# Phase II Site Characterization Report for the LEHR Environmental Restoration University of California at Davis

## Volume I

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PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION
FOR
U.S. DEPARTMENT OF ENERGY

## TABLE OF CONTENTS


| SECTION | PAGE |
|---|---|
| 1.0 INTRODUCTION | 1.1 |
| 1.1 PRE-1990 SCREENING AND CHARACTERIZATION | 1.1 |
| 1.2 PHASE II SOIL AND GROUNDWATER CHARACTERIZATION | 1.3 |
| 1.2.1 Scope | 1.3 |
| 1.2.2 Objectives | 1.3 |
| 1.2.3 Data Quality Objectives, Uses, and Limitation | 1.4 |
| 1.3 PLANNED SOIL AND GROUNDWATER INVESTIGATION | 1.4 |
| 1.4 QUALITY ASSURANCE | 1.4 |
| 1.5 HEALTH AND SAFETY | 1.5 |
| 1.6 ORGANIZATION OF REPORT | 1.5 |
| 2.0 BACKGROUND | 2.1 |
| 2.1 SITE DESCRIPTION | 2.1 |
| 2.1.1 Nearby Groundwater Wells | 2.4 |
| 2.2 HISTORY OF OPERATIONS | 2.10 |
| 2.3 POTENTIAL ENVIRONMENTAL IMPACTS | 2.11 |
| 2.3.1 Waste Systems | 2.11 |
| 2.3.2 Domestic Septic Tanks | 2.18 |
| 2.3.3 Chemical Dispensing Area | 2.18 |
| 2.3.4 Waste Burial | 2.18 |
| 2.3.5 Landfill Units | 2.20 |
| 2.3.6 Dog Pen Area | 2.24 |
| 2.3.7 Stormwater and Dry Wells | 2.24 |
| 2.3.8 Wastewater Treatment Plant | 2.25 |
| 2.3.9 Other Disposal Areas | 2.25 |
| 2.4 PHYSICAL SETTING | 2.26 |
| 2.4.1 Topography | 2.26 |
| 2.4.2 Geology | 2.26 |
| 2.4.2.1 Regional Geologic Setting | 2.27 |
| 2.4.2.2 Site Geology | 2.30 |
| 2.4.3 Hydrogeology | 2.34 |
| 2.4.3.1 Regional Hydrogeology | 2.34 |
| 2.4.3.2 Site Hydrogeology | 2.34 |
| 2.4.3.3 Local Groundwater Elevations and Gradients | 2.35 |
| 2.4.3.4 Groundwater Flow Rates | 2.35 |

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION

TABLE OF CONTENTS (Continued)

**SECTION** **PAGE**


2.4.4 Surface Water . . . . . 2.35
2.4.5 Meteorology . . . . . 2.36
2.4.6 Environmental Resources . . . . . 2.37
2.4.6.1 Land Use . . . . . 2.40
2.4.6.2 Special Status Species . . . . . 2.40
2.5 HUMAN RESOURCES . . . . . 2.40

3.0 PREVIOUS INVESTIGATIONS . . . . . 3.1
3.1 INITIAL ASSESSMENT SURVEY . . . . . 3.1
3.2 ENVIRONMENTAL SURVEY PRELIMINARY REPORT . . . . . 3.3
3.3 PHASE I INVESTIGATION . . . . . 3.3
3.4 EVALUATION OF ON-SITE WELLS . . . . . 3.4
3.5 SOLID WASTE ASSESSMENT TEST . . . . . 3.4
3.6 CONTAMINANT PATHWAY ANALYSIS . . . . . 3.5
3.7 EVALUATION OF POTENTIAL NITRATE AND HEXAVALENT CHROMIUM SOURCES . . . . . 3.5
3.8 PUTAH CREEK SEDIMENT AND WATER SAMPLING . . . . . 3.5
3.9 WASTE BURIAL TRENCH INVESTIGATION LEHR FACILITY . . . . . 3.6
3.10 CEQA PRELIMINARY ENVIRONMENTAL STUDY FOR SITE CHARACTERIZATION . . . . . 3.6
3.11 OLD UC DAVIS LANDFILL ADDITIONAL CHARACTERIZATION . . 3.7

4.0 RATIONALE AND APPROACH . . . . . 4.1
4.1 RATIONALE . . . . . 4.1
4.1.1 Review of Operable Unit . . . . . 4.1
4.1.2 Groundwater Contamination . . . . . 4.4
4.2 APPROACH . . . . . 4.5
4.2.1 Use of Existing Data . . . . . 4.5
4.2.2 Collect Data Only for Specific Needs . . . . . 4.6
4.2.3 Site-Specific Investigation . . . . . 4.6
4.2.4 Phased Investigation . . . . . 4.6
4.2.5 Specific Data Needs . . . . . 4.7
4.2.6 Data Quality Objectives . . . . . 4.7
4.2.7 Investigation Methodologies . . . . . 4.13
4.2.8 Data Evaluation Methodologies . . . . . 4.19
4.2.9 Minimizing Generation of Wastes . . . . . 4.22
4.2.10 Deviation from Work Plan . . . . . 4.23

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION

TABLE OF CONTENTS (Continued)

SECTION PAGE


5.0 PHASE II INVESTIGATION . . . . . 5.1
5.1 WBS 302 — LITERATURE REVIEW AND SURVEYING . . . . . 5.3
5.1.1 Literature Review . . . . . 5.3
5.1.2 Surveying . . . . . 5.4
5.2 WBS 303 — MONITORING WELL INSTALLATION AND SAMPLING . . . . . 5.4
5.2.1 Well Drilling . . . . . 5.7
5.2.2 Soil Sampling from Monitoring Well Borings . . . . . 5.9
5.2.3 Physical Testing . . . . . 5.9
5.2.4 Soil Sample Chemical Analysis . . . . . 5.9
5.2.5 Well Construction . . . . . 5.11
5.2.6 Well Construction Materials . . . . . 5.11
5.3 WBS 303 — GROUNDWATER SAMPLING . . . . . 5.12
5.3.1 Groundwater Sample Collection . . . . . 5.12
5.3.2 Groundwater Sample Analysis . . . . . 5.13
5.4 WBS 303 — SURFACE WATER SAMPLING . . . . . 5.13
5.4.1 Surface Water Sample Collection . . . . . 5.15
5.4.2 Surface Water Sample Analysis . . . . . 5.15
5.5 WBS 304 — SOIL BORINGS AND SAMPLING . . . . . 5.15
5.5.1 Deep Borings . . . . . 5.16
5.5.2 Intermediate Borings . . . . . 5.20
5.5.3 Shallow Soil Borings . . . . . 5.20
5.6 WBS 304 — SEDIMENT SAMPLING . . . . . 5.24
5.7 WBS 305 — DOMESTIC SEPTIC TANK INVESTIGATION . . . . . 5.24
5.8 WBS 306 — AQUIFER ANALYSIS . . . . . 5.27
5.8.1 Slug Tests and Analyses . . . . . 5.27
5.8.2 Aquifer Pumping Test . . . . . 5.29
5.8.3 Groundwater Modeling . . . . . 5.29
5.9 WBS 308 - WASTE CHARACTERIZATION . . . . . 5.32

6.0 FINDINGS . . . . . 6.1
6.1 STRATIGRAPHY . . . . . 6.1
6.1.1 Surface Soils . . . . . 6.1
6.1.2 Subsurface Profile . . . . . 6.6
6.2 HYDROGEOLOGY . . . . . 6.12
6.2.1 HSUs . . . . . 6.12

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION

TABLE OF CONTENTS (Continued)

**SECTION** **PAGE**


6.2.2 Groundwater Levels . . . . . 6.12
6.2.3 Hydraulic Gradients . . . . . 6.14
6.2.3.1 Vertical Gradient . . . . . 6.16
6.2.3.2 Lateral Gradient . . . . . 6.18
6.2.4 Hydraulic Conductivity . . . . . 6.20
6.3 SURFACE WATER . . . . . 6.24
6.4 CHEMICAL ANALYSIS . . . . . 6.27
6.4.1 Soil Sample Chemical Analyses . . . . . 6.27
6.4.1.1 Background . . . . . 6.31
6.4.1.2 Northern Area Downgradient (UCD-16, -19) . . . 6.36
6.4.1.3 Strontium-90 Leach Field . . . . . 6.42
6.4.1.4 Radium-226 Dry Well Area . . . . . 6.48
6.4.1.5 Southwest Chemical Dispensing Area (SB-19,19A,20,21/UCD-15) . . . . . 6.56
6.4.1.6 Dog Pen Areas, LEHR . . . . . 6.63
6.4.1.7 North Chemical Dispensing Area . . . . . 6.77
6.4.1.8 Old AEC Project Site, Main UC Davis Campus . . 6.82
6.4.2 Sediment Sample Chemical Analysis . . . . . 6.85
6.4.2.1 Wastewater Treatment Plant Outfall . . . . . 6.85
6.4.2.2 Lift Station . . . . . 6.89
6.4.2.3 Domestic Septic Tanks . . . . . 6.90
6.4.3 Surface Water Sample Analysis . . . . . 6.90
6.4.3.1 Fall Quarter, November 1990 . . . . . 6.90
6.4.3.2 Winter Quarter, February 1991 . . . . . 6.93
6.4.3.3 Spring Quarter, May 1991 . . . . . 6.97
6.4.3.4 Summer Quarter, August 1991 . . . . . 6.101
6.4.3.5 Fall Quarter, November 1991 . . . . . 6.105
6.4.4 Groundwater Sample Analysis . . . . . 6.111
6.4.4.1 Fall Quarter, November 1990 . . . . . 6.114
6.4.4.2 Winter Quarter, February 1991 . . . . . 6.120
6.4.4.3 Spring Quarter, May 1991 . . . . . 6.127
6.4.4.4 Summer Quarter, August 1991 . . . . . 6.135
6.4.4.5 Fall Quarter, November 1991 . . . . . 6.139
6.4.5 Statistical Analysis . . . . . 6.145
6.4.5.1 Statistical Analysis of Soil Data . . . . . 6.145
6.4.5.2 Statistical Analysis of Groundwater Data . . . . 6.150
6.5 GROUNDWATER MODEL RESULTS . . . . . 6.151

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION

TABLE OF CONTENTS (Continued)

SECTION PAGE


6.4.5 Statistical Analysis . . . . . 6.145
6.4.5.1 Statistical Analysis of Soil Data . . . . . 6.145
6.4.5.2 Statistical Analysis of Groundwater Data . . . . 6.150
6.5 GROUNDWATER MODEL RESULTS . . . . . 6.151
6.5.1 Data Description . . . . . 6.151
6.5.1.1 Recharge from Irrigation and Evapotranspiration 6.152
6.5.1.2 Boundary Conditions . . . . . 6.152
6.5.2 Flow Model Results . . . . . 6.154

7.0 DISCUSSION . . . . . 7.1
7.1 STRATIGRAPHY . . . . . 7.1
7.2 HYDROGEOLOGIC MODEL . . . . . 7.2
7.3 DISTRIBUTION OF CHEMICALS AND RADIONUCLIDES IN SOILS AND GROUNDWATER . . . . . 7.5
7.3.1 Chemical Mobility . . . . . 7.5
7.3.2 Distribution of Chemicals in Soils . . . . . 7.8
7.3.2.1 General Parameters . . . . . 7.8
7.3.2.2 Organic Compounds in Soils . . . . . 7.10
7.3.2.3 Metals . . . . . 7.11
7.3.2.4 Radionuclides in Soils . . . . . 7.13
7.3.3 Distribution of Chemicals in Groundwater . . . . . 7.18
7.3.3.1 General Inorganic Parameters . . . . . 7.18
7.3.3.2 Metals . . . . . 7.28
7.3.3.3 Organics . . . . . 7.36
7.3.3.4 Radionuclides . . . . . 7.42
7.3.4 Distribution of Chemicals in Surface Water . . . . . 7.44
7.3.4.1 General Inorganic Parameters . . . . . 7.44
7.3.4.2 Metals . . . . . 7.45
7.3.4.3 Organics . . . . . 7.47
7.3.4.4 Radionuclides . . . . . 7.47
7.3.5 Summary . . . . . 7.48

8.0 SUMMARY AND CONCLUSIONS . . . . . 8.1
8.1 SUMMARY . . . . . 8.1
8.2 CONCLUSIONS . . . . . 8.6

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION

TABLE OF CONTENTS (Continued)

SECTION PAGE


8.2.1 Soils . . . . . 8.6
8.2.1.1 Organic Compounds . . . . . 8.6
8.2.1.2 Metals . . . . . 8.7
8.2.1.3 Nitrate . . . . . 8.7
8.2.1.4 Radionuclides . . . . . 8.8
8.2.2 Hydrostratigraphy . . . . . 8.9
8.2.3 Groundwater . . . . . 8.9
8.2.3.1 Organic Compounds . . . . . 8.9
8.2.3.2 General Inorganic Parameters . . . . . 8.10
8.2.3.3 Metals . . . . . 8.11
8.2.3.4 Radionuclides . . . . . 8.12
8.2.4 Surface Water . . . . . 8.12
8.2.4.1 Organic Compounds . . . . . 8.12
8.2.4.2 General Inorganic Parameters . . . . . 8.13
8.2.4.3 Metals . . . . . 8.13
8.2.4.4 Radionuclides . . . . . 8.13

9.0 RECOMMENDATIONS . . . . . 9.1

10.0 REFERENCES CITED . . . . . 10.3

TABLE OF CONTENTS (Continued)

TABLE PAGE

## LIST OF TABLES

TABLE 2.1 LIST OF UC DAVIS FACILITIES ADJACENT TO LEHR . . . . . 2.5
TABLE 2.2 SUMMARY OF WELLS NEAR LEHR FACILITY . . . . . 2.8
TABLE 2.3 WASTEWATER TABULATION — IMHOFF TREATMENT SYSTEM 2.14
TABLE 2.4 LEHR RADIOACTIVE WASTE BURIAL DATA . . . . . 2.21
TABLE 2.5 SPECIAL STATUS SPECIES — NEAR SOUTH FORK OF PUTAH CREEK . . . . . 2.41
TABLE 3.1 SUMMARY OF PREVIOUS INVESTIGATIONS . . . . . 3.2
TABLE 4.1 COMPARISON OF PHASE II DATA TO CERCLA RI/FS REQUIREMENTS . . . . . 4.8
TABLE 4.2 EPA ANALYTICAL SUPPORT LEVELS . . . . . 4.14
TABLE 4.3 APPROPRIATE ANALYTICAL LEVELS — BY DATA USE . . . . . 4.15
TABLE 4.4 SUMMARY TABLE OF DATA OBJECTIVES . . . . . 4.16
TABLE 5.1 COMPLETION SCHEDULE . . . . . 5.2
TABLE 5.2 SUMMARY OF MONITORING WELLS . . . . . 5.8
TABLE 5.3 SUMMARY OF MONITORING WELL — SOIL SAMPLING . . . . . 5.10
TABLE 5.4 INTERMEDIATE AND DEEP SOIL BORING SAMPLE DEPTHS AND ANALYTICAL REQUESTS . . . . . 5.19
TABLE 5.5 SUMMARY OF LEHR DOG PEN SAMPLES AND ANALYTICAL REQUESTS . . . . . 5.21
TABLE 5.6 SOIL SAMPLE ANALYSIS — OLD AEC PROJECT SITE, MAIN CAMPUS . . . . . 5.23
TABLE 5.7 SEDIMENT SAMPLES AND ANALYTICAL REQUESTS . . . . . 5.25
TABLE 5.8 WELL-CONSTRUCTION DATA USED FOR SLUG TEST INTERPRETATION . . . . . 5.28
TABLE 5.9 MODEL INPUT PARAMETERS . . . . . 5.30
TABLE 6.1 VERTICAL GRADIENTS FOR WELL PAIRS . . . . . 6.17
TABLE 6.2 SLUG TEST RESULTS . . . . . 6.22
TABLE 6.3 UC DAVIS WASTEWATER TREATMENT PLANT — AVERAGE DAILY EFFLUENT FLOW . . . . . 6.26
TABLE 6.4 SOIL SAMPLE ANALYSIS — BACKGROUND AREA . . . . . 6.32
TABLE 6.5 SUMMARY OF DETECTIONS IN BACKGROUND AREA SOIL SAMPLES . . . . . 6.33
TABLE 6.6 SUMMARY OF BACKGROUND CONCENTRATIONS . . . . . 6.35
TABLE 6.7 SOIL SAMPLE ANALYSIS — NORTHERN AREA DOWNGRADIENT OF LEHR . . . . . 6.38

TABLE OF CONTENTS (Continued)

TABLE PAGE

TABLE 6.8 SUMMARY OF DETECTIONS IN NORTHERN AREA DOWNGRADIENT OF LEHR . . . . . 6.39
TABLE 6.9 SOIL SAMPLE ANALYSIS — STRONTIUM-90 LEACHFIELD . . . 6.43
TABLE 6.10 SUMMARY OF DETECTIONS IN STRONTIUM-90 LEACH FIELD SOILS . . . . . 6.44
TABLE 6.11 SOIL SAMPLE ANALYSIS — RADIUM 226 DRY WELL AREA . . 6.49
TABLE 6.12 SUMMARY OF DETECTIONS IN RADIUM-226 DRY WELL AREA . . . . . 6.50
TABLE 6.13 SOIL SAMPLE ANALYSIS — SOUTHWEST CHEMICAL DISPENSING AREA . . . . . 6.57
TABLE 6.14 SUMMARY OF DETECTIONS IN SOUTHWEST CHEMICAL DISPENSING AREA . . . . . 6.59
TABLE 6.15 SOIL SAMPLE — DOG PEN AREAS, LEHR . . . . . 6.64
TABLE 6.16 SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS . . . . . 6.65
TABLE 6.17 SOIL SAMPLE ANALYSIS — NORTH CHEMICAL DISPENSING AREA . . . . . 6.78
TABLE 6.18 DETECTIONS IN NORTH CHEMICAL DISPENSING AREA SOIL SAMPLES . . . . . 6.79
TABLE 6.19 SOIL SAMPLE ANALYSIS — OLD AEC PROJECT SITE, MAIN CAMPUS . . . . . 6.83
TABLE 6.20 SUMMARY OF DETECTIONS IN OLD AEC PROJECT SITE — MAIN UC DAVIS CAMPUS SOIL SAMPLES . . . . . 6.84
TABLE 6.21 SEDIMENT SAMPLES ANALYSIS . . . . . 6.87
TABLE 6.22 SUMMARY OF DETECTIONS IN SEDIMENT SAMPLES . . . . . 6.88
TABLE 6.23 SUMMARY OF SURFACE WATER DETECTIONS — FALL QUARTER, NOVEMBER 1990 . . . . . 6.91
TABLE 6.24 GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES — FALL 1990 . . . . . 6.94
TABLE 6.25 SUMMARY OF DETECTIONS IN SURFACE WATER — WINTER QUARTER, FEBRUARY 1991 . . . . . 6.95
TABLE 6.26 GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES — WINTER 1991 . . . . . 6.98
TABLE 6.27 SUMMARY OF DETECTIONS IN SURFACE WATER — SPRING QUARTER, MAY 1991 . . . . . 6.100
TABLE 6.28 GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES — SPRING 1991 . . . . . 6.102

TABLE OF CONTENTS (Continued)

TABLE PAGE

TABLE 6.29 SUMMARY OF DETECTIONS IN SURFACE WATER — SUMMER QUARTER, AUGUST 1991 . . . . . 6.104
TABLE 6.30 GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES — SUMMER 1991 . . . . . 6.106
TABLE 6.31 SUMMARY OF DETECTIONS IN SURFACE WATER — FALL QUARTER, NOVEMBER 1991 . . . . . 6.108
TABLE 6.32 REPORTED CONCENTRATION RANGES FOR GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES — FALL 1991 . . . . . 6.110
TABLE 6.33 GROUNDWATER SAMPLING SCHEDULE . . . . . 6.112
TABLE 6.34 SUMMARY OF DETECTIONS IN GROUNDWATER — FALL QUARTER, NOVEMBER 1990 . . . . . 6.116
TABLE 6.35 GROUNDWATER CHEMICAL PARAMETERS . . . . . 6.121
TABLE 6.36 SUMMARY OF DETECTIONS IN GROUNDWATER — WINTER QUARTER, FEBRUARY 1991 . . . . . 6.122
TABLE 6.37 GENERAL CHEMICAL PARAMETERS — GROUNDWATER — WINTER QUARTER, FEBRUARY 1991 . . . . . 6.128
TABLE 6.38 SUMMARY OF DETECTIONS IN GROUNDWATER — SPRING QUARTER, MAY 1991 . . . . . 6.130
TABLE 6.39 GENERAL CHEMICAL — GROUNDWATER — SPRING QUARTER, MAY 1991 . . . . . 6.134
TABLE 6.40 SUMMARY OF DETECTIONS IN GROUNDWATER — SUMMER QUARTER, AUGUST 1991 . . . . . 6.136
TABLE 6.41 GENERAL CHEMICAL PARAMETERS — GROUNDWATER — SUMMER QUARTER, AUGUST 1991 . . . . . 6.140
TABLE 6.42 SUMMARY OF DETECTIONS IN GROUNDWATER — FALL QUARTER, NOVEMBER 1991 . . . . . 6.141
TABLE 6.43 GENERAL CHEMICAL PARAMETERS — GROUNDWATER — FALL QUARTER, NOVEMBER 1991 . . . . . 6.146
TABLE 6.44 AVERAGE CONCENTRATIONS VS. 95% UPPER CONFIDENCE LIMIT . . . . . 6.148
TABLE 7.1 ADSORPTION AND DEGRADATION OF SELECTED ORGANIC COMPOUNDS . . . . . 7.12
TABLE 7.2 CHARACTERISTICS OF SELECTED RADIONUCLIDES . . . . . 7.14
TABLE 7.3 CONCENTRATIONS OF METALS IN GROUNDWATER . . . . . 7.29
TABLE 7.4 SUMMARY OF DETECTIONS OF METALS IN GROUNDWATER NOVEMBER, 1990 TO NOVEMBER 1991 . . . . . 7.32

TABLE OF CONTENTS (Continued)

TABLE PAGE

TABLE 7.5 SUMMARY OF DETECTIONS OF ORGANIC COMPOUNDS IN GROUNDWATER NOVEMBER, 1990 TO NOVEMBER 1991 . . . . . 7.41
TABLE 7.6 SUMMARY OF MEASUREMENTS OF RADIONUCLIDE ACTIVITY IN GROUNDWATER NOVEMBER, 1990 TO NOVEMBER 1991 . . . . . 7.43
TABLE 7.7 SUMMARY OF METALS DETECTIONS IN SURFACE WATER — NOVEMBER 1990 THROUGH NOVEMBER 1991 . . . . . 7.46

TABLE OF CONTENTS (Continued)

FIGURE PAGE

## LIST OF FIGURES

FIGURE 1.1 SITE LOCATION MAP . . . . . 1.2
FIGURE 2.1 SITE VICINITY MAP . . . . . 2.2
FIGURE 2.2 SITE STRUCTURES . . . . . 2.3
FIGURE 2.3 UC DAVIS FACILITIES ADJACENT TO LEHR . . . . . 2.6
FIGURE 2.4 GROUNDWATER WELLS NEAR LEHR FACILITY . . . . . 2.7
FIGURE 2.5 SCHEMATIC REPRESENTATION OF THE IMHOFF TREATMENT SYSTEM . . . . . 2.12
FIGURE 2.6 LOCATION OF THE IMHOFF AND RADIUM-226 TREATMENT SYSTEMS . . . . . 2.15
FIGURE 2.6A CONSTRUCTION DETAILS OF THE RADIUM-226 VERTICAL DRY WELLS . . . . . 2.16
FIGURE 2.7 FORMER WASTE DISPOSAL AREAS . . . . . 2.17
FIGURE 2.8 LOCATION OF DOMESTIC SEPTIC TANKS . . . . . 2.19
FIGURE 2.9 REGIONAL GEOLOGIC MAP . . . . . 2.28
FIGURE 2.10 REGIONAL GEOLOGIC CROSS SECTION A-A´ . . . . . 2.29
FIGURE 2.11 DISTRIBUTION OF SURFACE SOILS IN SITE VICINITY . . . . . 2.31
FIGURE 2.11A EXPLANATION OF SURFACE SOIL SYMBOLS . . . . . 2.32
FIGURE 2.12 GEOLOGIC CROSS SECTION B-B´ . . . . . 2.33
FIGURE 2.13 MEAN MONTHLY PRECIPITATION - DAVIS 2 WSW STATION 2.38
FIGURE 2.14 DAILY PRECIPITATION . . . . . 2.39
FIGURE 4.1 LEHR FACILITY . . . . . 4.3
FIGURE 4.2 RELATIVE PERCENTAGE DIFFERENCE OF BLIND DUPLICATE ANALYSES . . . . . 4.21
FIGURE 5.1A GROUNDWATER MONITORING WELL LOCATION MAP FIRST HSU WELLS . . . . . 5.5
FIGURE 5.1B GROUNDWATER MONITORING WELL LOCATION MAP SECOND HSU WELLS . . . . . 5.6
FIGURE 5.2 LOCATION MAP — SURFACE WATER AND SEDIMENT SAMPLES . . . . . 5.14
FIGURE 5.3 LOCATION MAP OF DEEP, INTERMEDIATE, AND SHALLOW SOIL BORINGS AT LEHR . . . . . 5.17
FIGURE 5.4 SHALLOW SOIL BORING LOCATIONS AT AEC PROJECT SITE, MAIN UC DAVIS CAMPUS . . . . . 5.18
FIGURE 5.5 APPROXIMATE LOCATIONS OF DOMESTIC SEPTIC TANKS . . 5.26

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION

TABLE OF CONTENTS (Continued)

FIGURE PAGE

FIGURE 5.6 NUMERICAL MODEL SET-UP, GRID ORIENTATION AND BOUNDARY CONDITIONS . . . . . 5.31
FIGURE 6.1 GROUNDWATER MONITORING WELL LOCATION MAP . . . . . 6.2
FIGURE 6.2 LOCATION MAP OF DEEP, INTERMEDIATE, AND SHALLOW SOIL BORINGS AT LEHR . . . . . 6.3
FIGURE 6.3 SURFACE SOILS IN LEHR VICINITY . . . . . 6.4
FIGURE 6.3A EXPLANATION FOR SURFACE SOIL MAP . . . . . 6.5
FIGURE 6.4 STRATIGRAPHIC CROSS SECTION A-A´ . . . . . 6.7
FIGURE 6.5 STRATIGRAPHIC CROSS SECTION B-B´ . . . . . 6.8
FIGURE 6.6 STRATIGRAPHIC CROSS SECTION C-C´ . . . . . 6.9
FIGURE 6.7 STRATIGRAPHIC CROSS SECTION D-D´ . . . . . 6.10
FIGURE 6.8 LOCATION MAP OF STRATIGRAPHIC SECTIONS . . . . . 6.11
FIGURE 6.9 HYDROGRAPHS FOR UCD-13 AND UCD-14 . . . . . 6.13
FIGURE 6.10 HYDROGRAPHS FOR UCD-4 AND UCD-15 . . . . . 6.15
FIGURE 6.11 GROUNDWATER ELEVATION CONTOUR MAP FOR THE FIRST HSU ON FEBRUARY 1, 1991 . . . . . 6.19
FIGURE 6.12 GROUNDWATER ELEVATION CONTOUR MAP FOR SECOND HSU ON FEBRUARY 1, 1991 . . . . . 6.21
FIGURE 6.13 PUTAH CREEK FLOWS - 1989-1992 . . . . . 6.25
FIGURE 6.14A AREAS OF INTEREST AT LEHR . . . . . 6.29
FIGURE 6.14B OLD AEC PROJECT SITE . . . . . 6.30
FIGURE 6.15 LOCATION MAP — SURFACE WATER AND SEDIMENT SAMPLES . . . . . 6.86
FIGURE 6.16 LOCATION MAP — GROUNDWATER MONITORING WELLS . 6.113
FIGURE 6.17 NUMERICAL MODEL SETUP, GRID ORIENTATION AND BOUNDARY CONDITIONS . . . . . 6.154
FIGURE 6.18 COMPARISON OF WATER LEVELS - FIRST HYDROSTRATIGRAPHIC UNIT FOR UCD-10 AND UCD-18 . . . . . 6.156
FIGURE 6.19 COMPARISON OF WATER LEVELS - SECOND HYDROSTRATIGRAPHIC UNIT FOR UCD-16 AND UCD-17 . . . . . 6.157
FIGURE 6.20 SIMULATED WATER LEVELS - FIRST AND SECOND HYDROSTRATIGRAPHIC UNITS FOR UCD-4 AND UCD-15 . . . . . 6.158
FIGURE 6.21 SIMULATED WATER LEVELS - FIRST HYDROSTRATIGRAPHIC UNIT, YEAR 20, END OF PUMPING . . . . . 6.159
FIGURE 6.22 SIMULATED WATER LEVELS - SECOND HYDROSTRATIGRAPHIC UNITS, YEAR 20, END OF PUMPING . . . . 6.160

TABLE OF CONTENTS (Continued)

FIGURE PAGE

FIGURE 7.1 GROUNDWATER CONCENTRATION CONTOURS — FIRST HYDROSTRATIGRAPHIC UNIT — TOTAL DISSOLVED SOLIDS ..... 7.20
FIGURE 7.2 GROUNDWATER CONCENTRATION CONTOURS — SECOND HYDROSTRATIGRAPHIC UNIT — TOTAL DISSOLVED SOLIDS ..... 7.21
FIGURE 7.3 TDS vs $NO^3$-N GROUNDWATER SAMPLES — NOVEMBER 1990 - NOVEMBER 1991 ..... 7.23
FIGURE 7.4 GROUNDWATER CONCENTRATION CONTOURS — FIRST HYDROSTRATIGRAPHIC UNIT — NITRATE AS N ..... 7.24
FIGURE 7.5 GROUNDWATER CONCENTRATION CONTOURS — SECOND HYDROSTRATIGRAPHIC UNIT — NITRATE AS N ..... 7.26
FIGURE 7.6 TOTAL Cr VS CrVI GROUNDWATER SAMPLES — NOVEMBER 1990 - NOVEMBER 1991 ..... 7.38
FIGURE 7.7 GROUNDWATER CONCENTRATION CONTOURS — FIRST HYDROSTRATIGRAPHIC UNIT — TOTAL CHROMIUM ..... 7.39
FIGURE 7.8 GROUNDWATER CONCENTRATION CONTOURS — SECOND HYDROSTRATIGRAPHIC UNIT — TOTAL CHROMIUM ..... 7.40

## LIST OF APPENDICES

**VOLUME II:**

| | |
|---|---|
| APPENDIX A | FIELD PROCEDURES |
| APPENDIX B | QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES |
| APPENDIX C | BORING AND CPT WELL LOGS |
| APPENDIX D | GROUNDWATER LEVEL DATA AND HYDROGRAPHS FOR LEHR MONITORING WELLS |
| APPENDIX E | FIELD DOCUMENTATION |

**VOLUME III:**

| | |
|---|---|
| APPENDIX F | ANALYTICAL DATA TABLES FOR SOIL AND SEDIMENT SAMPLES |
| APPENDIX G | ANALYTICAL DATA TABLES FOR GROUNDWATER SAMPLES |
| APPENDIX H | ANALYTICAL DATA TABLES FOR SURFACE WATER SAMPLES |
| APPENDIX I | GROUNDWATER CONTOUR MAPS |
| APPENDIX J | PHYSICAL SOIL DATA |
| APPENDIX K | SLUG TEST DATA |
| APPENDIX L | GROUNDWATER MODELING INPUT PARAMETERS AND OUTPUT |

**PROVIDED TO EMO UNDER SEPARATE COVER:**

| | |
|---|---|
| APPENDIX M | LABORATORY DATA SHEETS AND QA/QC DOCUMENTATION |

## ACRONYMS
## PHASE II SITE CHARACTERIZATION
## LEHR ENVIRONMENTAL RESTORATION

| | |
|---|---|
| AEC | Atomic Energy Commission |
| ANOVA | Analysis of Variance |
| ARAR | "Applicable requirements" and "relevant and appropriate requirements" |
| ASTM | American Society for Testing and Materials |
| bgs | below ground surface |
| CAM | California Assessment Manual |
| CCR | California Code of Regulations |
| CDFG | California Department of Fish and Game |
| CEP | Controls for Environmental Pollution |
| CEQA | California Environmental Quality Act |
| cfs | cubic feet per second |
| Ci | Curie |
| COC | Chain-of-Custody |
| COD | Chemical Oxygen Demand |
| cpm | counts per minute |
| CPT | Cone Penetrometer Testing |
| CQA | Coordinator of Quality of Assurance |
| CrVI | Hexavalent Chromium |
| DOE | Department of Energy |
| DOT | Department of Transportation |
| DWR | Department of Water Resources |
| EC | Electrical Conductivity |
| EH&S | Environmental Health and Safety |
| EMO | Environmental Management Operations |
| EPA | Environmental Protection Agency |

## ACRONYMS
## PHASE II SITE CHARACTERIZATION
## LEHR ENVIRONMENTAL RESTORATION
(Continued)

| | |
|---|---|
| FEMA | Federal Emergency Management Administration |
| gpm | gallons per minute |
| GPR | Ground Penetrating Radar |
| HSU | Hydrostratigraphic Unit |
| K | Hydraulic Conductivity |
| $K_v$ | Vertical Hydraulic Conductivity |
| LEHR | Laboratory for Energy-Related Health Research |
| LRDP | Long-Range Development Plan |
| MCL | Maximum Contaminant Level(s) |
| mgd | million gallons per day |
| MQA | Manager of Quality Assurance |
| NPL | National Priorities List |
| OVA | Organic Vapor Analyzer |
| PARCC | precision, accuracy, representativeness, completeness and comparability |
| PCB | Polychlorinated Biphenyls |
| PCD | Putah Creek Downstream |
| pCi/g | picoCuries per gram |
| pCi/L | picoCuries per liter |
| PCQA | Program Coordinator of Quality Assurance |
| PCU | Putah Creek Upstream |
| psi | pounds per square inch |
| QAPjP | Quality Assurance Project Plan |
| QAPP | Quality Assurance Program Plan |

## ACRONYMS
## PHASE II SITE CHARACTERIZATION
## LEHR ENVIRONMENTAL RESTORATION
(Continued)

| | |
|---|---|
| RPD | Relative Percent Difference |
| RWQCB | Regional Water Quality Control Board |
| SAN | San Francisco Operations Office (DOE) |
| SARA | Superfund Amendments and Reauthorization Act |
| SID | Solano Irrigation District |
| SOP | Standard Operating Procedures |
| SOW | Statement of Work |
| STLC | Soluble Threshold Limit Concentrations |
| STPO | Sewage Treatment Plant Outfall |
| SWAT | Solid Waste Assessment Test |
| TDS | Total Dissolved Solids |
| TPHRL | Toxic Pollutant Health Research Laboratory |
| TTLC | Total Threshold Limit Concentrations |
| UC | University of California |
| USCS | Unified Soil Classification System |
| USDA | U.S. Department of Agriculture |
| USGS | United States Geological Survey |
| VOCs | Volatile Organic Compounds |
| WBS | Work Breakdown Structure |
| WWTP | Wastewater Treatment Plant |

## Atomic Masses

Based on the atomic mass of $^{12}C$ = 12 exactly

Number in brackets denotes isotope of the longest known half-life

| Name | Symbol | Atomic Mass |
|---|---|---|
| Actinium | Ac | [227] |
| Aluminum | Al | 26.98 |
| Americium | Am | [243] |
| Antimony | Sb | 121.8 |
| Argon | Ar | 39.95 |
| Arsenic | As | 74.92 |
| Astatine | At | [210] |
| Barium | Ba | 137.3 |
| Berkelium | Bk | [247] |
| Beryllium | Be | 9.012 |
| Bismuth | Bi | 209.0 |
| Boron | B | 10.83 |
| Bromine | Br | 79.90 |
| Cadmium | Cd | 112.4 |
| Calcium | Ca | 40.08 |
| Californium | Cf | [251] |
| Carbon | C | 12.01 |
| Cerium | Ce | 140.1 |
| Cesium | Cs | 132.9 |
| Chlorine | Cl | 35.45 |
| Chromium | Cr | 52.00 |
| Cobalt | Co | 58.93 |
| Copper | Cu | 63.54 |
| Curium | Cm | [247] |
| Dysprosium | Dy | 162.5 |
| Einsteinium | Es | [254] |
| Erbium | Er | 167.3 |
| Europium | Eu | 152.0 |
| Fermium | Fm | [257] |
| Fluorine | F | 19.00 |
| Francium | Fr | [223] |
| Gadolinium | Gd | 157.3 |
| Gallium | Ga | 69.72 |
| Germanium | Ge | 72.59 |
| Gold | Au | 197.0 |
| Hafnium | Hf | 178.5 |
| Helium | He | 4.003 |
| Holmium | Ho | 164.9 |
| Hydrogen | H | 1.008 |
| Indium | In | 114.8 |
| Iodine | I | 126.9 |
| Iridium | Ir | 192.2 |
| Iron | Fe | 55.85 |
| Krypton | Kr | 83.80 |
| Lanthanum | La | 138.9 |
| Lawrencium | Lr | [256] |
| Lead | Pb | 207.2 |
| Lithium | Li | 6.941 |
| Lutetium | Lu | 175.0 |
| Magnesium | Mg | 24.31 |
| Manganese | Mn | 54.94 |
| Mendelevium | Md | [258] |
| Mercury | Hg | 200.6 |
| Molybdenum | Mo | 95.94 |
| Neodymium | Nd | 144.2 |
| Neon | Ne | 20.18 |
| Neptunium | Np | 237.0 |
| Nickel | Ni | 58.71 |
| Niobium | Nb | 92.91 |
| Nitrogen | N | 14.01 |
| Nobelium | No | [255] |
| Osmium | Os | 190.2 |
| Oxygen | O | 16.00 |
| Palladium | Pd | 106.4 |
| Phosphorus | P | 30.97 |
| Platinum | Pt | 195.1 |
| Plutonium | Pu | [244] |
| Polonium | Po | [209] |
| Potassium | K | 39.10 |
| Praseodymium | Pr | 140.9 |
| Promethium | Pm | [145] |
| Protactinium | Pa | 231.0 |
| Radium | Ra | 226.0 |
| Radon | Rn | [222] |
| Rhenium | Re | 186.2 |
| Rhodium | Rh | 102.9 |
| Rubidium | Rb | 85.47 |
| Ruthenium | Ru | 101.1 |
| Samarium | Sm | 150.4 |
| Scandium | Sc | 44.96 |
| Selenium | Se | 78.96 |
| Silicon | Si | 28.09 |
| Silver | Ag | 107.9 |
| Strontium | Sr | 87.62 |
| Sulfur | S | 32.06 |
| Tantalum | Ta | 108.9 |
| Technetium | Tc | 98.91 |
| Tellurium | Te | 127.6 |
| Terbium | Tb | 158.9 |
| Thallium | Tl | 204.4 |
| Thorium | Th | 232.0 |
| Thulium | Tm | 168.9 |
| Tin | Sn | 118.7 |
| Titanium | Ti | 47.90 |
| Tungsten | W | 183.9 |
| Uranium | U | 238.0 |
| Vanadium | V | 50.94 |
| Xenon | Xe | 131.3 |
| Ytterbium | Yb | 173.0 |
| Zinc | Zn | 65.37 |
| Zirconium | Zr | 91.22 |

# EXECUTIVE SUMMARY

Dames & Moore prepared this Phase II Site Characterization Report at the request of EMO and the DOE to present the results of investigations at the LEHR facility at the University of California in Davis, California. The scope of the Phase II Site Characterization was presented in the Phase II Site Characterization Work Plan, dated August 31, 1991.

Dames & Moore initiated the Phase II Site Characterization in February 1990. The majority of the soil sampling and monitoring well construction was conducted in 1990. Quarterly groundwater and surface water monitoring is ongoing. Five quarterly rounds of groundwater and surface water monitoring data (November 1990 through November 1991) are presented. The five quarterly rounds represent one full year's hydrologic cycle and allow evaluation of change in site constituents over time. Some tasks outlined in the Work Plan have been initiated but not completed.

Environmental impacts from past operations have been evaluated based on a review of data. Potential source areas exist at the site from past disposal practices associated with LEHR research, and from UC Davis campus activities. Waste systems, which primarily processed excrement from research animals, and shallow waste burial trenches were reported to be the primary source of radionuclides in soil and groundwater. The old landfill operated by UC Davis, trenches and disposal pits, chemical dispensing areas, and former septic systems, are known potential sources. It is likely that other potential disposal areas and potential environmental risks exist at the LEHR facility that have not been addressed as part of the Phase II investigation. These additional potential source areas include the Cobalt-60 Septic Tank, soils below the Imhoff tanks, the original Strontium-90 Leach Field, sewer lines that may have carried radiologic wastes, radiologic waste storage areas at the LEHR facility, floor drains located in the laboratory buildings, and the Old UC Davis Wastewater Treatment Plant just east of the LEHR facility. It is anticipated that these potential source areas will be further evaluated during the planned site-wide RI/FS under CERCLA.

The LEHR facility is located in the southeastern portion of the Sacramento Valley at an average elevation of approximately 50 feet above mean sea level. Subsurface materials consist of marine and continental sediments. Locally, sediments appear to have been deposited in a fluvial depositional system that exhibit gradational variations in stratigraphy.

Groundwater is encountered beneath the site at depths ranging from approximately 45 to 70 feet bgs and has been divided into two zones; the first hydrostratigraphic unit (HSU) consisting of fine-grained sediment varying from very fine-grained sandy silt to sandy clay; and the second HSU consisting of coarse sand and cobble gravel. Groundwater elevations fluctuate up to 25 feet per year.

The south fork of Putah Creek is adjacent to the southern border of the site, but is separated from the site by a levee. Data from the DWR indicates that flows in Putah Creek average from 0.17 cfs to 148 cfs in recent years (1989 to present). Putah Creek is a losing stream, and has been demonstrated to be in hydraulic communication with the first HSU.

At least 12 previous environmental studies have been conducted at the LEHR facility for both UC Davis and the DOE. Two surveys, the Initial Assessment Survey (Rockwell, 1984), and the Environmental Survey Preliminary Report (DOE, 1988), presented documentation of potential environmental impacts from past operations at the LEHR facility. The Phase I Investigation (Wahler 1988, and 1989) was an initial investigation of environmental impacts from past LEHR activities. An evaluation of LEHR groundwater wells for high turbidity levels was conducted in 1990 (Dames & Moore, 1990a). Two studies, the SWAT investigation (Dames & Moore, 1990b), and the Old UC Davis Landfill Additional Characterization (Dames & Moore, 1991a) addressed impact from the former UC Davis landfills. A Contaminant Pathway Analysis (Dames & Moore, 1990c) was conducted to assess health risk exposure from the LEHR facility area for UC Davis' LRDP. Other environmental studies included an Evaluation of Potential Nitrate and Hexavalent Chromium Sources (Dames & Moore, 1990d), a Waste Burial Trench Investigation (Dames & Moore, 1991b), sampling of sediment and surface water in Putah Creek (Dames & Moore, 1990e) and a CEQA Preliminary Study for Characterization activities (Dames & Moore, 1991c). Additional data from these reports can be categorized as EPA Level II analysis. Analytical methods used during these investigations were primarily EPA methods; however, most of these studies were not completed under an approved QA/QC plan, and therefore, results of these investigations were used only as a guide during this Phase II Site Characterization.

The hydrogeology at the LEHR facility was further characterized by the drilling and installation of 10 new groundwater monitoring wells, quarterly sampling of 10 new and 8 existing groundwater monitoring wells, 10 well permeability tests and surface water monitoring. Comparison of hydrographs from wells from both HSU's suggests hydraulic interconnection between the two zones. Vertical gradients between the two zones vary seasonally from a downward gradient between the months of April and August to an upward gradient between the months of August and April. Lateral gradients in the first HSU were calculated to be from 0.0001 to 0.0015 ft/ft to the northeast and the lateral gradient in the second HSU is 0.0015 ft/ft to the east-northeast. Hydraulic conductivities for the first HSU, as interpreted from slug tests, range from $1.9 \times 10^{-5}$ cm/sec ($6.2 \times 10^{-7}$ ft/sec) to $9.1 \times 10^{-3}$ cm/sec ($3.0 \times 10^{-4}$ ft/sec). Hydraulic conductivities for the second HSU, as interpreted from slug tests, range from $7.3 \times 10^{-3}$ cm/sec ($2.4 \times 10^{-4}$ ft/sec) to $1.0 \times 10^{-2}$ cm/sec ($3.3 \times 10^{-4}$ ft/sec). Surface water monitoring of Putah Creek concluded that the water table is continually being recharged by the creek.

Two hundred seventy-five soil samples were collected and 212 soil samples were analyzed from shallow, intermediate and deep soil borings for the Phase II Site Characterization. Analytical data

generated during this Phase II Site Characterization can be categorized under EPA Level III Analytical support level. Results from analysis of soil samples from local background (UCD-17 and UCD-18) showed reported concentrations of antimony, beryllium, copper, molybdenum and selenium above regional background concentrations. Tritium activity was reported in 18 soil samples collected and analyzed from on-site and off-site (background) locations. Background levels of radium-226 activity varied from 0.05 pCi/g to 1.4 pCi/g and strontium-90 activity ranged from non-detectable to 0.24 pCi/g. Methylene chloride was reported in ten samples, at concentrations ranging from 9.1 $\mu$g/Kg to 19.6 $\mu$g/Kg.

Twenty-five soil samples were collected and analyzed from the Strontium-90 Leach Field area. Results reported from this sampling indicated that hexavalent chromium was detected above background concentrations. No strontium-90 activity was reported in soil samples collected. Bismuth-214 activity was reported in soils analyzed from the Strontium-90 Leach Field area, but not in background soil. Nitrate levels decreased with depth and ranged from 1.8 mg/Kg to 92.0 mg/Kg. The volatile constituent methylene chloride was detected in six samples at concentrations from 11.2 $\mu$g/Kg to 22.9 $\mu$g/Kg.

Forty-seven soil samples were collected and analyzed from the Radium-226 Seepage area. Results reported from this sampling indicated that hexavalent chromium was detected above published regional background concentrations. Strontium-90 activity reported in soil samples measured exceeded background activity. The radioisotopes bismuth-214, lead-210 and tritium were reported in soil samples measured from the seepage pit area, but not in background/off-site samples. Nitrate concentrations were reported from 0.70 mg/Kg to 736.0 mg/Kg, with the highest concentrations reported from samples collected between 5.0 and 15.0 feet bgs. Methylene chloride was reported in 13 samples at concentrations ranging from 10.7 $\mu$g/Kg to 44.2 $\mu$g/Kg.

Twenty-one soil samples were collected and analyzed from the Southwest Chemical Dispensing area. The organic compounds methylene chloride and di-n-butylphthalate were detected in nine samples and six samples, respectively, at concentrations ranging from 8.8 $\mu$g/Kg to 37.6 $\mu$g/Kg, and 100 $\mu$g/Kg to 220 $\mu$g/Kg, respectively. Five samples analyzed for hexavalent chromium and seven samples for chromium were above background. Activity of the radionuclides bismuth-214 and tritium were reported in soil samples measured from the South Chemical Dispensing area, but not in background soil and thorium-232 activity was reported above background concentrations in soil. Six soil samples were reported to contain nitrate at concentrations exceeding background, ranging from 0.23 mg/Kg to 220.0 mg/Kg.

One hundred nine soil samples were collected and analyzed from the dog pen areas at the LEHR facility. Hexavalent chromium and chromium were reported at concentrations up to 3.98 mg/Kg and 152 mg/Kg, respectively. Nitrate was reported in concentrations ranging from 1.4 mg/Kg to 168 mg/kg

with 12 samples above background. Chlordane was reported in concentrations ranging from 0.5 μg/Kg to 480.0 μg/kg, with three samples having reported concentrations at or exceeding 200.0 μg/Kg. Methylene chloride and diethylphthalate were reported in one sample and five samples from the dog pens, respectively.

In the North Chemical Dispensing area, six soil samples were collected and analyzed. One sample had reported concentrations of methylene chloride and three samples had reported concentrations of chlordane at maximum concentrations of 9.7 μg/Kg and 70 μg/Kg, respectively. Hexavalent chromium and chromium were reported in all six samples and three samples, respectively, at concentrations up to 2.3 mg/Kg, and 97 mg/Kg, respectively. Nitrate was reported in all six samples collected from the North Chemical Dispensing area at concentrations ranging from 30.0 mg/Kg to 49.0 mg/Kg, all above background.

Twenty samples were collected and analyzed from dog pens at the former AEC site on the UC Davis main campus. Chlordane was reported in nine samples at concentrations ranging from 4.77 μg/Kg to 67.00 μg/Kg, and carbon-14 activity was reported in one replicate sample at 0.5 pCi/g.

One sample each of sediment from the stormwater lift station and the waste water treatment plant outfall were collected and analyzed. Only one organic compound, chlordane, was reported in lift station sediment. Nitrate was reported at concentrations of 3.7 mg/Kg and 6.4 mg/Kg in outfall sediment and lift station sediment, respectively. No metals were reported at concentrations significantly above background, and no radionuclides were measured in lift station or outfall sediments.

Five quarterly rounds, consisting of four samples per round, of surface water samples have been collected from Putah Creek. Chloroform was reported in samples analyzed from all five rounds, at a maximum concentration of 14 μg/L in sample PCD from Summer Quarter 1991. At least one of the pesticides, alpha-BHC, beta-BHC, or delta-BHC were detected in each of the five monitoring rounds with the highest reported concentration of delta-BHC at 0.033 μg/L in the STPO from summer quarter 1991. Nitrate was reported in all samples in all quarters at concentrations ranging from 400 μg/L to 11,900 μg/L, with the highest concentration in the STPO sample. Gross alpha and gross beta activity was reported in all samples, except samples collected in fall quarter 1991, at levels up to 31 pCi/L and 62 pCi/L, respectively. Strontium-90 activity was measured in three rounds, and tritium activity was measured in one round at levels up to 18 pCi/L and 1,341 pCi/L, respectively. Metals reported in surface water samples in all rounds were below background.

Five quarterly rounds of groundwater sample collection and analysis were conducted between November 1990 and November 1991. Results reported from groundwater sample analysis for volatile organics show consistent detections of 1,1-dichloroethane, 1,1-dichloroethene, and 1,2-dichloroethane in

well UCD-12 at concentrations up to 27 $\mu$g/L, 53.8 $\mu$g/L and 20 $\mu$g/L, respectively. Chloroform was reported in UCD-12 and UCD-21 in four out of five sampling rounds, and in all five sampling rounds, respectively. Maximum concentrations of chloroform were reported at 24,000 $\mu$g/L in the UCD-12 sample from winter quarter 1991. The semi-volatile organic bis (2-ethylhexyl) phthalate was reported in a variety of wells at concentrations up to 13.4 $\mu$g/L; however, only three wells, UCD-13, UCD-19, and UCD-24, had repeated detections of bis (2-ethylhexyl) phthalate, and there were no reported detections in the summer or fall 1991 quarters. Other organic parameters were reported, but were not detected on a consistent basis (consecutive rounds or repetitive wells).

Nitrate was reported in all wells sampled in all quarters. Wells UCD-1, -7, -10, -11, -12, -13, -19, -20, -21, and -24 had reported concentrations of nitrates above background in most quarterly monitoring rounds (four or five sampling rounds). Highest concentrations of nitrate were reported in the UCD-12 sample at 231 mg/L from winter quarter 1991.

Antimony, beryllium, molybdenum, and thallium were consistently reported in groundwater samples collected at concentrations exceeding regional background concentrations. However, these five metals were also reported as detected at similar concentrations in background wells (UCD-17 and UCD-18). Selenium was detected 10 times in 5 sampling quarters in downgradient groundwater wells, but was never reported in groundwater samples analyzed from background groundwater monitoring wells. Chromium was reported above background in most quarterly sampling rounds in wells UCD-11, -12, -13, -19, -20, and -21, and more than once in wells UCD-7 and -14. Hexavalent chromium was reported above background concentrations in most quarterly sampling rounds in wells UCD-1, -11, -12, -13, -19, -20, -21, and more than once in wells UCD-7 and -14.

Radionuclide activity including tritium, strontium-90 and carbon-14 were reported in groundwater samples measured. Additionally, gross alpha and gross beta activity were also reported. Gross alpha activity was measured in most quarterly sampling rounds in wells UCD-20, -21, and -24, with the highest activity of 27 pCi/L in the UCD-1 sample from fall quarter 1990. Gross beta activity was measured in most quarterly sampling rounds in wells UCD-1, -7, -10, -12, -13, -20, -21, -22, and -24, with the highest level of activity at 62 pCi/L in the sample from UCD-1 from fall quarter 1990. Tritium activity has been reported in most quarterly sampling rounds in wells UCD-13 and UCD-14, with highest activity in the sample from UCD-13 from Fall 1990. Strontium-90 activity has been reported in the Fall 1990, Winter 1991, and Spring 1991 quarterly sampling rounds in wells UCD-15 and -24, UCD-13 and -23, and UCD-1, -7, and -10; however no repeated measurements were reported. Carbon-14 activity was reported in groundwater samples collected from UCD-13 and -14 in spring 1991 and fall 1991 quarters, and spring and summer 1991 quarters, respectively. However, carbon-14 activity was measured only in selected wells.

In order to develop conclusions, the data collected on the LEHR facility were compared to regulatory criteria, off-site sample data (background), and published data from the literature. Statistical comparisons between on-site and off-site data were made where possible. Conclusions developed focus on the adequacy of the available data in assessing known or potential sources of chemicals associated with past activity at the LEHR facility.

Of the chemical constituents analyzed in soil, only chlordane and nitrate were reported at elevated concentrations in on-site soils compared to off-site soil. Chlordane was reported in several soil samples collected and analyzed from the Dog Pen Area, and is assumed to be the result of past use as an insecticide on laboratory animals. Concentrations of nitrate in soil samples collected from the Radium-226 Seepage Pit Area, the Strontium Leach Field Area, the Dog Pens, the North Chemical Dispensing Area and the Southwest Disposal Area were reported at greater concentrations then reported in background soils. These constituents in soil at the LEHR facility appears to be the result of past site activity.

Radionuclide activity measured in soils collected during the Phase II Investigation suggest that in general, activity measured in soil samples collected on-site are similar to soil samples collected and measured off-site. Results reported from previous studies show soil radionuclide activity in the waste burial trenches and the Southwest Disposal Area slightly higher than reported in the Phase II Investigation.

Elevated concentrations of chemical constituents reported in groundwater samples collected and analyzed from on-site wells include chloroform, 1,1 dichloroethane, 1,1 dichloroethene, 1,2 dichloroethane, hexavalent chromium, nitrate, and general mineral parameters (calcium, magnesium, sodium, potassium, chloride, nitrate and sulfate). Chloroform, 1,1,dichloroethane, 1,1 dichloroethene, and 1,2 dichloroethane were detected in samples collected from wells downgradient of Landfill Units 1 and 2 at concentrations that exceed their MCL. Hexavalent chromium concentrations reported in groundwater exceeded the MCL in samples collected from UCD-1, -7, -11, -12, -13, -14, -18, -20, -21, and -24. Nitrate concentrations reported in groundwater exceed the MCL in samples collected from UCD-1, -7, -10, -11, -13, -14, -19, -20 and -21. General mineral parameters are reported at higher concentrations in most downgradient wells compared to upgradient wells.

Reported activity of tritium and carbon-14 were elevated in samples collected from selected downgradient wells compared to upgradient wells. Tritium and carbon-14 activity was consistently reported in samples collected from UCD-13 and UCD-14, a first and second HSU well pair located in the vicinity of the waste burial trenches. All other radionuclide activity measured was either similar between on-site and background groundwater, or was not measured consistently over time. All reported results were below MCLs.

Sampling and analysis results received from the wastewater treatment outfall and surface water from Putah Creek suggest that surface water discharge contributes salts, organic compounds, metals, and radionuclides at relatively low concentrations, which eventually recharge groundwater. Reported concentrations rarely exceed MCLs.

Activity of three radionuclides were reported in surface water, tritium, carbon-14, and strontium-90. All reported measurements were below the MCLs. Scans of gross alpha and gross beta activity were reported in all five sampling rounds.

Based on the results of the Phase II investigation and the conclusions presented above, Dames & Moore is recommending additional investigation of soil, groundwater, and surface water at the LEHR facility. Recommendations presented in the draft Phase II Site Characterization Report represent the anticipated scope of work necessary for the site-wide soil and groundwater investigation, and will be revised based on further discussion and comments from EMO, DOE and the appropriate technical advisors.

PHASE II SITE CHARACTERIZATION REPORT
LEHR ENVIRONMENTAL RESTORATION
UNIVERSITY OF CALIFORNIA DAVIS

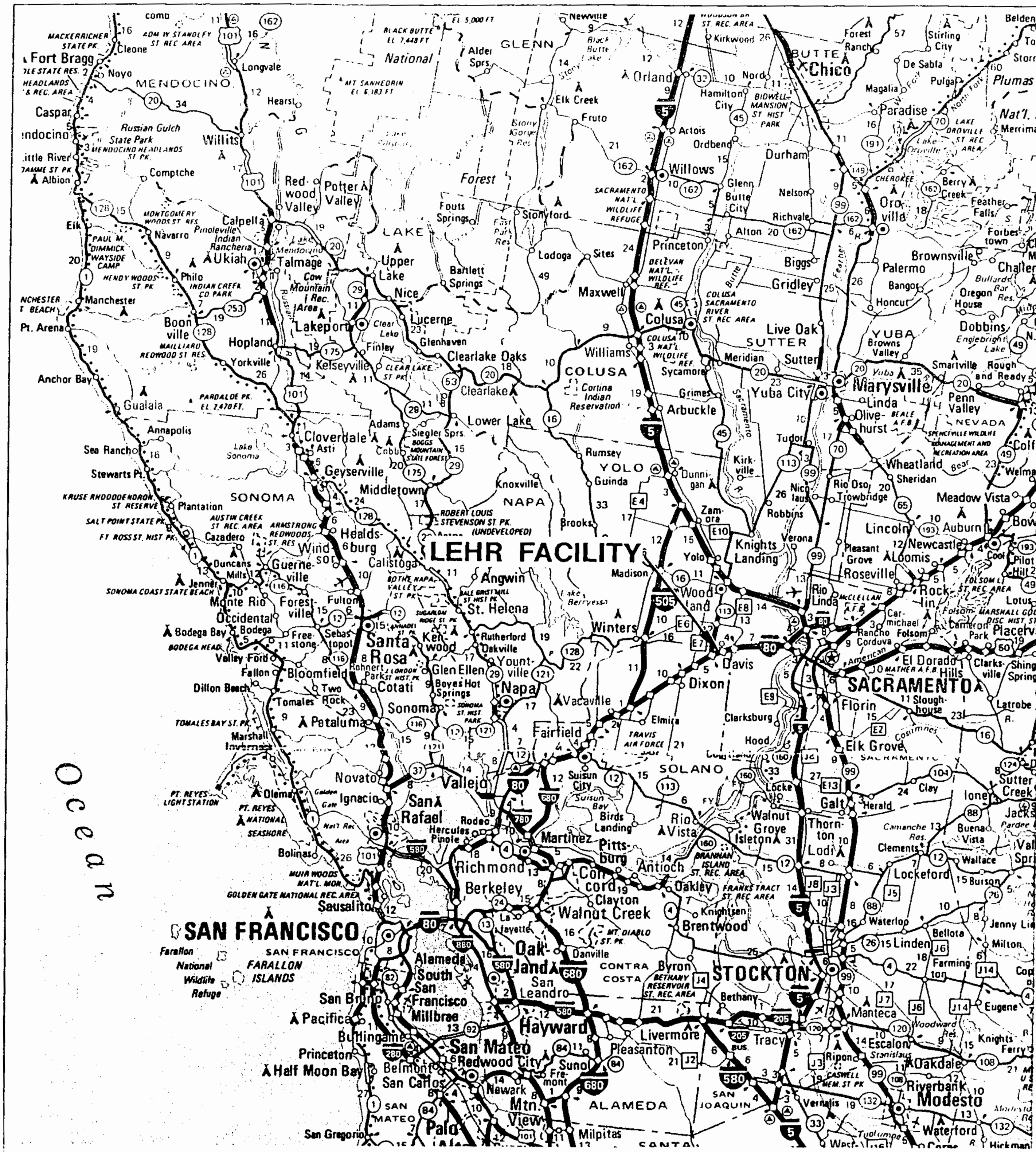
# 1.0 INTRODUCTION

This Phase II Site Characterization report presents the results of soil and surface and groundwater characterization conducted at the Laboratory for Energy-Related Health Research (LEHR) (Figure 1.1) over a period of two years (1990-1992). A brief summary of the results of previous (pre-1990) soil and groundwater screening activities are also presented in this report. The following is a brief description of past, current, and planned soil and groundwater characterization activities at LEHR.

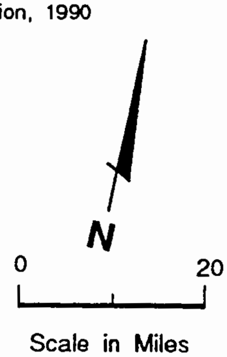
## 1.1 PRE-1990 SCREENING AND CHARACTERIZATION

A number of limited soil and groundwater screening activities were performed between 1984 and 1989. The scope of these activities ranged from document research to obtaining a limited number of soil and groundwater samples from selected locations. The objective of this limited sampling was to determine the presence or absence of certain chemical and radiological contaminants in localized soils and groundwater at the LEHR site. As such, most of the sampling efforts were performed without formal sampling and analysis or quality assurance/quality control (QA/QC) plans. The results of the pre-1990 screening activities indicated the presence of several contaminants in soil and groundwater. These contaminants included radionuclides, heavy metals, and various organic (primarily solvents) and inorganic compounds (primarily nitrate) parameters. Refer to Section 3.0 of this report for more information.

Because of the limitation of scope and data quality objectives (DQOs) of the pre-1990 site screening activities, data obtained from these activities may not be reliable or sufficient to draw any conclusions regarding the nature and extent of contamination at the LEHR site. Data, however, were used to scope the Phase II Site Characterization activities.




REFERENCE: California State Automobile Association, 1990




DAMES & MOORE

# SITE LOCATION MAP

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

10805-454-044 DOE10

FIGURE 1.1

## 1.2 PHASE II SOIL AND GROUNDWATER CHARACTERIZATION

The U.S. Department of Energy- (DOE) funded Phase II Site Characterization was initiated by UC Davis in February 1990. In March 1990, the DOE assumed full responsibility of this effort with Battelle's Environmental Management Operations (EMO) as its prime contractor. The DOE and EMO requested Dames & Moore to continue field activities as planned under a new contract with EMO.

### 1.2.1 Scope

The initial scope of the Phase II Site Characterization was limited to soil boring and sediment sampling at selected locations and installation and sampling of deep (120 feet) and shallow ($\approx$70 feet) groundwater monitoring wells. It also included quarterly sampling of groundwater and surface water from Putah Creek. The scope was later expanded to include aquifer analyses, and obtaining limited soil samples from the on-site underground domestic septic tanks. These activities were included in the Phase II Site Characterization work plan, sampling and analysis plan, quality assurance plan, and health and safety plan. The scope of soil characterization was limited to only DOE areas, including dog pens, leach fields, southwest burial trenches, chemical dispensing areas, and the on-campus AEC area. The other on-site contaminated areas (i.e., UC Davis trenches and landfill cells) were excluded from the scope of Phase II site characterization, because no historical or operational information was available at the time to indicate DOE involvement in these areas.

### 1.2.2 Objectives

The major objectives of the Phase II Site Characterization activities are presented below:

- Generate reliable data on groundwater, soil, sediment, and surface water to aid in the evaluation of the presence or absence of selected chemical and radiologic constituents;
- Evaluate the lateral and vertical extent of detected constituents in groundwater and soil at LEHR and surface water and sediment in the reach of the South Fork of Putah Creek adjacent to LEHR;
- Evaluate the physical condition of the exterior of eight abandoned domestic septic tanks at the site, and identify the chemical and radionuclide contamination of material within those tanks;

- Evaluate physical chemicals of the saturated and unsaturated zones beneath the site and develop a groundwater model to further assess hydrogeologic properties;
- Conduct screening to identify additional potential source areas of contamination at the facility;
- Assess overall environmental conditions at and near the site; and
- Compile and evaluate soil and groundwater characterization data and identify data gaps required to prepare a site-wide CERCLA Remedial Investigation/Feasibility Study (RI/FS) Work Plan.

Except for the domestic septic tanks, most of these objectives were achieved at the completion of Phase II characterization activities. Excavation and sampling of the domestic tank systems was deferred due to schedule problems associated with the removal and treatment of the low-level radioactive sludge contained in the Radium-226 and Strontium-90 septic tank systems. As a result, the nature and extent of contamination associated with the domestic septic tank systems remain unknown.

### 1.2.3 Data Quality Objectives, Uses, and Limitation

The Phase II soil and groundwater characterization activities were conducted in accordance with the requirements of QAMS-005 and NQA-1. If the analytical data presented in this Phase II characterization report were to be categorized according to EPA analytical support levels, the data would most likely be categorized as EPA Level III (EPA, 1987), which primarily requires that analysis is performed in an off-site analytical laboratory under a formal QA/QC plan. EPA Level III data are typically acceptable in support of site characterization, risk assessment, evaluation of remedial alternatives, remedial design and monitoring.

The data obtained during Phase II Site Characterization are reliable and of sufficient quality; however, they are limited in quantity and area coverage to support risk assessment, development of ARARs and evaluation of remedial alternatives under CERCLA. For example, only a few data points were obtained from the DOE burial trenches and leach field, and the nature and extent of contamination at the UC Davis portion of the site (landfill and UC Davis trenches) remain unknown. Tables 4.1 and 4.4 presented in Chapter 4.0 summarize the Phase II data objectives and compare data collected to CERCLA RI/FS requirements. Detailed site characterization would be required in order to prepare a site-wide RI document and to comply with the NEPA documentation for site remediation. Data obtained as part of RI activities will be used to support preparation of the Feasibility Study.

## 1.3 PLANNED SOIL AND GROUNDWATER INVESTIGATION

The planned soil and groundwater investigation will be conducted in accordance with CERCLA requirements. A detailed site-wide CERCLA RI/FS work plan will be prepared and implemented to cover all areas related to soil and groundwater issues at LEHR. The RI/FS work plan will address all CERCLA requirements and will be prepared to enable obtaining sufficient data to perform risk assessment, develop ARARs and evaluate remedial alternatives for soil and groundwater. This work plan will be implemented after being reviewed by regulatory agencies and approved by the DOE.

