Environmental Functional Area

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UCRL-AR-143121-14

Lawrence Livermore National Laboratory Experimental Test Site 300

Compliance Monitoring Program for the Closed Building 829 Facility

Annual Report 2014

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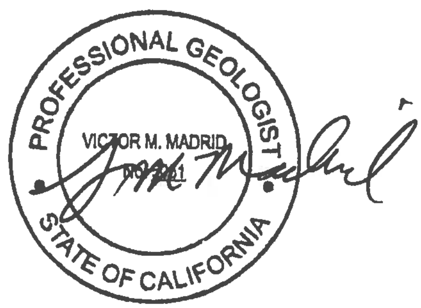

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1.1 Description of Site 300

The Lawrence Livermore National Laboratory (LLNL) Experimental Test Site (Site 300) is owned by the U.S. Department of Energy (DOE) and, effective October 1, 2007, has been operated by Lawrence Livermore National Security, LLC (LLNS). This site is located in the southern Altamont Hills of the Diablo Range, which is part of the Coast Range Physiographic Province. It is situated about 20 km (12 mi) east of the LLNL main site (**Figure 1**). Site 300 covers an area of approximately 28.3 km^2 (10.9 mi^2) north of Corral Hollow Road (**Figure 2**). Its elevation ranges from about 150 m (490 ft) in the southeast corner to about 530 m (1740 ft) in the northwest area. The western one-sixth of the site lies in Alameda County; the remaining portion is in San Joaquin County. The surrounding land is primarily agricultural. Site 300 is an active Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site.

1.2 Description of the B-829 Facility

As shown in **Figure 2**, the B-829 Facility is located in the High-Explosives (HE) Chemistry Area in the south-central portion of Site 300. The B-829 Facility, part of the B-829 Complex, was used to thermally treat explosives process waste generated by operations at Site 300 and similar waste from explosives research operations at the LLNL Livermore site. The B-829 Facility was operated under the Resource Conservation and Recovery Act (RCRA) as an interim status treatment facility. Built in 1955, the B-829 Facility consisted of three separate burn pits, which were constructed in unconsolidated sediments, and an open-air burn unit. The B-829 Facility was closed in 1998, and an impervious cap was constructed over the burn pits as described in the *Final Closure Plan for the High-Explosives Open Burn Treatment Facility at Lawrence Livermore National Laboratory Experimental Test Site 300* (B-829 Final Closure Plan) (Mathews and Taffet, 1997).

2.0 Post-Closure Monitoring and Inspection Activities

Monitoring and inspection of the closed burn pits during the post-closure period reflect the prime consideration: to protect human health and the environment by preventing any infiltration of rainwater that may cause the low concentrations of metals, radioactivity (i.e., gross alpha and gross beta), explosive compounds and volatile organic compounds (VOCs) in near-surface soils to migrate to groundwater. The design of the post-closure plan was originally presented in Chapter 2 of the *B-829 Final Closure Plan* (Mathews and Taffet, 1997).

In January 2002, LLNL submitted a revised *Post-Closure Permit Application for the B829 Facility* (LLNL, 2001) to the Department of Toxic Substances Control (DTSC). Subsequently, in February 2003, the DTSC issued the *Hazardous Waste Facility Post-Closure Permit for the B829 Facility* (DTSC, 2003), effective April 3, 2003 through April 2, 2013.

LLNL requested a permit modification in April 2005 (LLNL, 2005) to amend the text of the Building 829 Post Closure Operation Plan (formerly known as the "Post Closure Permit Application"). The revised operations plan reflects reductions in monitoring frequency for wells W-829-15 and W-829-22 as provided in Part III, 4(a) of the permit (DTSC, 2003), and includes statistical limits for constituents of concern consistent with the data contained in the LLNL Site 300 *Compliance Monitoring Program for the Closed Building 829 Facility* Annual Report 2004 (Revelli, 2005). On July 20, 2005, DTSC granted LLNL permission to implement these changes immediately (DTSC, 2005). A second modification was requested by LLNL in April 2008 (LLNL, 2008) to update current operations, and DTSC determined that LLNL could implement the five Class 1 changes that do not need DTSC's prior approval (DTSC, 2009).

On October 2, 2012, LLNL submitted to DTSC the Site 300 Building 829 (B829) Post-Closure Permit Renewal Application (LLNL, 2012) for this facility. DTSC issued an Initial Completeness Determination (DTSC, 2012) for this permit renewal application on December 14, 2012, and noted that the technical review of the LLNL application has begun.

2.1 Groundwater Monitoring

Based on groundwater samples recovered from boreholes, previous CERCLA remedial investigations determined that the perched groundwater near the B-829 Facility was contaminated with VOCs, primarily trichloroethene (TCE), but that the deeper regional aquifer was free of any contamination stemming from operation of the facility (Webster-Scholten, 1994). Subsequent assays of soil samples obtained from shallow boreholes prior to closure revealed that low concentrations of HE compounds, VOCs, and metals exist beneath the burn pits (Mathews and Taffet, 1997). Conservative transport modeling indicates that the shallow contamination will not adversely impact the regional aquifer, primarily because its downward movement is blocked by more than 100 m (330 ft) of unsaturated Neroly Formation sediments that include interbeds of claystone and siltstone. At this location in the regional aquifer, the flow rate is low; an estimated 0.05 to 0.1 gallons/minute. The groundwater flow velocity is about 20 feet/year, and the direction of flow is approximately ESE.

Beginning in 1999, the dual-purpose, groundwater-monitoring program described in the *B-829 Final Closure Plan* (Mathews and Taffet, 1997) was initiated for this area to track the fate of contaminants in the soil and perched water-bearing zone, and to monitor the deep regional aquifer for the unlikely appearance of any potential contaminants from the closed burn facility. This monitoring program remained in effect through the first quarter of 2003, at which time LLNL began implementation of the provisions specified in the *Hazardous Waste Facility Post-Closure Permit for the B829 Facility* (DTSC, 2003). Following the guidance outlined in the DTSC *Technical Completeness* (DTSC, 2002) assessment, LLNL installed one additional groundwater monitoring well (W-829-1938) at the point of compliance (POC) within 10 ft of the edge of the capped High Explosive Open Burn Treatment Facility. This well was screened in the regional aquifer, beneath the B-829 Facility. Since the first quarter of 2004, and continuing through 2014, well W-829-1938 has been used for quarterly collection of groundwater samples from the regional aquifer, as part of the permit-specified monitoring network (**Figure 3**). Also shown in **Figure 3** are two previously existing wells (W-829-15 and W-829-22), which were each sampled once in 2014, in accordance with the DTSC-approved change in sampling frequency (from quarterly to annually) for these two wells (DTSC, 2005). All samples collected from the B-829 Facility monitoring network wells in 2014 were analyzed for the permit-specified constituents of concern. Constituents of concern, as defined by Title 23 of the California Code of Regulations (CCR), Chapter 15, are waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from the B829 burn pits. The data obtained during CY 2014 are discussed in **Section 3.1.**

LLNL uses statistical methods consistent with the state regulations [CCR Title 22, Section 66264.97(e)(8)(D)] to accomplish the monitoring and reporting provisions of the post-closure plan (Mathews and Taffet, 1997). The methodology relies on our ability to establish a background concentration, which is defined as the concentration limit (CL), for each constituent of concern. Additionally, statistically determined limits of concentration (SLs) for the constituents of concern have been calculated from the monitoring data.

The CL and SL values presented in **Table 1** replicate those limits documented in previous annual reports. For wells W-829-15 and W-829-22, established before the permit (DTSC, 2003) was issued, the limits were first included in the 2002 Annual Report (Revelli, 2003). For well W-829-1938, developed in accordance with DTSC requirements (DTSC, 2002), the CLs and SLs were first included in the 2005 Annual Report (Revelli, 2006). These SL values (**Table 1**) served as the limits against which the analytical results from 2014 were compared. The SLs for most constituents of concern in **Table 1** are given as the analytical reporting limits (RLs), because the measurements are below the detection limits for those constituents.

SLs provide the basis for comparison with constituent of concern measurements in subsequent years to identify potential releases to the deep regional aquifer. If a future measurement exceeds an SL, LLNL will implement a method of data verification that involves two discrete retests, in accordance with CCR Section 66264.97(e)(8)(E). If an exceedance is confirmed by either or both of the retests, these results will be interpreted and reported as “statistically significant evidence of a release of the constituent of concern to groundwater.”

2.2 Inspection and Maintenance

The permit (DTSC, 2003) requires that LLNL perform quarterly inspections of the monitoring wells and monthly visual inspections of the closed B-829 Facility (final cover cap, drainage and diversion ditches, groundwater monitoring system, signage, etc.). Additional inspections are required after major rainstorms, significant earthquakes, or other events that may cause substantial damage to the capped facility. Any deficiencies noted, such as erosion of the cover, fissures or low spots, burrowing by animals, and bare areas needing reseeding, are remediated. In addition to these inspections performed by LLNL staff, an independent, California-registered Professional Engineer (PE) must perform an annual engineering inspection. The PE prepares a written inspection report, which includes comments and recommendations, and submits that documentation to LLNL.

3.0 Results of Post-Closure Monitoring and Inspection for CY 2014

3.1 Discussion of Monitoring Results

CY 2014 analytical results for the well locations W-829-15, W-829-22, and W-829-1938 are listed in **Tables 2, 3, and 4**, respectively. The annual sampling required for wells W-829-15 and W-829-22 (DTSC, 2005) was conducted during the second quarter of 2014, while well

W-829-1938 was sampled quarterly. Note that all non-detections of constituents are shown in the data tables as being less than (<) the analytical reporting limit (RL).

Appendix A presents graphical depictions of the pre-sampling groundwater elevations (GWE) and concentration trends for all confirmed constituent of concern detections above their respective RLs, for the permit-specified wells (W-829-15, W-829-22, and W-829-1938). Graphs for the two established wells (W-829-15 and W-829-22) present data accumulated over the last thirteen years, going back to 2002. The graphs for well W-829-1938, which was installed during CY 2003, present forty-four quarters of data; beginning with the first-quarter results from CY 2004.

In addition to the pre-sampling GWE measurements plotted in **Appendix A**, LLNL collects quarterly GWE measurements for the wells in this network as part of a larger, site-wide study. **Tables 2 and 3** include the quarterly results of this GWE study for the two wells in the B-829 network (W-829-15 and W-829-22) that were only sampled once during the year. The GWEs, for any given well, show very little fluctuation (less than one foot) across the four quarterly measurements. LLNL also collects field data for pH, temperature, and specific conductance at the time of sampling. The CY 2014 field data for these parameters (see **Tables 2, 3, and 4**) are consistent with results from recent years.

As in past years, the concentration trends shown in **Appendix A** generally reflect the natural background variability of the analytes detected at each of the three monitoring well locations. Other than the 2Q/14 barium concentration in well W-829-15 (49 µg/L, which remains at approximately twice the originally calculated background concentration) and the four quarterly manganese concentrations in well W-829-1938 (38 µg/L, 19 µg/L, 30 µg/L, and 61 µg/L, respectively, which range from approximately 30% to 100% of the originally calculated background concentration), these metal concentrations are not significantly different from background concentrations (the CLs shown in **Table 1**) for the deep aquifer beneath the HE Process Area. Nevertheless, as shown in the corresponding **Appendix A** plots, these results for barium and manganese are consistent with previously reported values.

For several years, the plot for gross beta at well W-829-15 has suggested that the more recent data (CY 2003 and beyond) might indicate less variable and a slightly lower background value (as compared to the CL presented in **Table 1**) for this constituent. Similarly, chromium, nickel, and zinc concentrations at well W-829-1938 have remained below their reporting limits (1 µg/L, 5 µg/L, and 20 µg/L; respectively) for the last nine years, after initial detections in CY 2004 or CY 2005. Of the three wells in this network (W-829-15, W-829-22, and W-829-1938), W-829-15 was the first completed (March 1995) and has the longest operation history. LLNL will continue to monitor for similar trends in background concentrations as additional data become available.

As shown in **Table 4**, the routine samples collected at well W-829-1938 during the 1Q/14 and 3Q/14 both showed an initial barium concentration of 31 µg/L. Because these values are above the statistical limit (SL = 30 µg/L) for this constituent at this location, these findings were reported to the DTSC (LLNL, 2014a and 2014c). To confirm these initial results, LLNL employed a method of data validation that utilizes discrete retests and is consistent with state regulations [CCR Title 22, Section 66264.97(e)(8)(E)]. A total of four additional groundwater samples were subsequently obtained from well W-829-1938; two retest samples were collected during the first quarter (March 5, 2014 & March 13, 2014) and two retest samples were collected during the third quarter (August 28, 2014 & September 4, 2014). These retest samples were analyzed for barium using the same analytical test (EPA Method 200.7) as used in the analyses of the routine quarterly samples. Results from the 1Q/14 resampling showed barium concentrations of 25 µg/L & 29 µg/L, and results from the 3Q/14 resampling showed barium concentrations of <25 µg/L & <25 µg/L, respectively. According to the state-approved methodology, these results (all below the SL for this constituent) invalidate the earlier apparent exceedances in the routine quarterly samples. DTSC was notified that the initial detections of barium were not confirmed. (LLNL, 2014b and 2014d).

The 4Q/14 result for gross beta in the well W-829-1938 routine sample (**Table 4;** 1.7 ± 1.5 pCi/L; 0.06 ± 0.06 Bq/L) was noted to be approximately an order of magnitude below the background concentration value (CL = 0.42 Bq/L; See **Table 1**) for gross beta results typically reported at this location. A 4Q/14 duplicate sample, collected during routine sampling at that same location for quality control purposes, showed a more typical result (0.29 ± 0.07 Bq/L). For that reason, the routine sample entry in **Table 4** is footnoted to add the duplicate sample result, and the corresponding plot in **Appendix A** shows duplicate sample value. Nevertheless, it should be noted that both the routine and duplicate samples are well below the SL (0.55 Bq/L) for this constituent.

During CY 2014, there were no confirmed constituent of concern detections, above their respective SLs (shown in **Table 1**), in groundwater samples from any of the three monitoring wells. Among the inorganic constituents, perchlorate was not detected above its RL in any sample. As discussed above, no metal constituent was detected at a confirmed concentration above its respective SL in CY 2014. All results for gross alpha and gross beta (the radioactive constituents of concern) were below their SL values. Neither organic nor explosive constituents of concern were detected in any samples at concentrations above their respective RLs.

3.2 Inspection of the B-829 Facility

During CY 2014, LLNL staff completed twelve monthly post-closure inspections of the covered area at the B-829 Facility and four quarterly inspections of the monitoring well network. The monthly inspection checklist form, used during these LLNL inspections, is provided in **Figure 4.** The checklist form used to document the monitoring well inspections, which are required quarterly, is shown in **Figure 5.** All completed forms are retained for three years in the Site 300 Manager's Office files.

The required annual cap inspection by a California-registered Professional Engineer was completed on April 8, 2014. [A copy of the *Building 829 Landfill Cap Annual Engineering Inspection* (Moore, 2014) is included in this report as **Appendix B**.] The inspection included a review of existing documentation on the cap as well as an on-site inspection. With two exceptions (i.e., some evidence of vegetation growth and vegetative debris accumulation in the drainage ditch, and a few shallow small burrowing animal holes; approximately 6 inches in diameter), all items required to be inspected under Title 22 of the CCR, Part 66264.228(k) were noted to be in good condition. The annual engineering inspection report contains one recommendation; remove vegetative growth and debris from the concrete lined drainage ditch, and seal concrete joints. This recommendation, which encompassed similar LLNL observations of debris in the drainage ditch (noted during the April monthly inspection), was implemented by the Site 300 Manager's Office during CY 2014.

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Table 1. Constituents of concern, typical analytical reporting limit (RL), background concentration limit (CL)[a], and statistical limit (SL)[b] for B-829 Facility monitoring wells W-829-15, W-829-22, and W-829-1938.

Constituent of concern	Typical analytical RL	Unit of measure	Well W-829-15		Well W-829-22		Well W-829-1938	
			CL	SL	CL	SL	CL	SL
Antimony	5	µg/L	<RL	RL	<RL	RL	<RL	RL
Arsenic	2	µg/L	17	22	<2.9	2.9	26	42
Barium	25	µg/L	26	75	<RL	RL	22	30
Beryllium	0.5	µg/L	<RL	RL	<RL	RL	<RL	RL
Cadmium	0.5	µg/L	<RL	RL	<RL	RL	<RL	RL
Chromium	1	µg/L	2.2	7.8	0.9	1.5	0.8	3.9
Cobalt	25	µg/L	<RL	RL	<RL	RL	<RL	RL
Copper	10	µg/L	<RL	RL	<RL	RL	<RL	RL
Lead	2	µg/L	<RL	RL	<RL	RL	<RL	RL
Manganese	10	µg/L	<RL	RL	<RL	RL	63	150
Mercury	0.2	µg/L	<RL	RL	<RL	RL	<RL	RL
Molybdenum	25	µg/L	24	27	<RL	RL	23	32
Nickel	5	µg/L	<RL	RL	<RL	RL	4.9	19
Selenium	2	µg/L	<RL	RL	<RL	RL	<RL	RL
Silver	0.5	µg/L	<RL	RL	<RL	RL	<RL	RL
Vanadium	25	µg/L	<RL	RL	<RL	RL	<RL	RL
Zinc	20	µg/L	<RL	RL	<RL	RL	11	30
Perchlorate	4	µg/L	<RL	RL	<RL	RL	<RL	RL

(continued)

Table 1. Constituents of concern, typical analytical reporting limit (RL), background concentration limit (CL)[a], and statistical limit (SL)[b] for B-829 Facility monitoring wells W-829-15, W-829-22, and W-829-1938 (concluded).

