U.S. Department of Energy

Livermore Site Office, Livermore, California 94550

Lawrence Livermore National Laboratory

University of California, Livermore, California 94550

UCRL-AR-126020-02

LLNL
Ground Water Project

2002 Annual Report

Technical Editors

V. Dibley
M. Dresen*
R. Bainer
E. Folsom
L. Berg
R. Depue
J. Coty

Contributing Authors

L. Berg
N. Borglin
Z. Demir
S. Gregory
B. Heffner
G. Howard
J. Karachewski*
P. Krauter
M. Maley**
K. Mansoor
W. McConachie
C. Noyes
R. Ruiz
R. Ward

*Weiss Associates, Emeryville, California
**ETIC Engineering, Oakland, California

Environmental Protection Department

Environmental Restoration Program and Division

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

UCRL-AR-126020-02

LLNL
Ground Water Project

2002 Annual Report

Technical Editors

V. Dibley
M. Dresen*
R. Bainer
E. Folsom
L. Berg
R. Depue
J. Coty

Contributing Authors

L. Berg
N. Borglin
Z. Demir
S. Gregory
B. Heffner
G. Howard
J. Karachewski*
P. Krauter
M. Maley**
K. Mansoor
W. McConachie
C. Noyes
R. Ruiz
R. Ward

*Weiss Associates, Emeryville, California
**ETIC Engineering, Oakland, California

Environmental Protection Department
Environmental Restoration Division

Acknowledgements

The Lawrence Livermore National Laboratory (LLNL) Ground Water Project is supported by a number of people who contribute significantly to the project. The editors and authors are pleased to recognize the efforts of the following people and services:

P. Anderson, R. Baine, H. Barnes, BC Laboratories, J. Bear, D. Burrus, CalTest Laboratories, M. Campbell, K. Carroll, S. Chamberlain, M. Chiarappa-Zucca, D. Claus, L. Cohan, S. Coleman, W. Daily, R. Davis, E. Diaz, V. Del llano, C. Dorkin, S. Ellis, S. Ezzedine, S. Flemming, B. Gansberg, General Environmental Laboratory, B. Goodrich, K. Graham, L. Graves, J. Greci, R. Hall, K. W. Henrich, Heyward, D. Hill, N. Hinkle, S. Hodgson, F. Hoffman, S. Hunter, B. Johnson, S. Kane, S. Kawaguchi, B. Kidd, L. Kita, D. Lager, G. Laguna, A. Lamarre, S. Lambaren, S. Levy, B. Lin, P. Lucero, P. Lyra, M. Maley, D. Martini, S. Martins, W. McConihe, W. McNab, D. McQueen, G. Metzger, B. Mitchell, N. Montez, M. Montgomery, S. Orloff, J. Poulter, W. Raatz, D. Ramirez, N. Ramos, K. Rauhut, A. Ritcey, R. Schnetz, D. Schwartz, P. Shepherd, S. Sobolak, J. Steenhoven, C. Stoker, J. Taggert, Thermo Retech Analytical Services, L. Truelsen, J. Tulk, J. Ulrech, J. Vallet, J. Van Fossen, H. Van Noy, M. Westerfelt, D. White, R. Woodward.

Table of Contents

List of Figures

List of Tables

Appendices

Summary

Significant 2002 Lawrence Livermore National Laboratory (LLNL) Livermore Site Ground Water Project (GWP) restoration activities included:

- Operating 27 ground water treatment facilities and one soil vapor treatment facility.
- Operating 82 ground water extraction wells.
- Installing ten new wells.
- Conducting seven hydraulic tests.
- Remedial Action Implementation Plan (RAIP)
- Meeting all DOE milestones: Constructing Treatment Facility C East (TFC-E), Treatment Facility 406 Northwest (TF406-NW), expanding soil vapor treatment facility 5475 (VTF5475), and preparing a Five-Year Review (Table 3).
- Removing over 146 kilograms (kg) of mass from ground water and soil (Table Summ-1).

In addition to the extraction wells, the Livermore Site currently has 512 monitor wells. Since remediation began in 1989, approximately 1,958 million gallons of ground water and over 38 million cubic feet of vapor have been treated, removing more than 1,380 kg of VOCs (Table Summ-2).

Table Summ-1. Summary of 2002 VOC remediation.

Treatment facility area	Volume of ground water treated (Mgal)	Volume of soil vapor treated (kft^3)	Estimated total VOC mass removed (kg)
TFA	**66.4**	??	**5.7**
TFB	**34.4**	??	**6.1**
TFC	**28.5**	??	**7.1**
TFD	**74.3**	??	**68.4**
TFE	**29.2**	??	**17.5**
TFG	**3.2**	??	**0.7**
TF406	**10.7**	??	**1.0**
TF5475	**0.1**	??	**0.7**
VTF5475	??	**5,068**	**37.7**
TF518	**1.3**	??	**0.6**
VTF518	??	**0**	**0.0**
Total	**248***	**5,068**	**146***

Notes:

Mgal = Millions of gallons.

kft^3 = Thousands of cubic feet.

kg = Kilograms.

*** = Rounded number.**

? = Not applicable.

Table Summ-2. Summary of cumulative VOC remediation.

Treatment facility area	Volume of ground water treated (Mgal)	Volume of soil vapor treated (kft^3)	Estimated total VOC mass removed (kg)
TFA	**966.4**	?	**154.3**
TFB	**208.0**	?	**54.2**
TFC	**157.3**	?	**53.9**
TFD	**397.7**	?	**499.9**
TFE	**143.6**	?	**138.6**
TFG	**18.6**	?	**3.7**
TF406	**55.8**	?	**7.7**
TF5475	**0.6**	?	**4.8**
VTF5475	?	??????	**306**
TF518	**9.8**	?	**4.3**
VTF518	?	**15,040**	**153**
Total	**1,958***	**38,320**	**1,380***

Notes:

kg = Kilograms.

kft^3 = Thousands of cubic feet.

Mgal = Millions of gallons.

*** = Rounded number.**

? = **Not applicable.**

1. Introduction

This report summarizes the Lawrence Livermore National Laboratory (LLNL) Livermore Site Ground Water Project (GWP) activities for the year 2002 in six sections: Regulatory Compliance; Field Investigations; Ground Water Flow and Transport Modeling; Summary of Remedial Action Program, including discussions of treatment facility activities; Ground Water Discharges during 2002; and Trends in Ground Water Analytical Results. The 2002 GWP quarterly self-monitoring reports (Bainer and Joma, 2002a; Bainer and Wong, 2002a; Bainer and Wong, 2002b; and Bainer and Wong, 2003) were issued separately.

Figure 1 shows the locations of monitor wells, selected piezometers, extraction wells, and treatment facilities at the Livermore Site and vicinity, as well as other areas referenced in this report. Wells drilled in 2002 are shown in blue type. Ten wells were installed in 2002 as shown in Table 1. Hydraulic tests were conducted on three wells in 2002 as shown in Table 2.

Appendices A through D present Well Construction and Closure Data, Hydraulic Test Results, the 2003 Ground Water Sampling Schedule, and the 2002 Drainage Retention Basin (DRB) Annual Monitoring Program Summary, respectively. Ground water volatile organic compound (VOC) analyses, water level elevations, and the Treatment Facility 406 (TF406) area ground water fuel hydrocarbon (FHC) analyses are available on request.

2. Regulatory Compliance

In 2002, the U.S. Department of Energy (DOE)/LLNL submitted the GWP 2001 Annual Report (Dibley et al., 2002) and Quarterly self-monitoring reports. In addition, DOE/LLNL completed all 2002 Remedial Action Implementation Plan (RAIP) milestones (Dresen et al., 1993). One milestone was delayed with regulatory concurrence because new work was not authorized under the Federal Continuing Budget Resolution at the beginning of Fiscal Year 2002 (Table 3).

The Community Work Group (CWG) met once in 2002 to discuss the DOE budget, the Consensus Statement, and progress of the Livermore Site cleanup. Correspondence and communication continued with CWG members throughout the year. DOE/LLNL met three times with members of Tri-Valley Communities Against a Radioactive Environment and their scientific advisor as part of the activities funded by an Environmental Protection Agency Technical Assistance Grant.

Other Livermore Site community relations activities in 2002 included communications and meetings with neighbors and local, regional, and national interest groups and other community organizations; making public presentations; producing and distributing the Environmental Community Letter; maintaining the Information Repositories and the Administrative Record; conducting tours of the site environmental activities; and responding to public and news media inquiries. In addition, community questions were addressed via electronic mail, and project documents, letters, and public notices were posted on a public website at www-envirinfo.llnl.gov.

3. Field Investigations

3.1. Ground Water Sampling

Sampling frequency and method for wells at LLNL are determined by the treatment facility Subproject Leaders, based on data quality objectives, cost-effective sampling algorithm results and hydraulic data.

In 2002, the GWP collected 1,231 water samples during 773 sampling events from approximately 310 wells. The analytes at these locations may include: VOCs, FHCs, polychlorinated biphenyls, metals, radionuclides, or combinations thereof.

Substantial cost reduction is achieved each year through the use of low-volume and specific-depth "grab" sampling methods and devices. Sampling methods used in 2002 were:

- Specific-depth grab sampling using an EasyPump: 459 events.
- Three volume pre-sample purge: 166 events.
- Low-volume pre-sample purge: 70 events.
- Other (bailer, grab samples with electronic submersible pump, etc.): 78 events.

Use of specific-depth grab sampling in 459 sampling events, or 60% of the total events, has allowed LLNL to:

- Save over $160,000 this year in replacement costs for dedicated sampling equipment.
- Significantly reduce technician sampling time while increasing personnel safety.
- Produce no wastewater for treatment and disposal when this method is used.

The need to collect and treat over 50,000 gallons of contaminated purge water annually has been eliminated by using the EasyPump. Of this total, generation of about 8,000 gallons of mixed waste (water containing both VOCs and tritium) is avoided each year at a significant cost savings by using the EasyPump compared to a standard 3 volume purge sampling method.

3.2. Source Investigations

A passive soil vapor survey using Gore-Sorber™ modules was conducted in the former Eastern Landing Mat (ELM) and Old Salvage Yard (OSY) areas of the Treatment Facility E (TFE) area (Fig. 1) to screen for VOCs in the vadose zone. Eighty Gore-Sorber™ modules were deployed to a depth of approximately three feet over an area of nine acres. Results from this study identified three possibly higher-concentration areas of VOCs in the vadose zone: (1) a location west of well W-909 with tetrachloroethene (PCE), trichloroethene (TCE), and 1,1-dichloroethene (1,1-DCE); (2) a location east of well W-259 with PCE and TCE; and (3) a poorly defined location southwest of the Trailer 5475 (T5475) area with PCE and TCE. The former ELM and OSY locations appear to be upgradient of high concentration ground water VOC plumes in hydrostratigraphic unit 2 (HSU 2). The results of this study will be used to locate vadose zone wells for the upcoming September 2003 ELM area RAIP milestone, and to plan additional passive soil vapor surveys in the southeastern quadrant of the site.

4. Ground Water Flow and Transport Modeling

Ground water flow and contaminant transport models are used at the Livermore Site to optimize remediation system design and operation, to support ongoing subsurface characterization activities, and to improve our ability to forecast, monitor, and interpret the progress of the ground water remediation program. In 2002, we continued to improve our three-dimensional (3-D) and two-dimensional (2-D) ground water models for the Livermore Site, and began incorporating capabilities to evaluate regional scale dewatering issues. Continued use of the existing models and development of new models in 2002 are described below.

4.1. Three-Dimensional Models

In 2002, DOE/LLNL continued to use the 3-D ground water flow and transport model developed for HSUs 1B and 2 (HSU 1B/2 model) to evaluate PCE and TCE transport throughout the Livermore Site. The model was used to optimize extraction well flow rates, evaluate potential capture zones of proposed extraction wells, and evaluate plume migration and hydraulic interference patterns under increased pumping conditions. The HSU 1B/2 model was also used to evaluate the role of the Recharge Basin (Fig. 1) in the overall remediation of the Treatment Facility A (TFA) area. The model was revised to include recent well pumping histories, changing boundary conditions, and refined flow and transport parameters to evaluate the effect of varying the quantity of TFA effluent discharged to the Recharge Basin. Figures 2 and 3 show the modeling results for the expected change in ground water elevations in relation to the simulated PCE plume for a recharge rate of 177 gpm, and no recharge. The plume configurations are shown for reference. These variable rate simulations indicate that potential decreases in effluent discharge to the Recharge Basin would not adversely affect ground water elevations or capture zones, and therefore should not prolong the overall remediation of the TFA area.

In addition to the HSU 1B/2 model, preliminary work began to develop a new 3-D model that incorporates all identified HSUs beneath the Livermore Site. The objectives of this 3-D model are to provide decision support for well field management that incorporates the limited vertical communication between HSUs, help understand the recharge characteristics of the deeper HSUs, and help evaluate regional-scale dewatering issues. The new 3-D model should be functional in Fiscal Year 2004.

4.2. Two-Dimensional Models

In 2002, DOE/LLNL continued to develop and improve 2-D models for deeper HSUs 3A, 3B, 4, and 5. The primary purpose of the individual 2-D models was to understand the flow and transport characteristics of each HSU separately before incorporating them into the larger, all HSU, 3-D model for the entire site described above. The 2-D models proved very useful in identifying the recharge and discharge boundary conditions of these HSUs, as well as areas of vertical communication. The 2-D model for HSU-2 was further refined to evaluate the effects of a potential injection well near the edge of saturation in the TFD area, and to help select the location for newly installed injection well W-1904. Alternative scenarios for the optimal location of an injection well and for different injection rates were simulated to evaluate the impact of injection in relation to plume migration, source area remediation, and dewatering issues.

5. Summary of Remedial Action Program

This section summarizes 2002 activities to support the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action Program at the Livermore Site. These activities include treatment system design, new construction, modifications to existing systems, treatment facility performance, treatability tests, well installation, well abandonment, and hydraulic tests.

In 2002, DOE/LLNL operated ground water treatment facilities in the TFA, Treatment Facility B (TFB), Treatment Facility C (TFC), TFD, TFE, Treatment Facility G (TFG), TF406, Treatment Facility 518 (TF518), and Treatment Facility 5475 (TF5475) areas (Fig. 1). A total of 82 ground water extraction wells supplied water to 27 treatment facilities at a combined average flow rate of about 472 gallons per minute (gpm). In 2002, these facilities treated about 248 million gallons of ground water and removed about 108 kilograms (kg) of VOCs (Table Summ-1) compared to 142 kg in 2001. The lower quantity of mass removed in 2002 is partially due to the decreased TFA capacity discussed in Section 5.1, and decreasing concentrations in TFD-area extraction wells. Since remediation began in 1989, approximately 1,958 million gallons of ground water have been treated, removing about 921 kg of VOCs from the ground water (Fig. 4 and Table Summ-2).

In addition, DOE/LLNL operated one vapor treatment facility (VTF), VTF5475. Two vapor extraction wells at T5475 operated at a combined average flow rate of 16 standard cubic ft per minute (scfm). In 2002, this facility treated about 5,068 thousand standard cubic ft (scf) of vapor and removed an estimated 37.7 kg of VOCs (Table Summ-1) compared to about 73 kg in 2001. The lower quantity of mass removed in 2002 is primarily due to decreasing concentrations in the extraction wells. Since initial operation, the two vapor treatment facilities (VTF5475 and VTF518, which was removed from service in 2001) have treated over 38 million cubic feet of vapor and removed about 459 kg of VOCs (Fig. 4 and Table Summ-2).

The ground water and soil vapor treatment systems have removed about 1,380 kg of VOC mass from the subsurface since remediation began in 1989 (Table Summ-2).

Wells installed in 2002 are presented in Table 1 and well construction data are presented in Table A-1 of Appendix A. Wells sealed and abandoned in 2002 are presented in Table A-2 of Appendix A. Hydraulic tests performed in 2002 are presented in Table 2 and test results are presented in Appendix B. Mass removed by treatment facility area in 2002 is presented in Table Summ-1, and cumulative mass removed by treatment facility area is presented in Table Summ-2. The treatment facilities, discharge locations, and associated extraction wells are presented in Table 4.

Treatment facility performance is evaluated using several different data sets. Figures 5 through 10 show the estimated hydraulic capture areas in HSUs 1B, 2, 3A, 3B, 4 and 5, respectively, based on 2002 ground water elevation data. Figures 11 through 16 show fourth quarter total VOC isoconcentrations in the same six HSUs. Contaminant concentration trends (Section 7) are also used to evaluate treatment facility performance and hydraulic capture. Figures 17 through 20 show treatment facilities, extraction wells, pipelines, discharge points, and self-monitoring program sampling locations for the new or modified facilities installed in 2002.

Activities and performance of each Livermore Site treatment facility in 2002 are briefly summarized below.

5.1. Treatment Facility A

Two treatment facilities, TFA and TFA East (TFA-E) operated in 2002 in the TFA area (Fig. 1). Both facilities complied with all permits throughout 2002.

Since September 2001, TFA has operated at less than optimal capacity because the Recharge Basin percolation capacity decreased from greater than 300 gpm for a single Recharge Basin cell to about 70 gpm for both cells combined. The decreased percolation capacity may be due to buildup of organic matter and silt accumulation in the bottom of the basin. DOE/LLNL is expanding TFA discharge options to include discharging directly into Arroyo Seco, as well as Arroyo Las Positas using a six-inch diameter discharge pipeline that would extend northward to the discharge ditch at TFB. These new discharge locations would allow TFA extraction wells to extract more water and TFA to operate at full capacity, thereby more effectively capturing the TFA source area and cleaning up the offsite plumes. In addition, the capacity limitations and maintenance of the Recharge Basin would be avoided (Bainer and Joma, 2002b). TFA started discharging directly to Arroyo Seco on December 19, 2002.

The TFA area extraction wells hydraulically control the VOC plumes in HSU 1B based on the capture zone analysis shown on the ground water elevation contour map (Fig. 5) and the total VOC isoconcentration map (Fig. 11). Pumping continues at offsite HSU 1B extraction well W-408 to ensure hydraulic control of the HSU 1B VOC plume at well W-1425, where the PCE concentration was 8 parts per billion (ppb) in September 2002. Despite reduced TFA treatment capacity, pumping from offsite HSU 2 extraction wells W-109 and W-904 was maintained at about 35 and 10 gpm, respectively, to help maintain hydraulic control of the HSU 2 VOC plume near well W-404 (Figs. 6 and 12) where the PCE concentration was 26 ppb in October 2002. Although VOC concentrations are relatively stable in HSU 3A in the TFA area, hydraulic control in this HSU has been diminished by the reduced TFA capacity discussed above.

In 2002, extraction well W-1805 was completed in HSU 1B next to the TFA North Pipeline (Fig. 1). Well W-1805 is positioned to clean up an area of elevated concentrations close to the western site border. Construction details for well W-1805 are provided in Table A-1 of Appendix A.

5.2. Treatment Facility B

TFB (Fig. 1) operated in compliance with all permits during 2002. Extraction well W-655 was not pumped at all in 2002 since all contaminants of concern continued to remain below Maximum Contaminant Levels (MCLs) at this location.

The TFB area extraction wells hydraulically control the VOC plumes in HSUs 1B and 2 based on the capture zone analysis shown on the ground water elevation contour maps (Figs. 5 and 6), the total VOC isoconcentration maps (Figs. 11 and 12) for each HSU, and stable or declining VOC concentrations in the area.

5.3. Treatment Facility C

Three treatment facilities, TFC, TFC Southeast (TFC-SE), and TFC East (TFC-E) operated in 2002 in the TFC area (Fig. 1). These facilities complied with all permits throughout 2002.

In the central and western TFC area, VOCs are confined to HSU 1B. In the eastern TFC area, VOCs are present in both HSU 1B and HSU 2. The TFC area extraction wells hydraulically control the VOC plumes in HSU 1B and HSU 2 based on the capture zone analysis shown on the ground water elevation contour maps (Figs. 5 and 6) and the total VOC isoconcentration maps (Figs. 11 and 12).

One new treatment facility was added to the TFC area in 2002. TFC-E (Miniature Treatment Unit 1 [MTU-1]), located west of the West Traffic Circle and south of Westgate Drive (Fig. 1), began operating on April 3, 2002. MTU-1 is equipped with an air stripper to treat VOCs in ground water, which also flows through ion-exchange resin columns to remove hexavalent chromium on a year-round basis. The effluent air is treated with granular activated carbon (GAC) to remove VOCs prior to venting to the atmosphere. Treated ground water from MTU-1 is discharged into underground storm drains that empty into Arroyo Las Positas (Fig. 18).

5.4. Treatment Facility D

Eight treatment facilities operated in 2002 in the TFD area (Fig. 1). These facilities are TFD, TFD West (TFD-W), TFD East (TFD-E), TFD Southeast (TFD-SE), TFD South (TFD-S), TFD Southshore (TFD-SS), Portable Treatment Unit 10 (PTU10), and Solar-powered Treatment Unit 10 (STU10). The latter two are temporary facilities that are included in the TFD totals on Tables Summ-1 and Summ-2, and the mass totals on Figure 4. STU10 ceased operation in the TFD area in 2002. STU10 was connected to well W-1550 and will be piped to TFD-E.

The TFD area extraction wells hydraulically control VOCs in HSUs 2, 3B, 4, and 5 based on the capture zone analysis shown on the ground water elevation contour maps (Figs. 6, 8, 9, and 10) and the total VOC isoconcentration maps (Figs. 12, 14, 15, and 16) for each HSU. Distal portions of VOC plumes in HSUs 1B and 2 in the western TFD area are being hydraulically controlled now that TFC-E is operating. Source control has been achieved in HSU 5. However, additional wells are needed to capture the distal portions of the VOC plume in HSU 3A. Pumping of HSU 3A extraction well W-1902 for the upcoming TFC-NE milestone in May 2003 will begin to address this issue.

Although no new Electro-osmosis tests were conducted in the TFD area in 2002, PTU10, located northeast of the DRB (Fig. 1), continued to operate in 2002 to expedite VOC mass removal and source area cleanup through conventional ground water extraction and above-ground treatment.

Seven monitor wells and two piezometers were sealed and abandoned in the TFD area in 2002 (Table A-2, Appendix A). Monitor wells W-010A, W-211, W-360, W-414, W-1218, W-1220, and W-1221 were sealed due to construction of the Terascale Simulation Facility. Piezometers SIP-HPA-102 and SIP-HPA-103, located north of the DRB, were sealed due to the planned construction of a new cafeteria.

Three new monitor wells and one extraction well were installed in the TFD area in 2002 (Fig. 1). Monitor well W-1802 was completed in HSU 3A in the TFD-W area. Multilevel monitor well W-1803 was completed in HSUs 4 and 5 northwest of the DRB. Multilevel monitor well W-1804 was completed in HSUs 2 and 3A south of the East Traffic Circle. Extraction well W-1902, completed in HSU 3A, was installed as part of the May 2003 TFC-NE RAIP milestone. Ground water extracted from this well will be treated at TFD-W, which will

eliminate the need to construct a new, separate facility at the TFC-NE location. Results of a one-hour drawdown test conducted on W-1802 are presented in Appendix B.

5.5. Treatment Facility E

Six treatment facilities, TFE East (TFE-E), TFE Northwest (TFE-NW), TFE Southwest (TFE-SW), TFE Southeast (TFE-SE), TFE West (TFE-W), and PTU4 operated in 2002 in the TFE area (Fig. 1). PTU4 is a portable hydraulic test unit that operates in the TFE area when not being used elsewhere for testing. PTU4 data are included in the TFE totals on Tables Summ-1 and Summ-2, and the mass totals on Figure 4.

All six TFE-area facilities complied with all permits throughout 2002. TFE-NW and PTU4 were shut down in September 2002 during an ongoing test to evaluate whether the VOC plumes captured by these facilities are being effectively captured by the TFD-S facility. Discontinued extraction from TFE-NW and PTU4 may also reduce dewatering in the southeast quadrant of the site, allowing increased extraction at other facilities. The two facilities may be restarted in the spring of 2003, pending the results of the test.

The TFE-E, TFE-NW, TFE-SW, TFE-SE, and TFE-W extraction wells hydraulically contain some portions of VOC plumes in HSUs 2 and 3A, most of the VOC plumes in HSUs 3B and 4, and all of the VOCs in HSU 5 based on the capture zone analysis shown on the ground water elevation contour maps (Figs. 6, 7, 8, 9, and 10) and the total VOC isoconcentration maps (Figs. 12, 13, 14, 15, and 16) for each HSU. Hydraulic control of the leading edge of a mobile HSU 2 VOC plume emanating from the TFE area will be achieved with activation of the TFG North (TFG-N) facility RAIP milestone scheduled for July 2003. TFG-N will be located near well W-1806 (Fig. 1).

One new dual-phase extraction well, W-1903, was installed northwest of TFE in 2002 (Fig. 1). Well W-1903, completed in HSU 2 and designed to extract both ground water and soil vapor, was installed as part of the September 2003 ELM source area remediation RAIP milestone. Well construction details are provided in Table A-1 of Appendix A.

5.6. Treatment Facility G

TFG-1 is located in the south-central portion of the Livermore Site (Fig. 1) and was in compliance with all permits in 2002.

TFG-1 extraction well W-1111 hydraulically controls VOCs in HSU 2 in the TFG area based on the capture zone analysis shown on the ground water elevation contour map (Fig. 6) and the total VOC isoconcentration map for HSU 2 (Fig. 12).

Two new extraction wells and one new monitor well were installed in the TFG area in 2002 (Fig. 1). HSU 1B extraction well W-1806 and HSU 2 extraction well W-1807 were installed as part of the upcoming TFG-N July 2003 RAIP milestone. Multilevel monitor well W-1901 was completed in HSUs 1B and 2 downgradient from the two extraction wells. Construction details and well development flow rates are provided in Table A-1 of Appendix A.

5.7. Treatment Facility 406

Two treatment facilities, TF406 and TF406 Northwest (TF406-NW), operated in the TF406 area in 2002. The TF406 area is located in the south-central portion of the Livermore Site (Fig. 1). Both treatment facilities were in compliance with all permits in 2002.

Passive bioremediation continued in the TF406 area during 2002 to remediate FHCs in HSUs 3A and 3B.

One new treatment facility, TF406-NW, was added to the TF406 area in 2002. TF406-NW (GAC Treatment Unit 3 [GTU3]), located east of Southgate Drive and south of South Outer Loop Road (Fig. 1), was activated July 16, 2002, fifteen days ahead of the RAIP milestone date. GTU3 uses GAC canisters in series to treat water from well W-1801. Treated ground water from GTU3 is discharged into a storm drain that flows north to Arroyo Las Positas (Fig. 19).

The TF406, TF406-NW, and TF518-North (see Section 5.9) extraction wells provide significant hydraulic control of VOC plumes in HSUs 3B and 4 and full control in HSU 5 in the TF406 area based on the capture zone analysis shown on the ground water elevation contour maps (Figs. 8, 9, and 10) and the total VOC isoconcentration maps (Figs. 14 ,15, and 16) for each HSU.

One new extraction well (W-1801) was installed in the TF406 area in 2002 (Fig.1). This well was completed in HSU 3A as part of the TF406-NW July RAIP 2002 milestone. Results of a one-hour drawdown test conducted on well W-1801 are presented in Appendix B.

5.8. Vapor Treatment Facility 518

Vapor treatment facility VTF518 (Fig. 1) did not operate during 2002 due to a blower malfunction, that was not repairable. The very low soil vapor flow rates (<1.0 scfm) yielded by VTF518 vapor extraction wells in 2001 are interpreted to be due to the high moisture content of shallow sediments at this location. The entire area around VTF518 was paved during 2002 to help reduce infiltration of surface water that may be contributing to the high moisture conditions. This area will be addressed in a July 30, 2004 RAIP milestone when both ground water and soil vapor extraction and treatment are implemented.

Water with relatively high concentrations (21.3 parts per million in December 2002) is extracted on a periodic basis from former vapor extraction well SVB-518-303. This water is collected in a tank and transported to TFD for treatment. Three instrumented membrane system (IMS) sampling/monitor wells, IMS-518-1616, SEA-518-301 and SEA-518-304, continued to monitor soil moisture levels and vadose zone vapor concentrations in the VTF518 area in 2002. The IMS system is used to collect vapor pressure, soil temperature, soil moisture, and soil vapor concentration data from various discrete depths.

5.9. Ground Water Treatment Facility 518 North

Treatment facility TF518 North (TF518-N) (Fig. 1) was in compliance with all permits in 2002. HSU 5 remained de-watered throughout 2002 in the area where TF518 was formerly located.

HSU 4 extraction well W-1410 at TF518 North, and HSU 5 extraction wells at adjacent treatment facility areas TF406 and TFE-SE continue to provide hydraulic control of VOC plumes in HSUs 4 and 5 based on the capture zone analysis shown on the ground water elevation contour

maps (Figs. 9 and 10) and the total VOC isoconcentration maps (Figs. 15 and 16). The sustained de-watering in HSU 5 impacts hydraulic control by widening the capture areas.

5.10. Treatment Facility 5475

Three ground water treatment facilities operated in 2002 in the T5475 area: TF5475-1, TF5475-2, and TF5475-3, located in the east-central portion of the Livermore Site (Figs. 1 and 20). TF5475-1 and TF5475-3 use catalytic reductive dehalogenation (CRD) to remediate the VOCs. Dual phase soil vapor and ground water extraction capacity was added to the HSU 3A extraction wells at TF5475-2 on September 23, 2002, seven days ahead of the RAIP milestone date.

TF5475-1 (CRD-1) and TF5475-2 (STU5) complied with all permit requirements throughout 2002. Destruction efficiency ranged from 97.9 to 98.7% in 2002 at TF5475-1 (CRD-1). Destruction efficiency of TF5475-3 (CRD-2) was greater than 97% for all samples except two. CRD-2 destruction efficiency was 88.5 and 78.3% on January 24, 2002 and October 17, 2002, respectively. Very low ground water extraction rates caused difficulty adjusting hydrogen flow. This has been remedied by operating 40 hours per week at higher ground water flow rates. Extraction wells W-1606 and W-1608 are not currently extracting ground water at TF5475-3 due to de-watering of HSU 3A in the T5475 area.

5.11. Vapor Treatment Facility 5475

In 2002, VTF5475 (Figs. 1 and 20) was expanded to treat soil vapor from HSU 3A dual phase extraction wells at TF5475-2 (see Section 5.10).

No effluent vapor from VTF5475 is released to the atmosphere due to reinjection of treated vapor to the subsurface. The Bay Area Air Quality Management District has granted the facility an exemption from air discharge requirements**.**

Two IMS sampling/monitor wells, SEA-ETS-506 and SEA-ETS-507, located near TF5475-3 (CRD-2), continued to monitor vadose zone remediation in the VTF5475 area. The IMS wells are used to collect vapor pressure, soil temperature, soil moisture, and soil vapor concentration data from various discrete depths.

6. Ground Water Discharges During 2002

In 2002, approximately 64 Mgal of treated ground water was discharged to the Recharge Basin, about 179 Mgal of treated ground water was discharged to Arroyo Las Positas, and an estimated 6 Mgal of treated ground water was discharged to Arroyo Seco.

7. Trends in Ground Water Analytical Results

In 2002, the decrease in concentrations observed in the Livermore Site VOC plumes reflects the 108 kg of VOCs removed by the ground water extraction wells during 2002 (Table Summ-1). The decline in VOC concentrations is primarily attributed to active ground water extraction and remediation. Notable results of VOC analyses of ground water received from the third quarter 2001 to the fourth quarter 2002 are discussed below. Well locations are shown on Figure 1.

