic Carbon 22217)

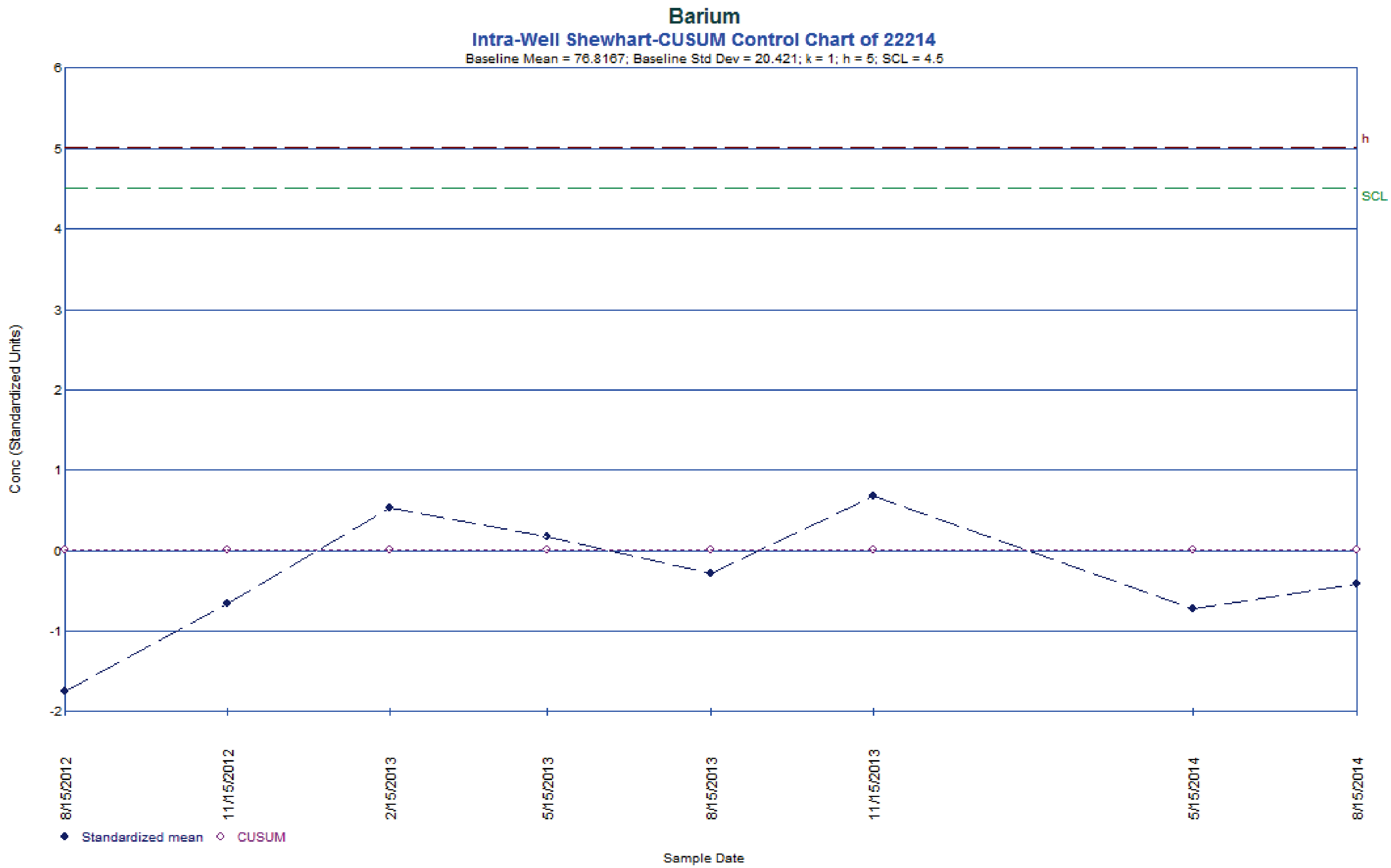


Figure A.5.8-44. Intra-Well Shewhart-CUSUM Control Chart (Barium 22214)

