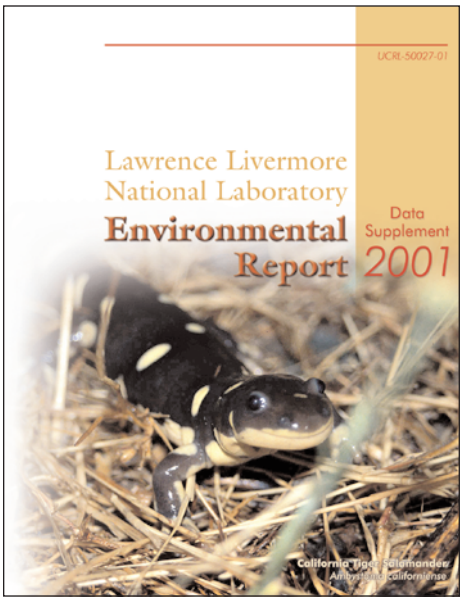
UCRL-50027-01

# Lawrence Livermore National Laboratory

# Environmental Report

## Data Supplement 2001

**California Tiger Salamander**
*Ambystoma californiense*




## Cover

The **California tiger salamander (*Ambystoma californiense*)** is endemic to the state of California and geographically isolated from other *Ambystomatid* salamanders (Shaffer and McKnight 1996). The California tiger salamander represents a small but important component of the spectacular diversity found in California's grassland communities. California tiger salamanders breed in ephemeral pools at Site 300 and have been observed within close proximity to the Livermore site.

### Distribution, Habitat and Ecology

The California tiger salamander is a large salamander (15 to 22 centimeters long), historically found in the Central Valley and adjacent foothills and coastal grasslands of California, areas with a Mediterranean climate of cool wet winters and hot dry summers (Loredo and Van Vuren 1996). Juveniles and adults live under ground, inhabiting the burrows of California ground squirrels (*Spermophilus beecheyi*) and pocket gophers (*Thomomys bottae*), and are rarely observed on the soil surface except during the winter breeding season when desiccation is not limiting. California tiger salamanders breed in fish-free (Petranka 1998), seasonally ephemeral pools and are considered an obligate vernal pool species (Morey 1996). Migrations to and from the ponds occur from November through April, although most breeding occurs from December through March (Petranka 1998). Males arrive first at the breeding pond followed by the females. Females attach their eggs singly, or in rare instances in groups of two to four on submergent or emergent vegetation, or other suitable substrates. Eggs hatch within 2 to 4 weeks after they are deposited and the larval stage lasts 3 to 6 months. Metamorphosis occurs during the dry summer months, and metamorphs typically migrate from the ponds at night during dry weather. The first night after leaving the breeding pond, metamorphs may move 6 to 57 meters from the pond (Loredo, Van Vuren, and Morrison 1996), with the total distance moved being unknown. The underground ecology of the California tiger salamanders, which constitutes over 90% of the species life history, is completely unknown.

### Status

The California tiger salamander is a state Species of Special Concern and Federal Candidate for listing (i.e., warranted but precluded). Within California, there are seven distinct population segments of the California tiger salamander. Two of the seven populations (Sonoma and Santa Barbara Counties) now receive federal protection, both under Emergency Rule, pursuant to the Endangered Species Act of 1973, as amended. Intensive human alteration of habitat over the past 150 years has resulted in the loss of greater than 90% of California's historic vernal pool habitats and extensive fragmentation of that which remains (Holland and Jain 1978). Additional significant population threats include predation by introduced species such as fish (Shaffer, Fisher, and Stanley 1993) and bullfrogs (*Rana catesbeiana*) (Shaffer and Stanley 1991), vehicle-related mortality during breeding migrations (Gibbs 1998), and rodent control programs (Loredo et al. 1994). Within the remaining range of the species, populations are considered fragmented and at risk of extinction; federal protection of the remaining populations appears inevitable at this time.

Michael G. van Hattem, LLNL Wildlife Biologist, provided the cover photo and information.

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# Environmental Report 2001

## *Data Supplement*


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# PREFACE

This Data Supplement to the Lawrence Livermore National Laboratory's (LLNL's) annual *Environmental Report 2001* was prepared for the U.S. Department of Energy. The main volume is intended to provide all information on LLNL's environmental impact and compliance activities that is of interest to most readers. The Data Supplement supports main volume summary data and is essentially a detailed data report that provides individual data points, where applicable. Some summary data are also included in the Data Supplement, and more detailed accounts are given of sample collection and analytical methods.

The two volumes are organized in a parallel fashion to aid the reader in cross-referencing between them. This supplement includes more detailed information to support the eight chapters in the main volume that cover monitoring of air effluent, air surveillance, sewerable water, surface water, groundwater, soil and sediment, vegetation and foodstuff, environmental radiation, and quality assurance. The other six chapters in the main volume have no supporting information in the Data Supplement.

As in our previous annual reports, data are presented in Système International (SI) units. In particular, the primary units used for radiological results are becquerels and sieverts for activity and dose, with curies and rem used secondarily ($1\ \text{Bq} = 2.7 \times 10^{-11}\ \text{Ci}$; $1\ \text{Sv} = 100\ \text{rem}$).

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**Indicates no supplemental data in this volume. Please see the main volume for detailed information on this subject.**

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**There are no supplemental data in this chapter. Please see the main volume for details about Compliance Summary.**

**There are no supplemental data in this chapter. Please see the main volume for details about Environmental Program Information.**

# Air Effluent Monitoring

*Paula J. Tate*

## Air Effluent Sampling Methods

In 2001, Lawrence Livermore National Laboratory used 77 continuously operating radiological sampling systems on air exhausts at seven facilities at the Livermore site (see main volume, **Table 4-1**). These samplers were used to determine actual emissions from operations involving radioactive materials at the facilities and to verify the integrity of emission control systems. For a further discussion, see Chapter 4 of the main volume.

Air samples for particulate emissions are extracted downstream of high-efficiency particulate air (HEPA) filters and prior to the discharge point to the atmosphere. In most cases, simple filter-type aerosol collection systems are used. However, in Buildings 332, continuous air monitors (CAMs) are used for sampling to check for alpha activity. In addition to collecting a sample of particles, the CAM units provide an alarm capability for the facility in the event of a release of particulates containing alpha activity. Both types of sampling systems, the simple filter type and alpha alarm monitors, are used to monitor discharge points from Building 332. In the event of a power outage, the air sampling systems in critical facilities are switched to auxiliary power and continue to operate.

The sample filters are 47-mm-diameter membrane filters and are changed weekly or biweekly, depending on the facility. After sample collection, filters are placed in glassine envelopes, and each envelope is tagged with a unique bar code label. Filter sample data—including location, equipment identification, bar code, sampling start date, sampling stop date, and flow rate—are entered into the Hazards Control Department (HCD) sample tracking and reporting (STAR) computer system. Sampling procedures are contained in the environmental section of the discipline action plan for a facility.

Filters are analyzed at the HCD Radiological Measurements Laboratory (RML) for gross alpha and beta activity using gas proportional counters. Analysis is delayed for at least four days following sample termination to allow for the decay of naturally occurring radon daughters. To verify the operation of the counting system, calibration and background samples are intermixed with the sample filters for analysis. Analytical techniques are consistent with the Environmental Protection Agency (EPA) recommended procedures. Further details about sampling and analysis are discussed in the *Environmental Monitoring Plan* (Tate et al. 1999).

Each stack of the Tritium Facility (Building 331) is monitored for tritium release by both a continuous monitoring alarm system and continuous molecular sieve samplers. The alarmed samplers, Overhoff ionization chambers, provide real-time total tritium concentration release levels (tritiated hydrogen gas and tritiated water combined).

The sieve samplers, which can discriminate between tritiated water vapor and tritiated hydrogen gas provide the values used for environmental reporting. Each sieve sampler (not alarmed) runs in parallel with an alarmed monitor and consists of two molecular sieves. The first sieve collects tritiated water vapor; the second sieve contains a palladium-coated catalyst that converts tritiated hydrogen to tritiated water and collects the tritiated water on the sieve. Sieves are changed weekly. The sieve samples are logged into the HCD STAR sample tracking system and submitted to the HCD Analytical Laboratory, where tritiated water is baked out and collected. RML analyzes the retrieved tritium for beta activity using scintillation counting techniques.

## Data

Annual summaries of gross alpha, gross beta, and tritium data for samplers at each monitored facility are summarized in Tables 4-1 through 4-7. The tables present the ratio of the number of results that have activity concentration greater than the analysis' minimum detectable concentration (MDC) to the total number of samples in the year, and the minimum, median, and maximum activity concentrations of the samples (in $Bq/m^3$). The MDC is defined as the smallest concentration of radioactive material that can be detected (distinguished from background) with some specified degree of confidence. Analytical results are reported as a measured concentration in Bq per volume of air. If the concentration reported is negative, the result is considered to be a nondetection (see Chapter 14).

**Table 4-1. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 175, 2001**

| B175 Emission Point[a] | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Alpha** | | | | |
| #1 | 0/49 | -107 | 6.11 | 300 |
| #2 | 0/49 | -170 | 7.81 | 110 |
| #3 | 0/49 | -107 | 17.1 | 200 |
| #4 | 0/49 | -168 | 2.61 | 294 |
| #5 | 0/49 | -183 | 15.9 | 357 |
| #6 | 0/48 | -75.9 | 12.1 | 206 |
| **Gross Beta** | | | | |
| #1 | 11/49 | -44.4 | 264 | 1000 |
| #2 | 1/49 | -166 | 158 | 670 |
| #3 | 3/49 | -144 | 156 | 950 |
| #4 | 0/49 | -195 | 50.7 | 566 |
| #5 | 14/49 | -102 | 297 | 2160 |
| #6 | 1/48 | -685 | 161 | 588 |

**Note:** The vacuum system was not operable for 3 weeks in January.

a A sample was lost from emission point 6 in May.

**Table 4-2. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 177, 2001**

| B177 Emission Point[a] | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Alpha** | | | | |
| #1 | 0/51 | -17.5 | 1.62 | 74.0 |
| **Gross Beta** | | | | |
| #1 | 0/51 | -64.8 | 29.2 | 128 |

a A sample was lost in June.

**Table 4-3. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 235, 2001**

| B235<br>Emission Point[a] | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Alpha** | | | | |
| #1 | 1/28 | -80.7 | -5.8 | 533 |
| **Gross Beta** | | | | |
| #1 | 0/28 | -299 | 59.0 | 396 |

a This sampling system was installed in June.

**Table 4-4. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 251, 2001**

| B251 Emission Point[a] | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Alpha** | | | | |
| #1 | 1/26 | -39.6 | 33.9 | 272 |
| #3 | 0/26 | -23.9 | 3.97 | 79.2 |
| #5 | 0/26 | -25.9 | 14.4 | 111 |
| #6 | 0/26 | -51.4 | 16.2 | 164 |
| #7 | 0/26 | -16.2 | 2.93 | 78.4 |
| #10 | 0/23 | -54.8 | 52.9 | 318 |
| #13 | 0/26 | -29.6 | 7.68 | 126 |
| #14 | 1/26 | -52.2 | 47.2 | 225 |
| #16 | 1/26 | -32.1 | 5.92 | 171 |
| #17 | 0/26 | -42.6 | 9.05 | 67.0 |
| #18 | 0/26 | -30.9 | 11.5 | 162 |
| #19 | 0/26 | -23.1 | -16.4 | 110 |
| #20 | 0/26 | -23.0 | -7.79 | 51.4 |
| #21 | 1/26 | -28.7 | 39.8 | 176 |
| #23 | 0/26 | -25.3 | 7.96 | 79.6 |
| #24 | 0/26 | -38.1 | 4.83 | 129 |
| #25 | 0/26 | -21.4 | 2.53 | 111 |
| #26 | 0/26 | -60.3 | -31.1 | 95.5 |
| #28 | 0/23 | -43.3 | 48.8 | 209 |
| #29 | 0/23 | -17.5 | 3.07 | 73.6 |
| #30 | 1/23 | -37.4 | 25.4 | 256 |
| #33 | 2/25 | -25.6 | 38.1 | 144 |
| #34 | 0/26 | -3.85 | 25.2 | 130 |
| #35 | 0/26 | -20.2 | 7.88 | 76.6 |
| #40 | 1/26 | -14.8 | -5.18 | 69.6 |
| #43 | 0/26 | -13.8 | 1.41 | 53.7 |
| #44 | 1/26 | -11.4 | 4.65 | 76.6 |
| #45 | 1/26 | -37.4 | 22.3 | 240 |
| #46 | 1/26 | -20.2 | 38.1 | 138 |
| #47 | 1/26 | -26.5 | 22.9 | 157 |
| #48 | 1/26 | -20.0 | 23.6 | 216 |
| #49 | 2/26 | -21.6 | 9.21 | 119 |

**Table 4-4. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 251, 2001 (concluded)**

| B251 Emission Point[a] | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Beta** | | | | |
| #1 | 0/26 | -230 | 64.8 | 312 |
| #3 | 0/26 | -96.6 | 27.5 | 141 |
| #5 | 6/26 | -40.3 | 113 | 490 |
| #6 | 1/26 | -276 | 72.0 | 655 |
| #7 | 2/26 | -41.1 | 38.0 | 153 |
| #10 | 7/23 | 119 | 370 | 1170 |
| #13 | 0/26 | -142 | 8.89 | 312 |
| #14 | 8/26 | 36.3 | 266 | 692 |
| #16 | 1/26 | -118 | 47.2 | 343 |
| #17 | 4/26 | -107 | 128 | 490 |
| #18 | 6/26 | -117 | 50.5 | 877 |
| #19 | 0/26 | -77.0 | 29.5 | 235 |
| #20 | 2/26 | -77.3 | -3.34 | 899 |
| #21 | 15/26 | 14.0 | 299 | 2130 |
| #23 | 1/26 | -157 | 10.9 | 1330 |
| #24 | 1/26 | -220 | 25.3 | 718 |
| #25 | 0/26 | -148 | 36.6 | 228 |
| #26 | 1/26 | -224 | 29.5 | 525 |
| #28 | 13/23 | 154 | 426 | 3350 |
| #29 | 0/23 | -98.4 | 16.8 | 222 |
| #30 | 4/23 | -77.7 | 229 | 599 |
| #33 | 20/25 | -0.081 | 481 | 950 |
| #34 | 17/26 | 62.5 | 270 | 725 |
| #35 | 1/26 | -93.6 | 34.2 | 303 |
| #40 | 2/26 | -38.1 | 32.9 | 167 |
| #43 | 2/26 | -17.5 | 37.9 | 118 |
| #44 | 7/26 | 0.592 | 69.0 | 245 |
| #45 | 0/26 | -70.3 | 52.5 | 349 |
| #46 | 25/26 | 136 | 294 | 780 |
| #47 | 22/26 | 47.4 | 294 | 990 |
| #48 | 8/26 | -73.3 | 105 | 480 |
| #49 | 14/26 | -57.7 | 238 | 1010 |

a Emission point Numbers 10, 28, 29, and 30 were removed from service in November

**Table 4-5. Summary of tritium in air effluent samples from monitored emission points at Building 331, 2001**

| B331<br>Emission Point | No.>MDC/ total samples | Minimum ($Bq/m^3$) | Median ($Bq/m^3$) | Maximum ($Bq/m^3$) |
|---|---|---|---|---|
| **HT** | | | | |
| **Stack 1** | 33/52 | -1.76 | 7.47 | 2020 |
| **Stack 2** | 52/52 | 54.4 | 105 | 2340 |
| **HTO** | | | | |
| **Stack 1** | 43/52 | 1.01 | 655 | 947 |
| **Stack 2** | 52/52 | 8.03 | 2180 | 4900 |

**Table 4-6. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 332, 2001**

| B332 Emission Point | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Alpha** | | | | |
| **SP-1A** | 0/52 | -50.0 | -3.07 | 61.8 |
| **SP-1B** | 0/52 | -29.1 | -15.1 | 54.4 |
| **SP-2A** | 0/52 | -30.3 | 6.29 | 87.3 |
| **SP-2B** | 0/52 | -40.0 | 5.07 | 61.1 |
| **SP-3** | 0/52 | -34.9 | -14.7 | 61.8 |
| **SP-4** | 0/52 | -32.7 | -14.7 | 58.8 |
| **SP-5** | 0/52 | -39.2 | -0.795 | 165 |
| **SP-6A** | 0/52 | -29.0 | -1.91 | 95.8 |
| **SP-6B** | 0/52 | -36.0 | 0.734 | 51.4 |
| **SP-7A** | 0/52 | -30.5 | -14.9 | 88.4 |
| **SP-7B** | 0/52 | -37.7 | 4.02 | 72.5 |
| **SP-8** | 0/52 | -33.3 | -5.36 | 71.4 |
| **SP-9** | 0/52 | -25.8 | 7.68 | 106 |
| **SP-10** | 0/52 | -72.2 | 13.4 | 158 |
| **SP-11** | 0/52 | -27.6 | -14.1 | 36.9 |
| **SP-12** | 0/52 | -48.5 | -27.8 | 283 |
| **Gross Beta** | | | | |
| **SP-1A** | 2/52 | -163 | 13.7 | 2420 |
| **SP-1B** | 0/52 | -129 | -0.159 | 196 |
| **SP-2A** | 0/52 | -163 | -2.97 | 176 |
| **SP-2B** | 0/52 | -98.1 | 4.98 | 311 |
| **SP-3** | 0/52 | -116 | 5.71 | 199 |
| **SP-4** | 0/52 | -111 | 14.3 | 124 |
| **SP-5** | 0/52 | -173 | -11.8 | 280 |
| **SP-6A** | 1/52 | -148 | 15.7 | 290 |
| **SP-6B** | 0/52 | -111 | 1.10 | 167 |
| **SP-7A** | 0/52 | -110 | -0.90 | 141 |
| **SP-7B** | 0/52 | -165 | -11.1 | 223 |
| **SP-8** | 0/52 | -129 | -2.95 | 123 |
| **SP-9** | 0/52 | -116 | -2.95 | 127 |
| **SP-10** | 0/52 | -295 | 23.7 | 316 |
| **SP-11** | 0/52 | -147 | -3.92 | 178 |
| **SP-12** | 0/52 | -219 | 26.6 | 313 |

**Table 4-7. Summary of gross alpha and gross beta in air effluent samples from monitored emission points at Building 491, 2001**

| B491 Emission Point | No.>MDC/ total samples | Minimum ($10^{-6}$ Bq/m$^3$) | Median ($10^{-6}$ Bq/m$^3$) | Maximum ($10^{-6}$ Bq/m$^3$) |
|---|---|---|---|---|
| **Gross Alpha** | | | | |
| #1 | 0/52 | -9.10 | 1.50 | 33.2 |
| **Gross Beta** | | | | |
| #1 | 3/52 | -36.6 | 16.6 | 374 |

# Ambient Air Monitoring

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## Air Surveillance Sampling

Lawrence Livermore National Laboratory conducts air surveillance sampling using several different networks, each one representing a general location and type of analysis. There are separate networks for sampling radiological particulates and beryllium particulates at both the Livermore site and Site 300 as well as a low-volume radiological air surveillance sampling network and a tritium sampling network in Livermore and one tritium sampling location at Site 300. Four different collection media are employed: glass fiber filters for radiological particulates, cellulose filters for beryllium particulates, membrane filters for low-volume radiological particulates, and silica gel for tritium. **Table 5-1** in the main volume lists which sampling locations are included in each network; sampling locations are shown in **Figures 5-1**, **5-2**, and **5-3** in the main volume.

## Air Particulate Networks

All particulate air samplers are positioned to ensure reasonable probability that any significant concentration of particulate effluents from LLNL operations will be detected.

The air particulate networks primarily use high-volume (hi-vol) air sampling units, which collect airborne particles on filters. These hi-vols use brushless motors and provide a readout of the total elapsed time, instantaneous flow rate, and total flow rate.

Mass flow totalizers in the hi-vols are checked weekly using a portable field calibration unit. If a hi-vol stops running or the measured flow rate differs more than 10% from the expected flow rate, it is recalibrated using a calibration source traceable to the National Institute for Standards and Technology (NIST). During operation, the flow rate is maintained within 10%, better than the Department of Energy (DOE) requirement of ±20%, of the nominal flow by using a mass flow controller that adjusts motor speed. All air particulate filters are changed each week at all locations.

After each particulate filter is removed from a sampler, it is identified by location, date on, date off, elapsed time, and flow rate; and it is given a sample identifier (a four-field code) that accompanies it throughout the analysis. Filters are then placed in glassine envelopes, and the sample information is recorded in a field tracking notebook. All air filters are processed at the end of each month according to their location and required analysis. **Table 5-1** in the main volume shows the analytical requirements for each location.

Radiological hi-vol samplers collect particulate at a continuous rate of 1 $m^3$/min using glass-fiber filters. The low-volume samplers collect particulate at a continuous rate of 0.03 $m^3$/min using membrane filters. Beryllium samplers collect particulate at a continuous rate of 0.43 $m^3$/min using Whatman-41 cellulose filters.

The details of air particulate sampling and sample change-out are described in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999). Details of high-volume sampler flow calibration are also discussed in a procedure (ORAD EMP-AP-CA), and details of air sample analysis are outlined in standard operating procedures provided by the analytical laboratories.

## Air Particulate—Radiological

The collection efficiency of particulate filters for radiological analysis should be greater than 95% (Marshall and Stevens 1980). LLNL uses glass-fiber filters that have this level of efficiency and that maintain continuous flowrates. A total volume of approximately 10,000 $m^3$ of air is sampled at each location each week for radiological analysis. Data are grouped in categories representing the following areas: perimeter, upwind, downwind, diffuse source (tritium only), and special interest locations.

The LLNL hi-vol radiological air particulate site perimeter network maintains seven samplers at the perimeter (CAFE, COW, CRED, MESQ, MET, SALV, and VIS), shown in the main volume **Figure 5-1**. CRED location was added in 1991 to monitor resuspension of plutonium from localized soil contamination and serves as the sitewide maximally exposed individual (SW-MEI) for NESHAPs reporting purposes. The Livermore Valley network shown in the main volume **Figure 5-2**, consists of four locations in the least prevalent wind directions (CHUR, FCC, FIRE, and HOSP), considered to be upwind or background, and four samplers located in the most prevalent downwind directions (AMON, PATT, TANK, and ZON7). An additional sampler is located upwind in an area of special interest at the Livermore Water Reclamation Plant (LWRP) because, in 1967, there was a plutonium release to the sanitary sewer that resulted in local soil contamination. The low-volume radiological air particulate network consists of two samplers located at HOSP and FCC.

Site 300 is monitored at eight locations (801E, ECP, EOBS, GOLF, NPS, WCP, WOBS, and COHO) placed around the site boundary and near onsite firing tables as shown in the main volume **Figure 5-3**. Off-site monitoring at Site 300 occurs at TFIR (in downtown City of Tracy).

Glass-fiber filters are collected from the field and placed in glassine bags. The glassine bags are gathered at the end of the month, and each filter is cut and separated to supply samples for the various analyses. Portions of all glass-fiber filters are sent for gross alpha and gross beta analysis. These samples are sent to the commercial analytical laboratory after a four-day delay to allow for decay of radon–thoron daughters. Gross alpha and gross beta activities are determined using a gas flow proportional counter.

As outlined in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991), data for gross alpha, gross beta, and gamma isotopes detected on air-filters are used only as trend indicators; specific radionuclide analysis is done for plutonium and uranium, depending on the location. All analytical results are reported as a measured concentration per volume of air. When activity is less than the minimum detection concentration (MDC), the calculated value is reported (see Chapter 14 for further details). Particle size distributions are not determined because the estimated effective dose equivalent to the maximally exposed individual is well below the 0.01 mSv (1 mrem) allowable limit (DOE 1991).

The analytical laboratory uses thorium-230 and strontium-90 as calibration sources to determine alpha and beta counting efficiencies, respectively. Annual counting-efficiency measurements are made for each detector. Cross-checks using standards certified by the Environmental Protection Agency (EPA) are also completed periodically. Background and efficiency checks are completed daily, and a matrix and method blank are run with every batch of 20 samples. Records are kept of background and counting efficiency variations that occur in the counting equipment. The analytical laboratory reports the actual instrumentation values, including negative results, that arise when background measurements are higher than those for the filters.

Portions of the glass-fiber filters from the Livermore route locations are analyzed for the presence of plutonium-239+240. Similarly, portions of the glass-fiber filters from the Site 300 route are analyzed for the presence of uranium-235 and uranium-238. The filters are placed in a muffled furnace to reduce organic content and then dissolved in a mixture of nitric acid and hydrochloric and/or hydrofluoric acids. Plutonium and uranium are separated by an ion-exchange process. Each separated element is purified further by ion exchange. They are then electroplated onto a stainless steel disk and analyzed by alpha spectrometry.

For gamma scanning, two site composites are created using another portion of all weekly glass fiber filters. One site composite is created for Livermore (COW, MESQ, MET, SALV, and VIS) and another for the Site 300 perimeter locations (801E, ECP, EOBS, GOLF, NPS, WCP, and WQBS). These composites are prepared for analysis in the same manner as the plutonium and uranium samples. After they are muffled and digested, they are counted for over 40 gamma-emitting radionuclides using Ge(Li) detectors.

In addition to the gamma scanning, the Livermore perimeter composite is analyzed for uranium and the Site 300 composite is analyzed for plutonium.

Replicate radiological quality assurance (QA) samples are processed to confirm the precision of the analytical results obtained from the samplers. A duplicate QA sampler is operated for two months in parallel with the permanent sampler at a given site. In addition, a trip blank is collected during each route. The QA trip blanks and QA duplicates are processed in the same manner as the routine samples and analyzed for the same radiological parameters.

## Air Particulate—Beryllium

Beryllium analysis requires an easily dissolvable filter with a low trace-metal background. Whatman-41 filters provide a balance between such requirements and particulate collection efficiency (Lindeken et al. 1963).

Beryllium is monitored at six Livermore perimeter locations (CAFE, COW, MESQ, MET, SALV, and VIS) as required by the Bay Area Air Quality Management District. Although there is no requirement to monitor beryllium at Site 300, as a best management practice, it is monitored at four locations (801E, EOBS, GOLF, and TFIR).

The details of air particulate sampling and sample change-out are described in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999). Details of high-volume sampler flow calibration are also discussed in a procedure (ORAD EMP-AP-CA).

The cellulose filters from each site are halved, with one portion saved on site for archiving, and the other composited into a monthly sample (one for each location) and sent out to the analytical laboratories for analysis. The off-site analytical laboratory digests the sample, using nitric acid, hydrochloric acid, and hydrogen peroxide during various heating and cooling phases. Care is taken to prevent the sample from boiling or baking dry. The resulting solution is diluted to 50 mL with blank water and the quantity of beryllium is determined by inductively coupled plasma-mass spectrometry.

Trip blanks are collected weekly from the Site 300 and Livermore networks, and split samples are chosen from the archived portions of the routine sample filters. LLNL sends them to the analytical laboratory as blind samples to help determine the accuracy of the analytical measurement.

## Air Tritium

LLNL maintains 12 continuously operating, airborne-tritium samplers on the Livermore site (main volume, **Figure 5-1**), six samplers in the Livermore Valley (main volume, **Figure 5-2**), and one at Site 300 (main volume, **Figure 5-3**). Four of the Livermore site locations (B292, B331, B514, and B624) monitor diffuse source emissions. The tritium samplers, operating at a flow rate of 700 $cm^3$/min, use a continuous vacuum pump to capture air moisture on silica gel contained in sampling flasks. These flasks are changed every two weeks, and the samples are identified by location, date on, date off, elapsed sampling time, instantaneous flow rate and the minimum, maximum and total flow during the sample period. The flow rate is verified biweekly with a rotameter that is calibrated once a year.

Each sample is given a sample identifier that accompanies it through analysis. Two additional samplers are rotated among the Livermore site or valley locations at two-month intervals to provide duplicate QA samples. Details of actual tritium sampling and a description of tritium sampler calibration can be found in Appendix B of the *Environmental Monitoring Plan* (Tate et al. 1999).

Once the samples are taken, water is separated from the silica gel by freeze-dried vacuum distillation, and the tritium concentration in the water is determined by liquid-scintillation counting. Airborne tritium sample analysis is done by LLNL's Chemistry and Materials Science Environmental Services Laboratory (CES). All analytical results are reported as concentrations per liter of extracted water and per cubic meter of air flow through the sampling medium. Details of the analytical procedure are described in SOP-EM-P542 (Low-Level Tritium Analysis—Freeze Dry).

For 2001, CES developed a correction factor to apply to all tritium concentrations obtained from water extracted water from the silica gel (Guthrie et al. 2001). The correction factor is necessary because silica gel, dried as much as possible without losing structural integrity, nevertheless still contains about 5% exchangeable water by weight. Thus, the concentration of tritium measured in water extracted from the silica gel will be lower than that of the air moisture collected by the silica gel (Baumgärtner and Kim 1990; Rosson et al. 1998; Rosson et al. 2000), because the collected tritium will be diluted by water in the silica gel that contains only background levels of tritium. The magnitude of the correction depends upon the amount of water collected compared with the amount of exchangeable water bound in the silica gel and is specific to the silica gel used by LLNL. For 2001, the average correction factor was 1.6

(range of 1.3 to 2.3). A small difference is seen between winter, when the absolute humidity is on average lower and less water will be collected from the air, than summer. The correction factor is applied to each sample based upon the amount of water collected and the initial weight of the dry silica gel.

## Data

Monthly summaries of gross alpha and gross beta data for the Livermore site and Site 300 are presented in Tables 5-1, 5-2, 5-3, and 5-11. The activities summarized in the tables displaying monthly medians are calculated from concentrations in samples collected weekly. Monthly plutonium data for each sampling location are shown in Tables 5-4, 5-5, and 5-12. Monthly uranium data for the Livermore site perimeter and Site 300 are presented in Table 5-13. The monthly low-volume gross alpha and gross beta data are summarized in Table 5-6. Biweekly tritium data for sampling locations in the Livermore Valley, Livermore site perimeter, and diffuse sources are shown in Tables 5-7, 5-8, and 5-9. Tables 5-10 and 5-15 present monthly beryllium data for Livermore site perimeter and Site 300 sampling locations. (Beryllium-7 was the only gamma isotope consistently detected.) Table 5-14 shows tritium-in-air data for Site 300. The activities shown in the tables displaying monthly and biweekly data are measured concentrations and their associated ±2σ counting errors. For the tritium data, both uncorrected and corrected median values for each sampling location are shown to demonstrate the effect of the correction factor on concentrations and to provide a direct comparison with concentrations from previous years.

The data generally reflect historic data values for these analytes at these locations. A detailed discussion of these results is provided in the main volume of this report.

**Table 5-1. Monthly median activities ($10^{-6}$ Bq/m$^3$) for gross alpha and gross beta in air samples summarized from weekly data for the LLNL perimeter locations, 2001[a]**

| Month | Sampling location | | | | | | | Monthly Median (all sites)[b] |
|---|---|---|---|---|---|---|---|---|
| | CAFE | COW | CRED | MESQ | MET | SALV | VIS | |
| **Gross alpha** | | | | | | | | |
| **Jan** | 99.2 | 124 | 129 | 121 | 124 | 68.1 | 93.9 | 121 |
| **Feb** | 47.9 | 54.5 | 36.5 | 27.9 | 21.8 | 129 | 33.7 | 36 |
| **Mar** | 35.8 | 46.6 | 55.7 | 45.0 | 36.4 | 42.7 | 47.2 | 45 |
| **Apr** | 58.1 | 56.5 | 61.6 | 26.4 | 57.7 | 42.0 | 44.7 | 57 |
| **May** | 70.3 | 68.7 | 114 | 76.2 | 70.3 | 83.0 | 79.3 | 76 |
| **Jun** | 42.9 | 63.0 | 42.3 | 67.6 | 39.9 | 46.0 | 19.1 | 43 |
| **Jul** | 38.0 | 46.8 | 42.9 | 67.6 | 52.6 | 47.3 | 34.8 | 47 |
| **Aug** | 49.6 | 40.5 | 31.6 | 36.3 | 38.5 | 45.5 | 36.7 | 39 |
| **Sep** | 43.7 | 31.3 | 36.2 | 8.08 | 12.9 | 27.0 | 22.8 | 27 |
| **Oct** | 93.7 | 76.6 | 58.7 | 72.8 | 77.9 | 80.5 | 68.5 | 77 |
| **Nov** | 104 | 85.9 | 127 | 90.6 | 83.3 | 88.2 | 55.2 | 88 |
| **Dec** | 26.4 | 18.6 | 5.74 | 25.7 | 28.8 | 10.9 | 31.3 | 26 |
| **Median[c]** | **48.8** | **55.5** | **49.3** | **56.3** | **46.3** | **46.7** | **40.7** | |
| **IQR[c,d]** | **34.5** | **25.6** | **38.3** | **46.2** | **37.7** | **38.6** | **25.4** | |
| **Maximum[e]** | **354** | **331** | **442** | **362** | **382** | **352** | **327** | |
| **Gross beta** | | | | | | | | |
| **Jan** | 1400 | 1490 | 1520 | 1430 | 1570 | 908 | 1580 | 1490 |
| **Feb** | 283 | 362 | 352 | 339 | 334 | 467 | 327 | 339 |
| **Mar** | 390 | 402 | 437 | 448 | 436 | 446 | 411 | 436 |
| **Apr** | 262 | 339 | 314 | 339 | 287 | 290 | 237 | 290 |
| **May** | 555 | 468 | 579 | 529 | 589 | 542 | 571 | 555 |
| **Jun** | 427 | 407 | 480 | 467 | 444 | 445 | 448 | 445 |
| **Jul** | 352 | 290 | 376 | 307 | 325 | 281 | 272 | 307 |
| **Aug** | 361 | 339 | 375 | 365 | 329 | 312 | 283 | 339 |
| **Sep** | 512 | 493 | 436 | 491 | 402 | 535 | 452 | 491 |
| **Oct** | 778 | 775 | 718 | 777 | 679 | 724 | 678 | 724 |
| **Nov** | 667 | 611 | 607 | 653 | 680 | 642 | 658 | 653 |
| **Dec** | 348 | 280 | 281 | 310 | 328 | 303 | 310 | 310 |
| **Median[c]** | **408** | **404** | **436** | **457** | **419** | **457** | **429** | |
| **IQR[c,d]** | **232** | **183** | **217** | **221** | **283** | **257** | **289** | |
| **Maximum[e]** | **2460** | **2830** | **2850** | **2900** | **2940** | **2940** | **2860** | |

a See main volume, **Figure 5-1**, for description of locations.

b Median of the monthly media values (CRED location included).

c Annual median and IQR for each location determined from monthly median of weekly data.

d IQR= Interquartile range

e Maximum value represents the highest value found in all weekly data for a given location

**Table 5-2. Monthly median activities ($10^{-6}$ Bq/m$^3$) for gross alpha and gross beta in air samples summarized from weekly data for Livermore Valley upwind locations, 2001[a]**

| Month | Livermore Valley upwind | | | | Special interest | Monthly Median (all sites)[b] |
|---|---|---|---|---|---|---|
| | CHUR | FCC | FIRE | HOSP | LWRP | |
| **Gross alpha** | | | | | | |
| **Jan** | 184 | 190 | 84.2 | 120 | 130 | 130 |
| **Feb** | 35.4 | 45.8 | 33.9 | 31.4 | 39.2 | 35.4 |
| **Mar** | 57.4 | 38.2 | 46.1 | 36.2 | 51.5 | 46.1 |
| **Apr** | 56.2 | 57.3 | 38.1 | 48.5 | 69.8 | 56.2 |
| **May** | 63.0 | 76.7 | 75.4 | 63.9 | 103 | 75.4 |
| **Jun** | 52.1 | 55.4 | 41.8 | 31.7 | 58.4 | 52.1 |
| **Jul** | 45.6 | 58.6 | 42.9 | 12.5 | 17.1 | 42.9 |
| **Aug** | 34.8 | 47.6 | 44.6 | 26.1 | 38.3 | 38.3 |
| **Sep** | 91.3 | 72.3 | 26.7 | 83.4 | 52.0 | 72.3 |
| **Oct** | 90.1 | 110 | 82.0 | 83.5 | 99.3 | 90.1 |
| **Nov** | 98.6 | 116 | 55.1 | 62.0 | 86.9 | 86.9 |
| **Dec** | 35.0 | 33.5 | 11.5 | 23.3 | 20.3 | 23.3 |
| **Median[c]** | **56.8** | **58.0** | **43.7** | **42.3** | **55.2** | |
| **IQR[c,d]** | **47.4** | **37.9** | **23.1** | **38.7** | **51.1** | |
| **Maximum[e]** | **390** | **452** | **330** | **314** | **432** | |
| **Gross beta** | | | | | | |
| **Jan** | 1700 | 1740 | 1620 | 1700 | 1740 | 1700 |
| **Feb** | 320 | 324 | 300 | 261 | 307 | 307 |
| **Mar** | 471 | 405 | 448 | 424 | 446 | 446 |
| **Apr** | 268 | 286 | 274 | 334 | 328 | 286 |
| **May** | 573 | 517 | 541 | 575 | 632 | 573 |
| **Jun** | 421 | 414 | 413 | 423 | 448 | 421 |
| **Jul** | 289 | 217 | 287 | 297 | 327 | 289 |
| **Aug** | 339 | 328 | 353 | 346 | 335 | 339 |
| **Sep** | 549 | 537 | 511 | 483 | 463 | 511 |
| **Oct** | 780 | 795 | 912 | 878 | 825 | 681 |
| **Nov** | 768 | 681 | 583 | 625 | 783 | 311 |
| **Dec** | 406 | 311 | 304 | 301 | 341 | 325 |
| **Median[c]** | **446** | **409** | **430** | **423** | **447** | |
| **IQR[c,d]** | **288** | **252** | **248** | **262** | **336** | |
| **Maximum[e]** | **3440** | **3230** | **2480** | **2290** | **2920** | |

a See main volume, **Figure 5-2**, for description of locations

b Median of the monthly median values (LWRP location included)

c Annual median and IQR for each location determined from monthly median of weekly data

d IQR= Interquartile range

e Maximum value represents the highest value found in all weekly data for the given location

**Table 5-3. Monthly median activities ($10^{-6}$ Bq/m$^3$) for gross alpha and gross beta in air samples summarized from weekly data for Livermore Valley downwind locations, 2001[a]**

| Month | Sampling locations | | | | Monthly Median (all sites)[b] |
|---|---|---|---|---|---|
| | AMON | PATT | TANK | ZON7 | |
| **Gross alpha** | | | | | |
| **Jan** | _(c) | 219 | 80.4 | 82.5 | 82.5 |
| **Feb** | _(c) | 43.9 | 39.7 | 53.0 | 43.9 |
| **Mar** | _(c) | 64.1 | 43.1 | 28.6 | 43.1 |
| **Apr** | _(c) | 51.9 | 52.1 | 46.3 | 51.9 |
| **May** | 74.0 | 82.9 | 64.3 | 56.8 | 69.2 |
| **Jun** | 34.3 | 32.9 | 46.0 | 63.5 | 40.2 |
| **Jul** | 44.3 | 71.0 | 49.9 | 72.8 | 60.5 |
| **Aug** | 37.1 | 32.1 | 41.4 | 35.0 | 36.1 |
| **Sep** | 71.3 | 84.7 | 41.3 | 93.1 | 78.0 |
| **Oct** | 62.1 | 90.6 | 85.1 | 64.4 | 74.8 |
| **Nov** | 79.8 | 74.2 | 86.0 | 101 | 82.9 |
| **Dec** | 25.2 | 19.5 | 24.8 | 14.8 | 22.2 |
| **Median[d]** | **53.2** | **67.6** | **48.0** | **60.2** | |
| **IQR[d,e]** | **35.6** | **42.2** | **27.0** | **31.8** | |
| **Maximum[f]** | **135** | **397** | **407** | **297** | |
| **Gross beta** | | | | | |
| **Jan** | _(c) | 1910 | 1690 | 1070 | 1690 |
| **Feb** | _(c) | 331 | 341 | 311 | 331 |
| **Mar** | _(c) | 589 | 484 | 455 | 484 |
| **Apr** | _(c) | 333 | 329 | 309 | 329 |
| **May** | 567 | 622 | 509 | 567 | 567 |
| **Jun** | 428 | 450 | 454 | 434 | 442 |
| **Jul** | 285 | 319 | 307 | 321 | 313 |
| **Aug** | 386 | 374 | 396 | 356 | 380 |
| **Sep** | 582 | 467 | 484 | 505 | 495 |
| **Oct** | 756 | 853 | 786 | 912 | 820 |
| **Nov** | 587 | 528 | 664 | 672 | 626 |
| **Dec** | 261 | 255 | 306 | 353 | 284 |
| **Median[d]** | **498** | **459** | **469** | **445** | |
| **IQR[d,e]** | **223** | **265** | **210** | **248** | |
| **Maximum[f]** | **1270** | **2390** | **2620** | **2700** | |

a See main volume, **Figure 5-2**, for description of locations.

b Median of the monthly median values

c No samples collected, see main volume Chapter 14.

d Annual median and IQR for each location determined from monthly median of weekly data

e IQR= Interquartile range

## Table 5-4. Plutonium-239+240 concentrations ($10^{-9}$ Bq/m$^3$) in air particulate samples, Livermore site perimeter [(a)], 2001

| Month | CAFE | COW | CRED | MESQ | MET | SALV | VIS |
|---|---|---|---|---|---|---|---|
| **Jan** | -3.61 ± 12.5 | 13.4 ± 15.6 | 7.72 ± 15.4 | 4.84 ± 9.68 | 3.93 ± 7.86 | 0 _(b) | 8.86 ± 12.6 |
| **Feb** | -7.35 ± 14.7 | 6.52 ± 13.1 | 24.4 ± 48.9 | 14.1 ± 34.7 | -15.9 ± 31.8 | 21.2 ± 42.4 | -5.88 ± 11.8 |
| **Mar** | 7.65 ± 15.3 | -5.46 ± 10.9 | 5.67 ± 25.3 | 13.7 ± 27.5 | 5.45 ± 19.0 | 16.7 ± 23.7 | -10.6 ± 21.3 |
| **Apr** | 19.4 ± 38.8 | -7.84 ± 15.7 | 20.4 ± 40.8 | 17.3 ± 24.4 | 56.1 ± 56.6 | 9.79 ± 19.6 | 23.8 ± 47.9 |
| **May** | -4.84 ± 16.8 | 0 _(b) | 1.01 ± 3.85 | 9.80 ± 13.9 | 5.90 ± 20.5 | 8.43 ± 20.7 | 15.8 ± 12.1 |
| **Jun** | 0.000 _(c) | -5.41 ± 24.2 | 0.615 ± 5.85 | 0.000 _(c) | -5.56 ± 11.2 | 4.92 ± 17.0 | 2.46 ± 10.5 |
| **Jul** | 13.4 ± 26.8 | 5.61 ± 11.2 | 44.3 ± 25.5 | 7.80 ± 15.6 | 3.63 ± 12.6 | 19.5 ± 19.6 | 0.544 ± 5.13 |
| **Aug** | 8.56 ± 12.1 | 4.82 ± 29.0 | 0 _(c) | -16.0 ± 23.9 | -17.6 ± 27.9 | -52.4 ± 36.7 | -9.52 ± 13.5 |
| **Sep** | 22.3 ± 44.8 | 32.4 ± 48.6 | 17.5 ± 42.8 | 0.000 _(c) | 47.8 ± 59.7 | 34.3 ± 48.6 | 10.0 ± 34.8 |
| **Oct** | 16.9 ± 33.8 | 10.7 ± 37.1 | 39.4 ± 56.1 | 0.000 _(c) | 954 ± 263 | 0 _(b) | 0.000 _(c) |
| **Nov** | -7.63 ± 26.4 | 9.63 ± 27.2 | -16.6 ± 35.4 | -7.22 ± 25.1 | 12.0 ± 24.0 | 13.6 ± 19.2 | -4.23 ± 14.7 |
| **Dec** | -11.3 ± 22.7 | -25.4 ± 25.6 | 45.1 ± 48.1 | -6.04 ± 20.9 | 0.000 _(c) | 7.25 ± 25.1 | -8.78 ± 17.6 |
| **Detection frequency** | **0/12** | **0/12** | **1/12** | **0/12** | **1/12** | **0/12** | **1/12** |
| **Median** | **3.83** | **5.22** | **12.6** | **2.42** | **4.69** | **9.11** | **0.272** |
| **IQR [(d)]** | **19.7** | **15.3** | **27.2** | **12.3** | **22.3** | **13.7** | **15.8** |
| **Maximum** | **22.3** | **32.4** | **45.1** | **17.3** | **954** | **34.3** | **23.8** |
| **Percent of DCG[(e)]** | **5.17E-04** | **7.05E-04** | **1.70E-03** | **3.27E-04** | **6.34E-04** | **1.23E-03** | **3.68E-05** |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2σ counting error) or as being less than or equal to the detection limit. If the concentration is less than the uncertainty or the detection limit, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See main volume, **Figure 5-1**, for description of location.

b Actual reported value from laboratory

c "0.000" indicates that the calculated results are less than the absolute value of $0.0005 \times 10^{-9}$ Bq/m$^3$.

d IQR=interquartile range

e DCG = Derived concentration guide of $7.4 \times 10^{-4}$ established by DOE. The DCG is the concentration of plutonium 239+240 that can be inhaled continuously 365 days a year without exceeding the Doe primary radiation protection standard for the public. Maximum value used to determine the percent DCG when median value is zero.

## Table 5-5. Plutonium concentrations in air particulate samples, Livermore Valley,[a] 2001

| Month | Livermore Valley downwind locations | | | |
|---|---|---|---|---|
| | AMON | PATT | TANK | ZON7 |
| | ($10^{-9}$ Bq/m$^3$) | | | |
| **Jan** | _(b) | 6.20 ± 21.4 | -10.6 ± 21.3 | 3.92 ± 7.83 |
| **Feb** | _(b) | 4.85 ± 21.6 | -6.66 ± 13.3 | 12.2 ± 17.2 |
| **Mar** | _(b) | 11.7 ± 16.6 | -15.6 ± 18.1 | 0 _(c) |
| **Apr** | _(b) | 29.5 ± 44.2 | -5.98 ± 31.7 | 7.22 ± 14.5 |
| **May** | -5.75 ± 11.5 | 5.39 ± 24.2 | 5.25 ± 23.4 | 17.7 ± 26.5 |
| **Jun** | 18.6 ± 18.6 | 0 _(c) | 8.66 ± 21.2 | 4.77 ± 21.3 |
| **Jul** | 12.0 ± 17.1 | 3.49 ± 6.98 | -3.18 ± 11.0 | 0 _(c) |
| **Aug** | 7.60 ± 26.2 | -4.30 ± 25.8 | 5.28 ± 50.8 | 0.000 ± _(d) |
| **Sep** | 50.0 ± 61.6 | 49.4 ± 80.6 | 568 ± 210 | 25.6 ± 36.3 |
| **Oct** | 0 _(c) | 28.9 ± 58.0 | 730 ± 198 | 21.1 ± 42.2 |
| **Nov** | -10.7 ± 26.0 | -6.29 ± 28.0 | 0.000 _(d) | 4.31 ± 25.8 |
| **Dec** | 10.1 ± 20.3 | 28.8 ± 40.9 | 103 ± 79 | 0 _(c) |
| **Detection frequency** | **0/12** | **0/12** | **3/12** | **0/12** |
| **Median** | **8.85** | **5.80** | **2.63** | **4.54** |
| **IQR** | **15.1** | **26.2** | **38.4** | **13.6** |
| **Maximum** | **50.0** | **49.4** | **730** | **25.6** |
| **Percent of DCG** | **1.20E-03** | **7.83E-04** | **3.55E-04** | **6.14E-04** |

## Table 5-5. Plutonium concentrations in air particulate samples, Livermore Valley, 2001 (concluded)

| Month | Livermore Valley upwind | | | | Special Interest |
|---|---|---|---|---|---|
| | CHUR | FCC | FIRE | HOSP | LWRP |
| | ($10^{-9}$ Bq/m$^3$) | | | | |
| Jan | 0 _(c) | 7.45 ± 14.9 | 15.7 ± 22.4 | 7.80 ± 11.1 | -8.03 ± 11.4 |
| Feb | -20.0 ± 23.2 | 4.99 ± 10.0 | 5.06 ± 22.7 | 0 _(c) | 4.56 ± 9.15 |
| Mar | 0.000 _(d) | 5.76 ± 20.0 | 0 _(c) | 4.62 ± 16.0 | -5.41 ± 24.2 |
| Apr | 5.27 ± 23.6 | 99.1 ± 57.2 | 4.91 ± 9.84 | 13.2 ± 15.3 | 19.1 ± 19.3 |
| May | 7.37 ± 25.4 | 16.0 ± 18.5 | 0 _(c) | -14.8 ± 21.0 | 15.4 ± 10.8 |
| Jun | -3.86 ± 13.4 | 0.000 _(d) | -13.8 ± 19.6 | 0.000 _(d) | 10.7 ± 11.0 |
| Jul | 0 _(c) | -8.47 ± 29.3 | 5.73 ± 11.5 | 22.8 ± 26.3 | -11.7 ± 21.2 |
| Aug | 0 _(c) | 7.75 ± 26.9 | 3.77 ± 7.54 | 8.43 ± 12.0 | 12.1 ± 26.9 |
| Sep | 12.2 ± 42.5 | 16.4 ± 23.3 | 120 ± 84.4 | 80.8 ± 69.7 | 93.2 ± 79.4 |
| Oct | 35.5 ± 50.4 | 11.5 ± 23.0 | 31.7 ± 47.4 | 113 ± 69.4 | 76.7 ± 89.5 |
| Nov | 0.000 _(d) | 29.8 ± 34.5 | -14.9 ± 17.3 | 5.27 ± 27.9 | -18.6 ± 35.8 |
| Dec | 9.72 ± 19.5 | 14.7 ± 29.6 | 17.4 ± 24.7 | 9.72 ± 33.7 | 0 _(c) |
| **Detection frequency** | **0/12** | **1/12** | **1/12** | **2/12** | **2/12** |
| **Median** | **0** | **9.63** | **4.99** | **8.12** | **7.63** |
| **IQR** | **7.96** | **10.5** | **16.1** | **12.1** | **22.4** |
| **Maximum** | **35.5** | **99.1** | **120** | **113** | **93.2** |
| **Percent of DCG [(e)]** | **4.80E-03** | **1.30E-03** | **6.74E-04** | **1.10E-03** | **1.03E-03** |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2σ counting error) or as being less than or equal to the detection limit. If the concentration is less than the uncertainty or the detection limit, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See main volume, **Figure 5-2**, for description of locations

b No samples collected, see main volume, Chapter 14.

c Actual reported value from laboratory

d "0.000" indicates that the calculated results are less than the absolute value of $0.0005 \times 10^{-9}$ Bq/m$^3$.

e DCG = Derived concentration guide of 7.4 X $10^{-4}$ Bq/m$^3$ established by DOE. The DCG is the concentration of plutonium 239+240 that can be inhaled continuously 365 days a year without exceeding the DOE primary radiation protection standard for the public. Maximum value used to determine the percent DCG when median value is zero.

**Table 5-6. Monthly median activities for gross alpha and gross beta summarized from weekly data from low-volume air samplers, 2001[a]**

| Month | Livermore Valley upwind | |
|---|---|---|
| | FCC | HOSP |
| | ($10^{-6}$ Bq/m$^3$) | |
| **Gross Alpha** | | |
| **Jan** | 20.5 | 35.9 |
| **Feb** | 56.2 | 59.9 |
| **Mar** | -10.7 | 38.7 |
| **Apr** | 61.6 | 15.8 |
| **May** | 75.1 | 38.7 |
| **Jun** | 23.8 | 25.3 |
| **Jul** | 61.4 | 74.0 |
| **Aug** | 28.5 | 15.2 |
| **Sep** | 13.3 | 60.9 |
| **Oct** | 73.3 | 71.4 |
| **Nov** | 35.2 | 3.31 |
| **Dec** | 30.8 | 25.0 |
| **Median** | **33.0** | **37.3** |
| **IQR[b]** | **38.5** | **37.5** |
| **Maximum** | **301** | **331** |
| **Gross Beta** | | |
| **Jan** | 1120 | 965 |
| **Feb** | 233 | 421 |
| **Mar** | 494 | 436 |
| **Apr** | 356 | 374 |
| **May** | 709 | 501 |
| **Jun** | 512 | 629 |
| **Jul** | 357 | 559 |
| **Aug** | 453 | 657 |
| **Sep** | 681 | 646 |
| **Oct** | 1130 | 995 |
| **Nov** | 850 | 629 |
| **Dec** | 330 | 403 |
| **Median** | **503** | **594** |
| **IQR[b]** | **387** | **216** |
| **Maximum** | **3370** | **3310** |

a See **Figure 5-2**, main volume, for sampling locations.

b IQR = Interquartile range

**Table 5-7. Tritium concentration in air, Livermore Valley, 2001**

| Month | Sampling locations[a] | | | | | |
|---|---|---|---|---|---|---|
| | AMON | FIRE | HOSP | PATT | VET | ZON7 |
| | (mBq/m$^3$) | | | | | |
| **Jan** | __(b) | 29.8 ± 10.5 | 10.8 ± 10.2 | __(c) | 45.9 ± 12.1 | 15.0 ± 10.5 |
| | __(b) | __(d) | -4.85 ± 17.1 | __(d) | 25.3 ± 16.5 | 30.6 ± 18.5 |
| **Feb** | __(b) | 12.5 ± 11.7 | 4.37 ± 11.7 | -0.218 ± 9.73 | 20.0 ± 13.0 | 12.9 ± 10.9 |
| | __(b) | 28.0 ± 17.6 | 12.9 ± 18.8 | 22.8 ± 15.8 | 20.8 ± 18.9 | 1.61 ± 15.3 |
| **Mar** | __(b) | -3.19 ± 16.4 | __(d) | -0.747 ± 14.6 | __(d) | -3.89 ± 16.5 |
| | __(b) | 7.47 ± 17.3 | 19.9 ± 17.7 | -19.2 ± 15.2 | 18.0 ± 18.0 | 12.8 ± 17.4 |
| | __(b) | 28.5 ± 21.3 | -16.8 ± 18.5 | -7.47 ± 19.4 | 6.48 ± 20.4 | 21.0 ± 19.4 |
| **Apr** | __(b) | 12.0 ± 16.2 | 9.95 ± 12.9 | 23.4 ± 15.2 | 9.36 ± 15.5 | 8.84 ± 13.5 |
| | __(b) | 0.770 ± 14.6 | -20.4 ± 10.7 | -3.92 ± 12.2 | 10.0 ± 14.5 | 6.66 ± 12.3 |
| **May** | -9.03 ± 13.3 | -17.4 ± 15.5 | -23.4 ± 17.1 | -23.0 ± 15.7 | -2.99 ± 18.1 | 4.85 ± 15.0 |
| | 13.6 ± 16.9 | 30.5 ± 18.8 | 4.22 ± 17.8 | 27.7 ± 18.6 | 13.5 ± 19.1 | 51.8 ± 18.9 |
| **Jun** | 33.2 ± 18.0 | 20.3 ± 17.8 | 1.32 ± 15.2 | 19.0 ± 18.0 | 14.1 ± 18.7 | 31.9 ± 17.8 |
| | 10.8 ± 14.5 | 11.5 ± 19.6 | 6.66 ± 17.9 | 9.99 ± 14.6 | 9.47 ± 16.9 | 2.90 ± 14.7 |
| **Jul** | -4.07 ± 24.3 | 8.21 ± 17.8 | -0.68 ± 18.3 | 18.3 ± 16.9 | 0.48 ± 19.3 | -11.9 ± 17.2 |
| | 1.88 ± 20.2 | -24.3 ± 20.5 | 23.2 ± 22.6 | -28.5 ± 23.3 | 17.2 ± 24.8 | 1.91 ± 18.6 |
| **Aug** | -4.00 ± 22.0 | -20.2 ± 21.3 | -18.2 ± 18.5 | -9.14 ± 20.4 | 7.70 ± 25.5 | 27.2 ± 22.0 |
| | 15.2 ± 19.3 | -1.34 ± 16.9 | 4.29 ± 20.2 | 15.0 ± 20.1 | 5.40 ± 23.6 | 33.0 ± 18.5 |
| | 33.2 ± 22.2 | 4.92 ± 17.9 | 0.418 ± 18.5 | -12.3 ± 17.9 | -10.8 ± 22.9 | 19.0 ± 19.7 |
| **Sep** | 17.3 ± 16.1 | 9.29 ± 16.2 | 20.2 ± 17.6 | 13.1 ± 16.6 | 4.59 ± 19.4 | 19.6 ± 16.1 |
| | 13.7 ± 23.0 | 15.6 ± 21.3 | -6.62 ± 20.0 | 1.37 ± 22.0 | 17.6 ± 24.5 | 35.4 ± 21.8 |
| **Oct** | 9.77 ± 16.2 | -10.7 ± 28.1 | -2.09 ± 17.4 | 7.44 ± 17.4 | 17.5 ± 21.8 | 26.8 ± 16.9 |
| | 4.07 ± 16.9 | 6.07 ± 17.3 | 4.66 ± 15.5 | 7.36 ± 17.4 | 12.8 ± 22.9 | -4.77 ± 15.4 |
| **Nov** | 2.85 ± 20.7 | 11.2 ± 21.3 | -10.1 ± 18.0 | 9.66 ± 20.8 | 18.8 ± 24.3 | 9.69 ± 18.4 |
| | -16.4 ± 23.5 | 6.14 ± 29.1 | 3.85 ± 20.5 | -24.3 ± 23.1 | 1.87 ± 20.5 | 22.0 ± 23.7 |
| **Dec** | -11.1 ± 19.9 | 0.755 ± 16.1 | 8.95 ± 14.4 | 24.2 ± 18.9 | 5.11 ± 16.7 | 16.8 ± 18.4 |
| | 21.9 ± 15.9 | 4.33 ± 15.2 | 14.0 ± 13.2 | 3.74 ± 17.0 | 2.08 ± 14.9 | 3.05 ± 14.8 |
| **Median[e]** | **9.77 [6.18]** | **7.47 [4.85]** | **4.22 [2.43]** | **5.55 [3.31]** | **10.0 [6.48]** | **14.0 [8.21]** |
| **Interquartile Range** | **19.2** | **11.7** | **14.8** | **23.7** | **12.5** | **22.1** |
| **Percent_of DCG[f]** | **2.6E-04** | **2.0E-04** | **1.1E-04** | **1.5E-04** | **2.7E-04** | **3.8E-04** |
| **Dose (nSv)[g]** | **2.1** | **1.6** | **0.89** | **1.2** | **2.1** | **2.9** |

**Note:** Radioactivities are reported as the measured concentration and an uncertainty (± 2σ counting error). If the concentration is less than the uncertainty, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See main volume, **Figure 5-2**, for sampling locations

b Sampling site power source damaged in auto accident.

c New location not yet operational

d No data. See main volume, Chapter 14.

e Number without brackets is the corrected median of the numbers listed; number with brackets is the uncorrected median to compare with previous years. See text for details.

f DCG = Derived Concentration Guide of 3.7 x $10^6$ mBq/m$^3$ for tritium in air. Percent is calculated from the median concentration.

g This dose is the effective dose equivalent from inhalation and skin absorption.