VOC concentrations on the western margin of the site either declined or remained unchanged during 2002, indicating continued effective hydraulic control of the western site boundary plumes in the TFA, TFB, and TFC areas. Concentrations in the TFA and TFB source areas increased slightly, however. While the areal extent of the offsite TFA HSU 1B total VOC plume remained largely unchanged in 2002, the entire offsite TFA HSU 2 plume dropped below 50 ppb for the first time. All offsite TFA HSU 3A wells remained below MCLs for all VOCs of concern.

In the TFB area, VOC concentrations were lower in HSU 1B close to Vasco Road, where TCE declined from 23 ppb in 2001 to 14 ppb in 2002. However, Freon 113 concentrations increased in the TFB source area (280 ppb in SIP-141-203 in April 2002, up from 6.5 ppb in May 2001).

In the central to northern TFC area, the lateral extent of HSU 1B total VOC concentrations above 50 ppb decreased significantly. Total VOC concentrations decreased along the western margin of the TFC area where well W-1116 decreased from 26 ppb to 5 ppb TCE in 2002, and well W-1102 decreased from 23 ppb to 5 ppb TCE.

HSU 2 Freon 11 concentrations in the northern TFD area continued to decline in response to pumping at TFD-W. Freon 11 in well W-423 declined from 420 ppb in 2001 to 150 ppb in 2002, and from 83 ppb to 54 ppb in well W-375.

Concentrations began to decline in 2002 in a mobile HSU 2 plume located in the western TFE area in response to pumping at TFE West (TFE-W). TCE in extraction well W-305 declined from 220 ppb TCE in 2001 to 76 ppb in 2002, while concentrations further downgradient at SIP-331-001, located west of TFE-W, declined from 20 ppb in 2001 to 15 ppb in 2002. The leading edge of this plume should be hydraulically contained once TFG-N, which will be located near well W-1807, is activated in 2003. TCE in the more proximal part of this plume declined in 2002, from 171 ppb to 64 ppb in well W-271 in response to pumping in the source area at TFE-E. Total VOC concentrations in the Old Salvage Yard source area, located near SIP-ETS-601 (Fig. 1), also known as the TFE Hotspot source area, increased significantly from 521 in 2001 to 1,684 in 2002 at SIP-ETS-601. Source area cleanup at the TFE Hotspot source area is scheduled to begin in 2005.

HSU 3A total VOC concentrations continued to decline in the T5475 area in 2002 due to a combination of soil vapor extraction at VTF5475 and regional dewatering of HSU 3A. VOCs in HSUs 3A, 3B, and 4 declined in the south-central TFD area in response to pumping at TFD-S and PTU4. TCE in HSU 3 well W-1504 declined from 400 ppb in 2001 to 180 ppb in 2002, and TCE in HSU 4 well W-1418 declined from 290 ppb in 2001 to 200 ppb in 2002. HSU 4 TCE concentrations also declined in the southwestern TFE area due to ongoing pumping at TFE-SW. TCE in HSU 4 wells W-354 and W-1520 declined from 83 ppb and 394 ppb in 2001 to 35 ppb and 161 ppb in 2002, respectively.

Significant decreases in HSU 5 VOC concentrations were observed in the TF406 area in 2002 in response to ground water extraction, particularly on DOE property administered by Sandia National Laboratory south of East Avenue. TCE in well W-509, positioned at the leading edge of a TCE plume, declined from 27 ppb in 2001 to less than 0.5 ppb in 2002. Closer to TF406, TCE in well W-1112 declined from 31 ppb to 9 ppb over the same period. The relatively rapid cleanup of this area suggests that the TF406 South facility proposed for 2006 may not be needed to achieve timely cleanup.

During 2002, tritium activities in ground water from all wells in the T5475 area remained below the MCL and continued to decrease by natural decay. Only one well, UP-292-007, located north of TFC-E, remains slightly above the 20,000 picocuries per liter (pCi/L) MCL in the Building 292 area (20,600 pCi/L in October 2002).

8. References

Bainer, R. W., and H. Joma (2002a), Letter Report: LLNL Livermore Site First Quarter Self-Monitoring Report, dated May 31, 2002.

Bainer, R. W., and H. Joma (2002b), Letter to Naomi Feger of the San Francisco Bay Regional Water Quality Control Board regarding proposed TFA discharge to Arroyo Las Positas, dated January 7, 2002.

Bainer, R. W., and P. W. Wong (2002a), Letter Report: LLNL Livermore Site Second Quarter Self-Monitoring Report, dated August 30, 2002.

Bainer, R. W., and P. W. Wong (2002b), Letter Report: LLNL Livermore Site Third Quarter Self-Monitoring Report, dated November 27, 2002.

Bainer, R. W., and P. W. Wong (2003), Letter Report: LLNL Livermore Site Fourth Quarter Self-Monitoring Report, dated February 28, 2003.

Dibley, V., M. Dresen, L. Berg, R. Bainer, and E. Folsom (Eds.) (2002), *LLNL Ground Water Project 2001 Annual Report*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-126020-01).

Dresen, M. D., J. P. Ziagos, A. J. Boegel, and E. M. Nichols (Eds.) (1993), *Remedial Action Implementation Plan for the LLNL Livermore Site*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-110532) (Page 43 revised September 2, 1993; Table 5 revised January 2003).

Figures

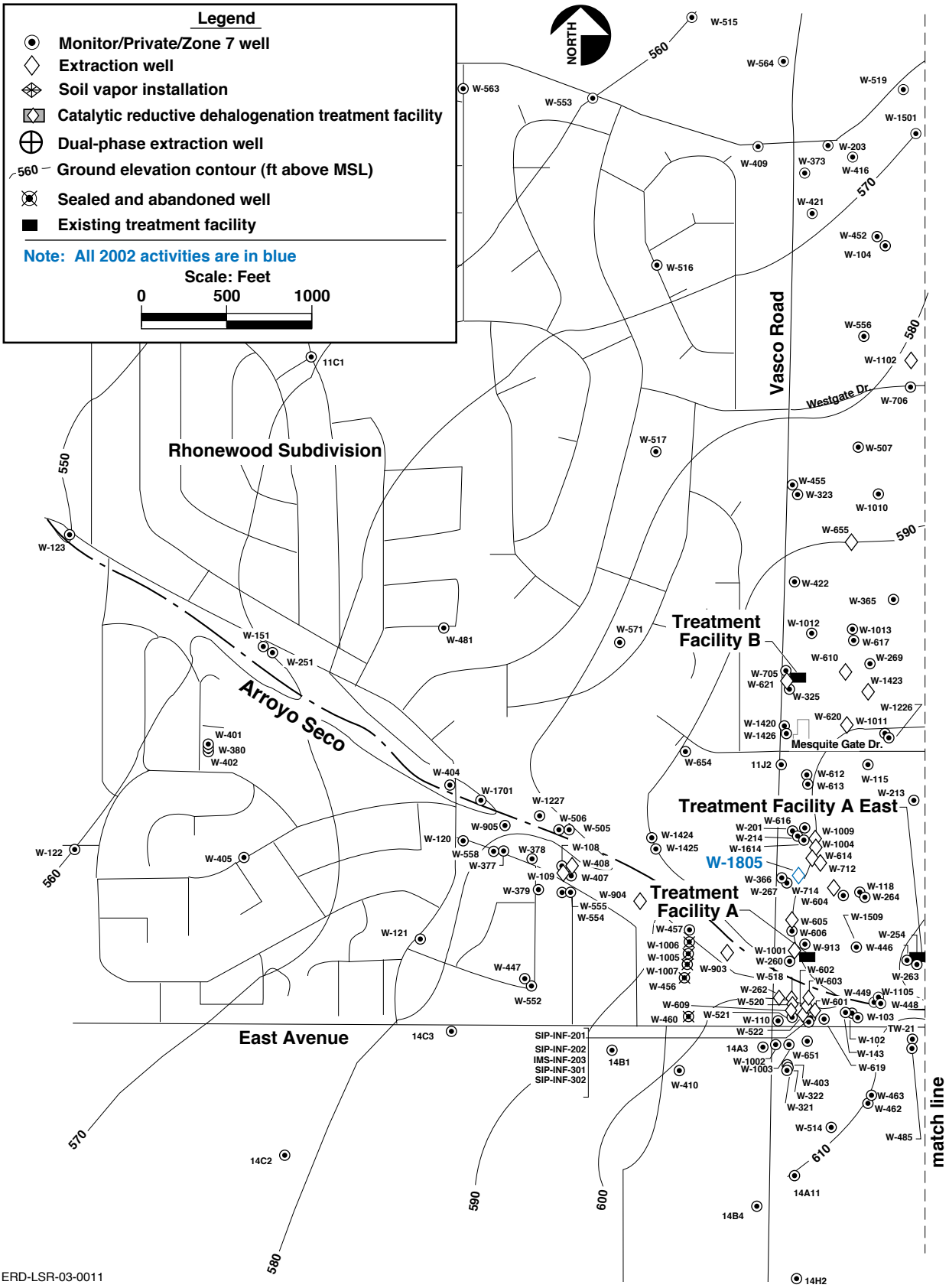


Figure 1. Locations of Livermore Site monitor wells, extraction wells, and treatment facilities, December 2002.

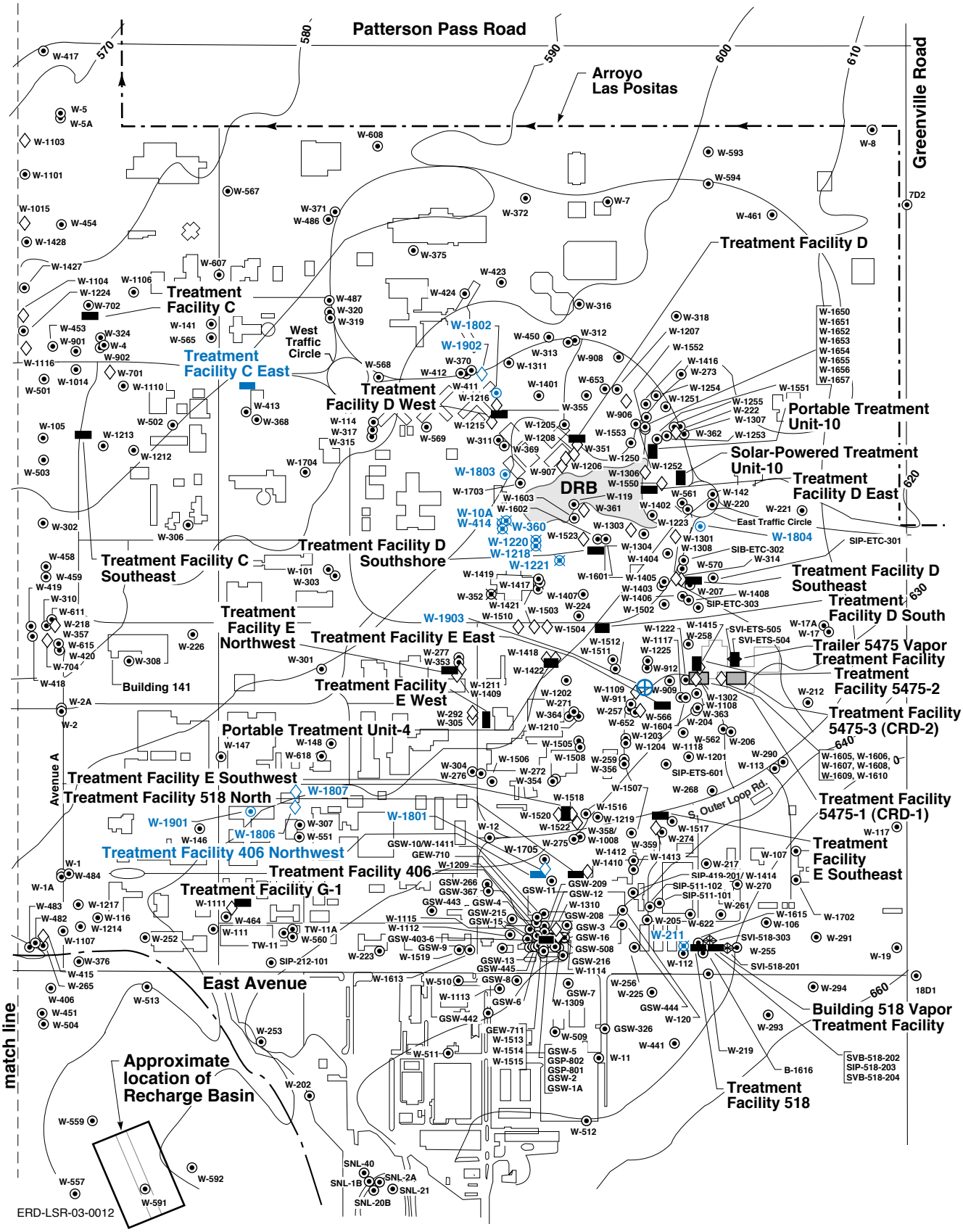
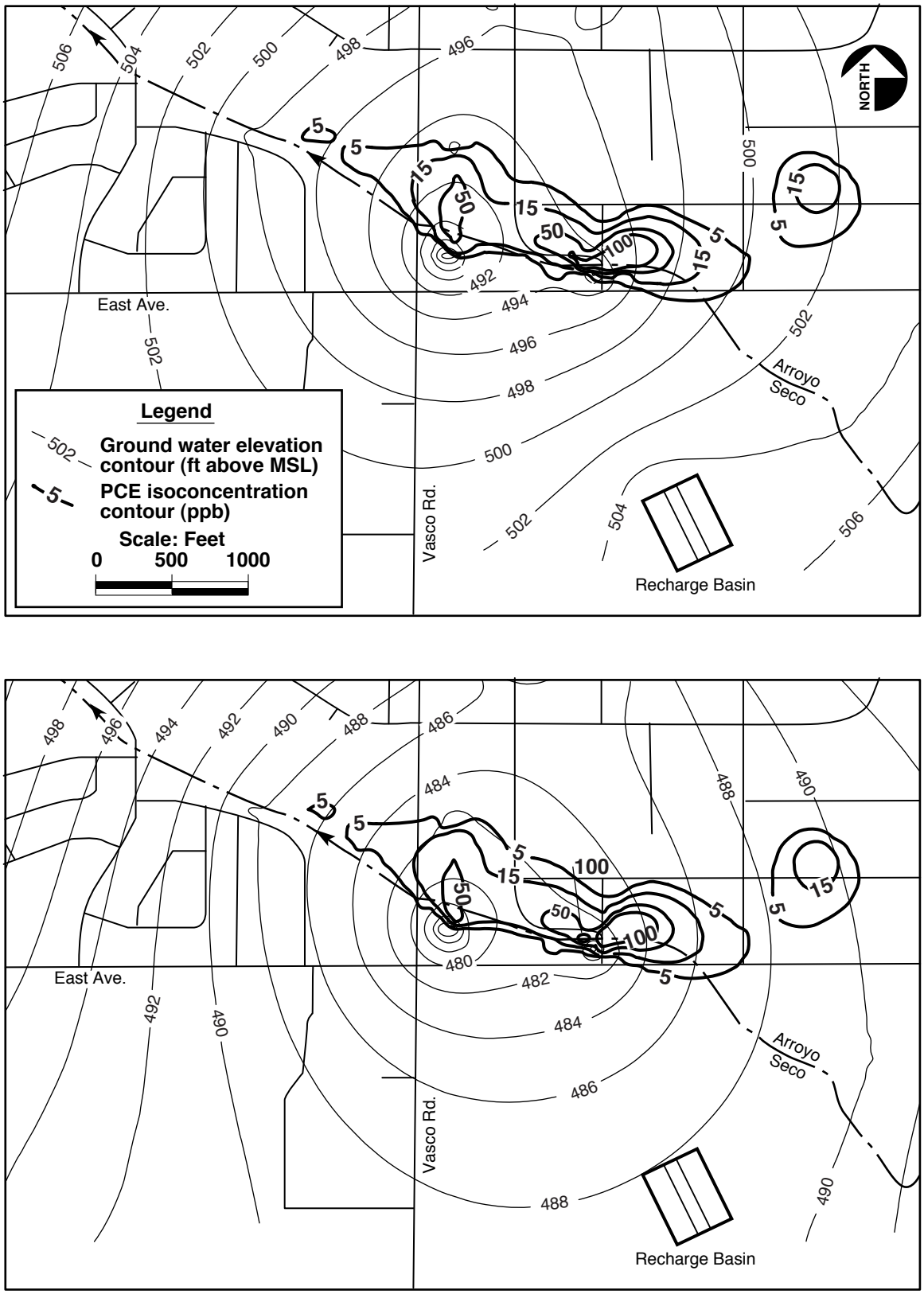
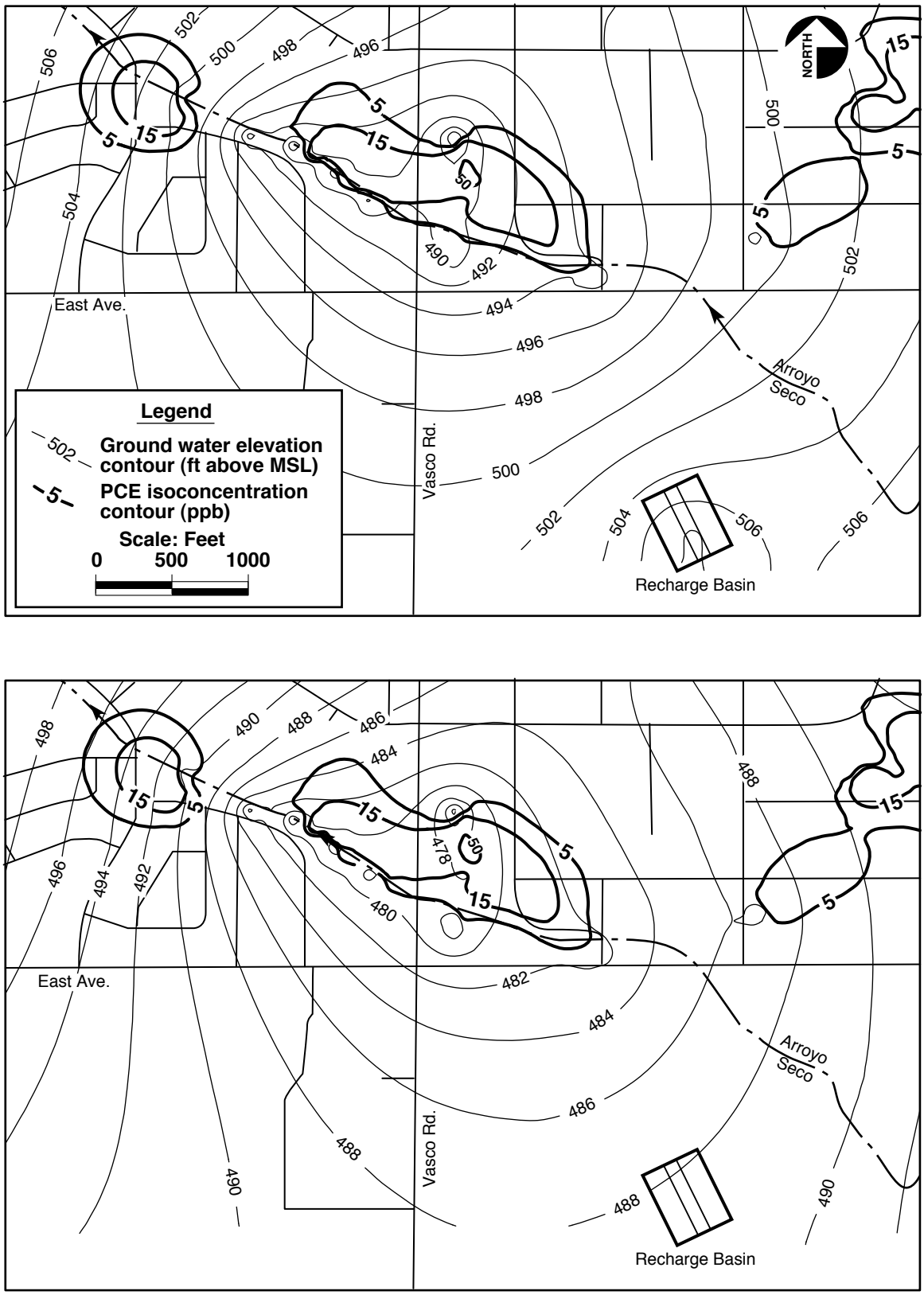


Figure 1 (continued).



ERD-LSR-03-0013

Figure 2. Simulated ground water elevations and PCE concentrations (ppb) in HSU 1B for a TFA effluent discharge rate of 177 gpm (top) and no discharge (bottom) to the Recharge Basin.



ERD-LSR-03-0014

Figure 3. Simulated ground water elevations and PCE concentrations (ppb) in HSU 2 for a TFA effluent discharge rate of 177 gpm (top) and no discharge (bottom) to the Recharge Basin.

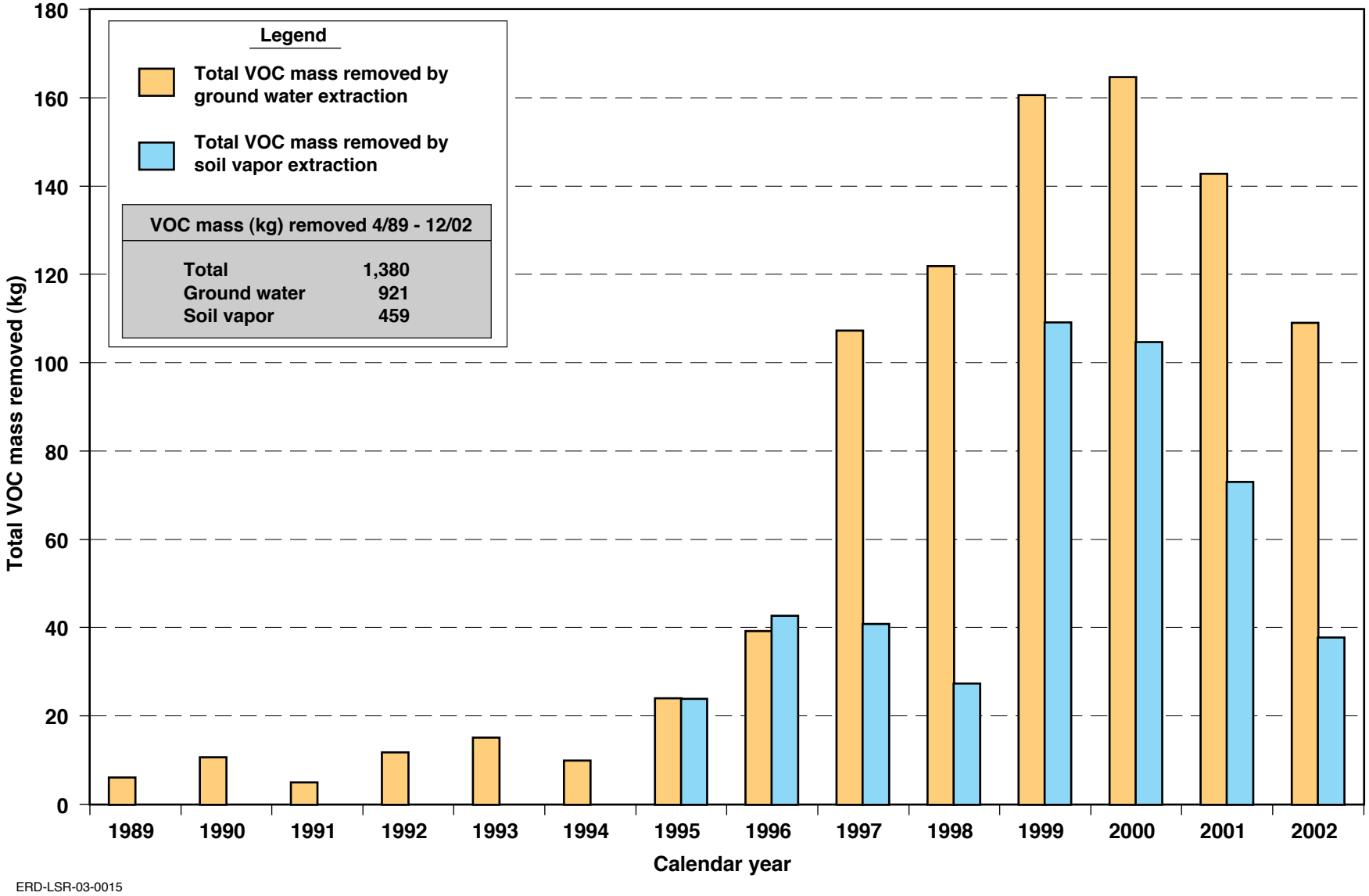
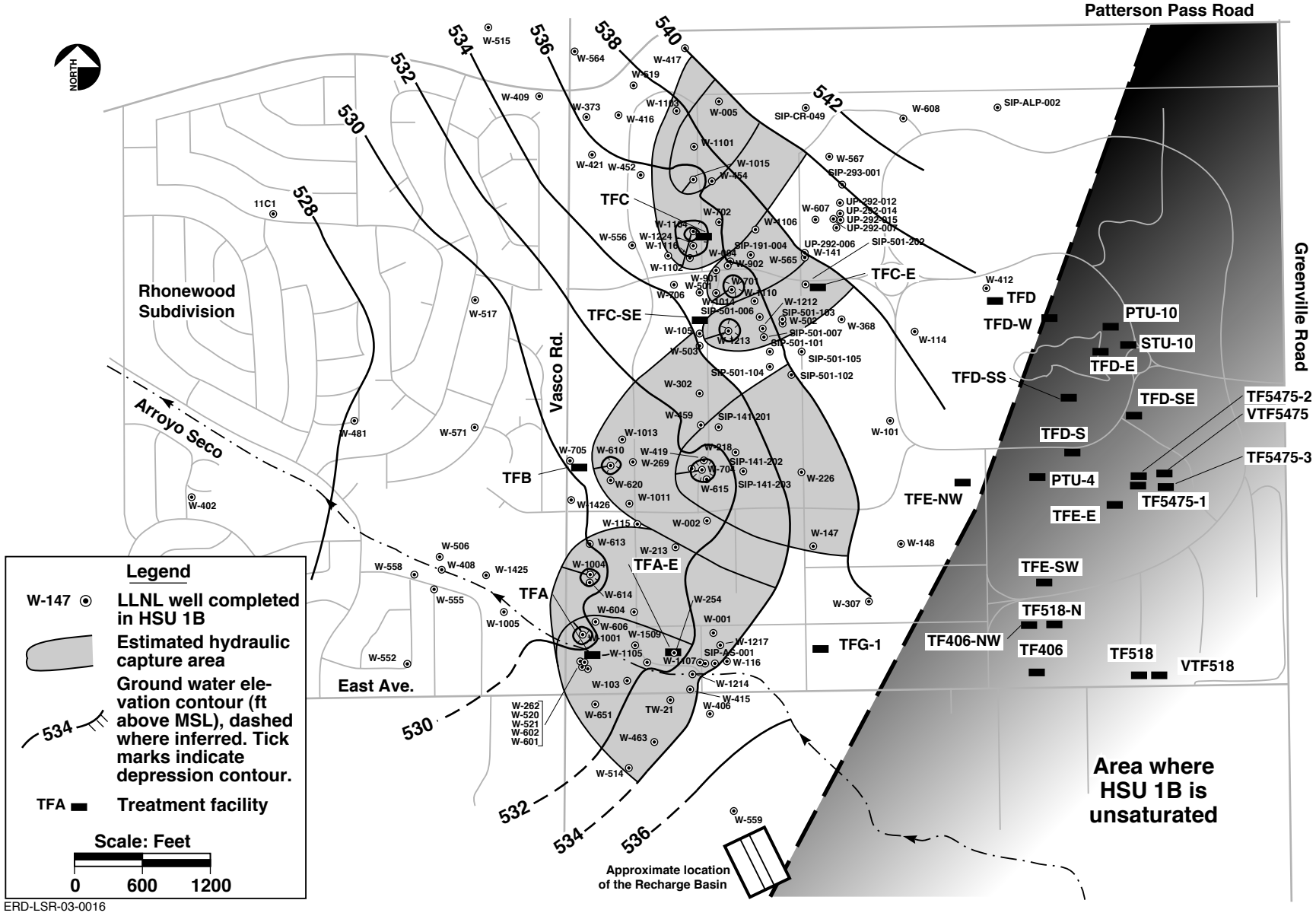


Figure 4. Total VOC mass removed from the Livermore Site subsurface over time.



ERD-LSR-03-0016

Figure 5. Ground water elevation contour map based on water levels collected from 136 wells completed within HSU 1B showing estimated hydraulic capture areas, LLNL and vicinity, November 2002.

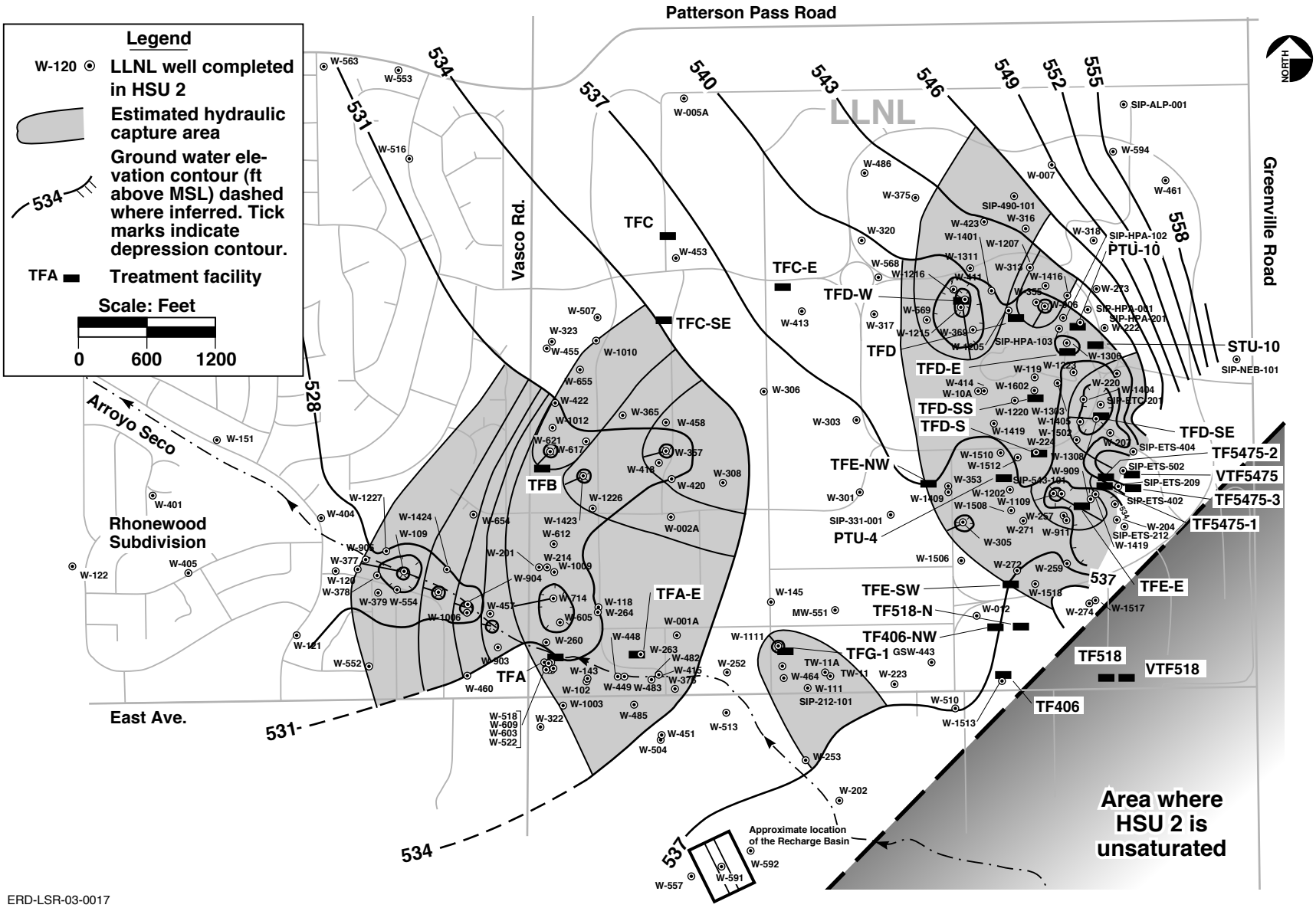


Figure 6. Ground water elevation contour map based on water levels collected from 172 wells completed within HSU 2 showing estimated hydraulic capture areas, LLNL and vicinity, November 2002.