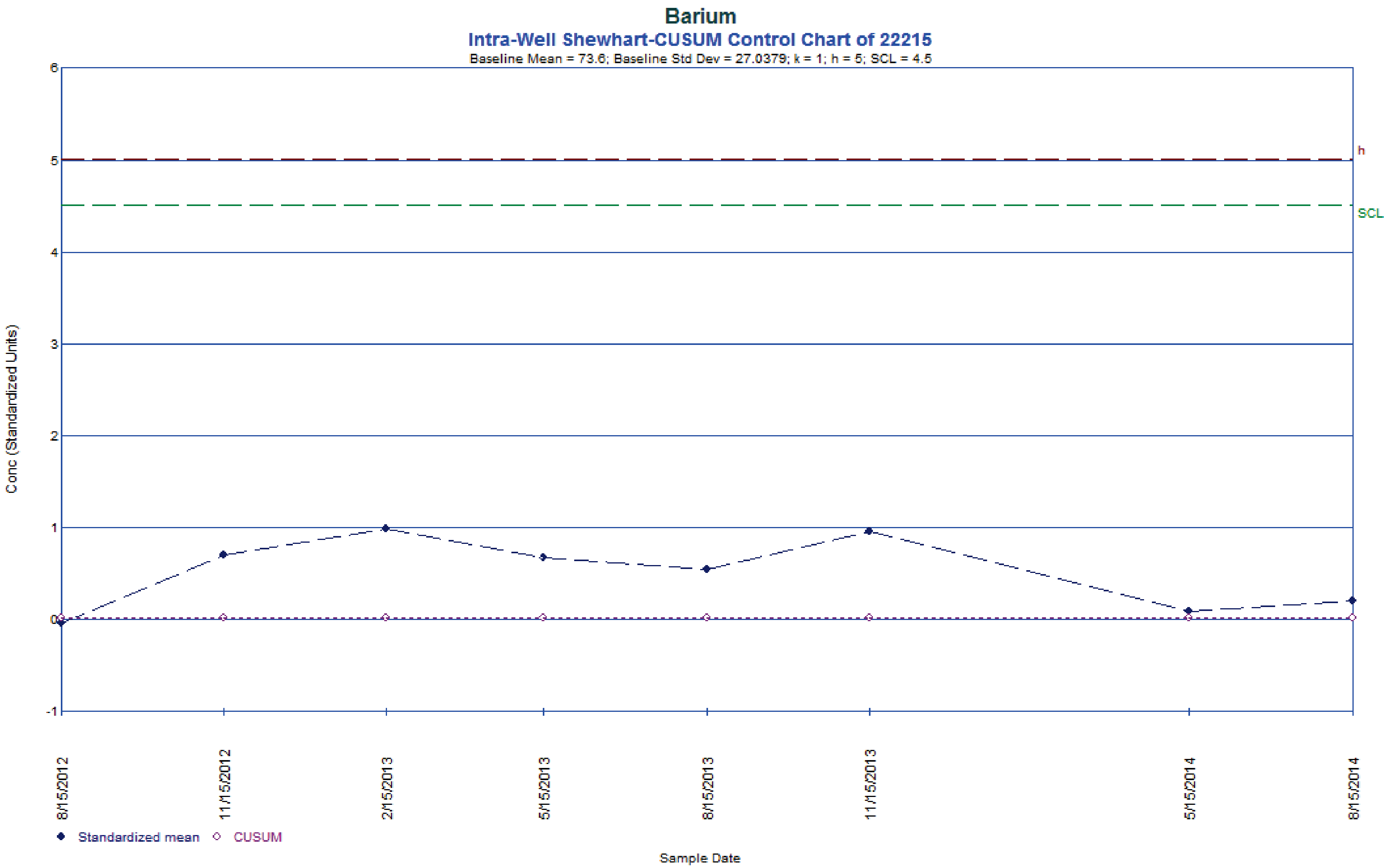


Figure A.5.8-45. Intra-Well Shewhart-CUSUM Control Chart (Barium 22215)

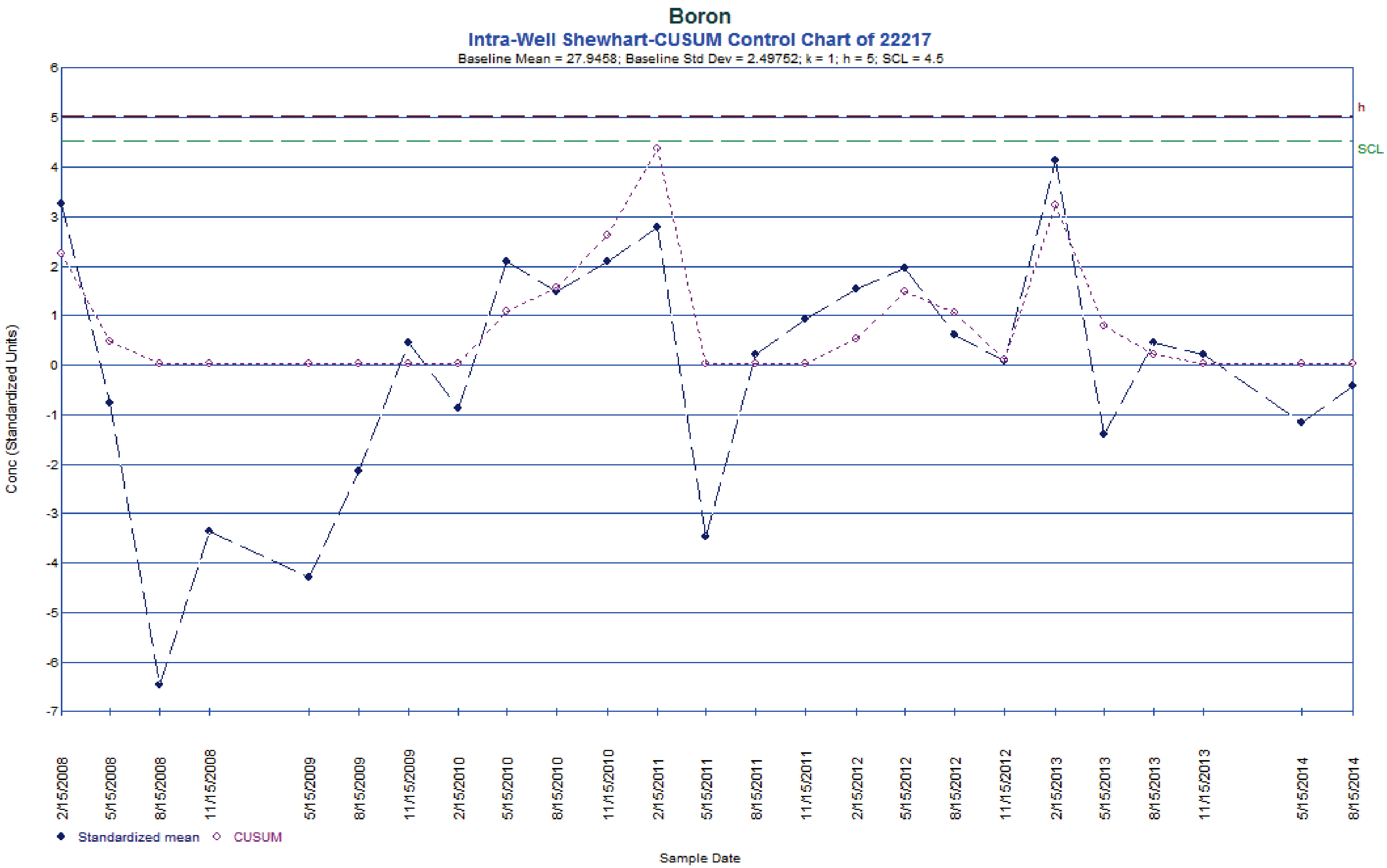


Figure A.5.8-46. Intra-Well Shewhart-CUSUM Control Chart (Boron 22217)

