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Remedial Design Report No. 1 for Treatment Facilities A and B Lawrence Livermore National Laboratory Livermore Site

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Summary

This report is the first of five Remedial Design (RD) Reports for the Lawrence Livermore National Laboratory (LLNL) Livermore Site. As described in the Remedial Action Implementation Plan (RAIP) (Dresen *et al.*, 1993), the five RD Reports will be prepared over a 3-year period to be consistent with projected funding levels and to optimize the cleanup. This RD Report is for Treatment Facilities A and B and their respective extraction wells and piezometer networks. Both of these facilities were constructed and tested for an EPA-approved pilot study for the Southwest Corner/Offsite Area. Treatment Facility A (TFA) has been operating since September 1989, and Treatment Facility B (TFB) has been operating since October 1990.

TFA is an ultraviolet light/hydrogen peroxide (UV/H_2O_2) ground water treatment system that has treated a total of approximately 43 million gallons of ground water to date. It was originally installed to treat up to 100 gallons per minute (gpm) of ground water containing volatile organic compounds (VOCs) at a cost of $672,000, and has since been upgraded to treat up to 150 gpm at an additional cost of $223,700. TFA is currently treating ground water from onsite extraction well EW-415 (extraction location 1 in the RAIP).

During recent drought conditions, most of the water treated at TFA was being used in LLNL cooling towers, for LLNL landscape irrigation, and in the drainage retention basin in central LLNL. Under non-drought conditions treated water from TFA is also discharged to a recharge basin south of East Avenue.

Since TFA has been operating, PCE concentrations from EW-415 have been reduced from about 900 parts per billion (ppb) to the current level of about 150 ppb. Within the coming year, TFA will also be treating ground water from the portion of the VOC plume that has migrated offsite. If additional extraction wells and piezometers are necessary, we estimate that the VOC plume in the TFA area will be hydraulically controlled in late 1994. TFA and its associated extraction wells will continue to operate until *in situ* VOC concentrations are at or below MCLs for 2 years.

TFB is also a UV/H_2O_2 ground water treatment system that has treated a total of approximately 1.5 million gallons of ground water to date. It was designed to treat up to 100 gpm of ground water containing VOCs at a cost of $446,400. TFB is currently treating ground water from an onsite extraction well cluster (MW-218, MW-357, and EW-704; extraction location 5 in the RAIP). Treated water from TFB has been discharged to a north-flowing drainage ditch adjacent to the east side of Vasco Road. If additional extraction wells and piezometers are necessary, we estimate that hydraulic capture of the VOC plume in the TFB area will be established in late 1994. TFB and its associated extraction wells will be operated until *in situ* VOC concentrations are below MCLs for 2 years.

The downgradient extraction wells for TFA and TFB will hydraulically control all VOCs west of LLNL and approximately 75% of the leading edge of the VOC plume. Extraction wells for planned Treatment Facility C, to be located north of TFB, are scheduled to begin operation in October 1993 and will begin to hydraulically control the remaining 25% of the western plume margin.

VOC sampling and water level monitoring for the wells and piezometers in the TFA and TFB vicinities will be conducted to monitor the progress of the cleanup and determine actual hydraulic capture areas. Results of all treatment system, extraction well, and piezometer monitoring will be included in the LLNL Monthly Progress Reports.

To optimize VOC mass removal, ensure hydraulic capture in all zones exceeding cleanup standards, and eliminate areas of little or no ground water flow, the extraction well field will be dynamically managed by varying the rates and locations of ground water extraction. In addition, LLNL is evaluating additional reinjection, possibly in conjunction with heat, surfactants and/or microbes, and cyclic pumping to accelerate the cleanup.

Appendices to this report contain RWQCB Waste Discharge Order Numbers 88-075 and 91-091 for TFA and TFB, respectively, and the Quality Assurance/Quality Control and Health and Safety Plans for construction and operations and maintenance for TFA and TFB.

1. Introduction

This report is the first of five Remedial Design (RD) Reports for the Lawrence Livermore National Laboratory (LLNL) Livermore Site, which is located about 40 miles east of San Francisco, California. The five RD Reports will be prepared over the next 3 years according to the schedule in the Remedial Action Implementation Plan (RAIP) for the Livermore Site (Dresen *et al.,* 1993). As described in the RAIP, the remedial actions presented in the Record of Decision (ROD) for the Livermore Site (DOE, 1992) will be phased-in over a 3-year period to be consistent with projected funding levels, and to enable determination of the actual, rather than predicted, effectiveness of the planned extraction and treatment systems before proceeding with subsequent phases.

The LLNL Livermore Site was placed on the U.S. Environmental Protection Agency's (EPA) National Priorities List in 1987. In November 1988, the U.S. Department of Energy (DOE), EPA, the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB), signed a Federal Facilities Agreement to facilitate compliance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended. As part of the CERCLA process, the LLNL Environmental Restoration Division has prepared a series of documents: the Remedial Investigation (May 1990) characterizes the site hydrogeology and contaminant distribution, the Feasibility Study (FS) (December 1990) screens and evaluates possible remedial alternatives, the Proposed Remedial Action Plan (October 1991) further evaluates conceptual remedial alternatives and recommends alternatives for ground water and soil remediation, the ROD (July 1992) codifies and binds DOE and EPA to a cleanup approach for ground water and soil, and the RAIP (January 1993) describes the approach to and presents a schedule for the remaining remedial actions.

As discussed in the ROD, the contaminants of concern at the Livermore Site are volatile organic compounds (VOCs), primarily trichloroethelyene (TCE) and perchloroethylene (PCE); fuel hydrocarbons, including benzene, chromium, and tritium; and perhaps lead. The Applicable or Relevant and Appropriate Requirements (ARARs) for the Livermore Site are detailed in the FS (Isherwood *et al.,* 1990). Performance and discharge standards are also presented in the ROD.

This initial RD Report is for Treatment Facility A (TFA) and Treatment Facility B (TFB) and their respective extraction wells and piezometer networks. The scope of this report is based on an outline provided by EPA (Gill, 1993) and subsequent discussions with EPA. Both TFA and TFB were constructed and tested for an EPA-approved pilot study for the Southwest Corner/Offsite Area. When the ROD for the Livermore Site was signed in August 1992, TFA and TFB were converted from pilot study to Remedial Action status. TFA has been operating since September 1989, and TFB has been operating since October 1990. This RD Report is a template for the four subsequent RD Reports which will cover the five remaining planned treatment facilities and their extraction wells and piezometer networks.

As specified by EPA, each RD Report will contain engineering design specifications for the ground water extraction and treatment systems, including piping and instrument diagrams, system descriptions, monitoring and construction schedules, and cost estimates. The RD Reports

will also include a Remedial Action Work Plan that contains Quality Assurance/Quality Control (QA/QC) Plans and Health and Safety Plans for construction operation and maintenance, and the requirements for offsite shipment of hazardous waste and for project closeout. The QA/QC and Health and Safety Plans for construction will be the same for all RD Reports. Therefore, these documents will be submitted with this initial RD Report only.

This document was prepared by LLNL for DOE with oversight from EPA, DTSC, and RWQCB. The five RD Reports are primary documents under the Federal Facility Agreement for the LLNL Livermore Site.

Sections 2 and 3 of this report are the remedial designs for TFA and TFB, respectively. Section 4 is the Remedial Action Work Plan for TFA and TFB. Appendices A through E present the RWQCB waste discharge permits, and the QA/QC and Health and Safety Plans for construction, operation, and maintenance of TFA and TFB.

2. Remedial Design for Treatment Facility A

2.1. TFA Design Summary

TFA is a ground water treatment facility located just north of Arroyo Seco near Vasco Road in the southwest part of the LLNL Livermore Site (Fig. 1). Its purpose is to treat ground water containing VOCs. Ground water in the TFA vicinity is being pumped to hydraulically control the southwestern portion of the ground water plume. The primary contaminants in the ground water at this location are PCE at about 100 parts per billion (ppb) and 1,1-DCE at 9 ppb (see Table 5, Section 2.2.2.2). In addition, TCE, Freon 113, 1,1-DCA, 1,1,1-TCA, and chloroform are also present in influent ground water, each at concentrations of 4 ppb or less. TFA consists of a commercially available ultraviolet light/hydrogen peroxide (UV/H_2O_2) ground water treatment unit and an air stripper. The treated ground water is discharged via a pipeline to a recharge basin located on property administered by Sandia National Laboratories south of East Avenue, and/or is used onsite at LLNL in cooling towers and/or for landscape irrigation.

2.2. Design Specifications

Design specifications for TFA extraction wells and piezometers and for the TFA treatment system are described in Sections 2.2.1 and 2.2.2.

2.2.1. Extraction Wells and Piezometers

As discussed in the RAIP (Dresen *et al.*, 1993), extraction locations 1, 2, 3, 4, 22, 23, and 24 will supply ground water to TFA (Fig. 1). A total of 21 extraction wells are tentatively planned at these locations. Eleven of these planned extraction wells are currently installed. The remaining wells are planned for installation in phases in Fiscal Years (FY) 93-95. Possible designs for the 21 TFA extraction wells are discussed in Section 3.1.1.2 of the RAIP and are shown in Table 1, and TFA extraction well and piezometer locations are shown in Figure 2. All existing and planned wells will be secured in locked enclosures.

TFA area extraction well locations are based on ground water modeling results (Chapter 3 and Appendix B in Isherwood *et al.*, 1990; Tompson, 1990; Tompson *et al.*, 1991; and Tompson

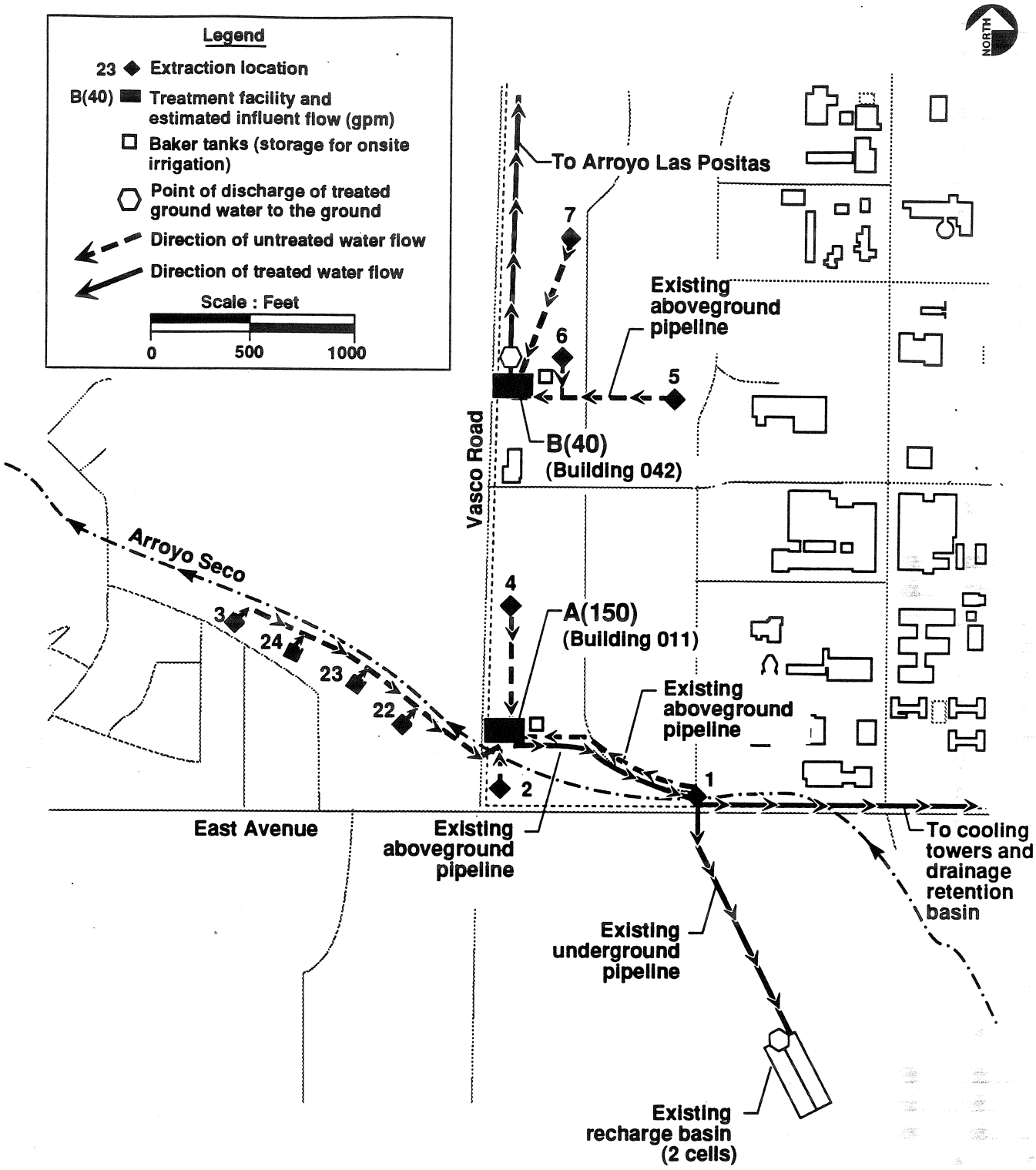

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Figure 1. Planned ground water extraction and recharge locations for TFA and TFB.

Table 1. TFA extraction well specifications.

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
Extraction location 1											
EW-415	EW-1-1	Multiple	12-Aug-88	205.0	183.7	79-179	65-180	First through sixth	50	75S50-8	129
Extraction location 2											
MW-520	EW-2-1B	Single	30-Aug-89	160.0	101.5	94-101.5	91.5-101	Second	16	16S10-10	98
MW-602	EW-2-1A	Single	06-Nov-89	168.0	100.0	90-100	90-100	Second	24	16S10-10	95
MW-619	EW-2-3	Single	07-Aug-90	330.0	252.0	232-252	228-253	Ninth	12	25S20-11	242
P-601	EW-2-1C	Single	13-Oct-89	146.0	96.0	88-96	86-97	Second	14	16S10-10	92
P-522	EW-2-2	Single	05-Oct-89	145.5	141.5	134-141.5	133-141.5	Third	24	25S20-11	138
Extraction location 3											
MW-408	EW-3-1	Single	16-Feb-88	131.0	122.5	101-122.5	99-122.5	Second	45	25S20-11	112
MW-109	EW-3-2	Single	02-Apr-85	289.0	147.0	137-147	136-147	Fourth	12	16S10-10	142
Extraction location 4											
TBI	EW-4-1	Single	—	—	—	71-90	—	First	(5)	—	—
MW-614	EW-4-2	Single	18-May-90	262.0	123.0	100-123	97-123	Second and third	7	16S10-10	112
MW-214	EW-4-3	Single	11-Apr-86	146.0	141.5	134-141.5	132-141.5	Fourth	28	16S10-10	138
MW-201	EW-4-4	Single	17-Oct-85	211.0	161.0	151-161	149.5-161	Fifth	10	16S05-9	156
EW-712	EW-4-5	Single	28-Aug-91	200.0	185.5	170-185.5	167-188	Sixth	10	16S10-10	178
Extraction location 22											
TBI	EW-22-1	Multiple w/seal?	—	—	—	90-100	—	Second	(5)	—	—

Table 1. Continued

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
TBI	EW-22-2	Multiple w/seal?	—	—	—	110-150	—	Third	(20-40)	—	—
TBI	EW-22-3	Multiple w/seal?	—	—	—	165-190	—	Fourth and fifth	(10-20)	—	—
Extraction location 23											
TBI	EW-23-1	Multiple w/seal?	—	—	—	90-100	—	Second	(5)	—	—
TBI	EW-23-2	Multiple w/seal?	—	—	—	110-150	—	Third	(20-40)	—	—
TBI	EW-23-3	Multiple w/seal?	—	—	—	165-190	—	Fourth and fifth	(10-20)	—	—
Extraction location 24											
TBI	EW-24-1	Multiple w/seal?	—	—	—	95-105	—	Second	(5)	—	—
TBI	EW-24-2	Multiple w/seal?	—	—	—	115-155	—	Third	(20-40)	—	—
TBI	EW-24-3	Multiple w/seal?	—	—	—	165-190	—	Fourth and fifth	(10-20)	—	—

Notes:

TBI = To be installed.

[a]Extraction well names provide the type of well (EW), its location (EW-1), and its depth relative to other extraction wells at the same location (i.e., EW-2-1 is shallower than EW-2-2). When multiple extraction wells are screened in the same water-bearing zone, a letter follows the zone designation (i.e., EW-2-2A EW-2-1B, etc.).

[b]The three extraction well designs are:
single=a well screened in only one water-bearing zone;
multiple w/seal=a well screened in more than one water-bearing zone with annular grout seals between zones;
multiple = a fully screened and sand packed well in multiple water-bearing zones.
Question marks indicate well design is preliminary. Additional information on these well designs and their applications is presented in the RAIP (Dresen et al., 1993).

[c]Numbered consecutively downward from ground surface at each extraction location. A water-bearing zone is defined as saturated permeable sediment greater than about 3 ft thick, separated from other permeable sediments above and below by at least 5 ft of low-permeability sediments.

[d]Estimated yield based on pumping test results. Actual long-term pumping rates will generally be lower. Where the extraction well is not yet installed, estimates of sustainable flow rates are shown in parentheses. These rates are based on the flow rates from nearby wells screened in similar zones and/or local hydrogeologic conditions.

[e]Pump type currently installed. All are Grundfos stainless steel submersible pumps. Nominal pump flow rates are 16S10-10 and 16S05-9 = 16 gpm, 25S20-11 = 25 gpm, and 75S50-8 = 75 gpm.

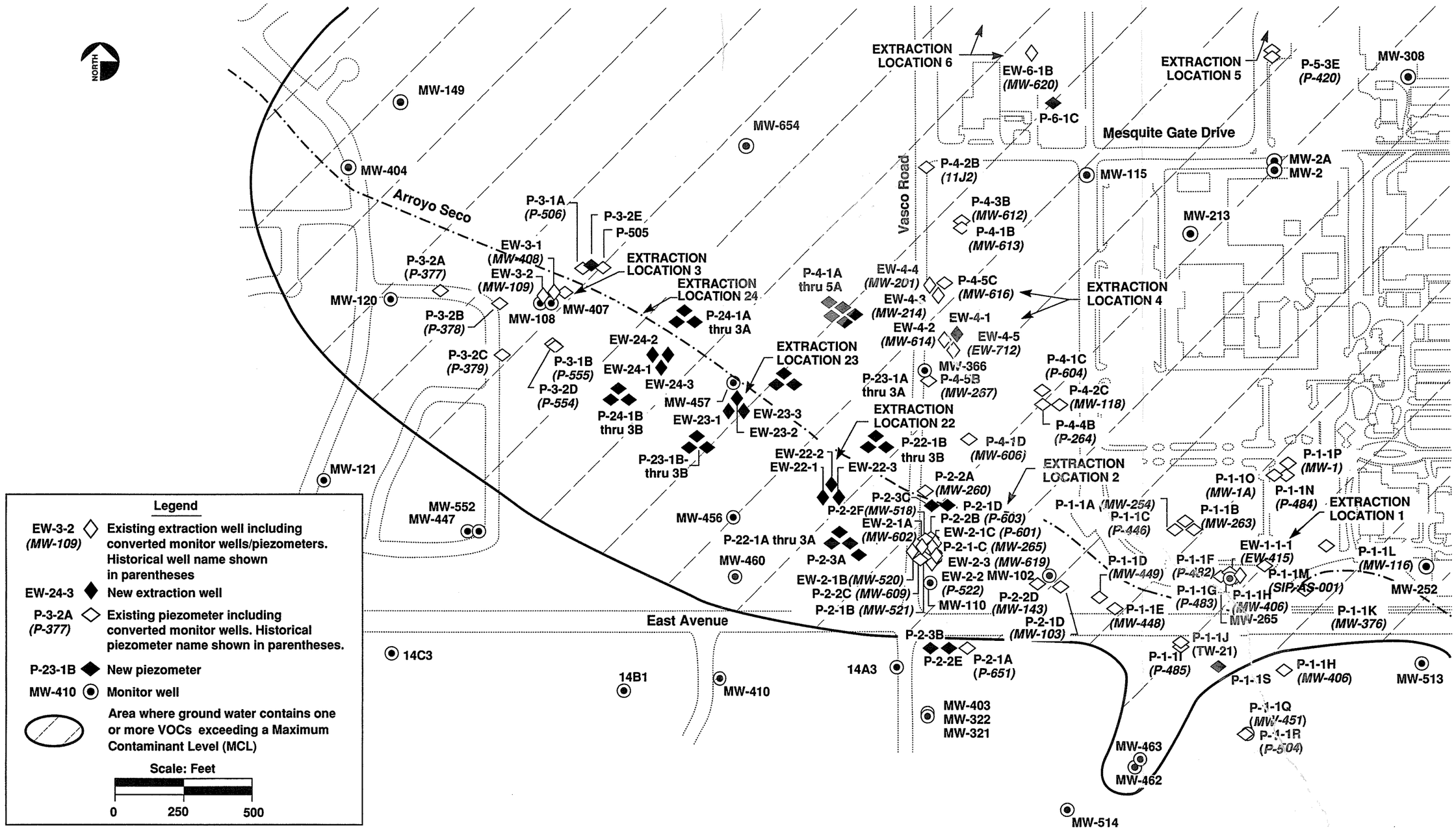

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Figure 2. TFA area extraction well and piezometer locations.

and Nichols, 1993), local hydrogeology (Thorpe *et al.*, 1990; Isherwood *et al.*, 1990), and the current understanding of the subsurface distribution of VOCs. In all cases, extraction locations were selected to capture ground water from all water-bearing zones where contaminants of concern exceed cleanup goals [i.e., Maximum Contaminant Levels (MCLs)]. The area in the TFA vicinity where one or more VOCs in ground water exceed an MCL is shown in Figure 2.

Table 1 shows estimates of the estimated maximum sustainable yields from each extraction well based on available hydraulic test results. With the exception of EW-1-1 (existing extraction well EW-415), pumping data are relatively limited, and the estimates in Table 1 probably represent maximum long-term steady-state yields. In most cases, as long-term ground water extraction progresses, yields decline due to dewatering of shallow sediments and/or influences from distant hydraulic boundaries. Although the maximum estimated sustainable yields in Table 1 total 371 gallons per minute (gpm), the long-term yield of these wells is estimated to be about 200 gpm. If the 200-gpm flow rate is ever realized, TFA will be upgraded accordingly with regulatory oversight to treat 200 gpm.

As shown on Figure 2, we plan to monitor a network of piezometers near the extraction wells to determine hydraulic capture zones and identify areas of stagnant ground water. A network of up to 62 piezometers is planned for TFA extraction wells; 40 of these piezometers are existing monitor wells and piezometers. The 22 remaining planned piezometers are scheduled for installation in phases in FY93-95. Design specifications for the 40 existing piezometers are shown in Table 2 along with the preliminary designs for the 20 planned new piezometers. A discussion of the monitoring plan for the TFA piezometer network is presented in Section 4.2.2.

As shown in Figure 3, TFA extraction locations 3 and 4 are the key locations for establishing hydraulic control of the leading edge of the VOC plume in the TFA area. Modeling indicates the leading edge of the plume will be captured by this proposed extraction scenario. If field data indicate a portion of the plume is not being captured, additional extraction wells and piezometers will be installed to establish capture of the leading edge of the plume.

All of the planned extraction wells for locations 3 and 4, except EW-4-1 and piezometers P-3-2E, and P-4-1A through P-4-5A (Fig. 2), are installed. EW-4-1 is scheduled for installation in mid- to late 1993. All pipelines from extraction location 3 and the associated new piezometers are scheduled for installation in FY93. Pipelines from extraction location 4 are scheduled for installation in FY94. Piezometers P-3-2E and P-4-1A through P-4-5A are planned for installation on private property and may not be installed until late 1993 or early 1994, after permission to drill is obtained from the property owners. In the unlikely event permission to drill cannot be obtained, alternative locations that will achieve the required ground water objectives will be chosen with regulatory oversight.

All extraction wells will begin pumping as soon as piping to TFA is completed. Initial flow rates will be maximized to establish capture zones as quickly as possible. Hydraulic test data indicate it will take about 4 to 6 weeks for the pumping wells to establish their full hydraulic capture zones. Modeling results suggest that sustained flow rates of about 50 gpm may be required for extraction locations 2 and 3, and about 15 gpm for extraction location 4 (Fig. 2) to fully capture the downgradient plume margins. Modeling results also indicate that pumping ground water from extraction location 1, although not required for downgradient plume margin

Table 2. TFA piezometer specifications.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
Extraction location 1							
MW-254	P-1-1A	21-Nov-85	277.0	91.5	84.5-91.5	81-91.5	3
MW-263	P-1-1B	07-Apr-86	146.0	130.0	123-130	120-130	1
P-446	P-1-1C	18-Dec-87	202.0	196.0	186-196	186-196	3
MW-449	P-1-1D	07-Mar-88	172.0	165.0	152-165	150-166.5	6
MW-448	P-1-1E	17-Feb-88	235.0	127.5	120.5-127.5	118-127.5	25
P-482	P-1-1F	15-Jan-88	218.0	170.0	165-170	162.5-170	<0.5
P-483	P-1-1G	26-Jan-88	140.0	130.0	115-130	114-130	2.5
MW-406	P-1-1H	20-Jan-88	213.0	94.0	79-84	79-94	7
P-485	P-1-1I	25-Feb-88	249.0	157.0	151-157	150-157	2
TW-21	P-1-1J	07-Jul-81	111.5	95.0	85-95	56.5-100	NA
MW-376	P-1-1K	27-Aug-87	249.0	172.0	162-172	157-175	3
MW-116	P-1-1L	14-Jun-85	181.0	91.0	86-91	84-91	0.3
SIP-AS-001	P-1-1M	27-Apr-90	100.5	90.5	81-90.5	77-90.5	NA
P-484	P-1-1N	11-Feb-88	255.0	188.0	185-188	183-190	0.5
MW-1A	P-1-1O	12-Apr-84	180.0	156.0	145-156	NA	1
MW-1	P-1-1P	21-Oct-80	122.5	116.0	95-100 104-114	74-116	7
MW-451	P-1-1Q	06-Apr-88	202.0	112.0	106-112	103-112	2
P-504	P-1-1R	21-Nov-88	358.0	167.0	157-167	153-167	10
TBI	P-1-1S	—	—	—	185-200	—	—
Extraction location 2							
P-651	P-2-1A	22-Feb-90	155.0	89.0	82-89	80-89	0.5
MW-521	P-2-1B	13-Sep-89	166.0	95.0	86-95	85-95	0.5
MW-262	P-2-1C	20-Mar-86	256.0	100.0	91-100	90-100	20

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
MW-103	P-2-1D	14-Feb-85	96.0	89.5	79.5-89.5	78.5-90	7
MW-260	P-2-2A	27-Feb-86	215.0	151.0	141-151	137-151	1.5
P-603	P-2-2B	15-Nov-89	150.0	147.0	141-147	140-147	6
MW-609	P-2-2C	21-Feb-90	120.0	112.0	104-112	102-112	7
MW-143	P-2-2D	12-Apr-85	130.0	126.0	121-126	119-126	0.8
MW-518	P-2-2F	08-Aug-89	251.0	139.0	131-139	129-139	6
TBI	P-2-3A	—	—	—	230-250	—	—
TBI	P-2-3B	—	—	—	230-250	—	—
TBI	P-2-3C	—	—	—	230-250	—	—
Extraction location 3							
P-506	P-3-1A	22-Dec-88	120.0	115.0	101-115	99-114	31
P-555	P-3-1B	05-Dec-88	122.0	116.5	102.5-116.5	99-118.5	14
P-377	P-3-2A	04-Sep-87	159.0	144.0	141.5-144	135-145	2.5
P-378	P-3-2B	09-Sep-87	155.0	150.0	146-150	139-151	5
P-379	P-3-2C	14-Sep-87	155.0	150.0	146-150	139-153	5
P-554	P-3-2D	22-Nov-88	239.0	141.5	126.5-141.4	124-143	60
TBI	P-3-2E	—	—	—	135-145	—	—
Extraction location 4							
TBI	P-4-1A	—	—	—	70-90	—	—
MW-613	P-4-1B	02-May-90	93.0	88.0	81.5-88	79-88.5	15
P-604	P-4-1C	27-Nov-89	111.0	83.0	76-82	74.5-82	0.5
P-606	P-4-1D	21-Dec-89	145.0	89.0	73-89	72-89.5	2
TBI	P-4-2A	—	—	—	100-125	—	—
11J2	P-4-2B	26-Apr-79	112.0	110.0	90-92 102-108	NA	NA
MW-118	P-4-2C	19-Jul-85	206.5	110.0	99-110	98-110	10

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
TBI	P-4-3A	—	—	—	130-140	—	—
MW-612	P-4-3B	19-Apr-90	222.0	136.0	126-136	124.5-137	14
P-605	P-4-3C	08-Dec-89	246.0	136.0	130-136	128.5-136	5
TBI	P-4-4A	—	—	—	150-160	—	—
MW-264	P-4-4B	14-Apr-86	170.0	151.0	141-151	139-151	23
TBI	P-4-5A	—	—	—	170-185	—	—
MW-267	P-4-5B	27-May-86	196.0	179.0	172.5-179	170-179	0.5
MW-616	P-4-5C	14-Jun-90	255.0	188.0	178-188	176-188.5	2
Extraction location 22							
TBI	P-22-1	—	—	—	90-100	—	—
TBI	P-22-2	—	—	—	110-150	—	—
TBI	P-22-3	—	—	—	165-190	—	—
Extraction location 23							
TBI	P-23-1A	—	—	—	90-100	—	—
TBI	P-23-1B	—	—	—	90-100	—	—
TBI	P-23-2A	—	—	—	110-150	—	—
TBI	P-23-2B	—	—	—	110-150	—	—
TBI	P-23-3A	—	—	—	165-190	—	—
TBI	P-23-3B	—	—	—	165-190	—	—
Extraction location 24							
TBI	P-24-1A	—	—	—	90-100	—	—
TBI	P-24-1B	—	—	—	90-100	—	—
TBI	P-24-2A	—	—	—	110-150	—	—
TBI	P-24-2B	—	—	—	110-150	—	—
TBI	P-24-3A	—	—	—	165-190	—	—

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
TBI	P-24-3B	—	—	—	165-190	—	—

Notes:

NA = Not available.

TBI = To be installed (FY93).

[a]Piezometer names show their location (i.e., P-24-1A is at extraction location 24) and the zone monitored (i.e., P-24-1A is screened in the first zone, as is EW-24-1). Letters following the zone designation indicate that multiple piezometers are screened in that zone.

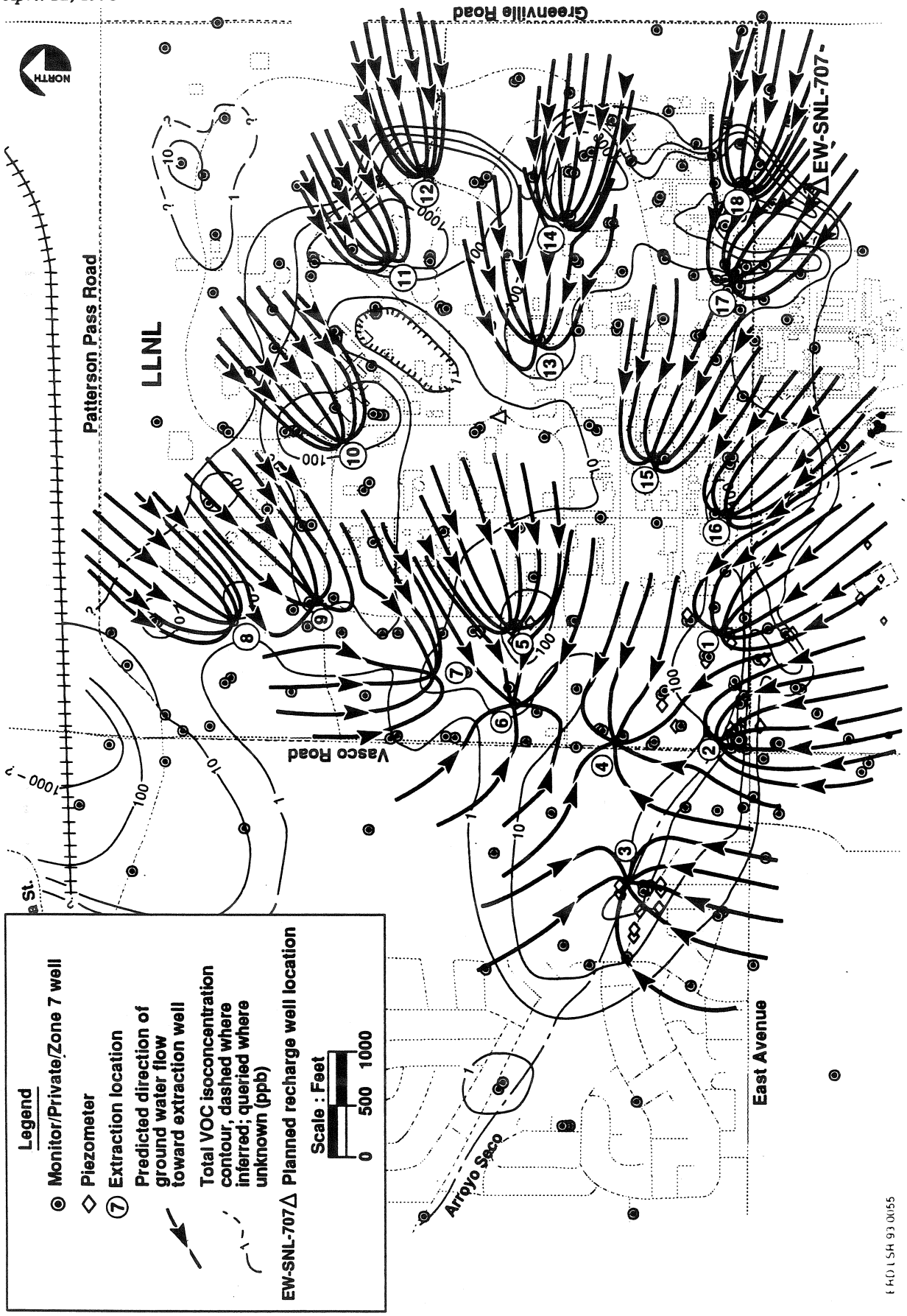

Figure 3. Extraction well hydraulic capture zones and recharge well locations (modified from the Record of Decision for the LLNL Livermore Site).

control, should decrease the estimated cleanup time.

LLNL will continue to monitor extraction flow rates, and ground water elevation and chemistry data to determine if the planned extraction scenario is completely capturing the VOC plumes. Determination of full plume capture will be established in collaboration with the regulatory agencies. If actual flow rates are substantially lower and/or the observed steady state drawdown fails to capture any part of the plume margin, additional extraction wells will be installed. The locations of these wells will be based on field water level data and recalibrated modeling results. If additional extraction wells are needed to establish full hydraulic capture of the VOC plume in the TFA area, we estimate that the new wells, piezometers, and pipelines would be installed and operating about one year later. The UV/H_2O_2 unit installed at TFA is capable of treating 200 gpm of ground water. The aeration tank to polish the effluent from the UV/H_2O_2 unit can currently treat up to 150 gpm. Upgrading TFA to treat 200 gpm, if necessary, would require a relatively short time period, because the upgrade only involves replacing or increasing the treatment capacity of the aeration tank. Thus, it is estimated that full hydraulic capture of the VOC plume in the TFA area should be established by late 1994, assuming that only one set of additional extraction wells is necessary.

2.2.2. TFA Specifications, Design, Performance, Controls, and Safeguards

The specifications, design, performance, controls, and safeguards for TFA and its associated piping are described in Sections 2.2.2.1 through 2.2.2.3.

2.2.2.1. Specifications and Design

TFA was originally designed, built, and operated to treat up to 100 gpm of ground water extracted from the southwest portion of the Livermore Site VOC plume. Initially, ground water was pumped only from extraction well EW-415 (extraction location 1) (Fig. 2). Later, the design flow rate was increased to 150 gpm to accomodate additional ground water pumped from the Detailed Study Area (DSA) (extraction location 2) in the southwest corner of the LLNL site, extraction locations 3 and 4, and planned additional wells located along Arroyo Seco west of LLNL (extraction locations 22-24). LLNL informed the RWQCB of the planned TFA flow rate increase. The RWQCB indicated that the Waste Discharge Requirement (WDR) permits (Appendix A) did not require amendment or reissue until such time as the originally specified 100-gpm limit in the permit is to be exceeded. LLNL is to notify the RWQCB 120 days in advance with a Waste Discharge Report, indicating the expected schedule for exceeding the 100 gpm limit. At that time, the RWQCB will decide whether to issue a new permit or amend the present permit.

VOCs are the chemicals of concern to be remediated by TFA. Design VOC influent concentrations from the LLNL FS (Isherwood *et al.*, 1990) are shown in Table 3. RWQCB Waste Discharge Requirement (WDR) Order No. 88-075 (included in Appendix A) limits the TFA effluent concentration to less than 5 ppb total VOCs. WDR Order No. 88-075 was adopted by the RWQCB on May 18, 1988, and has no expiration date. Bay Area Air Quality Management District's (BAAQMD) Best Available Control Technology (BACT) guidelines (BAAQMD, 1992) will be met by limiting atmospheric VOC emissions to concentrations less than 6 parts per million on a volume per volume basis ($ppm_{v/v}$).

Table 3. Design influent concentrations for TFA (from Isherwood *et al.*, 1990).

Constituent	Concentration (ppb)	
	Maximum influent	Average influent
PCE	350	280
TCE	9	7
1,1-DCE	15	12
1,2-DCE (cis and trans)	5	4
1,1,1-TCA	6	5
1,1-DCA	6	5
Chloroform	13	10
Freon 113	6	5

The specifications and design for TFA are presented below. The component specifications are presented in Table 4, and a piping and instrument diagram (P&ID) is presented in Plate 1*.

TFA is enclosed in a steel prefabricated (Butler type) building with outside dimensions of 25 x 15 x 12 feet. The building is insulated and lined with steel paneling on the interior. The structure rests on a 4-in. thick concrete (3,000 pounds per square inch [psi] rating) pad with steel rebar. A 10-in. thick concrete pad with steel rebar was installed for the LV-120 foundation. The building is constructed to the requirements of the Uniform Building Code, including the California seismic codes. For maintenance access, there is a 10 x 10 foot roll-up door on the front side of the building.

Ground water containing VOCs is extracted for treatment using Grundfos submersible pumps. These pumps are centrifugal stainless steel with a variety of horsepower (hp) and flow ratings. For extraction well EW-415 (extraction location 1), a 5-hp (3,450 revolutions per minute or rpm) Grundfos 75S50-8 pump was selected with a nominal rating of 80 gpm at 150 feet of head. The pump is powered by a 480-volt (v), three-phase motor. The pump also has a control circuit that will initiate a shutdown in the event of cavitation due to the loss of a net positive suction head. The pump is screened and has thermal overload protection. The pump controller has a circuit breaker for overload protection.

From the wellhead, the ground water is pumped to TFA through a 3-inch iron Schedule 80 pipeline. The distance from extraction well EW-415 to TFA is approximately 1,200 feet.

The influent to TFA from extraction location 2 (Fig. 1) is pumped through a buried double-walled pipeline that is instrumented with a leak detection system. This pipeline consists of a polypropylene, 3-inch, Schedule 80 inner pipeline surrounded by a 6-inch Schedule 40 outer pipeline. The leak detection system is a Trace Tek 300 Longline System manufactured by Raychem Corporation that is monitored and alarmed at TFA. This sytem is installed within the 6-inch outer pipeline and will simultaneously detect the presence of aqueous fluids at any point along the cable's length, sound an alarm at TFA, and pinpoint the distance from TFA to the leak.

* Plate 1 is located in a pocket inside the back cover of this report.

Table 4. Summary of TFA facility component specifications.

Component	Specification
TFA building	Steel prefabricated (Butler type) 25 x 15 x 12 feet
Concrete pad	4 inches with rebar (3,000 psi rating)
LV-120 foundation	10-inch concrete with rebar (3,000 psi rating)
Extraction well pump	Grundfos 75S50-8, 5 hp at 3,450 rpm, 480 v, 3-phase motor
Influent pipe line	Schedule 80 iron
Pressure reducing valve	Fisher control valve FS92W-165
Pressure regulator	Fisher 6492H
Over-pressure relief valve	3-inch Bailey pressure relief valve Model No. 118 9-25, Serial No. 81258
Filter canister	Cuno 12 DC3, stainless steel
Filter cartridges	Honeycomb Parker Hannifin Corporation Model No. M23R29-4A, 15 gpm at 0-2 psi differential pressure
H_2O_2 feed pumps	Liquid Metronics, Inc., Model No. A151-192SPX, 24 gallons per day (150 psi maximum)
H_2O_2 injection tubing	304 stainless steel, 0.035-inch wall thickness
H_2O_2 storage tanks	500-gallon polyethylene 1/4-inch single wall with 1/4-inch single wall double-containment shell
H_2O_2 splash containment	316 stainless steel 78 x 79 x 8 inches
LV-120 UV/H_2O_2	480-v, 3-phase, 60 Hz, with eight 15 kW medium pressure Hg vapor lamps
LV-120 oxidation chamber	Welded stainless steel, not ASME coded for pressure
LV-120 control system	OPTO-22 control unit with Paragon 500 control software
Polishing tank	1,575 gallon 1/4-inch ASTM A-36 steel
Polishing tank protective paint	Simpson Cordurite epoxy paint with zinc chromate epoxy primer
Supply and exhaust air blowers	Fuji 703
Supply air manifolds	2-inch Schedule 80 PVC
Carbon filter	Vent-Scrub VSC-200-C
Level control system	Warwick level control probes 120-v, single phase
Discharge pumps	Baldor 10-Hp, 480-v, 3-phase, 300 gpm
Influent pipeline from DSA cluster	Double-walled, polypropylene 3-inch Schedule 80 inner; 6-inch Schedule 40 outer
Influent pipeline from extraction location 3 (offsite Susan Lane)	Double-walled, polypropylene 3-inch Schedule 80 inner; 6-inch Schedule 40 outer
Leak detection system extraction location 2 pipelines	Trace Tek 300 Longline System, Raychem Corporation

The planned pipelines from extraction locations 3, 22, 23, and 24 to TFA will be constructed of the same double-walled polypropylene pipe and will be instrumented with an identical leak detection system to that described above.

The current plan for extraction location 4 is to pump the ground water to TFA through an above-grade Schedule 80 iron pipeline. The influent from extraction location 4 will pass through the pressure-reducing valve, enter the filter packs, and then enter the LV-120 UV/H_2O_2 unit for treatment.

Once at TFA, the ground water passes through a pressure-reducing valve. The valve reduces the in-line pressure from 80 to 100 pounds per square inch (psi) to about 10 to 12 psi. The valve is a 3-inch adjustable mechanical disc Fisher control valve FS92W-165 with a Fisher pressure regulator model 6492H. Ground water then enters a Cuno 12 DC3 stainless steel filter cannister with 12 30-inch-long polypropylene core filter cartridges. Each honeycomb cartridge (Parker Hannifin Corporation Model No. M23R29-4A) has a 1-inch inside diameter (ID) and 2 1/2-inch outside diameter (OD) and is rated at 15 gpm with a 0 to 2 psi pressure drop. Therefore, the pressure drop across the entire filter pack is about 2 psi, and the ground water enters the UV/H_2O_2 treatment unit at about 8 to 10 psi.

Before entering the UV/H_2O_2 treatment unit, H_2O_2 is injected into the influent stream of ground water. Two feed pumps are used to inject the H_2O_2. These pumps are Liquid Metronics, Inc., Model No. A151-192SPX positive displacement diaphragm pumps. Each pump has an adjustable stroke length and stroke frequency to vary the amount of H_2O_2 injected when necessary. The 50% H_2O_2 solution is stored in a 500-gallon, 1/4-inch-thick single-wall, polyethylene tank. Outside of this storage tank is another polyethylene single-wall shell that provides secondary containment. The H_2O_2 storage tank and its double containment rest on a raised steel pallet. Underneath the steel pallet is a 78- x 79- x 8-inch stainless steel rectangular pan that provides triple or tertiary containment. The whole assembly, including the H_2O_2 double containment, rests on a concrete floor that is 4 inches thick.

The H_2O_2 pumps can deliver 24 gallons per day at 150 psi maximum discharge head. The H_2O_2 is pumped through 1/4-inch 304 stainless steel tubing with a wall thickness of 0.035 inches.

After H_2O_2 injection, the ground water containing VOCs then enters the LV-120 UV/H_2O_2 unit. This is a 120 kilowatt (kW) unit that contains eight 15-kW medium pressure mercury vapor lamps. Each lamp is coaxially sealed within a 1/4-inch-thick wall quartz tube. The ground water never comes into direct contact with the mercury lamps. UV light disassociates the H_2O_2 to form the hydroxyl radical ($OH^{\bullet}$). The hydroxyl radical, in conjunction with the UV light, oxidizes the VOCs to nontoxic compounds such as water, chloride ions, and carbon dioxide.

The mercury vapor lamps are housed in two oxidation chambers containing four lamps each that are constructed of welded stainless steel lined with Teflon. Teflon is used because of its UV reflective properties. The oxidation chambers are not American Society of Mechanical Engineers (ASME)-rated pressure vessels coded and therefore cannot operate at pressures greater than 20 pounds per square inch gauge (psig.) A pressure relief valve is set at 15 psig, and a rupture disk in each vessel is set to rupture at 20 psig for protection.

The UV/H_2O_2 system includes the UV lamps and an electrical control system. The TFA

control system is an OPTO-22 control unit with Paragon 500 software. The software is designed such that additional well controls and other control features can be added as necessary. The UV/H_2O_2 unit is anchored to a 10-inch-thick concrete pad.

From the LV-120, the treated ground water is pumped to the polishing aeration tank through a 4-inch Schedule 80 iron pipe. The concentration of total VOCs in water entering the polishing tank is about 10 to 20 ppb, and the aeration process usually reduces these residual VOCs in the water to concentrations less than the analytic detection limit of 0.5 ppb. The 5-hp pump in well EW-415 pumps the water from the well to the polishing tank. The polishing tank is rectangular and fabricated with 1/4-inch American Society for Testing and Materials (ASTM) A-36 steel. Since the LV-120 does not treat all of the VOCs in ground water (notably 1,1,1-TCA and 1,1-DCA), the polishing tank was needed to meet the discharge requirements specified in WDR Order No. 88-075 (Appendix A).

The steel polishing tank is painted with Simpson Cordurite paint. This paint is epoxy-based and is applied to the interior and exterior surface of the tank that was primed with zinc chromate epoxy primer. Steel baffles form five individual cells within the tank interior. The polishing tank has a capacity of 1,575 gallons, which allows the necessary residence time to complete treatment of water from the UV/H_2O_2 unit.

The supply air for the aeration comes from a Fuji VFC 703A blower. This blower has an output of 150 actual cubic feet per minute (acfm) with an operating level of 5 feet of water in the polishing tank. Four of the five interior cells have air manifolds at the bottom of each cell. These manifolds are 2-inch Schedule 80 PVC pipe with the requisite number of 5/16-inch holes to allow 150 acfm to exit the manifold and aerate the water.

Once stripped from the water, the VOCs are exhausted from the polishing tank with the aid of another Fuji VFC 703A blower. The exhausted air stream passes through a Vent-Scrub VSC-200-C carbon canister at a rate of 220 acfm where the residual VOCs are adsorbed to the carbon. Assuming the same VOC concentrations in the influent water on March 5, 1991 (see Table 5 in Section 2.2.2.2), at a flow rate of 150 gpm (78.8 million gallons/year), 9.5 pounds of VOCs are adsorbed onto the GAC per year. The ratio of adsorbed VOCs to the VSC-400 carbon mass of 2.8% per year is lower than the typical carbon loading capacity of 10%. The VSC-400 will be replaced at 78-million-gallon intervals, and the GAC will be delivered to the LLNL Hazardous Waste Management Division to be subsequently regenerated or disposed offsite at a permitted facility.

The last cell within the polishing tank contains the level controls for the discharge system. The level control system is a 120-v, single-phase system consisting of Warwick level control probes. Two 10-hp Baldor (3,450 rpm) pumps are used to discharge the treated water from the polishing tank to the Baker tanks near TFA for use in the Central Cooling Tower system in south-central LLNL, or in the recharge basin south of East Avenue. The two Baldor 480-v, three-phase pumps have the capacity to pump treated water approximately 2,500 feet through a 6-inch Schedule 80 iron pipeline to the recharge basin. Each pump has a 300-gpm rating at 20 feet of water head.

The treated effluent from TFA is discharged to the recharge basin through a 6-inch Schedule 80 iron pipeline. The total length of pipeline from TFA to the recharge basin is about 2,500 feet.

2.2.2.2. Performance

Over 35 million gallons of ground water were extracted and treated to nondetectable levels by the initial Model LV-60 UV/H_2O_2 TFA treatment system between September 1989 and May 1991. Initial testing of TFA indicated the need for an aeration polishing system to remove 1,1,1-TCA, 1,1-DCA, chloroform, and Freon 113, which were not completely destroyed by the LV-60 UV/H_2O_2 unit. Treated water from these tests was discharged to holding tanks and aerated prior to discharge to comply with regulatory discharge limits. The LV-60 VOC destruction efficiency varied during the first year of operation due to formation of a coating on the quartz tubes that house the UV lamps. Analyses of this mineral coating indicated it was rich with iron. The decrease in LV-60 efficiency did not result in exceedance of discharge limits for TFA because the polishing system reduced concentrations below the discharge limits. The maintenance program was subsequently modified to include cleaning the quartz tubes every 2 weeks to remove the coating and restore the LV-60 efficiency.

After the first year of operation, the LV-60 PCE destruction efficiency averaged 95.5% at a flow rate of 50 gpm. TCE and 1,1-DCE were destroyed to nondetectable (<0.5 ppb) levels. The polishing aeration unit successfully reduced residual VOC concentrations in water to levels below the discharge limits of 5 ppb total VOCs, and usually (about 75% of the time) to levels below the analytical detection limit of 0.5 ppb. A GAC filter, installed downstream of the air outlet of the polishing aeration unit, prevented discharge of volatilized VOCs to the atmosphere. Table 5 summarizes representative system performance results for various VOCs for the initial LV-60 facility. System performance results at the beginning of ground water extraction showed higher VOC influent concentrations than reported in Table 5 for March 5, 1991; the higher VOC influent concentrations were successfully treated to levels below discharge limits at TFA.

Table 5. Performance results (March 5, 1991) for the LV-60 unit initally installed at TFA.

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet ($ppm_{v/v}$)[a]
PCE	100	1.5	<0.5	<1
TCE	4	<0.5	<0.5	<1
1,1-DCE	9	<0.5	<0.5	<1
1,1-DCA	3	2.5	<0.5	<1
1,1,1-TCA	3	3	<0.5	<1
Chloroform	3	3.5	<0.5	<1
Freon 113	4	4	<0.5	<1

[a]Parts per million on a volume-per-volume basis.

The upgraded 150-gpm TFA facility began operation in September 1991. This upgraded system uses a Model LV-120 UV/H_2O_2 unit. Approximately 8.3 million gallons of ground water were extracted and treated by the upgraded system through June 1992. Total ground water treated by both the initial and upgraded systems is 43.7 million gallons through June 1992. The

LV-120 UV/H_2O_2 treatment system currently installed at TFA destroys the double carbon bonded PCE with greater than 98.7% efficiency. The maintenance program for the LV-120 includes cleaning the quartz tubes to prevent buildup of coating on the tubes. The polishing aeration unit successfully reduces residual VOC concentrations in water below discharge limits of 5 ppb total VOCs, and usually (about 75% of the time) to levels below the detection limit of 0.5 ppb. The influent ground water mineral content at TFA is high, and the ground water pH is between 7.3-7.4. The bicarbonate concentration is about 500 ppm, and during air stripping carbonate is precipitated out of solution. Carbonate scale is removed during the preventive maintenance of the polishing tank. A GAC filter installed downstream of the air outlet of the polishing aeration unit prevents discharge of detectable concentrations of volatilized VOCs to the atmosphere. This is consistent with LLNL policy of zero air emissions where possible. Table 6 summarizes representative system performance results for various VOCs for the upgraded facility.

Quarterly monitoring of the exhaust air stream has not yet indicated breakthrough of any VOCs through the carbon filter because of the low concentrations entering the aeration polishing unit. The GAC filter at TFA was replaced and disposed offsite at a Resource Conservation and Recovery Act (RCRA)-permitted facility once thus far. Section 4.3 describes the process for filter disposal. The VOC loading rate on the GAC filter is very low. Mass balance calculations for March 5, 1991, indicate a VOC concentration in the influent air of 70 parts per billion on a volume per volume basis ($ppb_{v/v}$) for a GAC loading rate of 3.2 pounds per year at 50 gpm (26.3 million gallons/year). The influent concentration to the GAC is much lower than the BACT requirements for effluent air. The initial VSC-200 GAC filter was disposed through LLNL Hazardous Waste Management and replaced on October 22, 1991. TFA had treated 36 million gallons by that time. Assuming the same 70 $ppb_{v/v}$ vapor concentration, the carbon had adsorbed 4.38 pounds of VOCs. The mass ratio of VOCs to GAC of 3.1% is lower than that of the typical GAC loading of 10%. The VSC-200 GAC will be replaced at 36-million-gallon intervals and the GAC will be regenerated or disposed offsite. LLNL has chosen to be conservative regarding the GAC loading by changing the carbon at about one-third of the typical capacity.

The two treatment components at TFA, the LV-120 UV/H_2O_2 and the aeration unit, have a combined treatment capacity of about 200 gpm. This represents 50 gpm excess treatment capacity for TFA in its current configuration. The addition of larger capacity blowers to the aeration unit will increase its treatment capacity. A retrofit of this nature is relatively simple and can be accomplished in several days.

The average monthly influent PCE concentration dropped from 171 to 90 ppb during the last month (May 1991) of operation of the initial LV-60 system. PCE ground water concentrations recovered slightly during the 4.5 months the facility was shut down for upgrading. The PCE influent concentration for the LV-120-based facility averaged 107 ppb for June 1992.

Table 6. Performance results (April 30, 1992) for the LV-120 unit currently installed at TFA.

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet ($ppm_{v/v}$)[a]
PCE	110	<0.5	<0.5	<1
TCE	4	<0.5	<0.5	<1
1,1-DCE	10	<0.5	<0.5	<1
1,1-DCA	2	1.7	<0.5	<1
1,1,1-TCA	3	4.2	<0.5	<1
Chloroform	4	4.1	<0.5	<1
Freon 113	1	4.5	<0.5	<1
Carbon tetrachloride	<0.5	0.8	<0.5	<1

[a]Parts per million on a volume-per-volume basis.

2.2.2.3. Controls and Safeguards

TFA is equipped with an interlock control system. If any portion of the system malfunctions, the entire system, including the associated extraction well pumps, automatically shuts down. As shown on Plate 1, pressure relief valves and pressure rupture disks will shut the system down in the event of an equipment or system overpressure. An operator will be notified of a shutdown by an alarm system. The operator must determine and correct the problem before the system can be manually restarted.

The centrifugal extraction well pumps for TFA extraction wells have thermal shutoff devices to prevent overheating due to insufficient water levels in the wells. TFA has a pressure sensor on the H_2O_2 feed line that will shut the system down if H_2O_2 system pressure is less than 18 psi. Additionally, the facility will shut down if:

- A UV lamp fails.
- Excessive temperature in the reaction chamber is detected.
- Excessive moisture accumulates in the UV lamp enclosures.
- Flow is detected from either the influent or effluent overpressure relief devices.

The TFA aeration system also has:

- Supply and exhaust blower interlocks, which prevent system operation if either blower is offline.
- A high water level sensor in aeration tanks to keep the water level below the specified level.
- A supply air pressure control that will shut the system down in the event of a pipe break.

In addition, all underground pipelines (existing and planned) from extraction wells to TFA will be double-contained with a leak detection system installed inside the outer pipe. Accessible

pipelines are visually monitored for leaks on a daily basis.

2.2.3. Discharge of Treated Ground Water

Treated ground water from TFA is discharged to the ground surface at the LLNL recharge basin. During drought conditions, part of the treated water is used in the onsite cooling towers and for onsite irrigation to reduce the amount of water imported to LLNL. Some of the water has also been piped to the drainage retention basin in central LLNL to offset evaporative losses.

The LLNL recharge basin is located about 1,000 feet due south of East Avenue (Fig. 1) within a locked security fence. The basin consists of two rectangular cells, each covering an area about 550 by 100 feet. Two adjacent recharge cells were constructed to allow periodic maintenance of the inactive cell.

Treated ground water from TFA can be discharged to either of the recharge basin cells via an existing underground pipeline. Water discharged to the recharge basin percolates through the underlying unsaturated sediments and eventually recharges the local ground water system. About 25 million gallons of treated ground water from TFA were discharged to the basin from March 1989 to June 1992 under RWQCB WDR Order No. 88-075. Daily field observations conducted for TFA self-monitoring indicate that about 90% of the water discharged to the recharge basin to date has infiltrated into the ground.

2.3. Construction and Startup Schedule and Cost Estimates

TFA was the first ground water treatment facility installed at LLNL. It was installed as part of a pilot study to evaluate treatment of VOCs in ground water in the southwest part of LLNL.

Technology evaluations and conceptual designs were conducted by ERD. Following completion of the conceptual design, LLNL Plant Engineering completed the final design that was used for construction. When necessary, subcontractors were procured through a competitive process for facility construction.

Initially, air stripping technology was selected for pilot remediation of the VOCs in the southwest portion of the LLNL ground water plume. The original conceptual design called for a 25-foot air stripping tower. However, UV/H_2O_2 technology was eventually selected because it converts many of the VOCs to harmless compounds, and because of community concerns regarding the use of air strippers.

UV/H_2O_2 technology was relatively new for ground water restoration at that time (1988), thus providing an opportunity to evaluate its technical feasibility for the LLNL site. The design of TFA was begun in August 1988 and completed the following January. Construction of the facility started in December of 1988 and was completed in March 1989 (Table 7). Construction included the steel building that houses the treatment unit, the influent and effluent pipelines, a pressure-reducing manifold, and the recharge basin located on property administered by Sandia National Laboratories south of East Avenue (Fig. 1).

