Surface Water Monitoring

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Overview

Lawrence Livermore National Laboratory monitors surface water at the Livermore site, in surrounding regions of the Livermore Valley and Altamont Hills, and at Site 300. At the Livermore site and vicinity, LLNL monitors reservoirs and ponds, the Livermore site swimming pool, the Drainage Retention Basin (DRB), rainfall, tap water, storm water runoff, and receiving waters. At Site 300 and vicinity, surface water monitoring encompasses rainfall, cooling tower discharges, drinking water system discharges, storm water runoff, and receiving waters.

Given the diverse activities and environmental conditions at the LLNL sites and in the surrounding areas, the water samples are analyzed for several water quality parameters including radionuclides, high explosives, residual chlorine, total organic carbon, total organic halides, total suspended solids, conductivity, pH, chemical oxygen demand, total dissolved solids, oil and grease, metals, minerals, anions, temperature, nutrients, and a wide range of organic compounds. In addition, bioassays are performed annually on water entering and leaving the Livermore site via the Arroyo Las Positas, discharges from the DRB, and water contained in the DRB.

Storm Water

This section provides a general introduction to the storm water program at LLNL, including information on permits, constituent comparison criteria, building inspections, as well as sampling methods and results. The goals of the storm water runoff monitoring program are to demonstrate compliance with permit requirements, aid in implementing the Storm Water Pollution Prevention

Plans (SWPPPs) (Eccher et al. 1994a and b), assess the risk of storm water contamination from various potential sources, and evaluate the effectiveness of Best Management Practices (BMPs) for preventing storm water contamination.

General Information

Permits

To assess compliance with permit requirements, LLNL monitors storm water at the Livermore site in accordance with Waste Discharge Requirements (WDR 95-174), National Pollutant Discharge Elimination System permit (NPDES Permit No. CA0030023), issued in 1995 by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB 1995). In August 2000, the Central Valley Regional Water Quality Control Board (CVRWQCB) rescinded WDR 94-131, NPDES Permit No. CA0081396 for Site 300. LLNL submitted a Notice of Intent (NOI) to the State Water Resources Control Board (SWRCB) to cover storm water discharges at Site 300 previously permitted by WDR 94-131 under the Statewide General NPDES Permit for Storm Water Discharges Associated with Industrial Activity (WDR 97-03-DWQ, NPDES Permit No. CAS000001, SWRCB). In addition, Site 300 storm water monitoring meets the requirements of the *Post-Closure Plan for the Pit 6 Landfill Operable Unit* (Ferry et al. 1998). These permits include specific monitoring and reporting requirements. In addition to the storm water quality constituents required by the permits, LLNL monitors other constituents to provide a more complete water quality profile. The current list of analyses provided for storm water samples is given in **Table 7-1**.

Storm water monitoring follows the requirements in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. DOE 1991) and meets the applicable requirements of DOE Order 5400.1, *General Environmental Protection Program*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

NPDES permits for storm water require that LLNL sample effluent two times per year. In addition, LLNL is required to visually inspect the storm drainage system monthly during the wet season, whenever significant storms occur, and twice during the dry season to identify any dry weather flows. Influent sampling is also required at the Livermore site. LLNL monitors up to two more storm events each year at the Livermore site (a total of four sampling events) in support of DOE Orders 5400.1 and 5400.5. In addition, annual facility inspections are required to ensure that the BMPs are adequate and implemented.

LLNL also meets the storm water compliance monitoring requirements of the Statewide General NPDES Permit for Storm Water Discharges Associated with Construction Activity (Order 99-08-DWQ, NPDES Permit No. CAS000002) for construction projects that disturb two hectares of land or more (SWRCB 1999).

Constituent Criteria

Currently, there are no numeric criteria that limit concentrations of specific constituents in LLNL's storm water effluent. The Environmental Protection Agency (EPA) established parameter benchmark values, but stressed that these concentrations were not intended to be interpreted as effluent limits (U.S. EPA 2000). Rather, the values are levels that the EPA has used to determine if storm water discharged from any given facility merits further monitoring. Although these criteria are not directly applicable, they are used as comparison criteria to help evaluate LLNL's storm water management program. To further evaluate the storm water management program, LLNL established or calculated site-specific threshold

Table 7-1. Analyses conducted on storm water samples, 2000

Livermore site	Site 300
Specific conductance	Specific conductance
Total suspended solids (TSS)	Total dissolved solids (TDS)
pH	TSS
Chemical oxygen demand (COD)	pH
Fish bioassay (fathead minnow)	Potassium
Anions	Beryllium
General minerals	Mercury
Metals	Volatile organic compounds (VOCs)
Volatile organic compounds (VOCs)	Semivolatile organic compounds (SVOCs)
Semivolatile organic compounds (SVOCs)	Pesticides
Pesticides	PCBs
Oil and grease	Total organic halides
PCBs	Total organic carbon
Total organic carbon	Dioxins
Gross alpha and beta	Explosives
Tritium	Gross alpha and beta
Plutonium	Tritium
	Uranium

comparison criteria for a select group of parameters. A value exceeds the threshold if it is greater than the 95% confidence limit computed for the historical mean value for a specific parameter. A value that deserves further attention would therefore be in the upper 5% of recorded values (**Table 7-2**). The threshold comparison criteria are used to identify out-of-the-ordinary data that merit further investigation to determine if concentrations of that parameter are increasing in the storm water runoff.

For a better understanding of how LLNL storm water data relate to other target values, water samples are also compared with criteria listed in the *Water Quality Control Plan, San Francisco Bay Basin* (SFBRWQCB 1995), *The Water Quality Control Plan* (*Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region, Sacramento and San Joaquin River Basins* (Longley et al. 1994), EPA maximum contaminant levels (MCLs), and ambient water quality criteria (AWQC). The greatest importance is placed on the site-specific comparison criteria calculated from historical concentrations in storm runoff.

In addition to chemical monitoring, LLNL is required by NPDES permit WDR 95-174 to conduct acute and chronic fish toxicity testing in Arroyo Las Positas (Livermore site) once per wet season (defined as October of one year through April of the following year). Currently, LLNL is not required to test for fish toxicity at Site 300.

Table 7-2. Threshold comparison criteria for selected water quality parameters. The sources of values above these are examined to determine if any action is necessary.

Parameter	Livermore site	Site 300
Total suspended solids (TSS)	750 mg/L[(a)]	1700 mg/L[(a)]
Chemical oxygen demand (COD)	200 mg/L[(a)]	not monitored
pH	<6.0, >8.5[(a)]	<6.0, >9.0[(b)]
Nitrate (as NO_3)	10 mg/L[(a)]	not monitored
Orthophosphate	2.5 mg/L[(a)]	not monitored
Mercury	above RL[(c)]	above RL[(c)]
Beryllium	0.0016 mg/L[(a)]	0.0016 mg/L[(a)]
Chromium(VI)	0.016 mg/L[(d)]	not monitored
Copper	0.013 mg/L[(d)]	not monitored
Lead	0.015 mg/L[(e)]	0.015 mg/L[(a)]
Zinc	0.117 mg/L[(b)]	not monitored
Diuron	0.014 mg/L[(a)]	not monitored
Oil and grease	9 mg/L[(a)]	9 mg/L[(a)]
Tritium	36 Bq/L[(a)]	3.17 Bq/L[(a)]
Gross alpha	0.34 Bq/L[(a)]	0.90 Bq/L[(a)]
Gross beta	0.48 Bq/L[(a)]	1.73 Bq/L[(a)]

a Site-specific value calculated from historical data and studies. Most of these values are lower than the maximum contaminent levels (MCLs) or EPA benchmark values for drinking water except for TSS, COD, and Site 300 gross alpha, which have been demonstrated to be consistent with background values.

b EPA benchmark (calculated at 100 mg/L $CaCO_3$ hardness for zinc)

c RL = reporting limit = 0.0002 mg/L

d Ambient water quality criteria

e EPA primary maximum contaminant level (PMCL)

Inspections

Each directorate at LLNL conducts an annual inspection of its facilities to verify implementation of the SWPPPs and to ensure that measures to reduce pollutant loadings to storm water runoff are implemented. The Laboratory's associate directors certified in 2000 that their facilities comply with the provisions of WDR 94-131, WDR 95-174, and the SWPPPs. The deputy director for operations certifies the facilities directly reporting to the Director's Office, except those facilities in the Laboratory Site Operations organization, which are certified by the Laboratory Site Manager. LLNL submits annual storm water monitoring reports to the SFBRWQCB and to the CVRWQCB with the results of sampling, observations, and inspections.

Monitoring for construction projects permitted by Order 99-08-DWQ includes visual observations of construction sites by the construction staff before, during, and after storms to assess the effectiveness of implemented BMPs. Annual compliance certifications summarize these inspections.

As in past years, the SFBRWQCB requested submission of compliance status reports for the Livermore site construction projects. (The CVRWQCB has never requested compliance status reports for projects located at Site 300.) The 2000 compliance certifications (and compliance status reports) covered the period of June 1999 through May 2000. During this period, three Livermore site projects were inspected: the Decontamination and Waste Treatment Facility (DWTF), the National Ignition Facility (NIF), and the areas associated with the Soil Reuse Project. One Site 300 project, the Contained Firing Facility, was also inspected under this program.

Sampling

For the purpose of evaluating the overall impact of Livermore site and Site 300 operations on storm water quality, storm water flows are sampled at upstream and downstream locations. Because of flow patterns at the Livermore site, storm water at sampling locations includes water running onto the site from other sources, such as neighboring agricultural land, parking lots, and landscaped areas. In contrast, storm water at Site 300 is sampled at locations that target specific industrial activities, with no run-on from off-site sources. These samples provide information used to evaluate the effectiveness of LLNL's storm water pollution control program.

Livermore Site: As is commonly the case in urbanized areas, the surface water bodies and runoff pathways at LLNL do not represent the historical natural conditions. The drainage at the Livermore site was altered by construction activities several times up to 1966 (Thorpe et al. 1990) so that the current northwest flow of Arroyo Seco and the westward flow of Arroyo Las Positas do not represent historical flow paths. About 1.6 km to the west of the Livermore site, Arroyo Seco merges with Arroyo Las Positas, which continues to the west to eventually merge with Arroyo Mocho (see **Figure 7-1**).

The DRB was excavated and lined in 1992 to prevent infiltration of storm water that was dispersing groundwater contaminants. It also serves storm water diversion and flood control purposes. The DRB collects about one-fourth of the surface water runoff from the site and a portion of the Arroyo Las Positas drainage (**Figure 7-2**). When full, the DRB discharges north to a culvert that leads to Arroyo Las Positas. The remainder of the site drains either directly or indirectly into the two arroyos by way of storm drains and swales. Arroyo Seco cuts across the southwestern corner of the site. Arroyo Las Positas follows the northeastern and northern boundaries of the site and exits the site near the northwest corner.

The routine Livermore site storm water runoff monitoring network consists of nine sampling locations (**Figure 7-2**). Six locations characterize storm water either entering (influent: ALPE, ALPO, ASS2, and GRNE) or exiting (effluent: ASW and WPDC) the Livermore site. Locations CDB and CDB2 characterize runoff from the southeastern quadrant of the Livermore site entering the DRB, and location CDBX characterizes water leaving the DRB. Additional locations were sampled beginning in 1999 and continuing through 2000 as part of a tritium source investigation and are described in the Livermore Site Radioactive Constituents section in this chapter.

Site 300: Surface water at Site 300 consists of seasonal runoff, springs, and natural and man-made ponds. The primary waterway in the Site 300 area is Corral Hollow Creek, an ephemeral stream that borders the site to the south and southeast. No naturally continuously flowing streams are present in the Site 300 area. Elk Ravine is the major drainage channel for most of Site 300; it extends from the northwest portion of the site to the east-central area. Elk Ravine drains the center of the site into Corral Hollow Creek, which drains eastward to the San Joaquin River Basin. Some smaller canyons in the northeast portion of the site drain to the north and east toward Tracy.

There are at least 23 springs at Site 300. Nineteen are perennial, and four are intermittent. Most of the springs have very low flow rates and are recognized only by small marshy areas, pools of water, or vegetation. Numerous artificial surface water bodies are present at Site 300. A sewage evaporation pond and a sewage percolation pond are located in the southeast corner of the site in the General Services Area (GSA), and two lined, high-explosives (HE) surface water impoundments are located to the west in the Explosives Process Area. Monitoring results associated with these facilities are reported in Chapter 9. Three wetlands created by now-discontinued flows from cooling towers located at Buildings 827, 851, and 865 are currently maintained by discharges of potable water.

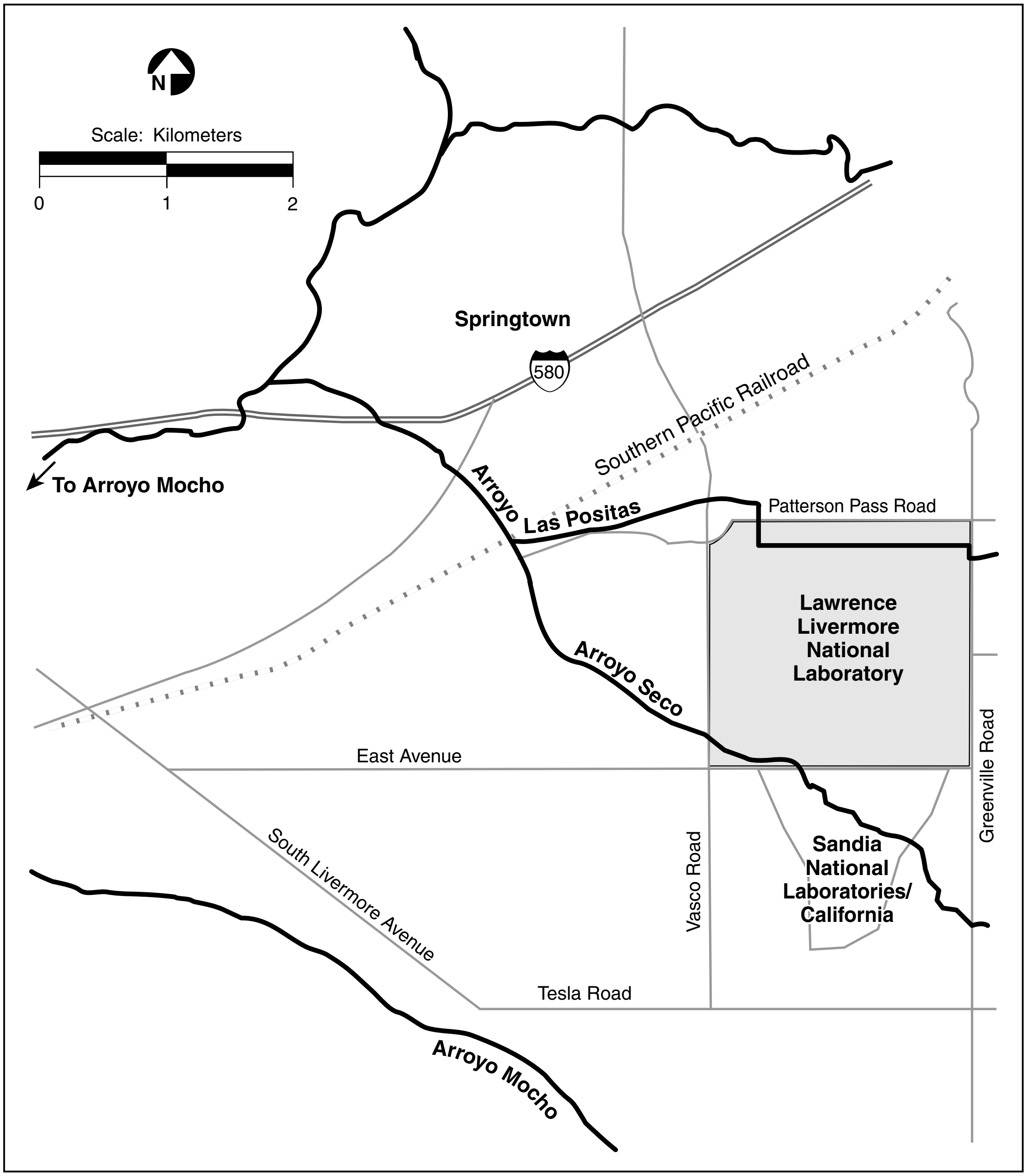


Figure 7-1. Surface waterways in the vicinity of the Livermore site

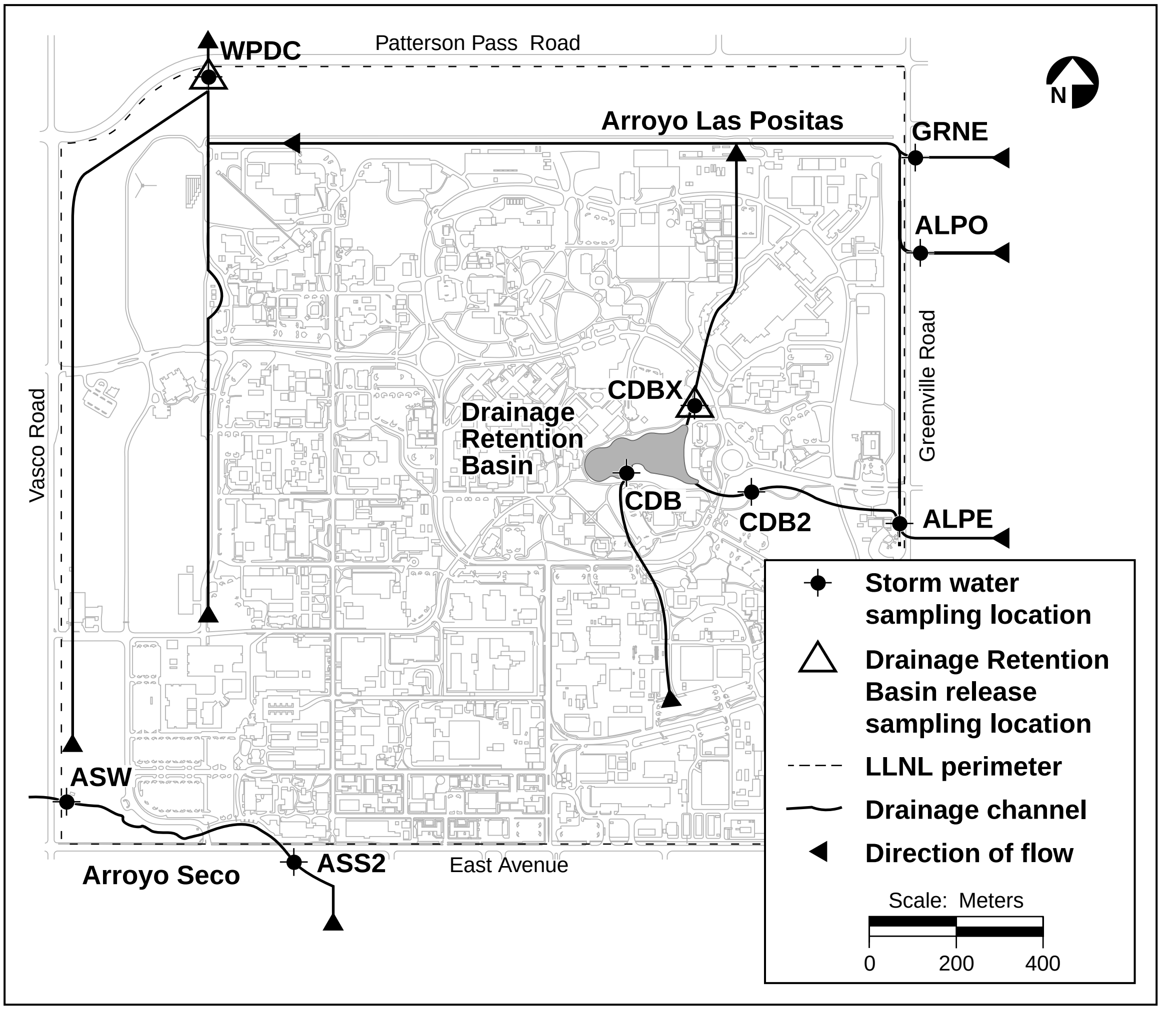


Figure 7-2. Storm water runoff and Drainage Retention Basin discharge sampling locations, Livermore site, 2000

The on-site Site 300 storm water sampling network began in 1994 with six locations and now consists of seven locations (Figure 7-3). Locations were selected to characterize storm water runoff at locations that could be affected by specific Site 300 activities.