## 1.4 QUALITY ASSURANCE

The Phase II Site Characterization has been conducted under the Quality Assurance Project Plan (QAPjP) which is consistent with the requirements of EPA QAMS-005 and NQA-1. QA procedures include protocol for documentation, data review, training, and surveillances and audits. All QA requirements are implemented by a project QA team, which operates independently of the project technical or management team. Quality assurance requirements include analytical laboratory and other subcontractor responsibilities.

The subcontract with CEP Laboratories in Santa Fe, New Mexico, also contained requirements that they comply with the project QAPP. Appendix B of this report contains a detailed description of the QA/QC procedures implemented during the Phase II Site Characterization.

## 1.5 HEALTH AND SAFETY

A site-specific Health and Safety Program for protection of workers at the site was established as required by the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) and as outlined in the project Health and Safety Plan (HSP). Under this Health and Safety program, employees working at the site were certified by a physician as fit to work, fit tested to wear respirators, and completed 40 hours of Health and Safety training. A Certified Industrial Hygienist implemented the Health and Safety program.

Radiological safety was coordinated with the UC Davis Environmental Health and Safety (EH&S) Office. UC Davis EH&S provided radiation safety orientation for field personnel, provided a radiation survey meter and personal dosimeters for exposure monitoring in the field; baseline internal dosimetry where taken prior to field work, and internal dosimetry measurements were taken after field work.

## 1.6 ORGANIZATION OF REPORT

This report consists of ten chapters, and contains thirteen appendices. Volume I contains the text, tables and figures, Volume II and Volume III contain the thirteen appendices.

Chapter 1.0 presents the introduction to this report. Chapter 2.0 presents background information and includes a history of operations, waste streams and disposal practices, and a discussion of the physical setting of LEHR. Chapter 3.0 presents a summary of known previous screening conducted at the LEHR facility. Chapter 4.0 presents the rationale and approach of the Phase II Site Characterization. Data evaluation methodologies are also described in Chapter 4.0.

The tasks conducted as part of the Phase II Site Characterization are described in Chapter 5.0. Specific activities for each portion of the investigation are defined as Work Breakdown Structure elements (WBS) 302 through 308.

Chapter 6.0 presents physical and chemical results from the Phase II Site Characterization. Soil chemical results are presented by area of interest and groundwater analytical results are presented by quarterly sampling rounds.

Chapter 7.0 presents a discussion of the findings of the Phase II Site Characterization, and synthesizes laboratory analytical results and physical data with site physical characteristics. Additionally, discussions of the lateral and vertical extent of site constituents of concern are presented. Conclusions are discussed in Chapter 8.0, and recommendations are presented in Chapter 9.0. References cited in this report are presented in Chapter 10.0.

Appendices presented in this report provide detailed descriptions of procedures followed and raw data collected during the Phase II Site Characterization. Appendices A through E are contained in Volume II, Appendices F through L are contained in Volume III. Appendix A presents the field procedures followed for soil, sediment, and water sample collection and soil boring and monitoring well installation. Also presented are chemical analyses requested for soil, sediment, and water samples.

Appendix B presents QA/QC activities conducted during the Phase II Site Characterization. Appendix C presents boring logs and monitoring well construction diagrams for borings and monitoring wells at the LEHR facility.

Appendix D presents hydrographs and groundwater level data for monitoring wells located at the LEHR site. Appendix E presents field documentation of soil and water sampling and monitoring well development. Also included are completed chain of custodies for all samples.

Appendices F and G present analytical results (in tabular form) for soil, sediment, and groundwater samples, respectively. Appendix H presents analytical results (in tabular form) for surface waster samples.

Appendix I presents groundwater elevation contour maps for the shallow and deep hydrostratigraphic units. The maps were constructed using groundwater elevation data presented in Appendix D.

Appendix J presents the results of physical testing completed on selected soil samples. Grain size distribution analysis conducted on sediments from UCD-18 and UCD-19 wells are included. Appendix K presents monitoring well slug test results in tabular and graphical form. Appendix L presents the groundwater modeling input parameters and data output. Appendix M contains the laboratory data sheets and laboratory QA/QC documentation.

# 2.0 BACKGROUND

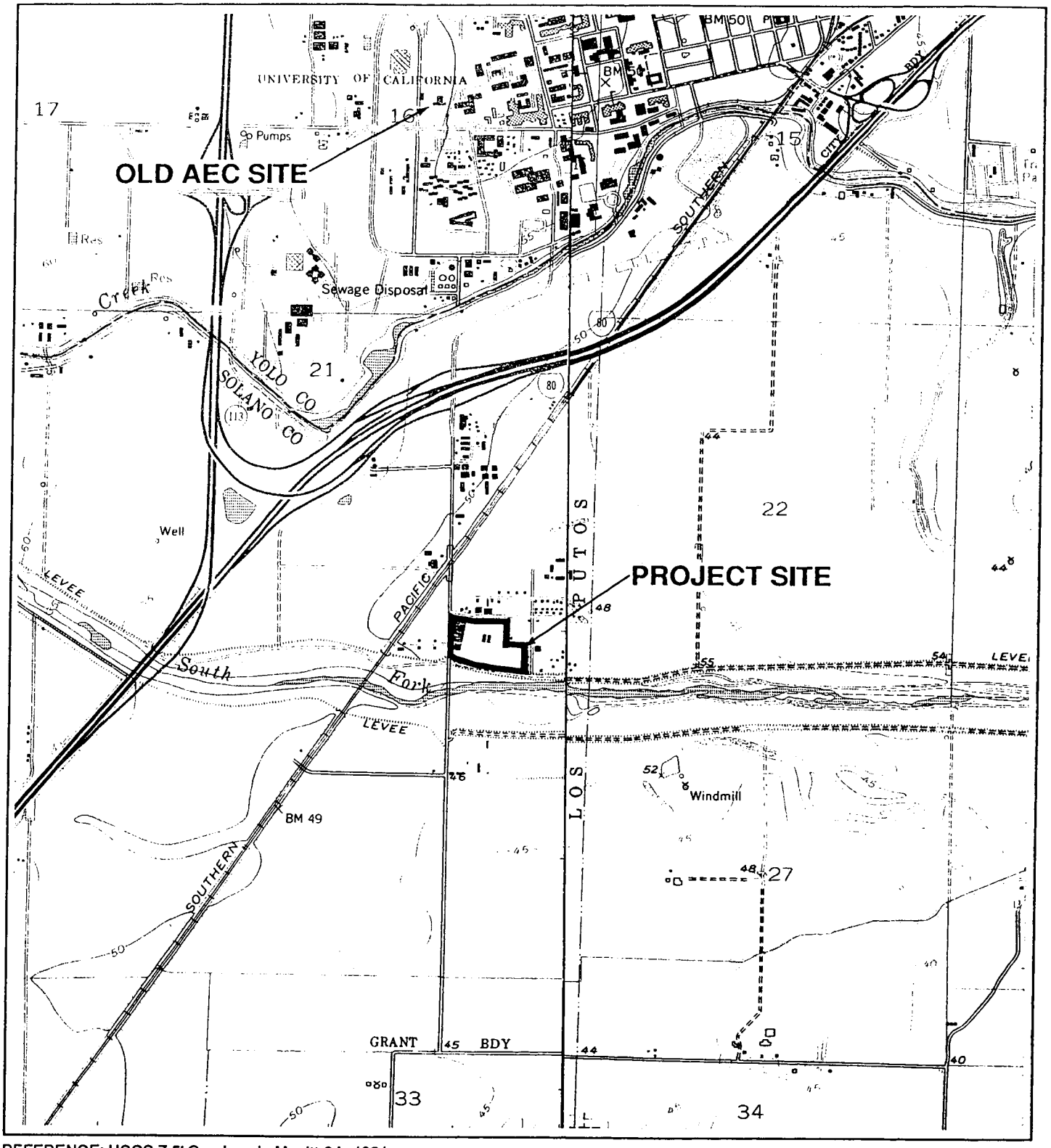
This chapter presents background information on the LEHR facility and surrounding area in order to establish a basic understanding of past operations and the physical attributes of the site. Section 2.1 gives a description of the structures and location of the LEHR facility. Section 2.2 presents a history of operations, and waste disposal and waste-generating processes. Section 2.3 summarizes the physical setting of the LEHR facility, including geology, hydrogeology, surface water flow, meteorology, and environmental resources. Lastly, Section 2.4 presents background data on human resources and demographics.

## 2.1 SITE DESCRIPTION

The LEHR facility is located in the southeast quarter of Section 21, Township 8 North, Range 2 East, Mount Diablo Baseline and Meridian (MDBM). The site is approximately one and one-half miles south of the main UC Davis campus and the town of Davis, and approximately three-quarters of a mile south of Interstate 80 on County Road 79 (Old Davis Road) in Solano County, California (Figure 2.1).

The site encompasses approximately 15 acres and consists of one- and two-story laboratory and office buildings, and animal-handling facilities in a rural-type setting. Of the 15 acres, approximately 40 percent (6 acres) is paved with asphalt or concrete, or covered by structures. Approximately 30 percent (4.5 acres) of the site is unpaved and kept relatively free of vegetation. Dog pen areas occupy approximately 20 percent (3 acres) of the LEHR facility, and approximately 5 percent (.75 acres) is heavily vegetated with large deep rooted vegetation. Based on habitat present at LEHR, the site is potentially host to a wide variety of animals including numerous species of birds, mammals, several of which are burrowing species, and reptiles including snakes. Special status species are discussed in Section 2.4.6.2. Major buildings and structures located at LEHR are listed below and shown on Figure 2.2.

| Building Number | Building Name | Building Number | Building Name |
|---|---|---|---|
| H-213 | Main Office and Laboratory | H-290 | Receiving and Business |
| H-219 | Animal Hospital 1 | H-300 | Storage |
| H-218 | Animal Hospital 2 | H-296 | Small Animal Quarters |
| H-214 | Imhoff | H-299 | Toxic Pollutant Health Res. Lab. |
| H-217 | Pathology Laboratory | H-289 | Cobalt-60 Auxiliary Building |
| H-215 | Clinical Medicine | H-229 | Cobalt-60 Source |
| H-216 | Specimen Storage and Feed Mix | H-292 | Geriatrics 1 |
| H-291 | Washdown Pad | H-293 | Geriatrics 2 |
| H-294 | Cellular Biology Lab | | |
| H-212 | Maintenance Shop | | |




REFERENCE: USGS 7.5' Quadrangle Merritt CA, 1981, Davis CA, 1982

N

0 2000

Scale in Feet

**SITE VICINITY MAP**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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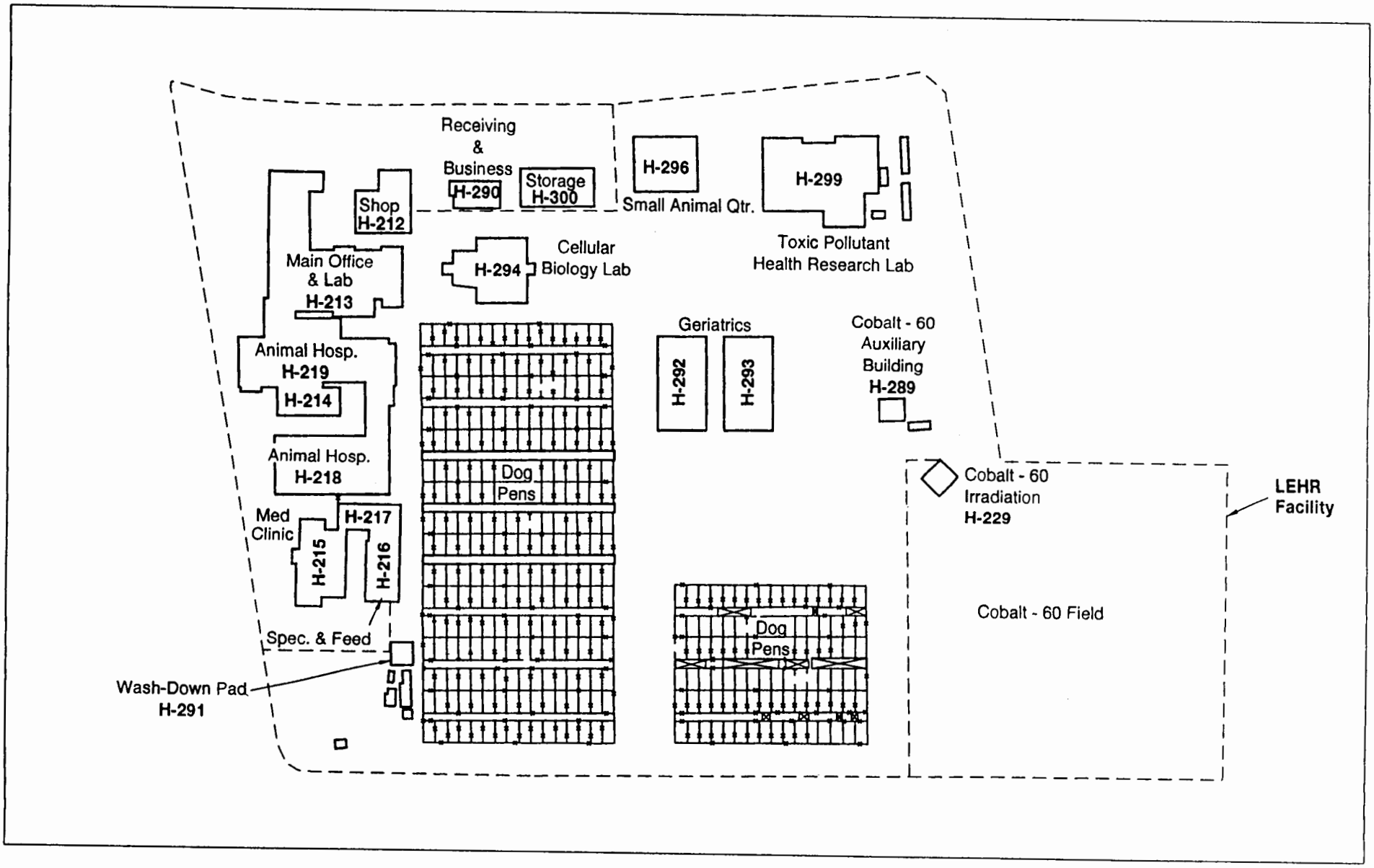
10805-454-044 DOE1

FIGURE 2.1




EXPLANATION

H-291 Building Number

0 150
Scale in Feet

N

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10805-454-044 DOE-139

**SITE STRUCTURES**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

FIGURE 2.2

The land is owned by the Regents of the University of California and leased to the DOE. All structures at the LEHR facility are owned by the DOE (DOE, 1988).

Also located at the LEHR facility are two inactive landfills: the Old UC Davis Landfill, closed in 1966, and a campus and DOE low-level radioactive waste disposal site, closed in 1974. A third inactive landfill unit is located approximately 600 feet east of the LEHR facility below the area currently occupied by the UC Davis Raptor Center.

The site is located in a rural area in the southeast portion of the UC Davis campus, and is bounded by UC Davis research facilities. The southern border of the LEHR facility is the northern levee of the South Fork of Putah Creek. Private land is adjacent to and surrounds UC Davis property on all sides. Most of the private land is used for agricultural purposes. Table 2.1 identifies UC Davis research facilities adjacent to the LEHR facility. Locations of these facilities are shown on Figure 2.3.

### 2.1.1 Nearby Groundwater Wells

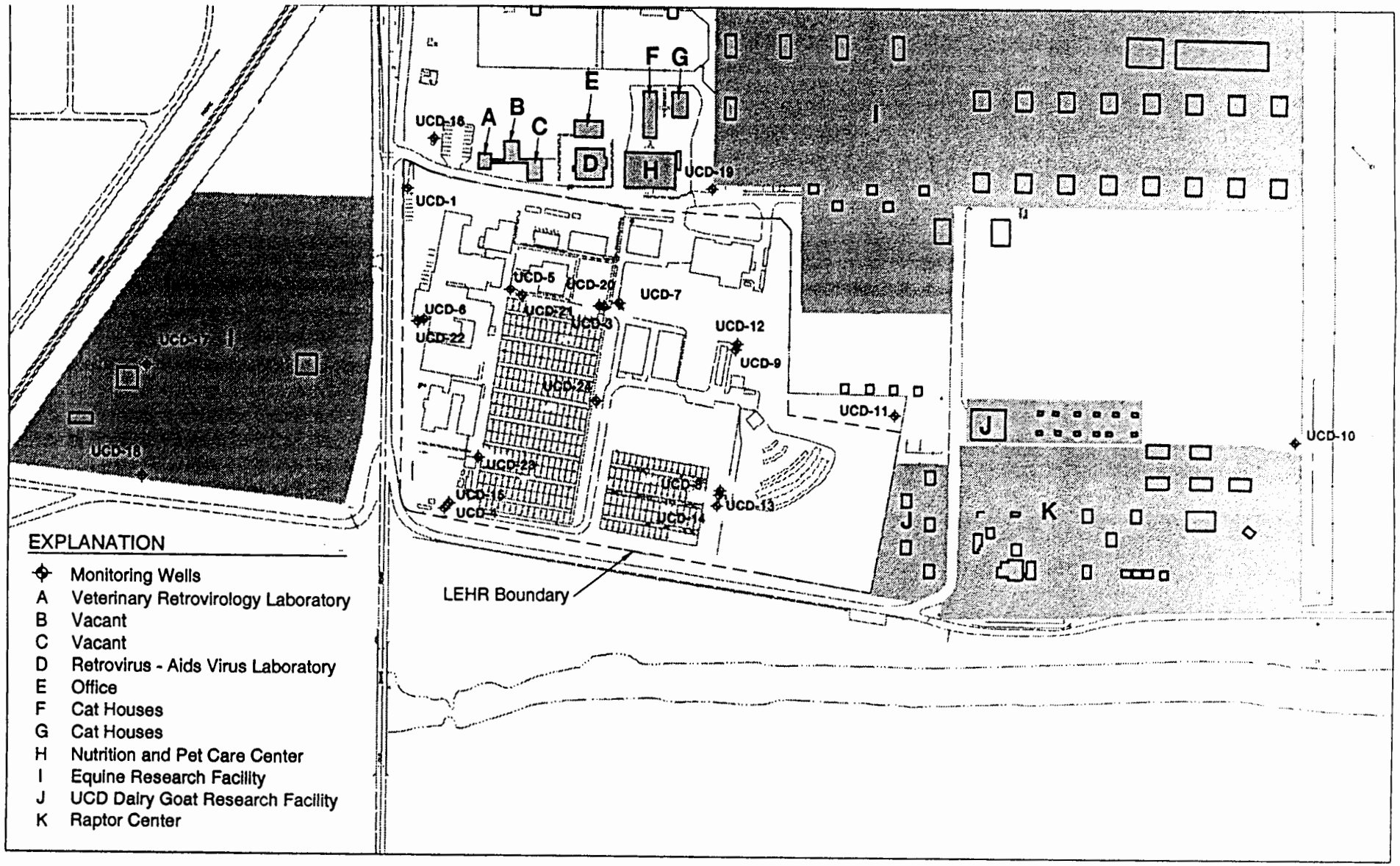
Due to the use of surrounding property (primarily agricultural), many domestic and supply wells are located proximal to the LEHR facility. Thirty-four groundwater wells are located within approximately one mile of the LEHR facility (Figure 2.4). Although the purpose of some of these wells is not documented, some are known to be used for irrigation and some for domestic purposes (Dames & Moore, 1990d). Well logs for 23 of the wells were obtained from the California Department of Water Resources (DWR), and are presented in Appendix C. These logs were previously presented in Appendix C of the Solid Waste Assessment Test (SWAT) (Dames & Moore, 1990b) for the Old UCD Landfill. Table 2.2 presents a summary of available data, including well designation, owner, use, total depth, screened interval, pumping rate and year of installation. Some of this information was obtained directly from UC Davis.

Pumping rates for groundwater wells are variable, and depends on several factors such as:

- purpose (municipal, single-residence domestic, irrigation, industrial, etc.);
- individual and local domestic needs;
- industry type and size;
- time of year and crop requirements (with irrigation wells);
- well construction; and
- pump size and efficiency.

TABLE 2.1
LIST OF UC DAVIS FACILITIES ADJACENT TO LEHR
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Building or Site | Function |
|---|---|
| A. Veterinary Retrovirology Laboratory | Hematology lab used for research on cats. |
| B. Vacant | None. |
| C. Vacant | None |
| D. Retrovirus - AIDS Virus Laboratory | Vaccine research and AIDS diagnostic work. |
| E. Office for D | Office. |
| F. Cat Houses | Cats are housed here for use in research. |
| G. Same as F | See above. |
| H. Nutrition and Pet Care Center | Raise cats for research on campus and sale of cats to other universities. |
| I. Equine Research Laboratory | Horses in corrals used in reproductive studies or horses that are quarantined. |
| J. UC Davis Dairy Goat Research Facility | Part of Animal Science on campus. Research classes from Vet. Med. held here. Several studies ongoing with respect to genetics, reproduction behavior, etc. |
| K. Raptor Center | Take in injured birds of prey and help them to recover. House birds that cannot fend for themselves in the wild. |




0 300
Scale in Feet

N

**UC DAVIS FACILITIES ADJACENT TO LEHR**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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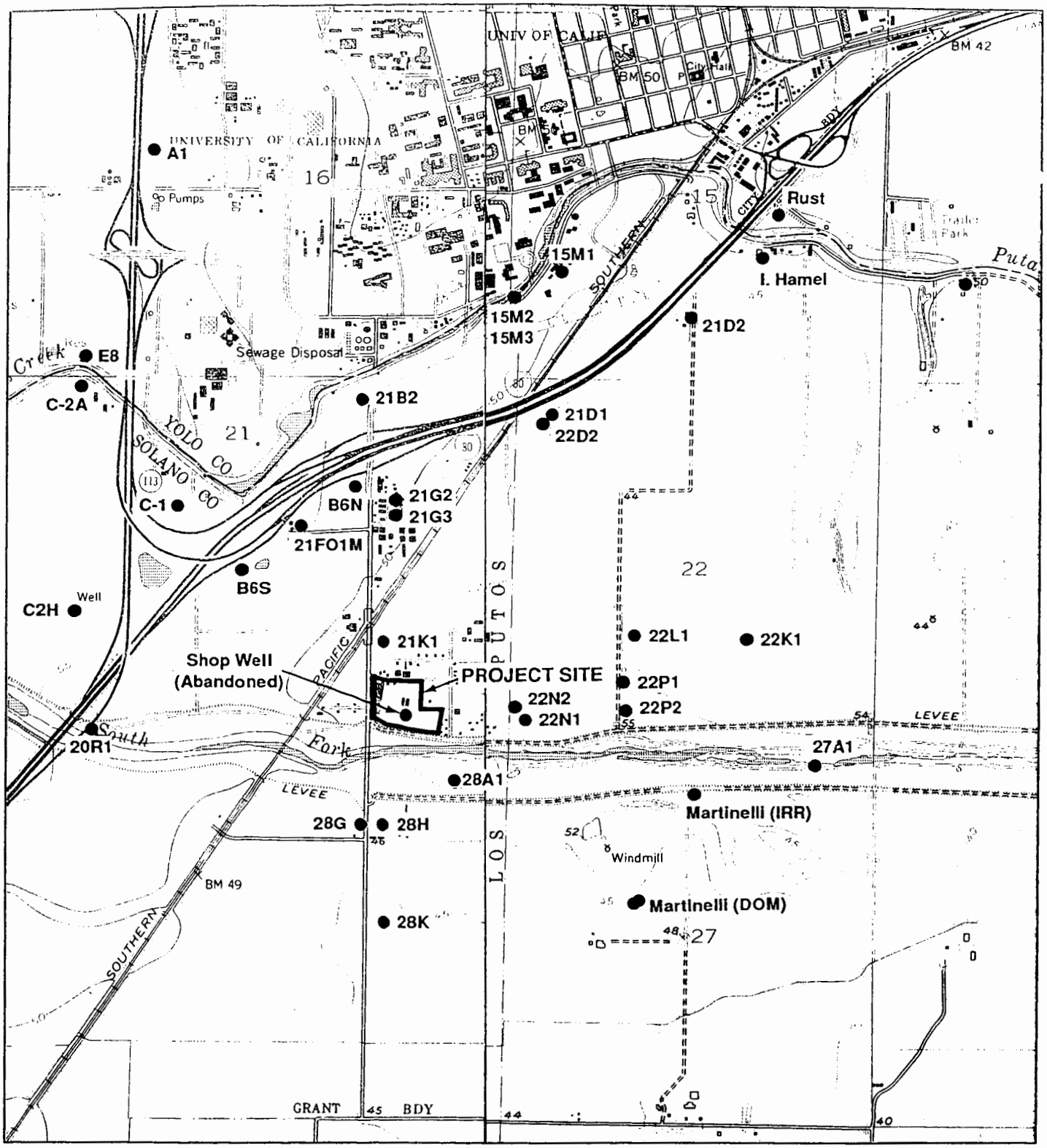
10805-454-044 DOE-126

FIGURE 2.3




REFERENCE: USGS 7.5' Quadrangles Merritt CA and Davis CA, 1981

EXPLANATION

● 15M1 Existing Groundwater Well

N

0 2000

Scale in Feet

# GROUNDWATER WELLS NEAR LEHR FACILITY

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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10805-454-044 DOE5

FIGURE 2.4

TABLE 2.2
SUMMARY OF WELLS NEAR LEHR FACILITY
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| WELL | OWNER | TOTAL DEPTH (ft. bgs) | SCREENED INTERVAL (ft. bgs) | YEAR DRILLED | USE | PUMPING RATE (gpm) |
|---|---|---|---|---|---|---|
| 8N-2E-15M1 | -- | 325 | 101-129; 162-171; 248-325 | 1941 | "Farm well" | ~450 |
| 8N-2E-15M2 | UC Davis | 322 | 283-322 | 1929 | "Farm well" | ~700 |
| 8N-2E-15M3 | UC Davis | 117 | -- | 1909 | "Farm well" | abandoned in 1929 |
| 8N-2E-20R1 | -- | 33.5 | 23-27 | 1953 | "Test well" | -- |
| 8N-2E-21B2 | UC Davis | 1450 | 1264-1432 | 1952 | domestic | ~1000 |
| 8N-2E-21F1 | UC Davis | 263 | 243-263 | 1962 | irrigation | not in use |
| 8N-2E-21G2 | UC Davis | 123 | 107-120 | 1918 | "Farm well" | not in use |
| 8N-2E-21G3 | Armstrong* | 224 | -- | 1932 | domestic | -- |
| 8N-2E-21K1 | UC Davis | 1430 | 1120-1400 | 1971 | domestic | not in use |
| 8N-2E-22D1 | Becker* | 443 | 118-364 | 1948 | unknown | -- |
| 8N-2E-22D2 | Becker* | 355 | 102-355 | 1948 | irrigation | -- |
| 8N-2E-22K1 | Forden & Becker* | 309 | 98-199 | 1948 | irrigation | -- |
| 8N-2E-22L1 | Hamel Bros.* | 403 | -- | -- | irrigation | -- |
| 8N-2E-22N1 | Hamel Bros.* | 340 | 105-340 | 1938 | irrigation | -- |
| 8N-2E-28A1 | Armstrong* | 158 | 90-158 | 1934 | unknown | -- |
| 8N-2E-28K | UC Davis | 1600 | -- | 1970 | test hole | not a well |
| 8N-2E-27A1 | Div. Water Resources | -- | -- | 1953 | test hole | -- |
| 8N-2E-28G | Roth* | 260 | 100-160 | 1979 | domestic | -- |
| 8N-2E-28H | Miller* | 265 | 198-265 | 1979 | domestic | -- |
| 8N-2E-21D2 | Hamel* | 308 | 184-188; 264-308 | 1971 | irrigation | -- |

TABLE 2.2 (CONTINUED)
SUMMARY OF WELLS NEAR LEHR FACILITY

| WELL | OWNER | TOTAL DEPTH (ft. bgs) | SCREENED INTERVAL (ft. bgs) | YEAR DRILLED | USE | PUMPING RATE (gpm) |
|---|---|---|---|---|---|---|
| 8N-2E-22N2 | Hamel Bros.* | 286 | 70-286 | -- | irrigation | -- |
| 8N-2E-22P1 | Hamel Bros.* | 297 | 98-297 | 1948 | irrigation | -- |
| 8N-2E-22P2 | Rust* | 456 | 100-120; 160-180; 197-290 | 1986 | irrigation | -- |
| -- | Rust | -- | -- | -- | unknown | -- |
| -- | I. Hamel | -- | -- | -- | unknown | -- |
| -- | O. Hamel | 403 | -- | -- | unknown | -- |
| -- | Martinelli | -- | -- | -- | irrigation | -- |
| -- | Martinelli | -- | -- | -- | domestic | -- |
| B6N | UC Davis | 635 | -- | 1964 | irrigation | ~1300 |
| B6S | UC Davis | 500 | -- | 1972 | irrigation | ~1000 |
| C2H | UC Davis | 244 | -- | 1932 | irrigation | 650 (design) |
| C1 | UC Davis | -- | -- | -- | irrigation | not in use |
| C3A | UC Davis | 248 | -- | 1932 | irrigation | 1100 (design) |
| E8 | UC Davis | 517 | -- | 1972 | irrigation | 1400 (design) |
| A1 | UC Davis | 300 | -- | 1952 | irrigation | 2900 (design) |
| "Shop Well" | UC Davis | 251 | -- | ~1950 | utility | abandoned in 1990 |

-- = Unknown
bgs = Below ground surface
* = Owner as of installation date; current owner not verified.
ft = feet
gpm = gallons per minute, estimated by installation subcontractor
(design) Estimated pumping rate based on design of well

In general, pumping rates for irrigation wells are higher than those for domestic wells. Approximate pumping rates for some of the University-owned wells near the LEHR facility are also presented in Table 2.2. Specific pumping rates for other privately-owned wells are not currently known.

## 2.2 HISTORY OF OPERATIONS

UC Davis has conducted radiological studies on laboratory animals for the DOE since the 1950s. The initial studies, conducted for the U.S. Atomic Energy Commission (AEC, now DOE), involved the x-irradiation of beagles at the UC Davis main campus. The main campus Old AEC Project site was located near the area at the northwest corner of Hutchison Drive and Kleiber Hall Drive (Figure 2.1). Eventually, x-irradiation experiments were discontinued at this site which was then used to house the breeding colony that supplied beagles for future studies at the LEHR facility. A portion of the former AEC site is currently occupied by the UC Davis Police and Fire Department offices, dormitory, parking areas, and an open field.

Full-scale experimental use of radioactive materials, including strontium-90 and radium-226, began at the LEHR facility in 1960. In the initial stages of operation at the LEHR facility, waste was handled through a central handling facility on the main campus. However, due to safety concerns, waste handling for LEHR-generated waste was returned to the LEHR facility in the early 1960s.

Portions of the LEHR facility site had previously been used as the UC Davis campus landfill. The landfill consisted of two separate disposal units. Disposal in the oldest unit (Inactive Disposal Unit No. 1) began in the 1940s and ceased in the late 1950s to early 1960s. The area is now covered by the Cobalt-60 Field at the LEHR facility. The next oldest disposal area (Inactive Disposal Unit No. 2) received wastes from 1956 to 1967. This disposal area is partially covered with the eastern most of two sets of dog pens used for animal research at the LEHR facility. A third landfill disposal unit located approximately 600 feet east of the LEHR facility (Inactive Disposal Unit No. 3), was used from 1963 to 1967. The combined total acreage for the three disposal areas is estimated at approximately six acres (Dames & Moore, 1990b).

In the early 1970s, an outdoor Cobalt-60 Field was constructed at the LEHR facility to study the effects of chronic exposure to penetrating gamma ray irradiation on bone marrow cells of beagles. The study was terminated in 1985; however, the source remains in place.

In 1975, a program in basic aerosol science was initiated at the LEHR facility to link the evaluation of airborne materials and the laboratory study of these materials utilizing cellular and animal models. The DOE (1988) reported that research activities in this program focused on the potential health

effects of release to the atmosphere of combustion products from fossil fuel power plants with emphasis on coal flyash.

In 1983, construction of the Toxic Pollutant Health Research Laboratory (TPHRL) was completed at the LEHR facility. This facility was designed for the study of highly toxic and carcinogenic agents including both radioactive and chemical materials. Research at the TPHRL included studies of the behavior of plutonium-241 and americium-241 in beagles and monkeys; radioactive and toxic gas-particle mechanistic aerosol studies; monodisperse aerosol inhalation deposition; intratracheal applications of carcinogen-coated particles; and an organic vapor uptake utilizing beagles (DOE, 1988).

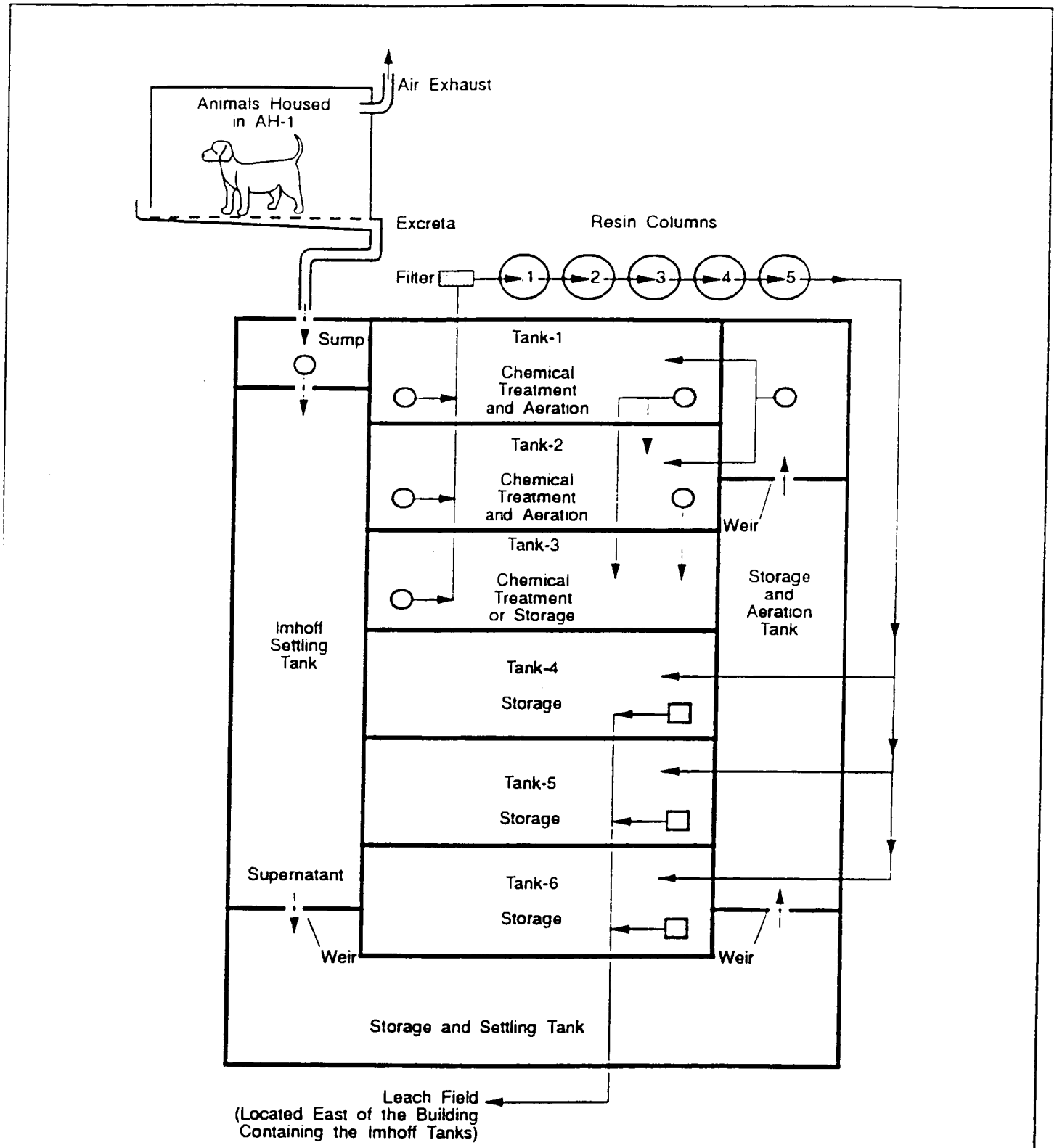
## 2.3 POTENTIAL ENVIRONMENTAL IMPACTS

During the 30-year operation of the LEHR facility, a variety of wastes were generated and disposed of on-site. These wastes included radioactive, biologic, chemical, municipal, and laboratory debris. Detailed descriptions of known waste-generating and disposal processes are described in the DOE, Environmental Survey Preliminary Report, dated March 1988. A brief summary of waste-generating processes or potential environmental impacts at the LEHR facility area presented below.

### 2.3.1 Waste Systems

Radiologic wastes generated from animal experiments using bone-seeking radionuclides were treated using two primary systems. From 1960 to 1987, effluent from strontium-90 experiments was processed through an Imhoff sewage treatment system. From 1982 to 1984, a total of 39.59 $\mu$Ci of plutonium-241 and 0.136 $\mu$Ci of americium-241 were processed through the Imhoff Treatment System. The Imhoff Treatment System used a series of settling tanks and cation exchange columns to treat approximately 200 to 500 gallons per day of waste prior to discharge to leach fields (Figure 2.5). The total throughput of strontium-90 to the Imhoff Treatment System is estimated at 943.2 mCi. After treatment through the Imhoff Treatment System, an estimated 2.55 mCi of strontium-90 was released to the Imhoff Leach Field and subsurface soil. The half-life of strontium-90 is 29 years.

The Imhoff Treatment System utilized the principals of primary sedimentation, aeration, chemical clarification, and filtration prior to passing wastewater through a cation exchange column. The tanks are below-grade and lined with concrete that is sealed with plastic sealant. Total capacity of the tanks is 46,000 gallons. During the years of operation, the tanks filled up with sludge. Sludge was removed by a subcontractor or pumped to a tanker truck. It is unclear if tanker truck sludge was disposed in the landfill. All sludge remaining in the Imhoff Treatment System was removed by DOE in 1992.




REFERENCE: Goldman, M., et al, 1963

## SCHEMATIC REPRESENTATION OF THE IMHOFF TREATMENT SYSTEM

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE7

FIGURE 2.5

The average concentration of strontium-90 reportedly released to the leach field was discharged in compliance with standards established by the Nuclear Regulatory Commission (NRC), $3 \times 10^{-7}$ mCi/mL. This concentration was recorded to have been exceeded in individual batch discharges due to a faulty valve that allowed raw waste to mix with treated batches. In 1987, a deionized water spill introduced additional water to the system and allowed cross-contamination of partially treated wastes.

The system has been inactive since 1987 and some drain lines were purged. The plastic sealant in all tanks was observed to be cracked and blistering, leaving concrete exposed. Water has been noted to be entering the sump to the system. The water was speculated to come from percolation from outside of the system, and it was not noted how the water was discharged. The integrity of the Imhoff Treatment System has never been tested.

Table 2.3 summarizes by year, the volume and strontium-90 level of inflow and effluent from the Imhoff Treatment System discharged to the leach fields, as recorded in DOE files. The table shows the number of batches (approximately 5,000 gallons each) of effluent treated during each year of system operation, total gallons included in those batches, the resulting clarified waste introduced to the exchange columns, and effluent strontium-90 concentrations.

The second waste treatment system consisted of the radium-226 processing system (Figure 2.6). An estimated 6.129 mCi of radium-226 was injected into beagles housed in AH-2, of which approximately 3.827 mCi was subsequently discharged to the radium-226 processing system (Figure 2.6). This system consisted of septic tanks, dry wells and a leach trench as shown on Figure 2.6. The combined capacity of the septic tanks is 14,400 gallons. The septic tanks allowed for the settling of solids, whereas fluids were fed through a distribution box to one of three vertical dry wells (Figure 2.6A). After frequent failures with the original system, a 91-foot-long, 14-foot-deep, and 3-foot-wide cobble-lined seepage trench was added in 1965.

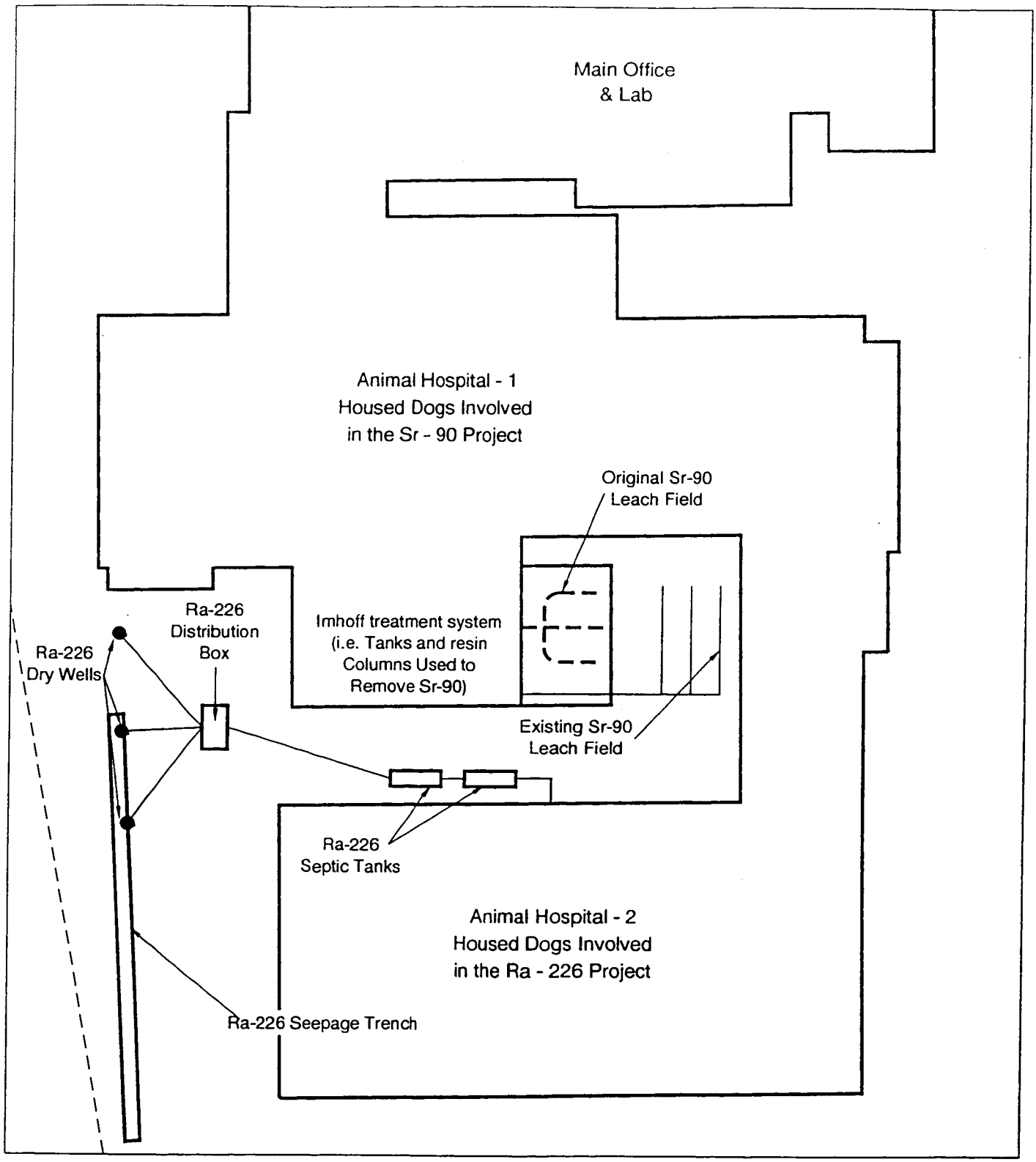
After initial failures, another overflow incident occurred with the radium-226 system in 1985. A sanitary line was blocked causing sewage to back up into the eastern radium-226 septic tank. This material was then pumped directly to the dry wells. Subsequent to this incident, the system was taken out of use. No formal closure has been initiated. One of the radium-226 septic tanks is empty and is speculated to have leaked.

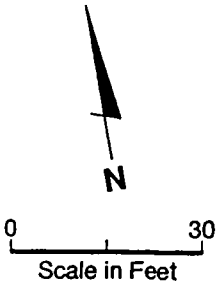
Waste from radium-226 experiments was held in two septic tanks. Radiologic wastes were also buried in trenches and pits (Figure 2.7). Radium-226 waste was separated through the septic tank system, then discharged to dry wells and a cobble-filled seepage trench located west of the septic system.

TABLE 2.3
WASTEWATER TABULATION
IMHOFF TREATMENT SYSTEM
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Year | No. of Batches | Total Gallons [c] | Clarified Waste (mCi)[a] | Decontamination Effluent (μCi)[b] |
|---|---|---|---|---|
| 1960-1961 | 16* | 6,300 | 4 | 19 |
| 1962 | 17* | 8,500 | 18 | 5 |
| 1963 | 19* | 9,400 | 15 | 11 |
| 1964 | 57 | 250,800 | 48 | 20 |
| 1965 | 53 | 226,800 | 83 | 216 |
| 1966 | 57 | 234,900 | 138 | 89 |
| 1967 | 70 | 280,700 | 144 | 389 |
| 1968 | 55 | 245,100 | 143 | 248 |
| 1969 | 30 | 151,200 | 25 | 150 |
| 1970 | 35 | 178,300 | 10 | 91 |
| 1971 | 37 | 192,400 | 2 | 181 |
| 1972 | 37 | 192,200 | 5 | 75 |
| 1973 | 37 | 192,400 | 2.64 | 81 |
| 1974 | 35 | 182,000 | 2.46 | 175 |
| 1975 | 33 | 171,600 | 1.43 | 332 |
| 1976 | 31 | 161,200 | 1.06 | 61 |
| 1977 | 26 | 130,000 | 0.991 | 50 |
| 1978 | 10 | 52,000 | 0.472 | 13 |
| 1979 | 25 | 135,000 | 0.659 | 25 |
| 1980 | 15 | 78,000 | 0.275 | 22 |
| 1981 | 7 | 36,400 | 0.165 | 31 |
| 1982 | 4 | 20,800 | 0.110 | 10 |
| 1983 | 4 | 20,800 | 0.078 | 5.5 |
| 1984 | N/A | 41,600 | N/A | 31 |
| 1985 | N/A | 54,000 | N/A | 26 |
| 1986 | N/A | 20,800 | N/A | 65 |
| 1987 | N/A | 15,600 | N/A | 139.5 |
| Totals | 710 | 3,288,800 | 645.340 | 2,555 |

Source: DOE, 1988
[a] Entering resin columns.
[b] Discharged to leach field.
[c] Totals using available data.
N/A Data not available.
* Batches approximately 500 gallons each.



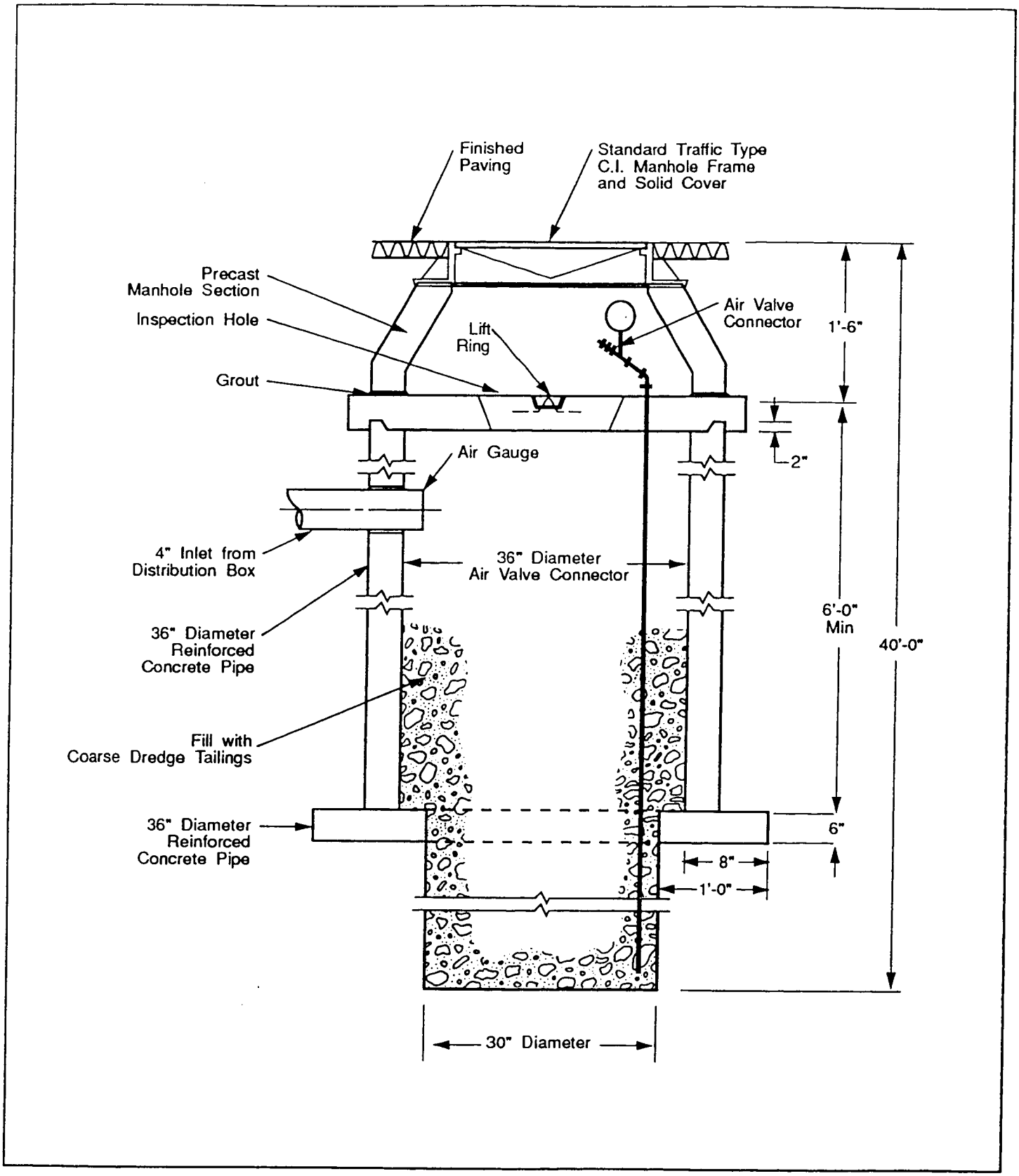

**LOCATION OF THE IMHOFF AND THE RADIUM-226 TREATMENT SYSTEMS**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-123

FIGURE 2.6




REFERENCE: UCD, 1962

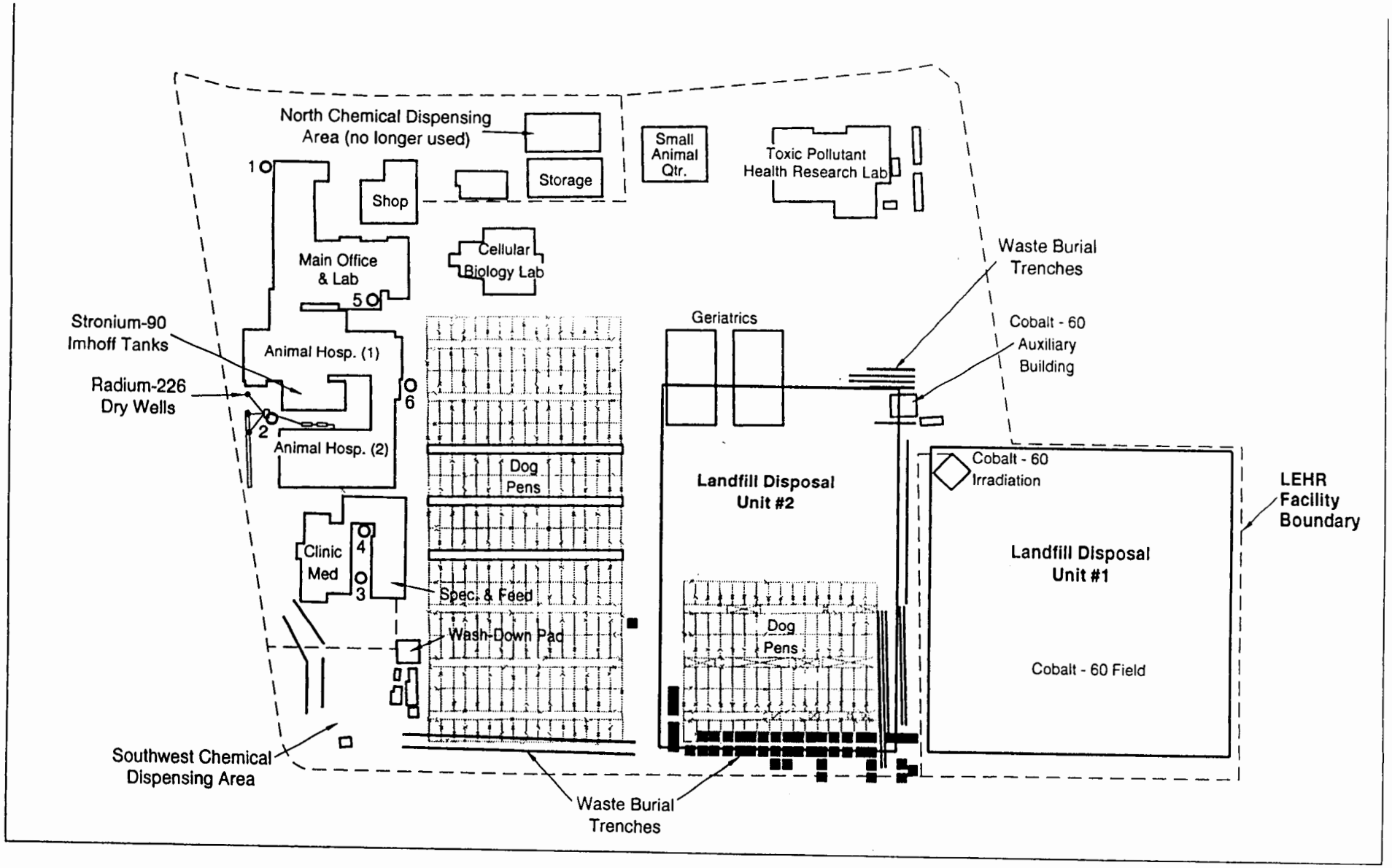
# CONSTRUCTION DETAILS OF THE RADIUM-226 VERTICAL DRY WELLS

Phase II Site Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE7

FIGURE 2.6A




EXPLANATION

- ■ Radioactive Trenches and Holes
- — Waste Burial Trenches
- ○ Domestic Septic Tanks

0 150
Scale in Feet

N

**FORMER WASTE DISPOSAL AREAS**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

FIGURE 2.7

DAMES & MOORE

10805-454-044 DOE-127

### 2.3.2 Domestic Septic Tanks

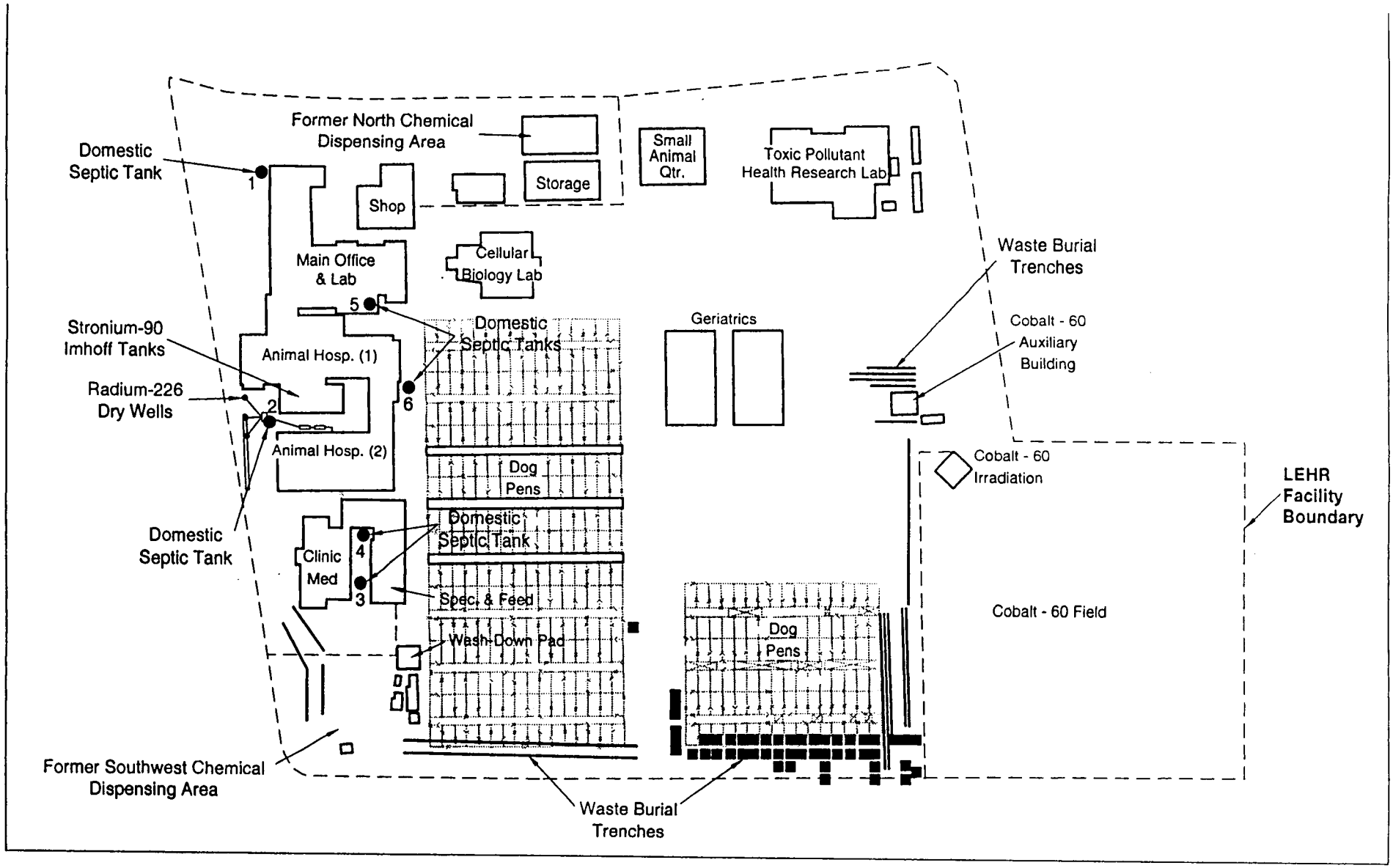
Non-radioactive liquid was disposed of at six on-site septic tanks (Figure 2.7) prior to 1971, when the LEHR facility was connected to the currently active UC Davis sewage treatment plant located at the main campus. Septic tanks were reported to have received all liquid wastes from the LEHR facility except for strontium-90 and radium-226 project wastes. However, during backup of the radium-226 system, one septic tank west of AH-2 was reported to have received effluent from AH-2. One septic tank, located between Animal Hospitals 1 and 2, was reported to be in use until 1988. Prior to connection to the UC Davis Wastewater Treatment Plant, the septic tanks were reported to have been filled with sand and abandoned in place. Effluent and influent lines were reported to be severed and capped. Any sludges that remained in the tanks are not reported to have been removed prior to filling tanks with sand.

### 2.3.3 Chemical Dispensing Area

The LEHR facility used various bulk chemicals including, but not limited to, acetone, kerosene, toluene, xylene, benzene, formaldehyde, ethyl alcohol, formalin, weed oil (diesel oil), and chlordane. These chemicals were stored and dispensed from two areas, the North Chemical Dispensing Area and the Southwest Chemical Dispensing Area (Figure 2.7). The chemicals were stored in an open-sided wooden structure in the southwestern portion of the LEHR facility. Chemicals may have been dumped in the dog pen areas, in trash pits in the old landfill, or the trenches and pits where radioactive wastes were buried (DOE, 1988). Chemical wastes associated with animal experiments may also have been disposed of through the septic system leach fields and seepage pits (DOE, 1988).

### 2.3.4 Waste Burial

Low-level radioactive solid waste generated by DOE-sponsored research at the LEHR facility was disposed in trenches located primarily in the southwest corner of the site (Figure 2.8). UC Davis disposed experimental waste in 19 trenches and 49 pits located along the southern boundary and eastern portion of the LEHR facility. The wastes were reportedly disposed in accordance with applicable regulations in place during that time. The UC Davis trenches are reported to have been approximately 2 feet wide and from 33 to 270 feet long, and disposal pits were typically 4 feet by 4 feet. The trenches and pits were reported to be between 8 and 10 feet deep. Potentially radiologic wastes from other UC Davis campus activities were reportedly disposed in these trenches and pits as well. In addition, it was reported by UC Davis personnel that some chemicals and laboratory wastes were disposed in the trenches and pits. Actual conditions or hazardous levels of wastes disposed in trenches and pits are unknown. Some of the waste has been confirmed to be biological (animal carcasses). Total quantities of waste disposal in trenches and pits were estimated at 30,150 cubic feet (Warren, 1985). Waste was reportedly covered with up to four feet of material.




EXPLANATION

- ■ Radioactive Trenches and Holes
- — Waste Burial Trenches
- ● Domestic Septic Tanks

0 150
Scale in Feet

N

DAMES & MOORE

10805-454-044 DOE-181

# LOCATION OF DOMESTIC SEPTIC TANKS

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

FIGURE 2.8

Based on records provided by UC Davis, most burial trenches or pits could contain both chemical and radiologic wastes. Trenches located in the southwest corner and the southern border of the main dog pens are reported to contain primarily LEHR waste. Two trenches between the two dog pens reportedly contain radiologic carcasses and other waste. Other waste trenches and pits were reported to have been used primarily by UC Davis; however, since these burial sites were open during LEHR facility operation, they may contain radioactive wastes.

Known radioactive wastes disposed in the disposal pits are summarized in Table 2.4. This table lists the known trenches and pits that reportedly received laboratory wastes from UC Davis and DOE records. This table identifies the contents of each pit and describes the location of each waste burial trench. In many cases, the amount and type of radionuclides in trenches at burial pits are also estimated.

### 2.3.5 Landfill Units

As discussed previously, prior to construction and during operation of the current LEHR facility, UC Davis disposed sanitary and chemical wastes on and east of the LEHR property in the Old UC Davis Landfill (Figure 2.7). The landfill consists of three separate landfill units that operated at different times. Two of the landfill units are located at LEHR. A more detailed discussion of the Old UC Davis Landfill is presented in the SWAT report prepared for UC Davis (Dames & Moore, 1990b).

The oldest of the three inactive disposal units (No. 1) is presently covered by the Cobalt-60 Field. Disposal reportedly began in this unit in the 1940s and ceased in the 1950s. General campus wastes and possibly chemical wastes appear to have been disposed at the landfill unit. Sewage sludge from the adjacent sewage treatment plant was reportedly disposed in the landfill, as well (DOE, 1988).

The second disposal unit (No. 2) was operated from 1956 to 1967, and consisted of twelve east-west oriented disposal pits. This unit is located in the mid-portion of the LEHR facility, and is partially covered with the easternmost of two sets of dog pens. The pits are reported to have averaged 10 feet in depth and are unlined. Types of wastes disposed at this site have not been documented, although general refuse, animal parts, ash from the UC Davis incinerator, and some liquid chemicals were reportedly disposed in this unit.

UC Davis operated a third disposal unit (No. 3) from 1963 to 1967. This unit is located east of the LEHR facility and former UC Davis Sewage Treatment Plant. Wastes were placed in two large, pit-like excavations and covered with a soil cap. This disposal area is outside of the LEHR facility boundaries (Dames & Moore, 1990b).