Table 7. TFA design and construction schedule.

Item	Design		Construction	
	Start	End	Start	End
TFA building (including piping and power)	8/88	1/89	12/88	3/89
Air stripping tower (project abandoned)	2/88	3/88		
Recharge basin, access road, and fence	8/88	1/89	12/88	3/89
Polishing tank and installation			5/89	6/89
LV-120 design and installation	4/91	5/91	6/91	9/91

TFA was constructed by LLNL Plant Engineering labor-only forces, with the exception of the building and the East Avenue pipe crossing. The building that houses the treatment facility and the East Avenue pipe crossing was constructed by a subcontractor.

The costs associated with building construction, shown in Table 8, include design and construction costs for the influent and effluent pipelines, facility power, and power to the EW-415 wellhead. The costs associated with the recharge basin include (1) the excavations for the pipeline across East Avenue to the basin and for the east and west cells of the basin, and (2) construction of the access road to, and a fence around, the basin.

The O&M costs are typical of the first few years of operation. After the DSA and offsite pipelines are installed and operating, the labor and materials annual costs are expected to decrease by approximately 50%.

Table 8. TFA cost summary.

Item	Original costs	TFA costs with modifications	Annual O&M
TFA building (including piping and power)	$472,500	$472,500	
Recharge basin, access road, and fence	116,500	116,500	
Polishing tank and installation	20,000	20,000	
LV-60 unit	63,000	63,000	
LV-120 unit	—	150,000	
LV-120 design and installation	—	73,700	
TFA Operation & Maintenance:			
Labor			80,000
Materials			50,000
Maintenance Contract			34,000
Total	$672,000	$895,700	$164,000

In May 1991, TFA was shutdown for the installation of the larger LV-120 UV/H_2O_2 treatment unit. The larger unit was necessary to accomodate higher flow rates, as discussed above. The design and installation costs were $73,700, and the capital cost of the larger unit and ancillary equipment was $150,000.

3. Remedial Design Criteria for Treatment Facility B

3.1. TFB Design Summary

TFB is a ground water treatment facility that is located along Vasco Road about one-quarter mile north of Mesquite Way (Fig. 1). The purpose of TFB is to treat ground water containing VOCs. Ground water from extraction locations 5, 6, and 7 is pumped to hydraulically control the central part of the leading edge of the westward moving ground water plume. The contaminants in the ground water at this location in order of highest concentration are TCE at 120 ppb and carbon tetrachloride at 5.5 ppb (see Table 13, Section 3.2.2.2). In addition, 1,1-DCE, chloroform, Freon 113, and 1,1-DCA are also present in the influent ground water at concentrations of about 2.5 ppb or less. TFB consists of a commercially available UV/H_2O_2 ground water treatment unit and an air stripper. The treated effluent is discharged to an excavated drainage ditch that flows north into Arroyo Las Positas in the northwest corner of the LLNL site. TFB meets the discharge requirements specified in California RWQCB WDR Order No. 91-091 (NPDES Permit No. CA0029289).

3.2. Design Specifications

Design specifications for TFB extraction wells and piezometers and for the TFB treatment system are described in Sections 3.2.1 and 3.2.2.

3.2.1. Extraction Wells and Piezometers

Extraction locations 5, 6, and 7 will supply ground water to TFB (Fig. 1). A total of seven existing extraction wells will be pumped at these locations. Additional extraction wells and/or locations may be used if complete hydraulic capture in the TFB area is not achieved with the existing seven wells. Design types for the seven TFB extraction wells are discussed in Section 3.1.1.2 of the RAIP and shown in Table 9. TFB area extraction well and piezometer locations are shown in Figure 4. All existing and planned wells will be secured in locked enclosures.

TFB area extraction well locations are based on ground water modeling results (Chapter 3 and Appendix B in Isherwood *et al.* (1990); Tompson (1990); Tompson *et al.* (1991); and Tompson and Nichols (1993); local hydrogeology in Thorpe *et al.* (1990); and the current understanding of the distribution of VOCs. In all cases, extraction locations were selected to capture ground water from all water-bearing zones where contaminants of concern exceed MCLs. The area in the TFB vicinity where one or more VOCs in ground water exceed an MCL is shown on Figure 4.

Table 9 shows estimates of the maximum sustainable yields from each extraction well based on available hydraulic test results. Because pumping data for the TFB extraction wells are limited, the sustainable yield estimates represent maximum long-term steady-state yields. Although the estimated maximum sustainable yields on Table 9 total 68 gpm, the long-term yield

Table 9. TFB extraction well specifications.

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
Extraction location 5											
MW-218	EW-5-1	Single	30-May-86	201.0	71.0	64.5-71	62-71	First	2	10S05-9	68
EW-704	EW-5-2A	Multiple w/seal	02-Feb-91	135.0	107.0	67-76 88-97	64.5-79.5 86.5-103.0	First and second	20	25S20-11	95.5
MW-357	EW-5-3	Single	12-Jan-87	197.0	123.0	107-123	105-123	Third	20	16S10-10	115
Extraction location 6											
MW-610	EW-6-1A	Single	16-Mar-90	453.0	84.5	69-84.5	67.5-84.5	First	4	10S05-9	77
P-620	EW-6-1B	Single	30-Aug-90	206.0	88.5	75-88.5	73-88.5	First	6	5S03-9	82
P-621	EW-6-2	Single	09-Sep-90	149.0	120.0	113-120	112-120	Second	4	5S03-9	117
Extraction location 7											
MW-655	EW-7-1	Single	25-Apr-90	193.0	130.0	121-129.5	119-129.5	Fourth	12	10S05-9	125

Notes:

[a]Extraction well names provide the type of well (EW), its location (EW-1), and its depth relative to other extraction wells at the same location (e.g., EW-2-1 is shallower than EW-2-2). When multiple extraction wells are screened in the same water-bearing zone, a letter follows the zone designation (e.g., EW-2-2A, EW-2-1B, etc.).

[b]The three extraction well designs are:
single= a well screened in only one water-bearing zone;
multiple w/seal= a well screened in more than one water-bearing zone with annular grout seals between screened zones;
multiple= a fully screened and sand packed well in multiple water-bearing zones.
Additional information on these well designs and their applications is presented in the RAIP (Dresen *et al.*, 1993).

[c]Numbered consecutively downward from ground surface at each extraction location. A water-bearing zone is defined as saturated permeable sediment greater than about 3 ft thick, separated from other permeable sediments above and below by at least 5 ft of low-permeability sediments.

[d]Estimated yield based on pumping test results. Actual long-term pumping rates will generally be lower. Where the extraction well is not yet installed, estimates of sustained flow rates are shown in parentheses. These rates are based on the flow rates from nearby wells screened in similar zones and/or local hydrogeologic conditions.

[e]Pump type currently installed. All are Grundfos stainless steel submersible pumps. Nominal flow rates are: 5S03-9= 5 gpm, 10S05-9 = 10 gpm, 16S10-10 = 16 gpm, and 25S20-11 = 25 gpm.

1. Introduction

This report is the first of five Remedial Design (RD) Reports for the Lawrence Livermore National Laboratory (LLNL) Livermore Site, which is located about 40 miles east of San Francisco, California. The five RD Reports will be prepared over the next 3 years according to the schedule in the Remedial Action Implementation Plan (RAIP) for the Livermore Site (Dresen *et al.,* 1993). As described in the RAIP, the remedial actions presented in the Record of Decision (ROD) for the Livermore Site (DOE, 1992) will be phased-in over a 3-year period to be consistent with projected funding levels, and to enable determination of the actual, rather than predicted, effectiveness of the planned extraction and treatment systems before proceeding with subsequent phases.

The LLNL Livermore Site was placed on the U.S. Environmental Protection Agency's (EPA) National Priorities List in 1987. In November 1988, the U.S. Department of Energy (DOE), EPA, the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB), signed a Federal Facilities Agreement to facilitate compliance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended. As part of the CERCLA process, the LLNL Environmental Restoration Division has prepared a series of documents: the Remedial Investigation (May 1990) characterizes the site hydrogeology and contaminant distribution, the Feasibility Study (FS) (December 1990) screens and evaluates possible remedial alternatives, the Proposed Remedial Action Plan (October 1991) further evaluates conceptual remedial alternatives and recommends alternatives for ground water and soil remediation, the ROD (July 1992) codifies and binds DOE and EPA to a cleanup approach for ground water and soil, and the RAIP (January 1993) describes the approach to and presents a schedule for the remaining remedial actions.

As discussed in the ROD, the contaminants of concern at the Livermore Site are volatile organic compounds (VOCs), primarily trichloroethelyene (TCE) and perchloroethylene (PCE); fuel hydrocarbons, including benzene, chromium, and tritium; and perhaps lead. The Applicable or Relevant and Appropriate Requirements (ARARs) for the Livermore Site are detailed in the FS (Isherwood *et al.,* 1990). Performance and discharge standards are also presented in the ROD.

This initial RD Report is for Treatment Facility A (TFA) and Treatment Facility B (TFB) and their respective extraction wells and piezometer networks. The scope of this report is based on an outline provided by EPA (Gill, 1993) and subsequent discussions with EPA. Both TFA and TFB were constructed and tested for an EPA-approved pilot study for the Southwest Corner/Offsite Area. When the ROD for the Livermore Site was signed in August 1992, TFA and TFB were converted from pilot study to Remedial Action status. TFA has been operating since September 1989, and TFB has been operating since October 1990. This RD Report is a template for the four subsequent RD Reports which will cover the five remaining planned treatment facilities and their extraction wells and piezometer networks.

As specified by EPA, each RD Report will contain engineering design specifications for the ground water extraction and treatment systems, including piping and instrument diagrams, system descriptions, monitoring and construction schedules, and cost estimates. The RD Reports

will also include a Remedial Action Work Plan that contains Quality Assurance/Quality Control (QA/QC) Plans and Health and Safety Plans for construction operation and maintenance, and the requirements for offsite shipment of hazardous waste and for project closeout. The QA/QC and Health and Safety Plans for construction will be the same for all RD Reports. Therefore, these documents will be submitted with this initial RD Report only.

This document was prepared by LLNL for DOE with oversight from EPA, DTSC, and RWQCB. The five RD Reports are primary documents under the Federal Facility Agreement for the LLNL Livermore Site.

Sections 2 and 3 of this report are the remedial designs for TFA and TFB, respectively. Section 4 is the Remedial Action Work Plan for TFA and TFB. Appendices A through E present the RWQCB waste discharge permits, and the QA/QC and Health and Safety Plans for construction, operation, and maintenance of TFA and TFB.

2. Remedial Design for Treatment Facility A

2.1. TFA Design Summary

TFA is a ground water treatment facility located just north of Arroyo Seco near Vasco Road in the southwest part of the LLNL Livermore Site (Fig. 1). Its purpose is to treat ground water containing VOCs. Ground water in the TFA vicinity is being pumped to hydraulically control the southwestern portion of the ground water plume. The primary contaminants in the ground water at this location are PCE at about 100 parts per billion (ppb) and 1,1-DCE at 9 ppb (see Table 5, Section 2.2.2.2). In addition, TCE, Freon 113, 1,1-DCA, 1,1,1-TCA, and chloroform are also present in influent ground water, each at concentrations of 4 ppb or less. TFA consists of a commercially available ultraviolet light/hydrogen peroxide (UV/H_2O_2) ground water treatment unit and an air stripper. The treated ground water is discharged via a pipeline to a recharge basin located on property administered by Sandia National Laboratories south of East Avenue, and/or is used onsite at LLNL in cooling towers and/or for landscape irrigation.

2.2. Design Specifications

Design specifications for TFA extraction wells and piezometers and for the TFA treatment system are described in Sections 2.2.1 and 2.2.2.

2.2.1. Extraction Wells and Piezometers

As discussed in the RAIP (Dresen *et al.*, 1993), extraction locations 1, 2, 3, 4, 22, 23, and 24 will supply ground water to TFA (Fig. 1). A total of 21 extraction wells are tentatively planned at these locations. Eleven of these planned extraction wells are currently installed. The remaining wells are planned for installation in phases in Fiscal Years (FY) 93-95. Possible designs for the 21 TFA extraction wells are discussed in Section 3.1.1.2 of the RAIP and are shown in Table 1, and TFA extraction well and piezometer locations are shown in Figure 2. All existing and planned wells will be secured in locked enclosures.

TFA area extraction well locations are based on ground water modeling results (Chapter 3 and Appendix B in Isherwood *et al.*, 1990; Tompson, 1990; Tompson *et al.*, 1991; and Tompson

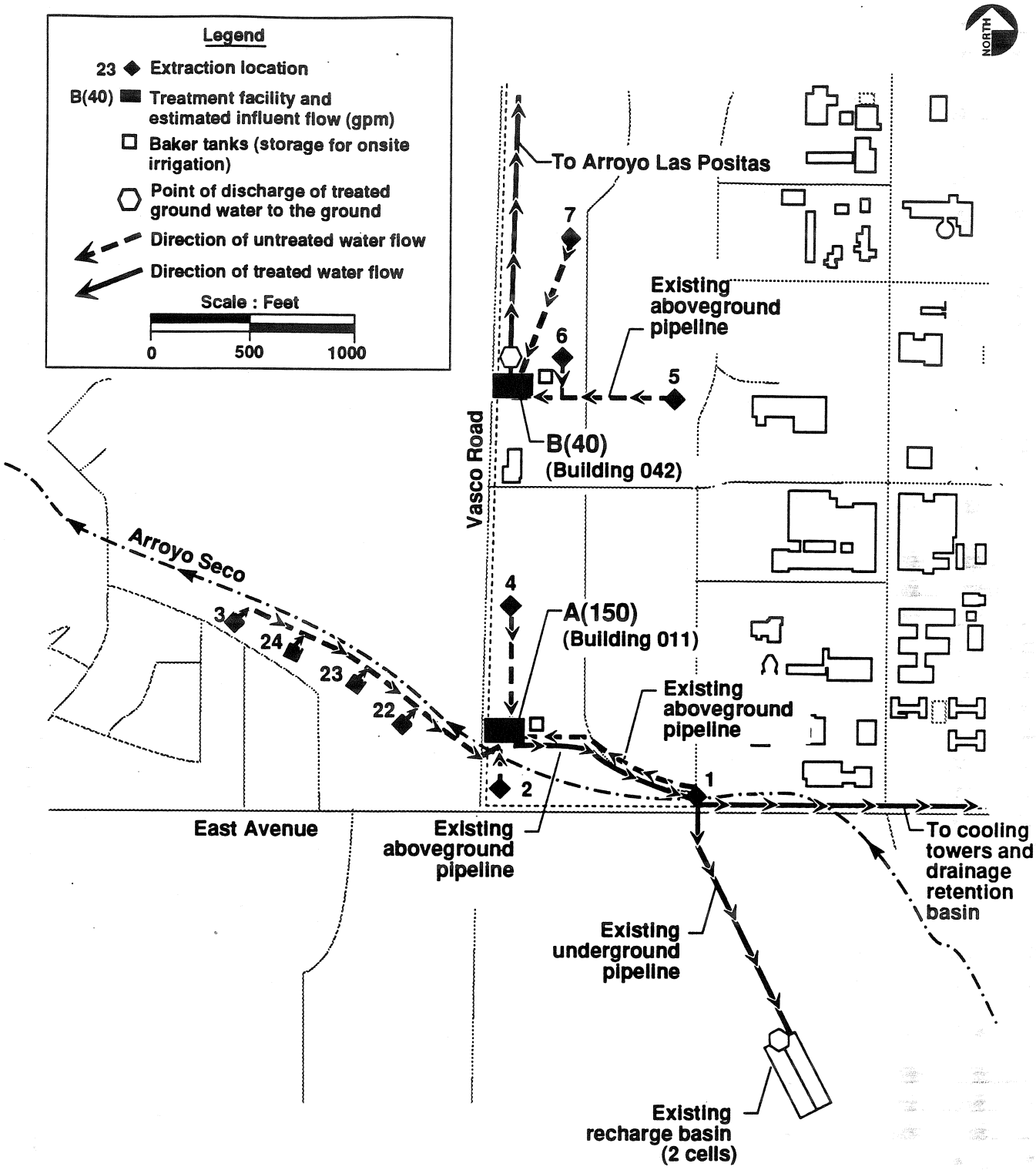

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Figure 1. Planned ground water extraction and recharge locations for TFA and TFB.

Table 1. TFA extraction well specifications.

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
Extraction location 1											
EW-415	EW-1-1	Multiple	12-Aug-88	205.0	183.7	79-179	65-180	First through sixth	50	75S50-8	129
Extraction location 2											
MW-520	EW-2-1B	Single	30-Aug-89	160.0	101.5	94-101.5	91.5-101	Second	16	16S10-10	98
MW-602	EW-2-1A	Single	06-Nov-89	168.0	100.0	90-100	90-100	Second	24	16S10-10	95
MW-619	EW-2-3	Single	07-Aug-90	330.0	252.0	232-252	228-253	Ninth	12	25S20-11	242
P-601	EW-2-1C	Single	13-Oct-89	146.0	96.0	88-96	86-97	Second	14	16S10-10	92
P-522	EW-2-2	Single	05-Oct-89	145.5	141.5	134-141.5	133-141.5	Third	24	25S20-11	138
Extraction location 3											
MW-408	EW-3-1	Single	16-Feb-88	131.0	122.5	101-122.5	99-122.5	Second	45	25S20-11	112
MW-109	EW-3-2	Single	02-Apr-85	289.0	147.0	137-147	136-147	Fourth	12	16S10-10	142
Extraction location 4											
TBI	EW-4-1	Single	—	—	—	71-90	—	First	(5)	—	—
MW-614	EW-4-2	Single	18-May-90	262.0	123.0	100-123	97-123	Second and third	7	16S10-10	112
MW-214	EW-4-3	Single	11-Apr-86	146.0	141.5	134-141.5	132-141.5	Fourth	28	16S10-10	138
MW-201	EW-4-4	Single	17-Oct-85	211.0	161.0	151-161	149.5-161	Fifth	10	16S05-9	156
EW-712	EW-4-5	Single	28-Aug-91	200.0	185.5	170-185.5	167-188	Sixth	10	16S10-10	178
Extraction location 22											
TBI	EW-22-1	Multiple w/seal?	—	—	—	90-100	—	Second	(5)	—	—

Table 1. Continued

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
TBI	EW-22-2	Multiple w/seal?	—	—	—	110-150	—	Third	(20-40)	—	—
TBI	EW-22-3	Multiple w/seal?	—	—	—	165-190	—	Fourth and fifth	(10-20)	—	—
Extraction location 23											
TBI	EW-23-1	Multiple w/seal?	—	—	—	90-100	—	Second	(5)	—	—
TBI	EW-23-2	Multiple w/seal?	—	—	—	110-150	—	Third	(20-40)	—	—
TBI	EW-23-3	Multiple w/seal?	—	—	—	165-190	—	Fourth and fifth	(10-20)	—	—
Extraction location 24											
TBI	EW-24-1	Multiple w/seal?	—	—	—	95-105	—	Second	(5)	—	—
TBI	EW-24-2	Multiple w/seal?	—	—	—	115-155	—	Third	(20-40)	—	—
TBI	EW-24-3	Multiple w/seal?	—	—	—	165-190	—	Fourth and fifth	(10-20)	—	—

Notes:

TBI = To be installed.

[a]Extraction well names provide the type of well (EW), its location (EW-1), and its depth relative to other extraction wells at the same location (i.e., EW-2-1 is shallower than EW-2-2). When multiple extraction wells are screened in the same water-bearing zone, a letter follows the zone designation (i.e., EW-2-2A EW-2-1B, etc.).

[b]The three extraction well designs are:
single=a well screened in only one water-bearing zone;
multiple w/seal=a well screened in more than one water-bearing zone with annular grout seals between zones;
multiple = a fully screened and sand packed well in multiple water-bearing zones.
Question marks indicate well design is preliminary. Additional information on these well designs and their applications is presented in the RAIP (Dresen et al., 1993).

[c]Numbered consecutively downward from ground surface at each extraction location. A water-bearing zone is defined as saturated permeable sediment greater than about 3 ft thick, separated from other permeable sediments above and below by at least 5 ft of low-permeability sediments.

[d]Estimated yield based on pumping test results. Actual long-term pumping rates will generally be lower. Where the extraction well is not yet installed, estimates of sustainable flow rates are shown in parentheses. These rates are based on the flow rates from nearby wells screened in similar zones and/or local hydrogeologic conditions.

[e]Pump type currently installed. All are Grundfos stainless steel submersible pumps. Nominal pump flow rates are 16S10-10 and 16S05-9 = 16 gpm, 25S20-11 = 25 gpm, and 75S50-8 = 75 gpm.

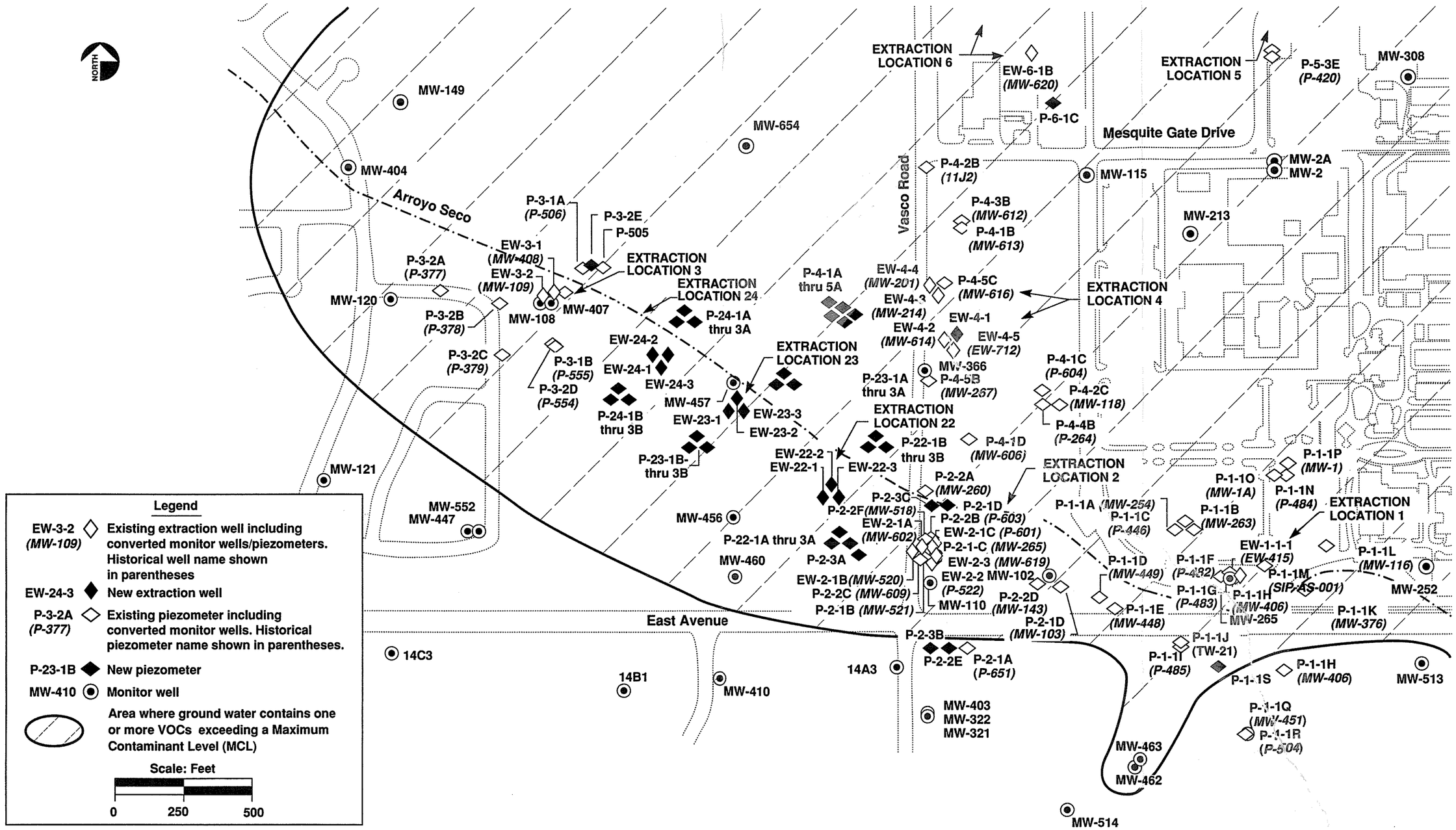

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Figure 2. TFA area extraction well and piezometer locations.

and Nichols, 1993), local hydrogeology (Thorpe *et al.*, 1990; Isherwood *et al.*, 1990), and the current understanding of the subsurface distribution of VOCs. In all cases, extraction locations were selected to capture ground water from all water-bearing zones where contaminants of concern exceed cleanup goals [i.e., Maximum Contaminant Levels (MCLs)]. The area in the TFA vicinity where one or more VOCs in ground water exceed an MCL is shown in Figure 2.

Table 1 shows estimates of the estimated maximum sustainable yields from each extraction well based on available hydraulic test results. With the exception of EW-1-1 (existing extraction well EW-415), pumping data are relatively limited, and the estimates in Table 1 probably represent maximum long-term steady-state yields. In most cases, as long-term ground water extraction progresses, yields decline due to dewatering of shallow sediments and/or influences from distant hydraulic boundaries. Although the maximum estimated sustainable yields in Table 1 total 371 gallons per minute (gpm), the long-term yield of these wells is estimated to be about 200 gpm. If the 200-gpm flow rate is ever realized, TFA will be upgraded accordingly with regulatory oversight to treat 200 gpm.

As shown on Figure 2, we plan to monitor a network of piezometers near the extraction wells to determine hydraulic capture zones and identify areas of stagnant ground water. A network of up to 62 piezometers is planned for TFA extraction wells; 40 of these piezometers are existing monitor wells and piezometers. The 22 remaining planned piezometers are scheduled for installation in phases in FY93-95. Design specifications for the 40 existing piezometers are shown in Table 2 along with the preliminary designs for the 20 planned new piezometers. A discussion of the monitoring plan for the TFA piezometer network is presented in Section 4.2.2.

As shown in Figure 3, TFA extraction locations 3 and 4 are the key locations for establishing hydraulic control of the leading edge of the VOC plume in the TFA area. Modeling indicates the leading edge of the plume will be captured by this proposed extraction scenario. If field data indicate a portion of the plume is not being captured, additional extraction wells and piezometers will be installed to establish capture of the leading edge of the plume.

All of the planned extraction wells for locations 3 and 4, except EW-4-1 and piezometers P-3-2E, and P-4-1A through P-4-5A (Fig. 2), are installed. EW-4-1 is scheduled for installation in mid- to late 1993. All pipelines from extraction location 3 and the associated new piezometers are scheduled for installation in FY93. Pipelines from extraction location 4 are scheduled for installation in FY94. Piezometers P-3-2E and P-4-1A through P-4-5A are planned for installation on private property and may not be installed until late 1993 or early 1994, after permission to drill is obtained from the property owners. In the unlikely event permission to drill cannot be obtained, alternative locations that will achieve the required ground water objectives will be chosen with regulatory oversight.

All extraction wells will begin pumping as soon as piping to TFA is completed. Initial flow rates will be maximized to establish capture zones as quickly as possible. Hydraulic test data indicate it will take about 4 to 6 weeks for the pumping wells to establish their full hydraulic capture zones. Modeling results suggest that sustained flow rates of about 50 gpm may be required for extraction locations 2 and 3, and about 15 gpm for extraction location 4 (Fig. 2) to fully capture the downgradient plume margins. Modeling results also indicate that pumping ground water from extraction location 1, although not required for downgradient plume margin

Table 2. TFA piezometer specifications.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
Extraction location 1							
MW-254	P-1-1A	21-Nov-85	277.0	91.5	84.5-91.5	81-91.5	3
MW-263	P-1-1B	07-Apr-86	146.0	130.0	123-130	120-130	1
P-446	P-1-1C	18-Dec-87	202.0	196.0	186-196	186-196	3
MW-449	P-1-1D	07-Mar-88	172.0	165.0	152-165	150-166.5	6
MW-448	P-1-1E	17-Feb-88	235.0	127.5	120.5-127.5	118-127.5	25
P-482	P-1-1F	15-Jan-88	218.0	170.0	165-170	162.5-170	<0.5
P-483	P-1-1G	26-Jan-88	140.0	130.0	115-130	114-130	2.5
MW-406	P-1-1H	20-Jan-88	213.0	94.0	79-84	79-94	7
P-485	P-1-1I	25-Feb-88	249.0	157.0	151-157	150-157	2
TW-21	P-1-1J	07-Jul-81	111.5	95.0	85-95	56.5-100	NA
MW-376	P-1-1K	27-Aug-87	249.0	172.0	162-172	157-175	3
MW-116	P-1-1L	14-Jun-85	181.0	91.0	86-91	84-91	0.3
SIP-AS-001	P-1-1M	27-Apr-90	100.5	90.5	81-90.5	77-90.5	NA
P-484	P-1-1N	11-Feb-88	255.0	188.0	185-188	183-190	0.5
MW-1A	P-1-1O	12-Apr-84	180.0	156.0	145-156	NA	1
MW-1	P-1-1P	21-Oct-80	122.5	116.0	95-100 104-114	74-116	7
MW-451	P-1-1Q	06-Apr-88	202.0	112.0	106-112	103-112	2
P-504	P-1-1R	21-Nov-88	358.0	167.0	157-167	153-167	10
TBI	P-1-1S	—	—	—	185-200	—	—
Extraction location 2							
P-651	P-2-1A	22-Feb-90	155.0	89.0	82-89	80-89	0.5
MW-521	P-2-1B	13-Sep-89	166.0	95.0	86-95	85-95	0.5
MW-262	P-2-1C	20-Mar-86	256.0	100.0	91-100	90-100	20

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
MW-103	P-2-1D	14-Feb-85	96.0	89.5	79.5-89.5	78.5-90	7
MW-260	P-2-2A	27-Feb-86	215.0	151.0	141-151	137-151	1.5
P-603	P-2-2B	15-Nov-89	150.0	147.0	141-147	140-147	6
MW-609	P-2-2C	21-Feb-90	120.0	112.0	104-112	102-112	7
MW-143	P-2-2D	12-Apr-85	130.0	126.0	121-126	119-126	0.8
MW-518	P-2-2F	08-Aug-89	251.0	139.0	131-139	129-139	6
TBI	P-2-3A	—	—	—	230-250	—	—
TBI	P-2-3B	—	—	—	230-250	—	—
TBI	P-2-3C	—	—	—	230-250	—	—
Extraction location 3							
P-506	P-3-1A	22-Dec-88	120.0	115.0	101-115	99-114	31
P-555	P-3-1B	05-Dec-88	122.0	116.5	102.5-116.5	99-118.5	14
P-377	P-3-2A	04-Sep-87	159.0	144.0	141.5-144	135-145	2.5
P-378	P-3-2B	09-Sep-87	155.0	150.0	146-150	139-151	5
P-379	P-3-2C	14-Sep-87	155.0	150.0	146-150	139-153	5
P-554	P-3-2D	22-Nov-88	239.0	141.5	126.5-141.4	124-143	60
TBI	P-3-2E	—	—	—	135-145	—	—
Extraction location 4							
TBI	P-4-1A	—	—	—	70-90	—	—
MW-613	P-4-1B	02-May-90	93.0	88.0	81.5-88	79-88.5	15
P-604	P-4-1C	27-Nov-89	111.0	83.0	76-82	74.5-82	0.5
P-606	P-4-1D	21-Dec-89	145.0	89.0	73-89	72-89.5	2
TBI	P-4-2A	—	—	—	100-125	—	—
11J2	P-4-2B	26-Apr-79	112.0	110.0	90-92 102-108	NA	NA
MW-118	P-4-2C	19-Jul-85	206.5	110.0	99-110	98-110	10

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
TBI	P-4-3A	—	—	—	130-140	—	—
MW-612	P-4-3B	19-Apr-90	222.0	136.0	126-136	124.5-137	14
P-605	P-4-3C	08-Dec-89	246.0	136.0	130-136	128.5-136	5
TBI	P-4-4A	—	—	—	150-160	—	—
MW-264	P-4-4B	14-Apr-86	170.0	151.0	141-151	139-151	23
TBI	P-4-5A	—	—	—	170-185	—	—
MW-267	P-4-5B	27-May-86	196.0	179.0	172.5-179	170-179	0.5
MW-616	P-4-5C	14-Jun-90	255.0	188.0	178-188	176-188.5	2
Extraction location 22							
TBI	P-22-1	—	—	—	90-100	—	—
TBI	P-22-2	—	—	—	110-150	—	—
TBI	P-22-3	—	—	—	165-190	—	—
Extraction location 23							
TBI	P-23-1A	—	—	—	90-100	—	—
TBI	P-23-1B	—	—	—	90-100	—	—
TBI	P-23-2A	—	—	—	110-150	—	—
TBI	P-23-2B	—	—	—	110-150	—	—
TBI	P-23-3A	—	—	—	165-190	—	—
TBI	P-23-3B	—	—	—	165-190	—	—
Extraction location 24							
TBI	P-24-1A	—	—	—	90-100	—	—
TBI	P-24-1B	—	—	—	90-100	—	—
TBI	P-24-2A	—	—	—	110-150	—	—
TBI	P-24-2B	—	—	—	110-150	—	—
TBI	P-24-3A	—	—	—	165-190	—	—

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
TBI	P-24-3B	—	—	—	165-190	—	—

Notes:

NA = Not available.

TBI = To be installed (FY93).

[a]Piezometer names show their location (i.e., P-24-1A is at extraction location 24) and the zone monitored (i.e., P-24-1A is screened in the first zone, as is EW-24-1). Letters following the zone designation indicate that multiple piezometers are screened in that zone.

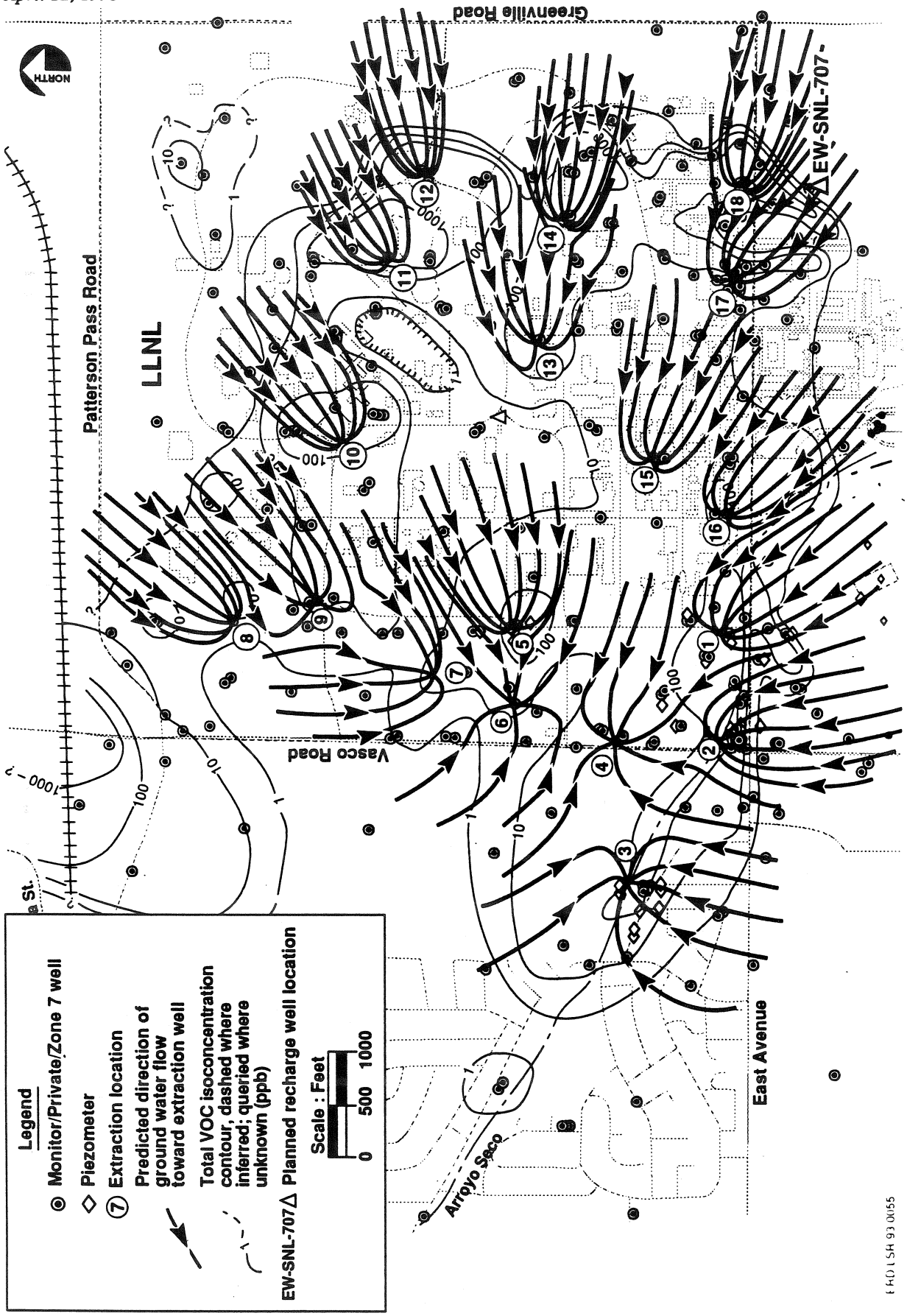

Figure 3. Extraction well hydraulic capture zones and recharge well locations (modified from the Record of Decision for the LLNL Livermore Site).

control, should decrease the estimated cleanup time.

LLNL will continue to monitor extraction flow rates, and ground water elevation and chemistry data to determine if the planned extraction scenario is completely capturing the VOC plumes. Determination of full plume capture will be established in collaboration with the regulatory agencies. If actual flow rates are substantially lower and/or the observed steady state drawdown fails to capture any part of the plume margin, additional extraction wells will be installed. The locations of these wells will be based on field water level data and recalibrated modeling results. If additional extraction wells are needed to establish full hydraulic capture of the VOC plume in the TFA area, we estimate that the new wells, piezometers, and pipelines would be installed and operating about one year later. The UV/H_2O_2 unit installed at TFA is capable of treating 200 gpm of ground water. The aeration tank to polish the effluent from the UV/H_2O_2 unit can currently treat up to 150 gpm. Upgrading TFA to treat 200 gpm, if necessary, would require a relatively short time period, because the upgrade only involves replacing or increasing the treatment capacity of the aeration tank. Thus, it is estimated that full hydraulic capture of the VOC plume in the TFA area should be established by late 1994, assuming that only one set of additional extraction wells is necessary.

2.2.2. TFA Specifications, Design, Performance, Controls, and Safeguards

The specifications, design, performance, controls, and safeguards for TFA and its associated piping are described in Sections 2.2.2.1 through 2.2.2.3.

2.2.2.1. Specifications and Design

TFA was originally designed, built, and operated to treat up to 100 gpm of ground water extracted from the southwest portion of the Livermore Site VOC plume. Initially, ground water was pumped only from extraction well EW-415 (extraction location 1) (Fig. 2). Later, the design flow rate was increased to 150 gpm to accomodate additional ground water pumped from the Detailed Study Area (DSA) (extraction location 2) in the southwest corner of the LLNL site, extraction locations 3 and 4, and planned additional wells located along Arroyo Seco west of LLNL (extraction locations 22-24). LLNL informed the RWQCB of the planned TFA flow rate increase. The RWQCB indicated that the Waste Discharge Requirement (WDR) permits (Appendix A) did not require amendment or reissue until such time as the originally specified 100-gpm limit in the permit is to be exceeded. LLNL is to notify the RWQCB 120 days in advance with a Waste Discharge Report, indicating the expected schedule for exceeding the 100 gpm limit. At that time, the RWQCB will decide whether to issue a new permit or amend the present permit.

VOCs are the chemicals of concern to be remediated by TFA. Design VOC influent concentrations from the LLNL FS (Isherwood *et al.*, 1990) are shown in Table 3. RWQCB Waste Discharge Requirement (WDR) Order No. 88-075 (included in Appendix A) limits the TFA effluent concentration to less than 5 ppb total VOCs. WDR Order No. 88-075 was adopted by the RWQCB on May 18, 1988, and has no expiration date. Bay Area Air Quality Management District's (BAAQMD) Best Available Control Technology (BACT) guidelines (BAAQMD, 1992) will be met by limiting atmospheric VOC emissions to concentrations less than 6 parts per million on a volume per volume basis ($ppm_{v/v}$).

Table 3. Design influent concentrations for TFA (from Isherwood *et al.*, 1990).

Constituent	Concentration (ppb)	
	Maximum influent	Average influent
PCE	350	280
TCE	9	7
1,1-DCE	15	12
1,2-DCE (cis and trans)	5	4
1,1,1-TCA	6	5
1,1-DCA	6	5
Chloroform	13	10
Freon 113	6	5

The specifications and design for TFA are presented below. The component specifications are presented in Table 4, and a piping and instrument diagram (P&ID) is presented in Plate 1*.

TFA is enclosed in a steel prefabricated (Butler type) building with outside dimensions of 25 x 15 x 12 feet. The building is insulated and lined with steel paneling on the interior. The structure rests on a 4-in. thick concrete (3,000 pounds per square inch [psi] rating) pad with steel rebar. A 10-in. thick concrete pad with steel rebar was installed for the LV-120 foundation. The building is constructed to the requirements of the Uniform Building Code, including the California seismic codes. For maintenance access, there is a 10 x 10 foot roll-up door on the front side of the building.

Ground water containing VOCs is extracted for treatment using Grundfos submersible pumps. These pumps are centrifugal stainless steel with a variety of horsepower (hp) and flow ratings. For extraction well EW-415 (extraction location 1), a 5-hp (3,450 revolutions per minute or rpm) Grundfos 75S50-8 pump was selected with a nominal rating of 80 gpm at 150 feet of head. The pump is powered by a 480-volt (v), three-phase motor. The pump also has a control circuit that will initiate a shutdown in the event of cavitation due to the loss of a net positive suction head. The pump is screened and has thermal overload protection. The pump controller has a circuit breaker for overload protection.

From the wellhead, the ground water is pumped to TFA through a 3-inch iron Schedule 80 pipeline. The distance from extraction well EW-415 to TFA is approximately 1,200 feet.

The influent to TFA from extraction location 2 (Fig. 1) is pumped through a buried double-walled pipeline that is instrumented with a leak detection system. This pipeline consists of a polypropylene, 3-inch, Schedule 80 inner pipeline surrounded by a 6-inch Schedule 40 outer pipeline. The leak detection system is a Trace Tek 300 Longline System manufactured by Raychem Corporation that is monitored and alarmed at TFA. This sytem is installed within the 6-inch outer pipeline and will simultaneously detect the presence of aqueous fluids at any point along the cable's length, sound an alarm at TFA, and pinpoint the distance from TFA to the leak.

* Plate 1 is located in a pocket inside the back cover of this report.

Table 4. Summary of TFA facility component specifications.

Component	Specification
TFA building	Steel prefabricated (Butler type) 25 x 15 x 12 feet
Concrete pad	4 inches with rebar (3,000 psi rating)
LV-120 foundation	10-inch concrete with rebar (3,000 psi rating)
Extraction well pump	Grundfos 75S50-8, 5 hp at 3,450 rpm, 480 v, 3-phase motor
Influent pipe line	Schedule 80 iron
Pressure reducing valve	Fisher control valve FS92W-165
Pressure regulator	Fisher 6492H
Over-pressure relief valve	3-inch Bailey pressure relief valve Model No. 118 9-25, Serial No. 81258
Filter canister	Cuno 12 DC3, stainless steel
Filter cartridges	Honeycomb Parker Hannifin Corporation Model No. M23R29-4A, 15 gpm at 0-2 psi differential pressure
H_2O_2 feed pumps	Liquid Metronics, Inc., Model No. A151-192SPX, 24 gallons per day (150 psi maximum)
H_2O_2 injection tubing	304 stainless steel, 0.035-inch wall thickness
H_2O_2 storage tanks	500-gallon polyethylene 1/4-inch single wall with 1/4-inch single wall double-containment shell
H_2O_2 splash containment	316 stainless steel 78 x 79 x 8 inches
LV-120 UV/H_2O_2	480-v, 3-phase, 60 Hz, with eight 15 kW medium pressure Hg vapor lamps
LV-120 oxidation chamber	Welded stainless steel, not ASME coded for pressure
LV-120 control system	OPTO-22 control unit with Paragon 500 control software
Polishing tank	1,575 gallon 1/4-inch ASTM A-36 steel
Polishing tank protective paint	Simpson Cordurite epoxy paint with zinc chromate epoxy primer
Supply and exhaust air blowers	Fuji 703
Supply air manifolds	2-inch Schedule 80 PVC
Carbon filter	Vent-Scrub VSC-200-C
Level control system	Warwick level control probes 120-v, single phase
Discharge pumps	Baldor 10-Hp, 480-v, 3-phase, 300 gpm
Influent pipeline from DSA cluster	Double-walled, polypropylene 3-inch Schedule 80 inner; 6-inch Schedule 40 outer
Influent pipeline from extraction location 3 (offsite Susan Lane)	Double-walled, polypropylene 3-inch Schedule 80 inner; 6-inch Schedule 40 outer
Leak detection system extraction location 2 pipelines	Trace Tek 300 Longline System, Raychem Corporation

The planned pipelines from extraction locations 3, 22, 23, and 24 to TFA will be constructed of the same double-walled polypropylene pipe and will be instrumented with an identical leak detection system to that described above.

The current plan for extraction location 4 is to pump the ground water to TFA through an above-grade Schedule 80 iron pipeline. The influent from extraction location 4 will pass through the pressure-reducing valve, enter the filter packs, and then enter the LV-120 UV/H_2O_2 unit for treatment.

Once at TFA, the ground water passes through a pressure-reducing valve. The valve reduces the in-line pressure from 80 to 100 pounds per square inch (psi) to about 10 to 12 psi. The valve is a 3-inch adjustable mechanical disc Fisher control valve FS92W-165 with a Fisher pressure regulator model 6492H. Ground water then enters a Cuno 12 DC3 stainless steel filter cannister with 12 30-inch-long polypropylene core filter cartridges. Each honeycomb cartridge (Parker Hannifin Corporation Model No. M23R29-4A) has a 1-inch inside diameter (ID) and 2 1/2-inch outside diameter (OD) and is rated at 15 gpm with a 0 to 2 psi pressure drop. Therefore, the pressure drop across the entire filter pack is about 2 psi, and the ground water enters the UV/H_2O_2 treatment unit at about 8 to 10 psi.

Before entering the UV/H_2O_2 treatment unit, H_2O_2 is injected into the influent stream of ground water. Two feed pumps are used to inject the H_2O_2. These pumps are Liquid Metronics, Inc., Model No. A151-192SPX positive displacement diaphragm pumps. Each pump has an adjustable stroke length and stroke frequency to vary the amount of H_2O_2 injected when necessary. The 50% H_2O_2 solution is stored in a 500-gallon, 1/4-inch-thick single-wall, polyethylene tank. Outside of this storage tank is another polyethylene single-wall shell that provides secondary containment. The H_2O_2 storage tank and its double containment rest on a raised steel pallet. Underneath the steel pallet is a 78- x 79- x 8-inch stainless steel rectangular pan that provides triple or tertiary containment. The whole assembly, including the H_2O_2 double containment, rests on a concrete floor that is 4 inches thick.

The H_2O_2 pumps can deliver 24 gallons per day at 150 psi maximum discharge head. The H_2O_2 is pumped through 1/4-inch 304 stainless steel tubing with a wall thickness of 0.035 inches.

After H_2O_2 injection, the ground water containing VOCs then enters the LV-120 UV/H_2O_2 unit. This is a 120 kilowatt (kW) unit that contains eight 15-kW medium pressure mercury vapor lamps. Each lamp is coaxially sealed within a 1/4-inch-thick wall quartz tube. The ground water never comes into direct contact with the mercury lamps. UV light disassociates the H_2O_2 to form the hydroxyl radical ($OH^{\bullet}$). The hydroxyl radical, in conjunction with the UV light, oxidizes the VOCs to nontoxic compounds such as water, chloride ions, and carbon dioxide.

The mercury vapor lamps are housed in two oxidation chambers containing four lamps each that are constructed of welded stainless steel lined with Teflon. Teflon is used because of its UV reflective properties. The oxidation chambers are not American Society of Mechanical Engineers (ASME)-rated pressure vessels coded and therefore cannot operate at pressures greater than 20 pounds per square inch gauge (psig.) A pressure relief valve is set at 15 psig, and a rupture disk in each vessel is set to rupture at 20 psig for protection.

The UV/H_2O_2 system includes the UV lamps and an electrical control system. The TFA

control system is an OPTO-22 control unit with Paragon 500 software. The software is designed such that additional well controls and other control features can be added as necessary. The UV/H_2O_2 unit is anchored to a 10-inch-thick concrete pad.

From the LV-120, the treated ground water is pumped to the polishing aeration tank through a 4-inch Schedule 80 iron pipe. The concentration of total VOCs in water entering the polishing tank is about 10 to 20 ppb, and the aeration process usually reduces these residual VOCs in the water to concentrations less than the analytic detection limit of 0.5 ppb. The 5-hp pump in well EW-415 pumps the water from the well to the polishing tank. The polishing tank is rectangular and fabricated with 1/4-inch American Society for Testing and Materials (ASTM) A-36 steel. Since the LV-120 does not treat all of the VOCs in ground water (notably 1,1,1-TCA and 1,1-DCA), the polishing tank was needed to meet the discharge requirements specified in WDR Order No. 88-075 (Appendix A).

The steel polishing tank is painted with Simpson Cordurite paint. This paint is epoxy-based and is applied to the interior and exterior surface of the tank that was primed with zinc chromate epoxy primer. Steel baffles form five individual cells within the tank interior. The polishing tank has a capacity of 1,575 gallons, which allows the necessary residence time to complete treatment of water from the UV/H_2O_2 unit.

The supply air for the aeration comes from a Fuji VFC 703A blower. This blower has an output of 150 actual cubic feet per minute (acfm) with an operating level of 5 feet of water in the polishing tank. Four of the five interior cells have air manifolds at the bottom of each cell. These manifolds are 2-inch Schedule 80 PVC pipe with the requisite number of 5/16-inch holes to allow 150 acfm to exit the manifold and aerate the water.

Once stripped from the water, the VOCs are exhausted from the polishing tank with the aid of another Fuji VFC 703A blower. The exhausted air stream passes through a Vent-Scrub VSC-200-C carbon canister at a rate of 220 acfm where the residual VOCs are adsorbed to the carbon. Assuming the same VOC concentrations in the influent water on March 5, 1991 (see Table 5 in Section 2.2.2.2), at a flow rate of 150 gpm (78.8 million gallons/year), 9.5 pounds of VOCs are adsorbed onto the GAC per year. The ratio of adsorbed VOCs to the VSC-400 carbon mass of 2.8% per year is lower than the typical carbon loading capacity of 10%. The VSC-400 will be replaced at 78-million-gallon intervals, and the GAC will be delivered to the LLNL Hazardous Waste Management Division to be subsequently regenerated or disposed offsite at a permitted facility.

The last cell within the polishing tank contains the level controls for the discharge system. The level control system is a 120-v, single-phase system consisting of Warwick level control probes. Two 10-hp Baldor (3,450 rpm) pumps are used to discharge the treated water from the polishing tank to the Baker tanks near TFA for use in the Central Cooling Tower system in south-central LLNL, or in the recharge basin south of East Avenue. The two Baldor 480-v, three-phase pumps have the capacity to pump treated water approximately 2,500 feet through a 6-inch Schedule 80 iron pipeline to the recharge basin. Each pump has a 300-gpm rating at 20 feet of water head.

The treated effluent from TFA is discharged to the recharge basin through a 6-inch Schedule 80 iron pipeline. The total length of pipeline from TFA to the recharge basin is about 2,500 feet.

2.2.2.2. Performance

Over 35 million gallons of ground water were extracted and treated to nondetectable levels by the initial Model LV-60 UV/H_2O_2 TFA treatment system between September 1989 and May 1991. Initial testing of TFA indicated the need for an aeration polishing system to remove 1,1,1-TCA, 1,1-DCA, chloroform, and Freon 113, which were not completely destroyed by the LV-60 UV/H_2O_2 unit. Treated water from these tests was discharged to holding tanks and aerated prior to discharge to comply with regulatory discharge limits. The LV-60 VOC destruction efficiency varied during the first year of operation due to formation of a coating on the quartz tubes that house the UV lamps. Analyses of this mineral coating indicated it was rich with iron. The decrease in LV-60 efficiency did not result in exceedance of discharge limits for TFA because the polishing system reduced concentrations below the discharge limits. The maintenance program was subsequently modified to include cleaning the quartz tubes every 2 weeks to remove the coating and restore the LV-60 efficiency.

After the first year of operation, the LV-60 PCE destruction efficiency averaged 95.5% at a flow rate of 50 gpm. TCE and 1,1-DCE were destroyed to nondetectable (<0.5 ppb) levels. The polishing aeration unit successfully reduced residual VOC concentrations in water to levels below the discharge limits of 5 ppb total VOCs, and usually (about 75% of the time) to levels below the analytical detection limit of 0.5 ppb. A GAC filter, installed downstream of the air outlet of the polishing aeration unit, prevented discharge of volatilized VOCs to the atmosphere. Table 5 summarizes representative system performance results for various VOCs for the initial LV-60 facility. System performance results at the beginning of ground water extraction showed higher VOC influent concentrations than reported in Table 5 for March 5, 1991; the higher VOC influent concentrations were successfully treated to levels below discharge limits at TFA.

Table 5. Performance results (March 5, 1991) for the LV-60 unit initally installed at TFA.

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet ($ppm_{v/v}$)[a]
PCE	100	1.5	<0.5	<1
TCE	4	<0.5	<0.5	<1
1,1-DCE	9	<0.5	<0.5	<1
1,1-DCA	3	2.5	<0.5	<1
1,1,1-TCA	3	3	<0.5	<1
Chloroform	3	3.5	<0.5	<1
Freon 113	4	4	<0.5	<1

[a]Parts per million on a volume-per-volume basis.

The upgraded 150-gpm TFA facility began operation in September 1991. This upgraded system uses a Model LV-120 UV/H_2O_2 unit. Approximately 8.3 million gallons of ground water were extracted and treated by the upgraded system through June 1992. Total ground water treated by both the initial and upgraded systems is 43.7 million gallons through June 1992. The

LV-120 UV/H_2O_2 treatment system currently installed at TFA destroys the double carbon bonded PCE with greater than 98.7% efficiency. The maintenance program for the LV-120 includes cleaning the quartz tubes to prevent buildup of coating on the tubes. The polishing aeration unit successfully reduces residual VOC concentrations in water below discharge limits of 5 ppb total VOCs, and usually (about 75% of the time) to levels below the detection limit of 0.5 ppb. The influent ground water mineral content at TFA is high, and the ground water pH is between 7.3-7.4. The bicarbonate concentration is about 500 ppm, and during air stripping carbonate is precipitated out of solution. Carbonate scale is removed during the preventive maintenance of the polishing tank. A GAC filter installed downstream of the air outlet of the polishing aeration unit prevents discharge of detectable concentrations of volatilized VOCs to the atmosphere. This is consistent with LLNL policy of zero air emissions where possible. Table 6 summarizes representative system performance results for various VOCs for the upgraded facility.

Quarterly monitoring of the exhaust air stream has not yet indicated breakthrough of any VOCs through the carbon filter because of the low concentrations entering the aeration polishing unit. The GAC filter at TFA was replaced and disposed offsite at a Resource Conservation and Recovery Act (RCRA)-permitted facility once thus far. Section 4.3 describes the process for filter disposal. The VOC loading rate on the GAC filter is very low. Mass balance calculations for March 5, 1991, indicate a VOC concentration in the influent air of 70 parts per billion on a volume per volume basis ($ppb_{v/v}$) for a GAC loading rate of 3.2 pounds per year at 50 gpm (26.3 million gallons/year). The influent concentration to the GAC is much lower than the BACT requirements for effluent air. The initial VSC-200 GAC filter was disposed through LLNL Hazardous Waste Management and replaced on October 22, 1991. TFA had treated 36 million gallons by that time. Assuming the same 70 $ppb_{v/v}$ vapor concentration, the carbon had adsorbed 4.38 pounds of VOCs. The mass ratio of VOCs to GAC of 3.1% is lower than that of the typical GAC loading of 10%. The VSC-200 GAC will be replaced at 36-million-gallon intervals and the GAC will be regenerated or disposed offsite. LLNL has chosen to be conservative regarding the GAC loading by changing the carbon at about one-third of the typical capacity.

The two treatment components at TFA, the LV-120 UV/H_2O_2 and the aeration unit, have a combined treatment capacity of about 200 gpm. This represents 50 gpm excess treatment capacity for TFA in its current configuration. The addition of larger capacity blowers to the aeration unit will increase its treatment capacity. A retrofit of this nature is relatively simple and can be accomplished in several days.

The average monthly influent PCE concentration dropped from 171 to 90 ppb during the last month (May 1991) of operation of the initial LV-60 system. PCE ground water concentrations recovered slightly during the 4.5 months the facility was shut down for upgrading. The PCE influent concentration for the LV-120-based facility averaged 107 ppb for June 1992.

Table 6. Performance results (April 30, 1992) for the LV-120 unit currently installed at TFA.

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet ($ppm_{v/v}$)[a]
PCE	110	<0.5	<0.5	<1
TCE	4	<0.5	<0.5	<1
1,1-DCE	10	<0.5	<0.5	<1
1,1-DCA	2	1.7	<0.5	<1
1,1,1-TCA	3	4.2	<0.5	<1
Chloroform	4	4.1	<0.5	<1
Freon 113	1	4.5	<0.5	<1
Carbon tetrachloride	<0.5	0.8	<0.5	<1

[a]Parts per million on a volume-per-volume basis.

2.2.2.3. Controls and Safeguards

TFA is equipped with an interlock control system. If any portion of the system malfunctions, the entire system, including the associated extraction well pumps, automatically shuts down. As shown on Plate 1, pressure relief valves and pressure rupture disks will shut the system down in the event of an equipment or system overpressure. An operator will be notified of a shutdown by an alarm system. The operator must determine and correct the problem before the system can be manually restarted.