**Table 5-8. Tritium concentration in air, Livermore site perimeter, 2001**

| Month | Sampling location[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CAFE | COW | DWTF | MESQ | MET | POOL | SALV | VIS |
| | (mBq/m³) | | | | | | | |
| **Jan** | __(b) | 49.2 ± 11.5 | __( c) | 66.6 ± 12.9 | 76.2 ± 14.8 | 133 ± 14.4 | 64.8 ± 12.4 | 78.4 ± 12.4 |
| | 100 ± 20.0 | 37.7 ± 17.4 | __( c) | __(b) | 92.1 ± 22.4 | __(b) | 47.7 ± 16.9 | 69.6 ± 16.5 |
| **Feb** | 51.1 ± 12.7 | 48.1 ± 13.1 | __( c) | 53.7 ± 17.0 | 73.6 ± 16.1 | 117 ± 15.1 | 51.4 ± 13.7 | 41.1 ± 12.2 |
| | 70.3 ± 17.9 | 69.6 ± 18.6 | __( c) | 26.2 ± 18.8 | 8.14 ± 16.4 | 89.5 ± 18.7 | 44.4 ± 17.7 | 50.3 ± 16.6 |
| **Mar** | 67.3 ± 18.3 | 30.0 ± 16.4 | __( c) | 6.22 ± 18.9 | 13.8 ± 17.5 | __(b) | 24.3 ± 13.4 | 24.8 ± 16.8 |
| | 29.0 ± 18.1 | 58.8 ± 20.7 | __( c) | 38.1 ± 20.9 | 29.9 ± 18.9 | 64.8 ± 18.8 | 19.9 ± 18.9 | 40.3 ± 20.5 |
| | __(b) | 30.3 ± 21.8 | __( c) | 24.6 ± 22.9 | 4.03 ± 20.3 | 75.5 ± 25.2 | 7.51 ± 21.5 | 95.5 ± 23.7 |
| **Apr** | 41.1 ± 16.5 | 35.1 ± 17.0 | __( c) | 23.0 ± 17.5 | 10.5 ± 15.8 | 78.1 ± 27.0 | 33.3 ± 15.1 | 58.1 ± 17.3 |
| | 19.4 ± 14.2 | 24.7 ± 15.0 | __( c) | -2.78 ± 14.4 | -2.60 ± 13.7 | 65.5 ± 16.2 | 16.5 ± 17.2 | 69.2 ± 21.2 |
| **May** | 89.9 ± 20.2 | 30.7 ± 14.6 | __( c) | -11.5 ± 17.1 | 8.36 ± 15.1 | __(b) | 15.3 ± 15.4 | 61.8 ± 25.4 |
| | 49.2 ± 21.7 | 45.5 ± 19.5 | __( c) | 13.2 ± 20.0 | 18.8 ± 17.7 | __(b) | 36.5 ± 18.4 | 82.1 ± 21.9 |
| **Jun** | 14.8 ± 18.6 | 97.7 ± 21.4 | __( c) | 14.7 ± 18.4 | 8.55 ± 18.3 | 51.4 ± 20.8 | 23.8 ± 16.1 | __(b) |
| | 74.4 ± 21.8 | 28.4 ± 18.2 | __( c) | 68.8 ± 19.8 | 48.8 ± 27.9 | 168 ± 28.2 | __(b) | 78.4 ± 28.9 |
| **Jul** | 41.4 ± 22.2 | 26.9 ± 19.2 | __( c) | -15.5 ± 19.5 | 7.03 ± 15.5 | 94.0 ± 23.0 | __(b) | 62.5 ± 18.7 |
| | 16.6 ± 26.2 | 23.0 ± 22.9 | __( c) | 4.18 ± 25.9 | -7.51 ± 19.8 | 79.9 ± 35.2 | 19.7 ± 22.6 | 34.2 ± 21.8 |
| **Aug** | -11.2 ± 23.3 | 12.0 ± 23.4 | __( c) | 10.9 ± 24.6 | -22.8 ± 21.4 | 46.6 ± 30.5 | -12.7 ± 20.8 | 26.2 ± 21.1 |
| | 21.5 ± 25.2 | 14.5 ± 18.9 | __( c) | -4.51 ± 22.8 | __(b) | __(b) | 21.5 ± 21.6 | 52.2 ± 20.9 |
| | 0.903 ± 22.9 | 23.9 ± 19.7 | __( c) | -5.85 ± 22.6 | -0.137 ± 18.2 | __(b) | 18.4 ± 20.5 | 37.7 ± 20.2 |
| **Sep** | 21.1 ± 18.9 | 39.2 ± 17.4 | __( c) | 31.0 ± 21.2 | 1.27 ± 17.6 | 67.3 ± 21.9 | 29.9 ± 18.1 | 86.2 ± 19.8 |
| | 27.1 ± 25.1 | 23.3 ± 21.6 | __( c) | 6.66 ± 25.9 | -5.33 ± 25.1 | 71.0 ± 38.1 | 23.5 ± 21.6 | 77.3 ± 24.5 |
| **Oct** | __(b) | 34.5 ± 18.9 | 33.9 ± 22.2 | 7.66 ± 20.1 | 47.0 ± 27.7 | 96.9 ± 23.2 | 71.0 ± 20.5 | 70.7 ± 21.0 |
| | 44.4 ± 15.5 | 28.0 ± 17.5 | 21.3 ± 20.8 | 54.8 ± 18.6 | 30.0 ± 19.8 | 161 ± 23.0 | 21.4 ± 16.9 | 62.9 ± 18.9 |
| **Nov** | __(b) | 22.9 ± 19.0 | 44.4 ± 25.3 | 40.7 ± 19.4 | 51.1 ± 25.6 | 154 ± 31.0 | 42.2 ± 20.1 | 9.44 ± 19.5 |
| | 47.0 ± 21.1 | __(b) | 48.1 ± 30.9 | 64.8 ± 26.0 | 29.2 ± 23.1 | 91.0 ± 25.8 | 13.1 ± 20.4 | 32.9 ± 22.3 |
| **Dec** | 38.1 ± 17.6 | 55.5 ± 20.1 | 61.8 ± 26.8 | 26.7 ± 22.3 | 1.65 ± 17.3 | 88.1 ± 22.5 | 29.9 ± 18.9 | 30.2 ± 17.6 |
| | 72.9 ± 16.2 | 20.4 ± 15.8 | 41.1 ± 16.6 | 26.1 ± 18.7 | 19.5 ± 16.3 | 105 ± 21.8 | 63.6 ± 16.9 | 17.6 ± 14.9 |
| **Median[d]** | **41.3 [24.8]** | **30.3 [18.1]** | **42.8 [26.0]** | **23.0 [13.9]** | **10.5 [6.4]** | **88.8 [58.8]** | **24.1 [15.8]** | **58.1 [35]** |
| **Interquartile Range** | **42.1** | **21.6** | **11.5** | **31.9** | **28.4** | **37.9** | **23.4** | **36.5** |
| **Percent of DCG[e]** | **1.1E-03** | **8.2E-04** | **1.2E-03** | **6.2E-04** | **2.8E-04** | **2.4E-03** | **6.5E-04** | **1.6E-03** |
| **Dose (nSv)[f]** | **8.7** | **6.4** | **9.0** | **4.8** | **2.2** | **19** | **5.1** | **12** |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (± 2σ counting error).

If the concentration is less than the uncertainty, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See **Figure 5-1**, main volume, for sampling locations.

b No data. See main volume, Chapter 14.

c New sampling location

d Number without brackets is the corrected median of the numbers listed; number with brackets is the uncorrected median to compare with previous years. See text for details.

e DCG = Derived Concentration Guide of 3.7 x $10^6$ mBq/m³ for tritium in air. Percent is calculated from the median concentration.

f This dose is the effective dose equivalent from inhalation and skin absorption.

**Table 5-9. Tritium concentration in air at locations near diffuse sources, 2001**

| Month | Sampling locations[a] | | | |
|---|---|---|---|---|
| | B292 | B331 | B514 | B624 |
| | (mBq/m³) | | | |
| **Jan** | 138 ± 15.3 | 243 ± 17.6 | 1320 ± 36.7 | 4630 ± 59.6 |
| | 199 ± 22.4 | 197 ± 21.9 | 1130 ± 38.9 | 4290 ± 62.2 |
| **Feb** | 120 ± 15.4 | 129 ± 16.0 | 1170 ± 37.0 | 3690 ± 55.5 |
| | 75.9 ± 18.6 | 129 ± 19.7 | 2350 ± 53.3 | 3330 ± 56.2 |
| **Mar** | 75.1 ± 18.2 | 91.8 ± 18.8 | 1480 ± 47.0 | 3010 ± 58.5 |
| | 49.2 ± 19.1 | 185 ± 23.3 | 1940 ± 57.4 | 2590 ± 58.5 |
| | 38.9 ± 20.7 | 218 ± 27.8 | 2520 ± 70.7 | 2220 ± 58.5 |
| **Apr** | __(b) | 186 ± 22.1 | 2360 ± 56.6 | 1660 ± 42.2 |
| | 43.3 ± 14.4 | 208 ± 22.6 | 1760 ± 48.5 | 1380 ± 41.8 |
| **May** | 30.2 ± 17.1 | 362 ± 25.8 | 1940 ± 50.0 | 2850 ± 56.2 |
| | 39.6 ± 18.8 | 459 ± 31.7 | __(b) | 1860 ± 51.8 |
| **Jun** | 52.5 ± 17.7 | 381 ± 30.8 | 96.2 ± 21.1 | 1600 ± 46.3 |
| | 59.6 ± 19.2 | 414 ± 31.1 | 126 ± 20.8 | 1790 ± 48.8 |
| **Jul** | 43.7 ± 20.0 | 407 ± 31.0 | 115 ± 23.5 | 1040 ± 39.2 |
| | 9.40 ± 21.9 | 259 ± 34.0 | -2.26 ± 23.7 | 625 ± 40.7 |
| **Aug** | -7.84 ± 21.1 | 199 ± 28.1 | 3.85 ± 22.3 | 525 ± 34.7 |
| | 7.99 ± 20.2 | 273 ± 30.1 | 33.1 ± 22.3 | 733 ± 38.1 |
| | __(b) | 282 ± 33.1 | 35.7 ± 22.2 | 977 ± 41.8 |
| **Sep** | 49.2 ± 16.8 | 448 ± 29.4 | 76.6 ± 20.6 | 1150 ± 41.8 |
| | 39.6 ± 22.1 | 625 ± 45.1 | 75.5 ± 26.5 | 1000 ± 45.1 |
| **Oct** | 78.8 ± 20.2 | 400 ± 30.0 | 169 ± 24.9 | 1850 ± 52.9 |
| | 39.2 ± 17.3 | 488 ± 30.6 | 209 ± 23.5 | 4000 ± 85.5 |
| **Nov** | 67.0 ± 20.0 | 340 ± 28.0 | 154 ± 24.8 | 2210 ± 56.2 |
| | 61.8 ± 23.5 | 403 ± 34.6 | 101 ± 19.9 | 1850 ± 56.6 |
| **Dec** | 57.0 ± 19.6 | 381 ± 31.7 | 63.3 ± 16.7 | 1470 ± 50.0 |
| | 102 ± 19.2 | 286 ± 28.0 | 111 ± 16.4 | 1590 ± 47.0 |
| **Median** | **50.9 [32.4]** | **284 [188]** | **154 [95.5]** | **1820 [1110]** |
| **Interquartile Range** | **35.8** | **201** | **1400** | **1580** |
| **Percent of DCG[d]** | **1.4E-03** | **7.7E-03** | **4.2E-03** | **4.9E-02** |
| **Dose (nSv)[e]** | **11** | **60** | **32** | **380** |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (± 2σ counting error). If the concentration is less than the uncertainty, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See **Figure 5-1**, main volume, for sampling locations.

b No data. See main volume, Chapter 14.

c Number without brackets is the corrected median of the numbers listed; number with brackets is the uncorrected median to compare with previous years. See text for details.

d DCG = Derived Concentration Guide of 3.7 x $10^6$ mBq/m³ for tritium in air. Percent is calculated from the median concentration.

e This dose is the effective dose equivalent from inhalation and skin absorption.

**Table 5-10. Beryllium concentration (pg/m$^3$) in Livermore perimeter air particulate samples, 2001 [(a)]**

| Month | CAFE | COW | MESQ | MET | SALV | VIS |
|---|---|---|---|---|---|---|
| **Jan** | 7.42 | 6.67 | 4.91 | 5.36 | 3.33 | 5.98 |
| **Feb** | 5.25 | 2.80 | 2.52 | 3.20 | 2.96 | 4.34 |
| **Mar** | 9.65 | 7.06 | 10.0 | 6.84 | 9.32 | 7.63 |
| **Apr** | 17.7 | 9.39 | 11.6 | 12.6 | 11.2 | 11.4 |
| **May** | 25.7 | 19.8 | 18.9 | 17.1 | 19.7 | 17.5 |
| **Jun** | 28.0 | 21.5 | 20.5 | 19.0 | 22.2 | 18.6 |
| **Jul** | 15.7 | 15.2 | 14.8 | 9.62 | 12.5 | 10.4 |
| **Aug** | 31.5 | 15.8 | 11.5 | 11.6 | 11.5 | 14.8 |
| **Sep** | 30.7 | 17.5 | 20.1 | 15.5 | 24.7 | 20.1 |
| **Oct** | 23.0 | 20.6 | 14.5 | 20.3 | 14.6 | 16.8 |
| **Nov** | 13.9 | 6.49 | 6.28 | 8.21 | 9.16 | 8.25 |
| **Dec** | 7.14 | 2.85 | 5.26 | 3.65 | 2.17 | 3.22 |
| **Detection Frequency [(b)]** | **11/12** | **10/12** | **9/12** | **9/12** | **9/12** | **9/12** |
| **Median** | **16.7** | **12.3** | **11.6** | **10.6** | **11.4** | **10.9** |
| **Maximum** | **31.5** | **21.5** | **20.5** | **20.3** | **24.7** | **20.1** |
| **IQR [(c)]** | **17.2** | **11.5** | **9.80** | **9.43** | **8.17** | **9.76** |
| **Percent of ACL[(d)]** | **0.167** | **0.123** | **0.116** | **0.106** | **0.114** | **0.109** |

a See **Figure 5-1,** for a description of locations.

b Detection frequecy is the number of samples with results above the the detection limit (6.0 pg/m$^3$) divided by the number of samples analyzed.

c IQR= Interquartile range

d ACL = Ambient Concentration Limit of 10,000 pg/m$^3$ is established by the Bay Area Air Quality Management District.

**Table 5-11. Monthly median activities ($10^{-6}$ Bq/m$^3$) for gross alpha and gross beta in air particulate samples summarized from weekly data for Site 300 on-site and off-site locations, 2001 [a]**

| Month | Site 300 perimeter | | | | | | | | Off-site | Monthly Median (all sites)[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | 801E | COHO | ECP | EOBS | GOLF | NPS | WCP | WOBS | TFIR | |
| **Gross alpha** | | | | | | | | | | |
| **Jan** | 159 | 134 | 147 | 150 | 113 | 105 | 91.4 | 90.8 | 127 | 127 |
| **Feb** | 40.7 | 40.9 | 43.3 | 24.5 | 29.3 | 49.5 | 18.6 | 37.4 | 46.8 | 40.7 |
| **Mar** | 43.5 | 50.1 | 57 | 45.8 | 48.6 | 57.5 | 40.7 | 46.3 | 62.8 | 48.6 |
| **Apr** | 53.6 | 48.3 | 63 | 59.1 | 61.3 | 78.6 | 40.5 | 57 | 58.9 | 58.9 |
| **May** | 155 | 102 | 98.9 | 120 | 87.9 | 96.6 | 76 | 109 | 86.2 | 98.9 |
| **Jun** | 83.4 | 76.5 | 57.9 | 109 | 63.9 | 37.7 | 75.6 | 67.3 | 73.2 | 73.2 |
| **Jul** | 50.5 | 64.1 | 60.0 | 97.7 | 69.1 | 38.4 | 53.4 | 70.4 | 46.1 | 60.0 |
| **Aug** | 55.2 | 57.7 | 24.6 | 52.0 | 50.6 | 63.6 | 49.9 | 58.0 | 51.4 | 52.0 |
| **Sep** | 41.5 | 63.8 | 72.8 | 54.7 | 29.7 | 40.2 | 51.7 | 49.7 | 65.3 | 51.7 |
| **Oct** | 119 | 112 | 117 | 106 | 97.6 | 116 | 102 | 104 | 124 | 112 |
| **Nov** | 153 | 124 | 133 | 93.1 | 156 | 136 | 131 | 120 | 147 | 133 |
| **Dec** | 15.9 | 13.8 | 37.2 | 34.4 | 33.1 | 5.29 | 19.8 | 0.890 | 27.9 | 19.8 |
| **Median[c]** | **54.4** | **64** | **61.5** | **76.1** | **62.6** | **60.6** | **52.6** | **62.7** | **64.1** | |
| **IQR [c,d]** | **84.5** | **54.9** | **49.9** | **56.3** | **45.6** | **58.9** | **39.2** | **45.2** | **45.4** | |
| **Maximum[e]** | **353** | **408** | **400** | **396** | **307** | **347** | **292** | **314** | **470** | |
| **Gross beta** | | | | | | | | | | |
| **Jan** | 1750 | 1540 | 1880 | 1260 | 1730 | 1630 | 1620 | 1590 | 1920 | 1630 |
| **Feb** | 336 | 322 | 425 | 336 | 424 | 402 | 340 | 370 | 425 | 370 |
| **Mar** | 482 | 403 | 562 | 438 | 533 | 452 | 405 | 434 | 481 | 452 |
| **Apr** | 409 | 354 | 374 | 307 | 339 | 344 | 309 | 316 | 399 | 344 |
| **May** | 798 | 636 | 645 | 809 | 611 | 704 | 621 | 634 | 715 | 645 |
| **Jun** | 479 | 409 | 502 | 610 | 477 | 565 | 465 | 452 | 450 | 477 |
| **Jul** | 539 | 423 | 475 | 686 | 412 | 477 | 372 | 453 | 393 | 453 |
| **Aug** | 465 | 459 | 460 | 513 | 425 | 453 | 435 | 539 | 438 | 459 |
| **Sep** | 846 | 729 | 737 | 752 | 737 | 812 | 723 | 826 | 669 | 737 |
| **Oct** | 1000 | 967 | 1020 | 979 | 961 | 873 | 932 | 1010 | 1080 | 979 |
| **Nov** | 826 | 857 | 785 | 692 | 873 | 767 | 838 | 685 | 1150 | 826 |
| **Dec** | 287 | 416 | 323 | 284 | 413 | 339 | 428 | 249 | 588 | 339 |
| **Median[c]** | **511** | **441** | **532** | **648** | **505** | **521** | **450** | **496** | **535** | |
| **IQR [c,d]** | **380** | **354** | **298** | **354** | **350** | **339** | **355** | **302** | **372** | |
| **Maximum[e]** | **2710** | **2630** | **2900** | **2430** | **3070** | **2780** | **2270** | **2330** | **3480** | |

a See main volume, **Figure 5-2**, for description of locations.

b Median of the monthly median values (TFIR location included).

c Annual median and IQR for each location determined from monthly median of weekly data.

d IQR= Interquartile range

e Maximum value represents the highest value found in all weekly data for the given location.

**Table 5-12. Plutonium-239+240 activity ($10^{-9}$ Bq/m$^3$) in air particulate samples, Site 300 composite [(a)], 2001**

| Month | Site 300 composite |
|---|---|
| **Jan** | 0.000 _(b) |
| **Feb** | 7.56 ± 15.2 |
| **Mar** | 4.02 ± 9.86 |
| **Apr** | 9.83 ± 14.0 |
| **May** | 3.69 ± 7.40 |
| **Jun** | 2.03 ± 16.7 |
| **Jul** | 0.000 _(b) |
| **Aug** | -4.00 ± 6.33 |
| **Sep** | 0.000 _(b) |
| **Oct** | 1.91 ± 29.4 |
| **Nov** | 2.10 ± 7.27 |
| **Dec** | 4.28 ± 8.56 |
| **Detection frequency** | **0/12** |
| **Median** | **2.07** |
| **IQR [(c)]** | **4.09** |
| **Maximum** | **9.83** |
| **Percent of DCG** | **2.79E-04** |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2σ counting error) or as being less than or equal to the detection limit. If the concentration is less than the uncertainty or the detection limit, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See main volume, Figure 5-3, for description of locations. Composite includes samples from 801E, ECP, EOBS, GOLF, NPS, WCP, WOBS.

b "0.000" indicates that the calculated results are less than the absolute value of $0.0005 \times 10^{-9}$ Bq/m$^3$.

c IQR=interquartile range

**Table 5.13. Uranium mass concentration in air particulate samples[a], 2001**

| Month | Uranium-235 ($10^{-7}$ µg/m$^3$) [b] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 801E | COHO | ECP | EOBS | GOLF | NPS | TFIR | WCP | WOBS | Livermore composite |
| Jan | 4.87 ± 8.46 | 5.48 ± 10.2 | -0.484 ± 8.35 | 7.51 ± 9.06 | 0.240 ± 7.94 | 5.09 ± 8.51 | 7.26 ± 8.69 | -0.166 ± 8.06 | -5.10 ± 8.58 | -8.17 ± 6.31 |
| Feb | 2.15 ± 10.2 | 3.35 ± 10.5 | 14.5 ± 11.5 | 1.27 ± 9.87 | 8.14 ± 12.4 | 5.19 ± 10.8 | 3.08 ± 10.6 | 1.58 ± 10.4 | 22.9 ± 12.9 | -6.38 ± 8.08 |
| Mar | 4.43 ± 9.53 | -8.36 ± 8.98 | 3.63 ± 11.1 | -0.788 ± 8.99 | -3.46 ± 8.84 | 1.83 ± 10.4 | 10.6 ± 10.0 | -0.368 ± 9.02 | 2.40 ± 9.12 | -4.88 ± 7.59 |
| Apr | 6.79 ± 19.3 | 2.67 ± 17.6 | 2.29 ± 19.5 | -7.98 ± 15.0 | -0.949 ± 17.1 | -2.66 ± 15.3 | 10.6 ± 21.4 | -5.84 ± 15.0 | -5.72 ± 15.7 | -9.91 ± 14.5 |
| May | 3.69 ± 12.3 | 13.3 ± 12.8 | 3.73 ± 9.69 | 8.05 ± 12.3 | 5.51 ± 11.3 | 13.6 ± 14.7 | 6.63 ± 10.6 | 12.8 ± 10.4 | -0.156 ± 8.96 | -0.852 ± 8.14 |
| Jun | 2.88 ± 10.5 | 25.0 ± 24.9 | 19.0 ± 17.2 | -2.26 ± 10.6 | 8.07 ± 13.2 | 7.46 ± 11.7 | 13.3 ± 15.8 | -0.912 ± 12.6 | -4.14 ± 10.3 | 8.90 ± 11.4 |
| Jul | 58.2 ± 8.82 | -2.04 ± 25.6 | -14.8 ± 28.1 | 46.0 ± 8.46 | -2.77 ± 28.3 | 47.7 ± 10.7 | -10.1 ± 30.2 | -11.5 ± 25.2 | -7.17 ± 26.0 | -17.8 ± 25.4 |
| Aug | -5.87 ± 10.3 | 6.98 ± 12.6 | 9.06 ± 12.5 | 10.9 ± 20.3 | 6.77 ± 12.4 | 16.4 ± 12.8 | -0.848 ± 13.6 | 2.93 ± 11.9 | 15.7 ± 12.6 | -10.2 ± 9.84 |
| Sep | 12.0 ± 11.7 | 4.17 ± 11.7 | 36.5 ± 14.3 | 25.8 ± 13.7 | 16.5 ± 14.3 | 26.3 ± 13.4 | 21.1 ± 12.9 | _(f) | 0.922 ± 11.1 | -8.80 ± 8.72 |
| Oct | -3.16 ± 10.0 | 3.32 ± 14.9 | -0.0925 ± 10.7 | -0.332 ± 10.6 | -1.08 ± 10.7 | -8.69 ± 9.34 | -4.44 ± 9.54 | -4.33 ± 10.2 | 0.369 ± 10.3 | -6.28 ± 9.19 |
| Nov | 17.2 ± 14.7 | 3.63 ± 12.9 | -10.7 ± 14.9 | 7.28 ± 17.2 | -5.47 ± 11.0 | -4.03 ± 11.7 | 2.95 ± 12.5 | 0.0926 ± 12.0 | 1.06 ± 11.6 | -7.23 ± 9.58 |
| Dec | -1.42 ± 6.60 | 10.7 ± 9.69 | -4.70 ± 7.58 | 2.13 ± 9.41 | -1.11 ± 8.13 | -6.31 ± 8.74 | 2.35 ± 8.79 | 26.8 ± 13.6 | 0.0919 ± 8.36 | -1.05 ± 7.04 |
| Median | 4.06 | 3.90 | 2.96 | 4.71 | -0.355 | 5.14 | 4.86 | -0.17 | 0.230 | -6.81 |
| IQR [d] | 6.84 | 4.75 | 12.0 | 9.21 | 8.62 | 17.3 | 9.05 | 4.88 | 5.78 | 5.16 |
| Maximum | 58.2 | 25.0 | 36.5 | 46.0 | 16.5 | 47.7 | 21.1 | 26.8 | 22.9 | 8.90 |
| Percent of DCG [e] | 8.64E-04 | 8.30E-04 | 6.30E-04 | 1.00E-03 | 3.51E-03 | 1.09E-03 | 1.03E-03 | 5.70E-03 | 4.90E-05 | 1.89E-03 |

**Table 5.13. Uranium mass concentration in air particulate samples[(a)], 2001 (concluded)**

| Month | Uranium-238 ($10^{-5}$ ug/m$^3$) [(c)] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 801E | COHO | ECP | EOBS | GOLF | NPS | TFIR | WCP | WOBS | Livermore composite |
| Jan | 3.77 ± 4.13 | 2.50 ± 4.43 | 2.62 ± 4.12 | -1.67 ± 3.84 | 1.89 ± 4.04 | 1.19 ± 3.96 | 2.36 ± 4.06 | 4.49 ± 4.22 | 0.829 ± 4.05 | -9.64 ± 3.25 |
| Feb | -1.32 ± 4.07 | 1.63 ± 4.35 | 2.23 ± 4.37 | -1.18 ± 4.11 | 1.62 ± 4.31 | 0.591 ± 4.31 | 3.08 ± 4.47 | 6.76 ± 4.67 | 32.9 ± 6.86 | -2.49 ± 3.91 |
| Mar | 3.24 ± 3.20 | 3.28 ± 3.49 | 6.86 ± 3.88 | 5.50 ± 3.44 | -0.148 ± 2.99 | 3.71 ± 3.44 | 5.59 ± 3.32 | 3.98 ± 3.29 | 3.85 ± 3.22 | -0.743 ± 2.82 |
| Apr | 7.50 ± 5.81 | 1.59 ± 5.13 | 2.57 ± 5.90 | 1.22 ± 4.95 | 3.29 ± 5.12 | 3.65 ± 5.05 | 7.63 ± 5.61 | 0.604 ± 4.78 | 5.80 ± 5.26 | -8.27 ± 4.39 |
| May | 10.8 ± 7.21 | 6.40 ± 4.83 | 6.24 ± 4.55 | 5.89 ± 6.87 | 5.64 ± 4.53 | 9.45 ± 7.41 | 13.3 ± 5.20 | 4.60 ± 4.29 | 5.57 ± 4.37 | -5.57 ± 3.86 |
| Jun | 1.37 ± 6.71 | 5.36 ± 6.06 | 6.54 ± 4.75 | 1.38 ± 6.84 | 8.61 ± 4.48 | 0.349 ± 6.92 | 13.3 ± 5.15 | 3.37 ± 4.71 | 4.38 ± 4.15 | 0.112 ± 4.22 |
| Jul | 70.3 ± 5.36 | 3.45 ± 6.48 | -2.49 ± 6.92 | 68.9 ± 5.40 | 1.78 ± 7.36 | 66.5 ± 5.62 | -1.17 ± 6.93 | -4.59 ± 6.10 | 0.944 ± 6.65 | -8.18 ± 6.17 |
| Aug | -3.26 ± 4.14 | -1.48 ± 4.29 | -2.52 ± 4.17 | -7.25 ± 4.55 | -3.12 ± 4.16 | -0.443 ± 4.23 | 4.56 ± 4.97 | 1.04 ± 4.52 | 0.739 ± 4.30 | -7.29 ± 3.68 |
| Sep | 1.63 ± 4.94 | 8.18 ± 5.58 | -0.889 ± 4.77 | 0.740 ± 4.94 | 2.09 ± 5.29 | 0.148 ± 4.86 | 14.1 ± 5.91 | _(f) | 3.85 ± 5.14 | -5.20 ± 4.36 |
| Oct | 18.7 ± 5.26 | 1.18 ± 4.27 | 3.56 ± 4.13 | 6.27 ± 4.29 | 1.19 ± 4.07 | -2.01 ± 3.69 | 2.71 ± 3.90 | 3.44 ± 4.22 | 2.01 ± 3.91 | 0.117 ± 3.86 |
| Nov | 5.47 ± 4.57 | 2.98 ± 4.27 | 4.43 ± 4.70 | 6.20 ± 4.73 | 2.23 ± 4.12 | 3.99 ± 4.24 | 5.70 ± 4.43 | 1.78 ± 3.98 | 1.48 ± 3.99 | -3.30 ± 3.46 |
| Dec | -0.0697 ± 2.88 | -4.28 ± 3.27 | -2.01 ± 3.46 | -5.31 ± 3.25 | -2.38 ± 3.42 | -1.77 ± 3.67 | 0.718 ± 3.70 | 47.7 ± 8.04 | -1.42 ± 3.43 | -11.0 ± 2.72 |
| Median | 3.51 | 2.74 | 2.60 | 1.30 | 1.84 | 0.891 | 5.08 | 3.44 | 2.93 | -5.39 |
| IQR | 7.31 | 2.44 | 6.05 | 7.27 | 1.64 | 3.78 | 6.43 | 3.14 | 3.76 | 6.15 |
| Maximum | 70.3 | 8.18 | 6.86 | 68.9 | 8.61 | 66.5 | 14.1 | 47.7 | 32.9 | 0.117 |
| Percent of DCG | 1.17E-02 | 9.13E-03 | 8.65E-03 | 4.33E-03 | 6.12E-03 | 2.97E-03 | 1.69E-02 | 1.15E-02 | 9.77E-03 | 3.90E-04 |

**Note:** Mass concentrations are reported as the measured concentration and an uncertainty (±2σ counting error). If the concentration is less than the uncertainty or the detection limit, the result is considered to be a nondetection. Negative values occur when the instrument or filter background is greater than the sample activity. See the main volume, Chapter 14.

a See **Figure 5-3**, main volume, for sampling locations at Site 300. Livermore composite consists of filters from CAFE, COW, MESQ, MET, SALV, and VIS, see **Figure 5-1**, main volume.

b Uranium-235 activities in Bq/m$^3$ can be determined by dividing the mass in µg/m$^3$ by 12.5.

c Uranium-238 activities in Bq/m$^3$ can be determined by dividing the weight in µg/m$^3$ by 80.3.

d IQR = Interquartile range

e Derived Concentration Guides (DCG) for activity in air are 0.3 µg/m$^3$ for $^{238}$U and 0.047 µg/m$^3$ for $^{235}$U. Percent DCG calculated from median value, unless median value is negative, in which case percent DCG calculated from the maximum.

f Data from laboratory failed the quality control acceptance criteria.

## Table 5-14. Tritium concentration in air, Site 300, 2001

| Month | Sampling location[a] | | |
|---|---|---|---|
| | COHO | | |
| | (mBq/m$^3$) | | |
| **Jan** | 16.9 | ± | 9.95 |
| | 0.500 | ± | 16.9 |
| | 17.4 | ± | 11.2 |
| **Feb** | 12.0 | ± | 15.2 |
| | -2.46 | ± | 17.4 |
| **Mar** | -10.6 | ± | 17.2 |
| | -34.3 | ± | 19.0 |
| **Apr** | -3.01 | ± | 13.9 |
| | 7.92 | ± | 13.1 |
| **May** | -7.14 | ± | 15.4 |
| | | __(b) | |
| **Jun** | 3.17 | ± | 13.9 |
| | 7.92 | ± | 14.1 |
| **Jul** | -8.77 | ± | 15.9 |
| | 4.26 | ± | 23.7 |
| **Aug** | 14.7 | ± | 22.7 |
| | -8.25 | ± | 19.6 |
| | -15.9 | ± | 15.1 |
| **Sep** | 3.17 | ± | 15.3 |
| | -10.0 | ± | 18.0 |
| **Oct** | -17.9 | ± | 15.8 |
| | -5.59 | ± | 15.1 |
| **Nov** | 1.39 | ± | 17.4 |
| | -11.6 | ± | 20.5 |
| **Dec** | -5.4 | ± | 17.4 |
| | 3.63 | ± | 15.3 |
| **Median[c]** | **-2.46 [-1.52]** | | |
| **Interquartile Range** | **13.0** | | |
| **Percent of DCG[d]** | **1.4E-05** | | |
| **Dose (nSv)[e]** | **0.10** | | |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (± 2σ counting error). If the concentration is less than the uncertainty, the result is considered to be a nondetection. See the main volume, Chapter 14.

a See the main volume, **Figure 5-3** for sampling location.

b No data; see main volume, Chapter 14.

c Number without brackets is the corrected median of the numbers listed; number with brackets is the uncorrected median to compare with previous years. See text for details.

d DCG = Derived Concentration Guide of 3.7 x $10^6$ mBq/m$^3$ for tritium in air. Percent calculated on the lowest positive concentration, because the median value is negative

e This dose is the effective dose equivalent from inhalation and skin absorption. Dose was determined based on the lowest positive concentration, because the median value is negative.

**Table 5-15. Beryllium concentration (pg/m$^3$) in air particulate samples, Site 300, 2001[a]**

| Month | On site | | | Off site |
|---|---|---|---|---|
| | 801E | EOBS | GOLF | TFIR |
| Jan | 2.44 | 1.46 | 5.86 | 8.08 |
| Feb | 7.69 | 0.956 | 2.69 | 4.81 |
| Mar | 6.41 | 5.11 | 7.37 | 10.9 |
| Apr | 17.5 | 9.49 | 10.7 | 21.5 |
| May | 27.5 | 17.6 | 22.8 | 26.4 |
| Jun | 23.0 | 14.0 | 16.1 | 25.3 |
| Jul | 24.9 | 11.4 | 12.2 | 21.2 |
| Aug | 14.1 | 10.1 | 11.4 | 21.6 |
| Sep | 31.8 | 12.8 | 16.4 | 23.9 |
| Oct | 33.1 | 18.3 | 21.2 | 26.4 |
| Nov | 8.15 | 8.19 | 7.30 | 12.0 |
| Dec | 2.49 | 1.82 | 1.83 | 4.76 |
| **Detection frequency [b]** | **10/12** | **8/12** | **9/12** | **10/12** |
| **Median** | **15.8** | **9.80** | **11.1** | **21.4** |
| **Maximum** | **33.1** | **18.3** | **22.8** | **26.4** |
| **IQR [c]** | **18.20** | **8.81** | **9.23** | **14.10** |
| **Percent of ACL** | **0.158** | **0.098** | **0.111** | **0.214** |

a See **Figure 5-1** for a description of locations.

b Detection frequecy is the number of samples with results above the the detection limit (6.0 pg/m$^3$) divided by the number of samples analyzed.

c IQR= Interquartile range

# Sewerable Water Monitoring

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## Discharges of Treated Groundwater

Discharges of groundwater to Lawrence Livermore National Laboratory's sanitary sewer must comply with the terms and conditions in Permit 1510G(01-02), issued by the Livermore Water Reclamation Plant (LWRP). Table 6-1 shows discharge dates and monitoring data for discharges of groundwater. The self-monitoring program prescribed in this groundwater discharge permit requires compliance with the parameters specified in **Table 6-2** in the main volume.

## Flow Monitoring Methods

To monitor effluent flow, LLNL used a flow chart recorder installed inside the LLNL Sewer Monitoring Station (SMS) and an ultrasonic flow sensor in the adjacent underground sewer vault (see main volume, **Figure 6-1**). Every day a flow totalizer reading was recorded on the flow chart recorder when the daily composite sample was acquired from the SMS. Daily total flows were calculated by subtracting sequentially recorded flow totalizer readings and were estimated when flow totalizer readings were not available. Table 6-2a shows the daily total flows. Table 6-2b presents monthly and annual flow summary statistics for 2001.

## Sewage Sampling Methods and Analytical Procedures

LLNL operated a flow-proportional, peristaltic-pump composite sampler in the SMS. This sampler created a 24-hour composite of the Livermore site sewage effluent by taking a sample every 3785 L of effluent. Every day, technologists transferred 500-mL aliquots of this 24-hour composite to polyethylene bottles and submitted them for analysis.

Two aliquots were submitted to LLNL's Hazards Control Analytical Laboratory (HCAL) for daily analyses of the gross alpha, gross beta, and tritium activity. For the gross alpha and gross beta analyses, HCAL digested a 150-mL aliquot, plated the digestate onto a planchette, and submitted the planchette to the Hazards Control Radiological Measurements Laboratory (HCRML) for a 100-min count in a gas-proportional counter. For the tritium analyses, HCAL distilled a 100-mL aliquot and submitted the distillate to HCRML. HCRML prepared 5 mL of the distillate with a scintillation cocktail and counted it for 100 min in a liquid scintillation counter. The analytical results for the gross alpha, gross beta, and tritium analyses are shown in Table 6-3.

A third daily aliquot was submitted to LLNL's Chemistry and Materials Science Environmental Services (CES). From the aliquots submitted for

each month, CES created a composite sample and analyzed it, first for $^{239}Pu$, and then for $^{137}Cs$.

The $^{239}Pu$ was analyzed by adding approximately 15 L of $MnO_2$ to the entire volume of the monthly composite sample to precipitate the plutonium. After the composite volume was digested with concentrated $HNO_3$, CES used ion-exchange chromatography to separate the plutonium from the rest of the sample. The plutonium eluted from the ion-exchange column was electroplated onto a stainless steel disk, and its activity was measured by alpha spectroscopy.

Before beginning analysis for $^{137}Cs$ activity in the monthly composite, CES returned any nonplutonium sample material generated from the ion-exchange process to the monthly composite sample in order to prevent $^{137}Cs$ loss. For the $^{137}Cs$ analysis, CES added $NH_4MoPO_4$ to the monthly composite sample in order to precipitate the cesium and then counted the composite sample using gamma spectroscopy. The analytical results for the $^{239}Pu$ and $^{137}Cs$ analyses are reported in the main volume, **Table 6-5.**

In 2001, LWRP provided two types of sample—treated effluent and sludge—to LLNL for analysis. LWRP collected two 500-mL aliquots of treated effluent daily and used them to create two different composite samples: (1) a week of daily aliquots, and (2) a month of daily aliquots. LLNL technologists transferred the weekly sample (composited in a 1-gal polyethylene bottle) to HCAL for gross alpha, gross beta, and tritium analyses. Table 6-4 shows the tritium results for the LWRP weekly composite sample.

CES analyzed the LWRP monthly sample, which is composited in a 5-gal polyethylene carboy, for $^{137}Cs$ using gamma spectroscopy and for $^{239}Pu$ using alpha spectroscopy. The results of the analysis are presented in **Table 6-5** of the main volume.

The other type of sample was sludge from the LWRP digesters. Each month, LWRP employees provided two 500-mL composite samples from each of the digesters. The composites consisted of aliquots taken from the circulating sludge once a week. LLNL collected the composite samples and submitted one 500-mL composite to HCAL and a second 500-mL composite to CES. HCAL analyzed the monthly composite for gross radioactivity and metals. CES composited all of the monthly samples on a quarterly basis and analyzed the quarterly composites for plutonium, cesium, and gamma-emitting radionuclides, using alpha spectroscopy for the plutonium and gamma spectroscopy for the cesium and gamma-emitting radionuclides. **Table 6-5** in the main volume shows the results for the $^{239}Pu$ analyses.

Throughout Chapter 6, gross alpha, gross beta, and tritium are displayed in bequerels per unit volume, and the activities shown in Tables 6-3 and 6-4 are the measured concentrations and their associated $\pm 2\sigma$ counting errors. A $\pm 2\sigma$ error is not shown when the measured concentration is below the limit of sensitivity (LOS). The LOS is determined individually for each sample analysis according to the following equation:

$$LOS = \frac{C}{Et}$$

where

C = Minimum significant count, above background radiation, for a length of time (t)

E = System counting efficiency

t = Sample counting time

LLNL also operated monitoring station C196 with a flow-proportional, peristaltic pump composite sampler adjacent to the SMS. This sampler functioned as a weekly composite sampler and acquired a 60-mL sample for every 30,280 L of effluent LLNL discharged during a seven-day period. Another sampler operated once a month for 24 hours as a single-day composite sampler and collected a 100-mL sample for every 7570 L of effluent discharged.

Aliquots were acquired each week from the weekly composite sample and every month from the 24-hour composite sample. From each weekly composite (and each monthly 24-hour composite), analysts transferred one 1-L aliquot to a polyethylene bottle. This aliquot was submitted to an off-site contract laboratory for analyses of aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, and zinc. The results for these analyses are presented in Tables 6-5 and 6-6; the EPA methods used for these analyses are identified by the method numbers 200.7, SM-3114B, 210.2, 200.7, 200.7, 200.7, 200.7, 239.2, 245.2, 249.2, 200.7, and 200.7, respectively. See the main volume, **Table 6-2**, for constituent analyses required by the LWRP permit.

Two additional aliquots from the weekly composite were submitted each week to HCAL for analyses of gross alpha, gross beta, and tritium. A subset of these results contributes to the completeness of the daily analytical results for gross alpha, gross beta, and tritium; this subset is reported and footnoted in Table 6-3.

Aliquots were submitted to the contract analytical laboratory for more extensive analyses on the 24-hour composite than on the weekly composite sample. Under the heading of "Composite sample," Table 6-7 lists these results by parameters, the EPA method numbers used for the analyses, and month. (The analytical methods are EPA methods unless otherwise indicated.) It should be noted that only Table 6-6 reports the monthly metals analytical results for those metals mentioned previously.

Concurrent with the monthly acquisition of a 24-hour composite, a portable, peristaltic-pump sampler collected instantaneous grab samples from the sewage stream in the sewer vault adjacent to SMS. These samples were submitted to a contract analytical laboratory for additional monitoring of water quality parameters and organic compounds. The results of this monitoring are presented in Table 6-7 under the "Grab sample" heading. The table lists the parameters and the EPA method numbers used for the analyses. Samples for oil and grease (as well as cyanide) are collected semiannually rather than monthly. The entries for oil and grease show the results for samples that were acquired at intervals during the day as well as the time of collection of each oil and grease sample.

## Quality Assurance Methods

Standard quality control and quality assurance procedures were followed in the collection of LLNL samples. When each sewage field sample was collected, it was labeled with the sampling location and date of sampling. In the laboratory, each sample was assigned a number that accompanied that sample during analysis. Additionally, split samples accounted for approximately 10% of the samples submitted for analytical work in 2001.

**Table 6-1. Laboratory analytical results for groundwater discharges to the sanitary sewer, January 1 through December 31, 2001**

| Sample dates | Discharge dates | pH[a] | Total toxic organics, mg/L[b] |
|---|---|---|---|
| 2/13/01 | 2/14/01 | 8 | 0.001[c] |
| 9/26/01 | 9/26/01 | 7 | 0.0059[d] |
| Discharge criteria | | 5 to 10 | <1.00 |

a pH was verified prior to discharge. The pH at final discharge may be slightly different but was always between 5 and 10.

b Total toxic organics (TTO) is the sum of concentrations of compounds detected by EPA Method 601/602, or approved alternate method for wastewater.

c Chloroform

d 0.0024 mg/L=1,1-Dichloroethane, 0.0024 mg/L=1,1-Dichloroethene, 0.0011 mg/L=Trichloroethene

**Table 6-2a. Daily flow totals for Livermore site sanitary sewer effluent (ML), 2001**

31-Dec 0.36

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.38 | 1.15 | 1.16 | 0.55 | 1.00 | 1.04 | 0.49 | 1.07 | 0.97 | 0.45 | 1.06 | 0.87 |
| 2 | 0.39 | 1.41 | 1.07 | 0.40 | 1.00 | 1.07 | 0.51 | 1.06 | 0.38 | 1.04 | 1.04 | 0.43 |
| 3 | 0.50 | 1.50 | 0.96 | 0.99 | 0.99 | 0.53 | 1.01 | 1.02 | 0.35 | 1.03 | 0.92 | 0.59 |
| 4 | 1.09 | 0.57 | 0.38 | 1.03 | 0.97 | 0.55 | 0.90 | 1.06 | 0.41 | 1.05 | 0.43 | 1.18 |
| 5 | 0.99 | 1.08 | 0.50 | 0.98 | 0.89 | 1.08 | 0.45 | 0.41 | 1.03 | 1.05 | 0.44 | 1.05 |
| 6 | 1.01 | 1.24 | 1.03 | 1.06 | 0.37 | 1.12 | 0.88 | 0.42 | 1.18 | 0.94 | 1.02 | 1.06 |
| 7 | 0.45 | 1.14 | 1.01 | 0.94 | 0.35 | 1.07 | 0.85 | 1.04 | 1.02 | 0.43 | 1.05 | 1.03 |
| 8 | 0.51 | 1.59 | 1.16 | 0.38 | 1.05 | 1.12 | 0.46 | 1.06 | 0.98 | 0.54 | 1.19 | 0.88 |
| 9 | 1.06 | 1.13 | 0.97 | 0.40 | 0.99 | 2.26 | 0.50 | 1.13 | 0.56 | 1.04 | 1.01 | 0.36 |
| 10 | 0.98 | 0.97 | 0.96 | 0.89 | 0.99 | 0.65 | 1.14 | 1.06 | 0.52 | 1.06 | 0.95 | 0.38 |
| 11 | 1.21 | 0.43 | 0.41 | 0.91 | 0.96 | 0.51 | 1.06 | 0.95 | 1.04 | 1.25 | 0.47 | 1.02 |
| 12 | 1.15 | 0.42 | 0.42 | 0.96 | 0.94 | 1.13 | 1.09 | 0.39 | 0.56 | 1.19 | 0.52 | 1.11 |
| 13 | 0.90 | 1.06 | 1.05 | 0.98 | 0.46 | 1.10 | 1.12 | 0.42 | 1.15 | 0.93 | 1.14 | 1.02 |
| 14 | 0.39 | 1.17 | 0.98 | 0.86 | 0.46 | 0.94 | 0.89 | 0.94 | 1.03 | 0.39 | 1.18 | 1.27 |
| 15 | 0.38 | 1.07 | 1.02 | 0.36 | 1.01 | 0.91 | 0.46 | 1.01 | 0.94 | 0.46 | 1.33 | 0.86 |
| 16 | 0.47 | 1.07 | 1.01 | 0.36 | 1.18 | 0.88 | 0.49 | 1.03 | 0.43 | 1.09 | 2.30 | 0.26 |
| 17 | 1.12 | 0.96 | 0.96 | 0.43 | 1.15 | 0.43 | 1.05 | 1.02 | 0.47 | 1.19 | 1.03 | 0.29 |
| 18 | 1.15 | 0.43 | 0.39 | 1.01 | 1.22 | 0.43 | 1.05 | 0.88 | 1.09 | 1.21 | 0.52 | 1.04 |
| 19 | 1.50 | 0.43 | 0.44 | 0.87 | 1.03 | 1.03 | 1.05 | 0.36 | 1.20 | 1.15 | 0.51 | 1.01 |
| 20 | 1.13 | 0.49 | 1.06 | 1.09 | 0.49 | 0.97 | 1.13 | 0.40 | 1.14 | 0.99 | 1.10 | 1.02 |
| 21 | 0.54 | 1.02 | 1.06 | 0.98 | 0.53 | 1.04 | 0.94 | 0.91 | 1.13 | 0.51 | 1.07 | 1.11 |
| 22 | 0.55 | 1.05 | 1.07 | 0.41 | 1.52 | 1.05 | 0.41 | 1.15 | 0.96 | 0.50 | 0.89 | 0.81 |
| 23 | 1.26 | 1.11 | 1.13 | 0.42 | 1.19 | 1.02 | 0.47 | 1.28 | 0.45 | 1.18 | 0.43 | 0.41 |
| 24 | 1.40 | 0.90 | 1.00 | 1.11 | 1.15 | 0.48 | 1.08 | 1.32 | 0.44 | 1.13 | 0.45 | 0.36 |
| 25 | 1.52 | 0.44 | 0.41 | 1.02 | 1.08 | 0.54 | 1.06 | 1.04 | 1.21 | 1.21 | 0.54 | 0.39 |
| 26 | 1.72 | 0.41 | 0.42 | 1.09 | 1.03 | 1.27 | 1.16 | 0.49 | 1.18 | 1.17 | 0.54 | 0.37 |
| 27 | 1.06 | 1.04 | 1.11 | 1.03 | 0.50 | 1.00 | 1.13 | 0.54 | 1.17 | 1.02 | 1.09 | 0.68 |
| 28 | 0.70 | 0.98 | 1.01 | 0.91 | 0.53 | 1.04 | 1.04 | 1.18 | 1.17 | 0.56 | 1.09 | 0.83 |
| 29 | 0.71 | | 1.09 | 0.40 | 0.57 | 1.05 | 0.61 | 1.16 | 0.95 | 0.55 | 1.17 | 0.89 |
| 30 | 1.40 | | 1.10 | 0.40 | 1.11 | 1.02 | 0.48 | 1.09 | 0.43 | 1.16 | 1.09 | 0.40 |
| 31 | 1.21 | | 0.91 | | 1.26 | | 1.05 | 1.18 | | 1.12 | | 0.47 |

Note: Weekend and holiday daily flow totals are shown in the boxed areas. Note that the majority of the flow volume recorded for a given day was actually discharged on the previous day.