TABLE 2.4
LEHR RADIOACTIVE WASTE BURIAL DATA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

I. Radioactive Waste Burial Holes

| Hole No. | Date | Description and Estimated Radionuclide Quantity |
|---|---|---|
| 1 | Unknown | Radioactive cow buried. Exact location and date not known. Cow burned on a Sunday. |
| 2 | 1956 | Dug in 1956. Exact location not known. |
| 3 | 5/16/61 | Radioactive calves buried 6' -0" deep from Vet. Med., Armstrong Tract. Exact location not known. |
| 4 | Unknown | Unknown |
| 5 | Unknown | Unknown |
| 6 | Unknown | Unknown |
| 7 | Unknown | Unknown |
| 8 | Unknown | Unknown |
| 9 | 2/5/63 | Not included in original table. |
| 10 | 4/23/63 | Not included in original table. |
| 11 | 7/9/63 | Not included in original table. |
| 12 | 9/5/63 | 0.537 nCi $^{14}C$ |
| 13 | 9/28/63 | .005 mCi $^{59}Fe$ |
| 14 | 10/8/63 | .03 mCi $^{59}Fe$ |
| 15 | 10/18/63 | 0.102 nCi $^{59}Fe$ |
| 16 | 3/3/64 | 3 nCi $^{45}Ca$ + 0.05 nCi $^{14}C$ + 4 nCi $^{32}P$ |
| 17 | 6/5/64 | 2.5 nCi $^{35}S$ + 4 nCi $^{14}C$ |
| 18 | 9/9/64 | .4 mCi C14 + .5 mCi $^{35}S$ + .75 mCi $^{14}C$ |
| 19 | 9/20/64 | 8 mCi $^{45}Ca$ + .1 mCi $^{3}H$ |
| 20 | 12/14/64 | .015 mCi $^{85}Sr$ + .06 mCi $^{137}Cs$ |
| 21 | 3/16/64 | 6 nCi $^{45}Ca$ + .1 mCi $^{14}C$ |
| 22 | 2/1/65 | 0.5 nCi $^{45}Ca$ |
| 23 | 2/12/65 | .06 mCi $^{59}Fe$ |
| 24 | 4/22/65 | 0.560 mCi $^{45}Ca$, 8 mCi $^{32}P$ |
| 25 | 8/17/65 | $^{14}C$-0.2 mCi, $^{3}H$-0.1 mCi, $^{35}S$-0.01 mCi, $^{59}Fe$-0.06 nCi |
| 26 | 9/8/65 | $^{3}H$-0.005 mCi, $^{35}S$-0.05 mCi, $^{65}Zn$-0.503 mCi, $^{22}Na$-0.02 mCi $^{45}Ca$-0.24 mCi, $^{131}I$-0.50 mCi, $^{14}C$-0.334 mCi, $^{59}Fe$-0.99 mCi |
| 27 | 4/26/66 | $^{14}C$-0.8 mCi |
| 28 | 10/24/66 | $^{14}C$-0.16 mCi, $^{59}Fe$-0.05 mCi, $^{238}U$-0.002 mCi, $^{226}Ra$-0.018 mCi $^{203}Hg$-1.5 mCi |
| 29 | 2/6/68 | $^{137}Cs$-.05 mCi, $^{14}C$-11.174 mCi $^{3}H$110.001 mCi, $^{131}I$-1.026 mCi |
| 30 | 6/14/68 | $^{14}C$-32.1992 mCi, $^{60}Co$-.23 mCi, unknown .005 mCi |

TABLE 2.4 (CONTINUED)

| Hole No. | Date | Description and Estimated Radionuclide Quantity |
|---|---|---|
| 31 | 7/12/68 | $^{137}$Cs-.15 mCi, $^{3}$H-2.21 mCi, $^{60}$Co-.003 mCi, $^{14}$C 18.276 mCi |
| 32 | 7/17/69 | $^{14}$C-44.77 mCi |
| 33 | 8/7/69 | $^{14}$C-27.033 mCi |
| 34 | 9/11/69 | $^{3}$H-55.282 mCi, $^{14}$C-32.251 mCi |
| 35 | 3/19/70 | $^{3}$H-26.388 mCi, $^{14}$C-42.699 mCi |
| 36 | 5/21/70 | $^{3}$H-24.903 mCi, $^{14}$C-45.2547 mCi, $^{60}$Co-.005 mCi |
| 37 | 6/25/70 | $^{3}$H-4.4083 mCi, $^{14}$C-47.9436 mCi, $^{35}$S-.5 mCi |
| 38 | 4/13/71 | $^{3}$H-19.621 mCi, $^{14}$C-33.318 mCi, $^{35}$S-0.6 mCi |
| 39 | 1/4/72 | $^{3}$H-24.451 mCi, $^{14}$C32.392 mCi, $^{35}$S-6.3 mCi, $^{22}$Na -1.051 mCi |
| 40 | 7/14/72 | $^{3}$H-93.4 mCi, $^{14}$C-30 mCi |
| 41 | 8/22/72 | $^{3}$H-38.85 mCi, $^{14}$C-33.1 mCi, $^{125}$I-1.5 mCi |
| 42 | 11/2/72 | $^{14}$C-15.294 mCi, $^{3}$H-44.035 mCi, $^{125}$I-4.5 mCi |
| 43 | 2/1/73 | $^{14}$C-35.1 mCi, $^{3}$H-26.0 mCi, $^{125}$I-5.0 mCi |
| 44 | 4/12/73 | $^{14}$C-60.1 mCi, $^{3}$H-75.0 mCi, $^{125}$I-5.0 mCi |
| 45 | 6/5/73 | $^{14}$C-32.55 mCi, $^{3}$H-42.7 mCi, $^{32}$P-46.66 mCi |
| 46 | 10/18/73 | $^{3}$H-51.96 mCi, $^{14}$C-45.55 mCi, $^{32}$P-67.26 mCi |
| 47 | 2/20/73 | $^{14}$C-28.63 mCi, H-3 30.17 mCi, $^{32}$P-90.31 mCi |
| 48 | 4/4/74 | $^{32}$P-89.401 mCi, $^{3}$H-45.286, $^{14}$C-25.53 mCi, $^{125}$I-.8768 mCi, $^{45}$Ca-.31 mCi, $^{22}$Na-.1351 mCi, $^{86}$Rb-3.8 mCi, $^{57}$Co-.0065 mCi, $^{51}$Cr/$^{75}$Se/$^{59}$Fe/$^{99}$Mo/$^{198}$Au/$^{133}$Xc/$^{111}$In/$^{203}$Hg/$^{67}$Ga (approximately 1.3 mCi each) |
| 49 | 7/16/74 | $^{14}$C-24.506 mCi, $^{3}$H-83.981 mCi, $^{32}$P-79.55 mCi, $^{35}$S-11.05 mCi, $^{22}$Na-.114 mCi, $^{86}$Rb-4.2 mCi, $^{75}$Se-.2 mCi, $^{45}$Ca-.001 mCi, $^{59}$Fe-.1 mCi, $^{36}$Cl-.254 mCi |

## II. Radioactive Waste Burial Trenches

| Trench No. | Date | Description |
|---|---|---|
| 1 | Unknown | 2'0" wide, 66'0" long, 10'0" from north fence line, and 3'0" from east fence line. Covered June 10, 1957. |
| 2 | 6/10/57 | 2'0" wide, 100'0" long, 16'0" from north fence line, and 3'0" from east fence line. Opened on June 10, 1957 and covered on October 27, 1957. |
| 3 | 10/25/57 | Same dimensions as Radioactive Trench #2. Distance from north fence line not known. Opened on October 25, 1957 and covered on May 9, 1958. |
| 4 | 5/9/58 | 2'0" wide, 45'0" long, and 30'0" from north fence line. Opened on May 9, 1958 and on November 1958. |
| 5 | 5/9/58 | 2'0" wide, 33'0" long, and 63'0" from north fence line. Opened on May 9, 1958 and on November 1958. |
| 6 | 11/13/58 | Dimensions on plot plan at right. Opened on November 13, 1958 and covered on May 29, 1959. |

TABLE 2.4 (CONTINUED)

| Trench No. | Date | Description |
|---|---|---|
| 7 | 5/29/59 | 2'0" wide and 123'0" long. Distance from east fence line not known. Trench dug on May 29, 1959 and covered on April 8, 1960. |
| 8 | 4/8/60 | 2'0" wide and length to center of rubbish Pit #3. Distance from east fence not known. Opened on April 8, 1960 and covered on September 28, 1960. |
| 9 | 9/23/60 | 2'0" wide and to center of rubbish Pit #3. 36'0" from east fence line. Opened on September 23, 1960 and probably closed on November 7, 1960. |
| 10 | 11/7/60 | Exact dimensions and location not known. Opened on November 7, 1960 and closed March 13, 1961. |
| 11 | 3/13/61 | 2'0" wide, 180'0" long and 9'0" to center of trench from east fence line. Opened on March 13, 1961. Dated closed not known. |
| 12 | 12/5/58 | 2'0" wide, 8'0" long, and 55'0" from southwest corner. 9'6" to center of trench from south fence. Charged to University Physician, Job #215160. Opened December 5, 1958. Date closed not known. |
| 13 | 5/29/59 | Continuation of Radioactive Trench #12. Dimensions on drawing. Opened on May 29, 1959 and closed on April 8, 1960. |
| 14 | 4/8/60 | 2'0" wide. Located between Radioactive Trench #13 and south fence line. Opened on April 8, 1960. Date closed unknown. |
| 15 | Unknown | Most likely used between 9/63 and 11/65. Probable contents - radium-226 and strontium-90 from dog fecal waste. |
| 16 | Unknown | As #15. |
| 17 | Unknown | As #15 and #16 |

Source: Warren, 1985

NOTE: Radionuclide quantities as recorded in Warren (1985); information not confirmed. Actual volumes of waste not known.

### 2.3.6 Dog Pen Area

Two outdoor dog pen areas containing approximately 350 separate pens are located at the LEHR facility. The westernmost set of pens originally contained 304 pens. In 1975, 48 pens were removed to allow construction of the Cellular Biology lab (Building H-294; Figure 2.2). These pens reportedly housed the dogs, which received the highest dosages of strontium-90 and radium-226. Dogs injected with strontium-90 were housed in Animal Hospital 1 for 540 days during treatment, and an additional 30 days following treatment. The out-door pens were used to house the dogs after their initial treatments.

Excreta from dogs housed in outdoor pens contained low levels of radiologic constituents. Solids were removed from the pens on a daily basis. Urine would be expected to evaporate rapidly upon contact with pen gravels. An estimated 2 mCi of strontium-90 and 0.5 mCi of radium-226 were potentially excreted in dog urine over the life of the project.

Chlordane was used on dogs kept in outdoor pens from 1960 until the early 1970s to control fleas. Chlordane was sprayed on dogs or dogs were dipped in chlordane, or with chlordane-kerosene, and returned to the dog pen areas. Annual usage or chlordane is estimated between 25 and 50 gallons. Spent chlordane from the dip tanks was recorded to have been disposed in trenches and pits.

### 2.3.7 Stormwater and Dry Wells

Stormwater runoff, observed to pond at several locations at the LEHR facility, has the potential to come in contact with impacted soils or facilities and to subsequently impact other areas. Potential sources include the southwest disposal area, trenches and burial pits along the southern border of the site, the dog pens, and the former Chemical Dispensing areas. LEHR facility personnel have reported that water levels in treatment tanks at the Imhoff building increase when it rains.

Stormwater at the LEHR facility was controlled with dry wells. Two dry wells have been reported to have been used. One well is located between the Clinical Pathology Building and the Feed Mix/Specimen Storage Building (Buildings H-215 and H-216, respectively; Figure 2.2), and the other is by the washdown pond (Building H-291). Other dry wells are reported to exist but the locations are unknown. Construction of dry wells typically consists of cobble- or gravel-filled open-bottom holes or trenches. Dry wells are typically deep enough to access permeable subsurface materials capable of receiving significant amounts of water.

### 2.3.8 Wastewater Treatment Plant

The Old UC Davis Sewage Treatment Plant is located adjacent to the eastern boundary of the LEHR facility. The Old UC Davis Sewage Treatment Plant processed campus wastewater until 1949 when a new wastewater treatment plant was constructed on the main UC Davis campus.

Dried sludge and possibly wet sludge from the Old Wastewater Treatment Plant reported to have been disposed in the Old UC Davis Landfill unit No. 1 in the area of the current Cobalt-60 Field. Liquid effluent from the Old Wastewater Treatment Plant was reportedly disposed through a gravel drain process located south of the former plant site.

The current wastewater treatment plant is located on the main campus. Effluent from the plant discharges to Putah Creek just west of Old Davis Road. The discharge is permitted under NPDES.

### 2.3.9 Other Disposal Areas

Materials such as dirt, wood, and concrete debris, were reported to have been disposed along the northern levee of the South Fork of Putah Creek; however, no reported hazardous or radioactive waste was disposed on the levee (DOE, 1988).

Other potential sources of environmental impact at the LEHR facility include, but are not limited to:

- Other potential spills or unrecorded handling activities;
- Other currently unidentified disposal areas at LEHR;
- The septic system located east of the Cobalt-60 source building;
- Soils below the Imhoff tanks potentially impacted from leakage;
- The original Strontium-90 Leachfield under the Imhoff building;
- Sewer lines and other piping that previously carried organic or radiologic waste streams;
- Airborne constituents, fugitive dust;
- Potential discharge of chemicals via sinks or floor drains;
- A reported spill of the sludge storage tanker;
- Impacts from storage of waste in Rad Waste Storage areas; and
- Washdown from the vehicle wash pond.

To date, these potential sources have not been investigated, nor has significant information, such as inventory data, been identified that suggests that any of these areas may be significant sources of contaminants. Therefore, volume and types of wastes potentially present in these areas cannot be

accurately estimated. The list is provided only to identify those areas or facilities that may need further investigation during the planned site-wide soil and groundwater investigation.

## 2.4 PHYSICAL SETTING

The LEHR facility is located in the southern portion of the Sacramento Valley. The Sacramento Valley extends from the Red Bluff area in the north to the Sacramento-San Joaquin Delta region in the south. The LEHR facility sits in a flat-lying or gently sloping area of former farmland.

The LEHR facility is located in a rural area, with approximately 75 percent of the surrounding land being used for agriculture. Approximately 40 percent of that land is irrigated. Major crops include fruits, nuts, and grains. Additionally, some of the nearby lands are used for cattle grazing (DOE, 1988).

### 2.4.1 Topography

The regional topography surrounding the LEHR facility is typical of the broad relatively flat Sacramento Valley. The Sacramento River, the primary drainage of the Sacramento Valley, is approximately 12 miles east of the site.

The site is situated on relatively flat-lying land termed the Putah Plain (DWR, 1978). The average elevation at the site is approximately 50 feet above mean sea level. Relief across the site is approximately two feet, with the lowest portion in the area of the Cobalt-60 Field. The land surface slope in the vicinity of the LEHR facility is approximately 0.001 foot/linear foot (5 feet per mile) to the east/northeast toward the Sacramento River. The site is not within the 100-year flood plain as defined in the 1982 FEMA Flood Insurance Maps.

Local drainage at the LEHR facility is generally to the south-southwest. As presented in facility drawings in the 1988 DOE Report, water from the dog pen area is collected in catchbasins and piped to the sanitary sewer. Drainage in the south and southwest area is collected in a stormwater drainage system and routed to the LEHR stormwater lift station and subsequently pumped to the west side of the Old Davis Road and discharged to Putah Creek.

### 2.4.2 Geology

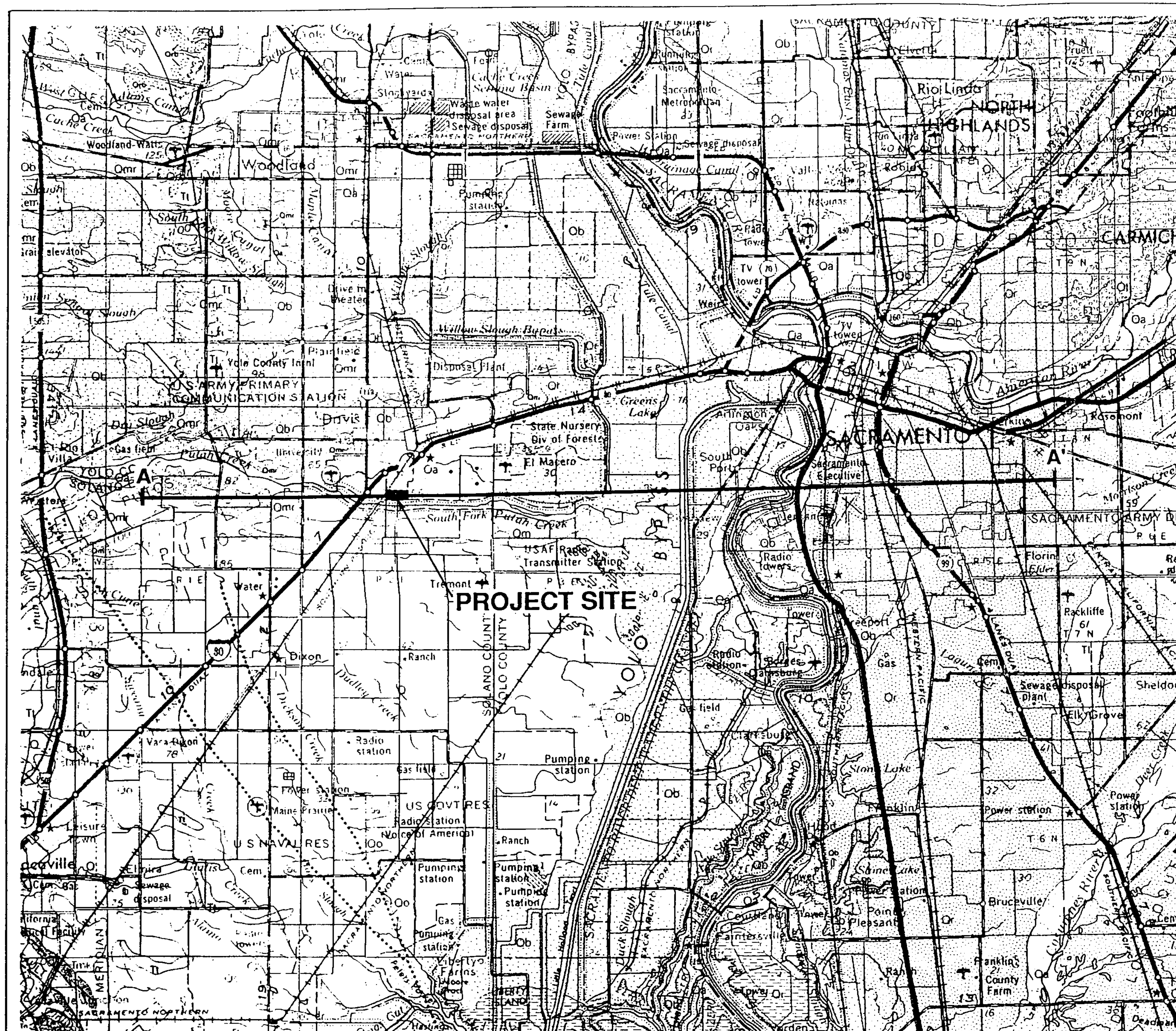
The Sacramento Valley is characterized by sedimentary deposits of both marine and continental origin. Deformation of these deposits due to uplift of the surrounding mountains has resulted in a regional dip of the sediments from the sides of the valley toward its axis.

#### 2.4.2.1 Regional Geologic Setting

The Sacramento Valley is a large, asymmetrical structural trough bordered by the Coast Ranges to the west, the Klamath Mountains and Cascade Range to the north, and the Sierra Nevada Mountains to the east. The valley has been filled with sediments derived from both marine and continental sources. Older sediments (Jurassic to Eocene) were deposited primarily in marine environments whereas younger sediments (Eocene to Recent) were deposited in continental environments including lacustrine, fluvial and alluvial fan environments as shown on Figure 2.9 (Olmsted and Davis, 1961). Near the eastern margin of the valley, sedimentary deposits form a thin veneer on crystalline basement rocks. Norris and Webb (1976) indicate a greatest thickness of over 30,000 feet of Jurassic age and younger sediments at the axis of the valley, which is west of its geographic centerline. Figure 2.10 is a regional cross section of the Sacramento Valley, showing the variation in thickness and the dip of the sediment fill. The cross section shows the western offset of the valley axis. As a result of this asymmetry, sedimentary deposits on the western margin of the valley dip much more steeply than those of the eastern margin. Beneath the central part of the valley where the site is located, sedimentary deposits are relatively flat-lying.

The site and the surrounding area are located on the geomorphic unit termed "low alluvial plains and fans" (DWR, 1978), specifically the Putah Plain. This surface represents the distal portions of the alluvial fan deposits associated with Putah Creek. Sediments which form these alluvial fan deposits consist mainly of silts and clays with coarse-grained sediments found locally. Fine-grained sediments represent overbank deposits, whereas the coarse-grained sediments represent channel deposits. The age of these deposits range from late Pleistocene to Recent. The thickness of the alluvial fan deposits is approximately 180 feet (DWR, 1978).

The alluvial fan deposits conformably overlie the Tehama Formation beneath the site. There is some evidence to suggest that farther west, this contact is unconformable (Hubbard, 1989). The Tehama Formation is Plio-Pleistocene in age and is the principal water-bearing formation on the west side of the Sacramento Valley. It is thought to be contemporaneous with the Laguna Formation of the east side of the valley (DWR, 1978; Olmsted and Davis, 1961).




SEDIMENTARY AND METASEDIMENTARY ROCKS

QUATERNARY

| Symbol | Unit |
|---|---|
| Q | Alluvium |
| | Mine and dredge tailings |
| Qa | Levee and channel deposits |
| Qb | Basin deposits *(Alluvium)* |
| Qi | Intertidal deposits *(Peaty mud)* |
| Qs | Dune sand |
| Ql | Lake deposits |
| Qo | Older alluvium |
| Qg | Glacial deposits |
| Qm | Modesto Formation *(Alluvium)* — $Qm_2$/$Qm_1$ Upper and lower members |
| Qr | Riverbank Formation *(Alluvium)* |
| Qmr | Modesto-Riverbank Formations *(Arkosic alluvium)* |
| | Montezuma Formation *(Poorly consolidated, clayey sand)* |
| | Turlock Lake Formation *(Sand, silt, and gravel)* |
| | Red Bluff Formation *(Gravel in reddish, silty or sandy matrix)* |
| | North Merced Gravel *(Thin pediment veneer)* |

TERTIARY

| Symbol | Unit |
|---|---|
| Tt | Tehama Formation *(Sand, silt, and volcaniclastic rocks)* |

A —— A' Cross Section Location

REFERENCE: Geologic Map of the Sacramento Quadrangle, CA, California Division of Mines and Geology, 1981

N

0 — 5
Scale in Miles

**REGIONAL GEOLOGIC MAI**
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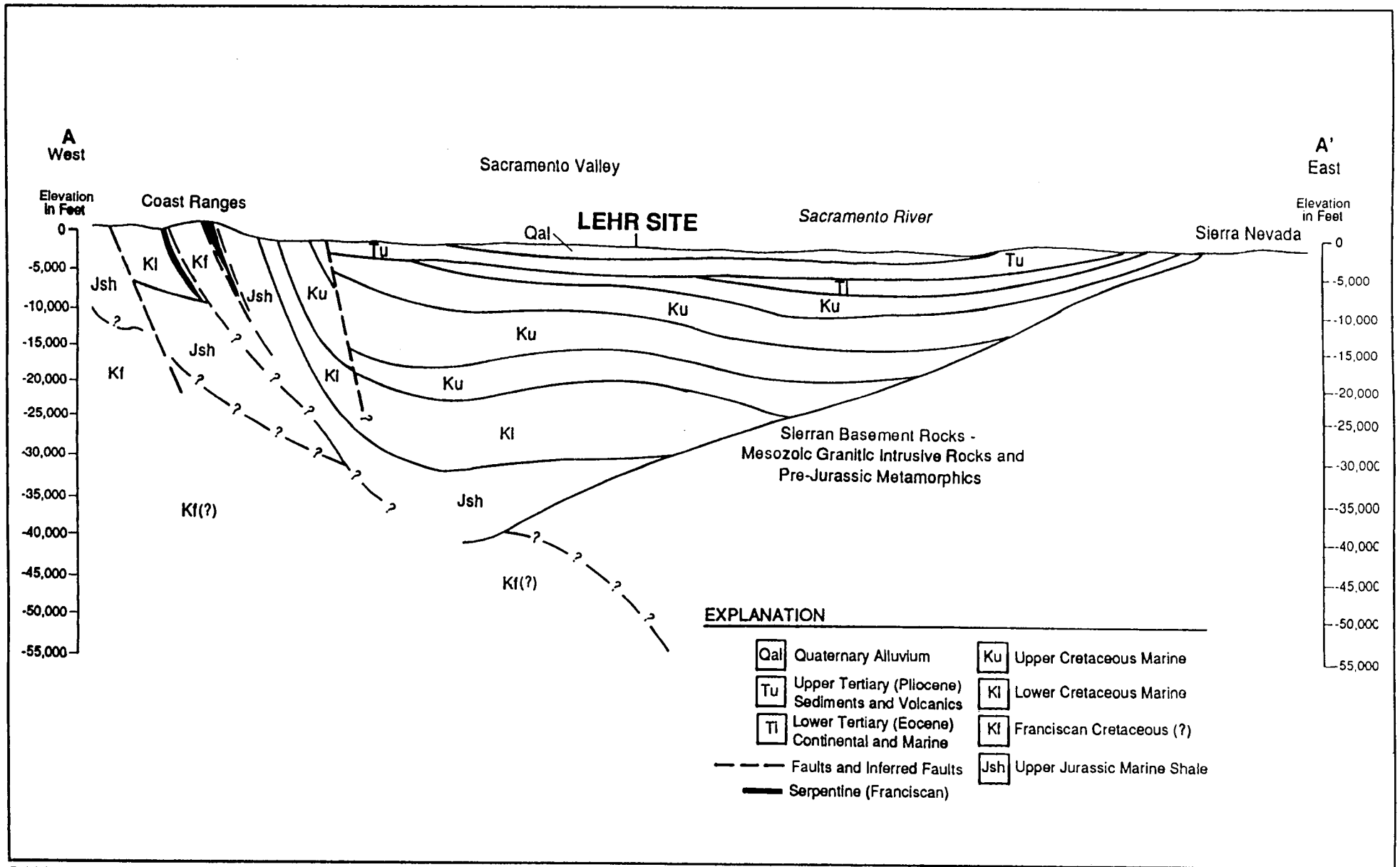
FIGURE 2




REFERENCE: Generalized from Norris and Webb, 1976

0 6
Scale in Miles

# REGIONAL GEOLOGIC CROSS SECTION A-A'

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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10805-454-044 DOE3

FIGURE 2.10

#### 2.4.2.2 Site Geology

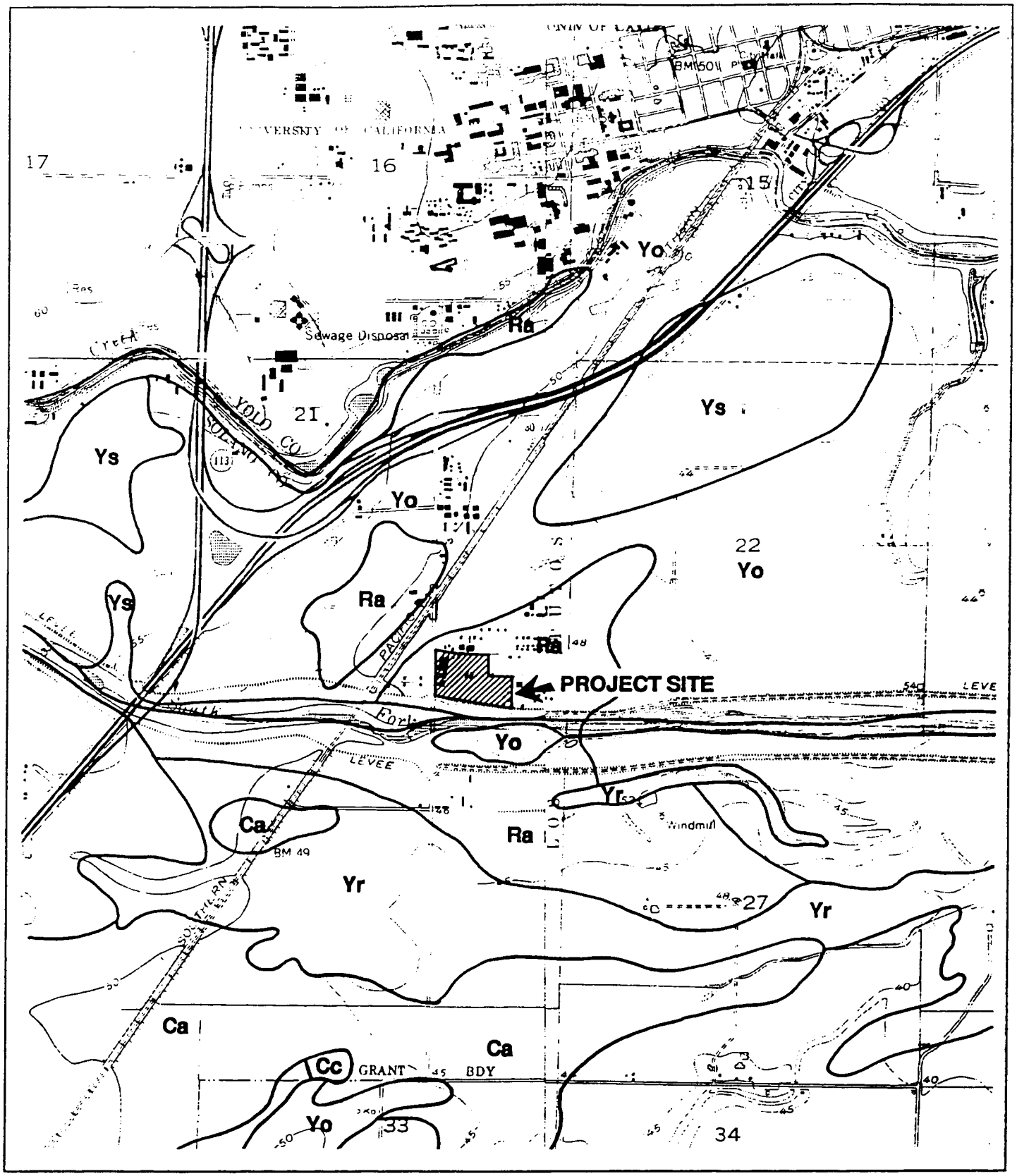
Surface soil at the LEHR facility is classified in the Reiff series, with a texture of fine sandy loam. The dominant texture of upper subsoil is sandy, and the dominant lower subsoil is gravelly, loamy (silty) sand. The soil is characterized by a deep, permeable profile, and good drainage. Figures 2.11 and 2.11A show soils in the vicinity of the site (including the Old AEC Project site) as mapped by the U.S. Department of Agriculture, Soil Conservation Service (Bates, 1977).

Stratigraphy at and near the LEHR facility has previously been evaluated by observation of soil cuttings, samples, and cores from drilling of borings for monitoring wells, shallow soil borings, and backhoe trenches. The borings for monitoring wells were drilled to an average depth of approximately 55 feet and a maximum depth of 90 feet.

Figure 2.12 is a schematic cross section of stratigraphy beneath the LEHR facility. This figure shows that sediments beneath the site from the ground surface to approximately 80 feet below ground surface (bgs) are predominantly fine-grained (silt or clay). Coarser sediments were observed in borings that penetrated deeper than 80 feet bgs (UCD-7), where coarse sand and gravel were encountered.

Sediments above the water table are typically red-brown, brown, or yellow-brown clayey silt to clay, have medium-stiff to very stiff consistency, and low moisture content. The upper five to ten feet is predominantly a fine sandy silt. A softer-consistency, silty layer exists at about 30 feet bgs in most of the borings.

Sediments encountered at the site appear to have been deposited in a fluvial depositional system. Common features in this type of depositional system include (from coarser to finer): channel, point-bar, overbank, and flood plain environments (Leeder, 1982). Gradation of one depositional setting into another is common, and deposits are often complex because of the shifting nature of the location of deposition. A more detailed description of site stratigraphy, which includes information obtained during this Phase II Site Characterization, is provided in Section 6.1.




REFERENCE: USGS 7.5' Quadrangles Merritt and Davis, CA 1981

SOURCE: Soil Survey of Solano County, USDA Soil Conservation Service 1977

0 2000
Scale in Feet

N

# DISTRIBUTION OF SURFACE SOILS IN SITE VICINITY

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE4

FIGURE 2.11

SOIL LEGEND

Each symbol consists of letters or a combination of letters and numbers. The first capitol letter is the initial one of the soil name. A second capitol letter, if used, shows the class of slope. Symbols without a slope letter are for nearly level soils. A final number, 2 or 3, in a symbol shows that the soil is named as eroded or severely eroded.

| SYMBOL | NAME |
|---|---|
| AcC | Altamont clay, 2 to 9 percent slopes |
| AcE | Altamont clay, 9 to 30 percent slopes |
| AcF2 | Altamont clay, 30 to 50 percent slopes, eroded |
| AlC | Altamont-San Ysidro-San Benito complex, 2 to 9 percent slopes |
| AlE | Altamont-San Ysidro-San Benito complex, 9 to 30 percent slopes |
| AmC | Altamont-Diablo clays, 2 to 9 percent slopes |
| AmE2 | Altamont-Diablo clays, 9 to 30 percent slopes, eroded |
| An | Alviso silty clay loam |
| AoA | Antioch-San Ysidro complex, 0 to 2 percent slopes |
| AoC | Antioch-San Ysidro complex, 2 to 9 percent slopes |
| AsA | Antioch-San Ysidro complex, thick surface, 0 to 2 percent slopes |
| AsC | Antioch-San Ysidro complex, thick surface, 2 to 9 percent slopes |
| BrA | Brentwood clay loam, 0 to 2 percent slopes |
| BrC | Brentwood clay loam, 2 to 9 percent slopes |
| Ca | Capay silty clay loam |
| Cc | Capay clay |
| CeA | Clear Lake clay, 0 to 2 percent slopes |
| CeB | Clear Lake clay, 2 to 5 percent slopes |
| ClA | Clear Lake clay, saline, 0 to 2 percent slopes |
| Cm | Columbia fine sandy loam |
| Cn | Conejo loam |
| Co | Conejo gravelly loam |
| Cr | Conejo clay loam |
| Cs | Conejo soils, wet |
| CvD2 | Corning gravelly loam, 2 to 15 percent slopes, eroded |
| CvE2 | Corning gravelly loam, 15 to 30 percent slopes, eroded |
| DoC | Diablo-Ayar clays, 2 to 9 percent slopes |
| DoE2 | Diablo-Ayar clays, 9 to 30 percent slopes, eroded |
| DbC | Dibble-Los Osos loams, 2 to 9 percent slopes |
| DbE | Dibble-Los Osos loams, 9 to 30 percent slopes |
| DbF2 | Dibble-Los Osos loams, 30 to 50 percent slopes eroded |
| DlC | Dibble-Los Osos clay loams, 2 to 9 percent slopes |
| DlE | Dibble-Los Osos clay loams, 9 to 30 percent slopes |
| DlF2 | Dibble-Los Osos clay loams, 30 to 50 percent slopes, eroded |
| Eb | Egbert silty clay loam |
| Ec | Egbert silty clay loam, occasionally flooded |
| GoG2 | Gaviota sandy loam, 30 to 75 percent slopes, eroded |
| GlE | Gilroy loam, 9 to 30 percent slopes |
| HaF | Hambright loam, 15 to 40 percent slopes |
| HtE | Hambright-Toomes stony loams, 9 to 30 percent slopes |
| Ja | Joice muck |
| Jb | Joice muck, clay subsoil variant |
| Ma | Mode land |
| MeG3 | Mayman-Los Gatos loams, 15 to 75 percent slopes, severely eroded |
| MkA | Millsop sandy loam, 0 to 2 percent slopes |
| MlC | Millsop-Los Osos complex, 2 to 9 percent slopes |
| MmE | Millsholm loam, 15 to 30 percent slopes |
| MmG2 | Millsholm loam, 30 to 75 percent slopes, eroded |
| MnC | Millsholm loam, moderately deep variant, 2 to 9 percent slopes |
| MnE | Millsholm loam, moderately deep variant, 9 to 30 percent slopes |
| Om | Omni clay loam |
| On | Omni silty clay |
| Pc | Pescadero clay loam |
| Pe | Pescadero clay |
| Ra | Reiff fine sandy loam |
| Rd | Reyes silty clay loam, drained |
| Re | Reyes silty clay |
| RnC | Rincon loam, 2 to 9 percent slopes |
| RoA | Rincon clay loam, 0 to 2 percent slopes |
| RoC | Rincon clay loam, 2 to 9 percent slopes |
| Rw | Riverwash |
| Ry | Ryde clay loam |
| Sa | Sacramento silty clay loam |
| Sc | Sacramento silty clay loam, occasionally flooded |
| Sd | Sacramento clay |
| SeA | San Ysidro sandy loam, 0 to 2 percent slopes |
| SeB | San Ysidro sandy loam, 2 to 5 percent slopes |
| SfA | San Ysidro sandy loam, thick surface, 0 to 2 percent slopes |
| Sh | Solano loam |
| Sk | Solano-Pescadero complex |
| Sm | Solano loam, dark surface variant |
| Sp | Suisun peaty muck |
| Sr | Sycamore silty clay loam |
| Ss | Sycamore silty clay loam, drained |
| St | Sycamore silty clay loam, saline |
| Su | Sycamore complex, occasionally flooded |
| Ta | Tambe mucky clay |
| Td | Tidal marsh |
| ToG2 | Toomes stony loam, 30 to 75 percent slopes eroded |
| TrE | Trimmer loam, 9 to 30 percent slopes |
| TsF2 | Trimmer cobbly clay loam, shallow variant, 15 to 50 percent slopes, eroded |
| Tu | Tujungo fine sand |
| Va | Valdez silt loam, drained |
| Vc | Valdez silty clay loam |
| Vd | Valdez silty clay loam, wet |
| Ve | Valdez silty clay loam, clay substratum |
| Wc | Willows clay |
| Yo | Yolo loam |
| Yr | Yolo loam, clay substratum |
| Ys | Yolo silty loam |

# EXPLANATION OF SURFACE SOIL SYMBOLS

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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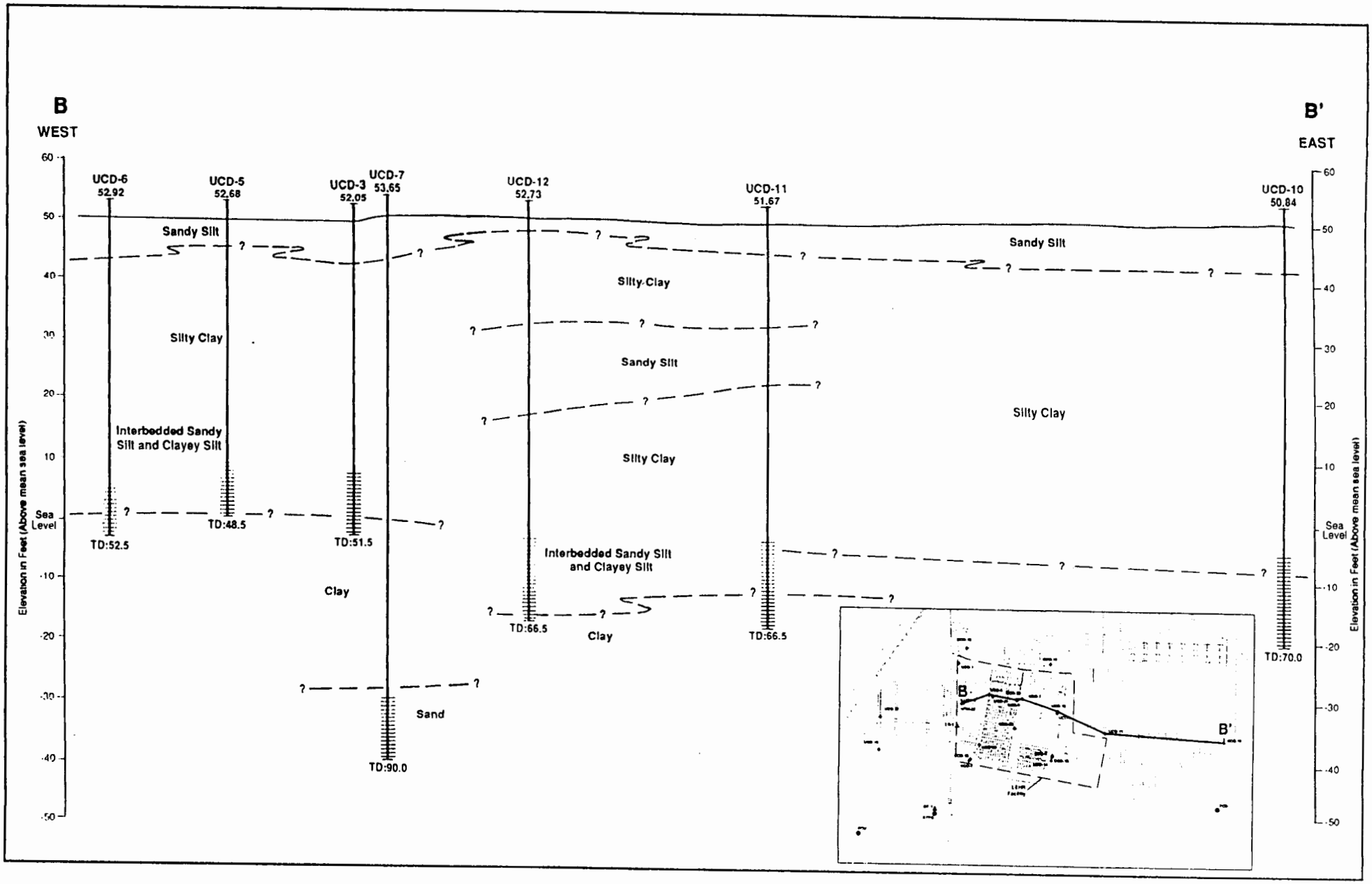
10805-454-044 DOE4

FIGURE 2.11A




Vertical Scale
0 30
0 300
Horizontal Scale

# GEOLOGIC CROSS SECTION B-B'

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE2

FIGURE 2.12

### 2.4.3 Hydrogeology

The major groundwater sources for public and private water supplies in the Sacramento Valley are the unconsolidated deposits of Pliocene and Pleistocene age, and the older alluvium. The younger alluvium and stream channel deposits are less frequently tapped for groundwater. Groundwater is recharged through leakage from streams and rivers, and direct infiltration from precipitation and irrigation.

#### 2.4.3.1 Regional Hydrogeology

The hydrogeology of the Sacramento Valley is characterized by both unconfined and confined aquifers in the nearly flat-lying or gently sloping sedimentary deposits in the upper 3,000 feet of section beneath the valley. No regionally identified confining units exist in the Sacramento Valley (DWR, 1978).

Groundwater flow direction, in a general sense, is toward the low-lying center of the valley from the west and east sides. In the vicinity of the site, regional groundwater flow is easterly from the Coast Ranges toward the Sacramento River (Dames & Moore, 1990b).

At various depths beneath the valley floor, fresh water gives way to saline water in the sedimentary deposits as a result of entrapment during deposition of sediments in a marine environment. The depth to the base of fresh water in the Sacramento Valley varies from as little as 400 feet to over 3,000 feet. Shallowest depths to saline water occur at the edges of the valley and around the Sutter Buttes, where the marine deposits are shallowest. The greatest depths to the base of fresh water are found in the southwest portion of the valley where the marine deposits are deepest (DWR, 1978).

#### 2.4.3.2 Site Hydrogeology

Groundwater is encountered beneath the site at depths ranging from approximately 45 to 70 feet bgs. During previous investigations, groundwater was divided into the "water-table zone" and the "deeper-aquifer zone" (Dames & Moore, 1990b). This report will refer to these units as the "first hydrostratigraphic unit" (HSU) and the "second HSU." Additional HSUs not yet evaluated under the Phase II investigation are present at greater depths.

The first HSU consists of relatively fine-grained sediments varying from very fine-grained sandy silt or silty sand to sandy clay. Pumping rates during development of monitoring wells installed in this zone were correspondingly low (as little as 0.5 gallons per minute). The second HSU consists of coarse sand and cobble gravel. A gravel layer is shown below a depth of about 80 feet on several logs for wells

located within one mile of the site, and therefore appears to be relatively extensive in this area. Additional details of the site hydrogeologic setting are discussed in Section 6.2.

#### 2.4.3.3 Local Groundwater Elevations and Gradients

Groundwater elevations beneath the site vary from approximately five feet above to 20 feet below mean sea level throughout the year. Generally, water levels are at their highest level in early spring and at their lowest levels in later summer.

Based on groundwater elevation contour maps constructed during previous investigations, local groundwater gradients across the site in the first HSU are calculated at approximately 0.0015 ft/ft. Generally, groundwater flow direction is toward the northeast; however, local temporary changes in flow direction and gradient do exist. Details on site hydrogeology, including groundwater levels, lateral and vertical gradients, and hydraulic conductivities, are presented in Section 6.2.

Section 6.5 presents details of groundwater modeling conducted for this Phase II investigation. The modeling addressed inflow and outflow to the groundwater system, and provides estimates for potential contaminant migration pathways.

#### 2.4.3.4 Groundwater Flow Rates

Groundwater flow rates for the first and second HSUs were calculated during the SWAT investigation and the Contaminant Migration Pathway Analysis conducted at the LEHR facility (Dames & Moore, 1990c). Flow rates were based on average water table gradients calculated from 1990 groundwater measurements, laboratory-determined permeabilities, slug tests, and assumed average porosities for saturated geologic materials.

The average flow velocity estimated for the first HSU is 1.6 ft/yr. The average value estimated for the second HSU is 71 ft/yr. Actual flow rates may vary in subsurface sediments because of buried channels and/or lenses of coarser-grained sediments that may provide pathways for flow.

### 2.4.4 Surface Water

The South Fork of Putah Creek is the principal surface water feature of the region. It meanders along the southern border of the UC Davis property, and the levee on its north bank forms the southern border of the LEHR facility. Putah Creek flows eastward from Lake Berryessa, and ultimately empties into the Yolo Bypass approximately 8 miles east of the UC Davis campus.

Putah Creek splits into north and south forks west of State Highway 113. This split was created in the late 19th century when local farmers dug a new channel south of the original streambed, thereby creating the South Fork of Putah Creek. In 1948, The United States Army Corps of Engineers dredged the south fork and dammed the North Fork west of State Highway 113, making the South Fork the only through-channel (Thomasson et al., 1960). The North Fork is now considered a euthrophied, or "dead" creek, although the University of California has converted a portion of the original channel passing through the campus into a landscaped impoundment and arboretum.

Flow in the South Fork of Putah Creek is regulated by releases from Monticello Dam at Lake Berryessa and the Solano Diversion Dam. The South Fork also receives treated effluent from the UC Davis Wastewater Treatment Plant (WWTP) via an outfall pipeline upstream of the LEHR facility. By law, a minimum flow of 5 cubic feet per second (cfs) must be maintained at the Davis gage on the South Fork. However, data from the Department of Water Resources indicate that flows during the period from 1974 through 1984 ranged from a minimum of 0 cfs to a maximum of 17,000 cfs. More recent data obtained from the Solano Irrigation District show that flows at Old Davis Road near the LEHR facility ranged from an average of 0.17 to 148 cfs, from 1989 to the present.[1] The South Fork of Putah Creek is a losing stream, and during most of the year, flow in the channel ceases within a few miles downstream of the LEHR facility. Only during high-water-flow events does water reach the Yolo Bypass.

The 100-year floodplain is confined within the Putah Creek levees at the southern boundary of the LEHR facility. The LEHR facility is in Federal Emergency Management Administration (FEMA) Zone C, which is classified as an area expected to experience minimal flooding. The site is not subject to inundation during the 100-year flood event.[2]

### 2.4.5 Meteorology

The climate in the region of the LEHR facility is temperate, with mild winters and long summers. In winter, the average temperature is 46.9 degrees Fahrenheit (°F), and the average daily minimum temperature is 37.6°F. The lowest recorded temperature of 12.2°F occurred in December 1932. In summer, the average temperature is 73.0°F, and the average daily maximum temperature is 92.3°F. The highest recorded temperature of 113°F occurred in July 1950 (NOAA, 1985; DOE, 1988).

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[1] Personal communication, Solano Irrigation District, March 1992.

[2] Personal communication, Art Jacobsen, Solano County Planning Department, March 1992.

The mean annual precipitation at the Davis 2 WSW station is 17.0 inches, most of which occurs between October and April (National Climatic Data Centers, 1992). The 100-year 24-hour storm event for this station is 4.45 inches, and the 10-year return period event is 3.15 inches.[3]

Since the winter of 1986/1987, most of California, including the Davis area, has experienced drought conditions. During the years 1989 through 1991, the mean annual precipitation recorded at the Davis 2 WSW station was 13.18 inches (NCDC, 1992). Figures 2.13 and 2.14 present mean historical rainfall data and daily rainfall that occurred during the Phase II investigation. Regionally, the drought has resulted in decreased aquifer recharge, and groundwater levels have decreased due to drought effects and pumping for agricultural, municipal, and industrial uses. Lower groundwater levels have also been observed locally in the Davis area.

The average daily relative humidity is about 80 percent in the winter, and 40 percent in the summer and early fall. Local humidity generally increases at night.

The sun shines approximately 95 percent of the time in summer and about 45 percent in winter. Low-lying, locally dense fog is common to the Sacramento Valley in late fall and winter, and obscures the sun up to about 20 percent of the time during those months.

The prevailing wind direction is from the south, reflecting frequent incursion of marine air through the Carquinez Strait into the Sacramento Valley. Changes in wind direction are common, with flows from the northwest occurring diurnally. Several times a year, strong winds blow from the north, generally following the passage of Pacific storm systems. When winds are present, 40 percent of the time, speeds are less than 3.7 mph; 50 percent of the time they are less than 8.1 mph; and exceed 16.2 mph only 10 percent of the time for short periods (NOAA, 1985; DOE, 1988).

### 2.4.6 Environmental Resources

Environmental resources in the vicinity of the LEHR facility include irrigated croplands, wetlands, and riparian areas. Each of these resources are discussed in the following sections.

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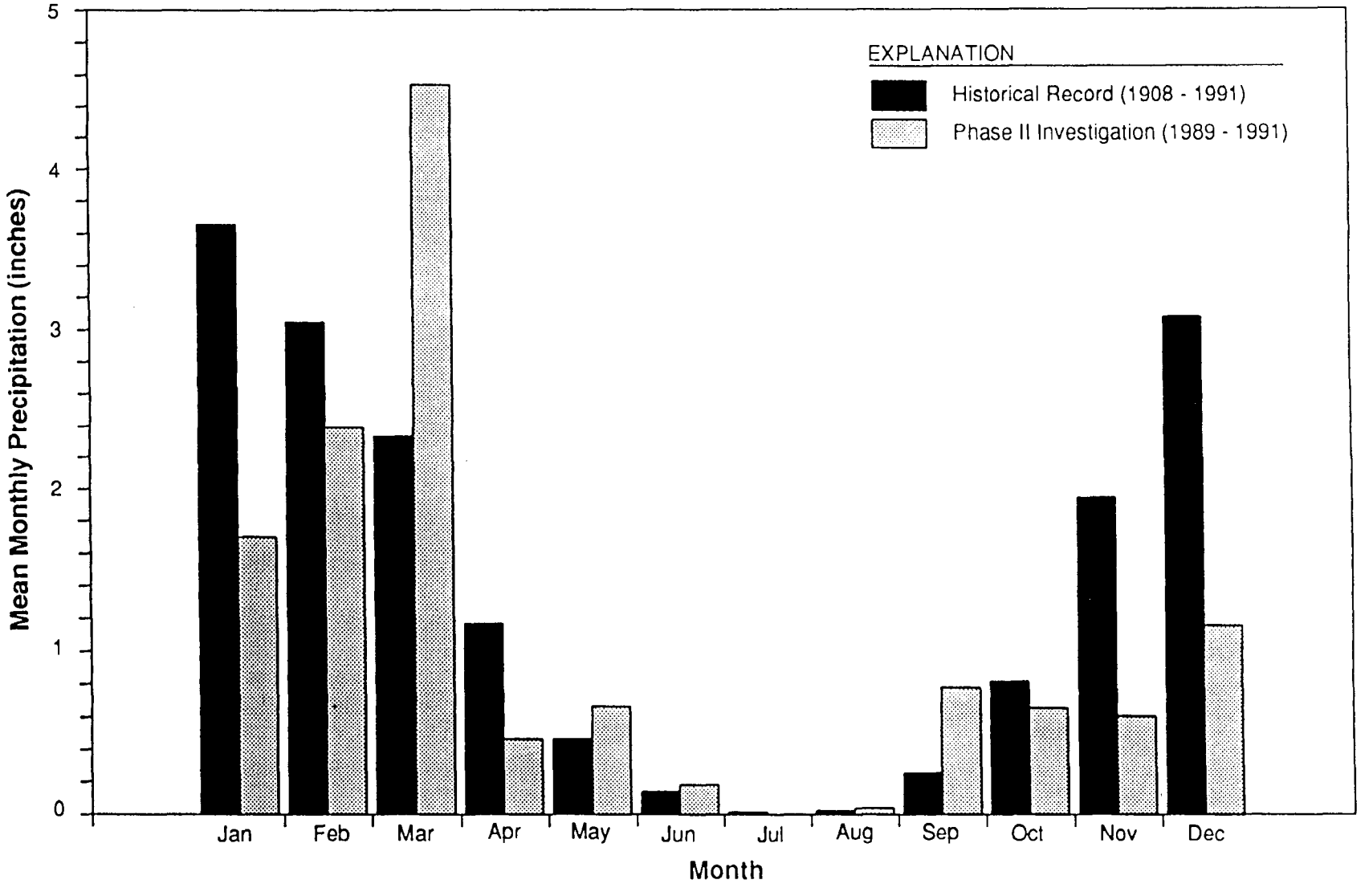
[3] Personal Communication, U.S. Army Corps of Engineers.




SOURCE: National Climatic Data Center, 1992

NOTE: Mean Yearly Precipitation = 17.00 inches (1908-1991)
Mean Yearly Precipitation = 13.18 inches (1989-1991)

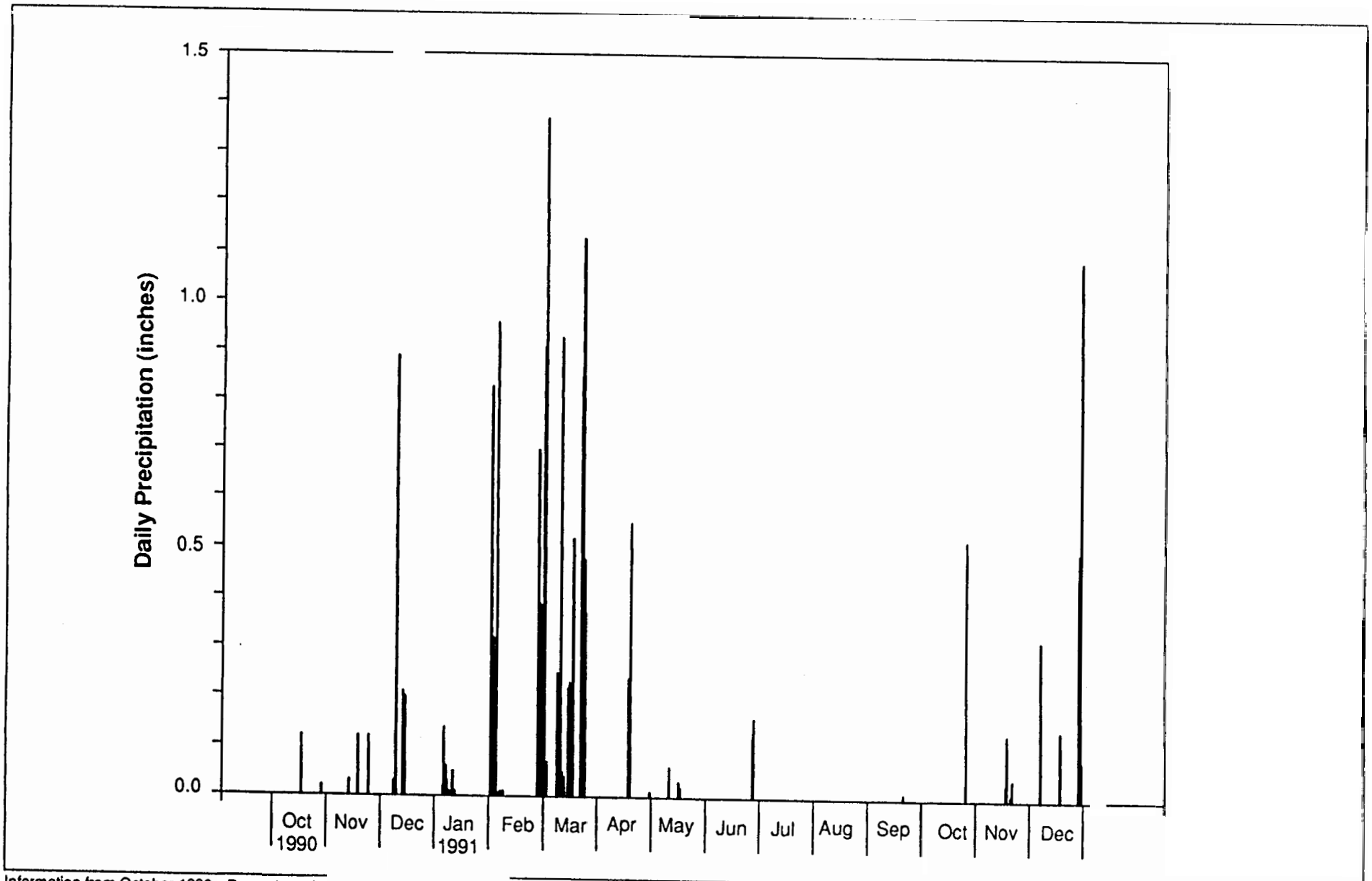
**MEAN MONTHLY PRECIPITATION**
**DAVIS 2 WSW STATION**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-78

FIGURE 2.13




Information from October 1990 - December 199
Davis 2 WSW station.

**DAILY PRECIPITATION**
Phase I Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993
FIGURE 2.14

DAMES & MOORE
10805-454 44 DOE-79

#### 2.4.6.1 Land Use

Land use in the vicinity of UC Davis and the LEHR facility is predominantly agricultural. Approximately 78 percent of the land in Yolo County is classified as farmland, and about 38 percent is irrigated cropland. Neighboring Solano County, where the facility is located, is also an agricultural area. About 60 percent of Solano County's total area is farmland, and 18 percent of the total land is irrigated cropland (United States Department of Commerce, Bureau of the Census, 1989). The major crops in the area are grains, nuts, and fruit. Stock animals are also raised.

#### 2.4.6.2 Special Status Species

The wetlands and riparian areas of the Yolo Basin serve as a critical wildlife habitat for a number of special status plants and animals, including Swainson's hawk, the giant garter snake, and valley oak. The South Fork of Putah Creek, which parallels the southern boundary of the LEHR facility, is a high-quality riparian habitat and provides important nesting and foraging areas for raptors, deer, and other wildlife. Valley oaks (which are covered by State Senate Concurrent Resolution No. 17), and cottonwood trees are an integral part of the habitat (Dames & Moore, 1991c). Additionally, the area contains blue elderberry shrubs, a critical habitat for the valley elderberry longhorn beetle. Table 2.5 presents a list of special-status species known to exist at or near the South Fork of Putah Creek.

## 2.5 HUMAN RESOURCES

The LEHR facility is located in the southeastern portion of the approximately 3,600-acre UC Davis property (UC Davis, 1989). UC Davis has a student population of approximately 21,000 and employs approximately 12,000 full-time faculty and staff[1]. The current population of Davis is approximately 46,000 and the current total population of Yolo County is about 141,000. This represents a growth rate of 25 percent between 1980 and 1990. Whites and Hispanics constitute approximately 88 percent of the County's population. Census data for employment and socioeconomic status are not yet available for the 1990 census; however, the 1980 census data indicate that of the total county population, 84 percent lived above the poverty level. The median family income in 1980 was $20,495 and 48 percent of the population over the age of 18 had completed at least one year of college (Sacramento Area Council of Governments, 1991).

---

[1] Personal communication, Angie Malloy, UC Davis

TABLE 2.5
SPECIAL STATUS SPECIES
NEAR SOUTH FORK OF PUTAH CREEK
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| TAXA | LISTING STATUS: [a] | | |
|---|---|---|---|
| | Federal | State | Other |
| *Quercus lobata*<br>Valley oak | | | CNPS |
| *Desmocerus californicus dimorphus*<br>Valley elderberry longhorn beetle | T | | |
| *Thamnophis gigas*<br>Giant garter snake | PE | T | |
| *Pelecanus erythrorhynchos*<br>American white pelican | | | SSC |
| *Casmerodius albus*<br>Great egret | | TDH | |
| *Buteo swainsoni*<br>Swainson's hawk | | T | |
| *Circus Cyaneus*<br>Northern harrier | | | SSC |
| *Agelaius tricolor*<br>Tricolored blackbird | C-2 | | SSC |
| *Plegadis chihi*<br>White-faced ibis | C-2 | | SSC |
| *Numenius americanus*<br>Long-billed curlew | C-2 | | SSC |
| *Grus canadensis tabida*<br>Greater Sandhill Crane | | T | |

a. Listing Status Codes:

CNPS = California Native Plant Society, List 4.
T = Threatened.
SSC = California Natural Diversity Database (CDFG) Species of Special Concern.
TDH = Taxa associated with habitat that is declining in California at an alarming rate.
C-2 = Category 2 Candidate for Federal listing.
PE = Proposed Endangered.

The LEHR facility is located in a rural area in northern Solano County just outside of Davis. The immediate vicinity comprises primarily agricultural land. There are a few single-family residences within approximately one mile of the facility, and UC Davis owns some nearby research facilities on all sides of the LEHR facility. Solano County has a total population of 340,092 (U.S. Department of Commerce, 1991). As of the 1980 census, the median family income in Solano County was $21,606, and 8.1 percent of the population lived below the poverty level. Approximately 77 percent of county residents over the age of 25 were high school graduates (U.S. Department of Commerce, 1983).

The more densely populated and fast-growing metropolitan Sacramento area is approximately 12 miles east of the LEHR facility. The current population of Sacramento County is about 1,040,000, and approximately 370,000 people live in the City of Sacramento.

# 3.0 PREVIOUS INVESTIGATIONS

Thirteen environmental studies have been conducted at the LEHR facility since 1984. The studies have been performed for both UC Davis and the DOE. These investigations are presented on Table 3.1 and summarized in the following sections. Additional information on results from previous investigations can be found in the reports for each investigation.

Analytical methods used during these investigations were primarily EPA methods; however, many of the projects were not completed under an approved QA/QC plan. Results of these investigations did indicate potential chemical and radiologic contamination at LEHR; however, the results were used only as a guide during the Phase II Site Characterization. Conclusions and recommendations presented in Chapters 8.0 and 9.0 of this report, respectively, are based primarily on analytical data obtained during the Phase II Site Characterization.

## 3.1 INITIAL ASSESSMENT SURVEY

Rockwell International conducted an Initial Assessment Survey of the LEHR facility in October 1984 (Rockwell, 1984) for DOE. The objective and purpose of the Rockwell investigation was to obtain preliminary environmental data by conducting an initial survey of the presence, nature and extent of radiological and chemical impacts which could either migrate to the environment or present an unanticipated cost in the decontamination and decommissioning of the LEHR facility. Investigative methods included soil borings for subsurface soil sampling, surface soil sampling, hand-held meter surveys, and wipe sample collection. No groundwater samples were collected.

A total of 22 soil samples were collected and analyzed for the Initial Assessment Survey. Results of these analyses indicated radium-226 and strontium-90 activity up to 0.204 pCi/g and 0.07 pCi/g, respectively, in the Radium-226 Dry Well area. Strontium-90, radium-226 and carbon-14 activity were reported at levels of 3.94 pCi/g, 17.3 pCi/g and 1.160 pCi/g, respectively, in the Southwest Chemical Dispensing area. The highest reported measurement of tritium activity was from the sample in the southeast corner of the eastern dog pens at 208 pCi/g. The pesticides heptachlor, aldrin, and dieldrin

TABLE 3.1
SUMMARY OF PREVIOUS INVESTIGATIONS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| REFERENCE | REPORT TITLE |
|---|---|
| Rockwell International | Initial Assessment Survey of the DOE LEHR Site; October 1984 |
| U.S. Department of Energy | Environmental Survey Preliminary Report; March 1988 |
| Wahler Associates | Groundwater and Soils Investigation of U.C. Davis Research Facility; December 1988 |
| | Groundwater and Soils Investigation of U.C. Davis Research Facility; May 1989 |
| Dames & Moore | Evaluation of On-Site Wells at UC Davis LEHR Facility; February 1990 |
| | Final SWAT Report, Old UC Davis Landfill; July 1990 |
| | Contaminant Pathway Analysis for the UC Davis Campus from the LEHR Study Site; July 1990 |
| | Evaluation of Potential Nitrate and Hexavalent Chromium Sources in the Vicinity of the UC Davis LEHR Facility; November 1990 |
| | Putah Creek Sediment and Water Sampling; December 1990 |
| | Waste Burial Trench Investigation LEHR Facility; July 1991 |
| | CEQA Preliminary Environmental Study for Site Characterization Work at the Inactive UC Davis Landfill; February 1991 |
| | Old UC Davis Landfill Additional Characterization — CPT and Hydropunch Investigation - UC Davis South Campus Inactive Disposal Sites; September 1991 |
| | Second-Round CPT/Hydropunch Investigation; November 1991 |

were found in almost pure concentrations in samples collected from exploratory trenches. Two samples, one from the Imhoff area and one from the area near UCD-24, contained reported concentrations of the common analytical laboratory contaminants methylene chloride and bis(2-ethylhexyl)phthalate.

## 3.2 ENVIRONMENTAL SURVEY PRELIMINARY REPORT

The DOE prepared an Environmental Survey Preliminary Report in March 1988 (DOE, 1988). The investigation was primarily a document research investigation to assess past site activities so that the site could be priority-ranked by the DOE for future investigation. The 1988 DOE investigation describes past disposal practices at or near the LEHR facility, and concluded that areas including the waste burial trenches, the Imhoff tanks, inactive septic tanks and associated leach fields, the chemical dispensing areas, the dog pen areas, the LEHR sanitary sewer system and the Cobalt-60 Field, are potential sources of soil and groundwater impacts beneath the site.

## 3.3 PHASE I INVESTIGATION

Wahler Associates performed work for both the DOE and UC Davis in two phases collectively identified as the Phase I Investigation (Wahler , 1988 and 1989). Work completed for both investigations was conducted concurrently. The Phase I Investigation targeted potential radioactive burial sites in an effort to evaluate the potential for soil or groundwater impacts downgradient of the site. Field work was conducted during 1987 and 1988, and included soil borings, exploration trenching and monitoring well installations in the first two saturated zones beneath the site.

The Phase I Investigation consisted of 43 soil borings, the installation and sampling (two rounds) of nine groundwater monitoring wells (UCD-1 through UCD-9), and the excavation of 16 backhoe trenches. Sample analysis results reported that groundwater wells UCD-8 and UCD-9 contained several volatile organic compounds including chloroform at concentrations up to 41.9 mg/L. Reported concentrations of nitrate in all wells ranged from 1.4 mg/L to 360 mg/L (in UCD-3). Reported concentrations of chromium in groundwater were elevated compared to background; however, it is not known if groundwater samples analyzed for metals were filtered. Strontium-90 and radium-226 activity were reported in soil samples from the Radium-226 Dry Well area at measurements up to 1.6 pCi/g and 1.23 pCi/g, respectively, and strontium-90 activity was reported in samples from soil in the Strontium-90 Leach Field area at measurements up to 0.02 pCi/g. Tritium activity was reported in one sample from UCD-1 in the northwest corner of the site at 102 pCi/g, and one exploratory trench in the Southwest Disposal Area contained measurable activity of radiation up to 2,500 cpm using a hand held survey meter.

## 3.4 EVALUATION OF ON-SITE WELLS

In June 1989, Dames & Moore evaluated high turbidity levels in the nine wells previously installed by Wahler Associates during their 1988 and 1989 investigations (Dames & Moore, 1990a). The scope of the evaluation included redevelopment of the wells using swab/surge, bailing, and pumping techniques. In addition to well development, groundwater samples were collected and analyzed for various chemical parameters to assess whether chemical properties of the groundwater and/or soil were the cause of, or contributed to, high turbidity. The report concluded that the high turbidity levels in the wells appeared to be due to improper sizing of well construction materials, and not the geochemical character of the groundwater. Information obtained from this study was used to design monitoring wells installed as part of the Phase II Site Characterization.

An old domestic supply well located beneath the maintenance shop at the LEHR facility (Old Shop Well) was also investigated by a downhole video camera survey. The well was found to be approximately 251 feet deep, with casing perforations from 76 to 130 feet bgs and from 220 to 251 feet bgs. Data from the survey was used to develop recommendations for abandonment of the well. The Old Shop Well was abandoned by UC Davis in 1990. Prior to abandonment of the well, UC Davis collected water samples for chemical and radiologic analysis.