Constituent of concern	Typical analytical RL	Unit of measure	Well W-829-15		Well W-829-22		Well W-829-1938	
			CL	SL	CL	SL	CL	SL
1,1,1-Trichloroethane	1	µg/L	<RL	RL	<RL	RL	<RL	RL
1,1-Dichloroethene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
1,2-Dichloroethane	1	µg/L	<RL	RL	<RL	RL	<RL	RL
cis-1,2-Dichloroethene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
trans-1,2-Dichloroethene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
1,2-Dichloroethene (total)	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Benzene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Carbon disulfide	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Chloroform	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Dichlorodifluoromethane	2	µg/L	<RL	RL	<RL	RL	<RL	RL
Ethylbenzene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Freon 113	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Tetrachloroethene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Toluene	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Total xylene isomers	2	µg/L	<RL	RL	<RL	RL	<RL	RL
Trichloroethene	0.5	µg/L	<RL	RL	<RL	RL	<RL	RL
Trichlorofluoromethane	1	µg/L	<RL	RL	<RL	RL	<RL	RL
Bis (2-ethylhexyl) phthalate	5	µg/L	<RL	RL	<RL	RL	<RL	RL
Phenols	5	µg/L	<RL	RL	<RL	RL	<RL	RL
HMX	1.0	µg/L	<RL	RL	<RL	RL	<RL	RL
RDX	1.0	µg/L	<RL	RL	<RL	RL	<RL	RL
TNT	5.0	µg/L	<RL	RL	<RL	RL	<RL	RL
Gross alpha	0.074	Bq/L	0	0.123	0	RL	0.01	0.11
Gross beta	0.11	Bq/L	1.81	3.77	0.27	0.43	0.42	0.55

a CL is defined as the average background concentration of a constituent of concern.

b SL is defined as the concentration of a constituent of concern, above which an exceedance occurs.

Table 2. B-829 area deep well W-829-15, monitoring results for year 2014.
(Constituent detections, when printed in bold, are discussed in the text.)

	Sampling dates 2014			
Constituents	**03/5/14[a]**	**04/15/14**	**08/20/14[a]**	**11/20/14[a]**
Field Data (units)				
Groundwater elevation (feet)	696.2	696.1	696.2	696.0
pH (pH Units)		8.16		
Temperature (degrees Celsius)		24.4		
Specific conductance (µmho/cm)		1041		
Inorganic (µg/L)				
Antimony		<5		
Arsenic		18		
Barium		**49**		
Beryllium		<0.5		
Cadmium		<0.5		
Chromium		<1		
Cobalt		<25		
Copper		<10		
Lead		<2		
Manganese		<10		
Mercury		<0.2		
Molybdenum		<25		
Nickel		<5		
Selenium		<2		
Silver		<0.5		
Vanadium		<25		
Zinc		<20		
Perchlorate		<4		
Turbidity (NT Units)		<0.10		
Organic (µg/L)				
1,1,1-Trichloroethane		<1		
1,1-Dichloroethene		<1		
1,2-Dichloroethane		<1		
cis-1,2-Dichloroethene		<1		
trans-1,2-Dichloroethene		<1		
1,2-Dichloroethene (total)		<1		
Benzene		<1		
Carbon disulfide		<1		
Chloroform		<1		
Dichlorodifluoromethane		<2		
Ethylbenzene		<1		
Freon 113		<1		
Tetrachloroethene		<1		
Toluene		<1		
Total xylene isomers		<2		
Trichloroethene		<0.5		
Trichlorofluoromethane		<1		
Bis(2-ethylhexyl)phthalate		<5		
Phenol		<5		
Explosive (µg/L)				
HMX		<1		
RDX		<1		
TNT		<5		
Radioactive (Bq/L)[b]				
Gross alpha		0.015±0.032		
Gross beta		0.26±0.05		

[a] No sampling required other than measurement of groundwater elevation (GWE).

[b] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2s counting errors.
(Divide these values by 0.037 to convert them to picocuries/liter.)
The reported value is negative when the measured sample radioactivity is less than the measured background activity.
The result is zero when the measured sample radioactivity is equal to the measured background activity.

Table 3. B-829 area deep well W-829-22, monitoring results for year 2014.
(Constituent detections, when printed in bold, are discussed in the text.)

	Sampling dates 2014			
Constituents	**3/5/14[a]**	**04/15/14**	**8/20/2014[a]**	**11/20/14[a]**
Field Data (units)				
Groundwater elevation (feet)	653.8	653.7	653.7	653.6
pH (pH Units)		8.44		
Temperature (degrees Celsius)		22.4		
Specific conductance (µmho/cm)		1051		
Inorganic (µg/L)				
Antimony		<5		
Arsenic		<2		
Barium		<25		
Beryllium		<0.5		
Cadmium		<0.5		
Chromium		<1		
Cobalt		<25		
Copper		<10		
Lead		<2		
Manganese		<10		
Mercury		<0.2		
Molybdenum		<25		
Nickel		<5		
Selenium		<2		
Silver		<0.5		
Vanadium		<25		
Zinc		<20		
Perchlorate		<4		
Turbidity (NT Units)		0.32		
Organic (µg/L)				
1,1,1-Trichloroethane		<1		
1,1-Dichloroethene		<1		
1,2-Dichloroethane		<1		
cis-1,2-Dichloroethene		<1		
trans-1,2-Dichloroethene		<1		
1,2-Dichloroethene (total)		<1		
Benzene		<1		
Carbon disulfide		<1		
Chloroform		<1		
Dichlorodifluoromethane		<2		
Ethylbenzene		<1		
Freon 113		<1		
Tetrachloroethene		<1		
Toluene		<1		
Total xylene isomers		<2		
Trichloroethene		<0.5		
Trichlorofluoromethane		<1		
Bis(2-ethylhexyl)phthalate		<5		
Phenol		<5		
Explosive (µg/L)				
HMX		<1		
RDX		<1		
TNT		<5		
Radioactive (Bq/L)[b]				
Gross alpha		-0.035±0.027		
Gross beta		0.17±0.04		

[a] No sampling required other than measurement of groundwater elevation (GWE).

[b] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2s counting errors.
(Divide these values by 0.037 to convert them to picocuries/liter.)
The reported value is negative when the measured sample radioactivity is less than the measured background activity.
The result is zero when the measured sample radioactivity is equal to the measured background activity.

Table 4. B-829 area deep well W-829-1938, monitoring results for year 2014.
(Constituent detections, when printed in bold, are discussed in the text.)

	Sampling dates 2014			
Constituents	**01/23/14**	**04/23/14**	**07/30/14**	**10/29/14**
Field Data (units)				
Groundwater elevation (feet)	706.2	706.4	706.1	706.1
pH (pH Units)	7.68	7.71	7.54	7.89
Temperature (degrees Celsius)	20.3	19.5	23.2	22.4
Specific conductance (μmho/cm)	1080	1095	1061	1063
Inorganic (μg/L)				
Antimony	<5	<5	<5	<5
Arsenic	26	23	23	23
Barium	**31**[b]	**27**	**31**[b]	**<25**
Beryllium	<0.5	<0.5	<0.5	<0.5
Cadmium	<0.5	<0.5	<0.5	<0.5
Chromium	<1	<1	<1	<1
Cobalt	<25	<25	<25	<25
Copper	<10	<10	<10	<10
Lead	<2	<2	<2	<2
Manganese	**38**	**19**	**30**	**61**
Mercury	<0.2	<0.2	<0.2	<0.2
Molybdenum	25	<25	<25	<25
Nickel	<5	<5	<5	<5
Selenium	<2	<2	<2	<2
Silver	<0.5	<0.5	<0.5	<0.5
Vanadium	<25	<25	<25	<25
Zinc	<20	<20	<20	<20
Perchlorate	<4	<4	<4	<4
Turbidity (NT Units)	25	10	0.23	22
Organic (μg/L)				
1,1,1-Trichloroethane	<1	<1	<1	<1
1,1-Dichloroethene	<1	<1	<1	<1
1,2-Dichloroethane	<1	<1	<1	<1
cis-1,2-Dichloroethene	<1	<1	<1	<1
trans-1,2-Dichloroethene	<1	<1	<1	<1
1,2-Dichloroethene (total)	<1	<1	<1	<1
Benzene	<1	<1	<1	<1
Carbon disulfide	<1	<1	<1	<1
Chloroform	<1	<1	<1	<1
Dichlorodifluoromethane	<2	<2	<2	<2
Ethylbenzene	<1	<1	<1	<1
Freon 113	<1	<1	<1	<1
Tetrachloroethene	<1	<1	<1	<1
Toluene	<1	<1	<1	<1
Total xylene isomers	<2	<2	<2	<2
Trichloroethene	<0.5	<0.5	<0.5	<0.5
Trichlorofluoromethane	<1	<1	<1	<1
Bis(2-ethylhexyl)phthalate	<5	<5	<5	<5
Phenol	<5	<5	<5	<5
Explosive (μg/L)				
HMX	<1	<1	<1	<1
RDX	<1	<1	<1	<1
TNT	<5	<5	<5	<5
Radioactive (Bq/L)[a]				
Gross alpha	-0.026±0.057	0.030±0.046	-0.215±0.080	0.059±0.041
Gross beta	0.41±0.11	0.37±0.07	0.43±0.09	**0.06**[c]**±0.06**

[a] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2s counting errors.
(Divide these values by 0.037 to convert them to picocuries/liter.)
The reported value is negative when the measured sample radioactivity is less than the measured background activity.
The result is zero when the measured sample radioactivity is equal to the measured background activity.

[b] Analytical results from two discrete retests each showed the concentration of this COC to be less than the SL.
The initial detection was not confirmed. See **Section 3.1**

[c] Gross beta result for this routine sample was noted to be approximately an order of magnitude below the CL.
The duplicate sample showed a more typical result (0.29 ± 0.07 Bq/L). See **Section 3.1**

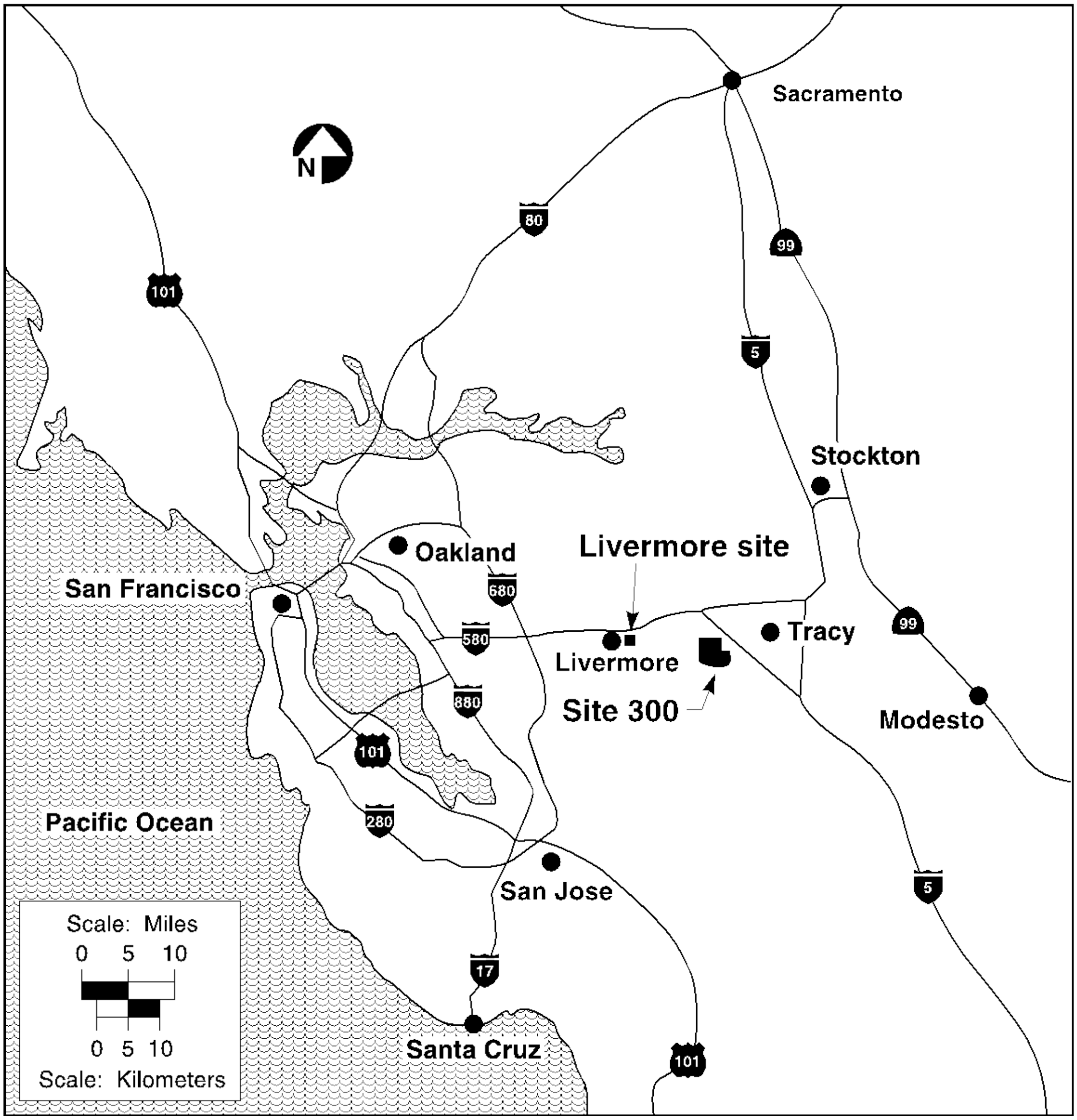


Figure 1. Locations of LLNL Livermore site and Site 300.

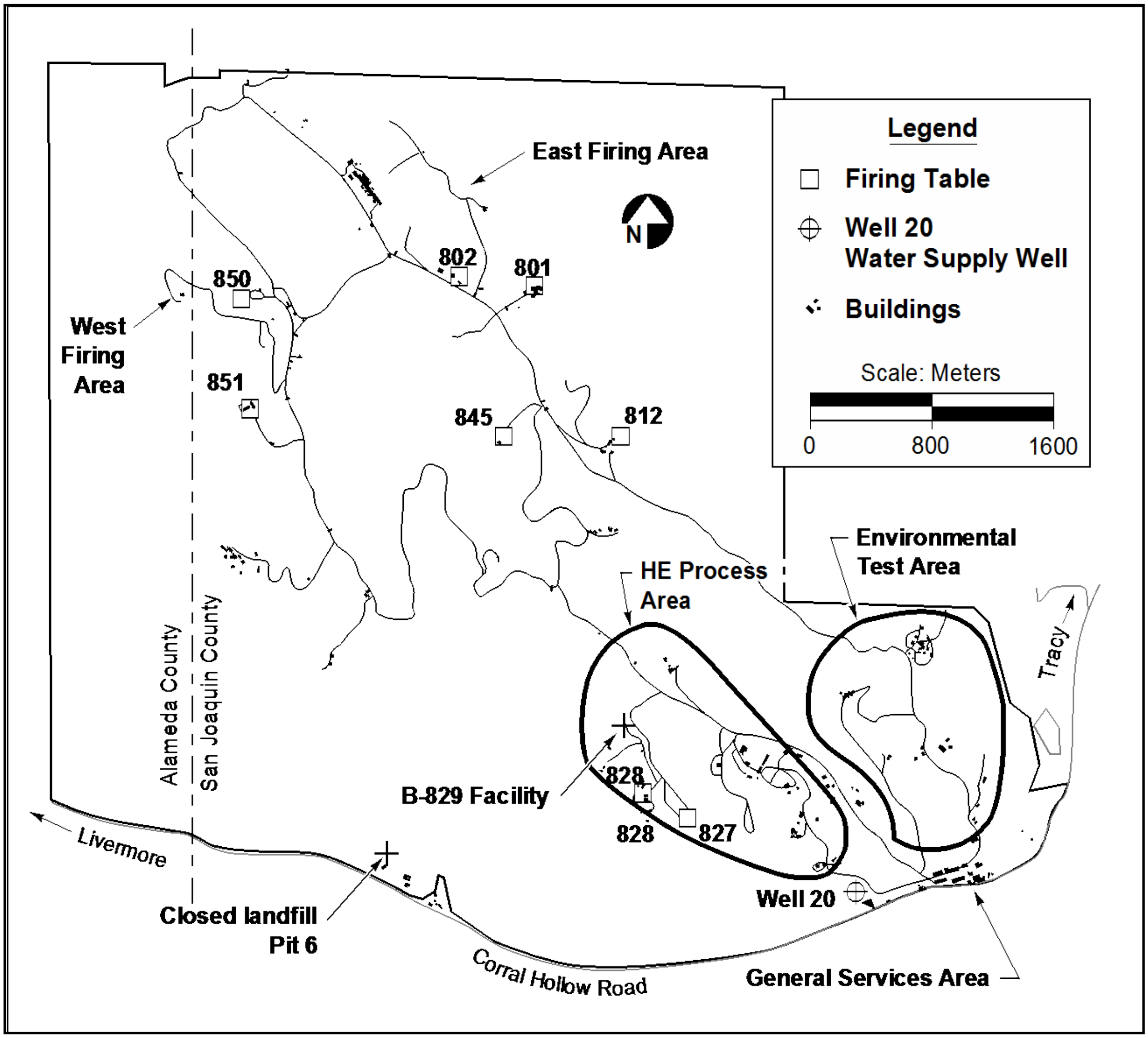


Figure 2. Location of the closed B-829 Facility at LLNL Site 300.