Off-site location CARW is used to characterize runoff in Corral Hollow Creek upstream and therefore is unaffected by Site 300 industrial activities. Location GEOCRK is used to characterize runoff in Corral Hollow Creek, downstream of Site 300.

Methods

At all monitoring locations at both the Livermore site and Site 300, samples are collected by grab sampling from the storm runoff flowing in the stream channels. Standard sample bottle requirements, special sampling techniques, and preservation requirements for each analyte are specified in the *Environmental Monitoring Plan* (Tate et al. 1999) and summarized below.

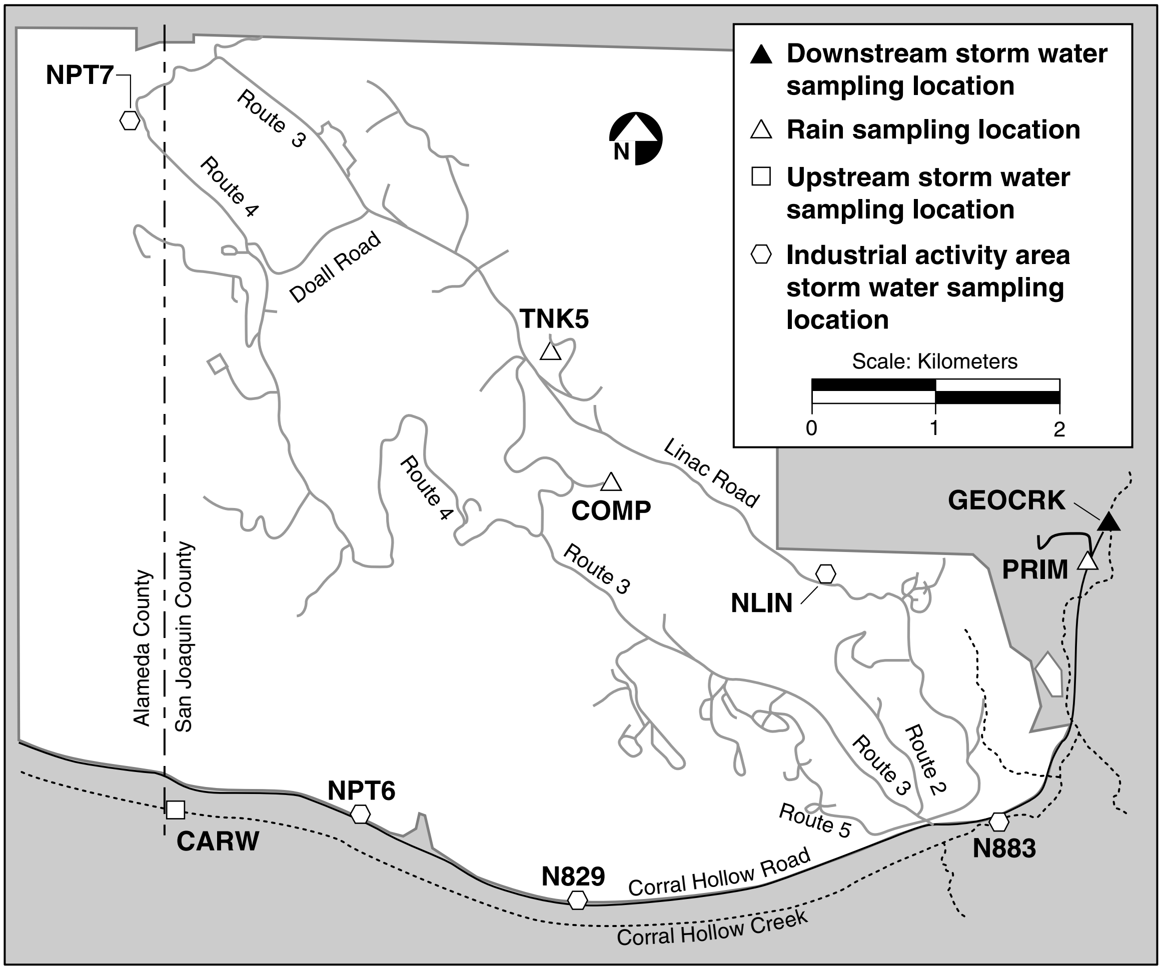


Figure 7-3. Stormwater and rainwater sampling locations at Site 300, 2000

Grab samples are collected by partially submerging sample bottles directly into the water and allowing them to fill with the sample water. If the water to be sampled is not directly accessible, a stainless-steel bucket or an automatic water sampler is used for sampling. The bucket is triple-rinsed with the water to be sampled, then dipped or submerged into the water, and withdrawn in a smooth motion. Sampling is conducted away from the edge of the arroyo to minimize the collection of sediment with water samples. Sample vials for volatile organics are filled before sample vials for all other constituents and parameters.

Results

Inspections

In accordance with WDR 95-174 and the LLNL SWPPP, all 12 directorate-level organizations at the Livermore site conducted the permit-required annual inspections during 2000. These inspections of more than 500 facilities indicated that all BMPs were in place, implemented, and adequate to protect storm water in all but seven instances at the Livermore site. Three of the exceptions noted were the absence of BMPs for the outdoor storage of materials (stored product, as well as cans of gasoline and chemical sealant). The gasoline cans were removed and the chemical sealant moved indoors, while the product materials were moved to a proper location. Work is progressing to transfer and ultimately dispose of the material. Additionally, excess equipment in the Building 235 dock area, contaminated with a photo-processing chemical by-product, has been decontaminated. The need for better runoff controls and a drainage swale were identified at Trailer 6303 and Building 622, respectively. Finally, it was determined that the beryllium found to be a roof contaminant at Building 241 is not mobile and poses no threat for storm water contamination. All Site 300 inspections of more than 100 facilities indicated that the applicable BMPs were in place, implemented, and adequate to protect storm water.

Additionally, LLNL conducted the permit-required inspections before, during, and after rain events at four permitted construction sites: three at the Livermore site and one at Site 300. The findings of these inspections indicated compliance with the permit and the construction site SWPPPs, with two exceptions documented in the 1999/2000 annual compliance certifications:

- The DWTF project did not update its SWPPP by the required deadline because construction operations were suspended. The DWTF SWPPP was revised prior to the recommencement of construction operations.

- The NIF project did not have the date of inspection on some of the inspection forms as required. The NIF storm water inspection forms were revised for the 2000/2001 rainy season.

Livermore Sampling

LLNL collected samples at all nine Livermore site locations on March 8, 2000. Earlier samples were collected from six locations on January 11 and February 14, 2000. The three monitoring locations that were not sampled on these dates were those where storm runoff flows into and out of the DRB. The fish and algae toxicity analyses were conducted during the January 11, 2000, sampling in order to catch the first flush that occurs at the beginning of the wet season.

Toxicity Monitoring: As required by WDR 95-174, grab samples were collected and analyzed for acute and chronic toxicity using the fathead minnow (*Pimephales promelas)* as the test species. The acute, 96-hour survival test was observed in undiluted storm water collected from location WPDC. The permit states that an acceptable survival rate is 20% lower than the survival rate of the control sample. The testing laboratory provides water for the quality control sample. As specified by the permit, upgradient water from influent locations ALPE, ALPO, and GRNE is used as an additional control. Thus, a difference of more than 20% between location WPDC and the control sample with the lowest survival rate is considered a failed test. If the test is failed, the permit requires LLNL to conduct additional toxicity testing during the next significant storm event. If two consecutive tests fail, LLNL must perform a toxicity reduction evaluation to identify the source of the toxicity. Survival in the acute test at WPDC and all corresponding influent locations (ALPE, ALPO, and GRNE) was 100% in 2000.

In the chronic test, storm water dilutions of 0 (laboratory control), 6.25, 12.5, 25, 50, and 100% (undiluted storm water) were used to determine a dose-response relationship, if any, for both survival and growth of the fathead minnow (see **Table 7-3**). No criteria are set by the permit for this test. In addition, this test is performed only on water from the effluent location (WPDC) and not on water from influent locations, so it is difficult to determine if toxicity should be attributed to LLNL or to upgradient water quality. From the data collected for this test, no observed effect concentrations

Table 7-3. Fish chronic toxicity test results, Livermore site, 2000

Sample Concen–tration (%)	7-day survival		7-day weight[a]	
	Average (%)	Standard deviation	Average (mg)	Standard deviation
Lab control	98	5.0	0.56	0.046
6.25	85	12.9	0.62	0.094
12.5	95	5.8	0.57	0.054
25	100	0	0.6	0.064
50	98	5.0	0.65	0.042
100	98	5.0	0.48	0.069

a Weight of the fathead minnows at the end of the 7-day toxicity test

(NOECs) or lowest observed effect concentrations (LOECs) were calculated using EPA/600/4-91-002. The NOECs and LOECs for survival and growth were 100%. Thus, both the acute and chronic fish toxicity tests indicated that storm water had no effect on survival or growth of the fathead minnow.

In addition to the flathead minnow toxicity test required by WDR 95-174, additional chronic toxicity tests for daphnid (*Ceriodaphnia dubia*) and freshwater algae (*Selenastrum capriocornutum*) were performed for water sampled at location WPDC on January 11, 2000. These additional tests were inadvertently performed by the analytical laboratory. These toxicity tests use the same dilutions as those described for the chronic fish toxicity. The daphnid toxicity is established with a 6-day survival test, and algae toxicities established by growth (cell counts) over a 96-hour period.

Toxicity was not observed in the daphnid test. However, algae growth was inhibited in the storm runoff compared with the control sample, with an NOEC of 12.5% and an LOEC of 25% (**Table 7-4**). As this toxicity test was conducted only at the effluent location (WPDC), there is no clear determination of whether algae growth was inhibited by an upstream activity or by activities at LLNL. However, past water quality data have indicated moderately high herbicide concentrations, specifically diuron, at one of the influent sampling locations (GRNE) in a tributary to Arroyo Las Positas (**Figure 7-4**). The influent concentrations of this herbicide, such as the peaks shown at GRNE in 1997 and 1999, are often higher than the effluent waters from LLNL. One exception is the peak in January 1999 at WPDC; however, this single peak was much smaller than the other peaks measured at GRNE. Influent concentrations of diuron were higher than effluent concentrations in 2000. Therefore, if the diuron is impacting algae growth in the storm water, then the problem is likely caused by an upstream source. Monitoring of algae toxicity will continue in 2001 to determine if this problem persists.

Table 7-4. Algae chronic toxicity test results, Livermore site, 2000

Sample concentration (%)	96-hour growth	
	Count (10^5 cells/mL)	Variance (%)
Lab control	11.9	10.2
6.25	11.6	9.0
12.5	12.5	6.4
25	10.1	9.9
50	6.0	8.3
100	5.0	7.7

Livermore Site Radioactive Constituents:

Storm water sampling and analysis were performed for gross alpha, gross beta, plutonium, and tritium. Storm water gross alpha, gross beta, and tritium results are summarized in **Table 7-5.** Complete results are in Data Supplement Tables 7-1, 7-2, and 7-3. Tritium activities at effluent locations were less than 4% of the respective MCLs. **Figures 7-5** through **7-8** show the historical activities of gross

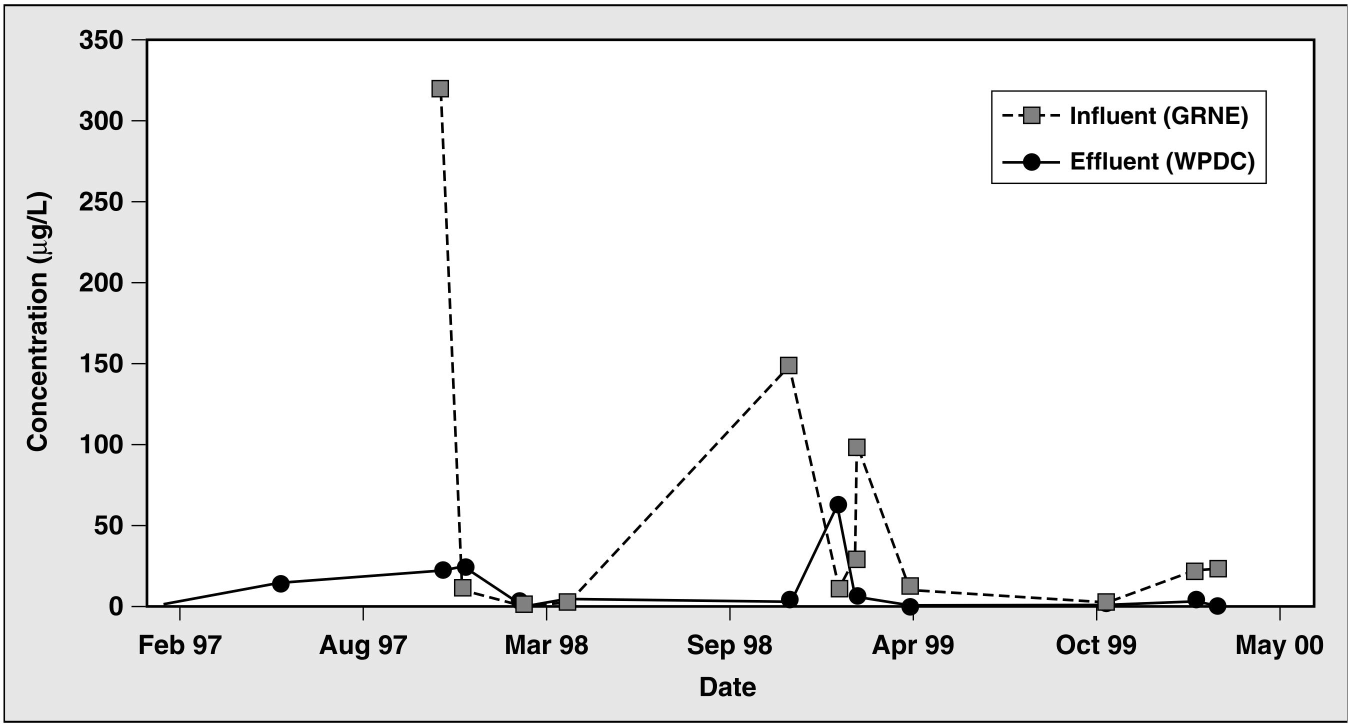


Figure 7-4. Diuron concentrations in Arroyo Las Positas storm water 1997–2000

Table 7-5. Radioactivity in storm water from the Livermore site, 2000[a]

Locations	Tritium (Bq/L)	Gross alpha (Bq/L)	Gross beta (Bq/L)
MCL	740	0.555	1.85
Influent			
Median	0.316	0.140	0.278
Minimum	–1.162	0.015	0.091
Maximum	2.683	0.685	1.040
Effluent			
Median	1.395	0.068	0.200
Minimum	0.129	0.031	0.189
Maximum	27.232	0.714	1.162

a See Chapter 14 for a complete explanation of calculated values.

alpha and gross beta, respectively, in storm runoff. There is no discernible trend in any of these figures. However, activities in water running on and off site are highly correlated.

LLNL began analyzing for plutonium in storm water in 1998. Samples were analyzed from the Arroyo Seco and Arroyo Las Positas effluent locations (ASW and WPDC). The unfiltered water was analyzed when the samples were low in suspended sediments. When the analytical laboratory determined that water samples contained sufficient sediment (as it did on January 11, 2000), a portion of the runoff was analyzed unfiltered, and the remaining runoff was filtered. The filtrate and filtered water were analyzed (three analyses total from each location). Plutonium was not found to be at activities above the detection limit for either the liquid or sediment portion of the storm water

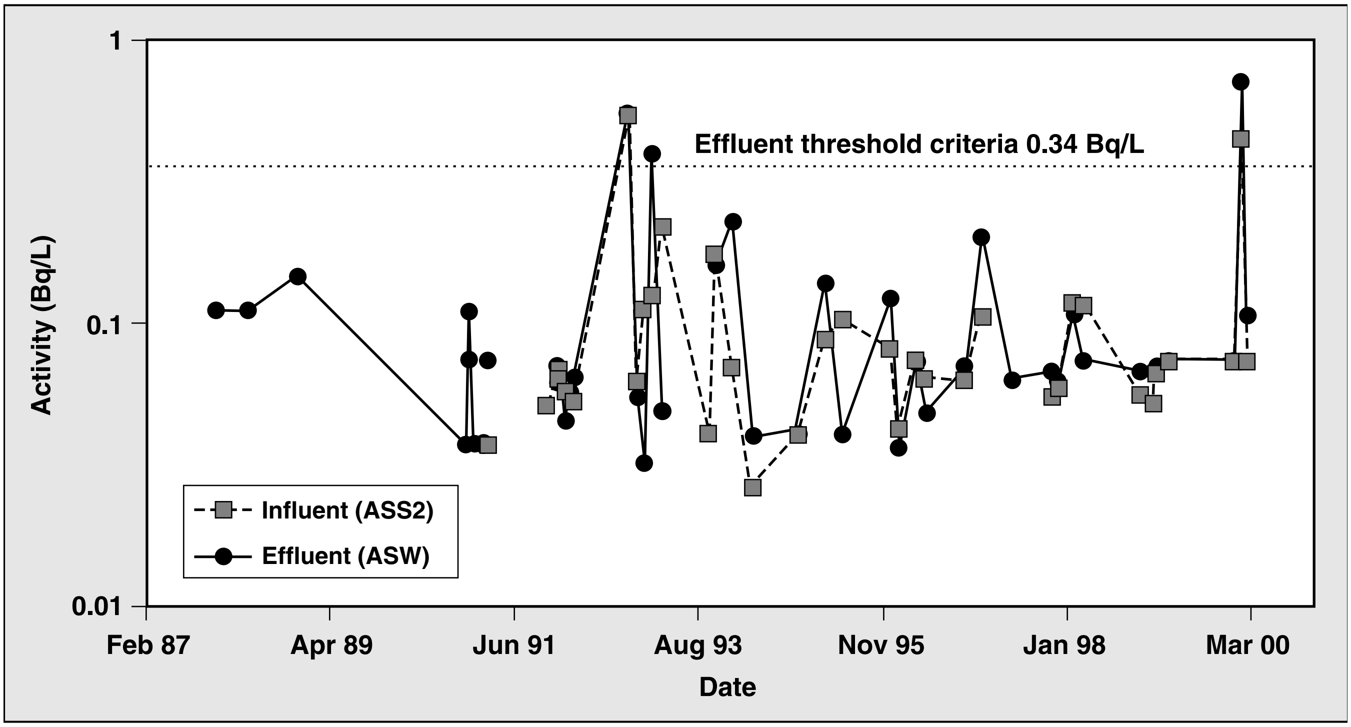


Figure 7-5. Gross alpha activities in Arroyo Seco storm water at the Livermore site compared with the LLNL site-specific threshold shown in Table 7-2

samples in 2000. Thus, there is no evidence in the data to indicate that LLNL has contributed plutonium to runoff. Complete plutonium results are found in Data Supplement Table 7-3.

Beginning with the 1996/1997 season, the tritium activity in Arroyo Las Positas was observed to be higher in storm water leaving the site than in storm water entering the site. On May 23, 1997, at location WPDC, where effluent is measured, a single higher-than-typical result for tritium in storm water (359 Bq/L) was measured. The historical trend in tritium levels at location WPDC is presented in **Figure 7-9**.