## 3.5 SOLID WASTE ASSESSMENT TEST

The Solid Waste Water Quality Assessment Test (SWAT) Report (Dames & Moore, 1990b) was prepared for UC Davis to assess the possibility of leakage from the three Old UC Davis Landfill disposal units located on and adjacent to the LEHR facility and the potential impacts to groundwater, surface water, vadose-zone water and soil. The SWAT Report was prepared in accordance with the Calderon Bill (AB 3525) and Title 23, Chapter 3, Subchapter 15 of the California Code of Regulations (CCR), and submitted to the Regional Water Quality Control Board Central Valley Region (RWQCB) in July 1990. During the SWAT investigation, five groundwater monitoring wells were installed (UCD-10 through UCD-14) in the first two saturated zones; one pre-existing monitoring well (UCD-2) was abandoned; four vadose-zone wells (lysimeters LW-1 through LW-4) were installed, and surface water in Putah Creek upgradient and downgradient of the site was sampled.

Analytical results of the SWAT reported that groundwater downgradient of Landfill Units 1 and 2 contain several VOCs including chloroform up to 17 mg/L, and elevated levels of general water quality parameters. Hexavalent chromium was also elevated (up to 0.38 mg/L) in UCD-11. Groundwater samples from UCD-8 and UCD-13 had measured tritium and carbon-14 activity up to 36,269 pCi/L, and 2,702 pCi/L, respectively.

## 3.6 CONTAMINANT PATHWAY ANALYSIS

In July 1990, an analysis of potential contaminant migration from the LEHR facility and adjacent sites to the main UC Davis campus was conducted to support the environmental documentation for the UC Davis Long Range Development Plan (Dames & Moore, 1990c). The following pathways were identified through which chemical and radiological constituents at LEHR could potentially migrate from the site and impact other areas of the campus:

- Direct contact with surface soils at the LEHR facility;
- Resuspension and dispersion (to the air) of fugitive dust from surface soils; and
- Migration through soil and groundwater.

Contaminants in soil and groundwater from the LEHR facility and adjacent sites were identified based on data obtained during the SWAT investigation for the Old UC Davis Landfill (Section 3.5). Analysis of the known contaminants, using environmental fate and transport models, indicated that impacts from the LEHR facility were not expected on the UC Davis campus north of Interstate 80.

## 3.7 EVALUATION OF POTENTIAL NITRATE AND HEXAVALENT CHROMIUM SOURCES

In March 1990, a study was conducted to assess elevated levels of hexavalent chromium and nitrate as nitrogen in privately owned wells near the LEHR facility (Dames & Moore, 1990d). The study was designed to evaluate the potential of various sources, including the LEHR facility, as the source for the elevated levels of these constituents. Potential sources of nitrate in domestic wells were speculated to include fertilizers used on crops in the vicinity, discharge from the UC Davis Wastewater Treatment Plant, domestic septic systems and past or current animal enclosures. Potential sources of hexavalent chromium were speculated to include sediments derived from the Coast Range to the west, geochemical mobilization, incineration ash, and metal plating wastes. The evaluation concluded that sufficient regional data do not exist to completely evaluate the sources of hexavalent chromium.

## 3.8 PUTAH CREEK SEDIMENT AND WATER SAMPLING

Sediment and surface water samples were collected from Putah Creek upstream and downstream from the LEHR facility in August 1990 (Dames & Moore, 1990e). The purpose of sampling was to collect data on creek sediments and water during low-flow conditions. The data was intended to be used as a baseline for low-flow periods in the creek.

Although no detections above regulatory criteria were reported for sediment or water, results of sample analyses reported some metals, volatile organic compounds, semivolatile organic compounds and

radioactivity. Hexavalent chromium was reported in water samples ranging from 0.01 to 0.03 mg/L and in sediment samples from less than 0.1 to 0.3 mg/Kg. Xylenes were reported in water samples ranging from 0.28 to 0.58 ug/L. Bromodichloromethene and chloroform were reported in water samples up to 0.54 and 2.50 ug/L respectively. Gross alpha activity was reported up to 6.0 pCi/L in water and 1.5 pCi/g in sediment samples. Gross Beta activity was reported up to 23 pCi/L in water and 2.9 pCi/g in sediment. Strontium-90 activity was reported up to 4.1 pCi/L in water and was not reported in sediment samples. No tritium activity was reported in water or sediment samples.

## 3.9 WASTE BURIAL TRENCH INVESTIGATION LEHR FACILITY

Dames & Moore supervised the excavation of 18 exploratory trenches and Ground Penetrating Radar (GPR) surveys for UC Davis. The purpose of the surveys was to locate and sample the contents of former waste burial trenches (Dames & Moore, 1991b). Exploratory trenches were excavated in areas of documented waste burial trenches. These areas include the vicinity of monitoring wells UCD-9 and UCD-12, along the east side of the eastern block of dog pens, along the south side of both blocks of dog pens, and in the southwest corner of the site.

UC Davis personnel collected and analyzed three grab soil samples to better assess impacts from waste burial trenches used by UC Davis. These were the only samples collected during this investigation. Results of the exploratory trenching suggest that the majority of the waste burial trenches documented exist, with the exception of trenches reported to be located by the Geriatrics building and areas near UCD-8. Results of soil samples collected from trenches located just north of UCD-12 reported measurements of radium-226 and thorium activity at 0.44 pCi/g and 0.51 pCi/g, respectively. Chlordane and tritium were reported in soil samples analyzed from this same area at 688 $\mu$g/kg and 0.61 pCi/g, respectively.

## 3.10 CEQA PRELIMINARY ENVIRONMENTAL STUDY FOR SITE CHARACTERIZATION

A preliminary environmental study was conducted for UC Davis as part of the ongoing characterization work for the Old UC Davis Landfill in compliance with the California Environmental Quality Act (CEQA) (Dames & Moore, 1991c). The purpose of the study was to assess potential environmental impacts of additional post-SWAT characterization work at the old landfill units at the LEHR facility. The environmental study evaluated each part of site characterization (i.e., drilling, well installation, development, sampling, etc.) work that could be performed, vehicles and equipment required, location of the work, and time required to complete the work. The study concluded that impacts from characterization would be temporary, consistent with existing land use, and less than significant, and therefore eligible for categorical exemption under 14 CCR 15306.

## 3.11 OLD UC DAVIS LANDFILL ADDITIONAL CHARACTERIZATION

As part of the Old UC Davis Landfill Additional Characterization, two CPT and Hydropunch™ investigations were performed in April 1991 and September 1991 to address comments and recommendations by the RWQCB on the SWAT report for the Old UC Davis Landfill (Dames & Moore, 1991d). The purpose of the investigation was to further evaluate the vertical and lateral extent of site constituents detected in groundwater samples collected during the SWAT investigation. The first CPT and Hydropunch™ investigation consisted of 20 CPT penetrations and 25 Hydropunch™ groundwater sample collections in areas downgradient of wells where elevated levels of site constituents were detected during SWAT monitoring. The second round CPT/Hydropunch™ investigation was conducted in to further evaluate the lateral and vertical extent of site constituents detected in groundwater during SWAT monitoring and first-round Hydropunch™ samples. The second round of CPT and Hydropunch™ consisted of 11 CPT penetrations and 25 Hydropunch™ groundwater samples downgradient from the site.

Results of analysis of Hydropunch™ samples reported chloroform, nitrate, hexavalent chromium, and tritium at elevated concentrations up to 59.0 mg/L, 68.4 mg/L, 0.34 mg/L, and 2,220 pCi/L, respectively, downgradient of Landfill Cells 1 and 2 in the first hydrostratigraphic unit (HSU).

Results of sample analysis in the second HSU show correlative concentrations of similar constituents to those reported in the first HSU down-gradient of Landfill Cells 1 and 2. Analysis of CPT data suggests that the first and second HSU are not hydraulically separated.

# 4.0 RATIONALE AND APPROACH

This chapter describes the rationale and approach used to meet the data objectives presented and approved in the Work Plan. The data objectives and scope are outlined in Chapter 1.0 and discussed in Chapter 5.0 of this report.

## 4.1 RATIONALE

The rationale behind this Phase II Site Characterization as presented in the Work Plan is to identify potential contaminant sources; to better define the magnitude and extent of impacts; and to identify deficiencies in the data collected at the site during previous investigations. The data quality objectives developed for this investigation were designed to:

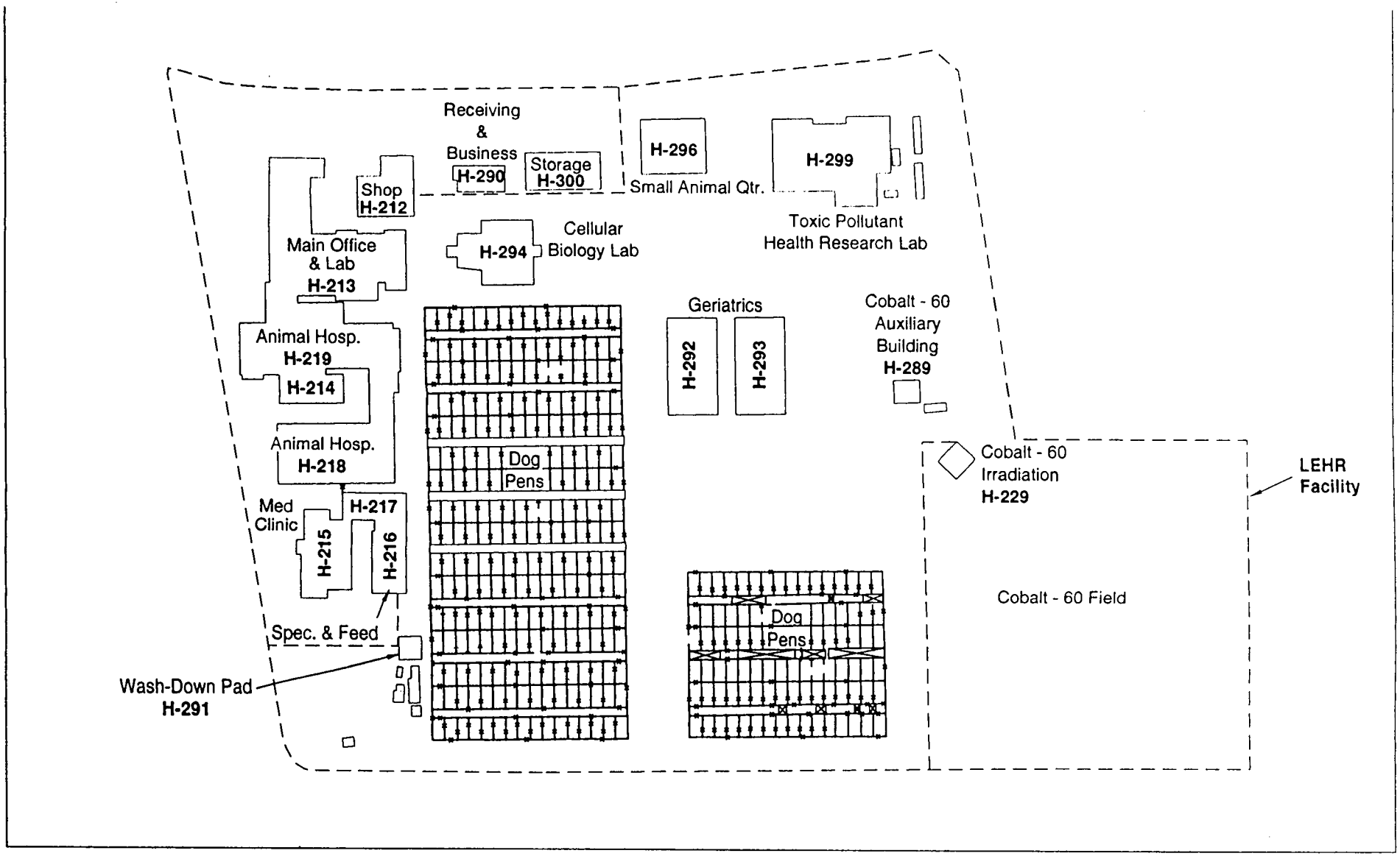
(1) Gather data that will be useful in evaluating the environmental risks posed by past operations, and environmental impacts at the LEHR site;

(2) Gather and report the data needed to evaluate the presence or absence of chemical constituents; and

(3) Assess vertical and lateral extent of significant concentrations of selected chemical and radiological parameters.

### 4.1.1 Review of Operable Unit

The current LEHR facility was constructed from 1958 to 1960. Initial experiments were conducted by the U.S. Atomic Energy Commission (AEC) at a temporary building at the Davis airport and two sites on the UC Davis main campus: one at the site currently occupied by Robbins Hall; and the second at the site currently occupied by the UC Davis Police and Fire Station. In 1960, the study was moved to the newly built LEHR facility (Figure 4.1). The initial programs conducted by the AEC were designed to study the biological effects associated with chronic low-level exposure of the skeleton to beta particle irradiation from deposits, primarily of the bone-seeking radionuclides, strontium-90 and radium-226. The beagle was chosen as the research subject which could be studied in sufficient detail to scale the results to human population that might be exposed. Eventually, more than 1,000 beagles were utilized in this study. Wastes from the strontium-90 studies were treated in the Imhoff Treatment System, and effluent was routed to a leach field east of the building containing the treatment tanks. Radium-226 wastes were routed into the radium-226 septic tanks and ultimately to the seepage pits and seepage trench located west of Imhoff (Building H-214). Because dogs were moved from one study area to another, the potential exists for radium-226 wastes to have been processed through the Imhoff Treatment System and strontium-90 wastes to have gone into the radium-226 system. After initial treatment, dogs were moved to outdoor dog pen areas. Excreta from the dogs was reportedly collected daily, urine was allowed to evaporate.




EXPLANATION

**H-291** Building Number

0 150
Scale in Feet

N

**LEHR FACILITY**
Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-124

FIGURE 4.1

In the early 1970s, an outdoor Cobalt-60 Field was constructed to study the effects on bone marrow cells of beagles from chronic exposure to penetrating gamma-ray irradiation. The cobalt-60 study was terminated in 1985.

Other experiments conducted at the LEHR facility include those at the Toxic Pollutant Health Research Laboratory (TPHRL), which used various toxic chemicals and radioisotopes including plutonium-241 and americium-241. Between 1982 and 1984, effluent from an experiment using these radioisotopes was routed through the Imhoff Treatment System (DOE, 1988).

In addition to DOE-funded studies at the LEHR facility, UC Davis operated one landfill with two units at the LEHR facility from the 1940s to 1967, and low-level radioactive disposal areas until 1974. LEHR and UC Davis reportedly disposed various radioactive, chemical, and biological wastes in unlined pits and trenches at the facility (Warren, 1985). In addition, sanitary and potentially radioactive wastes were disposed in septic systems and seepage pits. Further, the potential exists for inadvertent and undocumented releases of various chemicals and radionuclides to the ground surface or dry wells during previous operations at the site.

Although the LEHR facility is currently serviced by the UC Davis Wastewater Treatment Plant located on the main campus, there are six known abandoned domestic septic tanks, with indications of a seventh tank, at the LEHR facility. The septic tanks were reported to have received only non-radioactive liquid wastes from the LEHR facility. However, there are reports that one tank did receive radium-226 effluent for a short period of time.

To date, as discussed in Chapter 3.0, several limited-scope investigations have been conducted at and near the LEHR facility. These investigations (Table 3.1) included a review of past operating practices, and evaluations of potential soil and groundwater contamination. Various organic and inorganic chemicals, radionuclides, and metals have been found in soil and groundwater at the site. Based on these previous studies, hexavalent chromium, nitrate as nitrogen (N), chloroform, tritium, strontium-90 and radium-226 have been identified as the primary constituents of concern at LEHR.

### 4.1.2 Groundwater Contamination

Analytical results from laboratory testing of groundwater samples have shown that groundwater beneath the LEHR facility has been impacted by organic and inorganic chemicals, radionuclides, and metals. Elevated levels of site constituents, including chloroform, nitrate as (N), tritium, and hexavalent chromium, have been reported in groundwater samples collected from monitoring wells at the LEHR facility. Additionally, elevated levels of nitrate as (N) and hexavalent chromium have been reported in

groundwater samples collected from private supply wells located hydraulically upgradient, sidegradient, and downgradient of the LEHR facility.

Groundwater is present in water-table conditions at depths ranging from approximately 45 to 70 feet bgs. For the purposes of this investigation, the groundwater has been separated into two HSUs based on subsurface stratigraphy. The first HSU consists of the saturated fine-grained sediments from the water table, down to approximately 80 feet bgs. The second HSU (the first aquifer zone) consists of cobbles and gravel present between 80 and 135 feet bgs. Groundwater elevation data for wells at the LEHR facility are presented in Appendix D. Additional HSUs (greater than 150 feet bgs), known to exist on a regional basis, have yet to be investigated below the site. Site constituents have been reported from groundwater samples collected from the first and second HSUs.

## 4.2 APPROACH

The tasks developed for the collection and analysis of the data are presented in Chapter 5.0 and Appendix A of this report and in the Work Plan. Field documentation of investigative tasks is provided in Appendix E. The approach includes the use of existing data from previous environmental investigations conducted at LEHR. Additionally, site-specific data have been collected from previously identified areas of interest. The following sections detail the approach to data collection, and the methodologies used in data evaluation.

### 4.2.1 Use of Existing Data

Existing data from the Phase I and other previous investigations identified in Chapter 3.0 have been reviewed as part of the Phase II Site Characterization. As noted previously in Chapter 3.0, most of the analytical data presented in these reports would be categorized under EPA Level II analysis. Analytical methods used during these previous investigations were primarily EPA methods; however, because the projects were not completed under a formal QA/QC plan, the results have been used only as a guide during the Phase II Site Characterization. Data and records from the LEHR facility and UC Davis have been used to assess the types and quantities of chemicals and radionuclides used and their methods of disposal at the LEHR facility and the inactive landfill units. In addition, other published and unpublished data regarding regional and local hydrologic, hydrogeologic, and geologic data, have been reviewed and evaluated. The data review has been conducted to assist in evaluating the physical environment of the LEHR facility and assessing modes of potential contaminant sources, pathways, and transport.

### 4.2.2 Collect Data Only for Specific Needs

During the Phase II Site Characterization, data have been collected to evaluate specific areas of interest identified in previous investigations. These areas were initially defined in UC Davis' Request for Quotation (RFQ) for the Phase II Investigation. Based on the evaluation of the data collected, presented in Chapter 6.0, it is anticipated that additional data will be needed to more fully characterize the nature and extent of site contaminants. These data will be developed prior to site remediation or human health-based risk assessment activities.

### 4.2.3 Site-Specific Investigation

The Phase II Site Characterization is made up of a number of investigations of specific sites suspected or known to have had the potential to release or transport contaminants to the environment. Many areas of the LEHR facility and vicinity have been investigated in previous studies (e.g., disposal trenches and pits, Southwest Chemical Dispensing area). For this investigation, the sites currently being investigated are listed below:

- Southwest Chemical Dispensing Area;
- North Chemical Dispensing Area;
- Strontium-90 Leach Field;
- Radium-226 Septic System;
- Dog Pens at LEHR;
- Old AEC Project Site at the Current UC Davis Police and Fire Station;
- Domestic Septic Tanks;
- Lift Station at LEHR and UC Davis Wastewater Treatment Plant Outfall by Putah Creek;
- Surface Water of Putah Creek; and
- Groundwater.

Discussion of the investigation methodologies and sampling parameters for each of these sites is presented in Appendix A. Additional background on these and other potential environmental impacts is summarized in Chapter 2.0. Other potential sources for contaminants or pathways for contaminant migration are listed in Section 2.3.9.

### 4.2.4 Phased Investigation

The Phase II Site Characterization has been conducted in a phased approach. Phase II tasks that have been conducted and the approximate dates they were completed are discussed in Chapter 5.0. Soil borings and soil sample analyses were the first tasks conducted. Results of the soil analyses were used

to refine the locations of groundwater monitoring wells. Groundwater and surface water samples were collected and analyzed quarterly to obtain data at various times throughout the hydrologic cycle. Aquifer analysis has been conducted using data collected during the Phase II investigation.

#### 4.2.5 Specific Data Needs

The Phase II Site Characterization is designed to enhance the database for a number of specific parameters. These include enhancing the understanding of:

- The subsurface stratigraphy;
- The hydrologic properties of the saturated zone; and
- The types and extent of potential impacts to the environment.

This has been accomplished by investigating specific areas of the site that were identified as potential sources of contaminants, and by investigating the physical properties of both the saturated and unsaturated materials in the subsurface environment. Stratigraphy has been evaluated using soil boring and CPT data from previous investigations, and soil boring data from the 10 monitoring well borings and the 10 intermediate and deep soil borings completed during this Phase II investigation (Section 6.1). Hydrologic properties have been evaluated using groundwater level and slug test data collected from the LEHR monitoring wells (Section 6.2). The types and extent of potential contaminants in the environment have been evaluated using chemical analytical data developed from soil and water samples collected during this Phase II investigation and previous investigations (Section 6.4). Table 4.1 presents a comparison of data collected during the Phase II Site Characterization to CERCLA RI/FS requirements and identifies additional data needs to be fulfilled during the site-wide RI/FS process.

#### 4.2.6 Data Quality Objectives

Based on the QAPP developed for this Phase II Site Characterization, the overall data quality objective is to sample and analyze soils and water from the LEHR facility in such a manner that technical data generated during the site investigation are accurate and representative; are able to withstand scientific scrutiny; and are useful for environmental restoration of the LEHR facility. A variety of analytical methods were used to provide QA/QC data. These include collection and analyses of sample duplicates and blanks, and review of data interpretations.

COMPARISON OF PHASE II DATA TO CERCLA RI/FS REQUIREMENTS
PHASE II SITE CHARACTERIZATION
ENVIRONMENTAL RESTORATION

| CERCLA RI/FS REQUIREMENT | STATUS | DATA USES/ LIMITATIONS | FURTHER ACTION/ DATA GAP |
|---|---|---|---|
| **PHYSICAL CHARACTERISTICS** | | | |
| Surface Features; Geology; Soils and Vadose Zone; Surface Water Hydrology; Hydrogeology; Meteorology; Human Population and Land Uses; and Ecology | Data collected are adequate to support a Site Investigation (SI) under CERCLA for Hazardous Ranking System (HRS) scoring (EPA, 1992) and partially fulfills RI requirements. Physical characteristics of the LEHR facility have been described. A geologic and hydrogeologic model have been developed. Preliminary information on meteorology, human population and land use, and ecology are presented in this Phase II Site Characterization. | Data are useful for initial support of site characterization, baseline risk assessment and evaluation of remedial options activities. However, additional information on human population, land use, and ecology must be developed as part of the RI/FS process. | Additional more detailed information on soil and vadose zone characteristics (by source area); surface water; human population and land use; ecology; and hydrogeology will be obtained during the RI/FS process. |
| **SOURCES OF CONTAMINATION** | | | |
| Location and Dimensions | The information collected regarding the locations and dimensions of potential sources is sufficient to support an SI and partially fulfills RI requirements. Location and dimensions of potential sources have been identified to varying degrees.<br><br>Treatment systems: Locations; preliminary. Dimensions; obtained from drawings.<br><br>Disposal trenches: Locations; area is known. Dimensions; exact dimensions are unknown.<br><br>Dog pens: Locations; included in the geodetic survey. Dimensions; obtained from geodetic survey.<br><br>Other suspected sources including the UC Davis landfill cells and disposal trenches, and the domestic septic tanks were not investigated during the Phase II Site Characterization. This information must be obtained to conduct the RI/FS. | Preliminary source location data are useful for soil and groundwater characterization, baseline risk assessment and evaluation of remedial options. However, because exact locations and dimensions of all potential sources have not been identified, volumes of waste and potential exposure scenarios (risk) cannot be fully developed. | Exact location and dimensions of potential sources will be identified and volume of waste by source area will be calculated during the RI. Additional potential source locations such as the UC Davis Landfill cells and disposal trenches, the domestic septic tanks, unidentified disposal areas, soil below the Imhoff tanks, sewer lines, and discharges via sinks or floor drains will also be addressed during the RI/FS or decontamination and decommissioning activities. |

TABLE 4.1 (continued)

COMPARISON OF PHASE II DATA TO CERCLA RI/FS REQUIREMENTS
PHASE II SITE CHARACTERIZATION
ENVIRONMENTAL RESTORATION

| CERCLA RI/FS REQUIREMENT | STATUS | DATA USES/ LIMITATIONS | FURTHER ACTION/ DATA GAP |
|---|---|---|---|
| Characteristics of Contaminants | General physical and chemical characteristics of identified site contaminants have been developed and are of adequate quality for an SI and partially fulfill RI requirements. Locations of most suspected sources and anticipated contaminants have been identified; however, data are lacking concerning the characteristics and quantities of wastes in each area of interest. Characteristics of potential contaminants contained in areas not yet evaluated (disposal trenches, landfill cells, domestic septic tanks, sewers, discharges via floor drains, and unidentified disposal areas) must be supplemented during the RI/FS. | Specific physical and chemical characteristic information by source area must be supplemented to conduct a risk assessment and evaluation of remedial alternatives. Generally, more information is required for the disposal trenches, domestic septic tanks, sewers and landfill cells than is required from the treatment systems and dog pen areas. | Additional physical and chemical characteristics of soil and wastes will be further developed for known and suspected source areas during the RI/FS. |
| Potential Releases | Potential releases from sources can be inferred from process knowledge.<br><br>Treatment Systems: liquid discharge to soil, infiltration.<br><br>Disposal Trenches: liquids and solids discharged to soil, infiltration.<br><br>Dog Pens: Liquids and solids discharged to soil, infiltration.<br><br>Releases from other potential sources including landfill cells septic tanks, unidentified disposal areas; soil below the Imhoff tanks; and sewer lines will be addressed during the RI/FS and included in the Conceptual Site Model. | Data collected during the Phase II Site Characterization are of sufficient quality to assess potential releases from investigated sources. This information will be useful in initial evaluation of risk assessment and remedial action alternatives. However, additional potential sources and therefore potential releases exist at the LEHR facility that have not been evaluated. | Potential releases from known and suspected sources will be further addressed in the conceptual site model presented in the planned RI/FS Work Plan. Data gaps regarding potential sources identified in the conceptual site model will be addressed during the RI/FS. Some potential sources including discharge via sinks and floor drains will be evaluated during the decontamination and decommissioning of the buildings at LEHR. |
| NATURE AND EXTENT OF CONTAMINATION | | | |
| Groundwater | The data quality and quantity collected during the Phase II Site Characterization is sufficient to support an SI and partially fulfills RI requirements. Eighteen groundwater monitoring wells and three surface water locations have been sampled quarterly since 1990. Analytical results have been used to evaluate contaminant concentrations in groundwater beneath, and surface water adjacent to the LEHR facility. Limited background statistical analyses have been conducted on samples from upgradient wells. Insufficient source data exist to correlate elevated levels of site constituents to specific potential sources. | Data collected are of sufficient quality (EPA level III) to be used for site characterization, risk assessment and evaluation of remedial action alternatives (EPA, 1987). However, the lateral and vertical extent of site constituents in groundwater have not been fully defined. Available information on physical characteristics of the first and second hyrdostratigraphic units is insufficient to fully develop reliable groundwater modeling scenarios. | Further statistical evaluation of upgradient and downgradient groundwater, and correlation with statistically developed background levels will be conducted during the RI/FS. Additional monitoring wells will be installed to evaluate lateral and vertical extent of site constituents. Data quality levels will include EPA levels III, IV, and V. It is anticipated that additional soil data collected during the RI may allow better correlation of site constituents in groundwater with specific source areas. Groundwater modeling may be conducted to predict extent of migration for site constituents and aid in evaluation of remedial alternatives. |

COMPARISON OF PHASE II DATA TO CERCLA RI/FS REQUIREMENTS
PHASE II SITE CHARACTERIZATION
ENVIRONMENTAL RESTORATION

| CERCLA RI/FS REQUIREMENT | STATUS | DATA USES/ LIMITATIONS | FURTHER ACTION/ DATA GAP |
|---|---|---|---|
| Soil/Sediments | Soil samples have been collected from most suspected source areas to allow the evaluation of types of contaminants and their concentration ranges. However, for the treatment systems and disposal trenches, sample locations do not meet SI priorities to collect samples directly from potential sources.<br><br>Treatment Systems: Data collected are useful to evaluate lateral extent. However, no source strength data were collected directly from the treatment systems. Potential source strengths remain unknown.<br><br>Disposal Trenches: Data collected were useful for initial evaluation of lateral extent. No source samples have been collected directly from the disposal trenches. Potential source strengths remain unknown.<br><br>Dog Pens: Data are useful for a risk assessment. No samples have been collected from the area of the Cellular Biology Lab. Additional data are required to assess vertical extent.<br><br>Additional potential sources including the UC Davis landfill cells and disposal trenches, and domestic septic tanks were not evaluated as part of the Phase II Site Characterization. | Analytical data collected during the Phase II Site Characterization are of sufficient quality (EPA level III) to be used in conducting site characterization, risk assessment and initial evaluation of remedial action alternatives. However, the quantity of data must be supplemented in various degrees for each source area to complete RI/FS tasks. Generally more data are required in the disposal trenches, landfill cells and domestic septic tanks than is required from the treatment systems, or dog pen areas. Statistically supportable background levels must be developed to evaluate impacts on-site. | Statistically based background levels, lateral and vertical extent, correlation with potential and identified sources, and spatial and temporal trends will be further developed during the RI/FS. Soil samples will be collected directly from source areas including; disposal trenches, landfill cells, treatment systems, domestic septic tanks and others to evaluate source strengths and obtain information on contaminant types not previously identified. Data quality levels during the RI/FS will include EPA levels III, IV, and V. |
| Air | No air monitoring was conducted during the Phase II Site Characterization. | No analytical data have been collected. | Air monitoring will be conducted during the RI/FS to evaluate presence and extent of contaminants and to conduct risk assessment and evaluation of remedial action alternatives. |

TABLE 4.1 (continued)

COMPARISON OF PHASE II DATA TO CERCLA RI/FS REQUIREMENTS
PHASE II SITE CHARACTERIZATION
ENVIRONMENTAL RESTORATION

| CERCLA RI/FS REQUIREMENT | STATUS | DATA USES/ LIMITATIONS | FURTHER ACTION/ DATA GAP |
|---|---|---|---|
| **CONTAMINANT FATE AND TRANSPORT** | | | |
| Contaminant persistence, mobility, transformation, releases and migration (actual or potential) | Contaminant fate and transport factors are discussed in non site-specific terms. Specific parameters for some contaminants have been identified during this Phase II Site Characterization. However, interrelationships between known physical site characteristics and contaminant types by source are not discussed. | Evaluation of contaminant fate and transport is useful to partially support risk calculations and assessment of potential effectiveness of remedial action alternatives. However, limited amounts of physical and chemical data from several of the known and suspected source areas (disposal trenches, landfill cells, domestic septic tanks and sewer lines) do not allow a complete evaluation of risk or remedial alternatives. | Site-specific applications of physical and chemical information as it pertains to contaminant persistence, mobility, transformation, and migration will be addressed during the RI/FS. Additional chemical and physical data will be obtained for each of the potential source areas. Contaminant fate and transport information will be used to assess risk, develop remedial alternatives and provide a data base for monitoring the effectiveness of remedial actions. |
| **QUALITY ASSURANCE/QUALITY CONTROL** | | | |
| Evaluation of Results/Data Quality Objectives | Analytical data collected during the Phase II can be classified as EPA analytical support level III. EPA level III data are adequate for use in an SI and RI/FS. | EPA level III data are typically useful for initial support of Site Characterization; risk assessment; evaluation of remedial alternatives; and engineering and design and monitoring of remedial actions (EPA, 1987). However, additional quantities of EPA level IV and V data are needed to fully support the RI/FS tasks. | Specific Data Quality Objectives for additional data will be developed during preparation of the RI/FS Work Plan. Data developed during the RI/FS will be used to characterize site impacts, conduct a risk assessment and a feasibility study. Data quality levels will include EPA levels III, IV, and V. |
| **BASELINE RISK ASSESSMENT** | | | |
| Contaminant identification; Exposure Assessment; Toxicity Assessment; and Risk Characterization | A baseline risk assessment has not been completed for the LEHR facility. Data generated during the Phase II Site Characterization are of sufficient quality for baseline risk assessment and screening level calculations. However, the data quantity is insufficient to fully address all potential sources, migration pathways and human and ecological receptors. | Data collected are of sufficient quality (EPA level III) to be useful in the baseline risk assessment. The quantity of data required to fully evaluate each source area must be supplemented to complete the baseline risk assessment. | A Conceptual Site Model (CSM) that identifies source areas, release mechanisms, migration pathways and potential human and ecological receptors will be developed for the RI/FS Work Plan. The CSM will identify additional data quantity needs by source area. Data quality collected during the RI/FS will be EPA analytical support levels III, IV and V. |

COMPARISON OF PHASE II DATA TO CERCLA RI/FS REQUIREMENTS
PHASE II SITE CHARACTERIZATION
ENVIRONMENTAL RESTORATION

| CERCLA RI/FS REQUIREMENT | STATUS | DATA USES/ LIMITATIONS | FURTHER ACTION/ DATA GAP |
|---|---|---|---|
| **FEASIBILITY STUDY** | | | |
| Development of Screening Alternatives | No development and screening of alternatives has been conducted during the Phase II Site Characterization. | The data generated during the Phase II Site Characterization are of sufficient quality to initiate development and screening of remedial alternatives. However, additional information on waste characteristics and source strengths is required. | Data gaps specific to the evaluation and screening of alternatives will be addressed in the RI/FS Work Plan. Data required will be based on the scope of the remedial actions and remedial action objectives developed for the LEHR facility. |
| Treatability Investigations | No treatability investigations have been conducted for contaminated soil or groundwater at the LEHR facility. | The data collected as part of the Phase II Site Characterization will be useful for treatability investigations. The quantity of physical and chemical analyses must be supplemented to varying degrees by source area. | Data requirements for treatability investigations will be addressed in the RI/FS Work Plan. Data required will be based on the remedial action objectives which will be developed for the LEHR facility. |
| Detail and Analysis of Alternatives | No detailed analyses of remedial alternatives have been conducted during the Phase II Site Characterization. | The data collected during the Phase II Site Characterization of sufficient quality and will be useful for detailed analyses of alternatives. The required quantities of data will be assessed after the scope of remedial actions and remedial action objectives have been developed for the LEHR facility. | The baseline risk assessment; development and screening of alternatives; and treatability investigations must be conducted to support the detailed analysis of remedial alternatives. |

The Phase II investigation involved the collection of three types of data: field screening data, field hydraulic tests, and laboratory data. The quality objectives of screening data are commensurate with qualitative determinations, whereas hydrologic and laboratory data are quantitative to the degree defined by the EPA (SW-846) and in ASTM. Field screening data and field hydraulic tests can be categorized under EPA Level I and II analytical support levels (Table 4.2). Laboratory data generated during this Phase II Site Characterization would be categorized under EPA Level III analytical support level. Table 4.2 identifies the five EPA analytical levels and provides a brief description of the objectives of the levels. Table 4.3 identifies the appropriate analytical levels by intended data use. Table 4.4 provides a summary of the objectives for data developed during the Phase II Site Characterization. This table also summarizes additional data to be obtained during the planed RI/FS under CERCLA.

### 4.2.7 Investigation Methodologies

The Phase II Site Characterization incorporated a number of different methodologies to evaluate the physical and environmental conditions at the site. The methodologies included:

- Literature review;
- Assessment of physical conditions;
- Field screening for organic and radiologic constituents;
- Soil, groundwater and surface water sample collection through the use of hand-sampled soil borings and monitoring well installations;
- Geologic logging;
- Field testing of water samples for pH, EC and temperature;
- Laboratory analysis of samples for chemical, radiological and physical parameters;

TABLE 4.2
EPA ANALYTICAL SUPPORT LEVELS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Level | Description |
|---|---|
| I | Field screening or analysis using portable instruments. Results are often not compound specific and not quantitative, but they are available in real time. This is the least costly of the analytical options. Instruments may not respond to all compounds and may not be able to identify compounds. If the instruments are calibrated properly and data are interpreted correctly, Level I techniques can provide an indication of contamination. |
| II | Field analyses using more sophisticated portable analytical procedures (such as gas chromagraphy for organics and atomic absorption or x-ray fluorescence for metals). The instruments may be set up in a mobile on site laboratory. Results are available in real time or within several hours, and may provide tentative identification of compounds or be analyte specific. Data are typically reported in concentration ranges, and detection limits may vary from low parts per million to low parts per billion. Data quality depends on the use of suitable calibration standards, reference materials, sample-handling procedures, and training of the operator. In general, Level II techniques and instruments are mostly limited to volatiles and metals. |
| III | All analyses performed at an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program procedures, but do not usually use the validation or documentation procedures required of Contract Laboratory Program Level IV analysis. Detection limits and data quality are similar to Level IV, but results will generally be available in a shorter time. |
| IV | The Contract Laboratory Program routine analytical services. All analyses are performed in an off-site Contract Laboratory Program analytical laboratory following Contract Laboratory Program protocols. Generally, low microgram-per-liter detection limit for substances on the Hazardous Substance List (EPA 1986a), but also may provide identification of non-Hazardous Substance List compounds. Sample results may take several days to several weeks, and additional time may be required for data validation. Level IV results have known data quality supported by rigorous quality assurance and quality control protocols and documentation. |
| V | Analysis by nonstandard methods. All analyses are performed in an off-site analytical laboratory that may or may not be a Contract Laboratory Program laboratory. Method development or method modification may be required for specific constituents or detection limits, and additional lead time may be required. Detection limits and data quality are method specific. The Contract Laboratory Program special analytical services are Level V. |

TABLE 4.3
APPROPRIATE ANALYTICAL LEVELS — BY DATA USE
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | Site Characterization (including Health & Safety) | Risk Assessment | Evaluation of Alternatives | Engineering Design of Remedial Action | Monitoring During Implementation of Remedial Action | PRP Determination |
|---|---|---|---|---|---|---|
| Analytical Level I | ✓ | | | | ✓ | |
| Analytical Level II | ✓ | | ✓ | | ✓ | |
| Analytical Level III | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Analytical Level IV | | ✓ | ✓ | ✓ | | ✓ |
| Analytical Level V | | ✓ | | ✓ | | ✓ |
| Other | | | | ✓ | | |

PRP Potential Responsible Party

From: EPA, 1987, Data Quality Objectives for Remedial Response Activities.

TABLE 4.4
SUMMARY TABLE OF DATA OBJECTIVES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| DATA OBJECTIVES | STATUS | DATA TYPES USED | FURTHER ACTION/ DATA GAPS |
|---|---|---|---|
| Develop background levels of chemical and radiological constituents; | Data quality and quantity is adequate to develop preliminary background levels. Additional background locations must be sampled for the RI/FS. | Soil and groundwater chemical properties and previously published data | Additional background samples will be collected during the RI to provide an increased level of confidence in the background levels of identified site constituents. |
| Identify types of contaminants; | Data quality and quantity is adequate to identify types of contaminants in areas investigated during the Phase II Site Characterization (treatment systems, dog pens, southwest and north chemical dispensing areas). Data must be generated to identify types of contaminants in areas not yet evaluated (disposal trenches, landfill cells, domestic septic tanks, currently unidentified disposal areas, soil below the imhoff tanks, and sewer lines). Data quantity must be supplemented in various degrees by source areas for RI/FS.<br><br>Data quality and quantity is adequate to identify types of contaminants in groundwater and surface water. | Soil, groundwater and surface water chemical properties | As part of the RI, soil samples will be collected and analyzed from potential sources not addressed during the Phase II Site Characterization. These sources include DOE disposal trenchea, UC Davis landfill cells and disposal trenches, domestic septic tanks, currently unidentified disposal areas, soil below the imhoff tanks, and sewer lines. |
| Evaluate the presence or demonstrate the absence of constituenta across the site; | Data quality and quantity is adequate to evaluate presence of site constituents in source areas evaluated during the Phase II Site Characterization. Additional sources (disposal trenches, landfill cells, domestic septic tanks, currently unidentified disposal areas, soil below the imhoff tanks, and sewer lines) not addreased during the Phase II Site Characterization will be addressed during the RI/FS. Data quality and quantity is adequate to evaluate presence of site constituents in groundwater and surface water. | Soil, groundwater and surface water chemical properties | During the RI, soil samples will be collected and analyzed from potential sources not addressed during the Phase II Site Characterization. These sources include DOE disposal trenches, UC Davis landfill cells and disposal trenches, domestic septic tanks, currently unidentified disposal areas, soil below the imhoff tanks, and sewer lines. Quarterly monitoring of groundwater will continue, additional monitoring wells will be installed, and statistical analysis will be conducted on soil and water analytical data to establish extent of impacts across the site. |

TABLE 4.-- (continued)

SUMMARY TABLE OF DATA OBJECTIVES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| DATA OBJECTIVES | STATUS | DATA TYPES USED | FURTHER ACTION/ DATA GAPS |
|---|---|---|---|
| Evaluate the potential volumes of affected soil and groundwater; | The quality of data generated during the Phase II Site Characterization is adequate to support the evaluation of potential volumes of affected soil and groundwater. The quantity of samples must be supplemented in varying degrees for source areas. In general, less additional data are required from the dog pen and treatment systems areas than is required from the disposal trenches (DOE and UC Davis), landfill cells, unidentified areas, domestic septic tanks and sewer lines. | Soil, groundwater and surface water chemical properties; soil physical properties; groundwater levels | During the RI, additional soil and groundwater samples will be collected and analyzed to more fully evaluate the lateral and vertical extent of contaminants in each source area. Based on analytical data, and comparison to established background levels, volumes of affected soil and groundwater will be calculated. Volume calculations will be used to evaluate remedial actions. |
| Develop a conceptual site model for exposure pathways; | Analytical data quality and quantity are adequate to develop a conceptual site model. A conceptual site model that identifies potential source areas, release mechanisms, migration pathways, and potential human and ecological receptors will be presented in the RI/FS Work Plan. The conceptual site model will be used to identify data necessary to complete the RI/FS and risk assessment. | Soil physical properties; soil groundwater and surface water chemical properties; aquifer parameters; contaminant fate and transport data | A conceptual site model that identifies known and potential sources, release mechanisms, migration pathways, and potential human and ecological receptors will be presented in the RI/FS Work Plan. The conceptual site model will identify data needs to complete the RI/FS and risk assessment. |
| Provide reliable data for a baseline risk assessment and the development of site ARARs for the protection of human health and the environment; | Data generated during the Phase II Site Characterization are of sufficient quality for baseline risk assessment and screening level calculations. However, data quantity is insufficient to address all potential sources, migration pathways and receptors. Preliminary ARARs can be developed using Phase II data. | Soil physical properties; soil groundwater and surface water chemical properties; aquifer parameters; contaminant fate and transport data | Additional data will be collected from identified source areas during the planned RI/FS. Data quality collected during the RI/FS will include EPA analytical support levels III, IV and V. Site specific ARARs will be developed during the FS to evalaute appropriateness of remedial technologies and remedial actions. |

TABLE 4.-- (continued)

SUMMARY TABLE OF DATA OBJECTIVES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| DATA OBJECTIVES | STATUS | DATA TYPES USED | FURTHER ACTION/ DATA GAPS |
|---|---|---|---|
| Provide a representative database for soil and groundwater contamination at the site to allow the development and evaluation of remedial alternatives; | A representative database has been developed during this Phase II Site Characterization for soil and groundwater. Results of analyses from 188 soil samples collected from most suspected sources and background locations have been used to develop the soil database. Results of analyses from samples collected quarterly from eighteen groundwater monitoring wells and three surface water locations have been used to develop the water database. The data collected will be useful in developing the preliminary remedial alternatives during the RI/FS process. | Soil, groundwater and surface water chemical data; soil physical characteristics; contaminant fate and transport data | Additional data collected during the RI/FS will be added to the database for the LEHR facility. Data will useful for conducting statistical analyses and evaluating remedial alternatives. Additional data gaps will be addressed after the remedial action objectives have been developed for the LEHR facility. |
| Provide a reliable database for monitoring the short-term and long-term effectiveness of remedial activities; | Data collected during the Phase II Site Characterization are of sufficient quality to be useful in comparison monitoring of the short-term and long-term effectiveness of potential remedial actions that may be implemented at the LEHR facility. | Soil, groundwater and surface water chemical data | Data generated during the planned RI/FS will be included into the LEHR database. The database will provide a reliable basis to evaluate the short-term and long-term effectiveness of remedial actions. |

- Laboratory analysis of trip blanks, replicates, duplicates, and field blanks;

- Data acceptance using precision, accuracy, representativeness, completeness and comparability (PARCC) parameters;

- Data evaluation using various computer-based graphical and statistical methods; and

- Computer modeling of groundwater and contaminant transport parameters using the Modular Three-Dimensional Finite Difference Groundwater Flow Model (MODFLOW) coupled with a Modular Three-Dimensional Transport Model (MT3D).

These methodologies are outlined more completely in Chapter 5.0 and Appendix A of this report.

#### 4.2.8 Data Evaluation Methodologies

Results of soil, sediment, groundwater, and surface water analyses for the Phase II Site Characterization were evaluated in accordance with the procedures and Data Quality Objectives identified in the Work Plan, and with respect to PARCC (precision, accuracy, representativeness, completeness, and comparability). Approved soil and water sampling techniques were used so that representative samples were obtained for analysis. CEP Laboratories of Santa Fe, New Mexico performed the requested analyses, and provided soil and sediment data in hard-copy form, and groundwater and surface water data in hard-copy form and on disk.

The precision and accuracy of requested analysis were evaluated by the laboratory by analyzing method blank and spike samples, matrix spike and matrix spike duplicate samples, and surrogate spike samples for each analytical batch. Results from analysis of these samples were included in a quality assurance (QA) data section provided with each analytical data package and reviewed by Dames & Moore as part of the data evaluation. Results of the precision and accuracy evaluation are presented in Sections 6.4.1 (Soil), 6.4.2 (Sediment), 6.4.3 (Surface water), and 6.4.4 (Groundwater).

Generally, surrogate recoveries for organic and inorganic compounds met acceptance criteria (specified in the QAPjP) in over 95 percent of the quality control samples for soil and water analyses. For soil samples, matrix spike and matrix spike duplicate analysis met acceptance criteria for approximately 90 percent of the soil quality control samples. Acceptance criteria for water samples ranged from approximately 90 to 100 percent for matrix spikes and matrix spike duplicate analyses. Additional details on data evaluation are presented with the results of soil analyses and quarterly water sampling in Section 6.4.

Blind duplicate water samples were collected during all quarterly groundwater and surface water sampling rounds. These blind duplicate samples were collected at a rate of 10 percent, or 1 duplicate sample per 10 samples. The duplicates were analyzed for the same analytes. The results of the relative percentage difference (RPD) of the blind duplicate samples are presented in Figure 4.2.

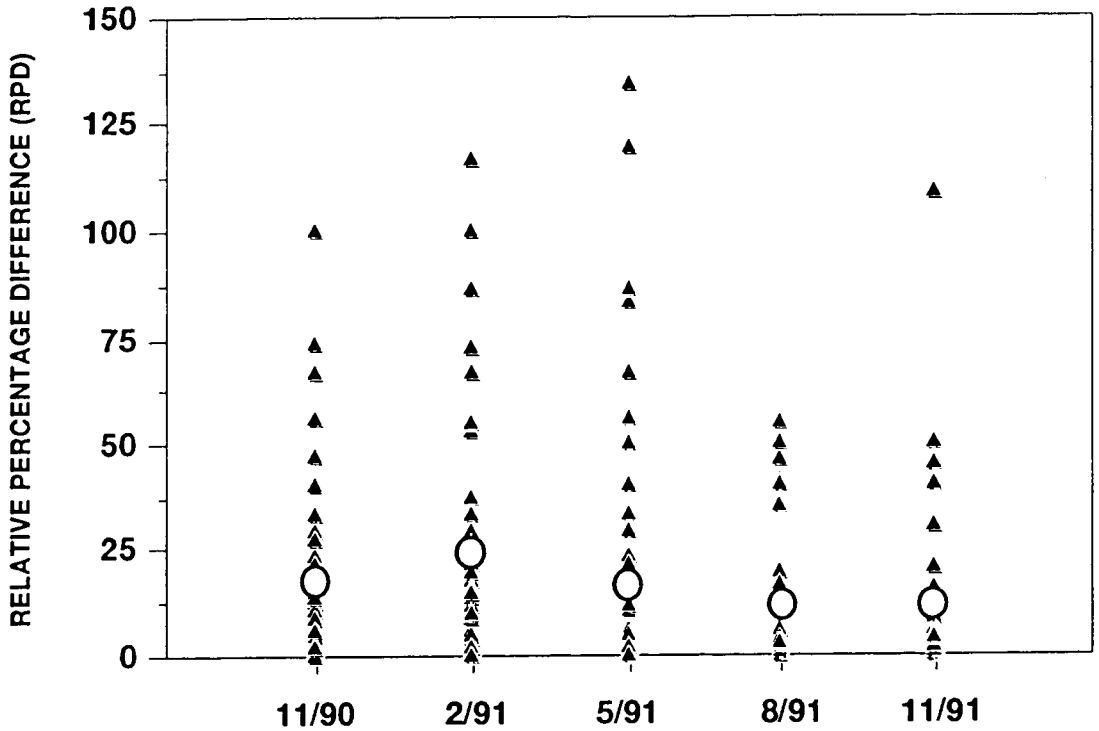
Figure 4.2 shows that the average RPD remained below 25 percent, the acceptance value stated in the QAPjP. The average RPD ranged from approximately 24 percent in the February 1991 sampling round to approximately 10 percent in the November 1991 sampling round. Additionally, Figure 4.2 shows that nine RPD values exceeded 75 percent. Of the nine RPD values which exceeded 75 percent, three were for total phosphate, three were for chemical oxygen demand (COD), and one each for nitrate, total dissolved solids (TDS), and gamma BHC. Other than RPD values for phosphate and COD, no consistent elevated RPD values for any of the inorganic, organic or radiologic analytes were measured. Neither phosphate nor COD are primary constituents of concern at LEHR. The distribution of RPD values measured in this data set did not bias the overall conclusions or recommendations presented in Chapters 8.0 and 9.0 respectively.

These results suggest that both internal quality control samples prepared by the laboratory (matrix spikes, matrix spike duplicates) as well as external quality control samples (blind duplicate water samples) met the data quality objectives for water samples stated in the QAPjP. For soil samples, external quality control samples such as duplicate soil samples cannot be obtained as discussed in the QAPjP. However, all soil sample analyses met their internal quality control performance objectives stated in the QAPjP.

RPD values for groundwater and surface water are presented in Appendix G Table G-7b and Appendix H Table H-7. Soil replicates were not evaluated using a relative percent difference calculation because inherent homogenities in soil samples cannot be accounted for in the analysis results.

In addition to laboratory QA data, trip blanks were analyzed for volatile organic compounds and results were reviewed by Dames & Moore for indication of potential contamination during sample handling and transport. Trip blanks, prepared by the laboratory, accompanied groundwater and surface water sample containers during sample collection, sample preservation, and sample shipment. When questionable detections were identified, CEP was contacted for an explanation and the appropriate batch of water samples was noted in the text of this report (see Sections 6.5.1 - 6.5.4).

Data completeness was checked by comparing analytical results with analyses requested on the Chain-of Custody. Checking for data completeness began with hand entry of hard-copy data (soil and sediment) or by transferring electronic data into the project database. The data were listed and compared with the hardcopy record. Data printouts for soil analyzed, sediment analyses, and for the first two




EXPLANATION

▲ Individual RPD Values

○ Average RPD Value

**RELATIVE PERCENTAGE DIFFERENCE OF BLIND DUPLICATE ANALYSES**

Phase II Soil Charecterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044.RPD

FIGURE 4.2

quarterly water sampling rounds were compared against hardcopy records line-by-line for 100 percent of the entries. A minor number of entry errors were identified, and the laboratory was notified of the discrepancies. In subsequent water sampling rounds, 25 percent of the data from each quarter sampling round was hand checked. Following the data output review, sample holding times were compared with the sample chronology provided by CEP. Missed hodling times were confirmed by CEP and noted in the text of this report (see Sections 6.5.1 through 6.5.4). The database output was evaluated for completeness against each sample chain-of-custody to establish a comparison of samples collected in the field with reported sample data. Any missing or erroneous information was immediately resolved.

Comparability of the analytical results for quarterly groundwater and surface water samples was evaluated by tabulating results from each sampling event and checking them against past quarterly results. Accepted data were interpreted using various graphical and statistical methods (Chapter 7.0). Commercial software used to manipulate the data and produce visual aids include:

- dBase III Plus, Ashton-Tate, 1987;
- Quattro® Pro Version 3.0, Borland International, Inc., 1990;
- Lotus 1-2-3, Lotus Development Corporation, 1991;
- GRAPHER™, Golden Software, Inc., 1989-1990;
- SURFER™, Golden Software, Inc., 1989-1990;
- MODFLOW, McDonald and Harbaugh, 1988;
- SLUGIX, Interpex, Limited, 1988;
- AutoCAD®, Autodesk, Inc., 1990;
- AutoScript-C™, Preco Industries, Inc., 1988; and
- WordPerfect 5.1, WordPerfect Corporation, 1988.

### 4.2.9 Minimizing Generation of Wastes

A number of potentially contaminated wastes were generated during the Phase II Site Characterization field investigation. These materials consist of excavated soil, purged groundwater, used personnel protective clothing, and decontamination products. The field program was designed to minimize waste generation, and during the field investigation, efforts were made to further reduce generated wastes without degrading the quality of the data generated, or endangering the health and safety of personnel. Soil and water wastes generated during the drilling and sampling of UCD-15, UCD-16 and UCD-17 were temporarily stored in polyethylene tanks and roll-off boxes before being transported, and disposed in an appropriate manner by UC Davis according to applicable federal, state, and local regulations. All other wastes, including soil, water, personnel protective equipment and decontamination products, are stored in closed 55-gallon drums placed in the Cobalt-60 Field. These wastes will be

disposed pending the results of the waste characterization study currently underway, and remain the responsibility of UC Davis.

4.2.10 Deviation from Work Plan

Three WBS tasks have not been completed as described in the Work Plan (Dames & Moore, 1990f). The three tasks include:

- WBS 305 — Domestic Septic Tank Investigation;
- WBS 303 — Groundwater Monitoring Well Installation; and
- WBS 308 — Waste Characterization.

In addition, a surface-water study has been initiated, but not completed.

Because of delays in the radium-226 and the Imhoff tank sludge removal projects, and their proximity to one of the domestic tanks to be evaluated, the domestic septic tank investigation task has not been completed on a schedule that allowed incorporation of the data into this Phase II Report. It is anticipated that the domestic septic tank investigation will be conducted as part of the planned RI/FS under CERCLA.

Fourteen groundwater monitoring wells were proposed in the Work Plan. At the time of this report, 10 groundwater monitoring wells have been installed (UCD-15 through UCD-24). These 10 wells have been incorporated into the quarterly groundwater sampling rounds. Locations for the remaining four monitoring wells (UCD-25 through UCD-28) are to be finalized based on the findings of this Phase II Site Characterization Report. It is anticipated that these new monitoring wells will be installed during the planned RI/FS under CERCLA. After installation, these new wells will be incorporated into the quarterly groundwater sampling as they are completed.

A work plan for the characterization of wastes generated during the previous Phase I and this Phase II investigation is currently being developed. This work plan describes the methodologies that will be used to characterize wastes for disposal purposes. The wastes are currently stored in closed 55-gallon drums placed in the Cobalt-60 Field at the LEHR facility, and remain the responsibility of UC Davis.

The surface water study to be completed with the surface water sampling was initiated but not completed. The objectives of the study were to quantify the interaction between the surface water (Putah Creek) and the first HSU, and identify other potential discharge sources upstream of the LEHR facility. Baseline information on creek flow and chemical analyses of creek water and sediments has been collected. However, a thorough investigation of potential point discharge sources upstream of the LEHR

facility has not been completed. Surface water sampling from locations upstream and downstream of the LEHR facility is continuing quarterly.

Variations in the scope were documented through formal revisions of the Work Plan. Revision Number 1 consisted of the increase in the number of groundwater monitoring wells from 10 to 14, expansion of the waste characterization task, and additional detail on data quality objectives in the QAPjP. Revision Number 2, currently being reviewed by EMO, consists of additional details on the investigation of the former AEC sites on the main UC Davis campus and additional procedures for evaluation of the domestic septic tanks at the LEHR facility. It is anticipated that those tasks not completed during the Phase II investigation will be included in the site-wide investigation planned for FY 1993.

## 5.0 PHASE II INVESTIGATION

Nine tasks were outlined in the Work Plan as presented in Chapter 1.0 of this report. These tasks were modified and redefined in EMO's (SOW) for FY 1990/1991 dated April 11, 1990, and further redefined in EMO's SOW for FY 1992 dated October 24, 1991.

The scope of work for the Phase II Site Characterization with WBS designations as defined in Task Order 099217 and the Work Plan are outlined below:

| | FY 91 WBS No. | FY 92 WBS No. |
|---|---|---|
| Literature Review and Surveying | 0401 | NA |
| Groundwater Monitoring Well Installation and Sampling | 0402 | 303A, 303C |
| Soil Boring and Sampling | 0403 | 302 |
| Sediment Sampling | 0404 | 304 |
| Surface Water Sampling | 0405 | 303A |
| Septic Tank Investigation | 0406 | 305 |
| Aquifer Analysis | 0407 | 306 |
| Phase II Report Preparation | 0408 | 307 |
| Waste Characterization | NA | 308 |

WBS = Work Breakdown Structure
303A = Quarterly Sampling
303C = Well Installation

Work Breakdown Structure designations were redefined between FY 1991 and FY 1992, as shown above. A project planning and management task with a QA/QC subtask was also initiated in both years. The Literature Review and Surveying task was completed in FY 91. In FY 92, the Waste Characterization task was added.

Table 5.1 presents the approximate dates each field task was conducted. Presented below is a summary of the tasks conducted for the Phase II Site Characterization. Appendix A presents more complete descriptions of field methods used during this investigation. Appendix B presents the QA/QC procedures implemented for data tracking and evaluation.

TABLE 5.1
COMPLETION SCHEDULE
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| TASK | | APPROXIMATE DATES COMPLETED |
|---|---|---|
| Shallow Soil Borings | Dog Pen Area | 2/20/90 through 2/22/90 |
| | North Chemical Dispensing | 3/8/90 through 3/9/90 |
| | Old AEC Project Site | 2/20/91 through 2/21/91 |
| Intermediate and Deep Borings | Southwest Chemical Dispensing Area | 3/8/90 through 3/9/90 |
| | Strontium-90 Leachfield | 3/9/90 through 3/12/90 |
| | Radium-226 Dry Wells | 3/13/90 through 3/14/90 |
| Sediment Sampling | | 2/22/90 |
| Monitoring Well Installation(1) | First HSU Monitoring Wells | 9/26/90 through 10/19/90 |
| | Second HSU Monitoring Wells | 3/29/90 through 4/10/90 |
| Quarterly Water Sampling | Fall 1990 | 10/29/90 through 11/9/90 |
| | Winter 1991 | 2/5/91 through 2/12/91 |
| | Spring 1991 | 5/13/91 through 5/21/91 |
| | Summer 1991 | 8/5/91 through 8/14/91 |
| | Fall 1991 | 11/18/91 through 11/26/91 |
| Aquifer Analysis | | 12/9/91 through 3/30/92 |
| Domestic Septic Tanks | | Pending |
| Waste Characterization | | Pending |

(1) Additional wells may be required. Phase II Site Characterization data will be used to optimize the locations of these wells.

## 5.1 WBS 302 — LITERATURE REVIEW AND SURVEYING

This Work Element consists of two tasks: a review of additional available published and unpublished literature regarding the site that has not been reviewed during previous work; and surveying sampling locations, monitoring wells and structures at the site with reference to the State Geodetic Standard.

### 5.1.1 Literature Review

Information obtained through the literature review is incorporated with information presented in past investigations to provide:

- An evaluation of the physical setting;
- Regional and local aspects of topography, geology, geohydrology, surface-water hydrology, meteorology, and environmental and human resources;
- A site conceptual model; and
- An initial evaluation of known and potential sources of contamination.

The Literature Review task was initiated by a detailed survey of the UC Davis files at the LEHR facility. Files and maps were catalogued, reviewed, and then copied for Dames & Moore's files. Notes on the review were maintained in a background file for future reference.

Prior to implementation of each of the investigation tasks, additional literature review was conducted. Background information from published literature or previous reports as appropriate for each field task was studied. University resources on hydrogeology, surface water, background soil and groundwater chemistry and results of previous investigations were reviewed by each field investigator. Data developed was used to more efficiently and accurately implement each field task.

In preparing this report, available unpublished and published data and reports were reviewed, and current and historical aerial photographs were evaluated. Data and records from the LEHR facility and UC Davis were reviewed to gain further information on the types and quantities of chemicals and radionuclides used and disposed at the LEHR facility and in the inactive landfill units. Numerous technical publications on similar chemical constituents on depositional environments were reviewed for reference. Emphasis was given to a review of the Phase I Site Investigation Report and other previously completed reports for the LEHR facility and Old UC Davis Landfill. A list of the previous environmental investigations conducted at the LEHR facility is presented in Chapter 3.0.

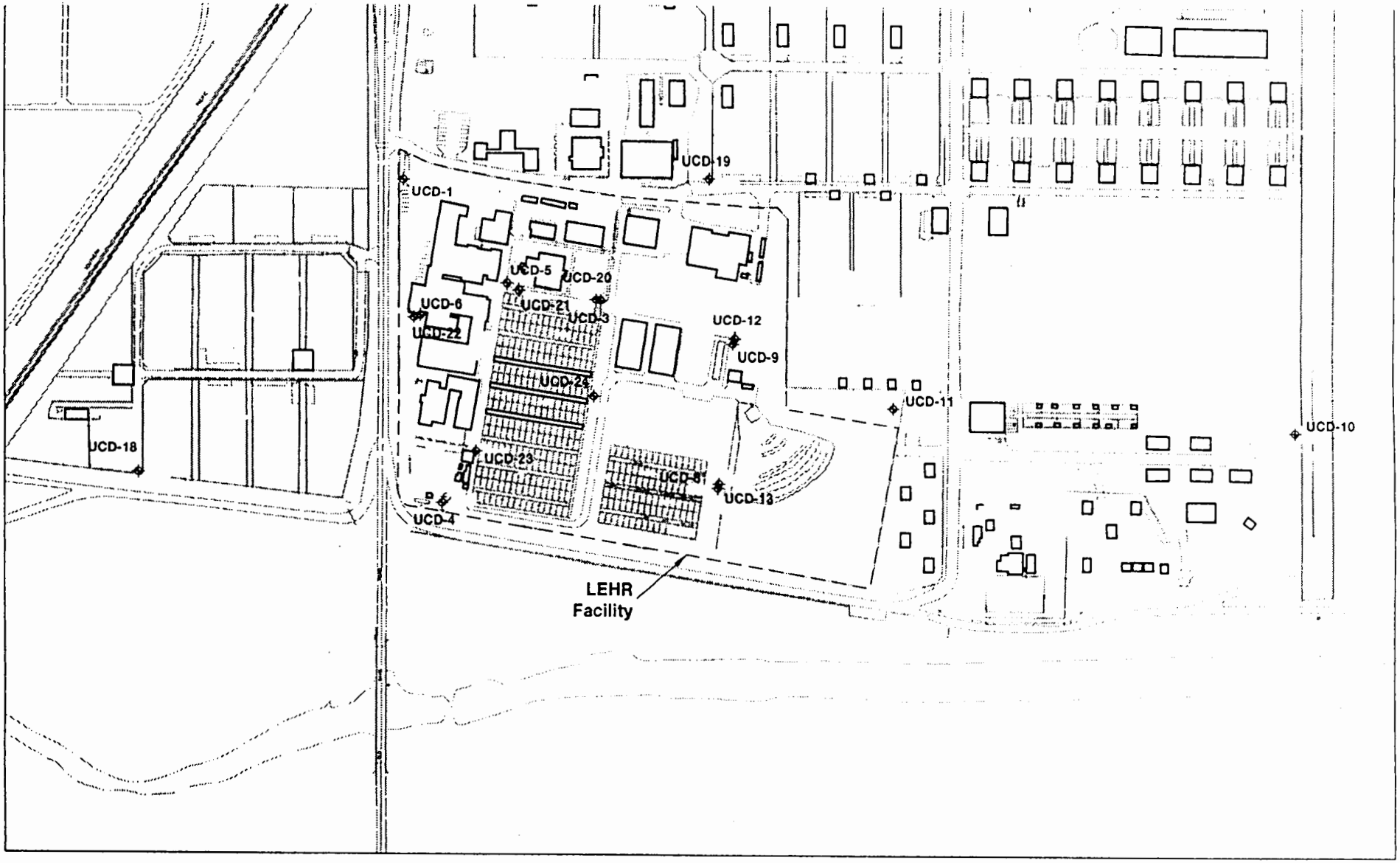
### 5.1.2 Surveying

To provide traceability of data, soil sampling locations and groundwater monitoring wells were tied vertically and horizontally to the State Geodetic Standard. Structures at the LEHR facility were located on a base map and topographic map of the LEHR facility and land within approximately 1,000 feet of the LEHR facility boundary. Six permanent benchmarks for horizontal and vertical survey control were established consisting of 4-inch-diameter brass survey markers set in 8- to 12-inch-diameter, 2-foot-deep, concrete footings. The base of the brass markers are flush with ground surface, and inscribed with applicable information, including the name of the site, date installed, coordinates, name of the horizontal grid system, and elevation in relation to the State Geodetic Standard. Horizontal controls are accurate to within 0.01 foot, and vertical accuracy is within 0.01 foot for monitoring wells, and within 0.01 foot for sampling locations.

The survey was conducted by Valley CAD of Sacramento, California. The aerial survey, flown on June 7, 1991, and photogrametric mapping were conducted by GEONEX of Sacramento, California. GEONEX provided Dames & Moore with a 1:200 scale topographic map of the LEHR facility and surrounding area. Additionally, all data were provided on computer discs in CAD files.