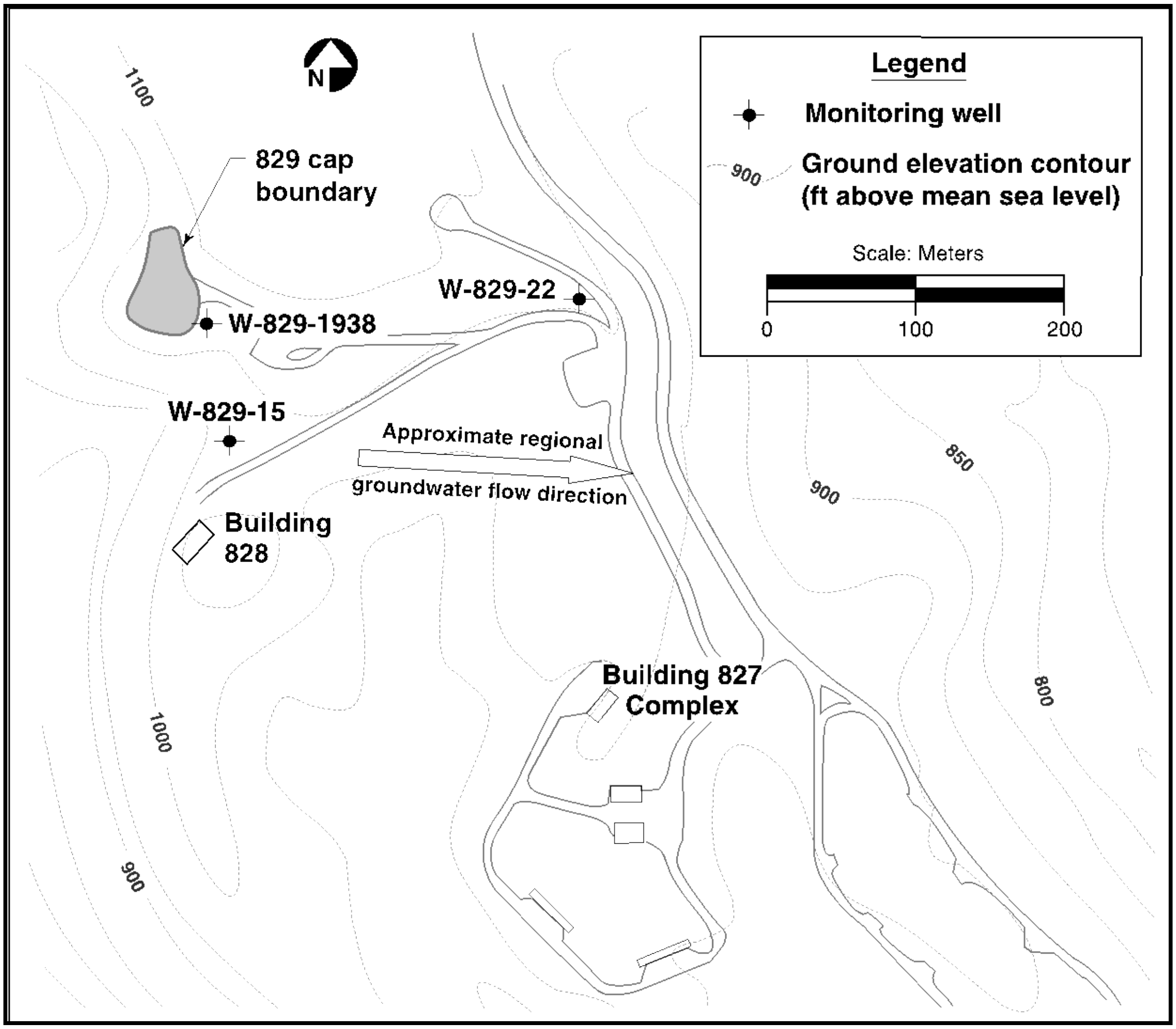


Figure 3. Location of the closed B-829 Facility and monitoring wells at LLNL Site 300.

Post-Closure Inspection Checklist

Location: ____________________ Inspector's name: _________________________________

Date: ________________________ Inspector's signature: ______________________________

Time: _______________________ Site 300 EA signature and date: ______________________

Condition of the facility	Condition as described?	If correction needed, describe condition and needed repairs.	Corrections completed?	Date completed
DESCRIPTION	**Yes / No**	**INSPECTOR'S COMMENTS**	**Y/N**	**DATE**
1. Cap is in good condition.				
a. No settlement or gullying observed.				
b. No surface erosion visible.				
c. No fissures visible.				
d. No cracks visible.				
e. No low spots visible.				
f. No animal burrows visible.				
g. No bare spots observed.				
h. No subsidence observed.				
i. No vegetation beyond topsoil layer observed.				
2. Runoff is diverted away from the cap.				
3. Erosion controls are present and in good condition (i.e, grading, vegetation, and clear diversion channels).				
4. Permanent, surveyed benchmarks are present and maintained.				
5. Groundwater monitoring network is in good working order.				
a. Well label is intact and legible.				
b. Surface seal is intact.				
c. No evidence of damage (i.e, settlement, pipe tilting, poor protective pipe condition, standing water around the pipe, etc.) is observed.				
6. Warning sign is in place.				
7. Emergency Coordinator's name and phone number posted.				
8. Communications are in good working order.				
9. Access available to emergency vehicles.				
10. Copy of Post-Closure Plan is on file at Site 300.				
11. Other observations attached.				

LS:KF:mt

Figure 4. B-829 Facility post-closure inspection checklist.

B829 Monitoring Well Inspection Checklist

Well No.	Is Well No. clearly marked?	Is surface seal intact?	Is well capped & locked ?	Is there evidence of damage?	Is there settlement?	Is there standing water?	Is reference point marked?
829-15							
829-22							
829-1938							

Comment Log

Well No.	Comments/Repair(s) Needed	Nature of Repair	Date Repair Completed	Completed by (name)
829-15				
829-22				
829-1938				

Form date: 5/5/06, rev.1

Inspection date:__________________________________Time:____

Inspector name:__________________________________Signature:______________________________________

Figure 5. B-829 Facility monitoring well inspection checklist.

Appendix A

Groundwater Elevation and Constituent of Concern Concentration Plots

Appendix A

Groundwater Elevation and Constituent of Concern Concentration Plots

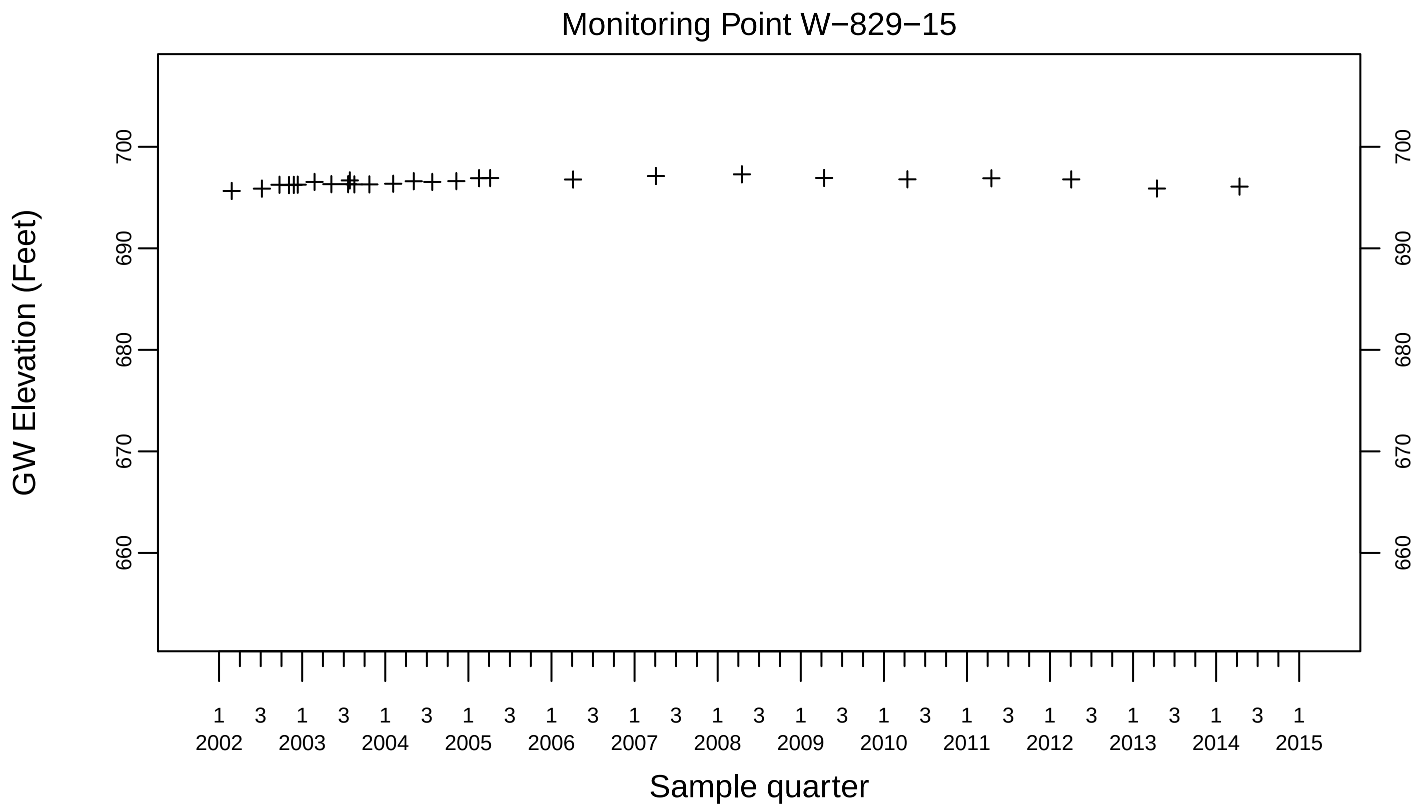
As required by the monitoring and reporting provisions of 22 CCR 66264.97(e), this appendix presents graphical depictions of groundwater elevations and concentration trends. Concentration-versus-time plots have been prepared for all confirmed constituent of concern (COC) detections above their respective analytical reporting limits (RLs), for the permit-specified wells. The graphs for the two established wells (W-829-15 and W-829-22) present data accumulated over the last thirteen years, going back to 2002. The graphs for well W-829-1938, first monitored in CY 2004, present the forty-four quarters of data available.

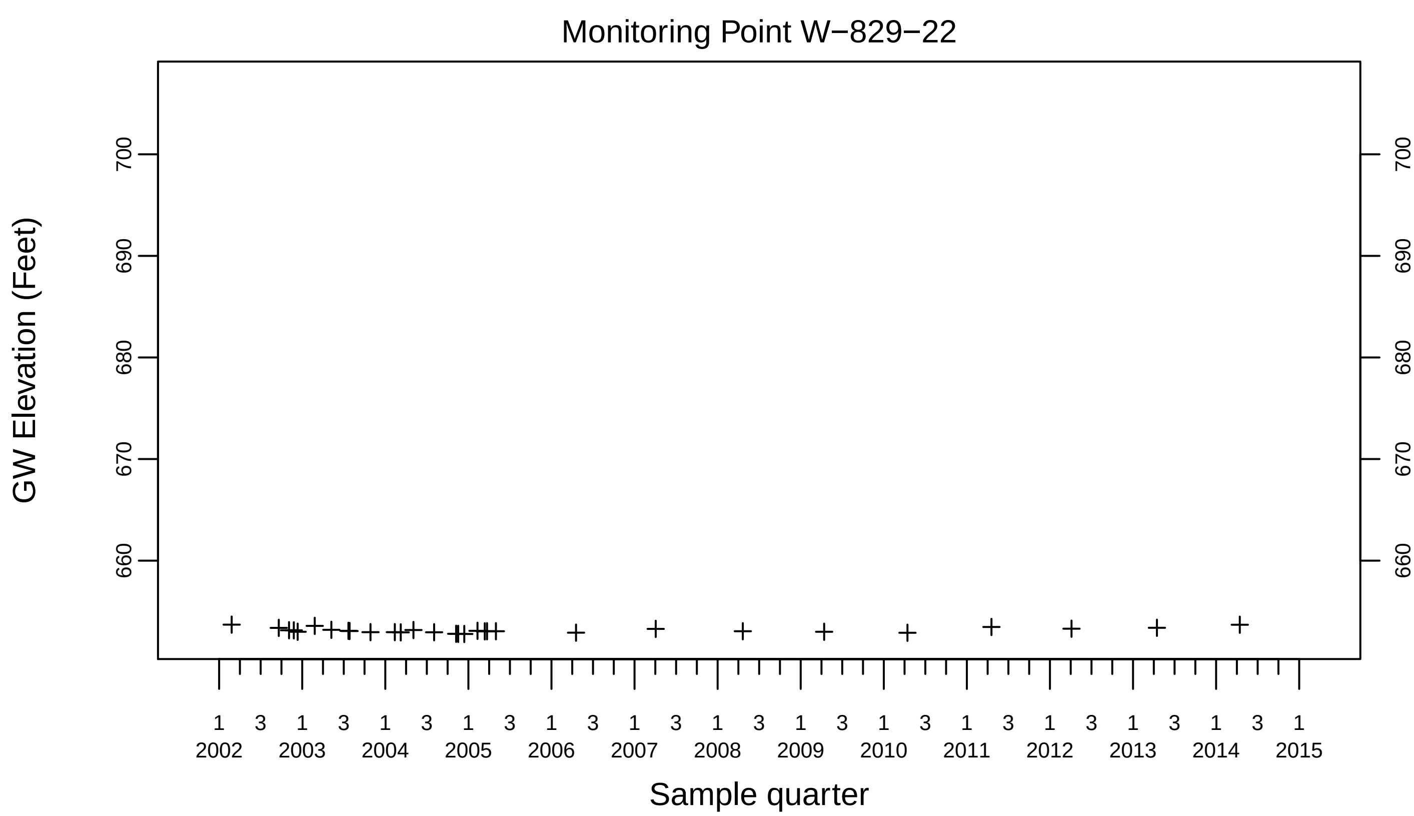
The sequence of graphs is by parameter (groundwater elevation, concentration, or activity) and by well. Graphs show the reported parameter on the y-axis, with time on the x-axis (time in years is divided into quarterly sample periods). The header and the vertical axis labels on each plot give the units of measurement. Statistical limits of concentration (SLs) are shown on the COC graphs as horizontal dotted lines. The numerical value of an SL is also given in the plot legend. Three different symbols are used to plot the COC data: a black diamond, an inverted white triangle, and a plus sign. Their different uses are explained below.

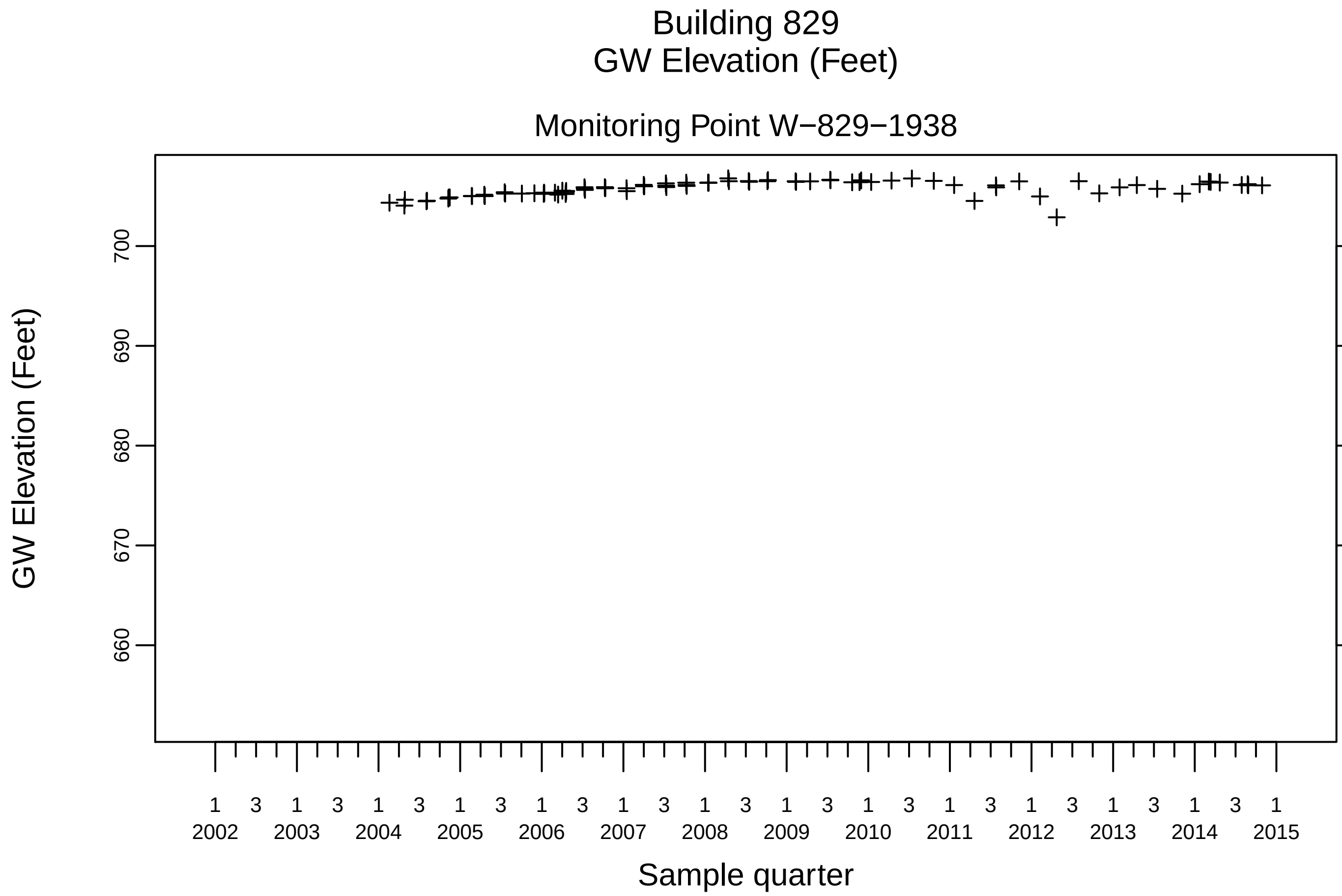
COC detections are plotted as black diamonds. Analytical laboratories report COC measurements above RLs as detections. (The RL for a COC is a contractual concentration value near zero.) COC concentrations below RLs are non-detections and are reported as “less than the RL.” For non-radioactive COCs, non-detections are assigned RL values and appear as inverted white triangles in the data graphs.