In response to the elevated effluent tritium levels, additional tritium investigations were initiated in the fall of 1998 to reconfirm the current evidence that effluent tritium activity is greater than influent tritium activity, and to identify potential sources of tritium to the storm runoff. These investigations included:

- Review of air tritium sampling results
- Increased frequency of rain sampling
- Increased frequency and number of locations of storm water sampling

The initial approach taken to evaluate tritium flow patterns across the Livermore site was to evaluate four locations upstream of WPDC (WPDW, 196S, WPDS, and 196E) (**Figure 7-10**), where the storm drainage channels join the main Arroyo Las Positas channel and leave the Livermore site. Samples were collected at these junctures on November 30, 1998, and reported in the *Environmental Report 1998* (Larson et al. 1999). Tritium

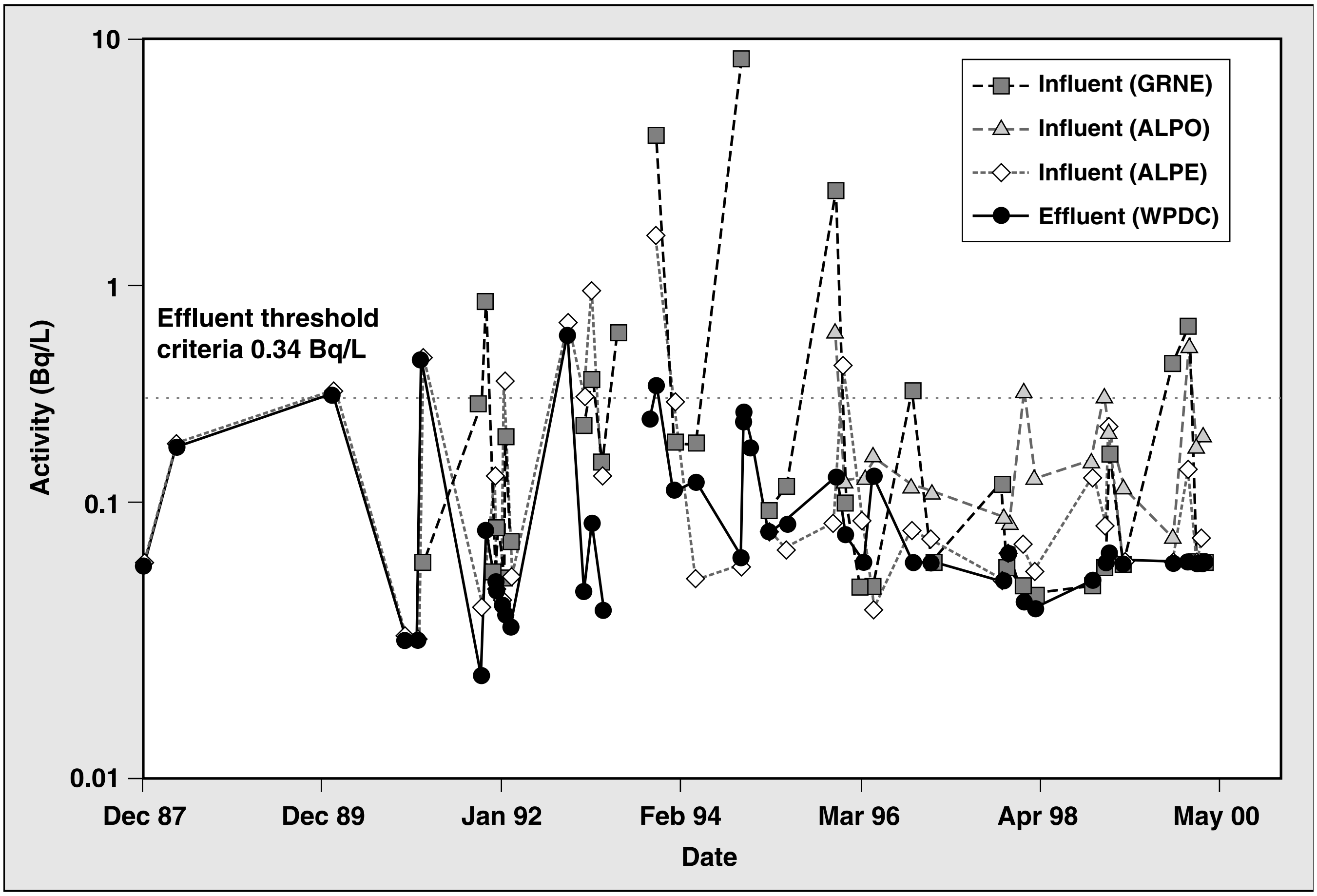


Figure 7-6. Gross alpha activities in Arroyo Las Positas storm water at the Livermore site compared with the LLNL site-specific threshold shown in Table 7-2

was not detected in the incoming channels (calculated values of 2.0 and 0.9 Bq/L at WPDW and 196S, respectively), but was detected at 31 Bq/L in the main Arroyo Las Positas channel at both WPDS and 196E.

Follow-up analyses during 1999 located a potential on-site source for the tritium in the storm water samples showing up in air samples near Building 331. On March 28, 1999, facility staff located a glove box with a faulty pump that was causing the glove box contents to vent directly to the building stack. However, continued detailed tritium observations from locations in the area (**Figure 7-10**) and in the north-south storm drain, found increased tritium activities revealing an additional source. Specifically, higher levels were found at locations 3726 and 2582 near buildings 331 and 343. The source of elevated tritium was tracked to a transportainer containing materials exposed to tritium. The transportainer had been placed outside Building 331 from April 1998 to April 30, 1999. It was moved to just outside Building 343, where it remained until August 2000, when it was removed and disposed of properly as radioactive waste.

Sampling of surface runoff in the vicinity of the transportainer near Building 343 found tritium concentrations as high as 41,138 Bq/L. These

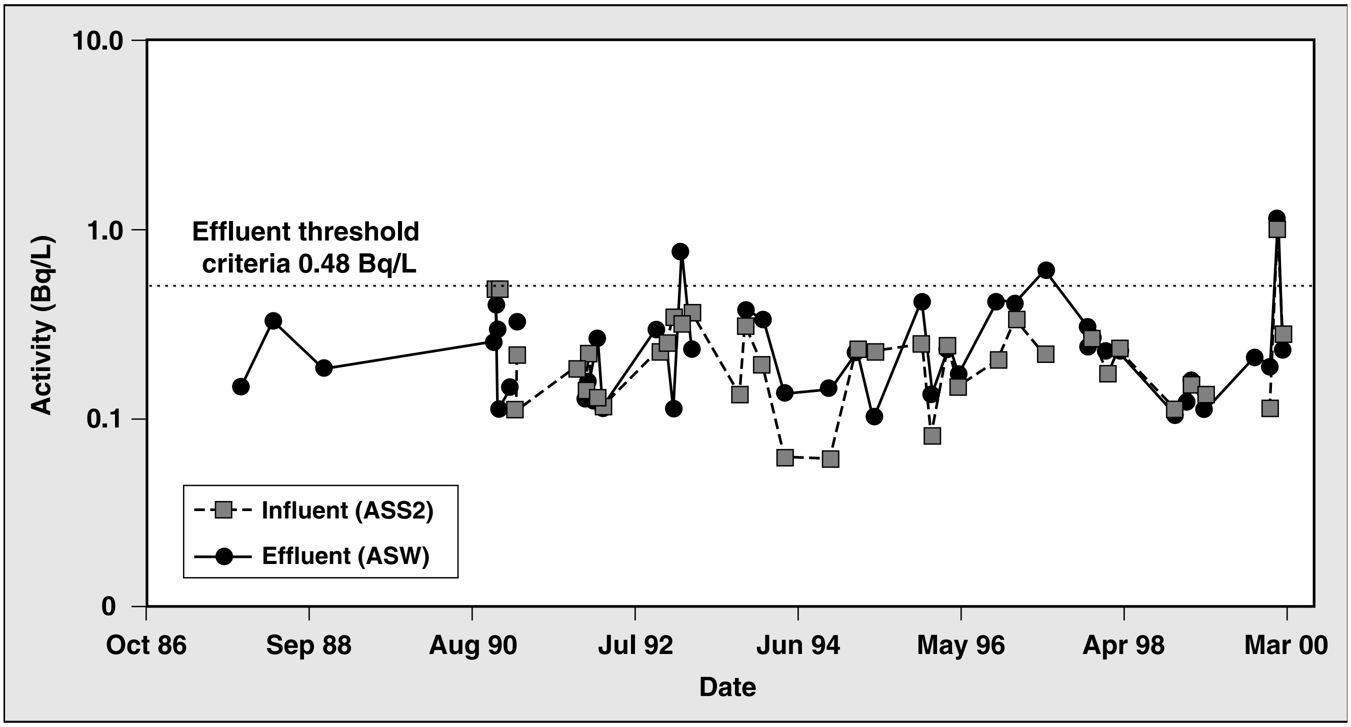


Figure 7-7. Gross beta activities in Arroyo Seco storm water at the Livermore site compared with the LLNL site-specific threshold shown in Table 7-2

samples were taken in the parking lot directly downgradient from the transportainer. This concentration was significantly diluted so that samples collected at the site outlet (WPDC) on the same day were not more than 4% of the drinking water standard for tritium (740 Bq/L). Continued monitoring of both surface runoff near Building 343 and sampling in the storm channels have demonstrated a rapid decrease in measured tritium concentrations since the transportainer was removed in August 2000 (**Figure 7-11**). Monitoring of this network will continue into 2001 until tritium concentrations in the north-south storm drain near Building 343 return to background levels (**Figure 7-12**).

Livermore Site Nonradioactive Constituents: In addition to data on radioactivity, the results for other water quality parameters were analyzed. Sample results were compared with the comparison criteria in **Table 7-2**; of greatest concern are the constituents that exceed comparison criteria at effluent points and whose concentrations are lower in influent than in effluent. If influent concentrations are higher than effluent concentrations, the source is generally assumed to be unrelated to LLNL operations; therefore, further investigation is not warranted. Constituents that exceeded comparison criteria for effluent and influent locations are listed in **Table 7-6**. Some of the constituents identified by this screening process (ions and metals) were not listed, as their presence has been attributed to naturally occurring concentrations transported in sediments during a previous two-year study (Brandstetter 1998). Furthermore, many of the high effluent values that occurred were recorded at an influent tributary to Arroyo Las Positas (ALPO) on March 8, 2000. On this date, the influent total suspended solids (TSS) concentration was also high. A correlation does exist

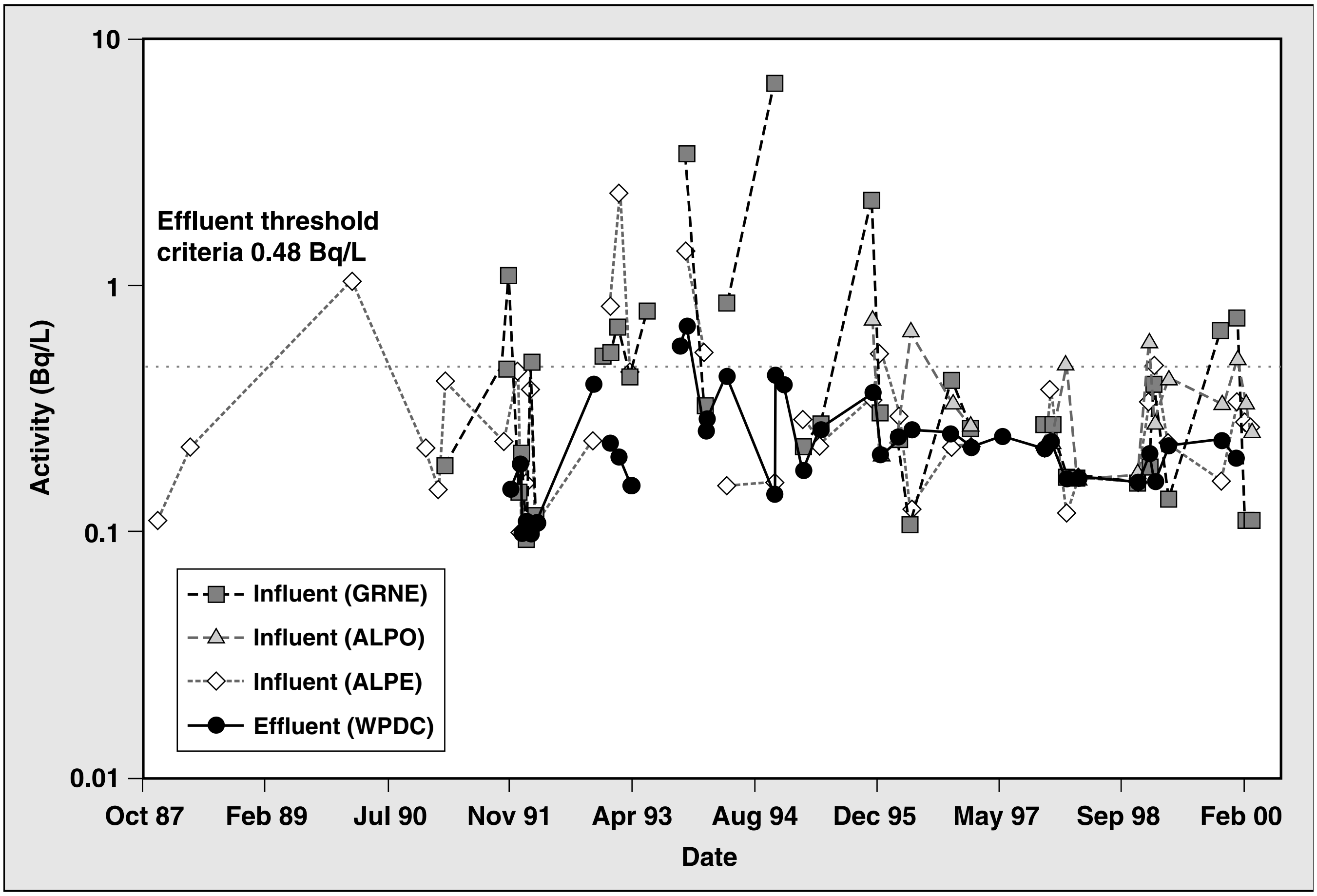


Figure 7-8. Gross beta activities in Arroyo Las Positas storm water at the Livermore site compared with the LLNL site-specific threshold shown in Table 7-2

between TSS and some metals; for example, correlation coefficients for zinc, iron, and aluminum to TSS are 0.21, 0.36, and 0.4, respectively. In addition, correlations between these metals (zinc to iron, iron to aluminum, and aluminum to zinc) were found to range from 0.31 to 0.99. These results suggest a natural, relatively consistent association between sediments and metals found in the storm water runoff from the Livermore site.

Using the threshold comparison criteria and the guideline that if influent values are much lower than effluent values, data from two water quality parameters from location ASW on Arroyo Seco (TSS and zinc on February 14) deserve further attention. After examining our sampling locations, it was discovered that an additional influent channel source into the arroyo was not being captured by our upstream sampling location (ASS2). Visual observations during storm flow suggested that the channel is a potential source for suspended sediment. If this is the source of the high TSS values on February 14, then it is also reasonable that, given the demonstrated correlation between TSS and zinc, the high sediment load also resulted in the high zinc concentration in the unfiltered samples. A new sampling location will be added to the newly identified channel in 2001 to test the hypothesis that it is a source for suspended sediment.

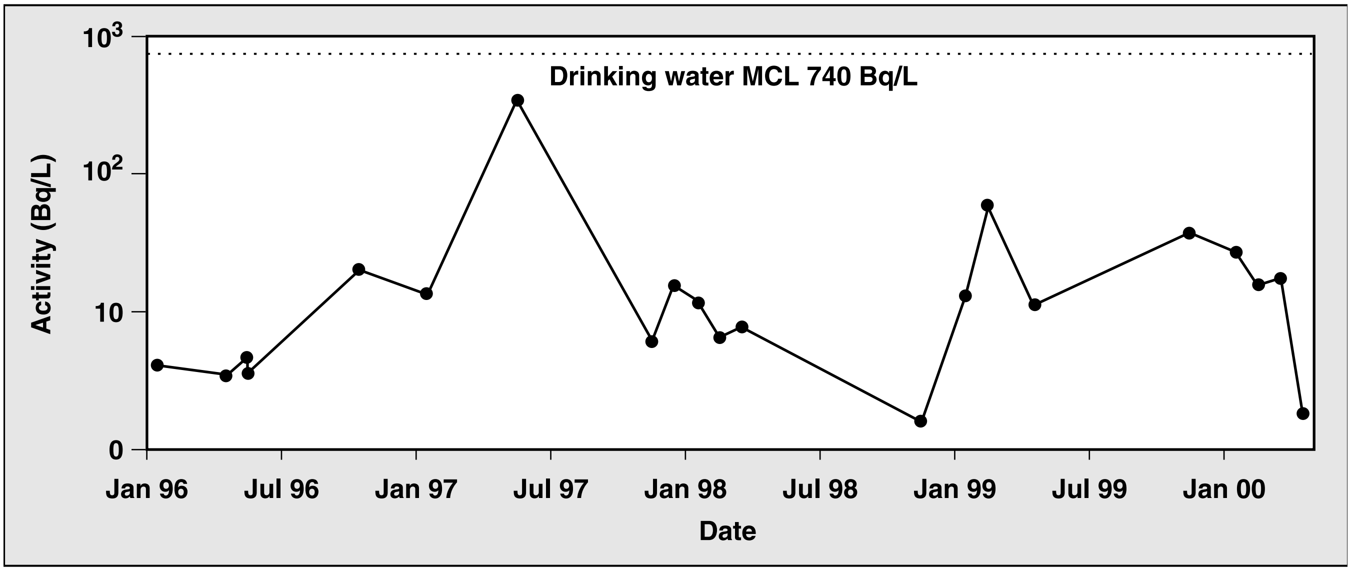


Figure 7-9. Tritium activity in Livermore site storm water at the outflow location WPDC compared with the drinking water maximum contaminant level (MCL)

Complete storm water results for nonradioactive constituents are presented in Data Supplement Tables 7-4, 7-5, and 7-6.

To build on the storm water monitoring program, LLNL began to examine the potential to use easily measured water quality parameters as indicators for those not as easily measured. Many basic chemical characteristics (e.g., pH, dissolved oxygen, and specific conductance) of storm water may be monitored in the stream channel in real time. As a precursor to designing a storm water monitoring system to collect regular data over short sampling intervals, relationships between water quality parameters and an indicator, such as specific conductance, must first be examined. To this end, LLNL performed regression analysis on the water quality data to relate specific conductance and other storm water constituents. The goal, to determine if specific conductance could be used as a indicator (or predictor) of the levels of other chemical components impacting stream water quality, will improve our understanding of runoff and solute transport in the storm water. Various parameters were compared to specific conductance and linear regression models, and the relative fits (r^2 values) of that model were estimated. The results are shown in **Figure 7-13**.