## 5.2 WBS 303 — MONITORING WELL INSTALLATION AND SAMPLING

During the Wahler Associates Phase I Investigation and the SWAT investigation of the Old UC Davis Landfill at the LEHR facility, 14 groundwater monitoring wells (UCD-1 through UCD-14); were installed. Twelve of these wells (UCD-1 through UCD-6, and UCD-8 through UCD-13) were installed in the first HSU (Figure 5.1A), and two wells (UCD-7 and UCD-14) were installed in the second HSU (Figure 5.1B). One well (UCD-2), installed during the Phase I investigation, was destroyed by UC Davis in February 1990, because it was located within Landfill Disposal Cell Unit 2. Ten additional groundwater monitoring wells (UCD-15 through UCD-24) were installed as part of this Phase II Site Characterization. Seven monitoring wells (UCD-18 through UCD-24) were installed in the first HSU (Figure 5.1A), and three wells (UCD-15, UCD-16 and UCD-17) were installed in the second HSU (Figure 5.1B). For the Phase II wells, the screened interval in first-HSU wells was the upper 10 feet of the water table zone, and over 70 percent of the zone of interest for the deeper wells. Following well installation and development, groundwater samples have been collected quarterly. Additional information on well drilling, soil sample collection and well construction are outlined below. Groundwater and soil sampling parameters from these monitoring wells is presented in Section 5.3.




EXPLANATION

Monitoring Wells

0 300
Scale in Feet

N

# GROUNDWATER MONITORING WELL LOCATION MAP FIRST HSU WELLS

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

FIGURE 5-1A

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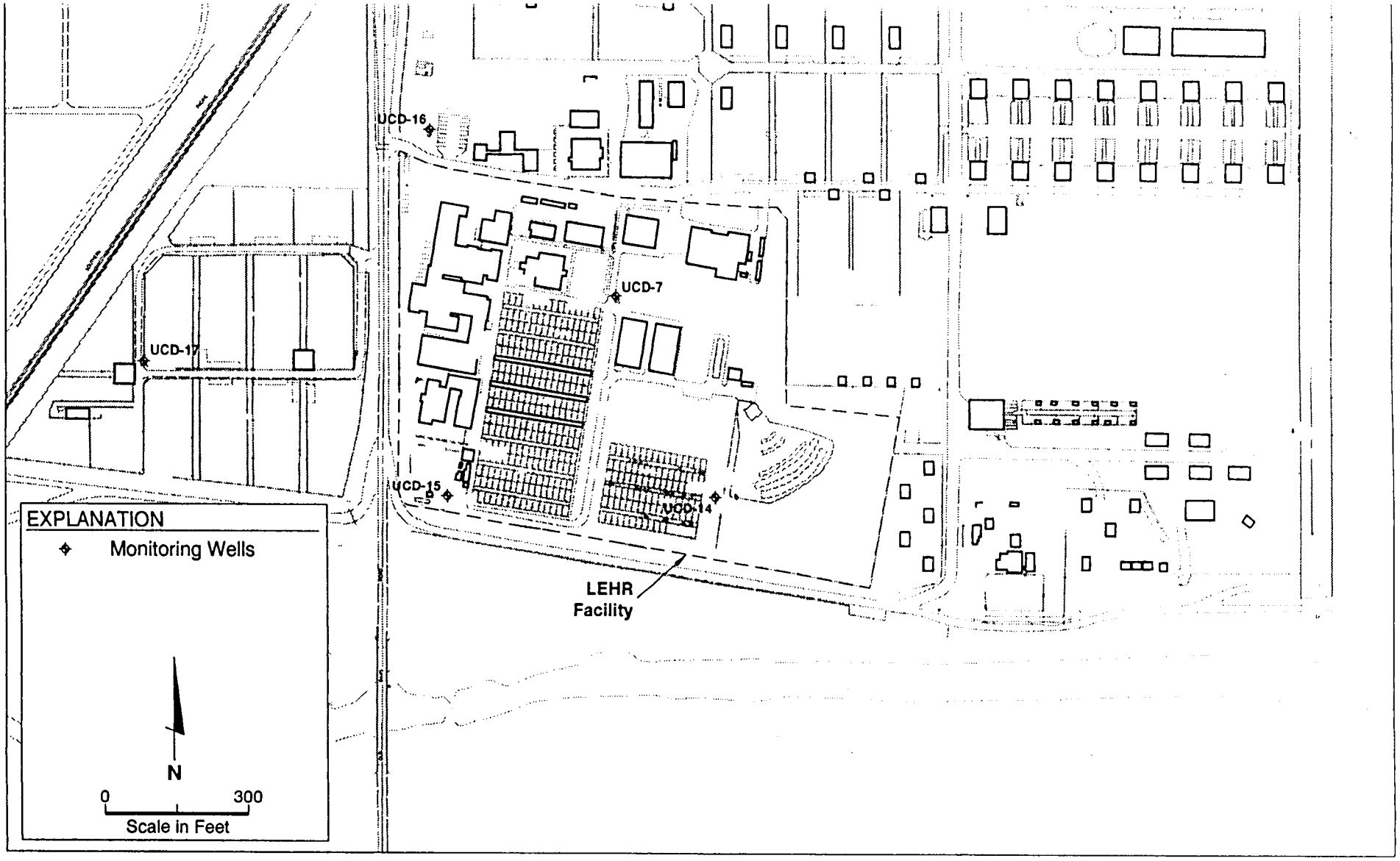


**GROUNDWATER MONITORING WELL LOCATION MAP SECOND HSU WELLS**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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10805-454-044 SJR 6/17/92 DOE-407

FIGURE 5-1B

Table 5.2 presents monitoring well completion depth, screened interval depths, and the respective hydrostratigraphic unit. Well locations were selected in order to triangulate groundwater gradients and to develop a spatial distribution of groundwater quality downgradient of potential source areas identified in previous investigations.

### 5.2.1 Well Drilling

Well borings for the first- and second-HSU groundwater monitoring wells were drilled under the supervision of a California State Registered Geologist representing Dames & Moore, with oversight by technical representatives from UC Davis and The Earth Technology Corporation. Details of drilling, and sampling methods, are outlined below and presented in Appendix A.

Borings for the seven monitoring wells in the first HSU (UCD-18 through UCD-24) were drilled by Water Development Corporation of Woodland, California between September 26, 1990 and October 19, 1990. The well borings were drilled using a CME 75 truck-mounted drilling rig equipped with 8- and 12-inch hollow-stem augers and continuous core capabilities. Pilot holes for well borings were initially drilled with 8-inch augers. Relatively undisturbed drive samples for chemical, radiological and physical analyses were collected, and pilot holes were continuously cored. Well borings were reamed with the 12-inch augers for monitoring well completion.

The three deeper well borings for monitoring wells in the second HSU, UCD-15, UCD-16 and UCD-17, were also drilled by Water Development Corporation. These boring were drilled between March 28, 1990 and April 10, 1990 using a Speedstar TH15 air rotary/casing hammer drill rig. Drive samples were collected from the surface to the groundwater table at approximately five-foot intervals. Because of problems encountered during installation of a monitoring well in the second HSU during the SWAT Investigation (UCD-14), no drive samples were collected from below the water table. Soil cuttings circulated to the surface by a drilling process were collected and observed continuously.

TABLE 5.2
SUMMARY OF MONITORING WELLS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Well Name | Total Depth | Screened Interval | HSU | Investigation | Date Completed |
|---|---|---|---|---|---|
| UCD - 1 | 56.5 | 46.5 - 56.5 | First | Wahler Associates 1989 | 10/09/87 |
| UCD - 3 | 49.0 | 39.0 - 49.0 | First | Wahler Associates 1989 | 10/23/87 |
| UCD - 4 | 57.2 | 45 - 55 | First | Wahler Associates 1989 | 10/14/87 |
| UCD - 5 | 48.0 | 38.0 - 48.0 | First | Wahler Associates 1989 | 10/22/87 |
| UCD - 6 | 50.0 | 40 - 50 | First | Wahler Associates 1989 | 10/21/87 |
| UCD - 7 | 90 | 80 - 90 | Second | Wahler Associates 1989 | 11/05/87 |
| UCD - 8 | 53.5 | 43.5 - 53.5 | First | Wahler Associates 1988 | 11/03/87 |
| UCD - 9 | 50.0 | 40.0 - 50.0 | First | Wahler Associates 1988 | 11/04/87 |
| UCD - 10 | 70.0 | 54 - 69 | First | Dames & Moore SWAT, 1990 | 10/11/89 |
| UCD - 11 | 66.5 | 50 - 65 | First | Dames & Moore SWAT, 1990 | 10/17/89 |
| UCD - 12 | 65.0 | 49.5 - 64.5 | First | Dames & Moore SWAT, 1990 | 10/19/89 |
| UCD - 13 | 65.0 | 50 - 65 | First | Dames & Moore SWAT, 1990 | 10/26/89 |
| UCD - 14 | 85 | 75 - 85 | Second | Dames & Moore SWAT, 1990 | 11/15/89 |
| UCD - 15 | 120.5 | 91 - 116 | Second | Dames & Moore, DOE Phase II | 03/28/90 |
| UCD - 16 | 122 | 92 - 117 | Second | Dames & Moore, DOE Phase II | 04/04/90 |
| UCD - 17 | 143 | 88 - 113 | Second | Dames & Moore, DOE Phase II | 04/10/90 |
| UCD - 18 | 70 | 54 - 69 | First | Dames & Moore, DOE Phase II | 10/04/90 |
| UCD - 19 | 74.5 | 71.5 - 56.5 | First | Dames & Moore, DOE Phase II | 10/01/90 |
| UCD - 20 | 73 | 57 - 72 | First | Dames & Moore, DOE Phase II | 10/09/90 |
| UCD - 21 | 73 | 57 - 72 | First | Dames & Moore, DOE Phase II | 10/11/90 |
| UCD - 22 | 73 | 57 - 72 | First | Dames & Moore, DOE Phase II | 10/25/90 |
| UCD - 23 | 73 | 56.5 - 71.5 | First | Dames & Moore, DOE Phase II | 10/17/90 |
| UCD - 24 | 73 | 57 - 72 | First | Dames & Moore, DOE Phase II | 10/22/90 |

NOTE: UCD-25 through UCD-28 were postponed pending findings of this Phase II Site Characterization Report. Locations of these monitoring wells may be changed to more accurately evaluate potential source areas.

HSU = Hydrostratigraphic Unit

### 5.2.2 Soil Sampling from Monitoring Well Borings

Soil samples from monitoring well borings were collected at approximately five-foot intervals at the depths listed in Table 5.3. Soil samples were collected using a Dames & Moore Type U Sampler as described in Appendix A. Six soil sample intervals from each boring were collected. Soil samples collected were sealed, tagged, and labeled with the appropriate information as described in Appendix A.

Soils from well drilling operations were logged in the field by the site geologist. Soils were classified using the Unified Soil Classification System (USCS). Additionally, boring logs contain information on sample collection, consistency of materials, penetration rates, and contaminant odor or visual observations.

### 5.2.3 Physical Testing

Five soil samples were tested for physical parameters to aid in the classification of soils, and to be used in contaminant transport modeling (Section 6.5). Soil samples were tested for grain size, permeability, and moisture/density. In addition, grain-size distribution of selected samples from the saturated zone for UCD-18 and UCD-19 was tested in the field to evaluate well screen and filter pack materials.

### 5.2.4 Soil Sample Chemical Analysis

Table 5.3 identifies soil samples collected from monitoring-well borings and submitted for chemical and radiological analyses, and lists chemical and radiological analyses requested. Samples were selected based on the potential contaminant sources in each area, the results of previous analyses, and the stratigraphy encountered in each borehole. Samples were jointly selected by the Dames & Moore field geologist, project manager, and the EMO technical representative. Results for soil sample analyses are presented in Appendix F.

TABLE 5.3
SUMMARY OF MONITORING WELL
SOIL SAMPLING[1]
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| UCD 15 | UCD 16 | UCD 17 | UCD 18 | UCD 19 | UCD 20 | UCD 21 | UCD 22 | UCD 23 | UCD 24 |
|---|---|---|---|---|---|---|---|---|---|
| NS | 1.5 | NS | NS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 |
| | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 |
| | | | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 |
| | | | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| | | | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 |
| | | | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| | | | 65.* | 65.0 | 65.* | 65.0 | 65.0 | 65.0 | 65.0 |
| | | | | 70.0 | 70.0 | 70.0 | 70.* | 70.0 | 70.0 |
| | | | | 73.* | | | | 75.* | |

Sample also submitted for physical testing.

Samples submitted for chemical and radiologic testing.

NS - No sample obtained.

**Analytical Requests**

17 CAM Metals
Hexavalent Chromium
Nitrates (as Nitrogen)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
Volatile Organic Compounds (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha Gross Beta
Tritium
Strontium 90
Gamma-Emitters

[1] Depths in feet below ground surface.

### 5.2.5 Well Construction

In addition to turbidity problems with Phase I and SWAT monitoring wells in the first HSU, large, seasonal water level fluctuations (up to 25 feet) cause these wells to become dry during summer months. In order to allow for the large groundwater-level fluctuations, 15-foot well screen sections were used in the Phase II monitoring wells in the first HSU (UCD-18 through UCD-24). Additionally, the Phase II monitoring wells were installed slightly deeper than existing wells.

The previously installed monitoring wells in the second HSU (UCD-7 and UCD-14) were completed to approximately 90 feet bgs with 15-foot screen sections. The three Phase II second-HSU monitoring wells (UCD-15, UCD-16, UCD-17) were completed to approximately 120 feet bgs with 25-foot screen sections, resulting in a well completion over approximately 75 percent of the aquifer interval. Details on installation of the three deep-aquifer monitoring wells are presented in Appendix A.

Prior to placement of the annular seal, wells were initially swabbed to help set the filter pack. Additional filter pack was then added, as necessary. In the deep wells, a bentonite slurry in place of bentonite pellets was used as a seal between the filter pack and the grout due to bridging problems encountered while attempting to set bentonite pellets. Wells were grouted to the surface and completed with a locking steel protective casing. Details on the drilling and well installation procedures are included in Appendix A.

Phase II monitoring wells were completed with an above-grade, locking, steel, protective casing (UCD-15, through UCD-20) or flush-mount, water-tight, locking well boxes (UCD-21 through UCD-24). Flush-mount completions were installed in high traffic areas. All PVC casing and stainless steel screen were steam cleaned prior to installation. The ground surface was graded away from the well head to prevent downward migration of water from precipitation or runoff. After completion, the elevation and location of all new Phase II monitoring wells were surveyed to the nearest 0.01 foot.

### 5.2.6 Well Construction Materials

In order to facilitate adequate development and reduce turbidity problems such as those encountered with the Phase I and SWAT monitoring wells, Phase II monitoring wells were constructed of four-inch-diameter, stainless steel, continuous wire-wrap screen. In addition, a filter pack finer than that in previously installed wells, was used. Details of monitoring-well construction are presented in Appendix A.

Grain-size distribution analyses were used to select the appropriate filter pack and well screen size for well completion. For the seven monitoring wells in the first HSU, 15-foot lengths of 4-inch-diameter,

stainless steel, wire-wrap screen with 0.010-inch slots were used. Schedule 40 blank PVC casing was used from the top of the screened interval to the ground surface. Lonestar 1C sand was used as filter pack material for these wells. In first-HSU wells, an approximately three-foot-thick layer of bentonite was placed on top of the filter pack using 1/4-inch-diameter bentonite pellets. The remaining annulus was grouted to the surface by tremmie methods with a two- to five-percent bentonite/cement grout mixture.

Based on discussions with the technical representative for EMO regarding the geologic materials present in the second HSU, wells were constructed using 4-inch-diameter, stainless steel, continuous wire-wrap screen with 0.020-inch-wide openings and with a No. 2/12 sand filter pack. Schedule 40 blank PVC casing was used from the top of the screened interval to the ground surface. A minimum five-foot-thick layer of volclay grout on bentonite slurry was used instead of bentonite pellets to avoid potential bridging problems. The remaining annulus was grouted to the surface by tremmie methods with a 2- to 5-percent bentonite/cement grout mixture. Details for construction and sampling procedures of Phase II wells are included in Appendix A.

## 5.3 WBS 303 — GROUNDWATER SAMPLING

Eighteen groundwater monitoring wells at the LEHR facility (Figure 5.1) were sampled on a quarterly schedule during the Phase II Site Characterization. The procedures used to collect these samples and the requested analyses are presented in the following sections and in detail in Appendix A.

### 5.3.1 Groundwater Sample Collection

Methods of sampling included the use of dedicated bladder pumps, dedicated submersible electric pumps, and disposable bailers. Prior to collecting samples, each well was purged to allow fresh formation water to enter the well casing. Monitoring wells UCD-1, -4 ,-7, -10, -11, -12, -13, and -14 were purged using dedicated bladder pumps (wells UCD-5, -6, -8, and -9 are duplicative wells). Monitoring wells UCD-15 through UCD-24 were purged using dedicated submersible electric pumps. If the static water levels dropped below the level of the pumps, the pumps were removed from the well, and the well was purged and sampled using a disposable bailer. Purging of each well continued until:

- Three to five casing volumes of water were removed from the well; and
- The field pH, specific conductivity, temperature and turbidity measurements of the purged water stabilized to within 10 percent of the previous readings.

"Dry" wells were confirmed by comparing field well depth measurements to well construction specifications, and documented on Field Record of Water Sampling forms, as presented in Appendix E. Details of sample collection are presented in Appendix A.

### 5.3.2 Groundwater Sample Analysis

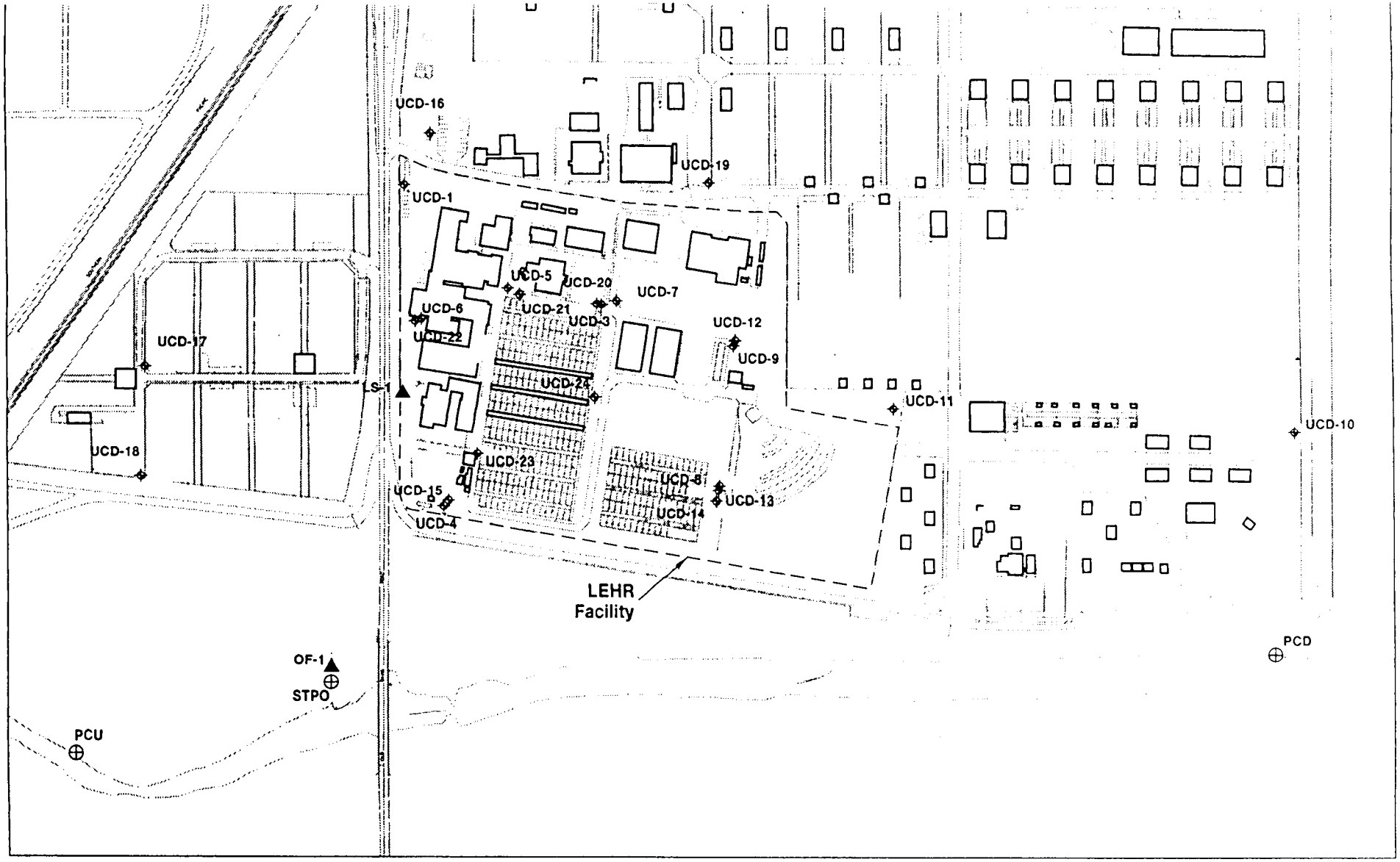
Groundwater samples were shipped via Federal Express (overnight delivery) to CEP Laboratories in Santa Fe, New Mexico. Requested analyses for groundwater samples are listed below (List 1 from Work Plan):

| | |
|---|---|
| Metals | Phosphate |
| Hexavalent Chromium | Chloride |
| Nitrates as Nitrogen | Alkalinity |
| Turbidity | Total Dissolved Solids |
| Formaldehyde | Chemical Oxygen Demand |
| Organochlorine Pesticides | Calcium |
| Volatile Organic Compounds | Magnesium |
| Semivolatile Organic Compounds | Potassium |
| Gross Alpha | Sulfate |
| Gross Beta | Sodium |
| Tritium | |
| Strontium-90 | |
| Gamma-Emitters | |

Results of groundwater sample analyses are presented in Appendix G.

## 5.4 WBS 303 — SURFACE WATER SAMPLING

Three surface water samples were collected from the locations shown on Figure 5.2 on a quarterly basis. Surface water samples were collected in conjunction with the quarterly groundwater samples described in Section 5.3. Two surface water samples were collected from Putah Creek, which borders the southern portion of the LEHR facility: surface water sample PCD is collected from downstream of the LEHR facility, and surface water sample PCU is collected from upstream of the LEHR facility. The third surface water sample, designated STPO, is collected from the UC Davis Wastewater Treatment Plant outfall approximately 60 feet before the confluence with Putah Creek.




EXPLANATION

- Monitoring Wells
- Sediment Samples
- Surface Water Samples

0 300
Scale in Feet

N

# LOCATION MAP SURFACE WATER AND SEDIMENT SAMPLES

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-161

FIGURE 5.2

### 5.4.1 Surface Water Sample Collection

Prior to sampling at each location, two to three field measurements of pH, electrical conductivity, temperature and turbidity were recorded. Surface water samples were collected using interchangeable glass sample bottles and a model "DH-48" depth-integrated water sampler. Water was transferred to appropriate laboratory-supplied sample containers and properly labeled. Additional details on surface water collection are presented in Appendix A.

### 5.4.2 Surface Water Sample Analysis

Surface water samples were shipped via Federal Express (overnight delivery) to CEP Laboratories in Santa Fe, New Mexico. Requested analyses for surface water samples are listed below (List 1 from Work Plan):

| | |
|---|---|
| Metals | Phosphate |
| Hexavalent Chromium | Chloride |
| Nitrates as Nitrogen | Alkalinity |
| Turbidity | Total Dissolved Solids |
| Formaldehyde | Chemical Oxygen Demand |
| Organochlorine Pesticides | Calcium |
| Volatile Organic Compounds | Magnesium |
| Semivolatile Organic Compounds | Potassium |
| Gross Alpha | Sulfate |
| Gross Beta | Sodium |
| Tritium | |
| Strontium-90 | |
| Gamma-Emitters | |

Results of surface water sample analyses are presented in Appendix H.

## 5.5 WBS 304 — SOIL BORINGS AND SAMPLING

Forty-eight soil borings were drilled during the Phase II Site Characterization. The borings have been divided into three categories:

| Category | Approximate Depth | Number Drilled | Approximate Date Completed |
|---|---|---|---|
| Deep borings | 30 feet | 7 | March 1990 |
| Intermediate borings | 10 feet | 3 | March 1990 |
| Shallow borings | 1.5 to 5 feet | 38 | February, March 1990, and February 1991 |

Soil boring locations are shown on Figures 5.3 and 5.4. The number of borings in each category was determined by UC Davis in their original RFQ for this investigation. Locations of deep and intermediate borings were jointly selected by the Dames & Moore on-site geologist, and the technical representatives for UC Davis and EMO. Generally, soil borings were located to evaluate areas identified in previous studies as having the potential to be impacted by past operational practices. Shallow borings in the dog pen areas were located by assigning a number to each dog pen and using a random number-generating program to pick the locations.

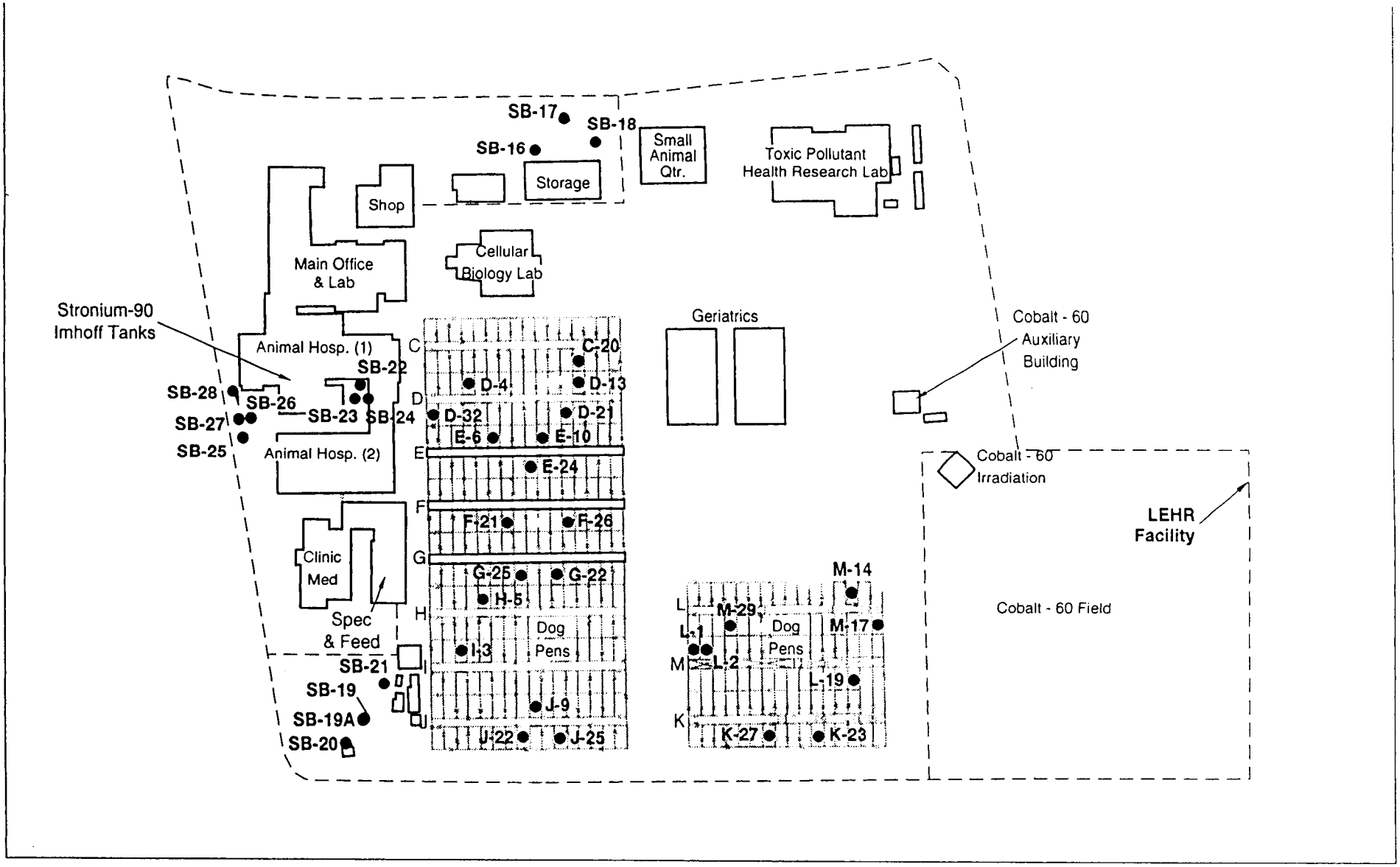
Soil samples collected from hydraulically upgradient/off-site groundwater monitoring wells (UCD-16, UCD-17 UCD-18 and UCD-19) were analyzed for the same chemical and radiologic constituents as soil samples from soil borings. Results from analysis of these samples were used to establish background soil baselines for comparison to results received from on-site sample analysis.

### 5.5.1 Deep Borings

Seven deep (30 feet deep) soil borings were drilled in the locations shown on Figure 5.3. Four of these borings (SB-25, -26, -27 and -28) are located near the Radium-226 Septic System to evaluate potential impacts from operation of this system. The remaining three deep borings (SB-22, SB-23 and SB-24) were drilled near the Strontium-90 Leach Field to evaluate potential impacts resulting from leachate discharged into the soil.

The seven deep soil borings were drilled by Water Development Corporation between March 9 and March 14, 1990. The soil borings were drilled and sampled using CME 55 drill rig and hollow-stem auger techniques. Details of drilling and sampling procedures are presented in Appendix A.

Soil samples were collected using the Dames & Moore Type U sampler at the surface, at a depth of 18 inches, and at intervals of 5 feet, or noted stratigraphic changes during drilling. Table 5.4 identifies soil sampling depths for the deep borings and further identifies those soil samples submitted to the laboratory for chemical and radiological analyses. Additionally, Table 5.4 lists the chemical and radiological analyses requested. Soil samples submitted to the laboratory were selected by the Dames & Moore on-site geologist and the EMO technical representative to evaluate potential contaminant concentrations of representative vertical sections of portions of the unsaturated zone. Sample selection was based on the potential contaminant sources in each area, the results of previous analyses, and the stratigraphy encountered in each borehole. Details on sampling procedures are included in Appendix A.



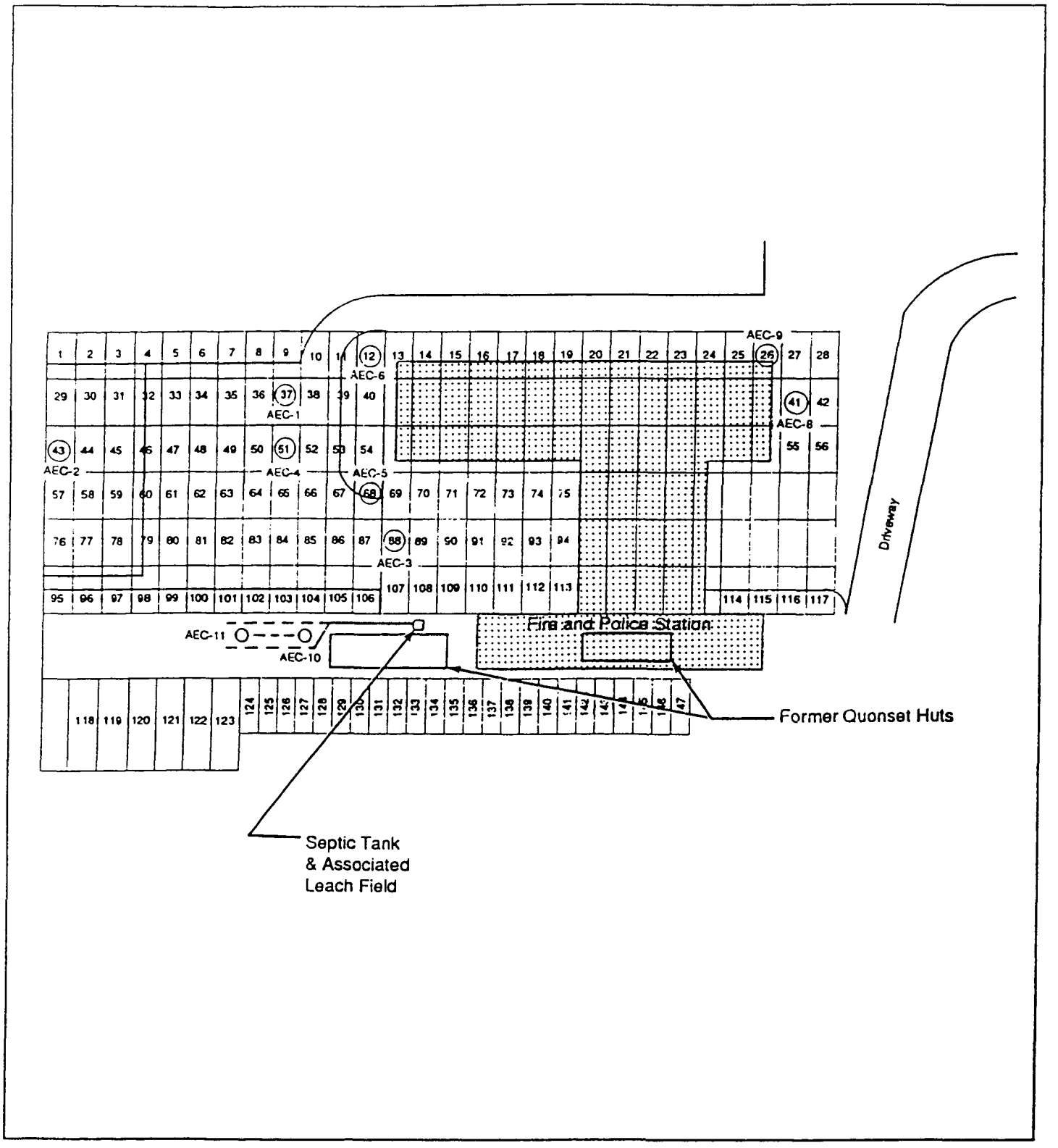

# LOCATION MAP OF DEEP, INTERMEDIATE AND SHALLOW SOIL BORINGS AT LEHR

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-156

FIGURE 5-3




EXPLANATION

(88) Boring Locations

N

0 60

Approximate Scale in Feet

# SHALLOW SOIL BORING LOCATIONS AT AEC PROJECT SITE MAIN UCD CAMPUS

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE1

FIGURE 5.4

TABLE 5.4
INTERMEDIATE AND DEEP SOIL BORING SAMPLE DEPTHS[a]
AND ANALYTICAL REQUESTS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| SB16 | SB17 | SB18 | SB19 | SB19A | SB20 | SB21 | SB22 | SB23 | SB24 | SB25 | SB26 | SB27 | SB28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.8 | 0.8 | 0.8 | 0.0 | NS | 0.0 | 0.0 | 0.8 | 0.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 1.8 | 1.8 | 1.8 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| | | | NS | NS | 2.5 | 2.5 | 2.5 | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.0 |
| | | | NS | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | NS |
| | | | 7.5 | | NS | 7.5 | NS | NS | NS | NS | NS | NS | 6.5 |
| | | | 10.0 | | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| | | | | | | | NS | 12.0 | NS | NS | NS | NS | NS |
| | | | | | | | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| | | | | | | | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| | | | | | | | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| | | | | | | | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |

Samples submitted for chemical and radiologic testing.

NS = No sample obtained.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates (as Nitrogen)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
Volatile Organic Compounds (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha Gross Beta
Tritium
Strontium 90
Gamma-Emitters
*Diesel
*Kerosene

---

[a] Depths in feet below ground surface.

[b] For SB-16 through SB-21 only.

### 5.5.2 Intermediate Borings

Three intermediate-depth soil borings were drilled by Water Development Corporation on March 8 and March 9, 1990. Drilling and sampling procedures were as described above in Section 5.5.1.

The three intermediate-depth (10 feet deep) soil borings (SB-19, SB-20 and SB-21) were drilled in the locations shown in Figure 5.3. In soil boring SB-19, no soil sample was recovered at the five-foot interval; therefore, soil boring SB-19A was drilled approximately 3 feet away to obtain a soil sample from the five-foot depth interval. The intermediate-depth soil borings are located in the Southwest Chemical Dispensing area to evaluate potential impacts from past disposal practices and the presence of chemicals that were reportedly used and stored in the area.

Table 5.4 identifies soil sampling depths for the intermediate borings and further identifies soil samples submitted to the laboratory for chemical and radiological analyses. Selection of soil samples submitted for analysis was performed using the rationale discussed in Section 5.5.1.

### 5.5.3 Shallow Soil Borings

Thirty-eight shallow (1.5 to 5 feet deep) soil borings were hand-drilled in locations shown in Figures 5.3 and 5.4. Soil samples were obtained using a hand-driven sampler as described in Appendix A. Samples were analyzed to evaluate potential impacts to the near-surface soils. Shallow soil borings were drilled to evaluate potential impact in the three areas identified below.

| Area of Interest | Number of Borings | Approximate Dates |
|---|---|---|
| Dog Pens (LEHR) | 25 | February 1990 |
| Northwest Chemical Dispensing Area (LEHR) | 3 | March 1990 |
| Old AEC Project Site (Main Campus) | 10 | February 1991 |

The 25 soil sampling locations in the LEHR dog pens (C-30 through M-29) were selected by assigning each dog pen a number and then using a random number-generating computer program. Approximately nine inches of gravel were removed from the sampling locations to expose the soil surface prior to sampling. Borings were then advanced to an approximate depth of 18 inches below grade. Samples were obtained from individual dog pens at the soil surface and a depth of 12 to 18 inches. Soil samples were analyzed for the presence of chemicals and radiologic materials from penned animals. Table 5.5 identifies the dog pen samples and also lists the chemical and radiologic analyses requested for the samples.

TABLE 5.5
SUMMARY OF LEHR DOG PEN SAMPLES AND
ANALYTICAL REQUESTS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Cage #/Ring | Depths (inches) | Cage #/Ring | Depth (inches) |
|---|---|---|---|
| E6 A | 0.0 | M17 A* | 0.0 |
| E6 C | 18.0 | M17 C* | 18.0 |
| E24 A | 0.0 | M14 A | 0.0 |
| E24 C | 18.0 | M14 C | 18.0 |
| E10 A | 0.0 | M29 A | 0.0 |
| E10 C | 18.0 | M29 C | 18.0 |
| F26 A | 0.0 | C20 B | 0.0 |
| F26 C | 18.0 | C20 C | 18.0 |
| F21 A | 0.0 | D32 A | 0.0 |
| F21 C | 18.0 | D32 C | 18.0 |
| G25 A | 0.0 | D4 A | 0.0 |
| G25 C | 18.0 | D4 C | 18.0 |
| G22 A | 0.0 | D21 A | 0.0 |
| G22 C | 18.0 | D21 C | 18.0 |
| J25 A* | 0.0 | D13 A | 0.0 |
| J25 C* | 18.0 | D13 C | 18.0 |
| J9 A | 0.0 | H5 A | 0.0 |
| J9 C | 18.0 | H5 C | 18.0 |
| K27 A* | 0.0 | I3 A | 0.0 |
| K27 C* | 18.0 | I3 C | 18.0 |
| K23 A* | 0.0 | L2 A | 0.0 |
| K23 C* | 18.0 | L2 C | 18.0 |
| L19 A | 0.0 | L1 A* | 0.0 |
| L10 C | 18.0 | L1 C* | 18.0 |
| | | J22 A | 0.0 |
| | | J22 C | 18.0 |

Samples submitted for chemical and radiologic testing.

**Analysis Request for Pen Samples**

Chloride
Nitrates
Radiologic Scan
* Also analyzed for Carbon-14

The three borings drilled in the North Chemical Dispensing Area are designated SB-16, SB-17, and SB-18. These borings were drilled to investigate the potential presence of chemical and radiologic materials in soil in this area. Asphalt in the area was removed prior to sampling using a hollow-stem auger coring tool. Road base from beneath the asphalt was removed prior to sampling. Soil samples were collected from the soil surface at a depth of 12 to 18 inches, using a hand-driven sampler. Table 5.5 presents the samples collected from these borings and submitted to the laboratory for chemical and radiological analysis. Additionally, Table 5.5 lists the chemical and radiologic analyses requested.

Ten shallow soil borings (AEC-1 through AEC-6 and AEC-8 through AEC-11) were drilled at the Old AEC Project site on the main UC Davis campus. The UC Davis Fire and Police Station currently occupy portions of this location (Figure 5.4).

Maps, design drawings, and aerial photos of both the Police and Fire Station and the Old AEC Project site dog pens were supplied by the University. Former dog pen locations not positioned beneath a building or driveway areas were assigned a number. A random number-generator was used to identify 8 of the 10 sampling locations. The locations identified using this method are shown on Figure 5.4. All locations were cleared by the University Physical Plant prior to sampling.

The remaining 2 of the 10 shallow AEC borings were located along the southern edge of the Old AEC Project site dog pen area. These sampling locations were chosen based on UC Davis records of a septic tank leach field in this vicinity. Locations of these borings and the reported leach field are shown on Figure 5-4. These borings were advanced to a total depth of five feet.

Soil samples from the AEC site were collected using a hand-driven sampler fitted with stainless steel sampling rings. Samples were collected to assess the presence of potential chemicals used during AEC project operations. Table 5.6 identifies the samples collected from the Old AEC Project site borings, and further identifies those samples submitted to the laboratory for chemical and radiological analyses. Table 5.6 also lists the chemical and radiological analyses requested for these samples.

Procedures for sampling were the same as those followed for sampling beneath the existing dog pens at LEHR. Sample locations requiring cutting of asphalt or concrete were repaired by UC Davis immediately following collection of soil samples.

TABLE 5.6
SOIL SAMPLE ANALYSIS[a]
OLD AEC PROJECT SITE, MAIN CAMPUS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| AEC-1 | AEC-2 | AEC-3 | AEC-4 | AEC-5 | AEC-6 | AEC-8 | AEC-9 | AEC-10 | AEC-11 |
|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.0 | 24.0 |
| 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 60.0 | 60.0 |

Samples submitted for chemical and radiologic testing.

Analytical Requests

Chlordane
Tritium
Strontium 90
Carbon 14

[a] Depths in inches below ground surface.

## 5.6 WBS 304 — SEDIMENT SAMPLING

Two sediment samples, one from the Storm Water Lift Station (LS-1) at the LEHR facility and the other from the UC Davis Wastewater Treatment Plant outfall (OF-1) by Putah Creek, were collected on February 22, 1990. Sediment samples were collected to evaluate potential chemical or radiologic impact from previous surface water and sediment discharge in these areas. The locations of sediment sampling points are shown on Figure 5.2.

The outfall sediment sample was collected using a clean garden trowel. The sediments were transferred to and transported in glass containers. Table 5.7 identifies the sediment samples submitted for chemical and radiological analyses and identifies the chemical and radiological analyses requested. Details of the sediment sampling procedures are described in Appendix A. Results of the sediment sample analyses are presented in Appendix F.

The underground holding tank at the Storm Water Lift Station was accessed through a manhole cover. The sediments at the bottom of the lift station were unconsolidated. A sediment sample was collected using an Ekman Dredge sampler and transferred to a glass container.

## 5.7 WBS 305 — DOMESTIC SEPTIC TANK INVESTIGATION

At the time of this report, the Domestic Septic Tank Investigation Task has not been completed. Details on the investigative methods to be used will be presented in the RI/FS Work Plan. A preliminary investigation of the condition of the domestic septic tanks was conducted in March 1990.

UC Davis personnel identified approximate locations of six abandoned domestic septic tanks from construction plans at the LEHR facility (shown in Figure 5.5). The condition of the six tanks are listed below.

| TANK NUMBER | LOCATION | CONDITION |
|---|---|---|
| 1 | Northwest corner of Main Office | Partially Destroyed |
| 2 | West of Imhoff Tanks | Good |
| 3 | Between the Clinical Pathology and Feed Mix and Specimen Storage Building | Good/ Filled with Gravel |
| 4 | Approximately 15 feet North of Tank #3 | Overlain by Several Utilities |
| 5 | Under Main Office Building | Unknown |
| 6 | Under Sidewalk near Animal Hospital #1 | Unknown |

TABLE 5.7
SEDIMENT SAMPLES AND
ANALYTICAL REQUESTS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

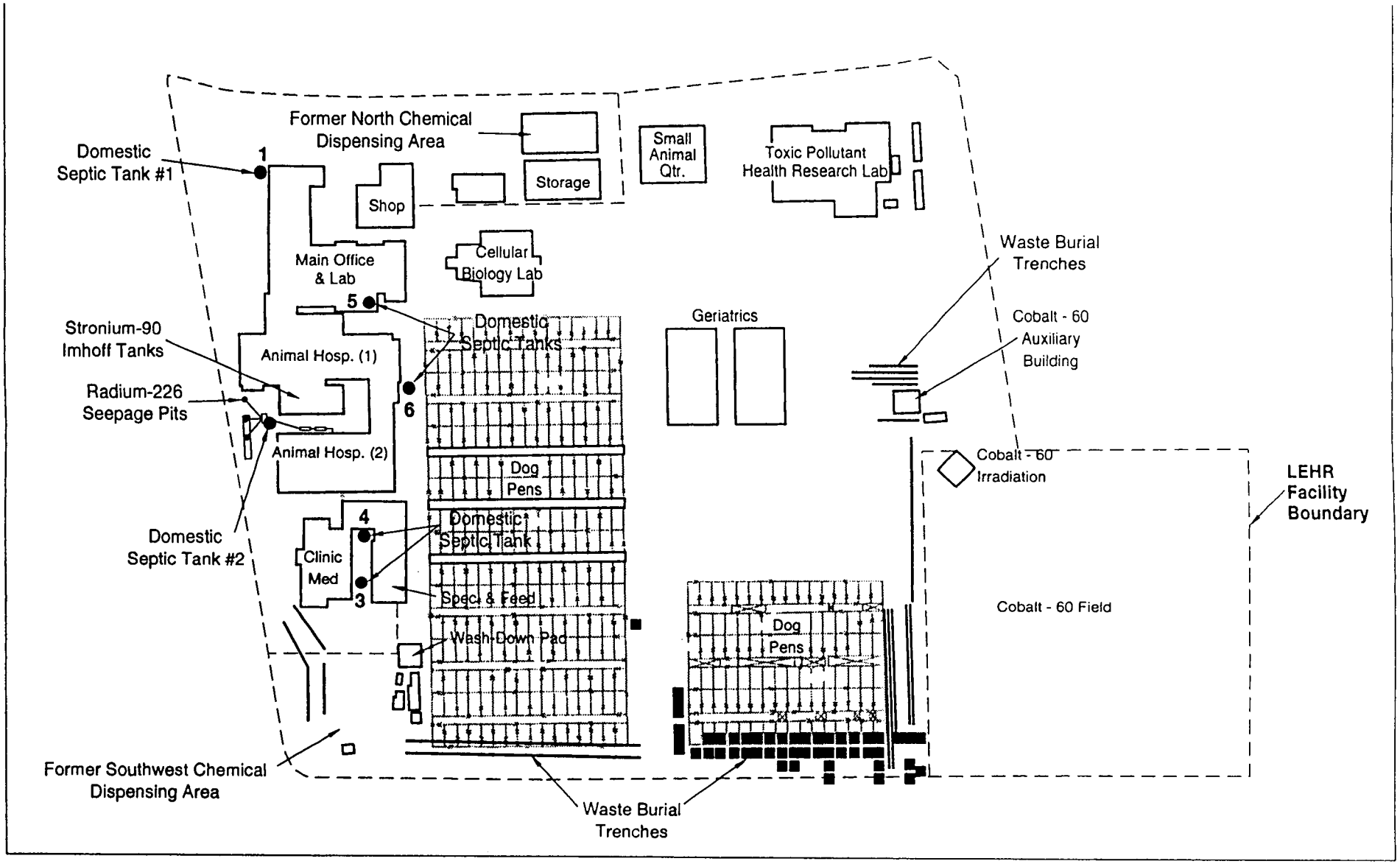
| Sample ID | Date |
|---|---|
| LS 1 | 02/22/90 |
| OF 1 | 02/22/90 |

LS: Lift Station
OF: Wastewater Treatment Plant Outfall

Samples submitted for chemical and radiologic testing.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates (as Nitrogen)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
Volatile Organic Compounds (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha Gross Beta
Tritium
Strontium-90
Gamma-Emitters




EXPLANATION

■ Radioactive Trenches and Holes

● Domestic Septic Tanks

0 150
Scale in Feet

N

# APPROXIMATE LOCATIONS OF DOMESTIC SEPTIC TANKS

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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10805-454-044 DOE-132

FIGURE 5.5

Three of the domestic septic tanks have been positively located using a combination of steel probes, shovels, and a backhoe. (Tanks 1, 2 and 3). Indication of a fourth domestic septic tank (Tank 4) was found in UC Davis utility installation records. Further delineation of the location of the tank reported to be located under the LEHR office building (Tank 5), or the tank reported to be under the sidewalk near Animal Hospital 1 (Tank 6) will be delayed until investigation of the other four tanks is completed.

## 5.8 WBS 306 — AQUIFER ANALYSIS

This section describes the aquifer studies and analyses conducted to estimate aquifer parameters that govern groundwater flow at the LEHR facility. Slug tests were conducted in selected wells to estimate hydraulic conductivity of the two hydrostratigraphic zones on site, while numerical modeling was used to illustrate relationships and interactions between zones.

### 5.8.1 Slug Tests and Analyses

Slug tests were conducted in 10 wells located at the LEHR facility. Nine of these wells are completed in the first HSU, and one well (UCD-17) is completed in the second HSU. Table 5.8 lists the wells tested along with relevant well-construction data, including well diameter, screened interval, and total depth.

Both rising and falling head tests were conducted in the 10 wells. First, static water levels were measured in all wells to be tested. After initial water-level measurement, any pumps were removed from the wells, and the water levels were rechecked. Next, pressure transducers, used to measure head, were lowered into the water column and the initial head was noted. Water levels were then displaced by lowering (or removing) a PVC slug into the well. Changes in water level over time were recorded by a datalogger pre-programmed to take measurements at specified time intervals. The PVC slug, connecting rope transducer, cable and water level indicator were washed between wells following standard decontamination procedures, as outlined in Appendix A.

Values of hydraulic conductivity *(K)* were estimated using the Bouwer and Rice Method (1976) for fully or partially penetrating wells in an unconfined aquifer (the first HSU). This method was also applied to UCD-17 (the second HSU), based on discussions in Bouwer (1989). Analyses were completed using computer software that utilizes a regression method based on the Bouwer and Rice Method. Details about the slug test procedure and method of analysis is included in Appendix A.

TABLE 5.8
WELL-CONSTRUCTION DATA USED FOR
SLUG TEST INTERPRETATION
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Well | Depth (ft.) | Perforated Interval (ft.) | Depth to Water (ft) | Aquifer Thickness (ft.) | Casing Radius (ft.) | Borehole Radius (ft.) |
|---|---|---|---|---|---|---|
| UCD-10 | 72.13 | 54-69 | 49.5 | 15 | 0.167 | 0.50 |
| UCD-11 | 67.93 | 50-65 | 49.9 | 15 | 0.167 | 0.50 |
| UCD-17 | 143 | 88-113 | 49.2 | 50 | 0.167 | 0.50 |
| UCD-18 | 70 | 54-69 | 46.4 | 15 | 0.167 | 0.50 |
| UCD-19 | 73.7 | 56.5-71.5 | 50.6 | 15 | 0.167 | 0.50 |
| UCD-20 | 73 | 57-72 | 48.8 | 15 | 0.167 | 0.50 |
| UCD-21 | 73 | 57-72 | 47.8 | 15 | 0.167 | 0.50 |
| UCD-22 | 73 | 57-72 | 47.8 | 15 | 0.167 | 0.50 |
| UCD-23 | 73 | 56.5-71.5 | 48.7 | 15 | 0.167 | 0.50 |
| UCD-24 | 73 | 57-72 | 47.8 | 15 | 0.167 | 0.50 |

### 5.8.2 Aquifer Pumping Test

An aquifer pumping test was originally scheduled on two wells at the LEHR facility. However, the pump test was not performed, pending a solution for disposal of potentially contaminated groundwater extracted during the pump test.

### 5.8.3 Groundwater Modeling

Aquifer properties were evaluated using Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) (McDonald and Harbaugh, 1988), which satisfies the EPA's general guidelines for groundwater modeling programs. MODFLOW was used to incorporate site-specific measurements, empirical correlations with published data, and comparison of simulated results to actual water levels. Additionally, stream-aquifer interactions and relations between the first and second HSUs could be addressed using a three-dimensional flow model.

the MODFLOW code was developed by the U.S. Geological Survey and is in the public domain and readily available for confirmation analysis. The modular nature of MODFLOW allows different aspects of the code to be used as appropriate for site-specific physical, hydraulic and chemical conditions. The use of MODFLOW for the LEHR site is specifically appropriate in that it allows a screening-level model to be developed based on initial information. As additional data are acquired, the model can readily be modified to incorporate new information and interpretations.

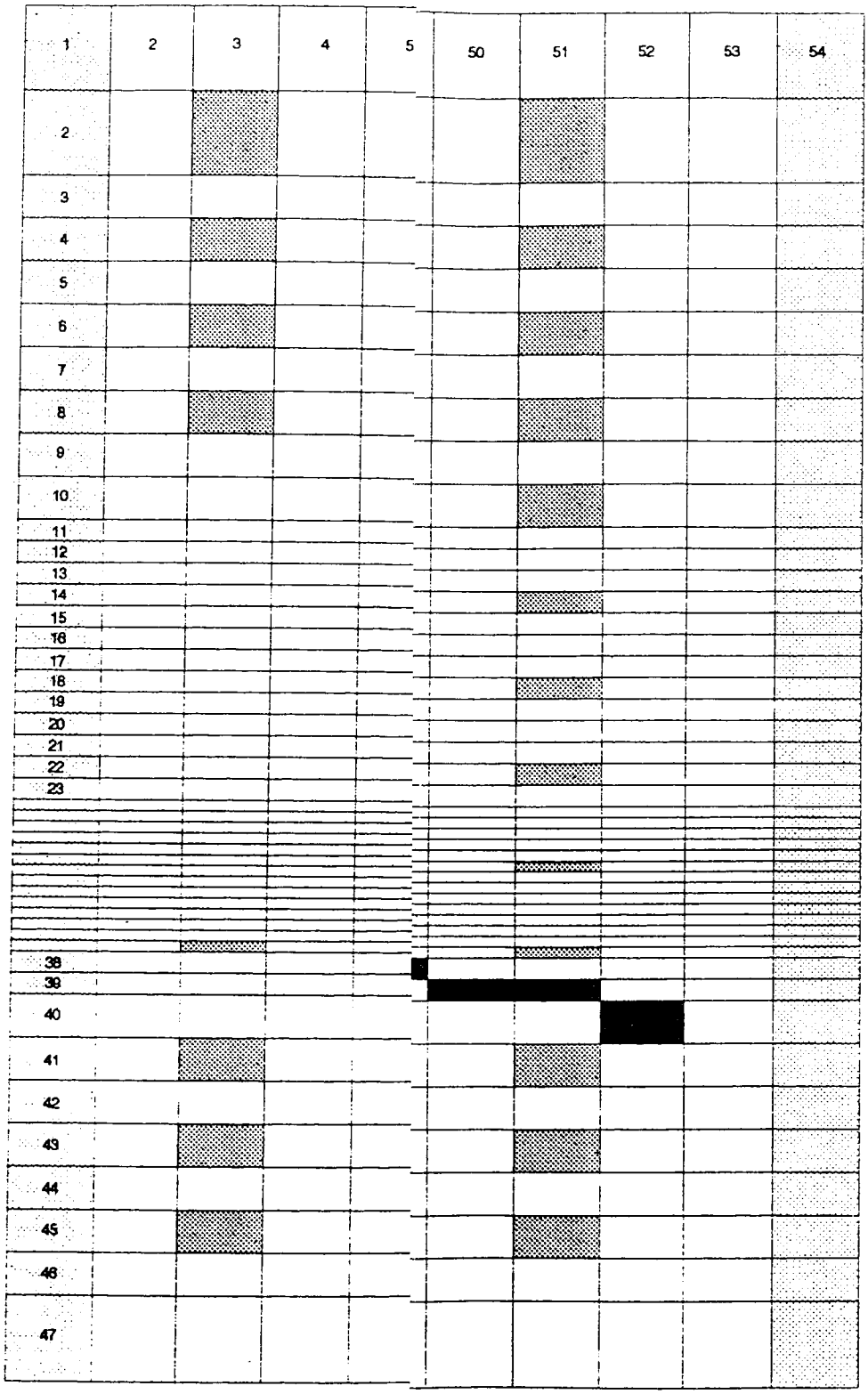
The three-dimensional flow model was set up with two layers — layer one representing the first HSU and layer two representing the second HSU. This two-layer system allowed for evaluation of hydraulic interaction between the first and second HSUs. In addition to interaction between hydrostratigraphic units, interactions between Putah Creek and the first HSU were also assessed.

Flow model input parameters are listed in Table 5.9, and include hydraulic conductivity (vertical and horizontal) of the first and second HSU, top and bottom elevations of the second HSU, storage coefficients, stream parameters (stage, bottom elevation and bottom conductivity), and boundary conditions. The model grid orientation and spacing in relation to the site are shown on Figure 5.6. The model boundaries were extended beyond the site to minimize boundary effects on groundwater movement across the site. Appendix A contains a discussion of each of these input parameters.

Transient calibration, comparing simulated versus measured water levels at specific locations over time, was conducted for the flow model. Goals of the model were to simulate seasonal fluctuations in water levels and changes in vertical gradient over time. Input parameters are listed in Table 5.9 and are discussed in Appendix A.

TABLE 5.9
MODEL INPUT PARAMETERS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Parameter | Layer | |
|---|---|---|
| | 1 | 2 |
| Aquifer Type | Unconfined | Confined |
| Hydraulic Conductivity | $7 \times 10^{-6}$ to $4 \times 10^{-5}$ ft/sec | 0.005 ft/sec |
| Storage Coefficient (specific yield) | 0.20 | 0.001 |
| Vertical Hydraulic Conductivity | $2.5 \times 10^{-6}$ ft/sec | 0.0025 ft/sec |
| Aquifer Top Elevation | Undefined | -50 feet |
| Aquifer Bottom Elevation | -50 feet | -100 feet |
| Porosity | 0.35 | 0.20 |
| Bulk Density | 1.7 g/ml | 1.7 g/ml |




# NUMERICAL MODEL SETUP, GRID ORIENTATION AND BOUNDARY CONDITIONS

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FIGURE 5.6

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## 5.9 WBS 308 - WASTE CHARACTERIZATION

A Work Plan for the characterization of wastes generated during the Phase I and Phase II investigations has been developed. The Work Plan describes the methodologies used to characterize wastes for disposal purposes. The wastes are currently stored in closed 55-gallon drums in the Cobalt-60 Field at the LEHR facility and remain the responsibility of UC Davis. Sampling of the wastes generated during the Phase I investigation has been performed; however, analytical results have not yet been received.

# 6.0 FINDINGS

Presented in Chapter 6.0 are the findings of the field investigations, laboratory testing, and data evaluation conducted to date at the LEHR facility. Data developed regarding stratigraphy, hydrogeologic conditions, surface water conditions, chemical testing results, and potential constituent migration pathway models are presented. Sections 6.1 through 6.5 present findings of the Phase II Site Characterization.

## 6.1 STRATIGRAPHY

The general stratigraphic profile at the site consists of gravel, sand, silt and clay deposited in a fluvial depositional system as discussed in Section 2.2. This section presents additional details of the geologic materials beneath the LEHR facility based on recent investigations. Borehole and CPT logs used to evaluate the site stratigraphy are presented in Appendix C. Figures 6.1 and 6.2 shows the locations of monitoring wells and soil borings completed during this Phase II investigation.

### 6.1.1 Surface Soils

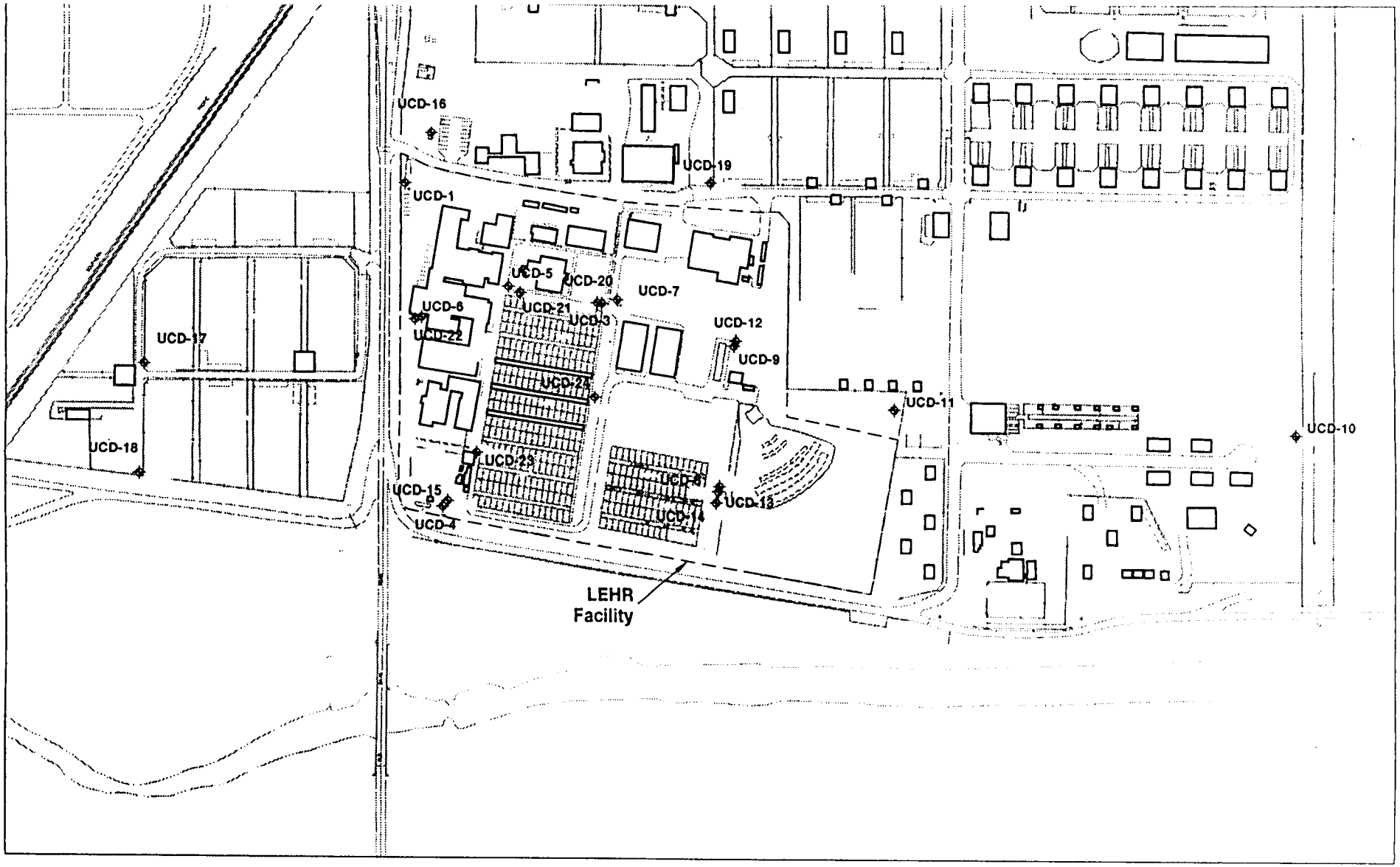
Figures 6.3 and 6.3A present surface soils in the site vicinity as mapped by the U.S. Department of Agriculture (USDA) Soil Conservation Service for Solano County (Bates, 1977). These soils formed on the surface of alluvial deposits as discussed below and are described as follows:

- Capay silt clay loam (Ca) - Dark grayish-brown to grayish-brown, 40 inches thick over pale brown and yellowish-brown clay loam to 60 inches +;

- Reiff fine sandy loam (Ra, Rw) - Grayish-brown to light yellowish-brown fine sandy loam to greater than 60 inches depth; and

- Yolo loam, loam clay substratum, and silty clay loam (Yo, Yr, Ys) - Dark grayish-brown silty clay loam to approximately 20 inches depth over a brown clay layer approximately 8 inches thick over brown loam to greater than 60 inches in depth.

These soils are relatively young, weakly developed soils that formed in alluvial parent material during late Pleistocene to Recent time. The "A" horizons (soil horizon nearest the surface) are relatively thick and organic rich, which makes these soils valuable for agricultural use (Bates, 1977).