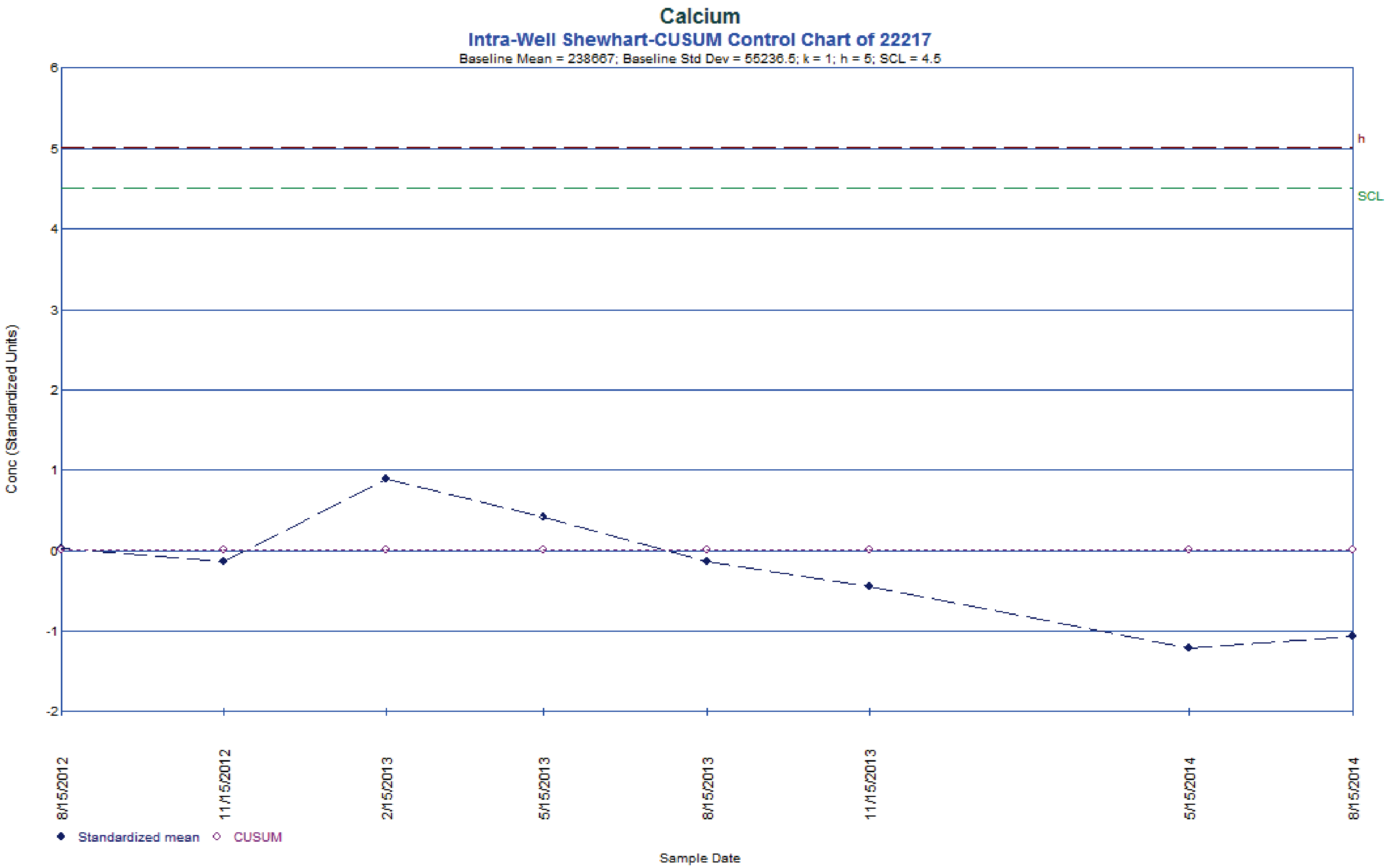


Figure A.5.8-47. Intra-Well Shewhart-CUSUM Control Chart (Calcium 22217)