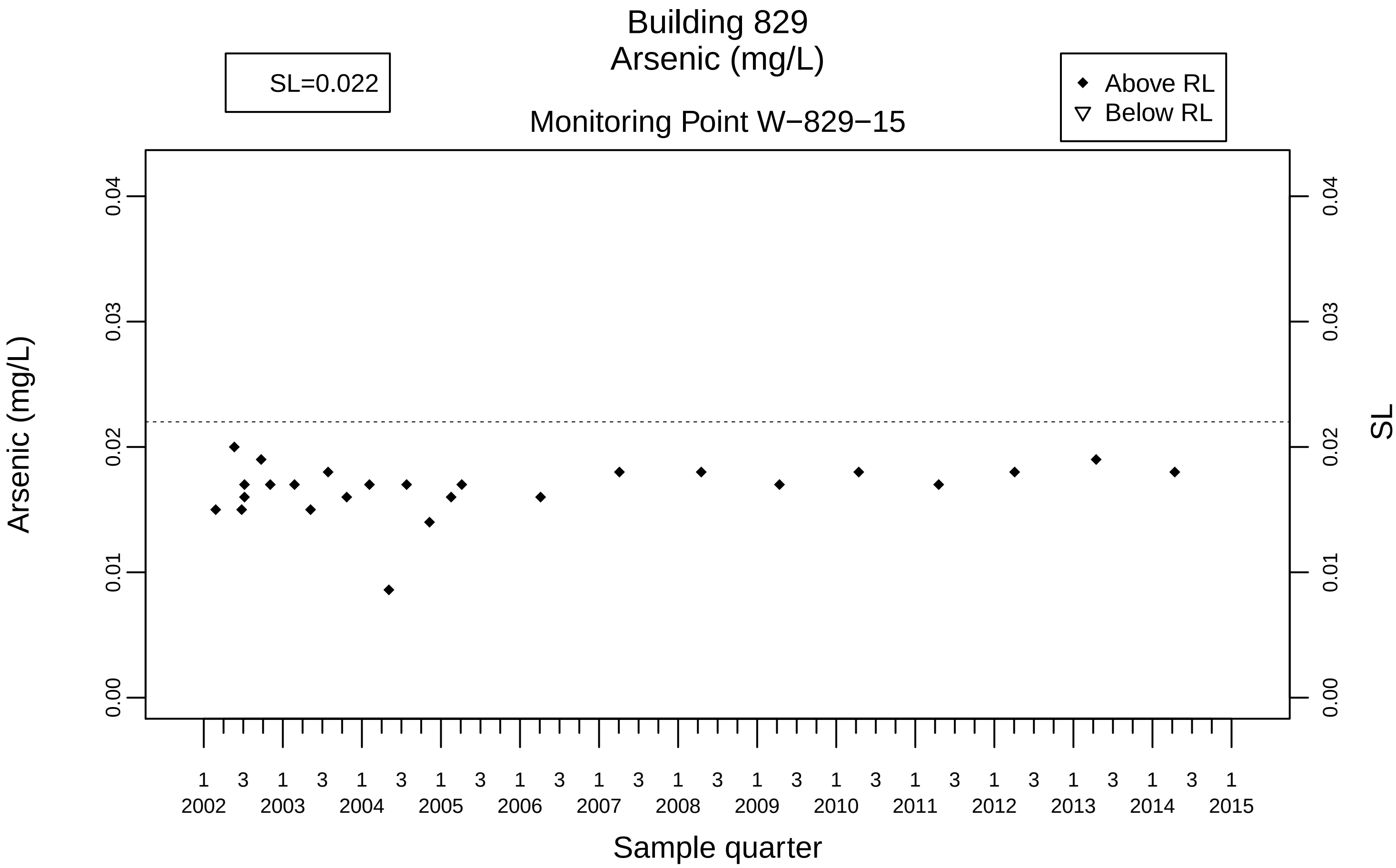
Non-detections of radioactive COCs, however, are treated differently. The reported value for radioactive COCs is the measured sample radioactivity minus the measured background radioactivity. When the result of this calculation is less than the RL, the value is plotted as a plus sign, indicating an estimated non-detection. (Note that the calculated value may be negative, or zero, if the measured sample radioactivity is less than, or equal to, the measured background activity.) When the reported activity is greater than the RL, the value is plotted as a black diamond, indicating a radioactive COC detection.

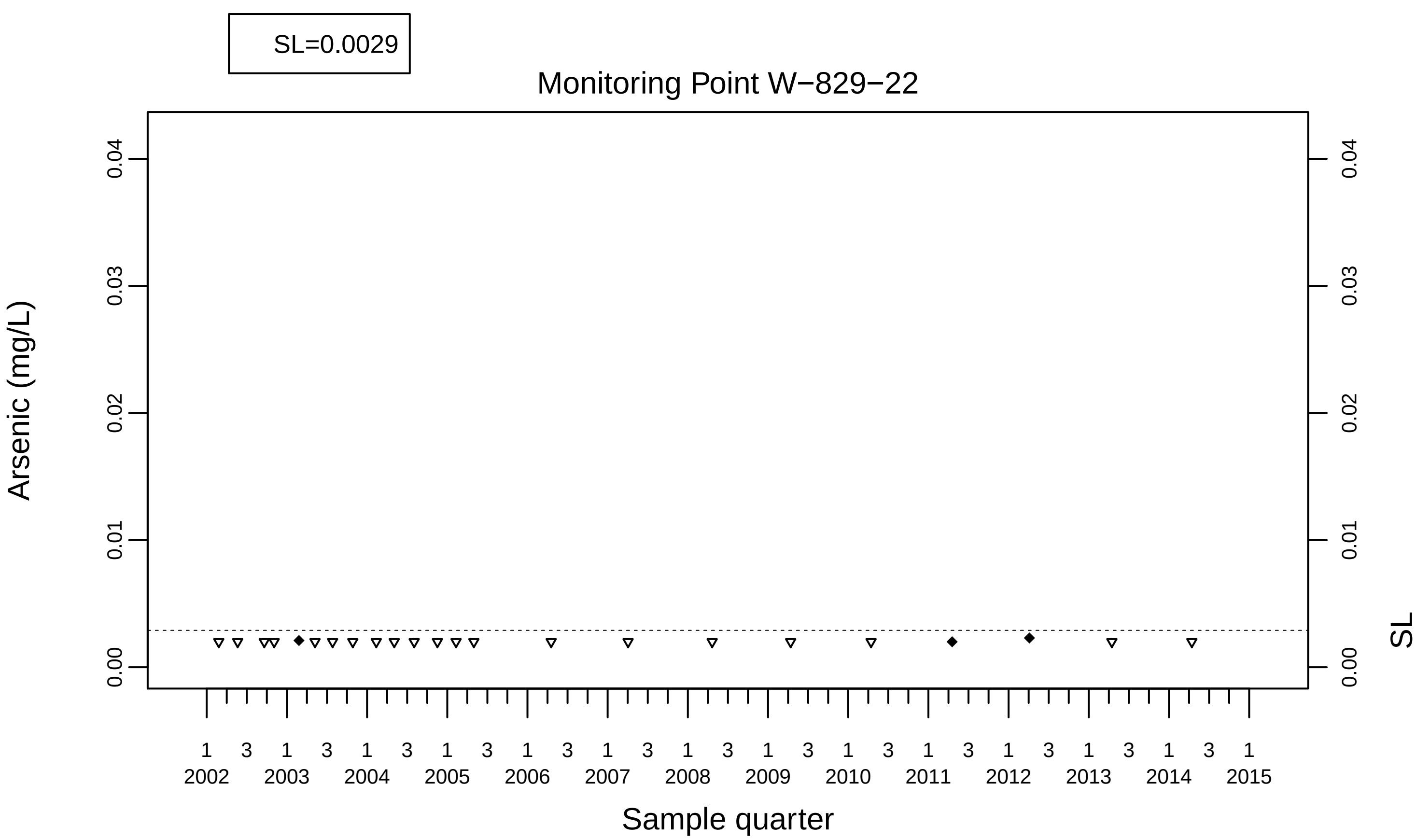
Building 829
GW Elevation (Feet)

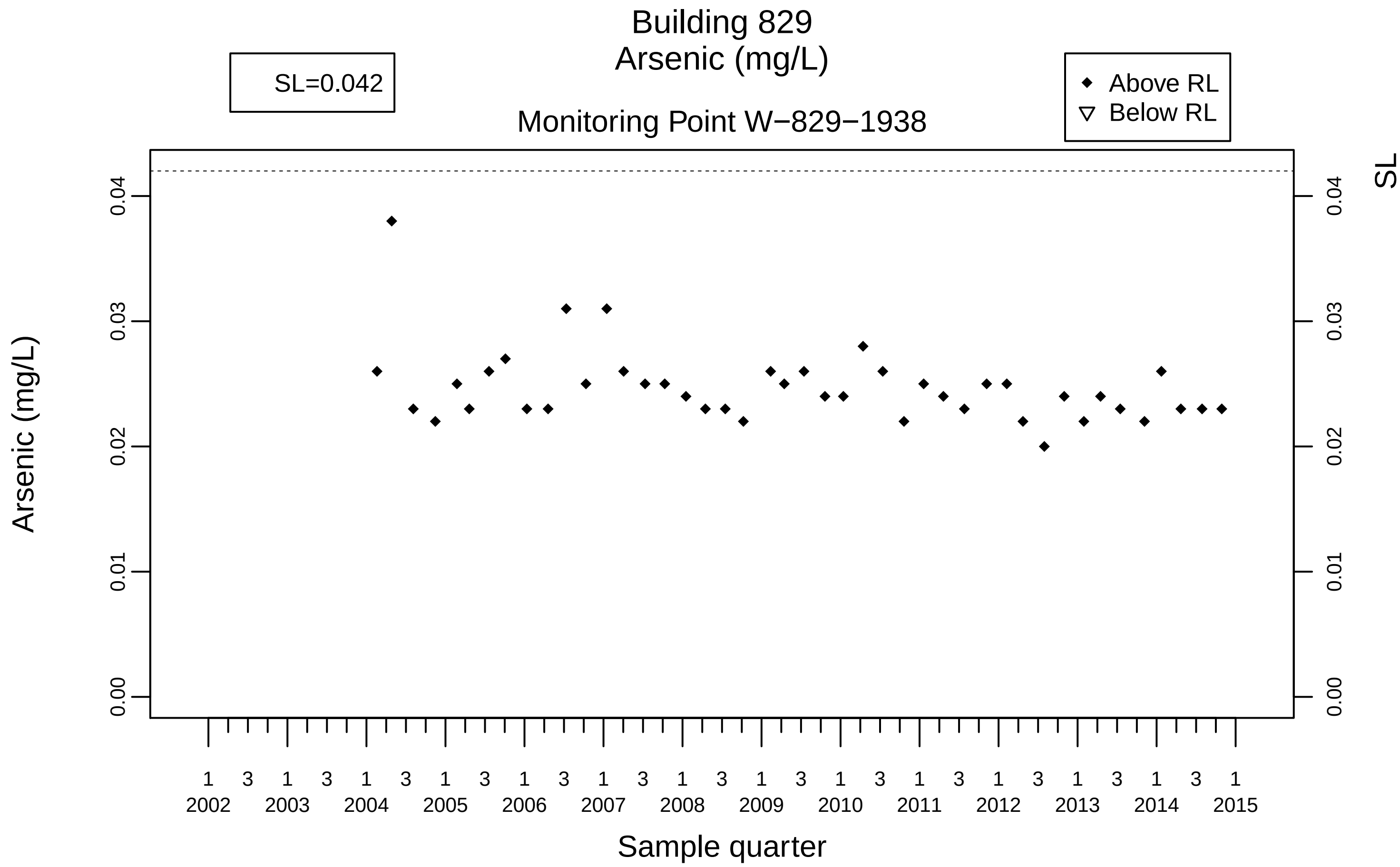


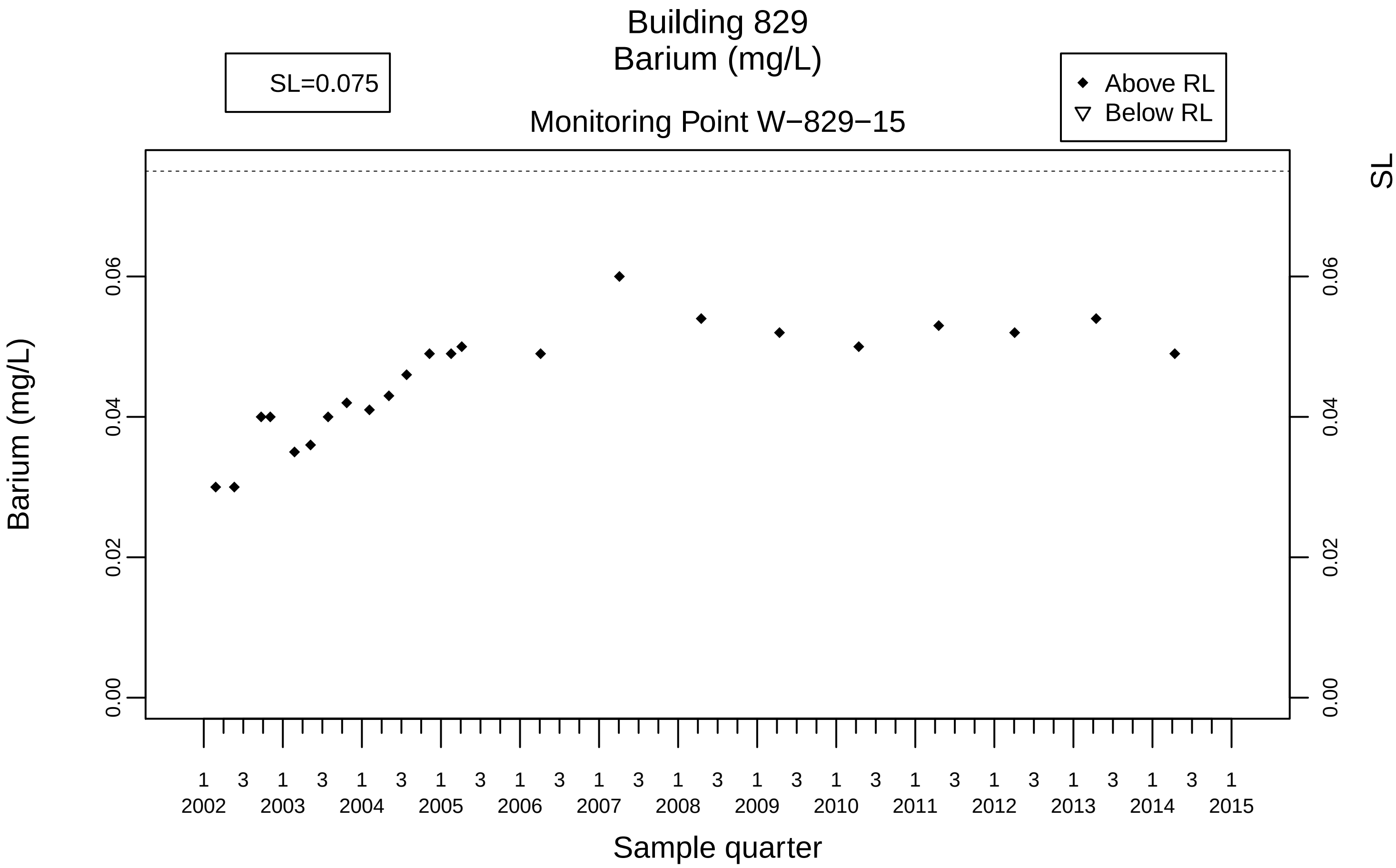


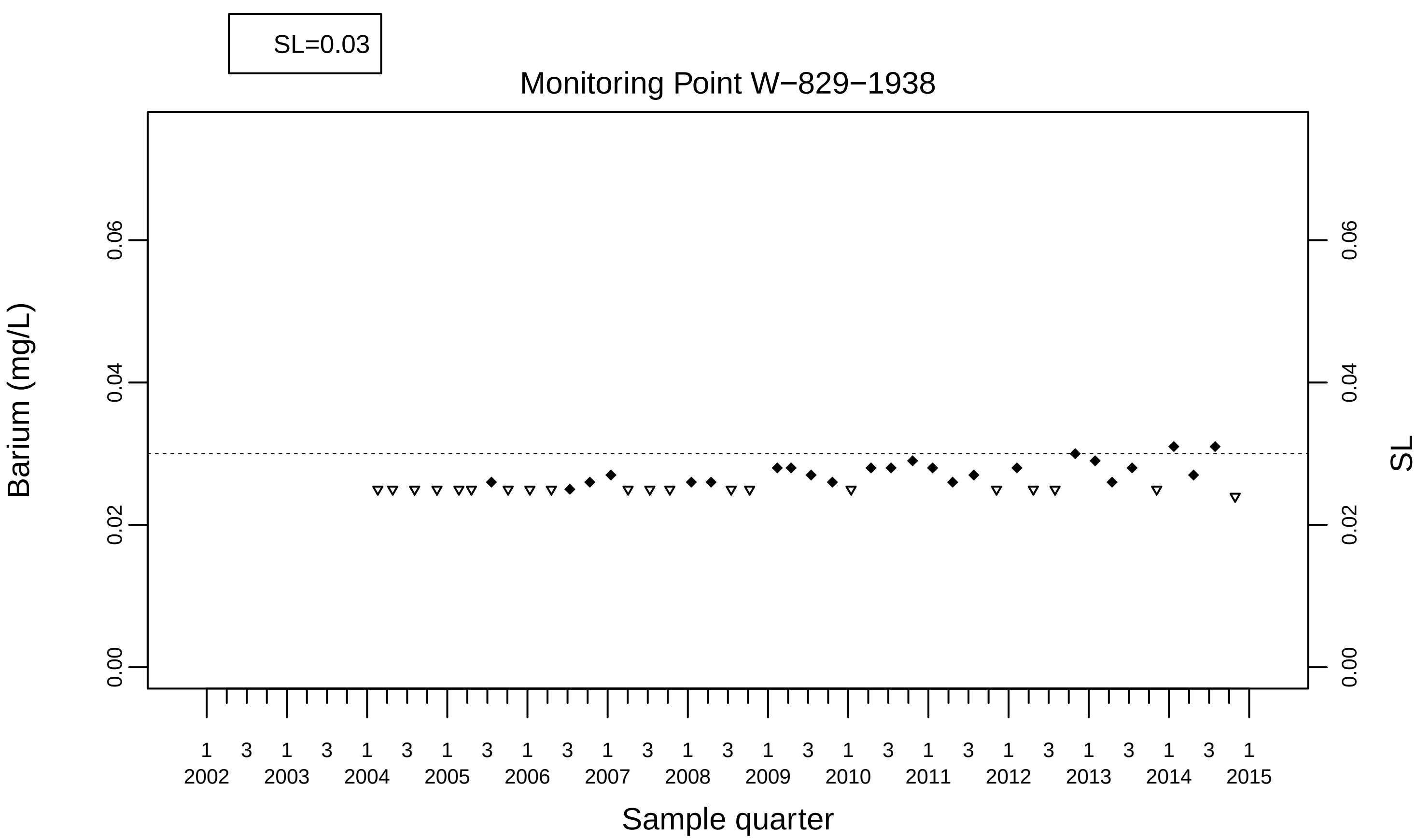

Building 829
GW Elevation (Feet)
Monitoring Point W−829−1938
GW Elevation (Feet)
700
690
680
670
660
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