The chemical parameters that influence the specific conductance measurement (i.e., chloride, sulfate, sodium, and fluoride) are highly correlated with r^2 values ranging from 0.82 to 0.98. There are two main potential causes for the correlations. The first is that the measurements are chemically related. Therefore, the concentration directly impacts the specific conductance, chloride for example. At the same time, a correlation between specific conductance and other parameters may result if water is consistently dominated by a single source, such as surface runoff or soil-water interflow. In this case, there may be no chemical relationship, only a consistency in where the water comes from. For example, the water could be high in specific conductance in a place that always adds dissolved oxygen because of rapid water flow. This may be the explanation for

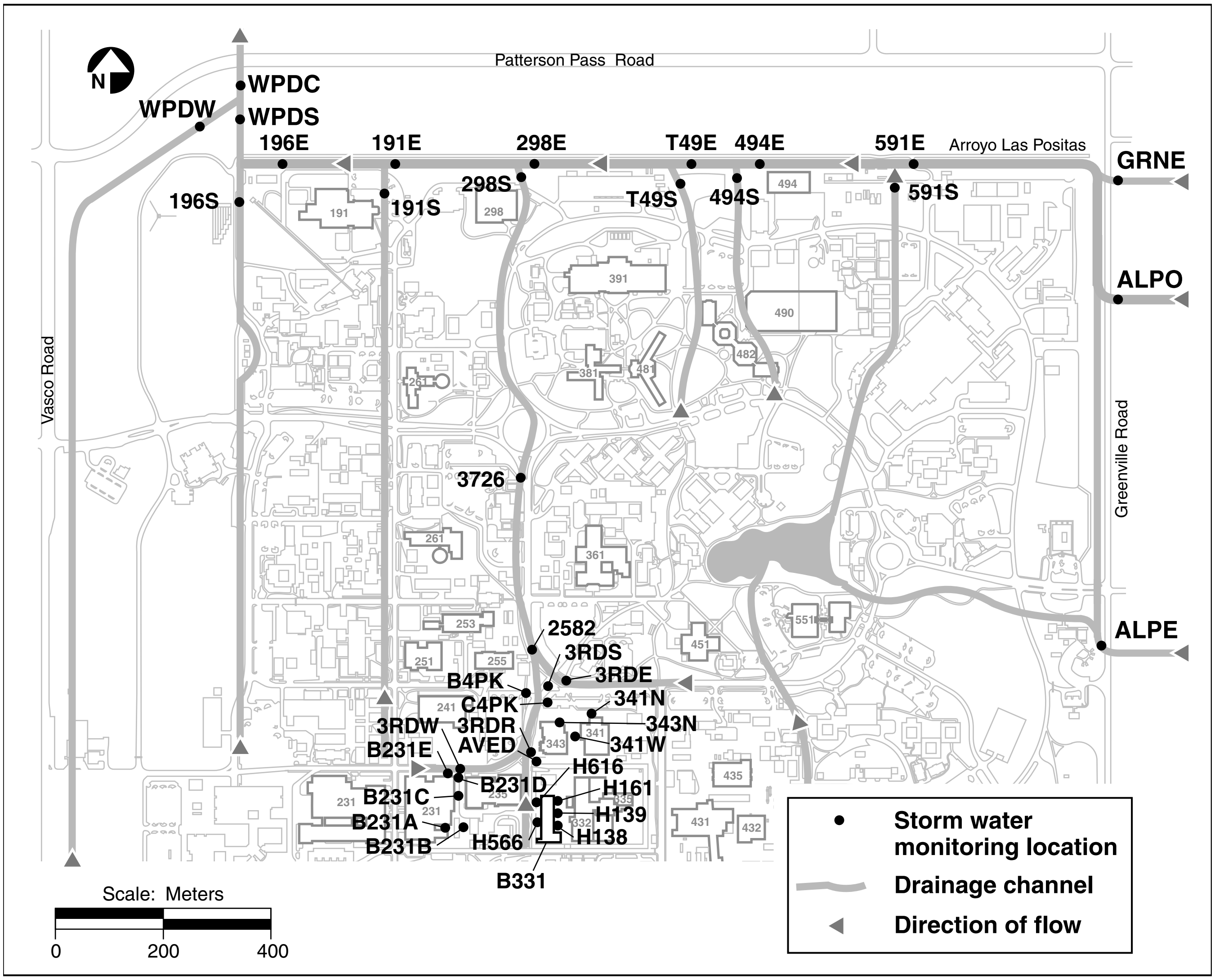


Figure 7-10. Sampling locations for the special tritium studies performed at Livermore site

the weaker relationships observed between specific conductance and pH or chemical oxygen demand, which have r^2 values of 0.39 and 0.05, respectively. The metals examined did not demonstrate a consistent relationship to specific conductance, so another indicator might be necessary.

There is the potential of using a few easily measurable water quality parameters to represent the transport distributions of other chemical components in storm runoff. Specific conductance is clearly a reasonable indicator for general minerals (ions) in the storm water, but is less useful for other parameters like metals. Over the next year, LLNL will continue to evaluate other indicators, specifically for metals. In addition, the potential of using continuous in-stream monitoring devices will be explored in an effort to increase our ability to assess potential environmental impacts of storm runoff from the Livermore site.

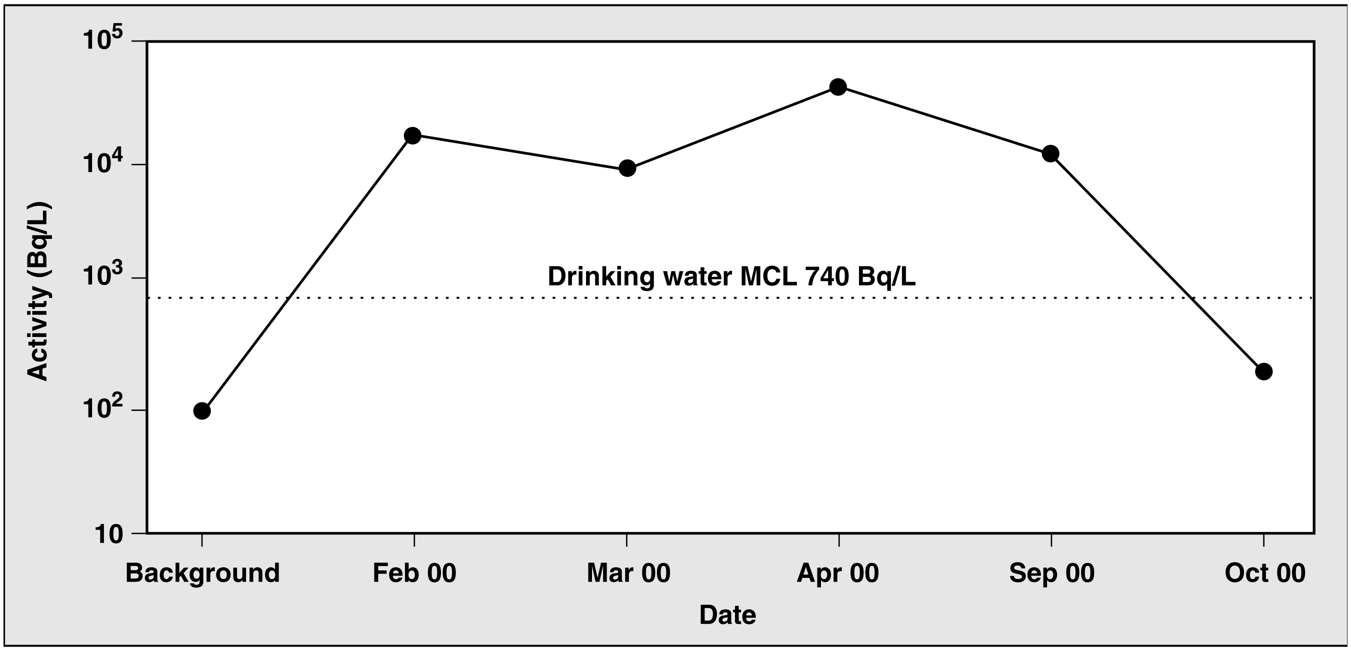


Figure 7-11. Tritium activity in Livermore site storm water at the locations near Building 343 where the transportainer was last located

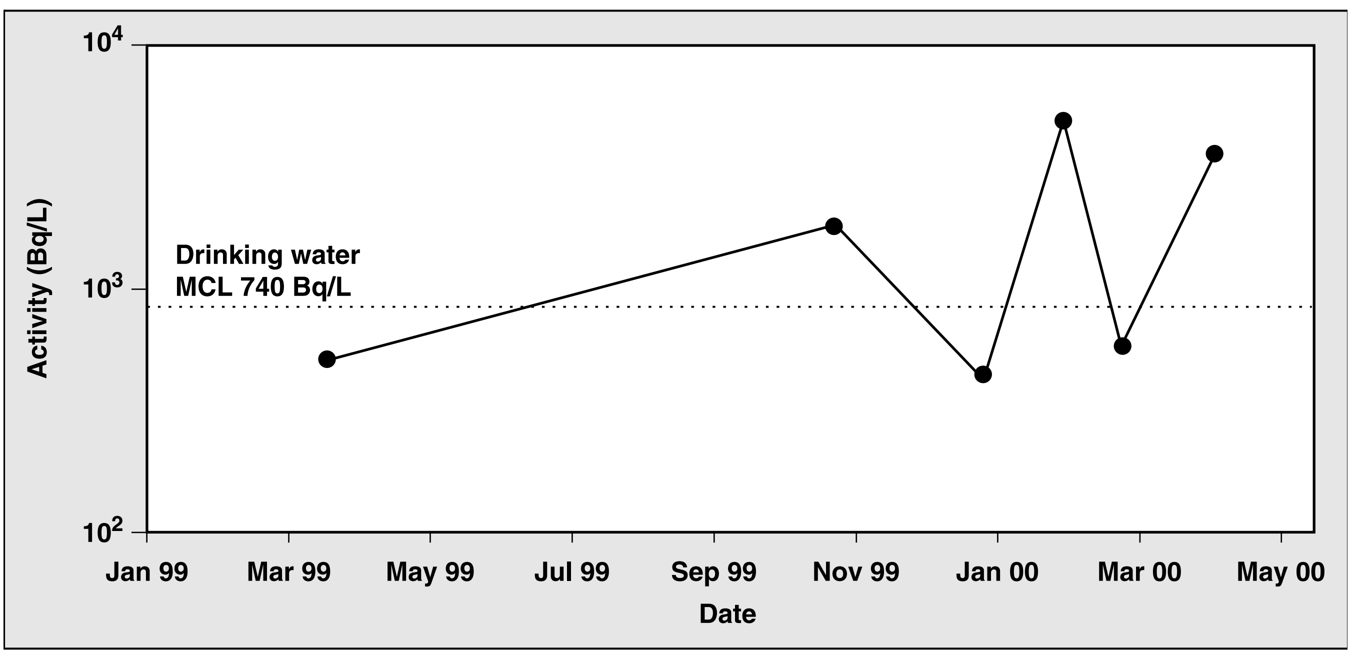


Figure 7-12. Tritium activity in Livermore storm water at location 3726 near Building 343 compared with the drinking water maximum contaminant level (MCL)

Table 7-6. Nonradioactive water quality parameters from the Livermore site in 2000 above the threshold comparison criteria shown in Table 7-2

Parameter	Date	Location	Influent or effluent	2000 results/ threshold criteria
Nitrate (as NO_3) (mg/L)	2/14	ALPO	Influent	13/10
	3/8	ALPO	Influent	14/10
Orthophosphate (mg/L)	2/14	ALPE	Influent	2.81/2.5
Total suspended solids (mg/L)	2/14	ASW	Effluent	835/750
Diuron (mg/L)	2/14	ALPO	Influent	0.023/0.014
	2/14	GRNE	Influent	0.022/0.014
	3/8	GRNE	Influent	0.024/0.014
Copper (mg/L)	2/14	ASS2	Influent	0.05/0.026
	2/14	ASW	Effluent	0.058/0.026
Chromium(VI) (mg/L)	2/14	ALPE	Influent	0.026/0.016
	2/14	ASW	Effluent	0.017/0.016
	2/14	GRNE	Influent	0.017/0.016
pH	3/8	ALPO	Influent	8.53/<6.0,>8.5
	3/8	ASS2	Influent	8.52/<6.0,>8.5
	3/8	ALPE	Influent	8.5/<6.0,>8.5
Zinc (mg/L)	2/14	ASW	Effluent	0.15/0.117

Site 300 Sampling

LLNL procedures specify sampling a minimum of two storms per rainy season from Site 300. Typically, a single storm does not produce runoff at all Site 300 locations, because Site 300 receives relatively little rainfall and is largely undeveloped. Therefore, at many locations, a series of large storms is required to saturate the ground before runoff occurs. In 2000, samples were collected at locations with flow on January 24, February 14, February 22, and March 2. There was no tritium above the minimum detectable activity in Site 300 storm water during 2000. The maximum values of all effluent gross alpha and gross beta results were 0.36 and 0.55 Bq/L, respectively, approximately 64% and 30% of the drinking water MCLs (0.56 and 1.85 Bq/L). (See Data Supplement, Table 7-7.) The maximum gross alpha and beta values for the downstream location GEOCRK were 1.06 and 1.42 Bq/L, respectively, where the gross alpha value that exceeds the LLNL threshold may be explained by a higher value in the upstream influent (CARW) of 1.306 Bq/L. This gross alpha value was the highest recorded for the year. The corresponding gross beta value at this upstream location was 1.95 Bq/L, which is also above our comparison criteria. This is not unusual, however, as this area has had relatively high background gross alpha and beta levels in stream flow that are closely associated with suspended sediment

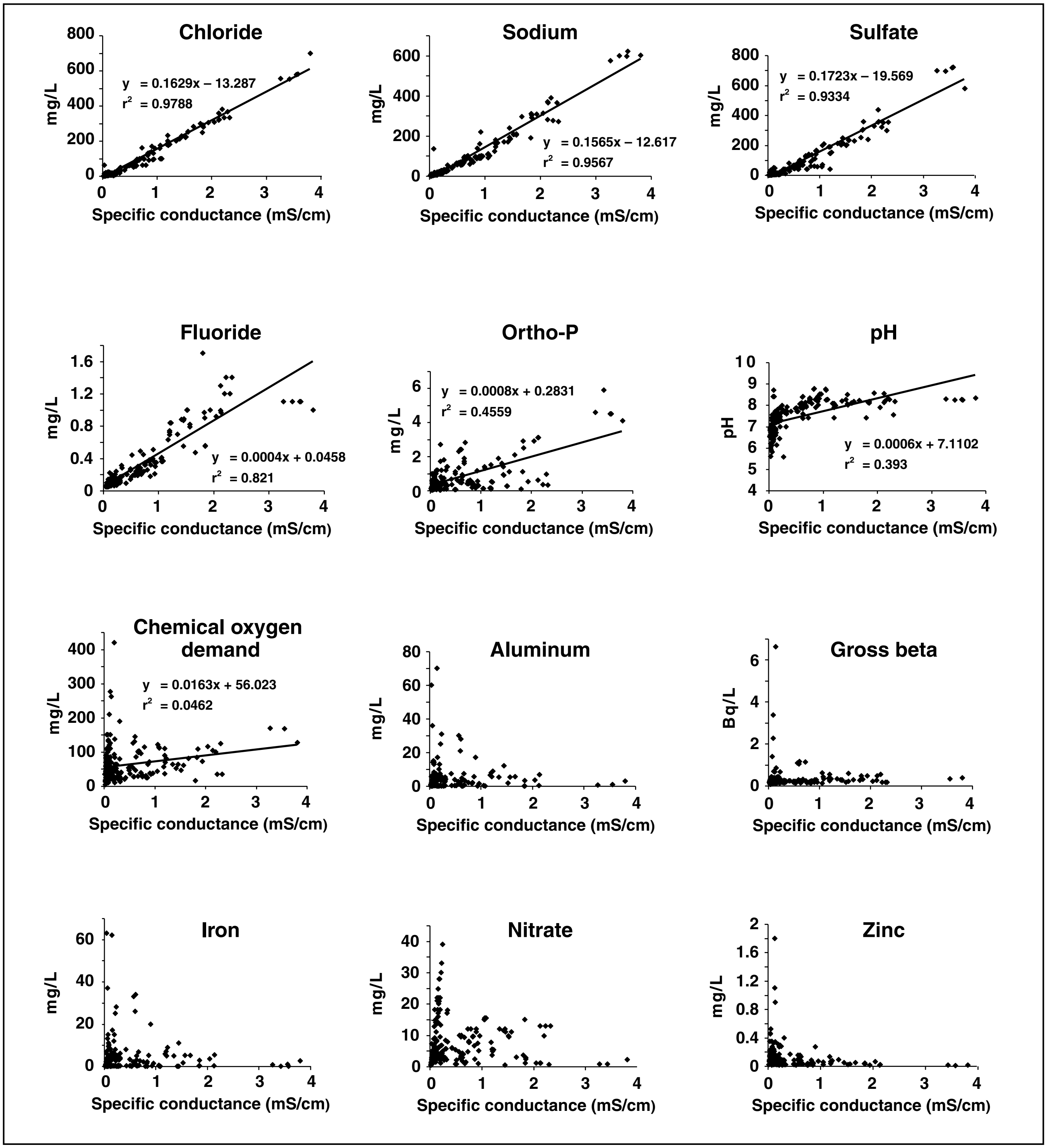


Figure 7-13. Correlations between selected parameters and specific conductance in storm water

(Harrach et al. 1996). As the high runoff energy of storm flow suspends sediment, it is likely that the source is natural. Regardless of the source, the upstream CARW gross alpha and beta levels are higher than the downstream point at GEOCRK, so the runoff from Site 300 is actually contributing to dilution of the upstream water, reducing the levels of TSS observed at GEOCRK (**Table** 7-7).

Table 7-7. Total suspended solids in storm water samples from Site 300 in 2000

Sampled date	Location	Total suspended solids (mg/L)
1/24	GEOCRK	<2
1/24	N883	443
1/24	NPT7	18
2/14	CARW	1710
2/14	GEOCRK	1100
2/14	NLIN	243
2/22	NPT7	64
3/2	N883	66.5

Tables 7-8 and 7-9 in the Data Supplement list results for nonradioactive constituents and dioxins in Site 300 storm water runoff. Because of a CERCLA remedial investigation finding of past releases of polychlorinated biphenyls (PCBs) and dioxins related to activities in the vicinity of Building 850, LLNL conducted an analysis for PCBs and dioxins at location NLIN, the storm water sampling location downstream of Building 850. The intent of the sampling was to determine whether these constituents are being released from the site in storm water runoff. Dioxins and furans were detected at low levels (maximum of 470 pg/L, or 4.7×10^{-7} mg/L); all concentrations were below MCLs and other comparison criteria.

Sampling at Pit 6 includes analyses required as part of the postclosure sampling; however, no storm runoff was sampled as the drains did not produce any runoff to collect in 2000.

Specific conductance and TSS at Site 300 locations were at times above comparison criteria. However, effluent levels were lower than levels at the upstream location CARW, indicating that the levels observed in effluent are typical for the area. Suspended sediment is an issue in Coral Hollow Creek, but it is clear that activities at Site 300 are not producing a majority of that sediment. In fact, storm water from the site appears to be contributing to the dilution of the upstream water that contains higher sediment loads (**Table** 7-7). The valley floor is dominated by an off-road motorcycle use area and ranching activities that are potential sources for sediment. All other Site 300 results were below comparison criteria.

Rainfall

This section discusses general information about rainfall in the Livermore site, Livermore Valley, and Site 300, as well as methods for sampling rainfall and the sampling results.

General Information

Livermore Site and Livermore Valley

Historically, the tritium activity measured in rainfall in the Livermore Valley results primarily from atmospheric emissions of tritiated water (HTO) from vent stacks at LLNL's Tritium Facility (Building 331), and from the former Tritium Research Laboratory at the Sandia National Laboratories/California (Sandia/California). The total measured atmospheric emission of HTO from LLNL facilities in 2000 was 1.60 TBq (see Chapter 4).

The rain sampling station locations are shown in **Figure 7-14**. The fixed stations are positioned to record the maximum activity expected down to background levels. The Building 343 rain sampling location is near the Tritium Facility (Building 331) and has historically recorded the maximum tritium activity in rainfall.

Site 300

One off-site location (PRIM) and two on-site locations (COMP and TNK5) are used to collect rainfall for tritium activity measurements at Site 300 (**Figure 7-3**).

Methods

Rainfall is sampled for tritium according to written procedures, described in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999) and summarized here. Rainfall is collected in stainless-steel buckets at specified locations. The buckets are placed in open areas and are elevated about 1 m above the ground to prevent collection of splash-back water. Rainwater samples are decanted into 250-mL amber glass bottles with Teflon-lined lids. The tritium activity of each sample is measured by scintillation counting (EPA Method 906).