The centrifugal extraction well pumps for TFA extraction wells have thermal shutoff devices to prevent overheating due to insufficient water levels in the wells. TFA has a pressure sensor on the H_2O_2 feed line that will shut the system down if H_2O_2 system pressure is less than 18 psi. Additionally, the facility will shut down if:

- A UV lamp fails.
- Excessive temperature in the reaction chamber is detected.
- Excessive moisture accumulates in the UV lamp enclosures.
- Flow is detected from either the influent or effluent overpressure relief devices.

The TFA aeration system also has:

- Supply and exhaust blower interlocks, which prevent system operation if either blower is offline.
- A high water level sensor in aeration tanks to keep the water level below the specified level.
- A supply air pressure control that will shut the system down in the event of a pipe break.

In addition, all underground pipelines (existing and planned) from extraction wells to TFA will be double-contained with a leak detection system installed inside the outer pipe. Accessible

pipelines are visually monitored for leaks on a daily basis.

2.2.3. Discharge of Treated Ground Water

Treated ground water from TFA is discharged to the ground surface at the LLNL recharge basin. During drought conditions, part of the treated water is used in the onsite cooling towers and for onsite irrigation to reduce the amount of water imported to LLNL. Some of the water has also been piped to the drainage retention basin in central LLNL to offset evaporative losses.

The LLNL recharge basin is located about 1,000 feet due south of East Avenue (Fig. 1) within a locked security fence. The basin consists of two rectangular cells, each covering an area about 550 by 100 feet. Two adjacent recharge cells were constructed to allow periodic maintenance of the inactive cell.

Treated ground water from TFA can be discharged to either of the recharge basin cells via an existing underground pipeline. Water discharged to the recharge basin percolates through the underlying unsaturated sediments and eventually recharges the local ground water system. About 25 million gallons of treated ground water from TFA were discharged to the basin from March 1989 to June 1992 under RWQCB WDR Order No. 88-075. Daily field observations conducted for TFA self-monitoring indicate that about 90% of the water discharged to the recharge basin to date has infiltrated into the ground.

2.3. Construction and Startup Schedule and Cost Estimates

TFA was the first ground water treatment facility installed at LLNL. It was installed as part of a pilot study to evaluate treatment of VOCs in ground water in the southwest part of LLNL.

Technology evaluations and conceptual designs were conducted by ERD. Following completion of the conceptual design, LLNL Plant Engineering completed the final design that was used for construction. When necessary, subcontractors were procured through a competitive process for facility construction.

Initially, air stripping technology was selected for pilot remediation of the VOCs in the southwest portion of the LLNL ground water plume. The original conceptual design called for a 25-foot air stripping tower. However, UV/H_2O_2 technology was eventually selected because it converts many of the VOCs to harmless compounds, and because of community concerns regarding the use of air strippers.

UV/H_2O_2 technology was relatively new for ground water restoration at that time (1988), thus providing an opportunity to evaluate its technical feasibility for the LLNL site. The design of TFA was begun in August 1988 and completed the following January. Construction of the facility started in December of 1988 and was completed in March 1989 (Table 7). Construction included the steel building that houses the treatment unit, the influent and effluent pipelines, a pressure-reducing manifold, and the recharge basin located on property administered by Sandia National Laboratories south of East Avenue (Fig. 1).

Table 7. TFA design and construction schedule.

Item	Design		Construction	
	Start	End	Start	End
TFA building (including piping and power)	8/88	1/89	12/88	3/89
Air stripping tower (project abandoned)	2/88	3/88		
Recharge basin, access road, and fence	8/88	1/89	12/88	3/89
Polishing tank and installation			5/89	6/89
LV-120 design and installation	4/91	5/91	6/91	9/91

TFA was constructed by LLNL Plant Engineering labor-only forces, with the exception of the building and the East Avenue pipe crossing. The building that houses the treatment facility and the East Avenue pipe crossing was constructed by a subcontractor.

The costs associated with building construction, shown in Table 8, include design and construction costs for the influent and effluent pipelines, facility power, and power to the EW-415 wellhead. The costs associated with the recharge basin include (1) the excavations for the pipeline across East Avenue to the basin and for the east and west cells of the basin, and (2) construction of the access road to, and a fence around, the basin.

The O&M costs are typical of the first few years of operation. After the DSA and offsite pipelines are installed and operating, the labor and materials annual costs are expected to decrease by approximately 50%.

Table 8. TFA cost summary.

Item	Original costs	TFA costs with modifications	Annual O&M
TFA building (including piping and power)	$472,500	$472,500	
Recharge basin, access road, and fence	116,500	116,500	
Polishing tank and installation	20,000	20,000	
LV-60 unit	63,000	63,000	
LV-120 unit	—	150,000	
LV-120 design and installation	—	73,700	
TFA Operation & Maintenance:			
Labor			80,000
Materials			50,000
Maintenance Contract			34,000
Total	$672,000	$895,700	$164,000

In May 1991, TFA was shutdown for the installation of the larger LV-120 UV/H_2O_2 treatment unit. The larger unit was necessary to accomodate higher flow rates, as discussed above. The design and installation costs were $73,700, and the capital cost of the larger unit and ancillary equipment was $150,000.

3. Remedial Design Criteria for Treatment Facility B

3.1. TFB Design Summary

TFB is a ground water treatment facility that is located along Vasco Road about one-quarter mile north of Mesquite Way (Fig. 1). The purpose of TFB is to treat ground water containing VOCs. Ground water from extraction locations 5, 6, and 7 is pumped to hydraulically control the central part of the leading edge of the westward moving ground water plume. The contaminants in the ground water at this location in order of highest concentration are TCE at 120 ppb and carbon tetrachloride at 5.5 ppb (see Table 13, Section 3.2.2.2). In addition, 1,1-DCE, chloroform, Freon 113, and 1,1-DCA are also present in the influent ground water at concentrations of about 2.5 ppb or less. TFB consists of a commercially available UV/H_2O_2 ground water treatment unit and an air stripper. The treated effluent is discharged to an excavated drainage ditch that flows north into Arroyo Las Positas in the northwest corner of the LLNL site. TFB meets the discharge requirements specified in California RWQCB WDR Order No. 91-091 (NPDES Permit No. CA0029289).

3.2. Design Specifications

Design specifications for TFB extraction wells and piezometers and for the TFB treatment system are described in Sections 3.2.1 and 3.2.2.

3.2.1. Extraction Wells and Piezometers

Extraction locations 5, 6, and 7 will supply ground water to TFB (Fig. 1). A total of seven existing extraction wells will be pumped at these locations. Additional extraction wells and/or locations may be used if complete hydraulic capture in the TFB area is not achieved with the existing seven wells. Design types for the seven TFB extraction wells are discussed in Section 3.1.1.2 of the RAIP and shown in Table 9. TFB area extraction well and piezometer locations are shown in Figure 4. All existing and planned wells will be secured in locked enclosures.

TFB area extraction well locations are based on ground water modeling results (Chapter 3 and Appendix B in Isherwood *et al.* (1990); Tompson (1990); Tompson *et al.* (1991); and Tompson and Nichols (1993); local hydrogeology in Thorpe *et al.* (1990); and the current understanding of the distribution of VOCs. In all cases, extraction locations were selected to capture ground water from all water-bearing zones where contaminants of concern exceed MCLs. The area in the TFB vicinity where one or more VOCs in ground water exceed an MCL is shown on Figure 4.

Table 9 shows estimates of the maximum sustainable yields from each extraction well based on available hydraulic test results. Because pumping data for the TFB extraction wells are limited, the sustainable yield estimates represent maximum long-term steady-state yields. Although the estimated maximum sustainable yields on Table 9 total 68 gpm, the long-term yield

Table 9. TFB extraction well specifications.

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
Extraction location 5											
MW-218	EW-5-1	Single	30-May-86	201.0	71.0	64.5-71	62-71	First	2	10S05-9	68
EW-704	EW-5-2A	Multiple w/seal	02-Feb-91	135.0	107.0	67-76 88-97	64.5-79.5 86.5-103.0	First and second	20	25S20-11	95.5
MW-357	EW-5-3	Single	12-Jan-87	197.0	123.0	107-123	105-123	Third	20	16S10-10	115
Extraction location 6											
MW-610	EW-6-1A	Single	16-Mar-90	453.0	84.5	69-84.5	67.5-84.5	First	4	10S05-9	77
P-620	EW-6-1B	Single	30-Aug-90	206.0	88.5	75-88.5	73-88.5	First	6	5S03-9	82
P-621	EW-6-2	Single	09-Sep-90	149.0	120.0	113-120	112-120	Second	4	5S03-9	117
Extraction location 7											
MW-655	EW-7-1	Single	25-Apr-90	193.0	130.0	121-129.5	119-129.5	Fourth	12	10S05-9	125

Notes:

[a]Extraction well names provide the type of well (EW), its location (EW-1), and its depth relative to other extraction wells at the same location (e.g., EW-2-1 is shallower than EW-2-2). When multiple extraction wells are screened in the same water-bearing zone, a letter follows the zone designation (e.g., EW-2-2A, EW-2-1B, etc.).

[b]The three extraction well designs are:
single= a well screened in only one water-bearing zone;
multiple w/seal= a well screened in more than one water-bearing zone with annular grout seals between screened zones;
multiple= a fully screened and sand packed well in multiple water-bearing zones.
Additional information on these well designs and their applications is presented in the RAIP (Dresen *et al.*, 1993).

[c]Numbered consecutively downward from ground surface at each extraction location. A water-bearing zone is defined as saturated permeable sediment greater than about 3 ft thick, separated from other permeable sediments above and below by at least 5 ft of low-permeability sediments.

[d]Estimated yield based on pumping test results. Actual long-term pumping rates will generally be lower. Where the extraction well is not yet installed, estimates of sustained flow rates are shown in parentheses. These rates are based on the flow rates from nearby wells screened in similar zones and/or local hydrogeologic conditions.

[e]Pump type currently installed. All are Grundfos stainless steel submersible pumps. Nominal flow rates are: 5S03-9= 5 gpm, 10S05-9 = 10 gpm, 16S10-10 = 16 gpm, and 25S20-11 = 25 gpm.

and Nichols, 1993), local hydrogeology (Thorpe *et al.*, 1990; Isherwood *et al.*, 1990), and the current understanding of the subsurface distribution of VOCs. In all cases, extraction locations were selected to capture ground water from all water-bearing zones where contaminants of concern exceed cleanup goals [i.e., Maximum Contaminant Levels (MCLs)]. The area in the TFA vicinity where one or more VOCs in ground water exceed an MCL is shown in Figure 2.

Table 1 shows estimates of the estimated maximum sustainable yields from each extraction well based on available hydraulic test results. With the exception of EW-1-1 (existing extraction well EW-415), pumping data are relatively limited, and the estimates in Table 1 probably represent maximum long-term steady-state yields. In most cases, as long-term ground water extraction progresses, yields decline due to dewatering of shallow sediments and/or influences from distant hydraulic boundaries. Although the maximum estimated sustainable yields in Table 1 total 371 gallons per minute (gpm), the long-term yield of these wells is estimated to be about 200 gpm. If the 200-gpm flow rate is ever realized, TFA will be upgraded accordingly with regulatory oversight to treat 200 gpm.

As shown on Figure 2, we plan to monitor a network of piezometers near the extraction wells to determine hydraulic capture zones and identify areas of stagnant ground water. A network of up to 62 piezometers is planned for TFA extraction wells; 40 of these piezometers are existing monitor wells and piezometers. The 22 remaining planned piezometers are scheduled for installation in phases in FY93-95. Design specifications for the 40 existing piezometers are shown in Table 2 along with the preliminary designs for the 20 planned new piezometers. A discussion of the monitoring plan for the TFA piezometer network is presented in Section 4.2.2.

As shown in Figure 3, TFA extraction locations 3 and 4 are the key locations for establishing hydraulic control of the leading edge of the VOC plume in the TFA area. Modeling indicates the leading edge of the plume will be captured by this proposed extraction scenario. If field data indicate a portion of the plume is not being captured, additional extraction wells and piezometers will be installed to establish capture of the leading edge of the plume.

All of the planned extraction wells for locations 3 and 4, except EW-4-1 and piezometers P-3-2E, and P-4-1A through P-4-5A (Fig. 2), are installed. EW-4-1 is scheduled for installation in mid- to late 1993. All pipelines from extraction location 3 and the associated new piezometers are scheduled for installation in FY93. Pipelines from extraction location 4 are scheduled for installation in FY94. Piezometers P-3-2E and P-4-1A through P-4-5A are planned for installation on private property and may not be installed until late 1993 or early 1994, after permission to drill is obtained from the property owners. In the unlikely event permission to drill cannot be obtained, alternative locations that will achieve the required ground water objectives will be chosen with regulatory oversight.

All extraction wells will begin pumping as soon as piping to TFA is completed. Initial flow rates will be maximized to establish capture zones as quickly as possible. Hydraulic test data indicate it will take about 4 to 6 weeks for the pumping wells to establish their full hydraulic capture zones. Modeling results suggest that sustained flow rates of about 50 gpm may be required for extraction locations 2 and 3, and about 15 gpm for extraction location 4 (Fig. 2) to fully capture the downgradient plume margins. Modeling results also indicate that pumping ground water from extraction location 1, although not required for downgradient plume margin

Table 2. TFA piezometer specifications.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
Extraction location 1							
MW-254	P-1-1A	21-Nov-85	277.0	91.5	84.5-91.5	81-91.5	3
MW-263	P-1-1B	07-Apr-86	146.0	130.0	123-130	120-130	1
P-446	P-1-1C	18-Dec-87	202.0	196.0	186-196	186-196	3
MW-449	P-1-1D	07-Mar-88	172.0	165.0	152-165	150-166.5	6
MW-448	P-1-1E	17-Feb-88	235.0	127.5	120.5-127.5	118-127.5	25
P-482	P-1-1F	15-Jan-88	218.0	170.0	165-170	162.5-170	<0.5
P-483	P-1-1G	26-Jan-88	140.0	130.0	115-130	114-130	2.5
MW-406	P-1-1H	20-Jan-88	213.0	94.0	79-84	79-94	7
P-485	P-1-1I	25-Feb-88	249.0	157.0	151-157	150-157	2
TW-21	P-1-1J	07-Jul-81	111.5	95.0	85-95	56.5-100	NA
MW-376	P-1-1K	27-Aug-87	249.0	172.0	162-172	157-175	3
MW-116	P-1-1L	14-Jun-85	181.0	91.0	86-91	84-91	0.3
SIP-AS-001	P-1-1M	27-Apr-90	100.5	90.5	81-90.5	77-90.5	NA
P-484	P-1-1N	11-Feb-88	255.0	188.0	185-188	183-190	0.5
MW-1A	P-1-1O	12-Apr-84	180.0	156.0	145-156	NA	1
MW-1	P-1-1P	21-Oct-80	122.5	116.0	95-100 104-114	74-116	7
MW-451	P-1-1Q	06-Apr-88	202.0	112.0	106-112	103-112	2
P-504	P-1-1R	21-Nov-88	358.0	167.0	157-167	153-167	10
TBI	P-1-1S	—	—	—	185-200	—	—
Extraction location 2							
P-651	P-2-1A	22-Feb-90	155.0	89.0	82-89	80-89	0.5
MW-521	P-2-1B	13-Sep-89	166.0	95.0	86-95	85-95	0.5
MW-262	P-2-1C	20-Mar-86	256.0	100.0	91-100	90-100	20

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
MW-103	P-2-1D	14-Feb-85	96.0	89.5	79.5-89.5	78.5-90	7
MW-260	P-2-2A	27-Feb-86	215.0	151.0	141-151	137-151	1.5
P-603	P-2-2B	15-Nov-89	150.0	147.0	141-147	140-147	6
MW-609	P-2-2C	21-Feb-90	120.0	112.0	104-112	102-112	7
MW-143	P-2-2D	12-Apr-85	130.0	126.0	121-126	119-126	0.8
MW-518	P-2-2F	08-Aug-89	251.0	139.0	131-139	129-139	6
TBI	P-2-3A	—	—	—	230-250	—	—
TBI	P-2-3B	—	—	—	230-250	—	—
TBI	P-2-3C	—	—	—	230-250	—	—
Extraction location 3							
P-506	P-3-1A	22-Dec-88	120.0	115.0	101-115	99-114	31
P-555	P-3-1B	05-Dec-88	122.0	116.5	102.5-116.5	99-118.5	14
P-377	P-3-2A	04-Sep-87	159.0	144.0	141.5-144	135-145	2.5
P-378	P-3-2B	09-Sep-87	155.0	150.0	146-150	139-151	5
P-379	P-3-2C	14-Sep-87	155.0	150.0	146-150	139-153	5
P-554	P-3-2D	22-Nov-88	239.0	141.5	126.5-141.4	124-143	60
TBI	P-3-2E	—	—	—	135-145	—	—
Extraction location 4							
TBI	P-4-1A	—	—	—	70-90	—	—
MW-613	P-4-1B	02-May-90	93.0	88.0	81.5-88	79-88.5	15
P-604	P-4-1C	27-Nov-89	111.0	83.0	76-82	74.5-82	0.5
P-606	P-4-1D	21-Dec-89	145.0	89.0	73-89	72-89.5	2
TBI	P-4-2A	—	—	—	100-125	—	—
11J2	P-4-2B	26-Apr-79	112.0	110.0	90-92 102-108	NA	NA
MW-118	P-4-2C	19-Jul-85	206.5	110.0	99-110	98-110	10

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
TBI	P-4-3A	—	—	—	130-140	—	—
MW-612	P-4-3B	19-Apr-90	222.0	136.0	126-136	124.5-137	14
P-605	P-4-3C	08-Dec-89	246.0	136.0	130-136	128.5-136	5
TBI	P-4-4A	—	—	—	150-160	—	—
MW-264	P-4-4B	14-Apr-86	170.0	151.0	141-151	139-151	23
TBI	P-4-5A	—	—	—	170-185	—	—
MW-267	P-4-5B	27-May-86	196.0	179.0	172.5-179	170-179	0.5
MW-616	P-4-5C	14-Jun-90	255.0	188.0	178-188	176-188.5	2
Extraction location 22							
TBI	P-22-1	—	—	—	90-100	—	—
TBI	P-22-2	—	—	—	110-150	—	—
TBI	P-22-3	—	—	—	165-190	—	—
Extraction location 23							
TBI	P-23-1A	—	—	—	90-100	—	—
TBI	P-23-1B	—	—	—	90-100	—	—
TBI	P-23-2A	—	—	—	110-150	—	—
TBI	P-23-2B	—	—	—	110-150	—	—
TBI	P-23-3A	—	—	—	165-190	—	—
TBI	P-23-3B	—	—	—	165-190	—	—
Extraction location 24							
TBI	P-24-1A	—	—	—	90-100	—	—
TBI	P-24-1B	—	—	—	90-100	—	—
TBI	P-24-2A	—	—	—	110-150	—	—
TBI	P-24-2B	—	—	—	110-150	—	—
TBI	P-24-3A	—	—	—	165-190	—	—

Table 2. Continued.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
TBI	P-24-3B	—	—	—	165-190	—	—

Notes:

NA = Not available.

TBI = To be installed (FY93).

[a]Piezometer names show their location (i.e., P-24-1A is at extraction location 24) and the zone monitored (i.e., P-24-1A is screened in the first zone, as is EW-24-1). Letters following the zone designation indicate that multiple piezometers are screened in that zone.

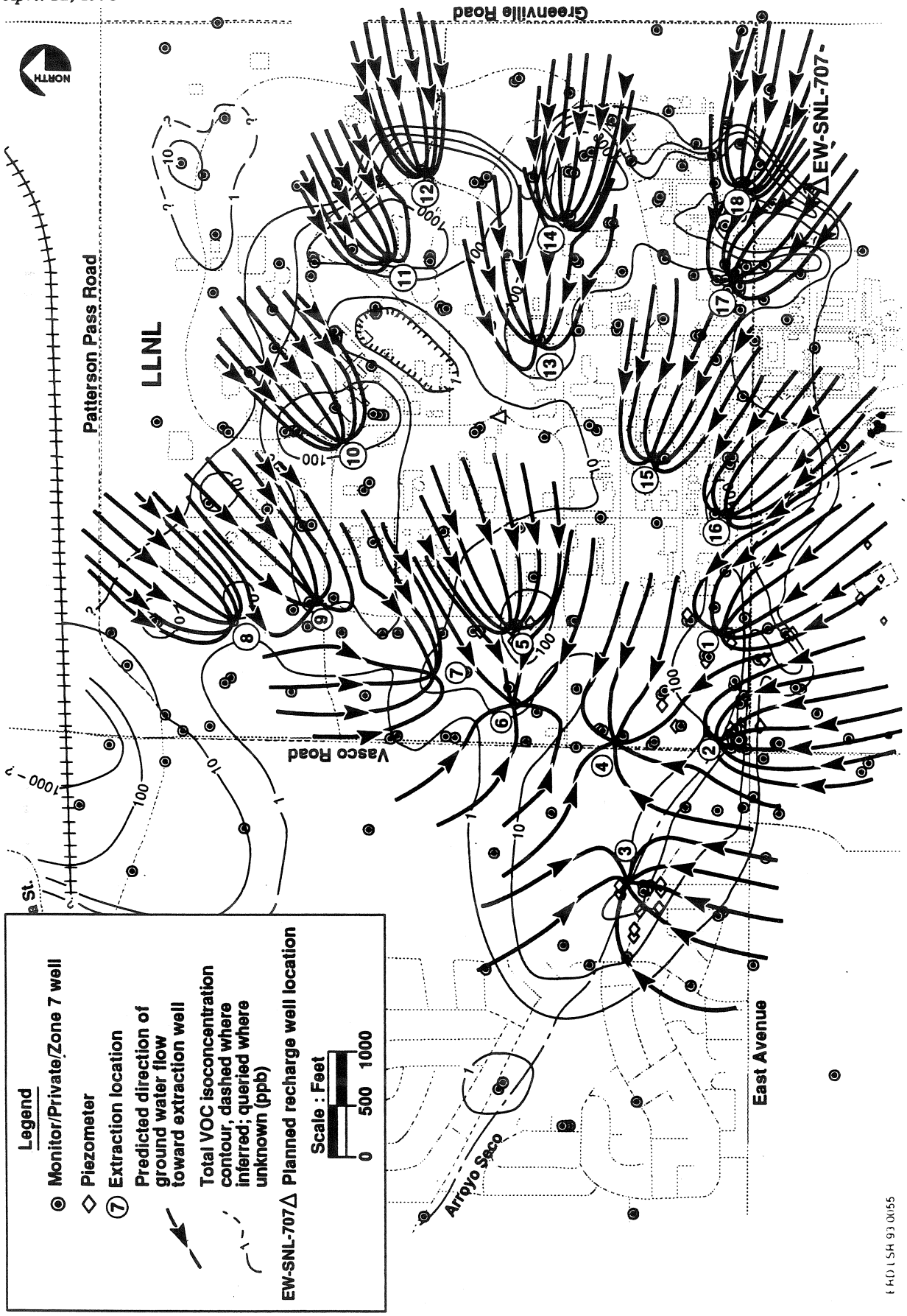

Figure 3. Extraction well hydraulic capture zones and recharge well locations (modified from the Record of Decision for the LLNL Livermore Site).

control, should decrease the estimated cleanup time.

LLNL will continue to monitor extraction flow rates, and ground water elevation and chemistry data to determine if the planned extraction scenario is completely capturing the VOC plumes. Determination of full plume capture will be established in collaboration with the regulatory agencies. If actual flow rates are substantially lower and/or the observed steady state drawdown fails to capture any part of the plume margin, additional extraction wells will be installed. The locations of these wells will be based on field water level data and recalibrated modeling results. If additional extraction wells are needed to establish full hydraulic capture of the VOC plume in the TFA area, we estimate that the new wells, piezometers, and pipelines would be installed and operating about one year later. The UV/H_2O_2 unit installed at TFA is capable of treating 200 gpm of ground water. The aeration tank to polish the effluent from the UV/H_2O_2 unit can currently treat up to 150 gpm. Upgrading TFA to treat 200 gpm, if necessary, would require a relatively short time period, because the upgrade only involves replacing or increasing the treatment capacity of the aeration tank. Thus, it is estimated that full hydraulic capture of the VOC plume in the TFA area should be established by late 1994, assuming that only one set of additional extraction wells is necessary.

2.2.2. TFA Specifications, Design, Performance, Controls, and Safeguards

The specifications, design, performance, controls, and safeguards for TFA and its associated piping are described in Sections 2.2.2.1 through 2.2.2.3.

2.2.2.1. Specifications and Design

TFA was originally designed, built, and operated to treat up to 100 gpm of ground water extracted from the southwest portion of the Livermore Site VOC plume. Initially, ground water was pumped only from extraction well EW-415 (extraction location 1) (Fig. 2). Later, the design flow rate was increased to 150 gpm to accomodate additional ground water pumped from the Detailed Study Area (DSA) (extraction location 2) in the southwest corner of the LLNL site, extraction locations 3 and 4, and planned additional wells located along Arroyo Seco west of LLNL (extraction locations 22-24). LLNL informed the RWQCB of the planned TFA flow rate increase. The RWQCB indicated that the Waste Discharge Requirement (WDR) permits (Appendix A) did not require amendment or reissue until such time as the originally specified 100-gpm limit in the permit is to be exceeded. LLNL is to notify the RWQCB 120 days in advance with a Waste Discharge Report, indicating the expected schedule for exceeding the 100 gpm limit. At that time, the RWQCB will decide whether to issue a new permit or amend the present permit.

VOCs are the chemicals of concern to be remediated by TFA. Design VOC influent concentrations from the LLNL FS (Isherwood *et al.*, 1990) are shown in Table 3. RWQCB Waste Discharge Requirement (WDR) Order No. 88-075 (included in Appendix A) limits the TFA effluent concentration to less than 5 ppb total VOCs. WDR Order No. 88-075 was adopted by the RWQCB on May 18, 1988, and has no expiration date. Bay Area Air Quality Management District's (BAAQMD) Best Available Control Technology (BACT) guidelines (BAAQMD, 1992) will be met by limiting atmospheric VOC emissions to concentrations less than 6 parts per million on a volume per volume basis ($ppm_{v/v}$).

Table 3. Design influent concentrations for TFA (from Isherwood *et al.*, 1990).

Constituent	Concentration (ppb)	
	Maximum influent	Average influent
PCE	350	280
TCE	9	7
1,1-DCE	15	12
1,2-DCE (cis and trans)	5	4
1,1,1-TCA	6	5
1,1-DCA	6	5
Chloroform	13	10
Freon 113	6	5

The specifications and design for TFA are presented below. The component specifications are presented in Table 4, and a piping and instrument diagram (P&ID) is presented in Plate 1*.

TFA is enclosed in a steel prefabricated (Butler type) building with outside dimensions of 25 x 15 x 12 feet. The building is insulated and lined with steel paneling on the interior. The structure rests on a 4-in. thick concrete (3,000 pounds per square inch [psi] rating) pad with steel rebar. A 10-in. thick concrete pad with steel rebar was installed for the LV-120 foundation. The building is constructed to the requirements of the Uniform Building Code, including the California seismic codes. For maintenance access, there is a 10 x 10 foot roll-up door on the front side of the building.

Ground water containing VOCs is extracted for treatment using Grundfos submersible pumps. These pumps are centrifugal stainless steel with a variety of horsepower (hp) and flow ratings. For extraction well EW-415 (extraction location 1), a 5-hp (3,450 revolutions per minute or rpm) Grundfos 75S50-8 pump was selected with a nominal rating of 80 gpm at 150 feet of head. The pump is powered by a 480-volt (v), three-phase motor. The pump also has a control circuit that will initiate a shutdown in the event of cavitation due to the loss of a net positive suction head. The pump is screened and has thermal overload protection. The pump controller has a circuit breaker for overload protection.

From the wellhead, the ground water is pumped to TFA through a 3-inch iron Schedule 80 pipeline. The distance from extraction well EW-415 to TFA is approximately 1,200 feet.

The influent to TFA from extraction location 2 (Fig. 1) is pumped through a buried double-walled pipeline that is instrumented with a leak detection system. This pipeline consists of a polypropylene, 3-inch, Schedule 80 inner pipeline surrounded by a 6-inch Schedule 40 outer pipeline. The leak detection system is a Trace Tek 300 Longline System manufactured by Raychem Corporation that is monitored and alarmed at TFA. This sytem is installed within the 6-inch outer pipeline and will simultaneously detect the presence of aqueous fluids at any point along the cable's length, sound an alarm at TFA, and pinpoint the distance from TFA to the leak.

* Plate 1 is located in a pocket inside the back cover of this report.

Table 4. Summary of TFA facility component specifications.

Component	Specification
TFA building	Steel prefabricated (Butler type) 25 x 15 x 12 feet
Concrete pad	4 inches with rebar (3,000 psi rating)
LV-120 foundation	10-inch concrete with rebar (3,000 psi rating)
Extraction well pump	Grundfos 75S50-8, 5 hp at 3,450 rpm, 480 v, 3-phase motor
Influent pipe line	Schedule 80 iron
Pressure reducing valve	Fisher control valve FS92W-165
Pressure regulator	Fisher 6492H
Over-pressure relief valve	3-inch Bailey pressure relief valve Model No. 118 9-25, Serial No. 81258
Filter canister	Cuno 12 DC3, stainless steel
Filter cartridges	Honeycomb Parker Hannifin Corporation Model No. M23R29-4A, 15 gpm at 0-2 psi differential pressure
H_2O_2 feed pumps	Liquid Metronics, Inc., Model No. A151-192SPX, 24 gallons per day (150 psi maximum)
H_2O_2 injection tubing	304 stainless steel, 0.035-inch wall thickness
H_2O_2 storage tanks	500-gallon polyethylene 1/4-inch single wall with 1/4-inch single wall double-containment shell
H_2O_2 splash containment	316 stainless steel 78 x 79 x 8 inches
LV-120 UV/H_2O_2	480-v, 3-phase, 60 Hz, with eight 15 kW medium pressure Hg vapor lamps
LV-120 oxidation chamber	Welded stainless steel, not ASME coded for pressure
LV-120 control system	OPTO-22 control unit with Paragon 500 control software
Polishing tank	1,575 gallon 1/4-inch ASTM A-36 steel
Polishing tank protective paint	Simpson Cordurite epoxy paint with zinc chromate epoxy primer
Supply and exhaust air blowers	Fuji 703
Supply air manifolds	2-inch Schedule 80 PVC
Carbon filter	Vent-Scrub VSC-200-C
Level control system	Warwick level control probes 120-v, single phase
Discharge pumps	Baldor 10-Hp, 480-v, 3-phase, 300 gpm
Influent pipeline from DSA cluster	Double-walled, polypropylene 3-inch Schedule 80 inner; 6-inch Schedule 40 outer
Influent pipeline from extraction location 3 (offsite Susan Lane)	Double-walled, polypropylene 3-inch Schedule 80 inner; 6-inch Schedule 40 outer
Leak detection system extraction location 2 pipelines	Trace Tek 300 Longline System, Raychem Corporation

The planned pipelines from extraction locations 3, 22, 23, and 24 to TFA will be constructed of the same double-walled polypropylene pipe and will be instrumented with an identical leak detection system to that described above.

The current plan for extraction location 4 is to pump the ground water to TFA through an above-grade Schedule 80 iron pipeline. The influent from extraction location 4 will pass through the pressure-reducing valve, enter the filter packs, and then enter the LV-120 UV/H_2O_2 unit for treatment.

Once at TFA, the ground water passes through a pressure-reducing valve. The valve reduces the in-line pressure from 80 to 100 pounds per square inch (psi) to about 10 to 12 psi. The valve is a 3-inch adjustable mechanical disc Fisher control valve FS92W-165 with a Fisher pressure regulator model 6492H. Ground water then enters a Cuno 12 DC3 stainless steel filter cannister with 12 30-inch-long polypropylene core filter cartridges. Each honeycomb cartridge (Parker Hannifin Corporation Model No. M23R29-4A) has a 1-inch inside diameter (ID) and 2 1/2-inch outside diameter (OD) and is rated at 15 gpm with a 0 to 2 psi pressure drop. Therefore, the pressure drop across the entire filter pack is about 2 psi, and the ground water enters the UV/H_2O_2 treatment unit at about 8 to 10 psi.

Before entering the UV/H_2O_2 treatment unit, H_2O_2 is injected into the influent stream of ground water. Two feed pumps are used to inject the H_2O_2. These pumps are Liquid Metronics, Inc., Model No. A151-192SPX positive displacement diaphragm pumps. Each pump has an adjustable stroke length and stroke frequency to vary the amount of H_2O_2 injected when necessary. The 50% H_2O_2 solution is stored in a 500-gallon, 1/4-inch-thick single-wall, polyethylene tank. Outside of this storage tank is another polyethylene single-wall shell that provides secondary containment. The H_2O_2 storage tank and its double containment rest on a raised steel pallet. Underneath the steel pallet is a 78- x 79- x 8-inch stainless steel rectangular pan that provides triple or tertiary containment. The whole assembly, including the H_2O_2 double containment, rests on a concrete floor that is 4 inches thick.

The H_2O_2 pumps can deliver 24 gallons per day at 150 psi maximum discharge head. The H_2O_2 is pumped through 1/4-inch 304 stainless steel tubing with a wall thickness of 0.035 inches.

After H_2O_2 injection, the ground water containing VOCs then enters the LV-120 UV/H_2O_2 unit. This is a 120 kilowatt (kW) unit that contains eight 15-kW medium pressure mercury vapor lamps. Each lamp is coaxially sealed within a 1/4-inch-thick wall quartz tube. The ground water never comes into direct contact with the mercury lamps. UV light disassociates the H_2O_2 to form the hydroxyl radical ($OH^{\bullet}$). The hydroxyl radical, in conjunction with the UV light, oxidizes the VOCs to nontoxic compounds such as water, chloride ions, and carbon dioxide.

The mercury vapor lamps are housed in two oxidation chambers containing four lamps each that are constructed of welded stainless steel lined with Teflon. Teflon is used because of its UV reflective properties. The oxidation chambers are not American Society of Mechanical Engineers (ASME)-rated pressure vessels coded and therefore cannot operate at pressures greater than 20 pounds per square inch gauge (psig.) A pressure relief valve is set at 15 psig, and a rupture disk in each vessel is set to rupture at 20 psig for protection.

The UV/H_2O_2 system includes the UV lamps and an electrical control system. The TFA

control system is an OPTO-22 control unit with Paragon 500 software. The software is designed such that additional well controls and other control features can be added as necessary. The UV/H_2O_2 unit is anchored to a 10-inch-thick concrete pad.

From the LV-120, the treated ground water is pumped to the polishing aeration tank through a 4-inch Schedule 80 iron pipe. The concentration of total VOCs in water entering the polishing tank is about 10 to 20 ppb, and the aeration process usually reduces these residual VOCs in the water to concentrations less than the analytic detection limit of 0.5 ppb. The 5-hp pump in well EW-415 pumps the water from the well to the polishing tank. The polishing tank is rectangular and fabricated with 1/4-inch American Society for Testing and Materials (ASTM) A-36 steel. Since the LV-120 does not treat all of the VOCs in ground water (notably 1,1,1-TCA and 1,1-DCA), the polishing tank was needed to meet the discharge requirements specified in WDR Order No. 88-075 (Appendix A).

The steel polishing tank is painted with Simpson Cordurite paint. This paint is epoxy-based and is applied to the interior and exterior surface of the tank that was primed with zinc chromate epoxy primer. Steel baffles form five individual cells within the tank interior. The polishing tank has a capacity of 1,575 gallons, which allows the necessary residence time to complete treatment of water from the UV/H_2O_2 unit.

The supply air for the aeration comes from a Fuji VFC 703A blower. This blower has an output of 150 actual cubic feet per minute (acfm) with an operating level of 5 feet of water in the polishing tank. Four of the five interior cells have air manifolds at the bottom of each cell. These manifolds are 2-inch Schedule 80 PVC pipe with the requisite number of 5/16-inch holes to allow 150 acfm to exit the manifold and aerate the water.

Once stripped from the water, the VOCs are exhausted from the polishing tank with the aid of another Fuji VFC 703A blower. The exhausted air stream passes through a Vent-Scrub VSC-200-C carbon canister at a rate of 220 acfm where the residual VOCs are adsorbed to the carbon. Assuming the same VOC concentrations in the influent water on March 5, 1991 (see Table 5 in Section 2.2.2.2), at a flow rate of 150 gpm (78.8 million gallons/year), 9.5 pounds of VOCs are adsorbed onto the GAC per year. The ratio of adsorbed VOCs to the VSC-400 carbon mass of 2.8% per year is lower than the typical carbon loading capacity of 10%. The VSC-400 will be replaced at 78-million-gallon intervals, and the GAC will be delivered to the LLNL Hazardous Waste Management Division to be subsequently regenerated or disposed offsite at a permitted facility.

The last cell within the polishing tank contains the level controls for the discharge system. The level control system is a 120-v, single-phase system consisting of Warwick level control probes. Two 10-hp Baldor (3,450 rpm) pumps are used to discharge the treated water from the polishing tank to the Baker tanks near TFA for use in the Central Cooling Tower system in south-central LLNL, or in the recharge basin south of East Avenue. The two Baldor 480-v, three-phase pumps have the capacity to pump treated water approximately 2,500 feet through a 6-inch Schedule 80 iron pipeline to the recharge basin. Each pump has a 300-gpm rating at 20 feet of water head.

The treated effluent from TFA is discharged to the recharge basin through a 6-inch Schedule 80 iron pipeline. The total length of pipeline from TFA to the recharge basin is about 2,500 feet.

2.2.2.2. Performance

Over 35 million gallons of ground water were extracted and treated to nondetectable levels by the initial Model LV-60 UV/H_2O_2 TFA treatment system between September 1989 and May 1991. Initial testing of TFA indicated the need for an aeration polishing system to remove 1,1,1-TCA, 1,1-DCA, chloroform, and Freon 113, which were not completely destroyed by the LV-60 UV/H_2O_2 unit. Treated water from these tests was discharged to holding tanks and aerated prior to discharge to comply with regulatory discharge limits. The LV-60 VOC destruction efficiency varied during the first year of operation due to formation of a coating on the quartz tubes that house the UV lamps. Analyses of this mineral coating indicated it was rich with iron. The decrease in LV-60 efficiency did not result in exceedance of discharge limits for TFA because the polishing system reduced concentrations below the discharge limits. The maintenance program was subsequently modified to include cleaning the quartz tubes every 2 weeks to remove the coating and restore the LV-60 efficiency.

After the first year of operation, the LV-60 PCE destruction efficiency averaged 95.5% at a flow rate of 50 gpm. TCE and 1,1-DCE were destroyed to nondetectable (<0.5 ppb) levels. The polishing aeration unit successfully reduced residual VOC concentrations in water to levels below the discharge limits of 5 ppb total VOCs, and usually (about 75% of the time) to levels below the analytical detection limit of 0.5 ppb. A GAC filter, installed downstream of the air outlet of the polishing aeration unit, prevented discharge of volatilized VOCs to the atmosphere. Table 5 summarizes representative system performance results for various VOCs for the initial LV-60 facility. System performance results at the beginning of ground water extraction showed higher VOC influent concentrations than reported in Table 5 for March 5, 1991; the higher VOC influent concentrations were successfully treated to levels below discharge limits at TFA.

Table 5. Performance results (March 5, 1991) for the LV-60 unit initally installed at TFA.

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet ($ppm_{v/v}$)[a]
PCE	100	1.5	<0.5	<1
TCE	4	<0.5	<0.5	<1
1,1-DCE	9	<0.5	<0.5	<1
1,1-DCA	3	2.5	<0.5	<1
1,1,1-TCA	3	3	<0.5	<1
Chloroform	3	3.5	<0.5	<1
Freon 113	4	4	<0.5	<1

[a]Parts per million on a volume-per-volume basis.

The upgraded 150-gpm TFA facility began operation in September 1991. This upgraded system uses a Model LV-120 UV/H_2O_2 unit. Approximately 8.3 million gallons of ground water were extracted and treated by the upgraded system through June 1992. Total ground water treated by both the initial and upgraded systems is 43.7 million gallons through June 1992. The

LV-120 UV/H_2O_2 treatment system currently installed at TFA destroys the double carbon bonded PCE with greater than 98.7% efficiency. The maintenance program for the LV-120 includes cleaning the quartz tubes to prevent buildup of coating on the tubes. The polishing aeration unit successfully reduces residual VOC concentrations in water below discharge limits of 5 ppb total VOCs, and usually (about 75% of the time) to levels below the detection limit of 0.5 ppb. The influent ground water mineral content at TFA is high, and the ground water pH is between 7.3-7.4. The bicarbonate concentration is about 500 ppm, and during air stripping carbonate is precipitated out of solution. Carbonate scale is removed during the preventive maintenance of the polishing tank. A GAC filter installed downstream of the air outlet of the polishing aeration unit prevents discharge of detectable concentrations of volatilized VOCs to the atmosphere. This is consistent with LLNL policy of zero air emissions where possible. Table 6 summarizes representative system performance results for various VOCs for the upgraded facility.

Quarterly monitoring of the exhaust air stream has not yet indicated breakthrough of any VOCs through the carbon filter because of the low concentrations entering the aeration polishing unit. The GAC filter at TFA was replaced and disposed offsite at a Resource Conservation and Recovery Act (RCRA)-permitted facility once thus far. Section 4.3 describes the process for filter disposal. The VOC loading rate on the GAC filter is very low. Mass balance calculations for March 5, 1991, indicate a VOC concentration in the influent air of 70 parts per billion on a volume per volume basis ($ppb_{v/v}$) for a GAC loading rate of 3.2 pounds per year at 50 gpm (26.3 million gallons/year). The influent concentration to the GAC is much lower than the BACT requirements for effluent air. The initial VSC-200 GAC filter was disposed through LLNL Hazardous Waste Management and replaced on October 22, 1991. TFA had treated 36 million gallons by that time. Assuming the same 70 $ppb_{v/v}$ vapor concentration, the carbon had adsorbed 4.38 pounds of VOCs. The mass ratio of VOCs to GAC of 3.1% is lower than that of the typical GAC loading of 10%. The VSC-200 GAC will be replaced at 36-million-gallon intervals and the GAC will be regenerated or disposed offsite. LLNL has chosen to be conservative regarding the GAC loading by changing the carbon at about one-third of the typical capacity.

The two treatment components at TFA, the LV-120 UV/H_2O_2 and the aeration unit, have a combined treatment capacity of about 200 gpm. This represents 50 gpm excess treatment capacity for TFA in its current configuration. The addition of larger capacity blowers to the aeration unit will increase its treatment capacity. A retrofit of this nature is relatively simple and can be accomplished in several days.

The average monthly influent PCE concentration dropped from 171 to 90 ppb during the last month (May 1991) of operation of the initial LV-60 system. PCE ground water concentrations recovered slightly during the 4.5 months the facility was shut down for upgrading. The PCE influent concentration for the LV-120-based facility averaged 107 ppb for June 1992.

Table 6. Performance results (April 30, 1992) for the LV-120 unit currently installed at TFA.

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet ($ppm_{v/v}$)[a]
PCE	110	<0.5	<0.5	<1
TCE	4	<0.5	<0.5	<1
1,1-DCE	10	<0.5	<0.5	<1
1,1-DCA	2	1.7	<0.5	<1
1,1,1-TCA	3	4.2	<0.5	<1
Chloroform	4	4.1	<0.5	<1
Freon 113	1	4.5	<0.5	<1
Carbon tetrachloride	<0.5	0.8	<0.5	<1

[a]Parts per million on a volume-per-volume basis.

2.2.2.3. Controls and Safeguards

TFA is equipped with an interlock control system. If any portion of the system malfunctions, the entire system, including the associated extraction well pumps, automatically shuts down. As shown on Plate 1, pressure relief valves and pressure rupture disks will shut the system down in the event of an equipment or system overpressure. An operator will be notified of a shutdown by an alarm system. The operator must determine and correct the problem before the system can be manually restarted.

The centrifugal extraction well pumps for TFA extraction wells have thermal shutoff devices to prevent overheating due to insufficient water levels in the wells. TFA has a pressure sensor on the H_2O_2 feed line that will shut the system down if H_2O_2 system pressure is less than 18 psi. Additionally, the facility will shut down if:

- A UV lamp fails.
- Excessive temperature in the reaction chamber is detected.
- Excessive moisture accumulates in the UV lamp enclosures.
- Flow is detected from either the influent or effluent overpressure relief devices.

The TFA aeration system also has:

- Supply and exhaust blower interlocks, which prevent system operation if either blower is offline.
- A high water level sensor in aeration tanks to keep the water level below the specified level.
- A supply air pressure control that will shut the system down in the event of a pipe break.

In addition, all underground pipelines (existing and planned) from extraction wells to TFA will be double-contained with a leak detection system installed inside the outer pipe. Accessible

pipelines are visually monitored for leaks on a daily basis.

2.2.3. Discharge of Treated Ground Water

Treated ground water from TFA is discharged to the ground surface at the LLNL recharge basin. During drought conditions, part of the treated water is used in the onsite cooling towers and for onsite irrigation to reduce the amount of water imported to LLNL. Some of the water has also been piped to the drainage retention basin in central LLNL to offset evaporative losses.

The LLNL recharge basin is located about 1,000 feet due south of East Avenue (Fig. 1) within a locked security fence. The basin consists of two rectangular cells, each covering an area about 550 by 100 feet. Two adjacent recharge cells were constructed to allow periodic maintenance of the inactive cell.

Treated ground water from TFA can be discharged to either of the recharge basin cells via an existing underground pipeline. Water discharged to the recharge basin percolates through the underlying unsaturated sediments and eventually recharges the local ground water system. About 25 million gallons of treated ground water from TFA were discharged to the basin from March 1989 to June 1992 under RWQCB WDR Order No. 88-075. Daily field observations conducted for TFA self-monitoring indicate that about 90% of the water discharged to the recharge basin to date has infiltrated into the ground.

2.3. Construction and Startup Schedule and Cost Estimates

TFA was the first ground water treatment facility installed at LLNL. It was installed as part of a pilot study to evaluate treatment of VOCs in ground water in the southwest part of LLNL.

Technology evaluations and conceptual designs were conducted by ERD. Following completion of the conceptual design, LLNL Plant Engineering completed the final design that was used for construction. When necessary, subcontractors were procured through a competitive process for facility construction.

Initially, air stripping technology was selected for pilot remediation of the VOCs in the southwest portion of the LLNL ground water plume. The original conceptual design called for a 25-foot air stripping tower. However, UV/H_2O_2 technology was eventually selected because it converts many of the VOCs to harmless compounds, and because of community concerns regarding the use of air strippers.

UV/H_2O_2 technology was relatively new for ground water restoration at that time (1988), thus providing an opportunity to evaluate its technical feasibility for the LLNL site. The design of TFA was begun in August 1988 and completed the following January. Construction of the facility started in December of 1988 and was completed in March 1989 (Table 7). Construction included the steel building that houses the treatment unit, the influent and effluent pipelines, a pressure-reducing manifold, and the recharge basin located on property administered by Sandia National Laboratories south of East Avenue (Fig. 1).

Table 7. TFA design and construction schedule.

Item	Design		Construction	
	Start	End	Start	End
TFA building (including piping and power)	8/88	1/89	12/88	3/89
Air stripping tower (project abandoned)	2/88	3/88		
Recharge basin, access road, and fence	8/88	1/89	12/88	3/89
Polishing tank and installation			5/89	6/89
LV-120 design and installation	4/91	5/91	6/91	9/91

TFA was constructed by LLNL Plant Engineering labor-only forces, with the exception of the building and the East Avenue pipe crossing. The building that houses the treatment facility and the East Avenue pipe crossing was constructed by a subcontractor.

The costs associated with building construction, shown in Table 8, include design and construction costs for the influent and effluent pipelines, facility power, and power to the EW-415 wellhead. The costs associated with the recharge basin include (1) the excavations for the pipeline across East Avenue to the basin and for the east and west cells of the basin, and (2) construction of the access road to, and a fence around, the basin.

The O&M costs are typical of the first few years of operation. After the DSA and offsite pipelines are installed and operating, the labor and materials annual costs are expected to decrease by approximately 50%.

Table 8. TFA cost summary.

Item	Original costs	TFA costs with modifications	Annual O&M
TFA building (including piping and power)	$472,500	$472,500	
Recharge basin, access road, and fence	116,500	116,500	
Polishing tank and installation	20,000	20,000	
LV-60 unit	63,000	63,000	
LV-120 unit	—	150,000	
LV-120 design and installation	—	73,700	
TFA Operation & Maintenance:			
Labor			80,000
Materials			50,000
Maintenance Contract			34,000
Total	$672,000	$895,700	$164,000

In May 1991, TFA was shutdown for the installation of the larger LV-120 UV/H_2O_2 treatment unit. The larger unit was necessary to accomodate higher flow rates, as discussed above. The design and installation costs were $73,700, and the capital cost of the larger unit and ancillary equipment was $150,000.

3. Remedial Design Criteria for Treatment Facility B

3.1. TFB Design Summary

TFB is a ground water treatment facility that is located along Vasco Road about one-quarter mile north of Mesquite Way (Fig. 1). The purpose of TFB is to treat ground water containing VOCs. Ground water from extraction locations 5, 6, and 7 is pumped to hydraulically control the central part of the leading edge of the westward moving ground water plume. The contaminants in the ground water at this location in order of highest concentration are TCE at 120 ppb and carbon tetrachloride at 5.5 ppb (see Table 13, Section 3.2.2.2). In addition, 1,1-DCE, chloroform, Freon 113, and 1,1-DCA are also present in the influent ground water at concentrations of about 2.5 ppb or less. TFB consists of a commercially available UV/H_2O_2 ground water treatment unit and an air stripper. The treated effluent is discharged to an excavated drainage ditch that flows north into Arroyo Las Positas in the northwest corner of the LLNL site. TFB meets the discharge requirements specified in California RWQCB WDR Order No. 91-091 (NPDES Permit No. CA0029289).

3.2. Design Specifications

Design specifications for TFB extraction wells and piezometers and for the TFB treatment system are described in Sections 3.2.1 and 3.2.2.

3.2.1. Extraction Wells and Piezometers

Extraction locations 5, 6, and 7 will supply ground water to TFB (Fig. 1). A total of seven existing extraction wells will be pumped at these locations. Additional extraction wells and/or locations may be used if complete hydraulic capture in the TFB area is not achieved with the existing seven wells. Design types for the seven TFB extraction wells are discussed in Section 3.1.1.2 of the RAIP and shown in Table 9. TFB area extraction well and piezometer locations are shown in Figure 4. All existing and planned wells will be secured in locked enclosures.

TFB area extraction well locations are based on ground water modeling results (Chapter 3 and Appendix B in Isherwood *et al.* (1990); Tompson (1990); Tompson *et al.* (1991); and Tompson and Nichols (1993); local hydrogeology in Thorpe *et al.* (1990); and the current understanding of the distribution of VOCs. In all cases, extraction locations were selected to capture ground water from all water-bearing zones where contaminants of concern exceed MCLs. The area in the TFB vicinity where one or more VOCs in ground water exceed an MCL is shown on Figure 4.

Table 9 shows estimates of the maximum sustainable yields from each extraction well based on available hydraulic test results. Because pumping data for the TFB extraction wells are limited, the sustainable yield estimates represent maximum long-term steady-state yields. Although the estimated maximum sustainable yields on Table 9 total 68 gpm, the long-term yield

Table 9. TFB extraction well specifications.

Well name	Extraction well name[a]	Well design[b]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Water-bearing zone[c]	Estimated maximum long-term steady state yield (gpm)[d]	Pump type[e]	Pump intake depth (ft)
Extraction location 5											
MW-218	EW-5-1	Single	30-May-86	201.0	71.0	64.5-71	62-71	First	2	10S05-9	68
EW-704	EW-5-2A	Multiple w/seal	02-Feb-91	135.0	107.0	67-76 88-97	64.5-79.5 86.5-103.0	First and second	20	25S20-11	95.5
MW-357	EW-5-3	Single	12-Jan-87	197.0	123.0	107-123	105-123	Third	20	16S10-10	115
Extraction location 6											
MW-610	EW-6-1A	Single	16-Mar-90	453.0	84.5	69-84.5	67.5-84.5	First	4	10S05-9	77
P-620	EW-6-1B	Single	30-Aug-90	206.0	88.5	75-88.5	73-88.5	First	6	5S03-9	82
P-621	EW-6-2	Single	09-Sep-90	149.0	120.0	113-120	112-120	Second	4	5S03-9	117
Extraction location 7											
MW-655	EW-7-1	Single	25-Apr-90	193.0	130.0	121-129.5	119-129.5	Fourth	12	10S05-9	125

Notes:

[a]Extraction well names provide the type of well (EW), its location (EW-1), and its depth relative to other extraction wells at the same location (e.g., EW-2-1 is shallower than EW-2-2). When multiple extraction wells are screened in the same water-bearing zone, a letter follows the zone designation (e.g., EW-2-2A, EW-2-1B, etc.).

[b]The three extraction well designs are:
single= a well screened in only one water-bearing zone;
multiple w/seal= a well screened in more than one water-bearing zone with annular grout seals between screened zones;
multiple= a fully screened and sand packed well in multiple water-bearing zones.
Additional information on these well designs and their applications is presented in the RAIP (Dresen *et al.*, 1993).

[c]Numbered consecutively downward from ground surface at each extraction location. A water-bearing zone is defined as saturated permeable sediment greater than about 3 ft thick, separated from other permeable sediments above and below by at least 5 ft of low-permeability sediments.

[d]Estimated yield based on pumping test results. Actual long-term pumping rates will generally be lower. Where the extraction well is not yet installed, estimates of sustained flow rates are shown in parentheses. These rates are based on the flow rates from nearby wells screened in similar zones and/or local hydrogeologic conditions.

[e]Pump type currently installed. All are Grundfos stainless steel submersible pumps. Nominal flow rates are: 5S03-9= 5 gpm, 10S05-9 = 10 gpm, 16S10-10 = 16 gpm, and 25S20-11 = 25 gpm.

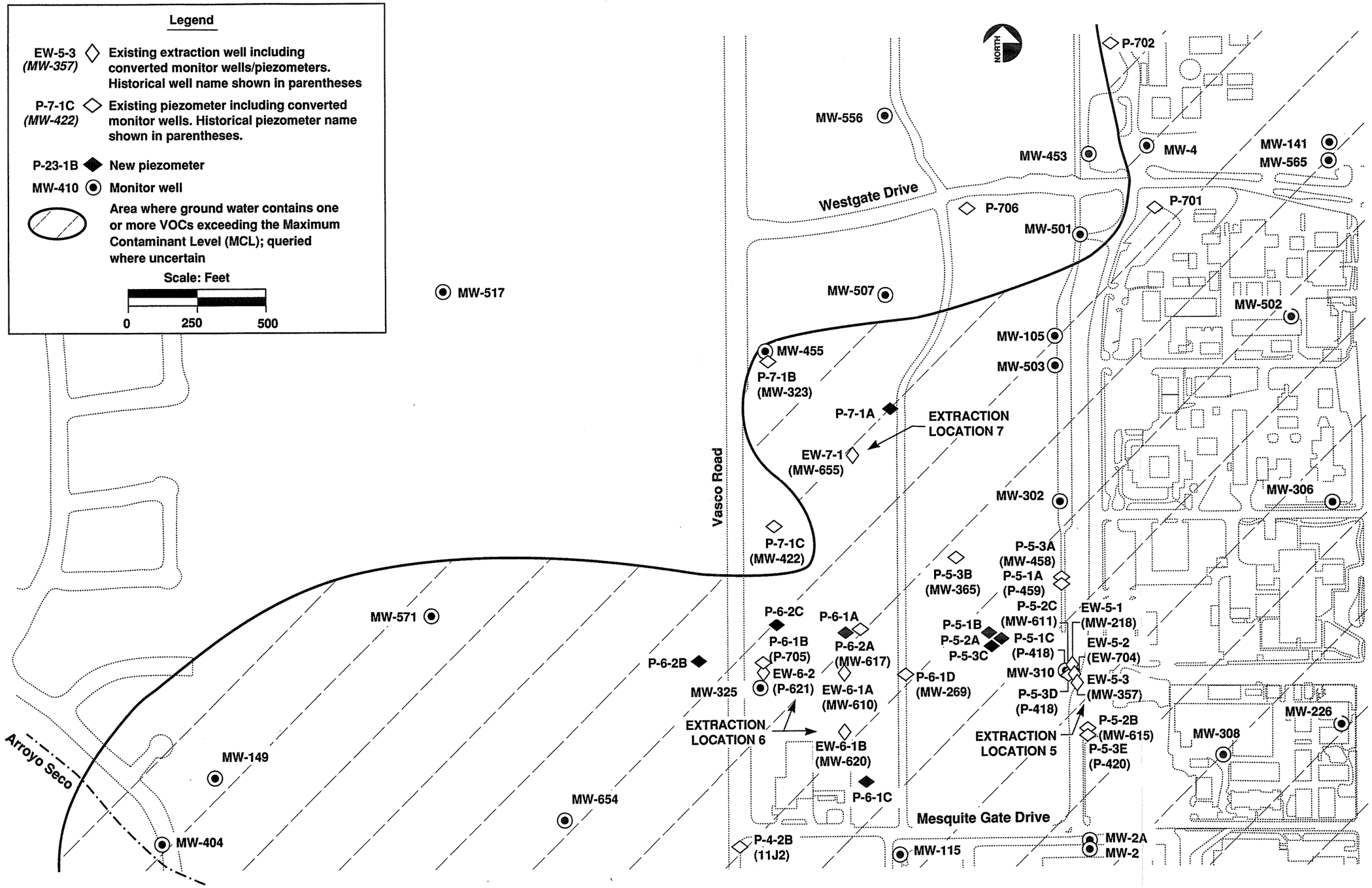

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Figure 4. TFB area extraction well and piezometer locations.

of these wells will probably be about 40 gpm.

As shown in Figure 4, a network of piezometers surrounding the TFB extraction wells will be monitored to determine hydraulic capture zones and identify areas of stagnant ground water. A network of 19 piezometers is planned for TFB extraction wells. Twelve of these piezometers are existing monitor wells and piezometers, and the seven remaining piezometers are planned for installation in phases in FY93-95. Design specifications for the 12 existing piezometers are shown in Table 10 along with the preliminary designs for the 7 planned piezometers. A discussion of the monitoring plan for the TFB piezometers is presented in Section 4.2.2.