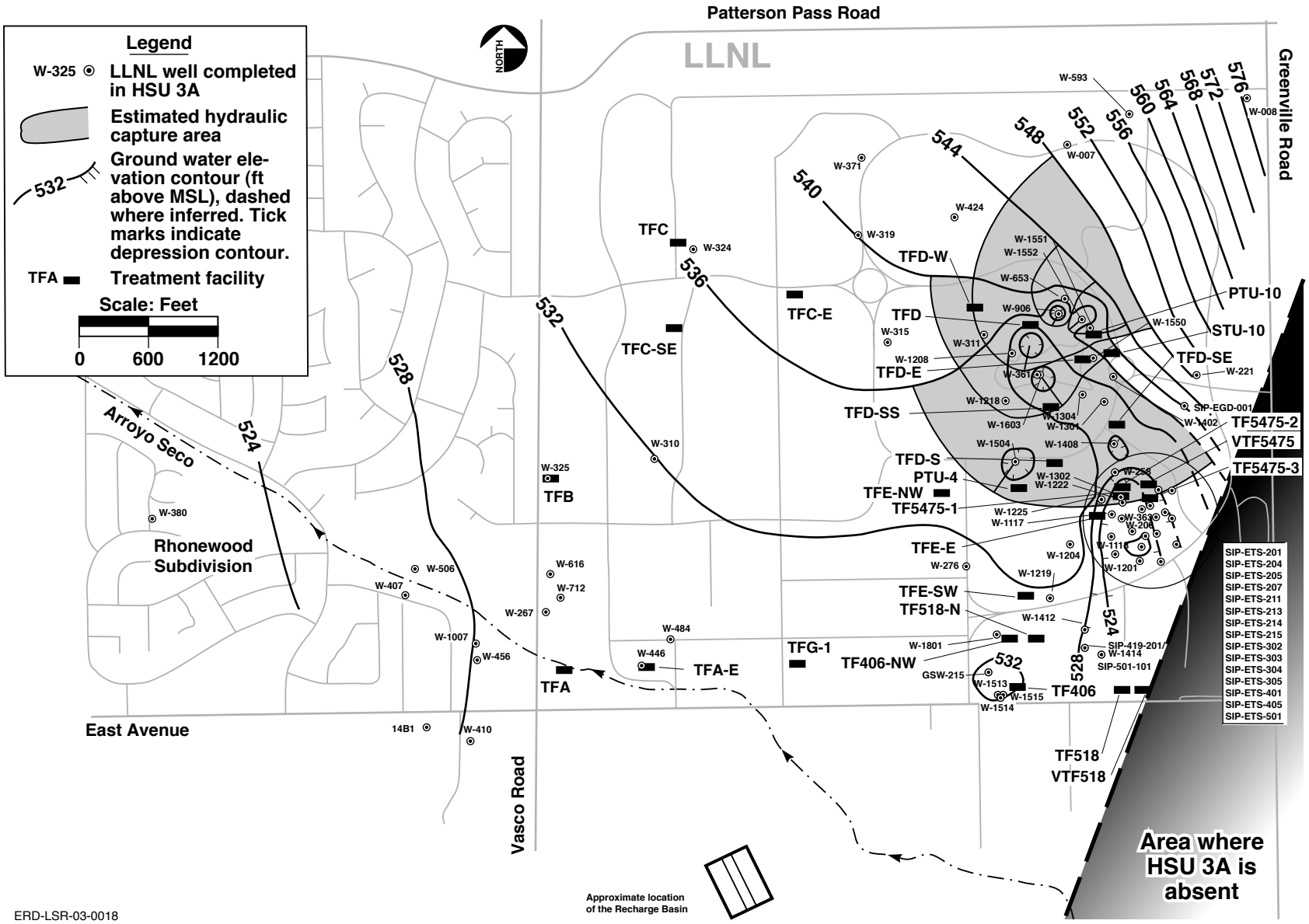


Figure 7. Ground water elevation contour map based on water levels collected from 65 wells completed within HSU 3A showing estimated hydraulic capture areas, LLNL and vicinity, October 2002.

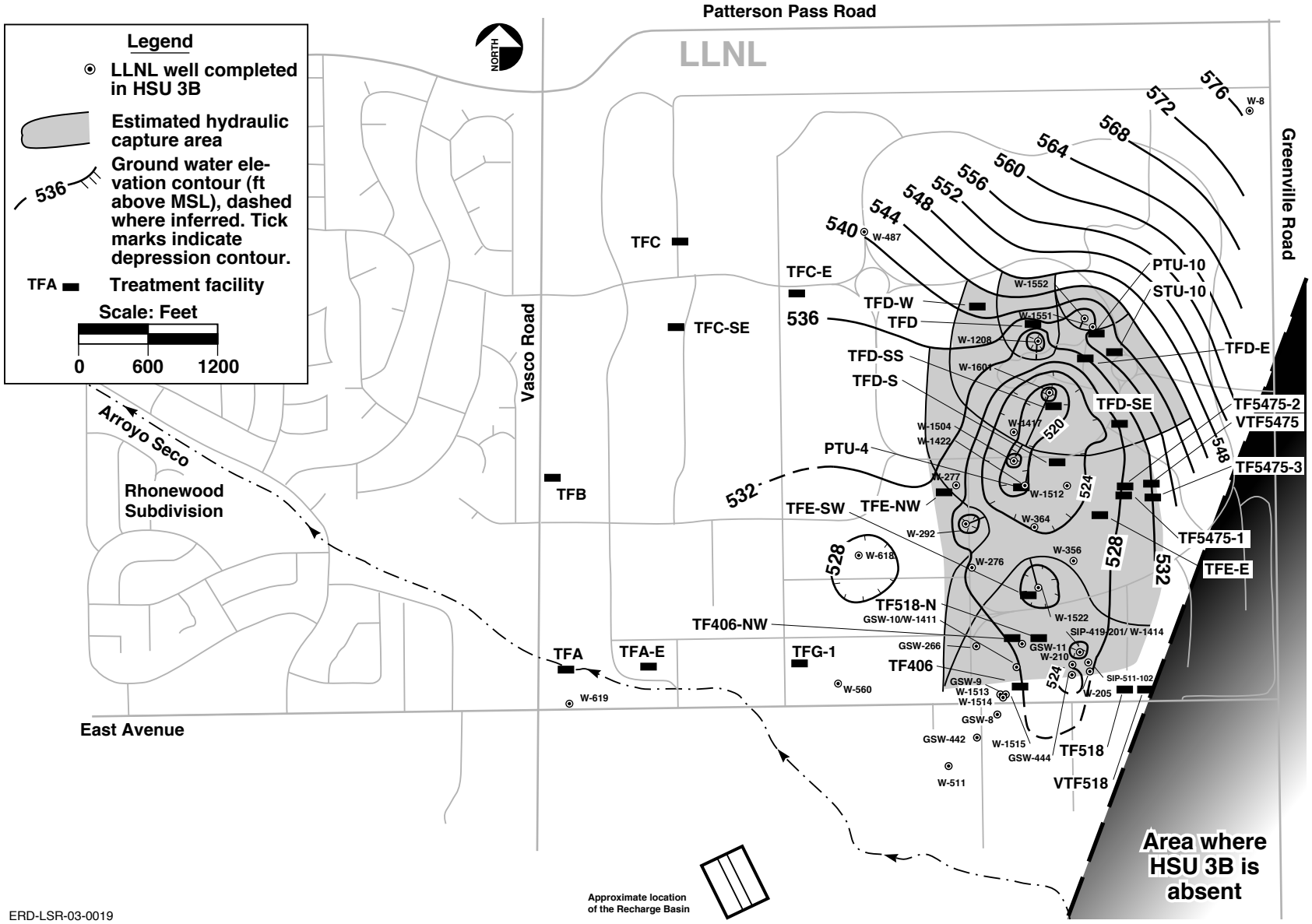


Figure 8. Ground water elevation contour map based on water levels collected from 29 wells completed within HSU 3B showing estimated hydraulic capture areas, LLNL and vicinity, October 2002.

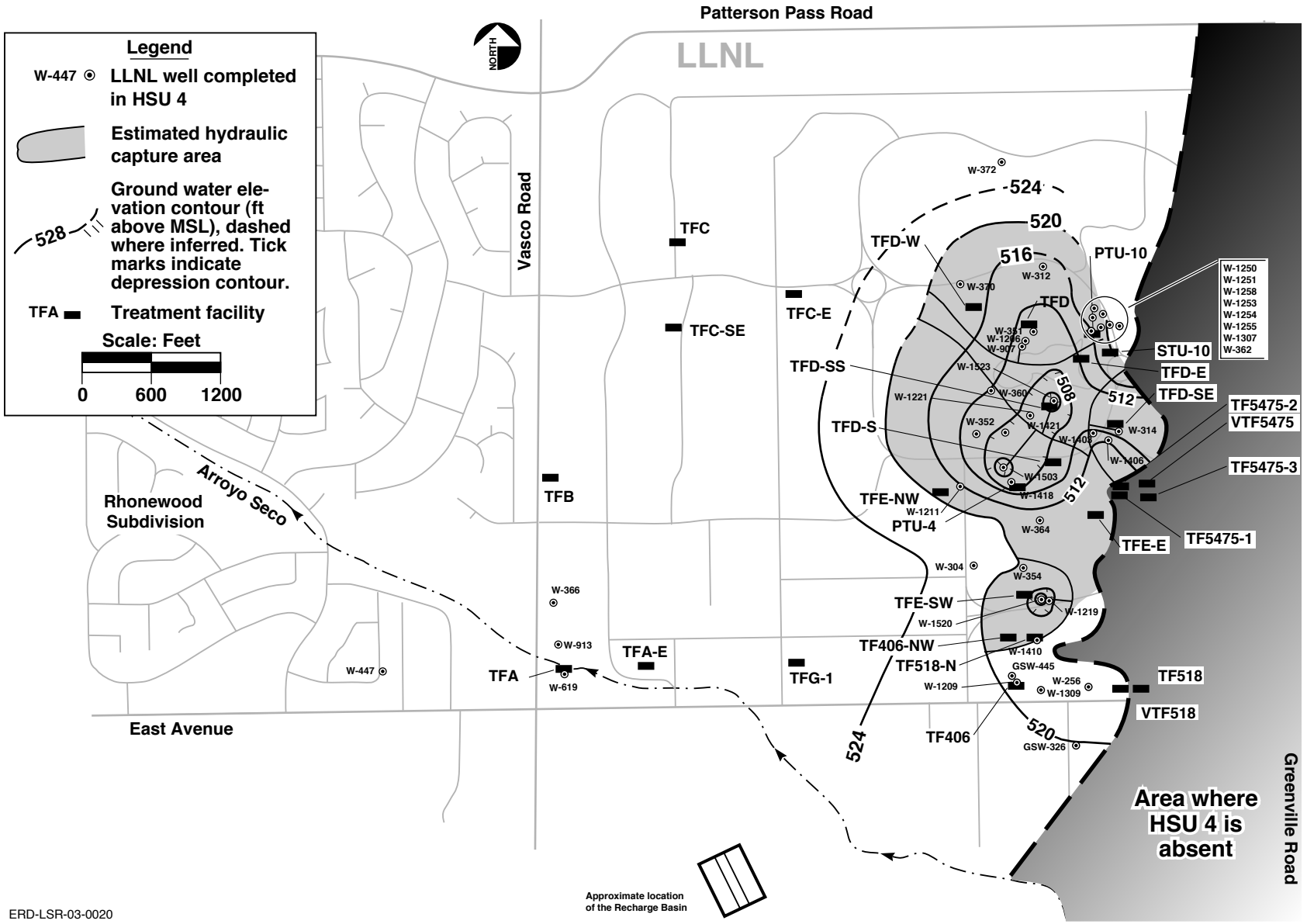


Figure 9. Ground water elevation contour map based on water levels collected from 31 wells completed within HSU 4 showing estimated hydraulic capture areas, LLNL and vicinity, October 2002.

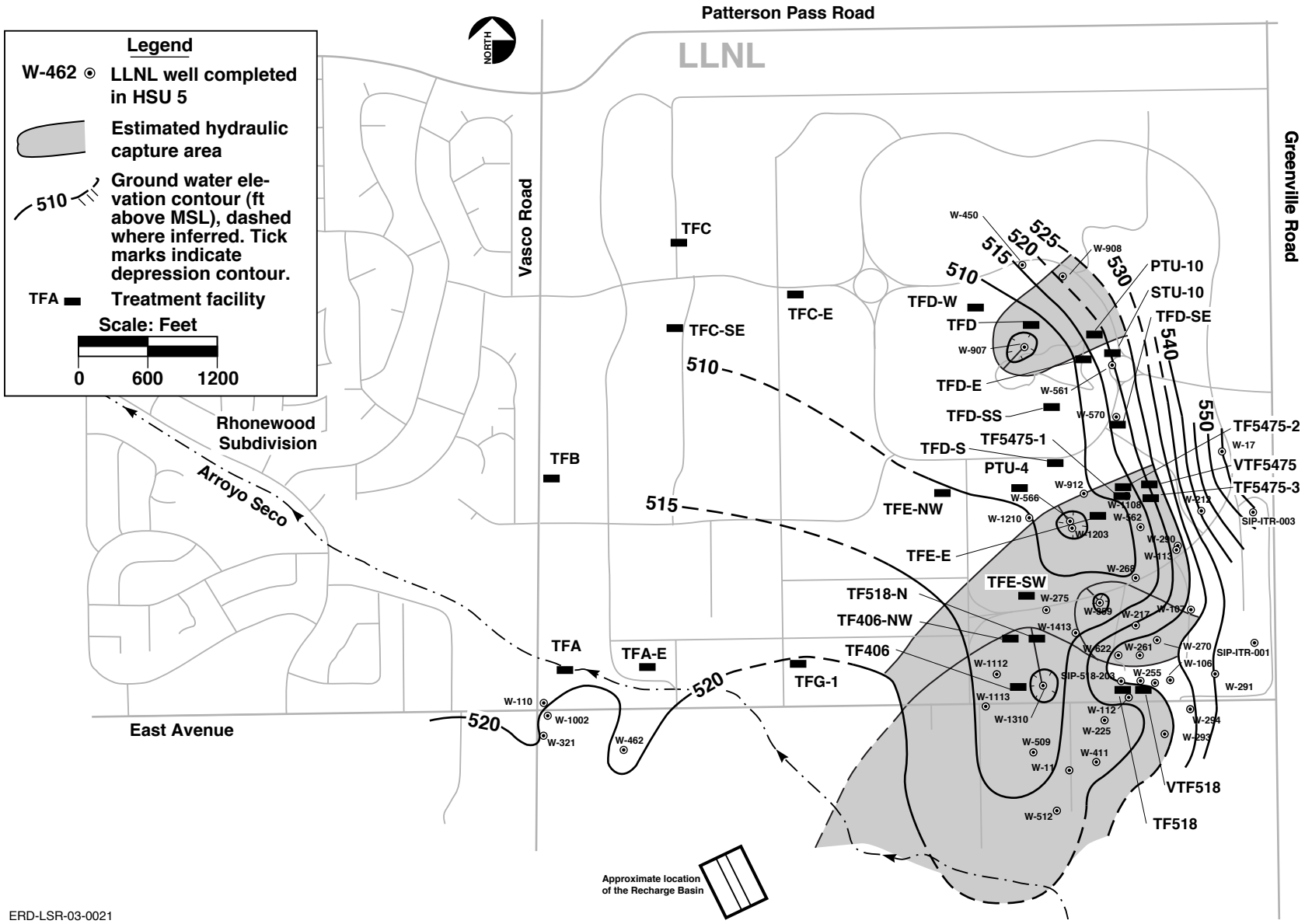


Figure 10. Ground water elevation contour map based on water levels collected from 47 wells completed within HSU 5 showing estimated hydraulic capture areas, LLNL and vicinity, November 2002.

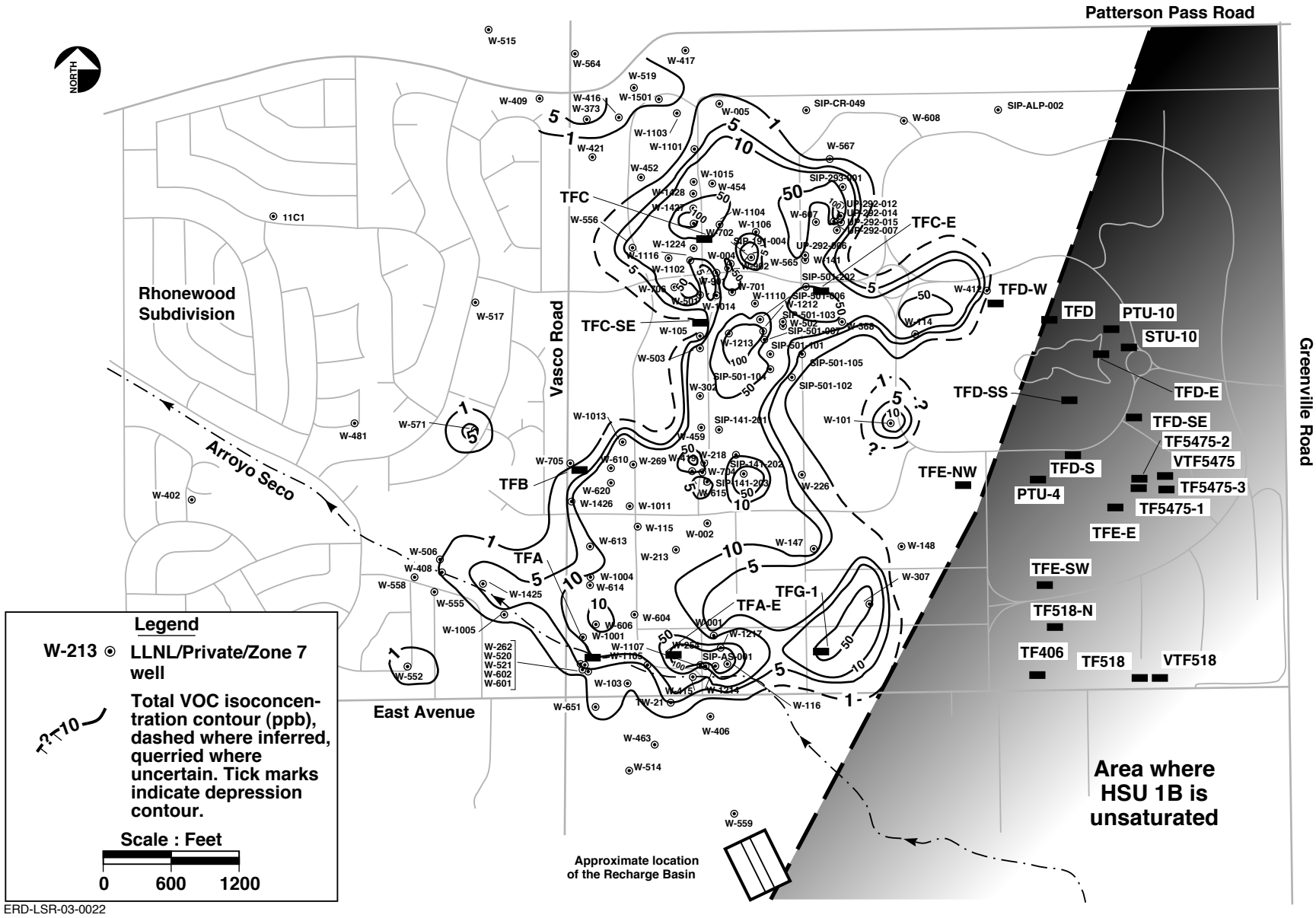
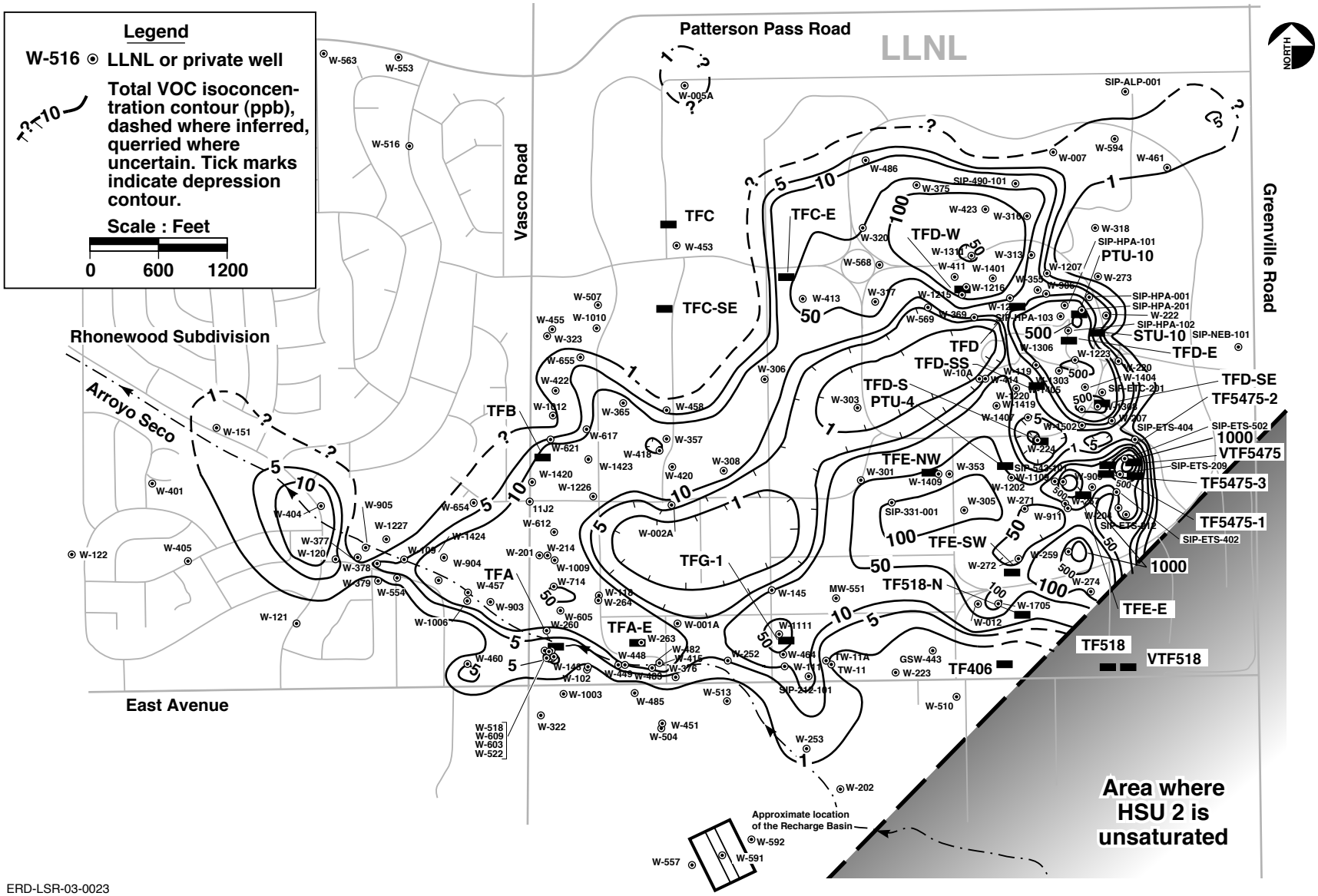


Figure 11. Isoconcentration contour map of total VOCs for 136 wells completed within HSU 1B based on samples collected in the fourth quarter of 2002 (or the next most recent data), and supplemented with soil chemistry data from 46 borehole locations.



ERD-LSR-03-0023

Figure 12. Isoconcentration contour map of total VOCs for 187 wells completed within HSU 2 based on samples collected in the fourth quarter of 2002 (or the next most recent data), and supplemented with soil chemistry data from 104 borehole locations.

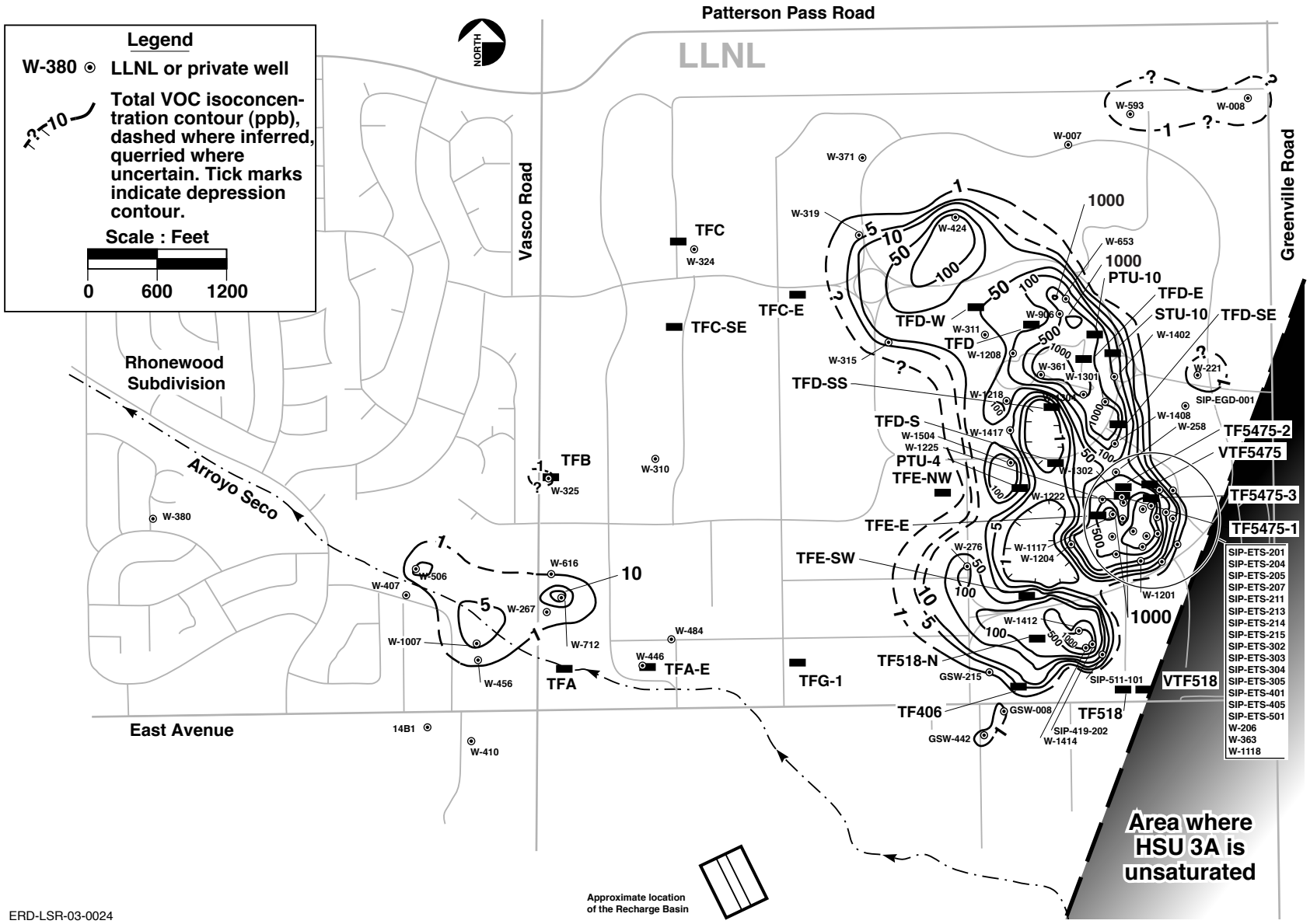


Figure 13. Isoconcentration contour map of total VOCs for 96 wells completed within HSU 3A based on samples collected in the fourth quarter of 2002 (or the next most recent data), and supplemented with soil chemistry data from 148 borehole locations.

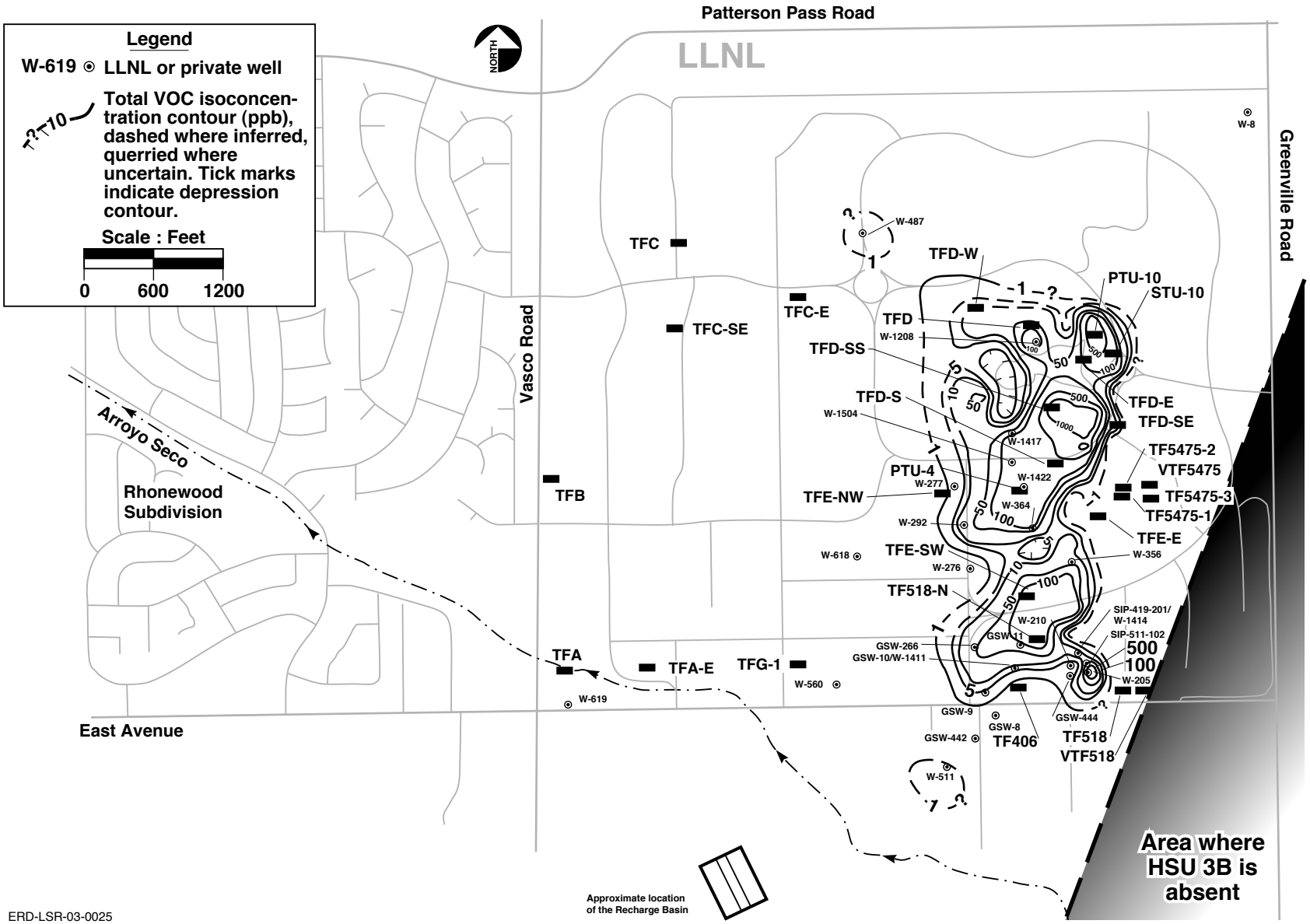


Figure 14. Isoconcentration contour map of total VOCs for 55 wells completed within HSU 3B based on samples collected in the fourth quarter of 2002 (or the next most recent data), and supplemented with soil chemistry data from 108 borehole locations.

