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**Environmental Protection Department**
**Operations and Regulatory Affairs Division**

# Lawrence Livermore National Laboratory Site 300

## Compliance Monitoring Program for the Closed Building 829 Facility

## Annual Report 2003

**Michael A. Revelli**

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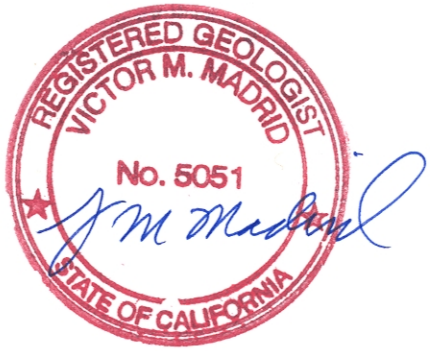


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## 1.1 Description of Site 300

The Lawrence Livermore National Laboratory (LLNL) Site 300 (Site 300) is owned by the U.S. Department of Energy (DOE) and is operated by the University of California as an experimental test site. Site 300 is located in the southern Altamont Hills of the Diablo Range, which is part of the Coast Range Physiographic Province. It is situated about 13 miles (mi) east of the city of Livermore, where the main site of LLNL is located (**Figure 1**).The site covers an area of approximately 11 $mi^2$ north of Corral Hollow Road (**Figure 2**). Elevation ranges from about 500 ft in the southeast corner to about 1750 ft in the northwest area. The western one-sixth of the site lies in Alameda County; the remaining portion is situated 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) Process Area Operable Unit 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 rain water that may cause the low concentrations of explosive compounds and volatile organic compounds (VOCs) in near-surface soils to migrate to groundwater. The design of the post-closure plan is 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). The DTSC issued the *Hazardous Waste Facility Post-Closure Permit for the B829 Facility* (DTSC 2003) on February 20, 2003. This permit, effective April 3, 2003 through April 2, 2013, necessitated changes to three key areas of the monitoring and inspection activities described in the *B-829 Final Closure Plan* (Mathews and Taffet 1997).

- First, the permit directed LLNL to install one additional groundwater monitoring well within ten feet of the boundary of the capped area. This new well (W-829-1938) and two existing wells (W-829-15 and W-829-22) constitute the groundwater monitoring locations (**Figure 3**) required by the permit.

- Second, the permit required slight modifications to the sampling plan and subsequent reporting requirements for the three wells. Perchlorate was added as a constituent of concern (COC). Both the cis- and trans-isomers of 1,2-dichloroethene (DCE) were included in the COC list, as well as total DCE. Groundwater elevations, measured at the time of sampling, shall be reported.

- Third, the permit specified that visual inspection of the covered area (previously performed quarterly) be conducted, at a minimum, on a monthly basis.

As discussed below, these required changes were implemented beginning in the second quarter of 2003.

## 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. In the regional aquifer, the flow rate is estimated to be 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 at the point of compliance (POC) within ten feet of the edge of the capped High Explosive Open Burn Treatment Facility. This well was screened in the regional aquifer, the uppermost aquifer beneath the B-829 Facility. The *B829 Well Installation As-Built Diagram* (LLNL 2003) for well W-29-1938 was submitted to DTSC in November 2003. Well W-829-1938 has since been equipped with a pump and will be sampled as part of the permit-specified groundwater monitoring network (**Figure 3**), beginning in the first quarter of 2004. Also shown in **Figure 3** are two previously existing wells (W-829-15 and W-829-22), which were used throughout 2003 for quarterly collection of groundwater samples from the regional aquifer. Two other deep wells (W-827-04 and W-827-05), which had been sampled under the *B-829 Final Closure Plan* (Mathews and Taffet 1997), were removed from the groundwater monitoring network specified in the permit; hence, these wells were sampled only during the first quarter of 2003. The most recently obtained data are discussed in **Section 3.1.**

Two shallow wells (W-829-06 and W-829-08), which had been sampled under the *B-829 Final Closure Plan* (Mathews and Taffet 1997), were also removed from the groundwater monitoring network specified in the permit (DTSC 2003). Beginning in the second quarter of 2003, LLNL's CERCLA Compliance Monitoring Program (CMP) took responsibility for sampling these two wells, screened in a perched water-bearing zone above the regional aquifer. Although these wells are no longer part of the permit's groundwater monitoring network, the analytical data collected during 2003 are appended to this report for completeness (**Appendix A**).

LLNL uses statistical methods consistent with the state regulations [California Code of 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 (COC). Additionally, statistically determined limits of concentration (SLs) for the COCs have been calculated from the monitoring data.

During CY 2000, LLNL developed a preliminary set of CLs and SLs for the specified COCs [See **Table 7.2** in LLNL (2000) and **Table 1** in DTSC (2003)]. These limits have been reviewed annually and revised to reflect the accumulating data. The CL and SL values for monitoring wells W-829-15 and W-829-22 (**Table 1**) are now based on five years of data, collected 1999 through 2003. They remain unchanged from the values developed and reported by LLNL last year (Revelli 2003) and reviewed by DTSC (DTSC 2004). The SLs for most of the COCs are given as the analytical reporting limits (RLs), because the measurements are below the detection limits for those constituents. Preliminary CLs and SLs for the recently installed well, W-829-1938, will be developed for each COC based on the quarterly sampling data collected during CY 2004. The CL and SL values for well W-829-1938, currently identified in **Table 1** as "to be determined" (TBD), will be documented in the annual report for 2004.

Updated SLs provide the basis for comparison with next year's quarterly COC measurements to identify potential releases to the deep regional aquifer. If a future measurement exceeds an SL, then we 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 COC to groundwater."

## 2.2 Inspection and Maintenance

As described in Section 2.3 of the *B-829 Final Closure Plan* (Mathews and Taffet 1997), LLNL performed a detailed visual inspection of the final cover cap, drainage and diversion ditches, groundwater monitoring system, signage, etc., of the closed B-829 Facility during the first quarter of 2003. Under the permit (DTSC 2003), effective April 2003, these visual inspections of the covered area are required on a monthly basis, and after each major storm and significant earthquake. 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 the Year 2003

## 3.1 Discussion of Monitoring Results

CY 2003 analytical results for the well locations W-829-15 and W-829-22 are listed in **Tables 2 and 3**, respectively. These wells were sampled in all four quarters of 2003. Wells W-827-04 and W-827-05 were sampled only in the first quarter of 2003, prior to implementation of the permit. As in past years, monitoring well W-827-04, screened above the present elevation of the water table in the deep regional aquifer, remained dry. CY 2003, first-quarter analytical results for well location W-827-05 are listed in **Table 4**. Note that all non-detections of constituents are shown in the data tables as being less than (<) the analytical reporting limit. **APPENDIX B** presents graphical depictions of groundwater elevations and concentration trends for all confirmed COC detections above their respective RLs, for the permit-specified wells (W-829-15 and W-829-22). The graphs present data accumulated over the last five years, going back to 1999, the first year of monitoring under the *B-829 Final Closure Plan* (Mathews and Taffet 1997).

During CY 2003, no organic or explosive COCs were detected above their respective RLs in groundwater samples from the deep monitoring wells (**Tables 2 and 3**). Similarly, first-quarter sampling at well W-827-05 (**Table 4**) did not detect any evidence of these COCs.

The inorganic constituents that were detected during 2003 (**Tables 2 and 3**) show concentrations that do not differ significantly from background concentrations (the CLs shown in **Table 1**) for the deep aquifer beneath the HE Process Area (Webster-Scholten 1994). Selenium, found at background concentrations of <0.001 to 0.033 mg/L in Site 300 groundwater (Webster-Scholten 1994), was detected at a concentration slightly above its statistical limit. This detection, identified in first-quarter samples, occurred at wells W-829-05 and W-827-22. Analytical details are summarized below.

In the first-quarter samples, selenium was detected in well W-829-22 (**Table 3**) at a concentration of 2.2 µg/L (SL = RL = 2 µg/L). Because these analytical results were not received until April 2003, it was not possible to collect two independent resamples during the first quarter. A recheck of the original sample, collected from well W-829-22 during the first quarter, showed selenium at 3 µg/L; chromium (SL = 1.5 µg/L), initially reported at 1.4 µg/L, showed a recheck value of 2 µg/L. Subsequently, neither selenium nor chromium was detected above their analytical reporting limits in the second-, third-, or fourth-quarter groundwater samples from well W-829-22. These subsequent nondetections are equivalent to discrete retest results, and they do not confirm the first-quarter detection of selenium or chromium in well W-829-22. Well W-827-05 (**Table 4**)

also showed a selenium concentration (3.2 µg/L), above the analytical reporting limit in the first quarter of 2003. In this case, however, confirmation samples were not collected, because under the permit (effective April 2003) well W-827-05 was no longer a defined monitoring location for the B-829 Facility.

As shown in **Table 2,** the contract laboratory reported fluoride as a non-detection (<0.05 mg/L) in the fourth-quarter sample from well W-829-15. The fourth-quarter quality control (QC) sample (also taken from this location), however, showed a fluoride concentration of 0.38 mg/L. Furthermore, fluoride has been detected at W-829-15 (0.22 mg/L to 0.57 mg/L) in each quarter since the post-closure monitoring program began in 1999. For these reasons, we believe the QC sample result (fluoride = 0.38 mg/L) best represents the fourth-quarter concentration of this state-specified water quality parameter in well W-829-15.

TOX was reported by the contract analytical laboratory to be above the analytical reporting limit (20 µg/L) in only the first-quarter groundwater samples from the wells W-829-15 (180 mg/L) (**Table 2**) and W-829-22 (130 mg/L) (**Table 3**). Although not a specified COC, TOX is included in the list of state-specified water quality parameters (Mathews and Taffet 1997). We suspect that these TOX detections in wells W-829-15 and W-829-22 are analytical artifacts for two reasons. First, TOX was reported below the RL in the three subsequent quarters. Second, unlike results for another Site 300 monitored area where TOX detections are accompanied by equivalent detections of specific organic halides (typically Freon 113), none of the VOC analyses for the deep water beneath the closed B-829 Facility have detected any specific organic halide COC above analytical reporting limits since post-closure monitoring began in 1999.

During 2003, as in past years, total organic carbon (TOC) was detected above its RL. (TOC is another analyte included in the list of state-specified water quality parameters, but not a specified COC.) TOC was reported by the contract analytical laboratory to be slightly above the reporting limit of 1 mg/L in the groundwater monitored at both deep monitoring wells (W-829-15 and W-829-22) during 2003. The maximum concentration measured was 2.0 mg/L in a fourth-quarter groundwater sample from well W-829-22 (**Table 3**). A TOC concentration of 1.5 mg/L was also measured in well W-827-05 (**Table 4**) during the first quarter of 2003. We believe that these reported TOC concentrations, near the RL and consistent with results from the past four years, are related to natural sources primarily because we have no statistical evidence of any carbon-based COCs above their RLs, which are typically measured three orders of magnitude more sensitive than the TOC RL.

## 3.2 Inspection of the B-829 Facility

During CY 2003, LLNL staff completed nine post-closure inspections of the covered area at the B-829 Facility. The first-quarter inspection occurred in February, and eight monthly inspections (April through December) were conducted following implementation of the permit. The inspection checklist form, used during these LLNL inspections, is provided in **Figure 4.** In addition, beginning with the May 2003 (second-quarter) sampling event, the checklist form shown in **Figure 5** was used to document the monitoring well inspections, completed during quarterly sampling. All completed forms are retained for three years by the LLNL Environmental and Special Projects Manager at Site 300. Finally, the required annual cap inspection by a California-registered Professional Engineer was completed during the third-quarter (see below).

On September 25, 2003, the B-829 cap was inspected by a California-registered Professional Engineer. (A copy of the *Annual Engineering Inspection of Site 300, 829 Cap*, prepared by Chow Engineering, Inc., and dated October 24, 2003, is included in this report as **Appendix C**.) The inspection included a review of existing documentation on the cap as well as an on-site inspection. 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 also contains three recommendations, which have been addressed by the Site 300 Manager's Office.

## 4.0 References

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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 deep 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 | TBD | TBD[c] |
| Arsenic | 2 | µg/L | 17 | 22 | <2.9 | 2.9 | TBD | TBD |
| Barium | 25 | µg/L | 26 | 75 | <RL | RL | TBD | TBD |
| Beryllium | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Cadmium | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Chromium | 1 | µg/L | 2.2 | 7.8 | 0.9 | 1.5 | TBD | TBD |
| Cobalt | 25 | µg/l | <RL | RL | <RL | RL | TBD | TBD |
| Copper | 10 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Lead | 2 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Manganese | 10 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Mercury | 0.2 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Molybdenum | 25 | µg/L | 24 | 27 | <RL | RL | TBD | TBD |
| Nickel | 5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Selenium | 2 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Silver | 1 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Vanadium | 25 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Zinc | 20 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Perchlorate | 4 | µg/L | <RL | RL | <RL | RL | TBD | TBD |

(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 deep 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 | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| 1,1-Dichloroethene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| 1,2-Dichloroethane | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| cis-1,2-Dichloroethene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| trans-1,2-Dichloroethene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| 1,2-Dichloroethene (total) | 1 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Benzene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Carbon disulfide | 5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Chloroform | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Dichlorodifluoromethane | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Ethylbenzene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Freon 113 | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Tetrachloroethene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Toluene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Total xylene isomers | 1 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Trichloroethene | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Trichlorofluoromethane | 0.5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Bis (2-ethylhexyl) phthalate | 5 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Phenols | 2 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| HMX | 5.0 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| RDX | 5.0 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| TNT | 5.0 | µg/L | <RL | RL | <RL | RL | TBD | TBD |
| Gross alpha | 0.074 | Bq/L | 0 | 0.123 | 0 | RL | TBD | TBD |
| Gross beta | 0.11 | Bq/L | 1.81 | 3.77 | 0.27 | 0.43 | TBD | TBD |

[a] CL is defined as the average background concentration of a COC.

[b] SL is defined as the concentration of a COC, above which an exceedance occurs.

[c] TBD indicates the value is "To Be Determined."