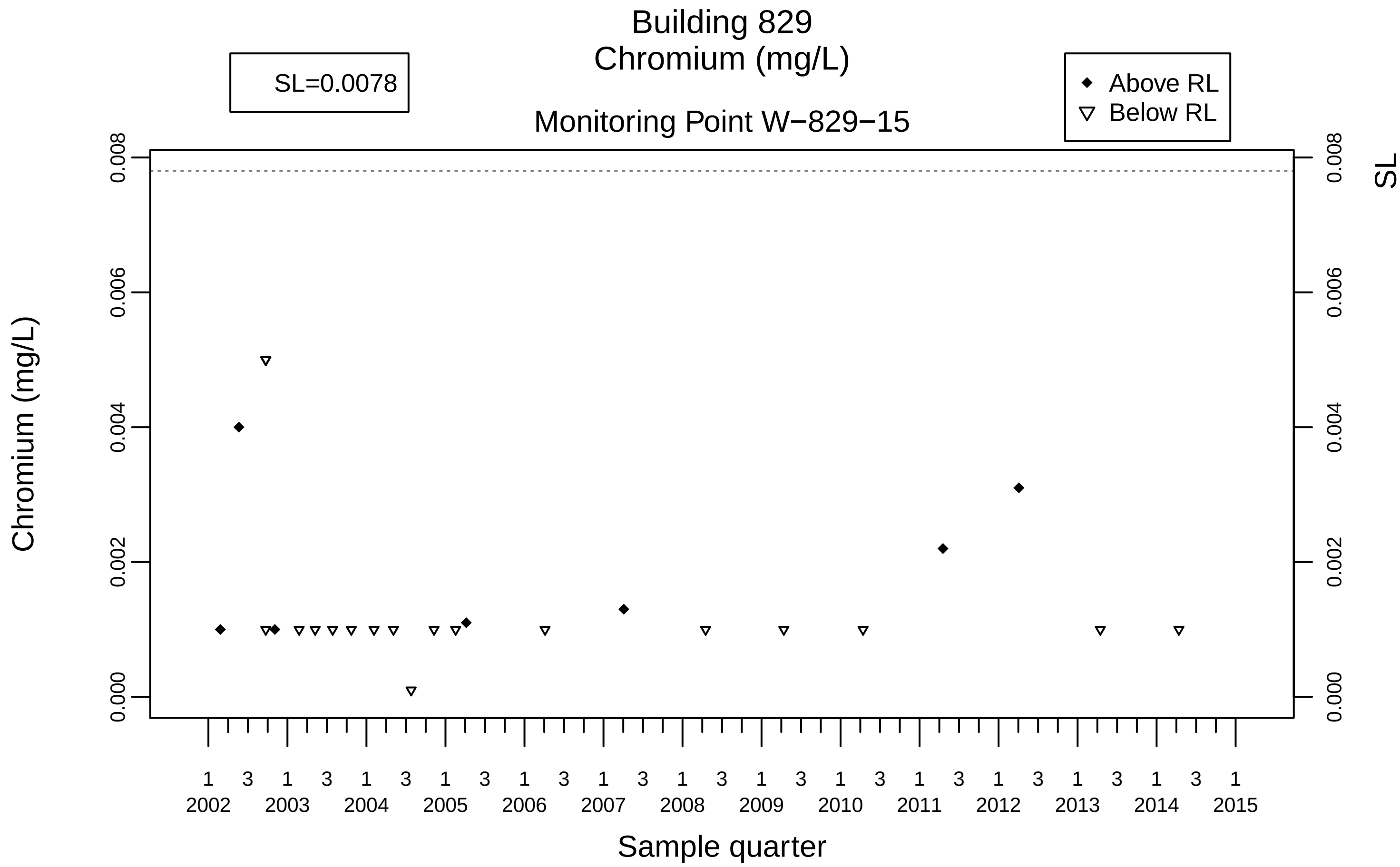

Building 829
Arsenic (mg/L)
SL=0.022
Above RL
Below RL
Monitoring Point W−829−15
Arsenic (mg/L)
SL
0.00
0.01
0.02
0.03
0.04
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

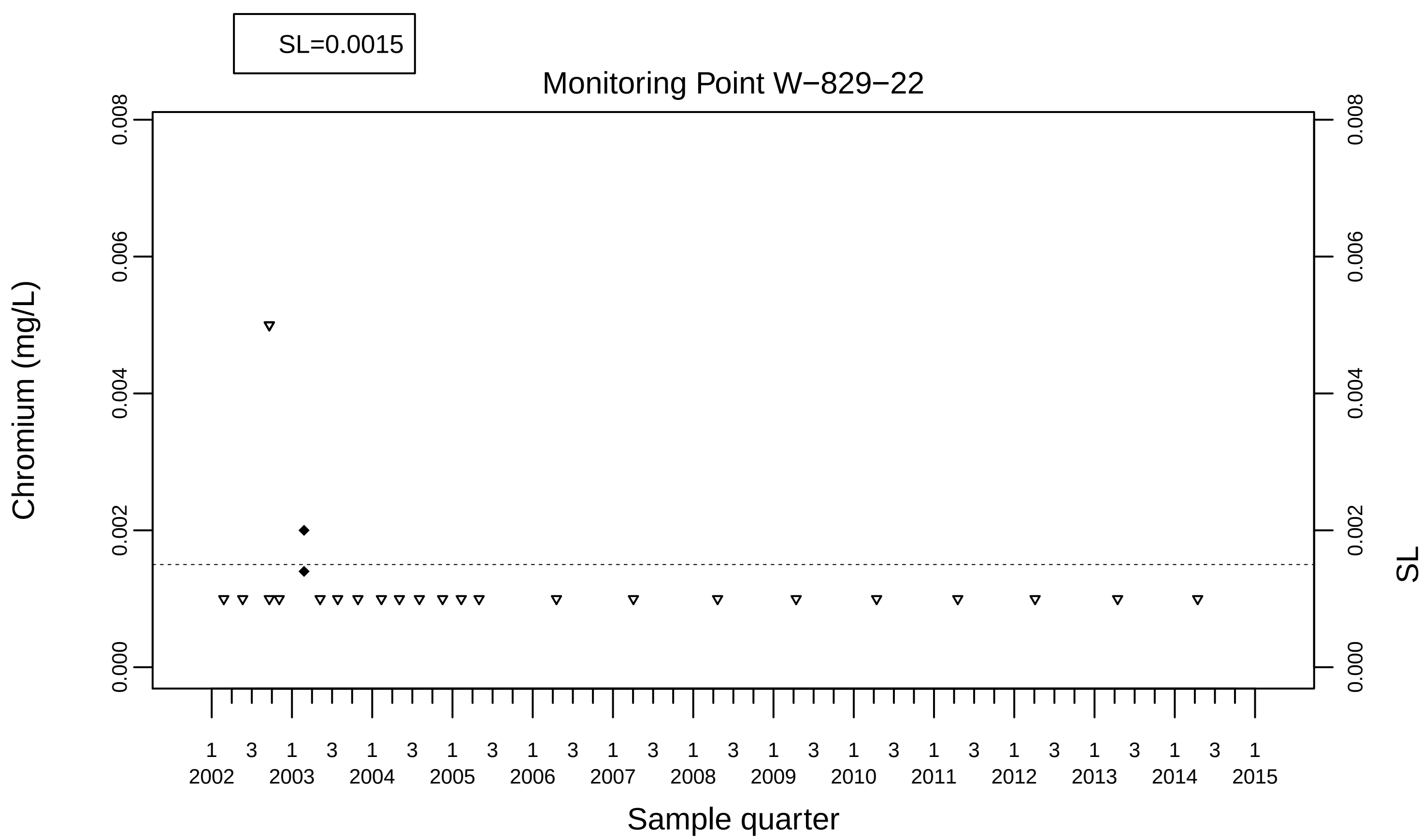

SL=0.0029
Monitoring Point W−829−22
Arsenic (mg/L)
SL
0.00
0.01
0.02
0.03
0.04
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

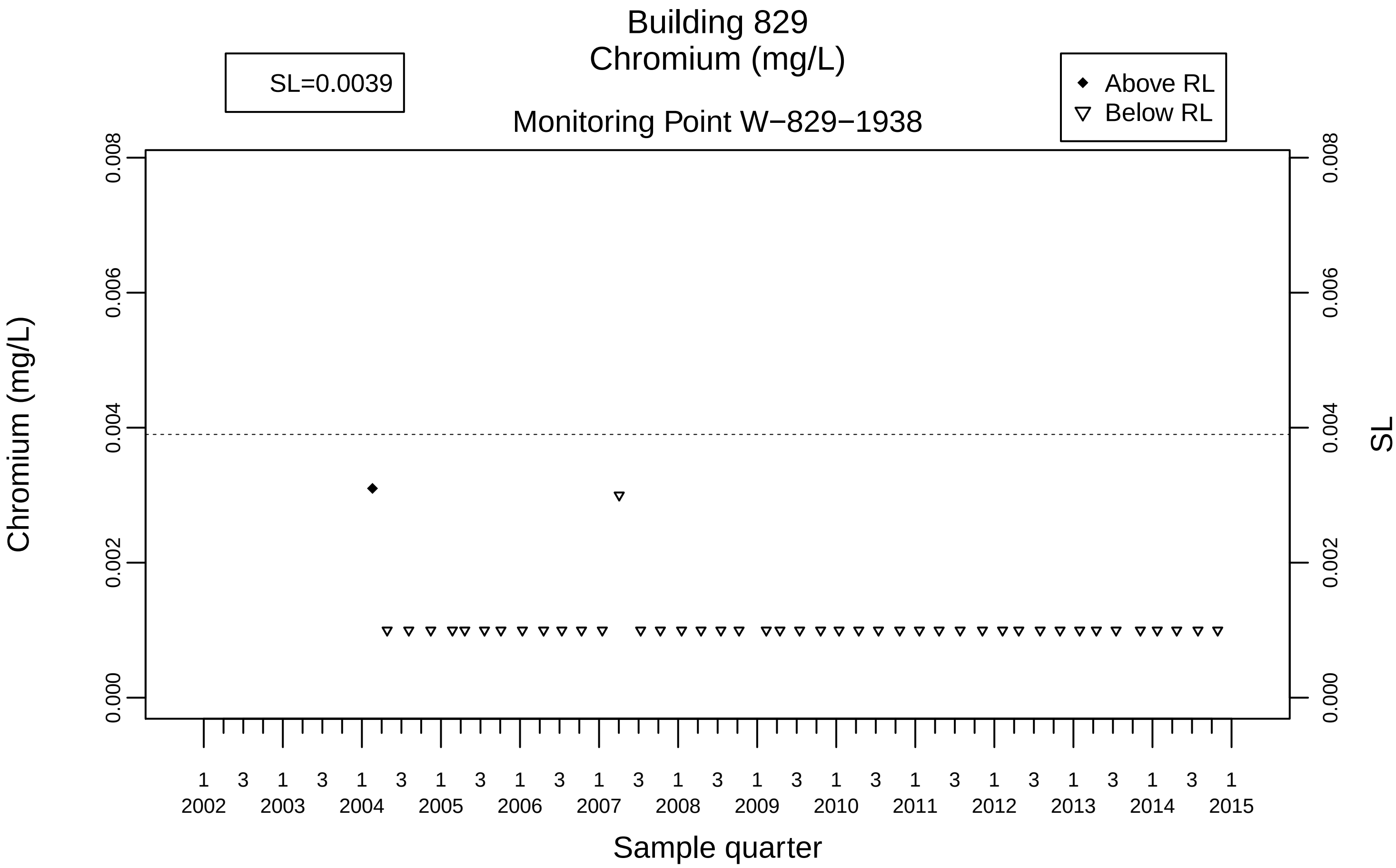

Building 829
Arsenic (mg/L)
SL=0.042
Monitoring Point W−829−1938
Above RL
Below RL
SL
Arsenic (mg/L)
0.00
0.01
0.02
0.03
0.04
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

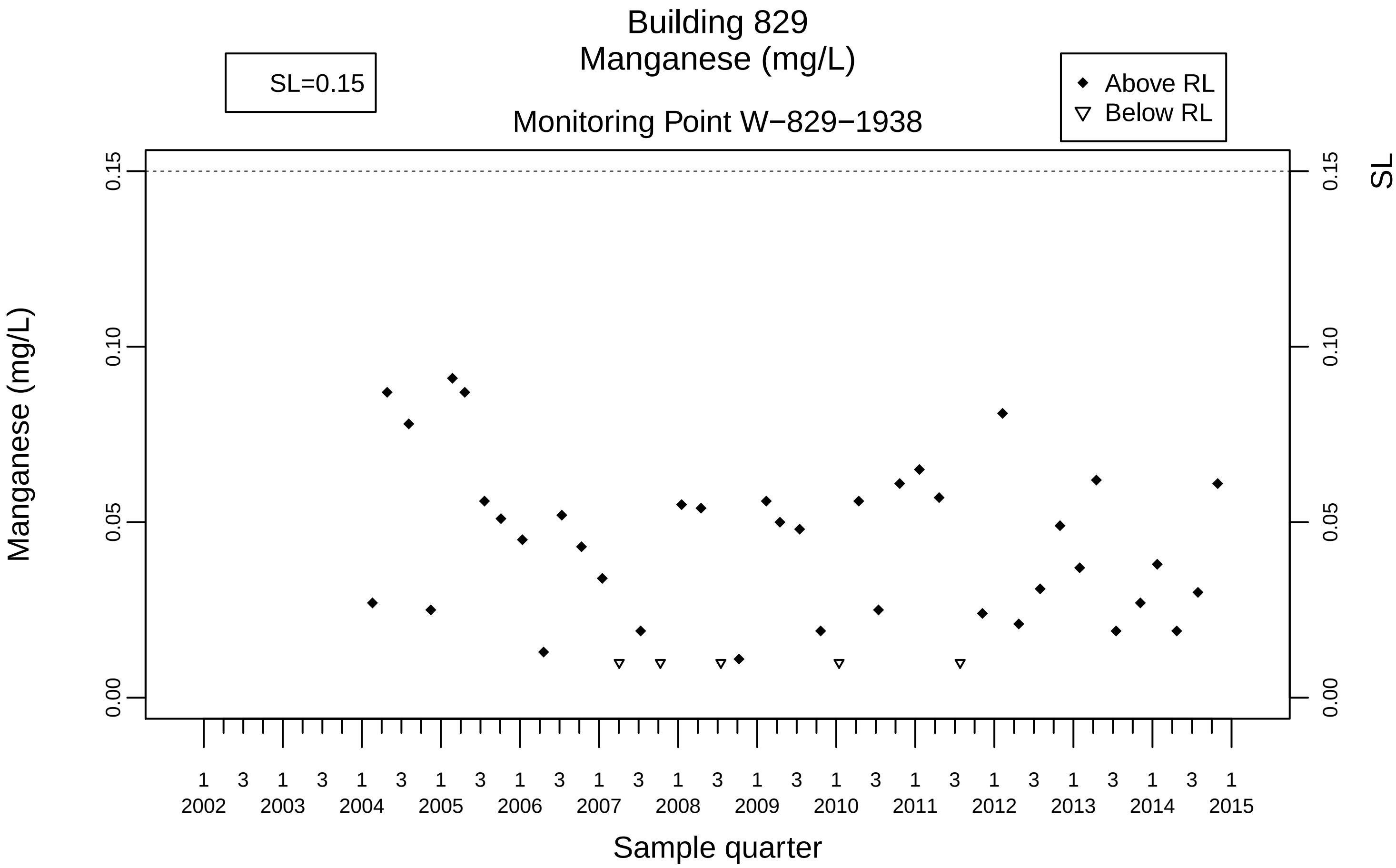

Building 829
Barium (mg/L)
SL=0.075
Above RL
Below RL
Monitoring Point W−829−15
Barium (mg/L)
Sample quarter
SL