TFB was designed to treat up to 100 gpm of ground water extracted from the western portion of the VOC plume. The influent VOC design concentrations for TFB are shown in Table 11.

As shown in Figure 3, TFB extraction locations 6 and 7 are the key locations for establishing hydraulic control of the leading edge of the VOC plume in the TFB area. Modeling indicates the leading edge of the plume will be captured by this proposed extraction scenario. If field data indicate a portion of the plume is not being captured, additional extraction wells and piezometers will be installed to establish capture of the leading edge of the plume.

All of the wells at extraction locations 6 and 7 are installed, and the planned new piezometers (Fig. 4) are scheduled for installation in mid- to late 1993. However, piezometer P-6-2B is planned for installation on private property and may not be installed until late 1993 or early 1994, after permission to drill is obtained from property owners. In the unlikley event permission to drill cannot be obtained, alternative locations that will achieve the required ground water objectives will be chosen with regulatory oversight. Pipelines connecting extraction locations 6 and 7 to TFB are scheduled for installation in mid-1994.

All extraction wells will begin pumping as soon as piping to TFB is completed. Initial flow rates will be maximized to establish capture zones as quickly as possible. Hydraulic test data indicate it will take about 4 to 6 weeks for the pumping wells to establish their full hydraulic capture zones. Modeling results suggest that sustained flow rates of about 10 gpm may be required for extraction locations 6 and 7 (Fig. 4) to fully capture the downgradient plume margins. We will continue to monitor extraction flow rates, and ground water elevation and chemistry data to determine if the planned extraction scenario is completely capturing the VOC plumes. Determination of full plume capture will be established in collaboration with the regulatory agencies. If actual flow rates are substantially lower and/or the observed steady state drawdown fails to capture any part of the plume margin, additional extraction wells will be installed. The locations of these wells will be based on new field water level data and recalibrated modeling results. If additional extraction wells are needed to establish full hydraulic capture of the VOC plume in the TFB area, we estimate that the new wells, piezometers, and pipelines would be installed and operating about one year later. Thus, it is estimated that full hydraulic capture of the VOC plume in the TFB area should be established by late 1994 if only one set of additional extraction wells is necessary.

The TFA and TFB extraction wells are designed to capture about 75% of the western margin of the VOC plume. Extraction wells for Treatment Facility C (TFC), to be located north of TFB, (Dresen *et al.*, 1993) will capture the remaining 25% of the western plume margin. TFC is scheduled to begin operation by the end of October 1993 (Dresen *et al.*, 1993).

Table 10. TFB piezometer specifications.

Well name	Piezometer name [a]	Date completed	Borehole depth (ft)	Casing depth (ft)	Perforated interval (ft)	Sand pack interval (ft)	Approximate flow rate (gpm)
Extraction location 5							
P-459	P-5-1A	20-Jul-88	76.0	73.0	59.5-73	57-73	1.5
TBI	P-5-1B	—	—	—	60-75	—	—
P-419	P-5-1C	29-Jun-88	82.0	75.5	62.5-75.5	60.5-76	3
TBI	P-5-2A	—	—	—	85-100	—	—
MW-615	P-5-2B	01-Jun-90	121.0	99.0	91-99	90-99	1.5
MW-611	P-5-2C	04-Apr-90	161.0	98.0	87.5-98	86-98.5	3.5
MW-458	P-5-3A	30-Jun-88	212.5	116.0	108-116	106-117.5	1
MW-365	P-5-3B	09-Apr-87	187.0	125.0	120-125	120-125	10
TBI	P-5-3C	—	—	—	105-120	—	—
P-418	P-5-3D	24-Jun-88	124.0	118.0	108-118	104-118.5	2.5
P-420	P-5-3E	26-Jul-88	127.0	111.0	105-111	103-113	3.5
Extraction location 6							
TBI	P-6-1A	—	—	—	65-90	—	—
P-705	P-6-1B	26-Dec-90	126.0	90.0	77-90	75.5-90.5	1
TBI	P-6-1C	—	—	—	65-90	—	—
MW-269	P-6-1D	16-Jun-86	185.0	92.0	79-92	76-92	5
P-617	P-6-2A	26-Jun-90	200.0	110.0	103-110	101-110	3
TBI	P-6-2B	—	—	—	100-120	—	—
TBI	P-6-2C	—	—	—	100-120	—	—
Extraction location 7							
TBI	P-7-1A	—	—	—	120-140	—	—
MW-323	P-7-1B	04-Aug-87	200.0	127.0	122-127	121-127	3
MW-422	P-7-1C	02-Sep-88	203.0	139.5	133-139.5	131-139.5	9

Notes:
NA = Not available.
TBI = To be installed.
[a] Piezometer names show their location (e.g., P-24-1A is at extraction location 24) and the zone monitored (e.g., P-24-1A is screened in the same zone as EW-24-1). Letters following the zone designation indicate that multiple piezometers are screened in that zone.

Table 11. Design influent concentrations for TFB (from Isherwood *et al.*, 1990).

Constituent	Concentration (ppb)	
	Maximum influent	Average influent
PCE	50	40
TCE	375	300
1,1-DCE	13	10
1,2-DCE (cis and trans)	4	3
1,1,1-TCA	1	1
1,1-DCA	6	5
1,2-DCA	1	1
Carbon tetrachloride	3	2
Chloroform	13	10
Freon 113	13	10

3.2.2. TFB Specifications, Design, Performance, Controls, and Safeguards

3.2.2.1. Specifications and Design

The specifications and design for TFB are presented below. The component specifications are presented in Table 12, and a piping and instrument diagram (P&ID) is presented as Plate 2* .

TFB is enclosed in a steel prefabricated (Butler type) building with outside dimensions of 25 x 15 x 12 feet. The building is insulated and lined with steel paneling on the interior. The structure rests on an 8-inch concrete (3,000 psi rating) pad with steel rebar, which is also the foundation for the current Peroxidation Systems, Inc., LVB-60 UV/H_2O_2 ground water treatment unit. There is additional space within the TFB building for another ground water treatment unit if necessary. The building is constructed according to the requirements of the Uniform Building Code (UBC), including the California seismic codes. For maintenance access, there is a 10 x 10 foot roll-up door on the front side of the building.

Ground water containing VOCs is extracted for treatment using Grundfos submersible pumps. These centrifugal pumps are constructed of stainless steel and have a variety of horsepower ratings. There are currently four extraction wells pumping ground water to TFB: MW-611, MW-218, EW-704, and MW-357. The pumps installed in each well are:

- MW-611: Grundfos 10S05-9, 3,450 rpm, 1/2 hp, 5 gpm at 230 feet of head,
- MW-218: Grundfos 10S05-9, 3,450 rpm, 1/2 hp, 5 gpm at 230 feet of head,
- EW-704: Grundfos 25S20-11, 3,450 rpm, 2 hp, 20 gpm at 250 feet of head,

* Plate 2 is located in a pocket inside the back cover of this report

Table 12. Summary of TFB facility component specifications.

Component	Specification
TFB building	Steel prefabricated (Butler type) 25 x 15 x 12 feet
Concrete pad and LVB-60 foundation	8- inches with rebar (3,000 psi rating)
Extraction well pumps	MW-611: Grundfos 10S05-9, 3,450 rpm, 1/2 hp, 5 gpm at 230 feet of head MW-218: Grundfos 10S05-9, 3,450 rpm, 1/2 hp, 5 gpm at 230 feet of head EW-704: Grundfos 25S20-11, 3,450 rpm, 2 hp, 20 gpm at 250 feet of head MW-357: Grundfos 16S10-10, 3,450 rpm, 1 hp, 20 gpm at 150 feet of head
Influent pipeline and sleeves	Schedule 80 PVC (1,100 feet)
Pressure-reducing valve	Bailey-Emeryville 32-J-1 mechanical disk pressure-reducing valve
Filter canister	Cuno 12 DC3, stainless steel
Filter cartridges	Honeycomb Parker Hannifin Corp. Model No. M23R29-4A, 15 gpm at 0-2 psi differential pressure
H_2O_2 feed pumps	Liquid Metronics, Inc., Model No. A751-192SPX, 24 gallons per day at 150 psi maximum
H_2O_2 injection tubing	304 stainless steel, 0.035-inch wall thickness
H_2O_2 storage tanks	300-gallon polyethylene 1/4-inch single-wall with 1/4-inch single-wall double-containment shell
H_2O_2 splash containment	316 stainless steel 70 x 74 x 8 inches
LVB-60 UV/H_2O_2 unit	Peroxidation Systems, Inc., 480 v 3-phase, 60 Hz with 4 15-kW medium pressure Hg vapor lamps
LVB-60 oxidation chamber	Welded stainless steel not ASME rated for pressure
LVB-60 control system	OPTO-22 control unit with Paragon 500 control software
Polishing tank	812 gallon, 1/4-inch ASTM A-36 steel 84 x 72 x 55.5 inches
Polishing tank protective paint	Simpson Cordurite epoxy paint with red oxide zinc phosphate epoxy primer
Supply and exhaust air blowers	Fuji VFC 703A
Supply air manifolds	2-inch Schedule 80 PVC
Carbon filter	Vent-Scrub VSC-200
Level control system for polishing tank discharge pumps	Warwick level control probes 120- v, single phase
Discharge pumps	Baldor 10- hp, 480 v, 3 phase, 150 gpm
Gravity flow discharge line and sleeves	6-inch buried Schedule 80 PVC
Gravity flow discharge line and sleeves from Baker tank	4-inch buried Schedule 80 PVC

- MW-357: Grundfos 16S10-10, 3,450 rpm, 1 hp, 20 gpm at 150 feet of head.

Each of these pumps is powered by a 230-volt, single-phase motor. Each pump also has a control circuit that will initiate a shutdown in the event of cavitation due to the loss of a net positive suction head.

From each wellhead, the ground water flows into a common 3-inch type-K copper pipeline. This pipeline is sleeved with a 2-inch PVC Schedule 80 pipeline to eliminate the occurrence of copper above permissible limits in the TFB effluent. Ground water is pumped through this 2-inch PVC-lined pipe approximately 1,100 feet to TFB.

Once at TFB, the 2-inch PVC pipeline is mated to a 3-inch Schedule 80 iron pipe. At this point, ground water passes through a pressure-reducing valve. The valve reduces the in-line pressure from 60-80 psi to about 10 psi. The valve is a 2 1/2-inch adjustable mechanical disk Bailey-Emeryville 32-J-1 valve. Ground water then enters a Cuno 12 DC3 stainless steel filter canister with 12 30-inch-long 5-micron polypropylene core filter cartridges. Each honeycomb cartridge (Parker-Hannifin Corporation Model No. M23R29-4A) is 1-inch ID and 2 1/2-inches OD and is rated at 15 gpm with a 0 to 2 psi pressure drop. Therefore, the pressure drop across the entire filter pack is about 2 psi, and the ground water enters the UV/H_2O_2 treatment unit at about 8 to 10 psi. Just before entering TFB, the Schedule 80 3-inch iron pipeline is mated to a 2-inch Schedule 80 PVC pipe. Once inside the building, the ground water enters the UV/H_2O_2 ground water treatment unit.

Before entering the UV/H_2O_2 treatment unit, H_2O_2 is injected into the influent ground water stream through a ball check valve. Two H_2O_2 feed pumps are used to inject the hydrogen peroxide. These pumps are Liquid Metronics, Inc., Model A751-192SPX positive displacement diaphragm pumps. Each pump has an adjustable stroke length and stroke frequency to vary the amount of injected H_2O_2 when necessary. The 50% H_2O_2 solution is stored in a 300-gallon, 1/4-inch-thick, single-wall, polyethylene tank. This tank is contained within another polyethylene single-wall tank that provides the required double containment. The H_2O_2 storage tank and its double containment rest on a raised steel pallet. Underneath the steel pallet is a stainless steel rectangular pan that measures 70 x 74 x 8 inches that provides triple containment. The whole assembly rests on a concrete floor that is 8 inches thick.

The H_2O_2 pumps can deliver 24 gallons per day at 150 psi maximum discharge head. The H_2O_2 is pumped through 1/4-inch 304 stainless steel tubing with a wall thickness of 0.035 inches.

After H_2O_2 injection, the ground water containing VOCs enters the Peroxidation Systems, Inc., LVB-60 treatment unit. This is a 60-kW unit that contains four 15-kW medium pressure mercury vapor lamps and has a treatment capacity of 100 gpm. Each lamp is coaxially sealed within a 1/4-inch wall thickness quartz tube. The ground water never directly contacts the mercury lamps. The UV light from the lamps disassociates the H_2O_2 to form the hydroxyl radical ($OH^{\bullet}$). The hydroxyl radical, in conjunction with the UV light, oxidizes the VOCs to nontoxic compounds such as water, chloride ions, and carbon dioxide.

The four 15-kW mercury vapor lamps are housed in an oxidation chamber that consists of welded stainless steel lined with Teflon. Teflon is used because of its UV reflective properties. The oxidation chambers are not ASME qualified for pressure and, therefore, cannot operate at pressures greater than 20 psig. A pressure relief valve is set at 15 psig, and a rupture disk in the

vessel is set to rupture at 20 psig for protection.

The UV/H_2O_2 system includes the UV lamps, and electrical control system. The TFB control system is an OPTO-22 control unit with Paragon 500 control software. The software is designed such that additional well controls and other control features can be added as necessary.

From the LVB-60, the treated ground water is pumped to the polishing tank. It is pumped through a 2-inch Schedule 80 PVC pipe that is mated to a 4-inch Schedule 80 iron pipeline at the point where the PVC pipeline exits the building. The concentration of total VOCs in the water entering the polishing tank is about 10 to 20 ppb, and the aeration process usually reduces these residual VOCs in the water to less than the analytic detection limit of 0.5 ppb. The Grundfos pumps in the extraction wells pump the water from the wells through the treatment process to the polishing tank. The polishing tank is fabricated with 1/4-inch ASTM A-36 steel and is rectangular in shape. Since the LVB-60 does not treat all of the VOCs in ground water (notably carbon tetrachloride and chloroform), the polishing tank was needed to meet the discharge requirements specified in California RWQCB WDR Order No. 91-091 (NPDES Permit No. CA0029289).

The steel polishing tank is painted with Simpson Cordurite paint. This paint is epoxy-based and was applied to the interior and exterior surface of the tank that was primed with red oxide zinc phosphate epoxy primer. The dimensions of the polishing tank are 84 x 72 x 55.5 inches. Five steel baffles form five individual cells within the tank interior. The tank has an operating volume of 812 gallons, which allows the necessary residence time to complete treatment of water from the UV/H_2O_2 unit.

The supply air for the aeration system comes from a Fuji VFC 703A blower. This blower is rated at 150 acfm at 5 feet of water head. Four of the five interior cells have air manifolds at the bottom of each cell. These manifolds are 2-inch Schedule 80 PVC pipe with the requisite number of 3/8-inch holes to allow 150 acfm to exit the manifold and aerate the water.

Once stripped from the water, the VOCs are exhausted from the polishing tank with the aid of another Fuji VFC 703A blower. The exhausted air stream passes through a Vent-Scrub VSC-200-C carbon canister at a rate of 220 acfm where the residual VOCs are sorbed to the carbon. Assuming the same VOC concentrations in the influent water as on March 19, 1991 (see Table 13 in Section 3.2.2.2) and a flow rate of 100 gpm (52.6 million gallons/year), 3.2 pounds of VOCs are sorbed onto the carbon per year. The mass ratio of sorbed VOCs to the VSC-200-C carbon of 2.2% per year is lower than the typical carbon loading capacity of 10%. The VCS-200-C carbon will be replaced at 52-million-gallon intervals, and the GAC will be delivered to the LLNL Hazardous Waste Management Division to be subsequently regenerated or disposed offsite at a RCRA-permitted facility. Section 4.3 describes the process for filter disposal.

The treated ground water is then discharged to an excavated ditch that parallels Vasco Road and flows north into Arroyo Las Positas. For routine operations, ground water flows from the polishing tank, via gravity, through a buried 6-inch Schedule 80 PVC pipeline to the excavated ditch about 30 feet away. Occasionally, system treatability and/or operational tests are performed at TFB. The treated ground water from these tests is stored in a Baker tank for analysis prior to discharge to verify that NPDES discharge limits are met. To accomplish this, two 10-hp Baldor (3,450 rpm) pumps pump treated water from the polishing tank to the Baker

tank. The pumps operate only when necessary and are controlled by a 120-v, single-phase system, consisting of Warwick level control probes. The Baldor pumps are operated by 480-v, three-phase motors. When required, a 1 1/2-inch fire hose is mated to the 3-inch Baldor pump manifold and water is pumped through the fire hose to the Baker tank. A buried 4-inch Schedule 80 PVC pipe discharges the water from the Baker tank to the excavated ditch via gravity flow. The length of this line is approximately 300 feet.

The design of TFB also includes additional influent ports that will allow water extracted from locations 6 and 7 to be pumped to TFB for treatment. These ports are located upstream of the pressure-reducing valve such that the LVB-60 operating pressure requirements are maintained.

3.2.2.2. Performance

Approximately 4.8 million gallons of ground water have been extracted, treated, and discharged from TFB through January 1993. Treated water from initial operational tests was stored in holding tanks and aerated to comply with discharge limits. The LVB-60 UV/H_2O_2 treatment system at TFB oxidizes the double carbon bonded TCE with greater than 99% efficiency at a flow rate of 12.4 gpm. Similar to the UV/H_2O_2 system at TFA, the maintenance program for the LVB-60 includes cleaning of the quartz tubes to prevent the buildup of mineral coatings. The polishing aeration unit successfully reduces residual VOC concentrations in water to concentrations below the 5 ppb total VOC discharge limit, and usually (about 90% of the time) reduces VOC concentrations below the detection limit of 0.5 ppb. The GAC filter prevents discharge of measurable VOCs to the atmosphere. Table 13 summarizes representative system performance results for various VOCs for the treatment facility. System performance results at the beginning of ground water extraction showed higher VOC and chromium influent concentrations than reported in Table 13 for March 19, 1991. The higher VOC and chromium influent concentrations were successfully treated to levels below discharge limits by TFB.

Table 13. TFB performance results (March 19, 1991).

Constituent	UV/H_2O_2 unit		Polishing system	Air discharge at
	Influent (ppb)	Effluent (ppb)	Effluent (ppb)	carbon-filter outlet (ppm v/v)[a]
TCE	120	<0.5	<0.5	<1
1,1-DCE	2.5	<0.5	<0.5	<1
Carbon tetrachloride	5.5	4.8	<0.5	<1
Chloroform	2	1.3	<0.5	<1
Freon 113	1.2	1.1	<0.5	<1
Total chromium	25	NS	30	NA
Hexavalent chromium	<10	NS	<10	NA

[a]Parts per million on a volume-per-volume basis.

NA-not applicable.

NS-no sample collected.

Following initial operation of TFB, we learned that about 30 ppb copper was present in TFB effluent, which is higher than the 20-ppb effluent limit specified in the NPDES permit. Consequently, the interior of the TFB 3-inch copper influent pipeline was sleeved with PVC, which reduced the copper concentrations to less than the 20-ppb NPDES discharge limit. TFA has not had this problem because the influent pipeline to TFA was not constructed of copper.

At the same time, we learned that hexavalent chromium was present in the effluent in concentrations of about 20 ppb, exceeding the discharge limit of 11 ppb. A detailed system analysis was performed to identify the source of the hexavalent chromium. The source was determined to be paint within the polishing tank. Calcium carbonate build-up had caused the paint to peel from the interior walls of the tank. The paint used for the interior surface of the tank had chromium as an additive, and some chromium leached out of the exposed paint surfaces. Because TFA has not experienced the mineral scaling in its polishing tank, due to higher flow rates than TFB, it has not had this problem. Chromium concentrations above the effluent discharge limit were mitigated by modifying the polishing tank design to reduce formation of mineral scale, and repainting the interior surfaces with protective paint free of chromium. LLNL is investigating background levels of chromium in the TFB area and will report the results in an upcoming Monthly Progress Report.

3.2.2.3. Controls and Safeguards

TFB is equipped with an interlock control system. If any portion of the system malfunctions, the entire system, including the associated extraction wells, automatically shuts down. As shown on Plate 2, pressure relief valves and pressure rupture disks will shut down the system in the event of an equipment or system overpressure. An operator will be notified of a shutdown by an alarm system. The operator must determine and correct the problem before the system can be manually restarted.

The centrifugal pumps used in TFB extraction wells have thermal shutoff devices to prevent overheating due to insufficient water levels in the wells. TFB has a pressure sensor on the H_2O_2 feed line that will shut the system down if the H_2O_2 system pressure is below 18 psi. Additionally, the facility will shut down if:

- A UV lamp fails.
- Excessive temperature in the reaction chamber is detected.
- Excessive moisture accumulates in the UV lamp enclosures.
- Flow is detected from either the influent or effluent overpressure relief devices.

The TFB aeration unit also has:

- Supply and exhaust blower interlocks, which prevent system operation if either blower fails.
- A high-water level sensor in aeration tanks to maintain the water level below a specified level.
- A supply air pressure control that will shut the system down in the event of pipe break.

In addition, any planned new underground pipelines from extraction wells to TFB which are

not visually accessible will be double-contained with a leak-detection system installed inside the outer pipe. Accessible pipelines will be visually monitored for leaks on a daily basis.

3.2.3. Discharge of Treated Ground Water

Ground water treated at TFB is discharged to an unlined, north-flowing drainage ditch located along the eastern side of Vasco Road (Figs. 1 and 5, in Section 4.2.1) and is used for onsite irrigation to reduce the amount of water imported to LLNL. In the future, water from TFB also may be used in LLNL cooling towers.

About 3,500 feet from the discharge point, the TFB drainage ditch flows into Arroyo Las Positas, which flows northwest from LLNL. TFB pilot study self-monitoring land observations indicate the majority of treated water discharged to this ditch infiltrates into the underlying sediments before reaching Arroyo Las Positas. Over 1.4 million gallons of treated ground water from TFB have been discharged to the Vasco Road ditch since September 1990 under RWQCB NPDES Permit No. CA0029289, WDR Order No. 91-091.

3.3. Construction and Startup Schedule and Cost Estimates

TFB was constructed by LLNL Plant Engineering labor-only forces. Because the building size requirements for TFB were virtually identical with those of TFA, the same building design for TFA was used with some minor modifications.

As shown in Table 14, TFB design started in December 1988 and was completed in March of the following year. Construction of the TFB building, piping, and power hookup began in March 1989 and was completed by August 1989.

The purchase price of the TFB LVB-60 UV/H_2O_2 treatment unit was $80,000 (Table 15). This was slightly more than the LV-60 for TFA (Table 8) due to a reactor design change that increased the operating efficiency of the unit. The new design changed the flow path of water within the reactor such that the exposure efficiency of the UV lamps increased. The flow path was adjusted from one of vertical bulk flow to sinuous flow along each UV lamp.

During operational testing of TFB, it was observed that the pump installed in one of the extraction wells, MW-611, was cavitating frequently, due to the low yield from the permeability of the screened sediments. A different set of pump controls was subsequently installed in MW-611 that shuts the pump down when cavitation occurs. The cost of this installation, which began in January 1991 and was completed in April 1991, was $9,200.

As mentioned in Section 3.2.2.2, TFB had slightly elevated levels of copper in the effluent, which were traced to the copper influent line. Rather than install a new pipeline, a PVC sleeve was installed inside the existing pipeline, bringing the total cost of TFB to $446,400. The sleeve was installed between June and July 1991.

TFB has an influent pipeline from extraction location 5 that is similar in length to TFA. However, TFB has a very short effluent pipeline compared to TFA. If the recharge basin and effluent line costs are subtracted from the original TFA total cost, the TFA cost would be approximately equivalent to the total cost of TFB.

The O&M costs are typical of the first few years of operation. After the pipelines from extraction locations 6 and 7 are installed and operating, the labor and materials annual costs are expected to decrease by approximately 50%.

Table 14. TFB design and construction schedule.

	Design		Construction	
Item	Start	End	Start	End
TFB building (including design and inspection)	12/88	3/89	3/89	8/89
Piping and power to wellheads			3/89	5/89
LVB-60 Unit			6/91	
Modification of MW-611 electrical			1/91	4/91
Modification of influent pipeline (sleeve)			6/91	7/91

Table 15. TFB cost summary.

Item	Costs	Annual Operations & Maintenance
TFB building (including design and inspection)	$169,000	—
Piping and power to well heads	165,000	—
LVB-60 Unit	80,000	—
Modification of MW-611 electrical	9,200	—
Modification of influent pipeline (PVC sleeve)	23,200	—
TFB Operation and Maintenance:	—	—
Labor	—	80,000
Materials	—	50,000
Maintenance contract	—	20,000
Total	$446,400	$150,000

4. Remedial Action Workplan

The Remedial Action Workplan for TFA and TFB includes Quality Assurance/Quality Control and Health and Safety Plans for construction, operation, and maintenance. Included also are monitoring and reporting programs, requirements for offsite shipment of hazardous waste, and procedures for facility and well closure. As discussed in the RAIP (Dresen *et al.*, 1993), LLNL will update the Community Relations Plan (CRP) for the post-ROD period. The draft revised CRP was submitted to the regulatory agencies on February 7, 1993.

4.1. Quality Assurance/Quality Control and Health and Safety Plans

The Quality Assurance/Quality Control (QA/QC) Plan for construction, included as Appendix B, defines the quality objectives and areas of responsibility for the construction of TFA, TFB, and the other planned treatment facilities. The Health and Safety Plan for construction of TFA, TFB, and the other planned facilities, included as Appendix C, describes how the construction manager works with the LLNL Hazards Control Department, with support from construction inspectors, to ensure safety during treatment facility construction. A supplement to the LLNL Health and Safety Manual (LLNL, 1992) is also included in Appendix C that describes the Construction Contractor Safety Program.

The QA/QC Plan for operation and maintenance of TFA and TFB is presented as Appendix D. This plan describes the organizational structure, responsibilities, and authority for operation and maintenance QA/QC, and the objectives, quality goals, and QA levels for operation and maintenance of TFA and TFB. Appendix E contains the Health and Safety Plans for operation and maintenance of TFA and TFB. These plans (1) analyze the hazards, (2) present hazard control measures and training requirements for operation and maintenance of TFA and TFB, and (3) present emergency safety procedures.

4.2. Monitoring and Reporting

The following sections discuss planned monitoring and reporting for TFA and TFB. The programs include self-monitoring, ground water quality sampling, capture zone monitoring, and criteria for determining when remediation is complete and for system closeout.

QA/QC procedures for collection, analysis, and documentation of influent and effluent ground water samples are included in the LLNL Quality Assurance Project Plan (QAPP) (Rice, 1989), which was prepared according to EPA guidance and was approved by EPA. In addition, the procedures for collection, analysis, and documentation of water samples are described in LLNL Standard Operating Procedures (SOPs) (Rice *et al.*, 1990) Nos.: 2.6, Sampling for Volatile Organic Compounds; 4.1, General Instructions for Field Personnel; 4.2, Sample Control and Documentation; 4.3, Sample Containers and Preservation; 4.4, Guide to the Handling, Packaging, and Shipping of Samples; 4.6, QA/QC Requirements for Data Generated by Analytical Laboratories; and 4.8, Calibration and Maintenance of Field Instruments Used in Measuring Parameters of Surface and Ground Water and Soils.

4.2.1. Treatment Facility Self-Monitoring Programs

This section describes the TFA and TFB self-monitoring programs. The TFA self-monitoring program satisfies the requirements of RWQCB WDR Order No. 88-075. The TFB self-monitoring program satisfies the requirements of RWQCB NPDES Permit No. 0029289, WDR Order No. 91-091. Both WDRs are included in Appendix A. Water samples are collected for TFA and TFB according to the schedules presented in Tables 16 and 17, respectively.

TFA and TFB influent samples, TFA-I001 and TFB-I002, respectively, are collected at sampling stations immediately prior to treatment, as shown in Figures 5 and 6. TFA and TFB effluent samples, TFA-PP3 and TFB-E002, respectively, are collected at sampling stations following treatment and prior to discharge. In 1990, LLNL began using water treated at TFA for onsite irrigation and in onsite cooling towers. At that time, TFA-PP3 replaced TFA-E1E/TFA-E1W as the TFA effluent sampling station because TFA-PP3 is located prior to the tank used for irrigation and cooling tower use (Fig. 5).

Receiving water samples are collected from the body of water (recharge basin or arroyo) receiving the discharge. At TFA, treated water not used in LLNL cooling towers or for onsite irrigation is discharged to either the east or west cell of the recharge basin, located about 1,000 ft southeast of TFA. As shown in Figure 5, two water samples are collected from the appropriate recharge basin cell, at opposite ends of the basin, if there is sufficient standing water. The recharge basin water samples are labeled either TFA-C1E and TFA-C2E or TFA-C1W and TFA-C2W to identify the cell (E for east; W for west) from which the sample was collected. The samples are collected 1 foot below the water surface and at least 2 feet from the edge of the cell, according to RWQCB specifications.

Ground water treated at TFB is discharged to a north-flowing unlined drainage ditch that flows into Arroyo Las Positas in the northwest corner of LLNL. As shown in Figure 6, the TFB receiving water sample TFB-R002 is collected at a station about 75 feet downstream from the effluent discharge point.

Shallow soil samples are collected annually from the recharge basin, as required by WDR Order No. 88-075 (Appendix A), at the eight locations shown in Figure 7. At each location, samples are analyzed for volatile and semivolatile organic compounds by EPA Methods 8240 (VOCs) and 8270 (semivolatiles), respectively. Soil samples are also analyzed for metals, as described in Table 16, and gross alpha, gross beta, and tritium. Recharge basin bottom sediment samples are identified by odd-numbered labels (i.e., TFA-RB-B1, -B3, -B5, and -B7), and are collected at depths less than 4 inches below the ground surface. *In situ* soil samples are identified by even-numbered labels (i.e., TFA-RB-B2, -B4, -B6, and -B8), and are collected at 1- to 1.5-foot depths below the ground surface, according to RWQCB specifications.

A photo-ionization detector or flame ionization detector is used to determine if any residual contaminants remain in the air effluent stream at both TFA and TFB. The photo-ionization detector uses UV light to ionize a vapor sample and measure the organic constituents within the vapor. The photo-ionization detectors used at LLNL are Organic Vapor Meters (OVMs) made by Thermo Environmental Instruments, Model No. 580. They are equipped with 10.0 electron volt (eV) lamps and detect double- and triple-bonded molecules. The ionization potential of TCE is 9.45 eV. Therefore, the OVM will easily detect TCE, which is the principal contaminant

Table 16. TFA self-monitoring sampling schedule.

Sample location[a]	Influent TFA-I001[a]	Effluent TFA-PP3[a, b]	Recharge Basin TFA-C1E/C1W and TFA-C2E/C2W[a]	Land observations[c]
Frequency[c]		Analysis		
Daily	Flow rate	Flow rate	—	—
Weekly	—	EPA 601[d]	—	Perform
Monthly	EPA 601[d] pH	Temperature pH	—	Complete report
Quarterly (March, June, Sept., Dec.)	Chlorides	Chlorides Fish toxicity[e] Turbidity[f] gross alpha and beta particles, tritium	Chlorides EPA 601[d]	—
Semiannually (April, Oct.)	Metals[g]	Metals[g]	Metals[g] gross alpha and beta particles, tritium Fish toxicity[e]	—
Annually (April)	EPA 624[h, i] EPA 625[k]	EPA 624[h,i] EPA 625[k]	EPA 602[j] EPA 625[k]	—

RWQCB specifications:

- Sampling of TFA-C1E/C1W and TFA-C2E/C2W should be coincident with TFA-I001 and TFA-PP3 sampling.
- If any instantaneous maximum limit is exceeded, the sampling frequency will be increased to daily until two samples collected on consecutive days show compliance with the instantaneous maximum.

[a]Sample locations shown in Figure 5.

[b]TFA-PP1 replaces TFA-E1W/TFA-E1E as the TFA effluent sample; see Figure 5.

[c]As required by RWQCB WDR Order No. 88-075.

[d]EPA 601 = EPA Method 601; analysis for volatile halocarbons by gas chromatography.

[e]Fish toxicity, 96 hours, survival in undiluted waste.

[f]Jackson turbidity units.

[g]Priority Pollutant Metals:

antimony	chromium (total)	mercury	silver
arsenic	copper	nickel	thallium
beryllium	lead	selenium	zinc
cadmium			

PLUS: boron, chromium (+6), iron, manganese, and cyanide

[h]When schedule calls for coincident EPA Method 601 and 624 analyses, only EPA 624 is conducted.

[i]EPA 624 = EPA Method 624; analysis for volatile organic compounds by gas chromatography/mass spectrometry.

[j]EPA 602= EPA Method 602; analysis for volatile aromatic hydrocarbons by gas chromatography.

[k]EPA 625 = EPA Method 625; analysis for semivolatile organic compounds by gas chromatography/mass spectrometry.

Table 17. TFB self-monitoring sampling schedule.

Sample location[a]	Influent TFB-I002[a]	Effluent TFB-E002[a]	Receiving water TFB-R002[a]	Land observations[b]
Frequency[b]		Analysis		
Daily	Flow rate	Flow rate	Flow rate	—
Weekly	—	EPA 601[c]	—	Perform
Monthly	EPA 601[c] pH	Temperature pH	EPA 601[c] Temperature pH	Complete report
Quarterly (Jan., April, July, Oct.)	Chlorides	Chlorides Fish toxicity[d] Turbidity[e] gross alpha and beta particles, tritium	Chlorides	—
Semiannually (March, Sept.)	Metals[f]	Metals[f]	Metals[f] Fish toxicity[d] Turbidity[e]	—
Annually (Sept.)	EPA 624[g, h] EPA 625[j]	EPA 624[g, h] EPA 625[j]	EPA 602[i] EPA 625[j] gross alpha and beta particles, tritium	—

RWQCB specifications:

- Sampling of TFB-R001 should be coincident with TFB-I002 and TFB-E002 sampling.
- If any instantaneous maximum limit is exceeded, the sampling frequency will be increased to daily until two samples collected on consecutive days show compliance with instantaneous maximum.

[a]Sample locations shown in Figure 6.

[b]As required by RWQCB NPDES Permit No. CA 0029289, WDR Order No. 91-091.

[c]EPA 601 = EPA Method 601; analysis for volatile halocarbons by gas chromatography.

[d]Fish toxicity, 96 hours, survival in undiluted waste.

[e]Jackson turbidity units

[f]Priority Pollutant Metals:

antimony	chromium (total)	mercury	silver
arsenic	copper	nickel	thallium
beryllium	lead	selenium	zinc
cadmium			

PLUS: boron, chromium (+6), iron, manganese, and cyanide

[g]When schedule calls for coincident EPA Method 601 and 624 analyses, only EPA 624 is conducted.

[h]EPA 624 = EPA Method 624; analysis for volatile organic compounds by gas chromatography/mass spectrometry.

[i]EPA 602= EPA Method 602; analysis for volatile aromatic hydrocarbons by gas chromatography.

[j]EPA 625 = EPA Method 625; analysis for semivolatile organic compounds by gas chromatography/mass spectrometry.

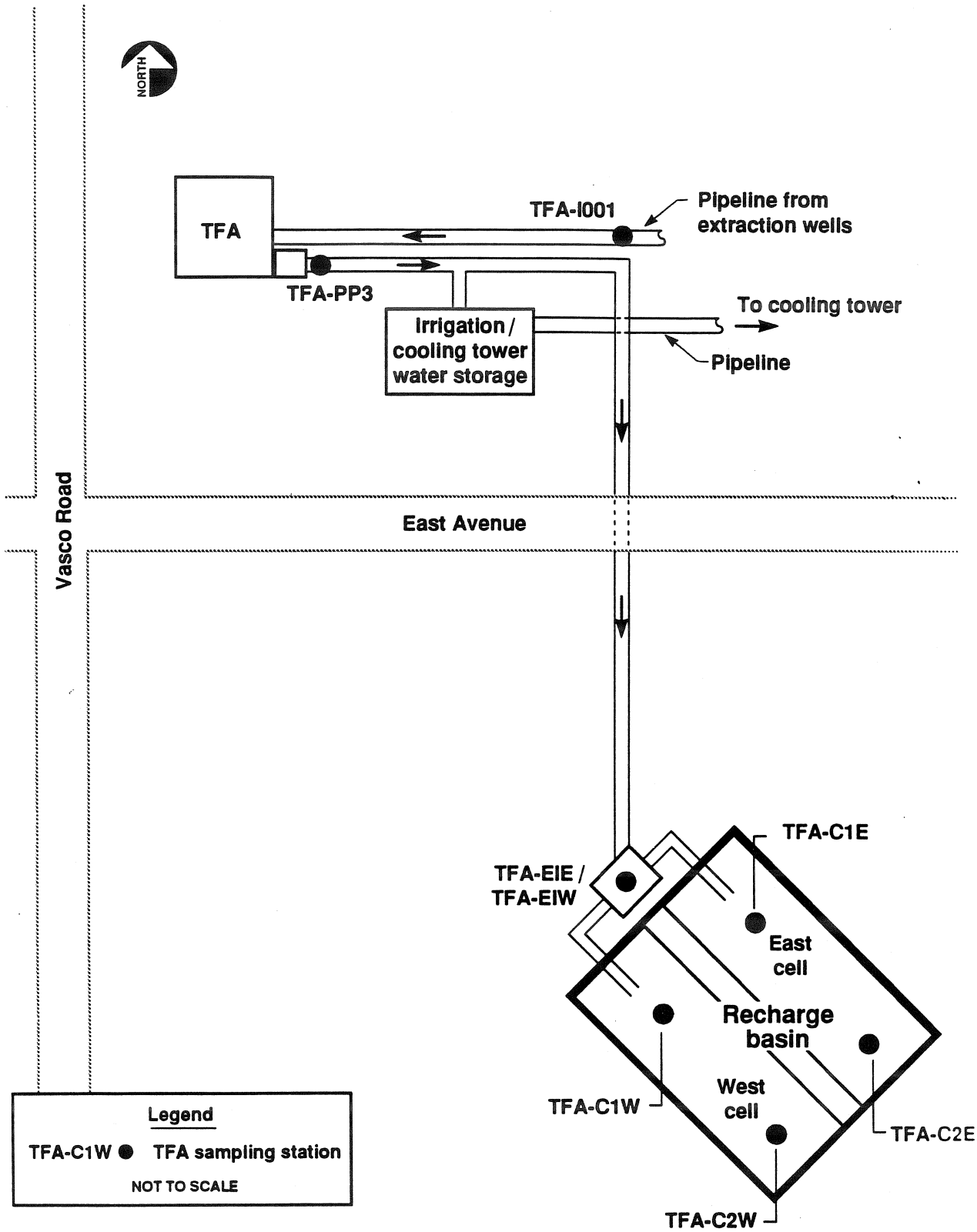

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Figure 5. Locations of TFA self-monitoring program sampling stations.

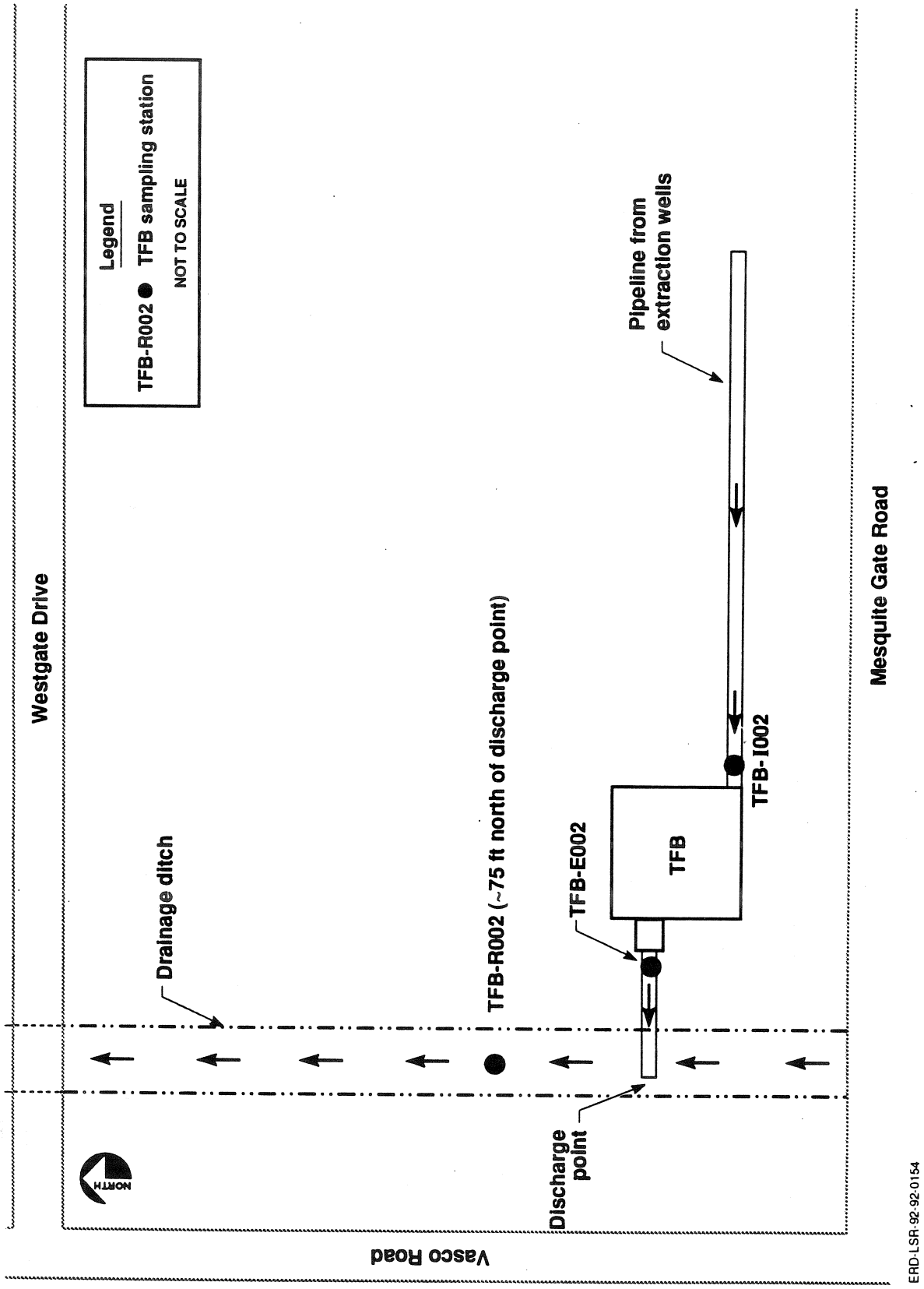
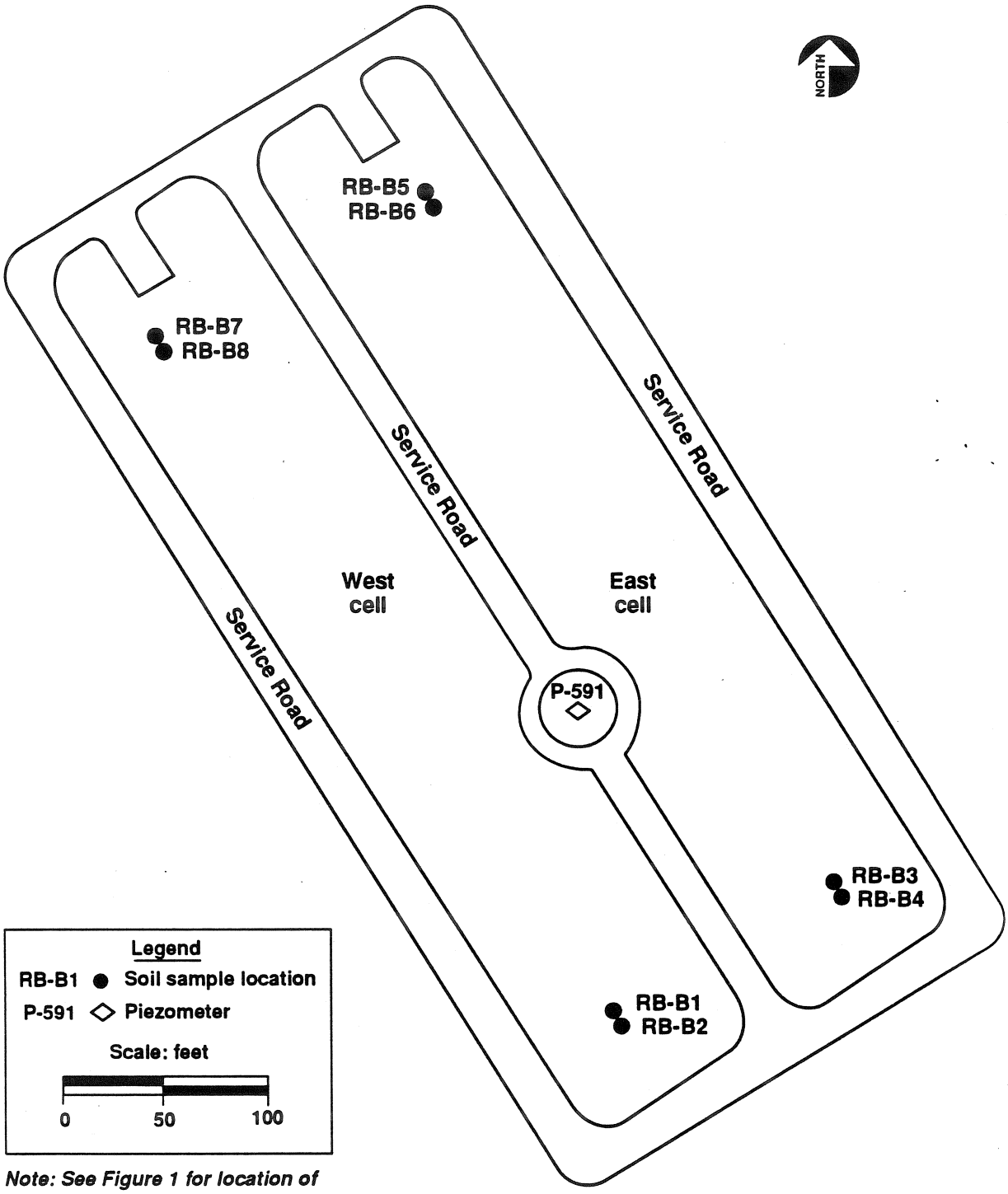


Figure 6. Locations of TFB self-monitoring program sampling stations.



Note: See Figure 1 for location of recharge basin

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Figure 7. Locations of annual recharge basin sediment samples.

treated by TFB. The flame-ionization detector uses the same principle as the photo-ionization detector. However, a flame is used to oxidize the vapor sample to determine the concentration of organic constituents. LLNL uses Foxboro/Century Organic Vapor Analyzers equipped with flame-ionization detectors. These instruments have a range of 1 to 100,000 ppm. The detection limits for these instruments, about 1 to 2 ppm, are sufficiently low to ensure compliance with air discharge limits.

Results of all self-monitoring activities will continue to be reported in the LLNL Monthly Progress Reports.

4.2.2. Ground Water Monitoring Sampling Schedule

Ground water samples are collected from existing monitor wells and piezometers according to the schedule shown in Table 18. Well and piezometer locations are shown in Figure 8. Monitor wells that are converted to extraction wells will be sampled quarterly. Ground water samples will also be collected quarterly from new monitor wells and piezometers installed to monitor the progress of the cleanup (Figs. 2 and 4). This sampling schedule is evaluated quarterly as the distribution of contaminants in ground water changes according to procedures detailed in McConachie (1993).

Self-monitoring influent water samples will be collected monthly at TFA and TFB to evaluate remediation effectiveness and calculate VOC mass removal. The TFA and TFB influent samples are analyzed for VOCs, semivolatiles, chlorides, and metals on the schedules presented in Tables 16 and 17, respectively.

Water levels in all monitor wells and piezometers will continue to be monitored on a monthly basis. Water levels in monitor wells and piezometers are measured either manually or using pressure transducers and data loggers. Depth to water and pumping rates in extraction wells are measured using pressure transducers and mechanical or electronic flow meters. The data are automatically recorded using data loggers. These data will be used to determine actual hydraulic capture areas and zones of little or no ground water movement. Based on hydraulic data, pumping locations and rates will be varied, and/or new extraction wells may be installed, to ensure complete hydraulic capture and the most expeditious remediation possible.

Results of all chemical analyses and quarterly ground water elevation contour maps will be presented and discussed in the LLNL Monthly Progress Reports. Flow lines and ground water capture zones will be interpreted from the water level data and presented quarterly in the Monthly Reports.

4.2.3. Extraction Well Pumping Strategy

Current simulations of long-term pumping and contaminant transport indicate that an estimated 50 years of sustained ground water pumping may be required to reach remediation goals. Modeling results are summarized in Tompson (1990), Tompson *et al.* (1991), and Tompson and Nichols (1993), (in preparation). Initially, all extraction wells will be pumped at the maximum sustainable rates to achieve the most rapid plume capture possible. After steady state is achieved, monitoring data will be used to refine and update the ground water models. As these results and new data are interpreted, changes in the well field configuration and pumping

Table 18. Ground water quality sampling schedule for monitor wells and piezometers in the vicinity of TFA and TFB extraction wells.

Well number	Analyses	Sampling frequency	Planned months of sampling
MW-1	Cr(VI),601	A	September
MW-1A	601	A	September
MW-2	Cr(VI),601	A	September
MW-2A	Cr(VI),601	A	September
MW-101	Cr(VI),601	A	June
MW-102	601	A	June
MW-103	601	Q	March, June, September, December
MW-108	601	A	June
MW-109	Cr(VI),601	Q	March, June, September, December
MW-110	Cr(VI),601	A	June
MW-111	601	S	June, December
MW-115	Cr(VI),601	A	September
MW-116	601	Q	March, June, September, December
MW-118	601	A	March
MW-120	Cr(VI),601	S	March, September
MW-121	601	Q	March, June, September, December
MW-122	601	S	March, September
MW-123	601	A	June
MW-143	Cr(VI),601	S	June, December
MW-146	601	A	June
MW-147	601	A	September
MW-148	Cr(VI),601	A	June
MW-149	Cr(VI),601	A	September
MW-151	601	S	March, September
MW-201	601	A	March
MW-202	601	A	June
MW-203	601	A	June
MW-213	601	A	June
MW-214	601	S	March, September
MW-218	Cr(VI),601	Q	March, June, September, December
MW-226	Cr(VI),601	A	September
MW-251	Cr(VI),601	S	March, September
MW-252	601	S	March
MW-253	601	A	September
MW-254	601	Q	March, June, September, December
MW-260	601	A	September
MW-262	601	Q	March, June, September, December
MW-263	601	S	June, December

Table 18. Continued.

Well number	Analyses	Sampling frequency	Planned months of sampling
MW-264	Cr(VI),601	A	March
MW-265	601	A	June
MW-267	Cr(VI),601	A	March
MW-269	601	S	June, December
MW-301	601	A	September
MW-302	Cr(VI),601	A	September
MW-303	601	A	June
MW-306	601	A	June
MW-307	Pb, 601	S	March, September
MW-308	Cr(VI),601	S	June, December
MW-310	601	A	June
MW-321	601	A	March
MW-322	601	A	March
MW-323	Cr(VI),601	A	September
MW-325	601	A	September
MW-357	Cr(VI),601	Q	March, September
MW-365	601	A	September
MW-366	601	A	March
MW-376	Cr(VI),601	A	June
MW-380	601	Q	March, June, September, December
MW-401	601	Q	March, June, September, December
MW-402	601	Q	March, June, September, December
MW-403	601	A	March
MW-404	Cr(VI),601	S	June, December
MW-405	601	Q	March, June, September, December
MW-406	601	A	June
MW-407	601	A	June
MW-408	601	A	June
MW-410	601	A	September
MW-422	Cr(VI),601	A	September
MW-447	601	Q	March, June, September, December
MW-448	Cr(VI),601	A	June
MW-449	Cr(VI),601	A	June
MW-451	601	A	September
MW-455	Cr(VI),601	A	September
MW-456	Cr(VI),601	A	June
MW-457	Cr(VI),601	Q	March, June, September, December
MW-458	Cr(VI),601	A	September
MW-460	Cr(VI),601	Q	March, June, September, December

Table 18. Continued.

Well number	Analyses	Sampling frequency	Planned months of sampling
MW-462	601	A	June
MW-463	601	A	June
MW-464	Cr(VI),601	S	March, September
MW-481	Cr(VI),601	Q	March, June, September, December
MW-513	601	S	March, September
MW-514	601	S	March, September
MW-517	601	Q	March, June, September, December
MW-518	601	A	June
MW-520	601	Q	March, June, September, December
MW-521	601	Q	March, June, September, December
MW-551	601	S	March, September
MW-552	Split,601	Q	March, June, September, December
MW-571	Cr(VI),601	A	June
MW-602	601	Q	March, June, September, December
MW-609	601	S	March, September
MW-610	601	S	March, September
MW-611	Cr(VI),601	Q	March, June, September, December
MW-612	601	S	March, September
MW-613	601	A	March
MW-614	601	S	March, September,
MW-615	Cr(VI),601	Q	March, June, September, December
MW-616	601	S	March, September
MW-618	601	S	June, December
MW-619	601	S	March, September
MW-654	Cr(VI),601	S	June, December
MW-655	Cr(VI),601	S	March, September
P-377	601	A	March
P-378	Cr(VI),601	S	March, September
P-379	601	Q	March, June, September, December
P-418	Cr(VI),601	S	March, September
P-419	Cr(VI),601	Q	March, June, September, December
P-420	601	S	March, September
P-446	601	A	June
P-459	Cr(VI),601	A	September
P-482	Cr(VI),601	A	March
P-483	Cr(VI),601	Q	March, June, September, December
P-484	601	A	September
P-485	601	A	June
P-504	601	A	March

Table 18. Continued.

Well number	Analyses	Sampling frequency	Planned months of sampling
P-505	Cr(VI),601	A	June
P-506	601	A	June
P-522	601	A	June
P-554	Cr(VI)601	Q	March, June, September, December
P-555	601	Q	March, June, September, December
P-557	601	A	September
P-558	601	A	March
P-559	601	A	June
P-591	Cr(VI),601	A	September
P-592	Pb, 601	A	September
P-601	Cr(VI),601	Q	June
P-603	601	A	June
P-604	601	S	June, December
P-605	Cr(VI),601	S	March, September
P-606	Cr(VI),601	S	March, September
P-617	601	Q	March, June, September, December
P-620	601	Q	March, June, September, December
P-621	601	Q	March, June, September, December
P-651	601	Q	March, June, September, December
P-705	601	Q	March, June, September, December
P-714	601	Q	March, June, September, December
EW-415	601	Q	March, June, September, December
EW-704	601	Q	March, June, September, December
EW-712	601	Q	March, June, September, December
TW-21	601	S	June, December
14A11	601	Q	March, June, September, December
14B1	601	Q	March, June, September, December
14B4	DDWM,601	Q	March, June, September, December
14C1	601	Q	March, June, September, December
14C2	601	Q	March, June, September, December
14C3	601	Q	March, June, September, December
14H1	DDWM,601	S	June, December

A = Annual.
S = Semiannual.
Q = Quarterly.
Cr (VI) = Hexavalent chromium.
601 = EPA Method 601 for halogenated VOCs.
Pb = Lead.
DDWM = Dissolved Drinking Water Metals.
Note: New piezometers and wells will be sampled quarterly for the first year. Subsequent monitoring frequency will be based on concentration and location with or relative to the plume.

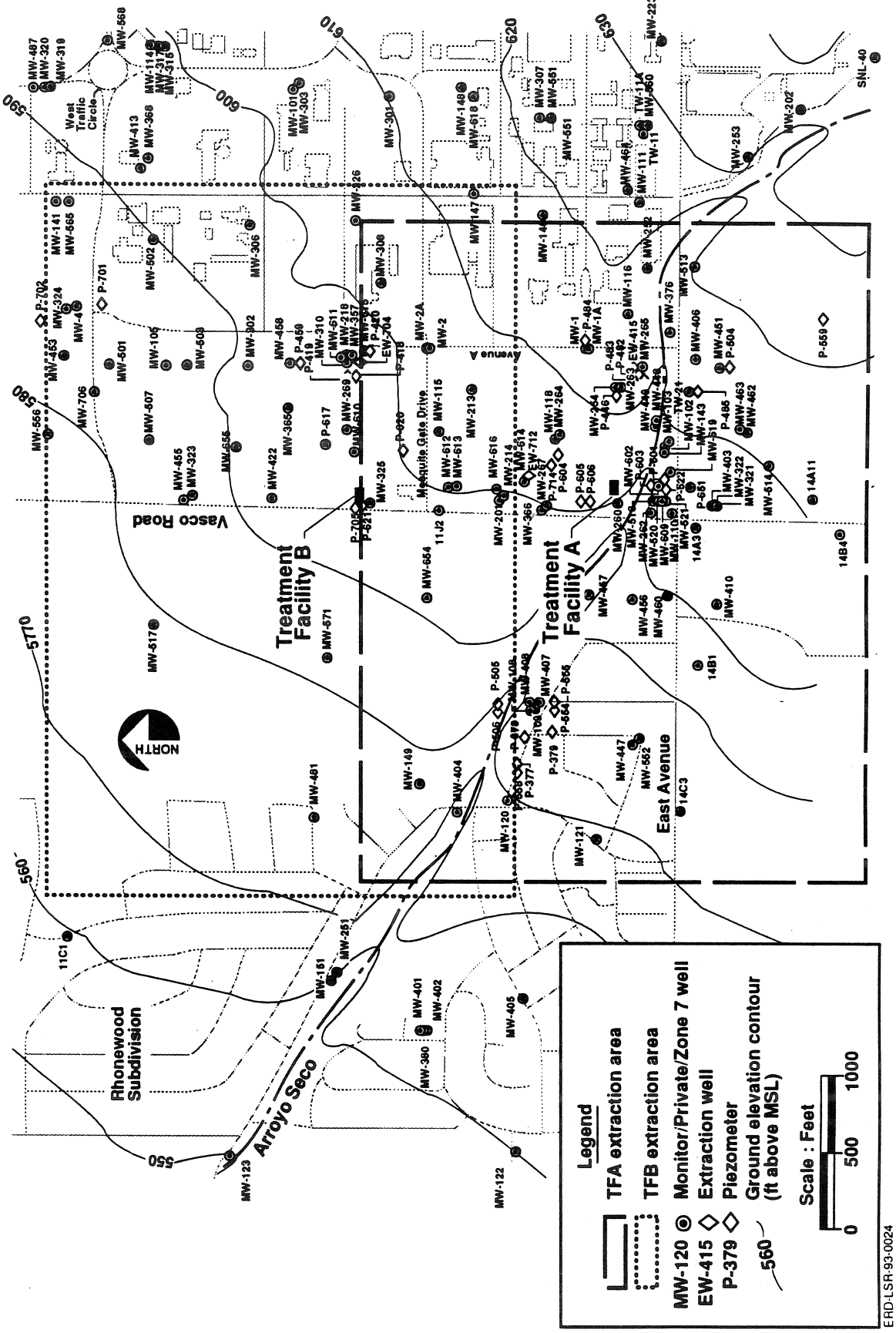

Figure 8. Monitor well, extraction well, and piezometer locations in the vicinity of TFA and TFB.

rates will likely be needed to optimize mass removal rates, maximize treatment and minimize dilution of contaminants, ensure hydraulic capture in all zones exceeding cleanup standards, and eliminate stagnation zones. Well condition will be periodically evaluated using data from pumping rates, drawdown, water clarity, and visual inspection. As required, extraction wells, monitor wells, and piezometers will be rehabilitated or replaced. All of these activities will be reported in LLNL Monthly Progress Reports.