**Table 2. B-829 area deep well W-829-15, monitoring results for year 2003.**
(Constituent detections, in bold, are discussed in the text.)

| Constituents | A[a] | B[b] | Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|
| | | | 24-Feb | 9-May | 29-Jul | 23-Oct |
| **General (units)** | | | | | | |
| Groundwater elevation (feet) | | | 697 | 696 | 697 | 696 |
| pH (pH Units) | | X | 8.78 | 9.01 | 8.57 | 8.82 |
| Specific conductance (µmho/cm) | | X | 1123 | 1025 | 1060 | 1080 |
| **Inorganic (µg/L)** | | | | | | |
| Antimony | X | | < 5 | < 5 | < 5 | < 5 |
| Arsenic | X | X | 17 | 15 | 18 | 16 |
| Barium | X | X | 35 | 36 | 40 | 42 |
| Beryllium | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | X | X | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | X | X | < 1 | < 1 | < 1 | < 1 |
| Cobalt | X | | < 25 | < 25 | < 25 | < 25 |
| Copper | X | | < 10 | < 10 | < 10 | < 10 |
| Iron | | X | < 50 | < 50 | < 50 | < 50 |
| Lead | X | X | < 2 | < 2 | < 2 | < 2 |
| Manganese | X | X | < 10 | < 10 | < 10 | < 10 |
| Mercury | X | X | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | X | | < 25 | < 25 | < 25 | < 25 |
| Nickel | X | | < 5 | < 5 | < 5 | < 5 |
| Selenium | X | X | < 2 | < 2 | < 2 | < 2 |
| Silver | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Vanadium | X | | < 25 | < 25 | < 25 | < 25 |
| Zinc | X | | < 20 | < 20 | < 20 | < 20 |
| Perchlorate | X | | < 3 | < 4 | < 4 | < 4 |
| Chloride (mg/L) | | X | 89 | 88 | 87 | 88 |
| Fluoride (mg/L) | | X | 0.28 | 0.26 | 0.26 | **< 0.05** |
| Nitrate (as $NO_3$) (mg/L) | | X | < 0.4 | < 0.4 | 1.8 | 0.53 |
| Sodium (mg/L) | | X | 180 | 190 | 190 | 170 |
| Sulfate (mg/L) | | X | 183 | 182 | 184 | 182 |
| Turbidity (NT Units) | | X | 0.16 | 0.34 | 0.26 | 0.14 |
| **Organic (µg/L)** | | | | | | |
| 1,1,1-Trichloroethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1-Dichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| cis-1,2-Dichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| trans-1,2-Dichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethene (total) | X | | < 1 | < 1 | < 1 | < 1 |
| Benzene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Carbon disulfide | X | | < 1 | < 1 | < 1 | < 1 |
| Chloroform | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dichlorodifluoromethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

(continued)

**Table 2. B-829 area deep well W-829-15, monitoring results for year 2003 (concluded).**
(Constituent detections, in bold, are discussed in the text.)

| Constituents | A[a] | B[b] | Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|
| | | | 24-Feb | 9-May | 29-Jul | 23-Oct |
| Ethylbenzene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Freon 113 | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tetrachloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Toluene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Total xylene isomers | X | | < 1 | < 1 | < 1 | < 1 |
| Trichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Trichlorofluoromethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| BHC, gamma isomer (Lindane) | | X | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Bis(2-ethylhexyl)phthalate | X | | < 5 | < 5 | < 5 | < 5 |
| Endrin | | X | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Phenol | X | X | < 2 | < 2 | < 2 | < 2 |
| Total organic halides (TOX) | | X | **180** | < 20 | < 20 | < 20 |
| Total organic carbon (TOC)(mg/L) | | X | **1.9** | **1.1** | **1.7** | **1.4** |
| Total coliform (MPN/100 mL) | | X | < 2 | < 2 | < 2 | < 2 |
| Methoxychlor | | X | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Toxaphene | | X | < 2 | < 2 | < 2 | < 2 |
| 2,4-D | | X | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| 2,4,5 TP (Silvex) | | X | < 0.07 | < 0.07 | < 0.07 | < 0.07 |
| **Explosive (µg/L)** | | | | | | |
| HMX | X | | < 5 | < 5 | < 5 | < 5 |
| RDX | X | | < 5 | < 5 | < 5 | < 5 |
| TNT | X | | < 5 | < 5 | < 5 | < 5 |
| **Radioactive (Bq/L)[c]** | | | | | | |
| Gross alpha | X | X | -0.01 ± 0.04 | 0.01 ± 0.04 | 0.001 ± 0.06 | -0.042 ± 0.044 |
| Gross beta | X | X | 1.06 ± 0.17 | 1.14 ± 0.19 | 1.2 ± 0.2 | 1.08 ± 0.18 |
| Radium 226 | | X | 0.004 ± 0.003 | 0.005 ± 0.003 | 0.006 ± 0.003 | 0.004 ± 0.003 |

[a] Column A denotes permit-specified constituents of concern (COCs) for the deep regional aquifer (DTSC 2003).

[b] Column B denotes California state-specified background water quality parameters [22 CCR 66265.97(e) (16)].

[c] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2-sigma 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 2003.**
(Constituent detections, in bold, are discussed in the text.)

| Constituents | A[a] | B[b] | Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|
| | | | 25-Feb | 9-May | 28-Jul | 28-Oct |
| **General (units)** | | | | | | |
| Groundwater elevation (feet) | | | 654 | 653 | 653 | 653 |
| pH (pH units) | | X | 8.49 | 8.47 | 8.44 | 8.48 |
| Specific conductance (µmho/cm) | | X | 1068 | 1038 | 1099 | 1046 |
| **Inorganic (µg/L)** | | | | | | |
| Antimony | X | | < 5 | < 5 | < 5 | < 5 |
| Arsenic | X | X | 2.1 | < 2 | < 2 | < 2 |
| Barium | X | X | < 25 | < 25 | < 25 | < 25 |
| Beryllium | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | X | X | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | X | X | 1.4 | < 1 | < 1 | < 1 |
| Cobalt | X | | < 25 | < 25 | < 25 | < 25 |
| Copper | X | | < 10 | < 10 | < 10 | < 10 |
| Iron | | X | < 50 | < 50 | < 50 | < 50 |
| Lead | X | X | < 2 | < 2 | < 2 | < 2 |
| Manganese | X | X | < 10 | < 10 | < 10 | < 10 |
| Mercury | X | X | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | X | | < 25 | < 25 | < 25 | < 25 |
| Nickel | X | | < 5 | < 5 | < 5 | < 5 |
| Selenium | X | X | **2.2** | < 2 | < 2 | < 2 |
| Silver | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Vanadium | X | | < 25 | < 25 | < 25 | < 25 |
| Zinc | X | | < 20 | < 20 | < 20 | < 20 |
| Perchlorate | X | | < 3 | < 4 | < 4 | < 4 |
| Chloride (mg/L) | | X | 102 | 100 | 107 | 100 |
| Fluoride (mg/L) | | X | 0.42 | 0.43 | 0.38 | 0.49 |
| Nitrate (as $NO_3$) (mg/L) | | X | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| Sodium (mg/L) | | X | 240 | 210 | 230 | 210 |
| Sulfate (mg/L) | | X | 179 | 159 | 184 | 155 |
| Turbidity (NT Units) | | X | < 0.1 | 0.18 | 2.1 | 0.30 |
| **Organic (µg/L)** | | | | | | |
| 1,1,1-Trichloroethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1-Dichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| cis-1,2-Dichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| trans-1,2-Dichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethene (total) | X | | < 1 | < 1 | < 1 | < 1 |
| Benzene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Carbon disulfide | X | | < 1 | < 1 | < 1 | < 1 |
| Chloroform | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dichlorodifluoromethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

(continued)

**Table 3. B-829 area deep well W-829-22, monitoring results for year 2003 (concluded).**
(Constituent detections, in bold, are discussed in the text.)

| Constituents | A[a] | B[b] | Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|
| | | | 25-Feb | 9-May | 28-Jul | 28-Oct |
| Ethylbenzene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Freon 113 | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tetrachloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Toluene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Total xylene isomers | X | | < 1 | < 1 | < 1 | < 1 |
| Trichloroethene | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Trichlorofluoromethane | X | | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| BHC, gamma isomer (Lindane) | | X | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Bis(2-ethylhexyl)phthalate | X | | < 5 | < 5 | < 5 | < 5 |
| Endrin | | X | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Phenol | X | X | < 2 | < 2 | < 2 | < 2 |
| Total organic halides (TOX) | | X | **130** | < 20 | < 20 | < 20 |
| Total organic carbon (TOC)(mg/L) | | X | < 1 | < 1 | < 1 | **2.0** |
| Total coliform (MPN/100 mL) | | X | < 2 | < 2 | < 2 | < 2 |
| Methoxychlor | | X | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Toxaphene | | X | < 2 | < 2 | < 2 | < 2 |
| 2,4-D | | X | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| 2,4,5 TP (Silvex) | | X | < 0.07 | < 0.07 | < 0.07 | < 0.07 |
| **Explosive (µg/L)** | | | | | | |
| HMX | X | | < 5 | < 5 | < 5 | < 5 |
| RDX | X | | < 5 | < 5 | < 5 | < 5 |
| TNT | X | | < 5 | < 5 | < 5 | < 5 |
| **Radioactive (Bq/L)[c]** | | | | | | |
| Gross alpha | X | X | -0.011 ± 0.04 | -0.004 ± 0.048 | 0.004 ± 0.04 | -0.038 ± 0.04 |
| Gross beta | X | X | 0.25 ± 0.06 | 0.25 ± 0.06 | 0.27 ± 0.06 | 0.23 ± 0.1 |
| Radium 226 | | X | 0.002 ± 0.002 | 0.003 ± 0.003 | -0.003 ± 0.003 | 0.005 ± 0.003 |

[a] Column A denotes permit-specified constituents of concern (COCs) for the deep regional aquifer (DTSC 2003).

[b] Column B denotes California state-specified background water quality parameters [22 CCR 66265.97(e) (16)].

[c] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2-sigma 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. Deep well W-827-05, first quarter monitoring results for year 2003.**
(Constituent detections, in bold, are discussed in the text.)

| Constituents | A[a] | B[b] | Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|
| | | | 21-Feb | *N/A* [c] | *N/A* [c] | *N/A* [c] |
| **General (units)** | | | | | | |
| Groundwater elevation (feet) | | | 651 | | | |
| pH (pH units) | | X | 7.63 | | | |
| Specific conductance (µmho/cm) | | X | 1891 | | | |
| **Inorganic (µg/L)** | | | | | | |
| Antimony | X | | < 5 | | | |
| Arsenic | X | X | 2.7 | | | |
| Barium | X | X | < 25 | | | |
| Beryllium | X | | < 0.5 | | | |
| Cadmium | X | X | < 0.5 | | | |
| Chromium | X | X | < 1 | | | |
| Cobalt | X | | < 25 | | | |
| Copper | X | | < 10 | | | |
| Iron | | X | < 50 | | | |
| Lead | X | X | < 2 | | | |
| Manganese | X | X | 100 | | | |
| Mercury | X | X | < 0.2 | | | |
| Molybdenum | X | | 28 | | | |
| Nickel | X | | < 5 | | | |
| Selenium | X | X | **3.2** | | | |
| Silver | X | | < 0.5 | | | |
| Vanadium | X | | < 25 | | | |
| Zinc | X | | < 20 | | | |
| Chloride (mg/L) | | X | 150 | | | |
| Fluoride (mg/L) | | X | 0.26 | | | |
| Nitrate (as $NO_3$) (mg/L) | | X | 1.1 | | | |
| Sodium (mg/L) | | X | 270 | | | |
| Sulfate (mg/L) | | X | 550 | | | |
| turbidity (NT Units) | | X | 0.4 | | | |
| **Organic (µg/L)** | | | | | | |
| 1,1,1-Trichloroethane | X | | < 0.5 | | | |
| 1,1-Dichloroethene | X | | < 0.5 | | | |
| 1,2-Dichloroethane | X | | < 0.5 | | | |
| 1,2-Dichloroethene (total) | X | | < 1 | | | |
| Benzene | X | | < 0.5 | | | |
| Carbon disulfide | X | | < 1 | | | |
| Chloroform | X | | < 0.5 | | | |
| Dichlorodifluoromethane | X | | < 0.5 | | | |

(continued)

**Table 4. Deep well W-827-05, first quarter monitoring results for year 2003 (concluded).**
(Constituent detections, in bold, are discussed in the text.)

| Constituents | A[a] | B[b] | Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|
| | | | 21-Feb | *N/A* [c] | *N/A* [c] | *N/A* [c] |
| Ethylbenzene | X | | < 0.5 | | | |
| Freon 113 | X | | < 0.5 | | | |
| Tetrachloroethene | X | | < 0.5 | | | |
| Toluene | X | | < 0.5 | | | |
| Total xylene isomers | X | | < 1 | | | |
| Trichloroethene | X | | < 0.5 | | | |
| Trichlorofluoromethane | X | | < 0.5 | | | |
| BHC, gamma isomer (Lindane) | | X | < 0.005 | | | |
| Bis(2-ethylhexyl)phthalate | X | | < 5 | | | |
| Endrin | | X | < 0.005 | | | |
| Phenol | X | X | < 2 | | | |
| Total organic halides (TOX) | | X | < 20 | | | |
| Total organic carbon (TOC) (mg/L) | | X | **1.5** | | | |
| Total coliform (MPN/100 mL) | | X | < 2 | | | |
| Methoxychlor | | X | < 0.01 | | | |
| Toxaphene | | X | < 2 | | | |
| 2,4-D | | X | < 0.4 | | | |
| 2,4,5 TP (Silvex) | | X | < 0.07 | | | |
| **Explosive (µg/L)** | | | | | | |
| HMX | X | | < 5 | | | |
| RDX | X | | < 5 | | | |
| TNT | X | | < 5 | | | |
| **Radioactive (Bq/L)**[d] | | | | | | |
| Gross alpha | X | X | 0.02 ± 0.07 | | | |
| Gross beta | X | X | 0.74 ± 0.15 | | | |
| Radium 226 | | X | 0.002 ± 0.002 | | | |

[a] Column A denotes LLNL-specified constituents of concern (COCs) for the deep regional aquifer (Mathews and Taffet 1997).