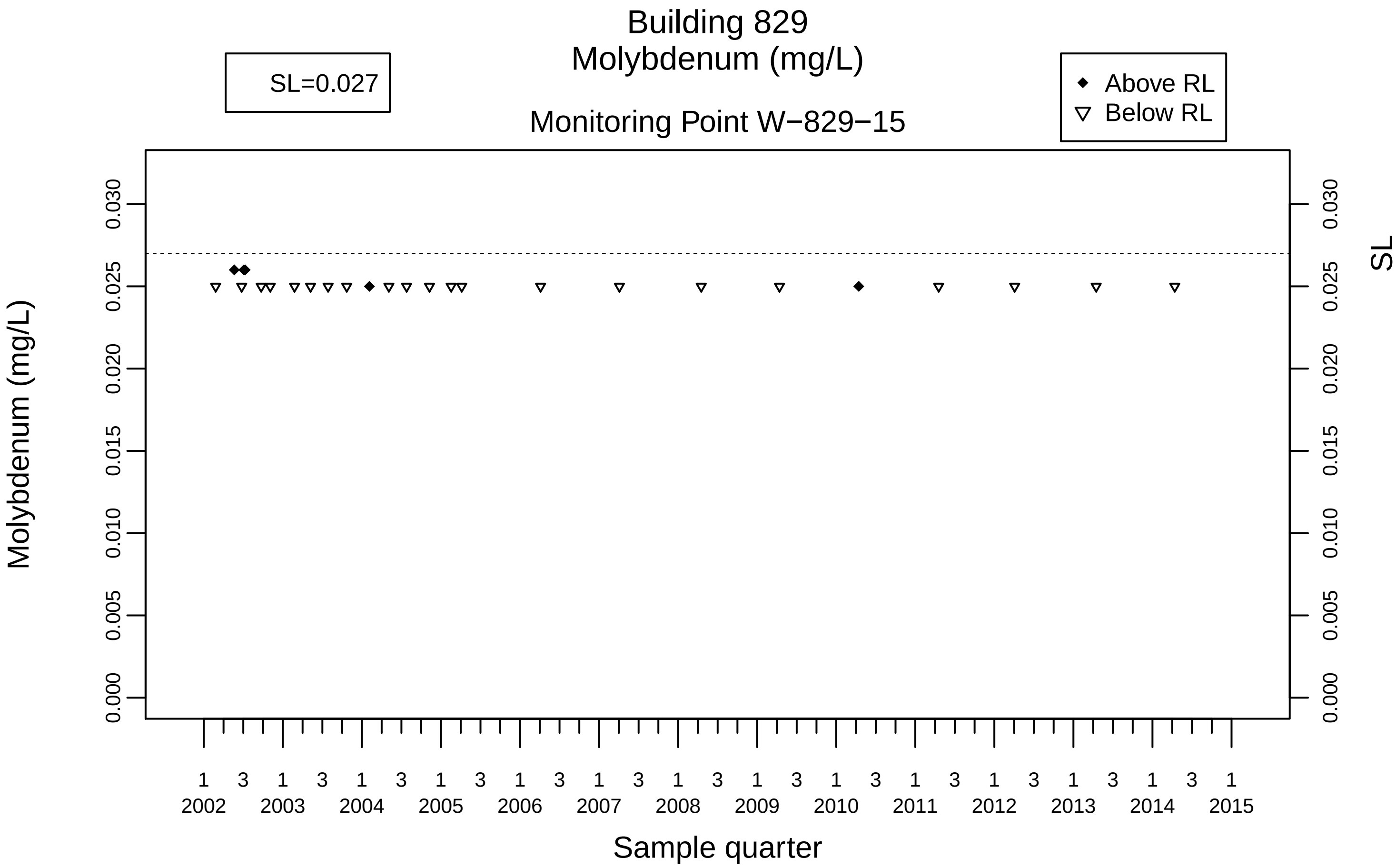

SL=0.03
Monitoring Point W−829−1938
Barium (mg/L)
Sample quarter
SL

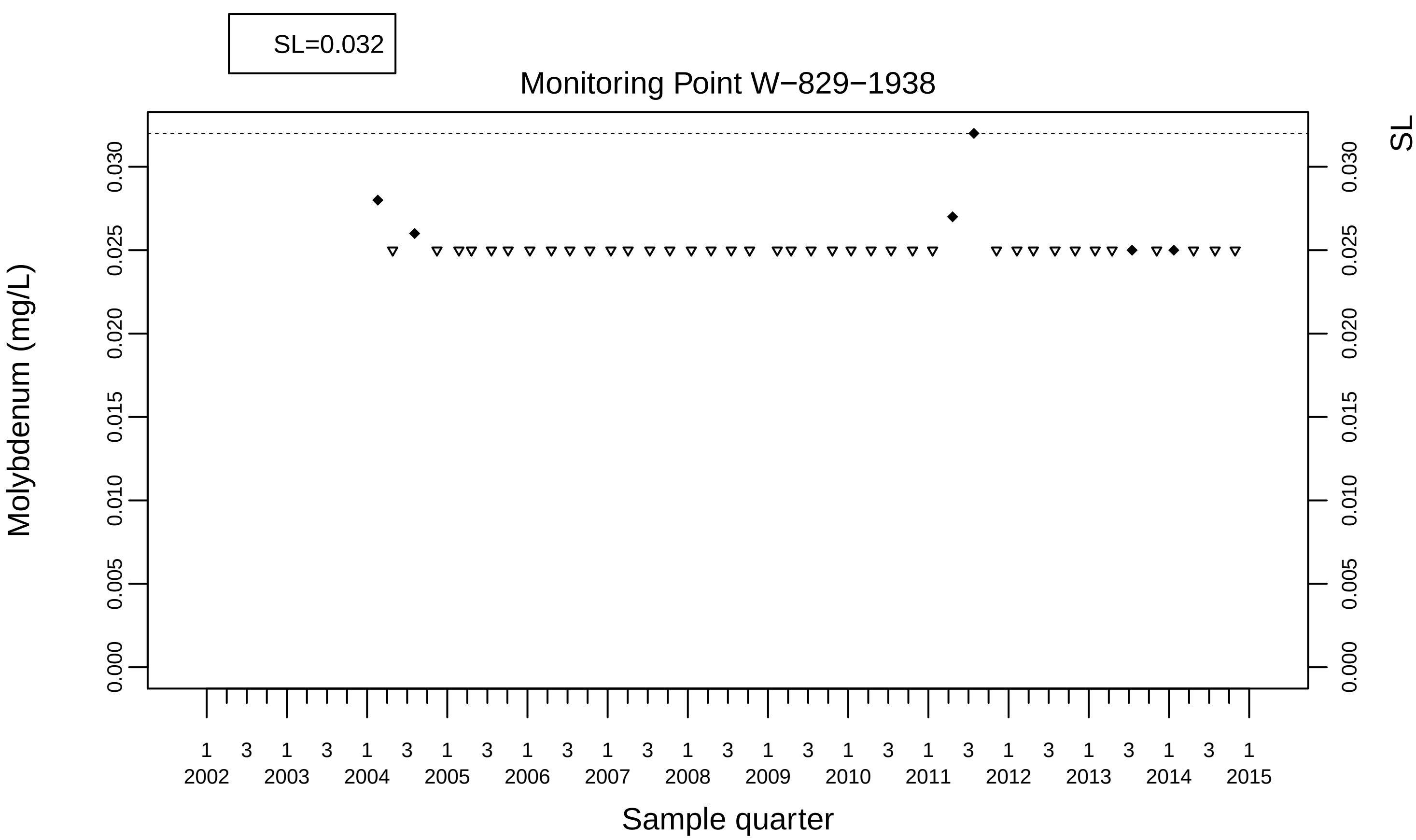

Building 829
Chromium (mg/L)
SL=0.0078
Above RL
Below RL
Monitoring Point W−829−15
Chromium (mg/L)
SL
0.000
0.002
0.004
0.006
0.008
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

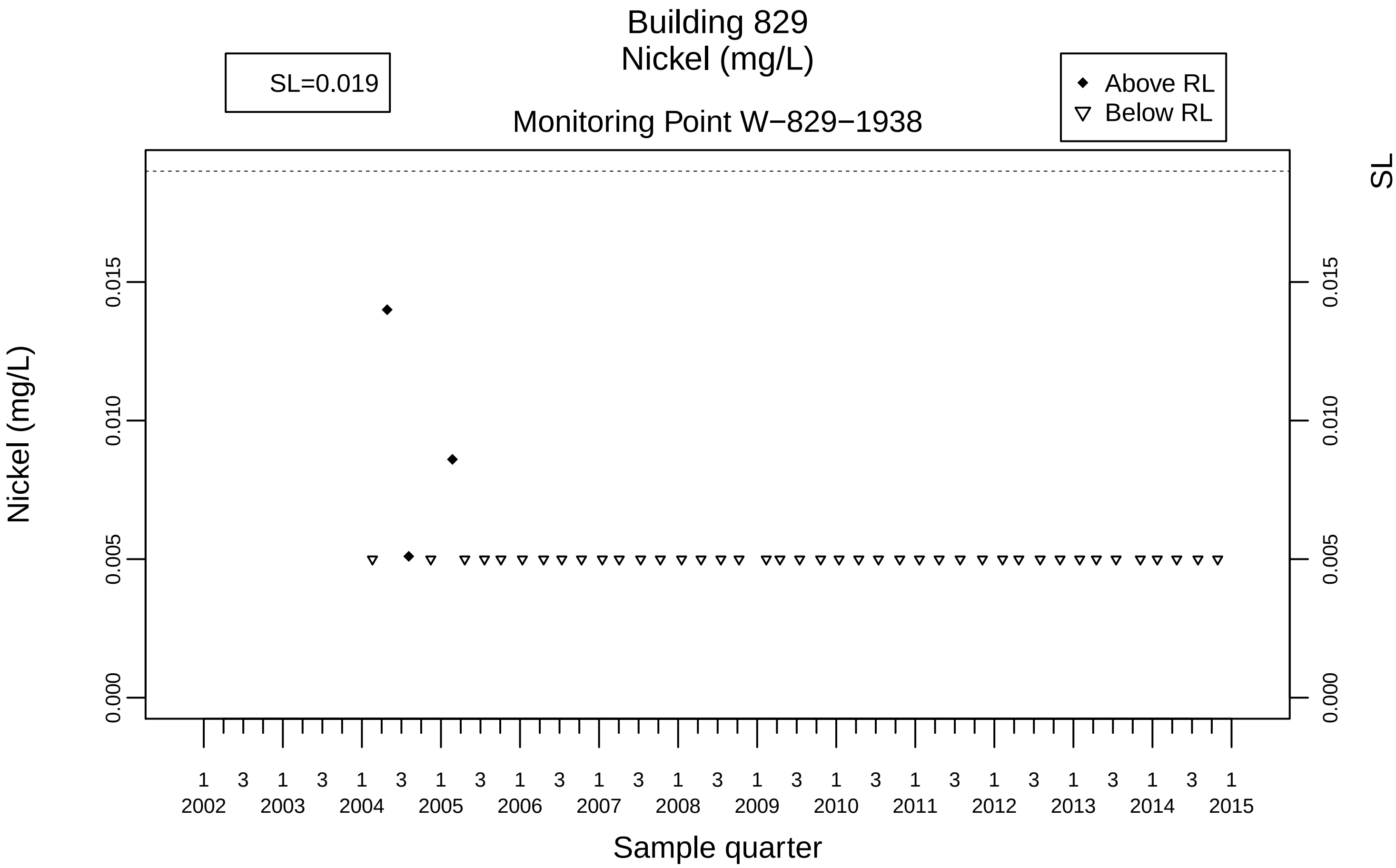

SL=0.0015
Monitoring Point W−829−22
Chromium (mg/L)
SL
0.000
0.002
0.004
0.006
0.008
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

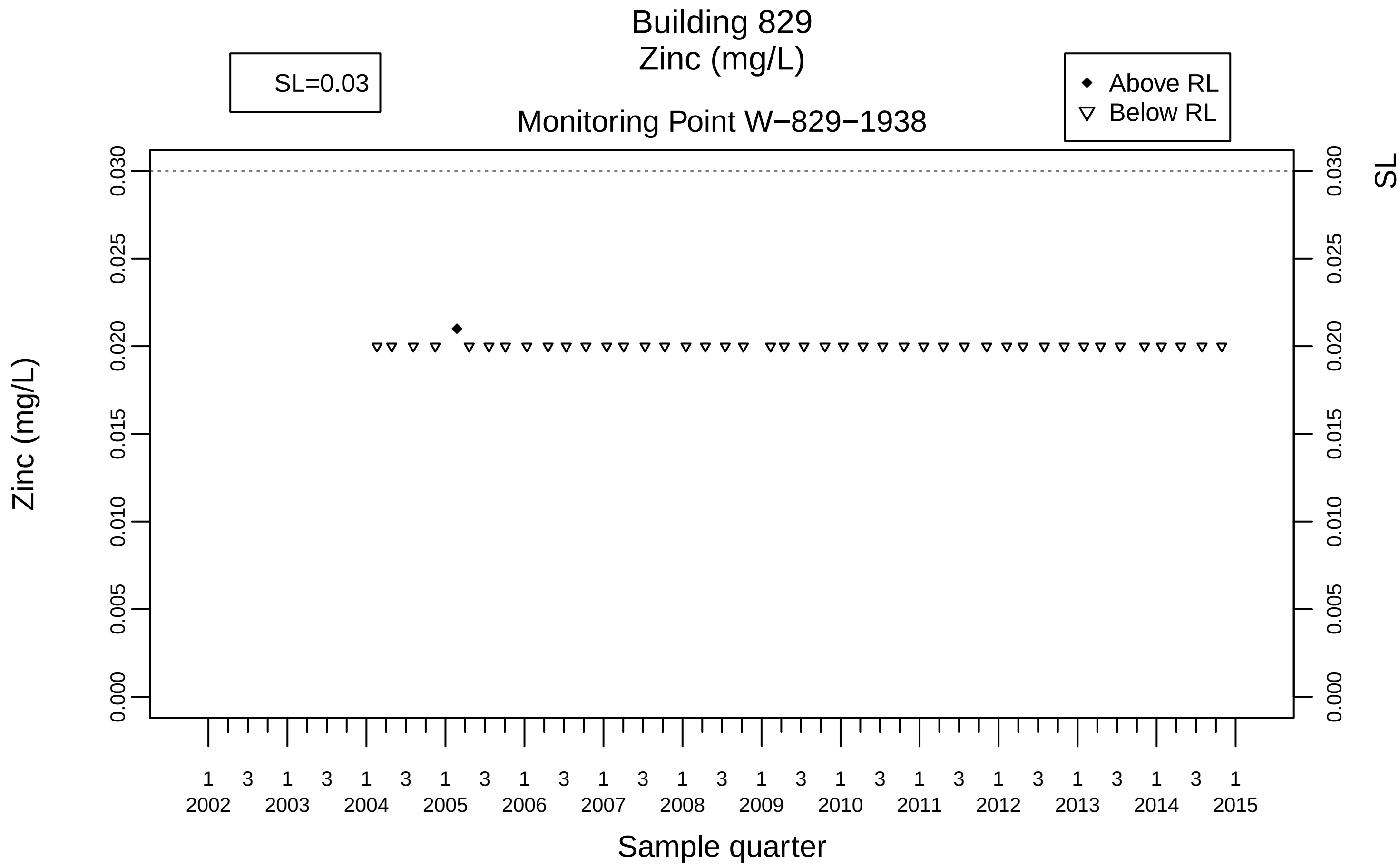

Building 829
Chromium (mg/L)
Monitoring Point W−829−1938
SL=0.0039
Above RL
Below RL
0.000
0.002
0.004
0.006
0.008
Chromium (mg/L)
SL
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

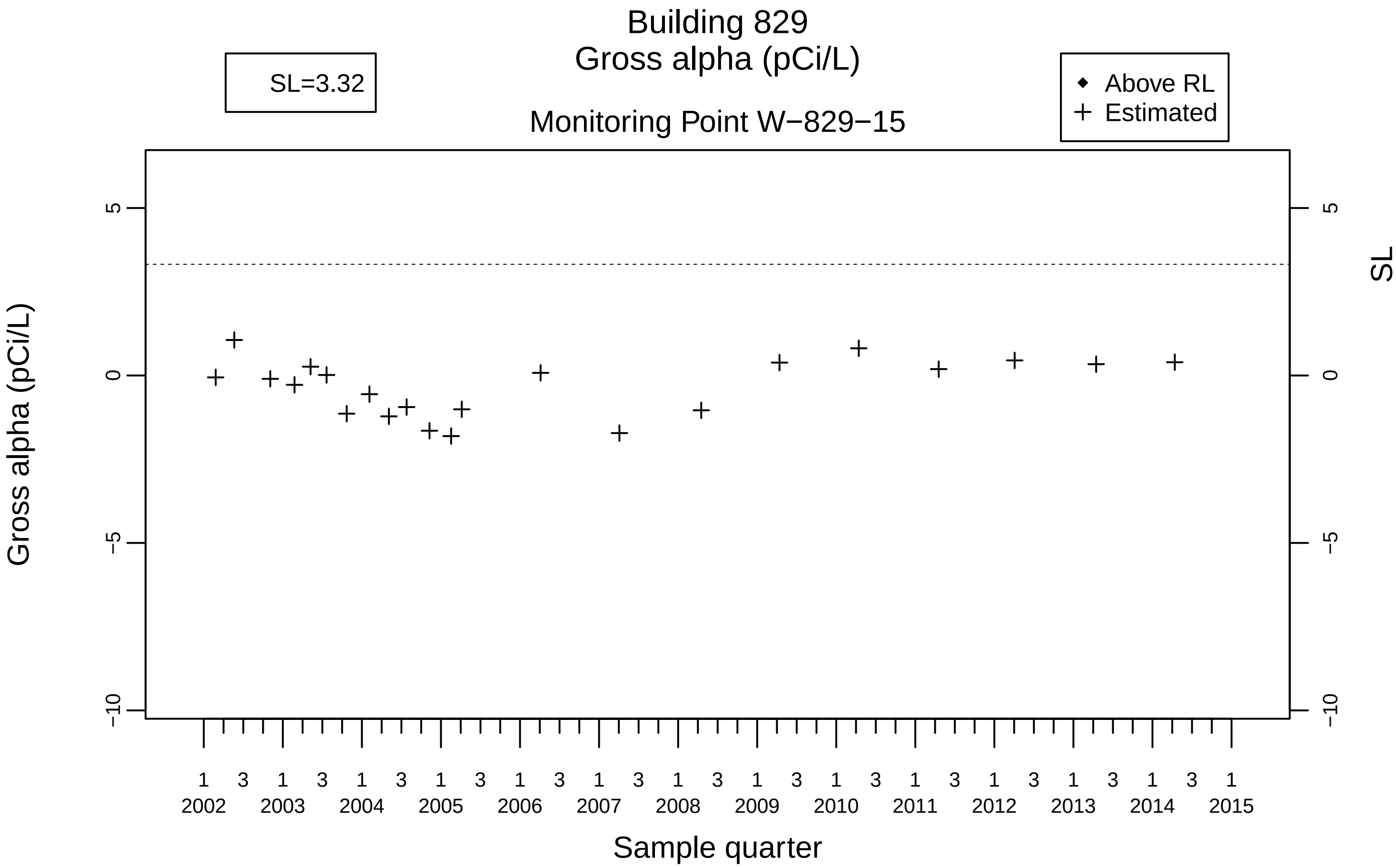

Building 829
Manganese (mg/L)
SL=0.15
Above RL
Below RL
Monitoring Point W−829−1938
Manganese (mg/L)
0.00
0.05
0.10
0.15
SL
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