**Table 6-2b. Monthly and annual flow summary statistics for Livermore site sanitary sewer effluent (ML), 2001.**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Weekend days and holidays** | | | | | | | | | | | | | |
| **Total** | **5.96** | **4.68** | **3.37** | **4.49** | **4.26** | **4.12** | **5.32** | **3.44** | **4.43** | **4.39** | **4.84** | **4.71** | **54.01** |
| Daily Minimum | 0.38 | 0.41 | 0.38 | 0.36 | 0.35 | 0.43 | 0.41 | 0.36 | 0.35 | 0.39 | 0.43 | 0.26 | 0.26 |
| Daily Maximum | 0.71 | 1.08 | 0.50 | 0.55 | 0.57 | 0.65 | 0.61 | 0.54 | 0.56 | 0.56 | 0.54 | 0.59 | 1.08 |
| Daily Mean | 0.50 | 0.52 | 0.42 | 0.41 | 0.47 | 0.52 | 0.48 | 0.43 | 0.44 | 0.49 | 0.48 | 0.39 | 0.48 |
| **Weekdays** | | | | | | | | | | | | | |
| **Total** | **22.86** | **21.53** | **23.87** | **18.71** | **23.71** | **24.20** | **20.66** | **24.62** | **21.10** | **24.20** | **21.58** | **18.76** | **265.78** |
| Daily Minimum | 0.90 | 0.90 | 0.91 | 0.86 | 0.89 | 0.88 | 0.85 | 0.88 | 0.56 | 0.93 | 0.19 | 0.68 | 0.19 |
| Daily Maximum | 1.72 | 1.59 | 1.16 | 1.11 | 1.52 | 2.26 | 1.16 | 1.32 | 1.21 | 1.25 | 2.30 | 1.27 | 2.30 |
| Daily Mean | 1.20 | 1.13 | 1.04 | 0.99 | 1.08 | 1.10 | 1.03 | 1.07 | 1.06 | 1.10 | 1.08 | 0.99 | 1.07 |
| **All days** | | | | | | | | | | | | | |
| **Total** | **28.83** | **26.21** | **27.23** | **23.19** | **27.97** | **28.32** | **25.97** | **28.06** | **25.53** | **28.59** | **27.55** | **23.47** | **320.92** |
| Daily Minimum | 0.38 | 0.41 | 0.38 | 0.36 | 0.35 | 0.43 | 0.41 | 0.36 | 0.35 | 0.39 | 0.43 | 0.26 | 0.26 |
| Daily Maximum | 1.72 | 1.59 | 1.16 | 1.11 | 1.52 | 2.26 | 1.16 | 1.32 | 1.21 | 1.25 | 2.30 | 1.27 | 2.30 |
| Daily Mean | 0.93 | 0.94 | 0.88 | 0.77 | 0.90 | 0.94 | 0.84 | 0.91 | 0.85 | 0.92 | 0.92 | 0.76 | 0.90 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[(a)] | Activity | LOS[(a)] | Activity | LOS[(a)] |
| January | 1 | 202±70.8 | 75.9 | 0.187±0.0785 | 0.115 | 3.77 | 10.4 |
| | 2 | 72.9 | 74.4 | 0.122±0.0757 | 0.114 | 1.52 | 10.5 |
| | 3 | 113±56.4 | 84.7 | 0.33±0.0892 | 0.117 | 3.05 | 10.4 |
| | 4 | -0.773 | 92.9 | 0.788±0.11 | 0.119 | 2.64±1.1 | 10.2 |
| | 5 | 15 | 95.5 | 1.35±0.131 | 0.12 | 1.62 | 10.6 |
| | 6 | 48.5 | 98.1 | 0.858±0.112 | 0.12 | -1.66 | 10.7 |
| | 7 | -23.6 | 108 | 0.969±0.116 | 0.122 | 3.67 | 10.5 |
| | 8 | -2.67 | 91.4 | 0.347±0.0901 | 0.119 | 0.32 | 10.5 |
| | 9 | 51.8 | 106 | 0.673±0.108 | 0.122 | 0.377 | 10.6 |
| | 10 | 93.6 | 138 | 1.15±0.127 | 0.13 | -0.481 | 10.2 |
| | 11 | 147±64.5 | 119 | 0.84±0.118 | 0.126 | 7.44 | 10.2 |
| | 12 | 114±53.4 | 113 | 0.877±0.114 | 0.124 | -7.47 | 10.8 |
| | 13 | 32.9 | 101 | 1.04±0.125 | 0.121 | -0.0426 | 10.3 |
| | 14 | 64 | 100 | 0.64±0.102 | 0.121 | 5.29 | 10.3 |
| | 15 | 48.8 | 80.3 | 0.134±0.0792 | 0.117 | -0.995 | 10.3 |
| | 16 | 42.2 | 88.4 | 0.403±0.0928 | 0.119 | 0.888 | 10.3 |
| | 17 | 99.2±50.6 | 98.1 | 0.64±0.102 | 0.121 | 3.27 | 10.5 |
| | 18 | 151±61.7 | 110 | 1.14±0.137 | 0.134 | -2.19 | 10.7 |
| | 19 | 47.7 | 101 | 0.792±0.119 | 0.132 | 0.139 | 10.4 |
| | 20 | 32 | 119 | 0.858±0.12 | 0.135 | -4.77 | 10.8 |
| | 21 | 58.5 | 107 | 0.366±0.102 | 0.134 | -4 | 10.8 |
| | 22 | 61.8 | 104 | 0.377±0.102 | 0.132 | -1.14 | 10.5 |
| | 23 | 159±70.2 | 130 | 1.16±0.139 | 0.138 | 5.25 | 10.4 |
| | 24 | -10.1 | 123 | 1.13±0.136 | 0.137 | 4.48 | 10.3 |
| | 25 | 69.2 | 129 | 0.87±0.122 | 0.137 | 0.277 | 10.4 |
| | 26 | 217±82.4 | 133 | 0.947±0.133 | 0.14 | 5.99 | 10.1 |
| | 27 | -79.9 | 132 | 0.877±0.123 | 0.138 | 3.85 | 10.1 |
| | 28 | 104 | 128 | 0.514±0.108 | 0.137 | 0.276 | 10.5 |
| | 29 | 19.3 | 131 | 0.451±0.108 | 0.138 | 3.25 | 10.1 |
| | 30 | 112 | 127 | 0.747±0.12 | 0.137 | 2.63 | 10.3 |
| | 31 | 42.6 | 118 | 0.87±0.122 | 0.133 | -3.55 | 10.5 |
| February | 1 | 120±56.2 | 114 | 1.09±0.131 | 0.132 | 3.44 | 10.1 |
| | 2 | 149±56.7 | 110 | 1.53±0.147 | 0.135 | 24.6±6.9 | 10.7 |
| | 3 | 127 | 136 | 0.825±0.124 | 0.137 | 8.4 | 10.1 |
| | 4 | 90.7 | 110 | 0.463±0.106 | 0.132 | 4.92 | 10.1 |
| | 5 | 276±100 | 128 | 0.548±0.11 | 0.136 | 1.57 | 10.2 |
| | 6 | 62.5 | 134 | 1.13±0.135 | 0.136 | 8.44 | 10.5 |
| | 7 | 106 | 132 | 1.71±0.152 | 0.135 | 1.49 | 10.7 |
| | 8 | 159±66.8 | 118 | 1.17±0.129 | 0.134 | -3.47 | 10.5 |
| | 9 | 149±69.9 | 139 | 1.18±0.141 | 0.138 | 3.7 | 10.4 |
| | 10 | 61.1 | 118 | 1.36±0.136 | 0.133 | 2.09 | 10.2 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| | 11 | 32.2 | 109 | 0.537±0.107 | 0.132 | 4.18 | 10.4 |
| | 12 | 4.11 | 117 | 0.00437±0.001 | 0.125 | 0.218 | 10.2 |
| | 13 | 14.3 | 145 | 0.629±0.113 | 0.131 | -1.21 | 10.4 |
| | 14 | 22.6 | 140 | 0.888±0.124 | 0.13 | -0.44 | 10.3 |
| | 15 | 7.55 | 115 | 0.836±0.117 | 0.125 | 0.555 | 10.4 |
| | 16 | 8.4 | 114 | 0.895±0.116 | 0.125 | -2.59 | 10.4 |
| | 17 | 69.2 | 112 | 0.84±0.118 | 0.124 | -4.37 | 10.8 |
| | 18 | 22.4 | 105 | 0.236±0.0872 | 0.122 | -1.92 | 10.5 |
| | 19 | 69.2 | 103 | 0.213±0.0854 | 0.121 | 6.73 | 10.2 |
| | 20 | 33.4 | 103 | 0.525±0.0998 | 0.121 | 6.44 | 10.3 |
| | 21 | 236±85.1 | 129 | 0.918±0.119 | 0.129 | -4.11 | 10.5 |
| | 22 | 145±56.4 | 130 | 1.27±0.14 | 0.129 | -0.592 | 10.8 |
| | 23 | -20.3 | 135 | 1.36±0.136 | 0.13 | -0.356 | 10.5 |
| | 24 | 91.4 | 108 | 1.28±0.128 | 0.122 | -3.09 | 10.5 |
| | 25 | 219±79 | 95.1 | 0.411±0.0945 | 0.12 | -2.21 | 10.4 |
| | 26 | 37.4 | 87 | 0.289±0.0867 | 0.118 | 3.31 | 10.2 |
| | 27 | 44.4 | 108 | 0.981±0.118 | 0.122 | -0.252 | 10.4 |
| | 28 | 87.3 | 107 | 0.951±0.114 | 0.122 | -1.52 | 10.8 |
| March | 1 | 117±54 | 108 | 0.725±0.109 | 0.122 | 3.45 | 10.3 |
| | 2 | 46.3 | 104 | 0.962±0.115 | 0.121 | 8.99 | 10.4 |
| | 3 | 234±72.6 | 102 | 1.04±0.125 | 0.121 | 2.99 | 10.4 |
| | 4 | 152±59.3 | 75.5 | 0.366±0.0877 | 0.115 | -0.585 | 10.7 |
| | 5 | 102±57.4 | 89.2 | 0.25±0.085 | 0.118 | -1.61 | 10.5 |
| | 6 | 246±78.7 | 125 | 1.3±0.13 | 0.127 | 2.31 | 10.3 |
| | 7 | 112±46.1 | 99.9 | 0.962±0.115 | 0.12 | 0 | 10.5 |
| | 8 | 114±46.6 | 111 | 1.08±0.119 | 0.123 | -2.53 | 10.6 |
| | 9 | 158±61.8 | 110 | 0.992±0.119 | 0.124 | -1.37 | 10.5 |
| | 10 | 62.9 | 99.9 | 1.03±0.124 | 0.121 | 3.56 | 10.1 |
| | 11 | 85.5±49.6 | 78.4 | 0.26±0.0858 | 0.117 | 2.56 | 10.2 |
| | 12 | 130±61.2 | 82.9 | 0.223±0.0846 | 0.118 | -0.685 | 10.5 |
| | 13 | 203±68.9 | 107 | 1.1±0.121 | 0.123 | 127±8.78 | 10.5 |
| | 14 | 139±54.3 | 101 | 0.981±0.118 | 0.122 | 292±11.1 | 10.2 |
| | 15 | 36.4 | 104 | 0.977±0.117 | 0.123 | 370±12.2 | 10.5 |
| | 16 | 55.1 | 107 | 0.87±0.113 | 0.124 | 310±11.5 | 10.6 |
| | 17 | 131±53.7 | 98.1 | 0.914±0.119 | 0.122 | 5.14 | 10.6 |
| | 18 | 54.4 | 102 | 0.707±0.106 | 0.122 | 2.08 | 10.6 |
| | 19 | 119±59.4 | 91 | 0.4±0.0919 | 0.12 | -1.64 | 10.5 |
| | 20 | 55.5 | 100 | 0.562±0.101 | 0.12 | 221±10.2 | 10.1 |
| | 21 | 80.7 | 98.4 | 0.921±0.12 | 0.12 | 111±8.41 | 10.5 |
| | 22 | 122±54.9 | 110 | 0.829±0.116 | 0.123 | 0.374 | 10.4 |
| | 23 | 20 | 122 | 0.936±0.122 | 0.127 | 1.92 | 10.4 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| | 24 | 190±68.5 | 99.2 | 0.825±0.116 | 0.12 | 1.31 | 8.55 |
| | 25 | 39.6 | 79.9 | 0.297±0.0861 | 0.116 | 3.4 | 8.47 |
| | 26 | 28.6 | 86.2 | 0.214±0.0834 | 0.118 | 2.21 | 8.58 |
| | 27 | 72.2 | 104 | 0.762±0.107 | 0.12 | -0.514 | 8.51 |
| | 28 | 114±44.4 | 96.6 | 0.966±0.116 | 0.119 | 1.72 | 8.21 |
| | 29 | 52.2 | 96.2 | 0.877±0.114 | 0.119 | -1.15 | 9.88 |
| | 30 | 185±57.4 | 96.9 | 1.19±0.119 | 0.119 | 7.36 | 10.2 |
| | 31 | 71.8 | 95.1 | 0.955±0.115 | 0.118 | -0.729 | 10.5 |
| April | 1 | 83.6 | 93.6 | 0.281±0.0872 | 0.118 | 4.63 | 10.2 |
| | 2 | 19.2 | 83.3 | 0.205±0.082 | 0.116 | 0.0803 | 10.4 |
| | 3 | 202±62.7 | 96.9 | 1.09±0.12 | 0.119 | 1.21 | 10.2 |
| | 4 | 75.1 | 104 | 0.944±0.113 | 0.12 | 4.4 | 9.99 |
| | 5 | 189±66 | 108 | 0.836±0.117 | 0.124 | -0.174 | 8.33 |
| | 6 | 28.3 | 105 | 0.814±0.114 | 0.123 | 3.81 | 8.29 |
| | 7 | 41.4 | 101 | 0.792±0.111 | 0.122 | -1.44 | 8.58 |
| | 8 | 135±59.4 | 91 | 0.389±0.0932 | 0.12 | 1.64 | 8.58 |
| | 9 | 102±51.9 | 87 | 0.339±0.0916 | 0.119 | -0.448 | 8.4 |
| | 10 | 110±45.2 | 104 | 0.877±0.114 | 0.122 | -2.76 | 8.55 |
| | 11 | 131±47.3 | 106 | 1.18±0.13 | 0.123 | 4.59 | 9.99 |
| | 12 | 42.9 | 98.4 | 0.87±0.113 | 0.12 | 1.89 | 10.2 |
| | 13 | 158±61.8 | 110 | 1.09±0.12 | 0.122 | -0.503 | 10.5 |
| | 14 | 139 | 94 | 0.884±0.115 | 0.119 | -1.79 | 10.4 |
| | 15 | 28.5 | 79.6 | 0.266±0.0851 | 0.116 | 2.93 | 10.2 |
| | 16 | 66.2 | 83.6 | 0.339±0.088 | 0.117 | 4.59 | 10.3 |
| | 17 | 72.9 | 88.8 | 0.377±0.0906 | 0.118 | 1.16 | 10.2 |
| | 18 | 255±76.6 | 100 | 1.16±0.128 | 0.12 | 6.59 | 9.77 |
| | 19 | 4.07 | 102 | 0.947±0.114 | 0.121 | -2.11 | 10.3 |
| | 20 | -6.55 | 114 | 0.944±0.123 | 0.124 | -1.29 | 10.4 |
| | 21 | 64 | 99.5 | 0.788±0.11 | 0.12 | 1.65 | 10.3 |
| | 22 | 53.3 | 75.1 | 0.135±0.0772 | 0.114 | 0.803 | 10.5 |
| | 23 | 44 | 83.3 | 0.188±0.081 | 0.117 | 7.51 | 10 |
| | 24 | 95.5 | 108 | 0.925±0.12 | 0.122 | -5.96 | 10.3 |
| | 25 | 36.1 | 117 | 1.32±0.132 | 0.125 | -0.751 | 10.6 |
| | 26 | 108 | 108 | 0.999±0.12 | 0.122 | 2.85 | 10.3 |
| | 27 | 152±59.5 | 117 | 1.02±0.122 | 0.125 | 1.87 | 10.5 |
| | 28 | 40.7 | 102 | 0.966±0.116 | 0.122 | 0.722 | 10.6 |
| | 29 | 41.1 | 80.7 | 0.193±0.0831 | 0.117 | -0.35 | 10.4 |
| | 30 | 29.3 | 81.4 | 0.164±0.0818 | 0.117 | -0.4 | 10.5 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| May | 1 | 118 | 122 | 0.101±0.0121 | 0.127 | 0.981 | 10.2 |
| | 2 | 60.7 | 98.8 | 0.936±0.112 | 0.121 | 6.81 | 9.95 |
| | 3 | 58.8 | 101 | 0.858±0.112 | 0.121 | 88.8 | 10.1 |
| | 4 | -15.4 | 116 | 0.855±0.12 | 0.125 | 40.7 | 10.5 |
| | 5 | 61.8 | 105 | 0.918±0.119 | 0.122 | 2.69 | 10.3 |
| | 6 | 214±87.8 | 135 | 0.559±0.106 | 0.13 | 6.55 | 10.2 |
| | 7 | 123±65.3 | 102 | 0.304±0.0912 | 0.121 | 0.485 | 10.5 |
| | 8 | 293±85 | 114 | 1.02±0.123 | 0.125 | 1.25 | 10.4 |
| | 9 | 199±65.6 | 104 | 1.02±0.123 | 0.122 | 1.7 | 10.3 |
| | 10 | 232±72 | 100 | 0.925±0.12 | 0.121 | 2.52 | 10.6 |
| | 11 | 90.7 | 105 | 0.932±0.121 | 0.122 | 3.07 | 10.3 |
| | 12 | 66.2 | 105 | 0.833±0.117 | 0.122 | 12.7 | 10.1 |
| | 13 | 34.5 | 110 | 0.503±0.101 | 0.124 | 2.04 | 10.3 |
| | 14 | 106±56.3 | 94.7 | 0.286±0.0885 | 0.12 | 1.17 | 10.5 |
| | 15 | 66.2 | 98.4 | 0.67±0.107 | 0.121 | -1.83 | 10.6 |
| | 16 | 70.3 | 94.4 | 0.855±0.111 | 0.12 | -2.63 | 10.4 |
| | 17 | 36.1 | 107 | 0.855±0.111 | 0.122 | -1.81 | 10.5 |
| | 18 | 124±52.2 | 116 | 0.881±0.114 | 0.125 | -0.981 | 10.4 |
| | 19 | 87.7 | 97.3 | 0.788±0.11 | 0.12 | 1.01 | 10.4 |
| | 20 | 71.8 | 87.3 | 0.233±0.084 | 0.118 | -1.02 | 10.5 |
| | 21 | 78.4 | 81.4 | 0.218±0.0827 | 0.117 | -0.537 | 10.3 |
| | 22 | 149±55 | 104 | 0.929±0.121 | 0.122 | 4.44 | 9.99 |
| | 23 | 107±48.1 | 94.7 | 0.648±0.104 | 0.12 | 9.14 | 9.95 |
| | 24 | 104±42.6 | 98.8 | 0.784±0.11 | 0.121 | 8.62 | 10.4 |
| | 25 | 97.7 | 112 | 0.94±0.122 | 0.125 | -1.7 | 10.2 |
| | 26 | 241±79.4 | 120 | 0.818±0.114 | 0.128 | 8.7 | 10 |
| | 27 | 97.7 | 114 | 0.551±0.105 | 0.126 | 1.55 | 10.3 |
| | 28 | 54 | 94 | 0.285±0.0884 | 0.121 | 7.62 | 10.1 |
| | 29 | 72.2 | 86.2 | 0.231±0.0853 | 0.119 | 1.99 | 10.4 |
| | 30 | 123±50.5 | 98.4 | 0.648±0.104 | 0.121 | 7.14 | 9.95 |
| | 31 | 72.9 | 106 | 0.969±0.116 | 0.123 | 6.14 | 10.4 |
| June | 1 | 162±64.7 | 113 | 0.892±0.116 | 0.123 | 2.06 | 10.2 |
| | 2 | 145±59.5 | 106 | 0.87±0.113 | 0.121 | -0.241 | 10.5 |
| | 3 | 51.4 | 80.3 | 0.272±0.0844 | 0.116 | 6.92 | 10.4 |
| | 4 | 104±55.9 | 81.8 | 0.214±0.0834 | 0.117 | -1.74 | 10.7 |
| | 5 | 103 | 109 | 0.548±0.104 | 0.122 | -1.93 | 10.6 |
| | 6 | 108 | 111 | 1.03±0.123 | 0.123 | 7.62 | 10.2 |
| | 7 | 58.5 | 104 | 0.866±0.113 | 0.121 | -1.12 | 10.5 |
| | 8 | 47 | 96.2 | 0.762±0.107 | 0.12 | -4.11 | 10.3 |
| | 9 | 53.7 | 121 | 0.459±0.106 | 0.132 | 6.22 | 10 |
| | 10 | 150±83.9 | 121 | 0.222±0.0889 | 0.126 | -0.261 | 10.4 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| | 11 | 67 | 98.4 | 0.411±0.0945 | 0.12 | 1.17 | 10.2 |
| | 12 | 37.7 | 108 | 0.655±0.105 | 0.122 | 3.33 | 11 |
| | 13 | -5.74 | 110 | 0.899±0.117 | 0.122 | -1.31 | 10.5 |
| | 14 | 10.5 | 109 | 0.585±0.105 | 0.122 | 8.07 | 9.99 |
| | 15 | 30.3 | 117 | 1.01±0.121 | 0.124 | 2.54 | 10.2 |
| | 16 | 74.7 | 101 | 0.799±0.112 | 0.12 | 2.85 | 9.95 |
| | 17 | 54 | 82.9 | 0.281±0.0872 | 0.116 | 6.18 | 10.2 |
| | 18 | 28.7 | 88.8 | 0.237±0.0854 | 0.117 | 2.01 | 10.3 |
| | 19 | 195±72.1 | 110 | 0.836±0.117 | 0.122 | 1.1 | 10.3 |
| | 20 | 5.92 | 102 | 0.858±0.112 | 0.12 | 1.85 | 10.5 |
| | 21 | 481±120 | 121 | 1.15±0.126 | 0.127 | 1.39 | 10.2 |
| | 22 | 1.81 | 119 | 0.762±0.114 | 0.126 | 8.77 | 10.1 |
| | 23 | 71.8 | 103 | 0.514±0.0977 | 0.122 | 5.77 | 10.2 |
| | 24 | 77 | 97.3 | 0.24±0.0864 | 0.12 | -0.138 | 10.4 |
| | 25 | 40.7 | 103 | 0.192±0.0845 | 0.122 | -0.821 | 10.2 |
| | 26 | 97.7 | 115 | 0.566±0.102 | 0.125 | 4.33 | 10.3 |
| | 27 | 102 | 105 | 0.955±0.115 | 0.122 | -2.29 | 10.7 |
| | 28 | 67.7 | 88.4 | 0.389±0.0932 | 0.12 | -2.39 | 10.6 |
| | 29 | 100±45.1 | 95.8 | 0.847±0.11 | 0.121 | -1.13 | 10.5 |
| | 30 | 73.6 | 93.6 | 0.729±0.109 | 0.121 | 1.36 | 10.5 |
| July | 1 | 96.6±54.1 | 83.3 | 0.249±0.0845 | 0.118 | 0.284 | 10.6 |
| | 2 | 40 | 74.4 | 0.067±0.067 | 0.116 | 8.7 | 9.99 |
| | 3 | 132±51.4 | 105 | 1.14±0.126 | 0.123 | -0.308 | 10.5 |
| | 4 | 88.8 | 101 | 0.895±0.116 | 0.122 | 5.25 | 10.5 |
| | 5 | 102±57.4 | 92.9 | 0.306±0.0887 | 0.121 | 4.96 | 10.5 |
| | 6 | 72.5 | 114 | 0.847±0.119 | 0.125 | 3.31 | 10.4 |
| | 7 | 55.5 | 104 | 0.892±0.116 | 0.121 | 4.96 | 9.99 |
| | 8 | 33 | 93.6 | 0.407±0.0936 | 0.119 | 0.918 | 10.4 |
| | 9 | 44.8 | 81.8 | 0.196±0.0824 | 0.116 | 0.155 | 10.6 |
| | 10 | 219±74.6 | 101 | 0.881±0.114 | 0.12 | 2.52 | 10.7 |
| | 11 | 43.3 | 114 | 0.944±0.123 | 0.124 | 1.14 | 10.4 |
| | 12 | 86.6 | 94.7 | 0.87±0.113 | 0.12 | 2.36 | 10.4 |
| | 13 | 145±47.9 | 101 | 1.55±0.138 | 0.121 | -2.36 | 10.8 |
| | 14 | 30.7 | 94.4 | 1.07±0.117 | 0.12 | 0.64 | 10.6 |
| | 15 | 65.5 | 84.4 | 0.246±0.086 | 0.118 | 2.49 | 10.5 |
| | 16 | 43.7 | 86.2 | 0.21±0.0841 | 0.118 | 6.29 | 10.3 |
| | 17 | 132±54.3 | 98.8 | 0.929±0.111 | 0.121 | -0.984 | 10.6 |
| | 18 | 89.9 | 117 | 1.1±0.121 | 0.125 | -0.881 | 10.5 |
| | 19 | 147±50.1 | 104 | 1.65±0.14 | 0.122 | 2.5 | 10.2 |
| | 20 | 139±57.2 | 115 | 1.1±0.121 | 0.125 | 3.7 | 10.3 |
| | 21 | 162±60.1 | 103 | 1.08±0.119 | 0.121 | -0.153 | 10.4 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| | 22 | -30 | 114 | 0.666±0.107 | 0.124 | 0.929 | 10.2 |
| | 23 | 113±61.1 | 89.5 | 0.231±0.0856 | 0.119 | 7.1 | 10.2 |
| | 24 | 244±85.3 | 120 | 1.23±0.136 | 0.128 | 0.559 | 10.4 |
| | 25 | 35.7 | 102 | 1.38±0.134 | 0.123 | 6.22 | 9.81 |
| | 26 | 6.73 | 107 | 0.955±0.124 | 0.124 | 11.4 | 10.2 |
| | 27 | 67.3 | 115 | 0.944±0.123 | 0.127 | 10.6 | 10.3 |
| | 28 | 4.14 | 113 | 0.814±0.114 | 0.126 | -3.05 | 10.5 |
| | 29 | 32 | 89.2 | 0.29±0.0898 | 0.12 | 2.38 | 10.5 |
| | 30 | 64.8 | 96.9 | 0.205±0.0861 | 0.122 | 1.42 | 10.4 |
| | 31 | -17 | 100 | 0.625±0.106 | 0.122 | -5.33 | 10.6 |
| August | 1 | 174±71.1 | 110 | 0.944±0.123 | 0.125 | 2.79 | 10.3 |
| | 2 | 108±28.1 | 105 | 4.03±0.214 | 0.134 | -3.31 | 10.4 |
| | 3 | -67.3 | 136 | 3.74±0.206 | 0.132 | 1.62 | 10.4 |
| | 4 | 73.6 | 131 | 1.12±0.135 | 0.131 | -0.614 | 10.7 |
| | 5 | 55.5 | 96.6 | 0.544±0.103 | 0.121 | 0.448 | 10.6 |
| | 6 | 30.2 | 86.6 | 0.306±0.0886 | 0.12 | 7.22 | 10.2 |
| | 7 | 22.4 | 90.3 | 0.648±0.104 | 0.12 | 7.59 | 10.3 |
| | 8 | 320±89.6 | 102 | 1.26±0.126 | 0.122 | 4.11 | 10.4 |
| | 9 | 125±59.9 | 104 | 0.907±0.118 | 0.122 | 0.692 | 10.6 |
| | 10 | 73.6 | 96.2 | 0.792±0.111 | 0.121 | 5.88 | 10.1 |
| | 11 | 77 | 91.8 | 0.762±0.107 | 0.12 | 2.87 | 10.3 |
| | 12 | 0.362 | 84 | 0.176±0.083 | 0.118 | -4.7 | 10.8 |
| | 13 | 30.5 | 87 | 0.225±0.0855 | 0.119 | -1.89 | 10.6 |
| | 14 | 96.2 | 101 | 1.01±0.121 | 0.122 | 2.01 | 10.1 |
| | 15 | 109±55.5 | 99.2 | 0.858±0.112 | 0.121 | 5.7 | 10.3 |
| | 16 | 107±60.1 | 104 | 0.725±0.109 | 0.122 | 6.03 | 10.1 |
| | 17 | 82.9 | 118 | 0.907±0.118 | 0.126 | 4.66 | 10.1 |
| | 18 | 37.4 | 97.3 | 0.877±0.114 | 0.121 | -1.64 | 10.6 |
| | 19 | 58.1 | 89.9 | 0.392±0.0941 | 0.12 | -0.0611 | 10.7 |
| | 20 | 77.7 | 90.3 | 0.229±0.0849 | 0.12 | 6.33 | 10.2 |
| | 21 | 110±63.5 | 103 | 0.551±0.0992 | 0.122 | 2.66 | 10.2 |
| | 22 | 43.7 | 108 | 0.74±0.111 | 0.123 | 1.63 | 10.6 |
| | 23 | 92.5 | 114 | 0.77±0.115 | 0.126 | 1.39 | 10.7 |
| | 24 | 31.5 | 117 | 0.74±0.111 | 0.127 | 4.55 | 10.5 |
| | 25 | 137±63 | 105 | 0.866±0.113 | 0.123 | 5.51 | 10.6 |
| | 26 | 143±68.7 | 102 | 0.522±0.0991 | 0.122 | 0.722 | 10.5 |
| | 27 | 147 | 95.1 | 0.396±0.095 | 0.121 | -1.66 | 10.9 |
| | 28 | 169 | 117 | 0.851±0.119 | 0.127 | 4.51 | 10.5 |
| | 29 | 112 | 121 | 1.09±0.131 | 0.128 | 9.73 | 10.2 |
| | 30 | 81 | 105 | 0.537±0.102 | 0.122 | 2.17 | 10.7 |
| | 31 | -40.7 | 128 | 0.747±0.112 | 0.129 | 6.62 | 10.4 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[(a)] | Activity | LOS[(a)] | Activity | LOS[(a)] |
| September | 1 | 114±53.6 | 103 | 0.792±0.111 | 0.122 | 3.85 | 10.4 |
| | 2 | 146±70.2 | 98.8 | 0.29±0.09 | 0.121 | 5.07 | 10.4 |
| | 3 | 96.9±58.2 | 88.1 | 0.221±0.0838 | 0.119 | 0.429 | 10.2 |
| | 4 | 69.6 | 95.5 | 0.433±0.0952 | 0.12 | -2.79 | 10.7 |
| | 5 | 163±68.4 | 132 | 1.07±0.128 | 0.13 | -0.914 | 11 |
| | 6 | 63.3 | 99.2 | 0.818±0.114 | 0.121 | 4.74 | 10.3 |
| | 7 | 22.9 | 109 | 1.03±0.124 | 0.127 | 1.12 | 10.5 |
| | 8 | 99.5 | 117 | 0.0999±0.012 | 0.13 | 0.729 | 10.5 |
| | 9 | 56.2 | 88.4 | 0.186±0.0856 | 0.123 | -3.34 | 10.8 |
| | 10 | 109±72.9 | 106 | 0.426±0.0979 | 0.126 | 0.807 | 10.7 |
| | 11 | 175±83.8 | 116 | 1.17±0.129 | 0.129 | -2.97 | 10.7 |
| | 12 | 50.7 | 98.8 | 0.766±0.115 | 0.125 | -1.22 | 10.6 |
| | 13 | 74.7 | 99.5 | 0.844±0.118 | 0.124 | 4.77 | 10.2 |
| | 14 | -30.6 | 102 | 0.796±0.111 | 0.125 | -1.37 | 10.8 |
| | 15 | 1.65 | 104 | 0.792±0.111 | 0.125 | -1.37 | 10.6 |
| | 16 | 3.68 | 85.8 | 0.242±0.087 | 0.121 | -4.92 | 10.9 |
| | 17 | 21.3 | 95.1 | 0.268±0.091 | 0.123 | 9.47 | 10.3 |
| | 18 | 141±74.9 | 109 | 0.932±0.121 | 0.127 | -0.22 | 10.6 |
| | 19 | 17.1 | 107 | 0.733±0.11 | 0.126 | -3.42 | 10.9 |
| | 20 | 81.4 | 103 | 0.825±0.116 | 0.122 | -2.63 | 10.7 |
| | 21 | 61.1 | 95.1 | 0.751±0.113 | 0.12 | 2.04 | 10.3 |
| | 22 | 196 | 107 | 0.981±0.118 | 0.123 | 4.14 | 10.2 |
| | 23 | 233 | 99.9 | 0.459±0.0963 | 0.121 | -0.644 | 10.7 |
| | 24 | 45.5 | 83.3 | 0.105±0.105 | 0.118 | 1.35 | 10.5 |
| | 25 | 124±63.4 | 102 | 0.651±0.104 | 0.122 | 4.37 | 10.8 |
| | 26 | 78.4 | 102 | 0.862±0.112 | 0.122 | 5.37 | 10.2 |
| | 27 | 45.9 | 102 | 0.666±0.107 | 0.125 | 3.37 | 10.4 |
| | 28 | 35.6 | 98.1 | 0.503±0.101 | 0.124 | 0.544 | 10.6 |
| | 29 | 9.66 | 105 | 0.84±0.118 | 0.126 | 7.1 | 10.5 |
| | 30 | 44 | 88.8 | 0.223±0.0869 | 0.122 | 4.37 | 10.2 |
| October | 1 | 67.7 | 106 | 0.411±0.0986 | 0.126 | 2.79 | 10.5 |
| | 2 | 55.5 | 94.4 | 0.348±0.0939 | 0.124 | 6.7 | 10.3 |
| | 3 | 138±74.3 | 108 | 0.888±0.115 | 0.127 | 7.03 | 10.3 |
| | 4 | 80.7 | 100 | 0.725±0.109 | 0.121 | -8.44 | 11.3 |
| | 5 | 13.8 | 113 | 0.733±0.11 | 0.124 | 6.99 | 10.1 |
| | 6 | 145±62.4 | 107 | 1.18±0.13 | 0.122 | 0.873 | 10.5 |
| | 7 | 146±67.2 | 85.1 | 0.244±0.0853 | 0.118 | 6.44 | 10.3 |
| | 8 | 74 | 89.9 | 0.272±0.0871 | 0.119 | 6.88 | 10.3 |
| | 9 | 82.1 | 105 | 0.969±0.116 | 0.124 | 1.89 | 10.3 |
| | 10 | 41.4 | 106 | 1.01±0.121 | 0.124 | -2.99 | 10.6 |
| | 11 | 145±73.8 | 120 | 0.903±0.117 | 0.128 | -2.74 | 10.8 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| | 12 | 115±61.9 | 102 | 0.766±0.115 | 0.123 | 6.48 | 10.7 |
| | 13 | 42.9 | 114 | 1.2±0.132 | 0.126 | 1.5 | 10.5 |
| | 14 | 81.8 | 104 | 0.555±0.105 | 0.123 | 0.977 | 10.7 |
| | 15 | 52.2 | 93.6 | 0.253±0.0887 | 0.121 | 4.74 | 10.4 |
| | 16 | 137±72.6 | 115 | 0.784±0.118 | 0.126 | 5.11 | 10.5 |
| | 17 | 76.2 | 116 | 1±0.12 | 0.127 | -6.25 | 10.8 |
| | 18 | 121±65.1 | 107 | 0.784±0.11 | 0.124 | -0.888 | 10.8 |
| | 19 | -9.88 | 127 | 0.788±0.118 | 0.129 | 2.01 | 10.6 |
| | 20 | 30.7 | 113 | 0.611±0.104 | 0.125 | 5.92 | 10.5 |
| | 21 | 171±80.5 | 109 | 0.35±0.0944 | 0.124 | 0.969 | 10.8 |
| | 22 | 80.3 | 94.7 | 0.3±0.0899 | 0.12 | 4.96 | 10.4 |
| | 23 | 94.4 | 143 | 1.02±0.123 | 0.131 | 8.95 | 10.5 |
| | 24 | 93.2 | 103 | 0.77±0.108 | 0.122 | -0.762 | 10.7 |
| | 25 | -31.4 | 103 | 0.803±0.112 | 0.122 | -1.97 | 10.5 |
| | 26 | 154±71 | 112 | 0.736±0.11 | 0.125 | -2.99 | 10.7 |
| | 27 | 209±75.3 | 104 | 0.992±0.119 | 0.122 | 3.36 | 10.6 |
| | 28 | 143±65.9 | 88.1 | 0.348±0.0904 | 0.119 | 4.96 | 10.7 |
| | 29 | 135±62 | 79.9 | 0.253±0.0835 | 0.117 | 4.33 | 10.7 |
| | 30 | 151±66.4 | 125 | 1.19±0.131 | 0.128 | 3.48 | 10.7 |
| | 31 | 570±130 | 108 | 1.37±0.132 | 0.124 | -4.88 | 11 |
| November | 1 | 29.1 | 89.2 | 0.611±0.104 | 0.119 | 3.85 | 10.8 |
| | 2 | 65.1 | 97.7 | 0.825±0.116 | 0.121 | -2.55 | 10.7 |
| | 3 | 140±63.1 | 111 | 0.884±0.115 | 0.124 | 2.11 | 10.5 |
| | 4 | 3 | 88.4 | 0.182±0.0836 | 0.119 | 4.77 | 10.5 |
| | 5 | 0.999 | 85.5 | 0.209±0.0838 | 0.118 | 4.22 | 10.5 |
| | 6 | 33.7 | 99.5 | 0.607±0.103 | 0.121 | 0.433 | 10.5 |
| | 7 | -22.3 | 115 | 1.18±0.129 | 0.125 | 9.51 | 10.4 |
| | 8 | 87.3 | 95.8 | 0.747±0.112 | 0.12 | 2.33 | 10.7 |
| | 9 | 55.1 | 99.9 | 0.895±0.116 | 0.121 | 5.81 | 10.7 |
| | 10 | 23.8 | 99.5 | 0.892±0.116 | 0.121 | -2.06 | 11 |
| | 11 | 41.1 | 78.8 | 0.235±0.0844 | 0.116 | 1.46 | 10.6 |
| | 12 | 83.6±53.5 | 80.7 | 0.215±0.0838 | 0.117 | 0.929 | 10.6 |
| | 13 | 33 | 102 | 0.858±0.112 | 0.121 | 2.73 | 10.8 |
| | 14 | 124±59.3 | 102 | 0.836±0.109 | 0.121 | 1.13 | 10.4 |
| | 15 | 47.7 | 102 | 0.729±0.109 | 0.121 | 1.76 | 10.6 |
| | 16 | 51.1 | 111 | 0.914±0.119 | 0.124 | -0.995 | 10.5 |
| | 17 | 159±70 | 98.4 | 0.714±0.107 | 0.121 | 1.1 | 10.4 |
| | 18 | 78.8 | 84.7 | 0.225±0.0853 | 0.118 | 9.92 | 10.2 |
| | 19 | 54.8 | 81 | 0.23±0.085 | 0.117 | -0.022 | 10.5 |
| | 20 | 110±59.3 | 101 | 0.781±0.109 | 0.121 | 2.31 | 10.5 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (continued)**

| Date | | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|---|
| | | Activity | LOS[(a)] | Activity | LOS[(a)] | Activity | LOS[(a)] |
| | 21 | 105 | 116 | 1.08±0.129 | 0.126 | -5.96 | 10.9 |
| | 22 | 92.5 | 122 | 0.847±0.119 | 0.128 | 4.92 | 10.5 |
| | 23 | -5.07 | 96.6 | 0.518±0.0984 | 0.121 | 5.74 | 10.2 |
| | 24 | 127±71.1 | 102 | 0.265±0.0873 | 0.122 | 4.81 | 10.3 |
| | 25 | 52.2 | 89.9 | 0.323±0.0903 | 0.12 | 3.33 | 10.4 |
| | 26 | 37400±1050 | 118 | 0.448±0.0492 | 0.126 | 3.42 | 10.5 |
| | 27 | 46.6 | 115 | 0.884±0.115 | 0.125 | -0.321 | 10.7 |
| | 28 | 59.9 | 111 | 0.858±0.112 | 0.124 | 2.24 | 10.8 |
| | 29 | 73.3 | 91.4 | 0.736±0.11 | 0.119 | 2.03 | 10.4 |
| | 30 | 67 | 104 | 0.84±0.109 | 0.121 | 1.05 | 10.8 |
| December | 1 | 116±52.3 | 107 | 0.777±0.109 | 0.122 | -0.288 | 10.9 |
| | 2 | -12 | 96.2 | 0.503±0.101 | 0.12 | 7.92 | 10.1 |
| | 3 | 16 | 82.5 | 0.151±0.0798 | 0.117 | 4.07 | 10.5 |
| | 4 | 72.5 | 104 | 0.907±0.118 | 0.121 | 1 | 10.5 |
| | 5 | 111±45.5 | 99.2 | 0.973±0.117 | 0.12 | -1.32 | 10.9 |
| | 6 | 65.5 | 100 | 0.999±0.12 | 0.121 | 0.522 | 10.7 |
| | 7 | -23.5 | 109 | 1.01±0.122 | 0.123 | 5.59 | 10.4 |
| | 8 | 134±57.4 | 102 | 0.881±0.114 | 0.122 | 7.36 | 10.6 |
| | 9 | 18.8 | 86.2 | 0.241±0.0867 | 0.119 | 1.25 | 10.8 |
| | 10 | 99.9±57.9 | 86.6 | 0.247±0.0865 | 0.119 | 1.75 | 10.7 |
| | 11 | 197±72.8 | 108 | 0.962±0.115 | 0.124 | -0.659 | 11.1 |
| | 12 | 79.6 | 130 | 1.03±0.124 | 0.13 | 3.57 | 10.7 |
| | 13 | 124±53.1 | 112 | 0.903±0.117 | 0.124 | 7.62 | 10.5 |
| | 14 | 46.3 | 114 | 1.03±0.124 | 0.125 | 1.14 | 10.9 |
| | 15 | 81.4 | 111 | 0.888±0.115 | 0.124 | -4.7 | 10.8 |
| | 16 | 22.2 | 126 | 0.921±0.12 | 0.128 | 2.35 | 10.7 |
| | 17 | 13.4 | 113 | 0.47±0.0987 | 0.124 | 0.74 | 11 |
| | 18 | 46.3 | 114 | 0.555±0.105 | 0.125 | -1 | 10.7 |
| | 19 | -36.5 | 115 | 0.847±0.119 | 0.124 | -0.185 | 10.7 |
| | 20 | 120±51.5 | 101 | 0.992±0.129 | 0.132 | 3.46 | 10.5 |
| | 21 | 226±88.2 | 128 | 0.773±0.116 | 0.128 | -0.322 | 10.7 |
| | 22 | 154±67.9 | 108 | 0.685±0.11 | 0.122 | 0.548 | 11 |
| | 23 | 105±65.1 | 93.6 | 0.14±0.0799 | 0.119 | -0.323 | 10.5 |
| | 24 | 47 | 82.9 | 0.199±0.0818 | 0.117 | 4.37 | 10.7 |
| | 25 | 192±80.7 | 99.9 | 0.231±0.0854 | 0.12 | -1.34 | 11.1 |
| | 26 | 33.1 | 79.6 | 0.157±0.0802 | 0.116 | -1.11 | 11 |
| | 27 | 152±67.1 | 118 | 0.881±0.114 | 0.125 | 0.899 | 11.1 |
| | 28 | -1.24 | 119 | 0.74±0.111 | 0.126 | 4.4 | 10.7 |

**Table 6-3. Daily monitoring results for gross alpha, gross beta, and tritium in the sanitary sewer effluent, 2001 (concluded)**

| Date | Gross alpha (uBq/mL) | | Gross beta (mBq/mL) | | Tritium(mBq/mL) | |
|---|---|---|---|---|---|---|
| | Activity | LOS[a] | Activity | LOS[a] | Activity | LOS[a] |
| 29 | 13.2 | 119 | 0.67±0.107 | 0.126 | 6.66 | 10.5 |
| 30 | 29.2 | 102 | 0.374±0.0934 | 0.122 | -4.18 | 11.5 |
| 31 | 95.5±57.3 | 83.3 | 0.175±0.0807 | 0.118 | 1.39 | 10.9 |

**Note:** The activities shown in this table are measured concentrations and their associated 2s counting errors. Activities do not include the 2s counting errors when the measured concentrations are less than the limit of sensitivity (LOS). See main volume, Chapter 14.

a LOS = Limit of sensitivity

**Table 6-4. Weekly composite results fo tritium (mBq/mL) for the LWRP effluent, 2001**

| Composite dates | Activity[a] | LOS[b] |
|---|---|---|
| 1/1-1/7 | 2.32 | 10.1 |
| 1/8-1/14 | -2.72 | 10.4 |
| 1/15-1/21 | -0.231 | 10.4 |
| 1/22-1/28 | 0.437 | 10.3 |
| 1/29-2/4 | 4.74 | 10.4 |
| 2/5-2/11 | -2.75 | 10.5 |
| 2/12-2/18 | -6.59 | 10.9 |
| 2/19-2/25 | -0.202 | 10.5 |
| 2/26-3/4 | 2.81 | 10.4 |
| 3/5-3/11 | 1.47 | 10.2 |
| 3/12-3/18 | 5.85 | 10.3 |
| 3/19-3/25 | -0.031 | 8.73 |
| 3/26-4/1 | 9.07 | 10.2 |
| 4/2-4/8 | -1.81 | 8.62 |
| 4/9-4/15 | 3.18 | 10.2 |
| 4/16-4/22 | -0.821 | 10.2 |
| 4/23-4/29 | -4.29 | 10.5 |
| 4/30-5/6 | -3.43 | 10.6 |
| 5/7-5/13 | -0.264 | 10.3 |
| 5/14-5/20 | -0.562 | 10.6 |
| 5/21-5/27 | 2.67 | 10.1 |
| 5/28-6/3 | 8.47 | 10.2 |
| 6/4-6/10 | 1.64 | 10.2 |
| 6/11-6/17 | 2.79 | 10.2 |
| 6/18-6/24 | 4.14 | 10.2 |
| 6/25-7/1 | 9.66 | 10.1 |

| Composite dates | Activity[a] | LOS[b] |
|---|---|---|
| 7/2-7/8 | 0.503 | 10.5 |
| 7/9-7/15 | -2.8 | 10.1 |
| 7/16-7/22 | 1.17 | 10.6 |
| 7/23-7/29 | -4.48 | 10.6 |
| 7/30-8/5 | 2.52 | 10.1 |
| 8/6-8/12 | 2.96 | 10.3 |
| 8/13-8/19 | 8.07 | 9.99 |
| 8/20-8/26 | 11.3 | 10.1 |
| 8/27-9/2 | 0.020 | 10.6 |
| 9/3-9/9 | 0.403 | 10.8 |
| 9/10-9/16 | 2.79 | 10.5 |
| 9/17-9/23 | 1.47 | 10.5 |
| 9/24-9/30 | 0.622 | 10.4 |
| 10/1-10/7 | 2.12 | 10.7 |
| 10/8-10/14 | 2.31 | 10.6 |
| 10/15-10/21 | -7.22 | 11.7 |
| 10/22-10/28 | 0.551 | 10.8 |
| 10/29-11/4 | 8.03 | 10.4 |
| 11/5-11/11 | -5.37 | 11.1 |
| 11/12-11/18 | -2.26 | 10.9 |
| 11/19-11/25 | -1.21 | 10.5 |
| 11/26-12/2 | 0.407 | 10.9 |
| 12/3-12/9 | -4.11 | 10.9 |
| 12/10-12/16 | 1.81 | 11 |
| 12/17-12/23 | -0.903 | 10.7 |
| 12/24-12/30 | 6.36 | 8.03 |
| 12/31/01-1/6/02 | -1.23 | 10.50 |

a The activities shown in this table are measured concentrations and their associated 2σ counting errors. Activities do not include the 2σ counting errors when the measured concentrations are less than the limit of sensitivity (LOS). See main volume, Chapter 14.

b LOS = Limit of sensitivity

**Table 6-5. Weekly composite for metals in LLNL sanitary sewer effluent, 2001**

| Composite dates | Parameter (mg/L) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ag | As | Cd | Cr | Cu | Hg | Ni | Pb | Zn |
| 12/27/00-1/3/01 | < 0.010 | < 0.0020 | < 0.0050 | < 0.010 | 0.056 | < 0.00020 | < 0.0050 | 0.0023 | 0.079 |
| 1/3-1/12 | < 0.010 | 0.0021 | < 0.0050 | < 0.010 | 0.045 | < 0.00020 | 0.0058 | 0.0025 | 0.072 |
| 1/12-1/17 | < 0.010 | < 0.0020 | < 0.0050 | 0.011 | 0.095 | < 0.00020 | < 0.0050 | 0.0046 | 0.15 |
| 1/17-1/24 | < 0.010 | 0.0040 | < 0.0050 | 0.014 | 0.11 | 0.00021 | 0.0066 | 0.012 | 0.26 |
| 1/24-1/31 | < 0.010 | 0.0051 | < 0.0050 | 0.037 | 0.095 | < 0.00020 | 0.019 | 0.0062 | 0.23 |
| 1/31-2/7 | < 0.010 | 0.0064 | < 0.0050 | 0.015 | 0.12 | 0.00032 | 0.0084 | 0.0094 | 0.29 |
| 2/7-2/14 | < 0.010 | 0.0064 | < 0.0050 | 0.013 | 0.12 | < 0.00020 | 0.0059 | 0.0093 | 0.30 |
| 2/14-2/21 | < 0.010 | 0.0052 | < 0.0050 | 0.020 | 0.19 | < 0.00020 | 0.0074 | 0.011 | 0.36 |
| 2/21-2/28 | < 0.010 | < 0.0020 | < 0.0050 | < 0.010 | 0.049 | < 0.00020 | 0.0054 | 0.0031 | 0.21 |
| 2/28-3/7 | < 0.010 | < 0.0040 | < 0.0050 | 0.022 | 0.12 | < 0.00020 | 0.0074 | 0.013 | 0.38 |
| 3/7-3/14 | < 0.010 | 0.0020 | < 0.0050 | 0.020 | 0.11 | < 0.00020 | 0.0064 | 0.019 | 0.31 |
| 3/14-3/21 | < 0.010 | 0.0029 | < 0.0050 | 0.030 | 0.14 | 0.00020 | 0.0083 | 0.035 | 0.42 |
| 3/21-3/28 | 0.010 | < 0.0040 | < 0.0050 | 0.014 | 0.17 | 0.00039 | 0.0084 | 0.014 | 0.37 |
| 3/28-4/4 | < 0.010 | < 0.0020 | < 0.0050 | < 0.010 | 0.10 | < 0.00020 | 0.0060 | 0.0059 | 0.25 |
| 4/4-4/11 | 0.036 | < 0.0040 | < 0.0050 | 0.014 | 0.15 | 0.00050 | 0.0086 | 0.012 | 0.49 |
| 4/11-4/18 | < 0.010 | < 0.0040 | < 0.0050 | < 0.010 | 0.13 | < 0.00040 | 0.0075 | 0.012 | 0.40 |
| 4/18-4/25 | < 0.010 | < 0.0040 | < 0.0050 | 0.029 | 0.14 | < 0.00020 | 0.0076 | 0.058 | 0.45 |
| 4/25-5/2 | < 0.010 | 0.0042 | < 0.0050 | 0.026 | 0.22 | < 0.00020 | 0.011 | 0.033 | 0.55 |
| 5/2-5/9 | < 0.010 | 0.0070 | < 0.0050 | 0.039 | 0.29 | < 0.00040 | < 0.0050 | 0.075 | 0.56 |
| 5/9-5/16 | < 0.010 | 0.0073 | < 0.0050 | 0.039 | 0.22 | 0.00042 | 0.0071 | 0.097 | 0.55 |
| 5/16-5/23 | < 0.010 | 0.0031 | < 0.0050 | 0.020 | 0.22 | 0.00068 | 0.0056 | 0.029 | 0.46 |
| 5/23-5/30 | 0.012 | 0.0040 | < 0.0050 | 0.032 | 0.19 | < 0.00020 | 0.0086 | 0.020 | 0.61 |
| 5/30-6/6 | < 0.010 | 0.0035 | < 0.0050 | 0.022 | 0.20 | < 0.00020 | 0.0077 | 0.024 | 0.58 |
| 6/6-6/13 | < 0.010 | 0.0029 | < 0.0050 | < 0.010 | 0.12 | < 0.00020 | 0.0050 | 0.0084 | 0.21 |
| 6/13-6/20 | < 0.010 | 0.0046 | < 0.0050 | 0.039 | 0.35 | 0.00086 | 0.013 | 0.021 | 0.53 |
| 6/20-6/27 | 0.012 | 0.0084 | < 0.0050 | 0.046 | 0.47 | 0.00076 | 0.014 | 0.056 | 0.70 |
| 6/27-7/4 | < 0.010 | < 0.0040 | < 0.0050 | 0.024 | 0.24 | 0.00041 | 0.0084 | 0.025 | 0.35 |
| 7/4-7/11 | < 0.010 | 0.0062 | < 0.0050 | 0.029 | 0.33 | < 0.00020 | 0.0077 | 0.062 | 0.46 |
| 7/11-7/18 | < 0.010 | < 0.0020 | < 0.0050 | 0.018 | 0.24 | < 0.00020 | 0.0058 | 0.012 | 0.37 |
| 7/18-7/25 | < 0.010 | 0.0031 | < 0.0050 | 0.035 | 0.36 | < 0.00080 | 0.0076 | 0.021 | 0.56 |
| 7/25-8/1 | < 0.010 | 0.0047 | < 0.0050 | 0.020 | 0.29 | < 0.00040 | 0.0087 | 0.051 | 0.37 |
| 8/1-8/8 | < 0.010 | 0.0060 | < 0.0050 | 0.020 | 0.34 | 0.00049 | 0.0065 | 0.059 | 0.42 |
| 8/8-8/15 | < 0.010 | 0.0067 | < 0.0050 | 0.033 | 0.36 | < 0.00020 | 0.011 | 0.059 | 0.56 |
| 8/15-8/22 | < 0.010 | 0.0070 | < 0.0050 | < 0.010 | 0.16 | 0.00041 | 0.0089 | 0.022 | 0.35 |
| 8/22-8/29 | < 0.010 | < 0.0040 | < 0.0050 | < 0.010 | 0.14 | < 0.00020 | < 0.0050 | 0.029 | 0.15 |
| 8/29-9/5 | < 0.010 | 0.0033 | < 0.0050 | 0.037 | 0.24 | < 0.00020 | 0.019 | 0.023 | 0.35 |
| 9/5-9/12 | < 0.010 | < 0.0040 | < 0.0050 | 0.020 | 0.20 | 0.00045 | 0.0070 | 0.025 | 0.37 |
| 9/12-9/19 | < 0.010 | < 0.0040 | < 0.0050 | 0.011 | 0.19 | < 0.00020 | 0.0051 | 0.019 | 0.27 |
| 9/19-9/26 | < 0.010 | 0.0038 | < 0.0050 | 0.032 | 0.51 | 0.00085 | 0.0089 | 0.029 | 0.49 |
| 9/26-10/3 | < 0.010 | 0.0023 | < 0.0050 | < 0.010 | 0.066 | < 0.00020 | < 0.0050 | 0.0037 | 0.14 |
| 10/3-10/10 | < 0.010 | 0.0026 | < 0.0050 | 0.013 | 0.066 | < 0.00020 | < 0.0050 | 0.0099 | 0.10 |
| 10/10-10/17 | < 0.010 | 0.0021 | < 0.0050 | 0.017 | 0.12 | < 0.00020 | 0.0055 | 0.010 | 0.25 |
| 10/17-10/24 | 0.037 | 0.0034 | < 0.0050 | 0.016 | 0.15 | 0.00028 | 0.0094 | 0.014 | 0.31 |
| 10/24-10/31 | 0.014 | < 0.0040 | < 0.0050 | 0.012 | 0.24 | 0.00050 | 0.0069 | 0.015 | 0.38 |
| 10/31-11/7 | < 0.010 | < 0.0020 | < 0.0050 | 0.015 | 0.19 | < 0.00020 | 0.0060 | 0.017 | 0.36 |
| 11/7-11/14 | < 0.010 | < 0.0020 | < 0.0050 | < 0.010 | 0.12 | < 0.00020 | 0.0054 | 0.013 | 0.20 |
| 11/14-11/21 | < 0.010 | < 0.0040 | < 0.0050 | < 0.010 | 0.11 | < 0.00020 | 0.0050 | 0.011 | 0.25 |
| 11/21-11/28 | < 0.010 | < 0.0040 | < 0.0050 | < 0.010 | 0.20 | 0.00033 | < 0.0050 | 0.020 | 0.37 |
| 11/28-12/5 | < 0.010 | 0.0026 | < 0.0050 | < 0.010 | 0.11 | < 0.00020 | < 0.0050 | < 0.0080 | 0.26 |
| 12/5-12/12 | < 0.010 | 0.0090 | < 0.0050 | < 0.010 | 0.094 | < 0.00020 | 0.0070 | 0.0075 | 0.23 |
| 12/12-12/19 | < 0.010 | 0.0021 | < 0.0050 | < 0.010 | 0.11 | 0.00036 | 0.0080 | 0.0093 | 0.26 |
| 12/19-12-26 | < 0.010 | < 0.0040 | < 0.0050 | 0.020 | 0.20 | < 0.00020 | 0.0064 | 0.016 | 0.46 |
| 12/26/01-1/2/02 | < 0.010 | < 0.0040 | < 0.0050 | 0.026 | 0.24 | 0.00042 | 0.0076 | 0.044 | 0.53 |

**Table 6-5. Weekly composite for metals in LLNL sanitary sewer effluent, 2001 (concluded)**

| Composite dates | Parameter (mg/L) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ag | As | Cd | Cr | Cu | Hg | Ni | Pb | Zn |
| **Summary of monthly composite results** | | | | | | | | | |
| **Detection frequency** | 6/53 | 32/53 | 0/53 | 38/53 | 53/53 | 19/53 | 45/53 | 52/53 | 53/53 |
| **Minimum (mg/L)** | < 0.010 | < 0.0020 | < 0.0050 | < 0.010 | 0.045 | < 0.00020 | < 0.005 | 0.0023 | 0.072 |
| **Maximum (mg/L)** | 0.037 | 0.0090 | < 0.0050 | 0.046 | 0.51 | 0.0009 | 0.019 | 0.097 | 0.70 |
| **Median (mg/L)** | < 0.010 | 0.0040 | < 0.0050 | 0.017 | 0.16 | < 0.00020 | 0.0070 | 0.016 | 0.36 |
| **IQR[a] (mg/L)** | —[b] | 0.0021 | —[b] | 0.018 | 0.12 | —[b] | 0.0030 | 0.017 | 0.21 |
| **50% of EPL[c] (mg/L)** | 0.1 | 0.03 | 0.07 | 0.31 | 0.5 | 0.005 | 0.305 | 0.1 | 1.5 |
| **Maximum/50% of EPL** | 0.37 | 0.30 | 0.071 | 0.15 | 1.02 | 0.17 | 0.062 | 0.97 | 0.47 |
| **Median/50% of EPL** | 0.10 | 0.13 | 0.071 | 0.05 | 0.32 | 0.040 | 0.023 | 0.16 | 0.24 |

a IQR = Interquartile range

b Because of the large number of nondetects, the interquartile range is omitted. See main volume, Chapter 14.

c EPL = Effluent pollutant limit

**Table 6-6. Monthly 24-hour composite results for metals in LLNL sanitary sewer effluent, 2001**

| Sample date | Parameter | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ag | Al | As | Be | Cd | Cr | Cu | Fe | Pb | Hg | Ni | Zn |
| 1/4 | < 0.010 | 0.28 | < 0.002 | < 0.0005 | < 0.005 | < 0.01 | 0.058 | 0.75 | 0.011 | < 0.0002 | < 0.005 | 0.12 |
| 2/14 | < 0.010 | 0.3 | 0.0067 | < 0.0005 | < 0.005 | < 0.01 | 0.11 | 0.97 | 0.0059 | < 0.0002 | 0.0055 | 0.2 |
| 3/7 | < 0.010 | 0.5 | < 0.004 | < 0.0005 | < 0.005 | 0.018 | 0.14 | 1.7 | 0.0097 | < 0.0002 | 0.0066 | 0.28 |
| 4/4 | 0.010 | 0.6 | < 0.002 | < 0.0005 | < 0.005 | 0.02 | 0.17 | 2.1 | 0.014 | < 0.0002 | 0.0082 | 0.37 |
| 5/3 | 0.010 | 0.83 | 0.0047 | < 0.0005 | < 0.005 | 0.023 | 0.13 | 1.8 | 0.018 | 0.00046 | 0.0072 | 0.36 |
| 6/5 | < 0.010 | 0.37 | < 0.002 | < 0.0005 | < 0.005 | < 0.01 | 0.11 | 1.3 | 0.013 | < 0.0002 | 0.0061 | 0.3 |
| 7/10 | < 0.010 | 0.72 | < 0.004 | < 0.0005 | < 0.005 | 0.016 | 0.27 | 2.3 | 0.053 | < 0.0002 | 0.0072 | 0.36 |
| 8/8 | < 0.010 | 0.4 | 0.007 | < 0.0005 | < 0.005 | 0.01 | 0.12 | 1 | 0.012 | < 0.0008 | < 0.005 | 0.25 |
| 9/5 | < 0.010 | 0.6 | 0.0024 | < 0.0005 | < 0.005 | 0.013 | 0.23 | 2 | 0.022 | < 0.0002 | 0.0077 | 0.38 |
| 10/9 | < 0.010 | 0.36 | < 0.004 | < 0.0005 | < 0.005 | 0.012 | 0.12 | 1.4 | 0.022 | 0.00034 | 0.0054 | 0.24 |
| 11/6 | < 0.010 | 0.24 | < 0.002 | < 0.0005 | < 0.005 | < 0.01 | 0.076 | 0.69 | 0.0078 | < 0.0002 | 0.01 | 0.22 |
| 12/4 | < 0.010 | 0.47 | 0.0022 | < 0.0005 | < 0.005 | < 0.01 | 0.11 | 1.2 | 0.009 | < 0.0002 | 0.0055 | 0.24 |
| **Summary of monthly composite results** | | | | | | | | | | | | |
| **Detection frequency** | 2/12 | 12/12 | 5/12 | 0/12 | 0/12 | 7/12 | 12/12 | 12/12 | 12/12 | 2/12 | 10/12 | 12/12 |
| **Minimum (mg/L)** | < 0.010 | 0.24 | < 0.002 | < 0.0005 | < 0.005 | < 0.01 | 0.058 | 0.69 | 0.0059 | < 0.0002 | < 0.005 | 0.12 |
| **Maximum (mg/L)** | 0.010 | 0.83 | 0.0067 | < 0.0005 | < 0.005 | 0.023 | 0.27 | 2.3 | 0.053 | 0.00046 | 0.01 | 0.38 |
| **Median (mg/L)** | < 0.010 | 0.44 | 0.0032 | < 0.0005 | < 0.005 | 0.011 | 0.12 | 1.35 | 0.013 | < 0.0002 | 0.0064 | 0.27 |
| **IQR[a] (mg/L)** | —(b) | 0.26 | —(b) | —(b) | —(b) | 0.0065 | 0.038 | 0.86 | 0.0095 | —(b) | 0.0019 | 0.13 |
| **EPL[c] (mg/L)** | 0.2 | —(d) | 0.06 | —(d) | 0.14 | 0.62 | 1.0 | —(d) | 0.2 | 0.01 | 0.61 | 3.0 |
| **Maximum/EPL** | 0.050 | —(d) | 0.11 | —(d) | 0.036 | 0.037 | 0.27 | —(d) | 0.27 | 0.046 | 0.016 | 0.13 |
| **Median/EPL** | 0.050 | —(d) | 0.053 | —(d) | 0.036 | 0.018 | 0.12 | —(d) | 0.063 | 0.020 | 0.010 | 0.088 |

a IQR = Interquartile range

b Because of the large number of nondetects, the interquartile range is omitted. See main volume, Chapter 14.

c EPL = Effluent pollutant limit

d There is no EPL for this parameter; therefore, no comparison value can be calculated.