[b] Column B denotes California state-specified background water quality parameters [22 CCR 66265.97(e) (16)].

[c] Effective April 3, 2003, well W-827-05 was no longer a defined monitoring location for the B-829 Facility.

[d] Radioactivity results in Becquerels/liter (Bq/L) are shown as the reported sample radioactivity and associated 2-sigma 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.

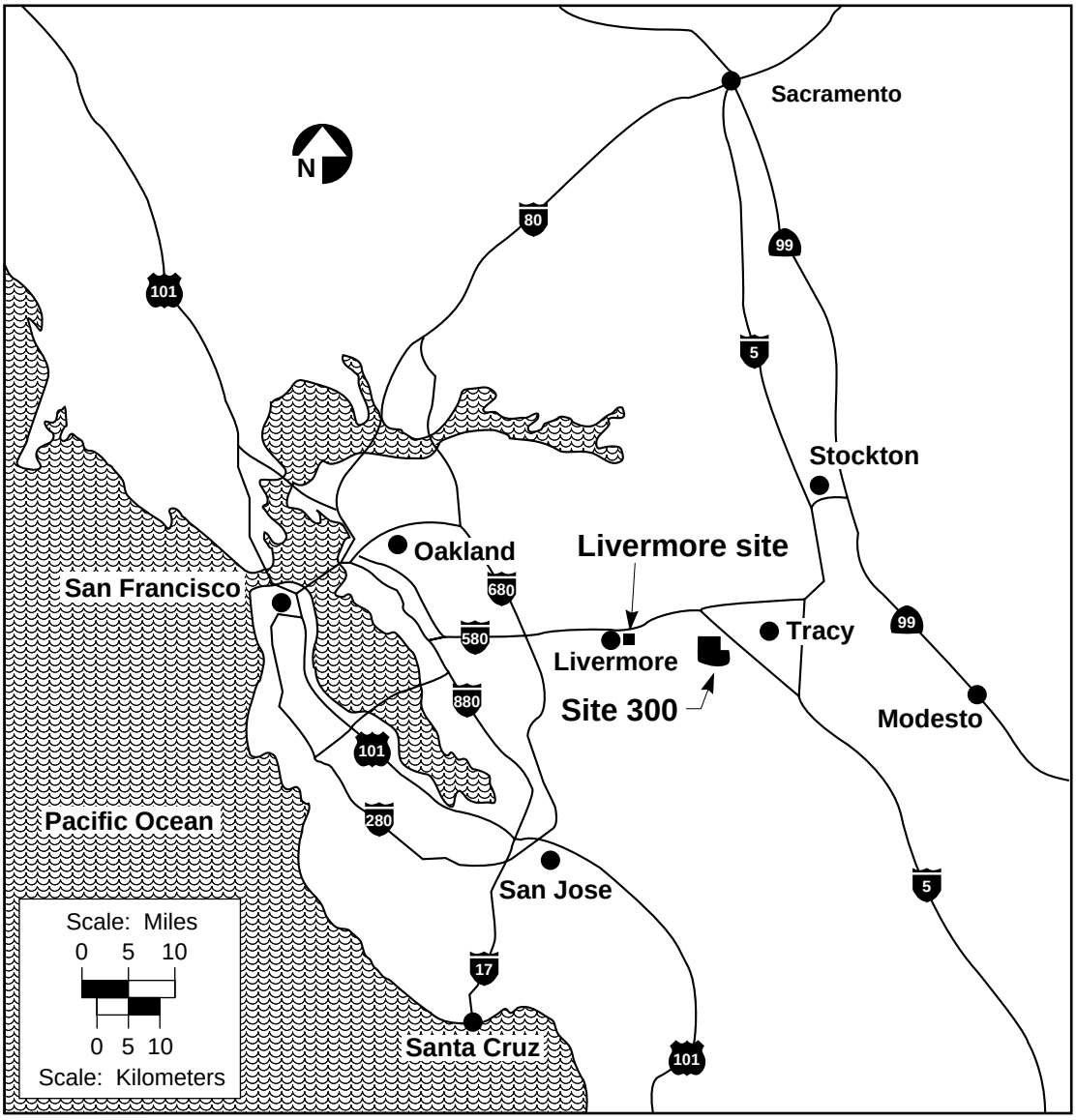



**Figure 1.** Locations of LLNL Livermore site and Site 300.

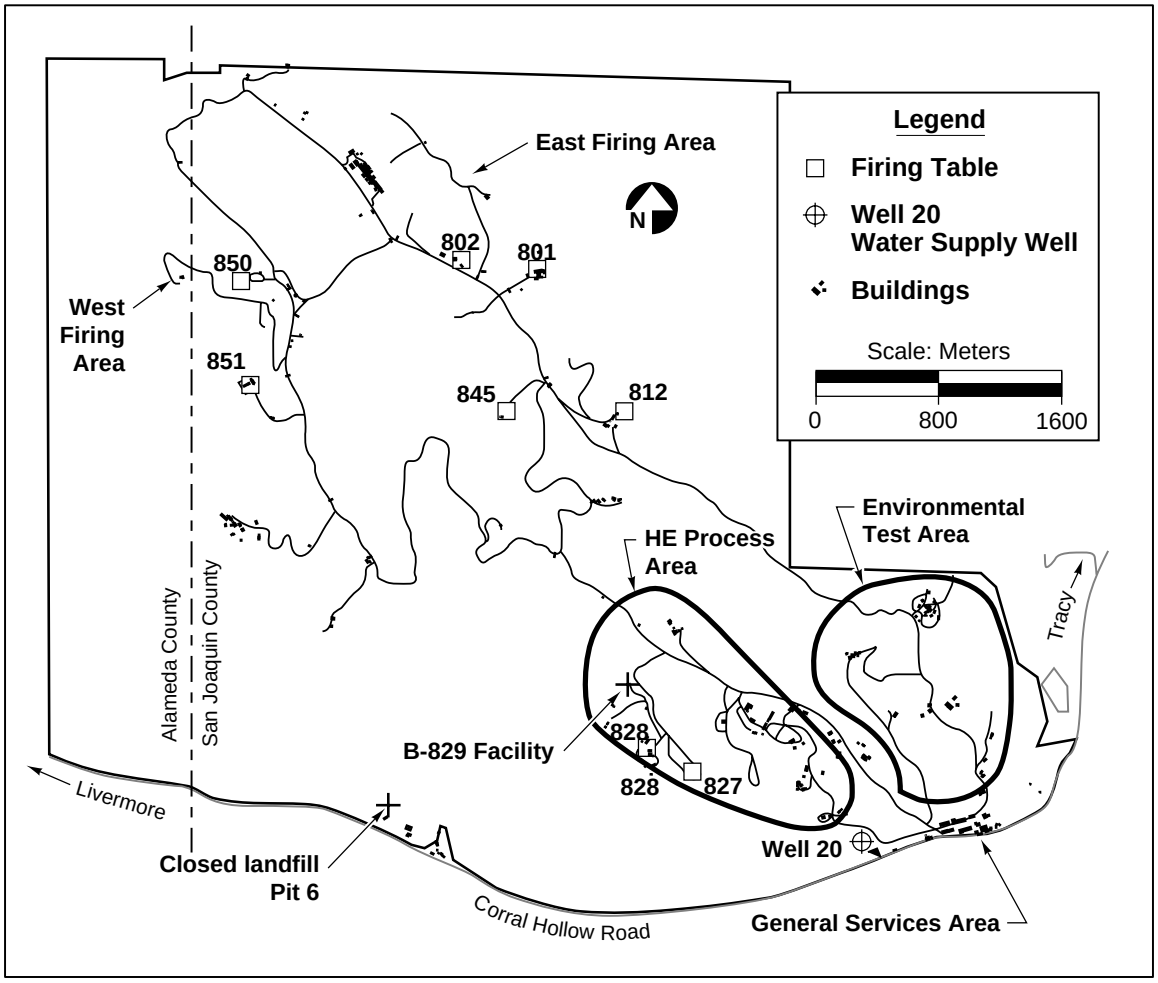



**Figure 2.** Location of the closed B-829 Facility at LLNL Site 300.

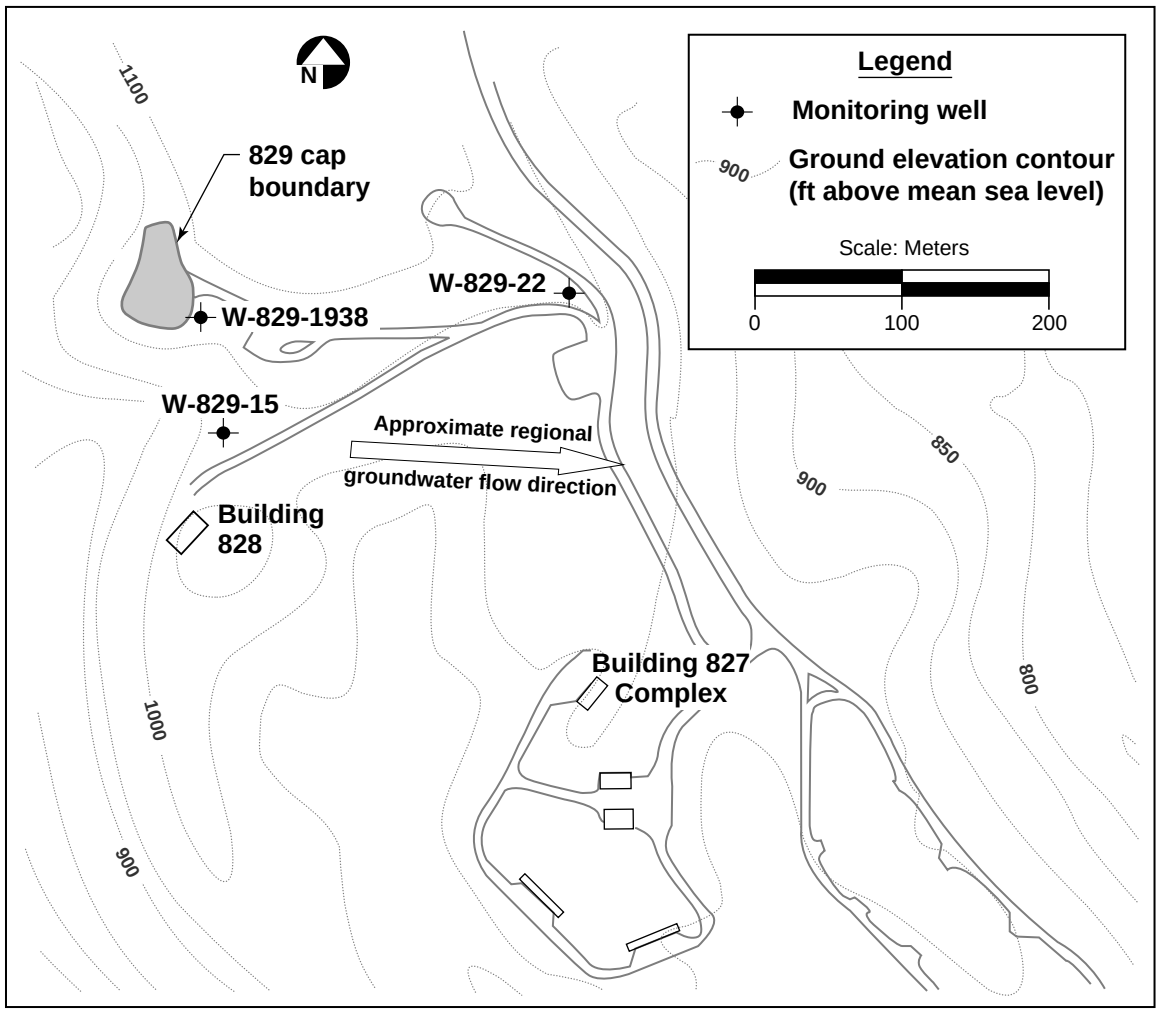



**Figure 3.** Location of the closed B-829 Facility and monitoring wells at LLNL Site 300.

Location: _____ Inspector's name: _____

Date: _____Inspector's signature: _____

Time: _____

| Condition of the facility | Condition as described? | If correction needed, describe condition and needed repairs. | Corrections completed? | Date completed |
|---|---|---|---|---|
| **DESCRIPTION** | **Y/N** | **INSPECTOR'S COMMENTS** | **Y/N** | **DATE** |
| 1. Cap is in good condition. | | | | |
| a. Settlement or gullying observed? | | | | |
| b. Surface erosion visible? | | | | |
| c. Fissures visible? | | | | |
| d. Cracks visible? | | | | |
| e. Low spots visible? | | | | |
| f. Animal burrows visible? | | | | |
| g. Bare spots observed? | | | | |
| h. Subsidence observed? | | | | |
| i. Vegetation beyond topsoil layer observed? | | | | |
| 2. Runoff is diverted away from HE Open Burn Treatment Facility. | | | | |
| 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. | | | | |

**Figure 4.** B-829 Facility post-closure 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? | Comments |
|---|---|---|---|---|---|---|---|---|
| **829-15** | | | | | | | | |
| **829-22** | | | | | | | | |
| **New well** | | | | | | | | |
| | | | | | | | | |

Form date: 4/17/03, rev.0

**Inspection date:**_____

**Inspector name:** _____ **Signature:**_____

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

# Appendix A

# Wells W-829-06 and W-829-08, Monitoring Results for CY 2003

## APPENDIX A. Wells W-829-06 and W-829-08, Monitoring Results for CY 2003

| | W-829-06 Sampling dates 2003 | | | | W-829-08 Sampling dates 2003 | | | |
|---|---|---|---|---|---|---|---|---|
| **Constituents (units)** | 21-Feb-03 | 23-May-03 | 04-Sep-03 | 19-Nov-03 | 21-Feb-03 | 23-May-03 | 23-Sep-03 | 19-Nov-03 |
| Nitrate (as NO3) (mg/L) | na[a] | 150. | 135. | na | na | 110. | 93.5 | na |
| Perchlorate (µg/L) | na | 6. | 9.9 | na | na | 7. | 9.9 | 11. |
| **Organic (µg/L)** | | | | | | | | |
| 1,1,1-Trichloroethane | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1-Dichloroethene | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethane | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethene (total) | 1.2 | 0.8 | < 1. | < 1. | < 1. | < 0.5 | < 1. | < 1. |
| Benzene | < 0.5 | na | na | na | < 0.5 | na | na | na |
| Carbon disulfide | < 1. | na | na | na | < 1. | na | na | na |
| Chloroform | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dichlorodifluoromethane | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Ethylbenzene | < 0.5 | na | na | na | < 0.5 | na | na | na |
| Freon 113 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Tetrachloroethene | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Toluene | < 0.5 | na | na | na | < 0.5 | na | na | na |
| Total xylene isomers | < 1. | na | na | na | < 1. | na | na | na |
| Trichloroethene | 210. | 170. | 150. | 130. | 21. | 29. | 23. | 25. |
| Trichlorofluoromethane | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| **Explosive (µg/L)** | | | | | | | | |
| HMX | < 5. | < 1. | < 5. | < 5. | < 5. | < 1. | < 5. | < 5. |
| RDX | < 5. | < 1. | < 5. | < 5. | < 5. | < 1. | < 5. | < 5. |
| TNT | < 5. | na | < 5. | < 5. | < 5. | na | < 5. | < 5. |

[a] Constituent not analyzed (na), in accordance with the controlling sampling plans.