EXPLANATION

Monitoring Wells

0 300

Scale in Feet

N

# LOCATION MAP
# GROUNDWATER MONITORING WELLS

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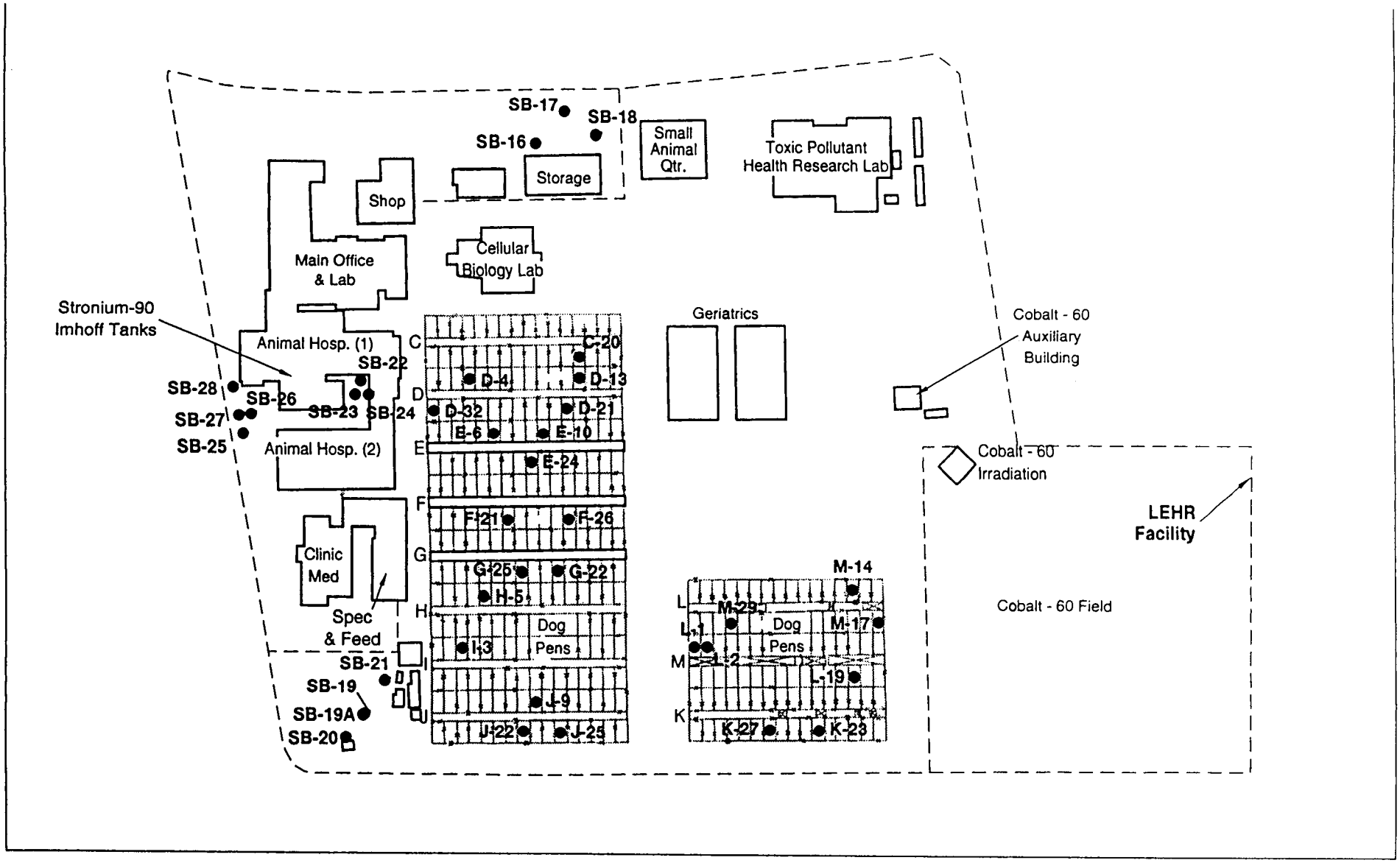
FIGURE 6.1




EXPLANATION

Soil Boring Locations

0 150
Scale in Feet

N

# LOCATION MAP OF DEEP, INTERMEDIATE AND SHALLOW SOIL BORINGS AT LEHR

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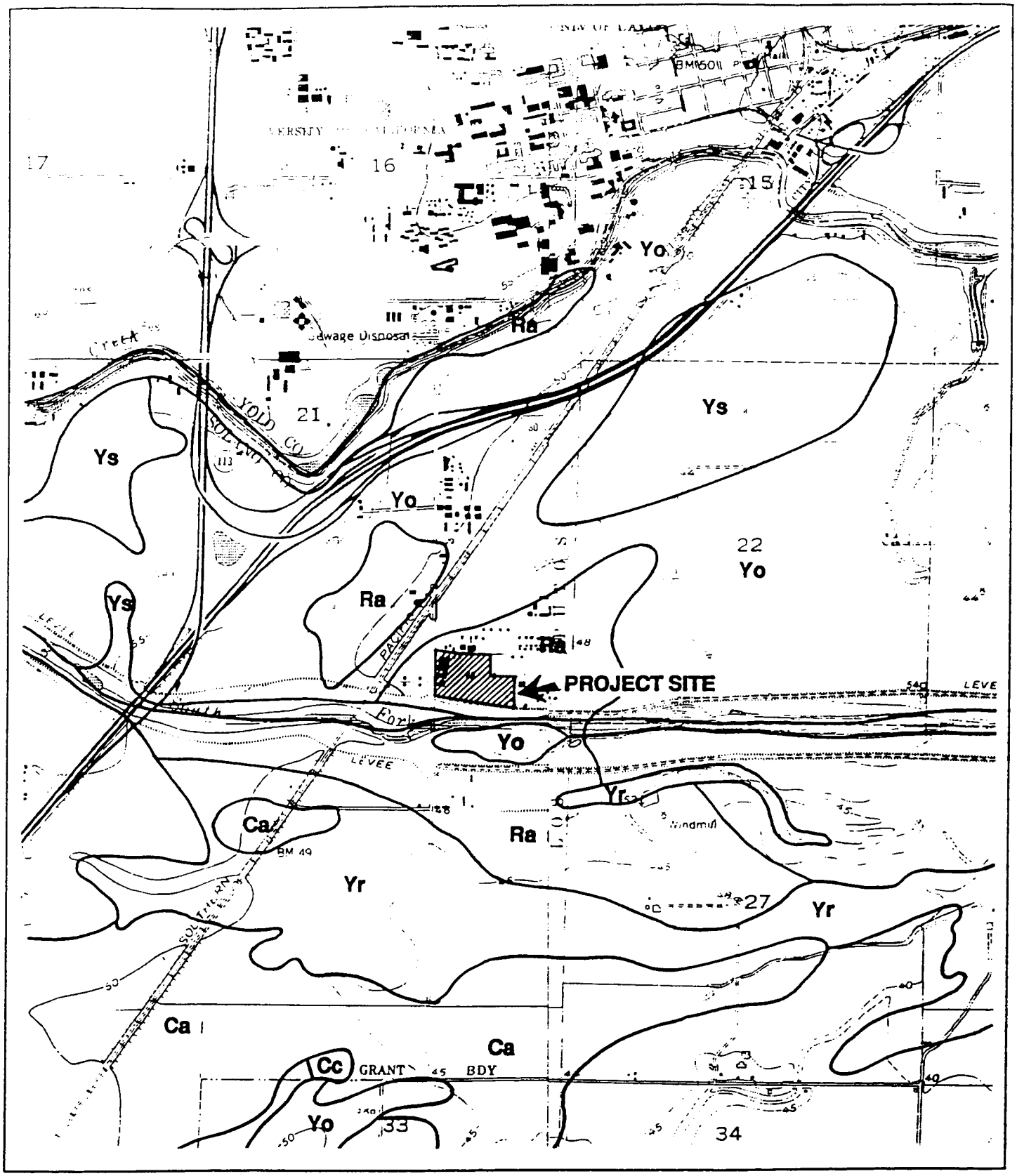
FIGURE 6.2




REFERENCE: USGS 7.5' Quadrangles Merritt and Davis, CA 1981

SOURCE: Soil Survey of Solano County, USDA Soil Conservation Service 1977

0 2000
Scale in Feet

N

**SURFACE SOILS IN LEHR VICINITY**

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FIGURE 6.3

SOIL LEGEND

Each symbol consists of letters or a combination of letters and numbers. The first capitol letter is the initial one of the soil name. A second capitol letter, if used, shows the class of slope. Symbols without a slope letter are for nearly level soils. A final number, 2 or 3, in a symbol shows that the soil is named as eroded or severely eroded.

| SYMBOL | NAME |
|---|---|
| AcC | Altamont clay, 2 to 9 percent slopes |
| AcE | Altamont clay, 9 to 30 percent slopes |
| AcF2 | Altamont clay, 30 to 50 percent slopes, eroded |
| AlC | Altamont-San Ysidro-San Benito complex, 2 to 9 percent slopes |
| AlE | Altamont-San Ysidro-San Benito complex, 9 to 30 percent slopes |
| AmC | Altamont-Diablo clays, 2 to 9 percent slopes |
| AmE2 | Altamont-Diablo clays, 9 to 30 percent slopes, eroded |
| An | Alviso silty clay loam |
| AoA | Antioch-San Ysidro complex, 0 to 2 percent slopes |
| AoC | Antioch-San Ysidro complex, 2 to 9 percent slopes |
| AsA | Antioch-San Ysidro complex, thick surface, 0 to 2 percent slopes |
| AsC | Antioch-San Ysidro complex, thick surface, 2 to 9 percent slopes |
| BrA | Brentwood clay loam, 0 to 2 percent slopes |
| BrC | Brentwood clay loam, 2 to 9 percent slopes |
| Ca | Capay silty clay loam |
| Cc | Capay clay |
| CeA | Clear Lake clay, 0 to 2 percent slopes |
| CeB | Clear Lake clay, 2 to 5 percent slopes |
| ClA | Clear Lake clay, saline, 0 to 2 percent slopes |
| Cm | Columbia fine sandy loam |
| Cn | Conejo loam |
| Co | Conejo gravelly loam |
| Cr | Conejo clay loam |
| Cs | Conejo soils, wet |
| CvD2 | Corning gravelly loam, 2 to 15 percent slopes, eroded |
| CvE2 | Corning gravelly loam, 15 to 30 percent slopes, eroded |
| DoC | Diablo-Ayar clays, 2 to 9 percent slopes |
| DoE2 | Diablo-Ayar clays, 9 to 30 percent slopes, eroded |
| DbC | Dibble-Los Osos loams, 2 to 9 percent slopes |
| DbE | Dibble-Los Osos loams, 9 to 30 percent slopes |
| DbF2 | Dibble-Los Osos loams, 30 to 50 percent slopes eroded |
| DlC | Dibble-Los Osos clay loams, 2 to 9 percent slopes |
| DlE | Dibble-Los Osos clay loams, 9 to 30 percent slopes |
| DlF2 | Dibble-Los Osos clay loams, 30 to 50 percent slopes, eroded |
| Eb | Egbert silty clay loam |
| Ec | Egbert silty clay loam, occasionally flooded |
| GoG2 | Gaviota sandy loam, 30 to 75 percent slopes, eroded |
| GlE | Gilroy loam, 9 to 30 percent slopes |
| HaF | Hambright loam, 15 to 40 percent slopes |
| HtE | Hambright-Toomes stony loams, 9 to 30 percent slopes |
| Ja | Joice muck |
| Jb | Joice muck, clay subsoil variant |
| Ma | Mode land |
| MeG3 | Mayman-Los Gatos loams, 15 to 75 percent slopes, severely eroded |
| MkA | Millsop sandy loam, 0 to 2 percent slopes |
| MlC | Millsop-Los Osos complex, 2 to 9 percent slopes |
| MmE | Millsholm loam, 15 to 30 percent slopes |
| MmG2 | Millsholm loam, 30 to 75 percent slopes, eroded |
| MnC | Millsholm loam, moderately deep variant, 2 to 9 percent slopes |
| MnE | Millsholm loam, moderately deep variant, 9 to 30 percent slopes |
| Om | Omni clay loam |
| On | Omni silty clay |
| Pc | Pescadero clay loam |
| Pe | Pescadero clay |
| Ra | Reiff fine sandy loam |
| Rd | Reyes silty clay loam, drained |
| Re | Reyes silty clay |
| RnC | Rincon loam, 2 to 9 percent slopes |
| RoA | Rincon clay loam, 0 to 2 percent slopes |
| RoC | Rincon clay loam, 2 to 9 percent slopes |
| Rw | Riverwash |
| Ry | Ryde clay loam |
| Sa | Sacramento silty clay loam |
| Sc | Sacramento silty clay loam, occasionally flooded |
| Sd | Sacramento clay |
| SeA | San Ysidro sandy loam, 0 to 2 percent slopes |
| SeB | San Ysidro sandy loam, 2 to 5 percent slopes |
| SfA | San Ysidro sandy loam, thick surface, 0 to 2 percent slopes |
| Sh | Solano loam |
| Sk | Solano-Pescadero complex |
| Sm | Solano loam, dark surface variant |
| Sp | Suisun peaty muck |
| Sr | Sycamore silty clay loam |
| Ss | Sycamore silty clay loam, drained |
| St | Sycamore silty clay loam, saline |
| Su | Sycamore complex, occasionally flooded |
| Ta | Tambe mucky clay |
| Td | Tidal marsh |
| ToG2 | Toomes stony loam, 30 to 75 percent slopes eroded |
| TrE | Trimmer loam, 9 to 30 percent slopes |
| TsF2 | Trimmer cobbly clay loam, shallow variant, 15 to 50 percent slopes, eroded |
| Tu | Tujungo fine sand |
| Va | Valdez silt loam, drained |
| Vc | Valdez silty clay loam |
| Vd | Valdez silty clay loam, wet |
| Ve | Valdez silty clay loam, clay substratum |
| Wc | Willows clay |
| Yo | Yolo loam |
| Yr | Yolo loam, clay substratum |
| Ys | Yolo silty loam |

# EXPLANATION OF SURFACE SOIL SYMBOLS

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FIGURE 6.3A

### 6.1.2 Subsurface Profile

Inferred geological cross sections across the site are shown on Figures 6.4 through 6.7. The cross section locations are presented on Figure 6.8. Because investigation data locations are up to 500 feet apart, subsurface features may be present which are not shown on the cross sections. The deepest boring drilled during the Phase II investigation, UCD-17, was completed at a depth of approximately 143 feet bgs.

The major units on-site and their nominal depths are:

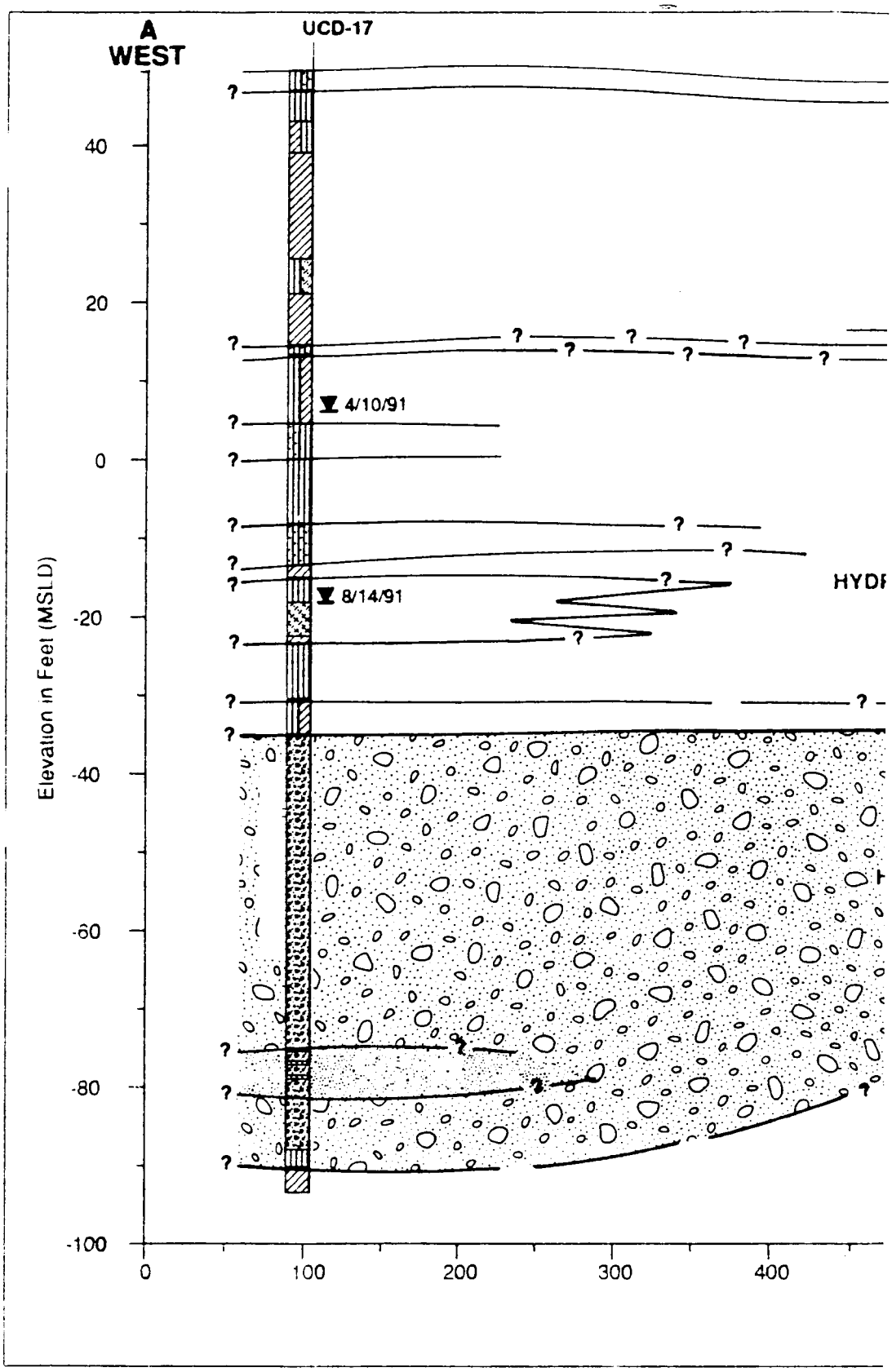
- 0 to 10 feet: surface soils;
- 10 to 80 feet: interbedded silt, clay and sand with some sand and gravel channel deposits;
- 80 to 135 feet: cobbles and gravels; and
- 135 to 143 feet: clay and some silt.

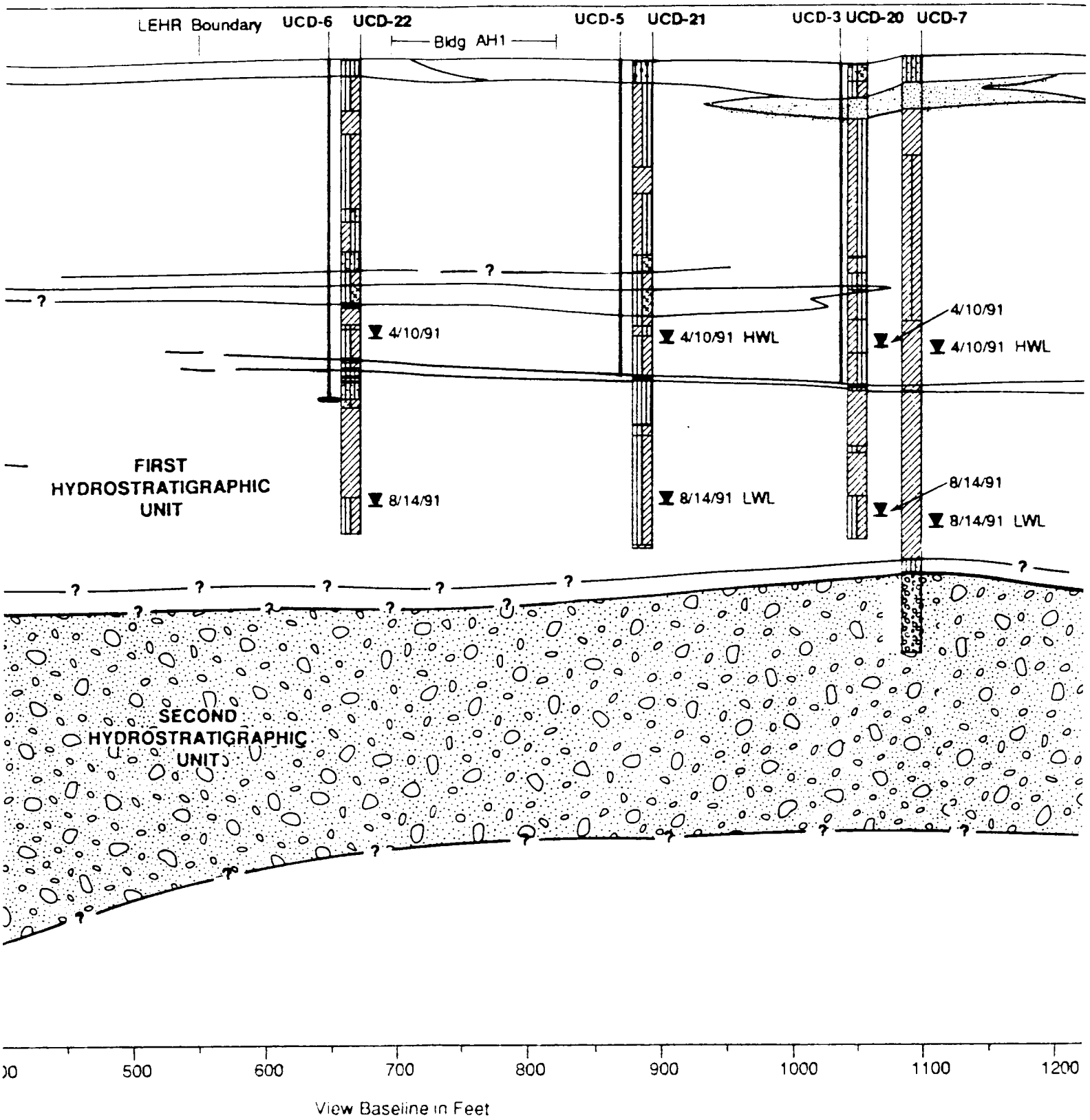
  (143 feet is the deepest depth drilled for this investigation.)

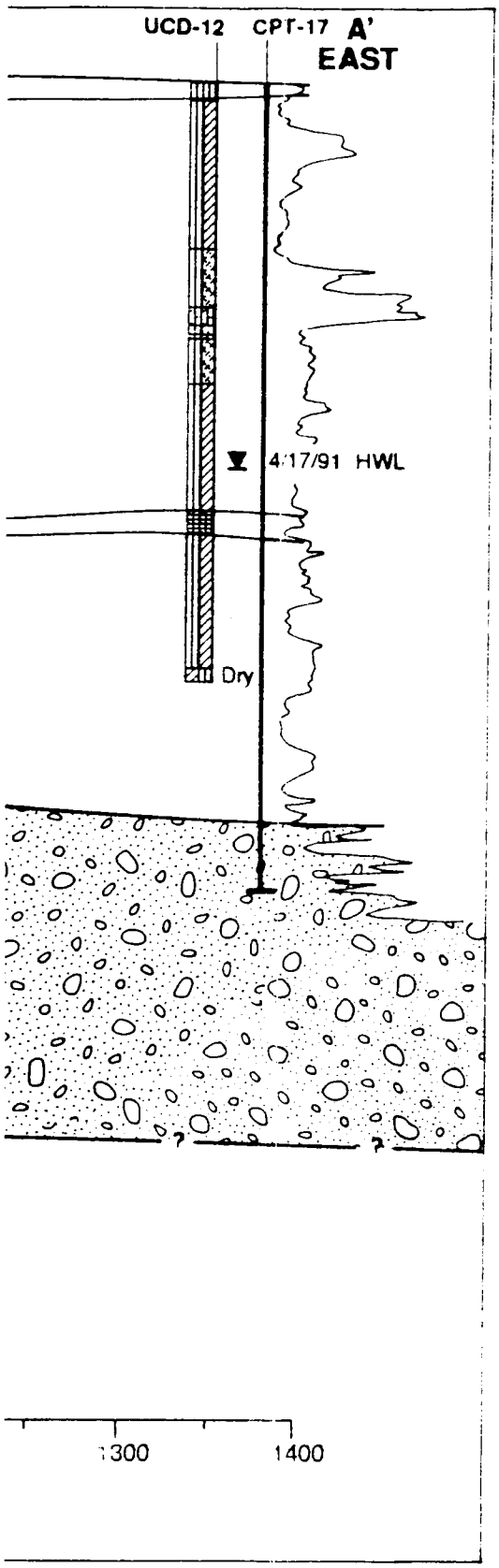
The major geologic units, from the youngest to the oldest, are summarized below. Some of the geologic units contain gradational sequences or more than one lithology. As shown in the cross sections, the units appear to be relatively flat-lying, reflecting the original depositional setting. Depths presented in this section are related to depth below ground surface (bgs).

- The surficial soils discussed above in Section 6.1.1 are underlain by a sequence of interbedded clay, silty clay, silt, and sand. This fine-grained unit is shown on the cross sections to be continuous across the site. The unit is typically 80 feet thick and contains some coarser-grained units of coarse sand and gravel, most of which cannot be traced between boreholes or CPT probe locations. One of the coarse-grained units is present in UCD-15 and UCD-4 at 53 feet bgs. This unit is approximately five feet thick and is similar in composition to the second HSU. However, gravel was not encountered in UCD-23, located approximately 10 feet northeast. The groundwater table is found in this stratigraphic unit and varies in depth from approximately 45 to 65 bgs, depending upon season. During installation of the first-HSU Phase II monitoring wells, the groundwater level was approximately 60 feet bgs.

- Well-rounded cobbles and gravels are encountered at approximately 80 feet bgs in UCD-7, UCD-14 through UCD-17, and in the CPT locations, and are considered laterally continuous beneath the LEHR site. The thickness of this unit ranges from 40 feet in UCD-15 to 52 feet in UCD-17. The overall lithology of the cobbles and gravels include chert, metamorphic, and volcanic clasts. This assemblage suggests that the source area for these materials was the Coast Ranges Geomorphic Province, located to the west.


A
WEST
UCD-17
4/10/91
8/14/91
HYDR
Elevation in Feet (MSLD)
40
20
0
-20
-40
-60
-80
-100
0
100
200
300
400


LEHR Boundary
UCD-6
UCD-22
Bldg AH1
UCD-5
UCD-21
UCD-3
UCD-20
UCD-7
4/10/91
4/10/91 HWL
4/10/91
4/10/91 HWL
FIRST
HYDROSTRATIGRAPHIC
UNIT
8/14/91
8/14/91 LWL
8/14/91
8/14/91 LWL
SECOND
HYDROSTRATIGRAPHIC
UNIT
500
600
700
800
900
1000
1100
1200
View Baseline in Feet




EXPLANATION

4/10/91 HWL Highest Recorded Groundwater Level Between 11/90 Through 2/92

8/14/91 LWL Lowest Recorded Groundwater Level Between 11/90 Through 2/92

Screened Interval

STRATIGRAPHIC LITHOLOGY

Interbedded Clay, Silty Clay and Silt

Fine-Grained Sand and Silty Sand

Well Rounded Cobbles and Gravel With Some Sand

BORING LOG LITHOLOGY

Silty Clay, Sandy Clay, Gravelly Clay

Clayey Silt, Sandy Silt, Gravelly Silt

Silty Sand, Sand With Silt

Clayey Sand, Sand With Clay

Clayey Gravel, Gravel With Clay

Silty Gravel, Gravel With Silt

Sandy Gravel, Gravel With Sand

Gravelly Sand, Sand With Gravel

# STRATIGRAPHIC CROSS SECTION A - A'

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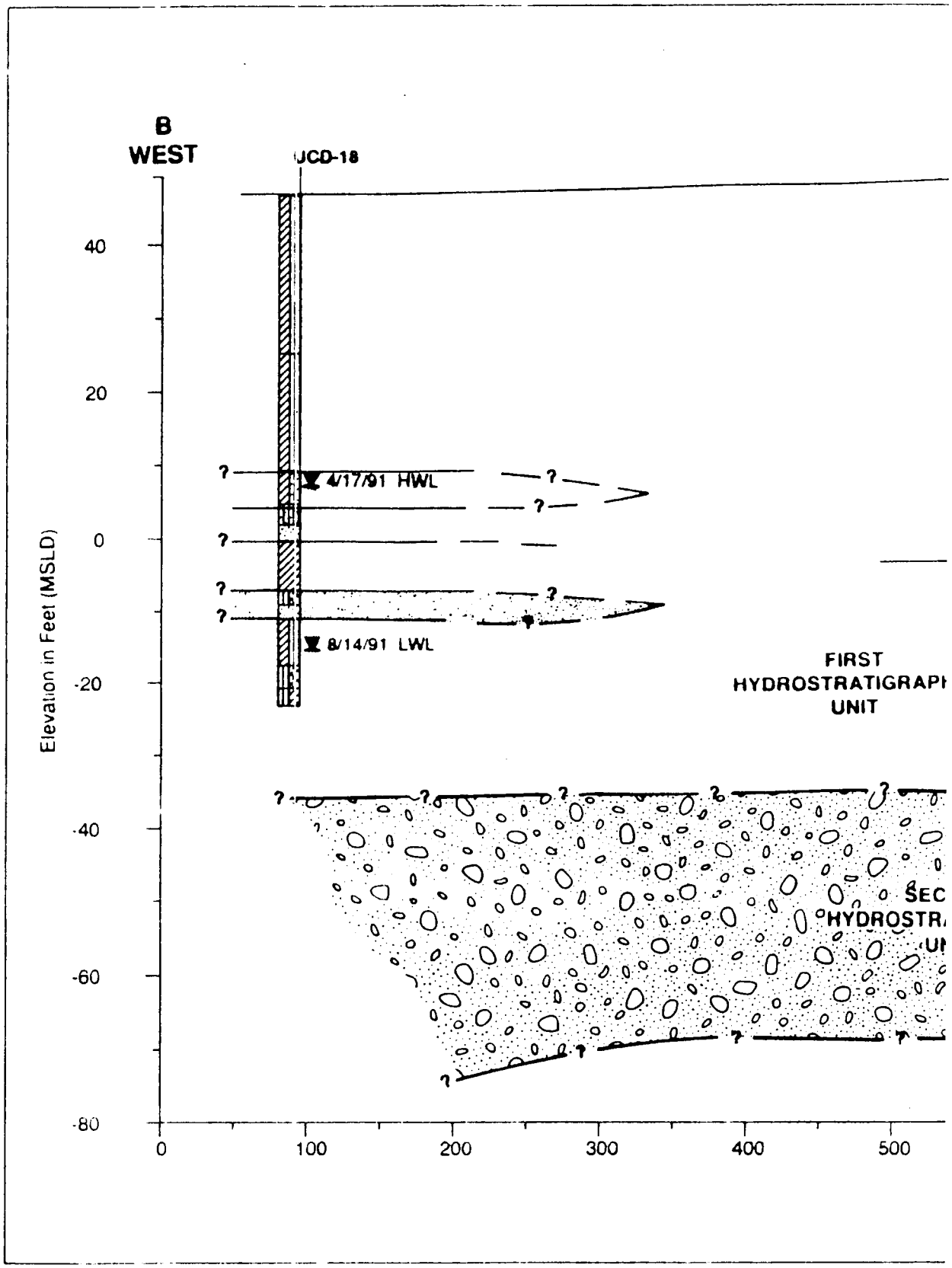
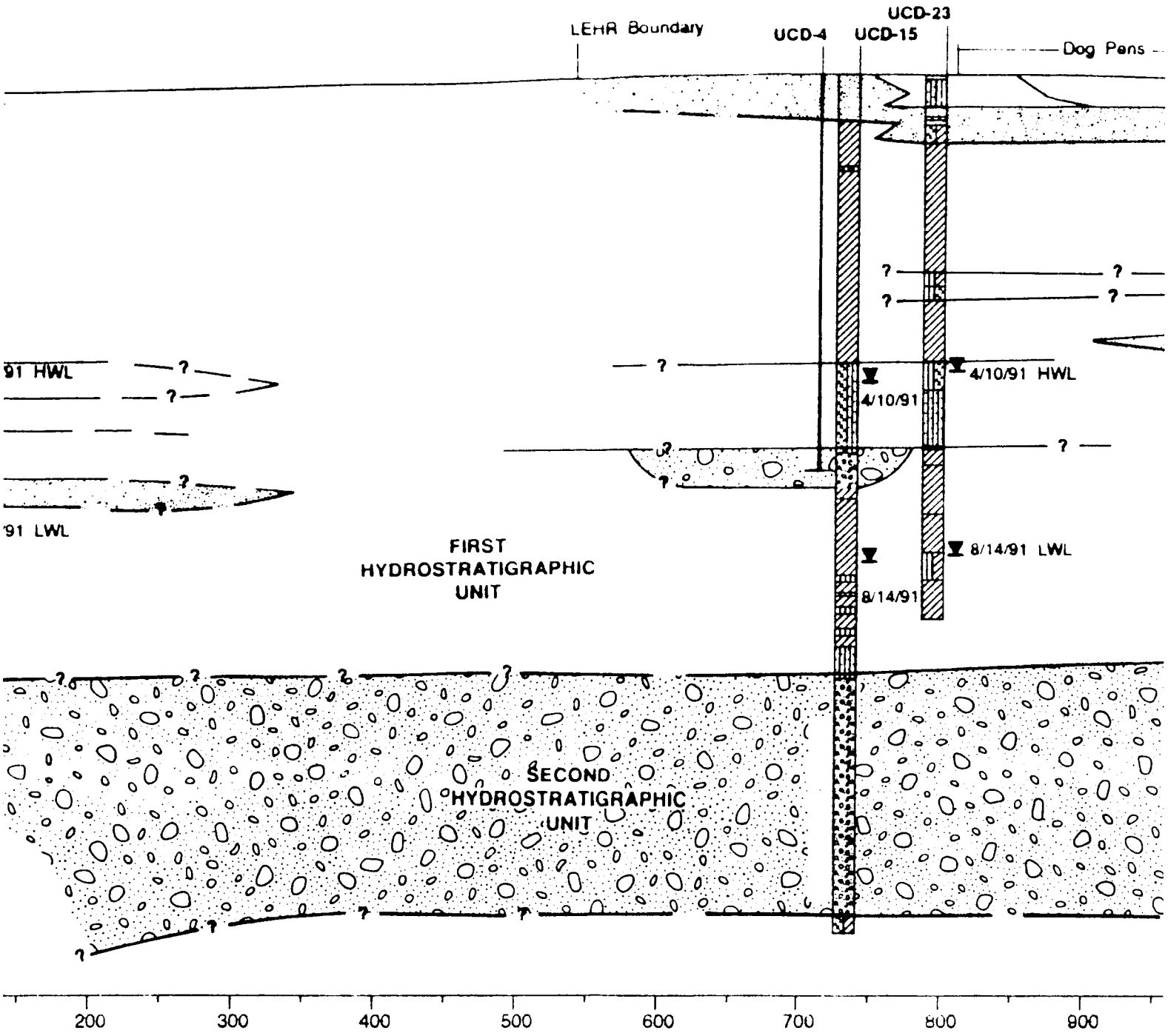
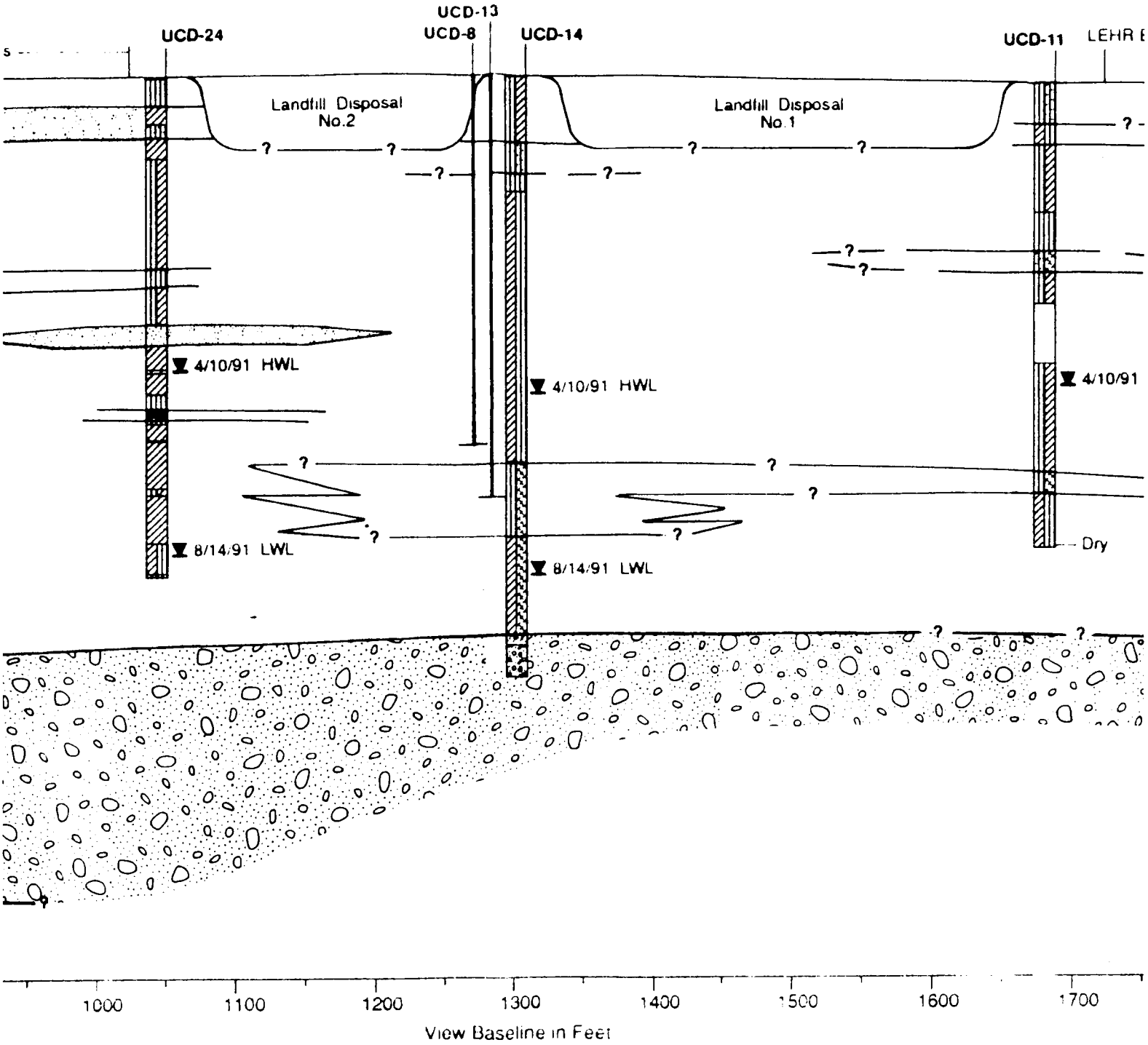
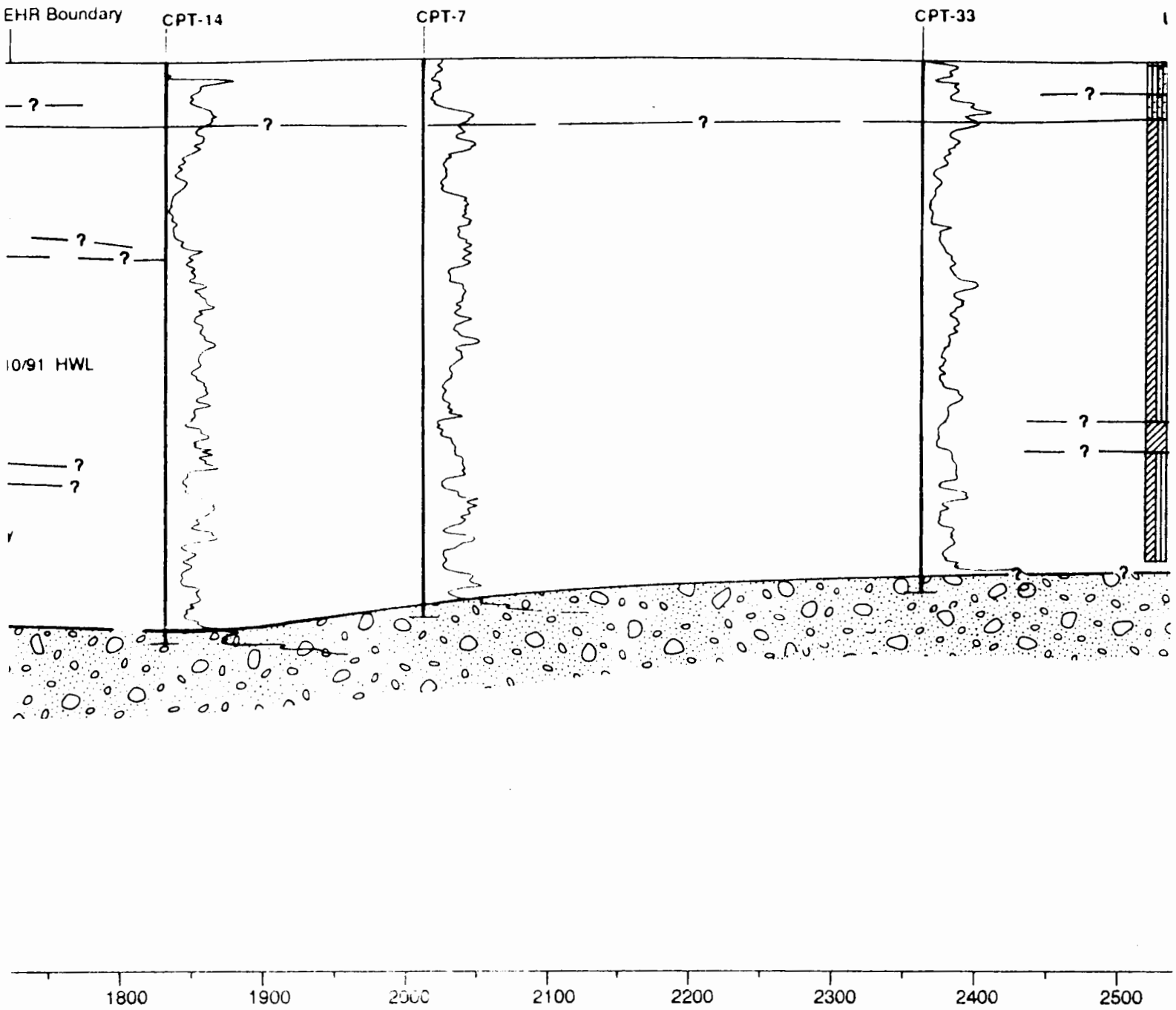
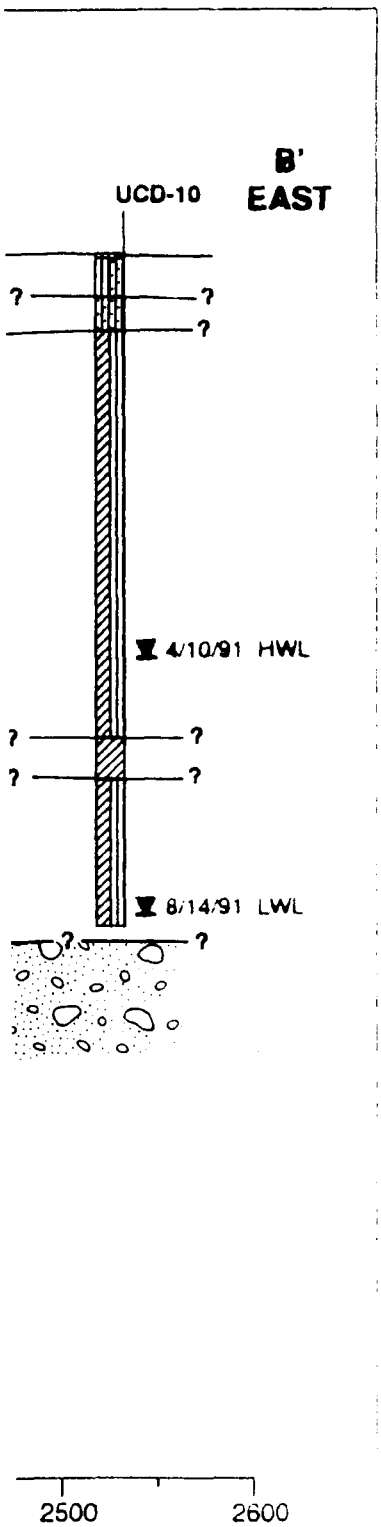
FIGURE 6.4


B
WEST
UCD-18
4/17/91 HWL
8/14/91 LWL
FIRST
HYDROSTRATIGRAPH
UNIT
SEC
HYDROSTR
UN
Elevation in Feet (MSLD)
40
20
0
-20
-40
-60
-80
0
100
200
300
400
500


LEHR Boundary
UCD-4
UCD-15
UCD-23
Dog Pens
91 HWL
91 LWL
4/10/91 HWL
4/10/91
8/14/91 LWL
8/14/91
FIRST
HYDROSTRATIGRAPHIC
UNIT
SECOND
HYDROSTRATIGRAPHIC
UNIT
200
300
400
500
600
700
800
900


UCD-24
UCD-13
UCD-8
UCD-14
UCD-11
LEHR E
Landfill Disposal No.2
Landfill Disposal No.1
4/10/91 HWL
4/10/91 HWL
4/10/91
8/14/91 LWL
8/14/91 LWL
Dry
1000
1100
1200
1300
1400
1500
1600
1700
View Baseline in Feet


EHR Boundary
CPT-14
CPT-7
CPT-33
10/91 HWL
1800
1900
2000
2100
2200
2300
2400
2500




EXPLANATION

4/10/91 HWL — Highest Recorded Groundwater Level Between 11/90 Through 2/92

8/14/91 LWL — Lowest Recorded Groundwater Level Between 11/90 Through 2/92

Screened Interval

STRATIGRAPHIC LITHOLOGY

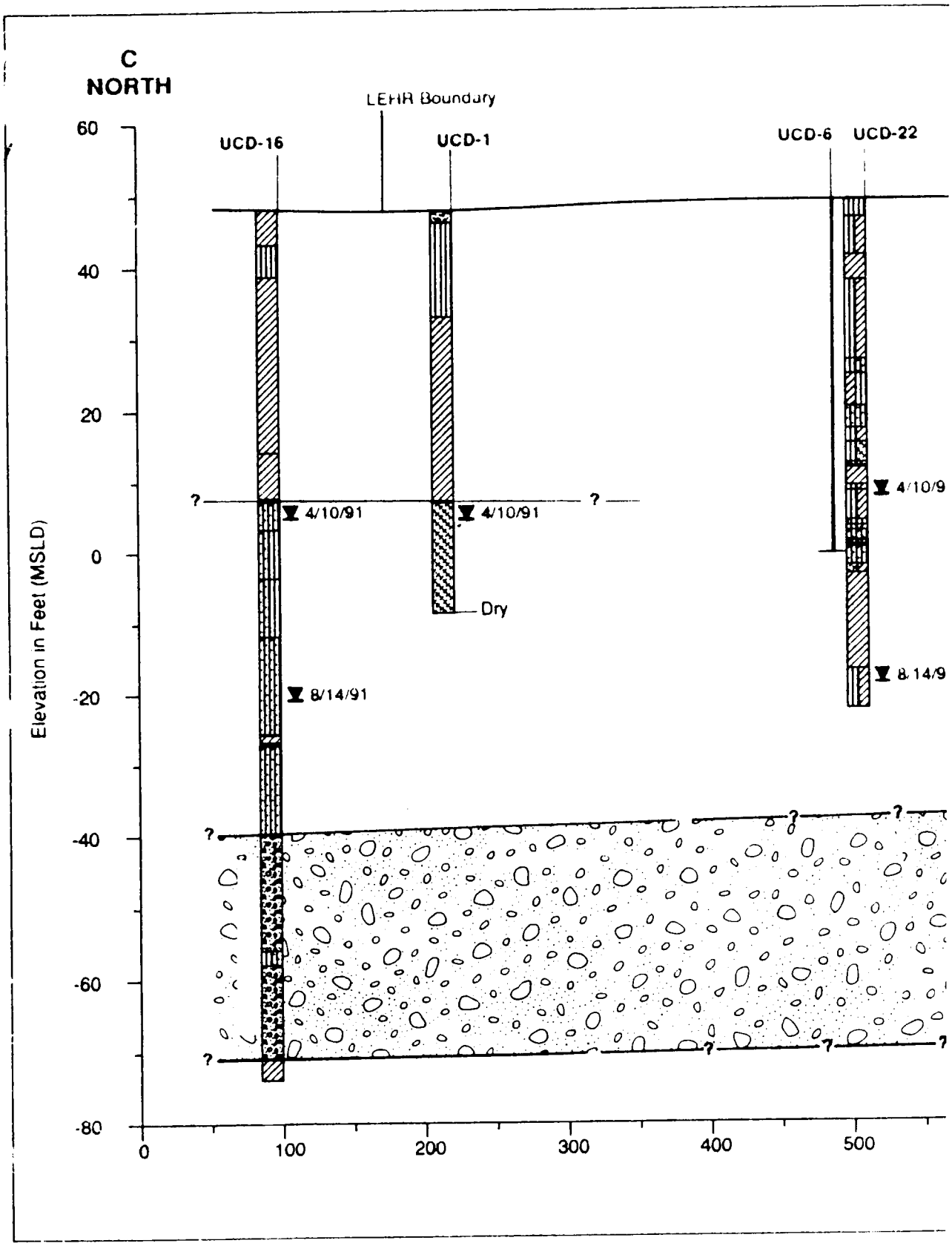
- Interbedded Clay, Silty Clay and Silt
- Fine-Grained Sand and Silty Sand
- Well Rounded Cobbles and Gravel With Some Sand

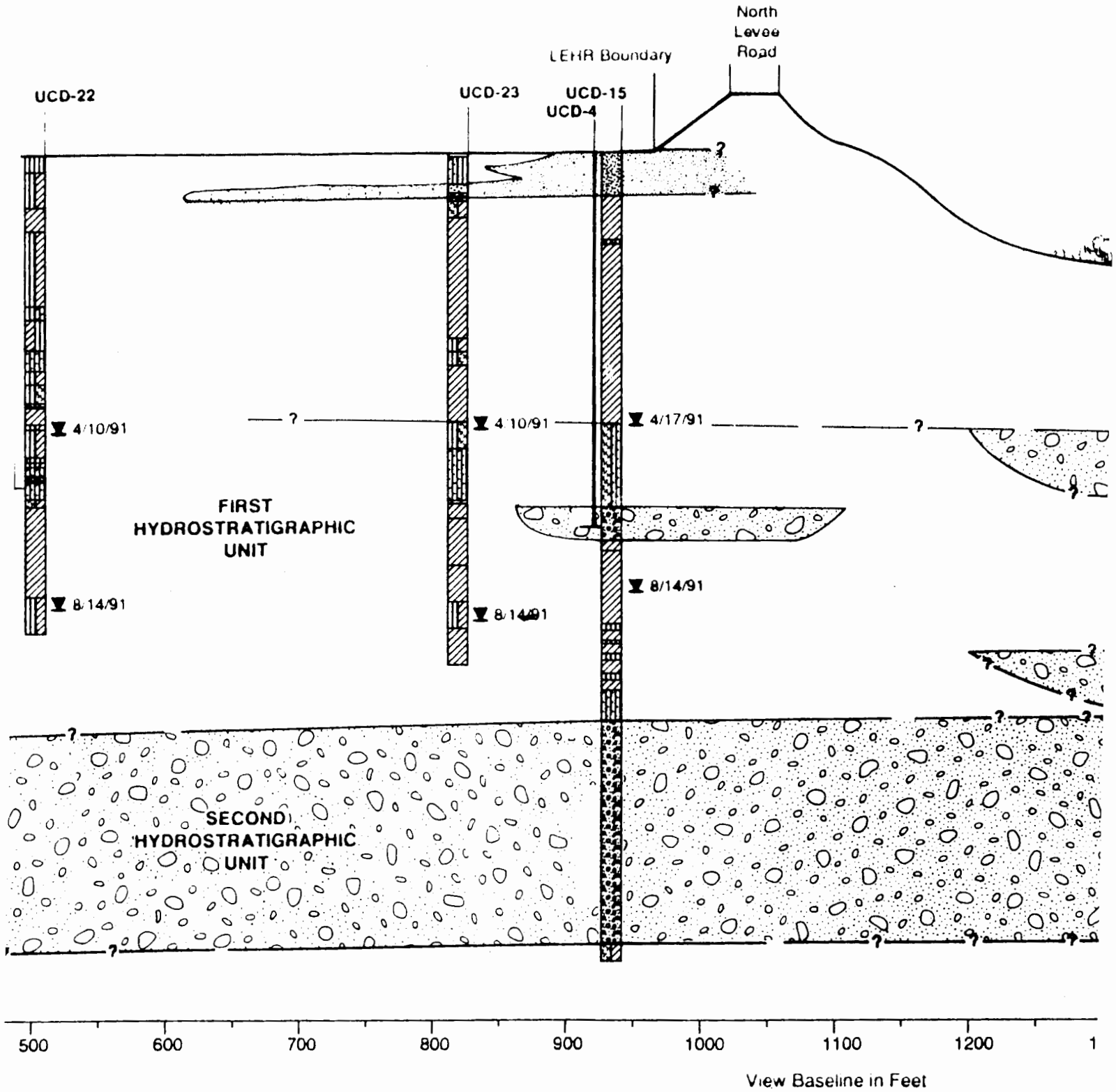
BORING LOG LITHOLOGY

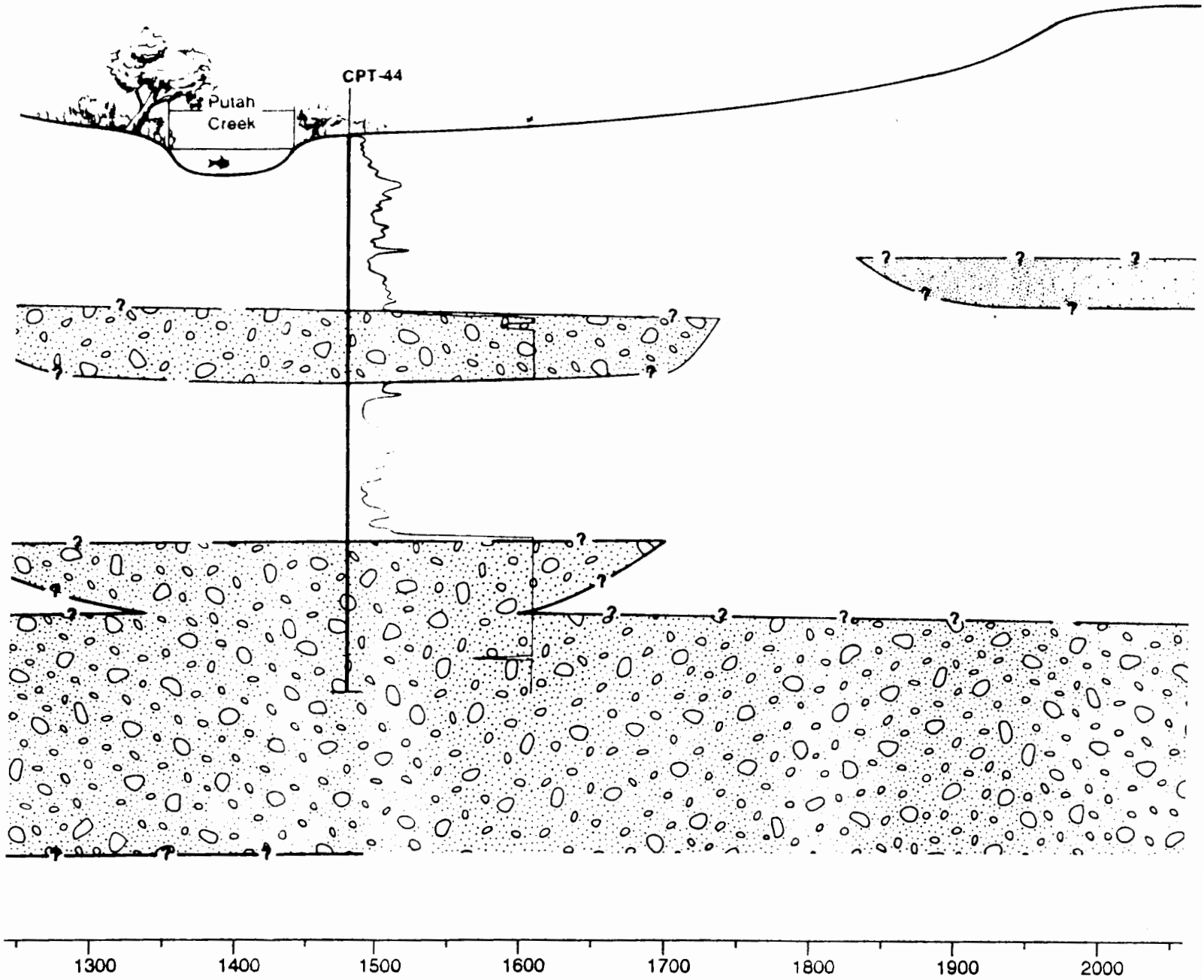
- Silty Clay, Sandy Clay, Gravelly Clay
- Clayey Silt, Sandy Silt, Gravelly Silt
- Silty Sand, Sand With Silt
- Clayey Sand, Sand With Clay
- Clayey Gravel, Gravel With Clay
- Silty Gravel, Gravel With Silt
- Sandy Gravel, Gravel With Sand
- Gravelly Sand, Sand With Gravel

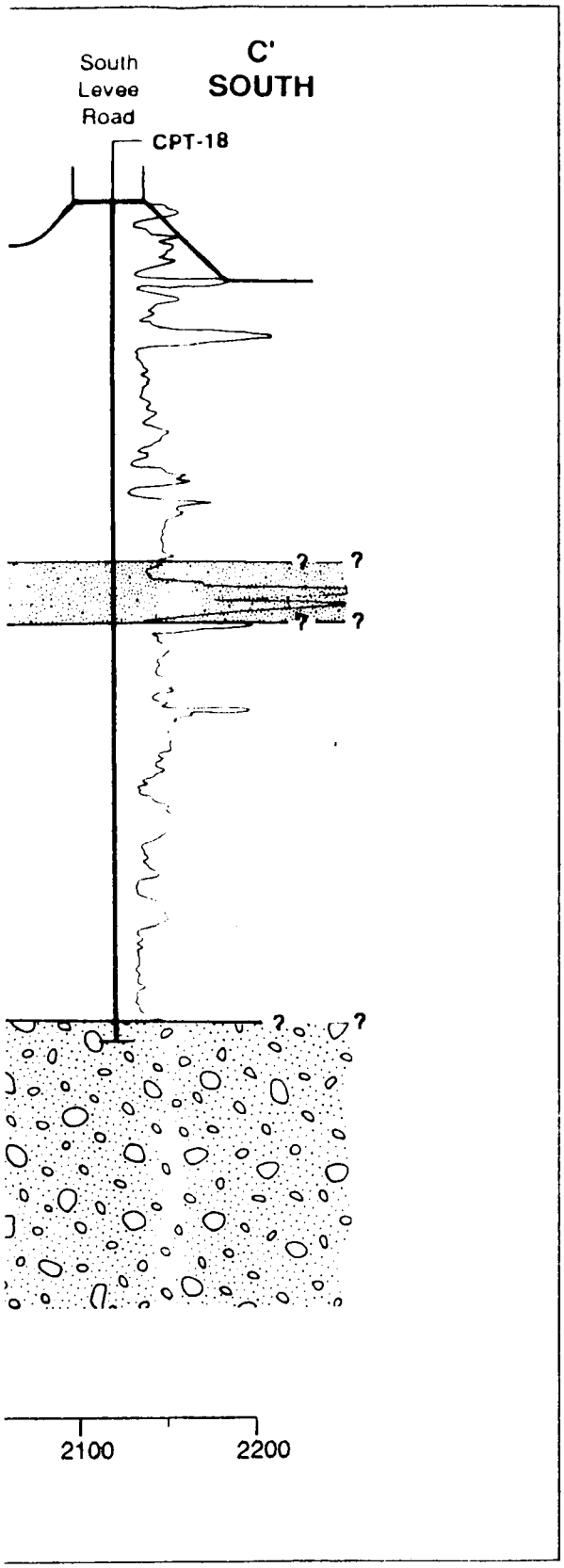
# STRATIGRAPHIC CROSS SECTION B - B'

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993


C
NORTH
LEHR Boundary
UCD-16
UCD-1
UCD-6
UCD-22
Elevation in Feet (MSLD)
60
40
20
0
-20
-40
-60
-80
0
100
200
300
400
500
4/10/91
4/10/91
Dry
8/14/91
4/10/9
8/14/9


North
Levee
Road
LEHR Boundary
UCD-22
UCD-23
UCD-15
UCD-4
4/10/91
4/10/91
4/17/91
8/14/91
8/14/91
8/14/91
FIRST
HYDROSTRATIGRAPHIC
UNIT
SECOND
HYDROSTRATIGRAPHIC
UNIT
500
600
700
800
900
1000
1100
1200
View Baseline in Feet


CPT-44
Putah
Creek
1300
1400
1500
1600
1700
1800
1900
2000




EXPLANATION

| | |
|---|---|
| 4/10/91 HWL | Highest Recorded Groundwater Level Between 11/90 through 2/92 |
| 8/14/91 LWL | Lowest Recorded Groundwater Level Between 11/90 through 2/93 |
| | Screened Intervals |

STRATIGRAPHIC LITHOLOGY

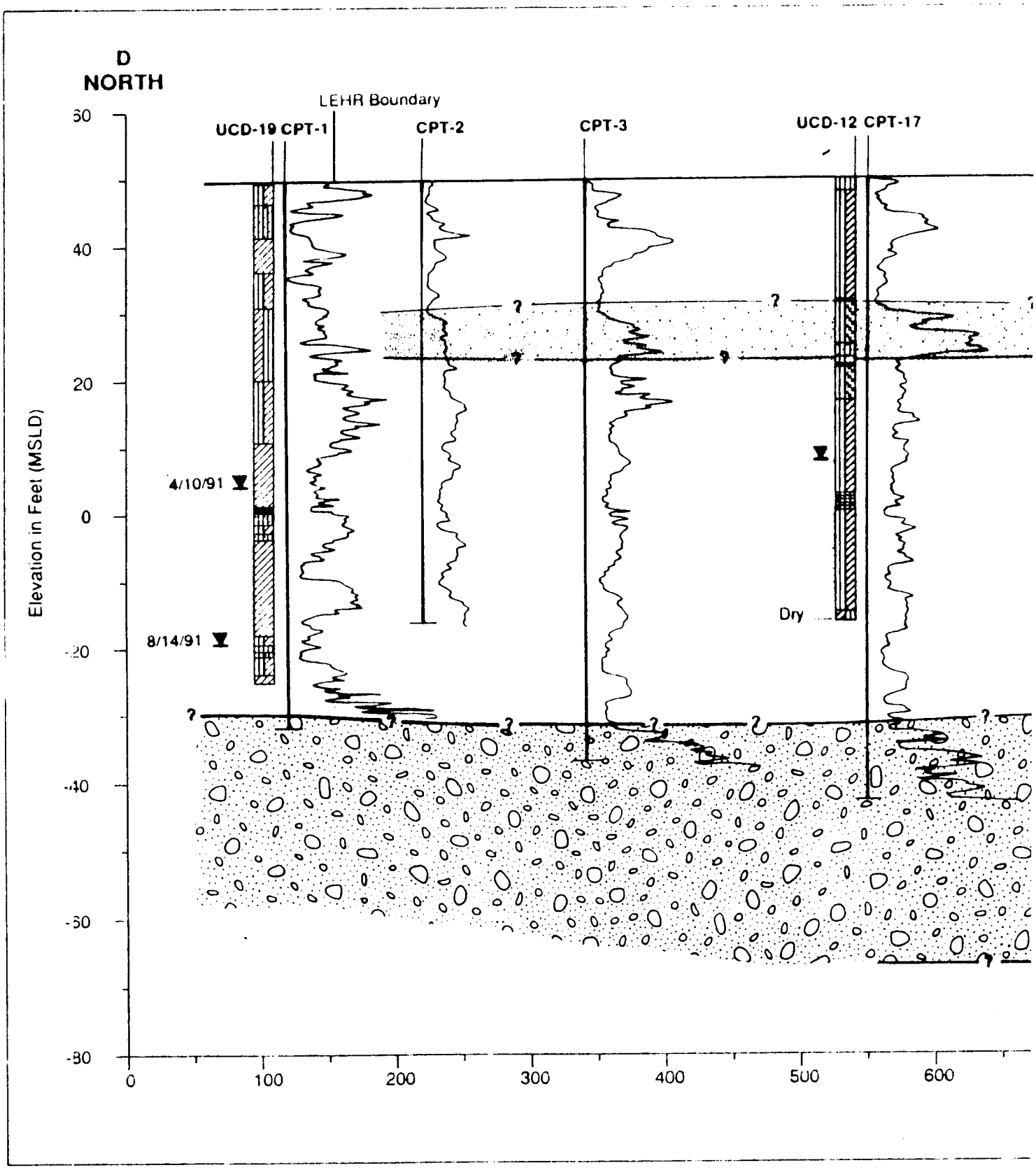
- Interbedded Clay, Silty Clay and Silt
- Fine-Grained Sand and Silty Sand
- Well Rounded Cobbles and Gravel With Some Sand