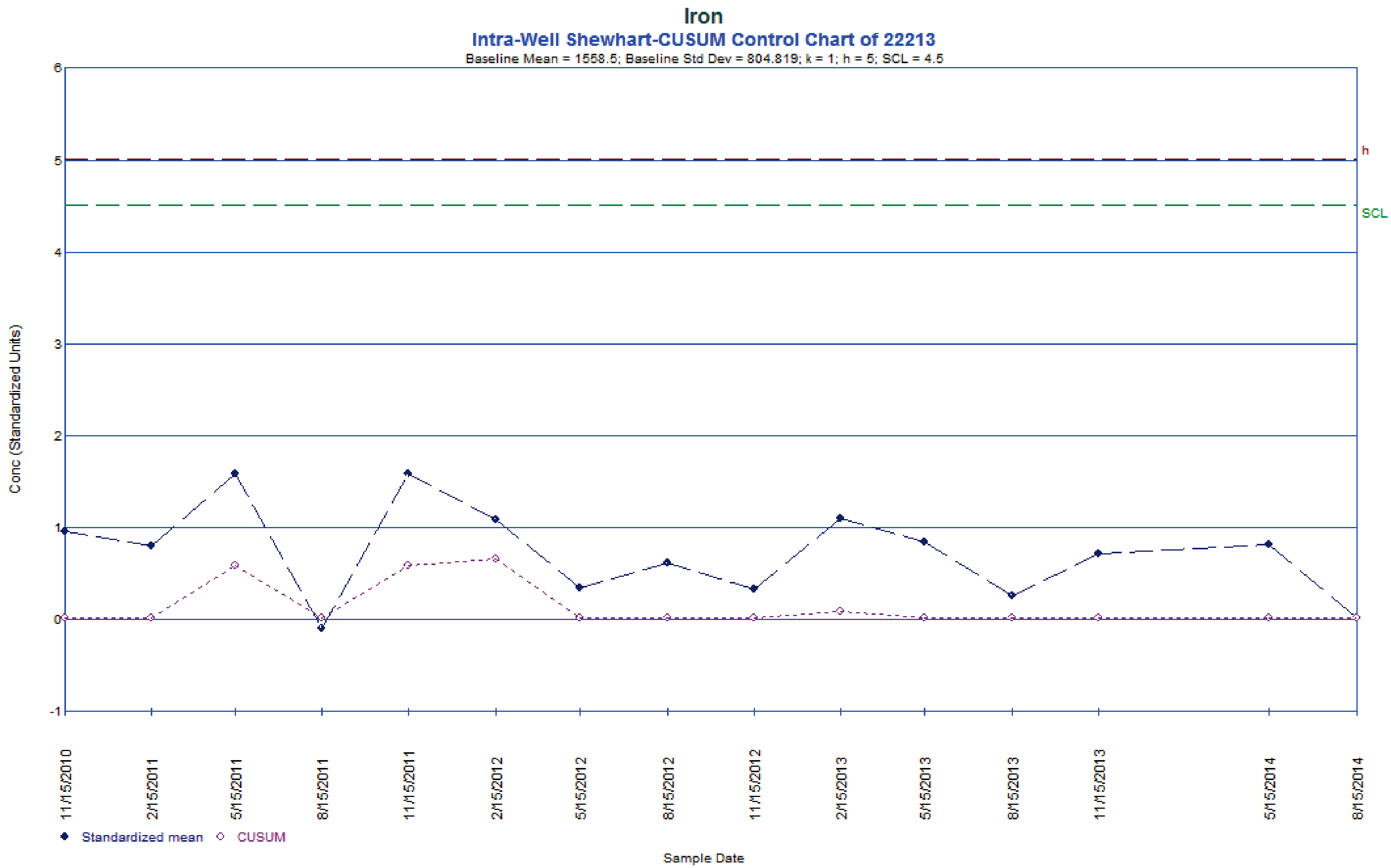


Figure A.5.8-48. Intra-Well Shewhart-CUSUM Control Chart (Iron 22213)

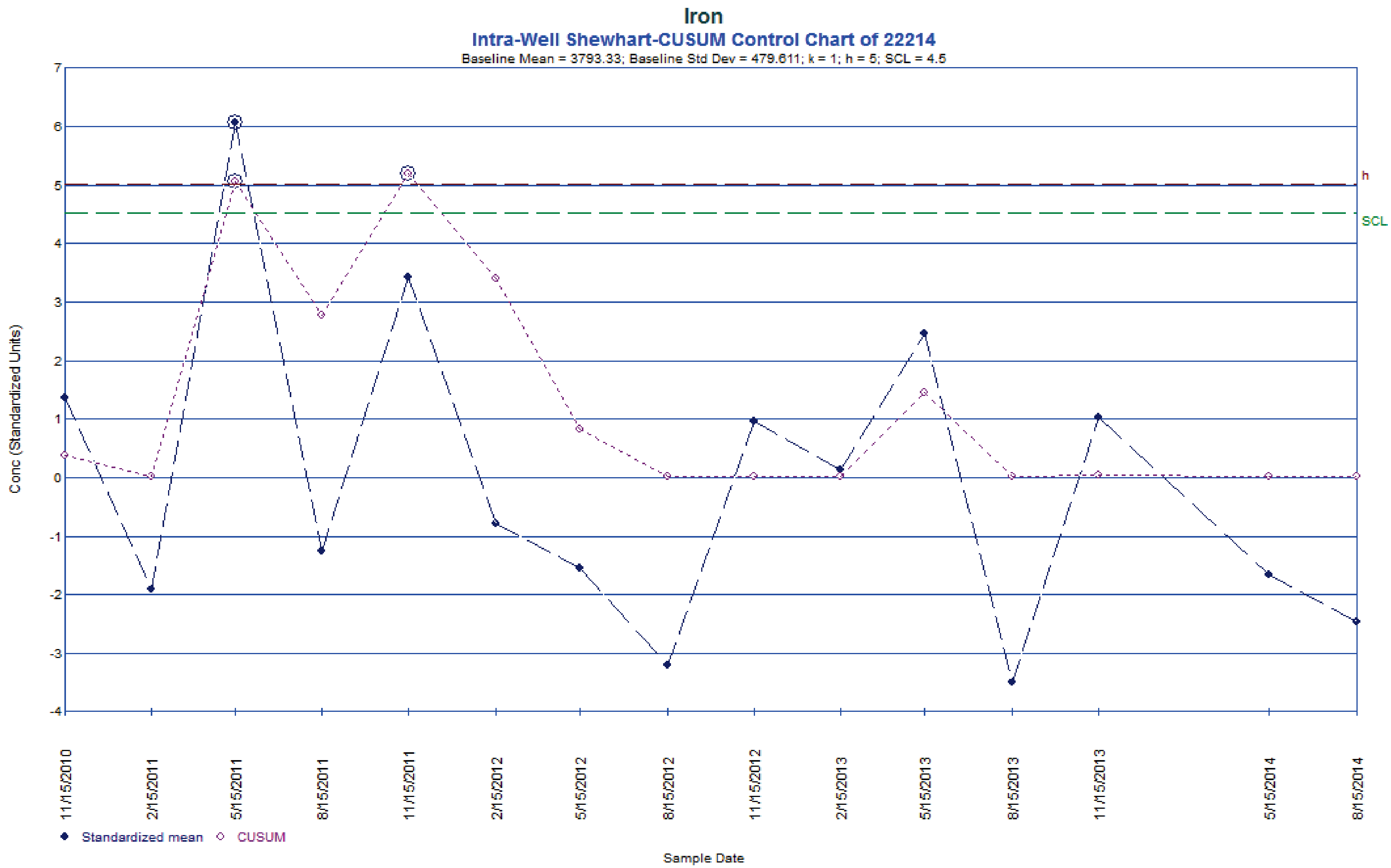


Figure A.5.8-49. Intra-Well Shewhart-CUSUM Control Chart (Iron 22214)