Based on the results of LLNL pilot studies and data from other sites, the VOC concentrations in ground water are expected to decrease rapidly at first, then stabilize, or decrease very slowly. Estimates of VOC mass removal over time at TFA and TFB are shown in Figures 9 and 10, respectively. The VOC mass removal rates were estimated using results from our two-dimensional, finite-element ground water flow and transport model (Tompson *et al.,* 1991; Tompson and Nichols, 1993). Actual VOC mass removal rates will depend on the concentration of VOCs in extracted ground water and long-term well yields. Several methods are being evaluated to maximize mass removal rates, including cyclical pumping and increased reinjection of treated ground water, which may include the injection of heat, surfactants, microbes, or nutrients (Isherwood *et al.*, 1992). Investigations will include laboratory and field studies to evaluate the effectiveness of the methods used to enhance contaminant mobility and mass removal.

In one approach, some of the LLNL extraction wells (i.e., those in source areas and with VOCs in the shallowest ground water) may be periodically shut off and the water levels allowed to recover. During the pump-off cycles, VOCs will desorb into the ground water from the sediments that were dewatered in the vicinity of the pumping wells. This may increase VOC removal rates near source areas, where most of the VOCs occur in the shallower water-bearing sediments. Different pump-on and pump-off cycles will be evaluated to determine the optimum periods of pumping and nonpumping to maximize VOC mass removal rates.

In another approach, additional reinjection of treated ground water may be used to increase the rate of flushing in regions of high VOC concentrations, and to mitigate excessive dewatering resulting from ground water extraction. Reinjection of treated water in selected locations will enhance desorption of contaminants and increase the rate of flushing in regions of slow ground water flow. The reinjection process may be enhanced by other means to increase the rate of cleanup. If the water is heated prior to reinjection, VOCs will have a greater tendency to desorb from the solids into the ground water than if the water is not heated. Similar benefits may arise if the reinjected water contains surfactants, which are compounds that increase the tendency for VOCs to dissolve in ground water. Such surfactants may be manufactured or microbially produced. If these or other methods are shown to be beneficial and cost-effective, they will be implemented with regulatory agency oversight.

As discussed in the RAIP, all reinjection well locations will be selected to be within the capture area of an extraction well since the reinjected water may contain up to 5 ppb total VOCs. Reinjection well locations will be selected to be in compliance with State Water Resources Control Board Resolution 68-16, which is an ARAR for the LLNL Livermore Site.

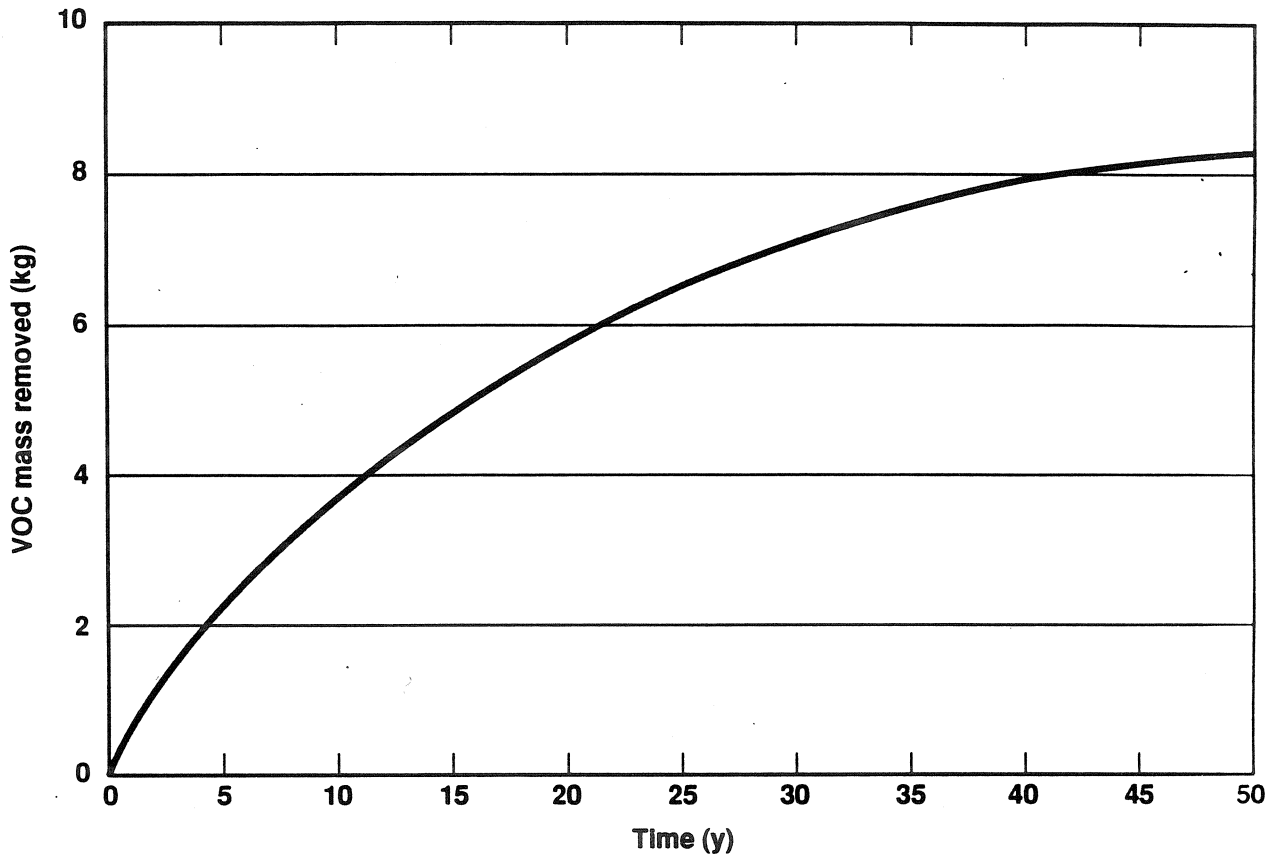

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Figure 9. Estimated VOC mass removed over time from ground water by TFA.

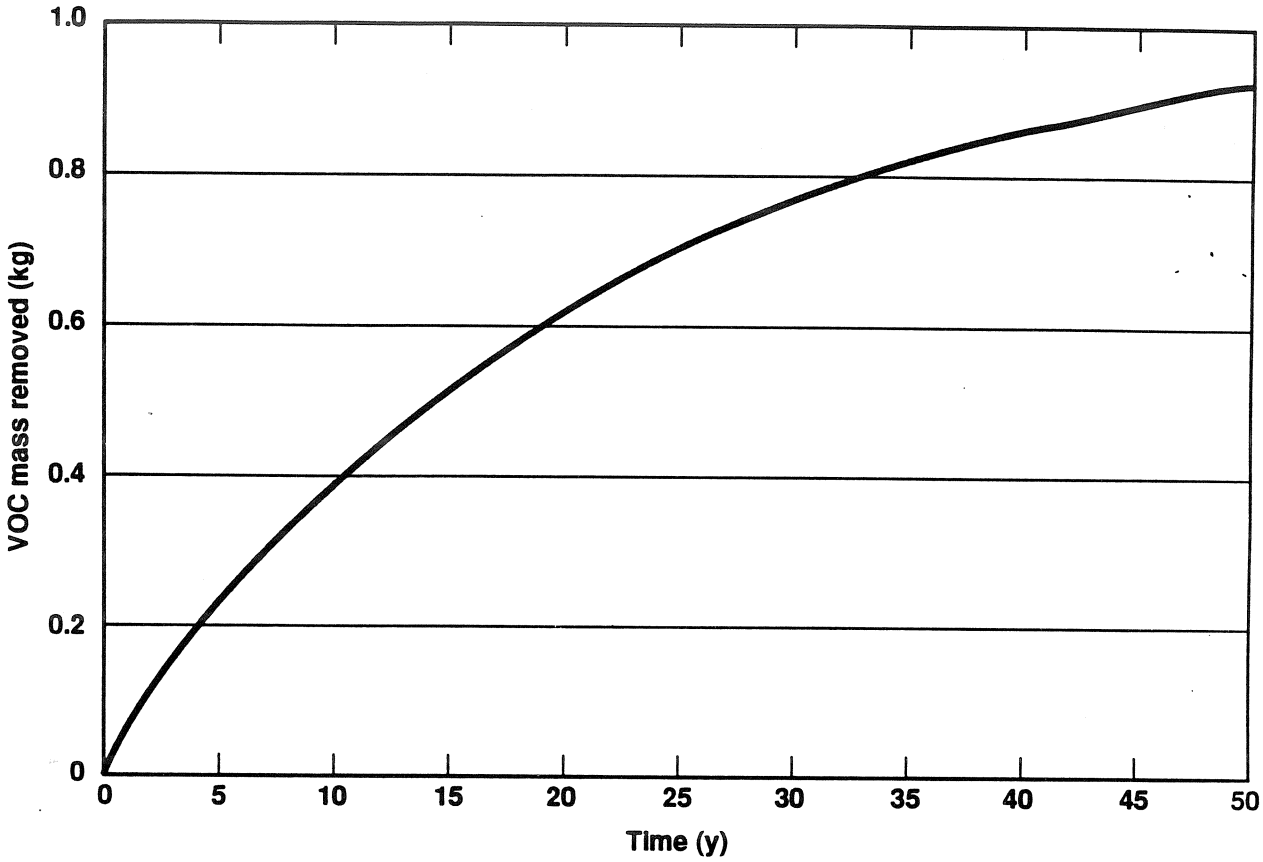

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Figure 10. Estimated VOC mass removed over time from ground water by TFB.

4.3. Requirements for Onsite Storage and Offsite Shipment of Hazardous Waste

GAC filters from TFA and TFB contain sorbed VOCs. These filters are shipped offsite for regeneration or disposal, and are managed as hazardous waste if appropriate. LLNL can temporarily store hazardous waste onsite for up to 90 days. Shipment and disposal is in accordance with Department of Transportation (DOT) 49 CFR and EPA 40 CFR, respectively. Additionally, waste shipments are made in accordance with California Title 22 requirements. The spent carbon filters will be packaged and labeled for shipment by LLNL's Hazardous Waste Managment Division. LLNL's Hazardous Waste Management Division operates under Interim Status and has submitted a RCRA Part B permit application to the DTSC. (California is a fully RCRA-authorized state). Once packaged, the carbon filters are shipped to one of several RCRA-permitted facilities for regeneration or disposal.

The H_2O_2 that remains when a treatment facility is closed and the mercury vapor lamps will be categorized as excess product and shipped to a site where they can be utilized. Shipping of the H_2O_2 will be in accordance with DOT 49 CFR and California 40 CFR and Title 22 regulations.

4.4. Requirements for Close-out

Decisions regarding when extraction should cease at specific wells, and when a particular treatment facility and its influent extraction wells should be decommissioned, will be based on achievement of MCLs in all the piezometers and wells in the capture zone for the extraction well/treatment facility. Such decisions will be made with regulatory agency oversight. Since the size and orientation of capture zones will change over the course of the cleanup, analysis of the vertical and horizontal distribution of the compounds of concern at the time MCLs are achieved will also be conducted. As specified in the ROD, sitewide cleanup will be complete when ground water samples taken from anywhere in the plume demonstrate that the regulatory standards have been met.

It is expected that VOC concentrations may rise in wells after extraction ceases due to slow desorption from fine-grained sediments. Therefore, contaminant concentrations will be monitored quarterly for a period of 2 years after pumping ceases. If concentrations rise above MCLs, extraction will resume at the appropriate wells until MCLs are again achieved. Several iterations of this pumping cycle may be required to achieve the remediation standards. Cleanup will be considered complete when contaminant concentrations remain below the remediation standards for 2 years. Cleanup completion will be determined in conjunction with the regulatory agencies.

After concurrence from the regulatory agencies that cleanup is complete, most of the LLNL extraction wells and piezometers will be sealed and abandoned. All wells screened in more than one water-bearing zone will be sealed to prevent potential vertical migration of compounds of concern. Wells will be sealed by pressure grouting using a grout mixture of 98% Portland cement and 2% bentonite powder by weight, as described in LLNL SOP 1.7 (Rice *et al.,* 1990). A minimal monitoring network, consisting of perhaps 20% of the existing wells, will remain in

place for general ground water quality monitoring. Most of these monitor wells will be located at downgradient plume margins and in former source areas.

TFA and TFB and their influent and discharge piping will be decommissioned after remediation is complete. The portions of the process equipment and piping that contact ground water will not contain hazardous concentrations of VOCs because the equipment will have been thoroughly flushed with ground water with VOC concentrations below MCLs. The process equipment will be sold or recycled if possible. Any wash water containing hazardous materials will be collected, sampled, and disposed at one of several RCRA-permitted facilities. The portions of the facilities that contain hazardous materials, such as H_2O_2 in the tank and feed lines, the mercury vapor lamps, and GAC with sorbed VOCs, will be disposed according to specifications in Section 4.3, "Requirements for Offsite Shipment of Hazardous Waste."

5. References

5.1. References Cited

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U.S. Environmental Protection Agency (EPA) (1989), *Interim Final Guidance on Preparing Superfund Decision Documents: The Proposed Plan, The Record of Decision, Explanation of Significant Difference, and The Record of Decision Amendment*; Office of Solid Waste and Emergency Response (OSWER) Directive 9335.3-02.

5.2. References for LLNL Facilities Standards, Specifications, and Guide Documents

5.2.1. General

Designs, construction drawings, and specifications will conform to and comply with the applicable requirements of the latest adopted edition of the references listed herein, which will be considered minimum requirements.

5.2.2. Regulations

U.S. Department of Energy (DOE)

DOE 5480.1	Chapter 7–Fire Protection Program
DOE 6430.1A	General Design Criteria

Code of Federal Regulations (CFR)

29 CFR 1910	Occupational Safety and Health Standards (OSHA)
29 CFR 1910.7	Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
47 CFR 15	Telecommunication (FCC Rules, Part 15)

State of California Department of Labor (DOL)

DOL Labor Code	Division 5—Safety in Employment; Chapter 9—Miscellaneous Labor Provisions

California Codes of Regulations (CCR)

CCR Title 8	Industrial Relations; Chapter 4, Subchapter 6
CCR Title 20	Public Utilities; Chapter 53—Energy Conservation in New Building Construction

University of California, Lawrence Livermore National Laboratory (UCRL)

UCRL 15910	Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards
UCRL 15714	Suspended Ceiling System Survey and Seismic Bracing Recommendations

5.2.3. Codes

American Concrete Institute (ACI)

ACI 318	Building Code Requirements for Reinforced Concrete

American Institute of Steel Construction (AISC)

AISC	Steel Construction Manual (Allowable Stress Design)

American National Standards Institute (ANSI)

ANSI A58.1	Building Code Requirements for Minimum Design Loads for Buildings and Other Structures

American Welding Society (AWS)

AWS D 1.1	Structural Welding Code—Steel

International Conference of Building Officials (ICBO)

ICBO UBC	Uniform Building Code
ICBO UMC	Uniform Mechanical Code
ICBO UPC	Uniform Plumbing Code

National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code
NFPA 72	Installation, Maintenance, and Use of Protective Signaling Systems
NFPA 72E	Automatic Fire Detectors
NFPA 72H	Test Procedures for Protective Signaling Systems
NFPA 90A	Installation of Air Conditioning and Ventilating Conditioning Systems

5.2.4. Standards

American Concrete Institute (ACI)

ACI 347 Recommended Practice for Concrete Form Work

American Society for Testing and Materials (ASTM)

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)

ASHRAE 90A Energy Conservation in New Building Design

American Water Works Association (AWWA)

Construction Specifications Institute (CSI)

National Electric Manufacturers Association (NEMA)

Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACCNA)

5.2.5. LLNL Manuals and Reports

M-010 LLNL Health and Safety Manual

LLNL Site Development and Facilities Utilization Plan

LLNL Landscape Master Plan and Design Guidelines

5.2.6. Facility As-Built Drawings

TFA:

PLA-88-011-001DA through 002D

PLM88-011-001DA through 011

PLE88-011-001D through 009D

TFB:

PLA-91-0420991D through 004D

PLM91-042-001D through 012D

PLE91-042-001D through 014D

6. Acronyms

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethylene
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARAR	Applicable or Relevant and Appropriate Requirement
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineer
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
AWWA	American Water Works Association
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CI	Construction Inspector
CM	Construction Manager
CRP	Community Relations Plan
CSI	Construction Specifications Institute
DCA	dichloroethane
DCE	dichloroethylene
DDWM	Dissolved Drinking Water Metals
DOE	U.S. Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
DSA	Detailed Study Area
DTSC	California Department of Toxic Substances Control
EE	Electronic Engineering
EEO	Equal Employment Opportunity
EPA	U.S. Environmental Protection Agency
ERD	Environmental Restoration Division
ES&H	Environmental Safety & Health
FCC	Federal Communications Commission
FY	fiscal year
GAC	granular activated carbon
HSP	Health and Safety Plan
ICBO	International Conference of Building Officials
LLNL	Lawrence Livermore National Laboratory
LMI	Liquid Metronics, Inc.
MCL	Maximum Contaminant Level
ME	Mechanical Engineering
M&I	materials and items
M&TE	measuring and testing equipment
NEMA	National Electric Manufacturers Association
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System

NRTL	Nationally Recognized Testing Laboratory
O&M	operations and maintenance
OTL	Operations Team Leader
OSHA	Occupational Safety and Health Administration
OSWER	U.S. EPA Office of Solid Waste and Emergency Response
PCE	perchloroethylene
PEPE	Plant Engineering Project Engineer
P&ID	process and instrument diagram
PM	Program Manager
PO	purchase order
PEPM	Plant Engineering Project Manager
PVC	polyvinyl chloride
QA	quality assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	quality control
RAIP	Remedial Action Implementation Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RE	Remediation Engineer
ROD	Record of Decision
RWQCB	California Regional Water Quality Control Board
SAN	San Francisco Operations Office of DOE
SL	Section Leader
SMACCNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
SOP	Standard Operating Procedure
TCA	trichloroethane
TCE	trichoroethylene
TFA	Treatment Facility A
TFB	Treatment Facility B
TFC	Treatment Facility C
UV/H_2O_2	ultraviolet light/hydrogen peroxide
VOC	volatile organic compound
WDR	Waste Discharge Requirement

Appendix A

RWQCB Waste Discharge Requirements
Order Nos. 88-075 and 91-091

Order No. 88-075

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. 88-075

WASTE DISCHARGE REQUIREMENTS FOR:

U. S. DEPARTMENT OF ENERGY,
and
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE
ALAMEDA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region, hereinafter called the Board, finds that:

1. Lawrence Livermore National Laboratories (LLNL), operates a research facility under contractual agreements with the U. S. Department of Energy (DOE). Discharge is proposed to be made under this Order onto adjoining DOE real property. Lawrence Livermore National Laboratory and the U. S. Department of Energy are hereinafter both referred to as dischargers. For the purposes of this Order, DOE will be responsible for compliance in the event that LLNL fails to comply with the requirements of this Order.

2. The dischargers propose to discharge extracted and treated ground water to land as part of a pilot study extraction test. The pilot test and proposed discharge are described in the dischargers' technical report entitled "Proposal for Pilot Ground Water Extraction and Treatment West of LLNL", submitted December 24, 1987, and in the application for NPDES Permit No. CA0029289, dated August 3, 1987.

3. The pilot study extraction test is intended to develop design criteria for preparation of proposed remedial alternatives under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 1980) and the Superfund Amendments and Reauthorization Act (SARA, 1986). This pilot study will include the construction and testing of three treatment systems, each receiving influent from one to three extraction wells, and is proposed to occur through May 1, 1990. Two of the treatment systems will discharge treated waste ground water to existing surface drainage systems and are covered under NPDES Permit No. CA0029289. The third treatment system (Treatment System A) will discharge treated waste ground water to the ground at locations not covered under the NPDES permit.

4. This Order will allow discharge of treated waste ground water from Treatment System A to be discharged: to a percolation pond (on adjoining DOE property) located approximately 4000 feet southeast of LLNL's southwest site boundary corner by pipeline from Treatment System A; to land south of LLNL's property boundary (adjoining DOE property) by general areal irrigation; or to LLNL site property grounds vegetation by irrigation. One or a combination of these proposed discharge methods will be used by LLNL to dispose of extracted and treated ground water. Treatment System A will receive influent from two or three new extraction wells for a total flow of up to 144,000 gallons per day.

5. Soil and ground water beneath the LLNL site, and offsite to the southwest, have been found to be polluted halogenated organic compounds, primarily solvents such as trichloroethylene and tetrachloroethylene, and petroluem hydrocarbons. Suspected releases have occurred from onsite landfills, storage facility spillage, underground tank and pipeline leakage, and past discharges to the site storm drain system.

6. Hydrogeologic investigation of the site and offsite soil and ground water pollution continues, under CERCLA/SARA regulations, in order to determine the full extent of pollution and the extent and migration characteristics of existing contaminant plumes.

7. Proposed treatment of polluted ground water extracted as part of the pilot extraction test study will be by air stripping prior to discharge to the ground defined in Finding 4. Treatment of the extracted ground water will meet the effluent limitations as set forth in this Order.

8. The Regional Board adopted a revised Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) on December 17, 1986. The Basin Plan contains water quality objectives and discharge prohibitions for the Livermore-Amador valley and all of its subbasins.

9. The existing and potential beneficial uses for surface waters in the Livermore-Amador ground water basin including Arroyo Mocho, Arroyo Seco, Arroyo Las Positas, Arroyo de la Laguna and their tributaries are:

    a. contact and non-contact water recreation,
    b. wildlife habitat,
    c. ground water recharge, and
    d. fish migration and spawning.

10. The existing and potential beneficial uses of the ground waters underlying the Livermore-Amador ground water basin and its subbasins are:

    a. municipal and domestic supply,
    b. industrial supply,
    c. industrial service supply, and
    d. agricultural supply.

11. The LLNL site is located in the eastern portion of the Livermore-Amador ground water basin, in the Spring and Mocho I subbasins. This part of the Livermore-Amador ground water basin is documented as a ground water recharge area in the Basin Plan and in technical reports submitted by the dischargers. One goal of these Waste Discharge Requirements is to restore extracted and treated waste ground water to the Spring and Mocho I ground water aquifers. The effluent limits of this Order are not expected to adversely impact the ground water in the Spring and Mocho I subbasins.

12. The project constitutes a minor modification to land and such activity is thereby exempt from the provisions of the California Environmental Quality Act in accordance with Section 15304, Title 14, of the California Administrative Code.

13. The dischargers and interested persons have been notified of the Board's intent to issue waste discharge requirements for the proposed discharge and have been provided with the opportunity for a public hearing and to submit their written comments and recommendations.

14. The Board, at a properly-noticed public meeting, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED, pursuant to the provisions of Division 7 of the California Water Code and regulations adopted thereunder, that the dischargers shall comply with the following:

A. <u>PROHIBITIONS</u>

1. The treatment, storage and discharge of treated waste ground water shall not create a nuisance as defined in Section 13050(m) of the California Water Code.

2. There shall be no bypass or overflow of untreated or inadequately treated waste ground water to waters of the State from the dischargers' wastewater collection, treatment or distribution facilities.

3. No waste ground water shall be allowed to escape from the designated disposal areas as either surface flow or as airborne spray.

4. The discharge of waste other than treated waste ground water, as defined in this Order, is prohibited.

5. The discharge of waste ground water to disposal areas other than those stipulated in this Order is prohibited.

6. For treated waste ground water discharged to a percolation pond:

   a. A minimum of 2 feet of freeboard shall be maintained in the pond at all times to prevent the threat of overflow.

   b. The pond shall be adequately protected from erosion and washout which may result from a rainfall event having a predicted frequency of once in 100 years.

7. For treated waste ground water discharged to the land by irrigation:

   a. No waste ground water shall be applied to the irrigation area during prolonged periods of rainfall or when soils are saturated.

8. For treated waste ground water discharged to LLNL site vegetation by irrigation:

   a. The public shall be effectively excluded from the irrigation disposal area by irrigation at night or early morning when wind velocity is minimal.

   b. The public shall be notified of the use of treated waste ground water through use of warning signs or similar to comply with this requirement.

   c. No waste ground water shall be applied to the irrigation areas during prolonged periods of rainfall or when soils are saturated.

9. Discharge of waste ground water in any of the disposal areas shall cease immediately when any prohibition or specification is violated.

B. Discharge Specifications

1. The discharge of waste ground water shall not degrade the quality of any ground water suitable for domestic use or cause an increase in any quality parameter that would make ground water unsuitable for irrigation use.

2. The waste ground water shall at all times meet the following quality limits prior to disposal:

Constituent	Units	Instantaneous Maximum
Metals		
Antimony	mg/l	1.46
Arsenic	ug/l	500
Beryllium	ug/l	0.68
Boron	mg/l	7
Cadmium	ug/l	100
Chromium +3	mg/l	1700
Chromium +6	ug/l	500
Copper	mg/l	2
Iron	mg/l	3
Lead	ug/l	500
Manganese	ug/l	500
Mercury	ug/l	20
Nickel	ug/l	134
Selenium	ug/l	100
Silver	ug/l	500
Thallium	ug/l	130
Zinc	mg/l	20
Volatile Organic Compounds		
Total Volatile Organic Compounds	ug/l	5

Total Volatile Organic Compounds include, but are not limited to:

Benzene, Bromoform, Carbon Tetrachloride, Chlorobenzene, Chlorodibromomethane, Chloroethane, Chloroform, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-Dichloroethylene, 1,2-Dichloropropane, Ethyl Benzene, Tetrachloroethylene, Toluene, trans-1,2-Dichloroethylene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethylene, Trichlorofluoromethane, Xylene(s), Vinyl Chloride

Acid Extractable Organic Compounds		
2,4-Dimethylphenol	ug/l	400
Phenol	ug/l	5
2,4,6-Trichlorophenol	ug/l	5

Base/Nuetral Extractable Organic Compounds		
1,4-Dichlorobenzene	ug/l	5
Napthalene	ug/l	620
Phenanthrene	ug/l	5
Pyrene	ug/l	5

C. Provisions

1. The dischargers shall comply with all sections of this Order immediately upon adoption.

2. The dischargers shall comply with a Self-Monitoring Program as ordered by the Executive Officer.

3. The dischargers shall permit the Board or its authorized representatives in accordance with California Water Code Section 13267(c):

   a. Entry upon premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Order;

   b. Access at reasonable times to any records that must be kept under the conditions of this Order;

   c. Inspection at reasonable times of any facility, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and

   d. To sample and monitor at reasonable times for the purpose of assuring compliance with this Order.

4. The dischargers shall maintain in good working order and operate, as efficiently as possible, any facility or control system installed or as modified to achieve compliance with this Order.

5. A contingency plan shall be developed outlining the actions to be taken in the event effluent quality fails to meet required standards. The plan must be submitted for review, to the satisfaction of the Executive Officer, prior to the startup of any disposal activity.

6. In the event of any change in control or ownership of land or treatment facilities presently owned or controlled by the dischargers, the dischargers shall notify the succeeding owner or operator of the existence of this Order by a letter, a copy of which shall be forwarded to this Board.

7. The dischargers shall file with the Board a report of waste discharge at least 120 days before making any material change in the character, location or volume of the discharge.

8. The Board will review this Order periodically and may revise the requirements when necessary.

I, Roger B. James, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on May 18, 1988.

for ROGER B. JAMES
Executive Officer

Attachments:
A. Site Map
B. Self-Monitoring Program

File No. 2199.9026 (MDK)

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

SELF-MONITORING PROGRAM

FOR

U. S. Department of Energy

and

Lawrence Livermore National Laboratory

Livermore, Alameda County

ORDER NO. 88-075

U. S. DEPARTMENT OF ENERGY
and
LAWRENCE LIVERMORE NATIONAL LABORATORY

I. GENERAL

Reporting responsibilities of waste dischargers are specified in Sections 13225(a), 13267(b), 13268, and 13387(b) of the California Water Code and this Regional Board's Resolution No. 73-16.

The principal purposes of a monitoring program by a waste discharger, also referred to as a self-monitoring program, are:

1. To document compliance with waste discharge requirements and prohibitions established by the Regional Board.

2. To facilitate self-policing by the waste dischargers in the prevention and abatement of pollution arising from discharge of waste ground water.

II. SAMPLING AND ANALYTICAL METHODS

Sample collection, storage, and analyses shall be performed according to the 40 CFR 136 or other methods approved and specified by the Executive Officer of this Regional Board.

Water and waste analyses shall be performed by a laboratory approved for these analyses by the State Department of Health Services (DHS) or a laboratory waived by the Executive Officer from obtaining a certification for these analyses by the DHS. The director of the laboratory whose name appears on the certification or his/her laboratory supervisor who is directly responsible for analytical work performed shall supervise all analytical work including appropriate quality assurance/quality control procedures in his/her laboratory and shall sign all reports of such work submitted to the Regional Board.

All monitoring instruments and equipment shall be properly calibrated and maintained to ensure measurement accuracy.

III. DEFINITION OF TERMS

1. Grab Sample is an individual sample collected in a short period of time not exceeding 15 minutes. Grab samples shall be collected during normal peak loading

conditions for the parameter of interest, which may or may not be during hydraulic peaks. It is used primarily in determining compliance with daily maximum and instantaneous maximum limits. Grab samples represent only the conditions that exist at the time the waste water is collected.

2. Flow Sample is the accurate measurement of the average daily flow volume using a properly calibrated and maintained flow measuring device. In this case, a flow sample would measure the average daily flow from Treatment System A, and into each of the disposal areas.

3. Instantaneous Maximum is the highest measurement for the calendar day.

4. Site Map is a topographic-based map of suitable scale to show features of interest and allow accurate scale measurements to be made from the map.

IV. SPECIFICATIONS FOR SAMPLING AND ANALYSIS

The Dischargers are required to perform observations, sampling and analyses as stipulated in the schedules of Tables 1, 2 and 3, and in accordance with the following conditions.

1. Influent

Samples of influent shall be collected on random days at the frequency stipulated in Table 1. Samples shall not include any sidestream wastes or other influent sources not covered under this Order. Deviation from this must be approved by the Executive Officer.

2. Effluent

a. Effluent sampling shall be coincident with influent sampling according to the schedule of Table 1, unless otherwise stipulated. The Board or Executive Officer may approve an alternative sampling plan if it is demonstrated to the Board's satisfaction that expected operating conditions warrant a deviation from the standard sampling plan.

b. If any instantaneous maximum limit is exceeded, the sampling frequency shall be increased to daily until two samples collected on consecutive days show compliance with the instantaneous maximum limit.

3. Percolation Pond

   a. Pond sampling shall be coincident with influent and effluent sampling unless otherwise stipulated. As in Section IV.2.a. above, an alternative plan may be approved by the Board or Executive Officer if warranted.

   b. Water samples shall be taken one foot below the water surface in the pond, and no less than two feet from the bank.

   c. The method of sampling shall be described in the self-monitoring report, and shall follow existing EPA or similar standards for impoundment sampling.

4. Soil Sampling

   a. Soil sampling may be coincident with influent, effluent and pond sampling. Samples shall be taken at specified points in the pond bottom, irrigated field and irrigated vegetation areas to determine if any buildup of contaminants in the soil is occurring.

   b. Initial soil samples shall be taken for the pond and irrigated field disposal areas, at the locations stipulated herein, upon adoption of this Order and prior to any discharge. These samples will be considered background level samples. Irrigated on site vegetation areas may be sampled initially at a time prior to first discharge of treated waste ground water.

   c. The method of soil sampling shall be described in the self-monitoring report, and shall follow existing EPA or similar standards for soil sampling.

   d. Soil samples shall be analyzed for all constituents represented in NPDES Permit No. CA0029289, Effluent Limitations, Section A.2.

   e. Soil samples from the percolation pond shall be taken of bottom sediments and also in situ soils at discreet depths. Soil samples from irrigated areas shall also be taken from discreet depths near the ground surface and 1 to 1 1/2 feet below ground surface as described in Section V.4., below.

5. Land Observations
Observations and measurements made of site conditions at confined or unconfined waste ground water disposal areas.

For confined disposal areas, or a percolation pond:

a. Measurement of freeboard shall be made at the lowest elevation point in the dike or sidewalls confining the liquid waste ground water in the pond. There shall be a minimum of 2 feet of freeboard, or distance between the water surface and lowest elevation point in the dike/sidewalls of the pond. Freeboard shall be measured routinely on a weekly basis, and more frequently (ie., at least once daily) during periods of intense precipitation.

b. Evidence of leakage, seepage, or overflow due to erosion of confining dike or pond sidewalls, with the affected area shown on a site map with an estimate of overflow volume.

c. Presence or absence of odor, its characterization, source, and distance of travel.

d. Estimated number of waterfowl and other water-associated birds in the pond area and vicinity.

e. Estimate of volume and rate of recharge.

f. Weather conditions including average air temperature and total precipitation during the intervening time between samples to include the day of sampling.

For unconfined disposal areas, or irrigation to field or on site vegetation areas:

a. Evidence of waste water escaping the disposal area as surface runoff or spray, shown as affected area on a site map.

b. Evidence of waste water ponding and any mosquito breeding problem within irrigated area due to excessive irrigation.

c. Presence or absence of odor, its characterization, source, and distance of travel.

d. Estimate of volume and rate of recharge.

e. Weather conditions including air temperature, total precipitation during the intervening time between samples to include the day of sampling, and estimated wind direction and velocity.

f. Warning signs or notices adequately posted to inform the public of the disposal of treated waste ground water by irrigation.

V. DESCRIPTION OF SAMPLING STATIONS

Station	Description
1. Influent	
I-001	At a point in ground water extraction, collection and treatment, utilizing Treatment System A (located near MW-103), immediately prior to treatment. This is the same I-001 station under NPDES Permit No. CA0029289, therefore the NPDES sample analytical results may be reported in this self-monitoring report according to the schedule of Table 1.
2. Effluent	
E-1	At a point in the effluent conveyance line immediately prior to discharge into the percolation pond. If more than one discharge point into the pond exists, then additional effluent points will be required.
E-2	At a point in the effluent conveyance line immediately prior to discharge into the field irrigation system.
E-3	At a point in the effluent conveyance line immediately prior to discharge into the irrigation to vegetation system.
3. Percolation Pond	
C-1, C-2	At opposing points in the pond. Samples of pond water shall be taken as noted in the sampling specifications in Section IV.3. above.

4. Soil

B-1, B-2	Percolation pond bottom sediment samples taken at opposing sides or ends of the pond. Samples shall be taken of pond bottom sediments to a depth no greater than about 4 inches.
B-3, B-4	Percolation pond in situ soil samples taken at opposing sides or ends of the pond, and adjacent to sample B-1 and B-2 locations. Samples shall be taken at a discreet depth of 1 or 1 1/2 feet below the pond bottom.
B-5 to B-'N'	At points spaced equidistantly around areas of irrigation. Samples shall be be taken in sets at the same or adjacent locations, at discreet depths of about 4 inches and 1 or 1 1/2 feet for irrigated fields, and 4 inches and 1 foot for irrigated vegetation. Each sample set shall represent about 25% of the area of irrigated field, and an area greater than 1000 feet square feet for irrigated onsite vegetation.

5. Land Observations

L-1 to L-4	Located at quarter-points of the pond periphery. Observations shall be taken in accordance with Table 2.
L-5 to L-'N'	Located at points equidistant around periphery of irrigated areas. Points shall be spaced at no greater than 400 feet.

VI. RECORDS TO BE MAINTAINED

1. Written reports, calibration and maintainence records, sampling and analytical records, and other compliance records shall be maintained by the dischargers at their facility. The records shall be available at the dischargers' facility for a period equal to the length of this Order. The retention time may be extended due to unresolved litigation or by request from the Regional Board or U. S. Environmental Protection Agency, Region IX.

2. Tabulation of flow data to include total flow volume per day and minimum/maximum daily flows.

3. Tabulation of treatment system bypassing or accidental waste spills shall be maintained and for each occurrence shall include: contaminant involved; quantity; length of time; cause; spill prevention/control plan in effect; effects; corrective measures taken; agencies notified.

VII. REPORTS TO BE FILED WITH THE REGIONAL BOARD

1. Report of Permit Violations
In the event the dischargers violate or threaten to violate the conditions of the waste discharge requirements, the dischargers shall notify the Regional Board office as soon as they or their agents have knowledge of the incident. Notice by telephone may be made to (415)464-1255, with a written confirmation report forwarded within 7 working days of telephone notification. The written report shall include the information stipulated in Section VI.3. above.

2. Self-Monitoring Reports

   a. Written reports shall be filed regularly for each month, and shall be submitted by the fifteenth day of the following month. The reports may be included as part of the monthly reports required under NPDES Permit No. CA0029289.

   b. Written reports shall include:

      1) Letter of Transmittal - discussions of permit violations for the past month to summarize details required in Section VI.3. above, and a of proposed corrective schedules for previous violation. The letter shall be certified as to veracity and correctness by signature of an authorized representative or responsible official of the dischargers'.

      2) Data - to include flow data, sampling methodologies, analytical results for the sampling schedule of Table 1, and observations in accordance with Tables 2 and 3. Analytical results shall be presented in tabular form by station, date and type of sample.

3) Compliance with Standard Observations - completed forms for Tables 2 and 3 shall accompany the self-monitoring report.

4) Site Map - a site map for all disposal areas shall accompany monthly reports showing locations of sample and observation stations, and any violation locations and effects.

c. Sampling Data Summary
A copy of the monthly self-monitoring report shall be submitted to the EPA's Superfund Division. Send reports to:

a) Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1111 Jackson Street, Room 6000
Oakland, California 94607

b) Regional Administrator
U. S. Environmental Protection Agency
Superfund Division
215 Fremont Street
San Francisco, California 94105

3. Annual Reporting
By January 30 of each year, the dischargers shall submit, in place of the end of the year monthly report, an annual report to the Regional Board covering the previous calendar year. The report may be part of the annual report submitted in compliance with NPDES Permit No. CA0029289. The report shall contain both tabular and graphical summaries of the monitoring data obtained during the previous year. In addition, the report shall contain a comprehensive discussion of the compliance record and the corrective actions taken or planned which may be needed to bring the dischargers into full compliance with the waste discharge requirements.

I Roger B. James, Executive Officer, hereby certify that the foregoing Self-Monitoring Program:

1. Has been developed in accordance with the procedure set forth in this Regional Board's Resolution 73-16 in order to obtain data and document compliance with waste discharge requirements established in Regional Board Order No. 88-075.

2. Is effective on the date shown below.

3. May be reviewed at any time subsequent to the effective date upon written notice from the Executive Officer or request from the dischargers, and revisions will be ordered by the Executive Officer.

for ROGER B. JAMES
Executive Officer

Effective Date: May 18, 1988

Attachments: Disposal Area Location Map
Sample Stations For A Typical Percolation Pond
Table 1
Table 2
Table 3

DISPOSAL AREA LOCATION MAP

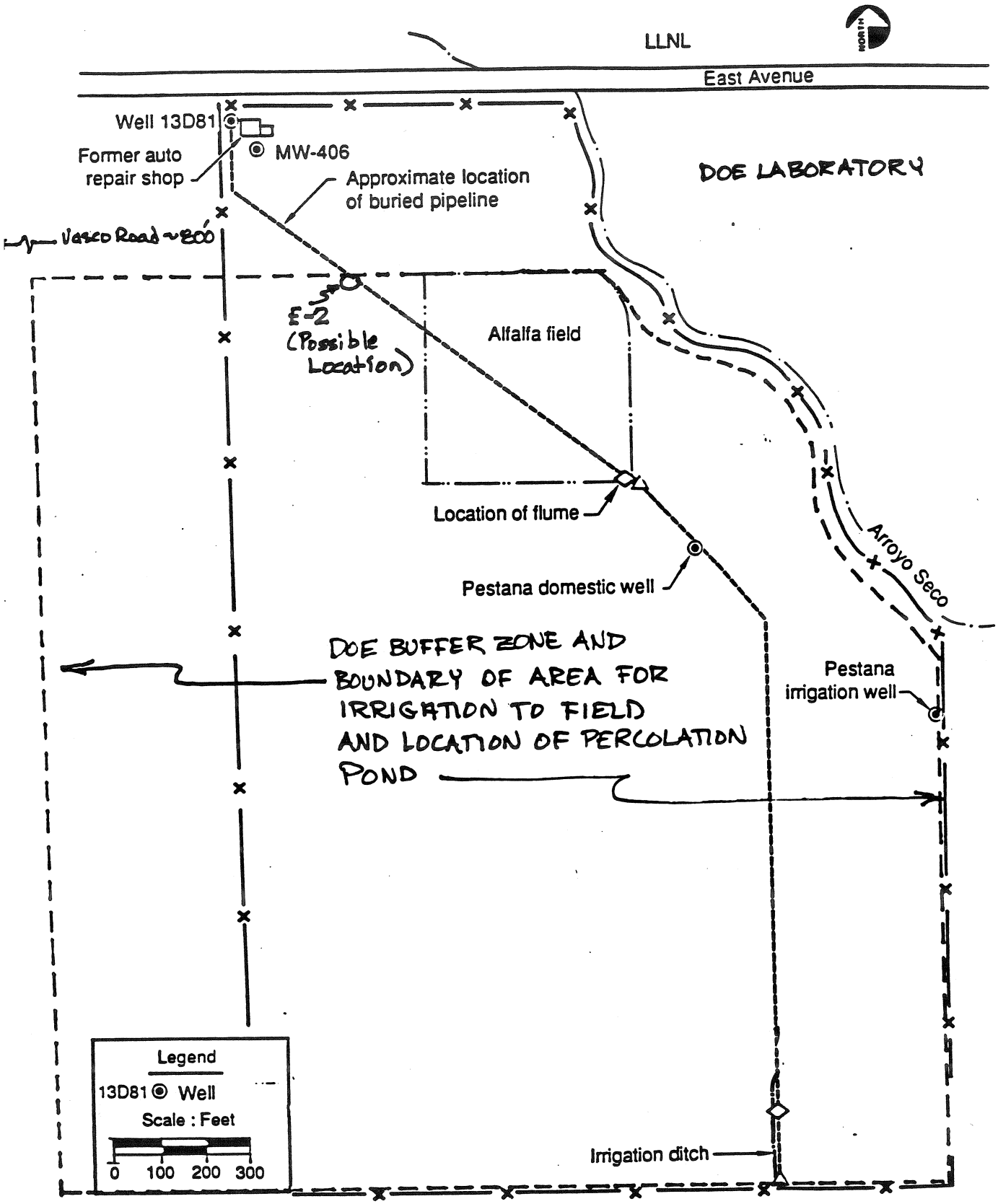

Figure 3. Former Pestana property layout.

SAMPLING STATIONS FOR TYPICAL PERCOLATION POND

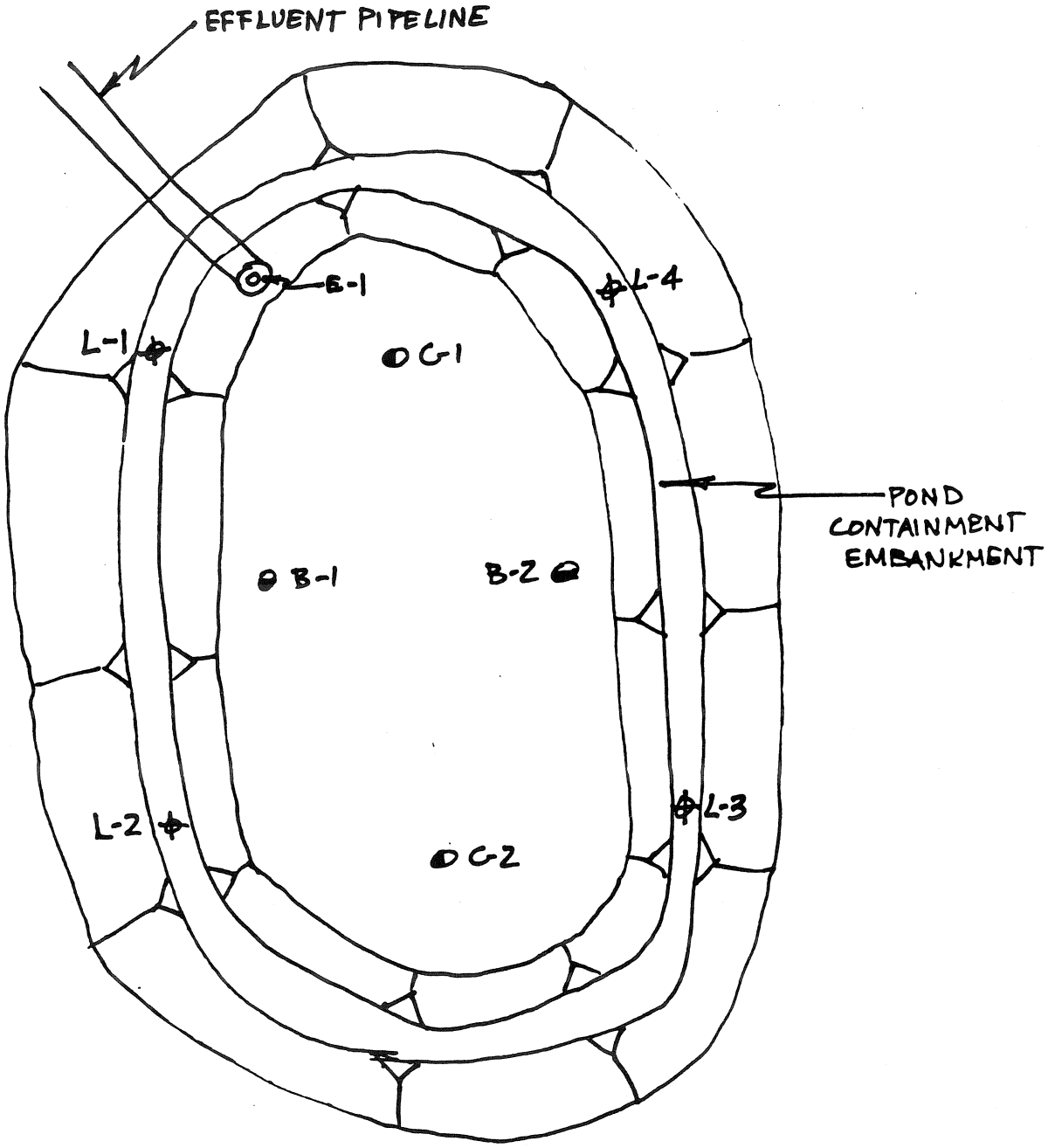

Table 1
SCHEDULE FOR SAMPLING, MEASUREMENTS, AND ANALYSIS
LAWRENCE LIVERMORE NATIONAL LABORATORY, AND
U. S. DEPARTMENT OF ENERGY

Sampling Station	I-001	E-1 to E-3	C-1, C-2	B-1, B-2	B-3, B-4	B-5 to B-N	L-1 to L-N
Sample Type	G	G	G	BS	BI	BI	O
Flow Rate (mgd)	D	D					
Fish Tox'y (1)		Q	S				
Turbidity (2)		Q					
pH, units	M	M					
Temperature, C		M					
Metals (3) mg/l, kg/day	I/S	I/S	S	B/A	B/A	B/A	
Gross alpha/ gross beta particles, tritium		I/A	S	B/A	B/A	B/A	
All Applicable Standard Observations							W
EPA 8040, ug/kg				B/A	B/A	B/A	
EPA 8240, ug/kg				B/A	B/A	B/A	
EPA 8270, ug/kg				B/A	B/A	B/A	
EPA 601 ug/l, kg/l	W/M	D/W	Q				
EPA 624 ug/l, kg/l	I/A*	I/A*	I/A*				
EPA 602 & 625 ug/l, kg/l	I/A	I/A	I/A				
Chlorides	Q	Q	Q				

Table 1 (continued)
SCHEDULE FOR SAMPLING, MEASUREMENTS, AND ANALYSIS

LEGEND FOR TABLE 1

Types of Stations

I = influent
E = effluent
C = receiving water
L = pond embankment or irrigated area periphery
B = soil sample at pond bottom or in irrigated area

Types of Samples

G = grab
BS = soil samples of pond bottom sediments
BI = soil samples of in situ soil below pond bottom or in irrigated areas
O = observation

Frequency of Sampling

D = daily, once each day
W = weekly, once each week
M = monthly, once each month
Q = quarterly, once each March, June, September and December
S = semiannually, twice each year
B/A = one sample immediately prior to discharge,then annually
D/W = daily for the first week then weekly
W/M = weekly for the first 4 weeks, then monthly
I/A = one sample during the first week of discharge, then annually
I/S = one sample during the first week of discharge, then semiannually

Notes

(1) Fish Toxicity, 96 hours, survival in undiluted waste
(2) Jackson turbidity units
(3) Metals to include: antimony, arsenic, berrylium, boron, cadmium, chromium (total), copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, zinc

Table 2
LAND OBSERVATIONS AT PERCOLATION POND
DISCHARGERS' SELF-MONITORING REPORT

1. Dischargers: U. S. Department of Energy, and Lawrence Livermore National Laboratory,

2. Reporting Period: Month_____ Year_____

3. Circle dates treated waste ground water discharged to percolation pond: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

4. Total flow volume for reporting month: _____ gallons

5. Estimated recharge: _____

6. Weather conditions: Average Air Temperature_____ Total Precip_____

7. Estimated number of waterfowl in pond vicinity: _____

8. Required weekly land observations, in feet for freeboard and 'yes' or 'no' for other observations, for weeks of reporting month:

	Weeks for Reporting Month
Date and Time	
Feet of freeboard	
Evidence for leakage or overflow	
Odor from waste water	

9. If less than 2 feet of freeboard or yes to any of above, a written report shall be submitted as per section VII.1., Self-Monitoring Program.

10. I certify that the information in this report, to the best of my knowledge, is true and correct.

Inspector Signature_____ Date_____

Table 3
LAND OBSERVATIONS IN IRRIGATED AREAS
DISCHARGERS' SELF-MONITORING REPORT

1. Dischargers: U. S. Department of Energy, and Lawrence Livermore National Laboratory,

2. Reporting Period: Month_____ Year_____

3. Circle dates treated waste ground water discharged to land by irrigation: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

4. Total flow volume for reporting month: _____ gallons

5. Estimated recharge:

6. Weather conditions:
Average Air Temperature_____ Total Precip_____ Wind Velocity_____

7. Required weekly land observations, as 'yes' or 'no', for weeks of reporting month:

Date and Time	Weeks for Reporting Month
Escape waste water, as surface flow or spray	
Evidence for ponding or mosquito problem	
Odor from waste water	
Warning signs posted	

8. If yes to any of above, a written report shall be submitted as per section VII.1., Self-Monitoring Program.

9. I certify that the information in this report, to the best of my knowledge, is true and correct.

Inspector Signature_____ Date_____

Order No. 91-091

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. 91-091
NPDES NO. CA0029289

RECEIVED
JUN 28 1991
ENVIRONMENTAL PROTECTION DEPT.
ENVIRONMENTAL RESTORATION DIV.

WASTE DISCHARGE REQUIREMENTS FOR;

U.S. DEPARTMENT OF ENERGY
and
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, ALAMEDA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region, (hereinafter the Board) finds that:

1. Lawrence Livermore National Laboratories (LLNL) operates a research facility under contractual agreements with the U.S. Department of Energy (DOE). LLNL and DOE are both hereinafter referred to as dischargers. For the purposes of this Order, DOE will be responsible for compliance in the event that LLNL fails to comply with its requirements.

2. By a report dated April 1991, the dischargers have applied for a revision of their current waste discharge requirements to include groundwater disposal/recharge via an infiltration trench and injection wells. These requirements will be permitted under the National Pollutant Discharge Elimination System.

3. Hazardous materials have been used, stored, and disposed of on the property since it was first used by the federal government in the 1940's as a Naval Air Station, and later as a research for DOE and its predecessor, the U.S. Atomic Energy Commission.

4. Soil and groundwater beneath the site are polluted with chemicals and solvents that have either current or historical usage onsite. These pollutants include trichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, 1,1-dichloroethylene, 1,1-dichloroethane, carbon tetrachloride, and other halogenated and petroleum hydrocarbons.

5. Suspected sources of hazardous waste releases are form onsite landfills, spillage from outdoor storage facilities that existed throughout the site, leakage from underground storage tanks and pipelines, and past discharges to the LLNL storm drain system. Hazardous waste releases from current research or maintenance activities is not presently ongoing.

6. More than 300 monitoring wells have been installed by the dischargers, both onsite and offsite. Groundwater monitoring data indicate that the groundwater is polluted in several locations beneath the site and that a plume of polluted groundwater extends offsite from the southwest, flowing in a northwesterly direction.

7. Volatile organic compounds (VOCs) in the groundwater occur in large but relatively diffuse plumes that underlie about 85% of the LLNL site and cover a total of about 1.1 miles. VOC plumes are from 30 to 100 feet thick and are rarely found below a depth of 200 feet. VOCs have migrated offsite in two areas: about 2,500 feet west of Vasco Road onto private property and about 800 feet south of the South East Corner Area onto DOE property used by Sandia Laboratories.

8. This permit covers several investigative and remedial activities that will generate treated groundwater as waste. These activities are proposed to be conducted in both onsite and offsite areas, and include:

Short Term Discharge

a. Routine sampling - 3 to 5 well bore volumes removed from monitoring wells prior to obtaining regular groundwater samples for water quality analyses

b. Well development - preparation of new monitoring wells

c. hydraulic testing - 1 hour to 2 day pump tests

Long Term Discharge

a. Pilot study pump test - long term pump test to develop remedial design criteria

b. remedial treatment - subject to approval by EPA, but may consist of groundwater extraction and treatment prior to discharge at effluent limitations set by this Order.

9. Waste generated from routine sampling, well development, and hydraulic testing will reach flows ranging from approximately 800 to 40,000 gallons per day (gpd). These activities will most likely occur on an intermittent basis, but if all three activities are conducted simultaneously maximum flows may reach approximately 51,000 gpd.

10. Presently, two pilot study treatment facilities discharge about 180,000 gpd of treated wastewater. Of the 180,000 gallons, 144,000 will be discharged under separate Waste Discharge Requirements. When a permanent remedial alternative is selected by EPA, and it consists of groundwater extraction and treatment, remedial treatment may reach an anticipated total flow of approximately 504,000 gpd.

11. Treated waste groundwater will be discharged to the ground, to storm sewers which flow into Arroyo Seco or Arroyo Las Positas, or directly into the arroyos. When there is sufficient storm water flow in the arroyos, treated groundwater may flow through Alameda Creek into into San Francisco Bay north of the Dumbarton Bridge.

12. LLNL proposes to discharge treated waste groundwater to an infiltration trench west of Greenville Road in southern LLNL, and injections wells located 100 feet south of MW-441. The infiltration trench and injection wells will serve to expedite groundwater cleanup, hydraulically control existing VOC plumes, minimize anticipated water table decreases, and conserve groundwater resources.

13. The portion of the Livermore-Amador Valley groundwater basin which LLNL occupies, part of the Spring and Mocho I subbasins, is recognized as a groundwater recharge area in the San Francisco Bay Basin Plan and in technical reports submitted by the dischargers. One goal of this Order is to maximize retention of discharged groundwater within the Spring and Mocho I subbasins.

14. This Order will allow discharge of treated groundwater directly to the ground surface, into the surface drainage system (surface drainage channels, storm drains, Arroyo Seco, or Arroyo Las Positas), into an infiltration trench, or injection wells. Discharge from the pilot study treatment systems will be allowed under this permit until a permanent remedial alternative is selected by EPA,

15. The Board adopted a revised Water Quality Control Plan (Basin Plan) for the San Francisco Bay Region on December 17, 1986, The Basin Plan contains objectives and discharge prohibitions for the Livermore-Amador Valley and its subbasins.

16. The existing and potential beneficial uses for surface waters in the Livermore-Amador Valley groundwater basin including Arroyo Mocho, Arroyo Seco, Arroyo Las Positas, Arroyo de la Laguna and their tributaries are:

    a. Contact and non-contact water recreation,
    b. Wildlife habitat,
    c. Groundwater recharge, and
    d. Fish migration and spawning.

17. The existing and potential beneficial uses for groundwater underlying the Livermore-Amador Valley groundwater basins and its subbasins are:

    a. Municipal and domestic supply,
    b. Industrial supply,
    c. Industrial service supply, and
    d. Agricultural supply.

18. The Basin Plan prohibits discharge of wastewater which has "particular characteristics of concern to beneficial uses":

    a. "at any point where the wastewater does not receive a minimal initial dilution of at least 10:1 or onto any nontidal water, dead-end slough, similar confined water, or any immediate tributary thereof", and

    b. "to Alameda Creek (watershed) where no natural flow occurs."

19. The Basin Plan allows for exemptions to the prohibitions referred to in Finding 18 above when it can be demonstrated that a net environmental benefit can be derived as a result of the discharge.

20. LLNL's discharge can be exempt from the Basin Plan prohibition because it is an integral part of a program to clean up contaminated groundwater and thereby produces a net environmental benefit. Receiving water concentrations are expected to be below levels that would affect beneficial uses. Should studies indicate unanticipated chronic effects, the Board will review the requirements of this Order based upon Receiving Water Limitations B.1.e.