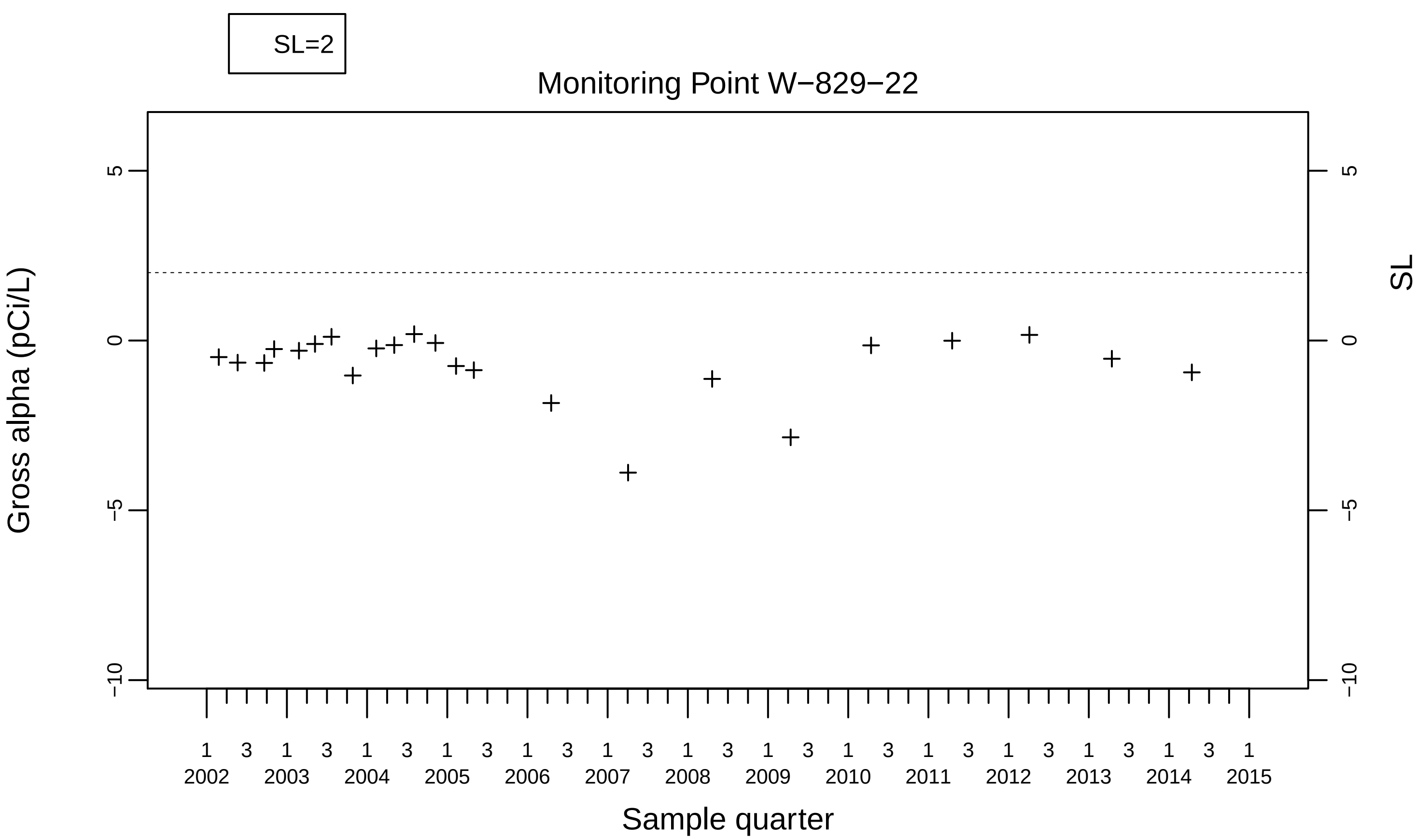

Building 829
Molybdenum (mg/L)
SL=0.027
Above RL
Below RL
Monitoring Point W−829−15
Molybdenum (mg/L)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
SL
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

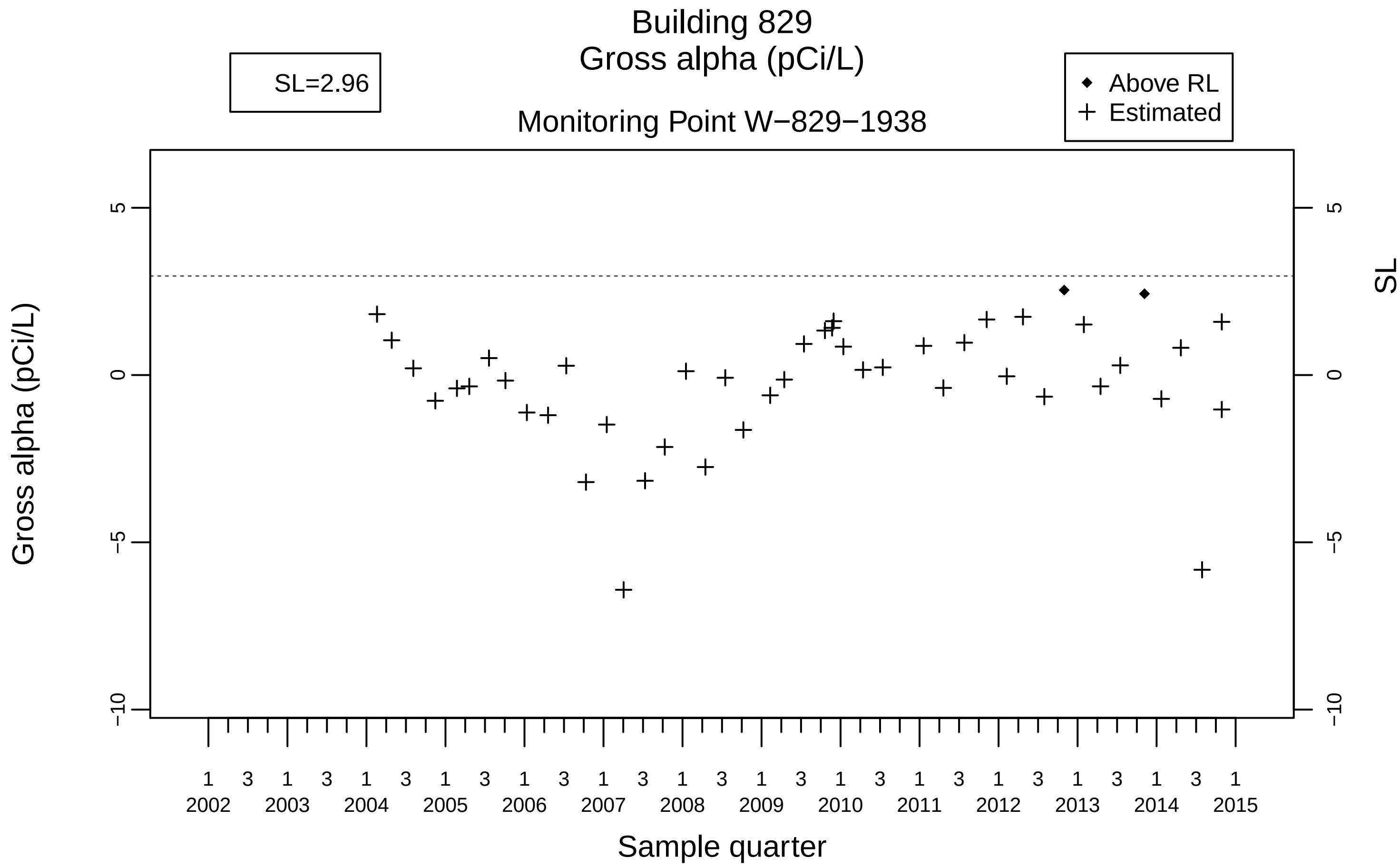

SL=0.032
Monitoring Point W−829−1938
Molybdenum (mg/L)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
SL
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

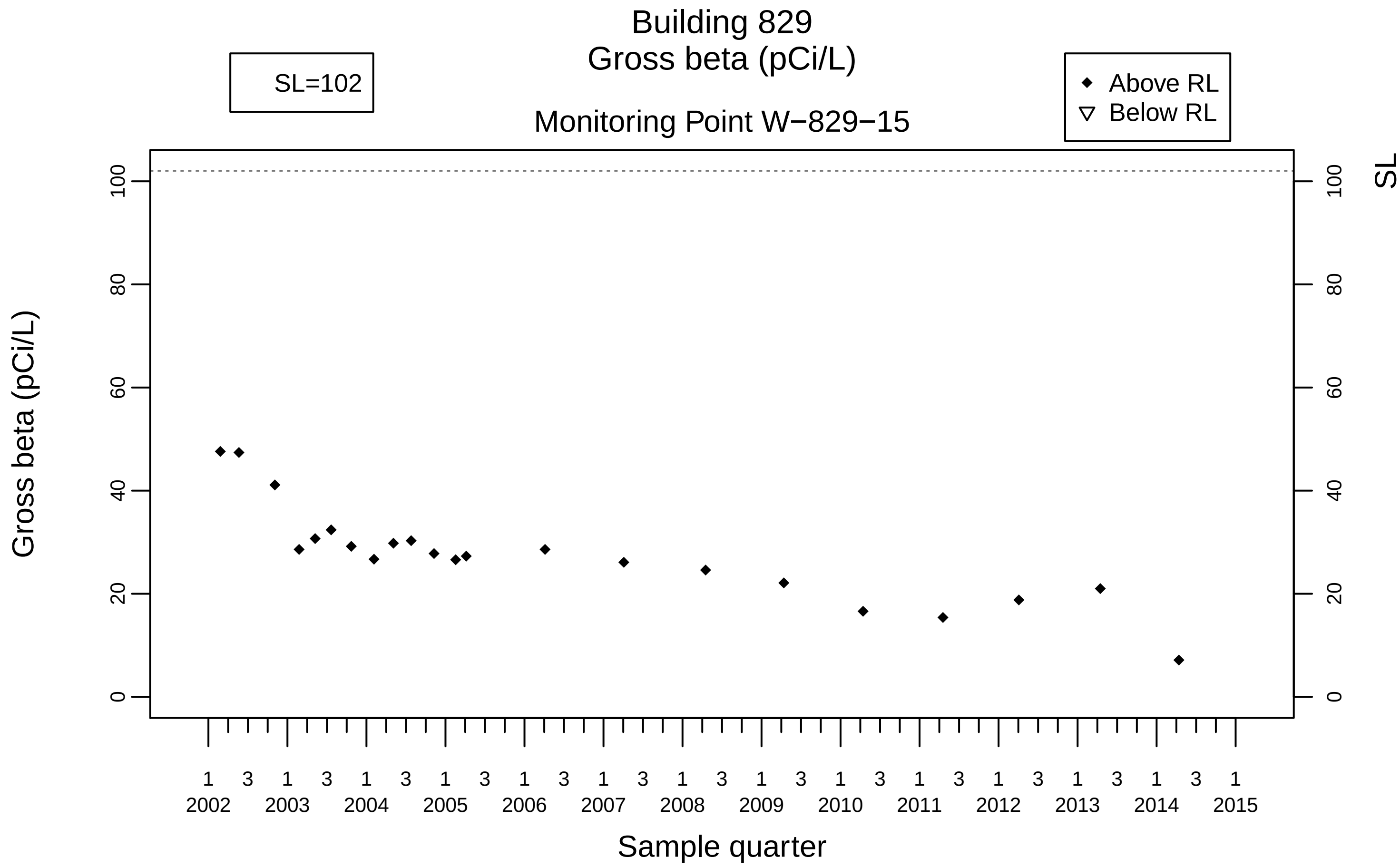

Building 829
Nickel (mg/L)
SL=0.019
Above RL
Below RL
Monitoring Point W−829−1938
SL
Nickel (mg/L)
0.000
0.005
0.010
0.015
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

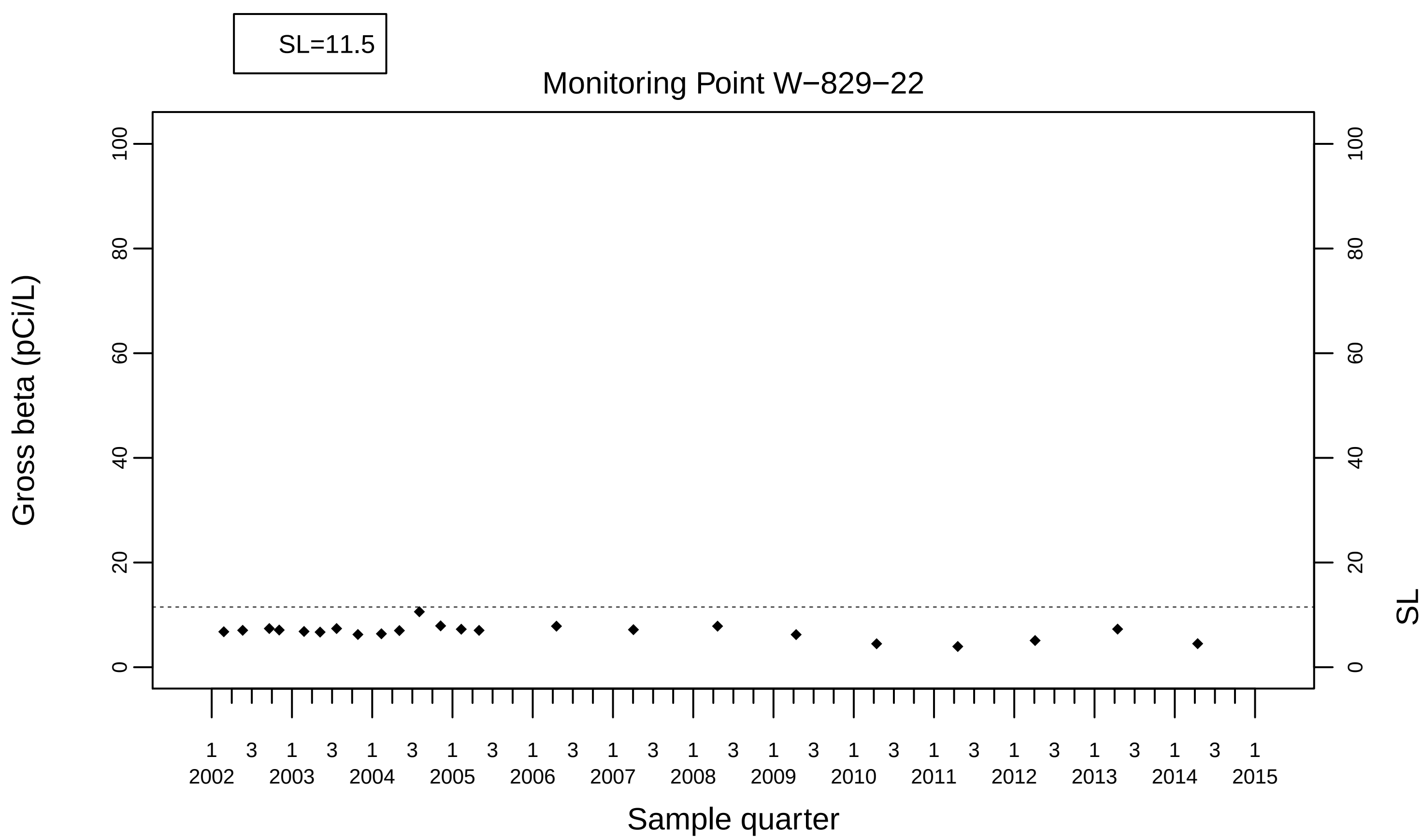

Building 829
Zinc (mg/L)
SL=0.03
Above RL
Below RL
Monitoring Point W−829−1938
Zinc (mg/L)
SL
0.000
0.005
0.010
0.015
0.020
0.025
0.030
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