# Appendix B

# Groundwater Elevation and COC Concentration Plots

# Appendix B

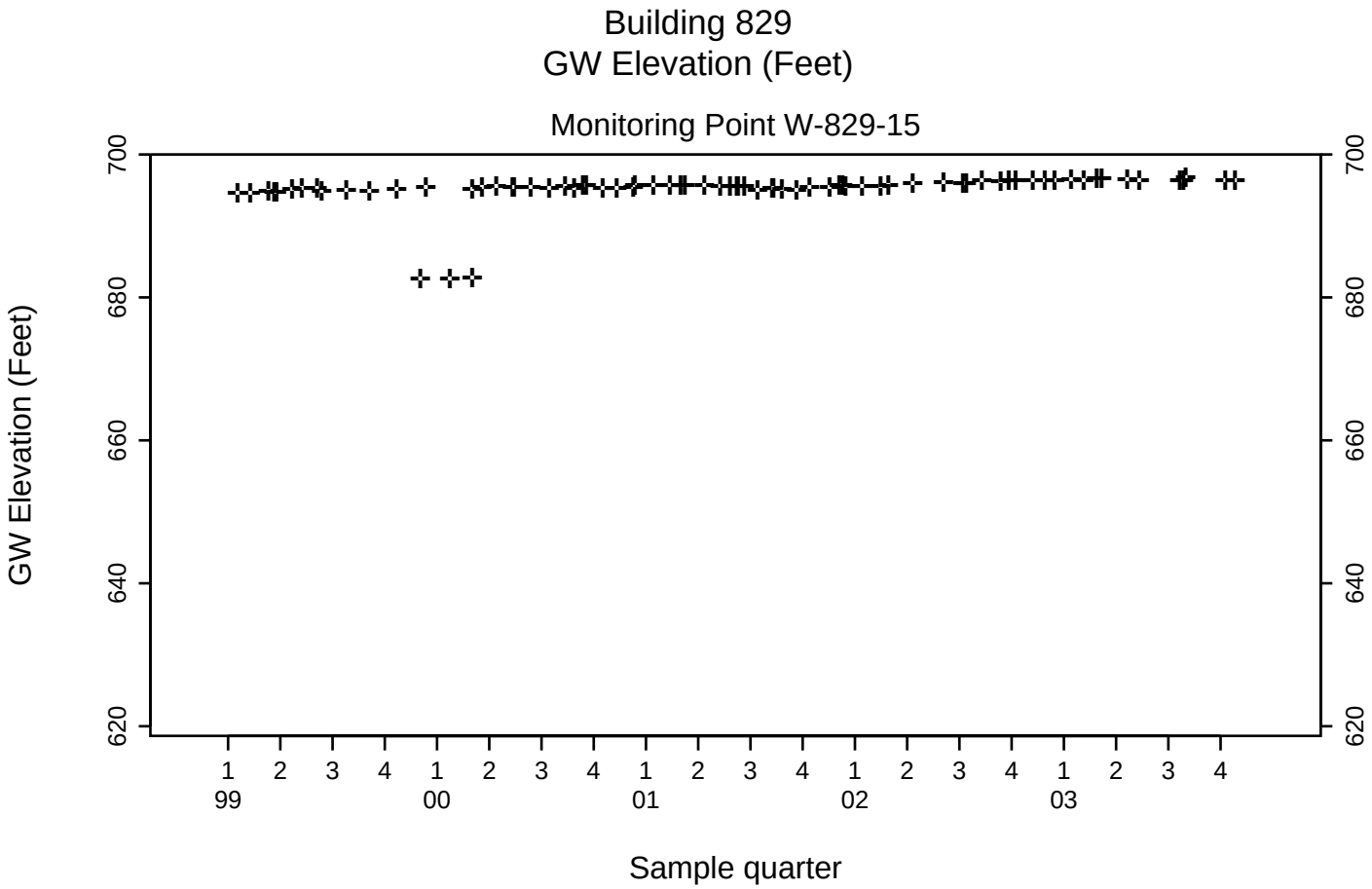
## Groundwater Elevation and COC Concentration Plots

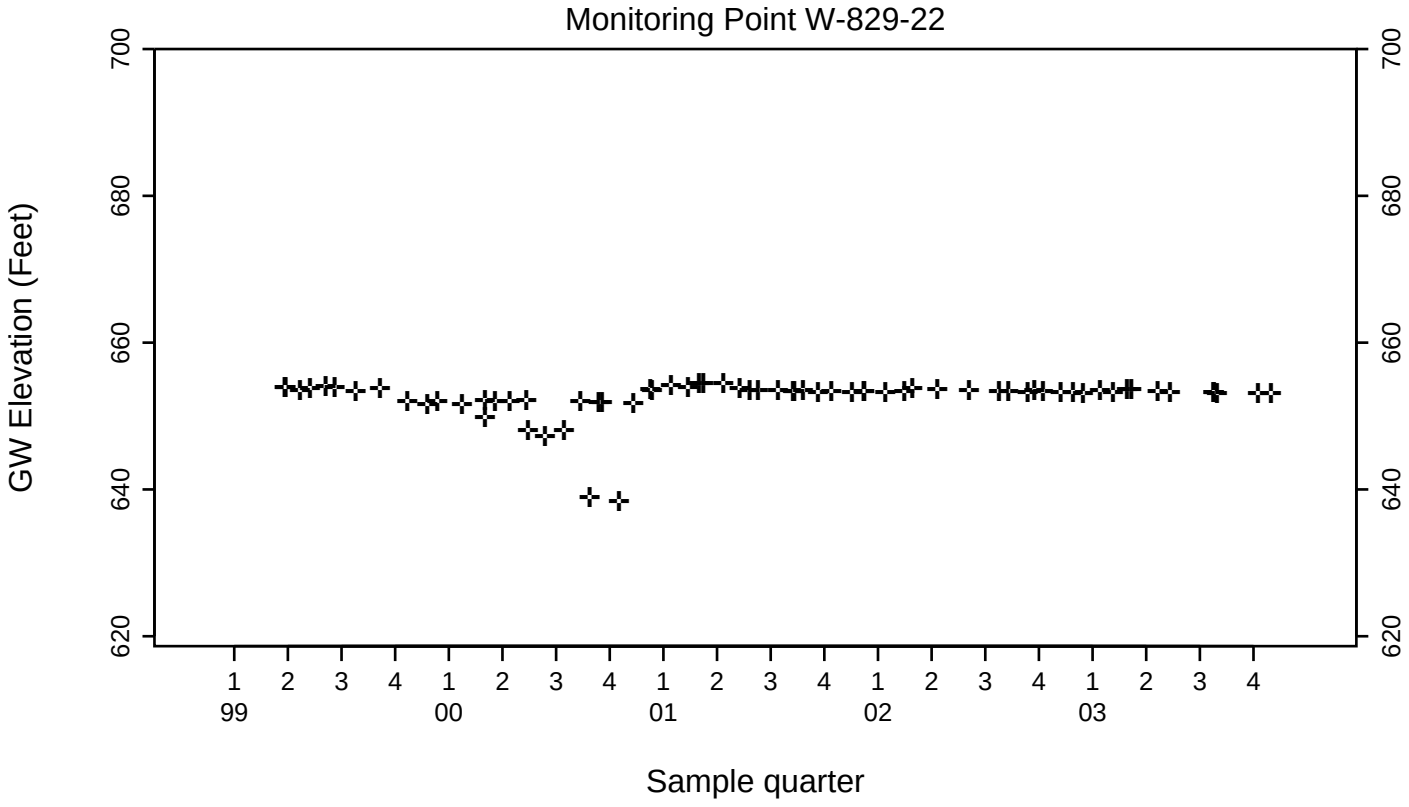
As required by the monitoring and reporting provisions of 22 CCR 66264.97(e), this appendix presents graphical depictions of groundwater elevations and concentration trends. Concentration-versus-time plots have been prepared for all confirmed constituent of concern (COC) detections above their respective analytical reporting limits (RLs), for the permit-specified wells (W-829-15 and W-829-22). The graphs present data accumulated over the last five years, going back to 1999, showing post-closure trends since the first year of monitoring under the *B-829 Final Closure Plan* (Mathews and Taffet 1997).

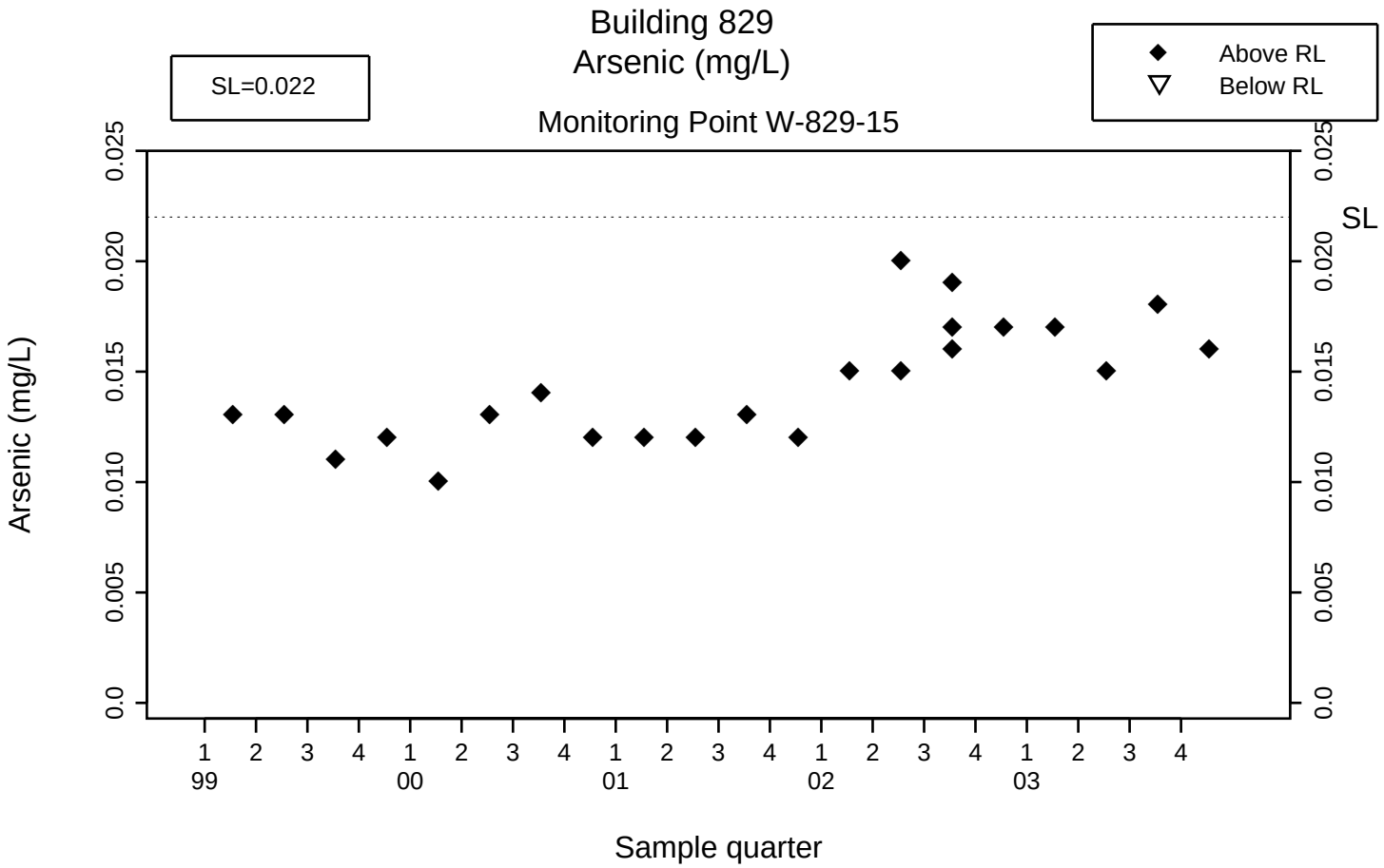
The sequence of graphs is by parameter (groundwater elevation, concentration, or activity) and by well. Graphs show the reported parameter on the y axis, with time on the x axis (time in years is divided into quarterly sample periods). The header and the vertical axis labels on each plot give the units 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.