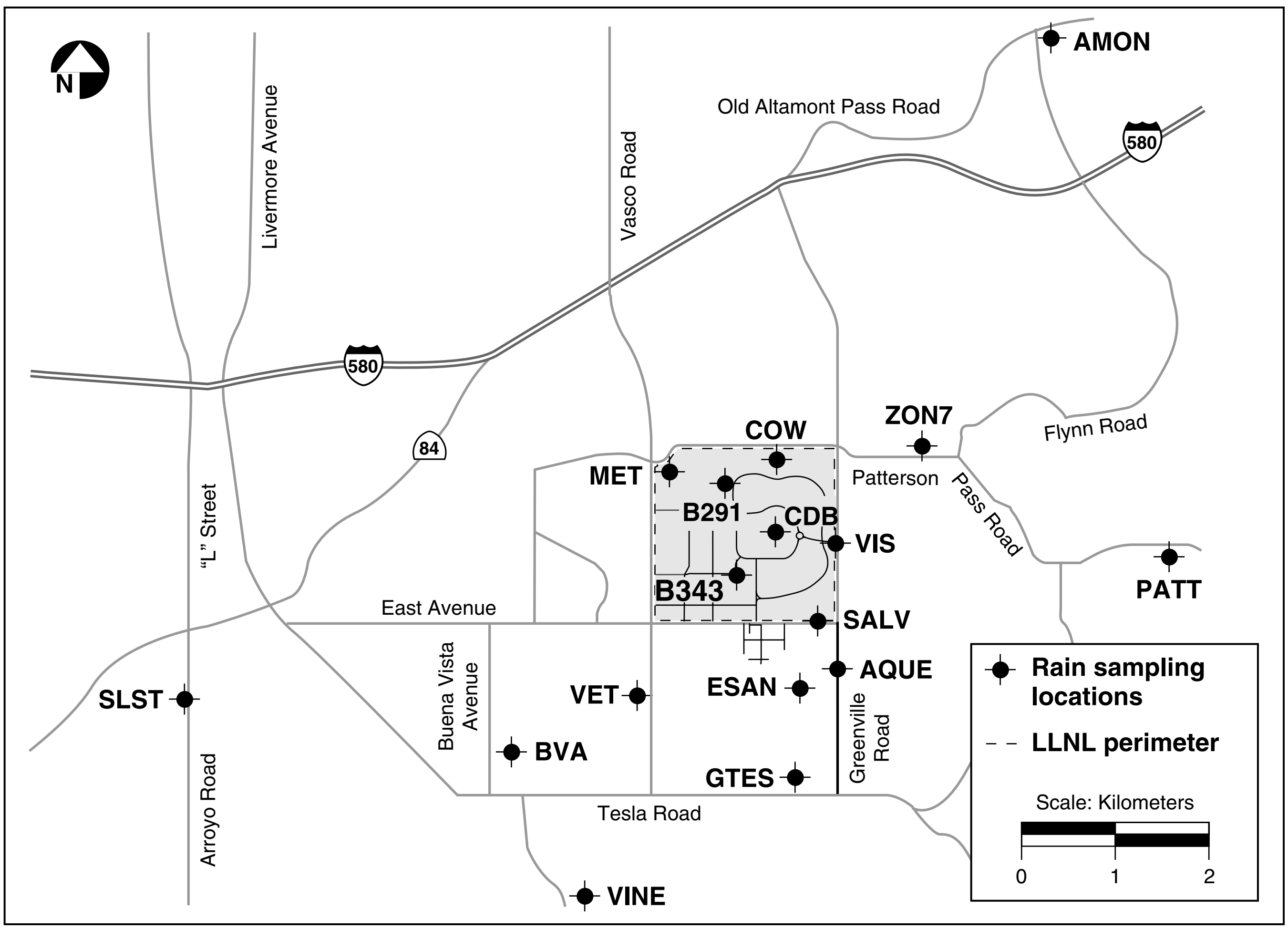


Figure 7-14. Rain sampling locations, Livermore site and Livermore Valley, 2000

Results

Livermore Site and Livermore Valley

During 2000, LLNL collected sets of rain samples following 7 rainfall events at the Livermore site (87 total routine samples obtained) and 4 events at Site 300 (10 total routine samples obtained). The tritium activities of the 97 routine rainwater samples obtained during 2000 are listed in Table 7-10 of the Data Supplement.

The Livermore site rainfall has exhibited elevated tritium activities in the past (Gallegos et al. 1994). During 2000, however, only one measurement of tritium activity in rainfall, obtained from one on-site location (Building 343), was above the 740 Bq/L MCL established by the EPA for drinking water. The activities of the remaining samples were very low, and most were at background level. As in the past, the on-site rainfall sampling location 343N (the sampling location nearest the Tritium Facility) showed the highest tritium activity for the year: 1413 Bq/L (see **Table 7-8**) for the rainfall event that immediately preceded the March 23 collection date. The highest off-site tritium activity measured in a routine sample during 2000 was less than 7 Bq/L (sample collected March 23 at location ESAN). All of the off-site routine rainfall samples measured during 2000 showed tritium activities less than 1% of the tritium MCL for drinking water.

Table 7-8. Tritium activities in rainfall for the Livermore site, Livermore Valley, and Site 300, 2000

Parameter	Livermore site (Bq/L)	Livermore Valley (Bq/L)	Site 300
Maximum	1413 ± 15.2	6.73 ± 1.75	0.223 ± 1.99
Minimum	–1.33 ± 1.52	–2.11 ± 1.44	–1.64 ± 1.97
Median	3.70	0.424	–0.0646
Interquartile range	10.2	2.42	0.548
Number of samples	43	44	10

The median tritium activity measured in rainfall at LLNL decreased from 19.0 Bq/L in 1999 to 3.7 Bq/L in 2000. This was primarily because of an overall reduction of on-site HTO emissions, from a total of 8.1 TBq for the year 1999 to a total of 1.6 TBq for the year 2000. The median tritium activity for rainfall at LLNL during 2000 reached its lowest level in the eleven year period beginning in 1990, when it was 65.9 Bq/L. This decrease mirrors the downward trend in total HTO emissions from LLNL's Tritium Facility (shown in **Figure 7-15**). HTO emissions have decreased from a total of 34.9 TBq for year 1990 to 8.1 TBq for year 1999 and to 1.6 TBq for year 2000. Values for median tritium activity shown in **Figure 7-15** are derived from the on-site LLNL rain sampling locations. Similar to tritium activities observed in on-site storm runoff, the tritium activity in rainfall at LLNL decreased even more during 2000 following the removal in August of a waste container (transportainer) that contained tritium-contaminated equipment.

Site 300

As in the past, none of the ten routine rain samples obtained from monitoring locations at Site 300 during 2000 showed tritium activities above background activity there, which is approximately 2 Bq/L.

Livermore Site Drainage Retention Basin

This section discusses general information about the DRB, sampling methods, and sampling results.

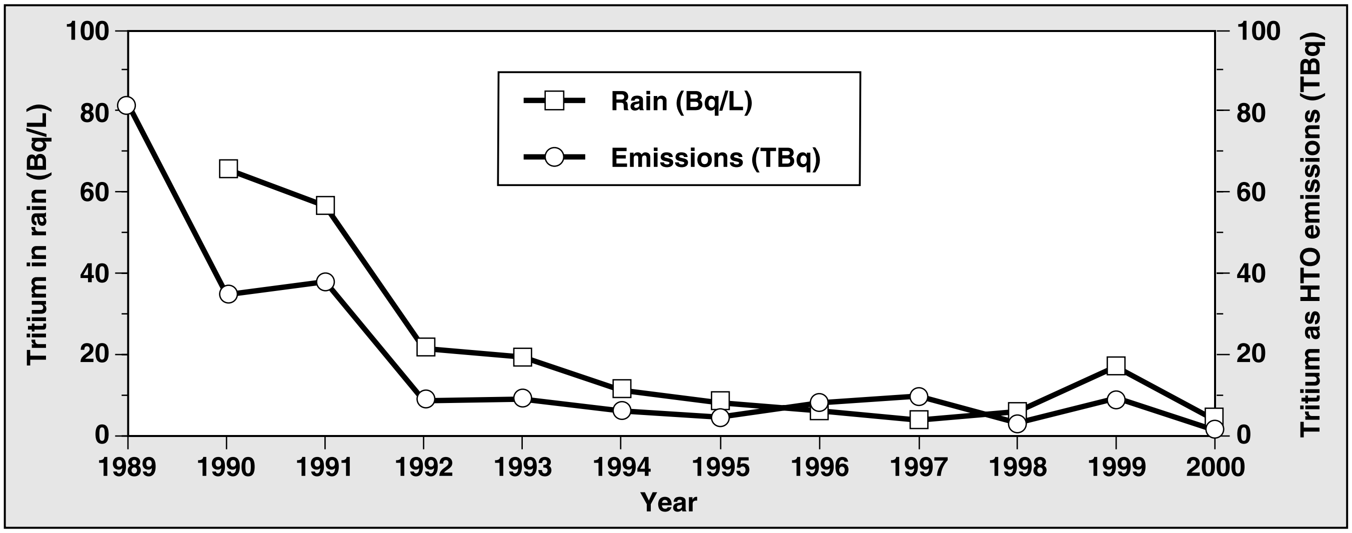


Figure 7-15. Trend of median tritium activity in rain and trend of total stack emissions of HTO. From 1989 to 1995 the emisssions are from the Livermore site and Sandia/California. Emissions from 1996 to 2000 are from LLNL only.

General Information

Previous environmental reports detail the history of the construction and management of the DRB (see Harrach et al. 1995-1997). Beginning in 1997, LLNL discharges to the DRB included routine treated groundwater from Treatment Facilities D and E, and from related portable treatment units. These discharges contribute a year-round source of water entering and exiting the DRB. Storm runoff still dominates wet weather flows through the DRB, but discharges from the treatment facilities now constitute a substantial portion of the total water passing through theDRB.

The SFBRWQCB regulates discharges from the DRB within the context of the Livermore site CERCLA *Record of Decision* (ROD) (U.S. DOE 1993), as modified by the *Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore Site* (Berg et al. 1997). The CERCLA ROD establishes discharge limits for all remedial activities at the Livermore site to meet applicable, relevant, and appropriate requirements derived from laws and regulations identified in the ROD, including the Federal Clean Water Act, the Federal and State Safe Drinking Water Acts, and the California Porter-Cologne Water Quality Control Act.

The DRB sampling program implements requirements established by the SFBRWQCB. The program consists of monitoring wet and dry weather releases for compliance with discharge limits, monitoring internal DRB water quality to support management actions established in the *Drainage Retention Basin Management Plan* (DRB Management Plan) (Limnion Corporation 1991), characterizing water quality before its release, and performing routine reporting. For purposes of determining discharge monitoring requirements and frequency, the wet season is defined as October 1 through May 31, the period when rain-related discharges usually occur (Galles 1997). Discharge limits are applied to the wet and dry seasons as defined in the *Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore*

Site (Berg et al. 1997) (wet season December 1 through March 31, dry season April 1 through November 30).

To characterize wet-season discharges, LLNL samples DRB discharges (at location CDBX) and the corresponding site outfall (at location WPDC) during the first release of the rainy season, and from a minimum of one additional storm (chosen in conjunction with storm water runoff sampling). During the dry season, samples are collected, at a minimum, from each discrete discharge event. Discharge sampling locations CDBX and WPDC are shown in **Figure 7-2**. LLNL collects samples at CDBX to determine compliance with discharge limits. Sampling at WPDC is done to identify any change in water quality as the DRB discharges travel through the LLNL storm water drainage system and leave the site. Sampling frequencies for CDBX and WPDC and effluent limits for discharges from the DRB, applied at CDBX, are found in Table 7-11 of the Data Supplement.

The routine management constituents, management action levels, and monitoring frequencies that apply to water contained in the DRB are identified in Data Supplement Table 7-12 and were established based on recommendations made in the DRB Management Plan. LLNL collects samples at the eight locations identified in **Figure 7-16** to determine whether water quality management objectives are met. Dissolved oxygen content and temperature are measured at the eight locations, while samples for the remaining chemical and physical constituents are collected from sample location

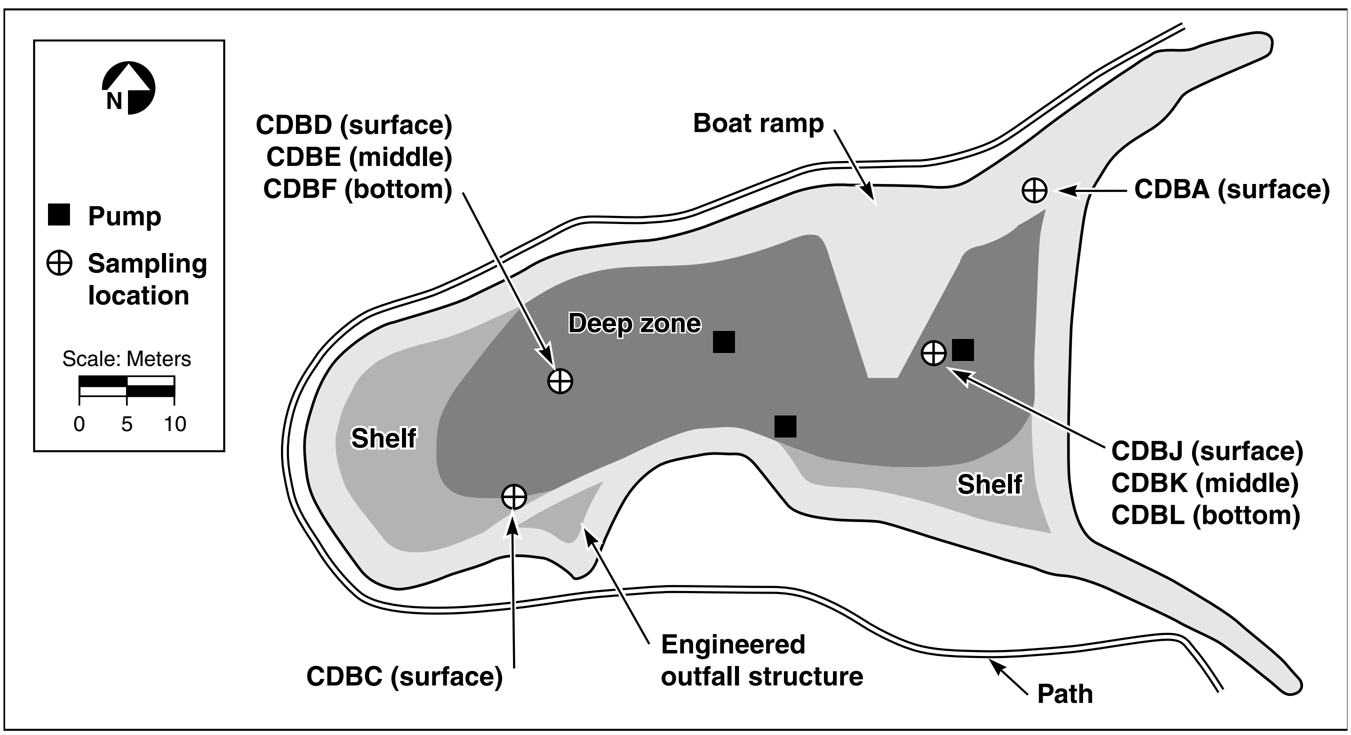


Figure 7-16. Sampling locations within the Drainage Retention Basin, 2000

CDBE because of the limited variability for these constituents within the DRB. CDBE is located at the middle depth of the DRB.

The DRB Management Plan identifies biological and microbiological surveys that are used as the primary means to assess the long-range environmental impact of DRB operations. LLNL monitors plant and animal species at the DRB, the drainage channels discharging into the DRB, and downstream portions of Arroyo Las Positas. LLNL's biologist conducts semiannual surveys to identify the presence or absence of amphibians, birds, and fishes, and annual surveys for mammals and plants.

LLNL drained the DRB in December 2000 for the first time since the start of operations. The draining was part of LLNL's bullfrog control strategy related to managing facility operation impacts on the California red-legged frog (*Rana aurora draytonii),* a federally listed threatened species. The draining was conducted following a plan submitted to and approved by the SFBRWQCB. Sediment-laden discharges were routed through sediment filter bags prior to discharging to the storm drainage system.

Methods

Sample collection procedures are discussed in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999). All samples from the DRB are collected as grab samples. Field measurements for dissolved oxygen and temperature are made using a dissolved oxygen/temperature meter, and turbidity is measured using a Secchi disk. Certified laboratories analyze the collected samples.

Biological and microbiological methods are discussed in detail in the *Environmental Monitoring Plan* (Tate et al. 1999). Biological surveys are conducted by LLNL's biologist. Animal surveys follow standard survey protocols such as *Raptor Management Techniques Manual* (Pendleton et al. 1987), *Inventory and Monitoring of Wildlife Habitat* (Cooperrider et al. 1986), and *Wildlife Management Techniques Manual* (Schemnitz 1980). Vegetation surveys use protocols identified in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). Because of a lack of resources, LLNL was again unable to conduct the microbiological survey.

Results

Samples collected during 2000 within the DRB at CDBE did not meet the management action levels for dissolved oxygen saturation, temperature, turbidity, nitrate (as N), total dissolved solids (TDS), total phosphorus (as P), ammonia nitrogen (as N), chemical oxygen demand, pH, and specific conductance (**Table 7-9**). No action was taken to adjust nutrient levels. Samples collected at CDBX and WPDC exceeded only the pH discharge limit (**Table 7-9**). All samples collected during the draining of the DRB complied with receiving water limits, except for the last sample, which exceeded the discharge limit for turbidity (the downstream receiving water turbidity reading exceeded the upstream turbidity reading by more than 10%). This exceedance occurred when the sediment filter bag ruptured.

Data for maintenance and release monitoring at sampling locations CDBA, CDBC, CDBD, CDBE, CDBF, CDBJ, CDBK, CDBL, CDBX, and WPDC, and from the biological survey are presented in Tables 7-11 through 7-19 in the Data Supplement. Data related to the draining of the DRB can be found in *LLNL Livermore Site Fourth Quarter 2000 Self-Monitoring Report* (Bainer and Abbott 2001).

Table 7-9. Summary of Drainage Retention Basin monitoring not meeting management action levels

Parameter	Management action level	Jan	Feb	Mar	Apr	May	June
Sampling location CDBE							
Ammonia nitrogen (as N) (mg/L)	0.1	—[a]	—[a]	—[a]	0.43	0.2	0.42
Dissolved oxygen saturation (%)[b]	<80% saturation	72	—[a]	77	—[a]	74	—[a]
Temperature (°C)[a]	<15 and > 26	12.7	13.2	14.9	—[a]	—[a]	—[a]
Turbidity (m)[a]	0.91	0.465	0.483	0.376	0.425	0.683	0.744
Nitrate (as N) (mg/L)	>0.2	3.3	1.1	0.88	0.96	—[a]	0.69
Specific conductance (μS/cm)	>900	1030	—[a]	—[a]	—[a]	—[a]	1080
Total dissolved solids (TDS) (mg/L)	>360	667	390	483	540	537	647
Total phosphorus (as P) (mg/L)	>0.02	0.11	0.46	0.38	0.32	0.3	0.21
Chemical oxygen demand (mg/L)	>20	—[c]	—[a]	—[c]	43	—[c]	—[c]
		July	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sampling location CDBE (continued)							
Dissolved oxygen saturation (%)[a]	<80% saturation	—[a]	72	—[a]	—[a]	—[a]	—[a]
Temperature (°C)[a]	<15 and >26	—[a]	—[a]	—[a]	—[a]	13.8	LA
Turbidity (m)[a]	0.91	0.897	0.613	0.775	—[a]	—[a]	—[a]
Nitrate (as N) (mg/L)	>0.2	0.24	NS[d]	—[a]	1.1	2.1	1.4
pH (pH units)	not <6.0 and >9.0	—[a]	NS	9.15	—[a]	—[a]	—[a]
Specific conductance (μS/cm)	>900	1120	NS	1130	1160	1080	1060
Total dissolved solids (TDS) (mg/L)	>360	657	NS	693	673	650	627
Total phosphorus (as P) (mg/L)	>0.02	0.14	NS	0.06	<0.05	0.05	0.07
Chemical oxygen demand (mg/L)	>20	29	—[a]	—[c]	22	—[c]	—[c]
	Discharge limit	**8 Mar**	**15 Jun**	**31 Jul**	**10 Aug**	**12 Sep**	**23 Oct**
Sampling location CDBX							
pH (pH units)	not <6.5 and >8.5	—[a]	8.56	8.71	9.12	9.16	8.8
Sampling location WPDC							
pH (pH units)	not <6.5 and >8.5	—[a]	8.81	—[a]	—[a]	—[a]	8.62

a Concentrations met management action level

b Monthly average, measurements taken weekly

c Chemical oxygen demand was analyzed once per quarter.

d NS = Sample not collected

Chemical and Physical Monitoring

Monthly averages for surface-level dissolved oxygen saturationwere at or above the management action level of at least 80% oxygen saturation for 4 of 12 months. Oxygen saturation is determined by the water temperature and the dissolved oxygen concentration and represents the oxygen available to aquatic organisms. Dissolved oxygen concentrations can be manually increased using aeration pumps. These pumps are started whenever oxygen concentrations at any level of the DRB drop close to or below the critical management action level of 5 mg/L.