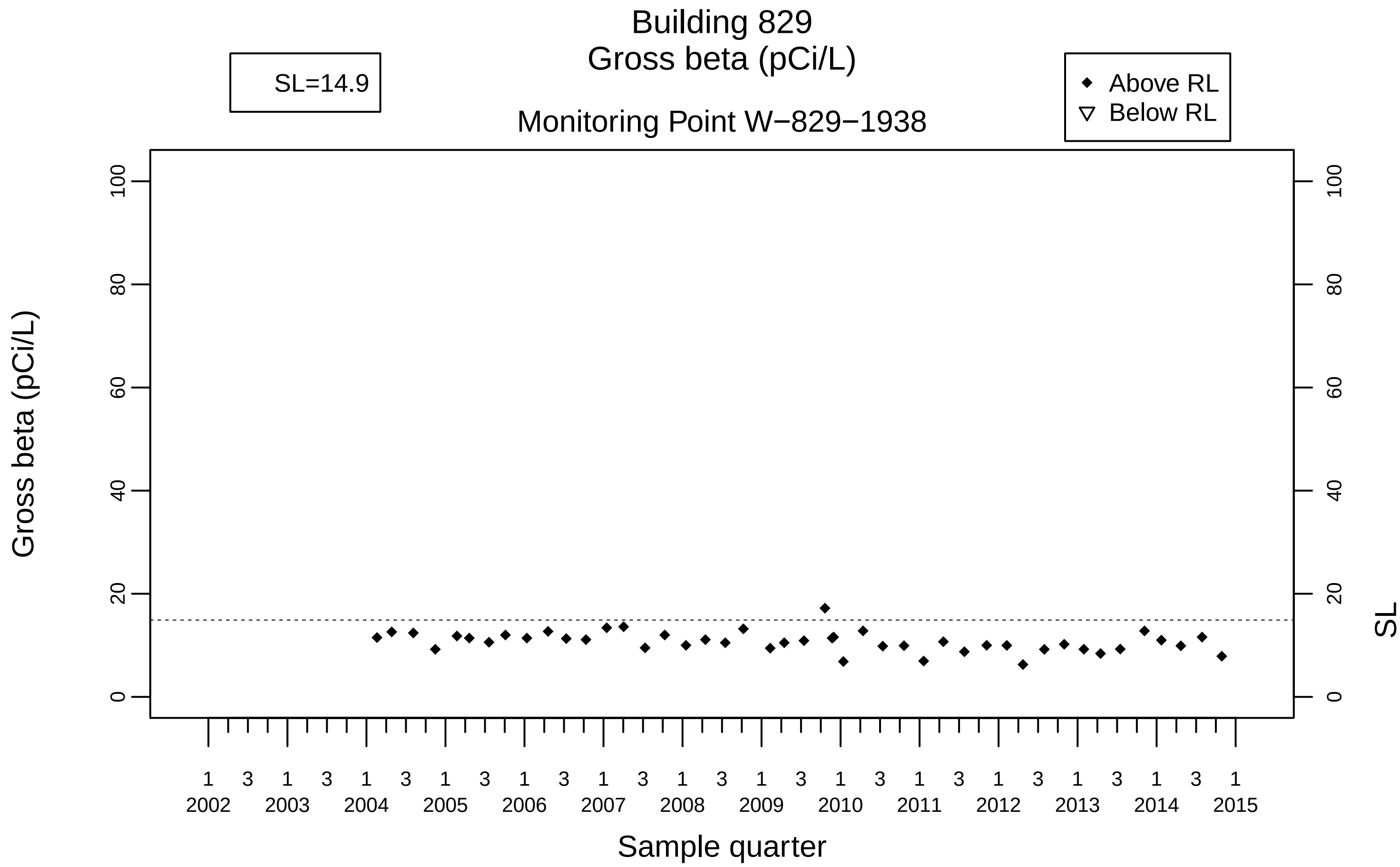

Building 829
Gross alpha (pCi/L)
SL=3.32
Above RL
Estimated
Monitoring Point W−829−15
Gross alpha (pCi/L)
SL
Sample quarter


SL=2
Monitoring Point W−829−22
Gross alpha (pCi/L)
SL
Sample quarter


Building 829
Gross alpha (pCi/L)
SL=2.96
Monitoring Point W−829−1938
Above RL
Estimated
Gross alpha (pCi/L)
SL
5
0
−5
−10
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter


Building 829
Gross beta (pCi/L)
SL=102
Above RL
Below RL
Monitoring Point W−829−15
Gross beta (pCi/L)
SL
0
20
40
60
80
100
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter


SL=11.5
Monitoring Point W−829−22
Gross beta (pCi/L)
SL
0
20
40
60
80
100
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter


Building 829
Gross beta (pCi/L)
SL=14.9
Above RL
Below RL
Monitoring Point W−829−1938
Gross beta (pCi/L)
SL
0
20
40
60
80
100
1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Sample quarter

Appendix B

LLNL Site 300
Building 829 Landfill Cap
Annual Engineering Inspection

Abri Environmental Engineering, Inc.

Environmental Management and Compliance Consultants

LLNL SITE 300 BUILDING 829 LANDFILL CAP ANNUAL ENGINEERING INSPECTION

May 2014

CERTIFICATION

Based on the information reviewed, I certify that this annual inspection and evaluation report fairly describes the condition of the closed Building 829 Landfill.

I certify under penalty of law that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete.

REGISTERED PROFESSIONAL ENGINEER
WILLIAM WEBBER MOORE
C18340
EXP. 6-30-15
CIVIL
STATE OF CALIFORNIA

William W. Moore, P.E.
California Civil Engineer, No. 18,340

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Executive Summary

Abri Environmental Engineering has performed the annual inspection of the Building 829 landfill cap at the Lawrence Livermore National Laboratory (LLNL) Site 300 located near the City of Tracy. Mr. William W. Moore, P.E., conducted this annual inspection on April 8, 2014. Mr. Moore is a California Registered Civil Engineer, with extensive experience in civil engineering, and hazardous waste management.

This report has been prepared consistent with the scope of work, dated February 19, 2014 and in compliance with 22CCR Section 66264.228(K). The report is based on the observations made during the inspection and review of the documents listed in section 1.0.

Building 829 Landfill cap is in good condition. The vegetation cover is thick and covers the soil cap over the pits; there is no visible erosion of the cap; and the drainage system is in good condition and appears to be functioning as intended. The groundwater monitoring system appears to be in good condition as well. Some vegetation growth and vegetative debris were observed in the concrete lined drainage ditch. Recommendations for the observations are made in section 2-14

1.0 Introduction

LLNL Site 300, EPA ID Number CA2890090002, is owned by the U.S. Department of Energy (DOE) and is operated jointly by the Lawrence Livermore National Security, LLC (LLNS) and DOE. The site comprises approximately 7,000 acres of largely undeveloped land and is primarily used as an explosives test facility. Site 300 is located 15 miles southeast of the LLNL Livermore Site, and 6 miles southwest of downtown City of Tracy, California, see Figure 1. About one-sixth of the site is in Alameda County and the balance is in San Joaquin County.

Building 829 landfill area is located in the southeastern side of Site 300, See Figure 2. Building 829 area was used to burn explosives and explosive contaminated wastes at the HE Open Burn Treatment Facility. In 1997 LLNL closed the facility according to a DTSC approved RCRA closure plan. As a result, the area was closed as a landfill with an engineered cap consisting of a minimum of 2 ft compacted general fill, a layer of geosynthetic material and a minimum of 2 ft vegetative soil.

The inspection of the cap included walking the surface and perimeter of the cap. Weather conditions were sunny, temperatures in 70's degree F with winds of about 3-10 miles per hour.

In conjunction with the inspection, the following project files and documents were reviewed:

- Closure Plan for the High-Explosives Open Burn Treatment Facility at Lawrence Livermore National Laboratory, Experimental Test Site 300, dated July 1993,
- Specification PCS-1227, Site 300 Building 829 HE Burn Pits Closure, dated September 1997,
- Annual Pit Survey Data from 2001 to 2013,
- Monthly Post-Closure Inspection Checklists, dated May 22, 2013; June 25, 2013; July 22, 2013; August 28, 2013; September 17, 2013; October 8, 2013; November 26, 2013; December 30, 2013; January 29, 2014; February 5, 2014; March 25, 2014; April 8, 2014.

2.0 Inspection Observations and Recommendations

The inspection of the cap included walking the surface and perimeter of the cap. The following sections describe the condition and recommendations.

The landfill has a 3 ft high retaining wall at the southwest corner of the cap. The wall appears to be in good condition and appears to be performing as intended.

2-1. Condition of Access Control (Fences, Gates and Warning Signs)

LLNL site 300 is a highly secured site with around the clock armed guards and perimeter fence. The entrance to the site is on Corral Hollow Road, which is secured by gates, fences and armed guards. Warning signs in English are posted adjacent to the pit, see Figure 3.

2-2 Condition of Vegetation

The landfill is covered with thick and well-established vegetation, see Figure 4.

2-3 Erosion

There was no erosion visible on the site.

2-4 Cracking

No cracks or other desiccation of the cover was visible during the site visit.

2-5 Disturbance by Adverse Weather

No erosion or other evidence of disturbance/damage due to adverse weather (i.e. freezing and thawing) was observed at the site.

2-6 Seepage

No evidence of seepage or discharge was observed beyond the existing collection structures at the facility.

2-7 Slope Stability

No indication of slope instability was observed. There was no sign of slumping or shallow, localized failure.

2-8 Subsidence

No evidence of subsidence was observed over the pit.

2-9 Settlement

Results of the annual pit survey data from 2001 to 2013 showed maximum settlement of 0.19 feet.

2-10 Condition of Groundwater Monitoring System

No evidence of compromise in structural integrity of the groundwater monitoring wells was observed.

2-11 Condition of Run-On and Run-Off Control Systems

Surface runoff diversion structures consist of a perimeter drainage V-ditch. The V-ditch has expansion joints every 12 ft and every other one is caulked. The remaining expansion joints appear to be saw cuts partially onto the surface of the concrete. The structure also collects water from the "drainage layer" of the cap through a series of drainage pipes. The concrete lining appears to be in good condition. Some vegetation growth, see Figure 5, and vegetative debris, see Figure 6, were observed in the concrete lined drainage ditch. It is recommended that the vegetative debris and growth be removed and the joints sealed.

2-12 Condition of Surveyed Benchmarks

The settlement markers appeared to be in good condition.

2-13 Burrowing Animals

A few shallow small burrowing animal holes, approximately 6 inches in diameter were observed, see figure 7. The animal holes were repaired as they were found.

2-14 List of recommendations for Building 829 Landfill

- Remove vegetative growth and debris. Seal concrete joints.

Figure 1 LLNL Location Map

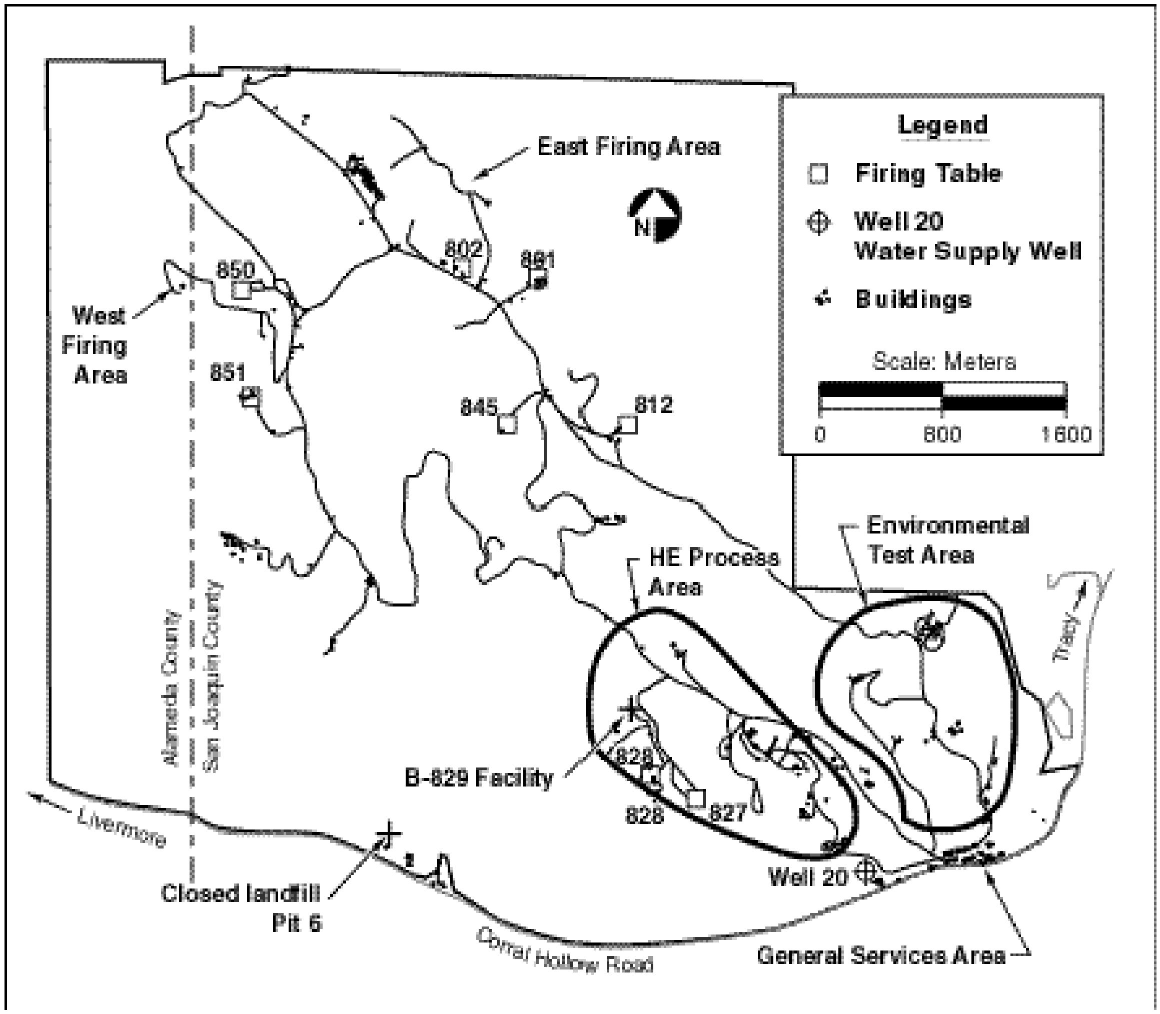

Figure 2 Building 829 Landfill Location Map

Figure 3 Building 829 Landfill Warning Signs

Figure 4 Building 829 Landfill Vegetation Cover Condition

Figure 5 Building 829 Landfill Vegetation Growth in Drainage Ditch

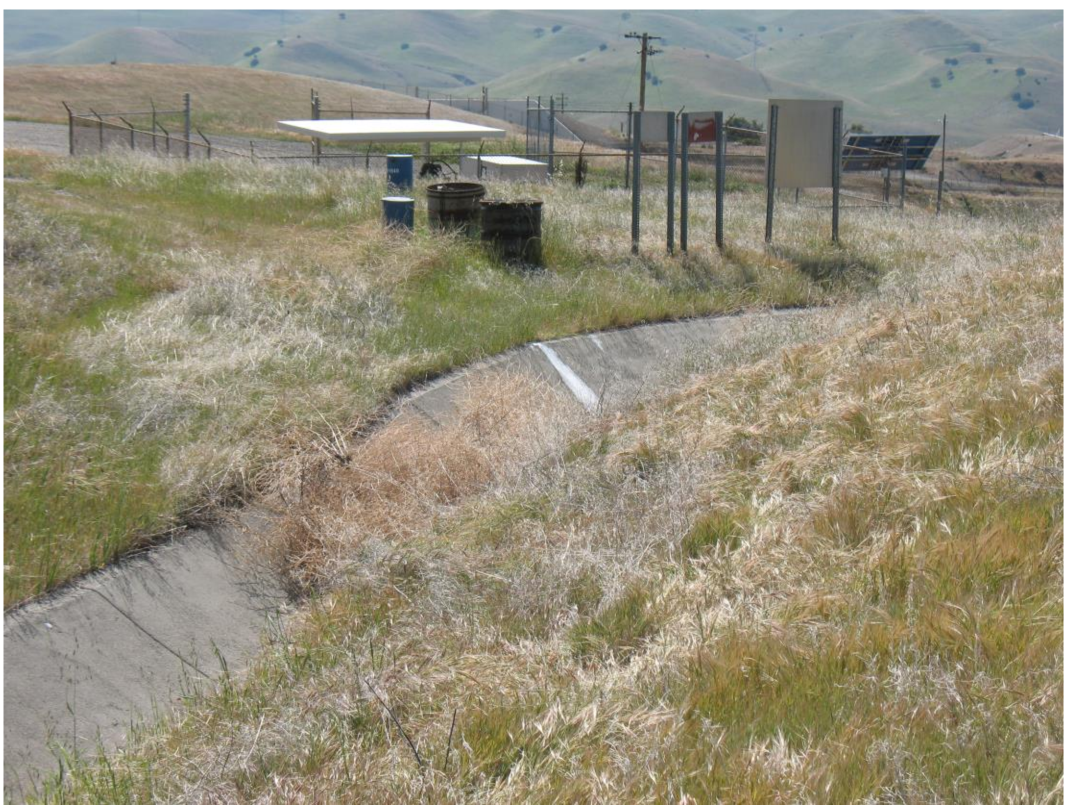

Figure 6 Building 829 Landfill Vegetation Debris in Drainage Ditch

Figure 7 Building 829 Landfill Burrowing Animal Hole

Appendix C

Acronyms and Abbreviations

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CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CL	concentration limit
COC	constituent of concern
CY	calendar year
DOE	Department of Energy
DTSC	Department of Toxic Substances Control
EPA	Environmental Protection Agency
GWE	groundwater elevation
HE	high explosives
LLC	Limited Liability Corporation
LLNL	Lawrence Livermore National Laboratory
LLNS	Lawrence Livermore National Security, LLC
PE	Professional Engineer
POC	point of compliance
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
SL	statistically determined limit of concentration
TCE	trichloroethene
VOC	volatile organic compound

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