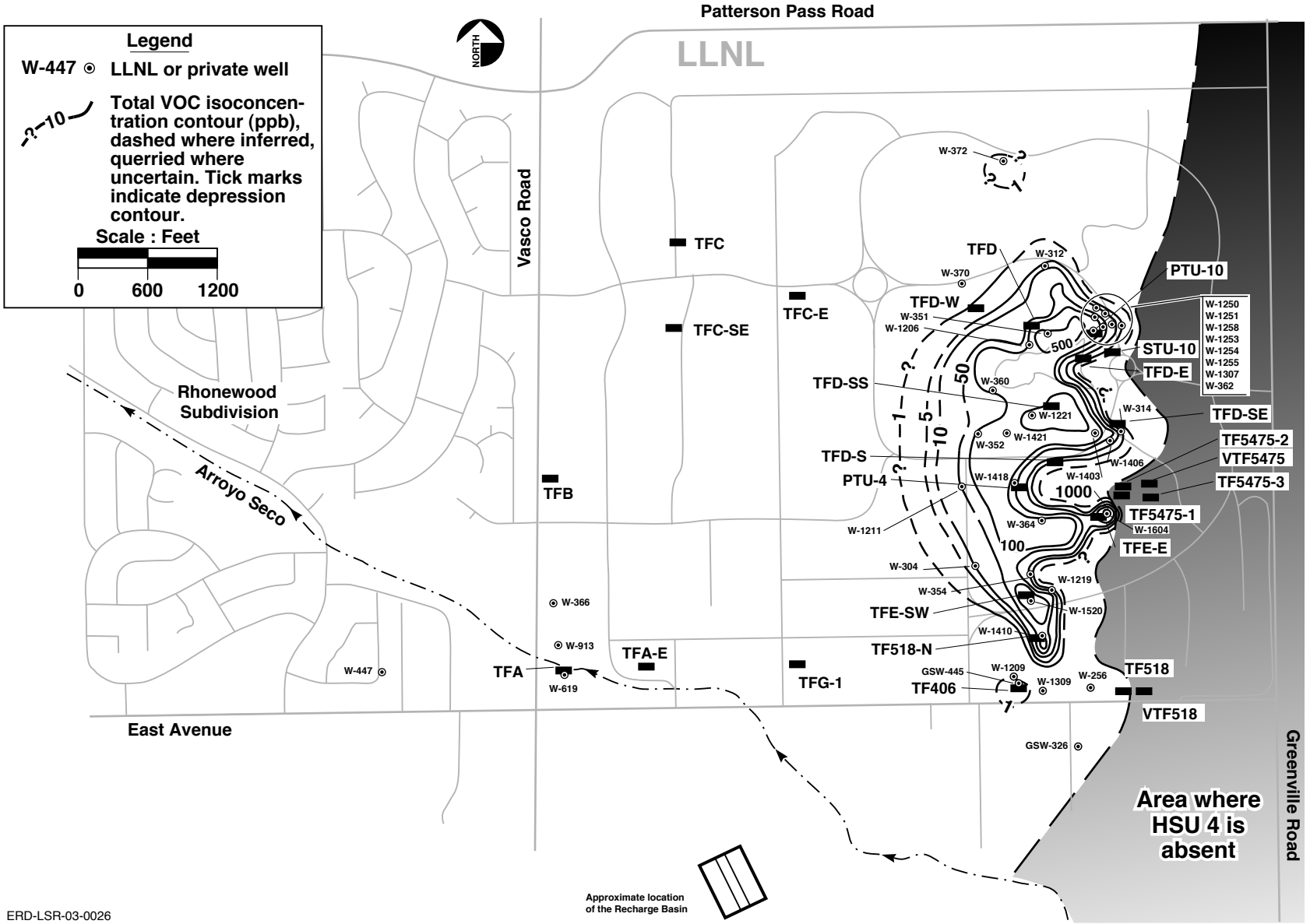


Figure 15. Isoconcentration contour map of total VOCs for 43 wells completed within HSU 4 based on samples collected in the fourth quarter of 2002 (or the next most recent data), and supplemented with soil chemistry data from 64 borehole locations.

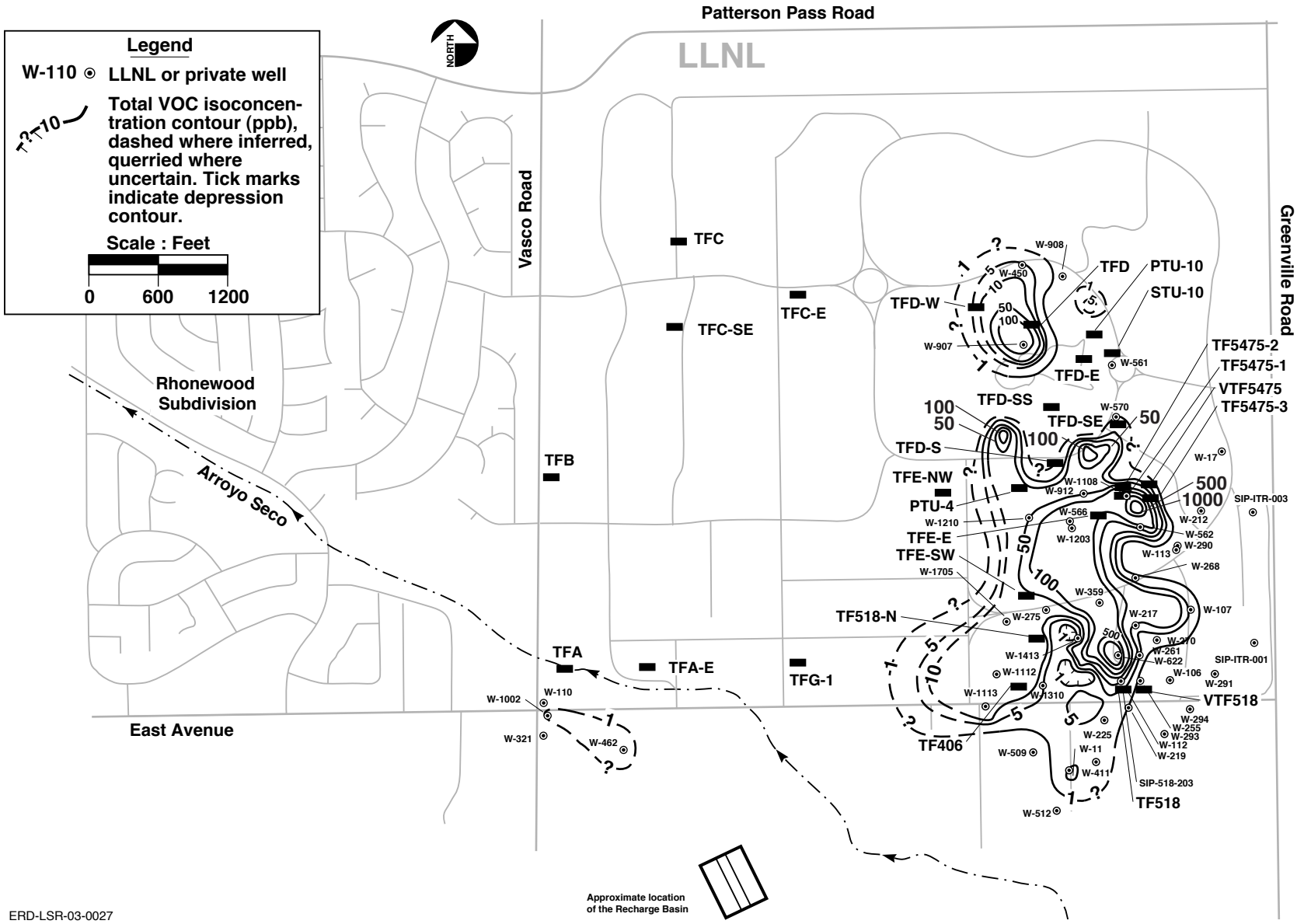
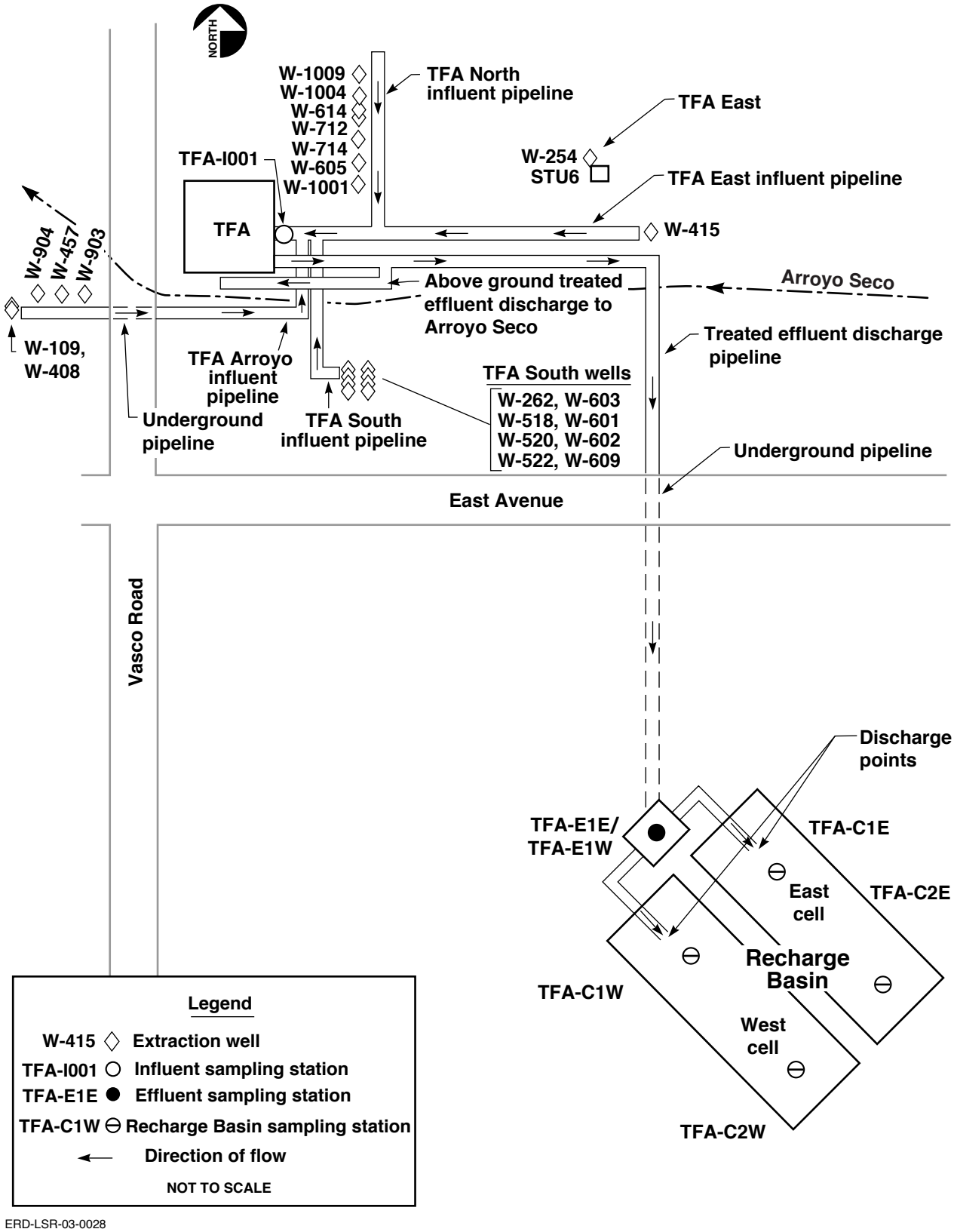
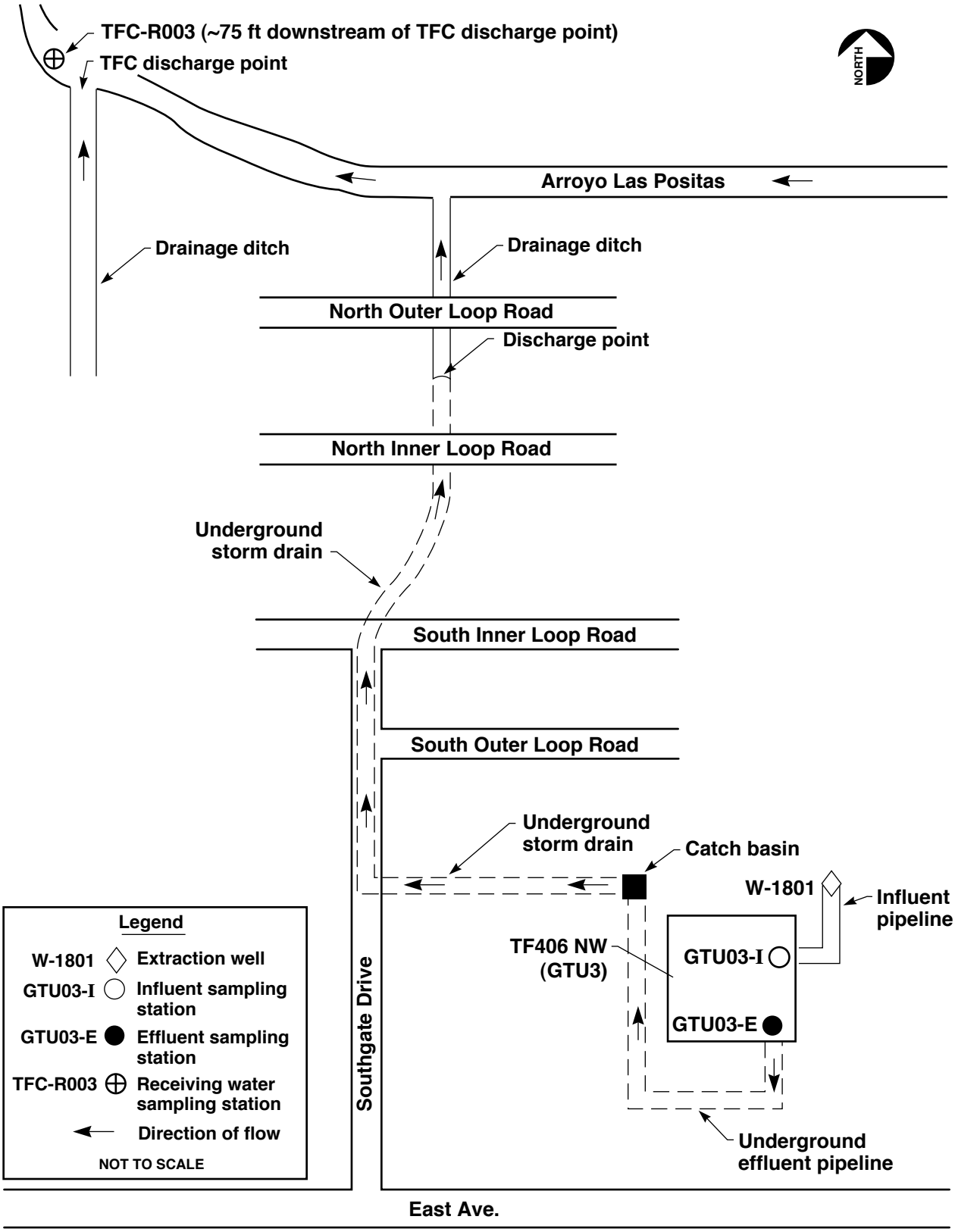


Figure 16. Isoconcentration contour map of total VOCs for 55 wells completed within HSU 5 based on samples collected in the fourth quarter of 2002 (or the next most recent data), and supplemented with soil chemistry data from 94 borehole locations.



ERD-LSR-03-0028

Figure 17. TFA extraction well, pipeline and discharge locations.



ERD-LSR-03-0030

Figure 19. TF406 Northwest extraction well, pipeline and discharge locations.

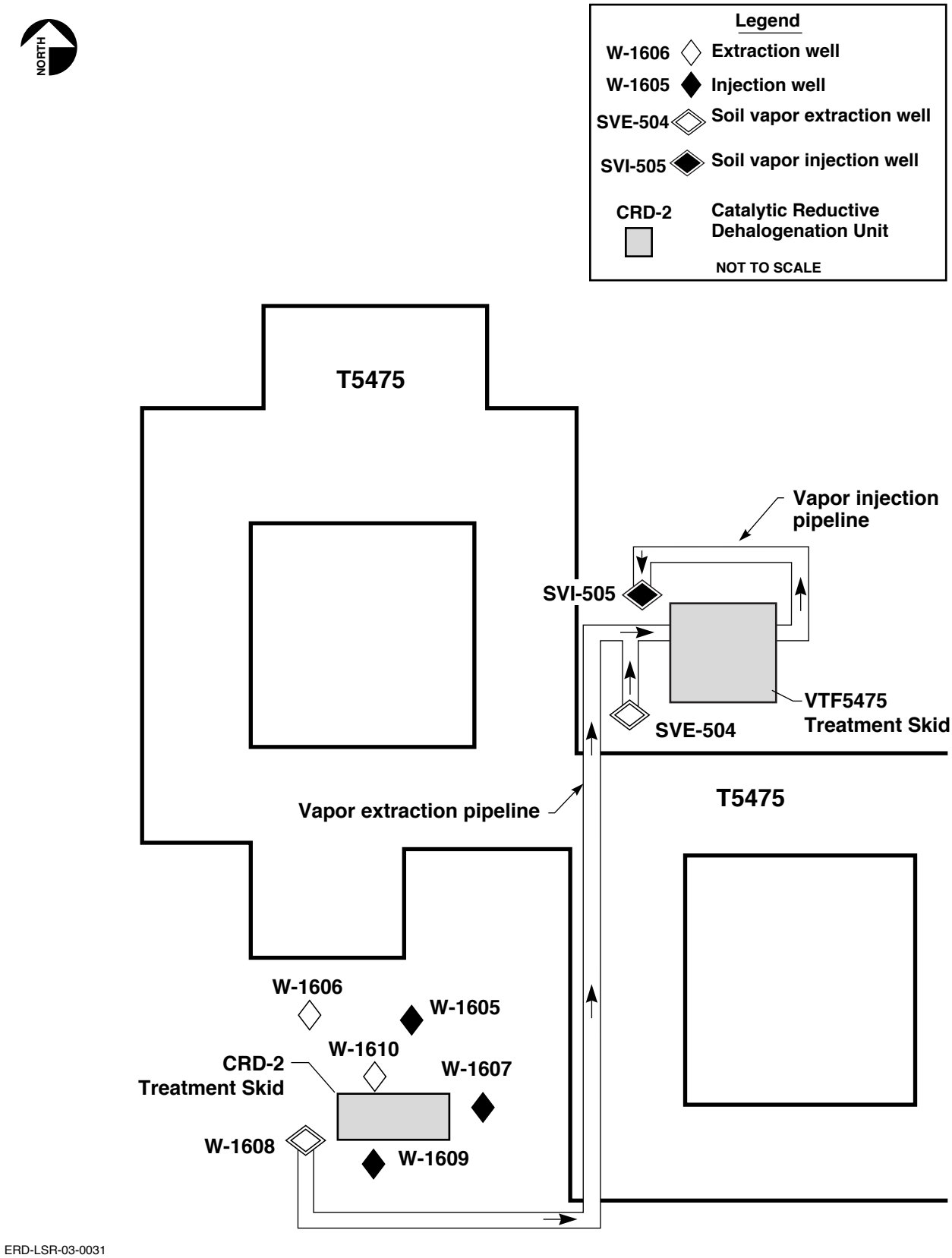


Figure 20. TF5475-3 (CRD-2) and VTF5475 extraction and injection well and pipeline locations.

Tables

Table 1. Livermore Site wells installed in 2002.

Treatment facility area	Well
TFA	W-1805
TFB	None
TFC	None
TFD	W-1802, W-1803, W-1804, W-1902
TFE	W-1903
TF406	W-1801
TFG	W-1806, W-1807, W-1901
TF518	None
TF5475	None

Note:

See Figure 1 for well locations.

Table 2. Wells in which hydraulic tests were conducted in 2002.

Treatment facility area	Well(s)
TFA	None
TFB	None
TFC	None
TFD	W-1801, W-1802
TFE	None
TF406	W-1705[a]
TFG	None
TF518	None
TF5475	None

Note:

See Figure 1 for well locations.

[a] **Hydraulic parameters are not reported in Appendix B for well W-1705 because the test data were not interpretable.**

Table 3. 2002 Livermore Site Remedial Action Implementation Plan milestones.

Milestone	Milestone date	Completion date
Begin TFC-E remediation	**01/31/02**	**04/03/02[a]**
Submit Draft Five-Year Review to the regulatory agencies and community	**04/30/02**	**04/29/02**
Receive regulatory comments on Draft Five-Year Review	**07/01/02**	**07/01/02**
Begin TF406 Northwest remediation	**07/31/02**	**07/16/02**
Submit Draft Final Five-Year Review to the regulatory agencies	**08/30/02**	**08/28/02**
Begin TF5475 soil vapor extraction expansion	**09/30/02**	**09/23/02**
Issue Five-Year Review	**09/30/02**	**09/30/02**

[a] Delayed with regulatory agency concurrence due to the Federal Continuing Budget Resolution.

Table 4. Summary of treatment facilities, discharge locations, and associated extraction wells.

Treatment facilities	Discharge location	Hydrostratigraphic Unit	Operating extraction wells
TFA	Recharge Basin on Sandia National Laboratories, CA property and Arroyo Seco	HSU-1B	W-262, W-408, W-520 W-601, W-602, W-1001, W-1004
		HSU-1B/2	W-415
		HSU-2	W-109, W-457, W-518, W-522, W-603, W-605, W-609, W-614, W-714, W-903, W-904, W-1009
		HSU-3A	W-712
TFA East	Arroyo Seco	HSU-1B	W-254
TFB	Arroyo Las Positas	HSU-1B	W-610, W-620, W-704
		HSU-2	W-357, W-621, W-655, W-1423
TFC	Arroyo Las Positas	HSU-1B	W-701, W-1015, W-1102, W-1103, W-1104, W-1116
TFC East	Arroyo Las Positas	HSU-1B	W-368
		HSU-2	W-413
TFC Southeast	Arroyo Las Positas	HSU-1B	W-1213
TFD	Arroyo Las Positas directly or via DRB	HSU-2/3A	W-906
		HSU-3A/3B	W-1208
		HSU-4	W-351, W-1206
		HSU-5	W-907
TFD West	Arroyo Las Positas	HSU-2	W-1215, W-1216
TFD East	Arroyo Las Positas directly or via DRB	HSU-2	W-1303, W-1306
		HSU-3A	W-1301
		HSU-4	W-1307
TFD Southeast	Arroyo Las Positas via the DRB	HSU-2	W-1308
		HSU-4	W-314
TFD South	Arroyo Las Positas via the DRB	HSU-2	W-1510
		HSU-3A/3B	W-1504
		HSU-4	W-1503
TFD Southshore	Arroyo Las Positas via the DRB	HSU-2	W-1602
		HSU-3A	W-1603
		HSU-3B	W-1601
		HSU-4	W-1523
Portable Treatment Unit No. 10	Arroyo Las Positas	HSU-3A/3B	W-1551, W-1552, W-1651, W-1654
Solar Treatment Unit No. 10	Arroyo Las Positas via the DRB	HSU-3A/3B	W-1550
TFE East	Arroyo Las Positas via the DRB	HSU-2	W-1109
		HSU-5	W-566
TFE Northwest	Arroyo Las Positas	HSU-2	W-1409
		HSU-4	W-1211

Table 4. Summary of treatment facilities, discharge locations, and associated extraction wells.

Treatment facilities	Discharge location	Hydrostratigraphic Unit	Operating extraction wells
TFE Southwest	Arroyo Las Positas via the DRB	HSU-2	W-1518
		HSU3B	W-1522
		HSU-4	W-1520
TFE Southeast	Arroyo Las Positas	HSU-5	W-359
TFE West	Arroyo Las Positas	HSU-2	W-305
		HSU-3B	W-292
Portable Treatment Unit No. 4	Arroyo Las Positas	HSU-3B	W-1422
		HSU-4	W-1418
TFG-1	Arroyo Seco	HSU-1B/2	W-1111
TF406	Arroyo Las Positas	HSU-5	W-1310
TF406 Northwest	Arroyo Las Positas	HSU-3A	W-1801
TF5475-1	Reinjected in well W-1302 (upper section)	HSU-3A	W-1302
TF5475-2	Arroyo Las Positas via the DRB	HSU-2	W-1415
TF5475-3	Reinjected in well W-1603	HSU-3A	W-1606, W-1608
		HSU-5	W-1610
VTF5475	Reinjected in SVI-ETS-505	N/A	SVI-ETS-504, W-1608
TF518-North	Arroyo Las Positas	HSU-4	W-1410

Note:

DRB = Drainage Retention Basin located in the central portion of the Livermore Site.

Appendix A

Well Construction and Closure Data

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
Monitor Wells						
W-1	**21-Oct-80**	**122.5**	**116.0**	**95–100**	**1B/2**	**NA**
W-1A	**12-Apr-84**	**180.0**	**156.0**	**145–156**	**2**	**NA**
W-2	**29-Aug-80**	**102.5**	**101.0**	**86–101**	**1B**	**NA**
W-2A	**02-Apr-84**	**185.0**	**164.0**	**150–164**	**2**	**NA**
W-4	**28-Jul-80**	**92.0**	**90.0**	**75–90**	**1B**	**NA**
W-5	**24-Oct-80**	**93.5**	**90.0**	**56–71 81–86**	**1B**	**NA**
W-5A	**09-Apr-84**	**115.0**	**105.0**	**95–105**	**2**	**NA**
W-7	**03-Oct-80**	**110.5**	**100.5**	**76–81 88–98**	**2/3A**	**NA**
W-8	**14-May-81**	**110.0**	**105.0**	**72–77 92–102**	**3A/3B**	**NA**
W-11	**03-Jun-81**	**252.0**	**191.0**	**136–141 177–187**	**5**	**NA**
W-12	**14-Aug-80**	**115.75**	**115.0**	**99–114**	**2**	**NA**
W-17	**08-Oct-80**	**114.0**	**114.0**	**94–109**	**5**	**NA**
W-17A	**20-May-81**	**181.4**	**160.0**	**127–132 147–157**	**7**	**NA**
W-19	**19-Sep-80**	**164.75**	**161.0**	**147–157**	**7**	**NA**
W-101	**25-Jan-85**	**77.0**	**72.0**	**62–72**	**1B**	**1**
W-102	**12-Feb-85**	**396.5**	**171.5**	**151.5–171.5**	**2**	**40**
W-103	**14-Feb-85**	**96.0**	**89.5**	**79.5–89.5**	**1B**	**5**
W-104	**21-Feb-85**	**61.5**	**56.5**	**38.75–56.5**	**1B**	**2.5**
W-105	**26-Feb-85**	**69.0**	**62.0**	**42–62**	**1B**	**0.7**
W-106	**06-Mar-85**	**144.0**	**134.5**	**127.5–134.5**	**5**	**0.1–0.2**
W-107	**13-Mar-85**	**128.0**	**122.0**	**115–122**	**5**	**1–3**
W-108	**21-Mar-85**	**113.5**	**69.0**	**57–69**	**1A**	**10**
W-110	**26-Apr-85**	**371.0**	**365.0**	**340–365**	**5**	**6**
W-111	**02-May-85**	**122.0**	**117.0**	**97–117**	**2**	**1.5**
W-113	**16-May-85**	**124.0**	**115.0**	**100–115**	**5**	**0.9**
W-114	**23-May-85**	**70.5**	**63.0**	**51–63**	**1B**	**0.5**
W-115	**03-Jun-85**	**106.0**	**95.0**	**88–95**	**1B**	**1.1**
W-116	**14-Jun-85**	**181.0**	**91.0**	**86–91**	**1B**	**0.3**
W-117	**27-Jun-85**	**202.0**	**148.0**	**138–148**	**7**	**0.2**

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-118	19-Jul-85	206.5	110.0	99–110	2	8
W-119	02-Aug-85	139.0	102.5	87.5–102.5	2	3.3
W-120	19-Aug-85	195.0	153.0	147–153	2	1
W-121	23-Aug-85	194.0	171.0	159–171	2	3.75
W-122	17-Aug-85	189.0	132.0	125–132	2	15
W-123	01-Oct-85	174.0	47.7	37.3–47.7	1A	5
W-141	23-Mar-85	61.5	60.0	45–60	1B	0.8
W-142	29-Mar-85	74.2	72.0	62–72	2	0.8
W-143	12-Apr-85	130.0	126.0	121–126	2	0.8
W-146	16-Jul-85	225.0	125.0	115–125	2	5
W-147	26-Jul-85	137.0	87.0	77–87	1B	0.5
W-148	08-Aug-85	152.0	98.0	83–98	1B	0.5
W-151	30-Sep-85	237.0	157.5	148.5–157.5	2	1.5
W-201	17-Oct-85	211.0	161.0	151–161	2	14
W-202	07-Nov-85	191.0	109.0	99–109	2	0.5
W-203	15-Nov-85	87.0	41.0	31–41	1A	3
W-204	22-Nov-85	110.0	110.0	100–110	2	5+
W-205	09-Dec-85	180.0	117.0	107–117	3B	<0.1
W-206	19-Dec-85	188.0	118.0	106–118	3A	<0.5
W-207	24-Jan-86	150.0	85.0	69–85	2	<0.5
W-210	11-Mar-86	176.0	113.0	108–113	3B	<0.5
W-212	28-Mar-86	183.0	136.0	124–136	5	1
W-213	04-Apr-86	174.0	100.0	94–100	1B	2
W-214	11-Apr-86	146.0	141.5	134–141.5	2	20+
W-217	20-May-86	200.0	112.5	98.5–112.5	5	<0.5
W-218	30-May-86	201.0	71.0	64.5–71	1B	6
W-219	13-Jun-86	214.0	148.0	141–148	5	2
W-220	25-Jun-86	196.0	92.5	82.5–92.5	2	<0.5
W-221	07-Jul-86	178.0	95.0	82–95	3A	2
W-222	17-Jul-86	197.0	83.0	63–83	2	5
W-223	15-Aug-86	202.0	153.0	146–153	2	5.2
W-224	26-Aug-86	199.0	88.0	78–88	2	3
W-225	09-Sep-86	238.0	166.0	152–166	5	2.5
W-226	25-Sep-86	173.0	86.0	71–86	1B	<0.25