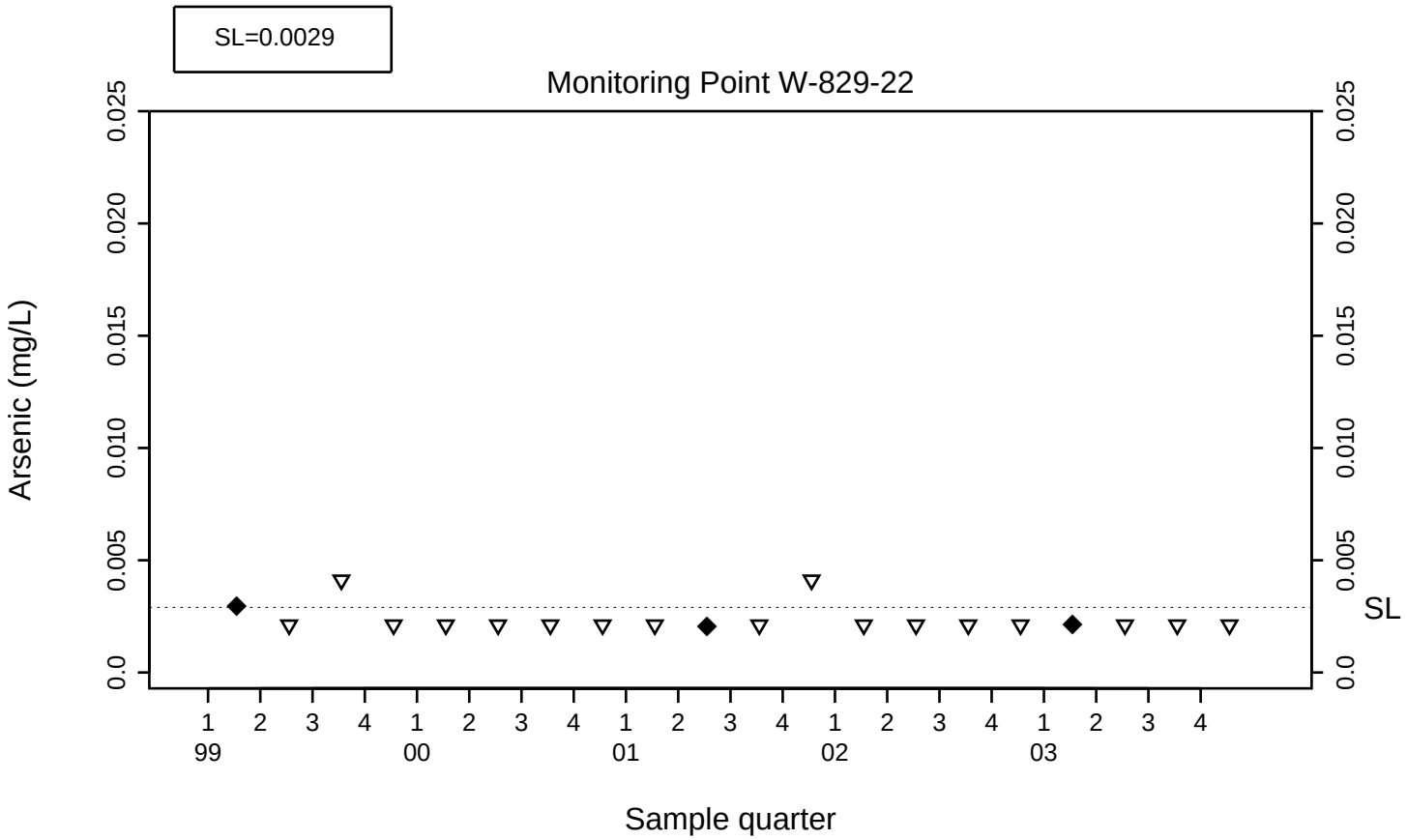
COC detections are plotted as black diamonds. Analytical laboratories report COC measurements above RLs as detections. (The RL for a COC is a contractual concentration value near zero.) COC concentrations below RLs are nondetections and are reported as “less than the RL.” For nonradioactive COCs, nondetections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

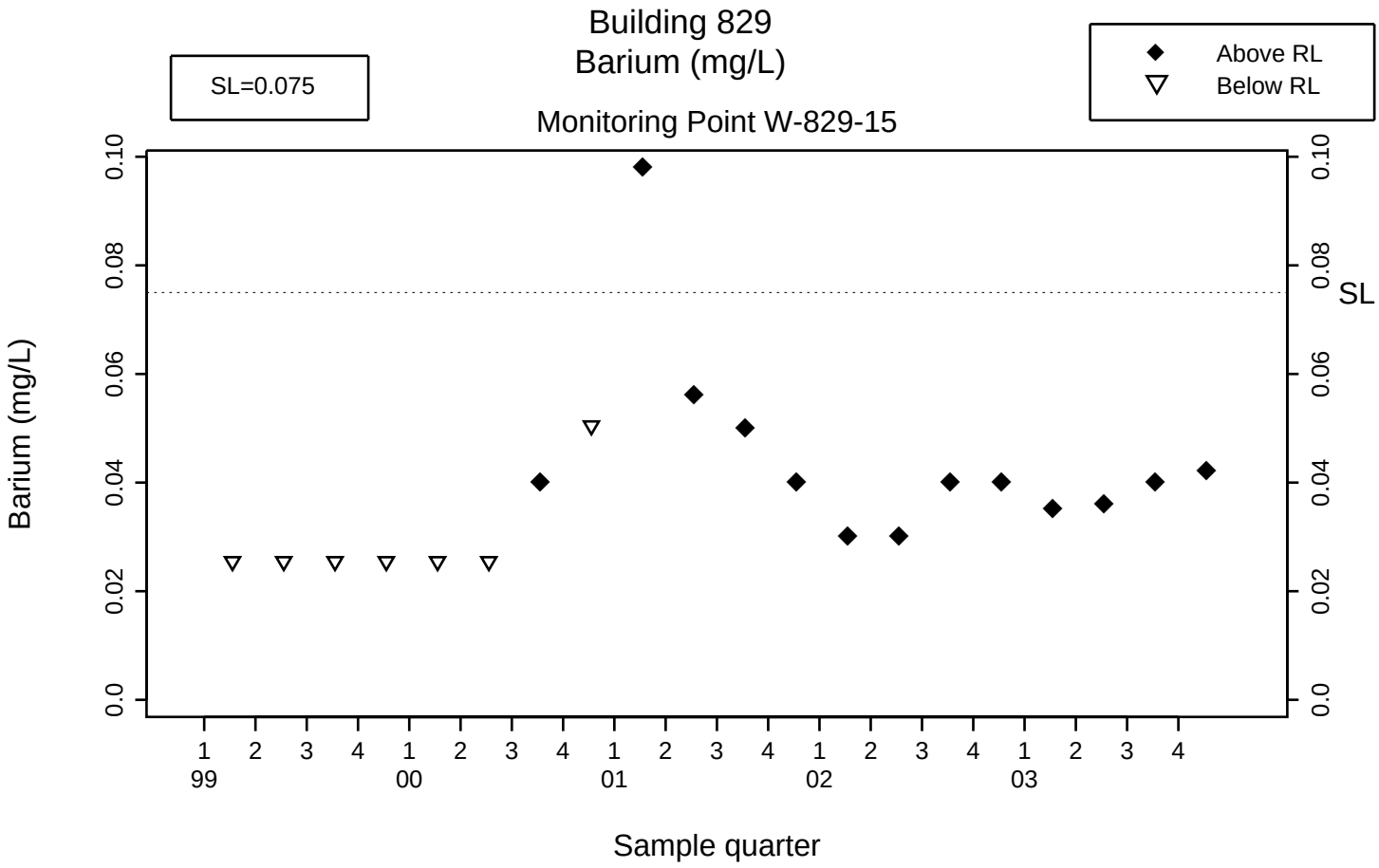
Nondetections of radioactive COCs, however, are treated differently. The reported value for radioactive COCs is the measured sample radioactivity minus the measured background radioactivity. When the result of this calculation is less than the RL, the value is plotted as a plus sign, indicating an estimated nondetection. (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.

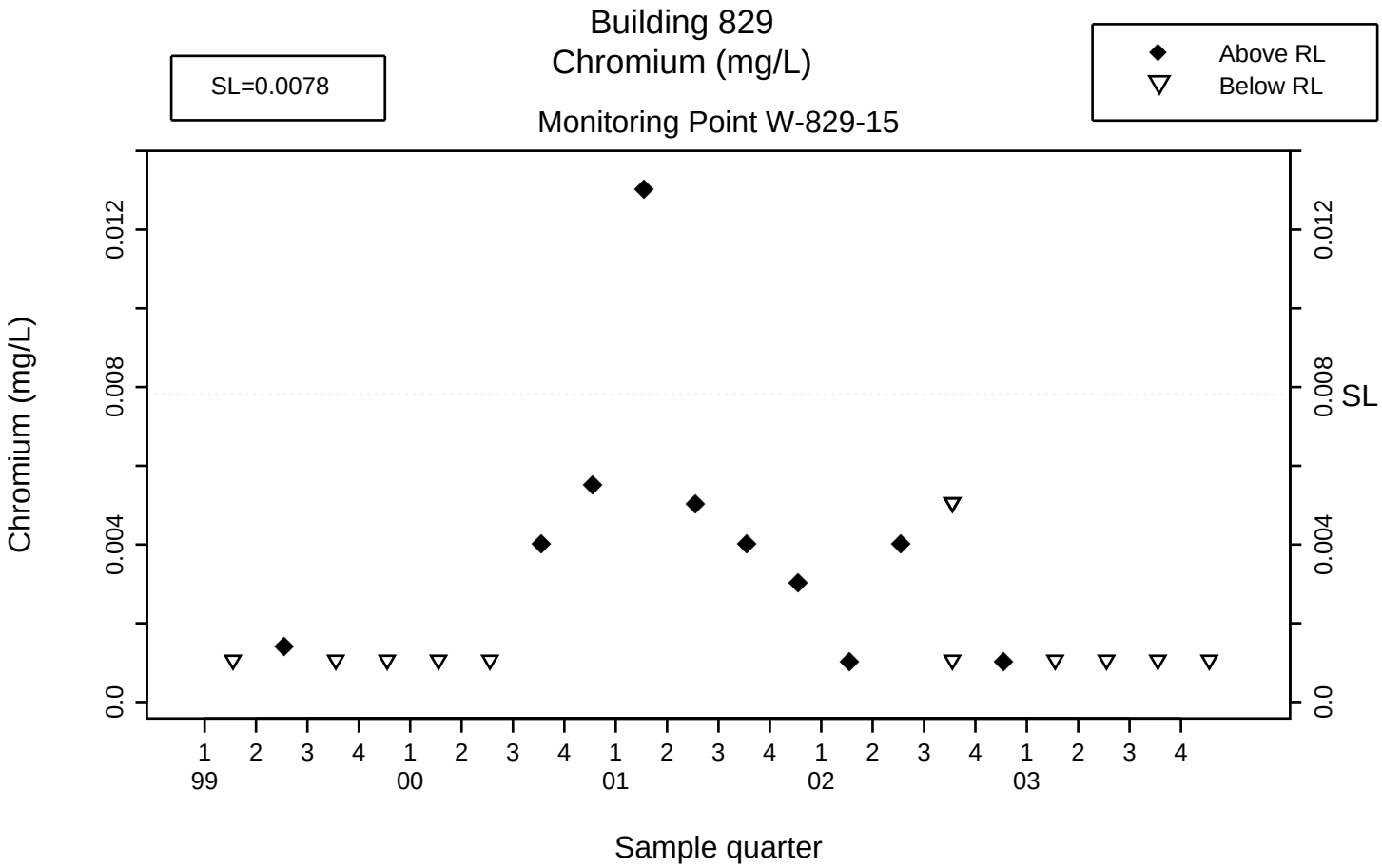

Building 829
GW Elevation (Feet)
Monitoring Point W-829-15
GW Elevation (Feet)
700
680
660
640
620
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

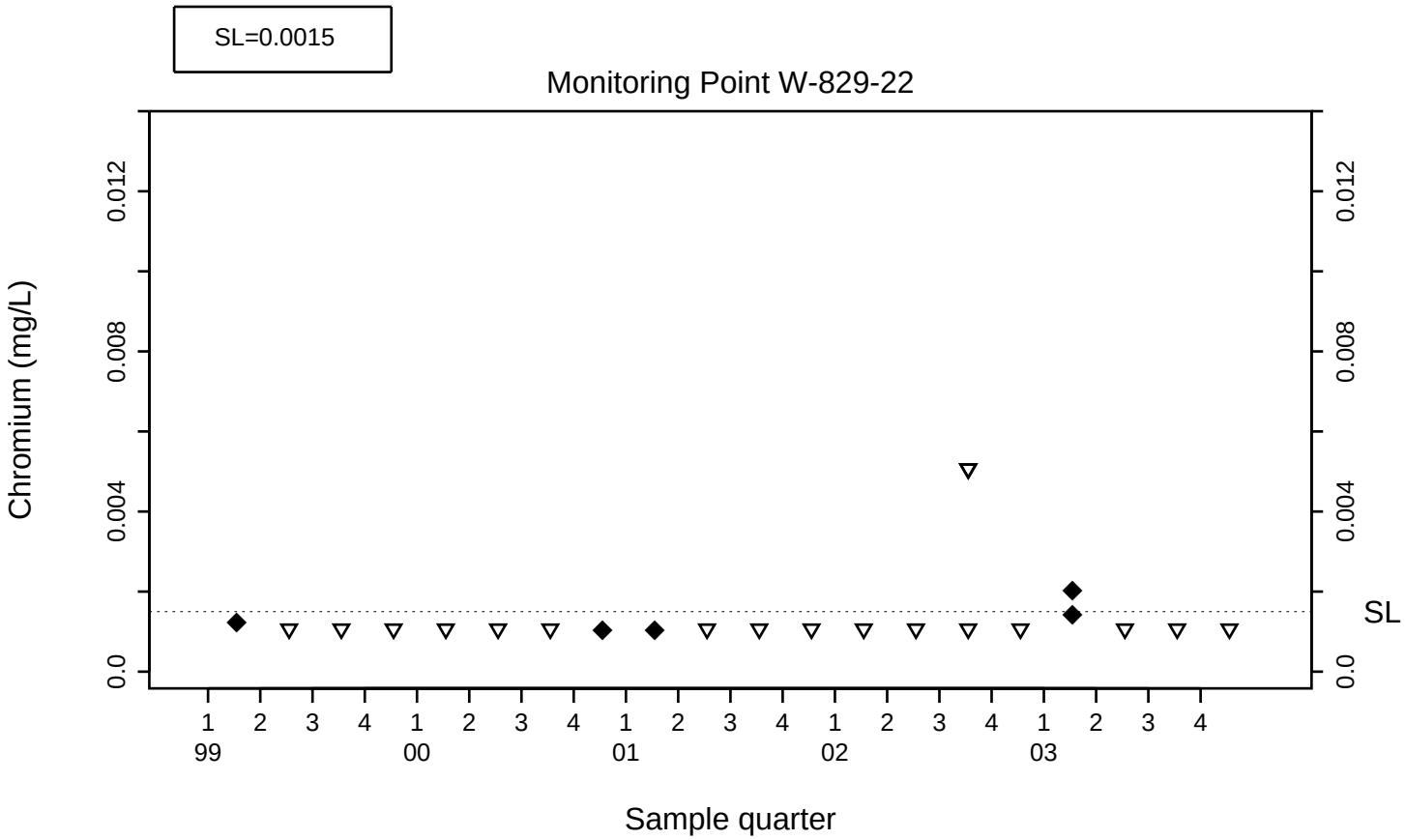

Monitoring Point W-829-22
GW Elevation (Feet)
700
680
660
640
620
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