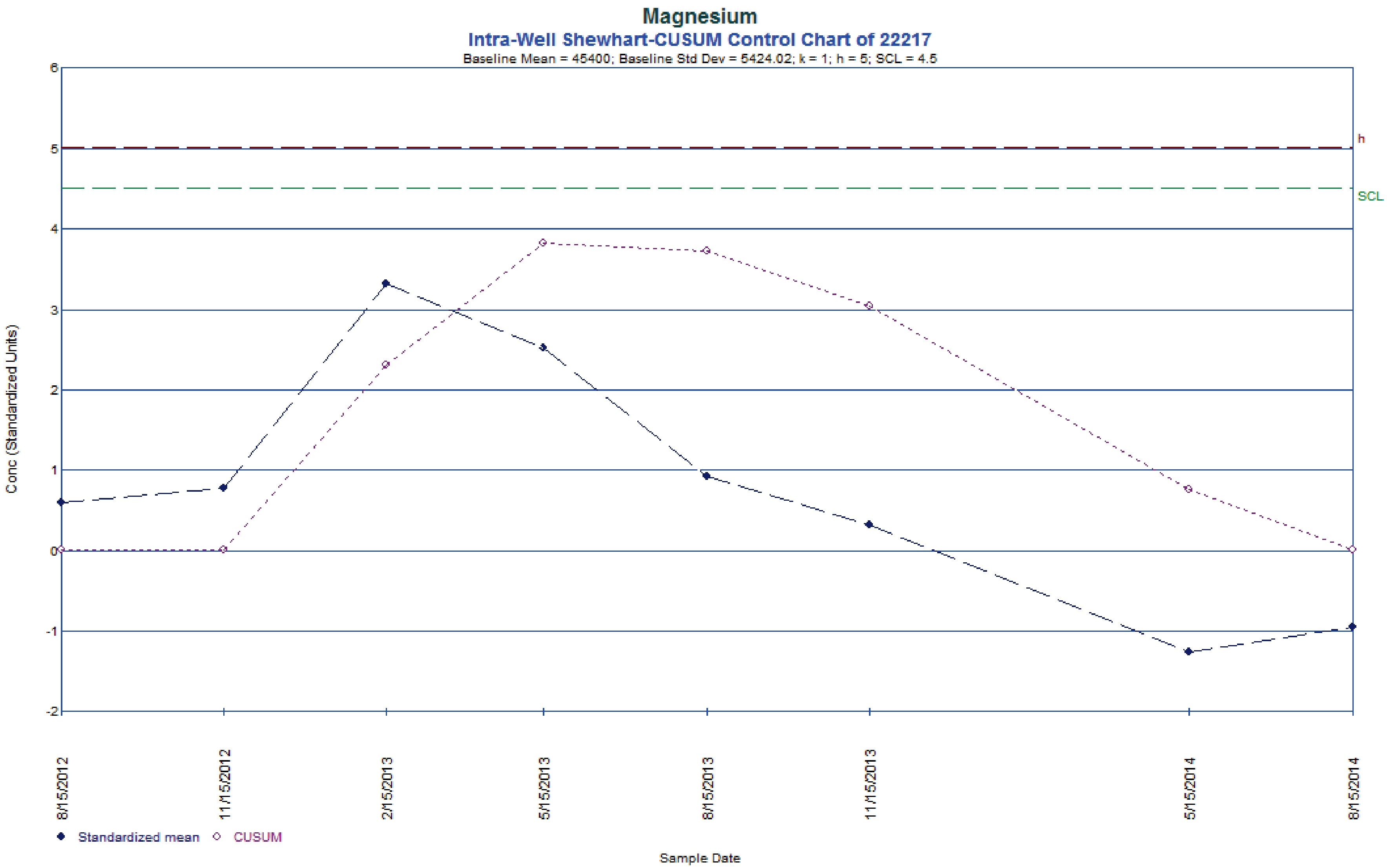


Figure A.5.8-50. Intra-Well Shewhart-CUSUM Control Chart (Magnesium 22217)