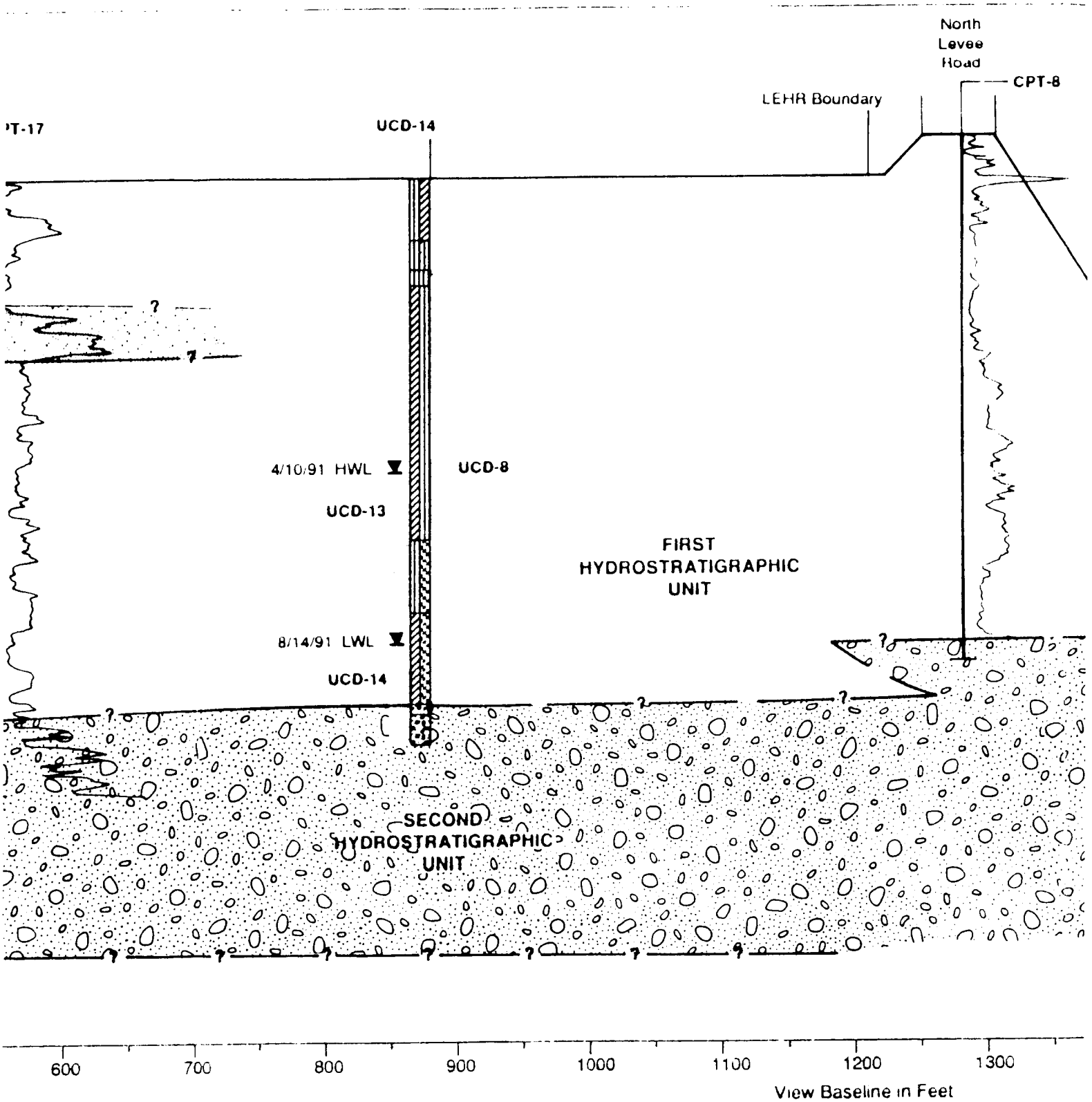
BORING LOG LITHOLOGY

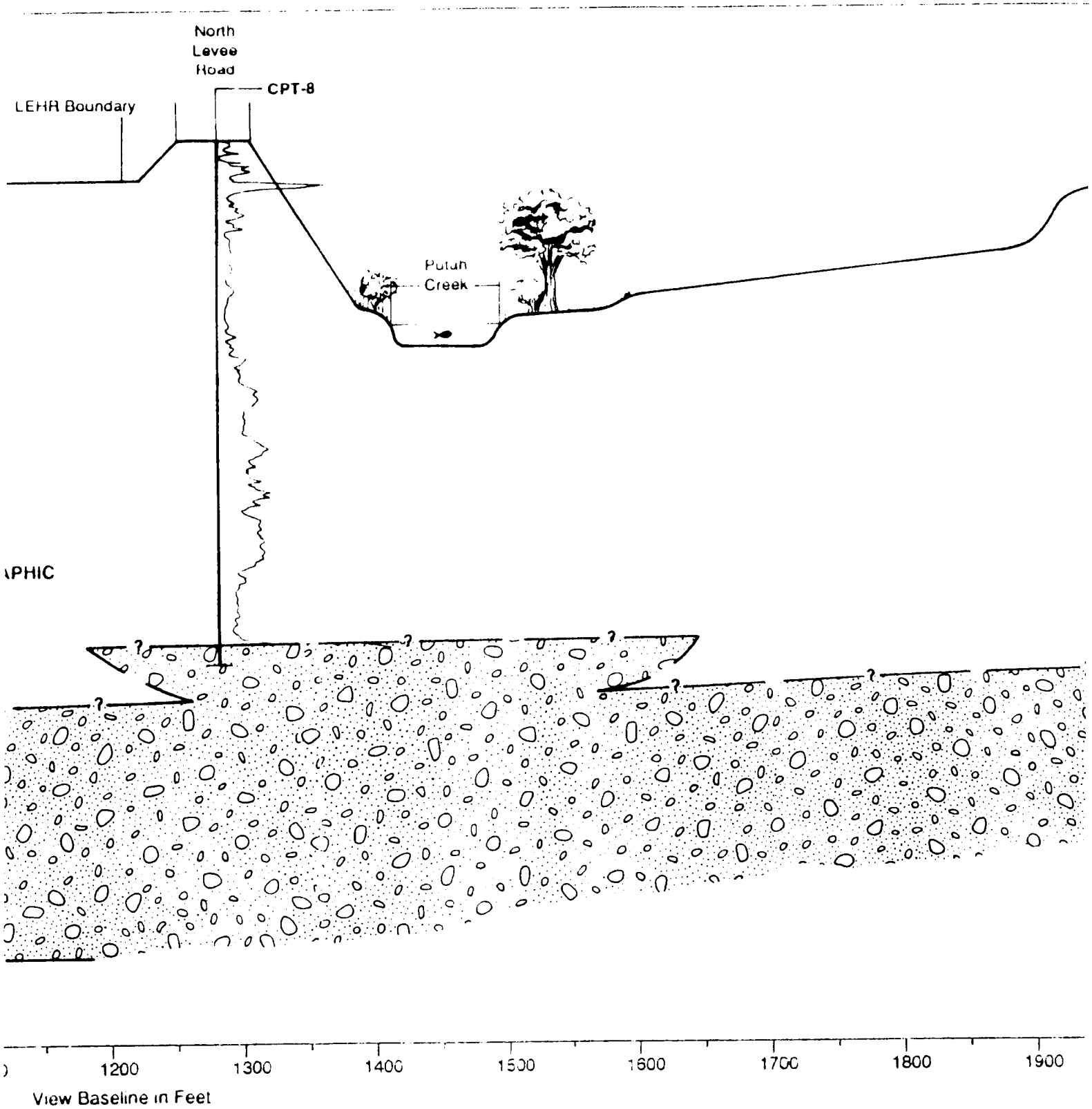
- Silty Clay, Sandy Clay, Gravelly Clay
- Clayey Silt, Sandy Silt, Gravelly Silt
- Silty Sand, Sand With Silt
- Clayey Sand, Sand With Clay
- Clayey Gravel, Gravel With Clay
- Silty Gravel, Gravel With Silt
- Sandy Gravel, Gravel With Sand
- Gravelly Sand, Sand With Gravel

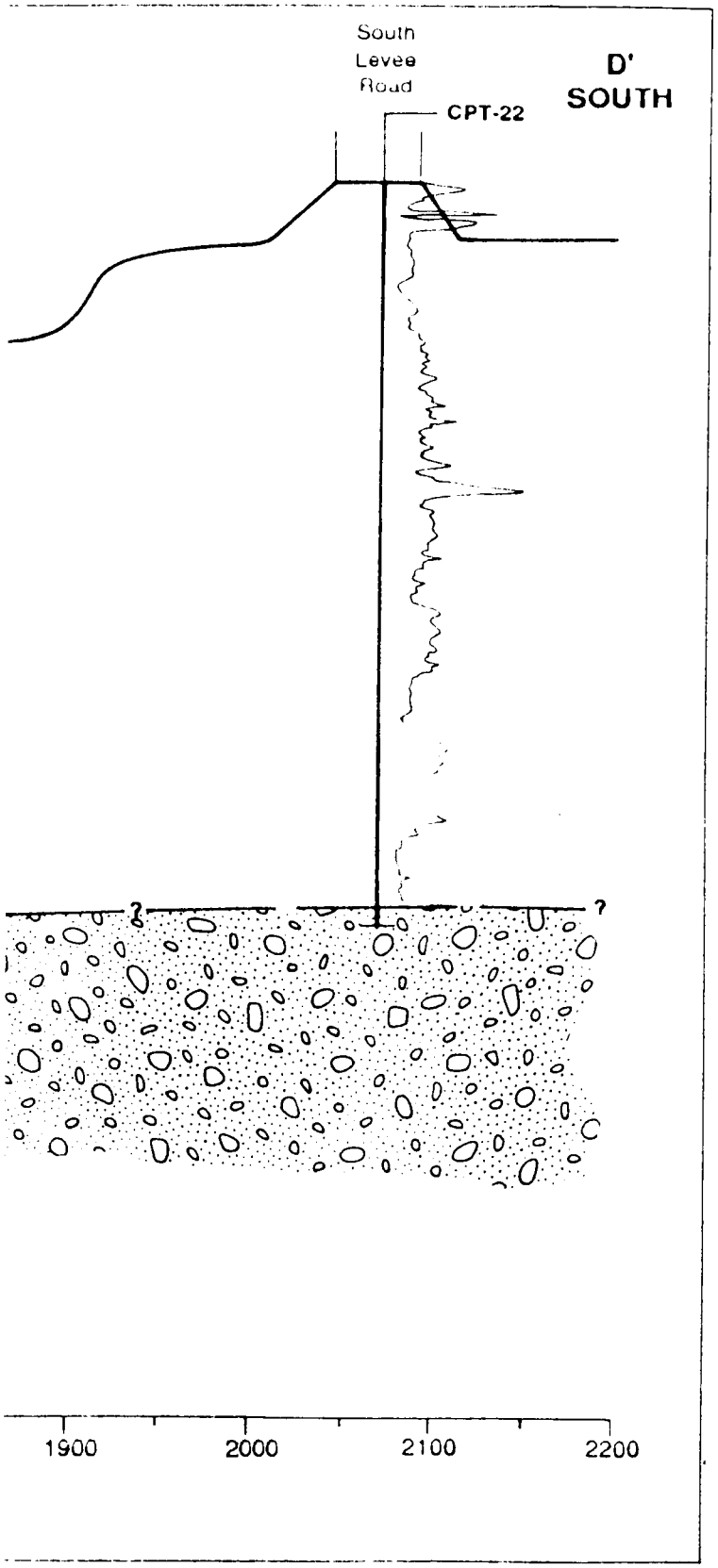
# STRATIGRAPHIC CROSS SECTION C - C

Phase II Site Characterizatic
LEHR Environmental Restoratic
FEBRUARY 19


D
NORTH
LEHR Boundary
UCD-19
CPT-1
CPT-2
CPT-3
UCD-12
CPT-17
4/10/91
8/14/91
Dry
Elevation in Feet (MSLD)
60
40
20
0
-20
-40
-60
-80
0
100
200
300
400
500
600


North
Levee
Road
CPT-8
LEHR Boundary
T-17
UCD-14
4/10/91 HWL
UCD-8
UCD-13
FIRST
HYDROSTRATIGRAPHIC
UNIT
8/14/91 LWL
UCD-14
SECOND
HYDROSTRATIGRAPHIC
UNIT
600
700
800
900
1000
1100
1200
1300
View Baseline in Feet


North
Levee
Road
CPT-8
LEHR Boundary
Putah
Creek
APHIC
1200
1300
1400
1500
1600
1700
1800
1900
View Baseline in Feet




EXPLANATION

| | | |
|---|---|---|
| ▼ | 4/10/91 HWL | Highest Recorded Groundwater Level Between 11/90 through 2/92 |
| ▼ | 8/14/91 LWL | Lowest Recorded Groundwater Level Between 11/90 through 2/93 |
| \| | | Screened Intervals |

STRATIGRAPHIC LITHOLOGY

- Interbedded Clay, Silty Clay and Silt
- Fine-Grained Sand and Silty Sand
- Well Rounded Cobbles and Gravel With Some Sand

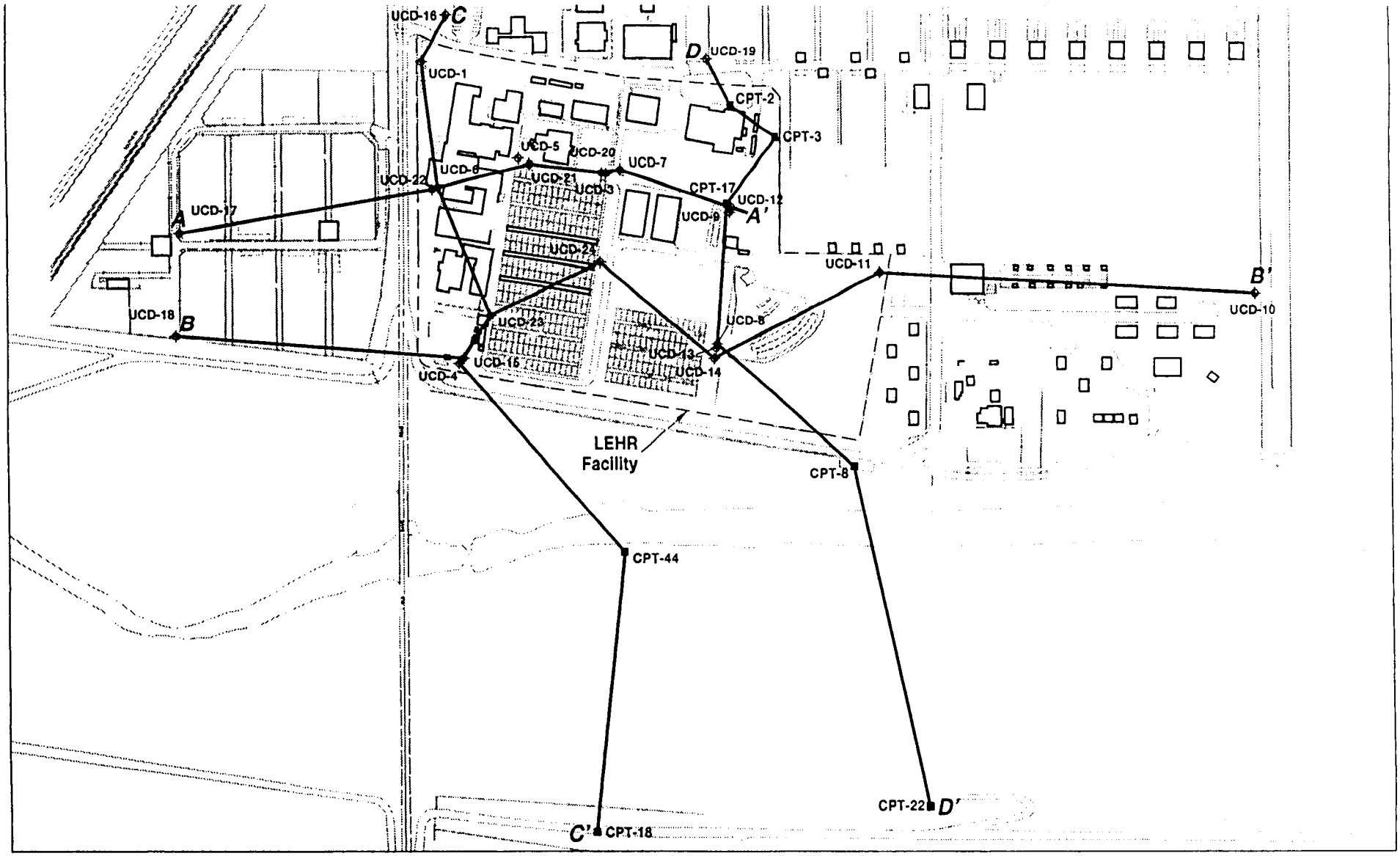
BORING LOG LITHOLOGY

- Silty Clay, Sandy Clay, Gravelly Clay
- Clayey Silt, Sandy Silt, Gravelly Silt
- Silty Sand, Sand With Silt
- Clayey Sand, Sand With Clay
- Clayey Gravel, Gravel With Clay
- Silty Gravel, Gravel With Silt
- Sandy Gravel, Gravel With Sand
- Gravelly Sand, Sand With Gravel

## STRATIGRAPHIC CROSS SECTION D - D

Phase II Site Characterizatio
LEHR Environmental Restoratio
FEBRUARY 199

FIGURE 6.7




EXPLANATION

Monitoring Wells

Cross Section Location

0 300

Scale in Feet

N

# LOCATION MAP OF STRATIGRAPHIC CROSS SECTIONS

Phase II Site Characterization

LEHR Environmental Restoration

FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-129

FIGURE 6.8

- Clay and silt underlie the cobbles and gravels and are shown as the lowest unit on the cross sections. The top of this clayey unit was encountered at depths ranging from 120 to 137 feet bgs. Maximum penetration into the clayey layer was about five feet. The clayey layer consists of light-brown clay with some silt, which is medium stiff and wet. The contact between this clay layer and the overlying cobble and gravel unit is sharp, and most likely represents an erosional contact due to channel scouring.

## 6.2 HYDROGEOLOGY

Data from monitoring-well borings, water levels, and slug tests have been used to evaluate HSUs, groundwater levels, hydraulic gradients, and hydraulic conductivities. Each of these hydrogeologic parameters are discussed in the following sections.

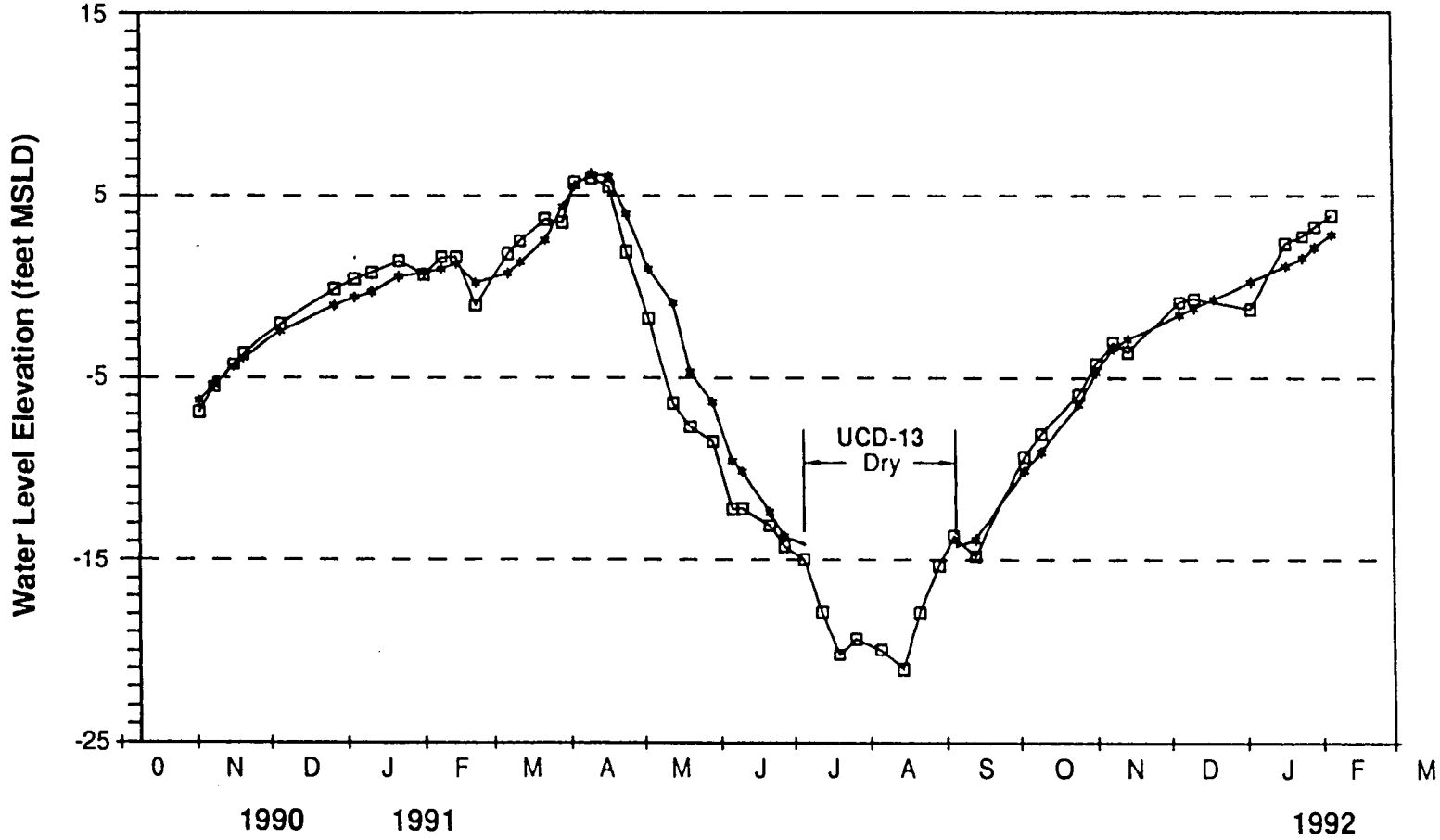
### 6.2.1 HSUs

For the purposes of this investigation, the saturated zone beneath the LEHR facility has been divided into two separate hydrostratigraphic units: the first HSU and the second HSU. This is based on the stratigraphy of the sediments present at the site, as discussed in Section 6.1.

The first HSU consists of those saturated sediments from the water table down to the top of the cobble and gravel unit. The thickness of this unit varies depending on the groundwater levels, as discussed in Section 6.2.2. The second HSU consists of the cobble and gravel unit found between approximately 80 and 135 feet bgs. Differences in hydraulic gradient and hydraulic conductivity between the two HSUs are discussed in Sections 6.2.3 and 6.2.4.

### 6.2.2 Groundwater Levels

Figure 6.9 shows hydrographs for monitoring well pair UCD-13 and UCD-14. UCD-13 is screened in the first HSU, and UCD-14 is screened in the second HSU. These two hydrographs represent typical elevation fluctuations in the first and second HSUs. The hydrographs were constructed using groundwater-level data collected weekly from November 1990 through February 1992. Hydrographs and tabulated groundwater level data for all monitoring wells located at the LEHR facility are presented in Appendix D. The hydrographs show that groundwater elevations vary from approximately seven feet above mean sea level in springtime to 17 feet below mean sea level in the summer. This fluctuation in groundwater levels causes several of the first-HSU monitoring wells, such as UCD-3, -4, -8, -9, -11, -12, and -13 installed during the Phase I and SWAT investigations, to become dry during the summer and early fall.




EXPLANATION

UCD-13 (First Hydrostratigraphic Unit)

UCD-14 (Second Hydrostratigraphic Unit)

**HYDROGRAPHS FOR UCD-13 AND UCD-14**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-60

FIGURE 6.9

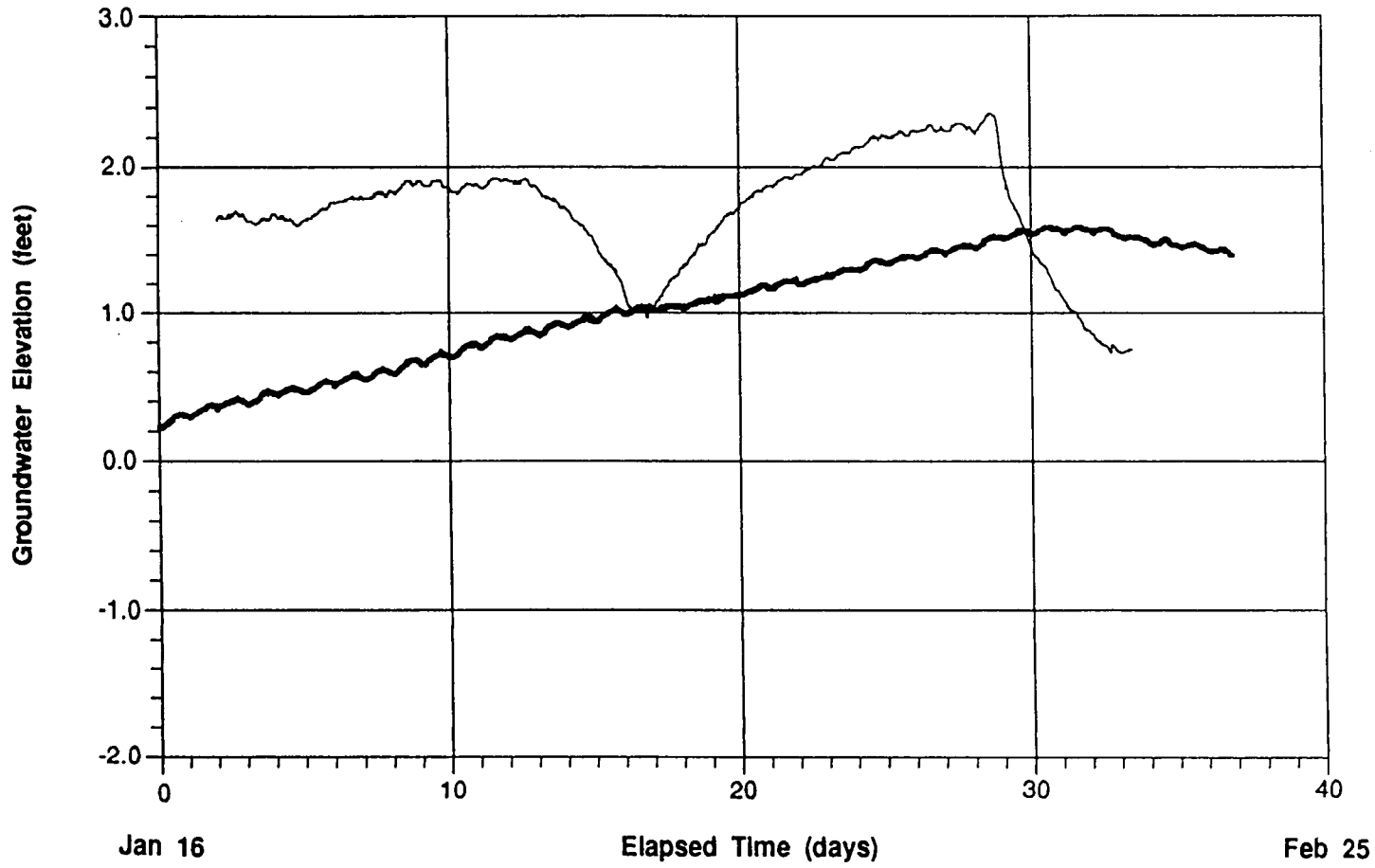
Review of the hydrographs show that the pattern of groundwater elevation fluctuation in the first and second HSUs is similar in shape and magnitude of change. The highest groundwater elevations for each of the hydrographs is in April 1991, after significant March 1991 rainfall. The lowest elevations were observed in August 1991. As shown on the hydrographs, groundwater elevations begin to increase in late August and September. Many of the hydrographs show a relatively small decline in water levels between the September 4, 1991 and September 13, 1991 groundwater elevation readings.

The decline in water levels between May and August corresponds to the growing season of irrigated crops in the site vicinity. These crops are irrigated by well water. The majority of the irrigation wells in the site vicinity are screened at depths less than 300 feet (Section 2.1).

Figure 6.10 shows hydrographs for monitoring well pair UCD-4 (first-HSU well) and UCD-15 (second-HSU well). These hydrographs were constructed using data obtained from an electronic data logging system that recorded water levels every 15 minutes from 2:30 P.M., January 16, 1991 through 4:30 P.M., February 22, 1991. The more detailed hydrographs from the data logging system show that water levels in the second HSU show more short-term variation and respond more quickly to short-duration events such as pumping. For example: from day 1 to day 12, the water level in UCD-15 is approximately 1 foot above the water level in UCD-4. From day 12 to day 16, the water level in UCD-15 drops approximately 1 foot; a similar drop is not recorded in UCD-4; however, there appears to be a flattening of the generally rising water level in UCD-4 from day 16 to day 18, a lag of four days after the initial drop in UCD-15. By day 17, water levels in UCD-15 have begun to recover and are fully recovered by day 24. At day 28, a second, larger drop in the water level in UCD-15 is recorded, and by day 33 the water level has dropped below the level of the recording device. During this drop in UCD-15, the water level in UCD-4 continues to rise until day 32 when the water level begins to decline. The lag time between the initial drop in UCD-15 and the drop in UCD-4 is approximately four days. The similar behavior of water levels in the first and second HSUs over longer periods infers there is a hydraulic interconnection between the two zones.

### 6.2.3 Hydraulic Gradients

Both vertical and lateral hydraulic gradients in the groundwater at the LEHR facility have been evaluated. The vertical gradient is the difference in hydraulic head between wells screened in two different HSUs at the same location. The lateral gradient is the change in hydraulic head per a specified unit distance for wells screened in the same HSU. The lateral gradient is measured in the direction of groundwater flow. The gradients have been evaluated using water-level data collected weekly during the Phase II investigation and are discussed below.




EXPLANATION

UCD-4 (First Hydrostratigraphic Unit)

UCD-15 (Second Hydrostratigraphic Unit)

# HYDROGRAPHS FOR UCD-4 AND UCD-15

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE9

FIGURE 6.10

#### 6.2.3.1 Vertical Gradient

The vertical gradient between the first and second HSUs has been evaluated using groundwater elevation data from three locations where first-HSU and second-HSU monitoring wells pairs are present. The well pairs used were monitoring wells UCD-4 and UCD-15; UCD-13 and UCD-14; and UCD-3 and UCD-7. Vertical gradient is calculated by dividing the difference in groundwater elevation from the two wells by the distance (in feet) between the base of the effective interval, in the first-HSU well, and the top of the second HSU. For example, the base of the effective interval in UCD-4 is 55.0 feet bgs, and the top of the second HSU in UCD-15 is at 80.5 feet bgs, a difference of 25.5 feet. The difference in groundwater elevations in the two wells on December 27, 1990, was 1.49 feet. The vertical gradient for that well pair location, on December 27, 1990 is calculated as 1.49 feet divided by 25.5 feet, or 0.058 ft/ft.

Vertical gradients are classified as upward or downward. An upward vertical gradient indicates the hydraulic head of the second HSU is at an elevation higher than the hydraulic head of the first HSU. A downward vertical gradient indicates that the hydraulic head of the second HSU is at an elevation lower than the hydraulic head of the first HSU. Vertical gradient cannot be evaluated when the groundwater level falls below the screened interval of the first-HSU well in a well pair.

Table 6.1 lists the calculated vertical gradients for each well pair location. This table shows the vertical gradient varies from an upward vertical gradient of 0.075 ft/ft at UCD-13/UCD-14 location on March 7, 1991 to a downward vertical gradient of 0.189 ft/ft at UCD-4\UCD-15 location on May 3, 1991. Table 6.1 also shows that vertical gradients not only vary over time (temporarily), but also vary with location (spatially). For example, on January 11, 1991, upward gradients are observed in pairs UCD-13/14 and UCD-13/7, while a downward vertical gradient is observed in pair UC Davis 4/15.

TABLE 6.1
VERTICAL GRADIENTS FOR WELL PAIRS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| DATE | UCD-4,-15 | UCD-13,-14 | UCD-3,-7 |
|---|---|---|---|
| 11/16/90 | 0.015 | 0.001 | UCD-3, DRY |
| 12/27/90 | 0.058 | 0.061 | UCD-3, DRY |
| 1/11/91 | <0.054> | 0.069 | 0.048 |
| 2/1/91 | 0.001 | 0.001 | <0.017> |
| 3/7/91 | 0.022 | 0.075 | 0.022 |
| 4/3/91 | <0.054> | 0.013 | <0.018> |
| 5/3/91 | <0.189> | <0.179> | UCD-3, DRY |
| 6/6/91 | UCD-4, DRY | <0.179> | UCD-3, DRY |
| 7/5/91 | UCD-4, DRY | <0.057> | UCD-3, DRY |
| 9/13/91 | UCD-4, DRY | <0.059> | UCD-3, DRY |
| 10/10/91 | UCD-4, DRY | 0.065 | UCD-3, DRY |
| 11/14/91 | 0.047 | <0.043> | UCD-3, DRY |

< > indicates downward vertical gradient.

Comparison of this table to the hydrographs presented in Section 6.2.2 (Figures 6.9 and 6.10) show there is typically an upward gradient when groundwater levels are relatively stable or rising, and a downward gradient when groundwater elevations are decreasing. The magnitude of the vertical gradient (upward or downward) is greatest when groundwater elevations are rising or falling sharply. A comparison of the hydrographs for well pair UCD-13/UCD-14 (Figure 6.9), and the vertical gradients for that well pair show that during January and February 1991, groundwater elevations were relatively stable to slightly increasing. In April, gradients stabilize in a period between rising and falling water levels. The upward vertical gradient for that well pair during the same months ranged from 0.069 ft/ft to 0.001 ft/ft. Conversely, during the months of May and June 1991, the water elevation dropped an average of approximately five feet per month, and the downward vertical gradient for those months was 0.179 ft/ft. This relationship appears to be independent of the lateral gradients across the site. Discussion of lateral gradients is provided below in Section 6.2.3.2.

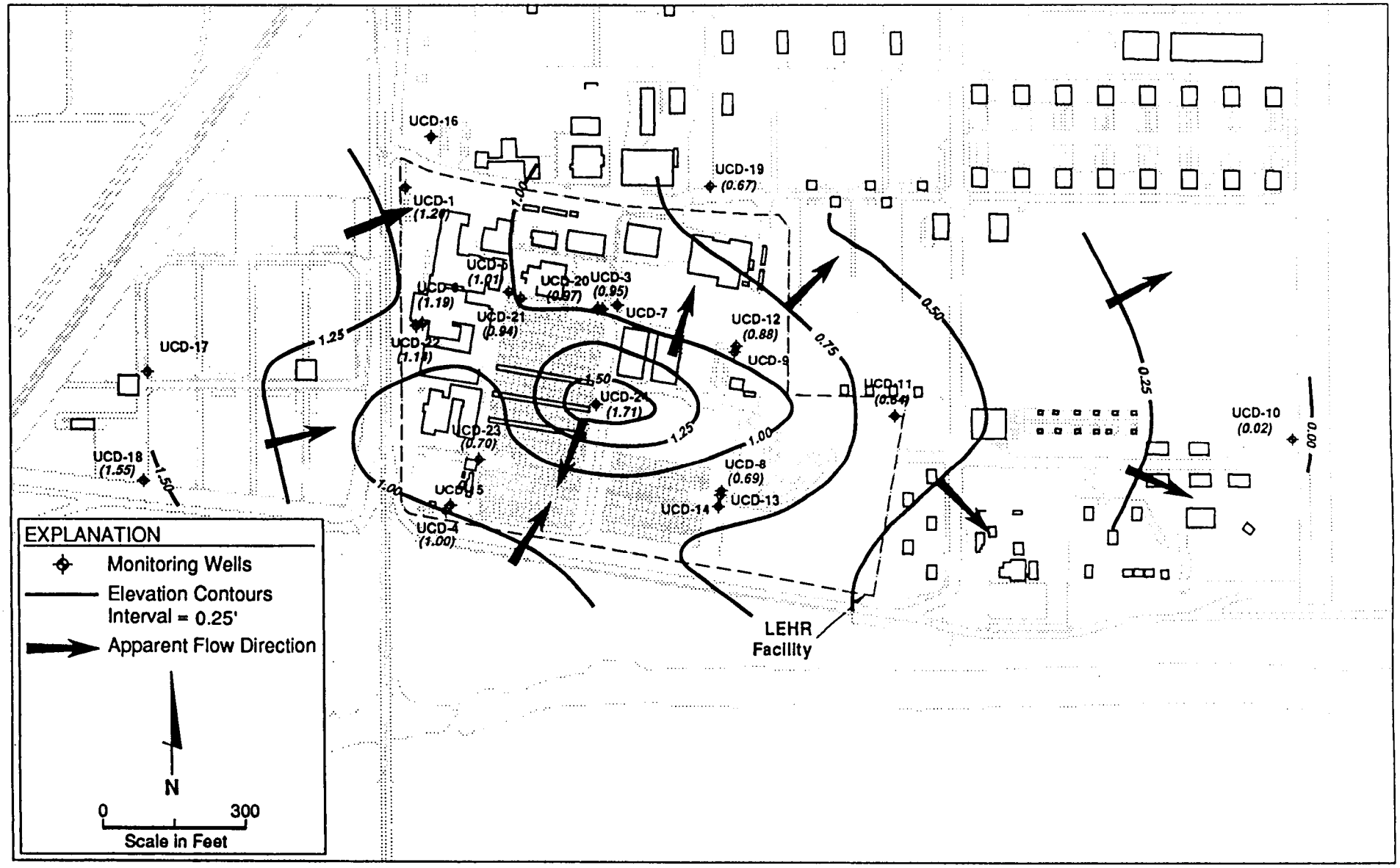
The detailed data logging data, as shown in Figure 6.10 and as discussed in Section 6.2.2, indicate that short-duration events such as local agricultural pumping can produce downward vertical gradients during periods of overall water-level increases. This is also seen in September and November 1990, and December and January 1992.

#### 6.2.3.2 Lateral Gradient

Lateral gradients in the first and second HSUs were evaluated using groundwater elevation data collected weekly during the Phase II investigation (Appendix D). Groundwater elevation contour maps were constructed for each HSU and used to assess lateral gradient in each HSU.

First HSU

Twelve groundwater elevation maps were constructed using data collected during the Phase II investigation. Figure 6.11 is an example groundwater elevation map for the first HSU from February 1, 1991 (an approximate mid-point during the Hydrologic Cycle). The groundwater elevation maps used in the Phase II evaluation are presented in Appendix I. Typically the lateral gradient of the first HSU across the site varies from approximately 0.0001 to 0.0015 ft/ft. Based on the groundwater maps presented in Appendix I, the direction of groundwater flow appears to be predominately northeast; however, local variations in apparent flow direction range from north to east.




# GROUNDWATER ELEVATION CONTOUR MAP
# FIRST HYDROSTRATIGRAPHIC UNIT
# FEBRUARY 1, 1991

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-62

FIGURE 6.11

Most of the groundwater maps for the first HSU exhibit an undulatory surface that gives an indication of local variation of flow direction. The maps show an overall northeast direction of flow with local highs (ridges) or lows (troughs) that give the impression of groundwater flow direction variances. These highs and lows are typically transient features that do not appear to last more than two weeks. The highs and lows may be the result of temporary hydraulic pressure differences within sediments with different permeabilities as the groundwater reacts to a given stress, such as increased infiltration from rainfall, increase or decrease in agricultural pumping, or changes in surface in-flow from Putah Creek. Examples of the transient features can be seen by comparing the groundwater elevation maps for October 10, 1991, and November 14, 1991, in Appendix I.

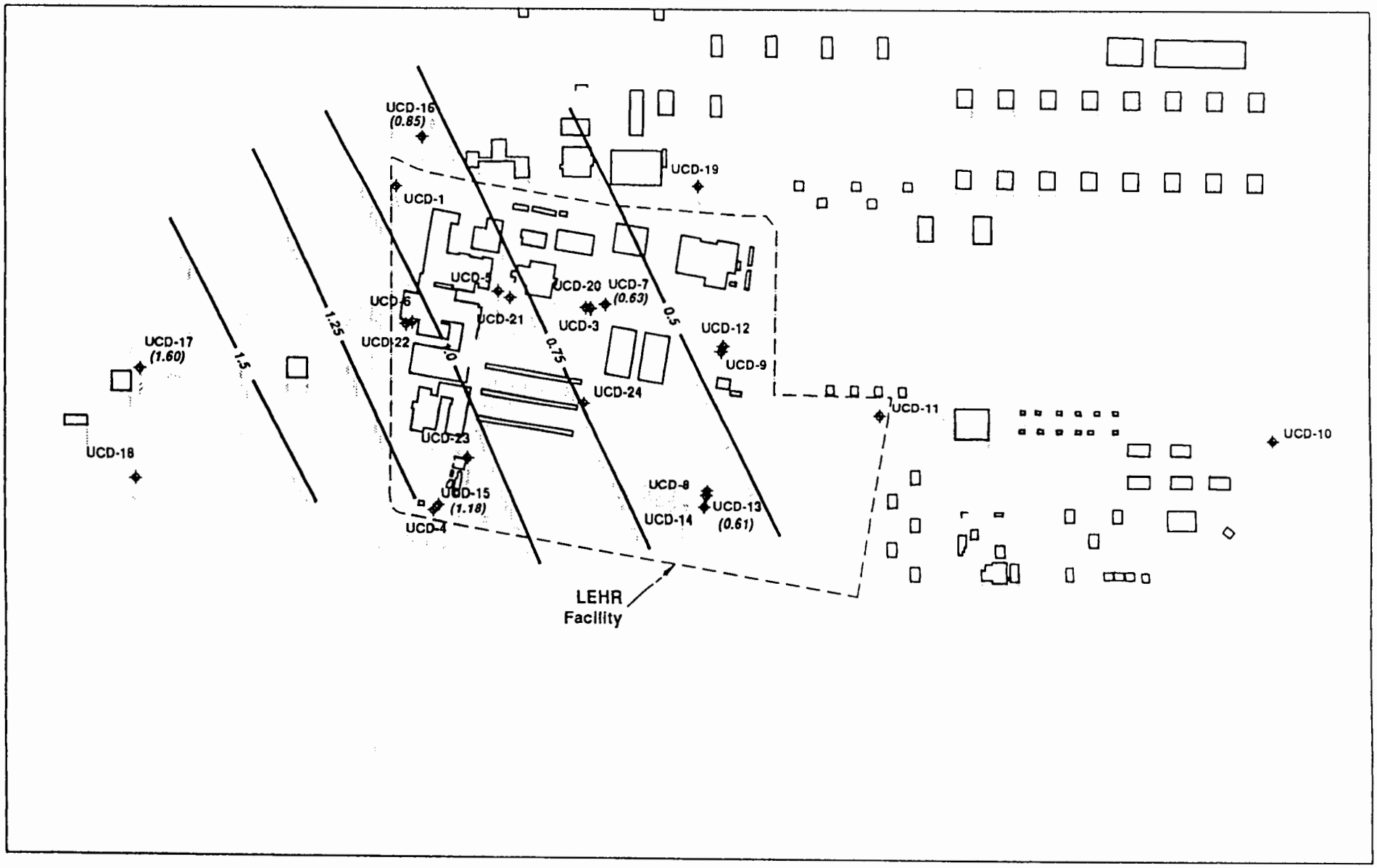
Second HSU

As with the first HSU, 12 groundwater elevation maps were constructed using groundwater levels collected, on the same days as the first-HSU wells, from wells screened in the second HSU. Figure 6.12 is a typical groundwater map of the second HSU constructed from data collected on February 1, 1991. The remainder of the groundwater contour maps used in the evaluation of the second HSU are presented in Appendix I. Based on the groundwater maps, the lateral gradient of the second HSU across the site is approximately 0.0015 ft/ft. The direction of flow appears to be predominantly toward the northeast to southeast; however, the direction of flow occasionally is east-southeast (June 6, 1991). Groundwater gradient and flow direction in the second HSU appear to be more consistent over the year than gradients and flow directions in the first HSU.

### 6.2.4 Hydraulic Conductivity

Two methods were used to assess hydraulic conductivity: laboratory permeability tests, and slug tests. Vertical permeability tests were completed in four soil samples during the Phase II Characterization. Permeability values ranged from $1.4 \times 10^{-7}$ cm/sec to $5.96 \times 10^{-9}$ cm/sec. Complete physical test results are presented in Appendix J. Slug tests were conducted in selected wells to estimate hydraulic conductivity near individual wells at various locations across the site. The results of these tests are discussed below. Vertical permeability results are considered to be low compared to permeabilities evaluated in slug tests, and expected values based on soil lithology.

Slug tests were conducted in 10 wells located at the LEHR facility. Nine of the wells are completed in the first HSU, while one well (UCD-17) is completed in the second HSU. These slug tests were conducted to supplement the slug test data for six wells developed during the Contaminant Pathway Analysis (Dames & Moore, 1990c). Table 6.2 lists the wells tested, along with specifics about their construction including well diameter, screened interval, and total depth.




EXPLANATION

Monitoring Wells

Concentration Contours
Interval = 0.25'

0 300
Scale in Feet

N

# GROUNDWATER ELEVATION CONTOUR MAP SECOND HYDROSTRATIGRAPHIC UNIT FEBRUARY 1, 1991

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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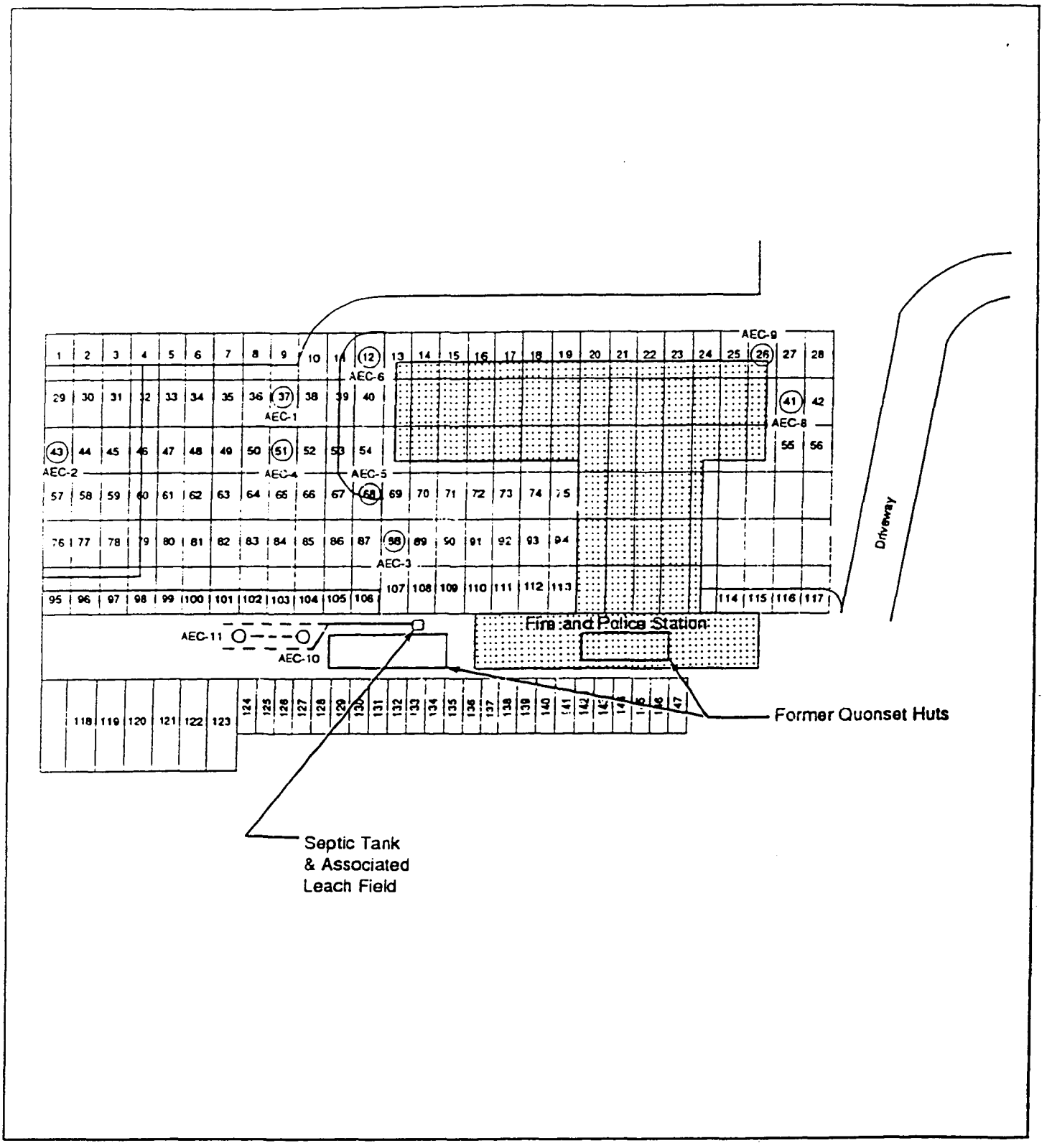
10805-454-044 DOE-63

FIGURE 6.12




EXPLANATION

(88) Boring Locations

N

0 60

Approximate Scale in Feet

**OLD AEC PROJECT SITE**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE1

FIGURE 6.14B

Laboratory control analyses for soil samples collected between September 26 and October 23, 1990 met acceptance criteria as specified in the QAPjP. Surrogate recoveries for organic compounds met acceptance criteria in all but two samples. Approximately 90 percent of matrix spike and matrix spike duplicate analyses fell within acceptable ranges as presented in the QAPjP.

#### 6.4.1.1 Background

A total of 12 soil samples was collected from the two monitoring wells installed off-site (UCD-17 and UCD-18). The samples collected from UCD-17 and -18 for the Phase II Site Characterization, are considered "background" samples. However, it should be noted that the quantity and location of samples may not be sufficient for a definitive assessment of background values for the LEHR facility. Eleven samples and one split QC sample were submitted for chemical and radiologic analyses. Table 6.4 identifies the depths from which samples were collected, as well as the samples submitted for physical and chemical and radiologic analysis. The analytical results for samples identified in Table 6.4 are discussed below and summarized as detections only in Table 6.5. The range of results reported in background soils is compared to published regional background ranges in Table 6.6. It should be noted that the published regional background range values are from surficial soils (approximately 20 cm below ground surface), whereas soil samples analyzed as part of this Phase II Investigation are from the surface and discrete depths. A statistical analysis of those results is presented in Section 6.4.5.

Volatile Organic Compounds

Methylene chloride was reported in four soil samples from UCD-17 in concentrations ranging from non-detectable ($<8.4$ $\mu$g/Kg) to 19.6 $\mu$g/Kg. No other detections of VOCs were reported.

Semivolatile Organic Compounds

Semivolatile organic compounds were not detected for soil samples analyzed from background well borings.

Pesticides and PCBs

Neither pesticides and PCBs were not detected for soil samples analyzed from background well borings.

TABLE 6.4
SOIL SAMPLE ANALYSIS
BACKGROUND AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| UCD 17 | UCD 18 |
|---|---|
| NS | NS |
| 5.0 | 5.0 |
| 10.0 | 10.0 |
| 15.0 | 15.0 |
| 20.0[1] | 20.0 |
| 25.0 | 25.0 |
| 30.0 | 30.0 |
| 35.0 | 35.0 |
| 40.0 | 40.0 |
| | 45.0 |
| | 50.0 |
| | 55.0 |
| | 60.0 |
| | 65.[2] |

Depths in feet below ground surface.
[1] Replicate sample taken
[2] Sample also submitted for physical testing.

Samples submitted for chemical and radiologic testing.

**Analytical Requests**

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha, Gross Beta
Tritium
Strontium-90
Gamma-Emitters

TABLE 6.5
SUMMARY OF DETECTIONS IN BACKGROUND AREA SOIL SAMPLES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-17 | UCD-17 | UCD-17 | UCD-17 | UCD-17 | UCD-17 | UCD-18 | UCD-18 | UCD-18 | UCD-18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 04/06/90 | 04/06/90 | 04/09/90 | 04/09/90 | 04/09/90 | 04/09/90 | 10/02/90 | 10/02/90 | 10/02/90 | 10/02/90 |
| | DEPTH | 5.0 | 10.0 | 20.0 | 20.0 | 30.0 | 40.0 | 5.0 | 20.0 | 35.0 | 45.0 |
| | QA | | | | D | | | | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES AND MISC. ANALYTES (mg/Kg) | NITROGEN, NITRATE (AS N) | 17 | 15 | 20 | 25 | 10 | 6 | 24.9 | 26.1 | 9.1 | 4.2 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | - | - | - | - | - | - | 22 | - | 26.5 | 12.9 |
| | ARSENIC (TOTAL) | - | - | - | - | - | 1.2 | 1.6 | 1.3 | 3 | 1.3 |
| | BARIUM (TOTAL) | 127 | 113 | 140 | 100 | 160 | 90 | 181 | 169 | 159 | 73.5 |
| | BERYLLIUM (TOTAL) | 0.1 | - | - | - | - | - | 3.64 | 0.3 | 0.3 | - |
| | CADMIUM (TOTAL) | 0.5 | 1.3 | 0.9 | 0.8 | 1.5 | 1.2 | 14.5 | 11.2 | 18.1 | 10.1 |
| | CHROMIUM (TOTAL) | 52 | 67 | 3 | 3 | 4 | 5 | 86.3 | 52.6 | 77.4 | 115 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | - | - | - | - | 0.29 | 1.98 | 1 | 0.29 |
| | COBALT (TOTAL) | 15 | 16 | 8 | 4 | - | 8 | 18.6 | 4 | 20.8 | 15.4 |
| | COPPER (TOTAL) | 45 | 51 | 51 | 38 | 50 | 55 | 33.6 | 27.7 | 44.9 | 14.1 |
| | LEAD (TOTAL) | 2 | 3 | 24 | 27 | 4 | 3 | 16.8 | 16.7 | 16 | 9.2 |
| | MERCURY (TOTAL) | 0.06 | - | - | - | - | - | 0.05 | 0.19 | 0.12 | 0.06 |
| | MOLYBDENUM (TOTAL) | 2 | 2 | 2 | 1 | 3 | 3 | 7.52 | 5.67 | 11.7 | - |
| | NICKEL (TOTAL) | 126 | - | 60 | 5 | 67 | - | 181 | 84.8 | 125 | 144 |
| | SELENIUM (TOTAL) | - | - | - | - | - | 3 | - | - | - | - |
| | SILVER (TOTAL) | 1 | 1 | 2 | 2 | 7 | 1 | - | - | - | - |
| | THALLIUM (TOTAL) | 1.7 | 2.1 | 32 | 24 | 30 | 30 | 4.6 | - | 5.3 | - |
| | VANADIUM (TOTAL) | 21 | 28 | 23 | 15 | 18 | 28 | 45.5 | 6.3 | 58.4 | 32.1 |
| | ZINC (TOTAL) | 46 | 54 | 50 | 43 | 46 | 57 | 55 | 49.8 | 77.4 | 31.6 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | 14.9 | 19.6 | - | 9.1 | - | 14.6 | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | 0.2 | - | - | - | - | - | - | - | - | - |
| | COBALT-60 | - | - | - | - | - | - | 0.17 | - | - | - |
| | GROSS ALPHA | 1.8 | 0.7 | 0.6 | 0.4 | - | 0.6 | 1.5 | 1.4 | 1.7 | - |
| | GROSS BETA | 4.7 | 3.7 | 0.6 | 0.6 | 0.4 | 0.8 | 2.7 | 2.3 | 3.2 | 1.2 |
| | POTASSIUM-40 | 7.3 | - | 13.2 | 7.68 | 8.52 | 8.31 | 23.9 | 46.4 | 22.7 | 11.8 |
| | RADIUM-226 | - | - | 0.7 | 0.6 | 0.8 | - | 0.6 | 1.4 | 0.4 | 0.6 |
| | STRONTIUM-90 | 0.24 | 0.08 | - | - | - | - | - | 0.1 | - | - |
| | THORIUM-232 | - | - | 0.9 | - | - | - | 0.66 | 1.1 | 0.9 | - |
| | TRITIUM | - | - | 0.5 | - | - | - | - | 0.4 | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.5 (Cont.)
SUMMARY OF DETECTIONS IN BACKGROUND AREA SOIL SAMPLES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-18 | UCD-18 |
|---|---|---|---|
| | DATE | 10/02/90 | 10/02/90 |
| | DEPTH | 55.0 | 65.0 |
| | QA | | |
| | ANALYTE | | |
| NITRATES AND MISC. ANALYTES (mg/Kg) | NITROGEN, NITRATE (AS N) | 39.8 | 2.1 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | 15.8 | 18.8 |
| | ARSENIC (TOTAL) | 3 | 2.5 |
| | BARIUM (TOTAL) | 71.5 | 85.8 |
| | BERYLLIUM (TOTAL) | 0.1 | 0.1 |
| | CADMIUM (TOTAL) | 13.5 | 13.4 |
| | CHROMIUM (TOTAL) | 156 | 71.7 |
| | CHROMIUM, HEXAVALENT (+6) | 1 | 0.2 |
| | COBALT (TOTAL) | 14.4 | 18.4 |
| | COPPER (TOTAL) | 21.3 | 30.8 |
| | LEAD (TOTAL) | 10.7 | 11.9 |
| | MERCURY (TOTAL) | 0.06 | 0.06 |
| | MOLYBDENUM (TOTAL) | - | 5.26 |
| | NICKEL (TOTAL) | 198 | 151 |
| | SELENIUM (TOTAL) | - | - |
| | SILVER (TOTAL) | - | - |
| | THALLIUM (TOTAL) | 3.7 | 5 |
| | VANADIUM (TOTAL) | 42.3 | 42.6 |
| | ZINC (TOTAL) | 41.7 | 51.3 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - |
| | COBALT-60 | - | - |
| | GROSS ALPHA | 1.2 | 1.2 |
| | GROSS BETA | 2.4 | 1.3 |
| | POTASSIUM-40 | 26.7 | 33.3 |
| | RADIUM-226 | 0.8 | 1.1 |
| | STRONTIUM-90 | 0.13 | 0.1 |
| | THORIUM-232 | 0.7 | 0.7 |
| | TRITIUM | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.6

SUMMARY OF DETECTIONS IN BACKGROUND CONCENTRATIONS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | |
|---|---|---|---|---|---|---|
| Parameter | Units | MIN | MAX | NUMB DET | SMALLEST | LARGEST |
| Antimony | mg/kg | <1 | 2.2 | 5 | 0.5 | 26.5 |
| Arsenic | mg/kg | 6.5 | 10 | 8 | 0.5 | 3.00 |
| Barium | mg/kg | 500 | 700 | 13 | 71.5 | 181.00 |
| Beryllium | mg/kg | <1 | 1 | 7 | 0.05 | 3.64 |
| Cadmium | mg/kg | -1 | | 13 | 0.5 | 18.10 |
| Chromium | mg/kg | 70 | 100 | 13 | 3 | 156.00 |
| Chromium, Hexavalent | mg/kg | NA | NA | 7 | 0.05 | 1.98 |
| Cobalt | mg/kg | 10 | 70 | 12 | 0.5 | 20.80 |
| Copper | mg/kg | 30 | 50 | 13 | 14.1 | 55.00 |
| Lead | mg/kg | 15 | 300 | 13 | 2 | 27.00 |
| Mercury | mg/kg | NA | NA | 8 | 0.02 | 0.19 |
| Molybdenum | mg/kg | <3 | 3 | 10 | 1 | 11.70 |
| Nickel | mg/kg | 15 | 300 | 11 | 5 | 198.00 |
| Selenium | mg/kg | <0.1 | 0.3 | 1 | 0.5 | 3.00 |
| Silver | mg/kg | NA | NA | 6 | 1 | 7.00 |
| Thallium | mg/kg | NA | NA | 10 | 1.5 | 32.00 |
| Vanadium | mg/kg | 100 | 500 | 13 | 6.3 | 58.50 |
| Zinc | mg/kg | 74 | 510 | 13 | 31.6 | 77.40 |
| Bismuth-214 | pCi/g | | | ND | | |
| Cesium-137 | pCi/g | | | 1 | 0.05 | 0.20 |
| Gross Alpha | pCi/g | | | 11 | 0.15 | 1.90 |
| Gross Beta | pCi/g | | | 13 | 0.4 | 4.70 |
| Lead-210 | pCi/g | | | ND | | |
| Lead-212 | pCi/g | | | ND | | |
| Lead-214 | pCi/g | | | ND | | |
| Potassium-40 | pCi/g | | | 12 | 2 | 46.40 |
| Radium-226 | pCi/g | | 0.77# | 10 | 0.05 | 1.40 |
| Strontium-90 | pCi/g | | | 5 | 0.025 | 0.24 |
| Thorium-232 | pCi/g | | 0.54# | 7 | 0.25 | 1.10 |
| Tritium | pCi/g | | | 3 | 0.1 | 0.50 |
| Cobalt-60 | pCi/g | | | 1 | 0.17 | 0.17 |

* H.T. Shacklette and J.G. Boerngen, 1984.

\# Average Value from Myrick and Berven, 1983.

Title 22 Metals

The reported results for metals analysis of the 11 background soil samples collected from UCD-17 and UCD-18 were compared to regional background concentrations identified from published sources (Shacklette and Boerngen, 1984). Table 6.6 lists published literature values for regional background range and the range of concentrations reported for background samples.

All of the Title 22 metals were detected in the background soil samples. Five metals, including antimony, beryllium, copper, molybdenum, and selenium, had maximum reported detections higher than the published regional background maximum concentration. Selenium was detected in only one of the samples analyzed. No regional background data was identified for cadmium, hexavalent chromium, silver, or thallium.

Hexavalent chromium, one of the site constituents of concern, was not detected (<0.1 mg/Kg) in UCD-17, but was detected in all six samples from UCD-18 varying from 0.2 to 1.98 mg/Kg.

Radionuclides

Table 6.5 summarizes the reported detections of radionuclides in the 12 background soil samples. Several radioisotopes, including cesium-137 and cobalt-60, were detected only once from the 12 samples. Gross alpha activity was reported in 11 of 12 samples up to 1.8 pCi/g. Gross beta activity was detected in all 12 samples ranging from 0.4 pCi/g to 4.7 pCi/g. Potassium-40 was reported in 12 samples from 2.0 pCi/g to 46.4 pCi/g, and radium-226 activity was reported in 10 samples, with a maximum reported detection of 1.4 pCi/g. Other radionuclides were detected at lesser frequency in the 25 samples. These radionuclides include thorium-232, strontium-90, and tritium. Table 6.6 lists published literature values for regional background ranges, and the range of concentrations reported for background samples.

Nitrates

Nitrate in soil samples collected from the two background well borings ranges from 2.1 to 39.8 mg/Kg. The average concentration for background levels of nitrate as (N) is 20.9 mg/Kg.

#### 6.4.1.2 Northern Area Downgradient (UCD-16, -19)

Two monitoring-well soil borings, UCD-16 and UCD-19, are not located in areas previously designated as areas of concern (Section 2.3). Therefore, results from these two borings, located in the northern part of the LEHR facility, are presented together and designated as the Northern Area Downgradient for data presentation purposes.

Thirteen soil samples were collected from these borings from 1.5 to 73 feet bgs. Eleven soil samples plus two replicate samples were submitted for analysis for the chemical and radiologic parameters listed in Table 6.7. The summary of detections for these 13 soil samples is presented in Table 6.8, and discussed below.

Volatile Organic Compounds

Methylene chloride was reported in all six soil samples from UCD-16, but was not detected in any of the samples analyzed from UCD-19. Concentrations varied from 10.8 to 17.9 $\mu$g/Kg. No other volatile compounds were reported.

Semivolatile Organic Compounds

Semivolatile organic compounds were were not detected for any of the 13 soil samples analyzed from the Northern Area Downgradient.

Pesticides and PCBs

Pesticides or PCBs were not detected for any of the 13 soil samples analyzed from the Northern Downgradient Area.

Title 22 Metals

All of the Title 22 metals were detected in soils from the Northern Area Downgradient of the LEHR facility. Table 6.8 compares the range of concentrations from the Northern Area Downgradient with background and regional concentrations. Hexavalent chromium was reported in six soil samples collected from the Northern Downgradient Area varying from non-detect (<0.1 mg/Kg) to 0.9 mg/Kg.

TABLE 6.7
SOIL SAMPLE ANALYSIS
NORTHERN AREA DOWNGRADIENT OF LEHR
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| UCD 16 | UCD 19 |
|---|---|
| 1.5 | 0.0 |
| 5.0 | 5.0 |
| 10.0 | 10.0 |
| 15.0 | 15.0 |
| 20.0 | 20.0 |
| 25.0 | 25.0 |
| 30.0 | 30.0 |
| 35.0 | 35.0 |
| 40.0 | 40.0 |
| | 45.0 |
| | 50.0[1] |
| | 55.0 |
| | 60.0 |
| | 65.0 |
| | 70.0 |
| | 73.[2] |

Depths in feet below ground surface
1 Replicate sample taken
2 Sample also submitted for physical testing

Samples submitted for chemical and radiologic testing.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha Gross Beta
Tritium
Strontium 90
Gamma-Emitters

TABLE 6.8
SUMMARY OF DETECTIONS IN NORTHERN AREA DOWNGRADIENT OF LEHR
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-16 | UCD-16 | UCD-16 | UCD-16 | UCD-16 | UCD-16 | UCD-19 | UCD-19 | UCD-19 | UCD-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 04/03/90 | 04/03/90 | 04/03/90 | 04/03/90 | 04/03/90 | 04/06/90 | 09/26/90 | 09/26/90 | 09/26/90 | 09/26/90 |
| | DEPTH | 5.0 | 10.0 | 15.0 | 30.0 | 40.0 | 1.5 | 1.0 | 20.0 | 40.0 | 50.0 |
| | QA | | | | | | | | | | D |
| | ANALYTE | | | | | | | | | | |
| NITRATES | NITROGEN, NITRATE (AS N) | 22 | 4 | 9 | 7 | 5 | 10 | 20 | 12.7 | 8.9 | 4.5 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | - | - | - | - | - | - | 18 | 19 | 31.4 | 20.3 |
| | ARSENIC (TOTAL) | 1.1 | 1 | 1.5 | - | 1.1 | - | 2.5 | 1 | 1.9 | 1.5 |
| | BARIUM (TOTAL) | - | 13 | 1 | - | - | 43 | 136 | 176 | 119 | 101 |
| | BERYLLIUM (TOTAL) | - | - | - | 0.1 | 0.1 | - | 0.4 | 0.5 | 0.6 | 0.4 |
| | CADMIUM (TOTAL) | 0.8 | 0.8 | 0.7 | 0.6 | 0.7 | 1.1 | 13.9 | 10.3 | 16.7 | 13.2 |
| | CHROMIUM (TOTAL) | 30 | - | 29 | 14 | 26 | 1 | 108 | 51.9 | 89.7 | 77.5 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | - | - | - | 0.2 | 0.2 | 0.5 | 0.9 | 0.5 |
| | COBALT (TOTAL) | 5 | 6 | 6 | 3 | - | 15 | 23 | 15.4 | 26.4 | 17.8 |
| | COPPER (TOTAL) | 30 | 31 | 32 | 27 | 30 | 49 | 34.1 | 29.7 | 53.9 | 33.1 |
| | LEAD (TOTAL) | 1.1 | 1.3 | 1.3 | 1 | 1 | 21 | 17.7 | 16.7 | 23.7 | 16.2 |
| | MERCURY (TOTAL) | - | - | - | - | - | 0.53 | 0.08 | - | 0.08 | 0.06 |
| | MOLYBDENUM (TOTAL) | - | 1 | 50 | 1 | 2 | 2 | 9.7 | 9.9 | 16.8 | 11.7 |
| | NICKEL (TOTAL) | 55 | 62 | - | 5 | 48 | 204 | 216 | 89.5 | 165 | 117 |
| | SILVER (TOTAL) | - | 4 | 1 | 1 | 2 | 2 | - | - | - | - |
| | THALLIUM (TOTAL) | 1.6 | 0.9 | 0.5 | 1 | 1.9 | 0.7 | 7.2 | 5.8 | 9.3 | 7.4 |
| | VANADIUM (TOTAL) | 11 | - | - | - | 11 | 19 | 44.8 | 39 | 58.5 | 49.6 |
| | ZINC (TOTAL) | 16 | 16 | 22 | 12 | 17 | 80 | 68.3 | 51.1 | 88.6 | 61.1 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | 17.8 | 16.6 | 14.3 | 15.5 | 10.8 | 17.9 | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | ACTINIUM-228 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.8 | 0.8 | 1.1 | 1.1 | 1.2 | 1.7 | 1.1 | 2.1 | 1.3 | 1 |
| | GROSS BETA | 6.3 | 5 | 4.9 | 5 | 4.9 | 5.6 | 3 | 3.4 | 3.4 | 2.6 |
| | LEAD-212 | - | - | - | - | - | - | - | - | - | - |
| | LEAD-214 | - | - | - | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 8.75 | 8.07 | 9.33 | 5.76 | 10.55 | 8.01 | - | - | - | - |
| | RADIUM-226 | 1.06 | - | 0.35 | 0.82 | - | - | - | - | - | - |
| | STRONTIUM-90 | - | - | - | - | 0.1 | 0.13 | - | - | 0.76 | - |
| | THALLIUM-208 | - | - | - | - | - | - | - | - | - | - |
| | THORIUM-232 | - | - | - | - | - | 0.8 | - | - | - | - |
| | TRITIUM | - | - | - | - | - | 0.5 | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.8 (Cont.)
SUMMARY OF DETECTIONS IN NORTHERN AREA DOWNGRADIENT OF LEHR
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-19 | UCD-19 | UCD-19 |
|---|---|---|---|---|
| | DATE | 09/27/90 | 09/27/90 | 09/27/90 |
| | DEPTH | 70.0 | 70.0 | 73.0 |
| | QA | | D | |
| | ANALYTE | | | |
| NITRATES | NITROGEN, NITRATE (AS N) | 17.6 | 3.8 | 23.5 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | 13.6 | 16.7 | 17.9 |
| | ARSENIC (TOTAL) | 1.9 | 2.3 | 1.1 |
| | BARIUM (TOTAL) | 58.55 | 59.32 | 118.18 |
| | BERYLLIUM (TOTAL) | 0.4 | 0.4 | 0.5 |
| | CADMIUM (TOTAL) | 0.1 | 0.1 | 0.1 |
| | CHROMIUM (TOTAL) | 73.34 | 75.74 | 50.81 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | 0.3 |
| | COBALT (TOTAL) | 20.4 | 19.9 | 17.8 |
| | COPPER (TOTAL) | 26.4 | 29.6 | 24.1 |
| | LEAD (TOTAL) | 10.7 | 22.53 | - |
| | MERCURY (TOTAL) | 0.05 | 0.04 | 0.06 |
| | MOLYBDENUM (TOTAL) | 8.1 | 8.8 | 10.4 |
| | NICKEL (TOTAL) | 162.6 | 152.3 | 141.1 |
| | SILVER (TOTAL) | 0.07 | - | - |
| | THALLIUM (TOTAL) | - | 6.3 | - |
| | VANADIUM (TOTAL) | 43.5 | 47 | 34.4 |
| | ZINC (TOTAL) | 47.5 | 48.9 | 38.1 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - |
| RADIONUCLIDES (pCi/gram) | ACTINIUM-228 | 0.82 | - | - |
| | GROSS ALPHA | 0.8 | 0.9 | 0.9 |
| | GROSS BETA | 2.9 | 3.1 | 3.7 |
| | LEAD-212 | 0.73 | 0.63 | 0.81 |
| | LEAD-214 | - | 0.56 | - |
| | POTASSIUM-40 | - | - | - |
| | RADIUM-226 | 0.4 | 0.55 | 0.72 |
| | STRONTIUM-90 | - | 19 | - |
| | THALLIUM-208 | 0.6 | 0.52 | 0.58 |
| | THORIUM-232 | - | - | - |
| | TRITIUM | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.8 (Cont.)
SUMMARY OF DETECTIONS IN NORTHERN AREA DOWNGRADIENT OF LEHR
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | NORTHERN AREA DOWNGRADIENT OF LEHR | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | 7 | 0.5 | 31.4 |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | 11 | 0.5 | 2.5 |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | 10 | 1 | 176 |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | 9 | 0.5 | 0.6 |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | 13 | 0.1 | 16.7 |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | 12 | 1 | 108 |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | 6 | 0.5 | 0.9 |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | 12 | 0.5 | 26.4 |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | 13 | 24.1 | 53.9 |
| Lead | 15 | 300 | 13 | 2 | 27.00 | 12 | 1 | 23.7 |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | 7 | 0.02 | 0.53 |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | 12 | 0.5 | 50 |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | 12 | 5 | 216 |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | 0 | | |
| Silver | NA | NA | 6 | 1 | 7.00 | 6 | 6.07 | 4 |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | 11 | 0.5 | 9.3 |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | 10 | 5 | 58.5 |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | 13 | 12 | 88.6 |
| Bismuth-214 | | | ND | | | 0 | | |
| Cesium-137 | | | 1 | 0.05 | 0.20 | 0 | | |
| Gross Alpha | | | 11 | 0.15 | 1.80 | 13 | 0.8 | 2.1 |
| Gross Beta | | | 12 | 0.4 | 4.70 | 13 | 2.6 | 6.3 |
| Lead-210 | | | ND | | | 0 | | |
| Lead-212 | | | ND | | | 3 | 0.63 | 0.81 |
| Lead-214 | | | ND | | | 1 | 0.56 | 0.56 |
| Potassium-40 | | | 12 | 2 | 46.40 | 6 | 5.76 | 10.55 |
| Radium-226 | | 0.77# | 10 | 0.05 | 1.40 | 6 | 0.05 | 1.06 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | 4 | 0.025 | 19 |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 1 | 0.35 | 0.8 |
| Tritium | | | 3 | 0.1 | 0.50 | 1 | 0.1 | 0.5 |
| Manganese-54 | | | ND | | | - | | |
| Gamma Spectral Analysis | | | ND | | | - | | |
| Cobalt-60 | | | 1 | 0.17 | 0.17 | - | | |
| Actinium-228 | | | | | | 1 | 0.82 | 0.82 |
| Thallium-208 | | | | | | 3 | 0.52 | 0.6 |

* H.T. Shacklette and J.G. Boerngen, 1984.
\# Average Value from Myrick and Berven, 1983.