**Table 6-7. Monthly monitoring results for physical and chemical characteristics of the LLNL sanitary sewer effluent, 2001**

| 24-hour composite sample parameters | EPA Methods | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Alkalinity (mg/L)** | | | | | | | | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | 310.1 | 173 | 234 | 222 | 228 | 245 | 243 | 241 | 243 | 245 | 218 | 226 | 224 |
| Carbonate Alk (as $CaCO_3$) | 310.1 | < 2.5 | < 2.5 | < 2.5 | < 1 | < 5 | < 5 | < 5 | < 5 | < 5 | < 2.5 | < 5 | < 5 |
| Hydroxide Alk (as $CaCO_3$) | 310.1 | < 2.5 | < 2.5 | < 2.5 | < 1 | < 5 | < 5 | < 5 | < 5 | < 5 | < 2.5 | < 5 | < 5 |
| Total Alkalinity (as $CaCO_3$) | 310.1 | 173 | 234 | 222 | 228 | 245 | 243 | 241 | 243 | 245 | 218 | 226 | 224 |
| **Anions (mg/L)** | | | | | | | | | | | | | |
| Bromide | 300.0 | 0.2 | < 0.1 | < 0.1 | 0.1 | 0.2 | 0.5 | 1.1 | 1.1 | 0.3 | 0.6 | 0.5 | 0.7 |
| Chloride | 300.0 | 27 | 104 | 52 | 42 | 59 | 50 | 44 | 49 | 46 | 40 | 37 | 46 |
| Fluoride | 300.0 | < 0.05 | 0.21 | < 0.05 | 0.12 | 0.21 | 0.21 | 0.098 | 0.14 | 0.13 | 0.1 | 0.1 | 0.92 |
| Nitrate (as N) | 353.2 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Nitrate (as $NO_3$) | 353.2 | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 4.4 | < 4.4 | < 4.4 | < 4.4 | < 4.4 | < 4.4 | < 4.4 | < 4.4 |
| Nitrate plus Nitrite (as N) | 353.2 | 0.25 | < 0.1 | 0.1 | < 0.1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Nitrite (as N) | 353.2 | 0.23 | < 0.02 | 0.024 | < 0.02 | < 0.02 | < 0.02 | 0.02 | 0.034 | < 0.02 | 0.02 | 0.033 | 0.02 |
| Nitrite (as $NO_2$) | 353.2 | 0.76 | < 0.065 | 0.078 | < 0.065 | < 0.065 | < 0.065 | 0.066 | 0.11 | < 0.065 | 0.066 | 0.11 | 0.066 |
| Ortho-Phosphate | 365.1 | 14.7 | 21.1 | 18.9 | 20.1 | 19.5 | 20.1 | 22.5 | 20.7 | 18.8 | 20 | 17 | 25 |
| Sulfate | 300.0 | 10 | 27 | 12 | 11 | 19 | 11 | 8.4 | 12 | 11 | 15 | 11 | 12 |
| **Nutrients (mg/L)** | | | | | | | | | | | | | |
| Ammonia Nitrogen (as N) | 350.1 | 36 | 43 | 45 | 49 | 56 | 59 | 55 | 43 | 49 | 48 | 45 | 47 |
| Total Kjeldahl Nitrogen | 351.2 | 35 | 60 | 68 | 72 | 75 | 72 | 67 | 77 | 68 | 64 | 94 | 74 |
| Total Phosphorus (as P) | 365.4 | 6.2 | 11 | 12 | 12 | 10 | 9.4 | 12 | 13 | 11 | 8 | 9.4 | 9.4 |
| **Oxygen demand (mg/L)** | | | | | | | | | | | | | |
| Biochemical Oxygen Demand | SM17-5210B | 100 | 239 | 226 | 458 | 397 | 315 | 810 | 520 | 351 | 234 | 183 | 351 |
| Chemical Oxygen Demand | 410.4 | 145 | 464 | 548 | 656 | 907 | 378 | 1100 | 1200 | 1780 | 924 | 415 | 464 |
| **Solids (mg/L)** | | | | | | | | | | | | | |
| Settleable Solids | 160.5 | 4 | 22 | 60 | 80 | 50 | 30 | 55 | 90 | 40 | 30 | 11 | 40 |
| Total dissolved solids (TDS) | 160.1 | 165 | 353 | 240 | 254 | 413 | 260 | 258 | 260 | 284 | 248 | 202 | 232 |
| Total suspended solids (TSS) | 160.2 | 88 | 280 | 440 | 600 | 350 | 280 | 650 | 640 | 420 | 190 | 240 | 500 |
| Volatile Solids | 160.4 | 140 | 280 | 393 | 603 | 563 | 410 | 593 | 913 | 530 | 430 | 328 | 582 |
| **Total metals (mg/L)** | | | | | | | | | | | | | |
| Beryllium | 210.2 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 |
| Calcium | 200.7 | 9.3 | 16 | 14 | 17 | 16 | 13 | 16 | 17 | 20 | 13 | 13 | 15 |
| Magnesium | 200.7 | 1.7 | 5.1 | 3.1 | 3.3 | 3.1 | 2.8 | 3 | 3.2 | 3.2 | 2.2 | 2.4 | 2.6 |
| Potassium | 200.7 | 15 | 21 | 22 | 24 | 22 | 22 | 22 | 22 | 23 | 18 | 19 | 20 |
| Selenium | 270.2 | < 0.002 | < 0.004 | < 0.002 | < 0.002 | < 0.004 | < 0.002 | < 0.004 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 |
| Sodium | 200.7 | 23 | 73 | 42 | 36 | 39 | 36 | 37 | 40 | 38 | 29 | 33 | 36 |
| **Total Organic Carbon (TOC) (mg/L)** | 415.1 | 54 | 72 | 56 | 73 | 64 | 64 | 53 | 57 | 57 | 38 | 44 | 53 |
| **Tributyltin (ng/L)** | GC-FPD | 14 | —(a) | —(a) | —(a) | —(a) | —(a) | 19 | —(a) | —(a) | —(a) | —(a) | —(a) |

**Table 6-7. Monthly monitoring results for physical and chemical characteristics of the LLNL sanitary sewer effluent, 2001 (continued)**

| 24-hour composite sample parameters | EPA Methods | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grab sample parameters** | | | | | | | | | | | | | |
| **Semivolatile organic compounds (ug/L)** | 625 | | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 1,2-Dichlorobenzene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 1,2-Diphenylhydrazine | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 1,3-Dichlorobenzene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 1,4-Dichlorobenzene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2,4,5-Trichlorophenol | | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 |
| 2,4,6-Trichlorophenol | | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 |
| 2,4-Dichlorophenol | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2,4-Dimethylphenol | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2,4-Dinitrophenol | | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 2,4-Dinitrotoluene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2,6-Dinitrotoluene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2-Chloronaphthalene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2-Chlorophenol | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2-Methyl-4,6-dinitrophenol | | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 2-Methylnaphthalene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2-Naphthylamine | | < 30 | < 20 | < 20 | < 20 | < 20 | < 20 | < 30 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 2-Nitroaniline | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 2-Nitrophenol | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 3,3-Dichlorobenzidine | | < 6 | < 5 | < 5 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 3-Nitroaniline | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 4-Bromophenylphenylether | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 4-Chloro-3-methylphenol | | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 |
| 4-Chloroaniline | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 4-Chlorophenylphenylether | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| 4-Nitroaniline | | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 |
| 4-Nitrophenol | | < 6 | < 5 | < 5 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Acenaphthene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Acenaphthylene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Aldrin | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Aniline | | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Anthracene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Benzidine | | < 30 | < 20 | < 20 | < 20 | < 20 | < 20 | < 30 | < 20 | < 20 | < 20 | < 20 | < 20 |
| Benzo(a)anthracene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Benzo(a)pyrene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |

**Table 6-7. Monthly monitoring results for physical and chemical characteristics of the LLNL sanitary sewer effluent, 2001 (continued)**

| 24-hour composite sample parameters | EPA Methods | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzo(b)fluoranthene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Benzo(g,h,i)perylene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Benzo(k)fluoranthene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Benzoic Acid | | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | 72 | 24 | < 10 | 34 | 33 |
| Benzyl Alcohol | | < 3 | 69 | 4.5 | 6.6 | 14 | < 2 | 11 | 71 | 7.2 | 7.6 | 3.9 | 12 |
| BHC, alpha isomer | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| BHC, beta isomer | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| BHC, delta isomer | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| BHC, gamma isomer (Lindane) | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Bis(2-chloroethoxy)methane | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Bis(2-chloroethyl)ether | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Bis(2-chloroisopropyl)ether | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Bis(2-ethylhexyl)phthalate | | 94 | 9.3 | < 5 | 13 | 21 | 11 | 25 | 12 | 8.3 | < 5 | 11 | 13 |
| Butylbenzylphthalate | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Chrysene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Di-n-octylphthalate | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Dibenzo(a,h)anthracene | | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 |
| Dibenzofuran | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Dibutylphthalate | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Dieldrin | | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 |
| Diethylphthalate | | 4.5 | 5.9 | 11 | 8.1 | 9.8 | 2.7 | 8.4 | 9.7 | 24 | 31 | 9.2 | 19 |
| Dimethylphthalate | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Endosulfan I | | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Endosulfan II | | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Endosulfan sulfate | | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 |
| Endrin | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Endrin aldehyde | | < 3 | < 2 | < 2 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Fluoranthene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Fluorene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Heptachlor | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Heptachlor epoxide | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Hexachlorobenzene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Hexachlorobutadiene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Hexachlorocyclopentadiene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Hexachloroethane | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Indeno(1,2,3-c,d)pyrene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Isophorone | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |

**Table 6-7. Monthly monitoring results for physical and chemical characteristics of the LLNL sanitary sewer effluent, 2001 (continued)**

| 24-hour composite sample parameters | EPA Methods | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| m- and p- Cresol | | 35 | 14 | < 2 | 21 | 5.4 | < 2 | 4.8 | 35 | 8.6 | < 2 | 9.7 | 16 |
| N-Nitrosodi-n-propylamine | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| N-Nitrosodimethylamine | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| N-Nitrosodiphenylamine | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Naphthalene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Nitrobenzene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| o-Cresol | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| p,p-DDD | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| p,p-DDE | | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 | < 4 | < 3 | < 3 | < 3 | < 3 | < 3 |
| p,p-DDT | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Pentachlorophenol | | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 | < 20 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Phenanthrene | | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Phenol | | 5.6 | < 2 | < 2 | < 2 | < 2 | < 2 | 10 | 12 | 17 | < 2 | < 2 | < 2 |
| Pyrene | | < 3 | < 2 | < 2 | < 2 | 2.1 | < 2 | < 3 | < 2 | < 2 | < 2 | < 2 | < 2 |
| **Total Cyanide (mg/L)** | 335.3 | < 0.02 | —(a) | —(a) | —(a) | —(a) | —(a) | < 0.02 | —(a) | —(a) | —(a) | —(a) | —(a) |
| **Total oil and grease (mg/L)** | 1664 | | | | | | | | | | | | |
| Oil and Grease - 7:00 a.m. | | 6 | —(a) | —(a) | —(a) | —(a) | —(a) | 6.6 | —(a) | —(a) | —(a) | —(a) | —(a) |
| Oil and Grease - 10:00 a.m. | | 18 | —(a) | —(a) | —(a) | —(a) | —(a) | 16 | —(a) | —(a) | —(a) | —(a) | —(a) |
| Oil and Grease - 2:00 p.m. | | 28 | —(a) | —(a) | —(a) | —(a) | —(a) | 31 | —(a) | —(a) | —(a) | —(a) | —(a) |
| Oil and Grease - 4:00 p.m. | | 26 | —(a) | —(a) | —(a) | —(a) | —(a) | 17 | —(a) | —(a) | —(a) | —(a) | —(a) |
| **Volatile organic compounds (ug/L)** | 624 | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1,2,2-Tetrachloroethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1,2-Trichloroethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1-Dichloroethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,1-Dichloroethene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichlorobenzene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethane | | < 0.5 | < 0.5 | 0.6 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,2-Dichloroethene (total) | | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 1,2-Dichloropropane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,3-Dichlorobenzene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 1,4-Dichlorobenzene | | 3.4 | 0.55 | < 0.5 | 0.78 | 0.55 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| 2-Butanone | | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 2-Chloroethylvinylether | | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| 2-Hexanone | | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 |
| 4-Methyl-2-pentanone | | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 |
| Acetone | | 150 | 160 | 370 | 120 | 220 | 230 | 300 | 120 | 300 | 480 | 98 | 410 |
| Benzene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 1.3 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Bromodichloromethane | | 0.74 | 3.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Bromoform | | < 0.5 | 1.7 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 3.4 |
| Bromomethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |

**Table 6-7. Monthly monitoring results for physical and chemical characteristics of the LLNL sanitary sewer effluent, 2001 (concluded)**

| 24-hour composite sample parameters | EPA Methods | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Carbon disulfide | | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Carbon tetrachloride | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chlorobenzene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chloroethane | | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 0.5 | < 1 | < 0.5 | < 0.5 | < 0.5 |
| Chloroform | | 20 | 7.7 | 8.1 | 7.5 | 7 | 14 | 10 | 11 | 9.7 | 7.8 | 8.7 | 11 |
| Chloromethane | | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 0.5 | < 1 | < 0.5 | < 0.5 | < 0.5 |
| cis-1,2-Dichloroethene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| cis-1,3-Dichloropropene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dibromochloromethane | | < 0.5 | 4.4 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dibromomethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Dichlorodifluoromethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Ethanol | | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 | < 1000 |
| Ethylbenzene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Freon 113 | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 1.2 | < 0.5 |
| Methylene chloride | | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | 1.6 | < 1 | < 1 | < 1 | < 1 |
| Naphthalene | | 0.79 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Styrene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 9.3 | 0.93 | < 0.5 |
| Tetrachloroethene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Toluene | | 1.4 | < 0.5 | < 0.5 | 0.59 | 0.71 | 0.57 | 1.1 | 1.1 | 0.6 | < 0.5 | < 0.5 | < 0.5 |
| Total xylene isomers | | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| trans-1,2-Dichloroethene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| trans-1,3-Dichloropropene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Trichloroethene | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Trichlorofluoromethane | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Vinyl chloride | | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

a Sampling for this parameter is required on a semiannual rather than a monthly basis.

# Surface Water Monitoring

*Chris Campbell*
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## Introduction

Lawrence Livermore National Laboratory monitors surface water at the Livermore site, in the surrounding regions of the Livermore Valley, and at Site 300 and its vicinity in the nearby Altamont Hills. At the first two locales, LLNL monitors reservoirs and ponds, the LLNL swimming pool, the Drainage Retention Basin (DRB), rainfall, tap water, and storm water runoff. Water samples are analyzed for radionuclides and a wide range of nonradioactive constituents.

The data shown for Site 300 and its vicinity include surface water monitoring, rainfall, and storm runoff. Samples of this water are analyzed for radionuclides, high explosives (HE), total organic carbon, total organic halides, total suspended solids, conductivity, and pH.

Chapter 7 of the main volume includes summary data tables and a detailed discussion and analysis of the data. This supplemental chapter presents additional datasets for 2001, from selected networks.

## Storm Water

LLNL technologists collect storm water samples for nonradiological analysis with bottles. Samples analyzed for tritium are collected in 250-mL, amber glass containers; samples for gross alpha and gross beta measurements are collected in 1000-mL polyethylene bottles.

Results for Livermore site routine tritium, gross alpha, and gross beta are presented in Table 7-1. Results for the tritium source investigation are presented in Table 7-2. Table 7-3 summarizes results for nonradioactive compounds, physical and chemical properties, and anions in Livermore site storm water. Table 7-4 shows results for gross alpha, gross beta, tritium, and uranium in Site 300 storm water. Results of PCB analyses at the Livermore site are presented in Table 7-5.

## Rainfall

Rainfall is collected in stainless steel buckets mounted at specified locations about 1 m above the ground to prevent collection of splashback water. Samples are decanted into 250-mL amber glass with Teflon-lined lids. The tritium activity of each sample is measured in a laboratory by scintillation counting (EPA Method 906). The results are presented in Table 7-6.

## Drainage Retention Basin

DRB discharge sampling locations (CDBX and WPDC), which monitor compliance with the Livermore site's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Record of Decision, are shown in the main volume in **Figure 7-2**. **Figure 7-12** of the main volume shows the sampling locations (CDBA and CDBC) used to monitor how water quality compares with maintenance goals and action levels.

**Figure 7-12** of the main volume also shows all eight locations where weekly sampling for dissolved oxygen and temperature occurs. Weekly transparency measurements and monthly, quarterly, semiannual, and annual samples are collected at sample location CDBE.

Tables 7-7 and 7-8 show DRB discharge limits and water quality management levels, respectively. Table 7-9 shows the compliance monitoring data for samples collected at sample locations CDBX and WPDC. Monthly, quarterly, and semiannual maintenance monitoring data for 2001 that were collected at sample location CDBE are shown in Tables 7-10, 7-11, and 7-12. Table 7-13 provides the weekly field measurements collected from sample locations CDBA, CDBC, CDBD, CDBE, CDBF, CDBJ, CDBK, and CDBL. A seasonal inventory of plants and animals observed at the Livermore site is given in Table 7-14.

## Other Waters

LLNL technologists sample surface and drinking water at and near the Livermore site and in the Livermore Valley using a tethered pail to collect water from surface sources; other locations are sampled directly from the outfall. Samples for tritium analysis are collected in 500-mL, argon-flushed glass containers; those for other radiological analyses are collected in acidified 1000-mL polyethylene bottles. Results are presented in Table 7-15.

**Table 7-1. Routine tritium, gross alpha, and gross beta sampling in storm water runoff at the Livermore site, 2001**

| Parameter | Date | Arroyo Seco | |
|---|---|---|---|
| | | Site influent | Site effluent |
| | | ASS2 | ASW |
| Tritium (Bq/L) | 1/8 | | -0.55 ± 2.04 |
| | 1/10 | -0.23 ± 2.15 | |
| | 2/12 | 0.18 ± 2.15 | -0.72 ± 2.15 |
| | 3/2 | | 5.33 ± 2.22 |
| | 4/6 | 2.44 ± 2.26 | -1.02 ± 2.22 |
| | 11/12 | -1.34 ± 2.26 | -2.51 ± 2.22 |
| | 12/20 | -1.85 ± 2.15 | -0.28 ± 2.22 |
| Gross alpha (Bq/L) | 1/8 | | 0.01 ± 0.01 |
| | 1/10 | 0.01 ± 0.01 | |
| | 2/12 | -0.01 ± 0.02 | -0.25 ± 0.22 |
| | 3/2 | | 0.02 ± 0.02 |
| | 4/6 | 0.01 ± 0.02 | 0.01 ± 0.02 |
| | 11/12 | 0.02 ± 0.01 | 0.01 ± 0.01 |
| | 12/20 | 0.02 ± 0.01 | 0.01 ± 0.01 |
| Gross beta (Bq/L) | 1/8 | | 0.09 ± 0.04 |
| | 1/10 | 0.08 ± 0.04 | |
| | 2/12 | 0.05 ± 0.04 | 0.10 ± 0.10 |
| | 3/2 | | 0.09 ± 0.05 |
| | 4/6 | 0.06 ± 0.04 | 0.02 ± 0.04 |
| | 11/12 | 0.11 ± 0.03 | 0.10 ± 0.03 |
| | 12/20 | 0.08 ± 0.03 | 0.09 ± 0.03 |

| Parameter | Date | Arroyo Las Positas | | | |
|---|---|---|---|---|---|
| | | Site influent | | | Site effluent |
| | | ALPE | ALPO | GRNE | WPDC |
| Tritium (Bq/L) | 1/8 | 0.07 ± 2.04 | | | 1.50 ± 2.07 |
| | 1/10 | | | -0.54 ± 2.15 | |
| | 2/12 | 0.89 ± 2.15 | -0.82 ± 2.18 | 0.18 ± 2.15 | 1.51 ± 2.18 |
| | 3/2 | -0.21 ± 2.04 | 0.90 ± 2.04 | -0.21 ± 2.04 | 0.91 ± 2.07 |
| | 4/6 | 1.67 ± 2.29 | -2.41 ± 2.22 | | 2.43 ± 2.33 |
| | 11/12 | -0.58 ± 2.22 | -0.08 ± 2.29 | 2.16 ± 2.29 | -2.33 ± 2.22 |
| | 12/20 | -0.74 ± 2.15 | 0.84 ± 2.22 | | 6.48 ± 2.44 |
| Gross alpha (Bq/L) | 1/8 | -0.10 ± 0.17 | 0.08 ± 0.12 | | 0.05 ± 0.04 |
| | 1/10 | | | 0.01 ± 0.01 | |
| | 2/12 | -0.01 ± 0.01 | 0.03 ± 0.06 | 0.02 ± 0.02 | 0.00 ± 0.01 |
| | 3/2 | 0.07 ± 0.10 | 0.04 ± 0.08 | 0.02 ± 0.02 | 0.02 ± 0.03 |
| | 4/6 | 0.02 ± 0.02 | 0.00 ± 0.09 | | 0.02 ± 0.03 |
| | 11/12 | 0.00 ± 0.01 | 0.07 ± 0.07 | 0.05 ± 0.03 | 0.01 ± 0.01 |
| | 12/20 | 0.06 | 0.14 ± 0.10 | 0.00 ± 0.01 | 0.06 ± 0.03 |
| Gross beta (Bq/L) | 1/8 | 0.38 ± 0.13 | 0.14 ± 0.10 | | 0.13 ± 0.04 |
| | 1/10 | | | 0.15 ± 0.04 | |
| | 2/12 | 0.06 ± 0.03 | 0.08 ± 0.04 | 0.19 ± 0.05 | 0.07 ± 0.03 |
| | 3/2 | 0.55 ± 0.12 | -0.19 ± 0.09 | 0.07 ± 0.04 | 0.10 ± 0.04 |
| | 4/6 | 0.09 ± 0.04 | 0.06 ± 0.05 | | 0.09 ± 0.05 |
| | 11/12 | 0.06 ± 0.04 | 0.51 ± 0.10 | 0.15 ± 0.04 | 0.11 ± 0.03 |
| | 12/20 | 0.21 ± 0.06 | 0.14 ± 0.05 | 0.04 ± 0.03 | 0.09 ± 0.03 |

**Table 7-1. Routine tritium, gross alpha, and gross beta sampling in storm water runoff at the Livermore site, 2001 (concluded)**

| Parameter | Date | Drainage Retention Basin | | |
|---|---|---|---|---|
| | | Site influent | | Site effluent |
| | | CDB | CDB2 | CDBX |
| Tritium (Bq/L) | 1/8 | | 23.90 ± 3.48 | |
| | 1/10 | 8.88 ± 2.44 | | |
| | 2/12 | 6.44 ± 2.33 | 32.60 ± 4.44 | |
| | 3/2 | 3.66 ± 2.15 | 7.07 ± 2.29 | 10.70 ± 2.52 |
| | 4/6 | 9.07 ± 2.63 | | |
| | 11/12 | 2.63 ± 2.29 | 1.72 ± 2.26 | 7.92 ± 2.55 |
| | 12/20 | 0.56 ± 2.22 | 4.63 ± 2.29 | 9.14 ± 2.59 |
| Gross alpha (Bq/L) | 1/8 | | 0.01 ± 0.03 | |
| | 1/10 | 0.05 ± 0.04 | | |
| | 2/12 | 0.07 ± 0.04 | 0.04 ± 0.04 | |
| | 3/2 | 0.02 ± 0.03 | 0.02 ± 0.03 | 0.06 ± 0.05 |
| | 4/6 | 0.00 ± 0.03 | | |
| | 11/12 | 0.01 ± 0.02 | 0.02 ± 0.02 | 0.04 ± 0.03 |
| | 12/20 | 0.01 ± 0.02 | 0.00 ± 0.07 | 0.02 ± 0.04 |
| Gross beta (Bq/L) | 1/8 | | 0.20 ± 0.04 | |
| | 1/10 | 0.11 ± 0.04 | | |
| | 2/12 | 0.07 ± 0.04 | 0.10 ± 0.04 | |
| | 3/2 | 0.10 ± 0.05 | 0.10 ± 0.04 | 0.07 ± 0.06 |
| | 4/6 | -0.04 ± 0.04 | | |
| | 11/12 | 0.06 ± 0.04 | 0.18 ± 0.04 | 0.11 ± 0.03 |
| | 12/20 | 0.10 ± 0.04 | 0.28 ± 0.07 | 0.08 ± 0.03 |

Note: Blank spaces indicate no analyses performed

**Table 7-2. Special tritium source investigation sampling in storm water runoff (Bq/L) of the Livemore site, 2001**

| Location | Storm date | Tritium (Bq/L) |
|---|---|---|
| L-2582-RO | 1/8 | 15.2 ± 2.96 |
| | 2/12 | 9.44 ± 2.44 |
| L-298E-RO | 1/8 | 2.71 ± 2.29 |
| | 2/12 | 5.66 ± 2.33 |
| L-298S-RO | 1/8 | 3.89 ± 2.41 |
| | 2/12 | 4.44 ± 2.18 |
| L-331E-RO | 2/12 | 245 ± 25.2 |
| | 4/6 | 169 ± 17.4 |
| L-341N-RO | 1/8 | 9.51 ± 2.63 |
| | 2/12 | 4.88 ± 2.26 |
| L-341W-RO | 1/8 | 14.4 ± 2.89 |
| | 2/12 | 4.22 ± 2.26 |
| L-343N-RO | 1/8 | 104 ± 11.1 |
| | 2/12 | 14.1 ± 2.74 |
| L-3726-RO | 1/8 | 15.2 ± 2.92 |
| | 2/12 | 7.77 ± 2.41 |
| L-3RDE-RO | 1/8 | 15.1 ± 2.92 |
| | 2/12 | 3.61 ± 2.18 |
| L-3RDR-RO | 1/8 | 0.08 ± 2.29 |
| | 2/12 | 7.33 ± 2.37 |
| L-3RDS-RO | 1/8 | 32 ± 4.44 |
| | 2/12 | 10.2 ± 2.48 |
| L-B4PK-RO | 1/8 | 10.4 ± 2.66 |
| | 2/12 | 9.29 ± 2.48 |
| L-C4PK-RO | 1/8 | 40 ± 4.81 |
| | 2/12 | 4.85 ± 2.22 |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| **Physical (mg/L)** | | | | | | | | | | |
| Chemical Oxygen Demand | 1/8 | | 150 | 120 | 41 | | 34 | | 80 | |
| | 1/10 | 110 | | | | 38 | | 87 | | |
| | 2/12 | 92 | 28 | 140 | 28 | 25 | 25 | 30 | 39 | |
| | 3/2 | | 26 | 120 | 79 | 20 | 30 | 36 | 29 | < 20 |
| | 4/6 | 71 | 78 | 110 | 50 | | 71 | 41 | | |
| | 11/12 | 76 | 80 | 85 | 275 | 61 | 52 | 66 | 150 | 49 |
| | 12/20 | 72 | 26 | 98 | < 25 | 26 | < 25 | 40 | 210 | < 25 |
| Total suspended solids (TSS) | 1/8 | | 71 | 40 | 9.5 | | 11 | | 32 | |
| | 1/10 | 57 | | | | 70 | | 46 | | |
| | 2/12 | 160 | 21 | 20 | 19 | 54 | 36 | 20 | 14 | |
| | 3/2 | | 18 | 43 | 220 | 28 | 51 | 89 | 18 | 21 |
| | 4/6 | 16 | 12 | 40 | 53 | | 58 | 8.5 | | |
| | 11/12 | 53 | 22 | 82 | 600 | 210 | 30 | 72 | 170 | 65 |
| | 12/20 | 180 | 84 | 180 | 96 | 54 | 16 | 130 | 35 | 3 |
| **Anions (mg/L)** | | | | | | | | | | |
| Bromide | 1/8 | | < 0.1 | 1 | 2.12 | | 0.7 | | 0.3 | |
| | 1/10 | < 0.1 | | | | 0.2 | | 0.2 | | |
| | 2/12 | < 0.1 | < 0.1 | 1.2 | 1.4 | 0.1 | < 0.1 | 0.2 | 0.2 | |
| | 3/2 | | < 0.1 | 1.4 | 1.2 | 0.1 | < 0.1 | 0.1 | < 0.1 | 0.4 |
| | 4/6 | < 0.1 | < 0.1 | < 0.1 | 2.14 | | < 0.1 | 0.2 | | |
| | 11/12 | < 0.1 | < 0.1 | < 0.1 | 4.17 | 0.3 | 0.1 | 0.1 | < 0.1 | 1.1 |
| | 12/20 | < 0.1 | < 0.1 | 0.6 | 2.35 | 0.1 | 0.2 | < 0.1 | 0.9 | 0.5 |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001 (continued)**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| Chloride | 1/8 | | 2.1 | 421 | 291 | | 144 | | 84 | |
| | 1/10 | 0.95 | | | | 18 | | 52 | | |
| | 2/12 | 1.2 | 1.8 | 488 | 227 | 8.8 | 18 | 46 | 86 | |
| | 3/2 | | 1.1 | 334 | 191 | 5.4 | 8.8 | 19 | 31 | 113 |
| | 4/6 | 1.8 | 3.6 | 6.3 | 308 | | 26 | 41 | | |
| | 11/12 | 1.8 | 1.8 | 2.4 | 362 | 17 | 17 | 23 | 4.2 | 129 |
| | 12/20 | 2 | 2 | 180 | 232 | 6.8 | 84 | 9.5 | 336 | 159 |
| Fluoride | 1/8 | | < 0.05 | 1.4 | 1.2 | | 0.42 | | 0.34 | |
| | 1/10 | < 0.05 | | | | 0.11 | | 0.23 | | |
| | 2/12 | < 0.05 | < 0.05 | 1.6 | 1.1 | 0.12 | < 0.05 | 0.22 | 0.3 | |
| | 3/2 | | < 0.05 | 1.4 | 0.86 | 0.13 | 0.078 | 0.12 | 0.16 | 0.37 |
| | 4/6 | 0.052 | < 0.05 | 0.18 | 1.2 | | 0.19 | 0.27 | | |
| | 11/12 | 0.096 | 0.12 | 0.12 | 1.1 | 0.19 | 0.16 | 0.19 | 0.13 | 0.36 |
| | 12/20 | < 0.05 | < 0.05 | 0.65 | 1.3 | 0.053 | 0.28 | < 0.05 | 0.76 | 0.37 |
| Sulfate | 1/8 | | 1.4 | 365 | 328 | | 51 | | 16 | |
| | 1/10 | 1 | | | | 24 | | 22 | | |
| | 2/12 | 2.9 | 1.7 | 453 | 228 | 7.2 | 12 | 17 | 52 | |
| | 3/2 | | 1.8 | 273 | 212 | 6.4 | 9.9 | 8.8 | 25 | 49 |
| | 4/6 | 3.8 | 1.8 | 7.2 | 358 | | 14 | 15 | | |
| | 11/12 | 2.7 | 2.4 | 3.4 | 347 | 15 | 7.8 | 10 | 7.3 | 40 |
| | 12/20 | 1.7 | 1.3 | 174 | 290 | 7.1 | 30 | 4.5 | 396 | 67 |
| Nitrate (as N) | 1/8 | | 0.83 | 0.75 | 2.8 | | 4.2 | | 1.2 | |
| | 1/10 | 0.41 | | | | 8.4 | | 2.6 | | |
| | 2/12 | 0.16 | 0.3 | 0.1 | 3 | 2.3 | 0.6 | 2.6 | 0.85 | |
| | 3/2 | | 0.41 | 0.38 | 3.2 | 2.3 | 0.82 | 1.5 | 0.64 | 2.3 |
| | 4/6 | 0.24 | 0.15 | 1.5 | 2.6 | | 1.7 | 3 | | |
| | 11/12 | 1.4 | 1.2 | 2.3 | 2.3 | 16 | 1.7 | 3 | 2 | 1.7 |
| | 12/20 | 0.2 | < 0.5 | 0.57 | 5 | 4.2 | 2.8 | 1.5 | 0.35 | 3.4 |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001 (continued)**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| Nitrate (as $NO_3$) | 1/8 | | 3.7 | 3.3 | 12 | | 19 | | 5.3 | |
| | 1/10 | 2 | | | | 37 | | 12 | | |
| | 2/12 | 0.71 | 1.3 | 0.44 | 13 | 10 | 2.7 | 12 | 3.9 | |
| | 3/2 | | 1.8 | 1.7 | 14 | 10 | 3.6 | 6.6 | 2.8 | 10 |
| | 4/6 | 1.1 | 0.66 | 6.5 | 11 | | 7.4 | 13 | | |
| | 11/12 | 6.3 | 5.3 | 10 | 10 | 69 | 7.7 | 13 | 9 | 7.6 |
| | 12/20 | 0.9 | < 2.2 | 2.5 | 22 | 19 | 12 | 6.7 | 1.6 | 15 |
| Nitrate plus Nitrite (as N) | 1/8 | | 0.91 | 0.75 | 2.8 | | 4.2 | | 1.2 | |
| | 1/10 | 0.46 | | | | 8.4 | | 2.6 | | |
| | 2/12 | 0.19 | 0.3 | 0.1 | 3 | 2.3 | 0.6 | 2.6 | 0.87 | |
| | 3/2 | | 0.41 | 0.38 | 3.3 | 2.3 | 0.82 | 1.5 | 0.64 | 2.3 |
| | 4/6 | 0.27 | 0.2 | 1.5 | 2.6 | | 1.7 | 3 | | |
| | 11/12 | 1.5 | 1.2 | 2.4 | 2.4 | 16 | 1.8 | 3 | 2.1 | 1.7 |
| | 12/20 | 0.24 | < 0.5 | 0.59 | 5.2 | 4.3 | 2.8 | 1.5 | 0.4 | 3.4 |
| Nitrite (as N) | 1/8 | | 0.075 | 0.04 | 0.04 | | 0.04 | | 0.047 | |
| | 1/10 | 0.05 | | | | 0.038 | | 0.038 | | |
| | 2/12 | 0.03 | 0.03 | < 0.02 | 0.045 | 0.045 | 0.02 | 0.02 | 0.02 | |
| | 3/2 | | 0.02 | 0.02 | 0.069 | 0.02 | 0.02 | < 0.02 | 0.02 | 0.054 |
| | 4/6 | 0.038 | 0.053 | 0.083 | 0.061 | | 0.038 | 0.02 | | |
| | 11/12 | 0.043 | 0.049 | 0.049 | 0.12 | 0.081 | 0.055 | 0.055 | 0.043 | 0.03 |
| | 12/20 | 0.033 | 0.033 | 0.02 | 0.084 | 0.033 | 0.02 | 0.033 | 0.048 | 0.033 |
| Nitrite (as NO2) | 1/8 | | 0.25 | 0.13 | 0.13 | | 0.13 | | 0.16 | |
| | 1/10 | 0.16 | | | | 0.13 | | 0.13 | | |
| | 2/12 | 0.098 | 0.098 | < 0.065 | 0.15 | 0.15 | 0.066 | 0.066 | 0.066 | |
| | 3/2 | | 0.066 | 0.066 | 0.23 | 0.066 | 0.066 | < 0.065 | 0.066 | 0.18 |
| | 4/6 | 0.13 | 0.18 | 0.27 | 0.2 | | 0.13 | 0.066 | | |
| | 11/12 | 0.14 | 0.16 | 0.16 | 0.41 | 0.26 | 0.18 | 0.18 | 0.14 | 0.099 |
| | 12/20 | 0.11 | 0.11 | 0.066 | 0.28 | 0.11 | 0.066 | 0.11 | 0.16 | 0.11 |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001 (continued)**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| Ortho-Phosphate | 1/8 | | 0.536 | 1.48 | 0.23 | | 0.24 | | 0.23 | |
| | 1/10 | 0.35 | | | | 0.6 | | 0.4 | | |
| | 2/12 | 0.3 | 0.24 | 1.8 | 0.41 | 0.609 | 0.19 | 0.21 | 0.37 | |
| | 3/2 | | 0.39 | 1.99 | 0.65 | 0.642 | 0.33 | 0.37 | 0.553 | 0.16 |
| | 4/6 | 0.777 | 0.54 | 1.09 | 0.42 | | 0.43 | 0.37 | | |
| | 11/12 | 0.834 | 0.5 | 0.661 | 0.937 | 0.842 | 0.44 | 0.825 | 0.791 | 0.2 |
| | 12/20 | 0.42 | 0.42 | 1.08 | 0.24 | 0.5 | 0.2 | 0.46 | 2.4 | 0.2 |
| **Alkalinity (mg/L)** | | | | | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | 1/8 | | 16 | 388 | 241 | | 185 | | 123 | |
| | 1/10 | 17 | | | | 36 | | 120 | | |
| | 2/12 | 16 | 19 | 458 | 232 | 41 | 39 | 130 | 102 | |
| | 3/2 | | 19 | 407 | 200 | 36 | 34 | 74.6 | 63.7 | 160 |
| | 4/6 | 10 | 18 | 34 | 253 | | 79.9 | 124 | | |
| | 11/12 | 15 | 18 | 87.9 | 219 | 25 | 54 | 67 | 21 | 115 |
| | 12/20 | 29 | 19 | 161 | 268 | 17 | 163 | 36 | 312 | 184 |
| Carbonate Alk (as $CaCO_3$) | 1/8 | | < 2.5 | 15 | 21 | | < 5 | | < 5 | |
| | 1/10 | < 2.5 | | | | < 2.5 | | < 2.5 | | |
| | 2/12 | < 2.5 | < 2.5 | 52 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | |
| | 3/2 | | < 2.5 | < 20 | < 10 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | 19 |
| | 4/6 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | | < 2.5 | < 2.5 | | |
| | 11/12 | < 2.5 | < 2.5 | 34 | < 10 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | 8.6 |
| | 12/20 | < 2.5 | < 2.5 | 54.2 | < 10 | < 2.5 | < 5 | < 2.5 | < 10 | < 5 |
| Total Alkalinity (as $CaCO_3$) | 1/8 | | 16 | 403 | 262 | | 185 | | 123 | |
| | 1/10 | 17 | | | | 36 | | 120 | | |
| | 2/12 | 16 | 19 | 511 | 232 | 41 | 39 | 130 | 102 | |
| | 3/2 | | 19 | 407 | 200 | 36 | 34 | 74.6 | 63.7 | 179 |
| | 4/6 | 10 | 18 | 34 | 253 | | 556 | 124 | | |
| | 11/12 | 15 | 18 | 122 | 219 | 25 | 54 | 67 | 21 | 123 |
| | 12/20 | 29 | 19 | 228 | 268 | 17 | 163 | 36 | 312 | 184 |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001 (continued)**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| **Herbicides (ug/L)** | | | | | | | | | | |
| Bromacil | 1/8 | | 3.9 | 1.1 | 7 | | < 1 | | 16 | |
| | 1/10 | < 1 | | | | 2500 | | 10 | | |
| | 2/12 | < 1 | 1.6 | 5.7 | 40 | 1200 | 5.9 | 4.4 | 12 | |
| | 3/2 | | < 2 | < 1 | 49 | 650 | 23 | 4.8 | 6.6 | 4.4 |
| | 4/6 | < 1 | < 1 | 1.9 | 9.6 | | < 1 | 1.2 | | |
| | 11/12 | < 1 | < 1 | 2.4 | 2.8 | 300 | 1.9 | < 1 | < 1 | < 1 |
| | 12/20 | < 1 | < 1 | 4.1 | 15 | 6900 | 1.9 | 1.7 | 1.4 | < 1 |
| Butylbenzylphthalate | 1/8 | | < 3 | < 2 | < 2 | | < 2 | | < 7 | |
| | 1/10 | < 2 | | | | < 800 | | < 4 | | |
| | 2/12 | < 1 | < 1 | < 1 | < 5 | < 500 | < 1 | < 1 | < 2 | |
| | 3/2 | | < 3 | 9.3 | < 10 | < 200 | < 5 | < 2 | < 2 | < 2 |
| | 4/6 | < 2 | < 2 | < 2 | < 2 | | < 2 | < 2 | | |
| | 11/12 | < 2 | < 2 | < 3 | < 2 | < 5 | < 2 | < 2 | < 2 | < 2 |
| | 12/20 | < 2 | < 2 | < 2 | < 2 | < 100 | < 2 | < 2 | < 2 | < 2 |
| Di (2-ethylhexyl) adipate | 1/8 | | < 2 | < 1 | < 1 | | 1.7 | | < 4 | |
| | 1/10 | < 1 | | | | < 400 | | < 2 | | |
| | 2/12 | < 1 | < 1 | < 1 | < 5 | < 500 | < 1 | < 1 | < 2 | |
| | 3/2 | | < 2 | < 1 | < 10 | < 200 | < 5 | < 1 | < 1 | < 1 |
| | 4/6 | < 1 | < 1 | < 1 | < 1 | | < 1 | < 1 | | |
| | 11/12 | < 1 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| | 12/20 | < 1 | < 1 | < 1 | < 1 | < 50 | < 1 | < 1 | < 1 | < 1 |
| Diazinon | 1/8 | | < 0.3 | < 0.2 | < 0.2 | | < 0.2 | | < 0.7 | |
| | 1/10 | < 0.2 | | | | < 80 | | < 0.4 | | |
| | 2/12 | < 0.5 | < 0.5 | < 0.5 | < 3 | < 300 | < 0.5 | < 0.5 | < 1 | |
| | 3/2 | | < 0.5 | < 0.5 | < 5 | < 100 | < 3 | < 0.5 | < 0.5 | < 0.5 |
| | 4/6 | < 0.5 | < 0.6 | < 0.5 | < 0.5 | | < 0.5 | < 0.5 | | |
| | 11/12 | < 0.5 | < 0.5 | < 0.6 | < 0.5 | 1.3 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| | 12/20 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 30 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001 (continued)**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| Dibutylphthalate | 1/8 | | < 2 | < 1 | < 1 | | < 1 | | < 4 | |
| | 1/10 | < 1 | | | | < 400 | | < 2 | | |
| | 2/12 | < 1 | < 1 | < 1 | < 5 | < 500 | < 1 | < 1 | < 2 | |
| | 3/2 | | < 2 | < 1 | < 10 | < 200 | < 5 | 1.14 | < 1 | < 1 |
| | 4/6 | < 1 | < 1 | < 1 | < 1 | | < 1 | < 1 | | |
| | 11/12 | < 1 | < 1 | < 2 | < 1 | < 3 | < 1 | < 1 | < 1 | < 1 |
| | 12/20 | < 1 | < 1 | < 1 | < 1 | < 50 | < 1 | < 1 | < 1 | < 1 |
| Diethylhexylphthalate | 1/8 | | < 4 | < 3 | < 3 | | 14 | | < 10 | |
| | 1/10 | < 3 | | | | < 2000 | | < 6 | | |
| Diuron | 1/8 | | 13 | 4.5 | 4.6 | | 14 | | 36 | |
| | 1/10 | < 1 | | | | 1600 | | 7.7 | | |
| | 2/12 | < 0.4 | 3.1 | 3.6 | 80 | 79 | 10 | 4.6 | 13 | |
| | 3/2 | | 1.8 | 1.6 | 93 | 36 | 13 | 3.6 | 14 | 5.4 |
| | 4/6 | < 0.8 | < 0.8 | 3.9 | 18 | | 3.6 | 21 | | |
| | 11/12 | < 0.4 | < 0.4 | 1.4 | < 0.4 | 7.6 | 0.87 | 1.1 | 5.1 | 1.3 |
| | 12/20 | < 0.4 | 1.9 | 1.4 | 3.6 | 5300 | 51 | 0.85 | 15 | 3.1 |
| Glyphosate | 1/8 | | 41 | 16 | < 9 | | 47 | | 24 | |
| | 1/10 | 12 | | | | 26 | | < 9 | | |
| | 2/12 | 12 | 9.1 | 37 | < 9 | 23 | 22 | < 9 | 18 | |
| | 3/2 | | 24 | 31 | < 9 | 24 | 22 | 17 | 12 | 14 |
| | 4/6 | 22 | 13 | 12 | < 9 | | 30 | 24 | | |
| | 11/12 | 23 | < 9 | 78 | < 9 | < 9 | < 9 | < 9 | 31 | < 9 |
| | 12/20 | < 9 | < 9 | 19 | < 9 | 15 | 21 | < 9 | < 9 | < 9 |
| **Dissolved metals (mg/L)** | | | | | | | | | | |
| Copper | 1/8 | | 0.007 | 0.007 | 0.002 | | 0.002 | | 0.006 | |
| | 3/2 | | 0.005 | 0.006 | < 0.002 | 0.004 | 0.004 | 0.004 | 0.006 | < 0.002 |
| | 4/6 | 0.01 | 0.008 | 0.01 | 0.004 | | 0.01 | 0.005 | | |
| | 11/12 | 0.0088 | 0.01 | 0.005 | 0.0095 | 0.004 | 0.005 | 0.0066 | 0.011 | 0.005 |
| | 12/20 | 0.002 | 0.003 | 0.003 | 0.003 | 0.001 | 0.002 | | | |

**Table 7-3. Nonradioactive consitituents detected in storm water runoff, Livermore site, 2001 (concluded)**

| Parameter | Storm dates | Arroyo Seco | | Arroyo Las Positas | | | | Drainage Retention Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site influent | Site effluent | Site influent | | | Site effluent | Site influent | | Site effluent |
| | | ASS2 | ASW | ALPE | ALPO | GRNE | WPDC | CDB | CDB2 | CDBX |
| **Miscellaneous organics (mg/L)** | | | | | | | | | | |
| Oil and Grease | 1/8 | | < 5 | < 5 | < 5 | | 14 | | < 5 | |
| | 1/10 | < 5 | | | | < 5 | | < 5 | | |
| | 2/12 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | |
| | 3/2 | | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| | 4/6 | < 6 | < 6 | < 6 | < 6 | | < 6 | < 5 | | |
| | 11/12 | < 6 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| | 12/20 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Total Organic Carbon (TOC) | 1/8 | | 19 | 32 | 7.1 | | 34 | | 11 | |
| | 1/10 | 9.2 | | | | 6 | | 8.3 | | |
| | 2/12 | 7.9 | 5.4 | 35 | 4.7 | 4.4 | 4.7 | 3 | 9.5 | |
| | 3/2 | | 5 | 26 | 6.9 | 3.4 | 5 | 4.2 | 9.2 | 4.6 |
| | 4/6 | 21 | 28 | 25 | 7.4 | | 22 | 12 | | |
| | 11/12 | 16 | 21 | 17 | 33 | 13 | 15 | 15 | 23 | 10 |
| | 12/20 | 4.8 | 6.4 | 14 | 6.4 | 9.3 | 4.7 | 5.7 | 35 | 5.8 |

Note: Blank spaces indicate no analyses performed

**Table 7-4. Radioactivity in storm water runoff, Site 300, 2001.**

| Parameter (Bq/L) | Sampling date | Upstream location | Effluent locations | | Downstream locations |
|---|---|---|---|---|---|
| | | CARW | N883 | NPT7 | GEOCRK |
| Gross alpha | 3/2 | 0.055 ± 0.09 | | | -0.049 ± 0.11 |
| | 4/6 | | | 0.006 ± 0.02 | 0.101 ± 0.14 |
| | 12/20 | 0.308 ± 0.11 | 0.012 ± 0.01 | 0.16 ± 0.05 | 0.02 ± 0.08 |
| Gross beta | 3/2 | 0.182 ± 0.07 | | | 0.286 ± 0.08 |
| | 4/6 | | | 0.128 ± 0.04 | 0.622 ± 0.17 |
| | 12/20 | 0.962 ± 0.16 | 0.044 ± 0.03 | 0.356 ± 0.07 | 0.246 ± 0.10 |
| Tritium* | 3/2 | -0.381 ± 2.22 | | | -0.548 ± 2.15 |
| | 4/6 | | | 0.266 ± 2.11 | -1.15 ± 2.07 |
| | 12/20 | 1.47 ± 2.15 | -0.073 ± 2.11 | 1.54 ± 2.15 | 0.659 ± 2.11 |
| Uranium 234 and Uranium 233 | 3/2 | 0.075 ± 0.01 | | | 0.06 ± 0.01 |
| | 4/6 | | | 0.003 ± 0.00 | 0.056 ± 0.01 |
| | 12/20 | 0.087 ± 0.01 | 0.001 ± 0.00 | 0.049 ± 0.01 | 0.057 ± 0.01 |
| Uranium 235 and Uranium 236 | 3/2 | 0.004 ± 0.00 | | | 0.004 ± 0.00 |
| | 4/6 | | | 0.000 ± 0.00 | 0.003 ± 0.00 |
| | 12/20 | 0.005 ± 0.00 | 0.000 ± 0.00 | 0.003 ± 0.00 | 0.003 ± 0.00 |
| Uranium 238 | 3/2 | 0.068 ± 0.01 | | | 0.055 ± 0.01 |
| | 4/6 | | | 0.003 ± 0.00 | 0.046 ± 0.01 |
| | 12/20 | 0.08 ± 0.01 | 0.002 ± 0.00 | 0.057 ± 0.01 | 0.051 ± 0.01 |

Note: Blank spaces indicate no analyses performed

* Tritium activities are presented relative to a low activity standard or “dead water”, as a result, it is possible to have negative values or measurements that were lower than the reference “dead water” standard.

**Table 7-5. Polychlorinated biphenyls (µg/L) in storm water at the Livermore Site, 2001**

| Locations | PCB 1016 | | | | PCB 1221 | | | |
|---|---|---|---|---|---|---|---|---|
| | Jan-01 | Apr-01 | Nov-01 | Dec-01 | Jan-01 | Apr-01 | Nov-01 | Dec-01 |
| **Arroyo Seco** | | | | | | | | |
| **Site influent** | | | | | | | | |
| ASSE-RO | n/a[a] | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| ASS2-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | | | | | |
| ASW-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Arroyo Las Positas** | | | | | | | | |
| **Site effluent** | | | | | | | | |
| ALPE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| ALPO-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| GRNE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | | | | | |
| WPDC-RO | < 0.2 | n/a | < 0.2 | < 0.2 | < 0.2 | n/a | < 0.2 | < 0.2 |
| **Drainage Retention Basin** | | | | | | | | |
| **DRB influent** | | | | | | | | |
| CDB-RO | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| CDB2-RO | < 0.2 | n/a | < 0.2 | < 0.2 | < 0.2 | n/a | < 0.2 | < 0.2 |
| **DRB effluent** | | | | | | | | |
| CDBX-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |

| Locations | PCB 1232 | | | | PCB 1242 | | | |
|---|---|---|---|---|---|---|---|---|
| | Jan-01 | Apr-01 | Nov-01 | Dec-01 | Jan-01 | Apr-01 | Nov-01 | Dec-01 |
| **Arroyo Seco** | | | | | | | | |
| **Site influent** | | | | | | | | |
| ASSE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| ASS2-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | | | | | |
| ASW-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Arroyo Las Positas** | | | | | | | | |
| **Site effluent** | | | | | | | | |
| ALPE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| ALPO-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| GRNE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | | | | | |
| WPDC-RO | < 0.2 | n/a | < 0.2 | < 0.2 | < 0.2 | n/a | < 0.2 | < 0.2 |
| **Drainage Retention Basin** | | | | | | | | |
| **DRB influent** | | | | | | | | |
| CDB-RO | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| CDB2-RO | < 0.2 | n/a | < 0.2 | < 0.2 | < 0.2 | n/a | < 0.2 | < 0.2 |
| **DRB effluent** | | | | | | | | |
| CDBX-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |

**Table 7-5: Polychlorinated biphenyls (µg/L) in storm water at the Livermore Site, 2001 (concluded)**

| Locations | PCB 1248 | | | | PCB 1254 | | | |
|---|---|---|---|---|---|---|---|---|
| | Jan-01 | Apr-01 | Nov-01 | Dec-01 | Jan-01 | Apr-01 | Nov-01 | Dec-01 |
| **Arroyo Seco** | | | | | | | | |
| **Site influent** | | | | | | | | |
| ASSE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| ASS2-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | | | | | |
| ASW-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Arroyo Las Positas** | | | | | | | | |
| **Site effluent** | | | | | | | | |
| ALPE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| ALPO-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| GRNE-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | | | | | |
| WPDC-RO | < 0.2 | n/a | < 0.2 | < 0.2 | < 0.2 | n/a | < 0.2 | < 0.2 |
| **Drainage Retention Basin** | | | | | | | | |
| **DRB influent** | | | | | | | | |
| CDB-RO | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| CDB2-RO | < 0.2 | n/a | < 0.2 | < 0.2 | < 0.2 | n/a | < 0.2 | < 0.2 |
| **DRB effluent** | | | | | | | | |
| CDBX-RO | n/a | n/a | < 0.2 | < 0.2 | n/a | n/a | < 0.2 | < 0.2 |

| Locations | PCB 1260 | | | |
|---|---|---|---|---|
| | Jan-01 | Apr-01 | Nov-01 | Dec-01 |
| **Arroyo Seco** | | | | |
| **Site influent** | | | | |
| ASSE-RO | n/a | n/a | < 0.2 | < 0.2 |
| ASS2-RO | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | |
| ASW-RO | n/a | n/a | < 0.2 | < 0.2 |
| **Arroyo Las Positas** | | | | |
| **Site effluent** | | | | |
| ALPE-RO | n/a | n/a | < 0.2 | < 0.2 |
| ALPO-RO | n/a | n/a | < 0.2 | < 0.2 |
| GRNE-RO | n/a | n/a | < 0.2 | < 0.2 |
| **Site effluent** | | | | |
| WPDC-RO | < 0.2 | n/a | < 0.2 | < 0.2 |
| **Drainage Retention Basin** | | | | |
| **DRB influent** | | | | |
| CDB-RO | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| CDB2-RO | < 0.2 | n/a | < 0.2 | < 0.2 |
| **DRB effluent** | | | | |
| CDBX-RO | n/a | n/a | < 0.2 | < 0.2 |

a n/a = no data available

**Table 7-6. Tritium in rain (Bq/L), Livermore site, Livermore Valley, and Site 300, 2001**

| | 1/9 | 2/12 | 3/2 | 11/13 |
|---|---|---|---|---|
| **Location** | **Livermore site** | | | |
| B343 | 12.60 ± 2.66 | 14.10 ± 2.63 | 6.99 ± 2.33 | 12.50 ± 2.74 |
| B291 | 2.89 ± 2.26 | 0.15 ± 2.18 | 2.53 ± 2.15 | 0.37 ± 2.11 |
| CDB | 3.17 ± 2.22 | 6.99 ± 2.41 | 4.44 ± 2.22 | 4.74 ± 2.15 |
| VIS | 1.34 ± 2.18 | 0.69 ± 2.18 | 2.00 ± 2.15 | 0.45 ± 2.15 |
| COW | 1.97 ± 2.00 | 0.39 ± 2.18 | 0.84 ± 2.11 | 0.80 ± 2.07 |
| SALV | 1.17 ± 2.18 | -1.69 ± 2.15 | 3.30 ± 2.18 | 0.15 ± 2.07 |
| MET | 1.96 ± 2.00 | 0.91 ± 2.00 | 1.61 ± 2.11 | -2.65 ± 2.11 |
| C4PK | 5.96 ± 2.18 | 5.44 ± 2.33 | 7.36 ± 2.29 | |
| | **Livermore Valley** | | | |
| ESAN | -0.96 ± 2.07 | -0.23 ± 2.18 | 2.39 ± 2.07 | -1.10 ± 2.07 |
| ZON7 | 0.18 ± 2.15 | -0.39 ± 2.18 | 0.56 ± 2.04 | -0.29 ± 2.07 |
| SLST | 0.35 ± 2.11 | -1.84 ± 2.15 | -0.97 ± 1.96 | 0.15 ± 2.07 |
| GTES | -1.32 ± 2.11 | -1.69 ± 2.15 | -0.49 ± 2.00 | -1.52 ± 2.00 |
| VINE | -2.88 ± 2.15 | -1.92 ± 2.15 | -0.28 ± 2.00 | -1.37 ± 2.00 |
| BVA | 0.18 ± 2.15 | -1.84 ± 2.15 | 0.07 ± 2.04 | -1.09 ± 2.04 |
| VET | -0.27 ± 2.11 | -2.30 ± 2.15 | -0.98 ± 2.00 | -0.15 ± 2.07 |
| PATT | -1.08 ± 2.15 | -2.46 ± 2.15 | -0.56 ± 2.00 | -1.51 ± 2.00 |
| AMON | 0.81 ± 2.18 | -0.69 ± 2.15 | 0.84 ± 2.04 | -1.07 ± 2.00 |
| | **Site 300** | | | |
| COMP | 1.09 ± 2.00 | 0.14 ± 2.00 | 0.77 ± 2.11 | -1.67 ± 2.18 |
| PRIM | 0.81 ± 1.96 | 0.98 ± 2.00 | -1.84 ± 2.07 | -2.19 ± 2.22 |
| TNK5 | 1.19 ± 2.04 | -0.42 ± 1.96 | 0.54 ± 2.11 | -1.82 ± 2.11 |

Note: Blank spaces indicate no analyses performed

**Table 7-7. Drainage Retention Basin discharge limits for CDBX, identified in CERCLA Record of Decision as amended, and sampling frequencies for CDBX and WPDC**

| Parameter | CDBX | WPDC | Effluent discharge limits | |
|---|---|---|---|---|
| | | | Dry season Apr 1–Nov 30 | Wet season Dec 1–Mar 31 |
| **Physical** | | | | |
| Specific conductance (μS/cm) | A | A | Not applicable | Not applicable |
| pH (units) | A & B | A & B | 6.5–8.5 | 6.5–8.5 |
| Total suspended solids (mg/L) | A & B | A & B | Not applicable | Not applicable |
| Total dissolved solids (mg/L) | A | A | Not applicable | Not applicable |
| Turbidity (NTU)[a] | A & B | A & B | >15 | >15 |
| **Toxicity** | | | | |
| Acute aquatic survival bioassay (% survival/96 hours) | A & B | A & B | Median of 90% survival and a 90 percentile value of not less than 70% survival for 96-hour bioassay | Median of 90% survival and a 90 percentile value of not less than 70% survival for 96-hour bioassay |
| Chronic bioassay Fathead minnow | A | —[b] | Not applicable | Not applicable |
| Water flea | A | —[b] | Not applicable | Not applicable |
| Algae | A | —[b] | Not applicable | Not applicable |
| **General minerals (mg/L)** | | | | |
| Total alkalinity | A | —[b] | Not applicable | Not applicable |
| Nitrate (as N) | A | —[b] | Not applicable | Not applicable |
| Nitrite (as N) | A | —[b] | Not applicable | Not applicable |
| **Metals (μg/L)** | | | | |
| Antimony | A & B | A & B | 6 | Not applicable[c] |
| Arsenic | A & B | A & B | 50 | 10 |
| Beryllium | A & B | A & B | 4 | Not applicable[c] |
| Boron | A & B | A & B | Not applicable[d] | Not applicable[c] |
| Cadmium | A & B | A & B | 5 | 2.2 |
| Chromium (total) | A & B | A & B | 50 | Not applicable[c] |
| Chromium(VI) | A & B | A & B | Not applicable[d] | 22 |
| Copper | A & B | A & B | 1300 | 23.6 |
| Iron | A & B | A & B | Not applicable[d] | Not applicable[c] |
| Lead | A & B | A & B | 15 | 6.4 |
| Manganese | A & B | A & B | Not applicable[d] | Not applicable[c] |
| Mercury | A & B | A & B | 2 | 2 |
| Nickel | A & B | A & B | 100 | 320 |
| Selenium | A & B | A & B | 50 | 10 |
| Silver | A & B | A & B | 100 | 8.2 |
| Thallium | A & B | A & B | 2 | Not applicable[c] |
| Zinc | A & B | A & B | Not applicable[d] | 220 |

**Table 7-7. Drainage Retention Basin discharge limits for CDBX, identified in CERCLA ROD as amended, and sampling frequencies for CDBX and WPDC (concluded)**

| Parameter | CDBX | WPDC | Effluent discharge limits | |
|---|---|---|---|---|
| | | | Dry season Apr 1–Nov 30 | Wet season Dec 1–Mar 31 |
| **Organics (μg/L)** | | | | |
| Herbicides (EPA 507, 547, 632) | A | —[b] | Not applicable | Not applicable |
| Volatile organic compounds (EPA Method 601 only) | A | —[b] | 5 | 5 |
| Tetrachloroethene | | | 4 | 4 |
| Vinyl chloride | | | 2 | 2 |
| Chemical oxygen demand | A | —[b] | Not applicable | Not applicable |
| Total organic carbon | A | —[b] | Not applicable | Not applicable |
| Polychlorinated biphenlyls | A & B | A & B | Not applicable | Not applicable |
| **Radioactivity (Bq/L)** | | | | |
| Alpha | A | —[b] | 0.56 | 0.56 |
| Beta | A | —[b] | 1.85 | 1.85 |
| Tritium | A | —[b] | 740 | 740 |

a NTU = Nephelometric Turbidity Units

b There is no sampling requirement for this parameter.

c No limit is established for aquatic life protection; however, aquatic life is protected by bioassay analysis.

d No maximum containment level is established for this metal.