21. The Basin Plan prohibits discharge of "all conservative toxic and deleterious substances, above those levels which can be achieved by a program acceptable to the Board, to waters of the Basin." The dischargers' groundwater extraction and treatment system and associated operation, maintenance, and monitoring plan constitutes an acceptable control program for minimizing discharge of toxicants to waters of the State.

22. Effluent limitations of this Order are based on the Basin Plan, State plans and policies, U.S. Environmental Protection agency guidance, and best engineering and geologic judgement as to the best available technology that is economically achievable.

23. The issuance of waste discharge requirements for this discharge is exempt from the provisions of Chapter 3 (commencing with Section 21100) of Division 13 of the Public Resources Code (CEQA) pursuant to Section 13389 of the California Water Code.

24. The Board has notified the dischargers and interested agencies and persons of its intent to reissue waste discharge requirements for the discharge and has provided them with the opportunity for a public hearing and an opportunity to submit their written views and recommendations.

25. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED that the dischargers; in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder; shall comply with the following:

A. EFFLUENT LIMITATIONS

1. Any effluent discharged to the ground surface onsite shall:

   a. not exceed 10,000 gallons per day,

   b. be treated before discharge to meet concentrations of less than two times the action level for each compound specified by the California Department of Health Services, and

   c. be less than 100 ppb of total volatile organic compounds.

2. The effluent at the point of discharge to Arroyo Seco, Arroyo Las Positas, surface drainage channels, storm drains, LLNL infiltration trench, or LLNL injection wells shall not contain constituents in excess of the following:

Constituent	Unit	Instantaneous Maximum
Metals		
Antimony	ug/l	1460
Arsenic	ug/l	20
Beryllium	ug/l	0.7
Boron	ug/l	7000
Cadmium	ug/l	5
Chromium, Total	ug/l	50
Chromium +6	ug/l	11
Copper	ug/l	20
Iron	ug/l	3000
Lead	ug/l	5.6
Manganese	ug/l	500
Mercury	ug/l	1
Nickel	ug/l	7.1
Selenium	ug/l	100

Silver	ug/l	2.3
Thallium	ug/l	130
Zinc	ug/l	58
Volatile Organic Compounds (VOCs)		
Benzene	ug/l	0.7
Tetrachloroethylene	ug/l	4
Vinyl Chloride	ug/l	2
Total VOCs	ug/l	5

Total VOCs include but are not limited to:

Benzene, Bromoform, Carbon Tetrachloride, Chlorobenzene, Chlorodibromomethane, Chloroethane, Chloroform, 1,1-Dichloroethane, 1,2-Dichloroethane, Ethylbenzene, Tetrachloroethylene, Toluene, trans-1,2,-Dichloroethylene, 1,1,1-Trichloroethane, Trichloroethylene, trichlorofluoromethane, Xylene(s), and Vinyl Chloride.

Total Petroleum Hydrocarbons As identified by modified EPA Method 8015	ug/l	50
Ethylene Dibromide As identified by EPA Method 504	ug/l	0.02
Polynuclear Aromatic Hydrocarbons Total, as identified by EPA Method 610 or 625	ug/l	15
Base/Neutral, Acid, and Pesticide Compounds Per constituent, as identified by EPA Method 610 or 625	ug/l	5

3. The pH of the discharge shall not exceed 8.5 nor be less than 6.5.

4. In any representative set of samples, the discharge of wastes shall meet the following limit of quality:

   TOXICITY: The survival of test fishes acceptable to the Executive Officer in 96-hour bioassays of the effluent as discharged shall be a median of 90% survival and a 90 percentile value of not less than 70% survival.

B. RECEIVING WATER LIMITATIONS

1. The discharge of wastes shall not cause the following conditions to exist in waters of the State at any place:

   a. floating, suspended, or deposited macroscopic particulate matter or foam;

b. bottom deposits or aquatic growths;

c. alteration of temperature or apparent color beyond present natural background levels;

d. visible, floating, suspended, or deposited oil or other products of petroleum origin; and

e. toxic or deleterious substances to be present in concentrations or quantities which will cause deleterious effects on aquatic biota, wildlife, or water fowl, or which render any of these unfit for human consumption at levels created in the receiving water or as a result of biological concentrations.

2. The discharge of waste shall not cause the following limit to be exceeded in waters of the State within one foot of the water surface:

pH: The pH shall not be depressed below 6.5 nor raised above 8.5, nor caused to vary from normal ambient pH levels by more than 0.5 pH units.

3. This discharge shall not cause a violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board as required by the Federal Water Pollution Control Act and regulations adopted thereunder. If more stringent applicable water quality standards are promulgated or approved pursuant to Section 303 of the Federal Water Pollution Control Act or amendments thereto, the Board will revise and modify this Order in accordance with the more stringent standards.

C. PROVISIONS

1. The dischargers shall comply with all sections of this Order immediately upon adoption. For the purposes of enforcing this Order, DOE shall be responsible for achieving full compliance with this Order within 60 days of the Executive Officer's determination that LLNL has failed to comply with the requirements of this Order.

2. The dischargers shall comply with the self-monitoring program as adopted by the Board and as may be amended by the Executive Officer.

3. Board Order 90-106 is hereby rescinded.

4. The dischargers shall notify the Board if the Self-monitoring program results indicate, or if discharge or any activity (to include all site investigation activity) has occurred or will occur which would result in the discharge of any toxic pollutant which is not limited by this Order.

5. Discharge of treated groundwater to the ground may occur only:

a. within LLNL legal site boundaries while conducting routine sampling, well development, or hydraulic testing,

b. if the total effluent volume does not exceed 10,000 gallons per day,

c. if the total VOCs in the discharge do no exceed concentrations of two times the action level for each compound specified by the California Department of Health Services, or does not exceed the limit under Effluent Limitation A.1, and

d. in offsite areas while conducting routine sampling, well development, or hydraulic testing if it has been shown that the pumped water contains VOC concentrations less that those listed in Item a.2 and permission is obtained from the owners.

6. Discharge of treated waste groundwater to the storm sewers may occur only:

a. within LLNL legal site boundaries,

b. in offsite areas if the discharge point to a waterway can be identified, and a receiving water sample point is established (if the new discharge point is downstream from all existing receiving water sample points) as discussed under item I.C., Part B, Self-monitoring program.

c. for any investigative or remedial activity that generates effluent at all volumes, and

d. if the discharge complies with all Effluent Limitations.

7. Discharge of treated waste groundwater to the Arroyo Seco, Arroyo Las Positas, LLNL infiltration trench, or LLNL injection wells may occur only:

a. in offsite or onsite areas,

b. for any investigative or remedial activity that generates effluent at all volumes, and

c. if the discharge complies with all Effluent Limitations.

8. Total discharge from all pilot studies treatment systems shall not exceed 360,000 gallons per day. Discharge from the pilot studies will be allowed under this permit until a Record of Decision for final remediation has been reached.

9. Effluent generated from treatment Facility A shall not be discharged at any point of the arroyo that crosses or is upstream of the main body of the offsite plume unless the channel is lined to prevent infiltration from the point of discharge downstream through the body of the plume. Discharge from treatment Facility A will be managed under separate Waste Discharge Requirements.

10. Any discharge to a location other than the discharge point(s) specified in Provisions 5 through 7 of this Order, or discharge of any hazardous constituent, will require a modification of this Order or submission of a second NPDES application.

11. For additional injection wells, the dischargers must submit a report describing well locations, well construction, and other information to show that discharge from the additional wells have adequate hydraulic control and monitoring. This report shall be to the satisfaction of the Executive Officer.

12. The dischargers shall comply with all items of the attached "Standard Provisions & Reporting Requirements, and Definitions dated December, 1986 except items A.10, B.2, C.8, and C.11.

13. This Order expires June 18, 1996. The dischargers must file a report of waste discharge in accordance with Title 23, Chapter 3, Subchapter 9 of the California Administrative Code no later than 180 days in advance of such expiration date as application for issuance of new waste discharge requirements.

14. This Order is issued to the dischargers in support of investigation and cleanup activities undertaken pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. Pursuant to CERCLA, all response actions taken by the dischargers must be consistent with guidelines, rule regulations, and criteria developed by the EPA. Issuance of this Order does not constitute approval by the State of California or EPA for any response activities. This Order is meant to facilitate the investigation of the extent of pollution, the evaluation of potential remedies, and the initiation of any selected remedies by specifying the manner in which waste groundwater from investigation and cleanup activities may be discharged.

15. This Order shall serve as a National Pollutant Discharge Elimination System permit pursuant to Section 402 of the Clean Water Act or amendments thereto and shall become effective 10 days after the date of its adoption provided the Regional Administrator, EPA has no objection. If the Regional Administrator objects to its issuance, the permit shall not be effective until such objection is withdrawn.

I, Steven R. Ritchie, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region on June 19, 1991.

Steven R. Ritchie
Executive Officer

Attachments:
a. Standard Provisions & Reporting Requirements, Dec 1986
b. Self-Monitoring Program

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
DECEMBER 1986

STANDARD PROVISIONS AND REPORTING REQUIREMENTS

A. General Provisions

1. All Provisions and Reporting Requirements apply to all regulated discharges unless otherwise noted.

2. Neither the treatment nor the discharge of pollutants shall create a pollution, contamination, or nuisance as defined by Section 13050 of the California Water Code.

3. The discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this order and permit which has a reasonable likelihood of adversely affecting public health or the environment, including such accelerated or additional monitoring as requested by the Regional Board or Executive Officer to determine the nature and impact of the violation. [40 CFR 122.41(d)]

4. All discharges authorized by this Order shall be consistent with the terms and conditions of this Order.

5. Pursuant to Environmental Protection Agency regulations the discharger must notify the Regional Board as soon as it knows or has reason to believe (1) that they have begun or expect to begin, use or manufacture of a pollutant not reported in the permit application, or (2) a discharge of toxic pollutants not limited by this permit has occurred, or will occur, in concentrations that exceed the limits specified in 40 CFR 122.42(a).

6. If a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307 (a) of the Clean Water Act, or amendments thereto, for a toxic pollutant which is present in the discharge authorized herein and such standard or prohibition is more stringent than any limitation upon such pollutant in a Board adopted Order, discharger must comply with the new standard or prohibition. the Board will revise or modify the Order in accordance with such toxic effluent standard or prohibition and so notify the discharger.

7. If more stringent applicable water quality standards are approved pursuant to Section 303 of the Clean Water Act, or amendments thereto, the discharger must comply with the new standard. The Board will revise and modify this Order in accordance with such more stringent standards.

8. The discharge of any radiological, chemical, or biological warfare agent waste is prohibited.

9. Solids storage prior to final disposal shall be maintained to minimize runoff, to prevent leaching, and shall comply with all requirements contained in Title 23, Chapter 3, Subchapter 15 of the California Administrative Code.

10. All facilities used for transport, treatment, or disposal of wastes shall be adequately protected against overflow or washout as the result of a 100-year frequency flood.

11. Collection, treatment, storage and disposal systems shall be operated in a manner that precludes public contact with wastewater, except where excluding the public is inappropriate, warning signs shall be posted.

12. Collected screenings, sludges, and other solids removed from liquid wastes shall be disposed of at a legal point of disposal, and in accordance with the provisions of Chapter 15 of Title 23 of the California Administration Code. For the purpose of this requirement, a legal point of disposal is defined as one for which waste discharge requirements have been prescribed or waived by a Regional Water Quality Control Board and which is in full compliance therewith.

13. This Order and Permit does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to the property of another, nor protect the discharger from liabilities under federal, state or local laws, nor create a vested right for the discharge to continue the waste discharge or guarantee the discharger a capacity right in the receiving water. [40 CFR 122.41(g)]

14. The Regional Board or its authorized representatives shall be allowed:

    a. Entry upon premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of the order and permit;

    b. Access to and copy at reasonable times any records that must be kept under the conditions of the order and permit;

    c. To inspect at reasonable times any facility, equipment (including monitoring and control equipment), practices, or operations regulated or required under the order and permit; and

    d. To photograph, sample, and monitor at reasonable times for the purpose of assuring compliance with the order and permit or as otherwise authorized by the Clean Water Act any substances or parameters at any locations. [40 CFR 122.41(i)]

15. This Order and Permit may be modified, revoked and reissued, or terminated in accordance with applicable State and/or Federal regulations. Cause for taking such action includes, but is not limited to any of the following:

    a. Violation of any term or condition contained in the Order and Permit;

    b. Obtaining the Order and Permit by misrepresentation, or by failure to disclose fully all relevant facts;

    c. Endangerment to public health or environment that can only be regulated to acceptable levels by order and permit modification or termination; and

    d. Any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

16. The filing of a request by the discharger for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit conditon. [40 CFR 122.41(f)]

17. The discharger shall furnish, within a reasonable time, any information the Regional Board may request to determine whether cause exists for modifying, revoking and reissuing, or terminating the permit. The discharger shall also furnish to the Regional Board, upon request, copies of records required to be kept by its permit. [40 CFR 122.41(h)]

18. Bypass (the intentional diversion of waste streams from any portion of a treatment facility) is prohibited. The Regional Board may take enforcement action against the discharger for plant bypass unless:

    a. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage. (Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.);

    b. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment down time. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

c. The permittee submitted advance notice of the need for a bypass to the Regional Board. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 10 days before the date of the bypass. The permittee shall submit notice of an unanticipated bypass as required by 40 CFR 122.41(l)(6) (24 hour notice), as required in paragraph C.10.

The permittee may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if it is for essential maintenance to assure efficient operation. In such a case, the above bypass conditions are not applicable.

B. Treatment Reliability

1. The discharger shall, at all times, properly operate and maintain all facilities and systems of treatment disposal and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with this order and permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. All of these procedures shall be described in an Operation and Maintenance Manual. The discharger shall keep in a state of readiness all systems necessary to achieve compliance with the conditions of this order and permit. All systems, both those in service and reserve, shall be inspected and maintained on a regular basis. Records shall be kept of the tests and made available to the Regional Board. [40 CFR 122.41(e)]

2. Safeguard to electric power failure:

a. The discharger shall, within ninety (90) days of the effective date of this permit, submit to the Regional Board for approval a description of the existing safeguards provided to assure that, should there be reduction, loss, or failure of electric power, the discharger shall comply with the terms and conditions of its Order. Such safeguards may include alternate power sources, standby generators, retention capacity, operating procedures or other means. A description of the safeguards provided shall include an analysis of the frequency, duration, and impact of power failures experienced over the past five years on effluent quality and on the capability of the discharger to comply with the terms and conditions of the Order. The adequacy of the safeguards is subject to the approval of the Regional Board.

b. Should the Regional Board not approve the existing safeguards, the discharger shall, within ninety (90) days of having been advised by the Regional Board that the existing safeguards are inadequate, provide to the Regional Board and the Environmental Protection Agency a schedule of compliance for providing safeguards such that in the event of reduction, loss, or failure of electric power, the permittee shall comply with the terms and conditions of this permit. The schedule of compliance shall, upon approval of the Regional Board Executive Officer, become a condition of the Order.

c. If the discharger already has approved plan(s), the plan shall be revised and updated as specified in the plan or whenever there has been a material change in design or operation. A revised plan shall be submitted to the Regional Board within ninety (90) days of the material change.

3. POTW facilities subject to this order and permit shall be supervised and operated by persons possessing certificates of appropriate grade pursuant to Chapter 3, Subchapter 14, Title 23 of the California Administrative Code.

C. General Reporting Requirements

1. All reports required by the order and permit and other information requested by the Regional Board or EPA Region 9 shall be signed by a principal executive officer or ranking elected official of the discharger, or by a duly authorized representative of that person. [40 CFR 122.22(b)]

2. All reports signed by a duly authorized representative shall contain the following certification:

"I certify under penalty of law that this document and all attachments are prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. [40 CFR 122.22(d)]

3. Should the discharger discover that it failed to submit any relevant facts or that it submitted incorrect information in any report, it shall promptly submit the missing or correct information. [40 CFR 122.41(l)(8)]

4. Any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall be subject to enforcement procedures as identified in Section D of these Provisions.

5. This permit is not transferable to any person except after notice to the Regional Board. The Regional Board may require modification or revocation and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

6. Transfer of control or ownership of a waste discharge facility under an National Pollutant Discharge Elimination System permit must be preceded by a notice to the Regional Board at least 30 days in advance of the proposed transfer date. The notice must include a written agreement between the existing discharger and proposed discharger containing specific dates for transfer of responsibility, coverage, and liability between them. Whether an order and permit may be transferred without modification or revocation and reissuance is at the discretion of the Regional Board. If order and permit modification or revocation and reissuance is necessary, transfer may be delayed 180 days after the Regional Board's receipt of a complete application for waste discharge requirements and an NPDES permit.

7. The discharger shall file with the Board a report of waste discharge at least 120 days before making any material change or proposed change in the character, location or volume of the discharge.

8. The discharger shall file with the Board, for Executive Officer review and approval within ninety (90) days after the effective date of this Order, a technical report or a statement that the existing plan(s) was reviewed and updated, as appropriate, on preventive (failsafe) and contirgency (cleanup) plans for controlling accidental discharges, and for minimizing the effect of such events. The technical report or updated revisions should:

   a. Identify the possible sources of accidental loss, untreated or partially treated waste bypass, and polluted drainage. Loading and storage areas, power outage, waste treatment unit outage, and failure of process equipment, tanks and pipes should be considered.

   b. Evaluate the effectiveness of present facilities and procedures and state when they became operational.

   c. Predict the effectiveness of the proposed facilities and procedures and provide an implementation schedule containing interim and final dates when they will be constructed, implemented, or operational.

This Board, after review of the technical report or updated revisions, may establish conditions which it deems necessary to control accidental discharges and to minimize the effects of such events. Such conditions may be incorporated as part of this Order, upon notice to the discharger. If the discharger already has an approved plan(s) he shall update them as specified in the plan(s).

9. Reports of compliance or noncompliance with, or any progress reports on, interim and final compliance dates contained in any compliance schedule shall be submitted within 10 working days following each scheduled date unless otherwise specified within this order and permit. If reporting noncompliance, the report shall include a description of the reason for failure to comply , a description and schedule of tasks necessary to achieve compliance and an estimated date for achieving full compliance. A final report shall be submitted within 10 working days of achieving full compliance, documenting full compliance

10. Twenty-four hour reporting:

    (a) The permittee shall report any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five working days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

    (b) The following shall be included as information that must be reported within 24 hours under this paragraph:

        (A) Any unanticipated bypass that exceeds any effluent limitation in the permit.

        (B) Any upset that exceeds any effluent limitation in the permit.

        (C) Violation of a maximum daily discharge limitation for any of the pollutants listed in this permit to be reported within 24 hours.

    (c) The Regional Board may waive the above-required written report on a case-by-case basis.

11. All POTWs must provide adequate notice to the Regional Board of:

    (a) Any introduction of new pollutants into the POTW from an indirect discharger that would be subject to Sections 301 or 306 of the Clean Water Act if it were directly discharging those pollutants.

    (b) Any substantial or material change in the volume or character of pollutants being introduced into that POTW by an input source at the time of issuance of the permit.

    Adequate notice shall include information on the quality and quantity of influent introduced into the POTW as well as any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

D. Enforcement

1. The provision contained in this enforcement section shall not act as a limitation on the statutory or regulatory authority of the Regional Board.

2. Any violation of the permit constitutes violation of the California Water Code and regulations adopted thereunder and the provisions of the Clean Water Act, and is the basis for enforcement action, permit termination, permit revocation and reissuance, denial of an application for permit reissuance; or a combination thereof.

3. The Regional Board may impose administrative civil liability, may refer a discharger to the State Attorney General to seek civil monetary penalties, may seek injunctive relief or take other appropriate enforcement action as provided in the California Water Code or federal law for violation of Regional Board orders.

4. It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this order and permit.

5. A discharger seeking to establish the occurrence of any upset (See Definitions, E.23) has the burden of proof. A discharger who wishes to establish the affirmative defense of any upset in an action brought for noncompliance shall demonstrate, through properly signed contemporaneous operating logs, or other relevant evidence that:

    a. an upset occurred and that the permittee can identify the cause(s) or the upset;

    b. the permitted facility was being properly operated at the time of the upset;

c. the permittee submitted notice of the upset as required in paragraph c.10.; and

d. the permittee complied with any remedial measures required under A.3.

No determination made before an action for noncompliance, such as during administrative review of claims that noncompliance was caused by an upset, is final administrative action subject to judicial review.

In any enforcement proceeding, the permittee seeking to establish the occurrence of any upset has the burden of proof. [40 CFR 122.41(n)]

E. Definitions

1. Bypass means the intentional diversion of waste streams from any portion of treatment facility.

2. Daily discharge means:

a. For flow rate measurements, the average flow rate measured during a calendar day or during any 24-hour period reasonably representative of the calendar day for purposes of sampling.

b. For pollutant measurements, the concentration or mass emission rate measured during a calendar day or during any 24-hour period reasonably representative of the calendar day for purposes of sampling.

3. Daily Maximum Limit means the maximum acceptable daily discharge. For pollutant measurements, unless otherwise specified, the results to be compared to the daily maximum limit are based on composite samples.

4. DDT and Derivatives shall mean the sum of the p,p' and o,p' isomers of DDT, DDD (TDE), and DDE.

5. Duly authorized representative is one whose:

a. Authorization is made in writing by a principal executive officer or ranking elected official;

b. Authorization specifies either an individual or a position having responsibililty for the overall operation of the regulated facility or activity, such as general manager in a partnership, manager, operator of a well or a well field, superintendent, positon of equivalent responsibility, or an individual or positon having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named positon.); and

c. Written authorization is submitted to the Regional Board and EPA Region 9. If an authorization becomes no longer accurate because a different individual or positon has responsibililty for the overall operation of the facility, a new authorization satisfying the requirements above must be submitted to the Regional Board and EPA Region 9 prior to or together with any reports, information, or applications to be signed by an authorized representative.

6. Hazardous substance means any substance designated under 40 CFR 116 pursuant to Section 311 of the Clean Water Act.

7. HCH shall mean the sum of the alpha, beta, gama (Lindane), and delta isomers of hexachlorocyclohexane.

8. Inadequately Treated Waste is wastewater receiving partial treatment but failing to meet discharge requirements.

9. Incompatible pollutants are:

a. Pollutants which create a fire or explosion hazard in the POTW;

b. Pollutants which will cause corrosive structural damage to the POTW, or wastewaters with pH lower than 5.0 pH units, unless the facilities are specifically designed to accommodate such wastewater;

c. Solid or viscous pollutants in amounts which will cause obstruction to the flow in the POTW resulting in interference;

d. Any pollutant, including oxygen-demanding pollutants (e.g., BOD) released into the wastewater system at a flow rate and/or pollutant concentration which will cause interference with the POTW.

e. Heat in amounts which will inhibit biological activity in the POTW and result in interference, or heat in such quantities that the temperature at the POTW treatment plant exceeds 40°C (104°F) unless the works is designed to accommodate such heat or the Regional Board approves alternate temperature limits.

10. Indirect discharger means a non-domestic discharger introducing pollutants into a publicly owned treatment and disposal system.

11. Initial dilution is the process which results in the rapid and irreversible turbulent mixing of wastewater with receiving water around the point of discharge.

12. Mass emission rate is obtained from the following calculation for any calendar day:

$$\text{Mass emission rate (lb/day)} = \frac{8.345}{N} \sum_{i=1}^{N} Q_i C_i$$

$$\text{Mass emission rate (kg/day)} = \frac{3.785}{N} \sum_{i=1}^{N} Q_i C_i$$

in which 'N' is the number of samples analyzed in any calendar day. 'Q_i' and 'C_i' are the flow rate (MGD) and the constituent concentration (mg/L), respectively, which are associated with each of the 'N' grab samples which may be taken in any calendar day. If a composite sample is taken, 'C_i' is the concentration measured in the composite sample and 'Q_i' is the average flow rate occurring during the period over which samples are composited. The daily concentration measured over any calendar day of all constituents shall be determined from the flow-weighted average of the same constituents in the combined waste streams as follows:

$$C_d = \text{Average daily concentration} = \frac{1}{Q_t} \sum_{i=1}^{N} Q_i C_i$$

in which 'N' is the number of component waste streams. 'Q' and 'C' are the flow rate (MGD) and the constituent concentration (mg/L), respectively, which are associated with each of the 'N' waste streams. 'Q_t' is the total flow rate of the combined waste streams.

13. Maximum allowable mass emission rate, whether for a 24-hour, weekly 7-day, monthly 30-day, or 6-month period, is a limitation expressed as a daily rate determined with the formulas in paragraph above, using the effluent concentration limit specified in the order and permit for the period and the specified allowable flow. (Refer to Section C of Part A of Self-monitoring Program for definitions of limitation period)

14. Overflow is defined as the intentional or unintentional spilling or forcing out of untreated or partially treated wastes from a transport system (e.g. through manholes, at pump stations, and at collection points) upstream from the plant headworks caused by excess flow in the transport system.

15. POTW means Publically Owned Treatment Works.

16. POTW Removal efficiency is expressed as the percentage of the ratio of pollutants removed by the treatment facilities to pollutants entering the treatment facilities. Removal efficiencies of a treatment plant shall be determined using monthly averages of pollutant concentration of influent and effluent samples collected at about the same time and using the following equation (or its equivalent):

    Removal Efficiency (%) = 100 X [1-(Effluent Conc/Influent Conc)]

    When preferred, the discharger may substitute mass loadings and mass emissions for the concentrations.

17. Priority pollutants are those constituents referred to in 40 CFR S122, Appendix D and listed in the EPA NPDES Application Form 2C, (dated 6/80) Items V-3 thru V-9.

18. Sludge means the solids, semi-liquid suspensions of solids, residues, screenings, grit, scum, and precipitates separated from, or created in wastewater by the unit processes of a treatment system. It also includes but is not limited to, all supernatant, filtrate, centrate, decantate, and thickener overflow/underflow in the solids handling parts of the wastewater treatment system.

19. Toxic pollutant means any pollutant listed as toxic under Section 307(a)(1) of the Clean Water Act or under 40 CFR S401.15.

20. Total Identifiable Chlorinated HydroCarbons (TICH) shall be measured by summing the individual concentrations of DDT, DDD, DDE, aldrin, BHC, chlordane, endrin, heptachlor, lindane, dieldrin, PCBs and other indentifiable chlorinated hydrocarbons.

21. Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass or overflow. It does not mean economic loss caused by delays in production.

22. Untreated waste is defined as raw wastewater.

23. Upset means an exceptional incident in which there is unintentional temporary noncompliance with effluent technology based permit limitations in the order and permit because of factors beyond the reasonable control of the discharger. It does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

24. Waste, waste discharge, discharge of waste, and discharge are used interchangeably in this order and permit. The requirements of this order and permit are applicable to the entire volume of water, and the material therein, which is disposed of to surface and ground waters of the State of California.

Table 3
LAND OBSERVATIONS IN IRRIGATED AREAS
DISCHARGERS' SELF-MONITORING REPORT

1. Dischargers: U. S. Department of Energy, and Lawrence Livermore National Laboratory,

2. Reporting Period: Month_____ Year_____

3. Circle dates treated waste ground water discharged to land by irrigation: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

4. Total flow volume for reporting month: _____ gallons

5. Estimated recharge:

6. Weather conditions:
   Average Air Temperature_____ Total Precip_____ Wind Velocity_____

7. Required weekly land observations, as 'yes' or 'no', for weeks of reporting month:

	Weeks for Reporting Month
Date and Time	
Escape waste water, as surface flow or spray	
Evidence for ponding or mosquito problem	
Odor from waste water	
Warning signs posted	

8. If yes to any of above, a written report shall be submitted as per section VII.1., Self-Monitoring Program.

9. I certify that the information in this report, to the best of my knowledge, is true and correct.

   Inspector Signature_____ Date_____

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

SELF-MONITORING PROGRAM
FOR:

U.S. DEPARTMENT OF ENERGY

and

LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, ALAMEDA COUNTY

NPDES NO. CA 0029289
ORDER NO. 91-091

CONSISTS OF:

PART A, January 1987

and PART B, Adopted June 19, 1991

December 1986
Mod. SBTD 1/23/87

SELF-MONITORING PROGRAM
PART A

A. GENERAL

Basis

Reporting responsibilities of waste dischargers are specified in Sections 13225(a), 13267(b), 13268, 13383 and 13387(b) of the California Water Code and this Regional Board's Resolution No. 73-16 and the Environmental Protection Agency's Discharge Monitoring Report (Form 3320-1).

Purpose

The principal purposes of a monitoring program by a waste discharger, also referred to as self-monitoring program, are: (1) to document compliance with waste discharge requirements and prohibitions established by this Regional Board, (2) to facilitate self-policing by the waste discharger in the prevention and abatement of pollution arising from waste discharge, (3) to develop or assist in the development of effluent or other limitations, discharge prohibitions, national standards of performance, pretreatment and toxicity standards, and other standards, and (4) to prepare water and wastewater quality inventories.

B. SAMPLING AND ANALYTICAL METHODS

Sample collection, storage, and analyses shall be performed according to the 40 CFR 136 or other methods approved and specified by the Executive Officer of this Regional Board. (See Appendix E, attached)

Water and waste analyses shall be performed by a laboratory approved for these analyses by the State Department of Health Services (DOHS) or a laboratory waived by the Executive Officer from obtaining a certification for these analyses by the DOHS. The director of the laboratory whose name appears on the certification or his/her laboratory supervisor who is directly responsible for analytical work performed shall supervise all analytical work including appropriate quality assurance/quality control procedures in his or her laboratory and shall sign all reports of such work submitted to the Regional Board.

All monitoring instruments and equipment shall be properly calibrated and maintained to ensure accuracy of measurements.

C. DEFINITION OF TERMS

1. A grab sample is defined as an individual sample collected in a short period of time not exceeding 15 minutes. Grab samples shall be collected during normal peak loading conditions for the parameter of interest, which may or may not be during hydraulic peaks. It is used primarily in determining compliance with daily maximum limits and instantaneous maximum limits. Grab samples represent only the condition that exists at the time the wastewater is collected.

2. A composite sample is defined as a sample composed of individual grab samples mixed in proportions varying not more than plus or minus five percent from the instantaneous rate (or highest concentration) of waste flow corresponding to each grab sample collected at regular intervals not greater than one hour, or collected by the use of continuous automatic sampling devices capable of attaining the proportional accuracy stipulated above throughout the period of discharge for 8 consecutive or of 24 consecutive hours, whichever is specified in Table 1 of Part B.

3. A flow sample is defined as the accurate measurement of the average daily flow volume using a properly calibrated and maintained flow measuring device.

4. Duly authorized representative is one whose:

   a. Authorization is made in writing by a principal executive officer or ranking elected official;

   b. Authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as general partner in a partnership, sole proprietor in a sole proprietorship, the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibililty for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

5. Average values for daily and monthly values are obtained by taking the sum of all daily values divided by the number of all daily values measured during the specified period.

6. Daily Maximum limit is the total discharge in a calendar day for pollutants measured by mass or the average measurement obtained for other pollutants.

7. Instantaneous maximum is defined as the highest measurement obtained for the calendar day.

8. Median of an ordered set of values is that value below and above which there is an equal number of values, or which is the arithmetic mean of the two middle levels, if there is no one middle value

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9. A 6-month median means a moving median of daily values for any 180 day period in which daily values represent flow-weighted average concentrations within a daily or 24-hour period. For intermittent discharges, the daily value shall be considered to equal zero for days on which no discharge occurred.

D. SPECIFICATIONS FOR SAMPLING AND ANALYSES

The discharger is required to perform sampling and analyses according to the schedule in Part B in accordance with the following conditions:

1. Influent

   a. Samples of influent shall be collected on varying days selected at random and shall not include any plant recirculation or other sidestream wastes. Deviation from this must be approved by the Executive Officer.

2. Effluent

   a. Samples of effluent shall be collected on days coincident with influent composite sampling unless otherwise stipulated. At least one sampling event/day shall be taken during major unit operation shutdown or startup. The Board or Executive Officer may approve an alternative sampling plan if it is demonstrated to the Board's satisfaction that expected operating conditions for the facility warrant a deviation from the standard sampling plan.

   b. Grab samples of effluent shall be collected during periods of maximum peak flows and shall coincide with effluent sample days.

   c. Fish bioassay samples shall be collected on days coincident with effluent sampling.

      1) Bioassay sample should be collected after chlorination, if chlorination is part of the treatment process. Bioassay test should be performed on dechlorinated samples. Dechlorination may be performed at the laboratory before testing.

      2) Total ammonia nitrogen shall be analyzed and un-ionized ammonia calculated whenever fish bioassay test results fail to meet the specified percent survival.

   d. If two consecutive samples of a constituent monitored on a weekly or monthly basis in a 30 day period exceed the effluent limit for any parameter, (or if the required sampling frequency is once per month and the monthly sample exceeds the limit), the sampling frequency shall be increased to daily until the additional sampling shows that the most recent three (3) days are in compliance.

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e. If any instantaneous maximum limit is exceeded, the discharge shall be terminated until the cause of violation is found and corrected.

f. If the final or intermediate results of any single bioassay test indicate a threatened violation (i.e. the percentage of surviving test organisms is less than the required survival percentage), a new test will begin and the discharger shall investigate the cause of the mortalities and report the finding in the next self-monitoring report.

g. Chlorine residual analyzers shall be calibrated against grab samples as frequently as necessary to maintain accurate control and reliable operation. If an effluent violation is detected, grab samples shall be collected at least every 30 minutes until compliance is achieved.

h. When any type of bypass occurs, grab samples shall be collected on a daily basis for all constituents at all affected discharge points which have effluent limits for the duration of the bypass.

3. Receiving Waters

a. Receiving water sampling shall be conducted on days coincident with sampling of effluent.

b. Receiving water samples shall be collected at each station on each sampling day during the period within 1 hour following low slack water. Where sampling at lower slack water period is not practical, sampling shall be performed during higher slack water period. Samples shall be collected within the discharge plume and downcurrent of the discharge point so as to be representative, unless otherwise stipulated.

c. Samples shall be collected within one foot below the surface of the receiving water body, unless otherwise stipulated.

E. Standard Observations

1. Receiving Water

a. Floating and suspended materials of waste origin (to include oil, grease, algae, and other macroscopic particulate matter): presence or absence, source, and size of affected area.

b. Discoloration and turbidity: description of color, source, and size of affected area.

c. Odor: presence or absence, characterization, source, distance of travel, and wind direction.

d. Evidence of beneficial water use: presence of water-associated waterfowl or wildlife, fishermen, and other recreational activities in the vicinity of the sampling stations.

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e. Hydrographic condition:

1) Time and height of corrected high and low tides (corrected to nearest NOAA location for the sampling date and time of sample and collection).

2) Depth of water columns and sampling depths.

f. Weather condition:

1) Air temperatures.

2) Wind - direction and estimated velocity.

3) Precipitation - total precipitation during the previous five days and on the day of observation.

2. Wastewater Effluent

a. Floating and suspended material of waste origin (to include oil, grease, algae, and other macroscopic particulate matter): presence or absence.

b. Odor: presence or absence, characterization, source, distance of travel.

3. Beach and Shoreline

a. Material of waste origin: presence or absence, description of material, estimated size of affected area, and source.

b. Beneficial use: estimated number of people sunbathing, swimming, waterskiing, surfing, etc.

4. Land Retention or Disposal Area

This applies both to liquid and solid wastes confined or unconfined.

a. For each impoundment determine amount of the freeboard at lowest point of dikes confining liquid wastes.

b. Evidence of leaching liquid from area of confinement and estimated size of affected area. (Show affected area on a sketch and volume of flow (gpm, etc.))

c. Odor: presence or absence, characterization, source, and distance of travel.

d. Estimated number of waterfowl and other water-associated birds in the disposal area and vicinity.

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5. Periphery of Waste Treatment and/or Disposal Facilities

   a. Odor: presence or absence, characterization, source, and distance of travel.

   b. Weather condition: wind direction and estimated velocity.

F. RECORDS TO BE MAINTAINED

1. Written reports, strip charts, calibration and maintenance records, and other records shall be maintained by the discharger and accessible (at the waste treatment plant), and retained for a minimum of three years. This period of retention shall be extended during the course of any unresolved litigation regarding this discharge or when requested by the Regional Board or Regional Administrator of the U.S. Environmental Protection Agency, Region IX. Such records shall show the following for each sample:

   a. Identity of sampling and observation stations by number.

   b. Date and time of sampling and/or observations.

   c. Method of sampling (See Section C - Definition of Terms)

   d. Type of fish bioassay test (96 hour static or flow-through bioassay)

   e. Date and time that analyses are started and completed, and name of personnel performing the analyses.

   f. Complete procedure used, including method of preserving sample and identity and volumes of reagents used. A reference to a specific section of Standard Methods is satisfactory

   g. Calculations of results.

   h. Results of analyses and/or observations.

2. A tabulation shall be maintained showing the following flow data for influent and effluent stations and disposal areas:

   a. Total waste flow or volume for each day.

   b. Maximum and minimum daily flows for each month.

3. A tabulation reflecting bypassing and accidental waste spills shall be maintained showing information items listed in Sections F -1 and F-2 for each occurrence.

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G. REPORTS TO BE FILED WITH THE REGIONAL BOARD

1. Spill Reports

If any hazardous substance is discharged in or on any waters of the state, or discharged and deposited where it is, or probably will be discharged in or on any waters of the state, the discharger shall report such a discharge to this Regional Board, at (415) 464-1255 on weekdays during office hours from 8 a.m. to 5 p.m., and to the Office of Emergency Services at (800) 852-7550 during non-office hours. A written report shall be filed with the Regional Board within five (5) working days and shall contain information relative to:

a. nature of waste or pollutant,

b. quantity involved,

c. duration of incident,

d. cause of spilling,

e. Spill Prevention, Control, and Countermeasure Plan (SPCC) in effect, if any,

f. estimated size of affected area,

g. nature of effects (i.e.,fish kill, discoloration of receiving water, etc.),

h. corrective measures that have been taken or planned, and a schedule of these activities, and

i. persons/agencies notified.

2. Reports of Plant Bypass, Treatment Unit Bypass and Permit Violation

In the event the discharger violates or threatens to violate the conditions of the waste discharge requirements and prohibitions or intends to permit a plant bypass or treatment unit bypass due to:

a. Maintenance work, power failures, or breakdown of waste treatment equipment, or

b. accidents caused by human error or negligence, or

c. other causes, such as acts of nature,

The discharger shall notify the Regional Board office by telephone as soon as he or his agents have knowledge of the incident and confirm this notification in writing within 5 working days of the telephone notification. The written report shall include time, date, duration and estimated volume of waste bypassed, method used in estimating volume and person notified of the incident. The report shall include

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pertinent information explaining reasons for the noncompliance and shall indicate what steps were taken to prevent the problem from recurring.

In addition, the waste discharger shall promptly accelerate his monitoring program to analyze the discharge at least once every day (Section D.2.h). Such daily analyses shall continue until such time as the effluent limits have been attained, until bypassing stops or until such time as the Executive Officer determines to be appropriate. The results of such monitoring shall be included in the regular Self-Monitoring Report.

3. The discharger shall file a written technical report to be received at least 30 days prior to advertising for bid (or 60 days prior to construction) on any construction project which would cause or aggravate the discharge of waste in violation of requirements; said report shall describe the nature, cost, and scheduling of all action necessary to preclude such discharge. In no case will any discharge of wastes in violation of permit and order be permitted unless notification is made to the Executive Officer and approval obtained from the Regional Board.

4. Self-Monitoring Reports

Written reports shall be filed regularly for each calendar month (unless specified otherwise) and filed no later than the fifteenth day of the following month. The reports shall be comprised of the following:

a. Letter of Transmittal:

A letter transmitting self-monitoring reports should accompany each report. Such a letter shall include:

1) Identification of all violations of waste discharge requirements found during the reporting period,

2) Details of the magnitude, frequency, and dates of all violations,

3) The cause of the violations, and

4) Discussion of the corrective actions taken or planned and the time schedule for completion. If the discharger has previously submitted a detailed time schedule for correcting requirement violations, a reference to the correspondence transmitting such schedule will be satisfactory.

Monitoring reports and the letter transmitting reports shall be signed by a principal executive officer or ranking elected official of the discharger, or by a duly authorized representative of that person.

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The letter shall contain the following certification:

"I certify under penalty of law that this document and all attachments are prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

b. Compliance Evaluation Summary

Each report shall be accompanied by a compliance evaluation summary sheet prepared by the discharger. The report format will be prepared following the example shown in APPENDIX A (attached). The discharger will prepare the format using those parameters and requirement limits for influent, effluent and receiving water constituents specified in the permit.

c. Map or Aerial Photograph

A map or aerial photograph shall accompany the report showing sampling and observation station locations.

d. Results of Analyses and Observations

Tabulations of the results from each required analysis specified in Part B by date, time, type of sample, detection limit and station, signed by the laboratory director. The report format will be prepared using the examples shown in APPENDIX B.

1) If the permittee monitors any pollutant more frequently than required by this permit using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Self-Monitoring Report.

2) Calculations for all limitations that require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

3) The report shall also identify a table identifying by method number the analytical procedures used for analyses. Any special methods shall be identified and should have prior approval of the Board's Executive Officer.

4) Lab results shall be copied and submitted as an appendix to the regular report.

e. Influent and Effluent Data Summary

Summary tabulations of the data to include for each constituent total number of analyses, maximum, minimum, and average values for each period. The report format will be the NPDES Discharge Monitoring Report, EPA Form 3320-1. Flow data shall be included.

1) The original is to be submitted to EPA:

Regional Administrator
U.S. Environmental Protection Agency
Attention: Enforcement Division (W-5)
215 Fremont Street
San Francisco, CA 94105

2) with a copy to the Regional Board:

Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1111 Jackson Street, Room 6000
Oakland, CA 94607

f. List of Approved Analyses

1) Listing of analyses for which the discharger is approved by the State Department of Health Services.

2) List of analyses performed for the discharger by another approved laboratory (and copies of reports signed by the laboratory director of that laboratory shall also be submitted as part of the report).

3) List of "waived" analyses, as approved by the Executive Officer.

g. Flow Data

1) The tabulation pursuant to Section F-2.

5. Annual Reporting

By January 31 of each year, the discharger shall submit an annual report to the Regional Board covering the previous calendar year. The report shall contain both tabular and graphical summaries of the monitoring data obtained during the previous year. In addition, the report shall contain a comprehensive discussion of the compliance record and the corrective actions taken or planned which may be needed to bring the discharger into full compliance with the waste discharge requirements. The report format will be prepared by the discharger using the examples shown in APPENDIX C (attached) and should be maintained and submitted with each regular self-monitoring report.

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PART B

U.S. DEPARTMENT OF ENERGY
and
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, ALAMEDA COUNTY

I. DESCRIPTION OF STATIONS

A. INFLUENT

Station	Description
I-001	At a point in ground water extraction, collection, and treatment utilizing Treatment Facility A; immediately prior to treatment.
I-002	At a point in ground water extraction, collection, and treatment utilizing Treatment Facility B; immediately prior to treatment.
I-003	At a point in ground water extraction, collection, and treatment utilizing Treatment Facility C; immediately prior to treatment.
I-004 to I-XXX	At a point in groundwater extraction and treatment that uses a single or multiple well treatment system, immediately prior to treatment. These points will be assigned by the dischargers to all monitoring or extraction wells listed in Finding 8 of Board Order 91-XXX when such activities are initiated. Once assigned, each number will be used in all future extraction events for the same well.

B. EFFLUENT

Station	Description
E-001	At a point in ground water extraction and treatment using Treatment Facility A; immediately following treatment and prior to discharge to surface waters or drainage ways.
E-002	At a point in ground water extraction and treatment using Treatment Facility B; immediately following treatment and prior to discharge to surface waters or drainage ways.
E-003	At a point in ground water extraction and treatment using Treatment Facility C; immediately following treatment and prior to discharge to surface waters or drainage ways.
E-004 to E-XXX	At a point in groundwater extraction and treatment that uses a single or multiple well treatment system, immediately following treatment and prior to discharge onto the ground site storm drain systems, surface waters, drainage ways, or injection wells. These points will be assigned by the dischargers to all monitoring or extraction wells listed in Finding 8 and provisions 5 to 7 of Board Order 91-XXX when such activities are initiated. Once assigned, each number will be used in all future extraction events for the same well.

C. RECEIVING WATERS

Station	Description
R-001	At a point in the north flowing drainage ditch east of Vasco Road, between 50 and 100 feet downstream from the effluent discharge point for Treatment Facility B.
R-002	At a point in Arroyo Seco between 50 and 100 feet downstream from the effluent discharge point for Treatment Facility C.
R-003 to R-XXX	At a point in Arroyo Las Positas, Arroyo Seco, or any surface drainage way between 50 and 100 feet downstream from the effluent discharge point established by the dischargers

II. SCHEDULE OF SAMPLING AND ANALYSIS

The schedule of sampling and analysis is provided in Table 1.

III. MODIFICATIONS TO PART A

A. ADDITIONS

Add Section E.1.e.3) to read:

Stream gage height measurements and their conversion to stream flow measurements.

B. DELETIONS

Sections D.2.b., D.2.g., E.1.e.1), E.3., and E.4.

C. MODIFICATIONS

All items of Self Monitoring Program Part A, dated January 1987 shall be complied with except for the following modifications:

1. Section D.2.a. shall be changed to read as follows:

   Samples of effluent shall be collected on days coincident with effluent grab samples unless otherwise stipulated. The Board or Executive Officer may approve an alternative sampling plan if it is demonstrated to the Board's satisfaction that expected treatment facility operation warrant a deviation from the standard sampling plan.

2. Section D.2.e. shall be changed to read as follows:

   If the instantaneous maximum limit is exceeded, the sampling facility shall be increased to daily until two samples collected on consecutive days show compliance with the instantaneous maximum limit.

3. Section D.3.b. shall be changed to read as follows:

3. Section D.3.b. shall be changed to read as follows:

   Receiving water samples shall be collected at each station on each sampling day. Samples shall be collected within the discharge plume and downcurrent of the discharge point so as to be representative, unless otherwise stipulated.

4. In Section F.1., the phrase:

   "... shall be maintained by the dischargers and accessible (at the waste treatment plant) ..."

   shall be changed to read as follows:

   "... shall be maintained by the dischargers and accessible (at the dischargers' facility) ..."

5. Information requested in Section G.4.e. shall be prepared in a format similar to EPA form 3320-1 and shall be submitted to the EPA's Superfund Division rather than the Enforcement Division.

6. Tha Annual Report required in Section G.5. shall be submitted in place of the end of year monthly report.

I, Steven R. Ritchie, Executive Officer, hereby certify that the foregoing Self-Monitoring Program:

1. Has been developed in accordance with procedures set forth in this Regional Board's Resolution No. 73-16 in order to obtain data and document compliance with waste discharge requirements established in Regional Board Order No 91-091.

2. Was adopted by the Board on June 19, 1991, and

3. May be reviewed at any time subsequent to the effective date upon written notice from the Executive Officer or request from the dischargers, and revisions will be ordered by the Executive Officer or the Regional Board.

Steven R. Ritchie
Executive Officer

Attachments:
1. Table 1
2. Site Map

TABLE 1

SCHEDULE FOR SAMPLING, MEASUREMENTS, AND ANALYSIS

pling Station	I001-I003	I004-IXXX		E001-E003	E004-EXXX		R001-R002	R003-RXXX					
PE OF SAMPLE	G	G		G	G		G	G					
ow Rate (mgd)	D	D		D	D		D	D					
D, 5-day, 20 C, or COD g/l & kg/day)													
lorine Residual & Dose (mg/l & kg/day)													
ttleable Matter l/1-hr. & cu. ft./day)													
otal Suspended Matter g/l & kg/day)													
il and Grease g/l & kg/day)													
oliform (Total or Fecal) PN/100 ml) per req't													
ish Tox'y 96-hr. urv'l in undiluted waste				Q	Q		2/Y	2/Y					
mmonia Nitrogen mg/l & kg/day)													
itrate Nitrogen mg/l & kg/day)													
itrite Nitrogen mg/l & kg/day)													
otal Organic Nitrogen mg/l & kg/day)													
otal Phosphate mg/l & kg/day)													
Turbidity (Jackson Turbidity Units)				Q	Q		2/Y	2/Y					
pH (units)	M	M		M	M		M	M					
Dissolved Oxygen (mg/l and % Saturation)													
Temperature (°C)				M	M		M	M					
Apparent Color (color units)													
Secchi Disc (inches)													
Sulfides (if DO<5.0 mg/l) Total & Dissolved (mg/l)													
Arsenic (mg/l & kg/day)	I/S	I/S		I/S	I/S		I/S	I/S					
Cadmium (mg/l & kg/day)	•	•		•	•		•	•					
Chromium, Total (mg/l & kg/day)	•	•		•	•		•	•					
Copper (mg/l & kg/day)	•	•		•	•		•	•					
Cyanide (mg/l & kg/day)	•	•		•	•		•	•					
Silver (mg/l & kg/day)	•	•		•	•		•	•					
Lead (mg/l & kg/day)	•	•		•	•		•	•					
Antimony, Berrylium, Boron, Iron, Manganese, Selenium, Thallium (mg/l & kg/day)	•	•		•	•		•	•					
Gross Alpha Particles, Gross Beta Particles, Tritium (pCi/l)	•			I/A	I/A		I/A	I/A					

TABLE [illegible]

SCHEDULE FOR SAMPLING, MEASUREMENTS, AND ANALYSIS

...g Station	I001-I003	I004-IXXX		E001-E003	E004-EXXX		R001-R002	R003-RXXX					
...OF SAMPLE	C	C		C	C		C	C					
...y ...& kg/day)	I/S	I/S		I/S	I/S		I/S	I/S					
...& kg/day)	•	•		•	•		•	•					
...& kg/day)	•	•		•	•		•	•					
...OC COMPOUNDS ...& kg/day)													
...plicable ...rd Observations				E	E		E	E					
...r Sediment Analyses ...bservations													
...Identifiable Chlorinated ...carbons (mg/l & kg/day)													
...01 (ug/l & kg/l)	W/M	W/M		D/W	D/W		W/M	W/M					
...24 (ug/l & kg/l)	I/A*	I/A*		I/A*	I/A*								
...02 & 625 (ug/l & kg/l)	I/A	W/M		I/A	D/W		I/A	W/M					
...l Dissolved Solids & ...ides (mg/l & kg/l)	Q	Q		Q	Q		Q	Q					

When EPA 624 is performed, it is not necessary to perform EPA 601

LEGEND FOR TABLE

...YPES OF SAMPLES

C = grab sample
...-24 = composite sample - 24-hour
...-X = composite sample - X hours (used when discharge does not continue for 24-hour period)
Cont = continuous sampling
DI = depth-integrated sample
BS = bottom sediment sample
O = observation

TYPES OF STATIONS

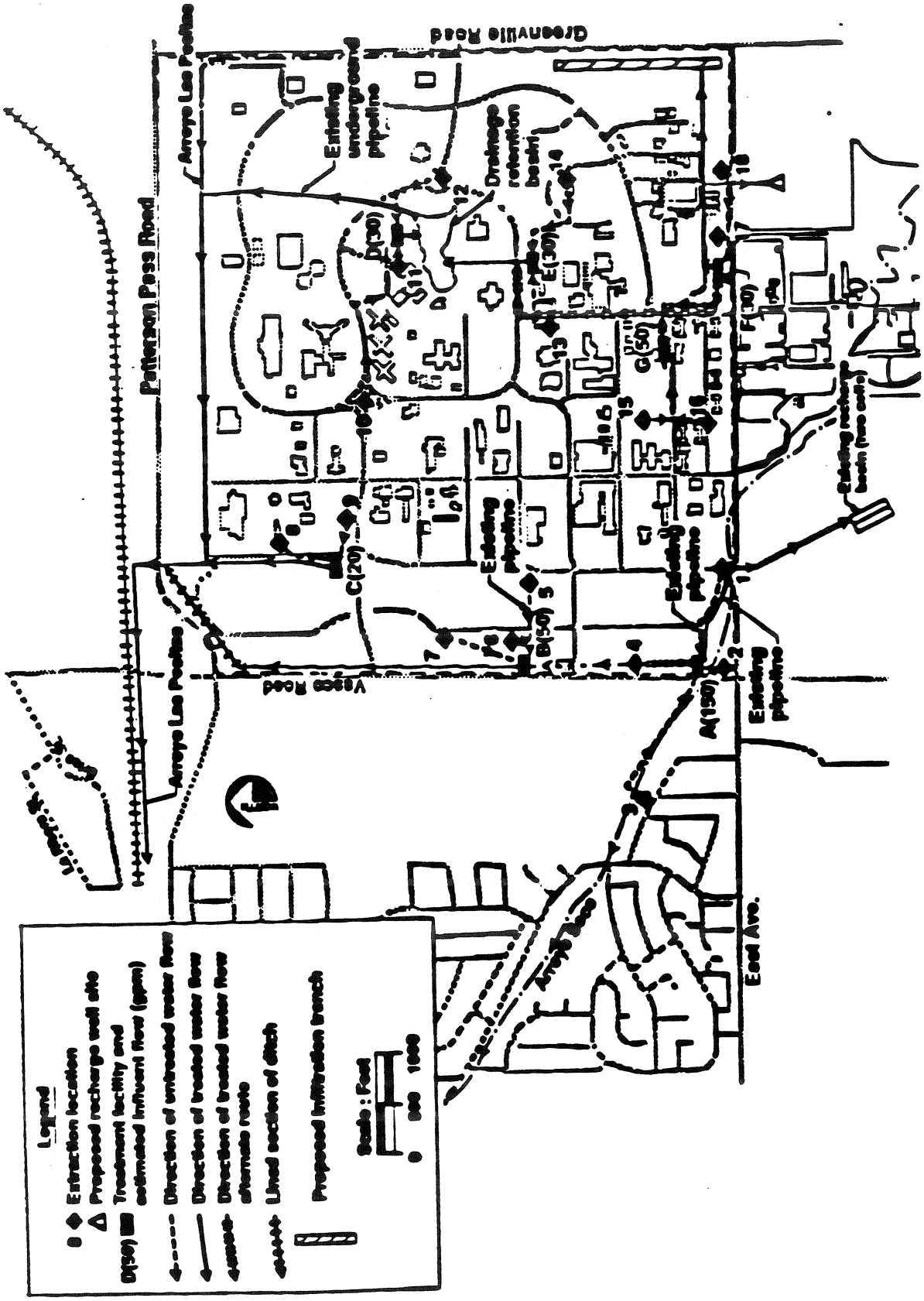
I = intake and/or water supply stations
A = treatment facility influent stations
E = waste effluent stations
C = receiving water stations
P = treatment facilities perimeter stations
L = basin and/or pond levee stations
B = bottom sediment stations
G = groundwater stations

...FREQUENCY OF SAMPLING

E = each occurence
H = once each hour
D = once each day
W = once each week
M = once each month
Y = once each year
= Daily for the first week, weekly thereafter
/M = Weekly for the first 4 weeks, monthly thereafter
/A = One sample during the first week of discharge, annually thereafter
/S = One sample during the first week of discharge, semi-annually thereafter

2/H = twice per hour
2/W = 2 days per week
5/W = 5 days per week
2/M = 2 days per month
2/Y = once in March and once in September
Q = quarterly, once in March, June, Sept. and December

2H = every 2 hours
2D = every 2 days
2W = every 2 weeks
3M = every 3 months
Cont = continuous



Preliminary ground water extraction and treatment facility locations (modified from Isherwood *et al.*, 1990).

Appendix B

Construction Quality Assurance/ Quality Control Plan

Appendix B

Construction Quality Assurance/ Quality Control Plan

B-1. Introduction

This quality assurance/quality control (QA/QC) plan has been developed in support of the construction of treatment facilities for ground water remediation at LLNL. This plan has been prepared for the LLNL ground water treatment facilities using NQA-1 as a guideline. NQA-1 (ASME, 1989) is the overall QA plan for LLNL.

The purpose of this plan is to define the quality objectives and areas of responsibility in accordance with the requirements of the construction of LLNL ground water treatment facilities. The ground water treatment facilities are identified as TFX in the following discussion. This plan has been developed to comply with LLNL QA policy and to address the applicable elements of NQA-1 and DOE Order 5700.6C.

This QA/QC plan covers quality assurance/quality control for design and construction for the LLNL ground water treatment facilities.

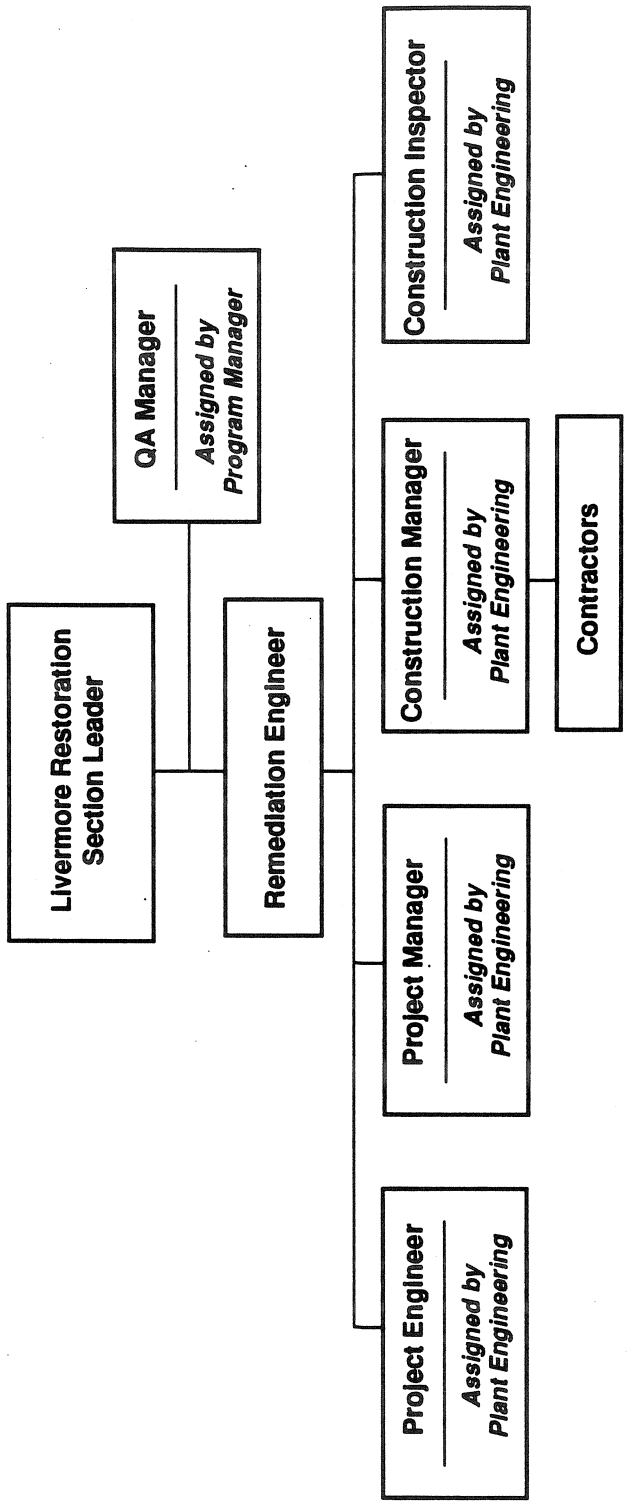
B-2. Organization

This section documents the organizational structure, the functional responsibilities, levels of authority, and lines of communications for those aspects of the construction of LLNL ground water treatment facilities which affect quality.