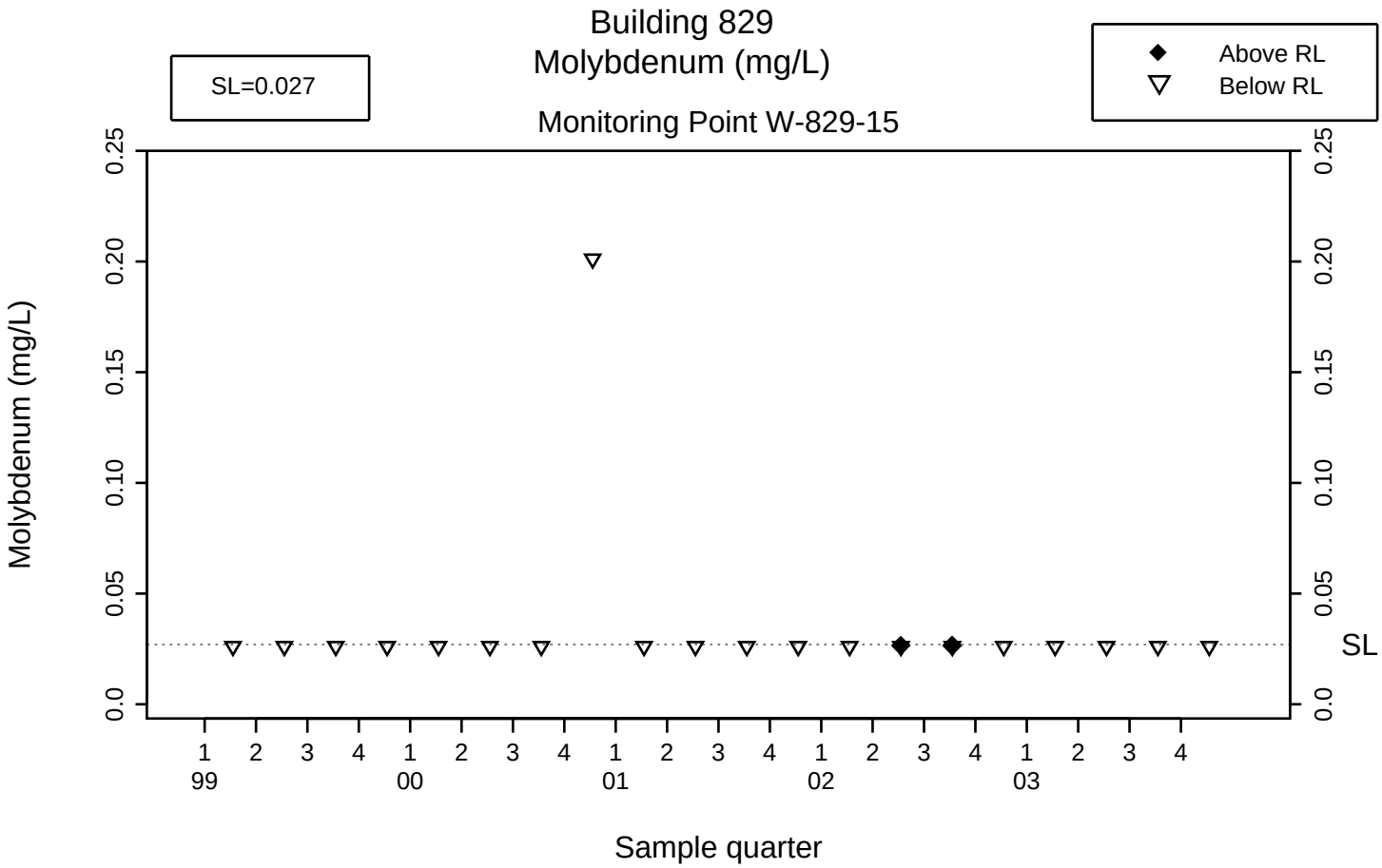

Building 829
Arsenic (mg/L)
SL=0.022
Above RL
Below RL
Monitoring Point W-829-15
Arsenic (mg/L)
0.0
0.005
0.010
0.015
0.020
0.025
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

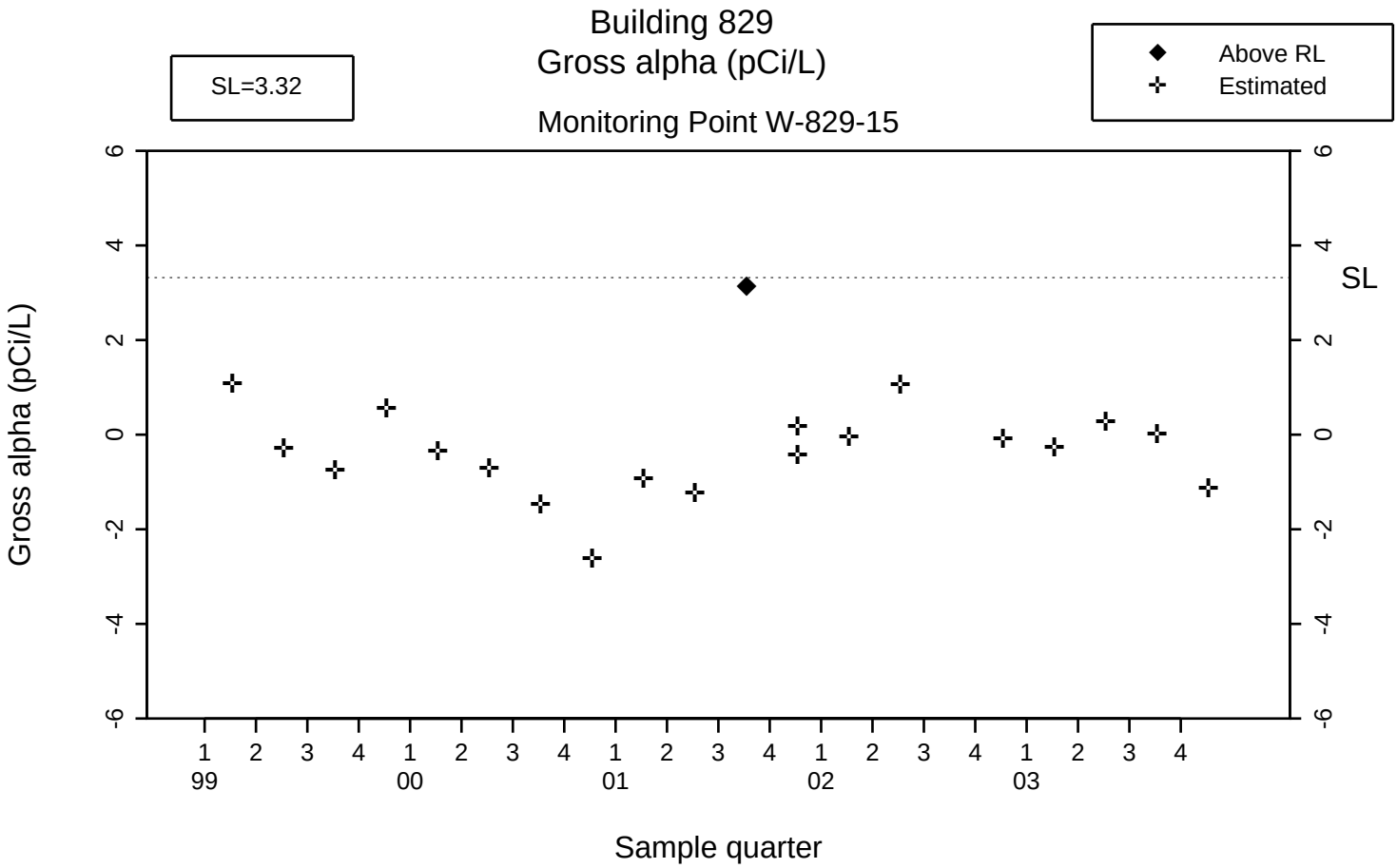

SL=0.0029
Monitoring Point W-829-22
Arsenic (mg/L)
0.0
0.005
0.010
0.015
0.020
0.025
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

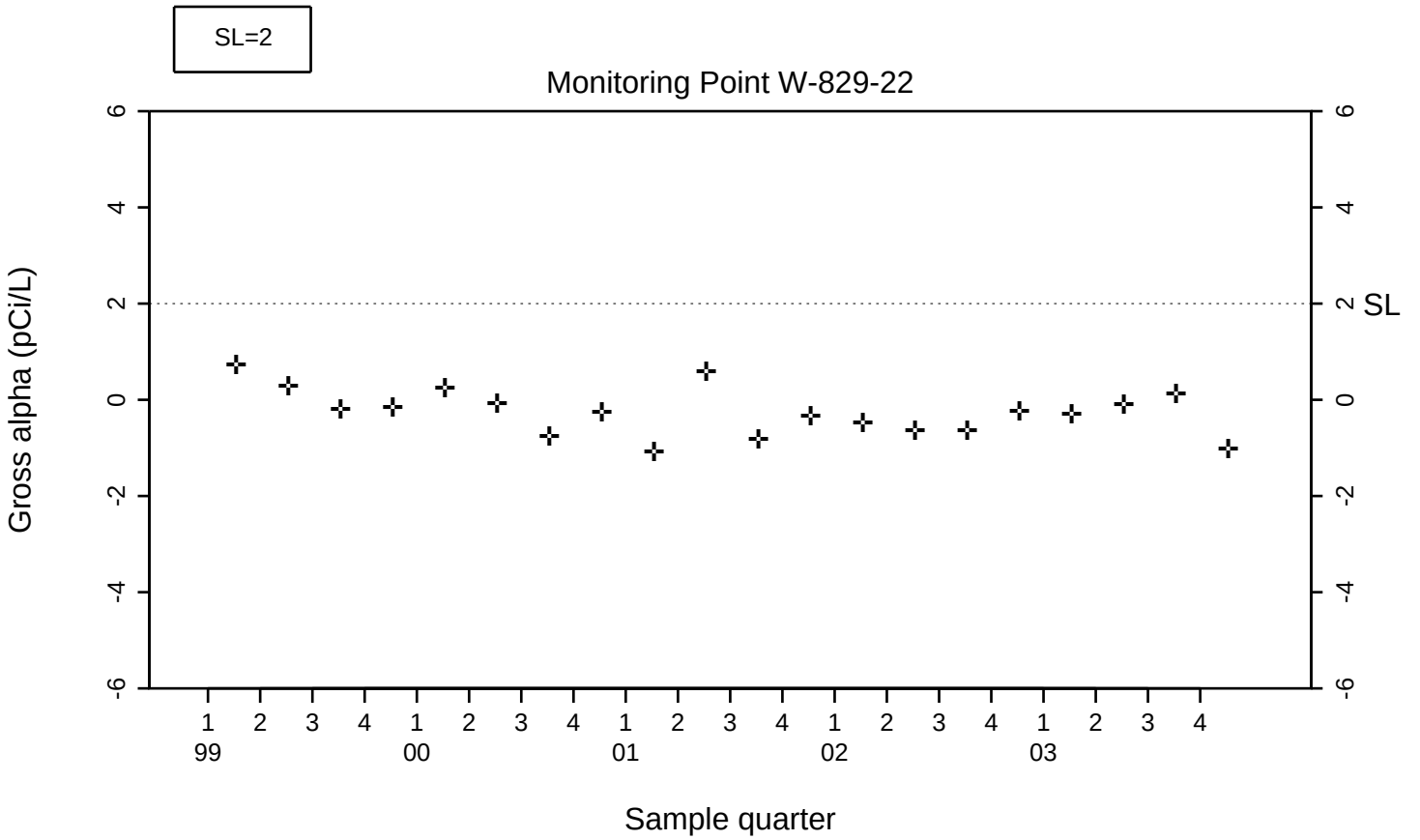

Building 829
Barium (mg/L)
Monitoring Point W-829-15
SL=0.075
Above RL
Below RL
Barium (mg/L)
0.0
0.02
0.04
0.06
0.08
0.10
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