A = Monitoring occurs at the first DRB discharge of the wet season and at one or more additional discharges associated with storm water runoff monitoring. Toxicity testing is required only on the first release.

B = Monitoring occurs at each dry season release. For purposes of discharge sampling, the dry season is defined to occur from June 1 through September 30.

**Table 7-8. Routine water quality management action levels and monitoring plan for the Drainage Retention Basin**

| Constituent | Location | Sampling frequency | Management action levels | |
|---|---|---|---|---|
| | | | Dry season Apr 1–Nov 30 | Wet season Dec 1–Mar 31 |
| **Physical** | | | | |
| Dissolved oxygen (mg/L) | CDBA, CDBC, CDBD, CDBE, CDBF, CDFJ, CDBK, CDBL | Weekly | <80% saturation and <5 mg/L | <80% saturation and <5 mg/L |
| Temperature (°C) | CDBA, CDBC, CDBD, CDBE, CDBF, CDFJ, CDBK, CDBL | Weekly | <15.6 and >26.7 | <15.6 and >26.7 |
| Total alkalinity (as $CaCO_3$) (mg/L) | CDBE | Monthly | <50 | <50 |
| Chlorophyll-a (mg/L) | CDBE | Monthly | >10 | >10 |
| pH (pH units) | CDBE | Monthly | <6.0 and >9.0 | <6.0 and >9.0 |
| Total dissolved solids (mg/L) | CDBE | Monthly | >360 | >360 |
| Total suspended solids (mg/L) | CDBE | Monthly | Not applicable | Not applicable |
| Turbidity (NTU)[a] | CDBE | Monthly | >15 | >15 |
| Transparency (m) | CDBE | Weekly | <0.91 | <0.91 |
| Chemical oxygen demand (mg/L) | CDBE | Quarterly | >20 | >20 |
| Oil and grease (mg/L) | CDBE | Quarterly | >15 | >15 |
| Specific conductance (μS/cm) | CDBE | Monthly | >900 | >900 |
| **Nutrients (mg/L)** | | | | |
| Nitrate (as N) | CDBE | Monthly | >0.2 | >0.2 |
| Nitrite (as N) | CDBE | Monthly | >0.2 | >0.2 |
| Ammonia nitrogen | CDBE | Monthly | >0.1 | >0.1 |
| Phosphate (as P) | CDBE | Monthly | >0.02 | >0.02 |
| **Microbiological (MPN[b]/100 mL)** | | | | |
| Total coliform | CDBE | Quarterly | >5000 | >5000 |
| Fecal coliform | CDBE | Quarterly | >400 | >400 |
| **Metals (μg/L)** | | | | |
| Antimony | CDBE | Semiannually | >6 | Not applicable |
| Arsenic | CDBE | Semiannually | >50 | >10 |
| Beryllium | CDBE | Semiannually | >4 | Not applicable |
| Boron | CDBE | Semiannually | Not applicable | Not applicable |
| Cadmium | CDBE | Semiannually | >5 | >2.2 |
| Chromium, total | CDBE | Semiannually | >50 | Not applicable |
| Chromium(VI) | CDBE | Semiannually | Not applicable | >22 |
| Copper | CDBE | Semiannually | >1300 | >23.6 |
| Iron | CDBE | Semiannually | Not applicable | Not applicable |

**Table 7-8. Routine water quality management action levels and monitoring plan for the Drainage Retention Basin (concluded)**

| Constituent | Location | Sampling frequency | Management action levels | |
|---|---|---|---|---|
| | | | Dry season Apr 1–Nov 30 | Wet season Dec 1–Mar 31 |
| **Metals (μg/L) (continued)** | | | | |
| Lead | CDBE | Semiannually | >15 | >6.4 |
| Manganese | CDBE | Semiannually | Not applicable | Not applicable |
| Mercury | CDBE | Semiannually | >2 | >2 |
| Nickel | CDBE | Semiannually | >100 | >320 |
| Selenium | CDBE | Semiannually | >50 | >10 |
| Silver | CDBE | Semiannually | >100 | >8.2 |
| Thallium | CDBE | Semiannually | >2 | Not applicable |
| Zinc | CDBE | Semiannually | Not applicable | >220 |
| **Organics (μg/L)** | | | | |
| Total volatile organic compounds (EPA Method 601 only) | CDBE | Semiannually | >5 | >5 |
| Tetrachloroethene | CDBE | Semiannually | >4 | >4 |
| Vinyl chloride | CDBE | Semiannually | >2 | >2 |
| Herbicides | CDBE | Semiannually | Not applicable | Not applicable |
| **Polychlorinated biphenyls (μg/L)** | CDBE | Semiannually | Not applicable | Not applicable |
| **Radiological (Bq/L)** | | | | |
| Gross alpha | CDBE | Semiannually | >0.56 | >0.56 |
| Gross beta | CDBE | Semiannually | >1.85 | >1.85 |
| Tritium | CDBE | Semiannually | >740 | >740 |
| **Toxicity** | | | | |
| Aquatic bioassay (% survival/96-hour) Fathead minnow | CDBE | Annually | 90% survival median, 90 percentile value of not less than 70% survival | 90% survival median, 90 percentile value of not less than 70% survival |
| Chronic bioassay Fathead minnow | CDBE | Annually | Not applicable | Not applicable |
| Water flea | CDBE | Annually | Not applicable | Not applicable |
| Algae | CDBE | Annually | Not applicable | Not applicable |

a NTU = Nephelometric Turbidity Units

b MPN = Most probable number

**Table 7-9. Compliance monitoring data for releases from the Drainage Retention Basin, wet season, 2001**

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| **Biological** | | | | | | |
| Aquatic bioassay | | | | | | |
| *Pimephales promelas survival (percent survival)* | na[a] | 95 | na | na | 95 | na |
| *Pimephales promelas growth (toxic units)* | na | < 1 | na | na | na | na |
| *Pimephales promelas growth IC 25* | na[b] | 14.51 | na | na | na | na |
| *Pimephales promelas growth LOEC* | na[c] | > 100 | na | na | na | na |
| *Pimephales promelas growth NOEC* | na[d] | > 100 | na | na | na | na |
| *Pimephales promelas survival (toxic units)* | na | < 1 | na | na | na | na |
| *Pimephales promelas survival LC 50* | na[e] | > 100 | na | na | na | na |
| *Pimephales promelas survival LOEC* | na | > 100 | na | na | na | na |
| *Pimephales promelas survival NOEC* | na | > 100 | na | na | na | na |
| *Ceriodaphnia dubia survival IC 50* | na | 1.65 | na | na | na | na |
| *Ceriodaphnia dubia survival LOEC* | na | > 100 | na | na | na | na |
| *Ceriodaphnia dubia survival NOEC* | na | > 100 | na | na | na | na |
| *Ceriodaphnia dubia survival (toxic units)* | na | < 1 | na | na | na | na |
| *Ceriodaphnia dubia reproduction IC 25* | na | 0.39 | na | na | na | na |
| *Ceriodaphnia dubia reproduction LOEC* | na | > 100 | na | na | na | na |
| *Ceriodaphnia dubia reproduction NOEC* | na | > 100 | na | na | na | na |
| *Ceriodaphnia dubia reproduction (toxic units)* | na | < 1 | na | na | na | na |
| *Selanastrum capriocornutum growth IC 25* | na | 2.41 | na | na | > 100 | na |
| *Selanastrum capriocornutum growth IC 50* | na | na | na | na | > 100 | na |
| *Selanastrum capriocornutum growth LOEC* | na | > 100 | na | na | > 100 | na |
| *Selanastrum capriocornutum growth NOEC* | na | > 100 | na | na | > 100 | na |
| *Selanastrum capriocornutum growth (toxic units)* | na | < 1 | na | na | < 1 | na |
| **Anions (mg/L)** | | | | | | |
| Bromide | 0.4 | 1.1 | 0.5 | < 0.1 | 0.1 | 0.2 |
| Chloride | 113 | 129 | 159 | 8.8 | 17 | 84 |
| Fluoride | 0.37 | 0.36 | 0.37 | 0.078 | 0.16 | 0.28 |
| Nitrate (as N) | 2.3 | 1.7 | 3.4 | 0.82 | 1.7 | 2.8 |
| Nitrate (as $NO_3$) | 10 | 7.6 | 15 | 3.6 | 7.7 | 12 |
| Nitrate plus Nitrite (as N) | 2.3 | 1.7 | 3.4 | 0.82 | 1.8 | 2.8 |
| Nitrite (as N) | 0.054 | 0.03 | 0.033 | 0.02 | 0.055 | 0.02 |
| Nitrite (as $NO_2$) | 0.18 | 0.099 | 0.11 | 0.066 | 0.18 | 0.066 |
| Ortho-Phosphate | 0.16 | 0.2 | 0.2 | 0.33 | 0.44 | 0.2 |
| Sulfate | 49 | 40 | 67 | 9.9 | 7.8 | 30 |
| **General minerals (mg/L)** | | | | | | |
| Aluminum | na | 3 | na | na | 2 | na |
| Bicarbonate Alk (as $CaCO_3$) | 160 | 115 | 184 | 34 | 76 | 163 |
| Calcium | 48 | 32 | 49 | 9.3 | 24 | 37 |
| Carbonate Alk (as $CaCO_3$) | 19 | 25 | < 5 | < 2.5 | < 2.5 | < 5 |

**Table 7-9. Compliance monitoring data for releases from the Drainage Retention Basin, wet season, 2001 (continued)**

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| Chloride | na | 108 | na | na | 62 | na |
| Copper | na | 0.01 | na | na | 0.01 | na |
| Fluoride | na | 0.26 | na | na | 0.17 | na |
| Hydroxide Alk (as $CaCO_3$) | < 2.5 | < 2.5 | < 5 | < 2.5 | < 2.5 | < 5 |
| Iron | na | 3.5 | na | na | 2.5 | na |
| Magnesium | 21 | 21 | 27 | 3.9 | 13 | 17 |
| Manganese | na | 0.1 | na | na | 0.076 | na |
| Nickel | na | < 0.05 | na | na | < 0.05 | na |
| Nitrate (as N) | na | 2.0 | na | na | 2.1 | na |
| Nitrate (as $NO_3$) | na | 8.9 | na | na | 9.3 | na |
| Nitrate plus Nitrite (as N) | na | 2 | na | na | 2.1 | na |
| Nitrite (as N) | na | 0.049 | na | na | 0.049 | na |
| Ortho-Phosphate | na | 0.49 | na | na | 0.39 | na |
| pH | 8.24 | 8.21 | 8.11 | 7.5 | 7.77 | 8.09 |
| Potassium | 2 | 3.2 | 1.7 | 1.9 | 3.7 | 2 |
| Sodium | 81 | 63 | 100 | 12 | 42 | 62 |
| Specific conductance (µmho/cm) | 831 | 655 | 990 | 138 | 437 | 620 |
| Sulfate | na | 37 | na | na | 27 | na |
| Surfactants | < 0.5 | 0.1 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Total Alkalinity (as $CaCO_3$) | 179 | 123 | 184 | 34 | 76 | 163 |
| Total dissolved solids (TDS) | 487 | 418 | 587 | 96 | 290 | 372 |
| Total Hardness (as $CaCO_3$) | 206 | 166 | 233 | 39 | 113 | 162 |
| Total Phosphorus (as P) | 0.09 | 0.26 | 0.07 | 0.16 | 0.22 | 0.1 |
| Zinc | na | 0.1 | na | na | 0.13 | na |
| **Dissolved metals (mg/L)** | | | | | | |
| Aluminum | < 0.05 | < 0.05 | na | 0.8 | < 0.05 | < 0.05 |
| Antimony | < 0.004 | < 0.004 | na | < 0.004 | < 0.004 | < 0.004 |
| Arsenic | < 0.002 | 0.002 | na | < 0.002 | < 0.002 | < 0.002 |
| Barium | 0.12 | 0.081 | na | 0.04 | 0.04 | 0.088 |
| Beryllium | < 0.0002 | < 0.0002 | na | < 0.0002 | < 0.0002 | < 0.0002 |
| Boron | 1.4 | 1.1 | na | 0.19 | 0.21 | 0.99 |
| Cadmium | < 0.0005 | < 0.0005 | na | < 0.0005 | < 0.0005 | < 0.0005 |
| Chromium | 0.005 | 0.003 | na | 0.002 | 0.002 | 0.004 |
| Cobalt | < 0.05 | < 0.05 | na | < 0.05 | < 0.05 | < 0.05 |
| Copper | < 0.002 | 0.005 | na | 0.004 | 0.005 | 0.002 |
| Chromium (VI) | 0.0062 | < 0.002 | na | 0.0055 | < 0.002 | 0.002 |
| Iron | < 0.05 | < 0.05 | na | 0.57 | 0.1 | < 0.05 |
| Lead | < 0.005 | < 0.005 | na | < 0.005 | < 0.005 | < 0.005 |
| Manganese | < 0.01 | < 0.01 | na | < 0.01 | 0.01 | < 0.01 |
| Mercury | < 0.0002 | < 0.0002 | na | < 0.0002 | < 0.0002 | < 0.0002 |
| Molybdenum | < 0.025 | < 0.025 | na | < 0.025 | < 0.025 | < 0.025 |

**Table 7-9. Compliance monitoring data for releases from the Drainage Retention Basin, wet season, 2001 (continued)**

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| Nickel | 0.003 | 0.002 | na | 0.005 | 0.003 | < 0.002 |
| Selenium | < 0.002 | < 0.002 | na | < 0.002 | < 0.002 | < 0.004 |
| Silver | < 0.002 | < 0.001 | na | < 0.002 | < 0.001 | < 0.001 |
| Thallium | < 0.001 | < 0.001 | na | < 0.001 | < 0.001 | < 0.001 |
| Vanadium | < 0.01 | < 0.01 | na | < 0.01 | < 0.01 | < 0.01 |
| Zinc | < 0.02 | < 0.02 | na | 0.05 | 0.038 | < 0.02 |
| **Total Metals (mg/L)** | | | | | | |
| Aluminum | 0.2 | 2.2 | 0.2 | 3.4 | 1.4 | 0.5 |
| Antimony | < 0.004 | < 0.004 | < 0.004 | < 0.004 | < 0.004 | < 0.004 |
| Arsenic | < 0.002 | 0.003 | 0.003 | < 0.002 | 0.003 | 0.003 |
| Barium | 0.11 | 0.099 | 0.093 | 0.06 | 0.088 | 0.083 |
| Beryllium | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 |
| Boron | 1.3 | 0.97 | 1.9 | 0.22 | 0.63 | 0.96 |
| Cadmium | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 | < 0.0005 |
| Chromium | 0.0068 | 0.0099 | 0.004 | 0.0097 | 0.0074 | 0.0055 |
| Cobalt | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| Copper | 0.003 | 0.011 | 0.002 | 0.01 | 0.0085 | 0.003 |
| Chromium (VI) | na | < 0.002 | 0.003 | na | < 0.002 | na |
| Iron | 0.26 | 3.1 | 0.19 | 3.4 | 1.8 | 0.53 |
| Lead | < 0.005 | 0.0073 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Manganese | 0.02 | 0.099 | 0.011 | 0.06 | 0.07 | < 0.01 |
| Mercury | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 |
| Molybdenum | < 0.025 | < 0.025 | < 0.025 | < 0.025 | < 0.025 | < 0.025 |
| Nickel | 0.003 | 0.012 | < 0.002 | 0.008 | 0.009 | 0.003 |
| Selenium | < 0.002 | < 0.002 | < 0.004 | < 0.002 | < 0.002 | < 0.004 |
| Silver | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Thallium | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Vanadium | < 0.01 | 0.01 | < 0.01 | < 0.01 | 0.01 | < 0.01 |
| Zinc | 0.02 | 0.095 | < 0.02 | 0.12 | 0.098 | 0.022 |
| **Volatile organic compounds (µg/L)** | | | | | | |
| 1,1,1-Trichloroethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,1,2,2-Tetrachloroethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,1,2-Trichloroethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,1-Dichloroethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,1-Dichloroethene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,2-Dichlorobenzene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,2-Dichloroethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,2-Dichloroethene (total) | < 1 | < 1 | < 1 | na | na | na |
| 1,2-Dichloropropane | < 0.5 | < 0.5 | < 0.5 | na | na | na |

**Table 7-9. Compliance monitoring data for releases from the Drainage Retention Basin, wet season, 2001 (continued)**

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| 1,3-Dichlorobenzene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 1,4-Dichlorobenzene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| 2-Chloroethylvinylether | < 10 | < 10 | < 10 | na | na | na |
| Bromodichloromethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Bromoform | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Bromomethane | < 0.5 | < 1 | < 1 | na | na | na |
| Carbon tetrachloride | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Chlorobenzene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Chloroethane | < 1 | < 0.5 | < 0.5 | na | na | na |
| Chloroform | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Chloromethane | < 1 | < 0.5 | < 0.5 | na | na | na |
| cis-1,2-Dichloroethene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| cis-1,3-Dichloropropene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Dibromochloromethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Dichlorodifluoromethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Freon 113 | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Methylene chloride | < 1 | < 1 | < 1 | na | na | na |
| Tetrachloroethene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Total Trihalomethanes | < 2 | < 2 | < 2 | na | na | na |
| trans-1,2-Dichloroethene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| trans-1,3-Dichloropropene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Trichloroethene | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Trichlorofluoromethane | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| Vinyl chloride | < 0.5 | < 0.5 | < 0.5 | na | na | na |
| **Polychlorinated biphenyls (µg/L)** | | | | | | |
| PCB 1016 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| PCB 1221 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| PCB 1232 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| PCB 1242 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| PCB 1248 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| PCB 1254 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| PCB 1260 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| **Herbicides (µg/L)** | | | | | | |
| Acenaphthylene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Alachlor | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Aldrin | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Anthracene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Atraton | < 0.6 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Atrazine | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Benzo(a)anthracene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |

**Table 7-9. Compliance monitoring data for releases from the Drainage Retention Basin, wet season, 2001 (continued)**

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| Benzo(a)pyrene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Benzo(b)fluoranthene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Benzo(g,h,i)perylene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Benzo(k)fluoranthene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| BHC, gamma isomer (Lindane) | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Bis(2-ethylhexyl)phthalate | < 3 | < 3 | < 3 | < 10 | < 3 | < 3 |
| Bromacil | 4.4 | < 1 | < 1 | 23 | 1.9 | 1.9 |
| Butachlor | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Butylbenzylphthalate | < 2 | < 2 | < 2 | < 5 | < 2 | < 2 |
| Chlordane | < 0.5 | < 0.5 | < 2 | < 3 | < 0.5 | < 2 |
| Chrysene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Di (2-ethylhexyl) adipate | < 1 | < 1 | < 1 | < 5 | < 1 | < 1 |
| Diazinon | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Dibenzo(a,h)anthracene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Dibutylphthalate | < 1 | < 1 | < 1 | < 5 | < 1 | < 1 |
| Dichlorvos | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Dieldrin | na | < 0.5 | < 0.5 | na | < 0.5 | < 0.5 |
| Diethylphthalate | < 2 | 2 | < 2 | < 10 | < 2 | < 2 |
| Dimethylphthalate | < 2 | < 2 | < 2 | < 10 | < 2 | < 2 |
| Disulfoton | na | < 0.5 | na | na | na | na |
| Diuron | 5.4 | 1.4 | 3.1 | 13 | 0.87 | 51 |
| Endrin | < 2 | < 2 | < 2 | < 10 | < 2 | < 2 |
| Endrin aldehyde | na | < 0.5 | na | na | < 0.5 | na |
| Ethoprop | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Fluorene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Glyphosate | 14 | 32 | < 9 | 22 | < 9 | < 0.5 |
| Heptachlor | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Heptachlor epoxide | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 1 |
| Hexachlorobenzene | < 1 | < 1 | < 1 | < 5 | < 1 | < 3 |
| Hexachlorocyclopentadiene | < 3 | < 3 | < 3 | < 10 | < 3 | < 0.5 |
| Indeno(1,2,3-c,d)pyrene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | na |
| Isophorone | na | < 0.5 | na | na | na | < 0.5 |
| Merphos | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.7 |
| Methoxychlor | < 0.7 | < 0.7 | < 0.7 | < 3 | < 0.7 | < 0.5 |
| Metolachlor | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Metribuzin | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Mevinphos | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | na |
| Pentachlorobenzene | < 0.5 | < 0.5 | < 0.5 | na | < 0.5 | < 1 |
| Pentachlorophenol | na | < 1 | < 1 | < 5 | < 1 | < 0.5 |
| Phenanthrene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |

## Table 7-9. Compliance monitoring data for releases from the Drainage Retention Basin, wet season, 2001 (concluded)

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| Prometon | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Prometryn | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Propachlor | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Pyrene | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | na |
| Secbumeton | na | na | na | na | na | < 0.5 |
| Simazine | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | < 0.5 |
| Stirophos | na | < 0.5 | < 0.5 | na | na | < 0.5 |
| Terbutryn | < 0.5 | < 0.5 | < 0.5 | < 3 | < 0.5 | na |
| Toxaphene | na | < 5 | na | na | na | 21 |
| **Miscellaneous organics (mg/L)** | | | | | | |
| Chemical Oxygen Demand | < 20 | 62 | < 25 | 30 | 52 | < 25 |
| Oil and Grease | < 5 | na | < 5 | < 5 | < 5 | < 5 |
| Total Organic Carbon (TOC) | 4.6 | 12 | 5.8 | 5 | 15 | 4.7 |
| Total suspended solids (TSS) | 21 | 59 | 3 | 51 | 42 | 16 |

| Parameter | CDBX sampling dates | | | WPDC sampling dates | | |
|---|---|---|---|---|---|---|
| | 3/2 | 11/12 | 12/20 | 3/2 | 11/12 | 12/20 |
| **Gross alpha (Bq/L)** | 0.063±0.048 | 0.042±0.031 | 0.021±0.037 | 0.025±0.026 | 0.013±0.014 | 0.065±0.033 |
| **Gross beta (Bq/L)** | 0.071±0.056 | 0.064±0.037 | 0.080±0.034 | 0.1±0.044 | 0.109±0.035 | 0.086±0.032 |
| **Tritium (Bq/L)** | 10.7±2.52 | 8.36±2.6 | 9.14±2.6 | 0.91±2.07 | -2.33±2.22 | 6.48±2.4 |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2s counting error) or as being less than or equal to the detection limit. If the concentration limit is less than or equal to the uncertainty or the detection limit, the result is considered to be a nondetection. See main volume, Chapter 14.

a na= Not analyzed because the analysis was not required.

b IC 25= 25% inhibition concentration; concentration at which 25% of the organisms show inhibition responses

c LOEC= Lowest observed effect concentration

d NOEC= No observed effect concentration

e LC 50= 50% lethal concentration; concentration at which 50% of organisms die

**Table 7-10. Monthly analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001**

| Parameter | Sampling dates | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/30 | 3/27 | 4/9 | 5/3 | 6/14 | 7/10 | 8/6 | 9/6 | 10/4 | 11/1 | 12/5 |
| **Nutrients (mg/L)** | | | | | | | | | | | |
| Ammonia nitrogen (as N) | 0.3 | 0.09 | 0.08 | 0.05 | 0.1 | 0.06 | < 0.025 | < 0.025 | 0.06 | < 0.025 | 0.05 |
| Nitrate (as N) | 2.3 | 2 | 1.7 | 1.1 | 0.66 | 0.42 | 0.96 | 0.87 | 1.9 | 0.57 | 1.7 |
| Nitrate (as $NO_3$) | 10 | 8.8 | 7.5 | 5 | 2.9 | 1.9 | 4.2 | 3.8 | 8.4 | 2.8 | 7.5 |
| Nitrate plus nitrite (as N) | 2.3 | 2.1 | 1.8 | 1.1 | 0.69 | 0.47 | 1 | 0.9 | 1.9 | 1.5 | 1.7 |
| Nitrite (as N) | 0.059 | 0.099 | 0.078 | 0.033 | 0.027 | 0.048 | 0.045 | 0.035 | 0.033 | 1.5 | 0.028 |
| Nitrite (as $NO_2$) | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Total Kjeldahl nitrogen | 0.95 | 0.51 | 0.66 | 0.6 | 0.96 | 1.1 | 1 | 0.89 | 0.84 | 0.57 | 0.68 |
| **Solids (mg/L)** | | | | | | | | | | | |
| Total suspended solids (TSS) | 22 | < 2 | < 2 | < 2 | 14 | 5.8 | < 10 | < 10 | < 10 | < 2 | 5 |
| Total Solids | 467 | 537 | 517 | 723 | 620 | 620 | 677 | 690 | 740 | 687 | 633 |
| Volatile Solids | 110 | 100 | 100 | 320 | 130 | 120 | 140 | 140 | 160 | 150 | 120 |
| Volatile Suspended Solids | < 3 | < 2 | < 2 | a | 11 | 5 | < 10 | < 10 | < 10 | < 2 | < 2 |
| **General minerals (mg/L)** | | | | | | | | | | | |
| Aluminum | 1.4 | 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.2 |
| Bicarbonate Alk (as $CaCO_3$) | 160 | 148 | 141 | 140 | 91 | 64.7 | 93.6 | 24 | 68.5 | 102 | 117 |
| Calcium | 45 | 48 | 47 | 45 | 46 | 35 | 41 | 38 | 43 | 44 | 47 |
| Carbonate Alk (as $CaCO_3$) | < 2.5 | 45 | 42 | 83 | 85 | 105 | 89.4 | 232 | 106 | 76 | 54.2 |
| Chloride | 111 | 131 | 136 | 134 | 172 | 186 | 201 | 202 | 216 | 202 | 182 |
| Copper | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Fluoride | 0.31 | 0.41 | 0.4 | 0.36 | 0.45 | 0.41 | 0.5 | 0.44 | 0.5 | 0.46 | 0.41 |
| Hydroxide Alk (as $CaCO_3$) | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 | < 2.5 |
| Iron | 1.3 | 0.081 | 0.082 | 0.05 | 0.07 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | 0.26 |
| Magnesium | 21 | 22 | 23 | 23 | 31 | 30 | 32 | 35 | 36 | 34 | 28 |
| Manganese | 0.053 | 0.023 | 0.055 | 0.035 | 0.037 | 30 | 0.046 | 0.037 | 0.016 | < 0.01 | 0.014 |
| Nickel | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| Nitrate (as N) | 2.2 | 2 | 1.7 | 1.1 | 0.63 | 0.42 | 0.96 | 0.83 | 1.8 | 1.5 | 1.7 |
| Nitrate (as $NO_3$) | 10 | 8.8 | 7.5 | 5 | 2.8 | 1.9 | 4.2 | 3.7 | 8 | 6.7 | 7.5 |
| Nitrate plus Nitrite (as N) | 2.3 | 2.1 | 1.8 | 1.1 | 0.66 | 0.47 | 1 | 0.86 | 1.8 | 1.5 | 1.7 |
| Nitrite (as N) | 0.074 | 0.099 | 0.078 | 0.033 | 0.027 | 0.048 | 0.045 | 0.035 | 0.033 | < 0.02 | 0.028 |
| Ortho-Phosphate | 0.23 | < 0.05 | 0.071 | < 0.05 | < 0.05 | < 0.05 | 0.16 | 0.1 | < 0.05 | < 0.05 | 0.13 |
| pH | 8.17 | 8.65 | 8.52 | 8.94 | 9.24 | 9.04 | 8.95 | 9.06 | 8.87 | 8.71 | 8.27 |
| Potassium | 2.4 | 1.8 | 1.9 | 1.8 | 2.2 | 1.9 | 1.8 | 1.4 | 1.6 | 1.6 | 2.1 |
| Sodium | 74 | 82 | 84 | 89 | 108 | 110 | 110 | 120 | 120 | 110 | 110 |

**Table 7-10. Monthly analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001 (continued)**

| Parameter | Sampling dates | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/30 | 3/27 | 4/9 | 5/3 | 6/14 | 7/10 | 8/6 | 9/6 | 10/4 | 11/1 | 12/5 |
| Specific Conductance | 753 | 876 | 861 | 819 | 950 | 991 | 1070 | 1070 | 1120 | 1100 | 1040 |
| Sulfate | 54 | 57 | 56 | 49 | 58 | 60 | 66 | 67 | 73 | 69 | 76 |
| Surfactants | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Total Alkalinity (as $CaCO_3$) | 160 | 193 | 183 | 223 | 176 | 169 | 183 | 256 | 174 | 178 | 172 |
| Total dissolved solids (TDS) | 423 | 503 | 490 | 470 | 563 | 580 | 617 | 690 | 663 | 667 | 613 |
| Total Hardness (as $CaCO_3$) | 199 | 210 | 212 | 207 | 242 | 211 | 234 | 239 | 256 | 250 | 233 |
| Total Phosphorus (as P) | 0.14 | 0.06 | 0.07 | < 0.05 | 0.18 | 0.06 | 0.06 | 0.06 | 0.07 | 0.1 | 0.07 |
| Zinc | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | <0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| **Miscellaneous organics (µg/L)** | | | | | | | | | | | |
| Chlorophyll a | 0.7 | < 5 | 6 | 6 | 11 | 18 | 23 | 16 | < 10 | 5 | 6 |

a The sample was not analyzed due to analytical laboratory error

**Table 7-10. Monthly analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001 (concluded)**

| Parameter | Number of samples | Minimum | Maximum | Median | Interquartile range |
|---|---|---|---|---|---|
| **Nutrients (mg/L)** | | | | | |
| Ammonia nitrogen (as N) | 11 | < 0.025 | 0.3 | 0.06 | 0.0475 |
| Nitrate (as N) | 11 | 0.42 | 2.3 | 1.1 | 1.04 |
| Nitrate (as $NO_3$) | 11 | 1.9 | 10 | 5 | 4.6 |
| Nitrate plus nitrite (as N) | 11 | < 0.47 | 2.3 | 1.5 | 0.9 |
| Nitrite (as N) | 10 | 0.027 | 1.5 | 0.045 | 0.0355 |
| Nitrite (as $NO_2$) | 11 | < 0.5 | 0.5 | 0.5 | 0 |
| Total Kjeldahl nitrogen | 11 | 0.51 | 1.1 | 0.84 | 0.325 |
| **Solids (mg/L)** | | | | | |
| Total suspended solids (TSS) | 11 | < 2 | 22 | 5.8 | 8 |
| Total Solids | 11 | 467 | 740 | 633 | 110 |
| Volatile Solids | 11 | 100 | 320 | 130 | 30 |
| Volatile Suspended Solids | 10 | < 2 | 11 | 4 | 8 |
| **General minerals (mg/L)** | | | | | |
| Aluminum | 11 | < 0.05 | 1.4 | 0.05 | 0 |
| Bicarbonate Alk (as $CaCO_3$) | 11 | 24 | 160 | 102 | 60.8 |
| Calcium | 11 | 35 | 48 | 45 | 4.5 |
| Carbonate Alk (as $CaCO_3$) | 11 | < 2.5 | 232 | 83 | 47.6 |
| Chloride | 11 | 111 | 216 | 182 | 66.5 |
| Copper | 11 | < 0.01 | < 0.01 | < 0.01 | 0 |
| Fluoride | 11 | 0.31 | 0.5 | 0.41 | 0.05 |
| Hydroxide Alk (as $CaCO_3$) | 11 | < 2.5 | < 2.5 | < 2.5 | 0 |
| Iron | 11 | < 0.05 | 1.3 | 0.05 | 0.0315 |
| Magnesium | 11 | 21 | 36 | 30 | 10 |
| Manganese | 11 | < 0.01 | 30 | 0.037 | 0.03 |
| Nickel | 11 | < 0.05 | < 0.05 | < 0.05 | 0 |
| Nitrate (as N) | 11 | 0.42 | 2.2 | 1.5 | 0.855 |
| Nitrate (as $NO_3$) | 11 | 1.9 | 10 | 6.7 | 3.8 |
| Nitrate plus Nitrite (as N) | 11 | 0.47 | 2.3 | 1.5 | 0.87 |
| Nitrite (as N) | 11 | < 0.02 | 0.099 | 0.035 | 0.0305 |
| Ortho-Phosphate | 11 | < 0.05 | 0.23 | < 0.05 | 0.065 |
| pH (units) | 11 | 8.17 | 9.24 | 8.87 | 0.41 |
| Potassium | 11 | 1.4 | 2.4 | 1.8 | 0.3 |
| Sodium | 11 | 74 | 120 | 110 | 23.5 |
| Specific Conductance (µmhos/cm) | 11 | 753 | 1120 | 991 | 201 |
| Sulfate | 11 | 49 | 76 | 60 | 11.5 |
| Surfactants | 11 | < 0.5 | < 0.5 | < 0.5 | 0 |
| | 11 | 160 | 256 | 178 | 15 |
| Total dissolved solids (TDS) | 11 | 423 | 690 | 580 | 144 |
| Total Hardness (as $CaCO_3$) | 11 | 199 | 256 | 233 | 30 |
| Total Phosphorus (as P) | 11 | < 0.05 | 0.18 | 0.07 | 0.025 |
| Zinc | 11 | < 0.05 | < 0.05 | < 0.05 | 0 |
| **Miscellaneous organics (µg/L)** | | | | | |
| Chlorophyll a | 11 | 0.7 | 23 | 6 | 8 |

**Table 7-11. Quarterly analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001**

| Parameter | Sampling dates | | | |
|---|---|---|---|---|
| | 1/30 | 4/9 | 7/10 | 10/4 |
| **Biological (MPN/100 mL)** | | | | |
| Fecal coliform | 33 | 140 | 36 | <2 |
| Total coliform | ≥2400 | 1600 | ≥2400 | 27 |
| **Miscellaneous organics (mg/L)** | | | | |
| Chemical oxygen demand | 20 | <20 | 41 | 22 |
| Oil and grease | <5 | <5 | <6 | <5 |

**Table 7-12. Semiannual/annual analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001**

| Parameter | Sampling dates[a] | | |
|---|---|---|---|
| | 4/9 | 10/4 | 10/12 |
| **Aqueous bioassay** | | | |
| *Pimephales promelas survival (percent survival)* | na(b) | na | 90 |
| *Pimephales promelas growth (toxic units)* | na | na | < 1 |
| *Pimephales promelas growth IC 25* [c] | na | na | > 100 |
| *Pimephales promelas growth IC 50* [d] | na | na | > 100 |
| *Pimephales promelas growth LOEC* [e] | na | na | > 100 |
| *Pimephales promelas growth NOEC* [f] | na | na | > 100 |
| *Pimephales promelas survival LC 50* [g] | na | na | > 100 |
| *Pimephales promelas survival LOEC* | na | na | > 100 |
| *Pimephales promelas survival NOEC* | na | na | > 100 |
| *Pimephales promelas survival (toxic units)* | na | na | < 1 |
| *Ceriodaphnia dubia survival LC 50* | na | na | > 100 |
| *Ceriodaphnia dubia survival LOEC* | na | na | > 100 |
| *Ceriodaphnia dubia survival NOEC* | na | na | > 100 |
| *Ceriodaphnia dubia survival (toxic units)* | na | na | < 1 |
| *Ceriodaphnia dubia reproduction IC 25* | na | na | 72 |
| *Ceriodaphnia dubia reproduction IC 50* | na | na | > 100 |
| *Ceriodaphnia dubia reproduction LOEC* | na | na | 100 |
| *Ceriodaphnia dubia reproduction NOEC* | na | na | 50 |
| *Ceriodaphnia dubia reproduction (toxic units)* | na | na | 2 |
| *Selanastrum capricornutum growth IC 25* | na | na | > 100 |
| *Selanastrum capricornutum growth IC 50* | na | na | > 100 |
| *Selanastrum capricornutum growth LOEC* | na | na | > 100 |
| *Selanastrum capricornutum growth NOEC* | na | na | > 100 |
| *Selanastrum capricornutum growth (toxic units)* | na | na | < 1 |
| **Total metals (mg/L)** | | | |
| Aluminum | 0.10 | < 0.05 | na |
| Antimony | < 0.004 | < 0.004 | na |
| Arsenic | < 0.002 | < 0.002 | na |
| Barium | 0.10 | 0.084 | na |
| Beryllium | < 0.0002 | < 0.0002 | na |
| Boron | 1.5 | 1.8 | na |
| Cadmium | < 0.0005 | < 0.0005 | na |
| Chromium | 0.005 | 0.0054 | na |
| Cobalt | < 0.050 | < 0.05 | na |
| Copper | 0.005 | < 0.001 | na |
| Hexavalent Chromium | 0.0059 | 0.005 | na |
| Iron | 0.12 | < 0.05 | na |
| Lead | < 0.005 | < 0.005 | na |
| Manganese | 0.06 | 0.016 | na |
| Mercury | < 0.0002 | < 0.0002 | na |
| Molybdenum | < 0.025 | < 0.025 | na |
| Nickel | 0.003 | < 0.002 | na |
| Selenium | < 0.002 | < 0.004 | na |
| Silver | < 0.001 | < 0.001 | na |
| Thallium | < 0.001 | < 0.001 | na |
| Vanadium | < 0.010 | < 0.01 | na |
| Zinc | < 0.020 | < 0.02 | na |
| **Volatile organic compounds (µg/L)** | | | |
| 1,1,1-Trichloroethane | < 0.5 | < 0.5 | na |
| 1,1,2,2-Tetrachloroethane | < 0.5 | < 0.5 | na |
| 1,1,2-Trichloroethane | < 0.5 | < 0.5 | na |
| 1,1-Dichloroethane | < 0.5 | < 0.5 | na |
| 1,1-Dichloroethene | < 0.5 | < 0.5 | na |
| 1,2-Dichlorobenzene | < 0.5 | < 0.5 | na |

**Table 7-12. Semiannual/annual analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001 (continued)**

| Parameter | Sampling dates[a] | | |
|---|---|---|---|
| | 4/9 | 10/4 | 10/12 |
| 1,2-Dichloroethane | < 0.5 | < 0.5 | na |
| 1,2-Dichloroethene (total) | < 1 | < 1 | na |
| 1,2-Dichloropropane | < 0.5 | < 0.5 | na |
| 1,3-Dichlorobenzene | < 0.5 | < 0.5 | na |
| 1,4-Dichlorobenzene | < 0.5 | < 0.5 | na |
| 2-Chloroethylvinylether | < 10 | < 10 | na |
| Bromodichloromethane | < 0.5 | < 0.5 | na |
| Bromoform | < 0.5 | < 0.5 | na |
| Bromomethane | < 0.5 | < 1 | na |
| Carbon tetrachloride | < 0.5 | < 0.5 | na |
| Chlorobenzene | < 0.5 | < 0.5 | na |
| Chloroethane | < 1 | < 0.5 | na |
| Chloroform | < 0.5 | < 0.5 | na |
| Chloromethane | < 1 | < 0.5 | na |
| cis-1,2-Dichloroethene | < 0.5 | < 0.5 | na |
| cis-1,3-Dichloropropene | < 0.5 | < 0.5 | na |
| Dibromochloromethane | < 0.5 | < 0.5 | na |
| Dichlorodifluoromethane | < 0.5 | < 0.5 | na |
| Freon 113 | < 0.5 | < 0.5 | na |
| Methylene chloride | < 1 | < 1 | na |
| Tetrachloroethene | < 0.5 | < 0.5 | na |
| Total Trihalomethanes | < 2 | < 2 | na |
| trans-1,2-Dichloroethene | < 0.5 | < 0.5 | na |
| trans-1,3-Dichloropropene | < 0.5 | < 0.5 | na |
| Trichloroethene | < 0.5 | < 0.5 | na |
| Trichlorofluoromethane | < 0.5 | < 0.5 | na |
| Vinyl chloride | < 0.5 | < 0.5 | na |
| **Herbicides (µg/L)** | | | |
| Acenaphthylene | < 0.5 | < 0.5 | na |
| Alachlor | < 0.5 | < 0.5 | na |
| Aldrin | < 0.5 | < 0.5 | na |
| Anthracene | < 0.5 | < 0.5 | na |
| Atraton | < 0.6 | < 0.5 | na |
| Atrazine | < 0.5 | < 0.5 | na |
| Benzo(a)anthracene | < 0.5 | < 0.5 | na |
| Benzo(a)pyrene | < 0.5 | < 0.5 | na |
| Benzo(b)fluoranthene | < 0.5 | < 0.5 | na |
| Benzo(g,h,i)perylene | < 0.5 | < 0.5 | na |
| Benzo(k)fluoranthene | < 0.5 | < 0.5 | na |
| BHC, gamma isomer (Lindane) | < 0.5 | < 0.5 | na |
| Bis(2-ethylhexyl)phthalate | < 3 | < 3 | na |
| Bromacil | 2.2 | < 1 | na |
| Butachlor | < 0.5 | < 0.5 | na |
| Butylbenzylphthalate | < 2 | < 2 | na |
| Chlordane | < 0.5 | < 2 | na |
| Chloropropham | < 0.5 | < 0.5 | na |
| Chlorpyrifos | < 0.5 | < 0.5 | na |
| Chrysene | < 0.5 | < 0.5 | na |
| Di (2-ethylhexyl) adipate | < 1 | < 1 | na |
| Diazinon | < 0.5 | < 0.5 | na |
| Dibenzo(a,h)anthracene | < 0.5 | < 0.5 | na |
| Dibutylphthalate | < 1 | < 1 | na |
| Dichlorvos | < 0.5 | < 0.5 | na |
| Diethylphthalate | < 2 | 3.9 | na |
| Dimethylphthalate | < 2 | < 2 | na |
| Diuron | 5.4 | < 0.4 | na |

**Table 7-12. Semiannual/annual analyses of water samples collected from the Drainage Retention Basin location CDBE, 2001 (concluded)**

| Parameter | Sampling dates[a] | | |
|---|---|---|---|
| | 4/9 | 10/4 | 10/12 |
| Endrin | < 2 | < 2 | na |
| Ethoprop | < 0.5 | < 0.5 | na |
| Fluorene | < 0.5 | < 0.5 | na |
| Glyphosate | < 9 | < 9 | na |
| Heptachlor | < 0.5 | < 0.5 | na |
| Heptachlor epoxide | < 0.5 | < 0.5 | na |
| Hexachlorobenzene | < 1 | < 1 | na |
| Hexachlorocyclopentadiene | < 3 | < 3 | na |
| Indeno(1,2,3-c,d)pyrene | < 0.5 | < 0.5 | na |
| Merphos | < 0.5 | < 0.5 | na |
| Methoxychlor | < 0.7 | < 0.7 | na |
| Metolachlor | < 0.5 | < 0.5 | na |
| Metribuzin | < 0.5 | < 0.5 | na |
| Mevinphos | < 0.5 | < 0.5 | na |
| Pentachlorophenol | < 1 | < 1 | na |
| Phenanthrene | < 0.5 | < 0.5 | na |
| Prometon | < 0.5 | < 0.5 | na |
| Prometryn | < 0.5 | < 0.5 | na |
| Propachlor | < 0.5 | < 0.5 | na |
| Pyrene | < 0.5 | < 0.5 | na |
| Simazine | < 0.5 | < 0.5 | na |
| Terbutryn | < 0.5 | < 0.5 | na |
| **Polychlorinated biphenyls (µg/L)** | | | |
| PCB 1016 | < 0.5 | < 0.2 | na |
| PCB 1221 | < 0.5 | < 0.2 | na |
| PCB 1232 | < 0.5 | < 0.2 | na |
| PCB 1242 | < 0.5 | < 0.2 | na |
| PCB 1248 | < 0.5 | < 0.2 | na |
| PCB 1254 | < 0.5 | < 0.2 | na |
| PCB 1260 | < 0.5 | < 0.2 | na |
| **Miscellaneous organics (mg/L)** | | | |
| Total Organic Carbon (TOC) | 5.1 | < 1 | na |
| **Radioactivity (Bq/L)** | | | |
| Gross alpha | 0.042 ± 0.048 | 0.097 ± 0.077 | na |
| Gross beta | 0.091 ± 0.044 | 0.17 ± 0.076 | na |
| Tritium | 9.4 ± 2.6 | 14.3 ± 3.41 | na |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2s counting error) or as being less than or equal to 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. See main volume, Chapter 14.

a Annual sampling for toxicity was conducted on 10/4, 10/12, and 10/18, because of scheduling conflicts and analytical laboratory error resulting in re-sampling.

b na= Not analyzed because not required or because sampled on a different date

c IC 25 = 25% inhibition concentration; concentration at which 25% of the organisms show inhibition responses

d IC 50 = 50% inhibition concentration; concentration at which 50% of the organisms show inhibition responses

e LOEC = Lowest observed effect concentration

f NOEC = No observed effect concentration

g LC 50 = 50% lethal concentration: concentration at which 50% of the organisms die

**Table 7-13. Field data collected from the Drainage Retention Basin at eight locations, 2001**

| Date | CDBA | | CDBC | | CDBD | | CDBE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Transparency Secchi Meters | Turbidity Hach NTU |
| 1/26 | 8.57 | 18.3 | 8.25 | 9.9 | 8.04 | 10.3 | 7.82 | 8.5 | 0.152 | a |
| 1/30 | 7.12 | 12.6 | b | b | 8.22 | 10.5 | 8.19 | 10.2 | 0.355 | a |
| 2/15 | 9.76 | 11.4 | 8.93 | 10.5 | 8.48 | 9.7 | 8.95 | 9.6 | 0.965 | a |
| 2/23 | 11.5 | 11.4 | 10.37 | 11.8 | 11.2 | 9.76 | 10.1 | 11 | 0.533 | a |
| 3/8 | 19.02 | 16 | 19 | 13.5 | 19.35 | 12.8 | 18.77 | 12.9 | 2.03 | a |
| 3/16 | 10.32 | 17.2 | 12.43 | 16.1 | 13.06 | 14.5 | 12.52 | 13.1 | 2.79 | a |
| 3/23 | 6.4 | 19.9 | 7.46 | 18.8 | 6.69 | 17.1 | 6.11 | 15.2 | 2.73 | a |
| 3/27 | 7.52 | 23.5 | 7.5 | 19.6 | 6.65 | 17.5 | 6.38 | 17.1 | 2.87 | a |
| 4/9 | 10.64 | 15.9 | 9.47 | 15.6 | 9.81 | 15 | 9.37 | 13.9 | 2.54 | a |
| 4/20 | 10 | 16.7 | 10.25 | 13.4 | 10.49 | 15.8 | 10.62 | 15.7 | 1.96 | a |
| 4/26 | 11.78 | 26.6 | 12.35 | 21.4 | 11.65 | 19.3 | 8.61 | 16 | 3.73 | a |
| 5/3 | 10.78 | 22.9 | 9.83 | 22.7 | 10.62 | 18.9 | 9.9 | 18.6 | 3.1 | a |
| 5/10 | 9.73 | c | 6.11 | c | 5.49 | c | 5.59 | c | 4.27 | a |
| 5/16 | 5.82 | 25.1 | 7.96 | 30.5 | 9.27 | 22.7 | 5.92 | 22.9 | 3.71 | a |
| 5/24 | 8.76 | 29.1 | 9.34 | 28.3 | 11.41 | 25.6 | 11.14 | 24.8 | 3.1 | a |
| 6/1 | 10.42 | 24.6 | 9.22 | 23.7 | 9.31 | 24.3 | 8.62 | 24.5 | 3.35 | a |
| 6/7 | 9.9 | 26.8 | 10.3 | 26.2 | 10.91 | 23.5 | 9.37 | 23 | 3.05 | a |
| 6/14 | 12.39 | 25.1 | 10.96 | 23.6 | 7.66 | 21.3 | 7.2 | 21.2 | 1.7 | a |
| 6/21 | 6.49 | c | 8.02 | c | 8.11 | c | 7.1 | c | 1.12 | a |
| 6/28 | 9.36 | 26 | 10.74 | 24.3 | 10.86 | 24 | 9.91 | 22.4 | 1.3 | a |
| 7/6 | 12.91 | c | 12.13 | c | 13.1 | c | 8.19 | c | 0.53 | a |
| 7/10 | 11.84 | c | 12.84 | c | 12.93 | c | 11.48 | c | 0.66 | 8.42 |
| 7/20 | 8.12 | 24 | 7.48 | 23.8 | 6.74 | 23.2 | 6.12 | 22.9 | 1.3 | 3.74 |
| 7/27 | 9.44 | 28.7 | 10.31 | 25.9 | 9.79 | 25.9 | 8.91 | 23.8 | 0.81 | 7.7 |
| 8/3 | 6.14 | 22.6 | 6.79 | 22.8 | 6.97 | 23.1 | 6.72 | 22.8 | 1.13 | 3.7 |
| 8/10 | 13.11 | 27.2 | 11.46 | 27.4 | 11.27 | 25.3 | 10.48 | 24.6 | 1.17 | 4.47 |
| 8/17 | 13.59 | 28.1 | 14.29 | 26.6 | 12.27 | 24.7 | 10.42 | 23.6 | 1.09 | 6.13 |
| 8/24 | 9.48 | 27.1 | 9.46 | 27 | 7.81 | 23.8 | 7.47 | 22.6 | 0.914 | 3.92 |
| 8/31 | 10.24 | 28.4 | 9.93 | 25.2 | 9.68 | 24 | 7.74 | 23.1 | 1.04 | 6.63 |
| 9/6 | 10.98 | 24.6 | 8.63 | 24.5 | 8.97 | 23.7 | 8.62 | 22.6 | 0.914 | 5.52 |
| 9/14 | 9.45 | 25.2 | 7.11 | 24.5 | 6.99 | 23.4 | 4.71 | 22.4 | 1.18 | 3.46 |
| 9/21 | 5.72 | 22.1 | 6.16 | 21.4 | 6.02 | 21.5 | 5.82 | 21.4 | 1.22 | 3.45 |
| 9/28 | 5.78 | 19.8 | 5.79 | 20.6 | 5.73 | 20.7 | 5.62 | 20.8 | 1.9 | 2.56 |
| 10/4 | 14.39 | 23.5 | 11.69 | 22.9 | 10.89 | 22 | 10.65 | 21.8 | 1.22 | 2.28 |
| 10/12 | 9.81 | 19.5 | 8.39 | 19.3 | 8.29 | 19.2 | 8.47 | 19.2 | 1.65 | 3.52 |
| 10/18 | 11.01 | 20.6 | 9.36 | 21 | 8.68 | 20.1 | 8.84 | 19.4 | 1.52 | 2.57 |
| 10/26 | 9.19 | 18.2 | 9.46 | 18.2 | 7.78 | 17.7 | 7.89 | 17.5 | 2.13 | 3.11 |

**Table 7-13. Field data collected from the Drainage Retention Basin at eight locations, 2001 (continued)**

| Date | CDBA | | CDBC | | CDBD | | CDBE | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Transparency Secchi Meters | Turbidity Hach NTU |
| 11/1 | 12.1 | 18.5 | 10.23 | 19.2 | 8.77 | 18.4 | 8.19 | 17.5 | 2.21 | 3.01 |
| 11/9 | 9.56 | 17.3 | 8.65 | 16.8 | 8.73 | 16.5 | 7.83 | 15.8 | 2.44 | 3.21 |
| 11/14 | 4.85 | 17 | 5.05 | 16.6 | 4.29 | 16 | 3.98 | 15.8 | 1.52 | 4.17 |
| 11/21 | 6.81 | 15.9 | 7.33 | 16.1 | 7.04 | 15.9 | 6.63 | 15.9 | 2.87 | 2.88 |
| 11/30 | 6.45 | 12.8 | 6.09 | 12.8 | 5.02 | 12.7 | 4.98 | 12.6 | 3.63 | 1.63 |
| 12/5 | 9.25 | 12.2 | 8.08 | 12.2 | 8.21 | 11.9 | 7.85 | 12 | 0.94 | 7.52 |
| 12/14 | 8.07 | 11 | 9.32 | 11.5 | 7.58 | 11.2 | 7.5 | 11.1 | 1.27 | na[b] |
| 12/21 | 7.84 | 11.1 | 9.06 | 11.1 | 7.88 | 10.9 | 7.78 | 10.4 | 0.61 | na |
| 12/27 | 14.72 | 11.4 | 12.97 | 11.6 | 16.1 | 11 | 15.01 | 10.6 | 1.22 | na |
| **Data Summary** | | | | | | | | | | |
| Number of samples | 46 | 42 | 45 | 41 | 46 | 42 | 46 | 42 | 46 | 22 |
| Minimum | 4.85 | 11 | 5.05 | 9.9 | 4.29 | 9.7 | 3.98 | 8.5 | 0.152 | 1.63 |
| Maximum | 19.02 | 29.1 | 14.29 | 30.5 | 19.35 | 25.6 | 18.77 | 24.8 | 4.27 | 8.42 |
| Median | 9.645 | 20.25 | 9.34 | 20.6 | 8.705 | 19.05 | 8.19 | 18.05 | 1.41 | 3.61 |
| Interquartile range | 3.11 | 8.93 | 2.41 | 8.7 | 3.28 | 8.73 | 2.95 | 9.3 | 1.63 | 2.22 |

**Table 7-13. Field data collected from the Drainage Retention Basin at eight locations, 2001 (continued)**

| Date | CDBF | | CDBJ | | CDBK | | CDBL | |
|---|---|---|---|---|---|---|---|---|
| | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C |
| 1/26 | 7.45 | 8.3 | 8.52 | 10.2 | 8.26 | 10.2 | 8.1 | 11.3 |
| 1/30 | 7.93 | 10.2 | 7.88 | 10.4 | 8.02 | 10.4 | 7.22 | 10.3 |
| 2/15 | 7.14 | 9.2 | 9.18 | 9.4 | 9.2 | 9.6 | 8.85 | 9.1 |
| 2/23 | 9.93 | 10.8 | 10.25 | 11 | 10.39 | 10.9 | 10.33 | 10.7 |
| 3/8 | 17.61 | 12.6 | 19.46 | 13.6 | 17.85 | 13.4 | 16.08 | 12.3 |
| 3/16 | 10.17 | 12.7 | 9.42 | 15.3 | 8.86 | 14.1 | 7.68 | 14.1 |
| 3/23 | 3.53 | 14.2 | 6.75 | 17.7 | 6.58 | 17.5 | 5.43 | 16.6 |
| 3/27 | 3.16 | 17 | 7.19 | 17.6 | 6.98 | 16.8 | 3.05 | 17 |
| 4/9 | 9.64 | 13.6 | 10.27 | 15.1 | 9.95 | 14.6 | 9.93 | 14.2 |
| 4/20 | 10.2 | 15.3 | 10.14 | 15.5 | 10.38 | 15 | 10.51 | 14.4 |
| 4/26 | 7.7 | 15.8 | 12.19 | 18.8 | 10.83 | 17 | 10.06 | 17.3 |
| 5/3 | 10.35 | 18.7 | 7.96 | 18.9 | 7.95 | 18.3 | 8.09 | 17.9 |
| 5/10 | 6.33 | c | 4.9 | c | 5.38 | c | 3.91 | c |
| 5/16 | 5.83 | 23.5 | 8.62 | 22.9 | 6.33 | 23.1 | 6.23 | 23.2 |
| 5/24 | 10.82 | 25.6 | 10.5 | 25.8 | 12.01 | 25.6 | 10.34 | 25.9 |
| 6/1 | 8.05 | 24.9 | 7.38 | 24.5 | 6.65 | 24.7 | 6.46 | 25.7 |
| 6/7 | 8.71 | 23.2 | 9.47 | 24.1 | 8.19 | 23.5 | 6.85 | 24.9 |
| 6/14 | 5.8 | 20.9 | 7.93 | 24.3 | 6.74 | 21.6 | 5.81 | 23.7 |
| 6/21 | 3.72 | c | 7.61 | c | 8.16 | c | 5.73 | c |
| 6/28 | 10.19 | 22.3 | 10.52 | 23.9 | 8.41 | 22.6 | 7.35 | 22.7 |
| 7/6 | 2.04 | c | 13.24 | c | 10.03 | c | 2.46 | c |
| 7/10 | 4.04 | c | 12.26 | c | 9.43 | c | 3.97 | c |
| 7/20 | 6.25 | 22.9 | 6.82 | 23.6 | 6.71 | 23.5 | 6.11 | 22.9 |
| 7/27 | 6.49 | 23.2 | 9.06 | 26.7 | 9.07 | 24.4 | 6.88 | 24.1 |
| 8/3 | 2.49 | 22.6 | 6.82 | 23 | 6.69 | 22.8 | 2.77 | 22.5 |
| 8/10 | 5.03 | 24.4 | 11.03 | 25.4 | 11.08 | 24.5 | 5.69 | 23.3 |
| 8/17 | 7.88 | 24.8 | 11.65 | 25.1 | 10.64 | 23.8 | 7.73 | 24.7 |
| 8/24 | 5.41 | 23.3 | 7.44 | 24 | 7.04 | 22.4 | 5.85 | 22.1 |
| 8/31 | 4.65 | 23.6 | 8.56 | 25.1 | 7.59 | 23.1 | 5.58 | 23.1 |
| 9/6 | 8.09 | 23.3 | 8.55 | 24 | 8.16 | 22.7 | 5.19 | 23.1 |
| 9/14 | 3.79 | 22.8 | 6.48 | 23.3 | 5.29 | 22 | 4.52 | 22.3 |
| 9/21 | 5.5 | 21.2 | 5.71 | 21.7 | 5.18 | 21.6 | 3.07 | 21.7 |
| 9/28 | 5.39 | 21.1 | 5.83 | 20.5 | 5.96 | 20.4 | 5.77 | 20.2 |
| 10/4 | 8.16 | 21.8 | 10.71 | 22.3 | 10.85 | 22.1 | 7.96 | 21.9 |
| 10/12 | 8.75 | 19.2 | 8.07 | 19.1 | 8.28 | 19.1 | 7.89 | 19.1 |
| 10/18 | 7.95 | 19.6 | 8.86 | 20.2 | 8.66 | 19.3 | 7.15 | 19.6 |
| 10/26 | 8.37 | 17.5 | 7.36 | 17.8 | 7.57 | 17.5 | 7.02 | 17.7 |