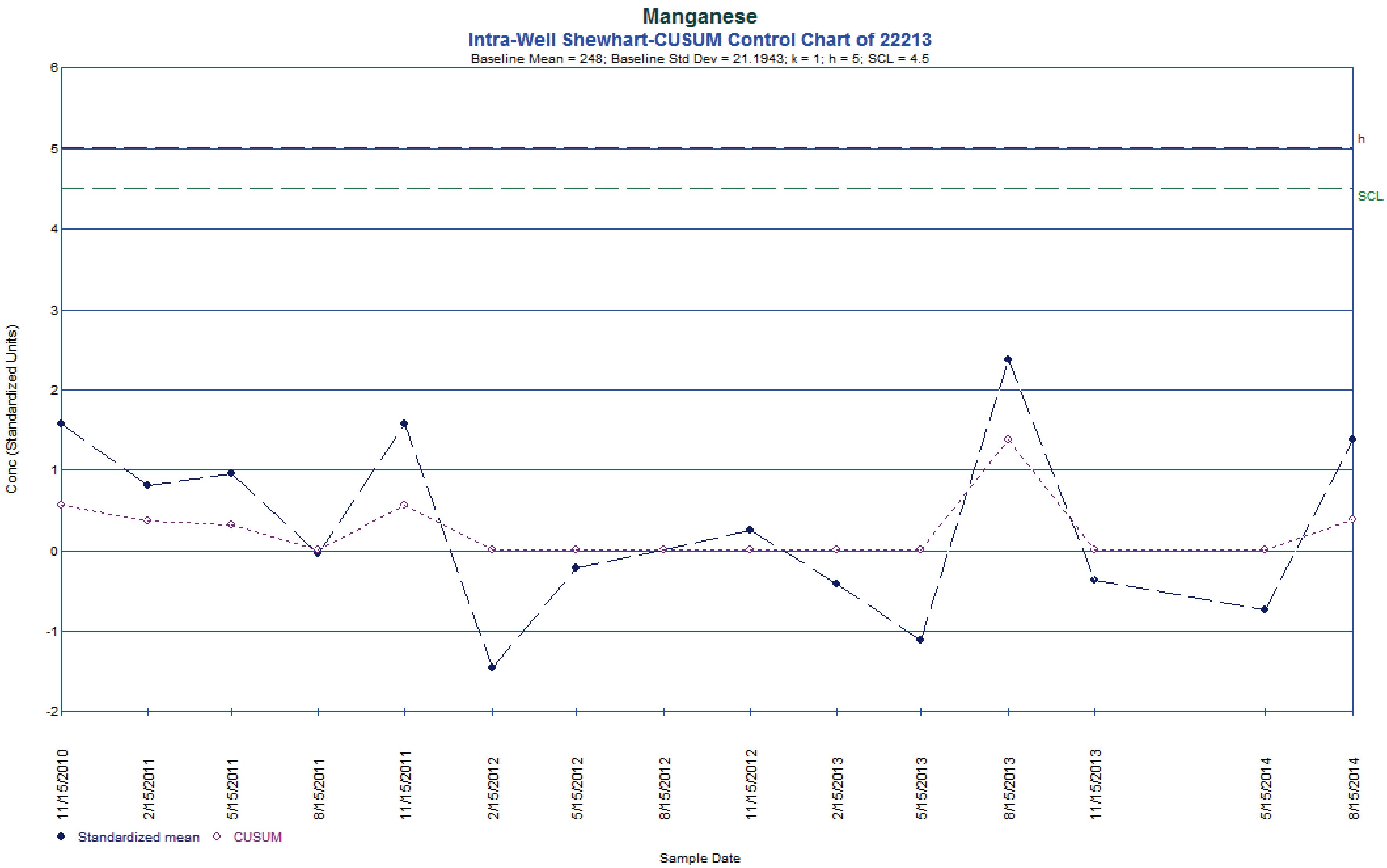


Figure A.5.8-51. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22213)

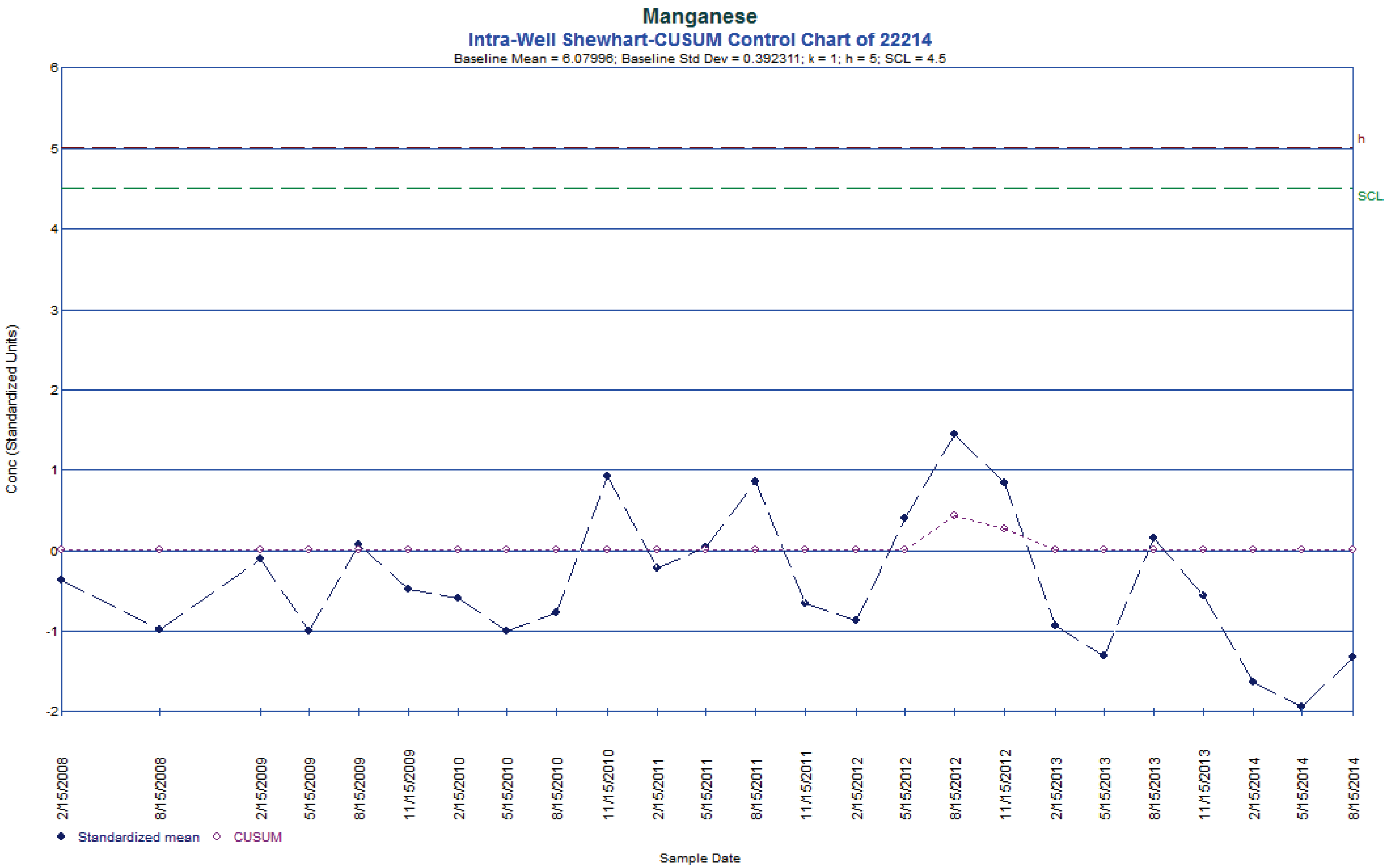


Figure A.5.8-52. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22214)