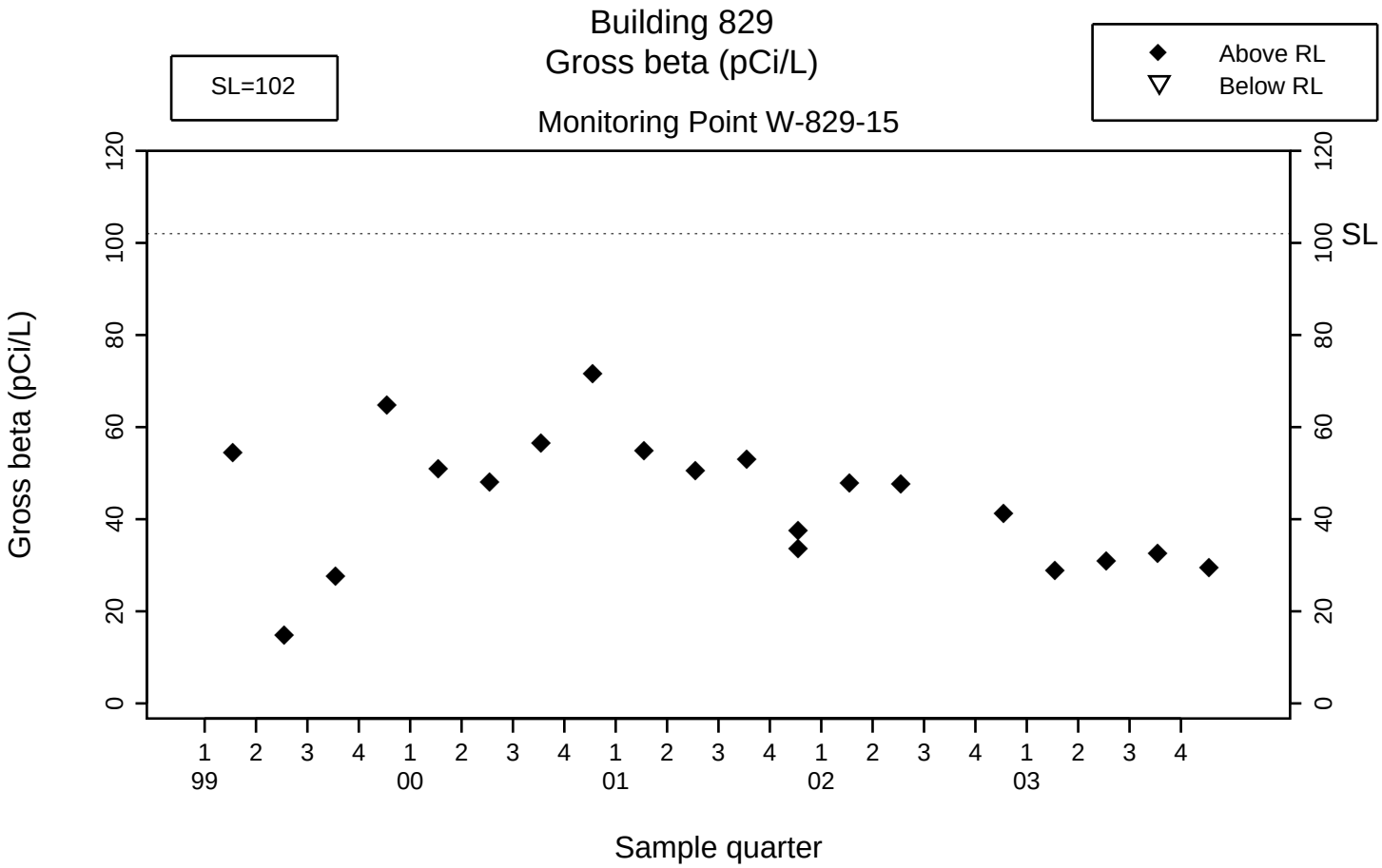

Building 829
Chromium (mg/L)
SL=0.0078
Above RL
Below RL
Monitoring Point W-829-15
Chromium (mg/L)
0.0
0.004
0.008
0.012
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

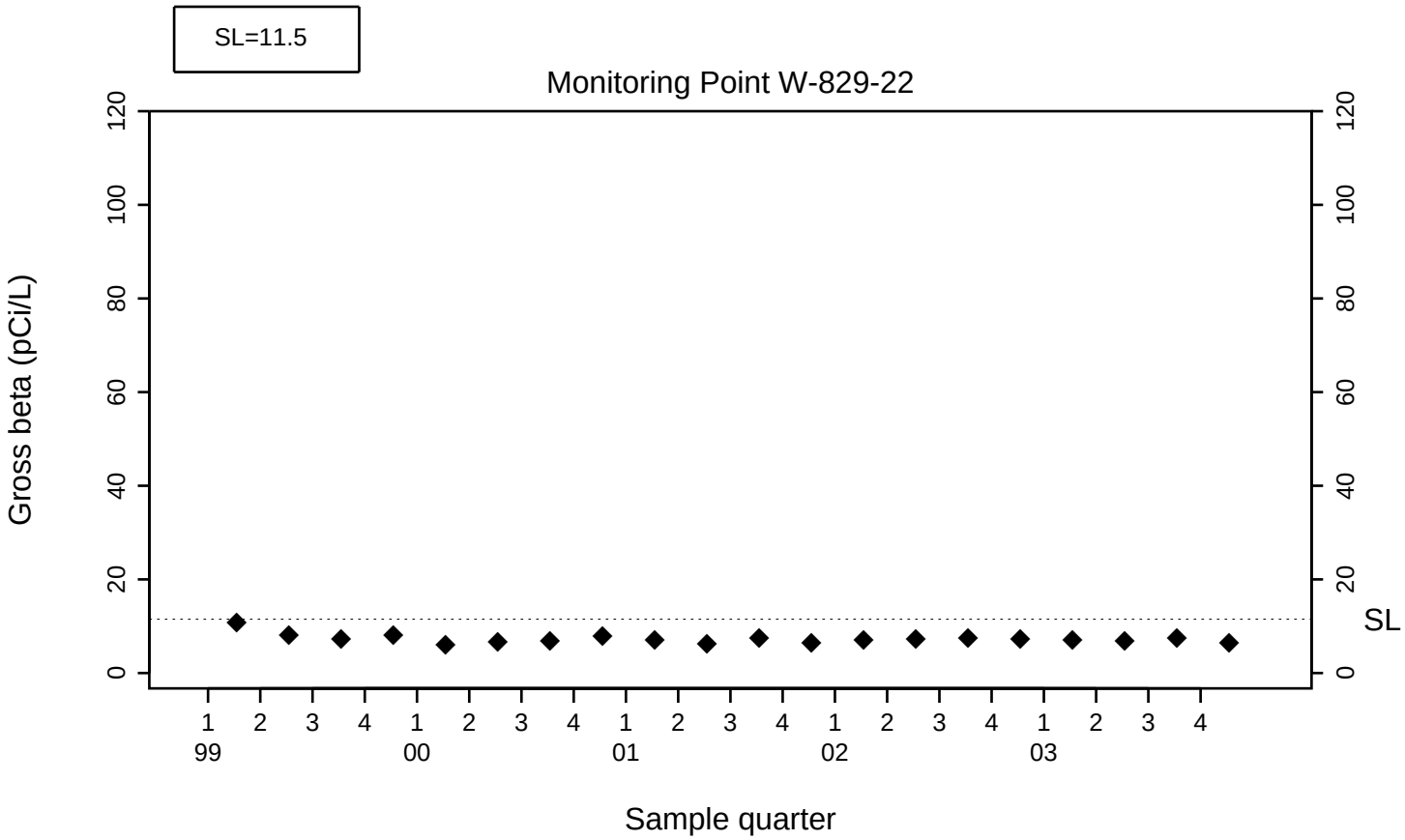

SL=0.0015
Monitoring Point W-829-22
Chromium (mg/L)
0.0
0.004
0.008
0.012
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter


Building 829
Molybdenum (mg/L)
Monitoring Point W-829-15
SL=0.027
Above RL
Below RL
Molybdenum (mg/L)
0.0
0.05
0.10
0.15
0.20
0.25
SL
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
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
99
00
01
02
03


SL=2
Monitoring Point W-829-22
Gross alpha (pCi/L)
SL
Sample quarter
99
00
01
02
03


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
120
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter


SL=11.5
Monitoring Point W-829-22
Gross beta (pCi/L)
SL
0
20
40
60
80
100
120
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
99 00 01 02 03
Sample quarter

# Appendix C

# Annual Engineering Inspection of Site 300, 829 Cap

**Appendix C**

# ANNUAL ENGINEERING INSPECTION

of

SITE 300 829 CAP

Prepared for:

**LAWRENCE LIVERMORE NATIONAL LABORATORY**
University of California
Livermore, CA 94551


Prepared By:

CHOW ENGINEERING, INC.
7770 Pardee Lane, Suite 100
Oakland, CA 94621

October 24, 2003

CHOW ENGINEERING, INC.

7770 Pardee Lane, Suite 100, Oakland, CA 94621
Tel: (510) 636-8500 FAX (510) 636-8544

October 24, 2003

Mr. Sav Mancieri
Lawrence Livermore National Laboratory
7000 East Avenue
PO Box 808, L-871
Livermore, CA 94551

**Subject: Year 2003 Annual Engineering Inspection of the Landfill for Cap 829, Site 300**

Dear Sav:

Chow Engineering, Inc. is pleased to submit this report on the Engineering Inspection of the 829 Landfill Cap, at the Lawrence Livermore National Laboratory (LLNL) location at Site 300. This site inspection was performed on September 25, 2003. This report was prepared based on the inspection and is the final activity in the present scope of work.

Please call me at (510) 636-8500 with any questions, or to let me know how else I can be of service. Thank you.

Sincerely,

Reuben H. Chow, P.E.
Principal

Enclosure

TABLE CONTENTS



**Figures**

## Executive Summary

Chow Engineering, Inc. (CE) has completed an inspection of the Building 829 Complex High-Explosives (HE) Open Burn Treatment Facility closure cap (829 cap) at Lawrence Livermore National Laboratory (LLNL) Site 300. This work was performed for Lawrence Livermore National Laboratory in accordance with the regulations specified in Title 22, Section 66264.300 of the California Code of Regulations (CCR), as required in Sections 66264.310 and 66265.310, for landfill caps. The inspection was supervised by a Professional Engineer registered in the State of California. The inspection included a review of existing documentation on the cap, and an on-site inspection of the 829 cap. This report documents the inspection procedures and findings, and includes comments and recommendations on the status and maintenance of the cap and associated closure facilities.

The 829 cap was inspected on September 25, 2003, by a California Registered Professional Engineer. The cap on the HE Open Burn Treatment Facility had been fully burned during an accidental fire at the site in the summer of 2000. Vegetation has grown to an average of 6 inches since the fire. The drainage system associated with the cap is in good condition and appears to be functioning properly. The groundwater monitoring wells associated with the cap generally appear to be in good condition. An additional monitoring well was observed being installed during the inspection. An annual land survey of the cap has been established to monitor for settlement.

## 1.0 Introduction

LLNL Site 300 is in the Altamont Hills, approximately 15 miles east of Livermore, California, and 8.5 miles southwest of Tracy (Figure 1). Site 300 is approximately 11 square miles and is bordered by Corral Hollow Road to the south. Approximately one sixth of the site is in Alameda County while the remainder is in San Joaquin County. The 829 complex is in Sections 16 and 17, Township 3 South, Range 4 East, Mount Diablo Base and Meridian in the southeastern corner of Site 300 (Figure 2). The 829 cap is in San Joaquin County. Site 300 is currently operated by the University of California as an active high explosives and materials testing site of the U.S. Department of Energy.

The HE Open Burn Treatment Facility has been closed, having been capped, graded, and revegetated under a California Department of Toxic Substance Control (DTSC) approved Resource Conservation and Recovery Act (RCRA) closure plan. The facility previously included three unlined pits and an open air burn unit that were used to thermally treat high-explosives waste (Figure 3). LLNL discontinued use of the HE Open Burn Treatment Facility in 1997. The facility was closed in place per the closure plan. The cap consists of four engineered layers which included a 2-foot soil and vegetative cover, a geocomposite drainage layer, a combined HDPE and geosynthetic clay liner, and a 2-ft-thick compacted foundation layer consisting of fine-grain silty sand with slightly varying silt, clay, and gravel content. Infiltration pipes were installed to intercept water and divert it to concrete drainage channels that direct surface flow around the cap and into drainage channels.

## 2.0 Inspection Comments and Recommendations

During the current inspection performed on September 25, 2003, all applicable items listed in 22 CCR 66264.288 (k) were addressed. In performing the inspection, the independent engineer walked the perimeter and the majority of the surface of the cap. The resulting comments and recommendations are discussed in the following text. The inspection checklists, documenting the items inspected in the field, are included in **Section 3.0** of this report.

### 2.1 829 Cap

In general, the 829 Cap appears to be in good condition. The cap is fully intact and the drainage system appears to be operating adequately. During the 2002 inspection and also during the current inspection, stress cracks along the south end of the pit were observed. A review of the survey data comparing 2001 and 2003 surveys verified that the maximum amount of settlement was only 0.05 inches at the 829 cap survey markers, with an average settlement value of 0.02. The following recommendations should be implemented to ensure effective function of the cap.

**Drainage Facilities:** The drainage facilities appear to be in good operating condition. Some dried vegetation (e.g., tumbleweeds) has accumulated in the drainage channel and should be removed.

**Vegetative cover/condition of the vegetation:** The aboveground portion of the vegetative cover was burned during an accidental fire at the site in the summer 2000. The vegetative cover has been restored and is in fairly good condition over the cap.

**Erosion:** During the current inspection, erosion of the cap was not observed. Erosion grooves were observed in an area at the northwest foundation of the cap. The grooves were up to 8 to 10 feet wide and 24 inches deep and continued 60 feet down the steep slope of the hillside.

**Cracking:** Cracking was observed during the 1999 inspection over several portions of the western and northern sections of the cap. During the 2000 inspection, the placement of new top soil had reduced the surfical cracking observed. During the 2002 inspection, stress cracks up to 1" wide and 50 feet in length were observed along the south side of the pit and intermittent stress cracks were observed on the west side of the cap. During this current inspection, surficial stress cracks were observed only on the south side of the pit.

**Groundwater monitoring system:** The groundwater monitoring wells appear to be intact and secured. A new RCRA groundwater monitoring well was being installed during this year's inspection.

**Surface improvements:** No rodent holes were observed during the inspection.

## 3.0 Inspection Checklists

The attached checklists include the items specified in 22 CCR Part 66264.228.