Chemical oxygen demand was above management action levels during the second through fourth quarters of 2000. Chlorophyll-a, though below the management action levels, had one spring and one summer peak indicating two algae blooms (**Figure 7-17**). The spring bloom was mild. The chlorophyll-a levels can be used as an indicator of algae populations and of the duration and intensity of algae blooms. The elevated pH level within the DRB corresponds to the peak of the fall bloom and may be associated with the occurrence of increased photosynthesis. The highest pH readings seen in the DRB discharge samples (**Table 7-9**) also correspond to the peak of the fall bloom.

Beginning during the summer of 1994, turbidity was below the management action level of 0.914 meters. Through May 2000, it continued to be mostly below 0.914 meters clarity (**Figure 7-18**). However, during 2000, the turbidity in the DRB began to decrease (Secchi disk depth readings became larger), resulting in

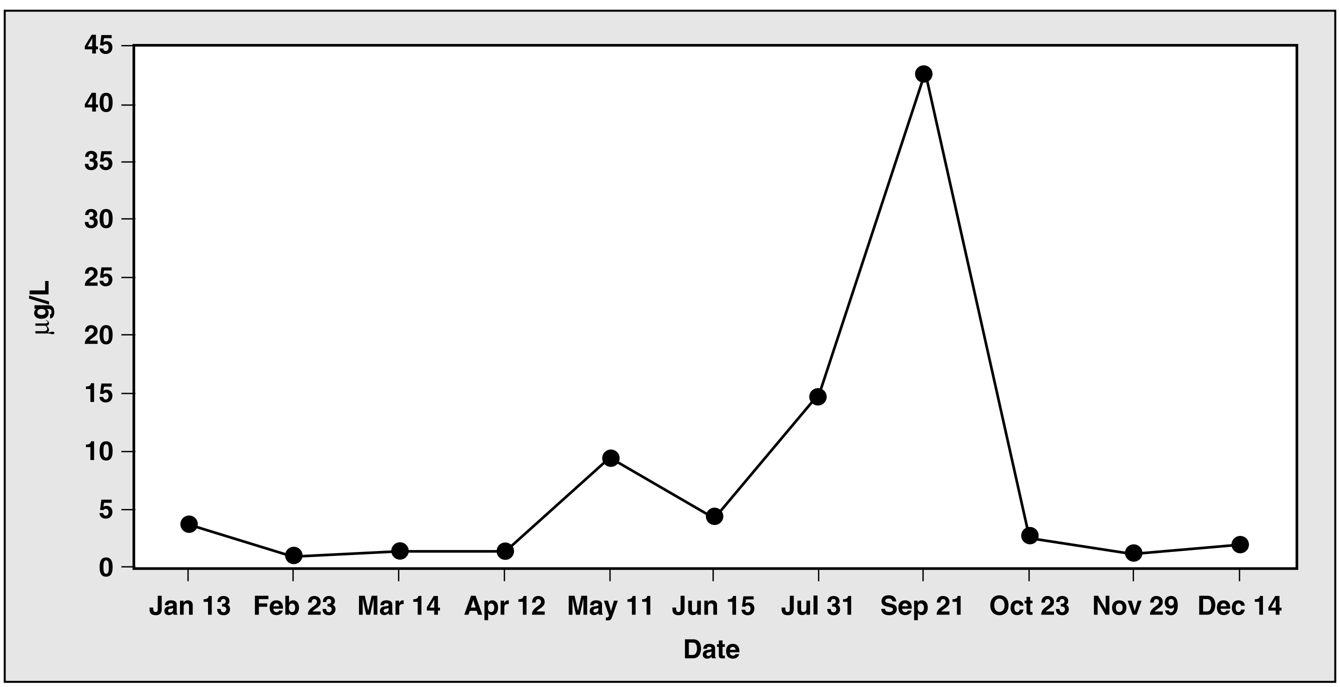


Figure 7-17. Monthly chlorophyll-a in the Drainage Retention Basin, 2000

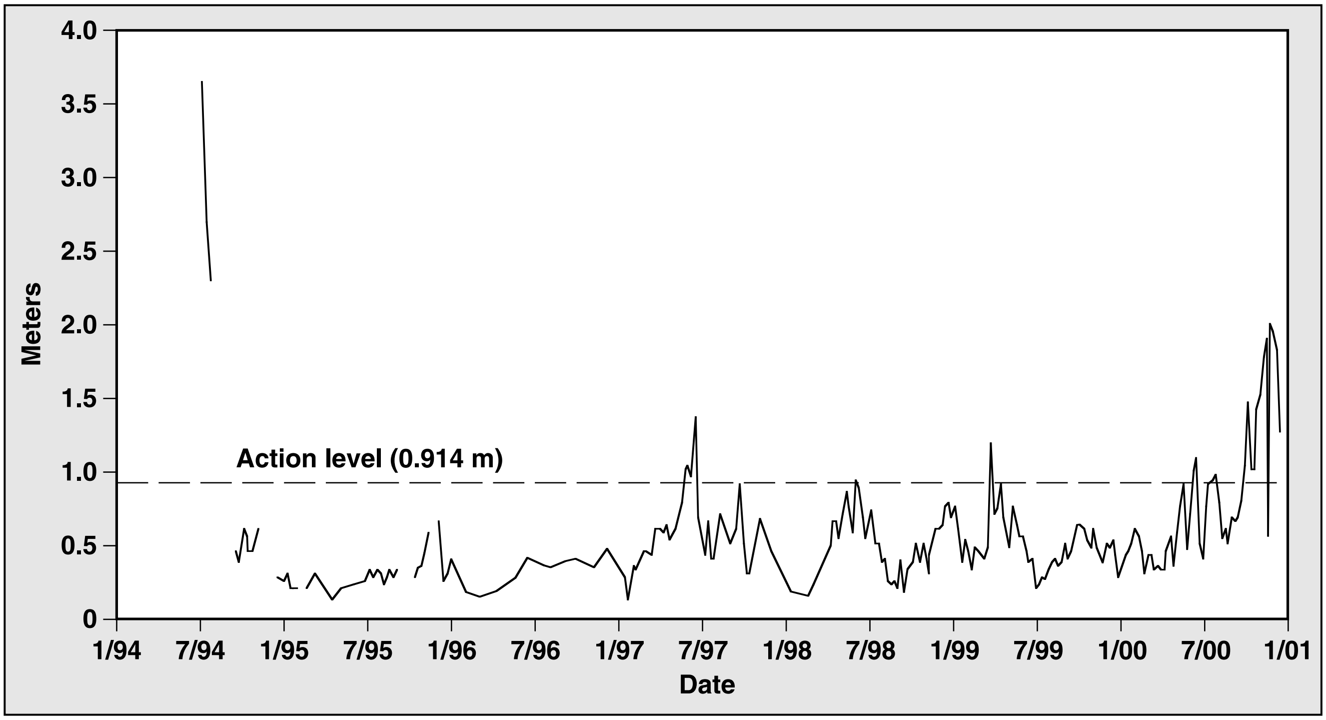


Figure 7-18. Turbidity in Drainage Retention Basin, 1994–2000

clearer water. Wet season turbidity probably results from sediments that pass through the sediment traps discharging into the DRB. Turbidity seen during the warmer summer months is most likely the result of algae growth (Harrach et al. 1996). Turbidity may also be caused by the operation of the aerators suspending sediments and preventing smaller particles from settling.

Beginning in the 1999/2000 wet season and throughout 2000, LLNL began to operate the DRB to minimize the water level fluctuations and maintain the water level as much as possible between 1 and 2 feet above the shelf. This management strategy allowed both submergent and emergent vegetation to be established throughout the DRB for the first time, which may explain the trend toward increased clarity.

Nutrient levels continued to be high during 2000 (**Figure 7-19**). Concentrations were well above management action levels throughout the year, but decreased concentrations occurred in the periods when chlorophyll-a was high (**Figure 7-17**), possibly indicating an uptake of nutrients during algae growth. Total phosphorus decreased throughout 2000, ending in concentrations near the management action levels. Sources of nitrate and phosphorous include external sources, storm water runoff, treated groundwater discharges, and an internal source of nutrient cycling related to algae and plant growth. In addition, ammonia exceeded the management action level during three months of the year. Ammonia formation is normally an indication of anoxic conditions. During 2000, total dissolved solids continued to exceed the management action levels with the

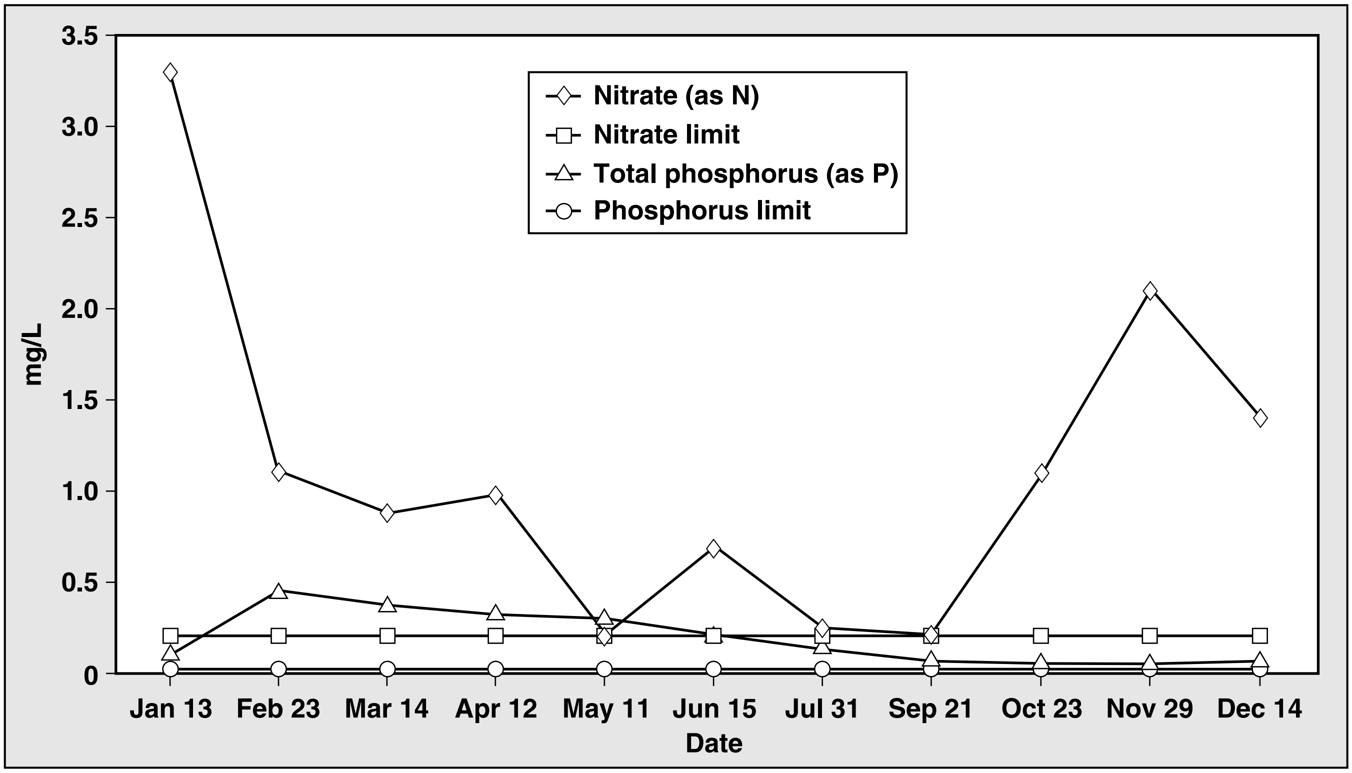


Figure 7-19. Nutrient levels in the Drainage Retention Basin, 2000

concentration exceeding 360 mg/L in all 11 months when samples were collected. Specific conductance exceeded the management action level of 900 µmhos/cm for 7 months, showing a relation between the increase in TDS and the increase seen in specific conductance.

LLNL collects and analyzes samples for acute fish toxicity and for the chronic toxicity of three species (fathead minnow, water flea, and algae) a minimum of once per year from sample location CDBE, and upon the first wet-season release at CDBX. In addition, LLNL collects acute fish toxicity samples from each discrete dry-season release. Samples collected in April from sample location CDBE showed very low levels of algae toxicity (2 toxic units). All other toxicity samples collected showed no toxic effects.

Biological Monitoring

Biological monitoring has not been conducted long enough to identify any trends resulting from operation of the DRB. However, biological monitoring has shown an expansion in the wetland areas in Arroyo Las Positas as a result of the continuous discharges of water from the DRB and other sources of treated groundwater throughout the dry season. The California red-legged frog is found in Arroyo Las Positas and the DRB. A number of other species routinely use the DRB, its tributaries, and receiving water; they are listed in Data Supplement Table 7-19.

Site 300 Cooling Towers

This section discusses general information about the Site 300 cooling towers, sampling methods, and sampling results.

General Information

As discussed in the "General Information" subsection of the "Storm Water" section, the CVRWQCB rescinded WDR 94-131, NPDES Permit No. CA0081396, on August 4, 2000. Discharges from the two primary cooling towers at Site 300, with some minor plumbing modifications to the Building 836A cooling tower, were determined by CVRWQCB staff to be discharges to the ground rather than to surface water drainage courses (SWDC). Therefore, an NPDES permit for the cooling tower discharges is unnecessary and the CVRWQCB plans to incorporate the cooling tower discharges into WDR 96-248 in 2001. WDR 94-131 and its effluent limits were in effect through August 2000. Pending the incorporation of the cooling tower discharges into WDR 96-248, LLNL continues to monitor the cooling tower wastewater discharges in accordance with the WDR 94-131 monitoring and reporting program.

Compliance sampling results were reported to the CVRWQCB quarterly through the second quarter of 2000.

Two primary cooling towers, located at Buildings 801 and 836A, regularly discharge to the ground. The 13 secondary cooling towers routinely discharge to percolation pits under a waiver of Waste Discharge Requirements from the CVRWQCB. Cooling tower locations are shown in **Figure 7-20**. The permit establishes separate effluent limits for the regular discharges from the primary cooling towers and secondary cooling towers, where discharges are occasionally diverted from the percolation pits for maintenance. One secondary cooling tower discharged to a surface water drainage course on two separate occasions in 2000.

Blowdown flow is monitored biweekly from the cooling towers located at Buildings 801 and 836A. TDS and pH are monitored quarterly at both locations.

Methods

Sample collection procedures are discussed in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999) and summarized here. To determine the effects of the cooling tower blowdown on Corral Hollow Creek, the permit requires quarterly pH monitoring of the creek, both upstream (background) and downstream of the cooling tower discharges, whenever the creek is flowing. CARW is the upstream sampling location, and GEOCRK is the downstream sampling location (**Figure 7-20**). The GEOCRK sampling location is also fed by discharges of treated groundwater from LLNL. Therefore, even when the upstream location is dry, there is often flow at GEOCRK. Field pH measurements, taken by LLNL technicians using calibrated meters, are used to monitor Corral Hollow Creek. These technicians also perform the required visual observations that are recorded on the field tracking forms along with the field pH measurements.

LLNL maintenance staff take operational TDS and pH measurements biweekly, using calibrated meters. LLNL reports these operational values at the request of CVRWQCB, but they are not used to determine compliance.

If the blowdown flow from one of the 13 secondary cooling towers is diverted to a surface water drainage course, the discharge is sampled for pH and TDS immediately. If the discharge continues, that location is monitored for the same constituents and on the same schedule as the primary cooling towers.

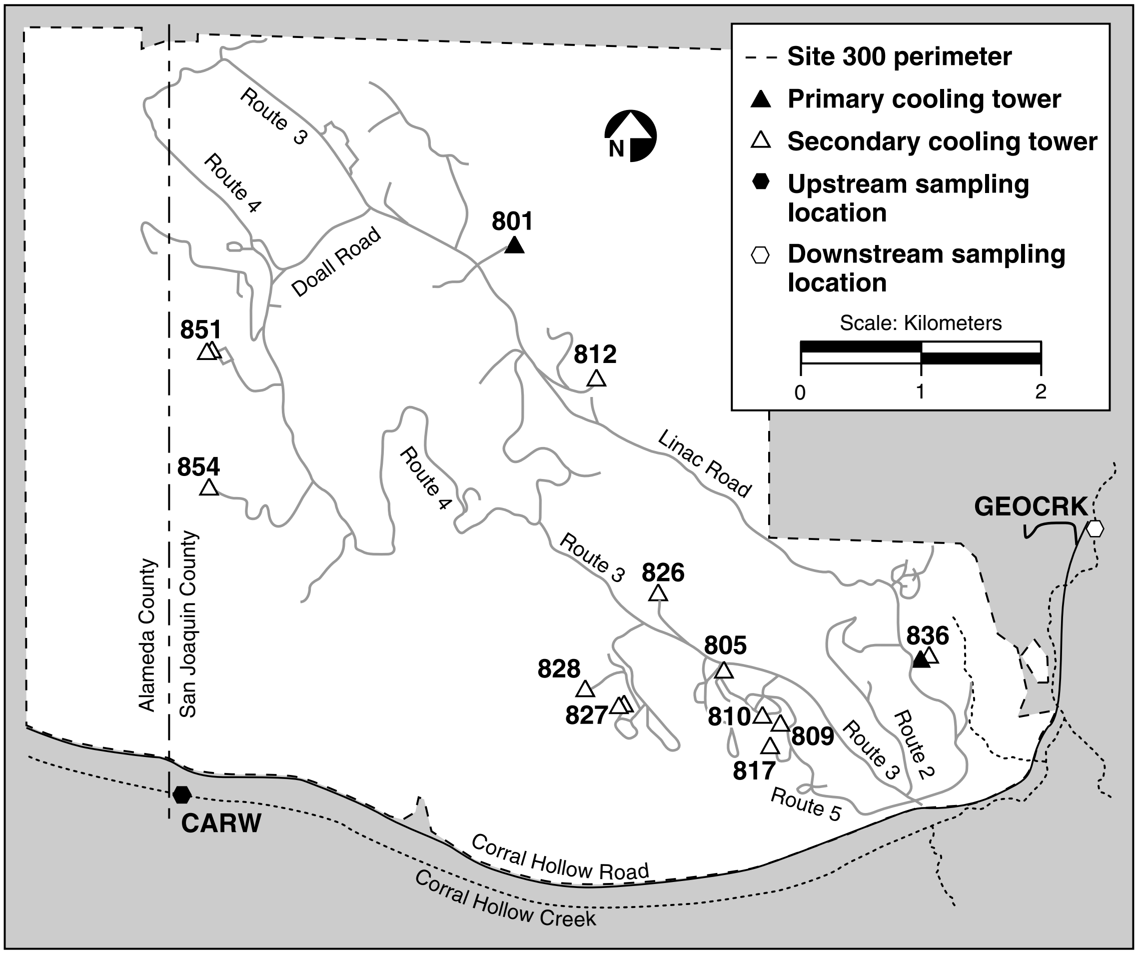


Figure 7-20. Cooling tower locations and receiving water monitoring locations, Site 300, 2000

Results

Biweekly and quarterly monitoring results are detailed in the quarterly self-monitoring report to the CVRWQCB for the first and second quarters of 2000. Although monitoring continued during the third and fourth quarters, the quarterly self-monitoring reports were discontinued when WDR 94-131 was rescinded. Summary data from primary cooling tower compliance monitoring and operational monitoring are found in **Tables 7-10** and **7-11**, respectively.