**Table 7-13. Field data collected from the Drainage Retention Basin at eight locations, 2001 (concluded)**

| Date | CDBF | | CDBJ | | CDBK | | CDBL | |
|---|---|---|---|---|---|---|---|---|
| | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C | Dissolved oxygen PPM | Temper-ature Degrees C |
| 11/1 | 8.42 | 17.9 | 8.78 | 18.4 | 7.85 | 17.5 | 7.23 | 18.1 |
| 11/9 | 7.85 | 15.8 | 8.12 | 16.4 | 7.93 | 15.8 | 7.61 | 15.8 |
| 11/14 | 3.45 | 16.1 | 4.37 | 16.3 | 3.77 | 15.8 | 3.17 | 16 |
| 11/21 | 5.61 | 15.9 | 7.89 | 15.9 | 7.45 | 15.9 | 5.89 | 15.9 |
| 11/30 | 5.02 | 12.8 | 4.99 | 12.7 | 5.22 | 12.6 | 4.88 | 12.7 |
| 12/5 | 8.08 | 12.4 | 7.97 | 11.9 | 7.89 | 11.9 | 7.75 | 12 |
| 12/14 | 7.34 | 11.1 | 7.67 | 11 | 7.66 | 11 | 7.44 | 10.8 |
| 12/21 | 7.83 | 10.3 | 7.84 | 11.1 | 7.6 | 10.4 | 7.69 | 10.5 |
| 12/27 | 14.58 | 10.6 | 12.1 | 11 | 11.74 | 10.8 | 11.64 | 10.9 |
| **Data Summary** | | | | | | | | |
| Number of samples | 46 | 42 | 46 | 42 | 46 | 42 | 46 | 42 |
| Minimum | 2.04 | 8.3 | 4.37 | 9.4 | 3.77 | 9.6 | 2.46 | 9.1 |
| Maximum | 17.61 | 25.6 | 19.46 | 26.7 | 17.85 | 25.6 | 16.08 | 25.9 |
| Median | 7.575 | 18.3 | 8.32 | 18.85 | 7.985 | 20.25 | 20.25 | 20.25 |
| Interquartile range | 3.01 | 9.88 | 2.83 | 8.68 | 2.57 | 8.45 | 2.25 | 8.73 |

a Measurements for turbidity using the field test kit began 7/10/01
b Location not available to sample because of low water level resulting from draining the basin
c Measurement not taken because of equipment failure
d na= Not analyzed because the analysis was not required

**Table 7-14. Seasonal inventory of plants and animals, Livermore site, 2001**

| Common name | Scientific name | Location | | | | | |
|---|---|---|---|---|---|---|---|
| | | DRB | | Arroyo Las Positas | | Tributaries | |
| | | Spring[a] | Fall[b] | Spring | Fall | Spring | Fall |
| **Birds** | | | | | | | |
| American coot | *Fulica americana* | NO[c] | P[d] | NO | NO | NO | NO |
| American crow | *Corvus bachyrhynchos* | P | P | P | P | P | P |
| American goldfinch | *Carduelis tristis* | NO | P | NO | P | NO | P |
| American kestrel | *Falco sparverius* | P | P | P | P | NO | NO |
| American robin | *Turdus migratorius* | P | P | P | P | NO | NO |
| Anna's hummingbird | *Calypte anna* | P | P | P | P | P | P |
| Belted kingfisher | *Ceryle alcyon* | P | P | P | P | NO | NO |
| Bewick's wren | *Thryomanes bewickii* | P | NO | NO | NO | NO | NO |
| Black phoebe | *Sayornis saya* | NO | NO | P | P | NO | NO |
| Black-chinned hummingbird | *Archilochus alexandri* | NO | NO | NO | NO | NO | NO |
| Black-crowned night-heron | *Nycticorax nycticorax* | NO | P | NO | P | NO | NO |
| Black-necked stilt | *Himantopus mexicanus* | P | P | NO | NO | NO | NO |
| Brewer's blackbird | *Euphagus cyanocephalus* | P | P | P | P | P | P |
| Brown-headed cowbird | *Molothrus ater* | NO | NO | P | NO | NO | NO |
| Bufflehead | *Bucephala* | P | P | NO | NO | NO | NO |
| Bushtit | *Psaltriparus minimus* | NO | NO | NO | NO | P | P |
| Canada goose | *Branta canadensis* | P | P | NO | NO | NO | NO |
| Cedar waxwing | *Bombycilla garrulus* | NO | NO | NO | NO | P | NO |
| Chestnut-backed chickadee | *Parus rufescens* | P | NO | P | NO | NO | NO |
| Cliff swallow | *Hirundo pyrrhonota* | P | NO | NO | NO | NO | NO |
| Common raven | *Corvus corax* | NO | NO | P | P | NO | NO |
| Common snipe | *Gallinago gallinago* | NO | P | NO | P | NO | NO |
| Cooper's hawk | *Accipiter cooperii* | NO | NO | NO | NO | P | NO |
| Dark-eyed junco | *Junco hyemalis* | P | NO | P | NO | P | NO |
| Double-crested cormorant | *Phalacrocorax auritus* | NO | NO | NO | NO | NO | NO |
| European starling | *Sturnus vulgaris* | P | P | P | P | P | P |
| Forester's tern | *Sterna forsteri* | P | NO | NO | NO | NO | NO |
| Golden crowned sparrow | *Zonotrichia atricapilla* | NO | NO | P | NO | NO | NO |
| Golden eagle | *Aquila chrysaetos* | NO | NO | P | NO | NO | NO |
| Great blue heron | *Ardea herodias* | NO | NO | P | NO | NO | NO |
| Great egret | *Casmerodius albus* | P | P | P | P | NO | NO |
| Greater Scaup | *Aythya marila* | NO | NO | NO | NO | NO | NO |
| Greater-yellow legs | *Tringa melanoleuca* | P | P | NO | NO | NO | NO |
| Green-backed heron | *Butorides striatus* | P | P | P | P | NO | NO |
| House finch | *Carpodacus mexicanus* | P | P | P | P | P | P |
| Killdeer | *Haradrius vociferus* | P | P | P | NO | NO | NO |
| Lesser goldfinch | *Carduelis lawrencei* | NO | P | NO | P | NO | P |

**Table 7-14. Seasonal inventory of plants and animals, Livermore site, 2001 (continued)**

| Common name | Scientific name | Location | | | | | |
|---|---|---|---|---|---|---|---|
| | | DRB | | Arroyo Las Positas | | Tributaries | |
| | | Spring[a] | Fall[b] | Spring | Fall | Spring | Fall |
| **Birds (continued)** | | | | | | | |
| Loggerhead shrike | *Lanius ludovicianus* | NO | NO | P | NO | NO | NO |
| Mallard | *Anas platyrhynchos* | P | P | P | NO | P | P |
| Mourning dove | *Zenaida macroura* | P | P | P | P | P | P |
| Northern rough-winged swallow | *Stelgidopteryx serripennis* | P | NO | P | NO | NO | NO |
| Nuttall's woodpecker | *Picoides nuttallii* | NO | NO | NO | NO | P | NO |
| Pied-billed grebe | *Podilymbus podiceps* | P | P | NO | NO | NO | NO |
| Red-shafted flicker | *Colaptes auratus* | P | P | P | P | NO | NO |
| Red-shouldered hawk | *Buteo lineatus* | NO | NO | P | P | NO | NO |
| Red-tailed hawk | *Buteo jamaicensis* | NO | NO | P | P | P | P |
| Red-winged blackbird | *Agelaius phoeniceus* | P | P | P | P | P | P |
| Rock dove | *Columba livia* | P | P | P | P | P | P |
| Ruby-crowned kinglet | *Regulus caledula* | P | P | P | NO | NO | NO |
| Scrub jay | *Aphelocoma coerulescens* | P | P | P | P | P | P |
| Snowy egret | *Egretta thula* | NO | NO | P | P | NO | NO |
| Song sparrow | *Zmelospiza melodia* | P | P | P | P | P | P |
| Turkey vulture | *Cathartes aura* | NO | NO | P | P | NO | NO |
| Western gull | *Larus occidentalis* | NO | NO | NO | NO | NO | NO |
| Western meadowlark | *Sturnella neglecta* | NO | NO | P | P | NO | NO |
| White-breasted nuthatch | *Sitta carolinensis* | NO | NO | NO | NO | P | P |
| White-crowned sparrow | *Zonotrichia leucophrys* | P | P | P | P | P | P |
| White-tailed kite | *Elanus leucurus* | NO | NO | P | P | NO | NO |
| Yellow-rumped warbler | *Dendroica coronata* | P | P | P | P | P | P |
| **Amphibians and reptiles** | | | | | | | |
| Bullfrog | *Rana catesbeiana* | P | P | NO | P | NO | NO |
| Pacific tree frog | *Hyla regilla* | P | P | P | P | P | P |
| California red-legged frog | *Rana aurora draytonii* | P | P | P | P | P | P |
| Western fence lizard | *Sceloporus occidentailis* | P | P | P | P | P | P |
| Western pond turtle | *Clemmys marmorata* | NO | NO | NO | NO | NO | NO |
| Western toad | *Bufo borieus* | P | P | P | P | P | P |
| **Fish** | | | | | | | |
| Catfish | *Ictalurus sp.* | —[e] | P | —[e] | P | —[e] | NO |
| goldfish | *Carrassius auratus* | —[e] | P | —[e] | NO | —[e] | NO |
| Mosquito fish | *Gambusia affinis* | —[e] | P | —[e] | P | —[e] | P |
| Prickly sculpin | *Cottus asper* | —[e] | P | —[e] | P | —[e] | NO |

**Table 7-14. Seasonal inventory of plants and animals, Livermore site, 2001 (concluded)**

| Common name | Scientific name | Spring[a] | Fall[b] |
|---|---|---|---|
| **Mammals (all locations)** | | | |
| California ground squirrel | *Spermophilus beecheyi* | —[e] | P |
| California meadow vole | *Microtus californicus* | —[e] | P |
| Feral house cat | *Felis domesticus* | —[e] | P |
| Gray fox | *Urocyon cinereoargenteus* | —[e] | P |
| House mouse | *Mus musculus* | —[e] | P |
| muskrat | *Ondatra zibethicus* | —[e] | P |
| Red fox | *Vulps vulpes* | —[e] | P |
| **Vegetation (all locations)** | | | |
| Alkali mallow | *Malvella leprosa* | P | P |
| Alkalis bullrush | *Scirpus robustus* | P | P |
| American water-plantain | *Alisma plantago-aquatica* | P | P |
| Bullrush | *Scripus spp.* | P | P |
| Cattail | *Typha latifolia* | P | P |
| Cocklebur | *Xanthium spinosum* | P | P |
| Coontail | *Ceratophyllum demersum* | P | P |
| Curly dock | *Rumex crispus* | P | P |
| Harding grass | *Phalaris aquatica* | P | P |
| Leafy pondweed | *Potamogeton foliosus* | P | P |
| Mulefat | *Baccharis salicifolius* | P | P |
| Narrow-leaved willow | *Salix exigua* | P | P |
| Red willow | *Salix laevigata* | P | P |
| Salt grass | *Distichlis spicata* | P | P |
| Spearscale | *Atriplex triangularis* | P | P |
| Tall flatsedge | *Cyperus eragrostis* | P | P |
| Water velvet | *Azolla mexicana* | P | P |
| Watercress | *Rorippa nasturium-aquaticum* | P | P |
| Waterpeper | *Polygonum hydropiperoides* | P | P |
| Willow | *Salix spp.* | P | P |

a Spring survey dates are as follows: amphibians: 2/8/01, 2/15/01, 3/8/01, and 3/20/01; birds: 2/9/01, 2/15/01, 3/9/01, and 3/20/01; and vegetation: 3/01.

b Fall survey dates are as follows: amphibians: 8/18/01, 10/24/01, 11/6/01, and 11/16/01; birds: 10/12/01, 10/26/01, 11/2/01, and 11/16/01; fish: 12/23/00–1/12/01; mammals: 10/26–29/01; and vegetation: 3/01 and 9/01.

c NO = Not observed

d P = Present

e Only fall surveys were completed for fish and mammals.

## Table 7-15. Radioactivity in surface and drinking water (Bq/L) in the Livermore Valley, 2001

| Locations | Date | Tritium | Gross alpha | Gross beta |
|---|---|---|---|---|
| **Drinking waters** | | | | |
| **BELL** | 2/5 | -0.644 ± 1.92 | 0.0111 ± 0.0518 | -0.000222 ± 0.0481 |
| | 7/24 | -1.22 ± 2.22 | 0.0183 ± 0.0207 | 0.0459 ± 0.0318 |
| **GAS** | 2/2 | -1.8 ± 1.92 | 0.0247 ± 0.037 | 0.0574 ± 0.0629 |
| | 7/24 | 0.918 ± 2.22 | -0.00999 ± 0.0333 | 0.00559 ± 0.0407 |
| **PALM** | 2/5 | -1.8 ± 1.92 | -0.0158 ± 0.0315 | 0.0962 ± 0.0518 |
| | 7/24 | -0.559 ± 2.22 | 0.0332 ± 0.0333 | 0.0332 ± 0.037 |
| **ORCH** | 2/5 | -0.644 ± 1.92 | 0.04 ± 0.0407 | 0.113 ± 0.0703 |
| | 7/25 | -1.21 ± 2.22 | 0.0121 ± 0.0444 | 0.177 ± 0.0444 |
| **TAP** | 2/5 | -0.577 ± 1.92 | 0.0243 ± 0.037 | -0.000333 ± 0.0851 |
| | 7/25 | -0.733 ± 2.18 | 0.00488 ± 0.0107 | 0.00455 ± 0.0285 |
| **Surface waters** | | | | |
| **CAL** | 2/2 | -0.385 ± 1.96 | -0.00781 ± 0.0181 | 0.135 ± 0.0518 |
| | 7/24 | -0.644 ± 2.22 | -0.00189 ± 0.00925 | 0.0422 ± 0.0274 |
| **DEL** | 2/5 | -0.451 ± 1.92 | 0.0114 ± 0.0285 | 0.0733 ± 0.0444 |
| | 7/25 | -1.64 ± 2.29 | -0.00829 ± 0.0229 | 0.0418 ± 0.0407 |
| **DUCK** | 2/2 | 0.258 ± 1.96 | -0.0243 ± 0.0851 | 0.149 ± 0.0703 |
| | 7/24 | 0.286 ± 2.29 | -0.028 ± 0.0555 | 0.162 ± 0.0555 |
| **ALAG** | 2/2 | -0.0644 ± 1.96 | 0.057 ± 0.074 | 0.0866 ± 0.0555 |
| | 7/24 | 1.65 ± 2.22 | 0.037 ± 0.0592 | 0.0988 ± 0.0407 |
| **SHAD** | 2/2 | 1.55 ± 2 | 0.0988 ± 0.0777 | 0.0157 ± 0.0518 |
| | 7/24 | 1.35 ± 2.18 | 0.00218 ± 0.0285 | 0.134 ± 0.037 |
| **ZON7** | 2/5 | -0.773 ± 1.92 | -0.00485 ± 0.0274 | 0.114 ± 0.0518 |
| | 7/24 | -0.648 ± 2.22 | 0.00315 ± 0.0181 | -0.0256 ± 0.034 |
| **On-site pool** | | | | |
| **POOL** | 2/5 | 0.385 ± 1.96 | 0.0422 ± 0.0703 | 0.071 ± 0.0481 |
| | 4/26 | 2.89 ± 2.15 | np[a] | np |
| | 7/25 | -2.3 ± 2.15 | -0.0309 ± 0.0348 | 0.0426 ± 0.0292 |
| | 11/15 | 0.294 ± 2.11 | np | np |

a 'np' means the analysis was not planned for that sampling event. Semiannual sampling and analysis is planned for gross alpha and gross beta radiation.

**There are no supplemental data in this chapter.**
**Please see the main volume for details about**
**Groundwater Investigation and Remediation.**

# Groundwater Monitoring

*Eric Christofferson*
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## Methods

Representative samples of groundwater from monitoring wells were obtained by following the written protocols contained in the *LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (SOPs)* (Dibley and Depue 2000). The protocols cover sampling techniques and specific information for the analytes that are routinely searched for in groundwater. Different sampling techniques were applied to different wells depending on whether they were fitted with submersible pumps, had to be bailed, or contained Barcad devices, where LLNL used nitrogen gas under pressure to extract water samples.

Typically, sampling technologists purged wells of standing water and waited for the wells to recover before they collected water samples. They wore disposable vinyl gloves to prevent accidental contamination during sampling and cleaned pH and depth-to-water probes with deionized water after each use. For quality assurance purposes, they obtained field blank samples and equipment blank samples to test the cleanliness of the sampling methods. They used clean sample containers and, where required, they used ultrapure chemicals (mostly acids) to preserve the samples.

Off-site laboratories performed most of the water analyses during 2001, under contract with LLNL. (Note that the groundwater radioactivity data for 2001 include some small negative values [in Bq/L]. These can occur when the independently determined correction for background radioactivity is subtracted from measurements of groundwater samples that contain little or no radioactive material.)

As with groundwater sampling, standard sample handling and hygiene procedures were employed to prevent cross-contamination (e.g., wearing disposable gloves, decontaminating sampling equipment, and maintaining samples at 4 ± 2° Celsius). Duplicates, field blanks, and trip blanks were collected for quality assurance/quality control purposes. Most analyses were performed off site by contract analytical laboratories except when the on-site laboratory offered better capabilities, such as lower detection limits.

Technologists sampled wastewater from the chemistry area in retention tanks associated with Buildings 825, 826, and 827 using Hazardous Waste Management Procedure 411. Wastewater was held in retention tanks until analytical results were reviewed for compliance with Waste Discharge Requirements No. 96-248.

## Livermore Site

Table 9-1 lists the groundwater constituents monitored at the Livermore site and at Site 300, the EPA (or other)-approved methods commonly used to measure them, and the detection limits (reporting limits) employed.

Table 9-2 reports tritium activities In Livermore Valley wells. Tables 9-3 to 9-5 report routine surveillance monitoring for wells along the Livermore site perimeter; wells W-008, W-017, and W-221 are upgradient and the remaining seven wells are downgradient from the site. Table 9-6 contains analytical data obtained from monitoring wells downgradient from the Taxi Strip Area, and Table 9-7 contains analytical data obtained from monitoring wells downgradient from the East Traffic Circle Area. Table 9-8 contains data from W-593, downgradient from the Decontamination and Waste Treatment Facility. Table 9-9 contains data from wells downgradient from the Hazardous Waste Management facilities near Buildings 514 and 612. Table 9-10 lists results of metals analyses from wells downgradient from where metal wastes are managed. Table 9-11 contains data from Plutonium Facility monitoring wells. Table 9-12 contains data from Tritium Facility monitoring wells. Table 9-13 contains monitoring data for wells near Building 151 where a potentially leaking pipeline connects to a retention tank system.

## Site 300

Tables 9-14 through 9-26 contain chemical data for Site 300 surveillance monitoring wells (Elk ravine drainage area, including closed landfill pits 2, 8, and 9, and Corral Hollow creek drainage area, including standby water supply, active water supply, and off-site wells).

Additional chemical data for Site 300 groundwater that was obtained during 2001 from compliance monitoring of closed landfill pits 1, 6, and 7, the closed HE burn pit, the active surface water impoundments, and the sewage ponds can be found in published compliance monitoring reports (Brown 2002; Christofferson and MacQueen 2002; Christofferson et al. 2002; Revelli 2002).

**Table 9-1a. Analytical methods and contractual reporting limits for inorganic constituents of concern in groundwater**

| Constituents of concern | Analytical method | Reporting limit[a,b] |
|---|---|---|
| **Metals and minerals (mg/L)** | | |
| All alkalinities | EPA 310.1 | 1 |
| Aluminum | EPA 200.7 | 0.05 or 0.2 |
| Ammonia nitrogen (as N) | EPA 350.3, 350.2, or 350.1 | 0.03 or 0.1 |
| Antimony | EPA 204.2 | 0.005 |
| Arsenic | EPA 206.2 | 0.002 |
| Barium | EPA 200.7 | 0.025 or 0.01 |
| Beryllium | EPA 210.2 | 0.0005 or 0.0002 |
| Boron | EPA 200.7 | 0.05 |
| Cadmium | EPA 213.2 | 0.0005 |
| Calcium | EPA 200.7 | 0.5 |
| Chloride | EPA 300.0 | 1 or 0.5 |
| Chromium | EPA 218.2 or 200.7 | 0.001 |
| Chromium(VI) | EPA 218.4 or EPA 7196 | 0.002 |
| Cobalt | EPA 200.7 | 0.025 or 0.05 |
| Copper | EPA 220.2 or 200.7 | 0.001, 0.01 or 0.05 |
| Fluoride | EPA 340.2 or 340.1 | 0.05 |
| Hardness, total (as $CaCO_3$) | SM 2320B | 1 |
| Iron | EPA 200.7 | 0.1 |
| Lead | EPA 239.2 | 0.002 or 0.005 |
| Magnesium | EPA 200.7 | 0.5 |
| Manganese | EPA 200.7 | 0.03 |
| Mercury | EPA 245.2 or 245.1 | 0.0002 |
| Molybdenum | EPA 200.7 | 0.025 |
| Nickel | EPA 249.2 or 200.7 | 0.002, 0.005 or 0.1 |
| Nitrate (as $NO_3$) | EPA 353.2, 354.1 or 300.0 | 0.5 |
| Ortho-phosphate | EPA 300.0, 365.1 or 365.2 | 0.05 |
| Perchlorate | EPA 314.0 | 0.004 |
| Potassium | EPA 200.7 | 1 |
| Selenium | EPA 270.2 | 0.002 |
| Silver | EPA 272.2 | 0.001 or 0.0005 |
| Sodium | EPA 200.7 | 1 or 0.1 |
| Sulfate | EPA 300.0 | 1 |
| Surfactants | EPA 425.1 | 0.5 |
| Thallium | EPA 279.2 | 0.001 |
| Total dissolved solids | EPA 160.1 | 1 |
| Total Kjeldahl nitrogen | EPA 351.2 or 351.3 | 0.2 |
| Total phosphorus (as P) | EPA 365.4 or SM 4500-P | 0.05 |

**Table 9-1a. Analytical methods and contractual reporting limits for inorganic constituents of concern in groundwater (concluded)**

| Constituents of concern | Analytical method | Reporting limit[a,b] |
|---|---|---|
| **Metals and minerals (mg/L) (continued)** | | |
| Vanadium | EPA 200.7 | 0.02 or 0.025 |
| Zinc | EPA 200.7 | 0.02 or 0.05 |
| **Phenolics (mg/L)** | | |
| Phenolics | EPA 420.1 | 0.005 |
| **General indicator parameters** | | |
| pH (pH units) | EPA 150.1 | none |
| Conductivity (µS/cm) | EPA 120.1 | none |
| Total organic carbon (mg/L) | EPA 9060 | 1 |
| Total organic halides (mg/L) | EPA 9020 | 0.02 |
| **Explosive compounds (µg/L)** | | |
| HMX[c] | EPA 8330 | 5 or 1 |
| RDX[d] | EPA 8330 | 5 or 1 |
| TNT[e] | EPA 8330 | 5 |
| **Radioactivity (Bq/L)** | | |
| Gross alpha | EPA 900 | 0.074 |
| Gross beta | EPA 900 | 0.11 |
| **Radioisotopes (Bq/L)** | | |
| Americium-241 | U-NAS-NS-3050 | 0.0037 |
| Plutonium-238 | U-NAS-NS-3050 | 0.0037 |
| Plutonium-239+240 | U-NAS-NS-3050 | 0.0037 |
| Radon-222 | EPA 913 | 3.7 |
| Radium-226 | EPA 903 | 0.0093 |
| Radium-228 | EPA 904 | 0.037 |
| Thorium-228 | U-NAS-NS-3050 | 0.009 |
| Thorium-230 | U-NAS-NS-3050 | 0.006 |
| Thorium-232 | U-NAS-NS-3050 | 0.006 |
| Tritium | LLNL-RAS-011 | 3.7 |
| Uranium-234 | EPA 907 | 0.0037 |
| Uranium-235 | EPA 907 | 0.0037 |
| Uranium-238 | EPA 907 | 0.0037 |

a The significant figures displayed in this table vary by constituents of concern. These variations reflect regulatory agency permit stipulations, or the applicable analytical laboratory contract under which the work was performed, or both.

b Analytical reporting limits varied by laboratory used.

c HMX is octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

d RDX is hexahydro-1,3,5-trinitro-1,3,5-triazine.

e TNT is 2,4,6-trinitrotoluene.

**Table 9-1b. Analytical methods and contractual reporting limits for organic constituents of concern in groundwater**

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 502.2 (or 524.2)** | |
| 1,1,1,2-Tetrachloroethane | 0.2 |
| 1,1,1-Trichloroethane | 0.2 |
| 1,1,2,2-Tetrachloroethane | 0.2 |
| 1,1,2-Trichloroethane | 0.2 |
| 1,1-Dichloroethane | 0.2 |
| 1,1-Dichloroethene | 0.2 |
| 1,1-Dichloropropene | 0.2 |
| 1,2,3-Trichlorobenzene | 0.2 |
| 1,2,3-Trichloropropane | 0.2 |
| 1,2,4-Trichlorobenzene | 0.2 |
| 1,2,4-Trimethylbenzene | 0.2 |
| 1,2-Dichlorobenzene | 0.2 |
| 1,2-Dichloroethane | 0.2 |
| 1,2-Dichloropropane | 0.2 |
| 1,3,5-Trimethylbenzene | 0.2 |
| 1,3-Dichlorobenzene | 0.2 |
| 1,3-Dichloropropane | 0.2 |
| 1,4-Dichlorobenzene | 0.2 |
| 2,2-Dichloropropane | 0.2 |
| 2-Chlorotoluene | 0.2 |
| 4-Chlorotoluene | 0.2 |
| Benzene | 0.2 |
| Bromobenzene | 0.2 |
| Bromochloromethane | 0.2 |
| Bromodichloromethane | 0.2 |
| Bromoform | 0.2 |
| Bromomethane | 0.2 |
| Carbon tetrachloride | 0.2 |
| Chlorobenzene | 0.2 |
| Chloroethane | 0.2 |
| Chloroform | 0.2 |
| Chloromethane | 0.2 |
| *cis*-1,2-Dichloroethene | 0.2 |
| *cis*-1,3-Dichloropropene | 0.5 |
| Dibromochloromethane | 0.2 |
| Dibromomethane | 0.2 |
| Dichlorodifluoromethane | 0.2 |
| Ethylbenzene | 0.2 |
| Freon 113 | 0.2 |
| Hexachlorobutadiene | 0.2 |
| Isopropylbenzene | 0.2 |
| *m*- and *p*-Xylene isomers | 0.2 |
| Methylene chloride | 0.2 |
| *n*-Butylbenzene | 0.2 |
| *n*-Propylbenzene | 0.2 |
| Naphthalene | 0.2 |
| *o*-Xylene | 0.2 |
| Isopropyl toluene | 0.2 |
| *sec*-Butylbenzene | 0.2 |
| Styrene | 0.2 |
| *tert*-Butylbenzene | 0.2 |
| Tetrachloroethene | 0.2 |
| Toluene | 0.2 |
| *trans*-1,2-Dichloroethene | 0.2 |
| *trans*-1,3-Dichloropropene | 0.2 |
| Trichloroethene | 0.2 |
| Trichlorofluoromethane | 0.2 |
| Vinyl chloride | 0.2 |
| **EPA Method 507 (or 525.2)** | |
| Alachlor | 0.5 |
| Atraton | 0.5 |
| Atrazine | 0.5 |
| Bromacil | 0.5 |
| Butachlor | 0.5 |
| Diazinon | 0.5 |
| Dichlorvos | 0.5 |
| Dimethoate | 0.5 |
| Ethoprop | 0.5 |
| Merphos | 0.5 |
| Metolachlor | 0.5 |
| Metribuzin | 0.5 |
| Mevinphos | 0.5 |
| Molinate | 0.5 |

**Table 9-1b. Analytical methods and contractual reporting limits for organic constituents of concern in groundwater (continued)**

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 507 (or 525.2) (continued)** | |
| Prometon | 0.5 |
| Prometryn | 0.5 |
| Simazine | 0.5 |
| Terbutryn | 0.5 |
| **EPA Method 524.2** | |
| 1,1,1,2-Tetrachloroethane | 1 |
| 1,1,1-Trichloroethane | 1 |
| 1,1,2,2-Tetrachloroethane | 1 |
| 1,1,2-Trichloroethane | 1 |
| 1,1-Dichloroethane | 1 |
| 1,1-Dichloroethene | 1 |
| 1,1-Dichloropropene | 1 |
| 1,2,3-Trichlorobenzene | 1 |
| 1,2,3-Trichloropropane | 1 |
| 1,2,4-Trichlorobenzene | 1 |
| 1,2,4-Trimethylbenzene | 1 |
| 1,2-Dibromo-3-chloropropane | 2 |
| 1,2-Dichlorobenzene | 1 |
| 1,2-Dichloroethane | 1 |
| 1,2-Dichloropropane | 1 |
| 1,3,5-Trimethylbenzene | 1 |
| 1,3-Dichlorobenzene | 1 |
| 1,3-Dichloropropane | 1 |
| 1,4-Dichlorobenzene | 1 |
| 2-Chlorotoluene | 1 |
| 4-Chlorotoluene | 1 |
| Benzene | 1 |
| Bromobenzene | 1 |
| Bromodichloromethane | 1 |
| Bromoform | 1 |
| Bromomethane | 2 |
| Carbon tetrachloride | 1 |
| Chlorobenzene | 1 |
| Chloroethane | 2 |
| Chloroform | 1 |
| Chloromethane | 2 |
| *cis*-1,2-Dichloroethene | 1 |
| *cis*-1,3-Dichloropropene | 1 |
| Dibromochloromethane | 1 |
| Dibromomethane | 1 |
| Dichlorodifluoromethane | 2 |
| Ethylbenzene | 1 |
| Ethylene dibromide | 1 |
| Freon 113 | 1 |
| Hexachlorobutadiene | 1 |
| Isopropylbenzene | 1 |
| *m*- and *p*-Xylene isomers | 1 |
| Methylene chloride | 1 |
| *n*-Butylbenzene | 1 |
| *n*-Propylbenzene | 1 |
| Naphthalene | 1 |
| *o*-Xylene | 1 |
| Isopropyl toluene | 1 |
| *sec*-Butylbenzene | 1 |
| Styrene | 1 |
| *tert*-Butylbenzene | 1 |
| Tetrachloroethene | 1 |
| Toluene | 1 |
| *trans*-1,2-Dichloroethene | 1 |
| *trans*-1,3-Dichloropropene | 1 |
| Trichloroethene | 0.5 |
| Trichlorofluoromethane | 1 |
| Vinyl chloride | 2 |
| **EPA Method 547** | |
| Glyphosate | 20 |
| **EPA Method 601** | |
| 1,1,1-Trichloroethane | 0.5 |
| 1,1,2,2-Tetrachloroethane | 0.5 |
| 1,1,2-Trichloroethane | 0.5 |
| 1,1-Dichloroethane | 0.5 |
| 1,1-Dichloroethene | 0.5 |
| 1,2-Dichlorobenzene | 0.5 |

**Table 9-1b. Analytical methods and contractual reporting limits for organic constituents of concern in groundwater (continued)**

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 601 (continued)** | |
| 1,2-Dichloroethane | 0.5 |
| 1,2-Dichloroethene (total) | 0.5 |
| 1,2-Dichloropropane | 0.5 |
| 1,3-Dichlorobenzene | 0.5 |
| 1,4-Dichlorobenzene | 0.5 |
| 2-Chloroethylvinylether | 0.5 |
| Bromodichloromethane | 0.5 |
| Bromoform | 0.5 |
| Bromomethane | 0.5 |
| Carbon tetrachloride | 0.5 |
| Chlorobenzene | 0.5 |
| Chloroethane | 0.5 |
| Chloroform | 0.5 |
| Chloromethane | 0.5 |
| *cis*-1,2-Dichloroethene | 0.5 |
| *cis*-1,3-Dichloropropene | 0.5 |
| Dibromochloromethane | 0.5 |
| Dichlorodifluoromethane | 0.5 |
| Freon 113 | 0.5 |
| Methylene chloride | 0.5 |
| Tetrachloroethene | 0.5 |
| *trans*-1,2-Dichloroethene | 0.5 |
| *trans*-1,3-Dichloropropene | 0.5 |
| Trichloroethene | 0.5 |
| Trichlorofluoromethane | 0.5 |
| Vinyl chloride | 0.5 |
| **EPA Method 602** | |
| 1,2-Dichlorobenzene | 0.3 |
| 1,3-Dichlorobenzene | 0.3 |
| 1,4-Dichlorobenzene | 0.3 |
| Benzene | 0.4 |
| Chlorobenzene | 0.3 |
| Ethylbenzene | 0.3 |
| *m*-Xylene isomers | 0.4 |

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 602 (continued)** | |
| *o*-Xylene | 0.4 |
| *p*-Xylene | 0.4 |
| Toluene | 0.3 |
| Total xylene isomers | 0.4 |
| **EPA Method 608** | |
| Aldrin | 0.05 |
| BHC, alpha isomer | 0.05 |
| BHC, beta isomer | 0.05 |
| BHC, delta isomer | 0.05 |
| BHC, gamma isomer (Lindane) | 0.05 |
| Chlordane | 0.2 |
| Dieldrin | 0.1 |
| Endosulfan I | 0.05 |
| Endosulfan II | 0.1 |
| Endosulfan sulfate | 0.1 |
| Endrin | 0.1 |
| Endrin aldehyde | 0.1 |
| Heptachlor | 0.05 |
| Heptachlor epoxide | 0.05 |
| Methoxychlor | 0.5 |
| 4,4'-DDD | 0.1 |
| 4,4'-DDE | 0.1 |
| 4,4'-DDT | 0.1 |
| Toxaphene | 1 |
| **EPA Method 615** | |
| 2,4,5-T | 0.5 |
| 2,4,5-TP (Silvex) | 0.2 |
| 2,4-D | 1 |
| 2,4-Dichlorophenoxy acetic acid | 2 |
| Dalapon | 10 |
| Dicamba | 1 |
| Dichloroprop | 2 |
| Dinoseb | 1 |
| MCPA | 250 |

**Table 9-1b. Analytical methods and contractual reporting limits for organic constituents of concern in groundwater (continued)**

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 615 (continued)** | |
| MCPP | 250 |
| **EPA Method 624** | |
| 1,1,1-Trichloroethane | 1 |
| 1,1,2,2-Tetrachloroethane | 1 |
| 1,1,2-Trichloroethane | 1 |
| 1,1-Dichloroethane | 1 |
| 1,1-Dichloroethene | 1 |
| 1,2-Dichlorobenzene | 1 |
| 1,2-Dichloroethane | 1 |
| 1,2-Dichloroethene (total) | 1 |
| 1,2-Dichloropropane | 1 |
| 1,3-Dichlorobenzene | 1 |
| 1,4-Dichlorobenzene | 1 |
| 2-Butanone | 20 |
| 2-Chloroethylvinylether | 20 |
| 2-Hexanone | 20 |
| 4-Methyl-2-pentanone | 20 |
| Acetone | 10 |
| Benzene | 1 |
| Bromodichloromethane | 1 |
| Bromoform | 1 |
| Bromomethane | 2 |
| Carbon disulfide | 1 |
| Carbon tetrachloride | 1 |
| Chlorobenzene | 1 |
| Chloroethane | 2 |
| Chloroform | 1 |
| Chloromethane | 2 |
| *cis*-1,2-Dichloroethene | 1 |
| *cis*-1,3-Dichloropropene | 1 |
| Dibromochloromethane | 1 |
| Dibromomethane | 1 |
| Dichlorodifluoromethane | 2 |
| Ethylbenzene | 1 |
| Freon 113 | 1 |
| Methylene chloride | 1 |
| Styrene | 1 |
| Tetrachloroethene | 1 |
| Toluene | 1 |
| Total xylene isomers | 2 |
| *trans*-1,2-Dichloroethene | 1 |
| *trans*-1,3-Dichloropropene | 1 |
| Trichloroethene | 0.5 |
| Trichlorofluoromethane | 1 |
| Vinyl acetate | 1 |
| Vinyl chloride | 1 |
| **EPA Method 625** | |
| 1,2,4-Trichlorobenzene | 5 |
| 1,2-Dichlorobenzene | 5 |
| 1,3-Dichlorobenzene | 5 |
| 1,4-Dichlorobenzene | 5 |
| 2,4,5-Trichlorophenol | 5 |
| 2,4,6-Trichlorophenol | 5 |
| 2,4-Dichlorophenol | 5 |
| 2,4-Dimethylphenol | 5 |
| 2,4-Dinitrophenol | 25 |
| 2,4-Dinitrotoluene | 5 |
| 2,6-Dinitrotoluene | 5 |
| 2-Chloronaphthalene | 5 |
| 2-Chlorophenol | 5 |
| 2-Methylphenol | 5 |
| 2-Methyl-4,6-dinitrophenol | 25 |
| 2-Methylnaphthalene | 5 |
| 2-Nitroaniline | 25 |
| 3,3'-Dichlorobenzidine | 10 |
| 3-Nitroaniline | 25 |
| 4-Bromophenylphenylether | 5 |
| 4-Chloro-3-methylphenol | 10 |
| 4-Chloroaniline | 10 |
| 4-Chlorophenylphenylether | 5 |
| 4-Nitroaniline | 25 |
| 4-Nitrophenol | 25 |
| Acenaphthene | 25 |
| Acenaphthylene | 5 |
| Anthracene | 5 |

**Table 9-1b. Analytical methods and contractual reporting limits for organic constituents of concern in groundwater (continued)**

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 625 (continued)** | |
| Benzo[*a*]anthracene | 5 |
| Benzo[*a*]pyrene | 5 |
| Benzo[*b*]fluoranthene | 5 |
| Benzo[*g,h,i*]perylene | 5 |
| Benzo[*k*]fluoranthene | 5 |
| Benzoic acid | 25 |
| Benzyl alcohol | 10 |
| Bis(2-chloroethoxy)methane | 5 |
| Bis(2-chloroisopropyl)ether | 5 |
| Bis(2-ethylhexyl)phthalate | 5 |
| Butylbenzylphthalate | 5 |
| Chrysene | 5 |
| Di-*n*-butylphthalate | 5 |
| Di-*n*-octylphthalate | 5 |
| Dibenzo[*a,h*]anthracene | 5 |
| Dibenzofuran | 5 |
| Diethylphthalate | 5 |
| Dimethylphthalate | 5 |
| Fluoranthene | 5 |
| Fluorene | 5 |
| Hexachlorobenzene | 5 |
| Hexachlorobutadiene | 5 |
| Hexachlorocyclopentadiene | 5 |
| Hexachloroethane | 5 |
| Indeno[*1,2,3-c,d*]pyrene | 5 |
| Isophorone | 5 |
| *m*- and *p*-Cresol | 5 |
| *N*-Nitroso-di-*n*-propylamine | 5 |
| *N*-Nitrosodiphenylamine | 5 |
| Naphthalene | 5 |
| Nitrobenzene | 5 |
| Pentachlorophenol | 5 |
| Phenanthrene | 5 |
| Phenol | 5 |
| Pyrene | 5 |

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 632** | |
| Diuron | 0.1 |
| **EPA Method 8082** | |
| Polychlorinated biphenyls | 0.5 |
| **EPA Method 8140** | |
| Bolstar | 1 |
| Chlorpyrifos | 1 |
| Coumaphos | 1 |
| Demeton | 1 |
| Diazinon | 1 |
| Dichlorvos | 1 |
| Disulfoton | 1 |
| Ethoprop | 1 |
| Fensulfothion | 1 |
| Fenthion | 1 |
| Merphos | 1 |
| Methyl Parathion | 1 |
| Mevinphos | 1 |
| Naled | 1 |
| Phorate | 1 |
| Prothiophos | 1 |
| Ronnel | 1 |
| Stirophos | 1 |
| Trichloronate | 1 |
| **EPA Method 8260** | |
| 1,1,1,2-Tetrachloroethane | 0.5 |
| 1,1,1-Trichloroethane | 0.5 |
| 1,1,2,2-Tetrachloroethane | 0.5 |
| 1,1,2-Trichloroethane | 0.5 |
| 1,1-Dichloroethane | 0.5 |
| 1,1-Dichloroethene | 0.5 |
| 1,2,3-Trichloropropane | 0.5 |
| 1,2-Dibromo-3-chloropropane | 0.5 |
| 1,2-Dichloroethane | 0.5 |
| 1,2-Dichloroethene (total) | 0.5 |
| 1,2-Dichloropropane | 0.5 |

**Table 9-1b. Analytical methods and contractual reporting limits for organic constituents of concern in groundwater (concluded)**

| Constituents of concern | Reporting limit (µg/L)[a,b] |
|---|---|
| **EPA Method 8260 (continued)** | |
| 2-Butanone | 0.5 |
| 2-Chloroethylvinylether | 0.5 |
| 2-Hexanone | 0.5 |
| 4-Methyl-2-pentanone | 0.5 |
| Acetone | 10 |
| Acetonitrile | 1 |
| Acrolein | 50 |
| Acrylonitrile | 50 |
| Benzene | 0.5 |
| Bromodichloromethane | 0.5 |
| Bromoform | 0.5 |
| Bromomethane | 0.5 |
| Carbon disulfide | 5 |
| Carbon tetrachloride | 0.5 |
| Chlorobenzene | 0.5 |
| Chloroethane | 0.5 |
| Chloroform | 0.5 |
| Chloromethane | 0.5 |
| Chloroprene | 5 |
| Dibromochloromethane | 0.5 |
| Dichlorodifluoromethane | 0.5 |
| Ethanol | 1000 |
| Ethylbenzene | 0.5 |
| Freon 113 | 0.5 |
| Methylene chloride | 0.5 |
| Styrene | 0.5 |
| Tetrachloroethene | 0.5 |
| Toluene | 0.5 |
| Total xylene isomers | 0.5 |
| Trichloroethene | 0.5 |
| Trichlorofluoromethane | 0.5 |
| Vinyl acetate | 20 |
| Vinyl chloride | 0.5 |
| *cis*-1,2-Dichloroethene | 0.5 |
| *cis*-1,3-Dichloropropene | 0.5 |
| *trans*-1,2-Dichloroethene | 0.5 |
| *trans*-1,3-Dichloropropene | 0.5 |

a The significant figures displayed in this table vary by constituents of concern. These variations reflect regulatory agency permit stipulations, or the applicable analytical laboratory contract under which the work was performed, or both.

b Analytical reporting limits varied by laboratory used.

**Table 9-1c. Radioisotopes and reporting limits for gamma spectroscopic analysis of constituents of concern in groundwater[a]**

| Constituents of concern | Typical reporting limit (Bq/L) |
|---|---|
| Actinium-228 | 4 |
| Americum-241 | 0.6 |
| Beryllium-7 | 3 |
| Cesium-134 | 0.4 |
| Cesium-137 | 0.4 |
| Cobalt-57 | 0.2 |
| Cobalt-60 | 0.4 |
| Europium-152 | 0.9 |
| Europium-154 | 1 |
| Europium-155 | 7 |
| Potassium-40 | 50 |
| Radium-226 | 0.7 |
| Thorium-228 | 1 |
| Thorium-234 | 1 |
| Thallium-208 | 80 |
| Uranium-235 | 1 |
| Zirconium-95 | 1 |

a The significant figures displayed in this table vary by constituents of concern. These variations reflect the applicable analytical laboratory contract under which the work was performed.

**Table 9-2. Tritium activity in Livermore Valley wells, 2001**

| Location | Sampling date | Tritium activity (Bq/L)[a] |
|---|---|---|
| 11B1 | Dec 04 | 2.7 ± 2.3 |
| 12A2 | Dec 04 | 0.6 ± 2.1 |
| 12D2 | Dec 04 | 2.5 ± 2.3 |
| 12G1 | Dec 04 | -1.3 ± 2.1 |
| 1H3 | Dec 04 | -0.2 ± 2.1 |
| 1P2 | Dec 04 | 2.4 ± 2.1 |
| 1R2 | Dec 04 | 0.8 ± 2.1 |
| 2R1 | Dec 04 | -2 ± 2.3 |
| 7C2 | Dec 04 | -4 ± 2.3 |
| 004 | Jul 09 | -1 ± 2.3 |
| 16B1 | Jul 27 | -1 ± 2.3 |
| 16L5 | Jul 09 | -1 ± 2.3 |
| 17D2 | Jul 27 | 0.2 ± 2.3 |
| 18A1 | Jul 27 | -0.3 ± 2.3 |
| 18A6 | Jul 27 | -1 ± 2.3 |
| 7P3 | Jul 27 | -3 ± 2.3 |
| 8F1 | Jul 27 | -2 ± 2.3 |
| 8P1 | Jul 27 | 0.7 ± 2.4 |
| 9B1 | Jul 27 | 0.8 ± 2.4 |
| 9M2 | Jul 27 | -0.6 ± 2.3 |
| 9M3 | Jul 27 | -0.2 ± 2.3 |

a Nondetections of tritium are equal to or are less than the 2σ uncertainty shown.

## Table 9-3. Livermore site background surveillance wells, 2001

| Constituents of concern[a] | W-008 | | W-221 | | W-017 | |
|---|---|---|---|---|---|---|
| **Inorganic (µg/L)** | **Jan 18** | **Apr 19** | **Jan 18** | **Apr 17** | **Feb 6** | **May 8** |
| pH (pH units) | np[b] | 7.72 | np | 7.53 | np | 7.58 |
| Field pH (pH units) | 7.25 | 7.33 | 7.17 | 7.14 | 7.09 | 7.39 |
| Conductivity (µS/cm) | np | 2560 | np | 1740 | np | 1050 |
| Total dissolved solids (TDS) (mg/L) | np | 1660 | np | 1020 | np | 553 |
| Water Temperature (°C) | 19 | 18.9 | 19.7 | 20.6 | 19.4 | 21.8 |
| Aluminum | np | < 50 | np | < 50 | np | < 50 |
| Copper | np | < 20 | np | < 10 | np | < 10 |
| Chromium (VI) | 7.8 | np | 4 | 4 | 5.7 | np |
| Iron | np | < 50 | np | < 50 | np | < 50 |
| Manganese | np | < 10 | np | < 10 | np | < 10 |
| Nickel | np | < 50 | np | < 50 | np | < 50 |
| Zinc | np | < 50 | np | < 50 | np | < 50 |
| **General minerals (mg/L)** | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | 243 | np | 335 | np | 203 |
| Calcium | np | 100 | np | 130 | np | 69 |
| Chloride | np | 490 | np | 304 | np | 191 |
| Fluoride | np | 1.4 | np | 0.63 | np | 0.47 |
| Magnesium | np | 56 | np | 46 | np | 51 |
| Nitrate | 19.9 | 20 | 27.7 | 34 | 8.9 | 11 |
| Ortho-Phosphate | np | 0.075 | np | 0.064 | np | 0.17 |
| Potassium | np | 2.1 | np | 2. | np | 1.6 |
| Sodium | np | 370 | np | 150 | np | 60 |
| Sulfate | np | 328 | np | 101 | np | 50 |
| Surfactants | np | < 0.5 | np | 0.5 | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | 490 | np | 514 | np | 381 |
| Total Phosphorus (as P) | np | < 0.05 | np | 0.05 | np | 0.06 |
| **Organic (µg/L)[c]** | | | | | | |
| Pesticides containing N & P (EPA 507) | nd[d] | nd | nd | nd | nd | nd |
| Glyphosate (EPA 547) | np | nd | np | nd | np | nd |
| Organophosphorus pesticides (EPA 8140) | nd | nd | nd | nd | nd | nd |
| Diuron (EPA 632) | np | nd | np | nd | np | nd |
| PCBs (EPA 8082) | np | nd | np | nd | np | nd |
| **Radioactive (Bq/L)[e]** | | | | | | |
| Gross alpha | 1.1 ± 0.1 | -0.01 ± 0.1 | 0.2 ± 0.1 | 0.2 ± 0.1 | 0.1 ± 0.1 | 0.1 ± 0.1 |
| Gross beta | 1.7 ± 0.1 | 0.4 ± 0.1 | 0.2 ± 0.1 | 0.1 ± 0.1 | 0.1 ± 0.0 | 0.1 ± 0.04 |
| Plutonium 238 | 0.0002 ± 0.0004 | np | 0.0001 ± 0.0002 | np | 0.0002 ± 0.0005 | np |
| Plutonium 239+240 | 0.0[f] ± 0.003 | np | 0.00004 ± 0.0002 | np | 0.0002 ± 0.0005 | np |
| Radium 226 | 0.001 ± 0.003 | 0.004 ± 0.002 | 0.002 ± 0.003 | 0.002 ± 0.002 | 0.03 ± 0.01 | 0.03 ± 0.005 |
| Radium 228 | 0.003 ± 0.02 | np | 0.01 ± 0.02 | np | -0.0003 ± 0.02 | np |
| Uranium (total) | 0.2 ± 0.02 | np | 0.25 ± 0.02 | np | 0.22 ± 0.02 | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.
b 'np' means the analysis was not planned for that sampling event.
c See **Table 9-1b** for list of constituents measured by each EPA method (number).
d 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.
e Nondetections of radioactive constituents are equal to or are less than the 2-σ uncertainty shown.
f The analytical laboratory reported the calculated value as zero.

## Table 9-4. Livermore site perimeter off-site surveillance wells, 2001

| Constituents of concern[a] | 14B1 | | W-121 | |
|---|---|---|---|---|
| **Inorganics (µg/L)** | **Feb 01** | **Apr 12** | **Feb 07** | **Apr 12** |
| pH (pH units) | np[b] | 7.56 | np | 7.91 |
| Field pH (pH units) | 7.32 | np | 7.96 | 7.94 |
| Conductivity (µS/cm) | np | 807 | np | 724 |
| Total dissolved solids (TDS) (mg/L) | np | 487 | np | 437 |
| Water Temperature (°C) | 20.6 | np | 18.9 | 19.5 |
| Aluminum | np | < 50 | np | < 50 |
| Copper | < 10 | < 10 | np | < 10 |
| Chromium (VI) | 7.5 | 12 | 9.7 | 11 |
| Iron | np | < 50 | np | < 50 |
| Lead | < 5 | np | np | np |
| Manganese | np | < 10 | np | < 10 |
| Nickel | np | < 50 | np | < 50 |
| Zinc | 210 | 220 | np | < 50 |
| **General minerals (mg/L)** | | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | 241 | np | 191 |
| Calcium | np | 60 | np | 38 |
| Chloride | np | 73 | np | 75 |
| Fluoride | np | 0.31 | np | 0.36 |
| Magnesium | np | 35 | np | 30 |
| Nitrate | 28.4 | 28 | 29 | 29 |
| Ortho-Phosphate | np | 0.25 | np | 0.23 |
| Potassium | np | 2 | np | 1.8 |
| Sodium | np | 68 | np | 69 |
| Sulfate | np | 44 | np | 39 |
| Surfactants | np | < 0.5 | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | 294 | np | 221 |
| Total Phosphorus (as P) | np | 0.09 | np | 0.07 |
| **Organic (µg/L)[c]** | | | | |
| Pesticides containing N & P (EPA 507) | nd[d] | nd | nd | nd |
| Glyphosate (EPA 547) | np | nd | np | nd |
| Organophosphorus pesticides (EPA 8140) | nd | nd | nd | nd |
| Diuron (EPA 632) | np | nd | np | nd |
| PCBs (EPA 8082) | np | nd | np | nd |
| **Radioactive (Bq/L)[e]** | | | | |
| Gross alpha | 0.04 ± 0.03 | 0.03 ± 0.05 | 0.05 ± 0.04 | -0.03 ± 0.04 |
| Gross beta | 0.10 ± 0.05 | 0.06 ± 0.04 | -0.03 ± 0.04 | 0.01 ± 0.04 |
| Plutonium 238 | -0.0002 ± 0.001 | np | 0.0001 ± 0.001 | np |
| Plutonium 239+240 | -0.0003 ± 0.0004 | np | -0.0002 ± 0.0005 | np |
| Radium 226 | 0.003 ± 0.004 | 0.002 ± 0.002 | 0.001 ± 0.002 | 0.004 ± 0.002 |
| Radium 228 | 0.001 ± 0.018 | np | 0.02 ± 0.02 | np |
| Uranium (total) | 0.06 ± 0.006 | np | 0.02 ± 0.003 | np |

## Table 9-4. Livermore site perimeter off-site surveillance wells, 2001 (concluded)

| Constituents of concern[a] | W-151 | | W-571 | |
|---|---|---|---|---|
| **Inorganics (µg/L)** | **Feb 07** | **Apr 12** | **Feb 01** | **Apr 12** |
| pH (pH units) | np[b] | 7.69 | np | 7.59 |
| Field pH (pH units) | 7.59 | 7.54 | 7.46 | 7.47 |
| Conductivity (µS/cm) | np | 870 | np | 857 |
| Total dissolved solids (TDS) (mg/L) | np | 527 | np | 503 |
| Water Temperature (°C) | 17.7 | 18.7 | 18.1 | 18.6 |
| Aluminum | np | < 50 | np | < 50 |
| Copper | np | < 10 | < 10 | < 10 |
| Chromium (VI) | 16 | 16 | 18 | 21 |
| Iron | np | < 50 | np | < 50 |
| Lead | np | np | < 5 | np |
| Manganese | np | < 10 | np | < 10 |
| Nickel | np | < 50 | np | < 50 |
| Zinc | np | < 50 | < 10 | < 50 |
| **General minerals (mg/L)** | | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | 250 | np | 244 |
| Calcium | np | 55 | np | 67 |
| Chloride | np | 87 | np | 89 |
| Fluoride | np | 0.32 | np | 0.37 |
| Magnesium | np | 39 | np | 26 |
| Nitrate (as $NO_3$) | 37.6 | 31 | 36.7 | 32 |
| Ortho-Phosphate | np | 0.25 | np | 0.19 |
| Potassium | np | 2 | np | 2.4 |
| Sodium | np | 72 | np | 74 |
| Sulfate | np | 32 | np | 32 |
| Surfactants | np | < 0.5 | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | 300 | np | 276 |
| Total Phosphorus (as P) | np | 0.09 | np | 0.07 |
| **Organic (µg/L)[c]** | | | | |
| Pesticides containing N & P (EPA 507) | nd[d] | nd | nd | nd |
| Glyphosate (EPA 547) | np | nd | np | nd |
| Organophosphorus pesticides (EPA 8140) | nd | nd | nd | nd |
| Diuron (EPA 632) | np | nd | np | nd |
| PCBs (EPA 8082) | np | nd | np | nd |
| **Radioactive (Bq/L)[e]** | | | | |
| Gross alpha | 0.02 ± 0.04 | 0.01 ± 0.04 | 0.04 ± 0.05 | 0.04 ± 0.04 |
| Gross beta | 0.09 ± 0.04 | 0.10 ± 0.06 | 0.11 ± 0.06 | 0.09 ± 0.05 |
| Plutonium 238 | 0.001 ± 0.001 | np | -0.001 ± 0.0004 | np |
| Plutonium 239+240 | 0.004 ± 0.001 | np | 0.004 ± 0.001 | np |
| Radium 226 | 0.009 ± 0.003 | 0.005 ± 0.002 | 0.005 ± 0.003 | 0.007 ± 0.003 |
| Radium 228 | -0.009 ± 0.02 | np | -0.01 ± 0.02 | np |
| Uranium (total) | 0.05 ± 0.005 | np | 0.09 ± 0.01 | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.
b 'np' means the analysis was not planned for that sampling event.
c See **Table 9-1b** for list of constituents measured by each EPA method (number).
d 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.
e Nondetections of radioactive constituents are equal to or are less than the 2σ uncertainty shown.