Figure B-1 shows the organization structure for QA activities. The descriptions below are not all-inclusive, but generally describe the QA responsibilities of those mainly involved in carrying out the QA program for the construction of LLNL ground water treatment facilities. The responsibilities of the individuals in Figure B-1 are described below:

- Section Leader (SL) issues this QA plan, and periodically reviews the implementation of the QA plan. He or she may request an independent review or formal audit of the QA program.

- Quality Assurance Manager (QAM) is responsible for the development and implementation of the QA plan, establishment and control of the QA document files, coordination with appropriate project personnel to assure compliance within groups over which the quality organization has no administrative control, and the development of



ERD-LSR-92-0163

Figure B-1. Organization chart for construction of treatment facilities.

tracking and reporting systems to provide management visibility of implementation activities and results. Additional responsibilities include participation in design reviews as required.

- Remediation Engineer (RE) is responsible for writing design criteria for equipment and flow rates to treat water and vapors to Applicable or Relevant and Appropriate Requirements (ARARs).

- LLNL Plant Engineering Project Manager (PEPM) reports to the Environmental Restoration Division (ERD) SL and RE. He/she coordinates and executes the project assigned to him. He/she is reponsible for approving minor technical field design changes with verbal consultation with the project engineer as appropriate. He/she is responsible for obtaining the required QA documents and placing them in the QA documents file.

- LLNL Plant Engineering Project Engineer (PEPE) is responsible for preparing drawings and specifications to meet criteria, conducting design reviews, preparing design reports, and preparing acceptance tests.

- Construction Manager (CM) is the manager of the construction phase of the conventional facility portion of construction projects. In consonance with the PEPE, he shall be responsible for the programmatic and technical adequacy of the conventional facilities portions of the project. The Construction Manager works with the SL, Construction Inspector (CI), and the PEPE in accordance with the requirements of the Construction Manager manual.

- Construction Inspector (CI) will perform all inspector's duties as specified in the "Construction Inspector's Policy and Procedures Manual," the "Construction Manager Manual," and this QA plan.

B-3. Quality Assurance Program

This section covers objectives, quality goals, and QA levels. The procedures for implementation of QA are included in the plan or cited in the list of codes, standards, and specifications (Table B-1).

B-3.1. Objective

The objective of the project supported by this QA plan is to extract contaminated water beneath LLNL and a smaller area to the west, treat it in facilities, and discharge it in compliance with standards set forth in the ROD.

B-3.2. Quality Goals

The quality goals of the project are to assure that the required quality level in the construction of LLNL ground water treatment facilities is attained and to:

- Define the quality assurance activities required to achieve quality in the constructed facilities.

- Assure compliance with design documentation.

- Graphically illustrate to the personnel who will execute the project, a matrix showing the QC requirements for each treatment facility; and to assign accountability for completing the QC requirements.
- Design and complete the QA records filing system. A list of the auditable records (including responsible personnel) required to document compliance with the requirements of this plan is shown in Table B-2.

Table B-1. Applicable Codes, Specifications, and Standards for Construction QA for ground water treatment facilities.

"LLNL Procurement Manual," Vol II, Books 1, 2, and Book 4 (Construction Subcontract Manual).
"LLNL Plant Engineering Manual," Volumes 1-5, latest revision.
"LLNL Plant Engineering Drafting Manual," PEL-P-02065.
"Guidelines For In-House Design Reviews and Project Presentations," Frank Tokarz/ Roger Lake, Plant Engineering Dept, Engineering/ Construction Division, LLNL, March 27, 1989 (with May 25, 1989 Rev.).
"Construction Manager Manual, Subcontracted Construction Projects," Plant Engineering Department, LLNL, W. Kleck, January, 1989.
"Construction Inspector's Policy and Procedures Manual," Plant Engineering Department, LLNL, (July, 1984).
"LLNL Health and Safety Manual."
Electronics Engineering / Instrument Services Calibration and Certification Manual, LER 87-1007-99.
Quality Assurance Plan for Calibration Services, Engineering Measurements and Analysis Section, Engineering Sciences Division, M.E.
LLNL Management Policy Memorandum MPM 02.2 "National Environmental Policy Act (NEPA) Compliance."

Table B-2. Required QA records.

QA File	QA Record Title	Person responsible
TFX-3-1	Design Criteria	PEPE
TFX-3-2	Design Calculations	PEPE
TFX-3-3a	Design Changes	PEPE
TFX-3-3b	Specifications	PEPE
TFX-3-4a	Drawing List	PEPM
TFX-3-4b	Specifications List	PEPM
TFX-3-6	NEPA Compliance Documents	PEPM
TFX-4-1	Design or Construction PO's	PEPM
TFX-6-1	As-Built Prints	CM
TFX-7-1	Notice of Completion	CM
TFX-9-1	Welder Certification	CI
TFX-9-2	Welding Test Reports	CI

TFX-9-3	Cemented Joints Test Reports	CI
TFX-10-1	Inspection Prints	CI
TFX-10-2	Final Inspection Report	CI
TFX-10-3	Final Acceptance Report	CI
TFX-18-1	Audit Requests & Reports	PEPM

Table B-3 identifies the applicability of NQA -1 elements to the quality assurance for LLNL ground water treatment facilities.

Table B-3. Applicability of NQA-1 Elements to the Quality Assurance of LLNL ground water treatment facilities.

NQA-1 Requirement	Title	Applicable?
Basic 1	Organization	Y
Supplement S-1	Terms and Definitions	Y
Supplement 1S-1	Supplementary Requirements for Organization	N
Basic 2	Quality Assurance Program	Y
Supplement 2S-1	Supplementary Requirements for the Qualification of Inspection and Test Personnel	N
Supplement 2S-2	Supplementary Requirements for the Qualification of Nondestructive Examination Personnel	N
Supplement 2S-3	Supplementary Requirements for the Qualification of Quality Assurance Program Audit Personnel	N
Supplement 2S-4	Supplementary Requirements for Personnel Indoctrination and Training	N
Basic 3	Design Control	Y
Supplement 3S-1	Supplementary Requirements for Design Control	N
Basic 4	Procurement Document Control	Y
Supplement 4S-1	Supplementary Requirements for Procurement Document Control	N
Basic 5	Instructions, Procedures, and Drawings	Y
Basic 6	Document Control	Y
Supplement 6S-1	Supplementary Requirements for Document Control	N
Basic 7	Control of Purchased Items and Services	Y
Supplement 7S-1	Supplementary Requirements for Control of Purchased Items and Services	N
Basic 8	Identification and Control of Items	Y
Supplement 8S-1	Supplementary Requirements for Identification and Control of Items	N
Basic 9	Control of Processes	Y

Supplement 9S-1	**Supplementary Requirements for Control of Processes**	**N**
Basic 10	**Inspection**	**Y**
Supplement 10S-1	**Supplementary Requirements for Inspection**	**N**
Basic 11	**Test Control**	**Y**
Supplement 11S-1	**Supplementary Requirements for Test Control**	**N**
Supplement 11S-2	**Supplementary Requirements for Computer Program Testing**	**N**
Basic 12	**Control of Measuring and Test Equipment**	**Y**
Supplement 12S-1	**Supplementary Requirements for Control of Measuring and Test Equipment**	**N**
Basic 13	**Handling, Storage and Shipping**	**Y**
Supplement 13S-1	**Supplementary Requirements for Handling Storage and Shipping**	**N**
Basic 14	**Inspection, Test and Operating Status**	**Y**
Basic 15	**Control of Nonconforming Items**	**Y**
Supplement 15S-1	**Supplementary Requirements for the Control of Nonconforming Items**	**N**
Basic 16	**Corrective Action**	**Y**
Basic 17	**Quality Assurance Records**	**Y**
Supplement 17S-1	**Supplementary Requirements for Quality Assurance Records**	**N**
Basic 18	**Audits**	**Y**
Supplement 18S-1	**Supplementary Requirements for Audits**	**N**

B-4. Design

B-4.1. Design Criteria

Procedure: The PEPE shall prepare a design criteria document for each component of each facility. A format and coverage similar to current Plant Engineering design criteria documents shall be used. The review and concurrence signatures for each component shall be developed by the PEPE and approved by the PEPM.

QA records to be filed as required in Table B-2:

TFX-3-1 The design criteria documents are:

- LLNL Plant Engineering Manual, Volumes 1-5, latest revision
- LLNL Plant Engineering Drafting Manual, PEL-P-02065

B-4.2. Design Calculations

The project PEPE for LLNL designs is responsible for preparing design calculations to document conformance to requirements, as specified in the design criteria document. The computations shall be presented in a well-indexed document with all assumptions stated, and reference made to supporting documents and texts. The full names of designer and checkers shall appear on the calculations with the date.

All calculations shall be signed and stamped by the registered professional engineer or architect or surveyor who is the responsible person performing the work.

QA records to be filed as required in Table B-2:

(TFX-3-2) Design Calculations.

B-4.3. Drawings and Specifications

The PEPE is responsible for the preparation of construction drawings and specifications that reflect the Design Criteria, and the requirements of the LLNL Plant Engineering Drafting Manual (see Table 4-2, Item 3). When drawing and specification changes are approved and issued, a copy of each shall be placed in the QA records file for each subproject.

QA records to be filed as required in Table B-2:

(TFX-3-3a) Change documents for approved drawings and specifications.

(TFX-3-3b) Copy of all specifications.

B-4.4. Drawing and Specification Lists

The PEPM is responsible for the preparation and updating of complete drawing and specification lists. The lists shall include all drawings, specifications, and changes for purchase order (PO) contracts, Labor Only contracts, Job Orders, and Mechanical and Electronic Engineering Department drawings. This list will serve as the index for the QA print files and as the list of prints required in the QA files.

QA records to be filed as required in Table B-2:

(TFX-3-4a) A current and/or final copy of the drawing list.

(TFX-3-4b) A current and/or final copy of the specification list.

B-4.5. National Environmental Policy Act (NEPA)

The PEPM is responsible for assuring compliance with NEPA requirements for activities within his project. Completed documentation consists of Plant Engineering Form 1, NEPA Compliance Project Notification Form, and NEPA Compliance Environmental Checklist. Memos to and from DOE and Environmental Impact Studies, as applicable, comprise objective evidence of NEPA compliance.

NEPA Compliance Documents to be filed as required in Table B-2 (TFX-3-6).

B-5. Procurement

B-5.1. Procurement Contracts

Preparation and approval of purchase order contracts for design, construction, material, and equipment shall comply with standard LLNL purchasing policies.

QA records to be filed as required in Table B-2:

(TFX-4-1) Copy of all design and construction POs, and a copy of all material and equipment POs over $ 5,000.

B-5.2. Instructions, Procedures, and Drawings

Instructions and procedures are contained in the applicable requirements in Table B-2, and design criteria documents. Drawings shall be prepared in accordance with LLNL Plant Engineering Drafting Manual, PEL-P-02065.

B-5.3. Documents

The approval and control of procurement documents shall conform to LLNL Procurement Manual, Vol. II, Books 1, 2, and 4. The control and approval of construction drawings shall conform to LLNL Plant Engineering Drafting Manual, PEL-P-02065. Control, format, and approvals of specifications shall conform to Plant Engineering Standard PEL-P-02075, Specifications.

All drawings shall be approved for construction and have all applicable approval signatures before the bidding process, or, for LLNL construction, before the estimate process. Approvals of major changes to instructions, drawings, and specifications shall be the same as for the original issue.

Minor technical design changes made in the field shall be approved by the CM and the CI on the inspection print, and on the as-built drawings.

QA records to be filed (as required in Table B-2):

(TFX-6-1) One set of as-built prints for each project.

B-5.4. Control of Purchased Items and Services

Purchased items and services shall be controlled in accordance with standard LLNL Purchasing Policies. A Notice of Completion shall be prepared with all required LLNL signature approvals, and sent to the Procurement Department before contract close-out.

QA records to be filed (as required in Table B-2):

(TFX-7-1) Copy of the Notice of Completion for each project

B-5.5. Handling, Storage, and Shipping

Items and materials shipped to LLNL shall be packaged, shipped, and stored according to instructions on drawings, specifications, contracts, and purchase orders. Receiving Inspection and/or the CI shall inspect incoming items and materials for damage during shipping and storage.

Handling equipment such as fork lifts and cranes shall be operated, maintained, and tested in compliance with DOE Order 5480.4 and OSHA Regulations 29 CFR parts 1910.178, .179, and .180. When LLNL equipment is used, compliance with the LLNL Health and Safety Manual is required.

Inspection reports are initiated and maintained per the Construction Inspector's Policy and Procedures Manual. No additional QA records are required for the QA files.

B-5.6. Control of Nonconforming Items

The CI and CM shall maintain cognizance of salvage (rejected or damaged) materials and items (M&I), and arrange for segregation ~~of~~, and prompt disposition, of LLNL supplied rejected M&I. The construction subcontractor shall be notified to immediately remove any rejected subcontractor supplied M&I from LLNL. Any nonconformance which cannot be immediately corrected and verified by the CI shall be documented on a Deficiency Notice or punch list as applicable. Nonconformances to be dispositioned as "use as is" or "repair" (as opposed to rework) must be recorded on a Deficiency Report, approved and signed by the CM.

Inspection reports are initiated and maintained per the Construction Inspector's Policy and Procedures Manual. No additional QA records are required for the QA files.

B-6. Construction

B-6.1. Identification and Control of Items

Material delivered to the job site is inspected to verify compliance with the approved submittals to assure that only correct and accepted items are used or installed.

The CM will request identification and inspection of items arriving at the construction site, when required. Acceptance of items or materials not in conformance with requirements shall be approved by the SL and PEPE, and shall comply with the LLNL Procurement Manual.

Inspection reports are initiated and maintained per the Construction Inspector's Policy and Procedures Manual. No additional QA records are required for the QA files.

B-6.2. Inspection, Test, and Operating Status

The CI and CM shall maintain cognizance of incoming and stored materials and items, and inspect or test them for conformance to requirements. When the CI or CM are concerned with maintaining identification of the status of a shipment of critical materials or items, they shall tag it to ensure that untested or rejected items are not inadvertently used.

Lockout tags shall be tied on electrical equipment, lifts and hoists, valves, etc., where such items: are unsafe to use; are uncertified; or to protect personnel working on the system.

Inspection reports are initiated and maintained per the Construction Inspector's Policy and Procedures Manual. No additional QA records are required for the QA files.

B-6.3. Control of Processes

Procedures for welding, bonding, and other processes shall be called out in specifications or drawings, as required.

When required in construction specifications, bonded joints, welding tests and inspections, and welder certifications shall be verified by the CM and the CI, as required.

QA records to be filed (as required in Table B-2):

(TFX-9-1) Welder certifications

(TFX-9-2) Welding test reports

(TFX-9-3) Cemented joints tests reports

B-6.4. Inspection

All construction work, and LLNL acceptances within the scope of this QA plan, including PO contract and labor contract only, are subjected to inspection. Work shall be inspected and documented according to the Construction Inspector's Policy and Procedures Manual and the Construction Manager Manual. The inspection team shall delay progress payments to the subcontractor if the work is not in place, or is not up to contract quality.

During construction, the CI shall maintain a set of as-built marked prints to compare with the subcontractor's prints, and shall review and approve the subcontractor's prints.

After construction, the CI shall verify the accuracy of the as-built drawings in accordance with the construction inspector's policy and procedures manual. The CI and PM shall indicate approval of the subcontractors marked up print by signing the as built drawing.

QA records to be filed (as required in Table B-2):

(TFX-10-1) All Inspection Prints, with copies of Field Memos, Change Orders, calculations, and sketches attached.

(TFX-10-2) Final Inspection Report per Construction Manager Manual.

(TFX-10-3) Final Acceptance report per Construction Manager Manual.

B-6.5. Control of Measuring and Test Equipment

Certified testing laboratory subcontractors shall periodically calibrate measuring and test equipment used for LLNL work according to the requirements in the contract, and according to military standard MIL-C-45662, Calibration System Requirements.

B-7. Activation

B-7.1. Activation of Measuring and Testing Equipment

All measuring and test equipment (M&TE) used in acceptance testing of electronic, monitoring, and interlocks systems and items shall be calibrated in accordance with the applicable LLNL calibration manual or plan. The individual conducting the test shall be responsible for assuring that all test equipment is calibrated and within its certification period.

The two major calibration laboratories at LLNL are the Engineering Measurements & Analysis Section, Engineering (ME); and the Instrument Services Group, Engineering Services Division, Electronic Engineering (EE). The ME facility typically calibrates M&TE that make pressure, force, displacement, flow humidity, acceleration, velocity, or temperature measurements. The EE facility services and calibrates M&TE that measures frequency, time, and electrical and magnetic measurements.

Calibration of M&TE may be performed by LLNL calibration laboratories or by outside vendors providing calibration services. Vendors providing calibration shall be required to meet the requirements of MIL-STD-45662.

No additional QA records are required in QA files, but such records are filed in the EE and ME calibration facilities.

B-8. Quality Assurance Records

B-8.1. Quality Assurance Records

QA records shall be prepared, archived, and made readily available as evidence that the treatment facilities were specified, designed, and constructed to meet the quality goals of this QA plan. They shall be protected and maintained for a minimum of 6 months after completion of the project prior to being microfilmed and archived for long-term storage.

The QA records specified by this plan do not include all the project records generated in the project. In addition to the QA records, there are microfilmed records maintained by Plant Engineering, and contract records maintained by the Procurement Department. Although these records are not defined as QA records, they are available for examination if required.

B-8.2. Filing Systems

QA records required by this plan shall be filed in lockable cabinets in the order given in Table 4-3. Before filing, each record shall be numbered and titled according to Table B-3, and stamped with a black ink stamp:

QA RECORD

QA PLAN NO. X-XXX-XX

DATE:_____

A file drawer insert shall be set up and labeled for each file number, and each record shall be placed in a labeled folder or binder. QA records are not working files, and shall not be so utilized. If files are borrowed, a file checkout system shall be used to track record location and to ensure their prompt return.

B-8.3. Plant Engineering Records

In addition to the separate QA records file of this QA plan, the PEPM, PEPE, CM, and CI shall organize and maintain working engineering files for the project. (These files are not QA records files; they are files normally kept when required for compliance or legal purposes.) Records, as specified in the Construction Manager Manual and the Construction Inspector's Manual, shall be collected by the CM, CI, and the PEPE, and transmitted by the PEPM to the Standards and Documentation group of PEPE for microfilming. These files shall be preserved for a period of not less than 6 years after project completion.

B-8.4. Procurement Department Records

The Procurement Department shall maintain an auditable Procurement Construction Contract File, as required in the Procurement Manual, for a period of not less than 6 years (this file is not designated as a QA file in this QA plan).

B-9. Audits

The project manager shall arrange for periodic independent audits of the implementation of this QA plan.

QA records to be filed:

(TFX-18-1) Audit requests and reports

B-10. References

1. American Society of Mechanical Engineers (ASME), 1989, NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, ASME NQA-1-1989 edition.
2. Construction Inspector's Policy and Procedure Manual, Plant Engineering Department, LLNL, July 1984.
3. Construction Manager Manual, Subcontracted Construction Projects, Plant Engineering Department LLNL, W. Kleck, January 1989.
4. DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, May 1984.
5. DOE Order 6430.1A, *General Design Criteria Manual.*
6. LLNL Plant Engineering Drafting Manual, PEL-P-02065.
7. LLNL Plant Engineering Manual, Volumes 1-5, latest revision.
8. OSHA Regulations 29 CFR Parts 1910.178, .179, and .180.

Appendix C

Construction Health and Safety Plan

Appendix C

Construction Health and Safety Plan

C-1 Health and Safety Plan:

The Construction Manager (CM) working in close harmony with LLNL Hazards Control with support from construction inspectors, is responsible for onsite construction safety to the extent outlined in the following paragraphs:

C-1.1. Construction Safety Plan

Every construction subcontract requires that the Subcontractor submit a prejob safety check list before Notice to Proceed is issued. The Hazards Control Construction Safety Coordinator shall review each prejob checklist for appropriateness and completeness. Deficiencies will be noted and the document returned to the contractor for revision. The document must be resubmitted until it passes review by the Construction Safety Coordinator. During the course of the construction, the CM shall ascertain that copies of the checklist/safety plan are available on the job site and that the Subcontractor has copies in his possession.

C-1.2. Construction Site Bulletin Board

The following notices must be displayed at the job site.

Safety Notices

a. "Notice to Employees," DOE Occupational Safety and Health Requirements.

b. Emergency telephone numbers for Medical Assistance and Fire Department.

c. Safety posters.

Miscellaneous Notices

a. Equal Employment Opportunity Posters (EEO).

b. Any other notices of general interest to the construction employees.

C-1.3. Safety Observations

Periodic construction site safety walk-through observations shall be made by the Construction Manager and an LLNL Hazards Control Representative.

The Construction Safety Coordinator will make periodic observations on major projects and less frequent observations on smaller jobs. The Construction Safety Coordinator, an industrial safety engineer, will arrange for visits by Hazards Control Disciplines (Industrial Hygiene, Fire Protection, Health Physics, etc.). Walk-through findings will be written up and filed for audit

purposes. Any hazards or lack of compliance with Federal codes noted on the walk-throughs shall be called to the attention of the Subcontractor's superintendent by the CM.

The Subcontractor should clearly understand that these observations will in no way absolve him/her of his/her basic responsibilities for safety on the construction job site. In imminent hazard situations, any LLNL or contract employee or contractor may stop the work creating the situation. In emergency situations, a Hazards Control representative may enter the site unannounced.

Construction safety inspections by outside agencies whether announced or unannounced shall be called to the attention of the CM. The CM will arrange with the LLNL Pass Office for receipt of prompt notification of unannounced site entry by State and Department of Labor (DOL) Inspectors. Any construction site safety inspection made by State or DOL Inspectors shall be promptly relayed to DOE, San Francisco (SAN) Safety Division, by the CM or Hazards Control Department Head. The CM shall be provided with and become familiar with 29 CFR Part 1926 and the Health and Safety Manual supplement 1.11, which is attached as part C-2 of this appendix.

C-1.4. Audit of Subcontractor's Safety Documentation

Periodically, the CM accompanied by a Hazards Control Representative shall audit the Subcontractor's safety documentation. The CM will call to Subcontractor's attention any deficiencies found during the audit. The Subcontractor shall clearly understand that these audits and the safety walk-throughs outlined in the preceding section are intended to assist him/her in obtaining compliance with required safety rules and regulations and in no way shall absolve him/her of his/her legal responsibility for safety on the construction site.

The following list outlines some of the major items to observe or which may be called to the attention of the Subcontractor during the periodic audits:

- 29 CFR Part 1926-copies.
- OSHA Accident Report Form and Form 200, Injury log.
- Documentation of weekly safety meetings.
- Copies of approved Construction Site Safety Plan.
- Required OSHA Records including but not limited to: 29 CFR Part 1926.29, 251, .550, .552, .601, .602, .701, .800, .803, .850, .900, etc.

C-2. LLNL Health and Safety Manual Supplement 1.11

Health & Safety Manual

Supplement 1.11

Construction Contractor Safety Program

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Construction Contractor Safety Program

Introduction

This Supplement describes the Lawrence Livermore National Laboratory (LLNL) Construction Contractor Safety Program. Contractors shall conduct their activities in a manner acceptable to LLNL and in accordance with the prescribed standards listed in the contract. Where the word "contractor" is used in this Supplement, it shall also be understood to include subcontractors to the Laboratory.

Responsibilities

Plant Engineering and Facilities Department Projects

Plant Engineering supervises the construction phases of most Laboratory construction projects. A Construction Manager and Inspector are assigned to each new project and are responsible for ensuring that the contractor fulfills the responsibilities specified by the contract.

Program Projects

The program management requesting the work supervises the construction phases of jobs that do not involve Plant Engineering. A Program Construction Coordinator is assigned to ensure that the contractor fulfills the responsibilities specified by the contract.

Hazards Control Department

Hazards Control audits the safety program of all construction contractors. This function is performed primarily by an Industrial Safety Engineer who serves as Construction Safety Coordinator to the Plant Engineering Construction Organization. Program construction projects are audited by the Industrial Safety Engineer assigned to the Safety Team for that program. The extent of auditing depends on the type of activity and the risk involved.

Procurement Department

The Construction Contracts Group, as directed by Plant Engineering, must see that every construction purchase order or subcontract includes a Contractor Safety Plan (an example is given in Appendix A of this Supplement) or a Contractor Prejob Checklist (Form LL-4721, shown in Appendix B of this Supplement) as part of the bid package.

Construction Contractors

Contractors are responsible for the safety of their personnel and for fulfilling other obligations specified by the contract. Contractor superintendents are responsible for eliminating hazardous conditions, monitoring their personnel for safe work practices, providing safe equipment, conducting safety meetings and training, and providing periodic safety reports. Employees are to be made aware of workplace hazards and are encouraged to promptly report any unsafe conditions to their contractor superintendent.

Construction or Specialty Subcontractors

On projects where the General Construction Contractor has subcontracted portions of work to other construction or specialty contractors, it is the responsibility of the General Construction Contractor to assure that any subcontractor is made aware of and adheres to the responsibilities specified in the "Construction Contractors" section above. The General Construction Contractor must consider the work to be done when completing the Contractor Safety Plan or Contractor Prejob Checklist.

LLNL Requirements

Safety Plans

A written Safety Plan is required for Major Projects. Major Projects include but are not limited to:

- Projects that cost over $750,000.
- Projects with severe hazards (i.e., deep trenching, steel erection, or wood construction above 70 ft).
- Projects that involve demolition of major structures.
- Projects that are DOE prime contracts.

Each safety plan shall reflect the type of construction safety required. Each contractor shall prepare the safety plan with concern for OSHA requirements and good safety practices (see Appendix A for a sample format).

Other projects may satisfy this requirement by submitting a Contractor Prejob Checklist (form LL-4721, shown in Appendix B). The submission of the safety plan or checklist must be accepted by Hazards Control and by either the Construction Manager or Program Construction Coordinator *before* work begins.

Prescribed Standards

A safe workplace shall be maintained in accordance with the requirements of the prescribed standards listed in the contract. Where differences exist between prescribed standards and codes, the one affording the greatest protection shall govern.

General Requirements

The following requirements are of special importance on all jobs:

- Contractors shall have a copy of the Code of Federal Regulations (29 CFR, Part 1926, OSHA Construction Industry Standards) on every job site or shall have access to a copy.
- The following information shall be posted conspicuously on all construction sites:
  - "Notice to Employees, US DOE Occupational Safety and Health Requirements," DOE F-5480.2 (11-81).
  - Emergency telephone number for LLNL Medical and Fire Department: 447-6880 (outside number) or Lab extension 2-7333; for Site 300, extension 3-5333.
- Contractors must report all injuries and illnesses. They may report them on LLNL Construction Injury Forms or with a copy of their insurance carrier's injury report. Forms must be submitted to either Construction Inspectors or LLNL representatives within 5 working days of an injury. LLNL Construction Injury Forms can be obtained from Construction Inspectors or Program Construction Coordinator personnel.
- Contractors must provide for orientation and training of employees in accordance with 29 CFR 1926.21.
- Contractors must provide first aid supplies and qualified personnel to administer first aid at the job site in accordance with 29 CFR 1926.50.
- Contractors must comply with housekeeping requirements (29 CFR 1926.25).
- Contractors must comply with all signs and tag requirements (29 CFR 1926.200).
- Contractors must provide all necessary personnel protective equipment (29 CFR 1926, Subpart E.).
- Contractors must provide ground-fault circuit interrupters on all single-phase 15- and 20-ampere receptacle outlets on all construction sites (29 CFR 1926.400).

Open Trench Barriers

Groups engaged in construction and maintenance work requiring open trenches or excavations must provide protection for pedestrians, bicyclists, and motor vehicles. Where possible, these areas should be backfilled immediately or provided with a continuous covering. Where this is not possible, barriers must be provided to warn personnel of the danger areas. Construction personnel must become aware of traffic patterns and provide walkways adjacent to occupied buildings, main thoroughfares, intersections, and at other recognized locations where pedestrian traffic occurs.

A construction barrier must meet the following criteria:

- Type II barricades, as defined in American National Standards Institute (ANSI) Standard D-6.1, must be positioned at 3-m (10-ft) intervals on each side of the trench. Spacing on each side of the trench should alternate to show barricades at 1.5-m (5-ft) intervals.
- Each barricade should be positioned at least 0.6 m (2 ft) away from the opening.
- Each barricade that will be in place during darkness must be equipped with a yellow flasher at least 20 cm (8 in.) in diameter. Flashers should be directed toward the outside of the excavation or perpendicular to the path of expected travel.

- Where continuous solid barriers are not provided, interconnecting ropes or special yellow plastic strip tape must be strung between the barricades.
- Crossing points are to be identified in construction drawings and sketches so that walkways and bridges equipped with standard guard rails (or equivalent) can be provided. Adequate lighting must be furnished at the crossing points.
- Wherever vehicle traffic will cross trenching operations, metal plate coverings must be installed to support the traffic.

Excavation and Trench Shoring

Pursuant to Labor Code 6707, the contractor shall include in the base bid all costs related to the provision of adequate sheeting, shoring, bracing, or equivalent method for the protection of life and limb. These methods shall conform to applicable Federal and State safety orders.

Before beginning any excavation that is 5 feet or more deep, the contractor shall submit to the Construction Manager or Program Construction Coordinator a detailed plan showing the design of shoring, bracing, sloping, or other provisions to be made to protect workers from the hazard of caving ground during the excavation. The proposed plan shall comply with the standards established by the State of California Construction Safety Orders, Title 24 of the California Administrative Code, and 29 CFR 1926 (Federal OSHA Construction Safety Standards). If the detailed plan varies from such shoring system standards, it shall be prepared by a registered civil or structural engineer whose name and registration number shall be indicated on the drawing. If a dispute arises as to whether the plan shall be prepared by a registered civil or structural engineer, LLNL's determination of the matter shall be final. The cost of required engineering services shall be borne by the contractor and shall be deemed to have been included in the amount bid for the work as stated in the Contract.

The review or approval of any plan showing the design of shoring, bracing, sloping, or other provisions for worker protection shall not relieve contractors from their obligation to comply with Construction Safety Order Standards, Title 24 of the California Administrative Code, and 29 CFR 1926 for the design and construction of such protective work. The contractor shall indemnify LLNL from any and all claims, liability, costs, actions, and causes of action arising out of, or related to, the failure of such protective systems. The contractor shall defend LLNL, its officers, employees, and agents in any litigation or proceeding brought with respect to the failure of such protective systems.

Confined Spaces

If a contractor employee is to enter a confined space (such as a tank, vault, hold, or manhole), the Construction Manager or Program Construction Coordinator must provide the contractor with a copy of the LLNL *Health & Safety Manual (H&SM)*. Supplement 26.14, "Work in Confined Spaces," available from the LLNL Hazards Control Department. Any such entry must be in accordance with the requirements of this Supplement. The Construction Safety Coordinator from Hazards Control must also be notified at least 5 working days before entry is made.

Fire Safety

The contractor shall obtain a Fire Safety Permit from the LLNL Fire Safety Division before using an open-flame or electric arc and must not start open flame or electric arc operations until a permit has been posted. The Inspector or Program Construction Coordinator will contact the LLNL Fire Safety Division to arrange for the Fire Safety Permit.

Electrical Utilities

When construction activities involve installing new or remodeled electrical utilities, the contractors must contact the Construction Manager or Project Construction Coordinator to arrange for a utility outage before these utilities are tied into existing LLNL utilities. The Plant Engineering Facilities Operation and Maintenance Division will identify the circuits and circuit breakers involved. The contractor representative may then open those circuit breakers that are 600 V or less and lockout-and-tag them (refer to LLNL *H&SM* Supplement 26.13, "General Lock and Tag Procedure") before the tie-in is made. Circuit breakers for LLNL facilities that control circuits over 600 V must be opened, locked-out-and-tagged, and grounded by the Facilities personnel. When the new utilities are ready to be energized, Facilities personnel must visually inspect and test all electrical equipment that operates at a potential over 600 V before it is placed in service. The contractor may join with the Construction Manager or Program Construction Coordinator to witness the switching and grounding work performed by LLNL employees.

Where new construction projects adjoin, or are associated with, LLNL-controlled utilities but do not affect LLNL personnel or activities, the Construction Manager or Program Construction Coordinator may request the Facilities Operations and Maintenance Division to lockout-and-tag certain sources of power (electrical and mechanical) for the safety of contractor personnel.

All lockout-and-tag operations must conform to LLNL *H&SM* Supplement 26.13.

All branch circuits shall be properly identified and safely terminated so as not to cause an electrical shock hazard.

Working in Radiation Areas

When a contractor brings a radioactive source on site or when contractor employees work in designated radiation areas, the LLNL Health Physics Group must be notified before the start of the job.

When radiation dosimeters are issued to contractor personnel, they must be exchanged at least on a quarterly basis (monthly, if required) and turned in at the completion of the job assignment.

All radiography work must comply with Title 17 of the California Administrative Code regarding radiation control regulations.

When contractor personnel are asked to work in designated radiation areas, the LLNL Health Physics Group will provide a 30-min briefing regarding radiation safety requirements.

Working With Asbestos

If work with asbestos is anticipated, the Hazards Control Safety Team for the area in which the work will be conducted must be notified at least 5 working days before the start of the job. Hazards Control must also be included in the planning or prejob discussion phase. Contract Specification 131 shall be included in the bid documents to all bidders.

Minimum Controls:

- Signs and partitions will be used to isolate the work area.
- Heating and air conditioning systems will be turned off.
- Floors and furnishings (if any) will be covered with plastic to facilitate cleanup.
- Asbestos materials will be wetted before being disturbed. A 1.5 solution of ethylene glycol and water may be used as a wetting agent.
- Asbestos waste or scrap will immediately be double bagged in plastic and labeled with caution labels.
- Eating or smoking will not be allowed in the work area.
- Employees who may be exposed to asbestos must be advised of the health hazards and means of protection available.
- A respirator that is approved for asbestos must be worn. Special clothing may also be required.

All contractors are required to comply with these minimum controls. Some situations may require additional controls. Contractors shall provide their own protective equipment and training to their personnel. Hazards Control will audit these areas and contractors for compliance with required LLNL Safety Standards.

Further information on asbestos handling can be found in the *H&SM* Supplement 21.19, "Safe Handling of Asbestos Products."

Stop-Work Procedures

The stop-work procedure at the Laboratory (LLNL *H&SM* Chapter 1.06) applies to all construction activities. The stop-work procedure will be used only where imminent-danger situations exist or where significant damage to equipment or property could occur if the operation continued. When a stop-work order is issued, only those areas of the construction project immediately involved in the hazardous situation are to be included in the order. A stop-work order is normally issued by the Construction Manager, the Program Construction Coordinator, or the Plant Engineering Inspector. If they are absent and the contractor personnel are involved in an imminent-danger situation, Hazards Control personnel shall stop the operation and immediately locate the Inspector, the Construction Manager, the Program Construction Coordinator, or the Construction Management Organization Leader. This is the only time that Hazards Control personnel are authorized to directly contact contractor personnel.

Differences of opinion between the Hazards Control Representative, the Construction Manager, the Program Construction Coordinator, and the Plant Engineering Inspector concerning a stop-work order shall immediately be referred to their respective Supervisors or Division Leaders for resolution. An Incident Analysis Report (LL-2574) may be required after each instance in which work has been stopped (see *H&SM* Supplement 4.08, "Incident Analysis Manual").

Accidents

Emergency Assistance

Contractors are responsible for providing first aid and medical assistance if their employees are injured or become ill. If emergency assistance or transportation is required because of the severity of the injury or illness, LLNL ambulance and emergency response personnel may be called. The emergency phone number (447-6880, or LLNL extension 2-7333, or extension 3-5333 for site 300) should be posted at the work site, and the contractor should give this information to all employees concerned. All incidents and accidents shall be reported to the Construction Manager, Construction Inspectors, or Program Construction Coordinator within 2 working days.

Immediate Notification

The contractor should notify the Construction Manager, Program Construction Coordinator, or Plant Engineering Inspector immediately if an incident occurs that involves –

- A fatality or possible fatality.
- An injury or illness that may produce permanent or prolonged disablement.
- Injury or illness to several employees in the same incident.
- Anything that could cause concern to LLNL employees or the public or that could have a significant effect on the off-site environment.

Additional notification requirements are described in the LLNL *H&SM* Chapter 4, "Incident Analysis and Reporting." The contractor shall cease all work at the site of the incident until the Construction Manager and Program Construction Coordinator and the Hazards Control Safety Team Leader for the area jointly provide additional instructions.

The site of an accident involving serious injury or fatality shall be isolated and access controlled until the area is released by Hazards Control. The area must remain intact until a safety evaluation has been completed.

Incident Analysis

The department administering the contract and Hazards Control shall jointly determine the extent of the incident and the mechanism for handling any required incident analysis, using the principles described in the LLNL *H&SM* Chapter 4.

Appendix A

Example of Contractor Safety Plan

SAFETY, ACCIDENT PREVENTION, AND FIRE PROTECTION PLAN
FOR
UNIVERSITY OF CALIFORNIA

LAWRENCE LIVERMORE NATIONAL LABORATORY

SUBCONTRACT NO._____

CONSTRUCTION OF

_____
(Insert Title of Subcontractor)

_____
(Name and Address of Subcontractor)

_____
(Signature of Subcontractor)

_____
(Date)

SAFETY, ACCIDENT PREVENTION, AND FIRE PREVENTION PLAN

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SAFETY, ACCIDENT PREVENTION, AND FIRE PREVENTION PLAN

POLICY STATEMENT

The policy is to provide a safe and healthful working environment for all personnel through proper inspection, guidance, and adherence to safety codes and standards. All work is to be done in a safe manner. Safety is a management responsibility. To prevent injuries, illnesses, accidental fires, and property damage, all supervisory personnel must demonstrate the ability to recognize hazards and take necessary steps to eliminate existing and potential hazards. All supervisors and employees will perform their duties in compliance with the required safety codes and standards.

PURPOSE

This Safety, Accident Prevention, and Fire Prevention Plan has been compiled to make all personnel working on the project thoroughly aware of the need to eliminate all possible causes of accidents.

SAFETY RESPONSIBILITIES

Safety is the responsibility of management. (Name)_____,(Title)_____, will be the designated on-site safety Representative for (company or firm name)_____. He/she will be responsible for administering the safety program of this (project name) project and will also be responsible for the inspections, training, and reporting needed to carry out this contract.

Construction superintendents are responsible for continuously checking for and eliminating all possible hazardous conditions. They are responsible for conducting safety meetings and for the constant training of personnel. All personnel must be trained to become aware of unsafe conditions and correct them. Any unsafe conditions must be immediately corrected or referred to management when corrective action is needed. All required safety equipment, if not provided by individual employees, will be supplied by the contractor.

Superintendents will make weekly safety inspections of the entire job, and a record of this inspection will be made available at the job site. Safety statistics will be reported as required by the Department of Labor, the Department of Energy (DOE), and the Lawrence Livermore National Laboratory (LLNL) of the University of California.

Each employee will be held responsible for performing his or her work in a safe manner. All employees must be ready at all times to correct or report unsafe conditions to their supervisors.

EMPLOYEE TRAINING

Bulletin Board

A bulletin board will be prominently placed next to the contractor's site office or as otherwise directed by the LLNL Construction Manager or Program Construction Coordinator. This board will post the following bulletins:

- Emergency phone numbers: Extension 2-7333 for LLNL, 447-6880 from outside the Laboratory site, and extension 3-5333 for Site 300.
- Dates and times that Supervisors' Safety Meetings will be held (minimum one per week).
- Dates, times, and places of Tool Box Meetings, and requirements for attendance (minimum one per week).
- The required DOE announcements and bulletins.
- Miscellaneous safety posters (DOE, LLNL, etc.).

Safety Meetings

Safety meetings will be held weekly for all employees. These meetings will be held to educate and train employees and to develop the proper safety attitude in the performance of their jobs. Attendance records will be maintained at the job site.

First Aid Stations

All personnel will also be instructed in emergency procedures, first aid, and the location of the LLNL first aid station.

MEDICAL SUPPLIES AND ASSISTANCE

First Aid

First aid kits will be placed in the field office and carried in the Superintendent's vehicle. First aid equipment will be inspected regularly for completeness, and an employee qualified in first aid will be on site during the normal work shift.

Emergency Phone Numbers

The emergency phone number card, in addition to being posted on the project bulletin board, will be posted prominently in work areas and carried in each superintendent's vehicle. Depending on the nature of the accident and the first aid or medical care required, the necessary assistance will be requested by phoning the emergency number indicated on the card.

PERSONNEL PROTECTIVE EQUIPMENT

Personnel protective equipment will be worn in compliance with prescribed codes and standards.

- Hard hats will be worn at all times in construction areas.
- Eye, ear, and face protection equipment will be worn as required by appropriate safety standards.
- Respiratory protective equipment will be used when the nature of the work requires it.
- Welding shields or goggles will be worn by personnel doing cutting or welding. (Only qualified personnel are to perform such tasks.)

EQUIPMENT SAFETY

Motor Vehicles

Operators will inspect vehicles daily before beginning work and at the end of the shift, reporting any obvious areas of possible malfunction (such as brakes or tires). Repairs will be made promptly. Defective vehicles will not be used until repairs are made.

Heavy Equipment

Audible alarms will be installed and maintained on all heavy equipment as specified in OSHA 1926.602 Job superintendents will make daily safety inspections. Operators are responsible for immediately reporting to supervisors any apparent or latent unsafe conditions of the equipment being operated. Job site records will be maintained as required under 29 CFR 1926, Federal OSHA Construction Safety Standards. Of particular interest are the requirements specified in 1926.29, 1926.251, 1926.550, 1926.552, 1926.602, and 1926.701 (although others are pertinent as well).

Hand Tools

All hand tools, whether self-owned or company-furnished, will be maintained in safe condition. Unsafe tools will not be used until repaired.

Guards required on power tools will be used at all times. Constant-pressure switches or controls will be used on all powered hand tools. Switch locking devices will be removed. Power grinders will have protective shields.

Electric tools will be grounded using three-prong plugs and receptacles (except for double-insulated tools). All 15- to 20-ampere receptacle outlets on single-phase circuits for the construction site will be protected by ground-fault circuit interrupters.

All gasoline or diesel powered tools and equipment will be stopped during refueling.

TRAFFIC CONTROL

Traffic control and routes are as indicated on the construction drawings and outlined in the written instructions. Sketches for the construction of certain detours in areas not indicated on the drawings will be submitted to the LLNL Construction Manager or Program Construction Coordinator for approval. Personnel are directed to become familiar with these details.

Required safety, fire, instructional, and traffic signs will be posted and obeyed. They will not be removed until their removal is approved by the Construction Manager or Program Construction Coordinator.

All flagmen will wear blaze orange vests.

FIRE PREVENTION

Hot Work Operations

A Fire Safety Permit is required for all hot work operations. Hot work operations include cutting, welding, brazing, soldering, thermal spraying, or any similar activity.

Smoking

Smoking is prohibited at or in the vicinity of hazardous operations or combustible or flammable materials. "No Smoking" signs will be posted in these areas. Smoking will be allowed only in designated areas. Where smoking is permitted, safe receptacles will be provided for smoking materials.

Waste Disposal

Accumulations of combustible waste material, dust, and debris will be removed from the structure and its immediate vicinity at the end of each work shift, or more frequently if necessary for safe operations. Good housekeeping will be maintained, and access will be kept clear at all times. If portable dumpsters are provided for waste disposal, they are to be located at least 25 ft from any structure.

The contractor is responsible for proper disposal of chemical and hazardous waste generated by the contractor in the performance of this contract. Preexisting hazardous material removed and discarded as waste by the contractor in the performance of this contract will be disposed of by LLNL.

Electrical Sources

All construction operation electrical wiring and equipment for light, heat, or power purposes will be in accordance with pertinent provisions of NFPA 70, *National Electrical Code*. Temporary lights will be equipped with guards to prevent accidental contact with the bulb. Guards will not be required when the reflectors are constructed with bulbs that are deeply recessed. Temporary lights will be equipped with heavy-duty electrical cords, with connections and insulation maintained in safe condition. Temporary lights will not be suspended by their electric cords unless the cords and lights are designed for such suspension. Splices will have insulation equal to that of the cable.

Fire Alarm Reporting

A public fire alarm box and telephone service to a responding fire department or equivalent facilities will be readily available near the premises. Instructions will be issued to notify the fire department immediately in case of fire. The local fire department number will be conspicuously posted near each telephone.

Access for Fire Fighting

Access routes for fire fighting equipment will be maintained. Fire hydrants will be kept clear of any obstructions.

Fire Extinguishers

Fire Extinguishers will be located on or adjacent to—

- Storage sites of combustibles.
- Fuel dispensing vehicles.
- Sites of hot work operations.
- The supervisor's vehicle.
- The supervisor's office or shed.

In addition, at least one approved extinguisher will be provided in plain sight on each floor at each usable stairway where combustible material could accumulate. Extinguishers will be placed within structures so that the maximum travel distance to an extinguisher is no more than 75 feet.

SANITATION AND INDUSTRIAL HYGIENE

Sanitation and Industrial Hygiene will comply with these listed standards:

- Toilet facilities will be provided at the work site.
- Bottled drinking water and disposable cups will be provided, along with a container for the disposal of used cups. This drinking water will be conveniently placed in the area of the work site.
- Proper ventilation will be maintained in order to avoid possible harmful buildup in areas where toxic fumes, dust, vapors, or gases may be produced. Respiratory protection will be supplied when adequate ventilation cannot be provided.

ACCIDENT REPORTING

Accident reporting must be an individual responsibility. All individuals who are injured must report the accident, however minor, to their immediate supervisor. Supervisors will obtain all pertinent information so that proper forms can be completed in the required number and forwarded to the construction inspector or LLNL representative within 2 working days. Supervisors will keep an injury log at the job site.

GENERAL AND SPECIAL INSTRUCTIONS

General Instructions

All employees will comply with the following general instructions:

- All employees will comply with this plan, assist all other employees in doing so, and report all dangerous conditions or practices immediately to their supervisors.
- All injuries must be reported promptly through the regular chain of supervision. Foremen and supervisors will be responsible for making proper reports to the contractor's company office.
- When injuries occur, the first step is always to provide medical care for the injured and to immediately eliminate any apparent cause of the injury. If a cause is not apparent, the work area and equipment must be secured until the cause is determined by qualified authorities.
- When a serious accident occurs, subcontractor management and the LLNL Construction Manager or Program Construction Coordinator will be notified immediately.
- No one will be permitted to work while his or her ability or alertness is impaired by illness, fatigue, medication, or other causes.
- Reporting to work under the influence of alcohol, stimulants, tranquilizers, or barbiturates—or using them during working hours—will be cause for termination.
- No guard, safety device, or appliance may be removed from tools, machinery, or equipment except for the purpose of making repairs. Such removal will only be done by persons qualified to make the repair, and they will first disconnect any power source and have the tool, machinery, or equipment in a safe area.
- Employees will not handle electrical equipment, machinery, vehicles, or air and water lines in a manner outside of the scope of their regular duty except with specific instructions from their supervisors.
- Employees will not enter trenches, ditches, or any other subsurface area without specific instructions from their supervisors.
- Employees will not enter or work in confined spaces (such as tanks, vaults, holds, or manholes) without specific instructions from their supervisors. All confined-space entries will be made in accordance with the

provisions of LLNL *H&SM* Supplement 26.14, "Working in Confined Spaces" (available through the Construction Manager or Program Construction Coordinator). The LLNL Hazards Control Construction Safety Coordinator must be notified at least 5 working days before entry is made.)

- If employees observe sand-blasting dust, asbestos fibers, smoke, or other possibly dangerous pollutants in the air of a work space, they should contact their supervisors for instructions.
- While handling hazardous chemicals or solvents, employees will follow directions and comply with any warnings or cautions affixed to the labels. Any questions concerning the use of such chemicals and personal protective equipment required will be directed to the supervisor.
- Flammable or combustible solvents will not be used for cleaning purposes without specific instructions from the supervisor, and such instructions will include the site and conditions of such use.
- The supervisor will have on site the Material Safety Data Sheets (MSDS) for all chemicals, flammables, solvents, paints, and other hazardous products used on the project.

Personal Protective Equipment

- It is the responsibility of supervisors and foremen to provide all employees with directions about employer-provided and employee-provided protective equipment necessary for each operation.
- Nonconductive safety hats will be worn at all times on the construction site, except in administrative areas.
- Strong nonslip gloves are recommended for all workers, except when wearing them could create greater risks.
- Safety shoes are recommended for all workers.
- Eye protection must be used by all employees while performing any operation in which a hazard to the eye exists. Examples of such operations are: welding, cutting, burning, sandblasting, grinding, hammering, and the use of pneumatic impact tools.

Ladders

- No employee may use a ladder that is defective or does not meet OSHA requirements.
- Wooden ladders will not be painted. They may be treated with linseed oil.
- Splicing of ladders is prohibited.
- Work will be arranged so that employees are able to face ladders and use both hands while climbing.
- The use of ladders to transport heavy or awkward-shaped items is prohibited.
- Step ladders must never be used as straight ladders. They must be fully opened at all times except when in storage. Employees will not be allowed to stand on the top step or end cap of step ladders.

Scaffolding

- All scaffolding will conform to 29 CFR 1926.451 (Federal OSHA Construction Safety Standards).
- All job site supervisors and foremen should be advised of their responsibility for the safety of their personnel when assigning personnel to work on or off scaffolding.
- It is imperative that the designated contractor safety representative make daily safety inspections of all scaffolding before use. Written records of such inspections will be maintained.
- If several crafts are using sections of the scaffolding simultaneously, it may be necessary to inspect the scaffolding more frequently, especially if other crafts are removing brackets, bracing, tie-wires, planking, or other objects to get their equipment or materials into place.
- Scaffolding inspection will include but not be limited to: base plates, sills, bracing, tie-ins, planking, access ladders to working levels, guardrails (handrail, midrail, and toeboard), anchorage to building structure and plumb scaffold.

Machinery and Vehicles

- Unless it is part of their regular duties, for which they have had adequate training, no employees may operate machinery or equipment without specific instructions and guidance. Only licensed operators may operate vehicles.

- Vehicles and equipment will be adequately secured against accidental or unauthorized starting or movement when not in use. Keys will be removed from vehicles at the end of the workday and placed in a secure area designated by the site safety representative.
- Operators must examine their equipment before starting and observe it carefully during use, reporting immediately any malfunction or deviation from safe performance.
- Floors and decks of equipment must be kept clean and free of anything that might cause slipping, tripping, or a falling hazard.
- The need for servicing or repairs will be reported to the supervisor. No repairs or adjustments will be made on units during operation. No lubrication will be performed on units during operation except those on which the manufacturer has installed safeguards specifically for the protection of the person doing the lubrication.
- Working under suspended loads id forbidden.
- Employees are prohibited from riding booms, loads, slings, hooks, or lift-truck forks or platforms.
- Air hoses must not be disconnected until they are bled and pressure is securely turned off at its source. All air hoses will meet the requirements of 29 CFR 1926.302h (Federal OSHA Construction Safety Standards).
- Employees must inspect all backfill areas before starting backfill operations.
- Adequate devices will be worn for protection of hearing by operators or employees working near units producing noise levels in excess of prescribed standards.
- No vehicle will be operated in a reckless or careless manner or at a speed that is not reasonable and proper with regard to weather, traffic, surface condition, visibility condition, load, or type of vehicle.
- All vehicular accidents that occur on the Laboratory site, of whatever size and nature, whether injury or non-injury, shall be reported immediately to the superintendent and to the LLNL Construction Manager or Program Safety Coordinator.
- Caution must be taken make sure that no one is below when equipment is used near tops of cuts, banks, or inclines.
- Special care, and an observer(s) with whom effective communication has been set up, will be used where there is a possibility of overturning equipment (for example, near tops of cuts, banks, inclines, deep fills, or soft or muddy terrain).
- Employees who are riding on flatbed trucks will ride sitting with their backs to the cab. Employees riding in the back of pickups will ride sitting on the bed of the pickup (see California Vehicle Code.)

Welding and Cutting–General

- Only trained employees, whose regular duties as assigned by their supervisors include welding and cutting, will perform this work.
- Only standard, approved, equipment will be used.
- Fire extinguishers will be easily accessible to all employees performing welding or cutting operations.
- Screens or shields will be provided for the protection of persons or combustible material exposed to sparks or falling objects; a fire-watch will be posted where necessary, with an adequate extinguisher and signaling device.
- When working on lead, zinc, or other material that could generate harmful fumes, adequate ventilation and exhaust devices will be provided. When ventilation is not practical or feasible, respiratory protection will be used.
- The designated safety representative or foreman will inspect the work site before any use of welding or cutting equipment to ensure that all combustibles in the work area have been removed or otherwise protected from the welding or cutting work. He or she will also assure that a current Fire Safety Permit for hot work is in effect at the designated job site.

Arc Welding

- Frames of welding machines operated from electric power sources must be properly grounded.
- When welding, employees must wear adequate masks or hoods with proper eye protection, gloves, and leather aprons as minimum protection; these will be supplemented with hard hats, safety shoes, and other protective gear where warranted.
- All employees and passersby near the welding area will be protected from eye flash-burns by use of partitions, screens, or other appropriate methods.
- Welding cables, cords, and leads must be neatly secured so as not to cause tripping.
- Electrode stubs will immediately be disposed of in a safe container.

Oxygen/Acetylene Welding and Cutting

- Cylinders must never be dropped or struck.
- Cylinders must be stored away from any source of heat.
- Where stored in the open, cylinders must be protected from continuous sunlight.
- Oxygen cylinders must be stored at least 20 feet away from those containing any fuel gas.
- Where stored inside, oxygen cylinders must be separated from those containing fuel gases by a 5-ft-high, noncombustible barrier with a fire rating of at least one half hour, or they must be separated by a 20-ft distance.
- Cylinders will be stored vertically and chained to prevent them from falling over.
- Cylinders will never be lifted by machinery unless they are in a safe stand or cradle or are otherwise positively secured against falling or being dropped.
- Special arrangements will be made to secure cylinders while they are being transported. Carrying them loose on the back of a truck or in a pickup is prohibited.
- Caps will be firmly screwed onto cylinders except when the cylinders are connected to a regulator during use.
- Oxygen cylinders will be kept free from oil or grease. Use of oil or grease as a lubricant for oxygen valves or attachments is prohibited.
- Smoking or flame is prohibited near welding gas cylinders or outlets.
- Field adjustment or repair of gauges, valves, accessories, or safety devices is prohibited.
- Acetylene must not be used for welding or cutting at pressures exceeding 15 psig.
- Acetylene cylinder valves will not be opened more than one full turn, and the wrench will be left on the valve stem so that the valve can be closed quickly if necessary.
- Oxygen cylinder valves will be opened fully and made hand-tight against the back seat. This takes the high-range cylinder pressure off the packing.
- Mixing gases in cylinders, refilling cylinders, or using cylinders for any use except their original purpose is prohibited.
- It is permissible to close torch valves alone only when work is briefly suspended and the operator is nearby. Any other interruption of use (e.g., if one cylinder becomes empty) necessitates closing the cylinder valves, followed promptly by opening the torch valves to purge lead-hoses and releasing the regulator screws.
- Hoses must never be hung from regulators, other equipment, or the cylinder tops.

Excavation, Trenching, and Shoring

All excavation, trenching, shoring, and backfilling will be in accordance with 29 CFR 1926, specifically Subpart P, copies of which will be available at the construction site. Superintendents and foremen will be familiar with these regulations and will direct workers accordingly. Any excavation or trench that is 5 feet or more deep will comply with the standards established by 29 CFR 1926.

Fall Protection

All floor or wall openings and platforms that expose workers to a fall of more than 4 ft will be covered or protected by guardrails.

Fall protection equipment (e.g., safety belts, body harnesses, lanyards, and lifelines) approved under 29 CFR 1926.104 and 29 CFR 1910 will be made available to and worn by all workers exposed to an unprotected fall of more than 10 ft.

PRESCRIBED CODES, STANDARDS, AND REGULATIONS

All work performed will be in accordance with the requirements of the latest edition of the following codes and standards, which will be considered minimum requirements:

- 29 CFR 1926, Safety and Health Regulations for Construction, Department of Labor (OSHA).
- 29 CFR 1910, Occupational Safety and Health Standards, Department of Labor.
- American National Standards for Safety (ANSI), as applicable.
- Safety Requirements for Construction, ANSI-A10 series.
- National Electrical Manufacturer's Association (NEMA), as applicable.

- National Fire Codes (NFPA).
- National Electrical Code (NEC-NFPA).
- National Plumbing Code (International Association of Plumbing and Mechanical Officials).
- Uniform Plumbing Code (International Association of Plumbing and Mechanical Officials).
- ASME Boiler and Pressure Vessel Code, Sections I-IX.
- 49 CFR 192, Pipeline Safety Standards.
- Any amendment or other safety codes applicable to the task being performed.