All TDS concentrations at the Buildings 801 and 836A cooling towers were below both the daily maximum (2400 mg/L) and monthly average (2000 mg/L) limits. For compliance samples, all TDS concentrations at the Building 827 cooling towers were below both the daily maximum (5000 mg/L) and monthly average (2000 mg/L) limits. However, the operational monitoring data, though below the daily maximum, exceeded the monthly average on two occasions. For the period ending May 22, the operational TDSs for cooling towers 827-1 and 827-2 were 3000 mg/L and 2400 mg/L, respectively. For the period ending December 4, the operational TDS for cooling tower 827-2 was 2500 mg/L. The compliance monitoring results demonstrate that cooling tower discharges were consistently in compliance with permitted limits (**Tables 7-10** and **7-11**). All pH samples collected from the cooling tower discharges were below the permitted maximum of 10.

Table 7-10. Summary data from compliance monitoring of primary cooling towers, Site 300, 2000

Test	Tower no.	Permitted maximum	Minimum	Maximum	Median	Interquartile range	Number of samples
Total dissolved solids (TDS) (mg/L)	801	2400	1100	1500	1300	—[(a)]	3
	836A	2400	1200	1500	1250	—[(a)]	4
	827[(b)]	5000	1300	1500	1300	—[(a)]	3
Blowdown flow (L/day)	801	16276	3237	11283	6268	3651	20
	836A	8138	0	3116	1071	1420	25
	827[(b)]	11355	393	7774	3318	4746	10
pH (pH units)	801	10	8.5	9.1	8.9	—[(a)]	3
	836A	10	8.3	9.2	8.9	—[(a)]	4
	827[(b)]	10	8.9	9.0	9.0	—[(a)]	3

a Not enough data points to determine

b Combined discharge from 827-1 and 827-2

Table 7-11. Summary data from operational monitoring of primary cooling towers, Site 300, 2000

Test	Tower no.	Permitted maximum	Minimum	Maximum	Median	Interquartile range	Number of samples
Total dissolved solids (TDS) (mg/L)	801	2400	1050	1400	1200	200	16
	836A	2400	900	1800	1125	213	22
	827-1	5000	1000	3000	1250	425	8
	827-2	5000	700	2500	1150	713	10
pH (pH units)	801	10	8.7	9.6	9.2	0.2	14
	836A	10	8.8	9.6	9.3	0.3	15
	827-1	10	8.7	9.8	9.4	0.6	8
	827-2	10	8.7	9.9	9.3	0.5	10

Blowdown flow at all the cooling towers was below the maximum permitted design flow for 2000. Because the Building 801 cooling tower was removed from service during the fourth quarter for installation of a new cooling tower, the summary data in **Table 7-10** consist of only the first through third quarters. For the Building 827 cooling towers, the summary data include only the dates the towers discharged to SWDC. For the Building 836A cooling tower, the summary data do not include flow data for the period ending June 7; a recording error made that data point unusable.

Two separate discharges occurred from the Building 827 secondary cooling tower in 2000. In March the Building 827 cooling tower percolation pit clogged with silt and overflowed to the SWDC. While evaluating the problem, LLNL allowed cooling tower blowdown to continue flowing to the percolation pit to minimize the amount of blowdown discharged to the SWDC. On May 23, the flow was diverted to the SWDC while the pit was repaired. Repairs were completed on May 24, after which flow returned to the percolation pit and LLNL discontinued routine monitoring. As required by the permit, monitoring samples for pH and TDS were collected immediately from both cooling towers that discharge to that pit. However, on March 29, the LLNL sampling staff inadvertently collected biweekly pH and TDS samples instead of conducting biweekly flow monitoring. The results from this extra set of samples (1100 mg/L TDS and 8.9 pH) are not included in **Table 7-10**. Sampling requirements were subsequently reviewed with the sampling staff, who initiated biweekly flow monitoring on April 12. The operational flow values for this interval demonstrate compliance. For the period ending March 27, the operational values were 2368 L/day for cooling tower 827-1 and 4769 L/day for cooling tower 827-2. These values are below the 11,355 L/day maximum permitted design flow.

On October 3, the Building 827 cooling tower percolation pit overflowed again and, as required by the permit, monitoring samples for pH and TDS were immediately collected. Analytical results were 1300 mg/L TDS and 9 pH for the combined discharge from 827-1 and 827-2. Routine monitoring of the Building 827 cooling towers continued through March 2001, when LLNL closed the clogged percolation pit and installed a new one. Permit limits for the secondary cooling towers require that the TDS must not exceed a monthly average of 2000 mg/L or 5000 mg/L daily, pH must not exceed 10, and flow must not exceed the permitted design maximum. Summary data are found in **Tables 7-10** (compliance monitoring) and **7-11** (operational monitoring).

First-quarter pH samples collected on February 14 measured a pH of 8.09 at CARW and 8.07 at the downstream GEOCRK location. These values are below the 8.5 pH limit.

During the second quarter, flow was observed only at GEOCRK. This downstream flow was sampled on May 10, May 24, June 7, and June 21; the resulting pH measurements were 9.02, 8.96, 8.98, and 8.9, respectively. Although these values are above the 8.5 pH limit, cooling tower blowdown did not cause the pH elevation in the receiving water. In the past, it was thought that cooling tower flow could reach Corral Hollow Creek only during significant rain events. However, the recent determination by CVRWQCB staff that cooling tower flow does not reach even on-site surface waters eliminates the pathway for the cooling tower flow to reach Corral Hollow Creek.

During the third quarter, flow was observed only at GEOCRK. This downstream flow was sampled on July 6, July 19, and August 16; the resulting pH measurements were 8.9, 9.31, and 8.0, respectively. Two of the three results are slightly above the

8.5 pH limit. As with the second-quarter samples, there was no pathway for the cooling tower flow to reach Corral Hollow Creek.

During the fourth quarter, flow was observed only at GEOCRK. This downstream flow was sampled on October 13 and November 7; the resulting pH measurements were 8.69 and 8.71, respectively.

Visual observations of Corral Hollow Creek were performed each quarter as required in the permit. The ambient pH did not change by more than 0.5 units, and no visible oil, grease, scum, foam, or floating suspended materials were noted in the creek during 2000.

Maintenance mechanics did not collect operational data for any cooling towers for the periods ending January 3, February 14, April 25, May 8, or September 25. Operational pH measurements were not taken for the period ending February 14 for any location, and for Building 801 for the period ending February 28, because of a broken pH meter. The Building 827-1 cooling tower was down for repair during the periods ending December 4 and December 18; therefore, no operational data were collected.

Site 300 Drinking Water System Discharges

This section discusses general information about the monitoring requirements for discharges from the Site 300 drinking water system, including permit information, sampling methods, and sampling results.

General Information

LLNL samples large-volume discharges from the Site 300 drinking water system that reach surface water drainage courses in accordance with the requirements of WDR 5-00-175, NPDES General Permit No. CAG995001. LLNL obtained coverage under this general permit for drinking water system discharges to surface waters when WDR 94-131 was rescinded in August 2000. The monitoring and reporting program that LLNL developed for these discharges was approved by the CVRWQCB.

Discharges that are subject to sampling under WDR 5-00-175 include:

Drinking Water Storage Tanks: monitor all discharges that have the potential to reach surface waters.

System flushes: monitor one flush per pressure zone per year for flushes that have the potential to reach surface waters.

Deadend flushes: semi-annually monitor all flushes that have the potential to reach surface waters, and for any discharge that continues for more than four months.

Discharges must comply with the effluent limits for residual chlorine established by the permit, which require that it must not be greater than 0.02 mg/L, and that the pH must be between 6.5 and 8.5. Discharges are also observed to ensure that no erosion results and no other pollutants are washed into surface waters. To meet the chlorine limit, drinking water system discharges with the potential to reach surface waters are dechlorinated.

Methods

Sample collection procedures are discussed in *Lawrence Livermore National Laboratory Site 300 Water Suppliers' Pollution Prevention and Monitoring and Reporting Program* (Mathews 2000). Grab samples are collected in accordance with Operations and Regulatory Affairs Division (ORAD) procedure EMP-W-S. Residual chlorine and pH are immediately analyzed in the field, using a spectrophotometer and calibrated pH meter, respectively.

Samples are collected at the point of discharge and at the point where the discharge flows into a surface water. If the discharge reaches Corral Hollow Creek, samples are collected at the upstream sampling location, CARW, and the downstream sampling location, GEOCRK (see **Figure 7-21**).

Results

Monitoring results are detailed in the quarterly self-monitoring reports to the CVRWQCB. Two drinking water system discharges occurred under the requirements of WDR 5-00-175 in calendar year 2000. The discharge resulted from system flushes that occurred on December 20 and 21, 2000, at Building 801. These data are found in **Table 7-12**.

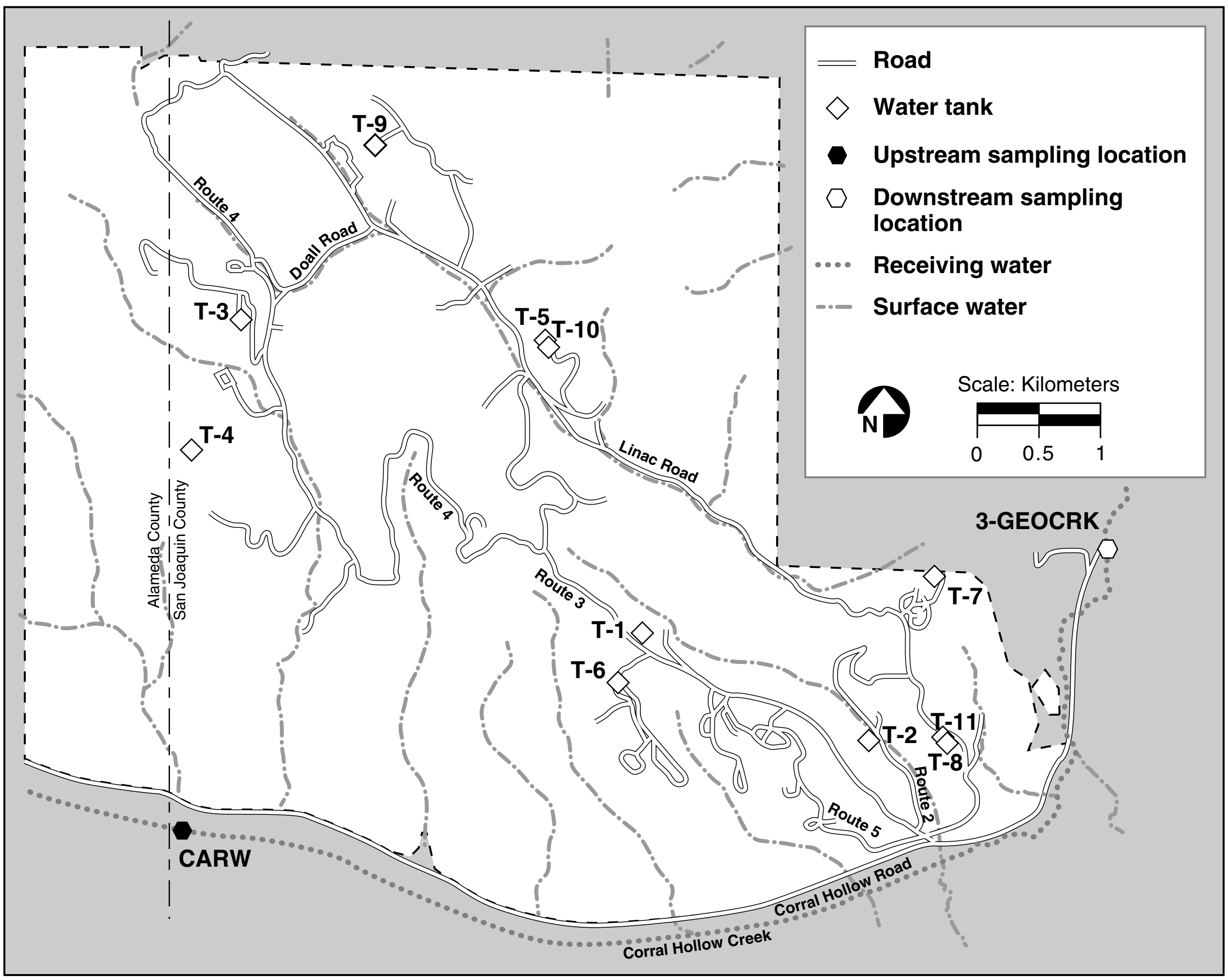


Figure 7-21. Site 300 surface waters, drinking water tanks, and receiving water monitoring locations

Table 7-12. Measured residual chlorine and pH values in flush water, Building 801, Pressure Zone 3

Date	Volume (gallons)	pH (units)		Residual chlorine (mg/L)	
		Effluent	Surface water	Effluent	Surface water
Permit limit	—	—	≥6.5, ≤8.5	—	0.02
12/20/00	10,000	8.82	8.45	0.01	NV[a]
12/21/00	4,250	8.3	NS[b]	0.01	NS[b]

a NV = not valid. Sample was collected, but the result was not valid because of interference; see discussion on page 7-36.

b NS = not sampled. Flush water did not reach surface water.

Residual chlorine concentrations at the point of discharge of both releases were 0.01 mg/L, which is in compliance with the surface water effluent limitation of 0.02 mg/L. LLNL staff experienced difficulties measuring the chlorine concentration in some of the samples using a spectrophotometer because of turbidity interference in the samples. These interferences invalidated the results of all the residual chlorine measurements, except those samples taken directly from the fire hydrant. To minimize turbidity interference in the future, LLNL plans to modify this field analysis procedure based on the spectrophotometer manufacturer's recommendations. The pH of the water entering the surface water on December 20 was 8.45, which is within the permitted range of 6.5 to 8.5. The December 21 release did not reach the surface water.

Observations of the December 20 release identified that high flow rates over a recently disturbed area resulted in turbidity in the discharge and some erosion of the stream bank. Because of the length of the travel time between the release point and the surface water, the release was completed before corrections could be made. During the second system flush that occurred on December 21, 2000, from the same release point, modifications were made to reduce the amount of mobilized sediment. These modifications included reducing the flow rate and moving the flow path by pumping the water to a different storm drainage channel. This move prevented the water from flowing through the maintenance zone where the water had picked up the majority of the sediment on the previous day.

Other Waters

This section discusses general information about monitoring network requirements, sampling methods, and sampling results.

General Information

Additional surface water monitoring is required by DOE Order 5400.1, *General Environmental Protection Program*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Surface and drinking water near the LLNL Livermore site and in the Livermore Valley are sampled at locations shown in **Figure 7-22**. Sampling locations DEL, ZON7, DUCK, ALAG, SHAD, and CAL are surface water bodies; of these, DEL, ZON7, and CAL are drinking water sources. BELL, GAS, PALM, ORCH, and TAP are drinking water outlets. Location POOL is the on-site swimming pool. Radioactivity data from drinking water sources and drinking water outlets are used to calculate drinking water statistics (see **Table 7-13**) and doses.

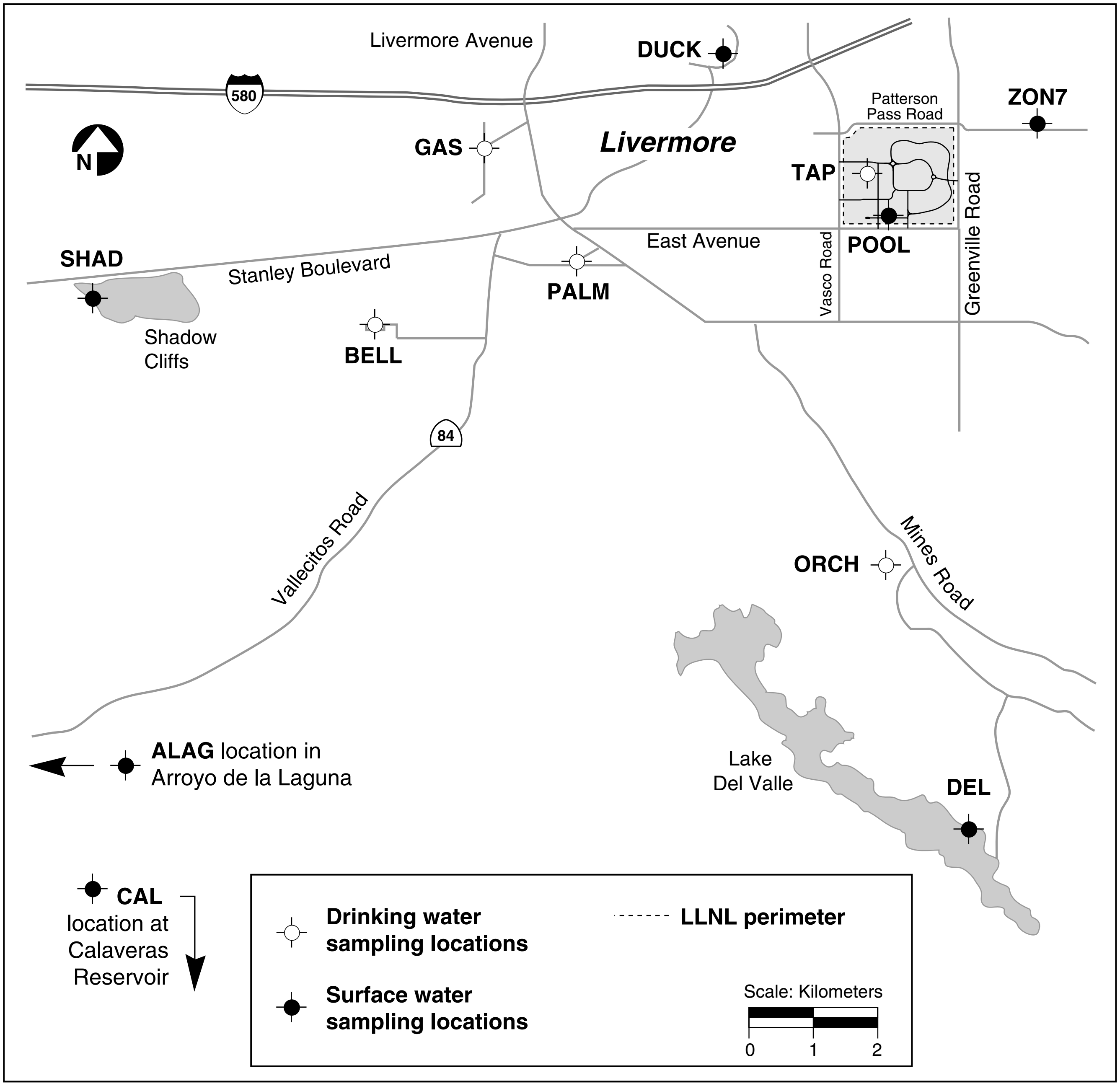


Figure 7-22. Surface and drinking water sampling locations, Livermore Valley, 2000

Methods

Samples are analyzed for gross alpha, gross beta, and tritium, according to procedures set out in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999). LLNL sampled these locations semiannually, in January and July 2000, for gross alpha, gross beta, and tritium. The on-site swimming pool location (POOL) was sampled semiannually for gross alpha and gross beta, and quarterly for tritium.