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-251	03-Oct-85	50.0	47.5	35.5–47.5	1A	2
W-252	18-Oct-85	197.0	126.0	108–126	2	3
W-253	30-Oct-85	180.0	128.0	112.5–128	2	1
W-255	05-Dec-85	187.0	124.0	115–124	5	1
W-256	19-Dec-85	187.0	137.0	132–137	5	<0.5
W-257	15-Jan-86	197.0	96.5	82.5–96.5	2	<0.5
W-258	31-Jan-86	157.0	121.5	116.5–121.5	3A	0.5
W-259	07-Feb-86	200.0	99.0	93.5–99	2	<0.5
W-260	27-Feb-86	215.0	151.0	141–151	2	3.5
W-261	12-Mar-86	225.0	118.5	109–118.5	5	<0.5
W-263	07-Apr-86	146.0	130.0	123–130	2	2
W-264	14-Apr-86	170.0	151.0	141–151	2	20+
W-265	25-Apr-86	216.0	211.0	205–211	3A	3
W-267	27-May-86	196.0	179.0	172.5–179	3A	1
W-268	04-Jun-86	213.0	150.5	138–150.5	5	1
W-269	16-Jun-86	185.0	92.0	79–92	1B	2
W-270	26-Jun-86	185.0	127.0	113–127	5	<0.5
W-271	07-Jul-86	201.0	112.0	105–112	2	2.1
W-272	18-Jul-86	226.0	110.0	95–110	2	1
W-273	11-Aug-86	203.0	84.0	64–84	2	3
W-274	21-Aug-86	217.0	95.0	90–95	2	<0.5
W-275	05-Sep-86	262.0	184.0	179–184	5	4
W-276	17-Sep-86	267.0	170.0	153.5–169.5	3A	12
W-277	03-Oct-86	254.0	169.0	163–169	3B	1.1
W-290	08-Jul-86	181.0	126.0	119.5–126	5	<0.5
W-291	24-Jul-86	194.0	137.0	127–137	5	<0.5
W-292	14-Aug-86	250.0	184.5	176–184.5	3B	9
W-293	27-Aug-86	229.0	155.0	145–155	5	<1
W-294	15-Sep-86	251.0	139.0	122–139	5	1
W-301	07-Oct-86	203.0	141.0	136–141	2	5.5
W-302	22-Oct-86	191.0	83.5	78–83.5	1B	2
W-303	28-Oct-86	197.0	128.0	124–128	2	15
W-304	12-Nov-86	207.0	200.0	195–200	4	1
W-305	18-Nov-86	146.0	138.0	128–138	2	20

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-306	04-Dec-86	207.0	110.0	98–110	2	8.5
W-307	15-Dec-86	214.0	102.0	93–102	1B	1
W-308	13-Jan-87	194.0	113.0	107–113	2	2
W-309	20-Jan-87	73.0	NA	NA	NA	NA
W-310	04-Feb-87	202.0	184.5	176.5–184.5	3A	10
W-311	20-Feb-87	226.5	147.5	134.5–147.5	3A	5
W-312	05-Mar-87	224.5	168.0	160–168	4	25
W-313	12-Mar-87	99.0	85.0	80–85	2	5.5
W-315	03-Apr-87	215.0	156.0	141–156	3A	15
W-316	15-Apr-87	196.0	71.0	66–72	2	3
W-317	20-Apr-87	100.0	95.0	88–95	2	7
W-318	28-Apr-87	200.0	81.0	74–81	2	0.5
W-319	05-May-87	198.0	125.0	119–125	3A	25
W-320	11-May-87	106.0	99.0	94–99	2	3
W-321	29-May-87	356.0	321.5	305–321.5	5	60
W-322	01-Jul-87	565.5	152.0	142–152	2	4
W-323	04-Aug-87	200.0	127.0	122–127	2	7
W-324	17-Aug-87	219.0	189.0	184–189	3A	15
W-325	28-Aug-87	312.0	170.0	158–170	3A	4
W-353	12-Nov-86	205.0	101.0	95.5–101	2	1
W-354	24-Nov-86	185.0	179.0	163–179	4/5	8
W-355	05-Dec-86	202.0	107.0	102–107	2	2
W-356	18-Dec-86	237.0	137.0	133–137	3B	6
W-362	13-Mar-87	151.0	145.0	131–145	4	12
W-363	24-Mar-87	195.0	129.0	117–129	3A	<0.5
W-364	31-Mar-87	195.0	165.0	155–165	3B/4	5
W-365	09-Apr-87	187.0	125.0	120–125	2	8.5
W-366	20-Apr-87	273.0	251.0	240–251	4	13
W-368	06-May-87	206.0	78.0	70–78	1B	3
W-369	14-May-87	204.0	113.0	107–113	2	2
W-370	29-May-87	286.0	208.0	196.5–208	4	5
W-371	12-Jun-87	233.0	162.0	155–162	3A	1.5
W-372	25-Jun-87	218.0	152.5	147.5–152.5	4	1
W-373	06-Jul-87	178.0	99.0	89–99	1B	7
W-375	29-Jul-87	223.0	71.0	65–71	2	0.75

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-376	27-Aug-87	249.0	172.0	162–172	2	2
W-377	04-Sep-87	159.0	144.0	141.5–144	2	2.5
W-378	09-Sep-87	155.0	150.0	146–150	2	5
W-379	14-Sep-87	155.0	150.0	146–150	2	5
W-380	01-Oct-87	195.0	182.0	170–182	3A	10
W-401	05-Nov-87	159.0	153.0	109–153	2	25
W-402	13-Oct-87	104.0	102.0	92–102	1B	40
W-403	16-Nov-87	585.0	495.0	485–495	7	3
W-404	04-Dec-87	245.0	158.0	150–158	2	33
W-405	04-Jan-88	244.0	162.0	132–162	2	50
W-406	20-Jan-88	213.0	94.0	79–84	1B	2
W-407	04-Feb-88	215.0	205.0	192–205	3A	4
W-409	07-Mar-88	272.0	78.0	71–78	1B	30
W-410	30-Mar-88	369.0	205.0	193–205	3A	35
W-411	12-Apr-88	192.0	138.0	131–138	2	8
W-412	18-Apr-88	104.0	74.0	67–74	1B	2.5
W-413	28-Apr-88	163.0	115.0	100–115	2	25
W-416	10-Jun-88	152.0	80.5	72–80.5	1B	30
W-417	20-Jun-88	152.0	60.0	51–60	1B	5
W-418	24-Jun-88	124.0	118.0	108–118	2	2.5
W-419	29-Jun-88	82.0	75.5	62.5–75.5	1B	3
W-420	26-Jul-88	127.0	111.0	105–111	2	5
W-421	23-Aug-88	181.0	90.0	75–90	1B	4.5
W-422	02-Sep-88	203.0	139.5	133–139.5	2	5
W-423	09-Sep-88	308.0	118.0	106–118	2	14
W-424	04-Oct-88	208.0	144.0	137–144	3A	3
W-441	14-Oct-87	250.0	144.0	135–144	5	2.5
W-446	18-Dec-87	202.0	196.0	186–196	3A	3
W-447	05-Feb-88	353.0	274.0	256–274	4	5
W-448	17-Feb-88	235.0	127.5	120.5–127.5	2	15
W-449	07-Mar-88	172.0	165.0	152–165	2	3
W-450	21-Mar-88	300.0	200.0	193–200	5	2
W-451	06-Apr-88	202.0	112.0	106–112	2	1.5
W-452	15-Apr-88	210.0	79.5	64–79.5	1B	5

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-453	27-Apr-88	185.0	130.3	121–130	2	4
W-454	09-May-88	196.0	83.5	73–83.5	1B	3
W-455	19-May-88	184.0	162.5	148–162.5	2	5
W-458	30-Jun-88	212.5	116.0	108–116	2	2
W-459	20-Jul-88	76.0	73.0	59.5–73	1B	1.5
W-461	16-Aug-88	133.0	51.5	41.5–51.5	2	<0.5
W-462	12-Sep-88	385.0	336.5	331–336.5	5	5
W-463	16-Sep-88	93.0	92.5	87–92.5	1B	5
W-464	30-Sep-88	253.0	104.5	96–104.5	2	3.5
W-481	04-Nov-88	224.5	105.0	100–105	1B	2
W-482	15-Jan-88	218.0	170.0	165–170	2	<0.5
W-483	26-Jan-88	140.0	130.0	115–130	2	2.5
W-484	11-Feb-88	255.0	188.0	185–188	3A	0.5
W-485	25-Feb-88	249.0	157.0	151–157	2	2
W-486	11-Mar-88	167.0	108.0	100–108	2	2
W-487	17-Mar-88	180.0	151.0	148–151	3B	1
W-501	13-Oct-88	174.0	92.0	84–92	1B	6.5
W-502	25-Oct-88	158.0	59.0	55–59	1B	<0.5
W-503	02-Nov-88	187.0	80.0	74–80	1B	1
W-504	21-Nov-88	358.0	167.0	157–167	2	3
W-505	15-Dec-88	278.0	180.0	167–180	3A	60
W-506	22-Dec-88	120.0	115.0	101–115	1B	30
W-507	18-Jan-89	158.0	139.0	129–139	2	50
W-508	17-Feb-89	316.0	305.0	287–305	7	60
W-509	03-Mar-89	305.0	184.0	179–184	5	1
W-510	15-Mar-89	300.0	119.0	111–119	2	<0.5
W-511	31-Mar-89	316.0	176.0	167–176	3B	1
W-512	13-Apr-89	261.0	176.0	166–176	5	2.5
W-513	26-Apr-89	259.0	115.0	102–115	2	1
W-514	17-May-89	386.0	115.5	92–115.5	1B	2
W-515	30-May-89	211.0	78.0	68–78	1B	3.5
W-516	09-Jun-89	203.0	119.0	114–119	2	15
W-517	20-Jun-89	215.0	88.0	80–88	1B	6.7
W-519	14-Aug-89	186.5	80.5	60–80.5	1B	25

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-521	13-Sep-89	166.0	95.0	86–95	1B	1
W-551	18-Oct-88	308.0	155.5	151–155.5	2	20
W-552	25-Oct-88	70.5	64.0	48.5–64	1B	3
W-553	03-Nov-88	186.0	106.5	99–106.5	2	1
W-554	22-Nov-88	239.0	141.5	126.5–141.4	2	60
W-555	05-Dec-88	122.0	116.5	102.5–116.5	1B	20
W-556	15-Dec-88	192.0	81.5	76–81.5	1B	6
W-557	22-Dec-88	122.5	118.0	102–118	2	2
W-558	17-Jan-89	117.0	110.5	101–110.5	1B	20
W-559	24-Jan-89	105.0	100.0	93–100	1B	0.75
W-560	07-Feb-89	263.0	206.5	201-206.5	3B	10
W-561	23-Feb-89	180.0	152.0	143–152	5	4
W-562	08-Mar-89	263.0	158.0	145–158	5	2
W-563	17-Mar-89	192.0	105.0	95–105	2	2
W-564	30-Mar-89	184.0	85.0	79.5–85	1B	3
W-565	06-Apr-89	177.0	82.5	75–82.5	1B	15
W-567	27-Apr-89	194.0	61.5	51–61	1B	10
W-568	05-Jun-89	156.0	101.0	97–101	2	30
W-569	16-May-89	215.0	109.5	101–109.5	2	4
W-570	09-Jun-89	180.0	175.0	161–175	5	1
W-571	15-Jun-89	223.5	207.5	102–107	1B	22
W-591	29-Nov-88	112.0	107.5	97–107.5	2	<0.5
W-592	12-Dec-88	136.5	113.0	101–113	2	1.5
W-593	06-Feb-89	159.0	92.5	82–92.5	3A	1.5
W-594	27-Feb-89	156.0	61.0	55–61	2	0.5
W-604	27-Nov-89	111.0	83.0	76–82	1B	0.5
W-606	21-Dec-89	145.0	89.0	73–89	1B	2
W-607	24-Jan-90	186.0	55.0	49–55	1B	3
W-608	07-Feb-90	162.0	66.0	55–66	1B	3
W-611	04-Apr-90	161.0	98.0	87.5–98	1B	2
W-612	19-Apr-90	222.0	136.0	126–136	2	10
W-613	02-May-90	93.0	88.0	81.5–88	1B	7
W-615	01-Jun-90	121.0	99.0	91–99	1B	3
W-616	14-Jun-90	255.0	188.0	178–188	3A	8

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-617	26-Jun-90	200.0	110.0	103–110	2	6
W-618	17-Jul-90	357.0	205.0	201–205	3B	10
W-619	07-Aug-90	330.0	252.0	232–252	3B/4	30
W-622	28-Sep-90	206.0	112.0	104–112	5	<0.5
W-651	22-Feb-90	155.0	89.0	82–89	1B	0.5
W-652	15-Mar-90	318.0	256.0	245–256	7	2
W-653	29-Mar-90	225.0	128.0	122–128	3A	0.5
W-654	11-Apr-90	240.0	158.0	140–158	2	20
W-702	24-Oct-90	180.5	95.0	77–95	1B	10
W-703	03-Dec-90	586.0	325.0	298–325	5	10
W-705	26-Dec-90	126.0	90.0	77–90	1B	2
W-706	16-Jan-91	178.0	84.0	71–84	1B	2
W-901	24-Feb-93	97.8	88.0	79–83	1B	1
W-902	22-Jan-93	95.5	88.0	80–83	1B	1
W-905	07-Apr-93	221.0	144.5	134–144	2	4
W-908	18-Aug-93	239.0	197.0	180–197	5/6	<0.5
W-909	04-Nov-93	252.0	113.5	80.5–108.5	2	2
W-911	20-Dec-93	180.0	113.5	73.5–108.5	2	3
W-912	07-Oct-93	239.0	174.0	168–174	5	3
W-913	08-Dec-93	454.0	255.0	235–255	4	25
W-1002	31-Jan-94	292.5	260.0	246–260	5	16
W-1003	08-Feb-94	184.0	147.0	140–147	2	1.5
W-1008	13-Apr-94	246.0	238.0	229.5–238	7	10
W-1010	24-May-94	463.0	142.0	128–142	2	20
W-1011	06-Jun-94	106.0	89.0	75–89	1B	3
W-1012	20-Jun-94	161.0	117.0	96–112	2	5
W-1013	29-Jun-94	147.0	73.0	65–73	1B	1.4
W-1014	12-Jul-94	99.0	89.0	65–89	1B	30
W-1101	10-Nov-94	200.0	79.0	76.0–79.0	1B	0.5
W-1105	17-Jan-95	110.0	93.0	78–93	1B	3.5–4
W-1106	08-Feb-95	245.0	86.0	76–85	1B	15

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-1107	06-Mar-95	199.5	93.0	74–88	1B	<0.5
W-1108	27-Mar-95	250.0	156.0	142–156	5	12
W-1110	04-May-95	252.0	92.2	68–92	1B	7
W-1112	28-Jun-95	263.0	210.0	201–210	5	3
W-1113	18-Jul-95	260.0	214.0	204–214	5	2.5
W-1115	12-Oct-95	126.5	118.2	108–118	3A	1
W-1117	11-Sep-95	154.0	132.3	122–132	3A	1
W-1118	27-Sep-95	225.0	125.0	115–125	3A	3.5
W-1201	18-Oct-95	225.0	133.0	125–133	3A	1
W-1202	26-Oct-95	99.3	99.0	83–99	2	5+
W-1203	07-Nov-95	224.0	206.2	196–206	5	18+
W-1204	20 Nov-95	225.0	126.2	118–126	3A	2.5
W-1205	27-Nov-95	91.0	82.0	72–82	2	<0.5
W-1207	13-Dec-95	92.0	90.0	70–90	2	<0.5
W-1209	26-Jan-96	210.0	164.0	148–164	4	3
W-1210	12-Feb-96	250.0	223.0	213–223	5	3
W-1212	19-Mar-96	150.0	75.0	52–75	1B	3
W-1214	22-Apr--96	180.0	100.0	80–100	1B	2
W-1217	15-May-96	182.0	98.5	78–98	1B	<0.5
W-1219	04-Jun-96	201.0	142.0	138–142	4	<0.5
W-1222	26-Jun-96	175.0	125.5	115–125	3A	6
W-1223	23-Jul-96	175.0	102.0	87–97	2	4
W-1224	05-Sep-96	125.0	104.5	99–104	1B	4.3
W-1225	14-Aug-96	150.0	121.2	113–121	3A	2
W-1226	06-Aug-96	155.0	126.5	116–126	2	1
W-1227	09-Oct-96	200.0	134.0	126–134	2	11
W-1250	07-Jun-96	210.0	200.0	130–135	4	0.85
W-1251	03-Jul-96	210.0	200.0	134–139	4	1.3
W-1252	25-Jul-96	208.0	202.3	135–140	4	<0.5
W-1253	15-Aug-96	206.0	200.1	127–132	4	<0.5
W-1254	15-Aug-96	125.0	200.0	131–141	4	26
W-1255	27-Aug-96	208.0	200.7	124–129	4	<0.5
W-1304	20-Feb-97	149.5	125.0	120–125	3A	0.75

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-1311	25-Sep-97	153.0	120.5	100–120	2	14
W-1401	15-Oct-97	250.0	120.0	105–120	2	7
W-1402	04-Nov-97	135.0	112.0	102–112	3A	4
W-1403	12-Nov-97	175.0	142.5	132–142	3B	3.5
W-1404	20-Nov-97	162.0	97.7	87–97	2	3.1
W-1405	24-Nov-97	100.0	97.8	87–97	2	4.5
W-1406	15-Dec-97	201.0	150.0	139.2–149.2	4	9.2
W-1407	12-Dec-97	224.0	118.7	105–118	2	1.5
W-1408	12-Jan-98	134.0	128.0	118–128	3A	3.8
W-1411	04-Feb-98	133.0	128.0	114–128	3A	10
W-1412	11-Feb-98	201.0	107.0	92–107	3A	0.75
W-1413	26-Mar-98	163.5	157.7	147–157	5	1
W-1414	31-Mar-98	128.0	107.5	97–107	3A	0.1
W-1416	02-Jun-98	194.5	105.0	85–100	2	10
W-1417	23-Apr-98	225.0	155.0	130–150	3A	20
W-1419	11-May-98	175.0	115.5	90–110	2	4.5
W-1420	17-June-98	177.5	112.0	102–112	2	10
W-1421	28-May-98	230.0	172.0	156–167	3B	3
W-1424	20-Aug-98	225.0	146.0	126–146	2	6.2
W-1425	31-Aug-98	115.0	100.5	88.5–100.5	1B	1
W-1426	09-Sep-98	89.0	85.0	70–85	1B	8
W-1427	22-Sep-98	104.0	80.2	70–80	1B	17
W-1428	29-Sep-98	104.0	78.4	63–78	1B	25
W-1501	13-Oct-98	126.0	86.0	72–86	1B	7.5
W-1502	28-Oct-98	204.0	98.7	88–98	2	1.7
W-1503	18-Nov-98	234.0	181.5	171–181	4	25
W-1504	14-Dec-98	168.0	162.5	140–160.4	3A/3B	21.7
W-1505	21-Jan-99	276.0	184.5	174–184	4	15
W-1506	8-Feb-99	160.0	120.0	110–120	2	3
W-1507	19-Feb-99	201.5	169.5	159–169	5	0.5
W-1508	3-Mar-99	135	128.5	118–128	2	0.75
W-1509	22-Mar-99	175	88.5	73–88	1B	8
W-1510	7-Apr-99	114.5	113.5	93–113	2	5

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-1511	22-Apr-99	229	146	138–146	3B	15
W-1512	29-Apr-99	100	98.5	88–98	2	0.5
W-1513	10-May-99	122	120	108–120	2/3A	0.1
W-1514	19-May-99	127.5	126	103–121	2/3A	6.5
W-1515	3-Jun-99	130	121.5	102–120	2/3A	3
W-1516	22-Jun-99	204.5	200	188–200	5	10
W-1517	29-Jun-99	154	122.4	87–97	2	0.1
W-1519	28-Jul-99	245	238	222–237	5	30
W-1553	12-Aug-99	153	130	98–125	3A/3B	0.5
W-1604	30-Nov-99	194	148.7	138–148	4	8
W-1605	07-Mar-00	120.5	112	90–107	3A	<0.5
W-1607	10-Feb-00	155.4	112	90–107	3A	<0.5
W-1609	17-Apr-00	155	135	110–130	5	0.5
W-1610	04-May-00	155.3	135	110–130	5	0.5
W-1613	27-Apr-00	219	174.3	168.5–173.5	3B	7
W-1614	18-May-00	100	89.8	79–89	1B	3
W-1615	17-Aug-00	55	48	15–48	1B/2	NA
W-1616	16-Aug-00	55	NA	NA	1B/2	NA
W-1701	3-Jul-01	185	180.8	140–155 165–175	2 2	10.5 10.5
W-1702	15-Jun-01	15	14.25	4–13	1B	NA
W-1703	23-Aug-01	358	341.5	331–341	LL	36
W-1704	19-Sep-01	240	118.8	98–118	2	1
W-1705	16-Oct-01	225	208.8	93–103 123–128 138–143 203–208	2 3A 3B 5	5 5 5 5
W-1802	02-Apr-02	175	162.2	147–157	3A	1.5
W-1803	24-Apr-02	245	240.08	175–185 225–235	4 5	3 >8
W-1804	22-May-02	155	110.8	80–95 100–105	2 3A	NA
W-1901	31-Oct-02	175	127	92–97 107–122	1B	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
TW-11	09-Jun-81	112.5	107.0	97–107	2	NA
TW-11A	16-Mar-84	163.0	160.0	133–160	2	NA
TW–21	12-Jun-81	111.5	95.0	85–95	1B	NA
GEW-710	02-Aug-91	159.0	158.0	94–137	3A/3B	25
GSW-1A	12-Jun-86	208.0	133.0	115–133	3A	12
GSW-2	14-Feb-85	113.0	107.0	87–107	2	NA
GSW-3	07-Feb-85	115.0	105.0	85–105	2	NA
GSW-4	22-Feb-85	112.0	106.0	86–106	2	NA
GSW-5	19-Mar-85	110.0	104.0	94–104	2	NA
GSW-6	28-Feb-86	212.0	137.0	121–137	3A	6
GSW-7	14-Mar-86	176.5	123.4	110.8–123.4	3A	2
GSW-8	01-Apr-86	176.0	133.0	127.5–133	3A	2
GSW-9	14-Apr-86	197.5	152.5	147–152.5	3B	1
GSW-11	07-May-86	182.5	126.0	116–126	3A	2
GSW-12	27-May-86	205.0	191.0	186.5–191	5	1
GSW-13	27-Jun-86	198.0	134.5	125–134.5	3A	1
GSW-15	14-Aug-87	148.0	145.0	20.5–28	1B	3.5
				38–44	1B	–
				50–56	2	–
				60–64	2	–
				68–73	2	–
				77–83	2	–
				95–105	2	–
				120–130	3A	–
GSW-16	19-Oct-87	146.0	145.0	23–28	1B	20.5–30
				38–43	1B	–
				50–55	2	–
				61–66	2	–
				78–83	2	–
				95–105	2	–
				120–130	3A	–
GSW-208	06-Feb-86	211.0	123.0	108–118	3A	<2
GSW-209	27-Feb-86	204.0	135.2	112.8–132.8	3A	2

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
GSW-215	22-Apr-86	213.5	133.5	127–133.5	3A	2
GSW-216	09-May-86	193.0	120.5	110.5–120.5	3A	3
GSW-266	08-May-86	220.0	166.0	159–166	3B	1
GSW–326	02-Oct-87	230.0	134.0	129–134	4	0.5
GSW–367	29-Apr-87	159.0	124.0	114–124	2	2
GSW-403-6	11-May-84	138.0	113.6	90–110	3A	NA
GSW-442	27-Oct-87	270.0	145.0	138–145	3A	0.5
GSW-443	09-Nov-87	291.0	141.0	123–141	2	5
GSW-444	20-Nov-87	278.0	120.0	110–120	3B	0.3
Dynamic Stripping Project Wells[c]						
GSP-SNL-001	07-Jan-92	147.0	104.0	99–104	2	NA
			131.0	118–131	3A	NA
GEW-808	05-Jun-92	164.0	150.0	50–140	2/3A	25
GIW-813	25-Jun-92	140.7	87.0	67–87	2	NA
			104.0	89–99	2	
			127.0	107–127	2/3A	NA
GIW-814	19-Jun-92	149.6	106.5	86.5–106.5	2	NA
			117.0	110–120	3A	
			132.0	121–141	3A	NA
GIW-815	15-Jun-92	143.0	97.0	77–97	2	NA
			117.0	102–112	2/3A	
			132.0	112.8–132	3A	NA
GEW-816	03-Jun-92	161.7	150.0	50–140	2/3A	40
GIW-817	29-Jun-92	150.1	102.0	82–102	2/3A	NA
			122.0	107–117	3A	
			141.0	121–141	3B	NA
GIW-818	06-Jul-92	150.0	102	82–102	2/3A	NA
			125	110–120	3A	
			140	120–140	3A	NA
GIW-819	10-Jul-92	150.0	98.6	78.6–98.6	2	NA
			123	108–118	3A	
			141	121–141	3A	NA
GIW-820	16-Jul-92	143.3	105	85–105	2	NA
			132	112–132	3A	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
HW-GP-001	17-Apr-92	120.0	77.0	67–77	2	NA
			113.0	103–113	3A	NA
HW-GP-002	13-May-92	120.0	78.0	68–78	2	NA
			117.0	107–117	3A	NA
HW-GP-003	20-May-92	119.0	76.5	66.5–76.5	2	NA
			119.0	109–119	3A	NA
HW-GP-102	13-Aug-93	140.0	137.5	72.5–133.5	2/3A	NA
HW-GP-103	23-Aug-93	138.0	137.5	71.5–132.5	2/3A	NA
HW-GP-104	02-Sep-93	138.0	137.2	72.2–132.2	2/3A	NA
HW-GP-105	28-Sep-93	138.0	137.5	72.5–132.5	2/3A	NA
TEP-GP-106	21-Sep-93	137.5	135.5	NA	NA	NA
Extraction Wells						
GSW-445	09-Dec-87	319.0	161.0	155–161	4	3
W-109	02-Apr-85	289.0	147.0	137–147	2	12
W-112	10-May-85	129.0	123.5	111–123.5	5	4
W-254	21-Nov-85	277.0	91.5	84.5–91.5	1B	5
W-262	20-Mar-86	256.0	100.0	91–100	1B	7
W-314	20-Mar-87	228.0	142.0	129–142	4	9.5
W-351	17-Oct-86	191.0	151.0	146–152	4	2.9
W-357	12-Jan-87	197.0	123.0	107–123	2	8
W-359	10-Feb-87	195.0	150.5	138–150.5	5	10
W-361	05-Mar-87	257.0	135.0	125–135	3A	4
W-408	16-Feb-88	131.0	122.5	101–122.5	1B	35
W-415	12-Aug-88	205.0	183.7	79–179	1B/2	>50
W-457	22-Jun-88	289.0	149.5	130–149.5	2	20
W-518	08-Aug-89	251.0	139.0	131–139	2	2.5
W-520	30-Aug-89	160.0	101.5	94–101.5	1B	12
W-522	05-Oct-89	145.5	141.5	134–141.5	2	25
W-566	19-Apr-89	317.0	207.0	197–207	5	12

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-601	13-Oct-89	146.0	96.0	88–96	1B	15
W-602	06-Nov-89	168.0	100.0	90–100	1B	10
W-603	15-Nov-89	150.0	147.0	141–147	2	5
W-605	08-Dec-89	246.0	136.0	130–136	2	10
W-609	21-Feb-90	120.0	112.0	104–112	2	4
W-610	16-Mar-90	453.0	84.5	69–84.5	1B	4
W-614	18-May-90	262.0	123.0	100–123	2	12
W-620	30-Aug-90	206.0	88.5	75–88.5	1B	5
W-621	09-Sep-90	149.0	120.0	113–120	2	4
W-655	25-Apr-90	193.0	130.0	121–129.5	2	2
W-701	10-Oct-90	159.0	86.0	74–86	1B	10
W-704	01-Feb-91	135.0	107.0	67–76 88–97	1B	20
W-712	29-Aug-91	200.0	185.5	170–185.5	3A	8
W-714	02-Jul-91	135.0	128.0	107–128	2	7.5
W-903	28-Apr-93	223.0	145	132–140	2	20
W-904	06-May-93	212.0	154.0	121–133 140–149	2	20
W-906	27-Jul-93	200.0	132.0	58–132	2/3A	10
W-907	02-Sep-93	239.0	220.0	172.7–188.8 204.5–215.0	4 5	25 NA
W-1001	20-Dec-93	105.0	92.0	85–92	1B	1.4
W-1004	23-Feb-94	99.0	97.0	71–91	1B	7
W-1009	02-May-94	191	140	134–140	2	20
W-1015	10-Aug-94	437	94	84–94	1B	20
W-1102	29-Nov-94	163.0	95.5	76.0–94.0	1B	8
W-1103	15-Dec-94	200.0	82.0	70.0–82.0	1B	3.5
W-1104	18-Jan-95	165.0	99.0	77–87 92–98	1B	35+
W-1109	11-Apr-95	121	113	94–108	2	3

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-1111	01-Jun-95	152	129	88–108 120–124	1B/2 2	10.5 NA
W-1116	17-Aug-95	214	101	72–98	1B	9
W-1206	06-Dec-95	220.0	191.0	174–186	4	40+
W-1208	09-Jan-96	166.0	163.0	135–163	3A/3B	40
W-1211	05-Mar-96	273.0	205.0	185–200	4	25+
W-1213	02-Apr-96	129.0	76.0	64–76	1B	5+
W-1215	17-Apr-96	175.0	120.0	103–120.5	2	8.5
W-1216	07-May-96	200.0	124.0	94–124	2	14
W-1301	04-Dec-96	180.0	120.3	112–120	3A	15
W-1302	21-Jan-97	145.0	138.9	116.5–122.2 125.8–133.8	3A	7.5
W-1303	06-Feb-97	199.5	107	78–102	2	10
W-1306	06-May-97	200	106	81–101	2	3.3
W-1307	07-Feb-97	150	142	126–136	4	20
W-1308	22-Jul-97	150.0	116.0	81–111	2	7
W-1309	11-Aug-97	220.0	157.0	142–152	4	6.0
W-1310	08-Sep-97	220.0	198.0	173–193	5	28
W-1409	23-Jan-98	143	140	76–140	2	20
W-1410	20-Feb-98	205.0	133.0	126–131	4	8
W-1415	15-Apr-98	182.0	104.8	74.5–104.5	2	2
W-1418	05-May-98	252.5	190.0	176–190	4	9
W-1422	14-May-98	173.5	169.0	162–169	3A/3B	10
W-1423	08-Jul-98	175.0	134.5	99.5–109.5 119.5–129.5	2	22.4
W-1503	18-Nov-98	234.0	181.5	171–181	4	25
W-1504	14-Dec-98	168.0	162.5	140–160.4	3A/3B	21.7
W-1510	7-Apr-99	114.5	113.5	93–113	2	5
W-1513	10-May-99	122	120	108–120	2/3A	0.1
W-1514	19-May-99	127.5	126	103–121	2/3A	6.5
W-1515	3-Jun-99	130	121.5	102–120	2/3A	3
W-1518	6-Jul-99	184	112	84–107	2	3