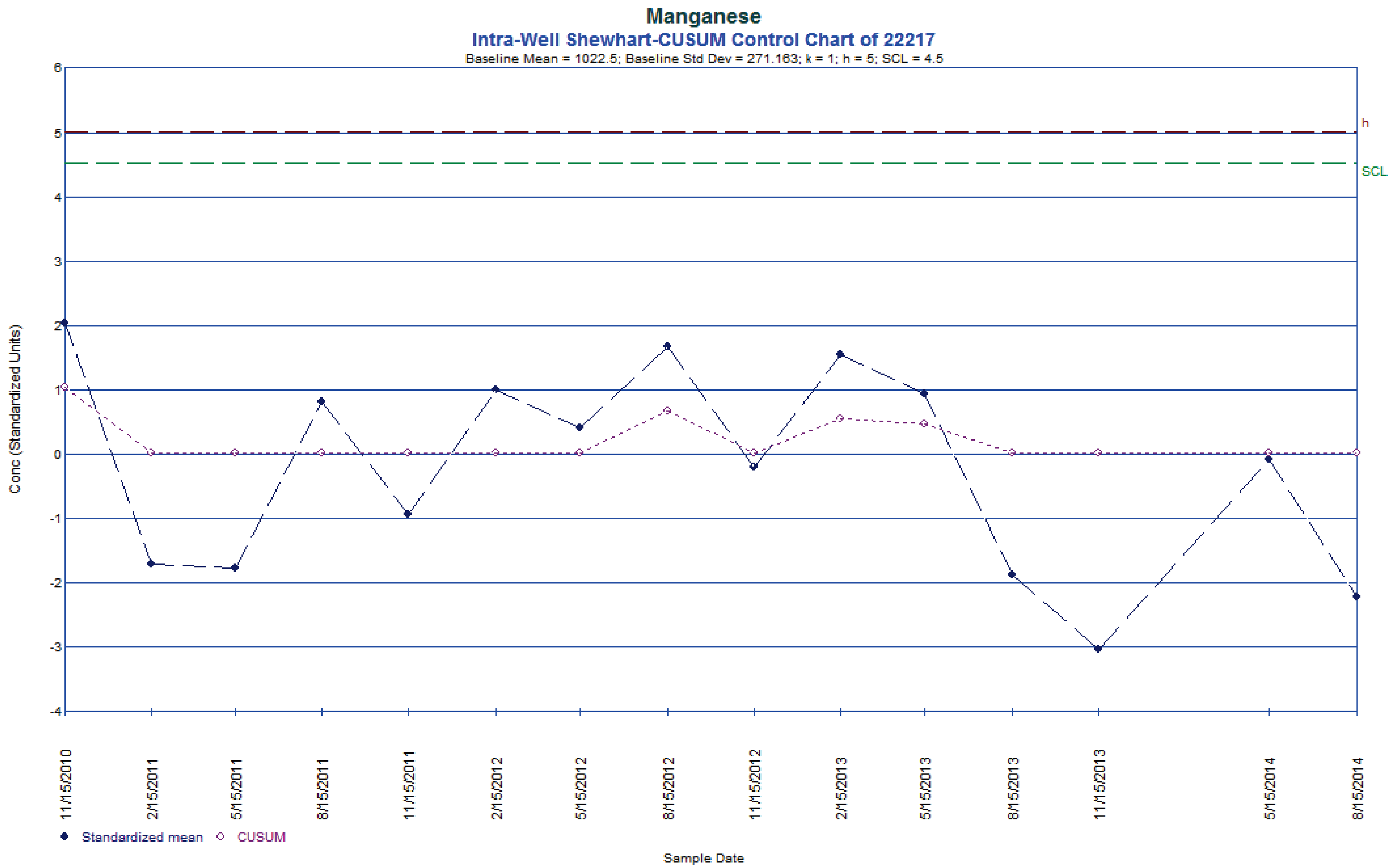


Figure A.5.8-53. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22217)