**Table 9-5. Livermore site perimeter on-site surveillance wells, 2001**

| Constituents of concern[a] | W-1012 | | W-556 | | W-373 | |
|---|---|---|---|---|---|---|
| | Feb 01 | Apr 17 | Jan 18 | May 08 | Jan 18 | Apr 19 |
| **Inorganics (µg/L)** | | | | | | |
| pH (pH units) | np[b] | 7.92 | np | 7.63 | np | 7.79 |
| Field pH (pH units) | 7.3 | 7.25 | 7.51 | 7.37 | 7.44 | 7.56 |
| Conductivity (µS/cm) | np | 1050 | np | 960 | na | 948 |
| Field Specific Conductance (µS/cm) | 935 | 944 | 814 | 852 | 810 | 817 |
| Total dissolved solids (TDS) (mg/L) | np | 590 | np | 553 | na | 563 |
| Water Temperature (°C) | 18.7 | 19.3 | 17.7 | 18.8 | 18.1 | 18.2 |
| Aluminum | np | < 50 | np | < 50 | np | < 0.05 |
| Copper | < 10 | < 10 | np | < 10 | np | < 0.02 |
| Chromium (VI) | 16 | 19 | 26 | na | 51 | na |
| Iron | np | < 50 | np | < 50 | np | < 0.05 |
| Lead | < 5 | np | np | np | np | np |
| Manganese | np | < 10 | np | < 10 | np | < 0.01 |
| Nickel | np | < 50 | np | < 50 | np | < 0.05 |
| Zinc | 11 | < 0.05 | np | < 50 | np | < 0.05 |
| **General minerals (mg/L)** | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | 270 | np | 239 | np | 211 |
| Calcium | np | 89 | np | 66 | np | 56 |
| Chloride | np | 123 | np | 130 | np | 125 |
| Fluoride | np | 0.24 | np | 0.33 | np | 0.5 |
| Magnesium | np | 32 | np | 24 | np | 21 |
| Nitrate | 73.2 | 67 | 30.6 | 30 | np | 13 |
| Ortho-Phosphate | np | 0.17 | np | 0.17 | np | 0.12 |
| Potassium | np | 2.7 | np | 1.8 | np | 1.6 |
| Sodium | np | 75 | np | 100 | np | 110 |
| Sulfate | np | 26 | np | 38 | np | 63 |
| Surfactants | np | < 0.5 | np | < 0.5 | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | 356 | np | 265 | np | 224 |
| Total Phosphorus (as P) | np | < 0.05 | np | 0.06 | np | < 0.05 |

**Table 9-5. Livermore site perimeter on-site surveillance wells, 2001 (concluded)**

| Constituents of concern[a] | W-1012 | | W-556 | | W-373 | |
|---|---|---|---|---|---|---|
| | Feb 01 | Apr 17 | Jan 18 | May 08 | Jan 18 | Apr 19 |
| **Organic (µg/L)[c]** | | | | | | |
| Pesticides containing N & P (EPA 507) | nd[d] | nd | nd | nd | nd | nd |
| Glyphosate (EPA 547) | np | nd | np | nd | np | nd |
| Organophosphorus pesticides (EPA 8140) | nd | nd | nd | nd | nd | nd |
| Diuron (EPA 632) | np | nd | np | nd | np | nd |
| PCBs (EPA 8082) | np | nd | np | nd | np | nd |
| **Radioactive (Bq/L)[e]** | | | | | | |
| Gross alpha | 0.09 ± 0.05 | 0.02 ± 0.05 | 0.01 ± 0.04 | 0.04 ± 0.06 | 0.09 ± 0.07 | 0.02 ± 0.05 |
| Gross beta | 0.1 ± 0.07 | 0.2 ± 0.06 | 0.11 ± 0.04 | 0.06 ± 0.04 | 0.08 ± 0.04 | 0.07 ± 0.04 |
| Plutonium 238 | -0.0004 ± 0.001 | np | 0.0001 ± 0.0003 | np | 0.00004 ± 0.0004 | np |
| Plutonium 239+240 | 0.0[f] ± 0.001 | np | -0.00004 ± 0.0001 | np | 0.0001 ± 0.0003 | np |
| Radium 226 | -0.001 ± 0.003 | 0.002 ± 0.002 | -0.004 ± 0.004 | 0.002 ± 0.002 | 0.005 ± 0.004 | 0.003 ± 0.002 |
| Radium 228 | -0.001 ± 0.02 | np | 0.009 ± 0.017 | np | -0.02 ± 0.02 | np |
| Uranium (total) | 0.11 ± 0.01 | np | 0.09 ± 0.01 | np | 0.07 ± 0.007 | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.
b 'np' means the analysis was not planned for that sampling event.
c See **Table 9-1b** for list of constituents measured by each EPA method (number).
d 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.
e Nondetections of radioactive constituents are equal to or are less than the 2σ uncertainty shown.
f The analytical laboratory reported the calculated value as zero.

**Table 9-6. Livermore site Taxi Strip surveillance wells, 2001**

| Constituents of concern[a] | W-204 | | W-363 | |
|---|---|---|---|---|
| **Inorganics (µg/L)** | **Feb 06** | **Jun 18** | **Feb 06** | **May 29** |
| Field pH (pH units) | 7.5 | np[b] | 7.22 | np |
| Field conductivity (µS/cm) | 394 | np | 431 | np |
| Water Temperature (°C) | 20.0 | np | 20.1 | np |
| Copper | < 10 | np | < 10 | np |
| Lead | < 5 | np | < 5 | np |
| Zinc | < 10 | np | < 10 | np |
| **Radioactive (Bq/L)[c]** | | | | |
| Americium 241 | 0.0009 ± 0.001 | np | 0.0003 ± 0.001 | np |
| Plutonium 238 | -0.0002 ± 0.001 | np | 0.0006 ± 0.002 | np |
| Plutonium 239+240 | 0.0004 ± 0.001 | np | -0.0003 ± 0.0005 | np |
| Radium 226 | -0.003 ± 0.003 | np | 0.0025 ± 0.003 | np |
| Radium 228 | -0.008 ± 0.02 | np | -0.004 ± 0.02 | np |
| Tritium | -1.7 ± 2.1 | -0.2 ± 2.1 | 75 ± 8 | 41 ± 5 |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c Nondetections of radioactive constituents are equal to, or are less than the 2σ uncertainty shown.

## Table 9-7. Livermore site East Traffic Circle Landfill surveillance wells, 2001

| Constituents of concern[a] | W-1308 | | | W-1303 | | |
|---|---|---|---|---|---|---|
| **Inorganics (µg/L)** | **Jan 26** | **Apr 11** | **Oct. 17** | **Jan 26** | **Apr 11** | **Oct. 17** |
| pH (pH units) | np[b] | np | 8.00 | np | 7.03 | 7.60 |
| Field pH (pH units) | np | 7.4 | 7.43 | np | np | 7.21 |
| Conductivity (µS/cm) | np | np | 940 | np | np | 1100 |
| Field conductivity (µS/cm) | np | 837 | 1035 | np | 1121 | 1261 |
| Water Temperature (°C) | np | 19.7 | 20.7 | np | 18.1 | 20.6 |
| Aluminum | np | np | < 200 | np | np | < 200 |
| Copper | < 10 | np | < 50 | < 10 | np | < 50 |
| Iron | np | | < 100 | np | np | < 100 |
| Lead | < 5 | np | < np | < 5 | np | < np |
| Manganese | np | np | < 30 | np | np | < 30 |
| Nickel | np | np | < 100 | np | np | < 100 |
| Zinc | < 10 | np | < 50 | < 10 | np | < 50 |
| **General minerals (mg/L)** | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | np | na[c] | np | np | 410 |
| Calcium | np | np | 84 | np | np | 120 |
| Chloride | np | np | 86 | np | np | 95 |
| Fluoride | np | np | 0.51 | np | np | 0.36 |
| Magnesium | np | np | 28 | np | np | 40 |
| Nitrate (as NO3) | np | np | 36 | np | np | 52 |
| Ortho-Phosphate | np | np | 0.02 | np | np | < 0.02 |
| Potassium | np | np | 4 | np | np | 4 |
| Sodium | np | np | 89 | np | np | 81 |
| Sulfate | np | np | 25 | np | np | 25 |
| Surfactants | np | np | < 0.5 | np | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | np | 320 | np | np | 460 |
| Total Phosphorus (as P) | np | np | < 0.05 | np | np | < 0.05 |
| **Organic (µg/L)[d]** | | | | | | |
| PCBs (EPA 8082) | np | nd[e] | np | np | nd | np |
| **Radioactive (Bq/L)[f]** | | | | | | |
| Americium 241 | 0.0006 ± 0.001 | np | np | 0.0003 ± 0.001 | np | np |
| Plutonium 238 | 0.0001 ± 0.0003 | np | np | 0.0 [g] ± 0.001 | np | np |
| Plutonium 239+240 | 0.0003 ± 0.001 | np | np | 0.0001 ± 0.0004 | np | np |
| Radium 226 | 0.005 ± 0.003 | np | np | 0.006 ± 0.003 | np | np |
| Radium 228 | 0.01 ± 0.02 | np | np | 0.01 ± 0.02 | np | np |
| Tritium | 21 ± 3 | np | np | 24 ± 3 | np | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.
b 'np' means the analysis was not planned for that sampling event.
c 'na' means not analyzed. (Not reported by analytical laboratory.)
d See **Table 9-1b** for list of constituents measured by EPA method 8082.
e 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.
f Nondetections of radioactive constituents are equal to, or are less than the 2σ uncertainty shown.
g The analytical laboratory reported the calculated value as zero.

**Table 9-7. Livermore site East Traffic Circle Landfill surveillance wells, 2001 (continued)**

| Constituents of concern[a] | W-119 | | | W-1306 | | |
|---|---|---|---|---|---|---|
| **Inorganics (µg/L)** | **Feb 05** | **May 08** | **Oct. 17** | **Jan 26** | **Apr 11** | **Oct. 17** |
| pH (pH units) | np[b] | np | 7.7 | np | np | 7.7 |
| Field pH (pH units) | 7.08 | 7.15 | 7.00 | np | np | 7.49 |
| Conductivity (µS/cm) | np | np | 870 | np | np | 1500 |
| Field conductivity (µS/cm) | 869 | 12.52 | 756 | np | np | 1470 |
| Total dissolved solids (TDS) (mg/L) | np | np | 510 | np | np | 990 |
| Water Temperature (°C) | 18.4 | 19.1 | 18.5 | np | np | 23 |
| Aluminum | np | np | < 200 | np | np | < 200 |
| Copper | < 10 | np | < 50 | < 10 | np | < 50 |
| Iron | np | np | < 100 | np | np | < 100 |
| Lead | < 5 | np | np | < 5 | np | np |
| Manganese | np | np | < 30 | np | np | < 30 |
| Nickel | np | np | < 100 | np | np | < 100 |
| Zinc | 11 | np | < 50 | < 10 | np | < 50 |
| **General minerals (mg/L)** | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | np | 250 | np | np | 380 |
| Calcium | np | np | 74 | np | np | 150 |
| Chloride | np | np | 75 | np | np | 230 |
| Fluoride | np | np | 0.44 | np | np | 0.37 |
| Magnesium | np | np | 24 | np | np | 53 |
| Nitrate (as NO3) | np | np | 37 | np | np | 50 |
| Ortho-Phosphate | np | np | 0.02 | np | np | 0.02 |
| Potassium | np | np | 3 | np | np | 4 |
| Sodium | np | np | 64 | np | np | 120 |
| Sulfate | np | np | 23 | np | np | 40 |
| Surfactants | np | np | < 0.5 | np | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | np | 280 | np | np | 590 |
| Total Phosphorus (as P) | np | np | < 0.05 | np | np | < 0.05 |
| **Organic (µg/L)[c]** | | | | | | |
| PCBs (EPA 8082) | np | nd[d] | np | 0.0 | nd | np |
| **Radioactive (Bq/L)[e]** | | | | | | |
| Americium 241 | 0.002 ± 0.002 | np | np | -0.0003 ± 0.002 | np | np |
| Plutonium 238 | 0.0009 ± 0.002 | np | np | 0.0 [f] ± 0.001 | np | np |
| Plutonium 239+240 | 0.0007 ± 0.0009 | np | np | -0.0001 ± 0.0003 | np | np |
| Radium 226 | -0.001 ± 0.003 | np | np | 0.008 ± 0.004 | np | np |
| Radium 228 | 0.00 ± 0.02 | np | np | 0.02 ± 0.02 | np | np |
| Tritium | 21 ± 3 | np | np | 9.7 ± 2.4 | np | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for list of constituents measured by EPA method 8082.

d 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.

e Nondetections of radioactive constituents are equal to, or are less than the 2σ uncertainty shown.

f The analytical laboratory reported the calculated value as zero.

**Table 9-7. Livermore site East Traffic Circle Landfill surveillance well, 2001 (concluded)**

| Constituents of concern[a] | W-906 | | |
|---|---|---|---|
| **Inorganics (µg/L)** | **Jan 26** | **Apr 11** | **Jul 19** |
| pH (pH units) | np[b] | np | 7.61 |
| Field pH (pH units) | np | np | 7.3 |
| Conductivity (µS/cm) | np | np | 1960 |
| Field conductivity (µS/cm) | np | np | 1963 |
| Total dissolved solids (TDS) (mg/L) | np | np | 1340 |
| Water Temperature (°C) | np | np | 23.5 |
| Aluminum | np | np | < 5 |
| Copper | < 10 | np | < 10 |
| Iron | np | np | < 50 |
| Lead | < 5 | np | na |
| Manganese | np | np | < 10 |
| Nickel | np | np | < 50 |
| Zinc | 43 | np | < 50 |
| **General minerals (mg/L)** | | | |
| Bicarbonate Alk (as $CaCO_3$) | np | np | 335 |
| Calcium | np | np | 170 |
| Chloride | np | np | 398 |
| Fluoride | np | np | 0.56 |
| Magnesium | np | np | 64 |
| Nitrate (as NO3) | np | np | 38 |
| Ortho-Phosphate | np | np | 0.099 |
| Potassium | np | np | 2 |
| Sodium | np | np | 140 |
| Sulfate | np | np | 65 |
| Surfactants | np | np | < 0.5 |
| Total Hardness (as $CaCO_3$) | np | np | 676 |
| Total Phosphorus (as P) | np | np | 0.05 |
| **Organic (µg/L)[c]** | | | |
| PCBs (EPA 8082) | np | nd[d] | np |
| **Radioactive (Bq/L)[e]** | | | |
| Americium 241 | 0.0007 ± 0.001 | np | np |
| Plutonium 238 | 0.0001 ± 0.0003 | np | np |
| Plutonium 239+240 | -0.00007 ± 0.0001 | np | np |
| Radium 226 | 0.002 ± 0.003 | np | np |
| Radium 228 | 0.004 ± 0.02 | np | np |
| Tritium | 4.5 ± 2.1 | np | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for list of constituents measured by EPA method 8082.

d 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.

e Nondetections of radioactive constituents are equal to, or are less than the 2σ uncertainty shown.

**Table 9-8. Livermore site near DWTF surveillance well, 2001**

| Constituents of concern[a] | W-593 |
|---|---|
| **Inorganics (µg/L)** | **Jul 18** |
| pH (pH units) | 7.73 |
| Field pH (pH units) | 7.33 |
| Conductivity (µS/cm) | 2320 |
| Field conductivity (µS/cm) | 2140 |
| Total dissolved solids (TDS) (mg/L) | 1400 |
| Water Temperature (°C) | 20.6 |
| Aluminum | < 50 |
| Copper | < 10 |
| Iron | < 50 |
| Manganese | < 10 |
| Nickel | < 50 |
| Zinc | < 50 |
| **General minerals (mg/L)** | |
| Bicarbonate Alk (as $CaCO_3$) | 276 |
| Calcium | 90 |
| Chloride | 449 |
| Fluoride | 1.1 |
| Magnesium | 53 |
| Nitrate (as $NO_3$) | 21 |
| Ortho-Phosphate | < 0.05 |
| Potassium | 2 |
| Sodium | 300 |
| Sulfate | 220 |
| Surfactants | < 0.5 |
| Total Hardness (as $CaCO_3$) | 444 |
| Total Phosphorus (as P) | < 0.05 |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

**Table 9-9. Livermore site Buildings 514/612 area surveillance wells, 2001**

| Constituents of concern[a] | W-270 | | W-359 | | GSW-011 | |
|---|---|---|---|---|---|---|
| **Inorganics (µg/L)** | **Jul 18** | **Oct 17** | **Jan 25** | **Oct 17** | **Feb 06** | **Oct 17** |
| pH (pH units) | 7.56 | 7.60 | np[b] | 7.80 | np | 7.80 |
| Field pH (pH units) | 6.63 | 7.08 | 7.34 | 6.67 | 7.24 | 7.67 |
| Conductivity (µS/cm) | 2660 | 1900 | np | 670 | np | 670 |
| Total dissolved solids (TDS) (mg/L) | 2510 | 2500 | np | na[c] | np | 500 |
| Water Temperature (°C) | 22.8 | 19.0 | 20. | 18.7 | 19.7 | 19.5 |
| Aluminum | < 100 | 300 | np | < 200 | np | < 200 |
| Copper | < 10 | < 50 | np | < 50 | np | < 50 |
| Iron | < 100 | 400 | np | < 30 | np | < 100 |
| Manganese | 90 | 100 | np | < 200 | np | < 30 |
| Mercury | np | np | < 0.2 | np | < 0.2 | np |
| Nickel | < 100 | < 100 | np | < 100 | np | < 100 |
| Zinc | < 100 | < 50 | np | < 50 | np | < 50 |
| **General minerals (mg/L)** | | | | | | |
| Bicarbonate Alk (as $CaCO_3$) | 356 | 340 | np | 160 | np | 330 |
| Calcium | 530 | 530 | np | 51 | np | 66 |
| Chloride | 51 | 46 | np | 74 | np | 40 |
| Fluoride | 0.64 | 0.70 | np | 0.31 | np | 0.43 |
| Magnesium | 65 | 61 | np | 22 | np | 29 |
| Nitrate | < 0.4 | < 0.1 | np | 28 | np | 32 |
| Ortho-Phosphate | 0.083 | 0.03 | np | 0.04 | np | 0.05 |
| Potassium | 2.6 | 5 | np | 3 | np | 4 |
| Sodium | 71 | 82 | np | 52 | np | 71 |
| Sulfate | 1400 | 900 | np | 17 | np | 21 |
| Surfactants | < 0.5 | < 0.5 | np | < 0.5 | np | 0.5 |
| Total Hardness (as $CaCO_3$) | 1580 | 1600 | np | 220 | np | 280 |
| Total Phosphorus (as P) | 0.06 | < 0.05 | np | 0.17 | np | 0.06 |
| **Organic (µg/L)[d]** | | | | | np | |
| PCBs (EPA 8082) | np | nd[e] | np | nd | np | nd |
| **Radioactive (Bq/L)[f]** | | | | | | |
| Tritium | np | np | 1.8 ± 2.2 | np | 3.3 ± 2.2 | np |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c 'na' means not analyzed (in error by analytical laboratory).

d See **Table 9-1b** for list of constituents measured by EPA method 8082.

e 'nd' means no EPA method constituent was detected above its RL. See **Table 9-1b** for method RLs.

f Nondetections of radioactive constituents are equal to, or are less than the 2σ uncertainty shown.

**Table 9-10. Livermore site metals surveillance wells, 2001**

| Constituents of concern[a] | W-307 | W-226 | W-306 |
|---|---|---|---|
| **Inorganic (µg/L)** | **Jan 31** | **Jan 31** | **Jan 31** |
| Field pH (pH units) | 7.20 | 7.68 | 7.40 |
| Field conductivity (µS/cm) | 1068 | 863 | 786 |
| Water Temperature (°C) | 16.1 | 16.5 | 20.1 |
| Aluminum | < 50 | < 50 | < 50 |
| Antimony | < 4 | < 4 | < 4 |
| Arsenic | < 2 | < 2 | < 2 |
| Barium | 290 | 160 | 96 |
| Beryllium | < 0.2 | < 0.2 | < 0.2 |
| Boron | 660 | 570 | 1,200 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 |
| Chromium | 19 | 32 | 42 |
| Chromium (VI) | 12 | 15 | 33 |
| Cobalt | < 50 | < 50 | < 50 |
| Copper | 2 | < 1 | < 1 |
| Iron | < 50 | < 50 | < 50 |
| Lead | < 5 | < 5 | < 5 |
| Manganese | < 10 | < 10 | < 10 |
| Mercury | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 |
| Nickel | < 2 | < 2 | < 2 |
| Selenium | < 2 | < 2 | < 2 |
| Silver | < 5 | < 5 | < 5 |
| Thallium | < 1 | < 1 | < 1 |
| Vanadium | < 10 | < 10 | < 10 |
| Zinc | < 20 | < 20 | < 20 |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

**Table 9-11. Livermore site Plutonium Facility surveillance wells, 2001**

| Constituents of concern | W-305 | W-101 | W-301 | W-148 | W-147 |
|---|---|---|---|---|---|
| **Inorganic (µg/L)** | **Feb 05** | **Jan 31** | **Jan 26** | **Jan 31** | **Jan 31** |
| Field pH (pH units) | 7.46 | 7.02 | 7.96 | 7.36 | 7.48 |
| Field conductivity (µS/cm) | 629 | 865 | 778 | 179 | 868 |
| Water Temperature (°C) | 19.8 | 20.3 | 16.8 | 18.6 | 19.0 |
| **Radioactive (Bq/L)**[a] | | | | | |
| Plutonium 238 | 0.0006 ± 0.0008 | 0.0003 ± 0.0005 | -0.0001 ± 0.0001 | -0.0001 ± 0.0003 | 0.0003 ± 0.0005 |
| Plutonium 239+240 | 0.0 [b] ± 0.0008 | 0.0003 ± 0.0005 | 0 [b] ± 0.0001 | -0.00007 ± 0.0005 | -0.0001 ± 0.0003 |

a Nondetections of plutonium are equal to, or are less than the 2σ uncertainty shown. Tritium monitoring results for groundwater from these wells are listed in **Table 9-14**.

b The analytical laboratory reported the calculated value as zero.

**Table 9-12. Livermore site Tritium Facility surveillance wells, 2001**

| Location | Screened in HSU | Sampling date | Tritium activity (Bq/L)[a] |
|---|---|---|---|
| **Upgradient from Tritium Facility (B331)** | | | |
| W-305 | 2 | Feb 05[b] | 5.4 ± 2.3 |
| | | Jul 19 | -1.6 ± 2.6 |
| | | Nov. 08 | 8.6 ± 2.6 |
| **Downgradient from Tritium Facility (B331)** | | | |
| SIP-331-001 | 2 | Mar 22 | 12.8 ± 2.7 |
| W-101 | 1B | Jan 31[b] | 10.9 ± 2.5 |
| W-147 | 1B | Jan 31[b] | 28.2 ± 3.7 |
| | | Jul 19 | 20.7 ± 3.6 |
| | | Oct 30 | 26.9 ± 3.7 |
| W-148 | 1B | Jan 31[b] | -1.2 ± 2.2 |
| | | Feb 26 | 3.3 ± 2.2 |
| | | Mar 22 | 24.0 ± 3.5 |
| | | May 17 | 5.8 ± 2.2 |
| | | Jul 19 | 8.7 ± 2.9 |
| | | Oct 30 | 56 ± 6.3 |
| W-301 | 2 | Jan 26[b] | 9.3 ± 2.4 |
| | | Feb 27 | 6.5 ± 2.3 |
| | | Mar 15 | 8.3 ± 2.4 |
| | | Apr 17 | 4.8 ± 2.4 |

a Nondetections of tritium are equal to, or are less than the 2σ uncertainty shown.

b Plutonium monitoring results for groundwater from these wells at these dates are listed in **Table 9-13**.

**Table 9-13. Livermore site Building 151 surveillance wells, 2001**

| Constituents of concern[a] | SIP-501-102 | SIP-141-201 | SIP-141-202 |
|---|---|---|---|
| **Inorganic (µg/L)** | **Nov 08** | **Nov 13** | **Nov 13** |
| pH (pH units) | 7.5 | 7.4 | 7.4 |
| Field pH (pH units) | 7.34 | 7.23 | 7.24 |
| Field conductivity (µS/cm) | 896 | 986 | 954 |
| Water Temperature (°C) | 19.6 | 18.4 | 19.0 |
| Antimony | < 5 | < 5 | < 5 |
| Arsenic | 3 | < 2 | < 2 |
| Barium | 180 | 100 | < 280 |
| Beryllium | < 0.5 | < 0.5 | 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 |
| Chromium | 22 | 18 | < 9 |
| Cobalt | < 25 | < 25 | 25 |
| Copper | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 |
| Selenium | < 5 | < 5 | < 5 |
| Silver | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 | < 2 |
| Vanadium | < 25 | < 25 | < 25 |
| Zinc | < 20 | < 20 | < 20 |
| **Organic (µg/L)[b]** | | | |
| EPA 8260 | | | |
| Carbon disulfide | 6 | < 5 | 6 |
| Carbon tetrachloride | < 1 | 1 | 2 |
| Chloroform | 3 | 5 | 3 |
| Freon 113 | 7 | 9 | 1 |
| Tetrachloroethene (PCE) | < 1 | 4 | < 1 |
| Trichloroethene (TCE) | 4 | < 1 | 69 |
| **Radioactive (Bq/L)[c]** | | | |
| Gross alpha | 0.057 ± 0.037 | 0.105 ± 0.052 | 0.044 ± 0.044 |
| Gross beta | 0.157 ± 0.041 | 0.169 ± 0.041 | 0.145 ± 0.041 |
| Americium 241 | 0.0005 ± 0.001 | 0.002 ± 0.001 | 0.0002 ± 0.0007 |
| Tritium | 14.7 ± 2.9 | 9.1 ± 2.6 | 8.9 ± 2.6 |
| Gamma Spectroscopy | nd[d] | nd | nd |

a Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

b See **Table 9-1b** for list of constituents measured by EPA Method 8260. No constituents were detected except for those listed.

c Nondetections of radioactive constituents are equal to, or are less than the 2σ uncertainty shown.

d 'nd' means no EPA Method 901.1 constituent was detected above its RL. See **Table 9-1c** for method RLs.

**Table 9-14. Site 300 Elk Ravine surveillance wells, 2001**

| Constituents of concern[a] | NC7-61 | | NC7-69 | | K2-04D | |
|---|---|---|---|---|---|---|
| | May 21 | Nov 15 | May 22 | Nov 15 | Jun 6 | Nov 14 |
| **Inorganic** | | | | | | |
| Arsenic | 15 | 18 | < 2 | < 2 | 11 | 12 |
| Barium | 83 | 82 | 25 | 26 | 36 | 36 |
| Berrylium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 | na[b] | 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 | na | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 | na | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 | na | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | 27 | np[c] | < 0.1 | np | 29 | np |
| Potassium (mg/L) | 5 | 5 | 6 | 6 | 4 | 4 |
| Selenium | < 2 | < 5 | < 2 | < 5 | na | < 5 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 | na | < 0.5 |
| Thallium | < 2 | < 2 | < 2 | < 2 | na | < 2 |
| Vanadium | 82 | 100 | < 25 | < 25 | 50 | 53 |
| Zinc | 20 | < 20 | < 20 | < 20 | < 20 | < 20 |
| **Organic[d]** | | | | | | |
| EPA Method 601 | nd[e] | nd | nd | nd | nd | nd |
| **Explosive** | | | | | | |
| HMX | < 1 | 4 | < 1 | < 1 | < 1 | < 1 |
| RDX | < 1 | 6 | < 1 | < 1 | < 1 | < 1 |
| **Radioactive[f]** | | | | | | |
| Gross alpha (Bq/L) | 0.02 ± 0.06 | 0.02 ± 0.03 | 0.005 ± 0.04 | 0.05 ± 0.03 | -0.04 ± 0.04 | 0.05 ± 0.03 |
| Gross beta (Bq/L) | 0.1 ± 0.06 | 0.2 ± 0.04 | 0.1 ± 0.04 | 0.2 ± 0.05 | 0.1 ± 0.04 | 0.1 ± 0.03 |
| Tritium (Bq/L) | 2200 ± 230 | 2100 ± 210 | -0.5 ± 2 | 0.1 ± 2 | 150 ± 15 | 160 ± 16 |
| Uranium (total, Bq/L) | 0.09 ± 0.01 | 0.09 ± 0.01 | 0.004 ± 0.003 | 0.002 ± 0.001 | 0.09 ± 0.01 | 0.09 ± 0.01 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'na' means not analyzed, because of a sampling error.

c 'np' means the analysis was not planned for that sampling event.

d See **Table 9-1b** for the EPA method 601 constituents and their RLs.

e 'nd' means no EPA method constituent was detected above its RL.

f Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-14. Site 300 Elk Ravine surveillance wells, 2001 (continued)**

| Constituents of concern[a] | K2-04S | | K2-01C | | NC2-12D | |
|---|---|---|---|---|---|---|
| | May 16 | Nov 14 | May 16 | Nov 14 | May 17 | Nov 14 |
| **Inorganic** | | | | | | |
| Arsenic | 15 | 15 | 8 | 6 | 11 | 13 |
| Barium | 58 | 57 | 33 | 48 | < 25 | < 25 |
| Berrylium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 | 1 | 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | 20 | 30 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | 35 | np[b] | 37 | np | 28 | np |
| Potassium (mg/L) | 5 | 5 | 5 | 7 | 5 | 5 |
| Selenium | < 2 | < 5 | < 2 | < 5 | < 2 | < 5 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Vanadium | 68 | 65 | 52 | 40 | 53 | 50 |
| Zinc | < 20 | < 20 | < 20 | < 20 | < 20 | 20 |
| **Organic[c]** | | | | | | |
| EPA Method 601 | nd[d] | nd | nd | nd | nd | nd |
| **Explosive** | | | | | | |
| HMX | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| RDX | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| **Radioactive[e]** | | | | | | |
| Gross alpha (Bq/L) | 0.02 ± 0.06 | 0.05 ± 0.03 | 0.05 ± 0.04 | 0.2 ± 0.07 | 0.06 ± 0.04 | 0.07 ± 0.03 |
| Gross beta (Bq/L) | 0.07 ± 0.05 | 0.2 ± 0.04 | 0.1 ± 0.05 | 0.3 ± 0.07 | 0.1 ± 0.05 | 0.2 ± 0.05 |
| Tritium (Bq/L) | 720 ± 74 | 730 ± 74 | 550 ± 56 | 400 ± 41 | 330 ± 33 | 320 ± 33 |
| Uranium (total, Bq/L) | 0.1 ± 0.02 | 0.1 ± 0.02 | 0.2 ± 0.02 | 0.4 ± 0.04 | 0.1 ± 0.02 | 0.1 ± 0.01 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for the EPA method 601 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-14. Site 300 Elk Ravine surveillance wells, 2001 (concluded)**

| Constituents of concern[a] | NC2-11D | | 812CRK (spring6) | | NC2-07 | |
|---|---|---|---|---|---|---|
| | May 17 | Nov 14 | May 21 | Nov 13 | May 16 | Nov 19 |
| **Inorganic** | | | | | | |
| Arsenic | 12 | 12 | 28 | 25 | 36 | 35 |
| Barium | < 25 | < 25 | 45 | 45 | 34 | 34 |
| Berrylium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | 3 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | 29 | np[b] | 11 | np | 17 | np |
| Potassium (mg/L) | 6 | 6 | 8 | 8 | 8 | 7 |
| Selenium | < 2 | < 5 | < 2 | < 5 | < 2 | < 5 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Vanadium | 51 | 49 | 60 | 55 | 50 | 48 |
| Zinc | < 20 | < 20 | < 20 | < 20 | < 20 | < 20 |
| **Organic[c]** | | | | | | |
| EPA Method 601 | nd[d] | nd | nd | nd | nd | nd |
| **Explosive** | | | | | | |
| HMX | < 1 | < 1 | < 1 | < 2 | < 1 | < 1 |
| RDX | < 1 | < 1 | < 1 | < 2 | < 1 | < 1 |
| **Radioactive[e]** | | | | | | |
| Gross alpha (Bq/L) | 0.09 ± 0.05 | 0.09 ± 0.04 | 0.03 ± 0.09 | 0.1 ± 0.06 | 0.1 ± 0.06 | 0.1 ± 0.05 |
| Gross beta (Bq/L) | 0.2 ± 0.06 | 0.2 ± 0.05 | 0.2 ± 0.07 | 0.3 ± 0.06 | 0.2 ± 0.06 | 0.3 ± 0.06 |
| Tritium (Bq/L) | 150 ± 16 | 160 ± 17 | 1 ± 2 | -0.7 ± 2 | 1 ± 2 | -0.8 ± 2 |
| Uranium (total, Bq/L) | 0.2 ± 0.02 | 0.8 ± 0.02 | 0.2 ± 0.02 | 0.2 ± 0.02 | 0.3 ± 0.03 | 0.2 ± 0.03 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for the EPA method 601 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-15a. Site 300 Pit 2 surveillance Barcads, 2001**

| Constituents of concern[a] | K1-02A[b] | K2-01A | |
|---|---|---|---|
| **Inorganic** | **May 30** | **May 30** | **Dec 17** |
| Arsenic | 14 | < 2 | < 2 |
| Barium | 37 | < 25 | 30 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | < 0.1 | < 0.1 | np[c] |
| Potassium (mg/L) | 5 | 7 | 5 |
| Selenium | < 2 | < 2 | < 4 |
| Silver | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 | < 1 |
| Vanadium | < 25 | < 25 | < 25 |
| Zinc | < 20 | < 20 | < 20 |
| **Explosive** | | | |
| HMX | < 5 | < 5 | < 5 |
| RDX | < 5 | < 5 | < 5 |
| **Radioactive**[d] | | | |
| Gross alpha (Bq/L) | 0.02 ± 0.03 | -0.04 ± 0.04 | -0.001 ± 0.02 |
| Gross beta (Bq/L) | 0.1 ± 0.04 | 0.1 ± 0.04 | 0.1 ± 0.04 |
| Tritium (Bq/L) | 2 ± 2 | 0.1 ± 2 | -1 ± 2 |
| Uranium (total, Bq/L) | 0.03 ± 0.003 | 0.003 ± 0.001 | 0.003 ± 0.002 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b Barcad K1-02A was not operational during the fourth quarter. No groundwater sample could be obtained.

c 'np' means the analysis was not planned for that sampling event.

d Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-15b. Site 300, Pit 2 surveillance Barcads, 2001**

| Constituents of concern[a] | K2-02A | | K2-02B | |
|---|---|---|---|---|
| **Inorganic** | **May 30** | **Dec 17** | **May 30** | **Dec 17** |
| Arsenic | 30 | 25 | < 2 | < 2 |
| Barium | < 25 | 30 | 26 | 30 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | < 0.1 | np[b] | < 0.1 | np |
| Potassium (mg/L) | 7 | 5 | 6 | 4 |
| Selenium | < 2 | < 4 | < 2 | < 4 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 1 | < 2 | < 1 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | < 20 | < 20 | < 20 | < 20 |
| **Explosive** | | | | |
| HMX | < 5 | < 5 | < 5 | < 5 |
| RDX | < 5 | < 5 | < 5 | < 5 |
| **Radioactive**[c] | | | | |
| Gross alpha (Bq/L) | 0.07 ± 0.07 | 0.01 ± 0.03 | 0.02 ± 0.03 | 0.01 ± 0.03 |
| Gross beta (Bq/L) | 0.2 ± 0.07 | 0.2 ± 0.05 | 0.1 ± 0.04 | 0.1 ± 0.04 |
| Tritium (Bq/L) | -1 ± 2 | 0.1 ± 2 | -0.1 ± 2 | -1 ± 2 |
| Uranium (total, Bq/L) | 0.1 ± 0.02 | 0.1 ± 0.02 | 0.001 ± 0.004 | 0.001 ± 0.005 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-15c. Site 300 Pit 2 surveillance well K1-01C, 2001**

| Constituents of concern[a] | Jan 18 | Apr 18 | Jul 9 | Oct 22 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Arsenic | 8 | 11 | 12 | 14 |
| Barium | < 25 | < 25 | < 25 | < 25 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | np[b] | 1 | np | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | 50 | 20 | 10 | < 10 |
| Iron (mg/L) | np | < 0.1 | np | < 0.1 |
| Lead | < 2 | < 2 | < 2 | < 2 |
| Manganese (mg/L) | np | < 0.1 | np | < 0.1 |
| Mercury | np | < 0.2 | np | < 0.2 |
| Nickel | < 5 | 6 | < 5 | < 5 |
| Nitrate (mg/L) | 26 | 8 | 21 | np |
| Potassium (mg/L) | 4 | 5 | 4 | 4 |
| Selenium | np | < 2 | np | < 5 |
| Silver | np | < 0.5 | np | < 0.5 |
| Sodium (mg/L) | np | 39 | np | 33 |
| Vanadium | 66 | 77 | 70 | 72 |
| Zinc | 30 | 30 | 20 | < 20 |
| **Organic**[c] | | | | |
| VOCs (EPA 601, or 624) | np | np | np | nd[d] |
| PCBs (EPA 8082) | np | np | np | nd |
| Semi-VOCs (EPA 625) | np | np | np | nd |
| Pesticides (EPA 608) | np | np | np | nd |
| TOC (mg/L) | np | np | np | 2 |
| **Explosive** | | | | |
| HMX | < 1 | < 1 | < 1 | < 1 |
| RDX | < 1 | < 1 | < 1 | < 1 |
| **Radioactive**[e] | | | | |
| Gross alpha (Bq/L) | 0.09 ± 0.04 | 0.1 ± 0.05 | 0.07 ± 0.03 | 0.05 ± 0.03 |
| Gross beta (Bq/L) | 0.1 ± 0.04 | 0.08 ± 0.04 | 0.1 ± 0.04 | 0.1 ± 0.04 |
| Radium 226 (Bq/L) | 0.03 ± 0.01 | 0.01 ± 0.005 | -0.005 ± 0.004 | 0.006 ± 0.005 |
| Tritium (Bq/L) | 14 ± 2.7 | 11 ± 2.6 | 12 ± 2.6 | 24 ± 3.5 |
| Uranium (total, Bq/L) | 0.1 ± 0.01 | 0.1 ± 0.01 | 0.1 ± 0.01 | 0.1 ± 0.01 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for EPA method (number) constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.
A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-16. Site 300 Pit 8 surveillance wells, 2001[a]**

| Constituents of concern[b] | K8-01 | K8-02B |
|---|---|---|
| **Inorganic** | **Jun 12** | **Jun 12** |
| Arsenic | 19 | 24 |
| Barium | < 25 | < 25 |
| Beryllium | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 |
| Chromium | 12 | 2 |
| Cobalt | < 25 | < 25 |
| Copper | < 10 | < 10 |
| Lead | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 |
| Nickel | < 5 | < 5 |
| Nitrate (mg/L) | 21 | 15 |
| Potassium (mg/L) | 7 | 7 |
| Selenium | < 2 | < 2 |
| Silver | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 |
| Vanadium | 75 | 69 |
| Zinc | < 20 | < 20 |
| **Organic**[c] | | |
| VOCs (EPA method 601) | nd (exc.)[d] | nd (exc.) |
| 1,2-Dichloroethane | 2.3 | < 0.5 |
| Trichloroethene | 4.9 | 2.2 |
| **Explosive** | | |
| HMX | < 1 | < 1 |
| RDX | < 1 | < 1 |
| **Radioactive**[e] | | |
| Gross alpha (Bq/L) | 0.11 ± 0.052 | 0.17 ± 0.063 |
| Gross beta (Bq/L) | 0.15 ± 0.056 | 0.42 ± 0.078 |
| Tritium (Bq/L) | 1.9 ± 2.2 | -0.63 ± 2.1 |
| Uranium (total, Bq/L) | 0.28 ± 0.023 | 0.38 ± 0.030 |

a Throughout 2001, well K8-03B was inaccessible, because of construction activities; well K8-04 was inaccessible, because of a bent casing; and well K8-05 was dry.

b Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses. Nondetections of nonradioactive constituents are shown as less than (<) the RL for that analysis.

c See **Table 9-1b** EPA method 601 constituents and their RLs.

d 'nd (exc.)' means no EPA method constituent was detected above its RL, except as listed.

e Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-17. Site 300 Pit 9 surveillance wells, 2001**

| Constituents of concern[a] | K9-01 | | K9-02 | |
|---|---|---|---|---|
| | Aug 14 | Dec 11 | Aug 14 | Dec 11 |
| **Inorganic** | | | | |
| Arsenic | 3 | 3 | 21 | 21 |
| Barium | < 25 | < 25 | < 25 | < 25 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | 31 | 27 | 47 | 47 |
| Nickel | 11 | < 5 | 7 | < 5 |
| Nitrate (mg/L) | 0.2 | np[b] | < 0.2 | np |
| Potassium (mg/L) | 16 | np | 40 | np |
| Selenium | < 2 | < 5 | < 2 | < 5 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 | < 2 | < 2 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | 40 | < 20 | 20 | < 20 |
| **Organic**[c] | | | | |
| VOCs (EPA method 601) | nd[d] | np | nd | np |
| **Explosive** | | | | |
| HMX | < 1 | np | < 1 | np |
| RDX | < 1 | np | < 1 | np |
| **Radioactive**[e] | | | | |
| Gross alpha (Bq/L) | -0.04 ± 0.06 | np | -0.001 ± 0.07 | np |
| Gross beta (Bq/L) | 0.4 ± 0.1 | np | 0.4 ± 0.09 | np |
| Tritium (Bq/L) | 3 ± 3 | np | -1 ± 3 | np |
| Uranium (total, Bq/L) | 0.005 ± 0.002 | np | 0.01 ± 0.003 | np |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.

Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for EPA method 601 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-17. Site 300 Pit 9 surveillance wells, 2001 (concluded)**

| Constituents of concern[a] | K9-03 | | K9-04 | |
|---|---|---|---|---|
| | Aug 14 | Dec 11 | Aug 14 | Dec 11 |
| **Inorganic** | | | | |
| Arsenic | 7 | 6 | < 2 | < 2 |
| Barium | < 25 | < 25 | < 25 | < 25 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | 27 | 27 | 26 | 26 |
| Nickel | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | < 0.1 | np[b] | < 0.1 | np |
| Potassium (mg/L) | 25 | np | 17 | np |
| Selenium | < 2 | < 5 | < 2 | < 2 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 2 | < 2 | < 2 | < 2 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | < 20 | < 20 | < 20 | < 20 |
| **Organic**[c] | | | | |
| VOCs (EPA method 601) | nd[d] | np | nd | np |
| **Explosive** | | | | |
| HMX | < 1 | np | < 1 | np |
| RDX | < 1 | np | < 1 | np |
| **Radioactive**[e] | | | | |
| Gross alpha (Bq/L) | -0.02 ± 0.06 | np | -0.06 ± 0.06 | np |
| Gross beta (Bq/L) | 0.5 ± 0.1 | np | 0.3 ± 0.07 | np |
| Tritium (Bq/L) | -5 ± 3 | np | -1 ± 2 | np |
| Uranium (total, Bq/L) | 0.02 ± 0.003 | np | 0.01 ± 0.003 | np |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.

Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for EPA method 601 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-18. Site 300 potable standby supply well 18, 2001**

| Constituents of concern[a] | Jan 17 | Apr 18 | Jul 18 | Oct 17 |
|---|---|---|---|---|
| **Organic**[b] | | | | |
| EPA method 502.2 | nd (exc.) | nd | nd (exc.) | nd |
| Trichloroethene (TCE) | 0.025 | < 0.20 | 0.22 | < 0.20 |
| **Radioactive**[c] | | | | |
| Gross alpha (Bq/L) | 0.03 ± 0.07 | -0.07 ± 0.08 | -0.01 ± 0.05 | -0.01 ± 0.07 |
| Gross beta (Bq/L) | 0.08 ± 0.05 | 0.2 ± 0.07 | 0.2 ± 0.06 | 0.1 ± 0.07 |
| Tritium (Bq/L) | 2 ± 2 | -0.4 ± 2 | -0.5 ± 2 | -0.7 ± 2 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b See **Table 9-1b** for EPA method 502.2 constituents and their RLs.
nd (exc.)' means no EPA method constituent was detected above its RL, except as listed.
nd' means no EPA method constituent was detected above its RL.

c Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.
A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-19. Site 300 potable supply well 20, 2001**

| Constituents of concern[a] | Jan 31 | Apr 30 | Jul 31 | Oct 29 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Arsenic | < 2 | < 2 | < 2 | < 2 |
| Barium | < 25 | < 25 | < 25 | < 25 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 8 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | < 0.5 | < 0.5 | < 0.1 | np[b] |
| Potassium (mg/L) | 9 | 13 | 9 | 9 |
| Selenium | < 2 | < 2 | < 4 | < 4 |
| Silver | < 5 | < 1 | < 1 | < 2 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | < 20 | < 20 | < 20 | < 20 |
| **Organic**[c] | | | | |
| EPA method 502.2 | nd[d] | nd | nd[e] | nd[f] |
| **Explosive** | | | | |
| HMX | < 5 | < 1 | < 5 | < 5 |
| RDX | < 5 | < 1 | < 5 | < 5 |
| **Radioactive**[g] | | | | |
| Gross alpha (Bq/L) | -0.02 ± 0.05 | -0.1 ± 0.1 | -0.04 ± 0.04 | -0.03 ± 0.04 |
| Gross beta (Bq/L) | 0.3 ± 0.07 | 0.2 ± 0.07 | 0.4 ± 0.1 | 0.2 ± 0.06 |
| Tritium (Bq/L) | -0.2 4 | -2 4 | -0.9 4 | -2 4 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses. Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for EPA method 502.2 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e Groundwater sample for VOC analysis obtained Aug 30.

f Groundwater sample for VOC analysis obtained Nov 29.

e Radioactive constituent nondetections are equal to, or are less than the 2-sigma uncertainty show A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-20. Site 300 off-site surveillance well CARNRW1, 2001**

| Constituents of concern | Jan 30 | Apr 30 | Jul 31 | Oct 29 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Perchlorate (mg/L) | np[a] | np | < 4 | np |
| **Organic**[b] | | | | |
| EPA method 601 | nd[c] | nd | nd | nd |
| **Radioactive** | | | | |
| Tritium (Bq/L)[d] | -2 ± 2 | -5 ± 2 | 1 ± 2 | -3 ± 2 |

a 'np' means the analysis was not planned for that sampling event.

b See **Table 9-1b** for the EPA method 601 constituents and their RLs.

c 'nd' means no EPA method 601 constituent was detected above its RL.

d The tritium measurements shown are calculated values that are below the RL for tritium.
A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-21. Site 300 off-site surveillance well CDF1, 2001**

| Constituents of concern[a] | Jan 30 | Apr 30 | Jul 31 | Oct 31 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Arsenic | 5 | 6 | 5 | 3 |
| Barium | 40 | 26 | 40 | 30 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | 2.9 | 1.2 | 3.7 | np[b] |
| Perchlorate (mg/L) | np | np | < 4 | < 4 |
| Potassium (mg/L) | 10 | 13 | 8.9 | 9 |
| Selenium | < 4 | < 2 | < 4 | < 2 |
| Silver | < 5 | < 0.5 | < 0.5 | < 2 |
| Thallium | < 1 | < 2 | < 1 | < 1 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | 120 | 70 | 130 | 20 |
| **Organic**[c] | | | | |
| EPA method 502.2 | nd[d] | nd | nd[e] | nd |
| EPA method 625 | np | np | nd | np |
| **Explosive** | | | | |
| HMX | < 5 | < 1 | < 5 | < 5 |
| RDX | < 5 | < 1 | < 5 | < 5 |
| **Radioactive**[f] | | | | |
| Gross alpha (Bq/L) | -0.07 ± 0.06 | -0.04 ± 0.05 | -0.001 ± 0.06 | -0.006 ± 0.03 |
| Gross beta (Bq/L) | 0.3 ± 0.06 | 0.3 ± 0.07 | 0.3 ± 0.07 | 0.2 ± 0.05 |
| Tritium (Bq/L) | -2 ± 2 | -2 ± 2 | -2 ± 2 | 2 ± 2 |
| Uranium (total, Bq/L) | np | np | 0.05 ± 0.02 | np |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for the EPA methods 502.2 and 625 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e The groundwater sample for the EPA method 502.2 analysis was obtained on August 15.

f Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-22. Site 300 off-site surveillance well CON1, 2001**

| Constituents of concern[a] | Jan 30 | Apr 30 | Jul 31 | Oct 31 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Arsenic | < 2 | < 2 | 2 | < 2 |
| Barium | 30 | < 25 | 30 | 30 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | 30 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | < 1 | < 1 | < 1 | np[b] |
| Perchlorate (mg/L) | np | np | < 4 | < 4 |
| Potassium (mg/L) | 11 | 18 | 10 | 10 |
| Selenium | < 4 | < 2 | < 4 | < 2 |
| Silver | < 5 | < 0.5 | < 0.5 | < 2 |
| Thallium | < 1 | < 2 | < 1 | < 1 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | 24 | < 20 | < 20 | < 20 |
| **Organic**[c] | | | | |
| EPA method 502.2 | nd[d] | nd | nd[e] | nd |
| EPA method 625 | np | np | nd | np |
| **Explosive** | | | | |
| HMX | < 5 | < 1 | < 5 | < 5 |
| RDX | < 5 | < 1 | < 5 | < 5 |
| **Radioactive**[f] | | | | |
| Gross alpha (Bq/L) | -0.1 ± 0.1 | -0.03 ± 0.08 | -0.03 ± 0.07 | -0.03 ± 0.06 |
| Gross beta (Bq/L) | 0.3 ± 0.1 | 0.2 ± 0.1 | 0.2 ± 0.07 | 0.2 ± 0.08 |
| Tritium (Bq/L) | -2 ± 2 | -0.6 ± 2 | -0.8 ± 2 | -4 ± 2 |
| Uranium (total, Bq/L) | np | np | 0.003 ± 0.001 | np |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for the EPA methods 502.2 and 625 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e The groundwater sample for the EPA method 502.2 analysis was obtained on August 15.

f Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

**Table 9-23. Site 300 off-site surveillance well GALLO1[a], 2001**

| Constituents of concern[b] | Jan 30 | May 30 | Jul 31 | Dec 18-20 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Arsenic | 5 | ns[c] | ns | 3 |
| Barium | 30 | ns | ns | < 25 |
| Beryllium | < 0.5 | ns | ns | < 0.5 |
| Cadmium | < 0.5 | ns | ns | < 0.5 |
| Chromium | < 1 | ns | ns | < 1 |
| Cobalt | < 25 | ns | ns | < 25 |
| Copper | < 10 | ns | ns | < 10 |
| Lead | < 2 | ns | ns | < 2 |
| Mercury | < 0.2 | ns | ns | < 0.2 |
| Molybdenum | < 25 | ns | ns | 40 |
| Nickel | < 5 | ns | ns | < 5 |
| Nitrate (mg/L) | 3 | < 0.5 | ns | np[d] |
| Potassium (mg/L) | 10 | ns | ns | 4 |
| Selenium | < 4 | ns | ns | < 4 |
| Silver | < 5 | ns | ns | < 1 |
| Thallium | < 1 | ns | ns | < 1 |
| Vanadium | < 25 | ns | ns | < 25 |
| Zinc | r[e] | ns | ns | < 20 |
| **Organic**[f] | | | | |
| EPA method 502.2 | nd | nd (exc.) | ns | nd (exc.) |
| Trichloroethene (TCE) | < 0.2 | 0.74 | | 0.65 |
| EPA method 625 | np | np | ns | np |
| **Explosive** | | | | |
| HMX | < 5 | < 5 | ns | < 5 |
| RDX | < 5 | < 5 | ns | < 5 |
| **Radioactive**[h] | | | | |
| Gross alpha (Bq/L) | -0.1 ± 0.06 | ns | ns | 0.01 ± 0.05 |
| Gross beta (Bq/L) | 0.2 ± 0.07 | ns | ns | 0.1 ± 0.05 |
| Tritium (Bq/L) | -1 ± 2 | ns | ns | 1 ± 2 |
| Uranium (total, Bq/L) | np | np | ns | np |

a Maintenance activities severely limited sampling of this private off-site well between January and December 2001.

b Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

c 'ns' means a groundwater sample could not be obtained for the analysis.

d 'np' means the analysis was not planned for that sampling event.

e 'r' means the analysis was deficient and was rejected.

f See **Table 9-1b** for the EPA methods 502.2 and 625 constituents and their RLs.
nd' means no EPA method constituent was detected above its RL.
nd (exc.)' means no EPA method constituent was detected above its RL, except as listed.

h Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.
A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-24. Site 300 off-site surveillance well CARNRW2, 2001**

| Constituents of concern[a] | Jan 30 | Apr 30 | Jul 31 | Oct 29 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Arsenic | 2 | 3 | 2 | < 2 |
| Barium | < 25 | < 25 | < 25 | < 25 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 8 |
| Mercury | < 0.2 | 0.2 | < 0.2 | < 0.2 |
| Molybdenum | 30 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | < 0.5 | < 0.1 | < 0.5 | np[b] |
| Perchlorate (mg/L) | np | np | < 4 | np |
| Potassium (mg/L) | 9 | 14 | 10 | 9 |
| Selenium | < 4 | < 2 | < 4 | < 4 |
| Silver | < 5 | < 0.5 | < 0.5 | < 2 |
| Thallium | < 1 | < 2 | < 1 | < 1 |
| Vanadium | < 25 | < 25 | < 25 | < 25 |
| Zinc | 24 | < 20 | < 20 | < 20 |
| **Organic**[c] | | | | |
| EPA method 502.2 | nd[d] | nd | nd[e] | nd |
| EPA method 625 | np | np | nd | np |
| **Explosive** | | | | |
| HMX | < 5 | < 1 | < 5 | < 5 |
| RDX | < 5 | < 1 | < 5 | < 5 |
| **Radioactive**[f] | | | | |
| Gross alpha (Bq/L) | -0.01 ± 0.06 | -0.05 ± 0.06 | -0.001 ± 0.06 | -0.03 ± 0.04 |
| Gross beta (Bq/L) | 0.3 ± 0.07 | 0.3 ± 0.07 | 0.2 ± 0.08 | 0.2 ± 0.06 |
| Tritium (Bq/L) | -1 ± 2 | -1 ± 2 | -0.1 ± 2 | -2 ± 2 |
| Uranium (total, Bq/L) | np | np | 0.007 ± 0.001 | np |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b 'np' means the analysis was not planned for that sampling event.

c See **Table 9-1b** for the EPA methods 502.2 and 625 constituents and their RLs.

d 'nd' means no EPA method constituent was detected above its RL.

e The ground water sample for the EPA method 502.2 analysis was obtained on August 17.

f Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.
A negative number means the sample radioactivity was less than the background radioactivity.

**Table 9-25. Site 300 off-site surveillance well CON2, 2001**

| Constituents of concern | Jan 30 | Apr 27 | Jul 31 | Oct 31 |
|---|---|---|---|---|
| **Inorganic** | | | | |
| Perchlorate (mg/L) | np[a] | np | < 4 | np |
| **Organic**[b] | | | | |
| EPA method 601 | nd[c] | nd | nd | nd |

a 'np' means the analysis was not planned for that sampling event.

b See **Table 9-1b** for the EPA method 601 constituents and their RLs.

c 'nd' means no EPA method 601 constituent was detected above its RL.

**Table 9-26. Site 300 annually monitored off-site surveillance wells, 2001**

| Constituents of concern[a] | MUL1 Sep 5 | MUL2 Sep 5 | STONEHAM1 Sep 6 | VIE1 Sep 5 | VIE2 Sep 5 | W-35A-04 Aug 27 |
|---|---|---|---|---|---|---|
| **Inorganic** | | | | | | |
| Arsenic | 5 | < 2 | < 2 | 13 | < 2 | 3 |
| Barium | 30 | < 25 | 40 | 50 | 30 | 71 |
| Berrylium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Cobalt | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| Copper | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 |
| Lead | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Mercury | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Molybdenum | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| Nickel | < 5 | < 5 | 14 | < 5 | < 5 | < 5 |
| Nitrate (mg/L) | 9 | 14 | < 1 | 30 | 24 | 9 |
| Perchlorate (mg/L) | < 4 | < 4 | < 4 | < 4 | < 4 | < 4 |
| Potassium (mg/L) | 6 | 9 | 8 | 8 | 3 | 7 |
| Selenium | < 4 | < 4 | < 10 | < 4 | < 4 | < 4 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Vanadium | < 25 | < 25 | < 25 | 30 | < 25 | < 25 |
| Zinc | 49 | < 20 | 34 | < 20 | < 20 | 34 |
| **Organic[b]** | | | | | | |
| EPA method 502.2 | nd[c] | nd | nd | nd | nd | nd |
| EPA method 625 | nd | nd | nd | nd | nd | nd |
| **Explosive** | | | | | | |
| HMX | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| RDX | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| **Radioactive[d]** | | | | | | |
| Gross alpha (Bq/L) | 0.05 ± 0.04 | 0.04 ± 0.07 | 0.2 ± 0.1 | 0.04 ± 0.04 | 0.06 ± 0.06 | 0.2 ± 0.1 |
| Gross beta (Bq/L) | 0.2 ± 0.05 | 0.3 ± 0.07 | 0.4 ± 0.1 | 0.2 ± 0.05 | 0.2 ± 0.1 | 0.2 ± 0.1 |
| Tritium (Bq/L) | -0.4 ± 2 | -3 ± 2 | -2 ± 2 | -1 ± 2 | -1 ± 2 | -1 ± 3 |
| Uranium (total, Bq/L) | 0.1 ± 0.01 | 0.03 ± 0.004 | 0.5 ± 0.04 | 0.1 ± 0.01 | 0.2 ± 0.02 | 0.2 ± 0.01 |

a Constituent units are µg/L (parts per billion) unless otherwise shown in parentheses.
Constituent nondetections other than radioactive are shown as less than (<) the RL for that analysis.

b See **Table 9-1b** for the EPA methods 502.2 and 625 constituents and their RLs.

c 'nd' means no EPA method constituent was detected above its RL.

d Radioactive constituent nondetections are equal to, or are less than the 2σ uncertainty shown.

# Soil and Sediment Monitoring

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## Surface Soil Methods

Prior to 1988, surface soil samples were collected at sites selected at random from Livermore Valley locations. These sites had been previously sampled for a 1971–1972 study conducted to determine background concentrations of radionuclides in area soils. In 1988, Livermore Valley surface soil sampling locations were chosen to coincide with air sampling locations to cover areas with contaminants from past incidents or to sample other areas of special concern (see **Figure 10-1**, in the main volume). In 1991, five additional soil sampling locations associated with air sampling locations were established. The 2001 Livermore Valley surface soil samples were collected from generally the same locations as those in 1991 to 2000.

The 2001 Site 300 soil samples were collected from the same 14 locations as those sampled between 1990 and 1998, and 2000. The PRIM location, which was sampled in 1999, became inaccessible and was removed from the sampling program in 2000 because the site owner discontinued operations. Analysis for plutonium in Site 300 soils was discontinued in 1997 because plutonium has not been used at the site, and sample results have continuously been at background levels since sampling began in 1972. The use of established sampling locations is preferred, when possible, from year to year because it allows us to determine more meaningful trends in data.