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
W-1520	23-Jul-99	178.3	173	160–168	4	3.5
W-1522	9-Aug-99	169	161	141–156	3B	9
W-1523	1-Aug-99	216	172.3	164–172	4	15
W-1550	22-Jun-99	200	130	98–125	3A/3B	10
W-1551	8-Jul-99	153	129	93–124	3A/3B	10.5
W-1552	27-Jul-99	153.5	130	97–125	3A/3B	2
W-1601	18-Oct-99	169	160	150–155	3B	3.5
W-1602	27-Oct-99	115.5	110.7	80–90 100–110	2	8
W-1603	10-Nov-99	144	140	130–135	3A	17.2
W-1606	27-Jan-00	175	112	90–107	3A	<0.5
W-1608	25-Feb-00	155	112	90–107	3A	<0.5
W-1650	03-Jan-00	145	126	96–121	3A/3B	2
W-1651	27-Jan-00	145	129	94–124	3A/3B	1
W-1652	09-Feb-00	145	127	92–122	3A/3B	0.33
W-1653	24-Feb-00	145	124.5	93.5–119.5	3A/3B	1.2
W-1654	25-Feb-00	146.5	128	93–123	3A/3B	0.8
W-1655	08-Mar-00	145	125	90–125	3A/3B	1.3
W-1656	14-Mar-00	145	125	95–120	3A/3B	5
W-1657	23-Mar-00	145	128	95–123	3A/3B	<1
W-1801	18-Mar-02	143	134.4	124–134	3A	>12
W-1805	20-Aug-02	110	100.8	70–80 85–95	1B	>10
W-1806	12-Sept-02	260	106.2	80.7–101.2	1B	NA
W-1807	07-Oct-02	165	130	115–125	2	NA
W-1902	21-Nov-02	175	165	140–145 150–160	3A	NA
W-1903	16-Dec-02	120	109	84–104	2	NA
Other Wells						
7D2	07-Jun-76	74	72.3	63.2–67.3	3A	NA
11C1	08-Jun-76	68	66.2	56.2–61.2	1B	NA
11H5	08-Nov-85	NA	255	NA	NA	NA
11J2	26-Apr-79	112	110	90–92 102–108	1B 2	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
11Q4	NA	NA	NA	NA	NA	NA
11Q5	NA	NA	NA	NA	NA	NA
14A3	07-Dec-77	NA	110	100–105	1B	NA
14A11[d]	NA	NA	NA	NA	NA	NA
14B1	13-Aug-59	300	234	146–149	2	NA
				192–195	3A	–
				198	3A	–
				200	3A	–
				203	3A	–
				205	3A	–
				207	3A	–
				209–213	3A	–
				226	3A	–
				230	3B	–
				234	3B	–
14B4	Aug-60	NA	260	143–148	2	NA
				155–159	2	–
				186–189	3A	–
				205–215	3A	–
				245–250	4	–
14B7	NA	NA	NA	NA	NA	NA
14H1	NA	NA	288	NA	NA	NA
14H2[d]	NA	NA	NA	NA	NA	NA
18D1[d]	NA	NA	NA	NA	7	NA
Source Investigation Piezometers						
SIP-141-201	02-Feb-96	77	74.2	57–74	1B	NA
SIP-141-202	12-Feb-96	80	74	64–74	1B	NA
SIP-141-203	20-Feb-96	87	83	72–83	1B	NA
SIP-191-001	15-Apr-94	50	45	40–45	1A	NA
SIP-191-002	21-Apr-94	50	61	45–61	1B	NA
SIP-191-003	26-Apr-94	50.5	45	35–45	1B	NA
SIP-191-004	29-Apr-94	57.5	53.5	47.5–53.5	1B	NA
SIP-191-005	04-May-94	54	48	42–48	1A	NA
SIP-191-101	18-Nov-94	68.5	64	58–64	1B	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
SIP-212-101	14-Mar-96	94	90.5	87–90.5	2	NA
SIP-293-001	05-Dec-90	56.5	50	45–50	1B	NA
SIP-331-001	21-Sep-91	122	116.5	106.5–116.5	2	NA
SIP-419-101	08-Sep-98	127	123	112–123	3B	NA
SIP-419-202	06-Mar-96	110	106.5	97–106.5	3A	NA
SIP-490-102	08-Nov-95	75	73.5	53.5–73.5	2	NA
SIP-501-004	20-0ct-94	60	56.9	48–56.9	1B	NA
SIP-501-006	11-Nov-92	59.5	56	50–56	1B	NA
SIP-501-007	16-Nov-92	64	59	53–59	1B	NA
SIP-501-101	10-May-94	77.5	73	69–73	1B	NA
SIP-501-102	16-May-94	77	73	67–73	1B	NA
SIP-501-103	20-Mar-94	63	57.5	51–57.5	1B	NA
SIP-501-104	15-Jul-94	67	62	50–62	1B	NA
SIP-501-105	01-Sep-94	73	68	63–68	1B	NA
SIP-501-201	29-Nov-94	65	58.5	54–58.5	1B	NA
SIP-501-202	01-Jul-95	70	64.5	58–64.5	1B	NA
SIP-511-101	25-Jan-96	110	106.7	100–106.7	3A	NA
SIP-511-102	02-Apr-96	114	110.3	108–110	3B	NA
SIP-514-107	03-Jan-90	21.5	17	9–17	1B	NA
SIP-514-109	05-Jan-90	21.5	20	7–22	1B	NA
SIP-514-112	08-Jan-90	21.5	18	7–18	1B	NA
SIP-514-114	09-Jan-90	21.5	17	4–17	1B	NA
SIP-514-116	10-Jan-90	21.5	17	7–17	1B	NA
SIP-514-117	11-Jan-90	21.5	17.5	7–17.5	1B	NA
SIP-514-119	12-Jan-90	21.5	16	6–16	1B	NA
SIP-514-123	17-Jan-90	26.5	23	11.5–23	1B	NA
SIP-514-124	18-Jan-90	21.5	17	6–17	1B	NA
SIP-514-125	19-Jan-90	21.5	15	6–15	1B	NA
SIP-514-126	18-Jan-90	26.5	21.5	4–21.5	1B	NA
SIP-518-203	19-Sep-95	127	127	121–127	5	NA
SIP-543-101	31-Jan-95	111	104	43–103	2	NA
SIP-ALP-001	03-May-90	66	60	45–60	2	NA
SIP-ALP-002	07-May-90	62	57.5	47.5–57.5	1B/2	NA
SIP-AS-001	30-Apr-90	100	100.5	81–90.5	1B	NA
SIP-CR-049	26-Feb-90	42	40	36–40	1B	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
SIP-EGD-001	16-Oct-90	101.5	85	75–85	2	NA
SIP-ETC-201	26-Mar-96	106	101	81–101	2	NA
SIP-ETC-301	12-Apr-99	102	83	76–82	2	NA
SIP-ETC-303	24-May-99	111	88.1	82–88	2	NA
SIP-ETS-201	05-Feb-91	95	90	85–90	3A	NA
SIP-ETS-204	07-May-91	93	97	87–97	3A	NA
SIP-ETS-205	20-Jun-91	103	95	89.5–95	3A	NA
SIP-ETS-209	25-Jul-91	96.6	90	79.75–90	2	NA
SIP-ETS-211	06-Aug-91	103	98.5	95–98.5	3A	NA
SIP-ETS-212	14-Aug-91	106.5	1023	97.5–1023	2	NA
SIP-ETS-213	15-Nov-91	118.5	116.5	108.5–116.5	3A	NA
SIP-ETS-214	22-Nov-91	101	101	86–101	3A	NA
SIP-ETS-215	03-Dec-91	94.5	94.5	84.5–94.5	3A	NA
SIP-ETS-302	30-Mar-92	117.4	113	97–113	3A	NA
SIP-ETS-303	02-Apr-92	110.7	102	95–102	3A	NA
SIP-ETS-304	27-Aug-92	100	97	90–97	3A	NA
SIP-ETS-306	11-Sep-92	101	93	80.5-93	3A	NA
SIP-ETS-401	02-Aug-95	122	121	116–121	3A	NA
SIP-ETS-402	08-Aug-95	110	107	97–107	2	NA
SIP-ETS-404	22-Aug-95	99	95.5	83.5–95.5	2	NA
SIP-ETS-405	29-Aug-95	126	123	114.5–123	5	NA
SIP-ETS-501	16-Nov-95	110	106.5	100–1006.5	3A	NA
SIP-ETS-502	05-Dec-95	95	88	80–88	2	NA
SIP-ETS-601	07-Jun-99	115.5	104.9	98.3–104.8	2	NA
SIP-HPA-001	20-Apr-90	92.75	75	65–75	2	NA
SIP- HPA-003	19-Apr-90	91.5	66	61–66	2	NA
SIP- HPA-201	14-May-96	97.5	76	71–76	2	NA
SIP-IES-001	16-Sep-92	50.2	46.5	44–46.5	1B	NA
SIP-IES-002	05-Oct-92	41.5	39.2	33–39.2	1A	NA
SIP-INF-201	30-Jun-98	85.9	85.0	64.9–84.6	1B	NA
SIP-INF-202	02-Jul-98	86.3	85.2	64.9–84.8	1B	NA
SIP-INF-301	24-Mar-99	97	95.4	60–95	1B	NA
SIP-INF-302	29-Mar-99	97	88.4	53–88	1B	NA
SIP-ITR-001	19-Apr-91	121.6	115	105–115	5	NA
SIP-ITR-002	02-Apr-91	100	84	79–84	5	NA

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
SIP-ITR-003	**25-Apr-91**	**121.5**	**106**	**98.5–106**	**5**	**NA**
SIP-NEB-101	**23-Sep-92**	**68.7**	**66**	**57–66**	**2**	**NA**
UP-292-006	**07-Nov-90**	**74**	**57.5**	**47.5–57.5**	**1B**	**NA**
UP-292-007	**26-Nov-90**	**71**	**56**	**46–56**	**1B**	**NA**
UP-292-012	**31-Oct-91**	**67.7**	**60**	**45–60**	**1B**	**NA**
UP-292-014	**07-Nov-91**	**66**	**66**	**50–66**	**1B**	**NA**
UP-292-015	**11-Nov-91**	**61.5**	**60.5**	**49.5–60.5**	**1B**	**NA**
UP-292-020	**30-Oct-92**	**68.5**	**64**	**56.5–64**	**1B**	**NA**
SIP-PA-002	**29-Jan-90**	**16.5**	**16.5**	**4–16.5**	**1B**	**NA**
SIP-PA-003	**26-Jan-90**	**18**	**14**	**4–14**	**1B**	**NA**
SIP-PA-005	**04-Jan-90**	**11.5**	**8**	**3–8**	**1B**	**NA**
SIP-PA-006	**04-Jan-90**	**13.5**	**12**	**5–12**	**1B**	**NA**
SIP-PA-007	**04-Jan-90**	**11.5**	**5**	**1–5**	**1B**	**NA**
SIP-PA-010	**25-Jan-90**	**11.5**	**9**	**3–9**	**1B**	**NA**
SIP-PA-012	**29-Jan-90**	**11.5**	**9**	**2–9**	**1B**	**NA**
SIP-PA-013	**24-Jan-90**	**16.5**	**13**	**8–13**	**1B**	**NA**
SIP-PA-015	**25-Jan-90**	**21.5**	**17.5**	**2–17.5**	**1B**	**NA**
SIP-PA-016	**24-Jan-90**	**11.5**	**11.5**	**7–11.5**	**1B**	**NA**
SIP-PA-017	**24-Jan-90**	**16.5**	**14**	**7–14**	**1B**	**NA**
SIP-PA-018	**25-Jan-90**	**11.5**	**8**	**6–8**	**1B**	**NA**
SIP-PA-019	**26-Jan-90**	**16.5**	**12**	**2–12**	**1B**	**NA**
SIP-PA-021	**23-Jan-90**	**11.5**	**10**	**2–10**	**1B**	**NA**
SIP-PA-024	**23-Jan-90**	**16.5**	**15**	**5–15**	**1B**	**NA**
SIP-PA-025	**23-Jan-90**	**11.5**	**7**	**4–7**	**1B**	**NA**
SIP-PA-026	**29-Jan-90**	**11.5**	**10**	**2–10**	**1B**	**NA**
SIP-PA-027	**29-Jan-90**	**8.5**	**7**	**2–7**	**1B**	**NA**
SIP-PA-028	**23-Jan-90**	**11**	**8**	**5–8**	**1B**	**NA**
SIP-PA-030	**24-Jan-90**	**11.5**	**8**	**4–8**	**1B**	**NA**
SIP-PA-034	**04-Jan-90**	**6.5**	**5**	**3–5**	**1B**	**NA**
SIP-PA-035	**04-Jan-90**	**11.5**	**11.5**	**6.5–11.5**	**1B**	**NA**
Soil Vapor Installations						
IMS-INF-203	**08-Jul-98**	**63**	**63**	**NA[e]**	**1A**	**NA**
SVI-518-101	**21-Sep-90**	**125**	**61**	**55–61**	**2**	**NA**
SVI-518-202	**03-Nov-93**	**120.6**	**73.8**	**19–73.8**	**1B/2**	**NA**
SVI-518-204	**05-Nov-93**	**121.5**	**46**	**24–46**	**1B/2**	**NA**

Table A-1. Well construction data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

Well number	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU[a] monitored	Well development flow rate (gpm)[b]
SEA-518-301	**11-Sep-95**	**102.6**	**100**	**NA[e]**	**1B/2/5**	**NA**
SVI-518-302	**22-Jun-95**	**104.5**	**39.3**	**11–39**	**1B**	**NA**
SEA-518-304	**11-Sep-95**	**100**	**50**	**NA[e]**	**1B/2/5**	**NA**
SEA-ETS-305	**03-Sep-92**	**85**	**85**	**NA[e]**	**1B/2**	**NA**
SVI-ETS-505	**18-Jul-96**	**80.5**	**77.5**	**45–75**	**2**	**NA**
SEA-ETS-506	**24-Jul-96**	**75**	**66**	**NA[e]**	**1B/2**	**NA**
SEA-ETS-507	**30-Jul-96**	**75**	**66**	**NA[e]**	**1B/2**	**NA**
Soil Vapor Extraction						
SVI-ETS-504	**09-Jul-96**	**76.5**	**67**	**42–67**	**2**	**NA**
SVI-518-201	**03-Mar-93**	**59.8**	**50**	**34–50**	**1B/2**	**NA**
SVI-518-303	**29-Jun-95**	**104.5**	**42**	**6–40**	**1B**	**NA**

Notes:

Boreholes B-707, B-708, B-709, B-713, B-715, and B-750 were drilled for the Dynamic Underground Stripping Demonstration Project "Clean Site."

= Wells installed in 2002.

NA = Not applicable or not available.

LL = Lower Livermore HSU.

[a] **Hydrostratigraphic Units (HSUs) are numbered consecutively downward from ground surface. An HSU is defined as sediments that are grouped together based on the hydrogeologic and contaminant transport properties. The permeable layers within an HSU are considered to be in good hydraulic communication, whereas permeable layers in different HSUs are considered to be in poor hydraulic communication. HSU contacts are interpreted and are subject to change.**

[b] **Flow rate after 4 hours of air-lift pumping/surging.**

[c] **Wells installed for the Dynamic Underground Stripping Demonstration Project include extraction wells (GEW series), injection wells (GIW series), temperature monitoring wells (TEP series), and heating wells (HW series). TEP wells consist of two nested 1-in. inside diameter (ID) piezometers surrounding a blank fiberglass 2-in. ID casing instrumented with geophysical sensors. Therefore, the screened intervals listed refer to the two individual piezometers.**

[d] **Well number was changed in December 1988 to be consistent with Alameda County Flood Control and Water Conservation District, Zone 7 well identification. Well number changes made on this table are:**

4A6 ------> 14H2

18D81 ------> 18D1

14A84 ------> 14A11

[e] **Instrumented membrane systems (IMS)(formerly FLUTe/SEAMIST membranes) with vapor ports set at varying depths.**

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California.

Well number	Date installed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU monitored	Closure date
Monitor Wells						
W-010-A	08-Sept-80	110.7	110.0	85–95 100–105	2	26-Feb-02
W-14A	26-Aug-80	111.0	109.0	80,95,105	2	11-Dec-87
W-15	17-Nov-80	285.0	267.0	239–265	7	13-May-88
W-18	22-Aug-80	161.0	152.5	80–90	2	11-Nov-85
				100–105	2	
				112–117	3A	
				128–133	5	
				143–153	5	
W-149	23-Aug-85	201.0	169.0	161–169	2	29-Aug-96
W-150	13-Sep-85	212.0	162.0	157–162	2	11-Apr-90
W-211	19-Mar-86	215.5	193.0	183—193	7	13-June-02
W-352	29-Oct-86	235.0	201.0	181–201	4	18-Dec-97
W-358	04-Feb-87	248.0	239.0	230–239	7	15-Apr-94
W-360	24-Feb-87	260	204.5	181.5–204.5	4	26-Feb-02
W-414	20-May-88	179.0	74.0	69.5–74	2	26-Feb-02
W-456	09-Jun-88	343.0	180.5	172–180.5	3A	15-Nov-00
W-460	22-Jul-88	361.0	140.5	135–140.5	2	15-Nov-00
W-1005	14-Mar-94	192.0	110.0	98–110	1B	14-Nov-00
W-1006	10-Mar-94	154.0	149.0	141–149	2	14-Nov-00
W-1007	31-Mar-94	199.5	182.0	172–182	3A	14-Nov-00
W-1114	07-Aug-95	223	205	177–200	5	22-Apr-97
W-1218	29-May-96	240	145.5	127–145	3A	27-Feb-02
W-1220	12-Jun-96	120	172	90–112	2	27-Feb-02
W-1221	01-Jul-96	220	172	162–172	4	28-Feb-02
GSW-1	05-Feb-85	112.0	109.0	85–106	3A	06-Jun-86
GSW-10	29-Apr-86	205.5	127.5	114–127.5	3B	27-Jan-98
GSW-20	18-May-84	134.0	101.3	95–101.3	3A	03-Sep-87
Extraction Wells						
GEW-711	24-May-91	167.5	157.0	94–137	3A,3B	16-Jun-92

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

	Date installed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU monitored	Closure date
Other Wells						
1N1	**15-Jan-48**	**600**	**600**	**427–442**	**7**	**21-Oct-88**
				450–453	**1B**	
				465–469	**NA**	
				500–515	**NA**	
				575–588	**NA**	
11A1	**08-Jun-76**	**66**	**64.7**	**54.7–59.7**	**NA**	**18-Aug-88**
2R9 (11A5)[a]	**NA**	**NA**	**NA**	**NA**	**NA**	**19-Jul-88**
11BA[b]	**NA**	**NA**	**NA**	**NA**	**NA**	**10-Jun-87**
11H1	**04-Nov-41**	**NA**	**519**	**157–161**	**NA**	**31-Oct-88**
				169–177	**NA**	
				224–228	**NA**	
				243–245	**NA**	
				254–256	**NA**	
				306–314	**NA**	
				319–327	**NA**	
				339–342	**NA**	
				414–419	**NA**	
				424–431	**NA**	
				477–479	**NA**	
11H4	**05-Apr-60**	**272**	**272**	**166–170**	**NA**	**07-Oct-88**
				174–176	**NA**	
				183–185	**NA**	
				200–202	**NA**	
				211–214	**NA**	
				224–230	**NA**	
				250–252	**NA**	
				260–265	**NA**	
11J1	**1941**	**160**	**NA**	**NA**	**NA**	**03-Aug-88**
11J4[c]	**1965**	**NA**	**NA**	**NA**	**NA**	**11-Oct-88**
11K1	**06-Jan-42**	**NA**	**621**	**247–255**	**NA**	**26-Sep-88**
				272–276	**NA**	
				297–304	**NA**	

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

	Date installed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU monitored	Closure date
				322–339	NA	
				554–557	NA	
				580–602	NA	
11K2	NA	NA	232	NA	NA	03-Oct-88
11Q2	NA	NA	264	NA	NA	16-Aug-88
11Q3	NA	NA	120	NA	NA	10-Aug-88
11Q6[c]	NA	NA	280	NA	NA	11-Jan-89
11R3	08-May-61	140	117	NA	NA	03-Sep-85
11R4	NA	NA	NA	NA	NA	03-Sep-85
11R5[c]	NA	NA	NA	NA	NA	26-Jul-85
12M1	09-Dec-42	702	702	375–378	NA	15-Apr-84
				420–426	NA	
				452–473	NA	
				560–564	NA	
				609–621	NA	
				626–657	NA	
12N1	14-Apr-42	702	681	392–399	NA	24-Jan-89
				514–518	NA	
				527–536	NA	
				666–670	NA	
				678–681	NA	
13D1[c]	29-Oct-56	NA	400	200–400	NA	23-Aug-88
14A1[c]	12-Jul-43	246	227	102–107	NA	13-Sep-88
				113–119	NA	
				144–148	NA	
				176–179	NA	
				188–190	NA	
				192–194	NA	
				219–222	NA	
				223–227	NA	
14A2[c]	15-Nov-56	NA	229	122–130	NA	12-Sep-88
				140–150	NA	
				160–180	NA	
14A4[c]	15-Jun-59	NA	252	167–170	NA	29-Aug-88

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

	Date installed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU monitored	Closure date
				175–179	NA	
				192–202	NA	
				235–246	NA	
14A8	NA	NA	86	NA	NA	22-Jul-88
14B2	22-Aug-56	NA	312	185–312	NA	11-Nov-88
14B8	NA	NA	385	NA	NA	23-Oct-89
TEP-GP-001	21-Jan-92	165.0	97.0 117.0 160.5	87–97 107–117	3A 3B	09-Feb-93
TEP-GP-003	28-Jan-92	161.0	129.5 161.0	124.5–129.5	3B	13-Feb-93
TEP-GP-004	05-Feb-92	161.0	106.0 134.0 161.0	96–106 124–134	3A 3B	13-Feb-93
TEP-GP-005	18-Feb-92	161.0	124.5 161.0	114.5–124.5	3B	13-Feb-93
TEP-GP-006	26-Feb-92	161.0	127.0 161.0	107–127	3B	13-Feb-93
TEP-GP-007	13-Mar-92	161.0	161.0			NA
TEP-GP-008	03-Mar-92	161.0	110.0 161.0	100–110	3A	13-Feb-93
TEP-GP-009	06-May-92	161.7	107.0 130.5 161.0	98–107 120.5–130.5	3A 3B	13-Feb-93
TEP-GP-010	24-Mar-92	161.0	124.5	114.5–124.5	3B	12-Feb-93
TEP-GP-011	07-Apr-92	161.0	108.0 161.0	98–108	3A	13-Feb-93
TEP-GP-002	24-Jun-92	161.4	133.0 161.0	102–112.5 122–133	3A 3B	NA
Source Investigation Piezometers						
SIP-ETC-302	22-Apr-99	104	89.4	79–89	2	26-Apr-99
SIP-ETS-105	11-Feb-90	110	103	87–103	3A	18-Nov-93
SIP-ETS-207	11-Jul-91	103.5	98.5	89.75–98.5	3A	05-Jan-00

Table A-2. Well closure data, LLNL Livermore Site and vicinity, Livermore, California (cont.).

	Date installed	Borehole depth (ft)	Casing depth (ft)	Perforated interval(s) (ft)	HSU monitored	Closure date
SIP-HPA-102	08-Dec-94	76	72	67–72	2	09-Apr-02
SIP-HPA-103	01-Mar-95	77	72.5	67–72.7	2	09-Apr-02
SIP-PA-029	22 -Jan-90	11.5	7	5-7	1B	18-Nov-93
SIP-419-201	29-Feb-96	126	107	97–107	3A/3B	25-Mar-98
SIP-490-101	01-Nov-95	59	56	53–56	2	21-Dec-95
SIP-514-101	28-Dec-89	26	22	7–22	1B	03-Sep-96
UP-292-001	03-Dec-90	54.6	49.5	44.5–49.5	1B	25-Sep-95

Notes:

= Wells sealed and abandoned in 2002.

NA = Not applicable or not available.

[a] **Well 11A5 was renamed 2R9 by the Alameda County Flood Control and Water Conservation District, Zone 7 in November 1997. Well 11A5 now corresponds to monitor well W-409.**

[b] **Well not recognized by Alameda County Flood Control and Water Conservation District, Zone 7.**

[c] **Well number was changed in December 1988 to be consistent with Alameda County Flood Control and Water Conservation District, Zone 7 well identification. Well identification changes made on this table are:**

11J81 ------> 11J4

11R81 ------> 11R5

11Q81 ------> 11Q6

13D81 ------> 13D1

14A81 ------> 14A1

14A82 ------> 14A2

14A83 ------> 14A4

Appendix B

Hydraulic Test Results

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-001	1-Dec-83	Drawdown	5.7	2,000	110	Fair
W-001	23-Jan-85	Drawdown	7.1	3,100	170	Good
W-001A	22-Jan-85	Drawdown	1.4	190	19	Good
W-002	1-Dec-83	Slug	NA	110	34	Poor
W-002A	24-Jan-85	Drawdown	10.3	2,700	200	Good
W-004	1-Dec-83	Drawdown	3.3	63	13	Good
W-005	1-Dec-83	Drawdown	4.3	110	20	Good
W-005	24-Jan-85	Drawdown	7.9	1,100	210	Fair
W-005A	23-Jan-85	Drawdown	13.0	1,300	130	Poor
W-007	1-Dec-83	Slug	NA	43	14	Fair
W-008	1-Dec-83	Drawdown	2.9	29	4.9	Fair
W-011	1-Dec-83	Drawdown	4.1	130	15	Good
W-017	1-Dec-83	Slug	NA	38	2.5	Good
W-017	21-Feb-86	Slug	NA	85	5.7	Good
W-018	1-Dec-83	Drawdown	2.6	20	2.7	Poor
W-102	25-Mar-86	Drawdown	6.4	1,100	76	Good
W-102	5-Sep-86	Drawdown	24.0	770	53	Good
W-102	15-Sep-86	Longterm	27.5	4,200	290	Good
W-103	25-Apr-86	Drawdown	6.7	15,000	1,500	Good
W-104	3-Mar-88	Drawdown	5.4	1,200	170	Fair
W-104	25-Mar-88	Drawdown	3.3	450	45	Fair
W-105	6-Apr-87	Drawdown	0.8	73	7.3	Fair
W-106	19-Feb-86	Slug	NA	7.4	1.3	Excel
W-107	17-Jun-85	Drawdown	1.0	94	9.4	Poor
W-108	29-Oct-85	Drawdown	7.9	750	63	Poor
W-109	5-Mar-86	Drawdown	8.1	3,200	530	Good
W-109	4-Sep-87	Drawdown	20.0	1,600	270	Good
W-109	29-Sep-87	Longterm	11.6	130	22	Fair
W-109	16-Oct-87	Drawdown	8.0	2,300	380	Fair
W-110	18-Jun-85	Drawdown	5.0	1,300	130	Good
W-111	13-Jun-85	Drawdown	1.0	370	37	Good
W-111	21-Nov-85	Drawdown	1.0	370	37	Good
W-112	18-Nov-86	Drawdown	13.4	2,100	170	Fair
W-112	15-Dec-86	Longterm	13.2	3,100	260	Fair
W-112	5-Nov-96	Longterm	13.7	3,300	260	Fair
W-113	17-Apr-86	Slug	NA	7.4	1.2	Excel