Appendix B

Contractor Prejob Checklist

SUBCONTRACTOR PREJOB CHECKLIST

COMPANY NAME _____ P.O./SUBCONTRACT NO. _____

ON-SITE CONSTRUCTION SUPERINTENDENT _____ JOB DESCRIPTION _____

This checklist consists of Occupational Health and Safety items that are most often overlooked by primary subcontractors and their lower-level subcontractors when performing work at LLNL. These items and all other Occupational Health and Safety Requirements in the contractual documents will be enforced. Place a check mark (√) in the appropriate column to indicate whether or not the item applies to work being performed by the primary subcontractor or its lower-level subcontractors.

I. MANDATORY REQUIREMENTS– ALL PROJECTS, GENERAL. THE SUBCONTRACTOR SHALL—

1. *Have Code of Federal Regulations (29 CFR 1926, OSHA) on job site.

*Construction Safety Regulations Part 1926 are available at no cost from the US Dept. of Labor, Office of Safety and Health, 450 Golden Gate Ave., Box 36017, San Francisco, CA 94102 [(415) 556-7260].

2. Display all required DOE notices furnished by LLNL.

3. Subcontractor shall provide for regular & frequent inspections of job sites, materials, and equipment to be made by competent persons (1926.20).
   a. The subcontractor is responsible to initiate immediate corrective action for any deficiencies noted during these inspections and for unsafe conditions and practices brought to his attention.
   b. The subcontractor shall immediately stop any activities considered to be "imminently hazardous."

4. Comply with injury/illness reporting requirements by submitting completed copy of Workman's Compensation Report or Contractor First Report of injury form to construction inspector within 5 days of injury.

5. Provide Laboratory's medical emergency telephone number—447-6880, or Lab Ext. 2-7333, or 3-5333 for Site 300—in a conspicuous location at the job site.

6. Provide for orientation & training of employees in accordance with 1926.21.

7. Provide first aid supplies and qualified personnel to administer first aid at the job site in accordance with 1926.50.

8. Comply with housekeeping requirements (1926.25).

9. Comply with all sign and tag requirements (1926.200).

10. ALL construction projects at LLNL are "Hard Hat Construction Sites," and hard hat signs shall be posted.

11. Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lighted while any work is in progress (1926.56).

12. Ensure that workers on construction projects wear substantial footwear. (1926.28).

13. Obtain an LLNL Fire Safety permit for welding or burning operations before start of project.

14. Provide and require the wearing of appropriate personal protective equipment in all operations where workers are exposed to hazardous conditions or where it is needed to reduce the hazard exposure to workers.

II. INDUSTRIAL SAFETY

A. Hand and power tools

1. The subcontractor shall inspect all tools and repair or replace tools with burrs, mushroom heads, and broken or damaged handles, and grips on files and rests, etc., in accordance with 1926.301.

2. Will the work performed on this project involve the use of electrically powered tools?
   YES ____ NO ____
   If yes, the following requirements apply.
   a. Install ground-fault circuit interrupters on all electrical power sources in accordance with the latest edition of the National Electrical Code.
   b. Ground all extension cords, outlets and electrical tools in accordance with 1926.404.

3. Equip all power tools with guards in accordance with 1926.300–304.

4. Will the work performed on this project involve the use of powder-actuated tools?
   YES ____ NO ____
   If yes, these tools shall be operated in accordance with 1926.302e. Eye protection shall be worn.

B. Ladders

1. Will the subcontractor use ladders on this project?
   YES ____ NO ____
   If yes, requirements a–d apply.
   a. Use and store ladders in accordance with 1926.450.
   b. Ladders to be used for electrical work shall be nonconductive in accordance with 1926.450a-11. Eye protection shall be worn.
   c. Submit a list of the kind and height of ladders to be used on the job site— e.g., extension ladders, job–made ladders.
   d. Repair defective ladders immediately or remove them from the LLNL site or construction site.

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C. Scaffolds

1 Will the subcontractor use scaffolds on this project?
YES_____ NO_____
If yes, requirements a–d apply.
a. The construction and erection of scaffolding shall be in accordance with 1926.451.
b. Submit a list of the kinds of scaffolding and working heights—e.g., wood, tubular, rolling, suspended, spiders, sky climbers, aerial lifts.
c. Scaffolds shall be equipped with guard rails consisting of a toprail, midrail and toe board.
d. Scaffolds shall be secured to a structure every 26 ft in height and 30 ft in length.

D. Roofing/Roof Work

1. Will the subcontractor be engaged in roofing or roof top work?
YES_____ NO_____
If yes, requirements a–f apply.
a. Roofing and roof top work shall be performed in accordance with 1926.500 (g).
b. Employees engaged in rooftop work shall be protected from falling from unprotected sides and roof edges by one or a combination of the following:
1. A motion-stopping-safety system (MSS system).
2. Warning lines erected not less than 6 ft. from roof edge.
3. A safety monitoring system.
c. Employees involved in handling materials at an unprotected roof edge shall be protected from falling by a MSS system
d. Guard rails shall be erected a minimum of 4 ft on each side of the access point through which materials are hoisted.
e. Materials shall be stored a minimum of 6 ft. from the roof edge.
f. Ladders used to access rooftops shall conform to 1926.450.

2. Will the work performed on this project involve the use of hot asphalt or pitch on the roof?
YES ____ NO____
If yes, requirements a–d apply.
a. Buckets containing hot asphalt or pitch shall not be carried on ladders.
b. Areas under hot materials lifting zones shall be barricaded off to keep personnel out of the area.
c. A clear path of travel shall be maintained along all paths of hot carry.
d. A class BC extinguisher shall be kept near each kettle or tanker in use.

E. Hoists, cranes, elevators, manlifts, cherry-pickers, backhoes, loaders

1. The subcontractor shall inspect and maintain inspection records of all equipment in accordance with 1926.550 and 1926.552–556.

2. All crane work in proximity to electrical distribution and transmission lines shall be protected as outlined in 1926.550 (a) 15.

G. Excavation, trenching, and shoring

1. Will the subcontractor be doing any excavation, trenching, or shoring on the project?
YES_____ NO_____
If yes, 1926.650 through .653 and requirements a–e apply.
a. Prior to excavation, attempts must be made to locate underground utilities.
b. Submit detailed specifications to LLNL on all jobs requiring shoring before starting any excavation.
c. Use lighted barricades on all roadways.
d. Barricading trenches at LLNL will conform to LLNL standards.
e. Equip all personnel bridges over trenching or excavation with safety railing.

H. Steel erection and assembly

1. All work shall be in accordance with 1926.750 through .752. Working on or off elevated surfaces shall be in accordance with 1926.104 and .105.

2. Before beginning work, submit a Fall Protection Plan, indicating the kind of work, heights involved, and fall protection equipment to be used, including for protection of personnel working below (e.g., safety nets, debris nets).

I. Personnel protective equipment

1. Will the work performed on this project involve hazards that require the use of any of the protective equipment listed below?
YES_____ NO_____

If yes, check the equipment that will be used on this job. Equipment shall be used in accordance with the referenced CFR section.

	If YES, check (√)
GOGGLES, 1926.102	
FACE SHIELDS, 1926.102	
WELDERS HOOD AND GOGGLES, 1926.102	
EYE PROTECTION FOR WELDER'S HELPERS, 1926.102	
RESPIRATORS, 1926.103	
EAR PLUGS OR EAR MUFFS, 1926.101 AND .103	
SAFETY BELTS, LANYARDS, LIFE LINES, ETC. 1926.104.	
METATARSAL GUARDS FOR JACK HAMMER AND TAMPER OPERATIONS. 1926.28(a)	

J. Explosives

1. Will explosives be used on this project?
YES ____ NO____

III. INDUSTRIAL HYGIENE

1. Will the subcontractor be working in a confined space (including manholes) where combustible, toxic, or other hazardous materials are present?
YES ____ NO ____
If yes, requirements a–d apply.
a. Perform work in accordance with LLNL *Health & Safety Manual* Supplement 26.14, "Working in Confined Spaces."

Continued on next page

b. Use supplied airline masks in confined areas such as manholes, or for sandblasting or similar activities (1926.28).
c. Use portable ventilation blower equipment in confined spaces and where combustible vapors or gases are present.
d. Arrange entry through Inspector with LLNL Construction Safety Coordinator five working days before the entry.

2. Sanitation
a. An adequate supply of drinking water, cups, and a waste receptacle shall be provided.
b. Toilets shall be provided in accordance with 1926.51(c).
c. Washing facilities shall be provided as outlined in 1926.51(f).

3. Will the work performed on this project involve the use of chemicals such as paints, solvents, adhesives, or other hazardous materials?
YES____ NO____
If yes, answer questions a–g.
a. Submit a list of these materials and attach Materials Safety Data Sheets
b. Are Material Safety Data Sheets provided for all employees using these materials?
YES____ NO____
c. Are all employees using these materials trained in safe handling?
YES____ NO____
d. Is sufficient ventilation being provided to control airborne concentrations of hazardous materials?
YES____ NO____
If yes, attach a detailed description.
e. Will respiratory protective equipment be provided for work where hazardous airborne materials are present?
YES____ NO____
If yes, attach a detailed description.
f. Will adequate skin and eye protection be provided?
YES____ NO____
If yes, attach a detailed description.
g. Will the contractor be using coal tar products?
YES____ NO____

4. Will workers be exposed to excessive noise levels(85 dBa) for more than 8 hours
YES____ NO____
If yes, attach a description of noise sources and the hearing protection to be used.

5. Will visible airborne soil and cement dust be generated?
YES____ NO____
a. If yes, will watering be used to control dust?
YES____ NO____
b. Will respirators be used to control worker exposures?
YES____ NO____

6. Will the work performed on this project involve the use of sandblasting equipment?
YES____ NO____
If yes, the subcontractor must provide and use appropriate personnel protective equipment in accordance with 1926.28. Attach a description.

7. Will the subcontractor work with asbestos?
YES____ NO____
If yes, the provisions of 1926.58 apply.

IV. FIRE PROTECTION AND PREVENTION

Will the following be available as needed?

	YES	NO
1. Fire Extinguishers located in or at—		
a. Construction offices, sheds, etc.	____	____
b. Scene of hot work, torch, welding, soldering.	____	____
c. Roofing operations (at tar pot and on roof).	____	____
d. Flammable liquid and gas storage areas.	____	____

NOTE: c and d require a fire extinguisher of 20BC as a minimum.

	YES	NO
2. No smoking signs in these areas:		
a. Flammable liquid and gas storage areas	____	____
b. Spray painting operations.	____	____
c. Equipment refueling areas.	____	____

3. Approved metal safety cans for all flammable and combustible liquids.
YES____ NO____

4. Will the subcontractor be welding or using cutting torches?
YES____ NO____
If yes, and indoors, attach a description of the ventilation system

5. A fire extinguisher rated not less than 2A shall be provided for each 3000 square feet (1926.150cc).

V. RADIATION SAFETY

1. Will radiography be performed or radioactive materials or ionizing radiation sources be used?
YES____ NO____
If yes, LLNLHealth Physics Group must be notified immediately before use. Compliance with 1910.95 and 10 CFR and CAL Title 17 is required.

SIGNATURE:_____ DATE:_____

FOR LLNL USE ONLY — Hazards Control Review of Checklist : ☐ Satisfactory ☐ Unsatisfactory

By:_____ Date:_____

Approval:

Buyer:_____ Inspector:_____ Construction Manager:_____

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C-3. References

LLNL, 1991, *Health and Safety Manual M-010, Supplement 1.11*, Contractor Safety Program, revised April 1988.

Appendix D

Operations and Maintenance Quality Assurance/Quality Control Plan

Appendix D

Operations and Maintenance Quality Assurance/Quality Control Plan

D-1. Introduction

This quality assurance/quality control (QA/QC) plan has been developed in support of the operation and maintenance of Treatment Facilities A and B (TFA and TFB) for ground water remediation in the western portion of LLNL. This plan was prepared to meet the operation and maintenance requirements of TFA and TFB using American Society of Mechanical Engineers (ASME) National Quality Assurance (NQA)-1-1989 Edition as a guideline.

The purpose of this plan is to define the quality objectives and areas of responsibility in accordance with the requirements of the operation and maintenance of TFA and TFB.

D-2. Organization

This section documents the organizational structure, the functional responsibilities, levels of authority, and lines of communications for those aspects of the operations and maintenance of TFA and TFB which affect quality.

Figure D-1 shows the organizational structure for QA activities. The descriptions below generally describe the QA responsibilities of those mainly involved in carrying out the QA program for the operations and maintenance of TFA and TFB. The LLNL Environmental Restoration Division (ERD) Livermore Site Restoration Section Leader, the Quality Assurance Manager, the Remediation Engineer, and the other individuals shown in Figure B-1 have the following responsibilities:

- The Livermore Site Restoration Section Leader (LSRSL) issues this QA plan, and periodically reviews the implementation of the QA plan. LSRSL may request an independent review or formal audit of the QA program.

- The Quality Assurance Manager (QAM) is responsible for the development and implementation of the QA plan, establishment and control of the QA document files, coordination with appropriate project personnel to assure compliance within groups over which the quality organization has no administrative control and the development of tracking and reporting systems to provide management visibility of implementation activities and results.

- The Remediation Engineer (RE) is responsible for overseeing facility start-up and monitoring its performance and operations.

- The Operations Team Leader (OTL) is responsible for the day to day maintenance and operation of ground water and soil treatment facilities. This includes scheduling required maintenance and ensuring that the maintenance requested is completed in a timely fashion.

- State Certified Analytical Laboratories using EPA methods are responsible for providing independent chemical analytical results on soil and ground water samples. For TFA and TFB, these samples are submitted as part of our self-monitoring program required by LLNL's discharge permits, in addition to operational testing samples collected prior to the

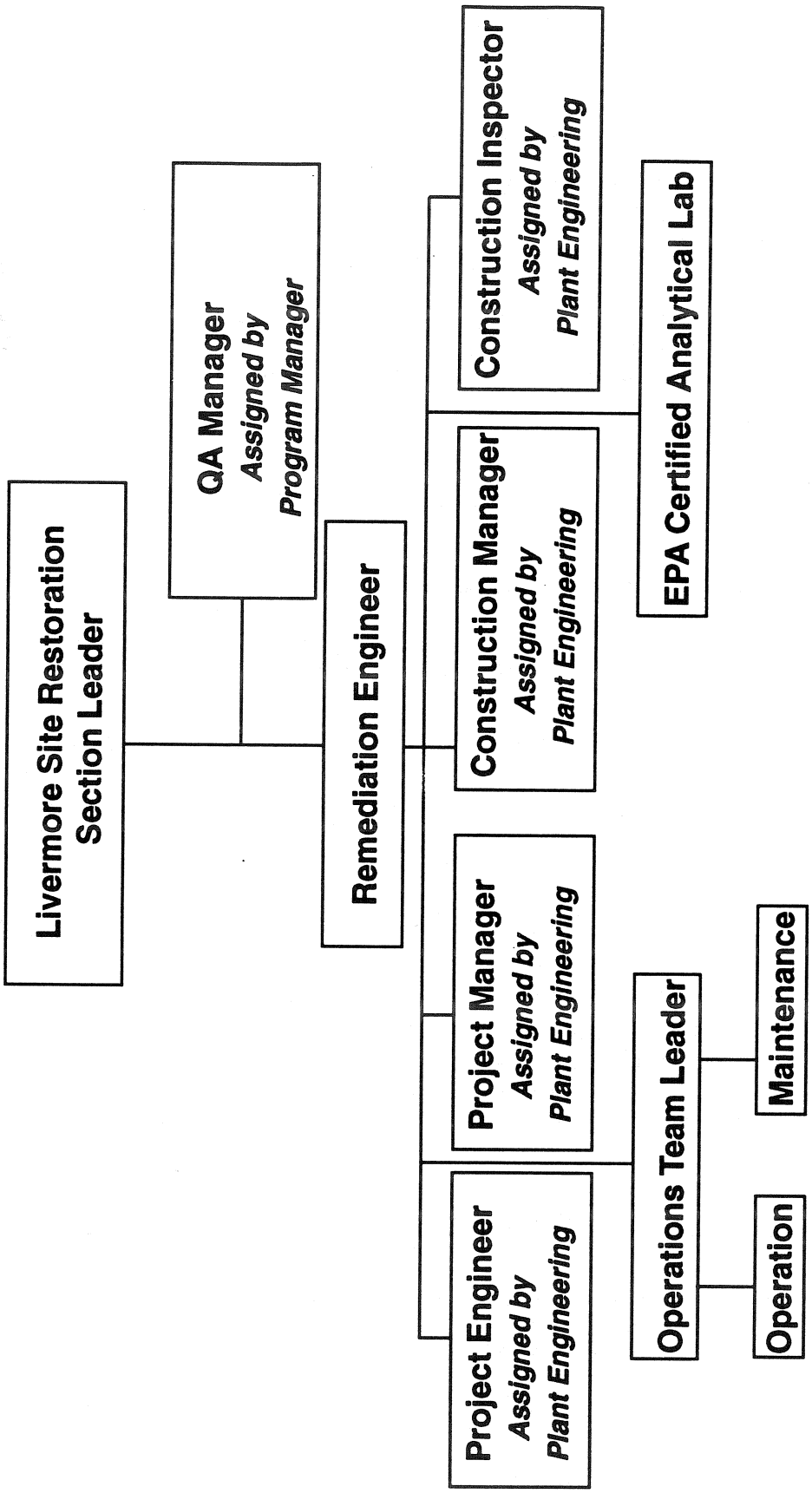

Figure D-1. Organization chart for operations and maintenance quality assurance/quality control for TFA and TFB.

official operation of a facility, and routine samples taken to evaluate facility performance.

- The LLNL Plant Engineering Project Manager (PEPM) reports to the Environmental Restoration Division (ERD) RDOSL and RE. The PEPM is responsible for approving minor technical field design changes with verbal consultation with the project engineer (PEPE) as appropriate. The PEPM is responsible for obtaining the required QA documents and placing them in the QA documents file.

- The LLNL Plant Engineering Project Engineer (PEPE) is responsible for preparing drawings and specifications to meet criteria, conducting design reviews, preparing design reports, and preparing acceptance tests.

- The Construction Manager (CM) acts as the single point contact with construction subcontractors, and reports and advises on status, projected cost and time of completion. Working in conjunction with the construction inspector, the CM protects LLNL's interest by assuring that all work is accomplished safely and in conformance with the contract documents. Reports operationally to the PEPM.

- The Construction Inspector (CI) will perform all inspector's duties as specified in the "Construction Inspector's Policy and Procedures Manual", the "Construction Manager Manual," and this QA plan.

D-3. Quality Assurance Program

This section covers objectives, quality goals, and QA levels. The procedures for implementation of QA are included in the plan or cited in the list of codes, standards, and specifications (Table D-1).

D-3.1. Objectives

The objectives of the project supported by this QA plan are:

- Assure excellence in maintenance services and operations to achieve quality.
- Provide the QA requirements to meet all programmatic and institutional needs.

This QA plan defines the process for providing confidence that these QA objectives will be achieved and that achievement will include due consideration for health, safety, property, and the environment. Table D-2 shows a list of auditable records (including responsible personnel) that are required to document compliance with the requirements of this plan. Table D-3 shows the 18 elements of NQA-1 and their applicability to the Site Restoration Section activities.

Table D-1. Applicable Codes, Specifications, and Standards for Operation and Maintenance QA for TFA and TFB.

"LLNL Procurement Manual," Vol II, Books 1, 2, and Book 4 (Construction Subcontract Manual).
"LLNL Plant Engineering Manual," Volumes 1-5, latest revision.
"LLNL Plant Engineering Drafting Manual," PEL-P-02065.
"Guidelines For In-House Design Reviews and Project Presentations," Frank Tokarz/ Roger Lake, Plant Engineering Department, Engineering/ Construction Division, LLNL, March 27, 1989 (with May 25, 1989 Rev.).
"Construction Manager Manual, Subcontracted Construction Projects," Plant Engineering Department, LLNL, W. Kleck, January, 1989.
"Construction Inspector's Policy and Procedures Manual," Plant Engineering Department, LLNL, (July, 1984).
LLNL "Health and Safety Manual" (M010-May 1991).
Electronics Engineering / Instrument Services Calibration and Certification Manual, LER 87-1007-99.
Quality Assurance Plan for Calibration Services, Engineering Measurements and Analysis Section, Engineering Sciences Division, M.E.
LLNL Management Policy Memorandum MPM 02.2 "National Environmental Policy Act (NEPA) Compliance".
DOE Order 4330.4A, Real Property Maintenance Management.
PE QA Program Plan, Rev. 1.
PE QA Manual PEL-P-01010, Rev. 0.
LLNL Environmental Protection Handbook, issued by the Environmental Protection Department.
PE Policy and Operations Manual PEL-P-01000.
PE Site 300 QA Plan, M-078-30.2, August 1990.
PE Maintenance and Operations QA Plan, M-078-30.6, September 1990.
PE Maintenance and Operations Electric Utilities QA Plan, M-078-30.10, October 1990.
PE Maintenance Services/Operations QA Plan, M-078-30.9, December 1990.
PE Maintenance and Operations Utilities QA Plan, M-078-30.7, July 1991.
PE Maintenance and Operations Maintenance Engineering and Production Control QA Plan, M-078-30.8, September 1991.
PE Maintenance and Operations Electric Utilities QA Plan, M-078-30.10, October 1991.

Table D-2. Required QA records.

QA Files	QA Record Title	Person responsible
TFA/B-2-1	Personnel Training Records	QAM
TFA/B-3-1	Design Criteria	PEPE
TFA/B-3-2	Design Calculations	PEPE
TFA/B-3-3a	Design Changes	PEPE
TFA/B-3-3b	Specifications	PEPE
TFA/B-3-4a	Drawing List	PEPM
TFA/B-3-4b	Specifications List	PEPM
TFA/B-3-6	NEPA Compliance Documents	PEPM
TFA/B-4-1	Design or Construction Purchase Orders	PEPM
TFA/B-5	Work Performance and Facility Operations log	OTL
TFA/B-6-1	As-Built Prints	CM
TFA/B-7-1	Notice of Completion	CM
TFA/B-9-1	Welder Certification	CI
TFA/B-9-2	Welding Test Reports	CI
TFA/B-9-3	Cemented Joints Test Reports	CI
TFA/B-10-1	Inspection Prints	CI
TFA/B-10-2	Final Inspection Report	CI
TFA/B-10-3	Final Acceptance Report	CI
TFA/B-18-1	Audit Requests & Reports	PEPM

Table D-3. Applicability of NQA-1 Elements to the Quality Assurance of TFA and TFB.

NQA-1 Requirement	Title	Applicable ?
Basic 1	Organization	Y
Supplement S-1	Terms and Definitions	Y
Supplement 1S-1	Supplementary Requirements for Organization	N
Basic 2	Quality Assurance Program	Y
Supplement 2S-1	Supplementary Requirements for the Qualification of Inspection and Test Personnel	N
Supplement 2S-2	Supplementary Requirements for the Qualification of Nondestructive Examination Personnel	N
Supplement 2S-3	Supplementary Requirements for the Qualification of Quality Assurance Program Audit Personnel	N
Supplement 2S-4	Supplementary Requirements for Personnel Indoctrination and Training	N
Basic 3	Design Control	Y
Supplement 3S-1	Supplementary Requirements for Design Control	N
Basic 4	Procurement Document Control	Y
Supplement 4S-1	Supplementary Requirements for Procurement Document Control	N
Basic 5	Instructions, Procedures, and Drawings	Y
Basic 6	Document Control	Y
Supplement 6S-1	Supplementary Requirements for Document Control	N
Basic 7	Control of Purchased Items and Services	Y
Supplement 7S-1	Supplementary Requirements for Control of Purchased Items and Services	N
Basic 8	Identification and Control of Items	Y
Supplement 8S-1	Supplementary Requirements for Identification and Control of Items	N
Basic 9	Control of Processes	Y
Supplement 9S-1	Supplementary Requirements for Control of Processes	N
Basic 10	Inspection	Y
Supplement 10S-1	Supplementary Requirements for Inspection	N
Basic 11	Test Control	Y
Supplement 11S-1	Supplementary Requirements for Test Control	N
Supplement 11S-2	Supplementary Requirements for Computer Program Testing	N
Basic 12	Control of Measuring and Test Equipment	Y
Supplement 12S-1	Supplementary Requirements for Control of Measuring and Test Equipment	N
Basic 13	Handling, Storage and Shipping	Y

Table D-3. Contined

NQA-1 Requirement	Title	Applicable ?
Supplement 13S-1	Supplementary Requirements for Handling Storage and Shipping	N
Basic 14	Inspection, Test and Operating Status	Y
Basic 15	Control of Nonconforming Items	Y
Supplement 15S-1	Supplementary Requirements for the Control of Nonconforming Items	N
Basic 16	Corrective Action	Y
Basic 17	Quality Assurance Records	Y
Supplement 17S-1	Supplementary Requirements for Quality Assurance Records	N
Basic 18	Audits	Y
Supplement 18S-1	Supplementary Requirements for Audits	N

D-4. Operations and Maintenance

D-4.1. Scope

TFA and TFB operate to treat ground water containing volatile organic compounds (VOCs). The ground water is treated to meet the requirements specified in California RWQCB Waste Discharge Requirement Order No. 88-075 and California RWQCB Waste Discharge Requirement Order No. 91-091 (NPDES Permit No. CA 0029289), respectively. Therefore, operations and maintenance activities at these facilities shall be controlled by quality procedures.

D-4.2. Operations

The LSRSL is responsible for ensuring the quality of operations at these facilities. The OTLs are responsible for ensuring that all field operations, including maintenance and operations are performed with the appropriate quality procedure and are completed in a timely fashion. Each treatment facility, per their respective permits, has a required Self-Monitoring Program. This involves collecting water samples for submission to State certified analytical laboratories for analysis by EPA methods. The results of these analyses are used by LLNL, EPA, RWQCB, and DTSC to monitor the performance of each treatment facility. The OTLs are responsible for ensuring that the technicians are properly trained to collect these samples according to documented procedures.

Each treatment facility has its own set of operating procedures. These procedures cover the different modes of operation including start-up and shutdown and are described in the TFA and TFB operating procedure manuals.

Daily operational logs are kept at each facility. These logs record the operating parameters of each system (i.e., temperature, pressure, etc.), the number and type of samples taken, any maintenance performed on the system and any adjustments made by the operators to the system.

D-4.3. Maintenance

Two types of maintenance are performed at the ground water treatment systems:

- Preventive
- Corrective

D-4.3.1. Preventive Maintenance

Preventive maintenance is performed on those components that need routine servicing and are part of systems related to quality. The preventive maintenance schedule is kept at each facility with the operations procedures for TFA and TFB. The OTL is responsible for ensuring that the preventive maintenance items are scheduled and completed. Maintenance is performed by the LLNL Plant Engineering Maintenance and Operations Department and follows the QA/QC manuals prepared by the PEPE to insure quality maintenance is performed.

D-4.3.2. TFA/TFB Operation and Maintenance Plan

TFA and TFB are ground water treatment facilities designed to operate on a 24 hour per day, seven days per week schedule. To keep these systems in continuous 24 hour operation, a preventive maintenance program is required.

There are two fundamental types of preventive maintenance performed at TFA and TFB; 1) preventive maintenance performed by the vendor of the LV-120 and LV-60 treatment units, Peroxidation Systems, Inc. and 2) preventive maintenance performed by LLNL.

LLNL ERD has a maintenance contract with Peroxidation Systems, Inc. This contract covers any major maintenance that needs to be performed on the units due to equipment failure. The following is a listing of some of those maintenance items covered by this contract:

- UV lamp replacement
- Rupture disc replacement
- Replenishment of H_2O_2 supply when needed
- Routine and corrective maintenance on Liquid Metronics, Inc. H_2O_2 pumps
- Replacement and/or servicing of UV lamp ballast
- Repair and/or servicing of any internal LV-120 electrical components

The major maintenance items mentioned above are performed as needed. Most of these maintenance actions occur as corrective maintenance.

The preventive maintenance performed by LLNL is set-up to keep the system operating in compliance with WDR Order No. 88-075 for TFA and WDR Order No. 91-091 (NPDES No. CA 0029289) for TFB and minimize the number of system shutdowns due to component failure. Completion of these preventive maintenance actions is recorded in the facility log by the facility operators. Table D-4 is a schedule of the preventive maintenance items performed by LLNL.

Table D-4. Preventive Maintenance at TFA/TFB.

Action	Frequency
CUNO filter changeouts	Every two months, earlier it necessary based on increased pressure differential across the filter
Clean quartz tubes	Every two weeks
Pump and blower preventive maintenance Bearing replacement Shaft balance Motor winding check Impellar blade check	Once per year
Flow rate checks on polishing system air influent manifold	Daily
Polishing tank and manifold cleanout	Once per year (sooner if required) at TFA Once per month at TFB
Carbon filter replacement	Every 36 million gallons of ground water treated
Eye wash system check	Daily
Influent and effluent pipeline integrity	Daily
Ground water sampling schedule	See WDR Order No. 88-075 (TFA) and WDR Order No. 91-091 (NPDES Permit No. CA 0029289) (TFB)
Check painted surfaces of polishing tank	Once per year or each time polishing tank is cleaned
Circuit breakers and electrical load centers	As needed

D-4.3.3. Corrective Maintenance

Corrective maintenance is performed when a system component fails or is beginning to fail and the quality of facility operations could be compromised if operation continues. Root cause analyses are performed each time a component fails before the corrective maintenance action commences. This is to ensure that the nature of the problem is understood and can be prevented. This root cause analysis is also used to modify the preventive maintenance plan where appropriate. The results of the root cause analyses are documented in the daily facility operations log. As with preventive maintenance, corrective maintenance is performed by the Plant Engineering personnel in accordance with their maintenance procedures and QA/QC plan.

All corrective maintenance actions and the time of completion are recorded in the facility daily operations log. Once complete, the specific component or system is started up and operated. This ensures that the maintenance was correctly performed and that system quality is maintained. An entry in the facility log is made indicating that an operational check was made following preventative or corrective maintenance and the performance of the new component of system is noted. If successful, the system is allowed to resume normal operations and discharge treated ground water.

D-4.4. Drawing and Specification

The PEPM is responsible for the preparation and updating of complete drawing and specification lists. The lists shall include all drawings, specifications, and changes for Purchase Order (PO) contracts, Labor Only contracts, Job Orders, and Mechanical and Electronic

Engineering Department drawings. This list will serve as the index for the QA print files and as the list of prints required in the QA files.

QA records to be filed as required in Table D-2:

(TFA/B-3-4a) A current and/or final copy of the drawing list.

(TFA/B-3-4b) A current and/or final copy of the specification list.

D-4.5. National Environmental Policy Act (NEPA)

The PEPM is responsible for assuring compliance with NEPA requirements. Completed documentation consists of LLNL Plant Engineering Form 1, NEPA Compliance Project Notification Form, and the NEPA Compliance Environmental Checklist. Memos to and from DOE and Environmental Impact Studies, as applicable, are evidence of NEPA compliance.

QA records to be filed as required in Table D-2:

(TFA/B-3-6) NEPA Compliance Documents

D-5. Procurement

D-5.1. Procurement Contracts

Preparation and approval of purchase order contracts when necessary for the purchase of equipment or services needed for maintenance shall comply with standard LLNL purchasing policies.

QA records to be filed as required in Table D-2:

(TFA/B-4-1) Copy of all material and equipment POs over $ 5,000.

D-5.2. Documents

The approval and control of procurement documents shall conform to LLNL Procurement Manual, Vol. II, Books 1, 2, and 4. The control and approval of maintenance construction drawings shall conform to LLNL Plant Engineering Drafting Manual, PEL-P-02065. Control, format, and approvals of specifications shall conform to Plant Engineering Standard PEL-P-02075, Specifications.

All drawings shall be approved for maintenance construction and have all applicable approval signatures before the bidding process, or, for LLNL construction, before the estimate process. Approvals of major changes to instructions, drawings, and specifications shall be the same as for the original issue.

Minor technical design changes made in the field shall be approved by the CM and the CI on the inspection print, and on the as-built drawings.

QA records to be filed (as required in Table D-2):

(TFA/B-6-1) One set of as-built prints for each project.

D-5.3. Control of Purchased Items and Services

Purchased items and services shall be controlled in accordance with standard LLNL Purchasing Policies. A Notice of Completion shall be prepared with all required LLNL signature

approvals, and sent to the LLNL Procurement Department before contract close-out.

QA records to be filed (as required in Table D-2).

(TFA/B-7-1) Copy of the Notice of Completion for each project.

D-5.4. Handling, Storage and Shipping

Items and materials shipped to LLNL shall be packaged, shipped, and stored according to instructions on drawings, specifications, contracts, and purchase orders. The Remediation Engineer or OTL will perform a receiving Inspection and/or the CI shall inspect incoming items and materials to identify any damage that may have ocurred during shipping and storage.

Handling equipment such as fork lifts and cranes shall be operated, maintained and tested in compliance with DOE and California State regulations. When LLNL equipment is used, compliance with the LLNL Health and Safety Manual is required.

Inspection reports are initiated and maintained per the CI's Policy and Procedures Manual. No additional QA records are required for the QA files.

D-5.5. Control of Nonconforming Items

The CI and CM shall maintain cognizance of salvage (rejected or damaged) materials and items (M&I), and arrange for segregation, and prompt disposition of LLNL supplied rejected M&I. The construction subcontractor shall be notified to immediately remove any rejected subcontractor supplied M&I from LLNL. Any nonconformance which cannot be immediately corrected and verified by the CI shall be documented on a Deficiency Notice or punch list as applicable. Nonconformances to be dispositioned as "use as is" or "repair" (as opposed to rework) must be recorded on a Deficiency Report, approved and signed by the CM.

Inspection reports are initiated and maintained per the CI's Policy and Procedures Manual. No additional QA records are required for the QA files.

D-6. Maintenance Support

D-6.1. Identification and Control of Items

Material delivered to the job site is inspected to verify compliance with the approved submittals to assure that only correct and accepted items are used or installed.

The CM will request identification and inspection of items arriving at the construction site, when required. Acceptance of items or materials not in conformance with requirements shall be approved by the RDOSL and PE, and shall comply with the LLNL Procurement Manual.

Inspection reports are initiated and maintained per the CI's Policy and Procedures Manual. No additional QA records are required for the QA files.

D-6.2. Inspection, Test, and Operating Status

The CI and CM shall maintain cognizance of incoming and stored materials and items, and inspect or test them for conformance to requirements. When the CI or CM are concerned with maintaining identification of the status of a shipment of critical materials or items, they shall tag it to ensure that untested or rejected items are not inadvertently used.

Lockout tags shall be tied on electrical equipment, lifts and hoists, valves, etc., where such items are unsafe to use, are uncertified, or to protect personnel working on the system.

Inspection reports are initiated and maintained per the CI's Policy and Procedures Manual. No additional QA records are required for the QA files.

D-6.3. Control of Processes

Procedures for welding, bonding and other processes shall be called out in specifications or drawings, as required.

When required in construction specifications, bonded joints and welding tests and inspections, and welder certifications shall be verified by the CM and the CI, as required.

QA records to be filed (as required in Table D-2):

(TFA/B-9-1) Welder certifications.

(TFA/B-9-2) Welding test reports.

(TFA/B-9-3) Cemented joints test reports.

D-6.4. Inspection

All maintenance work, and LLNL acceptances within the scope of this QA plan, including PO contract and labor contract only are subjected to inspection. Work shall be inspected and documented according to the "Construction Inspector's Policy and Procedures Manual" and the "Construction Manager Manual." The inspection team shall delay progress payments to the subcontractor if the work is not in place, or is not up to contract quality.

During construction of modifications, the CI shall maintain a set of as-built marked prints to compare with the subcontractor's prints, and shall review and approve the subcontractor's prints.

After construction the CI shall verify the accuracy of the as-built drawings in accordance with the construction inspector's policy and procedures manual. The CI and PEPM shall indicate approval of the subcontractors marked up print by signing the as built drawing.

QA records to be filed (as required in Table D-2):

(TFA/B-10-1) All Inspection Prints, with copies of Field Memos, Change Orders, calculations, and sketches attached.

(TFA/B-10-2) Final Inspection Report per Construction Manager Manual.

(TFA/B-10-3) Final Acceptance report per Construction Manager Manual.

D-6.5. Control of Measuring and Test Equipment

Certified testing laboratory subcontractors shall periodically calibrate measuring and test equipment used for LLNL work according to the requirements in the contract, and according to Federal and State codes.

D-7. Activation

D-7.1. Activation of Measuring and Testing Equipment

All measuring and test equipment (M&TE) used in acceptance testing of electronic, monitoring and interlocks systems and items shall be calibrated in accordance with the applicable LLNL calibration manual or plan. The individual conducting the test shall be responsible for assuring that all test equipment is calibrated and within its certification period.

The two major calibration laboratories at LLNL are the Engineering Measurements & Analysis Section, Engineering (ME), and the Instrument Services Group, Engineering Services Division, Electronic Engineering (EE). The ME facility typically calibrates M&TE that make pressure, force, displacement, flow, humidity, acceleration, velocity or temperature measurements. The EE facility services and calibrates M&TE that measures frequency, time, and electrical and magnetic measurements.

Calibration of M&TE may be performed by LLNL calibration laboratories or by outside vendors providing calibration services. Vendors providing calibration shall be required to meet the requirements of MIL-STD-45662, where necessary.

No additional QA records are required in QA files, but such records are filed in the EE and ME calibration facilities.

D-8. Quality Assurance Records

D-8.1. Quality Assurance Records

QA records shall be prepared, archived, and made readily available as evidence that TFA and TFB were specified, designed, constructed, operated, and maintaned to meet the quality goals of this QA plan. They shall be protected and maintained for a minimum of 6 months after completion of the project prior to being microfilmed and archived for long-term storage.

The QA records specified by this plan do not include all the project records generated in the project. In addition to the QA records, there are microfilmed records maintained by LLNL Plant Engineering, and contract records maintained by the LLNL Procurement Department. Although these records are not defined as QA records, they are available for examination if required.

D-8.2. Filing Systems

QA records required by this plan shall be filed in lockable cabinets in the order given in Table D-2. Before filing, each record shall be numbered and titled according to Table D-2, and stamped with a black ink stamp:

QA RECORD

QA PLAN NO. X-XXX-XX

DATE:_____

A file drawer insert shall be set up and labeled for each file number, and each record shall be placed in a labeled folder or binder and kept in the QAM's office. QA records are not working files, and shall not be so utilized. If files are borrowed, a file checkout system shall be used to track record location and to ensure their prompt return.

D-8.3. Plant Engineering Records

In addition to the separate QA records file of this QA plan, the PEPM, PE, CM, and CI shall organize and maintain working engineering files for the project. These files are not QA records files; they are files normally kept when required for compliance or legal purposes. Records, as specified in the CM Manual and the Construction Inspector's Manual shall be collected by the CM, CI, and the PEPE, and transmitted by the PEPM to the Standards and Documentation group of Plant Engineering for microfilming. These files shall be preserved for a period of not less than 6 years after project completion.

D-9. Audits

The PEPM shall arrange for periodic independent audits of the implementation of this QA plan.

QA records to be filed:

(TFA/B18-1) Audit requests and reports

D-10. References

1. American Society of Mechanical Engineers (ASME), 1989, NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, ASME NQA-1-1989 edition.

2. MIL - STD- 45662, "Calibration System Requirements."

Appendix E

Operations and Maintentance Health and Safety Plan

Appendix E

Operations and Maintenance Health and Safety Plan

Section E-1 of this appendix is the operations and maintenance (O&M) Health and Safety Plan (HSP) for TFA and the HSP for O&M of TFB is presented in Section E-2.

E-1. HSP for Ground Water Remediation at TFA

E-1.1. Reason for Issue

Safety procedures are required to operate the UV system, aeration system, and H_2O_2 delivery system. This HSP also serves as an administrative tool to summarize many of the requirements of the LLNL Health and Safety Manual which are pertinent to this facility operation. This HSP supplements the vendor's operating instruction manuals for the UV-LVB-120 treatment unit.

E-1.2. Work to be Done and Location of Activity

E-1.2.1.

Facility location is Building 011, located near Vasco Road and Arroyo Seco.

E-1.2.2.

Ground water containing about 200 ppb total volatile organic compounds (VOCs) to be extracted from EW-415, DSA and offsite wells utilizing submersible pumps generating 100 psi at 120 to 150 gpm maximum output.

E-1.2.3.

Influent stream pressure is reduced from 100 psi to <15 psi with an inline pressure reduction valve.

E-1.2.4.

An H_2O_2 solution concentration of 50% is injected at 20 psi into the influent stream from a 500-gallon dual containment storage tank elevating the influent stream to 100 ppm of H_2O_2.

E-1.2.5.

Oxidation of VOCs utilizing UV/photochemical process in Peroxidation Systems LVB-120, resulting in 90% to 95% destruction of total VOCs.

E-1.2.6.

Volatilization and extraction of residual VOCs uses an aeration tank to polish the effluent from the LVB-120.

E-1.2.7.

Treated ground water is discharged to the recharge basin located south of East Avenue on DOE property, or to LLNL cooling towers, or for LLNL landscape irrigation.

E-1.3. Responsibilities

E-1.3.1.

A.J. Boegel, phone number 422-7112, or LLNL pager 2264, is responsible for the safety of this operation and for assuring that all work is performed in conformance with this HSP and applicable sections of the LLNL Health and Safety Manual and Environmental Protection Handbook. In the absence of the responsible individual, Jerry Duarte 423-2638; pager 3180, shall assume these responsiblities.

E-1.3.2.

Any changes in operations that improve or do not significantly affect safety and environmental controls may be approved by the authorizing individual for this HSP and the LLNL Environmental Safety & Health (ES&H) team leader. The responsible individual will insure that this action is documented in a memorandum. Any changes in the operation that increase the hazard level, introduce additional hazards, or decrease safety shall not be made until a revision to this HSP has been reviewed and approved consistent with the review and approval process of the original HSP.

E-1.4. Hazard Analysis

E-1.4.1. Pressure Hazard

Injury may occur if LVB-120 reactor chamber rated at 25 psig is overpressurized. However, an inline 15 psi pressure relief valve prior to reactor chambers and 20 psi pressure rupture disks located at the end of each reactor chamber mitigate the overpressurization potential.

E-1.4.2. Chemical Hazard

Injury may occur from the 50% H_2O_2 solution stored in the 500-gallon-dual containment tank should eyes or skin come in contact with the solution, should ingestion occur or, should inhalation occur.

E-1.4.3. Confined Space

Injury may occur while entering, working in, and leaving the Baker tanks and the treatment

system polishing tank. Unauthorized access to the Baker tanks is controlled by removing the access ladder and securing the access with a chain and keyed lock. Unauthorized access to the polishing tank is accomplished by bolts and by attached equipment that require physical removal by two or more personnel.

E-1.4.4. Noise Hazard

E-1.4.4.1.

Injury may occur if continued exposure to the aeration system's blowers exceeds 6 hours.

E-1.4.4.2.

Injury may occur when aeration system's waste gate valve is actuated.

E-1.4.5. Electrical Hazard

Injury may occur if LVB-120 panel door is open and contact is made with energized electrical components.

E-1.5. Hazard Control

E-1.5.1. Pressure Hazard Control

A 15-psi pressure control valve is utilized, and a 20-psi pressure rupture safety disk insuring LVB-120 reactor chamber can not be overpressurized.

E-1.5.2. Chemical Hazard Control

E-1.5.2.1.

The 50% H_2O_2 solution is managed by Peroxidation System's qualified chemical handler. Therefore, facility operations personnel should not be exposed to the chemical hazard. If facility operations personnel elect to handle the 50% H_2O_2 solution, they must adhere to the following:

1. Notify the responsible individual as designated in section 3.0 of this HSP prior to start of any work activity requiring H_2O_2 solution handling.

2. Read and adhere to LLNL Health and Safety Manual sections 21, 21.05, and 21.045 and the Environmental Handbook prior to start of any work activity requiring the H_2O_2 solution handling.

E-1.5.2.2.

Follow Health and Safety Manual sections: 21, 21.05, 21.045, and any supplements that may be released related to hydrogen peroxide handling.

E-1.5.3. Confined Hazard Control

E-1.5.3.1.

Facility operators will follow Health and Safety Manual Section 26.14, Supplement 26.14, and will notify responsible individual designated in this FSP section 3.0 prior to entry into the confined space.

E-1.5.3.2.

Ladders are removed from Baker Tanks and secured with a chain and keyed lock. Key is stored in lock box in Bldg. 011.

E-1.5.3.3.

Polishing tank will remain bolted closed unless a facility operator with a second person is present.

E-1.5.4. Noise Hazard Control

E-1.5.4.1.

Noise protection is required when continuous exposure to aeration system blowers exceeds 4 hours.

E-1.5.4.2.

Noise protection is required for all personnel when the aeration system waste gate valve is actuated.

E-1.5.4.3.

Facility operator is required to follow noise safety precautions as outlined in LLNL Health and Safety Manual's Section 10.08 and Supplement 10.08.

E-1.5.5. Electrical Hazard Control

E-1.5.5.1.

Interlock system and panel doors with keyed locks prevent contact with energized electrical components. Keys to panel door locks are kept in lock box at Bldg. 011.

E-1.5.5.2.

All personnel will follow safety precautions as outlined in Health and Safety Manual sections.

E-1.6. Environmental Concerns and Controls

E-1.6.1.

Concern: H_2O_2 spill from 500-gallon storage tank.

Control: Secondary containment vessels encloses the primary 500-gallon tank.

E-1.6.2.

Concern: Discharge of untreated ground water.

Control: Interlocks will shut off flow and system if physical damage occurs.

Scheduled sampling per discharge permit monitors discharge.

Daily inspection by Facility Operator.

E-1.7. Training

E-1.7.1.

Basic Facility Operators Courses:

- HS0039, SARA/OSHA Training (40-hour course with refreshers every year).
- HS0001, New Employee Safety Orientation.
- HS1620, Standard First Aid.
- HS1640, CPR.
- HS5300, Back Care Workshop.

E-1.7.2.

Facility Operator Courses:

- HS1680–Fire Extinguisher Training.
- HS4150–Confined Space.
- HS4240–Chemical Safety.
- HS4360–Noise Safety.
- HS5030–Pressure Orientation.
- HS5210–Capacitor Safety.
- HS5220–Electrical Safety.
- HS5230–High Voltage Safety.

- HS6010–Radiation Safety.
- HS0006–Hazardous Waste Handling Practices.

E-1.7.3.

Training courses identified in this section do not qualify a person to operate the treatment equipment and treatment systems located at Bldg. 011. Only the responsible individual identified in section 1.3.1 of this HSP will determine if and when a person is qualified to operate the treatment facility at Bldg. 011. Once qualified, each technician's personnel file is updated to reflect their status as a treatment facility operator.

E-1.8. Maintenance

Items requiring periodic maintenance do not impact the safety of the operation.

E-1.9. Quality Assurance

E-1.9.1.

Scheduled weekly, monthly, quarterly, and annual sampling ensure compliance and quality.

E-1.10. Emergency Response Procedures

E-1.10.1.

In the event of an emergency, facility operations personnel will first dial "911" to report to the Emergency Dispatcher, then administer first aid if necessary to injured personnel. The Emergency Dispatcher uses reserved telephone lines to promptly relay the emergency call to the following members of the Emergency Response Team:

- Fire Department
- Security Department
- Hazards Control Safety Teams
- Plant Engineering
- Health Services

The Laboratory's Emergency Response Team will go to the scene of the emergency immediately.

During off-shift hours, the phone numbers of individuals to be notified in the event of an emergency is posted at the facility. The reference for the emergency response procedures is the LLNL Health and Safety Plan.

E-1.11. References

E-1.11.1.

Peroxidation Systems operating manual for the LVB-120 Perox-Pure System.

E-1.11.2.

Health and Safety Manual Sections:

1. LLNL General Policies and Responsibilities.
2. Work Planning and Safety Procedures.

10.08 Hearing Protection.

21. Chemicals.

21.04 Facilities and Equipment.

21.05 Handling Solid and Liquid Chemicals.

23. Electricity.

23.01 Introduction.

23.02 Biological Effects of Electrical Hazards.

23.03 Emergency Assistance and Rescue.

23.04 Personal Protective Equipment.

23.05 Design and Documentation Electrical Equipment.

23.06 Training Requirements for Electrical Work.

23.10 General Practices for Work on Electrical Equipment.

23.13 Work on Other Electrical Apparatus and Systems.

23.20 Clearances and Illumination for Electrical Enclosures.

23.21 Power Disconnect Points.

23.23 Extension Cords.

23.30 Portable Electric Tools and Equipment.

23.35 Power Supplies.

23.36 Microwave and Electromagnet Sources.

23.37 Electromagnets and Inductors.

23.38 Batteries.

23.39 Capacitors.

26.14 Working in Confined Spaces.

E-1.11.3. Health and Safety Manual Supplements

10.08 Noise–Its Measurements, Evaluation, and Control.

26.14 Working in Confined Spaces.

E-1.11.4. Environmental Protection Handbook

E-1.12. Reviewers

E-1.12.1.

Facility Supervisor.

Section Head or Group Leader.

Hazard Control Safety Team.

Individual assigned responsibility for safety.

Division/Department who authorized HSP.

Supervisor of matrixed technical personnel.

E-2. HSP for Ground Water Remediation at TFB

E-2.1. Reason for Issue

Safety procedures are required to operate the UV system, aeration system, and H_2O_2 delivery system. This HSP also serves as an administrative tool to summarize many of the requirements of the LLNL Health and Safety Manual which are pertinent to this facility operation. This HSP supplements the vendor's operating instruction manuals for the UV-LVB-60 treatment unit at TFB.

E-2.2. Work to be Done and Location of Activity

E-2.2.1.

Facility location is Building 042, located north of Mesquite Gate Drive near Vasco Road.

E-2.2.2.

Ground water containing about 200 ppb of total VOCs to be extracted from wells utilizing submersible pumps, generating 100 psi at 50 to 60 gpm maximum output.

E-2.2.3.

Influent stream pressure is reduced from 100 psi to <15 psi with an inline pressure reduction valve.

E-2.2.4

An H_2O_2 solution concentration of 50% is injected at 20 psi into the influent stream from a 300-gallon dual-containment storage tank, elevating the influent stream to 100 ppm of H_2O_2.

E-2.2.5.

VOCs are oxidized utilizing UV/photochemical process in Peroxidation System's LVB-60, resulting in 90% to 95% destruction of total VOCs.

E-2.2.6.

Residual VOCs are volatilized and extracted utilizing an aeration tank to polish the effluent from the LVB-60.

E-2.2.7.

Treated ground water is discharged to a north-flowing storm drainage ditch located west of Building 042, parallel to Vasco Road on DOE property.

E-2.3. Responsibilities

E-2.3.1.

John Ziagos, 422-5479, is responsible for the safety of this operation and for assuring that all work is performed in conformance with this HSP and applicable sections of the Health and Safety Manual and Environmental Protection Handbook. In the absence of the responsible individual, Jerry Duarte, 423-2638 or pager 3180, shall assume these responsiblities.

E-2.3.2.

Any changes in operations that improve or do not significantly affect safety and environmental controls may be approved by the authorizing individual for this HSP and the ES&H team leader. The responsible individual will insure that this action is documented in a memorandum. Any changes in the operation that increase the hazard level, introduce additional hazards, or decrease safety shall not be made until a revision to this HSP has been reviewed and approved consistent with the review and approval process of the original HSP.

E-2.4. Hazard Analysis

E-2.4.1. Pressure Hazard

Injury may occur if LVB-60 reactor chamber rated at 25 psig is overpressurized. However, an inline 15 psi pressure relief valve prior to reactor chamber and 20 psi pressure rupture disk located at the end of the reactor chamber mitigate the overpressurization potential.

E-2.4.2. Chemical Hazard

Injury may occur from the 50% H_2O_2 solution stored in the 300-gallon-dual containment tank should eyes or skin come in contact with the solution, should ingestion occur, or should inhalation occur.

E-2.4.3. Confined Space

Injury may occur while entering, working in, or leaving the Baker tanks. Unauthorized access to the Baker tanks is controlled by removing the access ladder and securing the access with a chain and keyed lock.

E-2.4.4. Noise Hazard

E-2.4.4.1.

Injury may occur if continued exposure to the aeration system's blowers exceeds 6 hours.

E-2.4.4.2.

Injury may occur when aeration system's waste gate valve is actuated.

E-2.4.5. Electrical Hazard

Injury may occur if LVB-60 panel door is open and contact is made with energized electrical components.

E-2.5 Hazard Control

E-2.5.1. Pressure Hazard Control

A 15-psi pressure control valve is utilized and a 20-psi pressure rupture safety disk insuring LVB-60 reactor chamber can not be overpressurized.

E-2.5.2. Chemical Hazard Control

E-2.5.2.1.

The 50% H_2O_2 solution is managed by the Peroxidation Systems qualifed chemical handler. Therefore, facility operations personnel should not be exposed to the chemical hazard. If facility operations personnel elect to handle the 50% H_2O_2 solution, they must adhere to the following:

1. Notify the responsible individual as designated in section 2.3.1. of this HSP prior to start of any work activity requiring H_2O_2 solution handling.

2. Read and adhere to Health and Safety Manual sections 21, 21.05, and 21.045 and the Environmental Handbook prior to start of any work activity requiring the H_2O_2 solution handling.

E-2.5.2.2.

Health and Safety Manual sections: 21, 21.05, 21.045, and any supplements that may be released related to H_2O_2 handling.

E-2.5.3. Confined Hazard Control

E-2.5.3.1.

Facility operators will follow Health and Safety Manual section 26.14, Supplement 26.14, and will notify responsible individual designated in this HSP section 3.0 prior to entry into the confined space.

E-2.5.3.2.

Ladders are removed from Baker Tanks and secured with a chain and keyed lock. Key is stored in lock box in Bldg. 042.

E-2.5.4. Noise Hazard Control

E-2.5.4.1.

Noise protection is required when continuous exposure to aeration system blowers exceeds 4 hours.

E-2.5.4.2.

Noise protection is required for all personnel when the aeration system waste gate valve is actuated.

E-2.5.4.3.

Facility operator is required to follow noise safety precautions as outlined in Health and Safety

Manual's section 10.08 and Supplement 10.08.

E-2.5.5. Electrical Hazard Control

E-2.5.5.1.

Interlock system and panel doors with keyed locks prevent contact with energized electrical components. Keys to panel door locks are kept in lock box at Bldg. 042.

E-2.5.5.2.

All personnel will follow safety precautions as outlined in Health and Safety Manual sections.

E-2.6. Environmental Concerns and Controls

E-2.6.1.

Concern: H_2O_2 spill from 300-gallon storage tank.

Control: Secondary containment vessels encloses the primary 300-gallon tank.

E-2.6.2.

Concern: Discharge of untreated ground water.

Control: Interlocks will shut off flow and system if physical damage occurs.

Scheduled sampling per discharge permit monitors discharge.

Daily inspection by Facility Operator.

E-2.7 Training

E-2.7.1. Basic Facility Operator Courses

- HS0039, SARA/OSHA Training (40 hour course with refreshers every year).
- HS0001, New Employee Safety Orientation.
- HS1620, Standard First Aid.
- HS1640, CPR.
- HS5300, Back Care Workshop.

E-2.7.2. Facility Operator Courses

- HS1680–Fire Extinguisher Training.

- HS4150–Confined Space.
- HS4240–Chemical Safety.
- HS4360–Noise Safety.
- HS5030–Pressure Orientation.
- HS5210–Capacitor Safety.
- HS5220–Electrical Safety.
- HS5230–High Voltage Safety.
- HS6010–Radiation Safety.
- HS0006–Hazardous Waste Handling Practices.

E-2.7.3.

Training courses identified in this section do not qualify a person to operate the treatment equipment and treatment systems located at Bldg. 042. Only the responsible individual identified in section 3.0 of this HSP will determine if and when a person is qualified to operate the treatment facility at Bldg. 042. Once qualified, each technician's personnel file is updated to reflect their status as a treatment facility operator.

E-2.8. Maintenance

Items requiring periodic maintenance do not impact the safety of the operation.

E-2.9. Quality Assurance

E-2.9.1.

Scheduled weekly, monthly, quarterly, and annual sampling insure compliance and quality.

E-2.10. Emergency Response Procedures

E-2.10.1.

In the event of an emergency, facility operations personnel will first dial "911" to report to the Emergency Dispatcher, then administer first aid if necessary to injured personnel. The Emergency Dispatcher uses reserved telephone lines to promptly relay the emergency call to the following members of the Emergency Response Team:

- Fire Department
- Security Department
- Hazards Control Safety Teams

- Plant Engineering
- Health Services

The Laboratory's Emergency Response Team will go to the scene of the emergency immediately.

During off-shift hours, the phone numbers of individuals to be notified in the event of an emergency is posted at the facility. The reference for the emergency response procedures is the LLNL Health and Safety Plan.

E-2.11. References

E-2.11.1.

Peroxidation Systems operating manual for the LVB-60 Perox-Pure System.

E-2.11.2. Health and Safety Manual Sections

1. LLNL General Policies and Responsibilities.

2. Work Planning and Safety Procedures.

10.08 Hearing Protection.

21. Chemicals.

21.04 Facilities and Equipment.

21.05 Handling Solid and Liquid Chemicals.

23. Electricity.

23.01 Introduction.

23.02 Biological Effects of Electrical Hazards.

23.03 Emergency Assistance and Rescue.

23.04 Personal Protective Equipment.

23.05 Design and Documentation Electrical Equipment.

23.06 Training Requirements for Electrical Work.

23.10 General Practices for Work on Electrical Equipment.

23.13 Work on Other Electrical Apparatus and Systems.

23.20 Clearances and Illumination for Electrical Enclosures.

23.21 Power Disconnect Points.

23.23 Extension Cords.

23.30 Portable Electric Tools and Equipment.

23.35 Power Supplies.

23.36 Microwave and Electromagnetic Sources.

23.37 Electromagnets and Inductors.

23.38 Batteries.

23.39 Capacitors.

26.14 Working in Confined Spaces.

E-2.11.3. Health and Safety Manual Supplements

10.08 Noise–Its Measurements, Evaluation, and Control.

26.14 Working in Confined Spaces.

E-2.11.4. Environment Protection Handbook

E-2.12. Reviewers

E-2.12.1.

Facility Supervisor.

Section Head or Group Leader.

Hazard Control Safety Team.

Individual assigned responsibility for safety.

Division/Department who authorized HSP.

Supervisor of matrixed technical personnel.