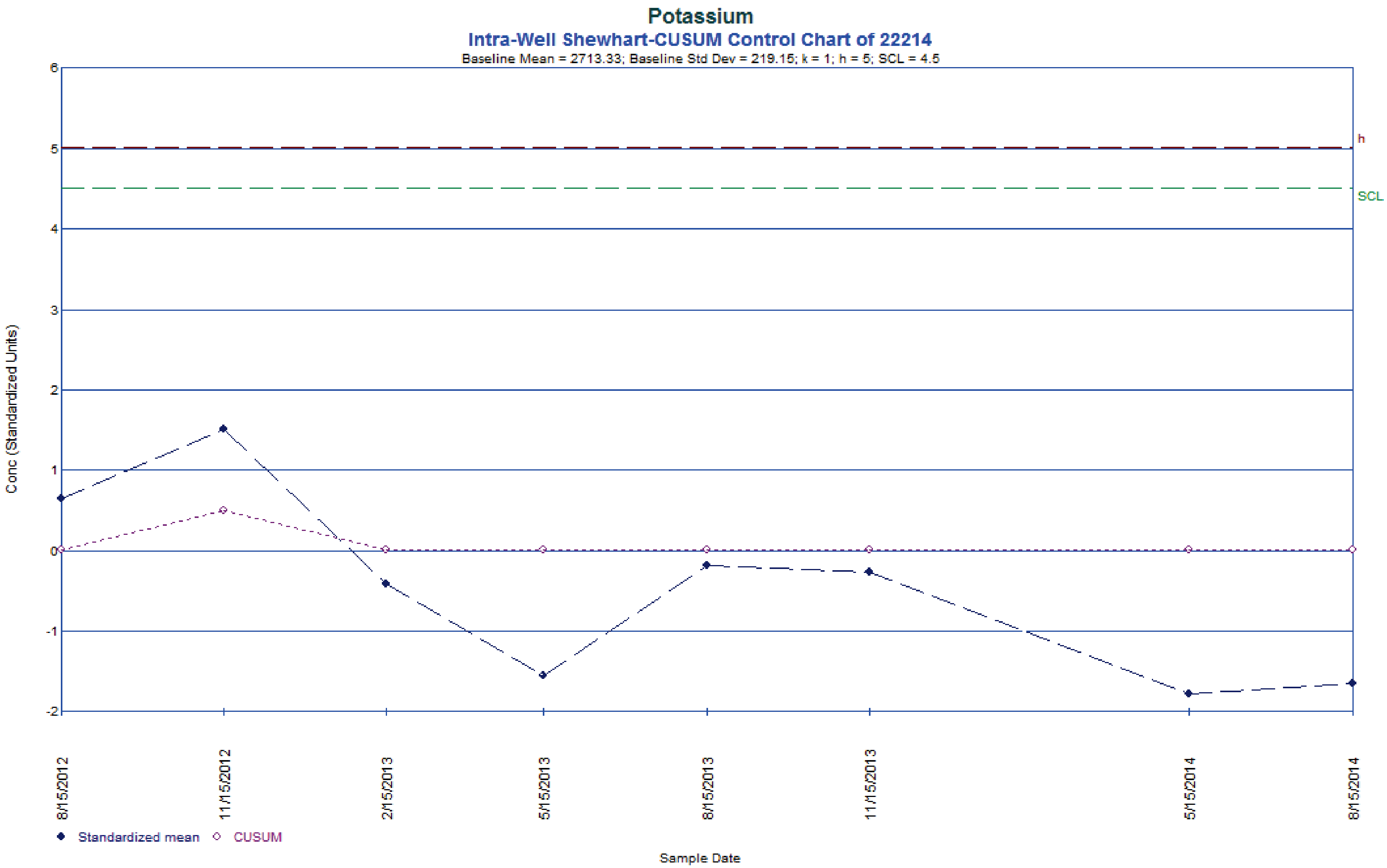


Figure A.5.8-54. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22214)

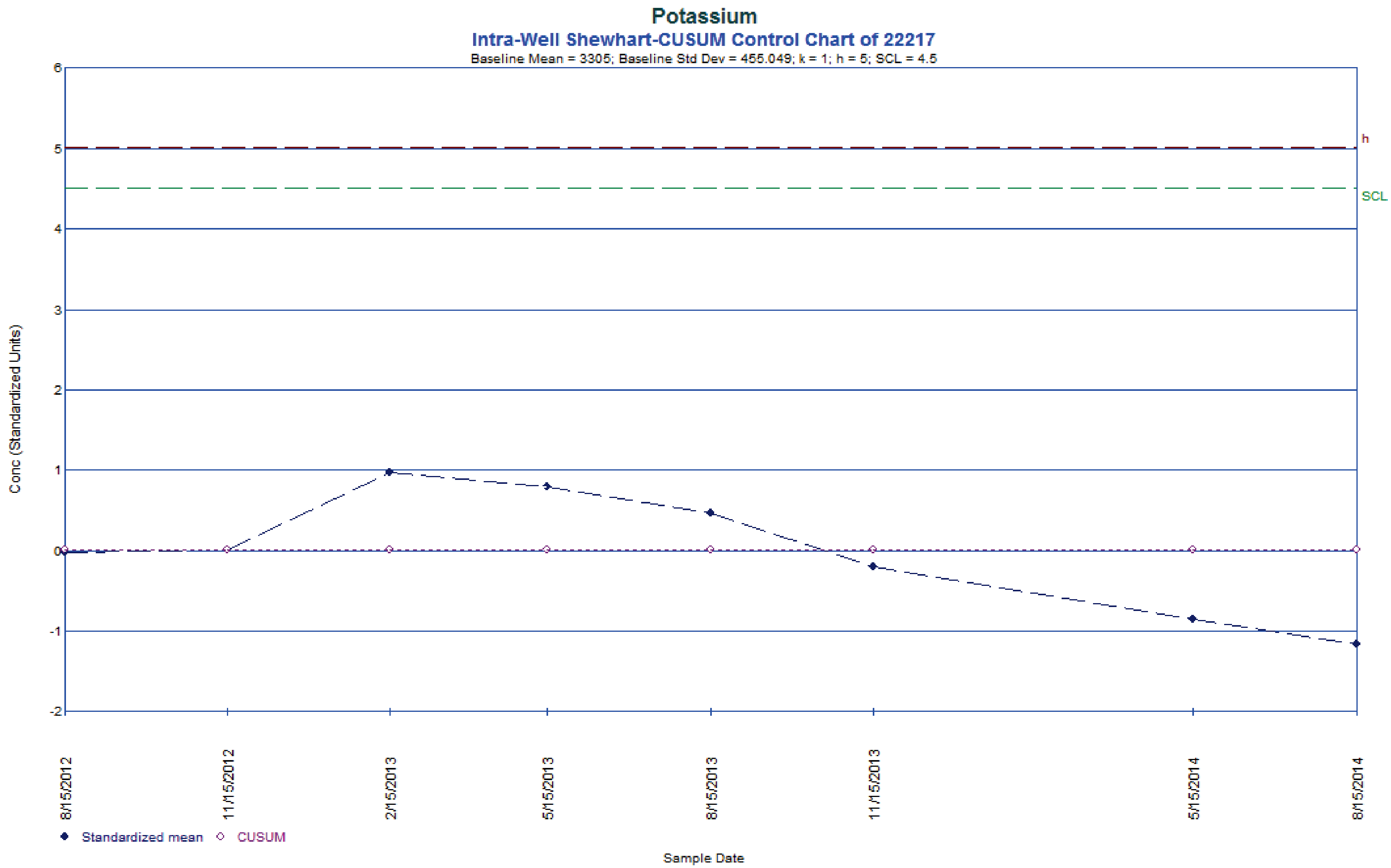


Figure A.5.8-55. Intra-Well Shewhart-CUSUM Control Chart (Potassium 22217)

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