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-115	5-Mar-86	Drawdown	1.1	180	30	Good
W-116	24-Dec-85	Slug	NA	37	7.5	Good
W-117	20-Feb-86	Slug	NA	2	0.4	Good
W-118	5-Mar-86	Drawdown	10.0	2,100	230	Good
W-119	8-Aug-85	Drawdown	2.0	1,600	110	Good
W-120	22-Apr-86	Drawdown	1.1	23	5.6	Poor
W-121	10-Sep-85	Drawdown	2.0	120	7.5	Good
W-121	23-Sep-85	Drawdown	4.0	23	1.5	Excel
W-121	14-Oct-85	Drawdown	3.0	34	2.2	Excel
W-121	15-Oct-85	Drawdown	4.5	45	3.0	Excel
W-122	28-Oct-85	Drawdown	10.8	490	49	Good
W-123	28-Oct-85	Drawdown	5.8	40	4.4	Poor
W-142	3-Mar-88	Slug	NA	2,600	330	Excel
W-143	3-Mar-88	Slug	NA	1,200	240	Excel
W-149	9-Sep-85	Drawdown	4.0	120	19	Good
W-149	11-Sep-85	Drawdown	8.0	95	16	Excel
W-149	11-Oct-85	Drawdown	4.8	58	9.7	Excel
W-149	11-Oct-85	Drawdown	7.0	70	12	Good
W-150	2-Oct-85	Drawdown	3.1	640	210	Fair
W-150	3-Oct-85	Drawdown	6.0	720	240	Fair
W-150	10-Oct-85	Drawdown	8.8	630	210	Fair
W-150	10-Oct-85	Drawdown	12.0	620	210.	Fair
W-151	28-Oct-85	Drawdown	5.8	550	61	Poor
W-201	5-Mar-86	Drawdown	10.0	740	86	Excel
W-203	2-Mar-88	Drawdown	6.6	1,100	110	Good
W-204	23-Jan-86	Drawdown	1.9	100	15	Fair
W-205	14-Feb-86	Slug	NA	5.9	1.9	Good
W-205	18-Feb-86	Slug	NA	5.9	1.9	Good
W-206	14-Apr-86	Slug	NA	120	11	Good
W-207	2-Mar-88	Slug	NA	380	32	Excel
W-210	9-Jun-86	Slug	NA	0.6	0.1	Good
W-211	22-Oct-86	Drawdown	2.9	37	12	Fair
W-211	8-Dec-86	Longterm	1.0	44	15	Fair
W-211	16-Sep-97	Longterm	1.1	14	1.4	Good
W-212	12-May-86	Drawdown	0.8	18	3.1	Poor
W-213	22-Apr-86	Drawdown	3.8	190	38	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-214	7-Oct-86	Longterm	27.6	2,300	350	Good
W-217	15-Jul-86	Slug	NA	750	120	Good
W-218	17-Jun-86	Drawdown	11.7	6,400	1,100	Good
W-218	12-Nov-86	Longterm	7.7	4,000	670	Good
W-219	15-Jul-86	Drawdown	4.3	620	76	Good
W-219	23-Feb-87	Longterm	5.2	66	8.0	Fair
W-220	21-Aug-86	Slug	NA	28	5.5	Excel
W-221	5-Aug-86	Drawdown	2.1	120	16	Fair
W-222	12-Aug-86	Drawdown	16.0	1,700	160	Excel
W-222	8-Mar-85	Longterm	7.7	1,100	180	Good
W-223	27-Aug-86	Drawdown	4.0	510	110	Good
W-224	28-Oct-86	Drawdown	7.6	3,600	400	Excel
W-225	23-Oct-86	Drawdown	4.0	85	11	Good
W-225	12-Jan-87	Longterm	2.0	62	8.5	Fair
W-226	31-Mar-87	Slug	NA	1,700	160	Fair
W-252	4-Nov-85	Drawdown	4.0	920	50	Fair
W-252	19-Nov-85	Drawdown	5.6	800	43	Fair
W-254	27-Jan-86	Drawdown	4.2	340	38	Fair
W-254	27-Feb-86	Drawdown	3.2	370	41	Good
W-255	21-Jan-86	Drawdown	5.0	2,800	250	Fair
W-255	21-Jan-86	Drawdown	6.0	2,000	180	Fair
W-255	6-Jan-87	Longterm	2.0	400	36	Fair
W-256	11-Apr-86	Slug	NA	11	5.5	Good
W-257	15-Apr-86	Slug	NA	120	24	Good
W-258	5-Jun-86	Slug	NA	35	9.0	Excel
W-258	29-Oct-86	Slug	NA	32	8.0	Good
W-259	26-Mar-88	Slug	NA	15	5.0	Good
W-260	25-Mar-86	Drawdown	3.0	140	22	Good
W-260	1-Oct-86	Longterm	1.4	120	18	Good
W-261	27-May-86	Slug	0.0	7	2.3	Excel
W-262	11-Apr-86	Drawdown	12.5	2,000	250	Excel
W-262	23-Sep-86	Longterm	22.0	2,750	340	Good
W-262	27-Apr-87	Longterm	23.1	6,800	810	Good
W-263	22-Apr-86	Drawdown	1.2	37	7.4	Poor
W-263	4-Nov-86	Longterm	1.8	76	15	Excel
W-264	7-May-86	Drawdown	8.1	930	100	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-264	29-Oct-86	Longterm	23.0	480	50	Good
W-265	19-May-86	Drawdown	0.7	180	34	Fair
W-267	2-Jun-86	Drawdown	0.5	420	85	Poor
W-268	14-Nov-86	Drawdown	5.0	230	18	Good
W-269	14-Jul-86	Drawdown	5.0	570	95	Good
W-270	30-Dec-86	Slug	NA	14	2.0	Good
W-271	4-Aug-86	Drawdown	5.5	340	76	Fair
W-272	19-Aug-86	Drawdown	0.8	150	30	Fair
W-273	27-Aug-86	Drawdown	3.2	600	90	Good
W-274	25-Mar-85	Slug	NA	38	7.6	Fair
W-274	02-Feb-99	Slug	NA	10	2	Fair
W-275	30-Oct-86	Drawdown	7.0	730	150	Fair
W-275	2-Mar-87	Longterm	5.5	830	170	Fair
W-276	21-Nov-86	Drawdown	13.0	960	110	Good
W-276	4-May-87	Longterm	24.0	2,700	300	Fair
W-277	3-Nov-86	Drawdown	0.9	74	25	Fair
W-290	5-Jan-87	Slug	NA	14	4.0	Excel
W-291	27-Jan-87	Slug	NA	25	7.1	Fair
W-292	28-Aug-86	Drawdown	6.0	400	56	Excel
W-294	29-Dec-86	Drawdown	5.3	5,300	29	Fair
W-294	29-Dec-86	Drawdown	5.9	5,400	300	Good
W-301	30-Oct-86	Drawdown	6.0	460	100	Good
W-302	18-Nov-86	Drawdown	1.0	100	27	Good
W-302	18-Nov-86	Drawdown	2.0	76	21	Fair
W-303	12-Nov-86	Drawdown	11.1	210	70	Good
W-304	13-Mar-87	Drawdown	0.9	74	25	Fair
W-305	26-Nov-86	Drawdown	19.0	720	72	Excel
W-305	18-May-87	Longterm	20.1	640	64	Excel
W-306	31-Mar-87	Drawdown	9.5	270	68	Good
W-307	26-Mar-87	Drawdown	0.9	66	33	Fair
W-308	4-Dec-87	Drawdown	2.6	27	5.4	Good
W-310	17-Feb-87	Drawdown	6.7	58	850	Good
W-311	19-Mar-87	Drawdown	9.8	130	12	Good
W-311	17-Nov-87	Longterm	9.9	370	26	Good
W-312	27-Mar-87	Drawdown	20.5	1,800	300	Poor
W-312	3-Nov-87	Longterm	18.8	1,700	280	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-313	25-Mar-87	Drawdown	7.9	3,000	600	Good
W-313	5-Oct-87	Longterm	9.6	3,400	680	Good
W-314	10-Apr-87	Drawdown	26.4	2,900	390	Good
W-314	13-Jul-87	Longterm	13.6	2,500	330	Fair
W-314	14-Oct-97	Longterm	12	1,400	100	Fair
W-315	9-Apr-87	Drawdown	15.4	150	11	Good
W-315	5-Jan-85	Longterm	24.5	571	41	Excel
W-316	4-May-87	Drawdown	7.8	1,400	280	Good
W-317	12-May-87	Drawdown	12.1	300	43	Fair
W-317	15-Dec-87	Longterm	8.2	120	17.1	Good
W-318	7-Aug-87	Slug	NA	120	16	Good
W-319	29-Jul-87	Drawdown	48.0	7,200	1,500	Good
W-320	15-May-87	Drawdown	1.8	58	17	Fair
W-320	15-May-87	Drawdown	3.0	22	3.7	Fair
W-320	26-Jun-87	Drawdown	2.1	49	14	Fair
W-321	28-Jul-87	Drawdown	40.0	6,600	450	Good
W-322	3-Aug-87	Drawdown	3.1	85	15	Good
W-323	11-Aug-87	Drawdown	3.4	205	59	Good
W-324	10-Sep-87	Drawdown	6.6	200	50	Good
W-325	10-Sep-87	Drawdown	6.0	160	13	Excel
W-351	12-Nov-86	Drawdown	5.7	27	14	Poor
W-352	30-Dec-86	Drawdown	20.0	280	14	Good
W-352	7-Jul-87	Longterm	19.5	120	6.0	Excel
W-353	20-Nov-86	Drawdown	2.1	60	17	Good
W-354	30-Dec-86	Drawdown	17.6	2,000	220	Fair
W-354	30-Dec-86	Drawdown	18.0	2,400	260	Good
W-354	20-Apr-87	Longterm	17.8	310	34	Good
W-355	29-Dec-86	Drawdown	2.1	19	5.0	Fair
W-356	17-Mar-87	Drawdown	5.7	180	59	Good
W-356	16-Jul-96	Longterm	4.9	230	57	Poor
W-357	18-Feb-87	Drawdown	15.0	1,300	110	Good
W-357	21-Jul-87	Longterm	9.2	210	18	Good
W-358	18-Mar-87	Drawdown	9.2	210	32	Excel
W-359	9-Mar-87	Longterm	19.0	2,800	290	Fair
W-359	20-Mar-87	Drawdown	18.6	1,100	110	Good
W-360	22-May-87	Drawdown	30.0	4,800	210	Excel

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-361	16-Mar-87	Drawdown	4.3	67	11	Good
W-361	12-Jan-85	Longterm	5.3	178	30	Good
W-362	23-Mar-87	Drawdown	16.4	470	49	Good
W-362	21-Sep-87	Longterm	13.6	370	39	Good
W-363	24-Jul-87	Slug	NA	20	3.0	Excel
W-364	8-Apr-87	Drawdown	8.6	51	10	Fair
W-364	1-Jun-87	Longterm	4.8	110	22	Good
W-365	14-May-87	Drawdown	10.0	36	15	Fair
W-366	11-May-87	Drawdown	19.0	780	92	Fair
W-368	11-May-87	Drawdown	2.9	81	8.5	Fair
W-368	31-Jul-01	Step	6.0	2,600	350	Fair
W-369	25-Jun-87	Drawdown	7.0	580	96	Good
W-369	10-Nov-87	Longterm	5.5	89	18	Good
W-370	23-Jun-87	Drawdown	4.4	84	10	Fair
W-371	24-Jun-87	Drawdown	3.3	15	3.0	Good
W-372	23-Nov-87	Slug	NA	310	62	Excel
W-373	28-Jul-87	Drawdown	4.0	660	77	Fair
W-373	28-Jul-87	Drawdown	6.5	50	6.0	Poor
W-376	26-Jan-88	Drawdown	2.9	65	8.5	Fair
W-380	23-Oct-87	Drawdown	4.0	33	4.7	Excel
W-401	23-Oct-87	Drawdown	42.0	950	24	Excel
W-402	22-Oct-87	Drawdown	41.0	13,500	1,400	Good
W-403	3-Dec-87	Drawdown	9.7	370	26	Good
W-404	4-Feb-85	Drawdown	45.0	3,200	530	Good
W-405	16-Feb-85	Drawdown	47.2	546	14	Good
W-406	28-Jan-85	Drawdown	7.4	7,500	940	Fair
W-407	23-Feb-85	Drawdown	14.4	75	7.5	Fair
W-408	5-Apr-85	Drawdown	45.0	43,000	3,100	Good
W-409	22-Mar-85	Drawdown	20.0	230	38	Good
W-410	28-Apr-85	Drawdown	35.0	6,800	570	Fair
W-411	5-May-85	Drawdown	14.0	50	83	Good
W-412	6-May-88	Drawdown	4.1	700	64	Fair
W-413	30-Aug-01	Drawdown	20.0	9,400	790	Good
W-414	27-Jul-85	Slug	NA	150	38	Good
W-415	31-Aug-85	Drawdown	10.0	3,100	78	Fair
W-416	11-Jul-85	Drawdown	50.0	2,600	330	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-417	27Jun-88	Drawdown	5.3	340	57	Fair
W-420	16-Aug-85	Drawdown	3.5	710	100	Excel
W-421	12-Sep-85	Drawdown	4.8	320	27	Excel
W-422	19-Sep-85	Drawdown	8.6	230	42	Good
W-423	12-Oct-85	Drawdown	22.0	1,500	130	Good
W-424	17-Oct-85	Drawdown	4.5	130	19	Good
W-441	30-Oct-87	Drawdown	6.0	500	56	Good
W-441	13-Apr-88	Drawdown	13.0	2,200	240	Poor
W-441	19-Apr-88	Longterm	14.0	470	52	Good
W-447	26-Feb-88	Drawdown	7.1	124	850	Poor
W-448	24-Mar-85	Drawdown	24.5	4,200	600	Good
W-449	21-Mar-85	Drawdown	6.2	170	11	Good
W-450	14-Apr-88	Drawdown	3.3	38	650	Fair
W-451	27-Apr-88	Drawdown	2.1	80	16	Good
W-452	2-May-88	Drawdown	5.2	310	21	Excel
W-453	3-May-88	Drawdown	5.8	67	7.4	Fair
W-455	22-Jun-88	Drawdown	5.8	160	13	Good
W-456	14-Jul-85	Drawdown	4.5	260	33	Fair
W-457	29-Jul-85	Drawdown	20.5	450	24	Excel
W-458	2-Aug-85	Drawdown	0.8	24	150	Fair
W-460	1-Sep-85	Drawdown	17.0	1,900	380	Fair
W-461	7-Sep-85	Slug	NA	690	140	Good
W-462	27-Sep-85	Drawdown	19.0	360	60	Good
W-463	11-Oct-85	Drawdown	24.0	1,600	200	Good
W-464	8-Nov-88	Drawdown	9.0	370	53	Good
W-481	2-Dec-87	Drawdown	1.1	8	1.7	Good
W-486	23-Mar-85	Drawdown	6.0	230	30	Good
W-487	14-Apr-88	Drawdown	2.2	45	15	Good
W-501	21-Oct-85	Drawdown	9.7	170	21	Good
W-502	14-Nov-85	Slug	NA	12	30	Good
W-503	11-Nov-88	Drawdown	1.3	15	3.0	Fair
W-504	8-Dec-85	Drawdown	10.0	590	84	Good
W-505	21-Mar-89	Drawdown	34.2	653	76	Good
W-506	10-Feb-89	Drawdown	31.0	7,423	460	Good
W-507	6-Feb-89	Drawdown	39.0	2,900	290	Good
W-508	29-Mar-89	Drawdown	30.0	47,000	2,600	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-509	11-May-89	Drawdown	0.9	10	2.0	Fair
W-510	11-May-89	Slug	NA	220	110	Good
W-511	11-May-89	Drawdown	1.7	63	11	Fair
W-512	27-Apr-89	Drawdown	2.9	85	9.4	Good
W-513	9-May-89	Drawdown	0.6	33	3.0	Fair
W-514	26-May-89	Drawdown	1.4	84	530	Fair
W-515	6-Jun-89	Drawdown	2.8	37	4.2	Fair
W-516	19-Jun-89	Drawdown	19.5	1,428	286	Good
W-517	27-Jun-89	Drawdown	7.3	370	53	Good
W-518	10-Aug-89	Drawdown	6.2	1,421	178	Good
W-519	31-Aug-89	Drawdown	31.5	5,700	475	Excel
W-520	24-Jan-90	Drawdown	22.8	3,300	560	Excel
W-521	1-Feb-90	Drawdown	0.6	44	4.9	Fair
W-522	5-Feb-90	Drawdown	20.0	3,700	620	Fair
W-551	8-Nov-85	Drawdown	37.0	350	88	Good
W-552	12-Dec-88	Drawdown	38.0	4,700	390	Good
W-553	17-Nov-85	Drawdown	2.2	55	7.9	Fair
W-554	10-Jan-89	Drawdown	21.5	1,800	150	Good
W-555	28-Dec-88	Drawdown	14.0	460	23	Fair
W-556	25-Jan-89	Drawdown	17.0	850	170	Fair
W-557	23-Jan-89	Drawdown	1.2	570	36	Poor
W-558	23-Mar-89	Drawdown	24.7	5,200	650	Good
W-560	8-Mar-89	Drawdown	1.7	30	7.6	Fair
W-561	13-Mar-89	Drawdown	1.1	12	2.1	Fair
W-562	28-Mar-89	Drawdown	1.0	16	2.3	Fair
W-563	31-Mar-89	Drawdown	1.1	14	2.3	Fair
W-564	26-Apr-89	Drawdown	1.6	44	5.0	Poor
W-565	18-Apr-89	Drawdown	15.6	1,600	260	Good
W-566	2-May-89	Drawdown	17.0	780	86	Good
W-566	31-Aug-93	Longterm	22.5	2,580	520	Fair
W-567	4-May-89	Drawdown	10.4	2,600	320	Excel
W-568	20-Jun-89	Drawdown	18.3	620	160	Fair
W-569	24-May-89	Drawdown	2.8	100	15	Fair
W-570	8-Jun-89	Drawdown	1.1	7	1.1	Fair
W-571	17-Jul-89	Drawdown	17.7	1,000	200	Excel
W-592	23-Jan-89	Drawdown	2.2	2,200	280	Poor

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-593	22-Feb-89	Drawdown	2.2	57	11.4	Good
W-594	16-Mar-89	Slug	NA	380	54	Excel
W-601	8-Feb-90	Drawdown	22.5	6,900	770	Excel
W-602	29-Jan-90	Drawdown	24.0	5,300	620	Good
W-603	7-Feb-90	Drawdown	6.1	100	20	Fair
W-604	20-Feb-90	Slug	NA	380	63	Good
W-605	28-Feb-90	Drawdown	4.8	50	12	Good
W-606	21-Feb-90	Slug	NA	120	20	Fair
W-607	22-Feb-90	Drawdown	1.4	800	100	Good
W-608	28-Feb-90	Drawdown	1.2	230	30	Fair
W-609	9-Mar-90	Drawdown	6.7	470	70	Good
W-610	28-Mar-90	Drawdown	5.8	5,500	380	Good
W-611	16-Apr-90	Drawdown	3.5	1,000	110	Fair
W-612	24-May-90	Drawdown	13.5	550	55	Good
W-612	05-Apr-94	Longterm	14	230	40	Good
W-613	23-May-90	Drawdown	4.8	2,550	360	Good
W-614	7-Jun-90	Drawdown	6.7	1,650	130	Good
W-615	21-Jun-90	Drawdown	1.3	130	19	Fair
W-616	27-Jun-90	Drawdown	2.0	390	40	Fair
W-617	12-Jul-90	Drawdown	2.8	53	6.8	Good
W-618	1-Aug-90	Drawdown	1.9	24	4.8	Fair
W-619	30-Aug-90	Drawdown	11.8	190	11	Good
W-620	1-Oct-90	Drawdown	5.8	6,500	650	Good
W-621	4-Oct-90	Drawdown	3.8	310	39	Good
W-622	12-Oct-90	Slug	NA	130	16	Fair
W-651	16-Mar-90	Slug	NA	530	180	Fair
W-652	22-Mar-90	Drawdown	1.0	11	3.8	Good
W-653	11-Apr-90	Drawdown	0.3	2	1.9	Fair
W-654	25-Apr-90	Drawdown	21.7	390	25	Fair
W-655	12-May-90	Drawdown	12.2	1,000	220	Good
W-701	23-Oct-90	Drawdown	14.5	6,800	650	Good
W-701	3-Oct-92	Step	16.5	5,200	430	Good
W-701	1-Apr-93	Drawdown	24.0	3,700	370	Good
W-702	29-Nov-90	Drawdown	2.5	150	30	Good
W-702	25-Feb-93	Step	4.6	36	7	Poor
W-703	19-Dec-90	Drawdown	7.0	230	9.1	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-704	4-Mar-91	Drawdown	19.0	1,800	140	Fair
W-705	20-Feb-91	Drawdown	0.8	40	6.1	Fair
W-706	29-Jan-91	Drawdown	0.2	8	1	Fair
W-712	25-Feb-92	Drawdown	7.8	750	48	Good
W-712	18-Mar-93	Longterm	15.1	1,440	93	Good
W-714	6-Dec-91	Drawdown	2.9	140	6.7	Good
W-902	25-Mar-93	Drawdown	0.6	6	2	Fair
W-909	18-Oct-95	Drawdown	2.7	150	5.1	Good
W-911	2-Feb-96	Drawdown	1.4	53	2.1	Good
W-912	10-Nov-95	Drawdown	4.1	65	11	Poor
W-913	16-Aug-95	Drawdown	23.5	730	36	Good
W-1001	13-Aug-95	Drawdown	1.3	170	25	Fair
W-1002	19-Jun-97	Drawdown	16.8	680	49	Good
W-1003	26-Jun-97	Drawdown	1.2	5.1	0.7	Poor
W-1006	17-Jun-97	Drawdown	17.4	180	23	Fair
W-1007	23-Sep-95	Drawdown	1.6	13	1.3	Fair
W-1008	17-Jan-97	Drawdown	7.3	110	13	Good
W-1010	10-Jul-95	Drawdown	20.3	1,650	140	Fair
W-1011	11-Jul-95	Drawdown	3.8	240	17	Good
W-1012	13-Jul-95	Drawdown	3.3	35	2.2	Fair
W-1013	13-Jul-95	Drawdown	2.7	2,000	250	Poor
W-1014	28-Aug-96	Drawdown	31.1	7,700	320	Good
W-1101	22-Nov-95	Drawdown	0.8	9.9	3.3	Good
W-1102	29-Jan-96	Drawdown	14.7	81	4.5	Fair
W-1103	29-Nov-95	Drawdown	3	19	1.6	Fair
W-1105	17-Jul-95	Drawdown	2.4	320	26	Fair
W-1106	24-Jul-96	Drawdown	7.1	5,200	580	Good
W-1107	9-Apr-97	Drawdown	6.7	3,500	250	Poor
W-1107	04-May-99	Drawdown	6.6	4,300	310	Fair
W-1108	3-Nov-95	Drawdown	12.3	950	68	Good
W-1108	25-Jun-96	Longterm	11.6	1,000	70	Poor
W-1109	26-Jun-95	Drawdown	8.7	460	33	Fair
W-1109	4-Jun-96	Longterm	6.8	760	40	Poor
W-1110	22-Jan-96	Drawdown	6.3	690	29	Fair
W-1111	20-Oct-95	Drawdown	15.8	2,100	95	Good
W-1111	9-Dec-96	Longterm	11.2	160	7.9	Poor

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1112	24-May-96	Drawdown	6.4	94	10	Fair
W-1113	26-Aug-96	Drawdown	1	5.5	0.6	Good
W-1114	27-Oct-95	Longterm	15.1	270	12	Fair
W-1116	23-Feb-96	Drawdown	6.6	290	11	Fair
W-1117	23-Aug-96	Drawdown	0.7	3.4	0.34	Fair
W-1118	18-Jan-96	Drawdown	5.6	350	35	Good
W-1201	1-Nov-96	Drawdown	1	8.3	0.92	Poor
W-1203	2-May-96	Drawdown	18.8	900	90	Good
125W-1204	22-Feb-96	Drawdown	1.3	17	2.2	Poor
W-1205	27-Nov-96	Slug	NA	330	33	Fair
W-1207	27-Nov-96	Slug	NA	900	45	Poor
W-1209	17-May-96	Drawdown	0.98	11	0.69	Good
W-1210	30-May-96	Drawdown	3.8	7.3	0.73	Fair
W-1211	26-Jul-96	Drawdown	28.6	5,000	330	Good
W-1212	14-May-96	Drawdown	1.9	35	2.5	Good
W-1212	10-Sep-96	Longterm	1.3	85	3.6	Poor
W-1213	22-Jul-96	Drawdown	11.6	500	42	Fair
W-1213	30-Jul-96	Longterm	9.6	440	37	Poor
W-1214	28-Apr-97	Drawdown	2.2	110	5.4	Fair
W-1215	15-Aug-96	Drawdown	11.6	610	61	Fair
W-1215	8-Oct-96	Longterm	9.8	3,000	300	Poor
W-1216	14-Aug-96	Drawdown	11.4	210	6.9	Good
W-1216	15-Oct-96	Longterm	11.1	160	5.4	Poor
W-1218	11-Nov-96	Drawdown	5.8	83	4.6	Fair
W-1218	8-Jul-97	Longterm	4.8	210	12	Fair
W-1219	27-May-97	Drawdown	0.4	2.5	0.63	Poor
W-1220	13-Nov-96	Drawdown	20.3	2,600	120	Good
W-1220	15-Jul-97	Longterm	20.0	4,700	210	Fair
W-1221	27-Dec-96	Drawdown	3.1	29	2.9	Fair
W-1222	31-Oct-96	Drawdown	6.1	430	43	Good
W-1224	22-May-97	Drawdown	5.0	55	11	Good
W-1225	31-Mar-97	Drawdown	4.1	83	10	Good
W-1226	27-Feb-97	Drawdown	2.2	14	1.4	Excel
W-1227	11-Apr-97	Drawdown	15.1	380	48	Fair
W-1254	19-Nov-96	Longterm	18.9	1,130	110	Fair
W-1301	10-Mar-97	Longterm	4.7	120	15	Fair

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1303	18-Mar-97	Longterm	7.8	490	21	Fair
W-1304	2-Jul-97	Drawdown	0.7	2.6	0.52	Poor
W-1306	30-Apr-97	Drawdown	2.8	24	1.2	Good
W-1306	18-Jun-97	Longterm	1.6	54	2.7	Poor
W-1307	31-Jul-97	Drawdown	11.6	1,100	110	Good
W-1308	14-Aug-97	Drawdown	6.5	150	5.1	Good
W-1308	7-Oct-977	Longterm	4.0	530	18	Fair
W-1309	15-Oct-97	Drawdown	9.1	90	8.9	Fair
W-1310	10-Mar-97	Drawdown	27.9	1,060	53	Good
W-1311	29-Oct-97	Drawdown	12.2	290	15	Good
W-1401	11-Nov-97	Drawdown	7.0	100	6.8	Excel
W-1402	12-Dec-97	Drawdown	2.6	100	10.2	Fair
W-1403	21-Jul-98	Drawdown	5.4	95	13	Good
W-1404	21-Apr-98	Drawdown	6.5	210	84	Good
W-1405	23-Apr-98	Drawdown	6.4	1,300	360	Fair
W-1406	17-Apr-98	Drawdown	11.1	3,600	360	Good
W-1407	3-Apr-98	Drawdown	1.1	8.7	1.0	Excellent
W-1408	15-Apr-98	Drawdown	2.7	85	28	Fair
W-1410	29-Jun-98	Drawdown	11.5	3,000	500	Poor
W-1410	08-Sep-99	Step	6.5	3,800	650	Poor
W-1411	15-May-98	Drawdown	12.3	14,700	1,300	Poor
W-1412	29-May-98	Slug	NA	2	0.67	Fair
W-1413	8-Jun-98	Drawdown	0.63	8.7	3.5	Fair
W-1415	11-Jun-98	Drawdown	0.87	18	1.2	Fair
W-1416	28-Jul-98	Drawdown	12.3	1,300	180	Good
W-1417	1-Jul-98	Drawdown	15.1	130	11	Good
W-1417	16-Jul-98	Step	5.9	150	13	Fair
W-1418	25-Sep-98	Drawdown	10.7	78	6.5	Excellent
W-1418	16-Dec-98	Step	10.5	490	41	Fair
W-1419	15-Jul-98	Step	6.1	47	3	Poor
W-1420	12-Aug-98	Drawdown	13.1	3,000	220	Poor
W-1421	14-Jul-98	Step	1.82	14	1.8	Poor
W-1421	17-Jul-98	Step	3.8	22	2.8	Poor
W-1422	18-Sep-98	Drawdown	12.0	170	33	Excellent
W-1422	18-Dec-98	Step	11.7	160	32	Good
W-1423	12-Nov-98	Drawdown	24.6	540	39	Fair

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
W-1424	1-Oct-98	Drawdown	6	48	6.9	Excellent
W-1425	1-Oct-98	Drawdown	1.4	15	2.4	Fair
W-1426	13-Nov-98	Drawdown	6.5	840	56	Good
W-1427	11-Jan-99	Drawdown	7.9	2,100	300	Good
W-1428	13-Jan-99	Drawdown	8.1	8,200	550	Good
W-1501	20-Nov-98	Drawdown	7.2	68	11	Good
W-1502	17-May-99	Drawdown	1.5	360	60	Good
W-1503	12-Feb-99	Drawdown	17.6	1,700	180	Good
W-1504	18-Feb-99	Drawdown	15.4	600	60	Fair
W-1505	29-Apr-99	Drawdown	11.2	280	35	Fair
W-1506	19-Apr-99	Drawdown	3.1	50	5.4	Good
W-1507	27-Apr-99	Drawdown	0.65	15	1.9	Fair
W-1508	28-Jun-01	Slug	NA	160	16	Good
W-1509	09-Apr-99	Drawdown	7.2	7,000	700	Good
W-1510	14-Apr-99	Drawdown	6.6	280	20	Fair
W-1512	21-Jun-01	Slug	NA	230	23	Good
W-1514	23-Jun-99	Longterm	5.8	440	90	Good
W-1515	18-Jan-00	Drawdown	1.5	26	1.5	Poor
W-1515	2-Feb-00	Longterm	1.1	75	4.1	Fair
W-1518	22-Mar-00	Step	6.0	440	19	Good
W-1520	21-Mar-00	Longterm	4.0	165	20	Poor
W-1522	20-Mar-00	Step	10.5	3,500	235	Good
W-1550	28-Dec-99	Drawdown	10.0	330	35	Fair
W-1601	25-Feb-00	Drawdown	3.0	35	3.6	Good
W-1602	3-Mar-00	Drawdown	8.3	3,100	310	Fair
W-1604	2-Apr-01	Drawdown	4.0	1,600	220	Fair
W-1610	14-Jul-00	Injection	2.0	17	0.8	Good
W-1610	17-Jul-00	Injection	3.0	17	0.8	Excel
W-1614	25-Aug-00	Drawdown	1.9	75	8.3	Good
W-1654	20-Apr-00	Drawdown	0.5	12	2.0	Good
W-1655	21-Apr-00	Drawdown	1.5	27	4.9	Good
W-1701	23-Jul-01	Drawdown	9.0	160	40	Good
W-1701	26-Sep-01	Longterm	15.0	60	15	Fair
W-1703	25-Oct-01	Drawdown	12.0	16,000	2,300	Fair
W-1801	3-May-02	Drawdown	10.0	6,600	660	Fair
W-1802	30-Sep-02	Drawdown	1.3	11	1.1	Fair

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
TW-11	24-Jan-85	Drawdown	0.3	200	20	Good
TW-11A	24-Jan-85	Drawdown	10.0	3,100	110	Fair
GSW-01	11-Dec-85	Slug	NA	72	0.2	Fair
GSW-01A	14-Jul-86	Drawdown	13.4	12,000	790	Good
GSW-02	17-Dec-85	Slug	NA	240	10	Good
GSW-03	23-Dec-85	Slug	NA	510	41	Good
GSW-04	19-Dec-85	Slug	NA	17	0.9	Good
GSW-05	12-Feb-86	Slug	NA	99	9	Excel
GSW-06	23-Iun-86	Drawdown	25.0	4,800	310	Good
GSW-06	16-Jun-87	Longterm	20.0	5,500	350	Good
GSW-07	3-Apr-86	Drawdown	4.3	230	23	Excel
GSW-08	19-Nov-86	Drawdown	2.0	230	38	Good
GSW-09	28-May-86	Drawdown	1.9	500	63	Poor
GSW-10	22-May-86	Drawdown	14.3	21,000	2,000	Good
GSW-11	2-Jun-86	Drawdown	4.7	390	45	Excel
GSW-12	7-Jun-86	Drawdown	0.8	51	11	Fair
GSW-13	4-Aug-86	Slug	NA	110	13	Excel
GSW-13	8-Aug-86	Slug	NA	62	7	Good
GSW-15	23-Feb-88	Drawdown	25.8	1,500	190	Good
GSW-208	8-May-86	Drawdown	1.9	440	80	Good
GSW-209	8-May-86	Drawdown	6.1	1,200	120	Good
GSW-215	4-Jun-86	Drawdown	1.9	220	40	Poor
GSW-216	16-Jan-92	Drawdown	10.5	3,500	440	Fair
GSW-266	20-Jun-86	Drawdown	2.1	470	72	Good
GSW-266	18-Nov-86	Drawdown	3.0	450	64	Good
GSW-266	18-Nov-86	Drawdown	4.7	410	59	Good
GSW-367	11-May-87	Drawdown	6.9	200	29	Fair
GSW-403-6	8-Dec-85	Slug	NA	4	0.2	Good
GSW-442	23-Nov-87	Drawdown	1.2	32	4.6	Good
GSW-443	30-Nov-87	Drawdown	10.3	260	8.7	Good
GSW-444	28-Jan-88	Slug	NA	9	0.86	Good
GSW-445	26-Jan-85	Drawdown	4.7	43	4.30	Fair
GEW-710	23-Sept-91	Step	36.0	4,800	220	Excel
GEW-816	15-Aug-92	Drawdown	39.0	12,000	1,100	Good
11H4	15-Jan-85	Drawdown	24.6	2,000	77	Good
11H4	19-Jan-85	Longterm	29.5	1,780	18	Good

Table B-1. Results of hydraulic tests.[a]

Well	Date	Type of test[b]	Flow rate (Q) (gpm)	Transmissivity (T) (gpd/ft)	Hydraulic conductivity (K)[c] (gpd/sq ft)	Data quality[d]
11J4	10-Jun-88	Drawdown	17.0	1,000	15	Excel
11J4	14-Jun-85	Longterm	16.0	1,100	16	Good
13D1	9-Feb-85	Longterm	50.0	4,800	48	Excel

Note:

NA = Not applicable.

= Hydraulic tests performed in 2002.

a The pumping test results were obtained by using the analytic techniques of Theis (1935), Cooper and Jacob (1946), Papadopulos and Cooper (1967), Hantush and Jacob (1955), Hantush (1960), or Boulton (1963). The particular method used depends on the character of the data obtained. The slug test results were obtained using the method of Cooper *et al.* (1967). (See references below.)

b "Drawdown" denotes 1-hr pumping tests; "Longterm" denotes 24- to 48-hr pumping tests; "Slug" denotes monitoring and recovery after an instantaneous change in ground water elevations; "Step" denotes a step-drawdown test, flow rate given is the maximum or final step.

c K is calculated by dividing T by the thickness of permeable sediments intercepted by the sand pack of the well. This thickness is the sum of all sediments with moderate to high estimated conductivities determined from the geologic and geophysical logs of the well.

d Hydraulic test quality criteria:

Excel: High confidence that type curve match is unique. Data are smooth and flow rate well controlled.

Good: Some confidence that curve match is unique. Data are not too "noisy." Well bore storage effects, if present, do not significantly interfere with the curve match. Boundary effects can be separated from properties of the pumped zone.