**Annual Landfill Inspection**
**Lawrence Livermore National Laboratory**
**Site 300**
**Pit 829**

Landfill: Pit 829 Date: Sept. 25, 2003
Weather: Sunny / Clear Time: 10:20 AM
Independent Engineer: Mr. Reuben Chow, P.E.
Signature:

The following items are required to be inspected under Title 22 of the California Code of Regulations, Part 66264.228(k). The comments are listed by number, following the checklist. Specific recommendations follow the comments:

| ITEM | DESCRIPTION | CONDITION | COMMENTS |
|---|---|---|---|
| 1. | Surface Improvements | Good | |
| 2. | Drainage Facilities | Good | 1 |
| 3. | Erosion Control Facilities | Good | 2 |
| 4. | Vegetative Cover | Good | |
| 5. | Gas Control Facilities | Not Applicable | |
| 6. | Gas Monitoring Facilities | Not Applicable | |
| 7. | Water Flowing From Disposal Area | No | |
| 8. | Leachate Flowing From Disposal Area | No | |
| 9. | Access Control (Fences & Gates) | Good | |
| 10. | Condition of Vegetation | Good | 3 |
| 11. | Erosion | Good | 2 |
| 12. | Cracking | Good | 4 |
| 13. | Disturbance by Cold Weather | Good | |
| 14. | Seepage | Good | |
| 15. | Slope Stability | Good | |
| 16. | Subsidence | Good | |
| 17. | Settlement | Good | |
| 18. | Monitoring of Leak Detection System | Not Applicable | |
| 19. | Operation of the Leachate Collection & Removal System | Not Applicable | |
| 20. | Monitoring The Groundwater Monitoring System | Good | |
| 21. | Condition of Run-on & Run-off Control Systems | Good | |
| 22. | Condition of Surveyed Benchmarks | Good | |

**Comments:**

1. Small amounts of vegetation were observed in the channel and should be removed.

2. The primary erosion control is the vegetation. The vegetative cover is in good condition. A depression has formed on the northeast portion of the cap which has not affected the integrity of the cap. This area should be monitored.

3. The average height of the vegetation is approximately 6 inches. The vegetation consists primarily of grasses.

4. Cracks on the south side of the cap were observed. An area 50 feet by 15 feet should be rolled and compacted and reseeded. At the northwest side of the cap foundation, deep erosion grooves were observed up to 8 to 10 feet wide and 24 inches deep.

**Recommendations:**

The south end of the pit should be rolled and compacted in areas of stress cracking over an area approximately 50 feet by 15 feet. The area should be revegetated following compaction.

Vegetation should be removed from the channel prior to the rainy season.

The erosion grooves at the northwestern area of the foundation of the cap should be monitored and best management practices employed to mitigate the conditions.

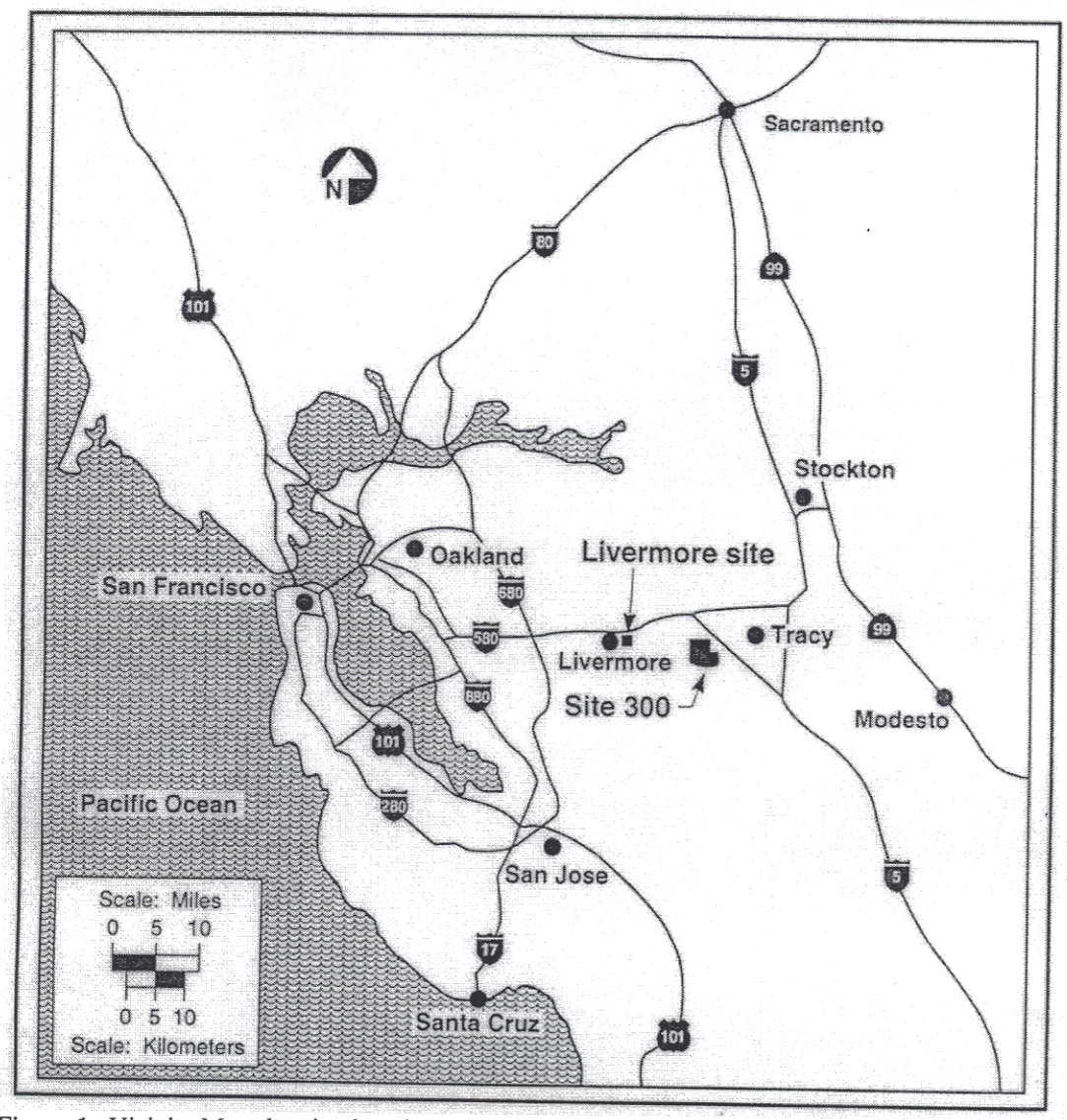



**Figure 1**. Vicinity Map showing locations of Livermore LLNL site and Site 300.
*Source: LLNL Environmental Report for 1998.*

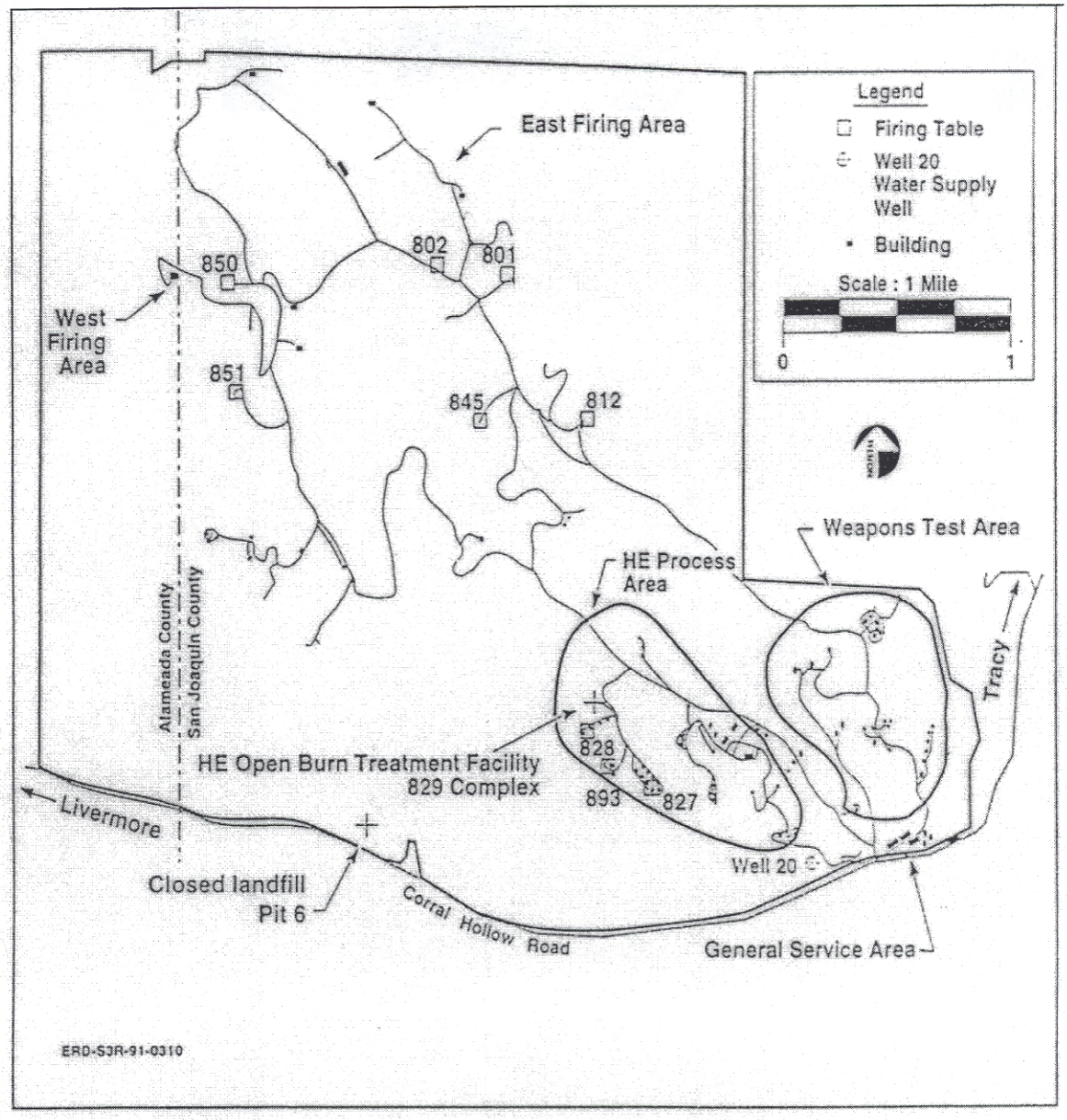



**Figure 2**. General Facilities Map
*Source: Compliance Monitoring Program Second Quarter Report April-June, 1997 for Site 300.*

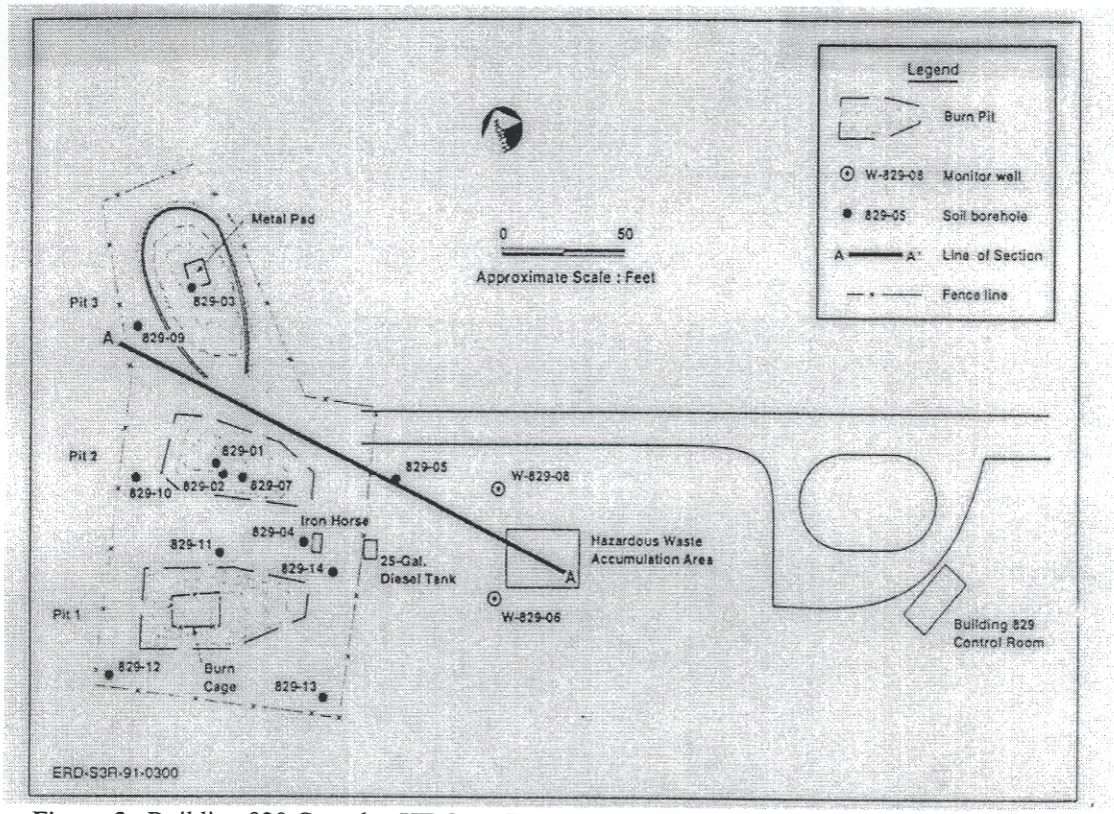



**Figure 3**. Building 829 Complex HE Open Burn Treatment Facility, Site 300

# Appendix D

# Acronyms and Abbreviations

# Appendix D

## Acronyms and Abbreviations

| | |
|---|---|
| **CCR** | California Code of Regulations |
| **CERCLA** | Comprehensive Environmental Response, Compensation and Liability Act |
| **CL** | concentration limit |
| **CMP** | Compliance Monitoring Plan |
| **COC** | constituent of concern |
| **CY** | calendar year |
| **DCE** | 1,2-dichloroethene |
| **DOE** | Department of Energy |
| **DTSC** | Department of Toxic Substances Control |
| **HE** | high explosive |
| **LLNL** | Lawrence Livermore National Laboratory |
| **mi** | mile |
| **MPN** | most probable number |
| **PE** | Professional Engineer |
| **POC** | point of compliance |
| **QC** | quality control |
| **RCRA** | Resource Conservation and Recovery Act |
| **RL** | reporting limit |
| **SL** | statistically determined limit of concentration |
| **TBD** | to be determined |
| **TCE** | trichloroethene |
| **TOC** | total organic carbon |
| **TOX** | total organic halides |
| **VOC** | volatile organic compound |

**Operations & Regulatory Affairs Division, Lawrence Livermore National Laboratory**
**University of California, P.O. Box 808, L-627, Livermore, California 94551**