Sampling locations at areas with known or suspected contaminants were monitored to delimit the extent of the contaminants and to track the contaminants from year to year. For example, six surface soil sampling locations are used to monitor soils near the Livermore Water Reclamation Plant (LWRP). These soils contain slightly elevated plutonium levels due to the resuspension of sludge that had been contaminated from a significant accidental release in 1967, as well as other releases to the sewer. Surface soil sampling is conducted according to written, standardized procedures contained in the *Environmental Monitoring Plan* (Tate et al. 1999). Samples are collected from undisturbed areas near the permanent sampling location marker. These areas generally are level, free of rocks, and unsheltered by trees or buildings. The sampling technicians choose two 1 m squares from which to collect the sample and record how far away and in what direction from the permanent marker the sample is collected. Each sample is a composite consisting of 10 subsamples that are collected with an 8.25 cm diameter stainless steel core sampler at the corners and the center of each square. All subsamples are collected from the top 5 cm of soil because surface deposition from the air is the primary pathway for potential contamination.

Quality assurance (QA) duplicate samples are submitted with each batch of soil samples. At locations chosen for duplicate sampling, two identical samples are obtained by collecting adjacent cores from the corners and center of the

sampling squares. Separate composites of 10 cores each are made, and the duplicate samples are identified with unique sample identifier codes.

Surface soil samples are dried, ground, sieved, and homogenized. Samples are analyzed by LLNL's Chemistry and Materials Science Environmental Services (CES) laboratory. The plutonium content of a 100 g sample aliquot is determined by alpha spectroscopy (Hall and Edwards 1994c). Other sample aliquots (300 g) are analyzed for more than 150 radionuclides by gamma spectroscopy, using a high-purity germanium (HPGe) detector (Hall and Edwards 1994a, b, and c). Only those nuclides measured above detection limits or of particular interest are reported. The 10 g subsamples of samples from Site 300 are sent to a contract analytical laboratory and are analyzed by atomic absorption spectroscopy (EPA Method 7091) for beryllium. Chain-of-custody procedures are followed throughout the sampling, delivery, and analytical processes.

## Surface Sediment Methods

Surface samples of a sediment are collected from arroyos and storm water drainages at and around the Livermore site after the cessation of spring runoff. For 2001, samples were analyzed for radionuclides.

Sediment was sampled from seven Livermore site drainages. The sediment sampling locations coincide with storm water runoff sampling locations so that the sampling results from these two media can be compared.

All surface sediment locations are marked by a permanent location marker, which serves as a reference point for each sampling location. Ten subsamples, 5-cm deep, are collected at 1-m intervals along a transect of the arroyo or drainage channel. At one of the subsample locations, a 15 cm deep sample is acquired for tritium analysis. The sample collection technicians record how far away and in what direction from the permanent marker the samples are actually collected. As with soil samples, QA samples are submitted with each batch of sediment samples.

Samples are analyzed by LLNL's CES laboratory. For samples collected for tritium analyses, CES uses freeze-drying techniques to recover water from the samples and determines the tritium content of the water by liquid-scintillation counting. The plutonium content of a sample aliquot is determined by alpha spectroscopy. Other sample aliquots are analyzed for radionuclides using gamma spectroscopy as described above for surface soil samples. The radioanalytical methods employed by the CES laboratory enable detection of concentrations at levels far more sensitive than regulatory limits. Chain-of-custody procedures are followed throughout the sampling, delivery, and analytical processes.

## Vadose Zone Soil Methods

Vadose zone soil samples are collected at the same locations as the surface sediments. One of the 10 surface subsample locations is selected for collection of the deeper vadose zone samples. A hand auger is used to collect a 30 to 45 cm deep sample, which is submitted for analysis for total metals by EPA Methods 200.7, 245.2, 7471A and 6010B. Soluble extraction and metals analyses are carried out by California's Waste Extraction Test, followed by the same analyses used for total metals on that extract. Through the use of an electric drive, a sample is collected at 45–65 cm deep for analysis of polychlorinated biphenyls by EPA Method 8082 and for soluble extraction of volatile organic compounds by

EPA's Toxicity Characteristic Leaching Procedure (EPA Method 1311), followed by EPA Method 8260 analysis. Chain-of-custody procedures are followed throughout the sampling, delivery, and analytical processes.

## Data

Table 10-1 presents the analytical data for gamma-emitting radionuclides for surface soil and sediment samples collected in 2001 in the Livermore Valley and Livermore site. Table 10-2 presents the data for background and fallout radionuclides, which include cesium-137, potassium-40, and thorium-232, for samples collected at Site 300.

The data generally reflect historic data values for these analytes at these locations. A detailed discussion of results is provided in the main volume of this report. Tables 10-3 and 10-4 list background levels for total and soluble metals in soils and sediments and de minimis concentrations for organics, respectively. Table 10-5 presents analytical values for soluble volatile organic compounds in Livermore site sediments. Tables 10-6 and 10-7 give results for total and dissolved metals, respectively

**Table 10-1. Gamma-emitting background and fallout radionuclides in soil and sediment in the Livermore Valley, 2001**

| Location identifier | Cesium-137 Bq/dry g | Potassium-40 Bq/dry g | Thorium-232[a] µg/dry g | Uranium-235[b] µg/dry g | Uranium-238[c] µg/dry g | U235/U238 ratio |
|---|---|---|---|---|---|---|
| **Livermore Valley soil** | | | | | | |
| L-AMON-SO | 0.0022 ± 0.00021 | 0.492 ± 0.00988 | 8.0 ± 0.22 | 0.020 ± 0.0042 | 2.1 ± 1.1 | 0.010 ± 0.0054 |
| L-CHUR-SO | 0.0046 ± 0.00030 | 0.514 ± 0.0248 | 8.7 ± 0.26 | 0.022 ± 0.011 | 2.0 ± 1.4 | 0.011 ± 0.0095 |
| L-COW-SO | <0.000091 | 0.492 ± 0.0138 | 8.1 ± 0.23 | 0.020 ± 0.011 | 1.7 ± 1.1 | 0.012 ± 0.010 |
| L-FCC-SO | 0.0018 ± 0.00026 | 0.374 ± 0.0120 | 6.1 ± 0.18 | 0.019 ± 0.0096 | 1.3 ± 0.79 | 0.015 ± 0.012 |
| L-HOSP-SO | 0.0057 ± 0.00038 | 0.385 ± 0.0123 | 5.5 ± 0.14 | 0.016 ± 0.0084 | 1.3 ± 0.75 | 0.012 ± 0.0094 |
| L-MESQ-SO | 0.00083 ± 0.00024 | 0.518 ± 0.0207 | 8.3 ± 0.21 | 0.022 ± 0.0089 | 2.0 ± 1.2 | 0.011 ± 0.0080 |
| L-MET-SO | 0.0013 ± 0.00030 | 0.522 ± 0.0125 | 7.2 ± 0.17 | 0.016 ± 0.0081 | 1.6 ± 0.65 | 0.010 ± 0.0065 |
| L-NEP-SO | 0.0017 ± 0.00028 | 0.474 ± 0.0104 | 6.9 ± 0.15 | 0.014 ± 0.0078 | 1.4 ± 0.70 | 0.010 ± 0.0075 |
| L-PATT-SO | 0.00072 ± 0.00018 | 0.525 ± 0.0158 | 8.0 ± 0.21 | 0.021 ± 0.0086 | 1.9 ± 0.95 | 0.011 ± 0.0071 |
| L-SALV-SO | 0.00097 ± 0.00025 | 0.389 ± 0.0101 | 7.8 ± 0.19 | 0.020 ± 0.0099 | 2.2 ± 0.91 | 0.0091 ± 0.0059 |
| L-TANK-SO | 0.0035 ± 0.00026 | 0.291 ± 0.00873 | 6.5 ± 0.16 | 0.018 ± 0.0093 | 1.6 ± 0.78 | 0.011 ± 0.0078 |
| L-VIS-SO | 0.00067 ± 0.00018 | 0.274 ± 0.00877 | 5.0 ± 0.13 | 0.013 ± 0.0075 | 1.4 ± 0.56 | 0.0093 ± 0.0065 |
| L-ZON7-SO | 0.0037 ± 0.00020 | 0.392 ± 0.0117 | 7.4 ± 0.19 | 0.020 ± 0.0078 | 1.6 ± 0.90 | 0.013 ± 0.0089 |
| **Median** | 0.0017 | 0.474 | 7.4 | 0.020 | 1.6 | 0.011 |
| **IQR** | 0.0027 | 0.129 | 1.5 | 0.0040 | 0.60 | 0.0020 |
| **Maximum** | 0.0057 | 0.525 | 8.7 | 0.022 | 2.2 | 0.015 |
| **LWRP soil** | | | | | | |
| L-WRP1-SO | 0.0041 ± 0.00024 | 0.422 ± 0.0101 | 6.8 ± 0.16 | 0.018 ± 0.0039 | 1.4 ± 0.84 | 0.013 ± 0.0083 |
| L-WRP2-SO | 0.0029 ± 0.00031 | 0.369 ± 0.0103 | 7.4 ± 0.18 | 0.017 ± 0.0093 | 1.6 ± 0.69 | 0.011 ± 0.0077 |
| L-WRP3-SO | 0.00043 ± 0.00021 | 0.337 ± 0.00877 | 7.1 ± 0.16 | 0.015 ± 0.0068 | 1.6 ± 1.1 | 0.0094 ± 0.0077 |
| L-WRP4-SO | 0.00038 ± 0.00019 | 0.336 ± 0.0107 | 7.3 ± 0.22 | 0.017 ± 0.0069 | 1.7 ± 0.96 | 0.010 ± 0.0070 |
| L-WRP5-SO | 0.00082 ± 0.00015 | 0.418 ± 0.0117 | 7.1 ± 0.18 | 0.019 ± 0.0038 | 1.9 ± 0.82 | 0.010 ± 0.0048 |
| L-WRP6-SO | 0.0010 ± 0.00017 | 0.422 ± 0.0127 | 7.2 ± 0.19 | 0.019 ± 0.0045 | 2.6 ± 1.0 | 0.0073 ± 0.0033 |
| **Median** | 0.00091 | 0.394 | 7.2 | 0.018 | 1.7 | 0.010 |
| **IQR** | 0.0019 | 0.0760 | 0.18 | 0.0018 | 0.25 | 0.0012 |
| **Maximum** | 0.0041 | 0.422 | 7.4 | 0.019 | 2.6 | 0.013 |
| **Livermore site surface sediment** | | | | | | |
| L-ALPE-SD | 0.00031 ± 0.00015 | 0.374 ± 0.0112 | 4.4 ± 0.13 | 0.013 ± 0.011 | 2.0 ± 1.6 | 0.0065 ± 0.0076 |
| L-ASS2-SD | 0.00035 ± 0.00018 | 0.455 ± 0.0128 | 4.0 ± 0.13 | 0.012 ± 0.0068 | 1.4 ± 1.0 | 0.0086 ± 0.0077 |
| L-ASW-SD | 0.00030 ± 0.00027 | 0.463 ± 0.0111 | 3.5 ± 0.13 | 0.0068 ± 0.0054 | 0.83 ± 0.80 | 0.0082 ± 0.010 |
| L-ESB-SD | 0.00072 ± 0.00019 | 0.407 ± 0.0098 | 6.2 ± 0.15 | 0.015 ± 0.0071 | 1.7 ± 1.3 | 0.0088 ± 0.0079 |
| L-GRNE-SD | 0.00070 ± 0.00021 | 0.481 ± 0.0096 | 6.0 ± 0.12 | 0.013 ± 0.0075 | 1.4 ± 0.31 | 0.0093 ± 0.0057 |
| L-WPDC-SD | <0.000057 | 0.522 ± 0.0125 | 8.7 ± 0.19 | 0.024 ± 0.0081 | 2.0 ± 0.59 | 0.012 ± 0.0054 |
| **Median** | 0.00033 | 0.459 | 5.2 | 0.013 | 1.6 | 0.0087 |
| **IQR** | 0.00031 | 0.0575 | 2.1 | 0.0023 | 0.53 | 0.00087 |
| **Maximum** | 0.00072 | 0.522 | 8.7 | 0.024 | 2.0 | 0.012 |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2σ counting error) or as being less than or equal to 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 non-detection. See the main volume, Chapter 14.

a Thorium-232 activities can be determined by multiplying the mass concentration provided in the table in µg/dry g by specific activity of thorium-232, i.e., 0.004044 Bq/µg, or 0.1093 pCi/µg.

b Uranium-235 activities can be determined by multiplying the mass concentration provided in the table in µg/dry g by specific activity of uranium-235, i.e., 0.080 Bq/µg, or 2.16 pCi/µg.

c Uranium-238 activities can be determined by multiplying the mass concentration provided in the table in µg/dry g by specific activity of uranium-238, i.e., 0.01245 Bq/µg, or 0.3367 pCi/µg.

**Table 10-2. Background and fallout radionuclides in soil at Site 300, 2001**

| Location identifier | Cesium-137 Bq/dry g | Potassium-40 Bq/dry g | Thorium-232[a] µg/dry g |
|---|---|---|---|
| 3-801E-SO | 0.0013 ± 0.0031 | 0.392 ± 0.0125 | 9.5 ± 0.21 |
| 3-801N-SO | 0.0024 ± 0.0025 | 0.448 ± 0.0161 | 12 ± 0.40 |
| 3-801W-SO | 0.0023 ± 0.0023 | 0.481 ± 0.0116 | 9.0 ± 0.20 |
| 3-812N-SO | <0.00010 | 0.396 ± 0.0111 | 5.6 ± 0.17 |
| 3-834W-SO | 0.0039 ± 0.00027 | 0.477 ± 0.0181 | 13 ± 0.30 |
| 3-851N-SO | 0.0014 ± 0.0002 | 0.444 ± 0.0116 | 15 ± 0.29 |
| 3-856N-SO | 0.0018 ± 0.00027 | 0.360 ± 0.0101 | 9.9 ± 0.22 |
| 3-858S-SO | 0.0033 ± 0.00035 | 0.548 ± 0.0131 | 11 ± 0.23 |
| 3-DSW-SO | 0.0033 ± 0.00022 | 0.385 ± 0.0100 | 8.9 ± 0.18 |
| 3-EOBS-SO | 0.00073 ± 0.0002 | 0.488 ± 0.0165 | 11 ± 0.33 |
| 3-EVAP-SO | 0.00065 ± 0.00025 | 0.353 ± 0.0127 | 8.8 ± 0.19 |
| 3-GOLF-SO | 0.00061 ± 0.00026 | 0.459 ± 0.0119 | 8.9 ± 0.19 |
| 3-NPS-SO | 0.0031 ± 0.00025 | 0.585 ± 0.0163 | 8.9 ± 0.23 |
| 3-WOBS-SO | 0.0042 ± 0.00022 | 0.385 ± 0.0115 | 8.0 ± 0.22 |
| **Median** | 0.0021 | 0.446 | 9.3 |
| **IQR** | 0.0024 | 0.0932 | 2.1 |
| **Maximum** | 0.0042 | 0.585 | 15 |

**Note:** Radioactivities are reported as the measured concentration and either an uncertainty (±2σ counting error) or as being less than or equal to 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 non-detection. See the main volume, Chapter 14.

a Thorium-232 activities can be determined by multiplying the mass concentration provided in the table in µg/dry g by specific activity of thorium-232, i.e., 0.004044 Bq/µg, or 0.1093 pCi/µg.

**Table 10-3. Background concentration values for metals in soils at the Livermore site**

| Metal | Background screening value Total (mg/kg wet weight soil) |
|---|---|
| Antimony | 1.12 |
| Arsenic | 8.51 |
| Barium | 308 |
| Beryllium | 0.62 |
| Cadmium | 1.59 |
| Chromium | 72.4 |
| Chromium(VI) | Any detection |
| Cobalt | 14.6 |
| Copper | 62.5 |
| Lead | 43.7 |
| Mercury | 0.14 |
| Molybdenum | Any detection |
| Nickel | 82.8 |
| Selenium | Any detection |
| Silver | Any detection |
| Thallium | Any detection |
| Vanadium | 65.2 |
| Zinc | 75.3 |

| Metal | Background screening value Soluble (mg/L) |
|---|---|
| Antimony | Any detection |
| Arsenic | 0.237 |
| Barium | 16.7 |
| Beryllium | Any detection |
| Boron | To be determined |
| Cadmium | Any detection |
| Chromium | 0.727 |
| Cobalt | 0.985 |
| Copper | 2.6 |
| Iron | To be determined |
| Lead | 0.987 |
| Manganese | To be determined |
| Mercury | 0.0063 |
| Molybdenum | Any detection |
| Nickel | 1.68 |
| Selenium | Any detection |
| Silver | Any detection |
| Thallium | Any detection |
| Vanadium | 1.22 |
| Zinc | 4.52 |

**Note:** Background values were developed for all soils and sediments at the Livermore site but are used here as a basis for comparison for analytical results for vadose zone soils.

**Table 10-4. De minimis concentration levels for organic and radioactive constituents of concern found in Livermore site soils and sediments**

| Constituents | Water quality objective | Reference | Attenuation factor | De minimis level |
|---|---|---|---|---|
| **Organics (µg/L)** | | | | |
| 1,2-Dichlorobenzene | 600 | CA Primary MCL[a] | 100 | 3000 |
| 1,3-Dichlorobenzene | 600 | CA DHS Action Level | 100 | 650 |
| 1-4-Dichlorobenzene | 5 | Cal Primary MCL | 100 | 25 |
| 1,1-Dichloroethane | 5 | Cal Primary MCL | 100 | 25 |
| 1-2-Dichloroethane | 0.5 | Cal Primary MCL | 100 | 2.5 |
| 1,1-Dichloroethene | 6 | Cal Primary MCL | 100 | 30 |
| 1,2-Dichloroethene | 6 | Cal Primary MCL | 100 | 30 |
| *cis*-1,2-Dichloroethene | 6 | Cal Primary MCL | 100 | 30 |
| *trans*-1,2-Dichloroethene | 10 | Cal Primary MCL | 100 | 50 |
| 1,1,1-Trichloroethane | 200 | Cal Primary MCL | 100 | 1000 |
| 1,1,2-Trichloroethane | 5 | Cal Primary MCL | 100 | 25 |
| Benzene | 1 | Cal Primary MCL | 100 | 5 |
| Carbon tetrachloride | 0.5 | Cal Primary MCL | 100 | 2.5 |
| Chlorobenzene | 70 | Cal Primary MCL | 100 | 350 |
| Chloroform | 100 | EPA Primary MCL | 100 | 400 |
| Diesel oil/kerosene | 100 | SNARL[b] | 100 | 500 |
| Ethyl benzene | 700 | Cal Primary MCL | 100 | 3500 |
| Freon 11 (trichlorofluoromethane) | 150 | Cal Primary MCL | 100 | 750 |
| Freon 12 (dichlorodifluoromethane) | 1000 | CA DHS Action Level | 100 | 5000 |
| Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane) | 1200 | Cal Primary MCL | 100 | 6000 |
| Gasoline | 5 | Other[c] | 100 | 25 |
| Methylene chloride | 5 | Cal Primary MCL | 100 | 25 |
| Methyl tertiary-butyl ether (MTBE) | 13 | Cal Primary MCL | 100 | 65 |
| Tetrachloroethene (PCE) | 5 | Cal Primary MCL | 100 | 25 |
| Toluene | 150 | Cal Primary MCL | 100 | 750 |
| Trichloroethene (TCE) | 5 | Cal Primary MCL | 100 | 25 |
| Xylene(s) | 1750 | Cal Primary MCL | 100 | 8750 |
| PCB (total) | 0.5 | Cal Primary MCL | 100 | 2.5 |
| Vinyl chloride | 0.5 | Cal Primary MCL | 100 | 2.5 |

**Table 10-4. De minimis concentration levels for organic and radioactive constituents of concern found in Livermore site soils and sediments (concluded)**

| Constituents | Water quality objective | Reference | Attenuation factor | De minimis level |
|---|---|---|---|---|
| **Radioactivity (Bq/L)** | | | | |
| Gross alpha | 0.56 | Cal Primary MCL | 100 | 5.6 |
| Gross beta | 1.9 | Cal Primary MCL | 100 | 19 |
| Tritium | 740 | Cal Primary MCL | 100 | 7400 |

**Note:** De minimis values were developed for all soils and sediments at the Livermore site but are used here as a basis for comparison for analytical results for vadose zone soils.

a MCL = Maximum contaminant level

b SNARL = Suggested No Adverse Response Level

c Other = Taste and odor threshold for gasoline

**Table 10-5. Concentrations of volatile organic compounds in Livermore site vadose zone soil obtained by TCLP extraction by EPA Method 1311, followed by analysis by EPA Method 8260, 2001**

| Organic compounds (ug/L)[a] | ASS2 | ASW | ALPE | GRNE | WPDC | ESB |
|---|---|---|---|---|---|---|
| Benzene | < 25 | < 25 | < 25 | < 25 | < 25 | < 200 |
| Carbon tetrachloride | < 13 | < 13 | < 13 | < 13 | < 13 | < 100 |
| Chlorobenzene | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |
| Chloroform | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |
| 1,1-Dichloroethene | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |
| 1,2-Dichloroethane | < 13 | < 13 | < 13 | < 13 | < 13 | < 100 |
| 1,4-Dichlorobenzene | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |
| 2-Butanone | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |
| Trichloroethene (TCE) | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |
| Vinyl chloride | < 50 | < 50 | < 50 | < 50 | < 50 | < 400 |

a Reporting limits at all locations were elevated due to matrix interferences.

**Table 10-6. Total metals in Livermore site vadose zone soil, 2001**

| Total metals (mg/kg wet weight soil)[a] | Arroyo Seco | | Arroyo Los Positas | | | Drainage Retention Basin |
|---|---|---|---|---|---|---|
| | Influent | Effluent | Influent | | Effluent | Influent |
| | ASS2 | ASW | ALPE | GRNE | WPDC | ESB |
| Antimony | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Arsenic | 2 | 2.2 | 2.2 | 2.4 | 2.8 | 2.1 |
| Barium | 55 | 73 | 120 | 68 | 200 | 110 |
| Beryllium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Chromium | 15 | 19 | 17 | 27 | 27 | 22 |
| Cobalt | 6 | 6 | 6 | 6 | 8 | 8 |
| Copper | 9 | 12 | 11 | 14 | 18 | 15 |
| Lead | < 10 | < 10 | 40 | 20 | < 10 | < 10 |
| Mercury | < 0.05 | 0.06 | < 0.05 | < 0.05 | 0.05 | 0.09 |
| Molybdenum | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| Nickel | 26 | 28 | 30 | 43 | 36 | 30 |
| Potassium | 870 | 960 | 860 | 400 | 1400 | 940 |
| Selenium | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Silver | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 |
| Thallium | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| Vanadium | 15 | 15 | 16 | 13 | 22 | 19 |
| Zinc | 33 | 53 | 36 | 19 | 31 | 47 |

a None of these metals' concentrations exceeds site background concentrations.

**Table 10-7. Soluble metals in Livermore site vadose zone soil, 2001**

| Soluble Metals (mg/L) | Arroyo Seco | | Arroyo Las Positas | | | Drainage Retention Basin |
|---|---|---|---|---|---|---|
| | Influent | Effluent | Influent | | Effluent | Influent |
| | ASS2 | ASW | ALPE | GRNE | WPDC | ESB |
| Antimony | < 0.06 | 1.6 | < 0.06 | < 0.06 | < 0.06 | < 0.06 |
| Arsenic | 0.07 | 0.16 | 0.09 | 0.12 | < 0.05 | 0.08 |
| Barium | 3.7 | 4.3 | 5.3 | 3.7 | 9.4 | 7 |
| Beryllium | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 | < 0.04 |
| Boron | < 0.5 | < 0.5 | 0.7 | < 0.5 | 0.9 | < 0.5 |
| Cadmium | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| Chromium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cobalt | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Copper | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Iron | 27 | 38 | 35 | 52 | 20 | 44 |
| Lead | < 0.5 | –[a] | 2 | 1.5 | < 0.5 | < 0.5 |
| Manganese | 21 | 19 | 16 | 3.2 | 18 | 30 |
| Mercury | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Molybdenum | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Nickel | < 0.5 | < 0.5 | 0.5 | 0.6 | 0.7 | 0.8 |
| Potassium | 34 | 31 | 25 | 12 | < 10 | 25 |
| Selenium[b] | 0.11 | 0.08 | 0.09 | 0.08 | 0.08 | 0.08 |
| Silver | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Thallium | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| Vanadium | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Zinc | 0.9 | 1.7 | 0.9 | < 0.5 | 0.5 | 2 |

a The concentration for this analyte reported by the analytical laboratory is highly suspect.
b Reported concentrations of selenium are biased high due to selenium detected in the method blank sample.

**There are no supplemental data in this chapter.**
**Please see the main volume for details about**
**Vegetation and Foodstuff Monitoring.**

# Environmental Radiation Monitoring

*Nicholas A. Bertoldo*

## Methods of Gamma Radiation Monitoring

The environmental gamma radiation is an important component of the laboratory's effort to maintain compliance and characterize the natural environment. In an effort to measure radiation levels in the vicinity of Lawrence Livermore Laboratory operations, 14 dosimeter locations are positioned on the site perimeter and 22 in the Livermore Valley. Similarly, 13 locations are maintained at Site 300 with 4 sites in the nearby area and 2 in the city of Tracy. These off-site locations were selected on the basis of proximity to LLNL operations. The off-site sampling locations are considered to be representative of the natural background and serve as a baseline comparison to operations.

Thermoluminescent dosimeters (TLDs) are deployed to the field on a quarterly basis following field preparation. Each TLD is labeled with a Lawrence Livermore National Laboratory dosimeter identification number and placed into an aluminized mylar sample pouch for protection from light and moisture. Duplicate trip blanks, transit control, and calibration control TLDs are prepared in the same way as environmental samples for field deployment.

Each TLD deployed in the field is placed such that the sample is located at approximately 1 m above ground to comply with *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. Department of Energy 1991). Upon their removal from the site locations at the end of each quarter, the environmentally exposed TLDs are taken to the LLNL Hazards Control dosimetry laboratory for processing. A field tracking form is used to record field deployment and collection dates and relevant notes. Details of the TLD calculations and reporting of external gamma-radiation dose are described in an Operations and Regulatory Affairs Division procedure.

LLNL uses the Panasonic Model UD-814AS1 TLD, which contains three thallium-activated calcium sulfate crystals ($CaSO_4$) and one lithium borate crystal ($Li_2B_4O_7$). The gamma-ray energy imparted to the TLD's crystal elements excite the electrons in the valence band to a higher energy state, creating a vacancy in the valence band known as a "hole." These electron holes are trapped in impurity sites within the crystal. When the TLDs are heated in the analytical laboratory, the thermal energy of the process raises the electron trap to the conduction band or the hole trap to the valence band, causing thermo-luminescence. This trapped energy is released in the form of light emission that is then measured by the photomultiplier tube output signal. The intensity of the light emission is proportional to the original gamma ray energy imparted to the TLD crystal elements (i.e., the TLD absorbed dose). After the TLD is measured, it is reheated and remeasured to affirm that all the energy has been release from the crystal elements. A near-zero

reading indicates that all the stored energy has been released. This process, called annealing, also verifies that the TLD is again ready for field deployment. When a TLD is found open on the ground, damaged, or lost, the associated annual dose reported is calculated from the average of the available mean quarterly dose values for that given location.

Gamma-radiation exposure is measured in roentgens (R), which is defined as the electronic charge required to ionize a given volume of air ($2.58 \times 10^{-4}$ C/kg air). The equivalent absorbed dose is $8.7 \times 10^{-3}$ Gy (0.87 rad) in air. The tissue equivalent absorbed dose is $9.6 \times 10^{-3}$ Gy (0.96 rad). The measured exposure is converted to dose equivalent by calibrating the dosimeters against sources that deliver a known absorbed dose and then applying the gamma-radiation quality factor of 1. The resultant dose-equivalent is reported for environmental dose in submultiple factors of $1 \times 10^{-3}$ sieverts or millisieverts (mSv) and compared to Department of Energy (DOE) Order 5400.5 radiation protection standards. Site boundary doses are compared to environmental background measurements to assess the contribution or impact, if any, from LLNL operations.

To ensure accuracy in TLD measurements, some TLDs are irradiated each quarter to specific exposures for calibration purposes, and others are irradiated to specific exposures to serve as quality-control accuracy checks. Duplicate TLDs are located in the field at several locations each quarter to assess TLD measurement precision. When the field deployment time is either less than or exceeds 90 days, the data is normalized to a standard, 90-day quarter or 360 days per year for the purpose of comparison. LLNL participates in the National Intercomparison Laboratory Study for external gamma radiation measurements, and LLNL processing complies with the DOE Environmental Measurement Laboratory standards.

## Tables

Data tables for the 2001 gamma-radiation monitoring network are presented below. Table 12-1 presents the Livermore site perimeter data, Table 12-2 presents the Livermore Valley data, Table 12-3 presents the Site 300 perimeter data, and Table 12-4 presents Tracy and other Site 300 off-site data. Summary data are discussed in detail in Chapter 12 of the main volume of this report.

**Table 12-1. Calculated dose from TLD environmental radiation measurement, Livermore site perimeter, 2001**

| Location [a] | Quarterly Dose (mSv)[b] | | | | | | | | | | | | Annual Dose [c] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan-Mar | | | Apr-Jun | | | Jul-Sep | | | Oct-Dec | | | (mSv) | | |
| L-001-TD | 0.150 | ± | 0.008 | 0.143 | ± | 0.005 | 0.151 | ± | 0.005 | 0.144 | ± | 0.002 | 0.588 | ± | 0.008 |
| L-004-TD | 0.149 | ± | 0.003 | 0.147 | ± | 0.001 | 0.161 | ± | 0.006 | 0.148 | ± | 0.005 | 0.605 | ± | 0.013 |
| L-005-TD | 0.154 | ± | 0.005 | 0.152 | ± | 0.001 | 0.155 | ± | 0.006 | 0.153 | ± | 0.004 | 0.614 | ± | 0.002 |
| L-006-TD | 0.146 | ± | 0.006 | 0.155 | ± | 0.009 | 0.150 | ± | 0.002 | 0.158 | ± | 0.003 | 0.609 | ± | 0.010 |
| L-011-TD | 0.121 | ± | 0.004 | 0.114 | ± | 0.003 | 0.117 | ± | 0.001 | 0.123 | ± | 0.004 | 0.475 | ± | 0.008 |
| L-014-TD | 0.143 | ± | 0.012 | 0.132 | ± | 0.004 | 0.129 | ± | 0.005 | 0.141 | ± | 0.004 | 0.545 | ± | 0.013 |
| L-016-TD | 0.134 | ± | 0.008 | 0.129 | ± | 0.002 | 0.145 | ± | 0.004 | 0.134 | ± | 0.006 | 0.542 | ± | 0.013 |
| L-042-TD | 0.134 | ± | 0.006 | 0.134 | ± | 0.005 | 0.153 | ± | 0.008 | 0.139 | ± | 0.004 | 0.560 | ± | 0.017 |
| L-043-TD | 0.138 | ± | 0.002 | 0.136 | ± | 0.006 | 0.135 | ± | 0.006 | 0.126 | ± | 0.005 | 0.535 | ± | 0.010 |
| L-047-TD | 0.119 | ± | 0.006 | 0.121 | ± | 0.003 | 0.137 | ± | 0.003 | 0.123 | ± | 0.002 | 0.500 | ± | 0.016 |
| L-052-TD | 0.137 | ± | 0.006 | 0.142 | ± | 0.003 | 0.135 | ± | 0.005 | 0.139 | ± | 0.002 | 0.553 | ± | 0.005 |
| L-056-TD | 0.139 | ± | 0.003 | 0.143 | ± | 0.003 | 0.141 | ± | 0.003 | 0.142 | ± | 0.003 | 0.565 | ± | 0.003 |
| L-068-TD | 0.142 | ± | 0.004 | 0.135 | ± | 0.007 | 0.148 | ± | 0.005 | 0.148 | ± | 0.006 | 0.573 | ± | 0.012 |
| L-069-TD | 0.154 | ± | 0.038 | 0.132 | ± | 0.003 | 0.138 | ± | 0.004 | 0.135 | ± | 0.006 | 0.559 | ± | 0.019 |
| **Mean [d]** | **0.140** | **±** | **0.006** | **0.137** | **±** | **0.006** | **0.143** | **±** | **0.006** | **0.140** | **±** | **0.006** | **0.560** | **±** | **0.002** |

Note: Measurement represents the TLD absorbed dose in mR converted to mSv.

a See **Figure 12-1** in the main volume for locations.
b Measurement uncertainty is reported as ± 2 σ of the data.
c Uncertainty is reported as 2 σ of the quarterly means.
d Uncertainty associated with the quarterly means is reported as two standard errors of the location data.

**Table 12-2. Calculated dose from TLD environmental radiation measurement, Livermore Valley, 2001**

| Location [a] | Quarterly Dose (mSv)[b] | | | | | | | | | | | | Annual Dose [c] (mSv) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan-Mar | | | Apr-Jun | | | Jul-Sep | | | Oct-Dec | | | | | |
| V-018-TD | 0.113 | ± | 0.001 | 0.118 | ± | 0.004 | 0.117 | ± | 0.003 | 0.112 | ± | 0.002 | 0.460 | ± | 0.005 |
| V-019-TD | 0.130 | ± | 0.005 | 0.126 | ± | 0.004 | 0.128 | ± | 0.005 | 0.142 | ± | 0.008 | 0.526 | ± | 0.014 |
| V-022-TD | 0.149 | ± | 0.011 | 0.144 | ± | 0.004 | 0.147 | ± | 0.004 | 0.151 | ± | 0.004 | 0.591 | ± | 0.005 |
| V-024-TD | 0.139 | ± | 0.007 | 0.146 | ± | 0.006 | 0.153 | ± | 0.011 | 0.149 | ± | 0.006 | 0.587 | ± | 0.011 |
| V-027-TD | 0.129 | ± | 0.005 | | _ (d) | | 0.140 | ± | 0.002 | 0.131 | ± | 0.007 | 0.400 | ± | 0.011 |
| V-028-TD | 0.131 | ± | 0.005 | 0.127 | ± | 0.003 | | _ (d) | | 0.145 | ± | 0.016 | 0.403 | ± | 0.018 |
| V-030-TD | 0.133 | ± | 0.004 | 0.143 | ± | 0.003 | 0.140 | ± | 0.001 | 0.139 | ± | 0.005 | 0.555 | ± | 0.008 |
| V-032-TD | 0.132 | ± | 0.009 | 0.132 | ± | 0.002 | 0.137 | ± | 0.001 | 0.140 | ± | 0.005 | 0.541 | ± | 0.007 |
| V-033-TD | 0.146 | ± | 0.005 | | _ (d) | | 0.152 | ± | 0.003 | 0.146 | ± | 0.004 | 0.444 | ± | 0.006 |
| V-035-TD | 0.154 | ± | 0.009 | | _ (d) | | 0.140 | ± | 0.001 | 0.143 | ± | 0.004 | 0.437 | ± | 0.014 |
| V-037-TD | 0.146 | ± | 0.005 | 0.139 | ± | 0.008 | 0.151 | ± | 0.009 | | _ (d) | | 0.436 | ± | 0.012 |
| V-045-TD | 0.132 | ± | 0.006 | 0.128 | ± | 0.003 | 0.141 | ± | 0.008 | 0.141 | ± | 0.004 | 0.542 | ± | 0.013 |
| V-057-TD | 0.144 | ± | 0.007 | 0.138 | ± | 0.003 | 0.155 | ± | 0.006 | 0.155 | ± | 0.004 | 0.592 | ± | 0.016 |
| V-060-TD | 0.138 | ± | 0.007 | 0.136 | ± | 0.005 | 0.137 | ± | 0.003 | 0.151 | ± | 0.004 | 0.562 | ± | 0.014 |
| V-066-TD | 0.154 | ± | 0.011 | | _ (d) | | | _ (d) | | 0.131 | ± | 0.005 | 0.285 | ± | 0.032 |
| V-070-TD | | _ (d) | | 0.139 | ± | 0.003 | | _ (d) | | 0.138 | ± | 0.003 | 0.277 | ± | 0.001 |
| V-072-TD | 0.155 | ± | 0.007 | 0.170 | ± | 0.008 | 0.166 | ± | 0.004 | 0.162 | ± | 0.002 | 0.653 | ± | 0.012 |
| V-074-TD | | _ (d) | | | _ (d) | | 0.128 | ± | 0.004 | | _ (d) | | | _ (e) | |
| V-075-TD | 0.121 | ± | 0.006 | 0.107 | ± | 0.002 | 0.122 | ± | 0.022 | 0.118 | ± | 0.003 | 0.468 | ± | 0.013 |
| V-076-TD | 0.127 | ± | 0.009 | 0.116 | ± | 0.001 | 0.131 | ± | 0.010 | 0.123 | ± | 0.006 | 0.497 | ± | 0.012 |
| V-077-TD | 0.143 | ± | 0.006 | | _ (d) | | 0.144 | ± | 0.004 | 0.137 | ± | 0.008 | 0.424 | ± | 0.007 |
| V-122-TD | 0.151 | ± | 0.006 | 0.168 | ± | 0.031 | 0.175 | ± | 0.004 | 0.166 | ± | 0.003 | 0.660 | ± | 0.020 |
| **Mean [f]** | **0.138** | **±** | **0.005** | **0.136** | **±** | **0.008** | **0.142** | **±** | **0.007** | **0.141** | **±** | **0.006** | **0.557** | **±** | **0.003** |

Note: Measurement represents the TLD absorbed dose in mR converted to mSv.

a See **Figure 12-2** in the main volume for locations.
b Measurement uncertainty is reported as ± 2 σ of the data.
c Uncertainty is reported as 2 σ of the quarterly means.
d Data are not available due to missing or damaged TLD.
e Insufficient Data to calculate the annual dose at this location
f Uncertainty associated with the quarterly means is reported as two standard errors of the location data

**Table 12-3. Calculated dose from TLD environmental radiation measurement, Site 300 perimeter, 2001**

| Location[a] | Quarterly Dose (mSv)[b] | | | | | | | | | | | | Annual Dose[c] (mSv) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan-Mar | | | Apr-Jun | | | Jul-Sep | | | Oct-Dec | | | | | |
| **3-078-TD** | 0.135 | ± | 0.003 | 0.134 | ± | 0.004 | 0.149 | ± | 0.003 | 0.148 | ± | 0.007 | 0.566 | ± | 0.016 |
| **3-081-TD** | 0.155 | ± | 0.006 | 0.164 | ± | 0.006 | 0.176 | ± | 0.004 | 0.187 | ± | 0.005 | 0.682 | ± | 0.027 |
| **3-082-TD** | 0.158 | ± | 0.005 | 0.161 | ± | 0.007 | 0.167 | ± | 0.008 | 0.147 | ± | 0.009 | 0.633 | ± | 0.016 |
| **3-085-TD** | 0.145 | ± | 0.002 | 0.155 | ± | 0.003 | 0.171 | ± | 0.007 | 0.166 | ± | 0.001 | 0.637 | ± | 0.023 |
| **3-086-TD** | 0.147 | ± | 0.003 | 0.158 | ± | 0.003 | 0.172 | ± | 0.005 | 0.166 | ± | 0.004 | 0.643 | ± | 0.021 |
| **3-088-TD** | 0.145 | ± | 0.003 | 0.160 | ± | 0.003 | 0.160 | ± | 0.003 | 0.171 | ± | 0.004 | 0.636 | ± | 0.021 |
| **3-089-TD** | 0.157 | ± | 0.004 | 0.165 | ± | 0.004 | 0.168 | ± | 0.003 | 0.168 | ± | 0.002 | 0.658 | ± | 0.010 |
| **3-091-TD** | 0.156 | ± | 0.009 | 0.173 | ± | 0.004 | 0.172 | ± | 0.008 | 0.171 | ± | 0.004 | 0.672 | ± | 0.016 |
| **3-121-TD** | 0.171 | ± | 0.003 | 0.192 | ± | 0.009 | 0.189 | ± | 0.003 | 0.193 | ± | 0.009 | 0.745 | ± | 0.020 |
| **3-123-TD** | 0.138 | ± | 0.008 | 0.136 | ± | 0.009 | 0.159 | ± | 0.004 | 0.140 | ± | 0.007 | 0.573 | ± | 0.021 |
| **3-124-TD** | 0.134 | ± | 0.007 | 0.178 | ± | 0.008 | 0.139 | ± | 0.015 | 0.142 | ± | 0.003 | 0.593 | ± | 0.040 |
| **3-125-TD** | 0.132 | ± | 0.004 | 0.134 | ± | 0.010 | 0.150 | ± | 0.003 | 0.153 | ± | 0.005 | 0.569 | ± | 0.021 |
| **3-126-TD** | 0.130 | ± | 0.008 | _ (d) | | | 0.139 | ± | 0.010 | 0.154 | ± | 0.001 | 0.423 | ± | 0.024 |
| **Mean [e]** | **0.146** | **±** | **0.007** | **0.159** | **±** | **0.010** | **0.162** | **±** | **0.008** | **0.162** | **±** | **0.010** | **0.629** | **±** | **0.008** |

**Note:** Measurement represents the TLD absorbed dose in mR converted to mSv.

a See **Figure 12-3** in the main volume for locations.
b Measurement uncertainty is reported as ± 2σ of the data.
c Uncertainty is reported as twice the propagated error of the quarterly means.
d Data are not available due to missing or damaged TLD.
e Uncertainty associated with the quarterly means is reported as two standard errors of the location data.

**Table 12-4. Calculated dose from TLD environmental radiation measurement, Tracy and other off-site locations in the vicinity of Site 300, 2001**

| Location[a] | Quarterly Dose (mSv)[b] | | | | | | | | | | | | Annual Dose[c] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan-Mar | | | Apr-Jun | | | Jul-Sep | | | Oct-Dec | | | (mSv) | | |
| **3-092-TD** | 0.136 | ± | 0.005 | 0.143 | ± | 0.004 | 0.161 | ± | 0.004 | 0.151 | ± | 0.006 | 0.591 | ± | 0.021 |
| **3-093-TD** | 0.159 | ± | 0.033 | 0.125 | ± | 0.004 | 0.147 | ± | 0.006 | 0.139 | ± | 0.001 | 0.570 | ± | 0.028 |
| **Mean [d]** | **0.148** | **±** | **0.023** | **0.134** | **±** | **0.018** | **0.154** | **±** | **0.014** | **0.145** | **±** | **0.012** | **0.581** | **±** | **0.008** |
| | | | | | | | | | | | | | | | |
| **3-090-TD** | 0.166 | ± | 0.012 | 0.179 | ± | 0.004 | 0.192 | ± | 0.003 | 0.174 | ± | 0.008 | 0.711 | ± | 0.021 |
| **3-094-TD** | 0.184 | ± | 0.008 | _ (e,f) | | | _ (e,f) | | | _ (e,f) | | | _ (g,h) | | |
| **3-096-TD** | 0.177 | ± | 0.010 | _ (e,f) | | | _ (e,f) | | | _ (e,f) | | | _ (g,h) | | |
| **3-099-TD** | 0.129 | ± | 0.004 | 0.146 | ± | 0.007 | 0.154 | ± | 0.008 | 0.151 | ± | 0.003 | 0.580 | ± | 0.022 |
| **Mean [f]** | **0.164** | **±** | **0.024** | **0.163** | **±** | **0.033** | **0.173** | **±** | **0.038** | **0.163** | **±** | **0.023** | **0.663** | **±** | **0.005** |

**Note:** Measurement represents the TLD absorbed dose in mR converted to mSv.

a See **Figure 12-3** in the main volume for locations.
b Measurement uncertainty is reported as ± 2σ of the data.
c Uncertainty is reported as twice the propagated error of the quarterly means.
d Uncertainty associated with the quarterly means is reported as two standard errors of the location data.
e Data are not available due to missing or damaged TLD.
f Location removed.
g Insufficient number of samples to calculate annual dose
h Insufficient number of samples to calculate SE

**There are no supplemental data in this chapter.**
**Please see the main volume for details about**
**Radiological Dose Assessment.**

# Quality Assurance

*Lucinda M. Clark*

## Laboratory Intercomparison Studies

Two laboratories at Lawrence Livermore National Laboratory that provide analytical services for environmental samples participated in the annual Environmental Monitoring Laboratory (EML) intercomparison studies program sponsored by the U.S. Department of Energy (DOE). The two LLNL laboratories are the Chemistry and Materials Science Environmental Services' (CES) Environmental Monitoring Radiation Laboratory (EMRL) and the Hazards Control Department's Analytical Laboratory (HCAL).

The results of CES EMRL's participation in the EML studies are presented in Table 14-1. According to the results, 38 of 41 analyses fell within established acceptance control limits. The results for Co-60 and Cs-137 on air filters for the QAP 54 Study were above the acceptable limits because the filter paper was counted using the wrong geometry. The geometry that was used placed the filter paper too close to the detector. In the future, the filter paper will be placed one to one and one half inches from the detector for counting. Additionally, the gamma software will be upgraded to a version that contains algorithms that provide more accurate calculations of activities. The results U-234 in soil for the QAP-54 Study were below the acceptable limit. This occurred because the wrong tracer aliquot was entered in the algorithm. Recalculation gave results in the acceptable range. In the future, the verification process for this analysis will include a check on the tracer aliquot.

The results of HCAL's participation in the 2000 EML studies (see Table 14-2) indicate that 10 of 10 sample results fell within the 3σ acceptance control limits. The results for both gross alpha and gross beta in water for the QAP-55 study were above the acceptable limits. Review of the analytical results was unable to provide a definitive explanation of the cause of these failures. HCAL suspects that the problem was related to sample preparation, however, this cannot be confirmed since no quality control (QC) samples were run with the QAP samples. The sample preparation process is being revised to include monitoring by QA personnel and the use of QC control samples to verify analytical results.

CES EMRL participated in two DOE Mixed Analyte Performance Evaluation Program (MAPEP) studies in 2000. The results of these studies are presented in Tables 14-3 and 14-4. Of the analyses reported by CES in these studies, 21 of 22 fell within acceptable limits. A false positive result for plutonium-238 in soil was reported in the MAPEP-00-S7 study. Corrective action to resolve this problem is currently being developed and implemented.

Although contract laboratories are also required to participate in laboratory intercomparison programs, permission to publish their results for comparison purposes was not granted for 2001.

**Table 14-1. LLNL's CES EMRL results from the DOE EML Quality Assurance Program, 2001**

| Analyte | EML study | CES value | EML value | CES/EML | Control limits ($3\sigma$)[a] | Warning limits ($2\sigma$) | Performance[b] |
|---|---|---|---|---|---|---|---|
| **Air filter (Bq/filter)** | | | | | | | |
| Am-241 | QAP 54 | 0.485 | 0.486 | 0.998 | 0.69-2.40 | 0.87-1.38 | Acceptable |
| Bq U | QAP 55 | 0.188 | 0.222 | 0.845 | 0.80-2.54 | 0.90-1.53 | Warning |
| Co-60 | QAP 54 | 22.5 | 19.4 | 1.31 | 0.79-1.30 | 0.87-1.13 | Not Acceptable |
| | QAP 55 | 20.0 | 17.5 | 1.14 | 0.79-1.30 | 0.87-1.13 | Warning |
| Cs-134 | QAP 55 | 15.3 | 13.0 | 1.18 | 0.74-1.21 | 0.82-1.10 | Warning |
| Cs-137 | QAP 54 | 12.1 | 8.76 | 1.38 | 0.78-1.35 | 0.88-1.16 | Not Acceptable |
| | QAP 55 | 20.4 | 17.1 | 1.19 | 0.78-1.35 | 0.88-1.16 | Warning |
| Mn-54 | QAP 55 | 95.1 | 81.2 | 1.17 | 0.80-1.36 | 0.89-1.20 | Acceptable |
| Pu-238 | QAP 54 | 0.202 | 0.215 | 0.940 | 0.66-1.35 | 0.88-1.12 | Acceptable |
| | QAP 55 | 0.075 | 0.071 | 1.06 | 0.66-1.35 | 0.88-1.12 | Acceptable |
| Pu-239 | QAP 54 | 0.135 | 0.136 | 0.993 | 0.69-1.29 | 0.89-1.13 | Acceptable |
| | | 0.241 | 0.229 | 1.05 | 0.69-1.29 | 0.89-1.13 | Acceptable |
| U-234 | QAP 54 | 0.041 | 0.046 | 0.880 | 0.80-1.92 | 0.90-1.36 | Warning |
| U-238 | QAP 54 | 0.037 | 0.046 | 0.813 | 0.80-1.59 | 0.90-1.26 | Warning |
| **Soil (Bq/kg)** | | | | | | | |
| Ac-228 | QAP 55 | 48.0 | 59.6 | 0.806 | 0.80-1.50 | 0.89-1.24 | Warning |
| Am-241 | QAP 54 | 15.3 | 14.8 | 1.034 | 0.63-2.64 | 0.84-1.53 | Acceptable |
| Cs-137 | QAP 54 | 1660 | 1740 | 0.954 | 0.80-1.29 | 0.90-1.18 | Acceptable |
| | QAP 55 | 572 | 612 | 0.934 | 0.80-1.29 | 0.90-1.18 | Acceptable |
| K-40 | QAP 54 | 494 | 468 | 1.056 | 0.80-1.37 | 0.90-1.23 | Acceptable |
| | QAP 55 | 658 | 623 | 1.06 | 0.80-1.37 | 0.90-1.23 | Acceptable |
| Pb-212 | QAP 55 | 62.1 | 58.3 | 1.065 | 0.74-1.36 | 0.90-1.22 | Acceptable |
| Pu-239 | QAP 54 | 25.8 | 25.6 | 1.008 | 0.71-1.33 | 0.87-1.16 | Acceptable |
| | QAP 55 | 8.86 | 8.95 | 0.990 | 0.71-1.33 | 0.87-1.16 | Acceptable |
| U-234 | QAP 54 | 30.2 | 43.6 | 0.693 | 0.71-1.27 | 0.86-1.11 | Not Acceptable |
| U-238 | QAP 54 | 32.6 | 46.1 | 0.707 | 0.63-1.34 | 0.83-1.11 | Warning |

**Table 14-1. LLNL's CES EMRL results from the DOE EML Quality Assurance Program, 2001 (concluded)**

| Analyte | EML study | CES value | EML value | CES/EML | Control limits (3σ)[a] | Warning limits (2σ) | Performance[b] |
|---|---|---|---|---|---|---|---|
| **Vegetation (Bq/kg)** | | | | | | | |
| Pu-239 | QAP 54 | 8.73 | 9.58 | 0.911 | 0.67-1.49 | 0.85-1.16 | Acceptable |
| | QAP 55 | 10.8 | 11.0 | 0.980 | 0.67-1.49 | 0.85-1.16 | Acceptable |
| **Water (Bq/L)** | | | | | | | |
| Am-241 | QAP 54 | 1.73 | 1.67 | 1.036 | 0.76-1.48 | 0.90-1.22 | Acceptable |
| Bq U | QAP 55 | 1.94 | 2.37 | 0.818 | 0.73-1.37 | 0.90-1.22 | Warning |
| Co-60 | QAP 54 | 108 | 98.2 | 1.10 | 0.80-1.20 | 0.90-1.12 | Acceptable |
| | QAP 55 | 223 | 209 | 1.07 | 0.80-1.20 | 0.90-1.12 | Acceptable |
| Cs-137 | QAP 54 | 80.1 | 73.0 | 1.10 | 0.80-1.24 | 0.90-1.15 | Acceptable |
| | QAP 55 | 48.7 | 45.1 | 1.08 | 0.80-1.24 | 0.90-1.15 | Acceptable |
| H-3 | QAP 54 | 69.4 | 79.3 | 0.875 | 0.74-2.29 | 0.84-1.31 | Acceptable |
| | QAP 55 | 158 | 207 | 0.763 | 0.74-2.29 | 0.84-1.31 | Warning |
| Pu-238 | QAP 54 | 1.560 | 1.580 | 0.987 | 0.74-1.22 | 0.90-1.10 | Acceptable |
| | QAP 55 | 1.11 | 1.09 | 1.02 | 0.74-1.22 | 0.90-1.10 | Acceptable |
| Pu-239 | QAP 54 | 1.640 | 1.640 | 1.000 | 0.75-1.26 | 0.90-1.11 | Acceptable |
| | QAP 55 | 1.74 | 1.63 | 1.07 | 0.75-1.26 | 0.90-1.11 | Acceptable |
| U-234 | QAP 54 | 0.907 | 1.040 | 0.872 | 0.80-1.40 | 0.90-1.23 | Warning |
| U-238 | QAP 54 | 0.910 | 1.040 | 0.875 | 0.80-1.29 | 0.90-1.19 | Warning |

a Control limits are established from historical QAP data and reported as the ratio of reported value to EML value. Limits were not applied where historical data were insufficient.

b Data are considered acceptable when they fall within the 2σ warning limits. Data should be checked for error when they are between the 2σ warning limits and the 3σ control limits. Data are considered unacceptable when they are outside the 3σ control limits.

**Table 14-2. LLNL's HCAL results from the DOE EML Quality Assurance Program, 2001**

| Analyte | EML study | HCAL value | EML value | HCAL/EML | Control limits (3σ) | Warning limits (2 σ) | Performance[a] |
|---|---|---|---|---|---|---|---|
| **Air filter (Bq/filter)** | | | | | | | |
| Gross alpha | QAP 54 | 3055 | 3.97 | 0.894 | 0.57-1.47 | 0.83-1.24 | Acceptable |
| | QAP 55 | 6.00 | 5.36 | 1.12 | 0.47-1.47 | 0.83-1.24 | Acceptable |
| Gross beta | QAP 54 | 2.29 | 2.58 | 0.888 | 0.76-1.52 | 0.88-1.29 | Acceptable |
| | QAP 55 | 13.4 | 12.8 | 1.05 | 0.76-1.52 | 0.88-1.29 | Acceptable |
| **Water (Bq/L)** | | | | | | | |
| Gross Alpha | QAP 54 | 1700 | 1900 | 0.895 | 0.58-1.26 | .079-1.12 | Acceptable |
| | QAP 55 | 1750 | 1150 | 1.52 | 0.58-1.26 | 0.79-1.12 | Not Acceptable |
| Gross Beta | QAP 54 | 1450 | 1297 | 1.12 | 0.56-1.50 | 0.75-1.33 | Acceptable |
| | QAP 55 | 12100 | 7970 | 1.52 | 0.56-1.50 | 0.75-1.33 | Not Acceptable |
| Tritium | QAP 54 | 80.5 | 79.3 | 1.02 | 0.74-2.29 | 0.84-1.31 | Acceptable |
| | QAP 55 | 212 | 207 | 1.02 | 0.74-2.29 | 0.84-1.31 | Acceptable |

a Data are considered acceptable when they fall within the 2σ warning limits. Data should be checked for error when they are between the 2σ warning limits and the 3σ control limits. Data are considered unacceptable when they are outside the 3σ control limits.

**Table 14-3. LLNL CES EMRL performance in the MAPEP-00-W8 Intercomparison Program for Water, 2001**

| Analyte | CES value | Units | Reference value | Bias (%) | Acceptance range | Performance[a] |
|---|---|---|---|---|---|---|
| Americium-241 | 1.09 | Bq/L | 1.06 | 2.8 | 0.74-1.38 | Acceptable |
| Cesium-134 | 231 | Bq/L | 283 | -18.4 | 198-368 | Acceptable |
| Cesium-137 | 93.2 | Bq/L | 94.4 | -1.3 | 66.1-123 | Acceptable |
| Cobalt-57 | 105 | Bq/L | 95.5 | 9.9 | 66.9-124 | Acceptable |
| Cobalt-60 | Not reported | — | 2.19 | — | 1.53-2.85 | Report Warning |
| Manganese-54 | Not reported | — | 2.87 | — | 2.01-3.73 | Report Warning |
| Plutonium-238 | 2.24 | Bq/L | 2.12 | 5.7 | 1.48-2.76 | Acceptable |
| Plutonium-239/240 | 1.99 | Bq/L | 1.86 | 7.0 | 1.30-2.42 | Acceptable |
| Uranium-234/233 | 0.926 | Bq/L | 0.99 | -6.5 | 0.69-1.29 | Acceptable |
| Uranium-238 | 0.948 | Bq/L | 1.02 | -7.1 | 0.71-1.33 | Acceptable |
| Zinc-65 | Not reported | — | 4.59 | — | 3.21-5.97 | Report Warning |

a Acceptable results have $|\text{bias}| \leq 20\%$. Results with warning have $20\% < |\text{bias}| \leq 30\%$.

**Table 14-4. LLNL CES EMRL performance in the MAPEP-01-S8 Intercomparison Program for Soil, 2001**

| Analyte | CES value | Units | Reference value | Bias (%) | Acceptance range | Performance[a] |
|---|---|---|---|---|---|---|
| Cesium-134 | 74.5 | Bq/kg | 91.1 | -18.2 | 63.8-118 | Acceptable |
| Cesium-137 | 1170 | Bq/kg | 1240 | -5.6 | 868-1610 | Acceptable |
| Cobalt-57 | 103 | Bq/kg | 103 | 0.0 | 72.1-134 | Acceptable |
| Cobalt-60 | 1280 | Bq/kg | 1270 | 0.8 | 889-1650 | Acceptable |
| Manganese-54 | 219 | Bq/kg | 203 | 7.9 | 142-264 | Acceptable |
| Plutonium-238 | 117 | Bq/kg | 115 | 1.7 | 80.5-149 | Acceptable |
| Plutonium-239/240 | 82.0 | Bq/kg | 83.4 | -1.7 | 58.4-108 | Acceptable |
| Potassium-40 | 740 | Bq/kg | 652 | 13.5 | 456-848 | Acceptable |
| Uranium-234/233 | 47.9 | Bq/kg | 60 | -20.2 | 42.0-78.0 | Warning |
| Uranium-238 | 161 | Bq/kg | 191 | -15.7 | 134-248 | Acceptable |
| Zinc-65 | 451 | Bq/kg | 382 | 18.1 | 267-497 | Acceptable |

a Acceptable results have | bias | ≤20%. Results acceptable with warning have | bias | >20% less but ≤30%.

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