Fair: Low confidence that curve match is unique. Data are "noisy." Multiple leakiness and other boundary effects tend to obscure the curve match.

Poor: Unique curve match cannot be obtained due to multiple boundaries, well bore storage, uneven flow rate, or equipment problems. Usually, the test is repeated.

References

Boulton, N. S. (1963), "Analysis of Data from Non-Equilibrium Pumping Tests Allowing for Delayed Yield from Storage," *Proc. Inst. Civ. Eng.* **26**, 469?482.

Cooper, H. H., Jr., J. D. Bredehoeft, and I. S. Papadopulos (1967), "Response of a Finite-Diameter Well to an Instantaneous Charge of Water," *Water Resour. Res.* **3**, 263?269.

Cooper, H. H., and C. E. Jacob (1946), "A Generalized Graphical Method of Evaluating Formation Constants and Summarizing Well Field History," *Am. Geophys. Union Trans.* **27**, 526?534.

Hantush, M. S. (1960), "Modification of the Theory of Leaky Aquifers," *J. of Geophys. Res.* **65**, 3173?3725.

Hantush, M. S., and C. E. Jacob (1955), "Non-Steady Radial Flow in an Infinite Leaky Aquifer," *Am. Geophys. Union Trans.* **36**(1), 95?100.

Papadopulos, I. S., and H. H. Cooper, Jr. (1967), "Drawdown in a Well of Large Diameter," *Water Resour. Res.* **3**, 241?244.

Theis, C. V. (1935), "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage," *Am. Geophys. Union Trans.* **16**, 519?524.

Appendix C

2003 Ground Water Sampling Schedule

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-001	O	2-03	
W-001A	O	1-03	
W-002	A	1-03	
W-002A	O	2-03	
W-004	O	2-03	
W-005	O	3-03	
W-005A	O	4-03	
W-007	E	4-04	
W-008	E	4-04	WGMG
W-011	E	2-04	
W-012	A	4-03	
W-017	E	1-04	WGMG
W-017A	E	4-04	
W-019	O	1-03	
W-101	E	2-04	WGMG
W-102	O	3-03	
W-103	E	4-04	
W-104	Q	1-03	
W-105	O	4-03	
W-106	E	4-04	
W-107	E	4-04	
W-108	O	3-03	
W-110	Q	1-03	
W-111	E	3-04	
W-113	O	1-03	
W-114	Q	1-03	
W-115	O	4-03	
W-116	Q	1-03	
W-117	O	1-03	
W-118	E	4-04	
W-119	Q	1-03	WGMG
W-120	Q	1-03	
W-121	Q	1-03	WGMG
W-122	E	1-04	
W-123	E	1-04	
W-141	E	2-04	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-142	O	1-03	
W-143	A	3-03	
W-146	O	4-03	
W-147	E	3-04	WGMG
W-148	O	4-03	WGMG
W-151	Q	1-03	WGMG
W-201	A	3-03	
W-202	E	1-04	
W-203	E	2-04	
W-204	A	1-03	WGMG
W-205	Q	1-03	
W-206	Q	1-03	
W-207	Q	1-03	
W-210	Q	1-03	
W-212	E	4-04	
W-213	O	4-03	
W-214	Q	1-03	
W-217	O	1-03	
W-218	Q	1-03	
W-219	E	4-04	
W-220	A	2-03	
W-221	E	2-04	WGMG
W-222	A	3-03	
W-223	O	4-03	
W-224	O	1-03	
W-225	A	2-03	
W-226	E	2-04	WGMG/NPDES
W-251	Q	1-03	
W-252	O	4-03	
W-253	O	1-03	
W-255	Q	1-03	
W-256	O	4-03	
W-257	Q	1-03	
W-258	Q	1-03	
W-259	Q	1-03	
W-260	A	1-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-261	A	1-03	
W-263	Q	1-03	
W-264	A	2-03	
W-265	O	3-03	
W-267	E	4-04	
W-268	A	3-03	
W-269	A	3-03	
W-270	E	3-04	
W-271	Q	1-03	
W-272	Q	1-03	
W-273	O	4-03	
W-274	Q	1-03	
W-275	Q	1-03	
W-276	S	2-03	
W-277	E	4-04	
W-290	E	4-04	
W-291	O	1-03	
W-293	E	2-04	
W-294	O	2-03	
W-301	A	2-03	WGMG
W-302	E	1-04	
W-303	O	2-03	
W-304	A	1-03	
W-306	O	2-03	WGMG/NPDES
W-307	Q	1-03	WGMG/NPDES
W-308	A	4-03	
W-310	O	1-03	
W-311	A	4-03	
W-312	O	2-03	
W-313	S	1-03	
W-315	Q	1-03	
W-316	Q	1-03	
W-317	Q	1-03	
W-318	Q	1-03	
W-319	O	1-03	
W-320	A	1-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-321	O	4-03	
W-322	Q	1-03	
W-323	Q	1-03	
W-324	E	2-04	
W-325	O	1-03	
W-353	S	2-03	
W-354	Q	1-03	
W-355	S	2-03	
W-356	Q	1-03	
W-361	Q	1-03	
W-362	S	2-03	
W-363	Q	1-03	WGMG
W-364	Q	1-03	
W-365	O	2-03	
W-366	O	2-03	
W-369	Q	1-03	
W-370	O	4-03	
W-371	O	3-03	
W-372	A	1-03	
W-373	O	2-03	WGMG
W-375	Q	1-03	
W-376	O	2-03	
W-377	E	2-04	
W-378	A	2-03	
W-379	A	1-03	
W-380	O	1-03	
W-401	E	2-04	
W-402	O	1-03	
W-403	A	1-03	
W-404	Q	1-03	
W-405	Q	1-03	
W-406	E	4-04	
W-407	Q	1-03	
W-409	S	2-03	
W-410	Q	1-03	
W-411	Q	1-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-412	O	3-03	
W-416	E	2-04	
W-417	O	4-03	
W-418	E	4-04	
W-419	Q	1-03	
W-420	A	1-03	
W-421	Q	1-03	
W-422	E	4-04	
W-423	Q	1-03	
W-424	Q	1-03	
W-446	E	1-04	
W-447	E	4-04	
W-448	E	3-04	
W-449	E	4-04	
W-450	S	1-03	
W-451	E	1-04	
W-452	E	4-04	
W-453	A	2-03	
W-454	A	1-03	
W-455	E	3-04	
W-458	E	4-04	
W-459	O	2-03	
W-461	Q	1-03	
W-462	E	4-04	
W-463	E	1-04	
W-464	S	1-03	
W-481	Q	1-03	
W-482	A	2-03	
W-483	O	2-03	
W-484	E	4-04	
W-485	E	2-04	
W-486	O	2-03	
W-487	O	1-03	
W-501	A	2-03	
W-502	E	2-04	
W-503	O	4-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-504	O	4-03	
W-505	E	2-04	
W-506	E	2-04	
W-507	O	3-03	
W-509	Q	1-03	
W-510	O	1-03	
W-511	Q	1-03	
W-512	E	1-04	
W-513	E	2-04	
W-514	O	4-03	
W-515	S	2-03	
W-516	A	2-03	
W-517	Q	1-03	
W-519	O	4-03	
W-521	E	3-04	
W-551	S	1-03	
W-552	E	3-04	
W-553	E	4-04	
W-554	E	3-04	
W-555	O	2-03	
W-556	O	2-03	
W-557	E	4-04	
W-558	Q	1-03	
W-559	E	4-04	
W-560	E	2-04	
W-561	E	3-04	
W-562	E	2-04	
W-563	E	3-04	
W-564	S	2-03	
W-565	A	3-03	
W-567	A	4-03	
W-568	A	3-03	
W-569	A	4-03	
W-570	E	4-04	
W-571	E	2-04	WGMG
W-591	E	4-04	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-592	O	3-03	
W-593	O	1-03	
W-594	O	1-03	
W-604	A	4-03	
W-606	S	2-03	
W-607	E	1-04	
W-608	A	3-03	
W-611	Q	1-03	
W-612	S	2-03	
W-613	E	3-04	
W-615	S	1-03	
W-616	E	1-04	
W-617	E	4-04	
W-618	Q	1-03	
W-619	O	3-03	
W-622	Q	1-03	
W-651	Q	1-03	
W-652	O	2-03	
W-653	Q	4-04	
W-654	S	1-03	
W-702	O	1-03	
W-705	A	4-03	
W-706	E	3-04	
W-750	A	4-03	
W-901	E	2-04	
W-902	A	1-03	
W-905	O	3-03	
W-908	O	1-03	
W-909	Q	1-03	
W-911	Q	1-03	
W-912	Q	1-03	
W-913	Q	1-03	
W-1002	A	4-03	
W-1003	O	4-03	
W-1008	E	4-04	
W-1010	O	4-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-1011	O	2-03	
W-1012	E	2-04	WGMG
W-1013	O	3-03	
W-1014	A	4-03	
W-1101	O	2-03	
W-1105	E	3-04	
W-1106	A	3-03	
W-1107	S	2-03	
W-1108	Q	1-03	
W-1110	S	1-03	
W-1112	Q	1-03	
W-1113	A	2-03	
W-1115	E	1-04	
W-1117	Q	1-03	
W-1118	Q	1-03	
W-1201	Q	1-03	
W-1202	Q	1-03	
W-1203	Q	1-03	
W-1204	Q	1-03	
W-1205	Q	1-03	
W-1207	A	4-03	
W-1209	Q	4-03	
W-1210	Q	1-03	
W-1212	S	2-03	
W-1214	Q	1-03	
W-1217	Q	1-03	
W-1219	S	1-03	
W-1222	Q	1-03	
W-1309	Q	1-03	
W-1223	Q	1-03	
W-1224	O	2-03	
W-1225	Q	1-03	
W-1226	O	4-03	
W-1227	A	1-03	
W-1250	Q	1-03	
W-1251	S	1-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-1252	Q	1-03	
W-1253	S	2-03	
W-1254	Q	1-03	
W-1255	Q	1-03	
W-1304	Q	1-03	
W-1311	Q	1-03	
W-1401	Q	1-03	
W-1402	Q	1-03	
W-1403	Q	1-03	
W-1404	Q	1-03	
W-1405	Q	1-03	
W-1406	Q	3-03	
W-1407	Q	1-03	
W-1408	Q	1-03	
W-1411	A	1-03	
W-1412	Q	1-03	
W-1413	E	1-04	
W-1414	Q	1-03	
W-1416	S	2-03	
W-1417	Q	1-03	
W-1419	A	3-03	
W-1420	O	4-03	
W-1421	Q	1-03	
W-1424	A	3-03	
W-1425	Q	1-03	
W-1426	O	4-03	
W-1427	S	2-03	
W-1428	E	4-04	
W-1501	E	3-04	
W-1502	E	4-04	
W-1505	Q	1-03	
W-1506	S	1-03	
W-1507	A	2-03	
W-1508	S	2-03	
W-1509	Q	1-03	
W-1511	Q	1-03	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
W-1512	A	4-03	
W-1513	E	1-04	
W-1514	E	1-04	
W-1515	E	1-04	
W-1516	S	1-03	
W-1517	A	3-03	
W-1519	A	1-03	
W-1553	Q	1-03	
W-1604	Q	1-03	
W-1613	Q	1-03	
W-1614	A	2-03	
W-1701	Q	1-03	
W-1703	Q	1-03	
W-1704	Q	1-03	
W-1705	Q	1-03	
W-1802	Q	1-03	
W-1803	Q	1-03	
W-1804	Q	1-03	
W-1805	Q	1-03	
W-1806	Q	1-03	
W-1807	Q	1-03	
TW-11	A	1-03	
TW-11A	A	4-03	
TW-21	E	3-04	
11C1	A	2-03	
14A11	O	1-03	
14A3	O	1-03	
14B1	E	3-04	WGMG
14B4	O	2-03	
14C1	Q	1-03	
14C2	E	1-04	
14C3	A	1-03	
14H1	O	1-03	
18D1	O	2-03	
GEW-710	A	1-03	
GSW-006	E	3-04	

Table C-1. 2003 LLNL Livermore Site VOC ground water sampling schedule.

Well number	VOC sampling frequency	Next quarter sample date	Additional analytes (Q1-03)
GSW-007	O	4-03	
GSW-008	O	2-03	
GSW-009	Q	1-03	
GSW-011	S	1-03	
GSW-013	O	3-03	
GSW-215	A	2-03	
GSW-216	Q	1-03	
GSW-266	S	1-03	
GSW-326	O	2-03	
GSW-367	A	1-03	
GSW-442	O	1-03	
GSW-443	E	3-04	
GSW-444	A	1-03	
GSW-445	A	2-03	

Notes:

All analyses are by EPA Method 601 for purgeable halocarbons.

E = Even years.

O = Odd years.

A = Annual.

S = Semiannual.

Q = Quarterly.

NPDES = National Pollutant Discharge Elimination System.

WGMG = LLNL Water Guidance and Monitoring Group. This work is related to the environmental surveillance monitoring programs carried out at DOE sites to complement restoration activities.

Appendix D

2002 Drainage Retention Basin Annual Monitoring Program Summary

Appendix D

2002 Drainage Retention Basin Annual Monitoring Program Summary

This Appendix summarizes the 2002 LLNL Operations and Regulatory Affairs Division routine maintenance activities, maintenance monitoring, and discharge data for the Drainage Retention Basin (DRB). The DRB is an artificial water body that was originally designed with a 43 acre-ft capacity. In 2000, the DRB was re-surveyed and shown to have an actual capacity of about 37 acre-ft (approximately 12 million gallons). The DRB is located in the central portion of the Livermore Site (Fig. D-1), and receives storm water runoff and treated ground water discharges.

DRB samples are collected at the first planned release of the rainy season and, at a minimum, in conjunction with one additional storm water monitoring event, as requested by the California Regional Water Quality Control Board (RWQCB)–San Francisco Bay Region. In addition, samples of each dry season release event are collected. Release water samples are collected at sample location CDBX and are compared with the LLNL Arroyo Las Positas outfall samples collected at sample location WPDC (Fig. D-1). Release samples are used to determine compliance with discharge limits established in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) *Record of Decision (ROD) for the Lawrence Livermore National Laboratory, Livermore Site* (DOE, 1992) and the *Explanation of Significant Differences (ESD) for Metals Discharge Limits at the Lawrence Livermore National Laboratory, Livermore Site* (Berg et al., 1997).

Weekly maintenance field monitoring measurements are conducted at sample locations CDBA, CDBC, CDBD, CDBE, CDBF, CDBJ, CDBK, and CDBL (Fig. D-2). Monthly, quarterly, semi-annual, and annual maintenance samples are collected at sampling location CDBE (Fig. D-2). Maintenance samples are used as the basis for management decisions regarding the DRB. Management action levels (MALs) are specified in the *Drainage Retention Basin Management Plan, Lawrence Livermore National Laboratory* (Limnion Corp., 1991).

Complete analytical results of samples collected within the basin and from releases are reported in the LLNL Livermore Site Project Quarterly Self-Monitoring Reports for 2002.

D.1. Drainage Retention Basin Maintenance Monitoring

Samples collected during 2002 within the DRB at sample location CDBE did not meet the MALs for chemical oxygen demand, dissolved oxygen, oxygen saturation, nitrate, pH, specific conductance, temperature, total dissolved solids, total phosphorus (as phosphorus), and transparency (Table D-1).

Table D-1. Constituents monitored at CDBE exceeding management action levels (MALs) in 2002.

Analysis	MAL	Maximum 2002 value	Minimum 2002 value	Samples not meeting MALs/samples collected
Chemical Oxygen Demand (mg/L)	>20	58	<25	4/4
Dissolved Oxygen (% saturation)	<80	168	35.7	12/42
Dissolved Oxygen (mg/L)	<5	18.4	0.43	5/42
Nitrate (as N) (mg/L)	>0.2	2.3	<0.1	12/12
pH (units)	<6.0 and >9.0	9.87	7.97	4/12
Specific Conductance (µmhos)	>900	1,270	939	12/12
Temperature (degrees C)	<15 and >26	32.4	9.6	24/43
Total Dissolved Solids (mg/L)	>360	820	557	12/12
Total Phosphorous (as P) (mg/L)	>0.02	0.22	<0.05	12/12
Transparency (meters)	<0.914	4.17	0.18	8/49

In general, the water quality in the DRB continued to improve during 2002 over previous years. This may be related to continuation of a management strategy implemented in 2000 that focuses on stabilizing the water level to reduce the stress to the overall aquatic system in conjunction with increasing amounts of treated ground water discharged into the DRB. During 2001, growth of a greater variety and quantity of submerged and emergent vegetation was observed. The vegetation is not an ideal native species composition. By the end of 2002 and the third year of this new management strategy, DRB monitoring indicated a sustained increased in water clarity. The clarity of the water increased from a recorded high of 2.0 meters in 2000, to a high of 4.27 meters in 2001, and remained high in 2002 with transparency measured at 4.17 meters in late April. Additionally, chlorophyll "a" concentrations remained low (indicating less biomass during algae blooms), and decreased nutrient and phosphorus concentrations were again observed throughout 2002.

Ammonia nitrogen was not observed at levels exceeding its MAL during 2002. The presence of ammonia in the water usually indicates that anaerobic activity is occurring. Lower dissolved oxygen levels in the middle and lower depths of the DRB support evidence of anaerobic or anoxic activity. However, in 2002 the occurrence of dissolved oxygen exceeding the MAL decreased by about 12 percent (from 17 occurrences in 2001 to 12 occurrences in 2002). Chemical oxygen demand was possibly above the MAL all four quarters of 2002. However, this cannot be confirmed since the analytical laboratory detection limit for chemical oxygen demand exceeds the MAL. The oxygen demand is most likely a result of increasing organic debris associated with annual algae bloom cycles and decaying organic debris from runoff during winter storms.

Total phosphorous was also above the MAL throughout 2002 and reached a maximum of 0.22 milligrams per liter (mg/L) in January 2002. Although this concentration is still well above the 0.02 mg/L MAL, it is substantially below the maximum 1998 concentration of 1.9 mg/L that

occurred prior to changing the method of treating scaling in the ground water treatment facilities from *JP-7* (a phosphate based anti scaling agent) to *Belsperse 161*.

Nitrate as nitrogen concentrations also continued to be above the MAL during 2002. Nitrate is introduced into the DRB with winter storm flows and in treated ground water discharges.

Although nutrient levels have been high since 1994, chlorophyll "a", which indicates the level of alga growth, remained well below the 10 mg/L MAL, ranging from <1 microgram per liter (µg/L) to 27 µg/L in 2002. An aquatic system is considered to be eutrophic when chlorophyll "a" levels exceed 10 µg/L. However, the chlorophyll "a" concentration, and therefore the algae mass, decreased substantially from the recorded high of 42.7 µ/L in 2000. Chronic toxicity tests on fish, daphnid, and algae, collected in October 2002, showed only a small amount of toxicity for the daphnid *Ceriodaphnia dubia* (2 toxic units).

Semiannual and annual maintenance sampling was conducted during April and October 2002, respectively. Quarterly sampling was conducted in January, April, July, and October. Results for oil and grease, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), total organic carbon, gross alpha, gross beta, and tritium all met their MALs.

Only two organic compounds, 1,1,2-trichloroethane (1,1,2-TCA) (2.4 µg/L), and diuron, an herbicide (1.2 µg/L), were detected in samples collected from the DRB on April 4, 2002. There is no MAL for 1,1,2-TCA, and there have been no previous detections of this compound in the DRB. Because the October 2002 sample contained no 1,1,2-TCA, the April 2002 detection was believed to be an isolated incident and no further investigation was initiated. Diuron has been detected in storm water influent to the DRB. Chronic toxicity tests show this compound is toxic to algae at concentrations at and above 14 µg/L, as reported in the *Environmental Report for 2001* (Gallegos et al., 2002). No Diuron was detected in the sample collected on October 4, 2002.

Semi-annual biological monitoring continued throughout 2002, as reported in the LLNL *Site Annual Environmental Report.*

D-2. Drainage Retention Basin Discharge Monitoring

Releases from the DRB occurred continuously throughout the year except during brief periods to facilitate work within the DRB or downstream.

Dry season release samples were collected five times between June and September of 2002. The first release of the 2002–2003 wet season was collected on November 8, 2002, in conjunction with storm water monitoring. Discharges from the DRB were below discharge limits for all parameters except pH. Discharge samples collected at CDBX exceeded the pH limit of 8.5 units in all six wet and dry season monitoring events reported. The minimum recorded pH was 8.56, and the maximum was 9.72. Corresponding samples collected at the site outfall (WPDC) exceeded the pH discharge limit in three of the six 2002 sampling events. The minimum pH at the outfall was 7.16 and the maximum pH was 8.69.

The second wet-season sampling event also occurred in conjunction with storm water monitoring, on December 16, 2002. Analytical data, including the measured pH value, are not yet available for this release event.

In a letter dated March 22, 2001 (Steenhoven, 2001), LLNL provided the RWQCB information indicating sediments in the DRB had a median PCB concentration of 43 parts per billion. Subsequently, Michael Rochette of the RWQCB requested that LLNL begin monitoring for PCBs in DRB releases to verify that PCBs were not detectable in the water. He also requested that turbidity readings be taken at sample location CDBX at the time of manual releases along with turbidity readings before and during these releases at sample location WPDC. LLNL began monitoring for PCBs in all release samples collected at sample locations CDBX and WPDC on June 26, 2001. To date, there have been no detectable PCB concentrations in release samples.

DRB discharge water was sampled for both VOCs and herbicides. The only organic compounds above detection limits were 1,1,2-TCA (3 µ/L) and chloroform (0.6 µ/L). Both compounds were detected in samples collected during the first dry-season monitoring event on June 4, 2002.

D-3. Future Activities

Additionally, the DRB monitoring strategy was recently modified according to plans submitted to the RWQCB in December 2002 (Jackson, 2002). For monitoring locations within the basin, the new sampling protocol will include bi-weekly monitoring for turbidity, transparency, dissolved oxygen, and temperature, and monthly sampling for volatile suspended solids, total phosphorus, nitrate as nitrogen, and chlorophyll "a" at location CDBE only. Data generated from these monitoring events occurring after December 2002, will be reviewed and maintained, but will not be included in future iterations of this report. Wet and dry season discharges from the DRB will continue to be monitored at locations CDBX and WPDC, and these data will continue to be discussed in future reports in accordance with the ROD and ESD.

D-4. References

Berg, L., E. Folsom, M. Dresen, R. Bainer, A. Lamarre (Eds.) (1997), *Explanation of Significant Differences for Metals Discharge Limits at the Lawrence Livermore National Laboratory Livermore Site,* Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-125927).

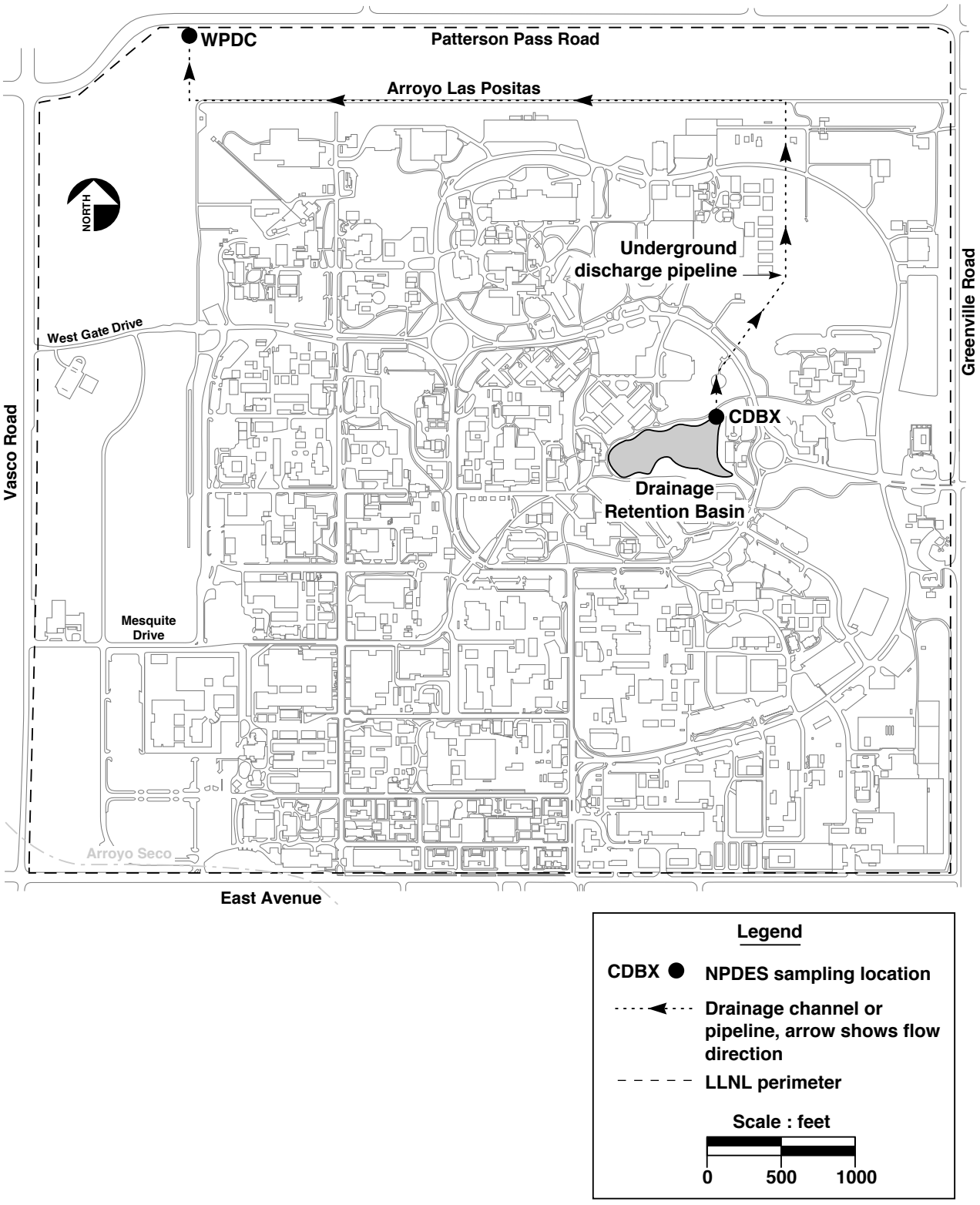
Gallegos, G. M., P. E. Althouse, N. A. Bertoldo, R. G. Blake, S. L. Brigdon, C. G. Campbell, E. Christofferson, L. M. Clark, A. R. Greyson, R. J. Harrach, H. E. Jones, D. H. MacQueen, S. Mathews, S. Ring Peterson, M. A. Revelli, L. Sanchez, M. J. Taffet, P. J. Tate, R. Ward, R. A. Williams (2002), *Lawrence Livermore National Laboratory Environmental Report for 2001*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-50027-01).

Jackson, C. S. (2002), Division Leader, Operations and Regulatory Affairs Division, LLNL "Drainage Retention Basin Monitoring Plan," letter to Naomi Feger, San Francisco Bay Regional Water Quality Control Board, December 6, 2002.

Steenhoven, J. C. (2001), Deputy Division Leader, Environmental Restoration Division, LLNL "Drainage Retention Basin Retrofit Project," letter to Dennis Mishek, DOD/DOE Section Leader, San Francisco Regional Water Quality Control Board, March 22, 2001.

The Limnion Corporation (1991), *Drainage Retention Basin Management Plan: Lawrence Livermore National Laboratory,* Concord, Calif.

U.S. Department of Energy (DOE) (1992), *Record of Decision for the Lawrence Livermore National Laboratory, Livermore Site*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-109105).



ERD-LSR-03-0049

Figure D-1. Location of the Drainage Retention Basin showing discharge sampling locations.

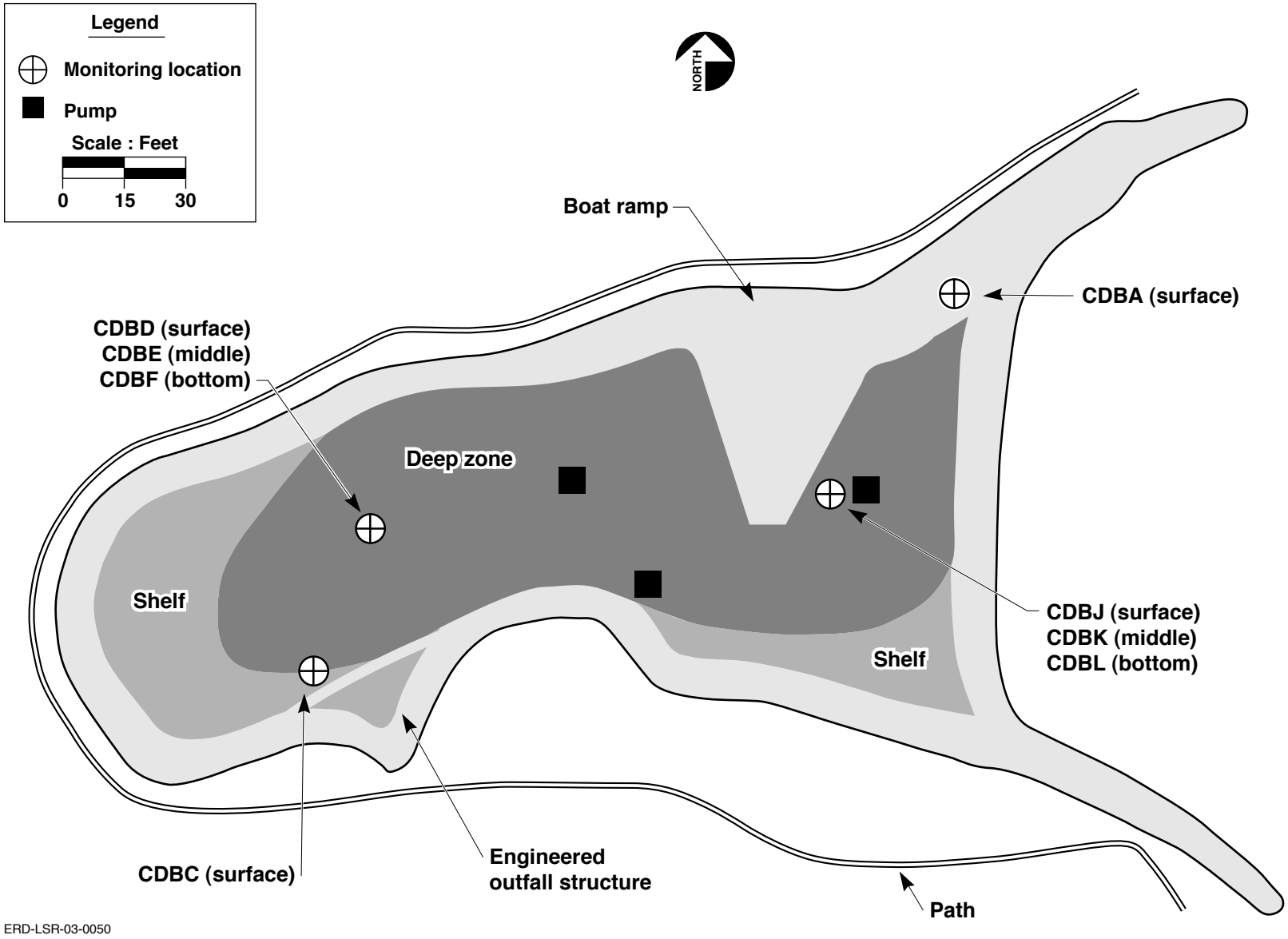


Figure D-2. Monitoring locations in the Drainage Retention Basin.