Table 7-13. Radioactivity in surface and drinking water in the Livermore Valley, 2000

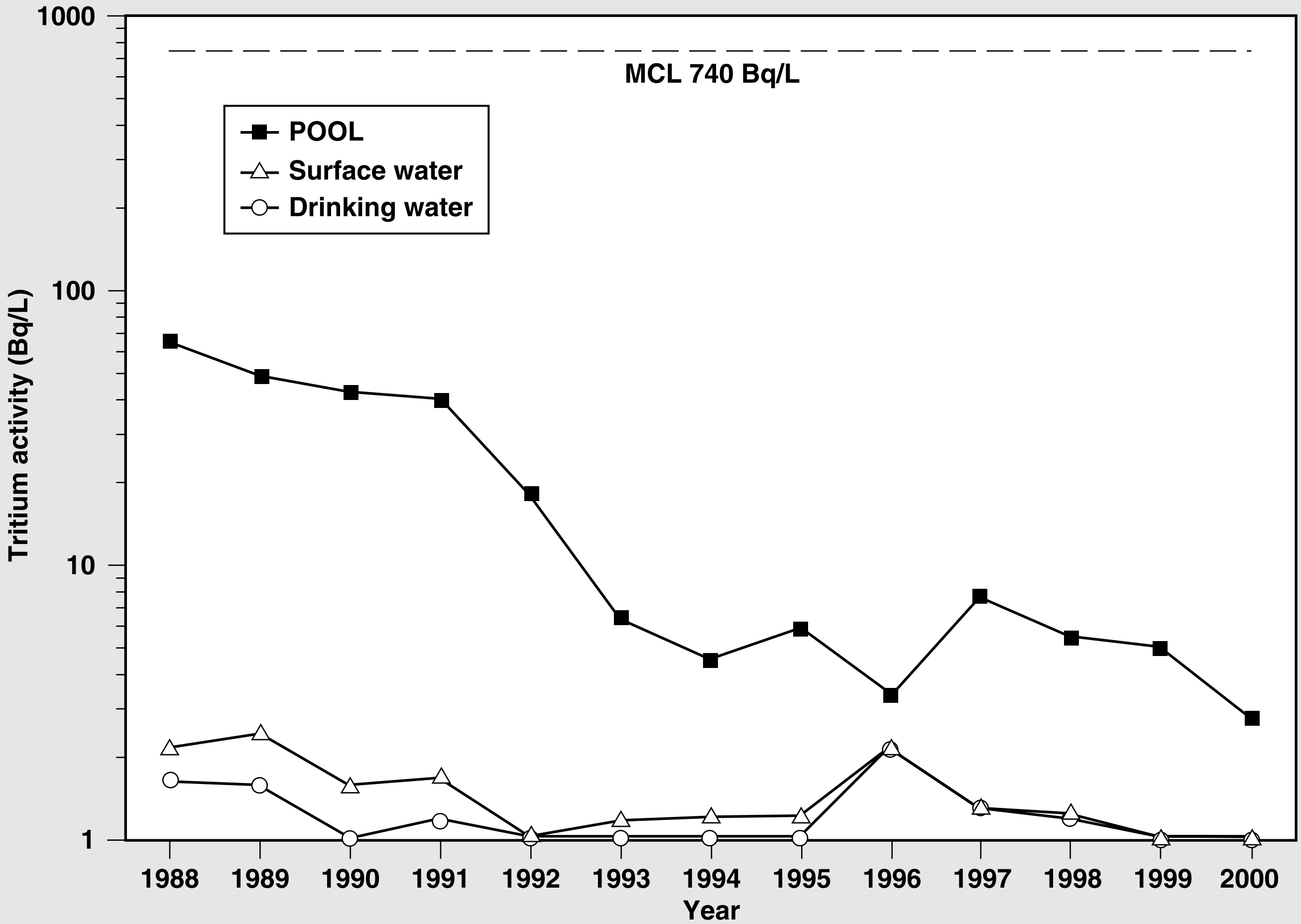
Locations	Tritium (Bq/L)	Gross alpha (Bq/L)	Gross beta (Bq/L)
All locations			
Median	0.372	0.028	0.111
Minimum	–1.52	0.002	0.029
Maximum	4.51	0.235	0.463
Interquartile range	0.845	0.068	0.103
Drinking water locations			
Median	0.045	0.025	0.107
Minimum	–0.70	0.007	0.029
Maximum	1.89	0.103	0.463
Interquartile range	0.82	0.024	0.110
Drinking water MCL	740	0.56	1.85

Note: Radioactivities are reported as the measured concentration and either an uncertainty (±2σ counting error) or as being less than the detection limit. If the concentration is less than or equal to the uncertainty or the detection limit, the result is considered to be a nondetection.

Results

The median activity for tritium in surface and drinking waters, with the exception of POOL samples and one GAS sample, was estimated from calculated values below the laboratory's minimum detectable activities, or minimum quantifiable activities. The maximum tritium activity detected was less than 1% of the MCL in LLNL's on-site swimming pool. Median activities for gross alpha and gross beta radiation in surface and drinking water samples were approximately 5% of their respective MCLs. However, maximum activities detected for gross alpha and gross beta, respectively, were 0.235 Bq/L and 0.463 Bq/L; both less than 50% of their respective MCLs (see **Table 7-13**). Detailed data are in Table 7-20 of the Data Supplement. Historically, gross alpha and gross beta radiation have fluctuated around the laboratory minimum detectable activities. At these very low levels, the error measurements are nearly equal to the measured values so that no trends are apparent in the data.

Historical median tritium values in surface and drinking waters in the Livermore Valley since 1988 are shown in **Figure 7-23**. Water in the LLNL swimming pool has had the highest tritium activities since 1988 because it is closest to tritium sources within LLNL. The highest individual tritium activity measured in the pool was 87.3 Bq/L in a sample collected in the second quarter of 1988, equal to about 12% of the drinking water MCL. The highest historical drinking water activity measured for tritium was 3.03 Bq/L or about 0.4 % of MCL, in a first quarter 1988 sample from location ORCH, a well used for drinking water. Tritium activities in the LLNL pool and in the other surface and drinking water locations have been decreasing since that time.



Notes:

- Values for surface water and drinking water (but not POOL) in 1997 and 1998 were not detected and are, therefore, plotted at minimum detectable levels.
- Activities that are less than 1.0 Bq/L are plotted at a value of 1.0 Bq/L.

Figure 7-23. Annual median tritium activity in Livermore Valley surface and drinking water, 1988 to 2000

Arroyo Las Positas Maintenance Project

This section discusses general information about the monitoring requirements for discharges occurring during maintenance activities within Arroyo Las Positas, including permit information, sampling methods, and sampling results.

General Information

LLNL performs annual maintenance activities within the flood-control channel that diverts the flows of Arroyo Las Positas around the perimeter of the LLNL Livermore site. Maintenance activities include phased desilting of the 7000-linear-foot stretch of Arroyo Las Positas on LLNL property over five years, trimming cattail heights, and conducting bank stabilization/erosion control activities. These activities are regulated by:

- WDR 99-086 issued by the SFBRWQCB in 1999
- A Biological Opinion issued by U.S. Fish and Wildlife Service in 1999
- A streambed alteration agreement issued by California Department of Fish and Game in 1998
- A nationwide permit for the construction of six check dams issued by the Army Corps of Engineers in 2000

Work is done in pre-identified zones (**Figure 7-24**). Each year, no more than 20 percent of the arroyo length is desilted following the pre-identified patchwork pattern. LLNL conducted maintenance work within Zone 3 during August and September 2000, with the exception of Zone 3A because California red-legged frog tadpoles were present. With agency

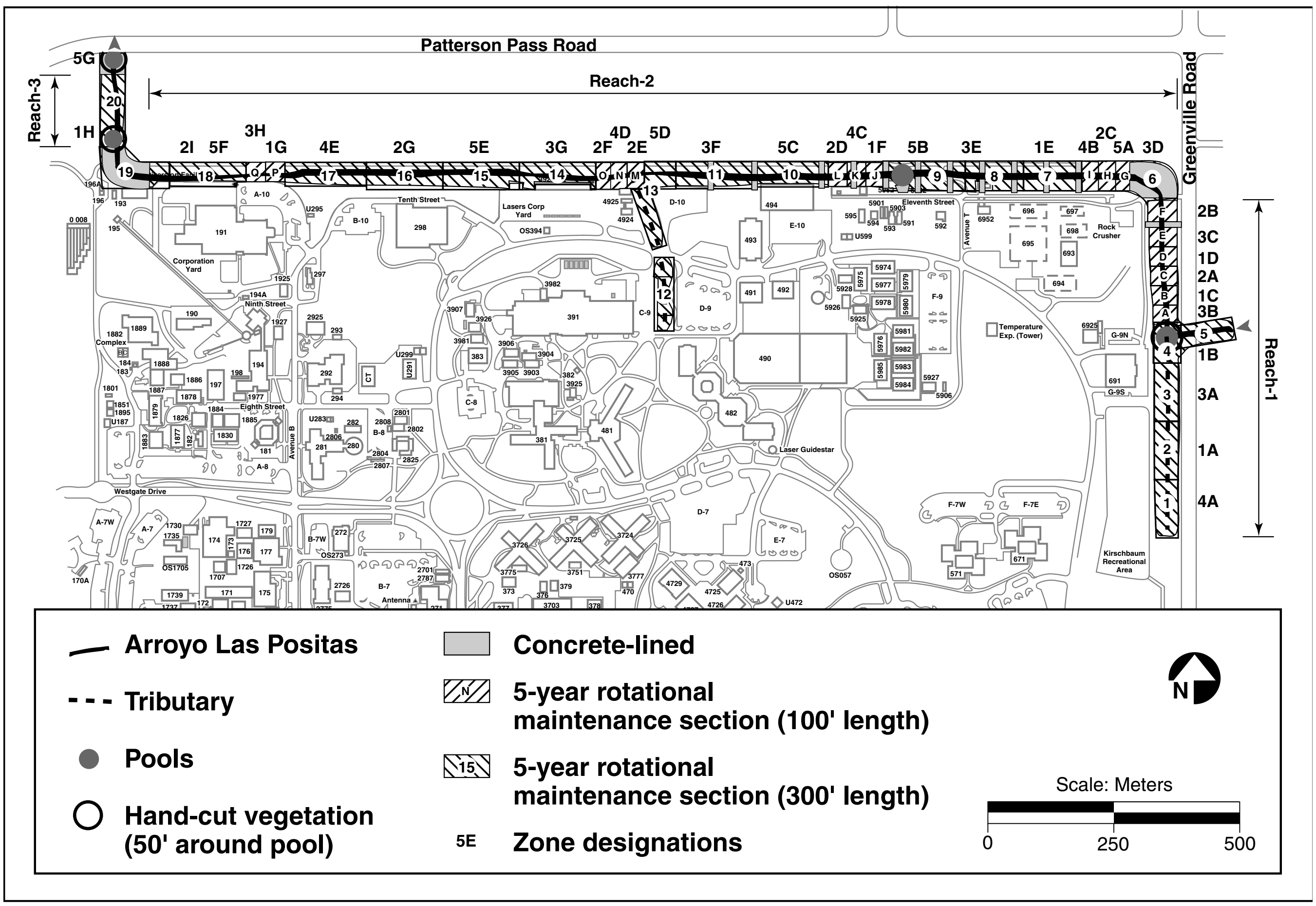


Figure 7-24. Arroyo Las Positas maintenance zones

approvals, LLNL worked in Zones 1C, 2A, and 1D instead of Zone 3A. These three sections were equal in length toZone 3A.

Discharges occur as a result of dewatering or water diversions, but they cannot cause the receiving water limits, specified in WDR 99-086, to be exceeded. Monitoring is conducted following requirements established in Self-Monitoring Program 99-086 to document compliance with effluent requirements and prohibitions established in WDR 99-086. LLNL submits self-monitoring reports to the SFBRWQCB annually when any receiving water limit is exceeded while work occurred.

Methods

Samples are collected following procedure EMP-W-S and Water Sampling Supplement EMP-WSS-ALP SOP, set up by the ORAD of the Environmental Protection Department at LLNL. Turbidity, pH, and dissolved oxygen are immediately analyzed in the field using calibrated meters. Weekly duplicate samples are collected and sent to a certified laboratory for analysis.

Receiving water (downstream) samples are collected at the work site twice a day at times evenly spaced during work hours. Receiving water samples are collected no more than 50 feet downstream of the work site while water is diverted around or dewatered from the work site. Upstream samples are collected to characterize background conditions and are collected at least 500 feet above the work site. Prestart background samples are also collected to characterize the receiving water and help evaluate the impact of discharges on the receiving water.

Results

Monitoring results are detailed in the annual self-monitoring report to the SFBRWQCB (Galles 2000c) and are presented in **Table 7-14**. Water diversion during desilting activities occurred only at sections 3E and 3G. All other sections were dry during the work period, and monitoring was not required. Although receiving water limits were exceeded briefly at Zone 3E on August 28, no violations of the receiving water limits occurred and there were no failures of structural or administrative controls.

Turbidity exceeded the allowed incremental increase of 10% of background downstream, and pH exceeded the allowed incremental change of 0.5 units at Zone 3E on August 28, 2000. The arroyo was dry upstream of the work area. The diverted water was discharged into an isolated pool downstream of the work area. Beyond the pool, the arroyo was dry. The sample collected on August 24 from the isolated pool was used to determine background for the day, because the sample was collected prior to any water being discharged into the pool.

The increased turbidity appeared to be a result of the dewatering activity. The water was being pumped out of the work zone and discharged downstream into the standing pool of water. LLNL staff immediately implemented the corrective action identified in the *Water Diversion, Desilting, and Sediment Transport Best Management Practice Plan for Arroyo Las Positas Maintenance Project* (Galles 2000b) and began pumping water onto the banks of the arroyo in a manner that prevented the water from flowing back into the stream channel. This best management practice corrected for both the turbidity and the pH. The pH within the standing pool returned to levels consistent with the August 2000 pH levels

Table 7-14. Arroyo Las Positas maintenance project monitoring data, 2000

Date	Time	Turbidity (NTU)	pH (pH units)	Dissolved oxygen (mg/L)
Location: Zone 3E, prestart (background)				
July 31, 2000	1046	5.1	7.7	2.8
Location: Zone 3E, downstream				
August 24, 2000	1330	42.2	7.8	2.35
August 28, 2000	1052	78.5	8.3	8.8
August 28, 2000	1300	90.2	8.16	5.4
August 28, 2000	1515	98.3	—[(a)]	—[(a)]
August 29, 2000	0825	48.1	8.05	3.6
August 29, 2000	1320	46.5	7.92	3.61
August 30, 2000	0955	41.9	—[(a)]	—[(a)]
Location Zone 3G, prestart (background)				
July 31, 2000	1021	120	8.8	11.2
Location: Zone 3G, upstream				
August 31, 2000	1220	123	7.82	3.06
September 5, 2000	0949	2.9	7.9	6.35
September 7, 2000	0945	21.1	7.76	2.93
September 8, 2000	0841	26.8	7.87	3.46
September 11, 2000	0931	12.6	8.21	3.75
September 12, 2000	0938	24.3	8.2	4.13
September 13, 2000	0930	27.5	8.02	3.32
September 14, 2000	1000	10.0	8.16	3.74
September 15, 2000	0830	14.9	7.94	4.96
Location: Zone 3G, downstream				
August 31, 2000	1240	6.7	8.25	3.88
August 31, 2000	1405	3.4	8.78	5.51
September 5, 2000	1015	4.1	8.1	6.92
September 5, 2000	1345	2.7	8.3	5.4
September 7, 2000	0915	8.0	8.21	6.31
September 8, 2000	0910	6.4	8.27	5.82
September 8, 2000	1514	8.22	5.23	3.8
September 11, 2000	0940	9.2	8.33	6.47
September 11, 2000	1430	5.1	8.31	4.46
September 12, 2000	1005	7.6	8.35	5.92
September 12, 2000	1340	3.3	8.83	4.69
September 13, 2000	0945	4.9	8.37	5.77
September 13, 2000	1446	4.1	7.94	4.23
September 14, 2000	1020	9.8	8.36	5.26
September 14, 2000	1515	3.3	8.25	4.0
September 15, 2000	0850	7.5	8.37	7.41
September 15, 2000	1310	5.4	8.31	6.24

a Sample is not required because receiving water returned to background values.

within two hours, while the turbidity returned to levels consistent with August 2000 turbidity levels by the next morning.

No measurable flow left the Livermore site during the Arroyo Las Positas maintenance project. The majority of the treated groundwater discharges were diverted from the Arroyo and held within the DRB for the duration of the project. Those treated groundwater flows occurring downstream of the DRB were not sufficient to result in a discharge off the Livermore site. Flow from Arroyo Las Positas coming onto the Livermore site was successfully held behind a strawbale cofferdam installed just upstream of Zone 3B. No flow diversions were required around Zones 1C, 1D, 2A, 3B, and 3C.

Environmental Impacts

This section discusses the environmental impacts of storm water, rainfall, the DRB, cooling towers, and other waters.

Storm Water

The potential off-site impact of tritium was estimated by determining the effective dose equivalent (EDE). (See Appendix A for the method LLNL used to calculate dose.) Median tritium activity in storm water runoff effluent (location WPDC) was 15.4 Bq/L, about 2% of the MCL. The EDE to an adult who ingested 2 L/day of water at the maximum storm water tritium concentration for 1 year would be less than 0.0002 mSv (0.02 mrem), or 0.02% of the 1 mSv DOE standard allowable dose for ingestion. Median effluent gross alpha and gross beta activities in Livermore site storm water were 0.20 and 0.23 Bq/L, both less than 36% of their respective MCLs.

Concentrations of some metals were above comparison criteria; this was caused by metals associated with suspended solids in the storm water. Storm water quality runoff from Site 300 is similar to background levels. Although some 2000 storm water results were above comparison criteria at the LLNL site, there is no evidence of any impact to off-site biota. The acute and chronic fish toxicity tests conducted during 2000 showed no toxicity in LLNL storm water runoff, further supporting the conclusion that LLNL storm water has no adverse effect on off-site biota. Algae toxicity tests did reveal growth inhibition for algae in the storm water. However, it appears that this impact may not be associated with activities at LLNL. Monitoring will be continued to demonstrate that the growth inhibition is caused by activities upstream from the Livermore site.

Rainfall

Livermore Site and Livermore Valley

Tritium in rainfall had a negligible impact on the environment at the LLNL Livermore site and in the Livermore Valley. The median tritium activity measured in rainfall at LLNL decreased from 19.0 Bq/L in 1999 to 3.7 Bq/L in 2000. The off-site median tritium activity for year 2000 is less than 0.5 Bq/L, which is not significantly different from atmospheric background levels.

Site 300

Tritium in rainfall had a negligible impact on the environment at Site 300. The measured tritium activities of rainfall samples taken at Site 300 were all either less than the minimum detectable activity or less than the 2σ uncertainty. The tritium activity measured in rainfall at Site 300 has been indistinguishable from atmospheric background levels over the past 28 years.

Drainage Retention Basin

There is no evidence of adverse environmental impact resulting from releases from the DRB. Although mild toxicity to algae was observed in the

DRB and in water discharged from the DRB, there is no evidence that the discharge had an effect on the downstream receiving water. Because of the frequent dry season discharges that occurred from the DRB, discharges from groundwater treatment facilities, and the wetter rainfall years that occurred from 1997 through 1999, wetland vegetation has increased both up- and downstream of the DRB. The federally listed threatened California red-legged frog has colonized these wetland areas.

Cooling Towers

Both primary cooling towers at Site 300 that discharge to surface were within their permitted limits for pH and TDS. Flow from these cooling towers was below the maximum permitted design flow. Thus, data indicate no negative impact to surface waters from these cooling towers. Compliance samples for pH, TDS, and blowdown flow from the secondary cooling tower percolation pit overflows at Building 827 were also within permitted limits. However, on two occasions the operational TDS values were below the daily maximum but above the monthly average. On both of these occasions, the receiving water, Corral Hollow Creek, was not flowing.

Because blowdown flow from the cooling towers does not reach Corral Hollow Creek, it is unlikely to have a negative impact on the receiving water.

Site 300 Drinking Water System Discharges

The two releases from the Site 300 drinking water system met the permit effluent limits for pH and residual chlorine, which are designed to protect aquatic life. Water from the two releases percolated into the ground within and just prior to reaching Elk Ravine, further minimizing the environmental effects of the water release.

Other Waters

The potential impact of tritium on drinking water supplies was estimated by determining the EDE (see Appendix A). Maximum tritium activity in drinking waters was 1.89 Bq/L. The EDE to an adult who ingested 2 L/day of water at this maximum concentration for a year would be 0.024 µSv, or 0.06% of the DOE standard allowable dose of 40 µSv for drinking water systems. Gross alpha and gross beta activities (as well as tritium activies) were below their MCLs. The sample data indicate that the impact of LLNL Livermore site operations on surface and drinking waters is negligible.

Arroyo Las Positas Maintenance Project

Discharges of diverted water related to the Arroyo Las Positas maintenance project did not adversely impact receiving water quality. Though there were two instances where receiving water quality criteria were exceeded briefly (one for turbidity and one for pH), LLNL immediately implemented corrective actions and redirected dewatering discharges away from the arroyo. The discharges went to an isolated pool within Arroyo Las Positas and did not impact the receiving waters. The isolated pool returned to background values for turbidity and pH by the next day.