Radionuclides

Table 6.8 summarizes the reported detections of radionuclide activity in the 13 soil samples from the Northern Downgradient Area. Gross alpha and gross beta activity was detected in all 13 samples and ranged from 0.8 to 2.1 pCi/g and 2.9 to 6.3 pCi/g, respectively. Potassium-40 was detected in 6 samples, all from UCD-16, and ranged from 5.76 to 10.55 pCi/g. Lead-212 and thallium-208 activity was detected three times each, and lead-214, thorium-232, and tritium activity was detected once at low activity levels. Strontium-90 was detected three times at 0.1 to 0.76 pCi/g. However, a fourth detection of strontium-90 was reported in a replicate soil sample from UCD-19 at 70 feet bgs, at 19 pCi/g. Other samples from 70 and 73 feet bgs did not detect strontium-90 (<0.05 pCi/g). A single detection of actinium-228 at 0.82 pCi/g was detected in the 70-foot-bgs sample, but was not detected in the replicate sample.

Nitrates

Nitrate was detected in all 13 soil samples from the Northern Downgradient Area. The concentrations ranged from 3.8 to 23.5 mg/Kg, similar to background soils. The concentration of nitrate as (N) did not consistently increase or decrease with depth. The highest nitrate as (N) concentration observed, 23.5 mg/Kg, was reported from the sample from UCD-19 taken at 73 feet bgs.

#### 6.4.1.3 Strontium-90 Leach Field (SB-22, -23, -24)

A total of 25 soil samples was collected from the three soil borings drilled in the Strontium-90 Leach Field area. Nineteen, plus two replicates of these samples, were submitted for chemical and radiologic analyses. Table 6.9 identifies the depths from which samples were collected and the samples submitted for chemical and radiologic analyses. Additionally, the table lists analyses requested for the samples. The analytical results for samples identified in Table 6.9 are discussed below and summarized in Table 6.10.

Volatile Organic Compounds

Methylene chloride was reported in six soil samples from SB-22 and SB-24. Concentrations ranged from 11.2 $\mu$g/Kg to 22.9 $\mu$g/Kg. No other detections of VOCs were reported.

Semivolatile Organic Compounds

Semivolatile organic compounds were were detected for samples collected from the three soil borings installed in the Strontium-90 Leach Field.

TABLE 6.9
SOIL SAMPLE ANALYSIS
STRONTIUM-90 LEACHFIELD
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| SB22 | SB23 | SB24 |
|---|---|---|
| 0.8 | 0.5 | 1.0 |
| 2.5 | 2.0 | 2.5 |
| 5.0 | 5.0 | 5.0 |
| 10.0 | 10.0 | 10.0 |
| NS | 12.0* | NS |
| 15.0 | 15.0 | 15.0 |
| 20.0 | 20.0 | 20.0 |
| 25.0 | 25.0 | 25.0 |
| 30.0 | 30.0 | 30.0* |

* replicate sample submitted.
NS = No sample.

Samples submitted for chemical and radiologic testing.

Analytical Requests
17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha, Gross Beta
Tritium
Strontium-90
Gamma-Emitters

TABLE 6.10
SUMMARY OF DETECTIONS IN STRONTIUM-90 LEACH FIELD SOILS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-22 | SB-22 | SB-22 | SB-22 | SB-22 | SB-22 | SB-22 | SB-23 | SB-23 | SB-23 | SB-23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/09/90 | 03/09/90 | 03/09/90 | 03/09/90 | 03/09/90 | 03/09/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 |
| | DEPTH | 0.8 | 2.5 | 5.0 | 10.0 | 15.0 | 20.0 | 30.0 | 0.5 | 2.0 | 5.0 | 12.0 |
| | QA | | | | | | | | | | | |
| | ANALYTE | | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 1.8 | 1.8 | 6.4 | 8.3 | 7.4 | 5.5 | 52 | 9.2 | 16 | 6.4 | 7.4 |
| METALS (mg/Kg) | ARSENIC (TOTAL) | 3.7 | 3.8 | 3.4 | 4.3 | 3.7 | 2.9 | 3.7 | 3.8 | 4.3 | 2.4 | 3.7 |
| | BARIUM (TOTAL) | 127 | 116 | 59 | 152 | 147 | 94 | - | 95 | 84 | 88 | 112 |
| | BERYLLIUM (TOTAL) | - | - | - | - | - | - | 0.4 | 0.4 | 0.2 | 0.1 | 0.1 |
| | CADMIUM (TOTAL) | - | - | 0.9 | 0.2 | - | - | - | - | - | 0.9 | 0.1 |
| | CHROMIUM (TOTAL) | 77.9 | 63.5 | 78 | 53 | 57.1 | 29.7 | 20.7 | 79.2 | 60.8 | 120 | 58.3 |
| | CHROMIUM, HEXAVALENT (+6) | 0.2 | 0.3 | 0.2 | - | - | 0.2 | 1.6 | 0.7 | 3.6 | 1.1 | 0.3 |
| | COBALT (TOTAL) | 30 | 29.4 | 30.3 | 33.3 | 34.7 | 23.7 | 29.1 | 38.4 | 28.2 | 27.8 | 34.2 |
| | COPPER (TOTAL) | 6 | 5 | 6.1 | 5 | 7 | 4 | 6 | 7 | 7 | 7 | 6 |
| | LEAD (TOTAL) | 4 | 7 | 6.7 | 7.1 | 4.9 | 6.3 | 2.5 | 6.2 | 6.6 | 4.8 | 6.6 |
| | MERCURY (TOTAL) | 0.24 | 0.27 | - | 0.06 | 0.09 | - | - | 0.34 | 0.55 | 0.15 | 0.05 |
| | NICKEL (TOTAL) | 237 | 207 | 139 | 179 | 179 | 52 | 118 | 88.3 | 260 | 250 | 193 |
| | VANADIUM (TOTAL) | 19 | 19 | 22 | 18 | 18 | 11.8 | 15 | 22 | 15 | 15 | 16 |
| | ZINC (TOTAL) | 58 | 9 | 120 | 69 | 67 | 48 | 51 | 66 | 57 | 65 | 62 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | 11.2 | 22.9 | 14.3 | 16.4 | - | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | - | - | - | - | 0.3 | - | - | - | - |
| | CESIUM-137 | - | - | 0.1 | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.1 | 0.9 | 2.2 | 2.1 | 1.5 | 2.3 | 1.7 | - | - | 0.7 | 0.9 |
| | GROSS BETA | 4.3 | 4.8 | 7.6 | 6.1 | 3.5 | 4.4 | 5.7 | 5.7 | 3.9 | 4.2 | 5 |
| | LEAD-212 | 0.46 | - | - | - | 0.44 | 0.4 | - | - | - | 0.31 | 0.4 |
| | LEAD-214 | 0.46 | - | - | - | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 8.66 | 4.83 | 4.16 | 5.93 | 9.51 | 12.31 | 8.05 | 6.88 | 8.88 | 5.89 | 7.97 |
| | RADIUM-226 | - | 0.75 | - | - | - | 0.57 | 0.33 | - | 0.24 | - | - |
| | THORIUM-232 | - | - | - | - | - | - | - | - | 0.7 | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH represented in feet below ground surface.

TABLE 6.10 (Cont.)
SUMMARY OF DETECTIONS IN STRONTIUM-90 LEACH FIELD SOILS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-23 | SB-23 | SB-23 | SB-24 | SB-24 | SB-24 | SB-24 | SB-24 | SB-24 | SB-24 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 | 03/12/90 |
| | DEPTH | 12.0 | 20.0 | 30.0 | 1.0 | 2.5 | 5.0 | 10.0 | 20.0 | 30.0 | 30.0 |
| | QA | D | | | | | | | | | D |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 32 | 48 | 80 | 3.7 | 18 | 5.5 | 5.5 | 92 | 32 | 60 |
| METALS (mg/Kg) | ARSENIC (TOTAL) | 3.9 | 3.2 | 2.6 | 4 | 3.8 | 4.1 | 3.6 | 2.6 | 5.1 | 3.6 |
| | BARIUM (TOTAL) | 117 | 1.5 | - | - | 129 | 101 | 120 | 152 | 92 | 111 |
| | BERYLLIUM (TOTAL) | 0.3 | 0.2 | 0.1 | 0.2 | 0.4 | - | 0.4 | 0.1 | 0.1 | 0.5 |
| | CADMIUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | CHROMIUM (TOTAL) | 49.5 | 33.8 | 52.1 | 61.8 | 81.8 | 74.6 | 153.2 | 53.2 | 49.7 | 52.5 |
| | CHROMIUM, HEXAVALENT (+6) | 0.5 | - | 2.2 | 7 | 3 | 2.7 | - | - | 2.5 | 5 |
| | COBALT (TOTAL) | 35.5 | 23.2 | 25.6 | 27.6 | 31.3 | 27.8 | 27.3 | 18.4 | 31.9 | 15.6 |
| | COPPER (TOTAL) | 7 | 7 | - | 6 | 5 | 6 | 8 | 7 | 8 | - |
| | LEAD (TOTAL) | 7.3 | 8 | 4.4 | 6 | 5.3 | 6.3 | 6 | 5.1 | 6.6 | 6.3 |
| | MERCURY (TOTAL) | 0.06 | - | - | 0.35 | 0.23 | 0.05 | 0.05 | - | - | 0.06 |
| | NICKEL (TOTAL) | 205 | 77.7 | 122 | 232 | 271 | 260 | 217 | 84.9 | 170 | 143 |
| | VANADIUM (TOTAL) | 16 | 15 | 11.8 | 16 | 13 | 15 | 13 | 13.6 | 15 | 11.4 |
| | ZINC (TOTAL) | 74 | 62 | 45 | 56 | 56 | 55 | 66 | 60 | 59 | 57 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - | - | - | - | - | 11.4 | 12.6 | - |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | - | - | - | - | - | 0.39 | - | - |
| | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.9 | 0.6 | 0.9 | 1.6 | - | - | - | - | - | - |
| | GROSS BETA | 5.8 | 5.4 | 6.8 | 5 | 0.4 | 0.9 | 0.5 | 0.6 | 0.4 | 0.4 |
| | LEAD-212 | 0.41 | 0.41 | 0.44 | 0.36 | 0.38 | - | 0.64 | 0.37 | 0.41 | - |
| | LEAD-214 | - | - | - | - | - | - | - | - | 0.41 | - |
| | POTASSIUM-40 | 8.81 | 8.33 | 7.15 | 9.48 | 6.85 | 8.14 | 10.79 | 10.27 | 8.49 | 8.13 |
| | RADIUM-226 | 0.71 | - | - | - | - | - | - | 0.43 | - | 0.44 |
| | THORIUM-232 | - | - | - | - | - | - | 1 | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH is represented in feet below ground surface.

TABLE 6.10 (CONT.)

SUMMARY OF DETECTIONS IN STRONTIUM-90 LEACH FIELD SOILS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | STRONTIUM-90 LEACH FIELD | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | ND | -- | -- |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | 21 | 2.4 | 5.1 |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | 18 | 1.5 | 152 |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | 14 | 0.05 | 0.5 |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | 4 | 0.05 | 0.9 |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | 21 | 20.7 | 153.2 |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | 16 | 0.05 | 7 |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | 21 | 15.6 | 38.4 |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | 19 | 0.5 | 8 |
| Lead | 15 | 300 | 13 | 2 | 27.00 | 21 | 2.5 | 8 |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | 14 | 0.02 | 0.55 |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | ND | -- | -- |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | 21 | 52 | 271 |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | ND | -- | -- |
| Silver | NA | NA | 6 | 1 | 7.00 | ND | -- | -- |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | ND | -- | -- |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | 21 | 11.4 | 22 |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | 21 | 9 | 120 |
| Bismuth-214 | | | ND | | | 2 | 0.3 | 0.39 |
| Cesium-137 | | | 1 | 0.05 | 0.20 | 1 | 0.05 | 0.1 |
| Gross Alpha | | | 11 | 0.15 | 1.90 | 13 | 0.15 | 2.3 |
| Gross Beta | | | 13 | 0.4 | 4.70 | 21 | 0.4 | 7.6 |
| Lead-210 | | | ND | | | ND | -- | -- |
| Lead-212 | | | ND | | | 13 | 0.31 | 0.64 |
| Lead-214 | | | ND | | | 2 | 0.41 | 0.46 |
| Potassium-40 | | | 12 | 2 | 46.40 | 21 | 4.16 | 12.31 |
| Radium-226 | | 0.77# | 10 | 0.05 | 1.40 | 7 | 0.05 | 0.75 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | ND | -- | -- |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 2 | 0.35 | 1 |
| Tritium | | | 3 | 0.1 | 0.50 | ND | -- | -- |
| Manganese-54 | | | ND | | | ND | -- | -- |
| Gamma Spectral Analysis | | | ND | | | ND | -- | -- |
| Cobalt-60 | | | 1 | 0.17 | 0.17 | ND | -- | -- |

* H.T. Shacklette and J.G. Boerngen, 1984.

\# Average Value from Myrick and Berven, 1983.

Pesticides and PCBs

Pesticides and PCBs were not detected for samples collected from the three soil borings in the Strontium-90 Leach Field.

Title 22 Metals

Twelve of the Title 22 metals were reported in the soil samples analyzed from the Strontium-90 Leach Field area. Antimony, molybdenum, selenium, silver, and thallium were not detected. The maximum concentrations reported for arsenic, cobalt, mercury, nickel, zinc, and hexavalent chromium are higher than the maximum concentrations reported in the background samples. However, the concentrations reported for these metals are less than published regional concentrations identified by Shacklette and Boerngen (1984). A summary of the reported metals detections is presented in Table 6.10.

Radionuclides

Radioisotopes and their maximum reported activity detected in soil samples analyzed from the Strontium-90 Leach Field include:

| RADIOISOTOPE | MAXIMUM REPORTED DETECTION |
|---|---|
| Bismuth-214 | 0.39 pCi/g |
| Cesium-137 | 0.10 pCi/g |
| Gross Alpha | 2.30 pCi/g |
| Gross Beta | 7.60 pCi/g |
| Lead-212 | 0.64 pCi/g |
| Lead-214 | 0.46 pCi/g |
| Potassium-40 | 12.31 pCi/g |
| Radium-226 | 0.75 pCi/g |
| Thorium-232 | 1.00 pCi/g |

No strontium-90 activity was reported in samples analyzed from the Strontium-90 Leach Field. Bismuth-214 activity was reported in four samples, and ranged from 0.3 pCi/g to 0.39 pCi/g. Bismuth-214 was not reported in the background samples analyzed. The highest reported detections from gross alpha and gross beta activity are higher than reported detections in the background samples. Review of Table 6.10 indicates that other activities of reported radioisotopes are consistent with background levels.

Nitrates

Nitrate as (N) was reported in all 21 soil samples analyzed from this area. Levels of nitrate ranged from 1.8 mg/Kg to 92.0 mg/Kg. Generally, nitrate levels increased with depth as shown below.

| SAMPLE DEPTH (in feet bgs) | SB-22 | SB-23 | SB-24 |
|---|---|---|---|
| 0.5-1.0 | 1.8 | 9.2 | 3.7 |
| 2.5 | 1.8 | 16.0** | 18.0 |
| 5.0 | 6.4 | 6.4 | 5.5 |
| 10.0 | 8.3 | 7.4/32.0*# | 5.5 |
| 15.0 | 7.4 | NA | NA |
| 20.0 | 5.5 | 48.0 | 92.0 |
| 25.0 | NA | NA | NA |
| 30.0 | 52.0 | 80.0 | 32.0/60.0* |

* - Primary sample/replicate sample
** - Actual depth is 2.0 feet bgs
\# - Actual depth is 12.0 feet bgs

NA - Sample not analyzed
NA - No Analysis

6.4.1.4 Radium-226 Dry Well Area

A total of 47 soil samples was collected from four soil borings and one monitoring well boring drilled in the Radium-226 Dry Well area. Thirty of these samples, plus three QA/QC replicates, were submitted for chemical and radiologic analyses. Table 6.11 identifies the soil borings and the monitoring well boring, the depths from which samples were collected, and the samples submitted for chemical and radiologic analyses. Additionally, the table lists analyses requested for the samples. The analytical results for samples identified in Table 6.11 are discussed below and summarized in Table 6.12.

Volatile Organic Compounds

Methylene chloride was reported in 12 soil samples and one replicate sample from SB-25, -26, -27 and -28. Concentrations ranged from 10.7 $\mu$g/Kg to 44.2 $\mu$g/Kg. No other detections of VOCs were reported.

Semivolatile Organic Compounds

Semivolatile organic compounds were not detected for samples collected from the four soil borings in the Radium-226 Dry Well area.

TABLE 6.11
SOIL SAMPLE ANALYSIS
RADIUM 226 DRY WELL AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| SB25 | SB26 | SB27 | SB28 | UCD 22 |
|---|---|---|---|---|
| 1.0 | 1.0 | 1.0 | 1.0 | 0.0 |
| 2.5 | 2.5 | 2.5 | 2.0 | NS |
| 5.0 | 5.0 | 5.0 | 6.5 | 5.0 |
| 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| 15.0 | 15.0[1] | 15.0 | 15.0[1] | 15.0 |
| 20.0 | 20.0 | 20.0 | 20.0 | 20.0[1] |
| 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| | | | | 35.0 |
| | | | | 40.0 |
| | | | | 45.0 |
| | | | | 50.0 |
| | | | | 55.0 |
| | | | | 60.0 |
| | | | | 65.0 |
| | | | | 70.[2] |

Depths in feet below ground surface.
1 Replicate samples analyzed
2 Sample submitted for physical testing.
NS = Not sampled.

Samples submitted for chemical and radiologic testing.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha, Gross Beta
Tritium
Strontium-90
Gamma-Emitters

TABLE 6.12
SUMMARY OF DETECTIONS IN RADIUM-226 DRY WELL AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-25 | SB-25 | SB-25 | SB-25 | SB-25 | SB-25 | SB-26 | SB-26 | SB-26 | SB-26 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 |
| | DEPTH | 5.0 | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 | 2.5 | 5.0 | 10.0 | 15.0 |
| | QA | | | | | | | | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 103 | 58 | 345 | - | 1.8 | 1.8 | 62 | 32 | 49 | 2.8 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | ARSENIC (TOTAL) | 2.9 | 2.9 | 2.9 | 3.2 | 3.7 | 1.9 | 2.3 | 3.3 | 3.1 | 3.2 |
| | BARIUM (TOTAL) | 170 | 113 | 154 | 108 | 132 | 25 | 136 | 152 | 143 | 113 |
| | BERYLLIUM (TOTAL) | - | 0.3 | 0.1 | 0.4 | - | 0.6 | 0.7 | 0.4 | 2.4 | 0.5 |
| | CADMIUM (TOTAL) | - | 0.4 | - | - | - | - | - | - | - | - |
| | CHROMIUM (TOTAL) | 70.8 | 55 | 49.9 | 36.8 | 59.9 | 45 | 43.2 | 63 | 55.8 | 39.5 |
| | CHROMIUM, HEXAVALENT (+6) | 1.2 | 0.9 | - | 4 | 1.2 | 3 | 1.7 | 0.3 | 0.2 | 0.2 |
| | COBALT (TOTAL) | 30.3 | 31 | 34.1 | 29.2 | 37 | 27.6 | 28.4 | 33.5 | 32.7 | 27.4 |
| | COPPER (TOTAL) | 4 | 7 | 7 | 7 | 7 | 7 | 10 | 8 | 10 | 50 |
| | LEAD (TOTAL) | 7.2 | 4.4 | 5 | 5.3 | 4.6 | 3.4 | 5.1 | 4.6 | 5.7 | 4.5 |
| | MERCURY (TOTAL) | 0.32 | 0.19 | - | - | - | - | 0.15 | 0.06 | - | - |
| | MOLYBDENUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | NICKEL (TOTAL) | 209 | 192 | 149 | 86.2 | 183 | 243 | 280 | 233 | 231 | 164 |
| | THALLIUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | VANADIUM (TOTAL) | 29 | 18 | 20 | 22 | 25 | 25 | 39 | 28 | 33 | 27 |
| | ZINC (TOTAL) | 165 | 52 | 63 | 60 | 69 | 53 | 64 | 63 | 66 | 64 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | 16.8 | 25.8 | - | - | - | 13.1 | 15.6 | 14.5 | - | - |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | 0.66 | - | 1.97 | 0.51 | - | - | - | - | - | - |
| | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 0.2 | 0.2 | 0.4 | 0.3 | 0.7 | 0.9 | 0.6 | 0.1 | - | - |
| | GROSS BETA | 6 | 3.2 | 6.4 | 3.6 | 3.5 | 5 | 6.1 | 6 | 4.2 | 1.4 |
| | LEAD-210 | - | - | - | 0.81 | - | - | - | - | - | - |
| | LEAD-212 | 0.37 | 0.93 | - | 0.81 | - | - | 0.41 | - | 0.53 | 0.38 |
| | LEAD-214 | - | 0.74 | 0.88 | - | - | 0.66 | - | - | - | - |
| | POTASSIUM-40 | 5.52 | 9.47 | 8.6 | 13.01 | 12.26 | 10.46 | 9 | 11.16 | 13.73 | 10.12 |
| | RADIUM-226 | 0.72 | - | 1.23 | 0.56 | - | 0.8 | - | - | - | - |
| | STRONTIUM-90 | 0.25 | 0.32 | 0.16 | - | - | 0.36 | - | - | 0.16 | 0.15 |
| | THORIUM-232 | - | 0.7 | - | - | - | - | - | 0.7 | 0.7 | - |
| | TRITIUM | - | - | - | - | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.12 (Cont.)
SUMMARY OF DETECTIONS IN RADIUM-226 DRY WELL AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-26 | SB-26 | SB-26 | SB-27 | SB-27 | SB-27 | SB-27 | SB-27 | SB-27 | SB-28 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/13/90 | 03/14/90 |
| | DEPTH | 15.0 | 25.0 | 30.0 | 5.0 | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 | 6.5 |
| | QA | D | | | | | | | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 3.7 | 15 | 7.4 | 37 | 71 | 17 | 6.4 | 24 | 0.7 | 552 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | ARSENIC (TOTAL) | 3.2 | 3.5 | 3.2 | 4.3 | 3.4 | 3.2 | 3.1 | 2.5 | 3.1 | 2.3 |
| | BARIUM (TOTAL) | 104 | 144 | 147 | 128 | 96 | 100 | 62 | 88 | 86 | 27 |
| | BERYLLIUM (TOTAL) | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.4 | 0.6 |
| | CADMIUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | CHROMIUM (TOTAL) | 43.3 | 41.2 | 42.7 | 39.1 | 50.2 | 9.8 | 9.3 | 120 | 37.9 | 30.5 |
| | CHROMIUM, HEXAVALENT (+6) | 0.4 | 5 | 3 | 1.2 | 0.3 | 0.4 | 3.4 | 1.4 | 3 | 0.1 |
| | COBALT (TOTAL) | 33.1 | 26.6 | 26.6 | 36.4 | 24.9 | 21.4 | 19.2 | 23.9 | 24.5 | 38.4 |
| | COPPER (TOTAL) | 9 | 11 | 8 | 9 | 9 | 6 | 6 | 6 | 5 | 7 |
| | LEAD (TOTAL) | 5 | 4.4 | 4.3 | 5 | 4.6 | 4.3 | 4 | 4.5 | 2.9 | 4.5 |
| | MERCURY (TOTAL) | 0.13 | - | - | 0.06 | - | - | - | - | - | - |
| | MOLYBDENUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | NICKEL (TOTAL) | 169 | 177 | 174 | 228 | 209 | 131 | 82.5 | 89.2 | 165 | 61.4 |
| | THALLIUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | VANADIUM (TOTAL) | 36 | 38 | 36 | 39 | 36 | 25 | 22 | 20 | 33 | 26 |
| | ZINC (TOTAL) | 68 | 76 | 59 | 71 | 66 | 59 | 56 | 51 | 54 | 65 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | 16.9 | 23 | - | - | - | - | 10.7 | - | 24.9 |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | - | - | - | - | - | - | - | - |
| | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.5 | 1.9 | 1.7 | 0.9 | 2.1 | 1.1 | 1.4 | 1.5 | 1.3 | 1.2 |
| | GROSS BETA | 5 | 5.4 | 5 | 5 | 5 | 6.3 | 5.3 | 6 | 5.3 | 6.4 |
| | LEAD-210 | - | - | - | - | - | - | - | - | - | - |
| | LEAD-212 | - | - | - | - | - | - | 0.59 | - | - | - |
| | LEAD-214 | - | - | - | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 15.95 | 8.29 | 10.31 | 10.01 | 14.31 | 10.58 | 14.46 | 11.87 | 9.5 | 9.62 |
| | RADIUM-226 | - | - | 0.84 | 0.5 | - | 1.17 | - | 0.68 | - | 0.48 |
| | STRONTIUM-90 | - | - | - | - | 0.16 | 0.14 | 0.06 | - | - | - |
| | THORIUM-232 | 0.7 | - | - | 0.7 | - | - | 0.8 | 1 | - | - |
| | TRITIUM | - | - | - | - | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.12 (Cont.)
SUMMARY OF DETECTIONS IN RADIUM-226 DRY WELL AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-28 | SB-28 | SB-28 | SB-28 | SB-28 | SB-28 | UCD-22 | UCD-22 | UCD-22 | UCD-22 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/14/90 | 03/14/90 | 03/14/90 | 03/14/90 | 03/14/90 | 03/14/90 | 10/23/90 | 10/23/90 | 10/23/90 | 10/23/90 |
| | DEPTH | 10.0 | 15 0 | 15 0 | 20 0 | 25 0 | 30 0 | 5.0 | 10.0 | 20.0 | 20.0 |
| | QA | | | D | | | | | | | D |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 390 | 620 | 736 | 4.4 | 12 | 28 | 71.2 | 56.8 | 62.1 | 62.7 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | - | - | - | - | - | - | 12.5 | 12.4 | 10 | 10.5 |
| | ARSENIC (TOTAL) | 3.4 | 4.2 | 3.3 | 3.2 | 3.6 | 3.7 | 1.5 | - | 1 | 1.9 |
| | BARIUM (TOTAL) | 106 | 35 | 147 | 96 | 63 | 67 | 177 | 262 | 195 | 196 |
| | BERYLLIUM (TOTAL) | 0.6 | 0.6 | 0.5 | 0.7 | 0.2 | 1.2 | 0.4 | 0.1 | 0.1 | 0.1 |
| | CADMIUM (TOTAL) | - | - | 0.1 | - | - | - | 24.1 | 20.6 | 15.8 | 15.4 |
| | CHROMIUM (TOTAL) | 36 | 39 5 | 20.8 | 22.4 | 43 1 | 57.1 | 94.2 | 92.4 | 29.5 | 27.9 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | - | - | 2 | 2.6 | 0.3 | 0.2 | 0.8 | 4 |
| | COBALT (TOTAL) | 36.2 | 26.3 | 30.7 | 17.8 | 29.8 | 22.6 | 25.6 | 23.2 | 28.3 | 12.9 |
| | COPPER (TOTAL) | 4 | 3 | 11 | 5 | 31 | 10 | 45.2 | 39.3 | 26.5 | 25 |
| | LEAD (TOTAL) | 4.5 | 4.7 | 4.8 | 3.8 | 4.5 | 2.4 | 19.3 | 16.7 | 19.2 | 15 |
| | MERCURY (TOTAL) | - | - | - | - | - | - | 0.08 | 0.06 | - | - |
| | MOLYBDENUM (TOTAL) | - | - | - | - | - | - | 10.9 | 9.9 | 6.3 | 7.6 |
| | NICKEL (TOTAL) | 207 | 153 | 173 | 174 | 171 | 163 | 199 | 204 | 51.3 | 38.5 |
| | THALLIUM (TOTAL) | - | - | - | - | - | - | - | - | - | - |
| | VANADIUM (TOTAL) | 41 | 30 | 25 | 13 | 34 | 23 | 55 | 45.7 | 34.2 | 36.7 |
| | ZINC (TOTAL) | 70 | 64 | 62 | 50 | 70 | 41 | 67.4 | 64.7 | 45.8 | 42 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | 44.2 | 13.7 | 20.7 | - | - | 20.8 | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | 3.03 | 1.23 | - | - | - | - | - | - | - |
| | CESIUM-137 | - | 0.24 | 0.26 | - | - | - | - | - | - | - |
| | GROSS ALPHA | 0.9 | 1.7 | 1.2 | 0.9 | 1.3 | 0.9 | 1.7 | 1.8 | 1.1 | 1.7 |
| | GROSS BETA | 5.4 | 6.5 | 5.7 | 5.6 | 5.7 | 6.6 | 3.7 | 3.7 | 2.5 | 2.7 |
| | LEAD-210 | - | - | - | - | - | - | - | - | - | - |
| | LEAD-212 | 0.4 | 0.42 | - | - | 0.51 | - | - | - | - | - |
| | LEAD-214 | 1.1 | 1.04 | 1.14 | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 17.24 | 10.11 | 8.55 | 8.36 | 4.38 | 5.89 | 1.4 | 2.1 | 1.6 | 2.5 |
| | RADIUM-226 | 0.91 | 0.96 | 1.35 | - | - | - | 0.9 | 0.5 | 0.5 | 0.6 |
| | STRONTIUM-90 | - | 0.61 | - | - | 0.07 | - | - | - | - | 0.4 |
| | THORIUM-232 | - | - | - | - | - | - | 0.8 | 1 | 0.5 | 0.6 |
| | TRITIUM | - | - | - | 0.4 | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.12 (Cont.)
SUMMARY OF DETECTIONS IN RADIUM-226 DRY WELL AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-22 | UCD-22 | UCD-22 |
|---|---|---|---|---|
| | DATE | 10/23/90 | 10/23/90 | 10/23/90 |
| | DEPTH | 30.0 | 40.0 | 55.0 |
| | QA | | | |
| | ANALYTE | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 28.9 | 12.1 | 9.3 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | 13.1 | 15.5 | 14.4 |
| | ARSENIC (TOTAL) | 1.2 | 2.7 | 2 |
| | BARIUM (TOTAL) | 129 | 89.9 | 156 |
| | BERYLLIUM (TOTAL) | 0.2 | 0.1 | 0.2 |
| | CADMIUM (TOTAL) | 20.4 | 21.9 | 19.5 |
| | CHROMIUM (TOTAL) | 65.8 | 21.9 | 69.6 |
| | CHROMIUM, HEXAVALENT (+6) | 1.2 | 0.4 | 0.5 |
| | COBALT (TOTAL) | 21.8 | 15.7 | 27.4 |
| | COPPER (TOTAL) | 34.9 | 37.3 | 38.7 |
| | LEAD (TOTAL) | 16.6 | 14 | 18.7 |
| | MERCURY (TOTAL) | 0.08 | 0.06 | 0.13 |
| | MOLYBDENUM (TOTAL) | 7.4 | 9.6 | 9.9 |
| | NICKEL (TOTAL) | 180 | 147 | 172 |
| | THALLIUM (TOTAL) | 5.1 | - | 5.5 |
| | VANADIUM (TOTAL) | 48.3 | 52.9 | 48.5 |
| | ZINC (TOTAL) | 58.4 | 60.2 | 59 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | - |
| | CESIUM-137 | - | - | - |
| | GROSS ALPHA | 1 | 1.9 | 1.4 |
| | GROSS BETA | 2.5 | 2.1 | 3.9 |
| | LEAD-210 | - | - | - |
| | LEAD-212 | - | - | - |
| | LEAD-214 | - | - | - |
| | POTASSIUM-40 | 2.8 | 3.7 | 1.1 |
| | RADIUM-226 | 0.8 | 1.1 | 0.4 |
| | STRONTIUM-90 | - | - | - |
| | THORIUM-232 | 0.8 | 0.7 | 0.4 |
| | TRITIUM | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

TABLE 6.12 (Cont.)
SUMMARY OF DETECTIONS IN RADIUM-226 DRY WELL AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | RADIUM-226 DRY WELL AREA | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | 14 | 0.5 | 15.5 |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | 38 | 0.5 | 4.3 |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | 40 | 25 | 262 |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | 38 | 0.05 | 2.4 |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | 16 | 0.05 | 24.1 |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | 40 | 9.3 | 120 |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | 35 | 0.05 | 5 |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | 40 | 12.9 | 38.4 |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | 40 | 3 | 50 |
| Lead | 15 | 300 | 13 | 2 | 27.00 | 40 | 2.4 | 19.3 |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | 16 | 0.02 | 0.32 |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | 14 | 0.5 | 10.9 |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | 40 | 38.5 | 280 |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | | | |
| Silver | NA | NA | 6 | 1 | 7.00 | | | |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | 4 | 0.5 | 5.5 |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | 40 | 13 | 55 |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | 40 | 41 | 165 |
| Bismuth-214 | | | ND | | | 5 | 0.51 | 3.03 |
| Cesium-137 | | | 1 | 0.05 | 0.20 | 2 | 0.05 | 0.26 |
| Gross Alpha | | | 11 | 0.15 | 1.90 | 31 | 0.1 | 2.1 |
| Gross Beta | | | 13 | 0.4 | 4.70 | 33 | 1.4 | 6.6 |
| Lead-210 | | | ND | | | 1 | 0.81 | 0.81 |
| Lead-212 | | | ND | | | 10 | 0.37 | 0.93 |
| Lead-214 | | | ND | | | 6 | 0.66 | 1.14 |
| Potassium-40 | | | 12 | 2 | 46.40 | 33 | 1.1 | 17.24 |
| Radium-226 | | 0.77# | 10 | 0.05 | 1.40 | 19 | 0.05 | 1.35 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | 12 | 0.025 | 0.61 |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 14 | 0.35 | 1 |
| Tritium | | | 3 | 0.1 | 0.50 | 1 | 0.1 | 0.4 |
| Cobalt-60 | | | 1 | 0.17 | 0.17 | | | |

* H.T. Shacklette and J.G. Boerngen, 1984.
\# Average Value from Myrick and Berven, 1983.

Pesticides and PCBs

Pesticides and PCBs were not detected for samples collected from the four soil borings in the Radium-226 Dry Well area.

Title 22 Metals

Sixteen of the Title 22 metals were reported in soil samples analyzed from the Radium-226 Dry Well area. Selenium and silver were not reported. The maximum concentrations reported for arsenic, barium, cadmium, hexavalent chromium, cobalt, mercury, nickel, and zinc are higher than the maximum concentrations reported in the background samples. However, the concentrations reported for these metals are less than published regional concentrations identified by Shacklette and Boerngen (1984). A summary of the reported metals detections is presented in Table 6.12. Generally, the highest reported levels (greater than 1.0 mg/Kg) of hexavalent chromium are found at depths between 20 and 30 feet bgs; however, only two soil samples, UCD-22-40.0 and UCD-22-55.0, were collected from below 30 feet bgs in this area. Levels of hexavalent chromium in these samples was reported at 0.40 mg/Kg and 0.50 mg/Kg respectively.

Radionuclides

Radioisotopes and their maximum reported activities detected in soil samples collected from the Radium-226 Dry Well area include:

| RADIOISOTOPE | MAXIMUM REPORTED DETECTION |
|---|---|
| Bismuth-214 | 3.03 pCi/g |
| Cesium-137 | 0.26 pCi/g |
| Gross Alpha | 2.10 pCi/g |
| Gross Beta | 6.60 pCi/g |
| Lead-210 | 0.81 pCi/g |
| Lead-212 | 0.93 pCi/g |
| Lead-214 | 1.14 pCi/g |
| Potassium-40 | 17.24 pCi/g |
| Radium-226 | 1.35 pCi/g |
| Strontium-90 | 0.61 pCi/g |
| Thorium-232 | 1.00 pCi/g |
| Tritium | 0.40 pCi/g |

Bismuth-214, Lead-210, Lead-212, and Lead-214 activities were not reported in background samples. The maximum reported activity for cesium-137, gross alpha, gross beta and strontium-90 are higher than the maximum reported activity in the background samples. Review of Table 6.12 indicates that all other activities of reported radioisotopes, including radium-226, are consistent with background levels.

Nitrates

Nitrate as (N) was reported in 32 of the 33 soil samples analyzed from borings and monitoring wells installed in the Radium-226 Dry Well area. Reported levels of nitrates ranged from 0.70 mg/Kg to 736.0 mg/Kg. Generally, the highest levels (greater than 100 mg/Kg) were reported from samples collected from SB-25 and SB-28 at depths between 5.0 and 15.0 feet bgs. Levels of nitrate in soil in the Radium-226 Dry Well area are listed below.

| SAMPLE DEPTH (in feet bgs) | SB-25 | SB-26 | SB-27 | SB-28 | UCD-22 |
|---|---|---|---|---|---|
| 2.5 | NA | 62.0 | NA | NA | NS |
| 5.0 | 103.0 | 32.0 | 37.0 | 552.0** | 71.2 |
| 10.0 | 58.0 | 49.0 | 71.0 | 390.0 | 56.8 |
| 15.0 | 345.0 | 2.8/3.7* | 17.0 | 620.0/736.0* | NA |
| 20.0 | ND | NA | 6.4 | 4.4 | 62.1/62.7* |
| 25.0 | 1.8 | 15.0 | 24.0 | 12.0 | NA |
| 30.0 | 1.8 | 7.4 | 0.7 | 28.0 | 28.9 |
| 40.0 | NS | NS | NS | NS | 12.1 |
| 55.0 | NS | NS | NS | NS | 9.3 |

** - Actual depth is 6.5 feet bgs.
* - Primary sample/replicate sample
NS - No samples collected
NA - Sample not analyzed
ND - Below Reported Detection Limits

### 6.4.1.5 Southwest Chemical Dispensing Area (SB-19,19A,20,21/UCD-15)

A total of 21 soil samples was collected from four intermediate-depth soil borings and one monitoring-well boring drilled in the Southwest Chemical Dispensing area. Eighteen of these samples, plus three QA/QC replicates, were submitted for chemical and radiologic analyses. Table 6.13 identifies the soil borings and the monitoring well boring, the depths from which samples were collected and the

TABLE 6.13
SOIL SAMPLE ANALYSIS
SOUTHWEST CHEMICAL DISPENSING AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| SB19 | SB19A | SB20 | SB21 | UCD 15 |
|---|---|---|---|---|
| 0.0[1] | NS | 0.0 | 0.0 | NS |
| NS | NS | 2.5 | 2.5 | NS |
| NS | 5.0 | 5.0 | 5.0 | 5.0 |
| 7.5 | | NS | 7.5 | NS |
| 10.0 | | 10.0 | 10.0[1] | 10.0 |
| | | | | 15.0 |
| | | | | 20.0 |
| | | | | 25.0 |
| | | | | 30.0 |
| | | | | 35.0[1] |

Depths in feet below ground surface.
1 Replicate sample analyzed.
NS = Not sampled.

Samples submitted for chemical and radiologic testing.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha, Gross Beta
Tritium
Strontium-90
Gamma-Emitters
* Diesel
* Kerosene
* For SB-19 and SB-21 only

samples submitted for chemical and radiologic analyses. Additionally, the table lists analyses requested for the samples. The analytical results for samples identified in Table 6.13 are discussed below and summarized in Table 6.14.

Volatile Organic Compounds

Methylene chloride was reported in eight soil samples and one replicate sample from SB-19, SB-21, and UCD-15. Concentrations ranged from 8.8 $\mu$g/Kg to 37.6 $\mu$g/Kg. No other detections of VOCs were reported.

Semivolatile Organic Compounds

Di-N-Butyl Phthalate was reported in six soil samples and one replicate sample from SB-19, SB-20, and SB-21. Concentrations ranged from 100 $\mu$g/Kg to 220 $\mu$g/Kg. No other detections of semivolatile organic compounds were reported.

Pesticides and PCBs

Pesticides and PCBs were not detected for samples collected from the five soil borings in the Southwest Chemical Dispensing area.

Title 22 Metals

Fifteen of the Title 22 metals were reported in soil samples analyzed from the Southwest Chemical Dispensing area. Antimony and selenium were not reported. The maximum concentrations reported for arsenic, beryllium, cobalt, copper, mercury, molybdenum, nickel, silver, vanadium, and zinc are higher than the maximum concentrations reported in the background samples. However, only two of these metals (beryllium and copper) are reported in concentrations higher than published regional concentrations identified by Shacklette and Boerngen (1984). A summary of the reported metals detections is presented in Table 6.14. Hexavalent chromium in samples from the Southwest Chemical Dispensing area was reported at levels ranging from not detected (<0.1 mg/Kg) to 1.56 mg/Kg. The mean concentration for hexavalent chromium from these samples is 0.37 mg/Kg.

TABLE 6.14
SUMMARY OF DETECTIONS IN SOUTHWEST CHEMICAL DISPENSING AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-19 | SB-19 | SB-19 | SB-19 | SB-19 | SB-20 | SB-20 | SB-20 | SB-20 | SB-21 | SB-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/08/90 | 03/08/90 | 03/08/90 | 03/08/90 | 03/08/90 | 03/09/90 | 03/09/90 | 03/09/90 | 03/09/90 | 03/09/90 | 03/09/90 |
| | DEPTH | 0.0 | 0.0 | 5.0 | 7.5 | 10.0 | 0.0 | 2.5 | 5.0 | 10.0 | 2.5 | 5.0 |
| | QA | | D | | | | | | | | | |
| | ANALYTE | | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 190 | 220 | 67 | 120 | 180 | 1.4 | 0.23 | 27 | 10 | 0.92 | 3.7 |
| METALS (mg/Kg) | ARSENIC (TOTAL) | 5.1 | 3.1 | 4.4 | 4 | 2.7 | 4.3 | 4.1 | 3.6 | 4.2 | 4.3 | 3.8 |
| | BARIUM (TOTAL) | 130 | 95 | 181 | 126 | 111 | 104 | 71 | 133 | 93 | 93 | 108 |
| | BERYLLIUM (TOTAL) | 3.1 | 3.1 | - | - | - | 4.8 | - | - | - | - | - |
| | CADMIUM (TOTAL) | 0.2 | 0.1 | 0.1 | - | 0.2 | 0.2 | - | 0.1 | - | 0.1 | - |
| | CHROMIUM (TOTAL) | 54.5 | 49.6 | 71.5 | 71.5 | 81 | 73.9 | 83.9 | 53.9 | 60.9 | 114 | 81.8 |
| | CHROMIUM, HEXAVALENT (+6) | 0.6 | 1.2 | - | 0.2 | 0.3 | 0.7 | 0.7 | 0.1 | 0.1 | 0.6 | - |
| | COBALT (TOTAL) | 30.4 | 26.7 | 25.6 | 19 | 21.2 | 18.6 | 24.8 | 9.9 | 25 | 21.6 | 18.7 |
| | COPPER (TOTAL) | - | 7 | 8 | 6 | 9 | 7 | 6 | 5 | 7 | 8 | 55 |
| | LEAD (TOTAL) | 4.9 | 4.8 | 7.2 | 4 | 4.3 | 7.1 | 6.1 | 6.2 | 7 | 6.3 | 6 |
| | MERCURY (TOTAL) | 0.45 | 0.29 | 0.07 | 0.35 | 0.04 | 0.45 | 0.22 | 0.06 | 0.11 | 0.27 | 0.42 |
| | MOLYBDENUM (TOTAL) | - | 3 | - | - | 2 | - | - | - | - | - | - |
| | NICKEL (TOTAL) | 264 | 279.9 | 220 | 267 | 200.7 | 261 | 248 | 175 | 231 | 370 | 244 |
| | SILVER (TOTAL) | - | - | - | - | - | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | - | - | - | - | - | - | - | - | - | - | - |
| | VANADIUM (TOTAL) | 36 | 27 | 53 | 18 | 24 | 18 | 19 | 27 | 22 | 22 | 25 |
| | ZINC (TOTAL) | 63 | 50 | 74 | 52 | 67 | 60 | 52 | 73 | 72 | 56 | 56 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | 17.4 | - | 8.8 | - | - | - | - | - | - | - | - |
| SEMIVOLATILE ORGANICS (ug/Kg) | DI-N-BUTYL PHTHALATE | - | 220 | - | - | - | - | 200 | - | 150 | 100 | 180 |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | - | - | 1.38 | - | - | 0.42 | - | - | - |
| | GROSS ALPHA | - | 4 | 1.7 | - | 2.8 | 2.9 | - | - | - | - | 1.4 |
| | GROSS BETA | 5.7 | 8.2 | 6.2 | 4.8 | 7.1 | 6.7 | 3.3 | 3.2 | 3.8 | 4 | 5.4 |
| | LEAD-212 | - | - | 0.6 | - | 0.66 | - | - | 0.69 | - | - | 0.66 |
| | POTASSIUM-40 | 12.54 | 14.95 | 9.01 | 6.04 | 8.82 | 5.65 | 6.69 | 9.93 | 7.32 | 11.3 | 9.99 |
| | RADIUM-226 | - | - | - | - | 0.9 | - | - | 0.46 | - | 0.26 | - |
| | STRONTIUM-90 | - | - | 0.7 | - | - | - | - | - | 0.18 | - | 0.3 |
| | THORIUM-232 | 0.6 | - | 0.7 | - | - | - | - | - | - | - | - |
| | TRITIUM | 0.3 | - | - | 0.3 | - | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH represented in feet below ground surface.

TABLE 6.14 (Cont.)
SUMMARY OF DETECTIONS IN SOUTHWEST CHEMICAL DISPENSING AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-21 | SB-21 | SB-21 | UCD-15 | UCD-15 | UCD-15 | UCD-15 | UCD-15 | UCD-15 | UCD-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 03/09/90 | 03/09/90 | 03/09/90 | 03/27/90 | 03/27/90 | 03/27/90 | 03/29/90 | 03/29/90 | 03/29/90 | 03/29/90 |
| | DEPTH | 7.5 | 10.0 | 10.0 | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 | 35.0 | 35.0 |
| | QA | | | D | | | | | | | D |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 3.7 | 7.4 | 21 | 23 | 9.2 | 12 | 9.7 | 5.3 | 5.5 | 7.8 |
| METALS (mg/Kg) | ARSENIC (TOTAL) | 3.1 | 4.2 | 3.8 | 1.2 | 1 | - | 2.1 | 2.5 | 1 | 2 |
| | BARIUM (TOTAL) | 161 | 130 | 138 | 117 | 96 | 65 | 40 | 96 | 97 | 105 |
| | BERYLLIUM (TOTAL) | - | - | - | 0.2 | 0.3 | 0.2 | - | 0.3 | 0.3 | - |
| | CADMIUM (TOTAL) | 0.2 | 0.1 | 0.1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | CHROMIUM (TOTAL) | 59.2 | 54.8 | 56.6 | 63 | 44 | 33 | 73 | 59 | 59 | - |
| | CHROMIUM, HEXAVALENT (+6) | - | 0.2 | 0.1 | - | - | - | - | - | - | - |
| | COBALT (TOTAL) | 29.7 | 32.7 | 35 | 16 | 15 | 12 | 22 | 14 | 16 | - |
| | COPPER (TOTAL) | 5 | 7 | 7 | 51 | 51 | 37 | 57 | 63 | 52 | 51 |
| | LEAD (TOTAL) | 1.4 | 6.1 | 5.3 | 6.8 | 4.5 | 3.3 | 6.7 | 9.6 | 4.4 | 4.5 |
| | MERCURY (TOTAL) | 0.14 | 0.21 | 0.04 | 0.093 | 0.054 | 0.18 | 0.15 | 0.07 | 0.12 | 0.07 |
| | MOLYBDENUM (TOTAL) | - | - | - | 2 | 1 | 57 | 20 | 25 | 3 | 4 |
| | NICKEL (TOTAL) | 198 | 198 | 200 | 165 | 129 | 44 | 132 | 104 | - | 120 |
| | SILVER (TOTAL) | - | - | - | - | - | 6 | - | - | - | 2 |
| | THALLIUM (TOTAL) | - | - | - | 1.7 | 2 | 1.7 | 1.6 | 1.8 | 1.8 | 0.7 |
| | VANADIUM (TOTAL) | 16 | 19 | 19 | 27 | 34 | 20 | 24 | 27 | 22 | 23 |
| | ZINC (TOTAL) | 64 | 65 | 70 | 29 | 30 | 17 | 57 | 71 | 59 | 56 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | 18.7 | - | 37.6 | 20 | 28.5 | - | 16.8 | 20.2 | 26 |
| SEMIVOLATILE ORGANICS (ug/Kg) | DI-N-BUTYL PHTHALATE | 110 | 150 | - | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | - | - | - | 3.3 | 2.2 | 3.2 | 2.5 | 1 | 1.7 | 1.3 |
| | GROSS BETA | 1.9 | 2.9 | 2.4 | 5.1 | 3.4 | 3.6 | 3.6 | 5 | 5.9 | 6.6 |
| | LEAD-212 | 0.69 | - | 0.36 | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 8.95 | - | 11.28 | 9.36 | 16.56 | 6.14 | 7.81 | 6.72 | 12.8 | 5.8 |
| | RADIUM-226 | - | - | 0.7 | - | - | - | - | - | - | - |
| | STRONTIUM-90 | - | - | - | - | 0.17 | - | 0.2 | - | - | 0.51 |
| | THORIUM-232 | 1.44 | - | - | - | 1.01 | - | - | - | - | - |
| | TRITIUM | - | - | 0.5 | 4.92 | 5.35 | 5.55 | 5.2 | - | - | 2.61 |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH represented in feet below ground surface.

TABLE 6.14 (Cont.)

SUMMARY OF DETECTIONS IN SOUTHWEST CHEMICAL DISPENSING AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | SOUTHWEST CHEMICAL DISPENSING AREA | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | ND | | |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | 20 | 0.5 | 5.1 |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | 22 | 40 | 181 |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | 9 | 0.05 | 4.8 |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | 18 | 0.05 | 10.7 |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | 21 | 5 | 114 |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | 12 | 0.05 | 1.56 |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | 21 | 0.5 | 35 |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | 21 | 0.5 | 63 |
| Lead | 15 | 300 | 13 | 2 | 27.00 | 22 | 1.4 | 9.69 |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | 22 | 0.04 | 0.45 |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | 9 | 0.5 | 57 |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | 21 | 5 | 370 |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | 0 | | |
| Silver | NA | NA | 6 | 1 | 7.00 | 2 | 0.5 | 6 |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | 7 | 0.05 | 2 |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | 22 | 16 | 53 |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | 22 | 17 | 74 |
| Bismuth-214 | | | ND | – | – | 2 | 0.42 | 1.38 |
| Cesium-137 | | | 1 | 0.05 | 0.20 | ND | 0 | 0 |
| Gross Alpha | | | 11 | 0.15 | 1.90 | 13 | 0.3 | 4 |
| Gross Beta | | | 13 | 0.4 | 4.70 | 22 | 1.9 | 8.2 |
| Lead-210 | | | ND | – | – | ND | 0 | 0 |
| Lead-212 | | | ND | – | – | 6 | 0.36 | 0.69 |
| Lead-214 | | | ND | – | – | ND | 0 | 0 |
| Potassium-40 | | | 12 | 2 | 46.40 | 21 | 0.9 | 16.56 |
| Radium-226 | | 0.77# | 10 | 0.5 | 1.40 | 5 | 0.05 | 0.9 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | 6 | 0.025 | 0.7 |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 5 | 0.35 | 1.44 |
| Tritium | | | 3 | 0.1 | 0.50 | 8 | 0.1 | 5.55 |
| Manganese-54 | | | ND | | | ND | 0 | 0 |

* H.T. Shacklette and J.G. Boerngen, 1984.

\# Average Value from Myrick and Berven, 1983.

Radionuclides

Radioisotopes and their maximum reported activities detected in soil samples collected from the Southwest Chemical Dispensing area include:

| RADIOISOTOPE | MAXIMUM REPORTED DETECTION |
|---|---|
| Bismuth-214 | 1.38 pCi/g |
| Gross Alpha | 4.00 pCi/g |
| Gross Beta | 8.20 pCi/g |
| Lead-212 | 0.69 pCi/g |
| Potassium-40 | 16.56 pCi/g |
| Radium-226 | 0.90 pCi/g |
| Strontium-90 | 0.70 pCi/g |
| Thorium-232 | 1.44 pCi/g |
| Tritium | 5.55 pCi/g |

Bismuth-214 and Lead-212 activities were not reported in background samples. The maximum reported activity for gross alpha, gross beta, strontium-90, thorium-232, and tritium are higher than the maximum reported activity in the background samples. Review of Table 6.14 shows that other activities of reported radioisotopes are consistent with background levels.

Nitrates

Nitrate as (N) was reported in all 21 samples analyzed from soil borings and monitoring well borings installed in the Southwest Chemical Dispensing area. Reported detections ranged from 0.23 mg/Kg to 220.0 mg/Kg. The highest reported levels of nitrates in this area were from soils collected from SB-19. Levels of nitrates for the borings and monitoring well boring are listed below.

| SAMPLE DEPTH (in feet bgs) | SB-19 | SB-19A | SB-20 | SB-21 | UCD-15 |
|---|---|---|---|---|---|
| 0.0 | 190.0/220.0* | NS | 1.4 | NA | NS |
| 2.5 | NS | NS | 0.23 | 0.92 | NS |
| 5.0 | NS | 67.0 | 27.0 | 3.70 | NA |
| 7.5 | 120.0 | NS | NS | 3.70 | NS |
| 10.0 | 180.0 | NS | 10.0 | 7.4/21.0* | 23.0 |
| 15.0 | NS | NS | NS | NS | 9.2 |
| 20.0 | NS | NS | NS | NS | 12.0 |
| 25.0 | NS | NS | NS | NS | 9.7 |
| 30.0 | NS | NS | NS | NS | 5.3 |
| 35.0 | NS | NS | NS | NS | 5.5/7.8* |

* - Primary Sample/Replicate Sample
NA - Sample not submitted for analyses.
NS - No sample collected from this depth.
Note: Total depth drilled for SB-19, SB-20 and SB-21 is 10 feet.
Total depth drilled for SB-19A is 5.0 feet.

Hydrocarbons

Neither diesel nor kerosene was not detected for soil samples collected from the Southwest Chemical Dispensing area.

### 6.4.1.6 Dog Pen Areas, LEHR

A total of 109 soil samples was collected from 25 dog pens and four monitoring-well borings drilled in the LEHR dog pen areas. Seventy-two, plus eleven QA/QC replicates of these samples, were submitted for chemical and radiologic analyses. Table 6.15 identifies the sampled dog pens and the monitoring well borings, the depths from which samples were collected and the samples submitted for chemical and radiologic analyses. Additionally, the table lists analyses requested for the samples. The analytical results for samples identified in Table 6.15 are discussed below and summarized in Table 6.16.

Volatile Organic Compounds

Methylene chloride was reported in one soil sample from UCD-23 at 120 $\mu$g/Kg. No other detections of VOCs were reported.

Semivolatile Organic Compounds

Diethyl phthalate was reported in five soil samples from UCD-24 at concentrations ranging from 810 $\mu$g/Kg to 1,200 $\mu$g/Kg. No other detections of semivolatile organic compounds were reported.

Pesticides and PCBs

Chlordane was reported in 17 of the soil samples submitted from the dog pen area. Reported detections of chlordane range from 0.51 $\mu$g/Kg to 480 $\mu$g/Kg. Three of the samples had reported detections that were significantly higher than the other 14 samples with detections of chlordane. Soil samples PS-M17-18.0 (inches), UCD-20-0.0, and UCD-21-0.0 had reported detections of chlordane at or above 200 $\mu$g/Kg. The other 14 reported detections were less than 35 $\mu$g/Kg. No other pesticides or PCBs were reported for the samples collected from this area.

TABLE 6.15
SOIL SAMPLE
DOG PEN AREAS, LEHR
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

**Pen Samples**

| Cage #/ Ring | Depth (inches) | Cage #/ Ring | Depth (inches) |
|---|---|---|---|
| E6 A | 0.0 | M17 A* | 0.0 |
| E6 C | 18.0 | M17 C* | 18.0 |
| E24 A | 0.0 | M14 A | 0.0 |
| E24 C | 18.0 | M14 C | 18.0 |
| E10 A | 0.0 | M29 A | 0.0 |
| E10 C | 18.0 | M29 C | 18.0 |
| F26 A | 0.0 | C20 B | 0.0 |
| F26 C | 18.0 | C20 C | 18.0 |
| F21 A | 0.0 | D32 A | 0.0 |
| F21 C | 18.0 | D32 C | 18.0 |
| G25 A | 0.0 | D4 A | 0.0 |
| G25 C | 18.0 | D4 C | 18.0 |
| G22 A | 0.0 | D21 A | 0.0 |
| G22 C | 18.0 | D21 C | 18.0 |
| J25 A | 80.0 | D13 A | 0.0 |
| J25 C* | 18.0 | D13 C | 18.0 |
| J9 A | 0.0 | H5 A | 0.0 |
| J9 C | 18.0 | H5 C | 18.0 |
| K27 A* | 0.0 | I3 A | 0.0 |
| K27 C* | 18.0 | I3 C | 18.0 |
| K23 A* | 0.0 | L2 A | 0.0 |
| K23 C* | 18.0 | L2 C | 18.0 |
| L19 A | 0.0 | L1 A* | 0.0 |
| L19 C | 18.0 | L1 C* | 18.0 |
| | | J22 A | 0.0 |
| | | J22 C | 18.0 |

Samples submitted for chemical and radiologic testing.

**Analysis Request for Pen Samples**

Chlordane
Nitrates as (N)
Radiologic Scan
• also analyzed for Carbon-14

**Monitoring Wells**

| UCD 20 | UCD 21 | UCD 23 | UCD 24 |
|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 |
| 5.0 | 5.0 | 5.0 | 5.0 |
| 10.0 | 10.0 | 10.0 | 10.0 |
| 15.0 | 15.0 | 15.0 | 15.0 |
| 20.0 | 20.0 | 20.0 | 20.0 |
| 25.0 | 25.0 | 25.0 | 25.0 |
| 30.0 | 30.0 | 30.0 | 30.0 |
| 35.0 | 35.0 | 35.0 | 35.0 |
| 40.0 | 40.0 | 40.0 | 40.0 |
| 45.0 | 45.0 | 45.0 | 45.0 |
| 50.0 | 50.0 | 50.0 | 50.0 |
| 55.0 | 55.0 | 55.0 | 55.0 |
| 60.0 | 60.0 | 60.0 | 60.0 |
| 65.* | 65.0 | 65.0 | 65.0 |
| 70.0 | 70.0 | 70.0 | 70.* |
| | | 75.* | |

* Sample submitted for physical testing.

Samples submitted for chemical and radiologic testing.

**Analysis Request for Monitoring Well Soil Boring Samples**

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha, Gross Beta
Tritium
Strontium-90
Gamma-Emitters

TABLE 6.16
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PS-C20 | PS-C20 | PS-D04 | PS-D04 | PS-D13 | PS-D13 | PS-D13 | PS-D21 | PS-D21 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 02/20/90 | 02/20/90 | 02/20/90 | 02/20/90 | 02/20/90 | 02/20/90 | 02/20/90 | 02/20/90 | 02/20/90 |
| | DEPTH (1) | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" | 0.0" | 18.0" | 0.0" | 18.0" |
| | QA | D | | | | | D | | | |
| | ANALYTE | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 3.7 | 2.8 | 2.8 | 1.8 | 3.7 | 1.8 | 2.8 | 4.6 | 1.4 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | - | 5.5 | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.5 | 1.1 | 1.6 | 1.2 | 1.4 | 2.3 | 1 | 1.4 | 1 |
| | GROSS BETA | 6.7 | 7.3 | 6.5 | 4 | 6.8 | 7.8 | 4.9 | 7.5 | 7.5 |
| | POTASSIUM-40 | 13.9 | 12.5 | 7.7 | 14.2 | 7.1 | 6.9 | 9.6 | 7 | 5.3 |
| | RADIUM-226 | - | - | - | - | - | - | - | - | - |
| | STRONTIUM-90 | - | - | - | - | - | - | - | - | - |
| | THORIUM-232 | - | - | - | - | - | - | - | - | - |
| | TRITIUM | - | - | - | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
(1) Depth is represented in inches below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PS-D32 | PS-D32 | PS-E06 | PS-E06 | PS-E10 | PS-E10 | PS-E24 | PS-E24 | PS-E24 | PS-F21 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 02/20/90 | 02/20/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 |
| | DEPTH (1) | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" | 0.0" | 18.0" | 0.0" |
| | QA | | | | | | | | D | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 4.6 | 2.8 | 136 | 168 | 49.7 | 20.2 | 40 | 5.52 | 64 | 12 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | - | - | - | - | - | - | - | - | 5.9 |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.1 | 1.1 | 1.5 | 0.8 | 1 | 2.3 | 3 | 0.8 | 1.3 | 0.6 |
| | GROSS BETA | 6.6 | 6 | 5.3 | 7.4 | 7.5 | 6.7 | 12.4 | 5.8 | 6.2 | 4.5 |
| | POTASSIUM-40 | 9.7 | 5.5 | 11.86 | 9.07 | 9.75 | 12.78 | 13.43 | 8.31 | 13.3 | 9.75 |
| | RADIUM-226 | - | - | - | - | - | 0.4 | - | 0.7 | 0.6 | 0.5 |
| | STRONTIUM-90 | - | - | - | - | - | - | - | - | - | 0.17 |
| | THORIUM-232 | - | - | - | - | - | - | 0.7 | 0.5 | - | - |
| | TRITIUM | - | - | 1.5 | - | 0.4 | 0.4 | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
(1) Depth is represented in inches below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PS-F21 | PS-F26 | PS-F26 | PS-G22 | PS-G22 | PS-G22 | PS-G25 | PS-G25 | PS-H05 | PS-H05 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/22/90 | 02/20/90 | 02/20/90 |
| | DEPTH (1) | 18 0" | 0.0" | 18.0" | 0.0" | 0.0" | 18 0" | 0.0" | 18.0" | 0.0" | 18.0" |
| | QA | | | | | D | | | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 19.3 | 3.68 | 6.44 | 13.8 | 19.3 | 24.8 | 9.2 | 11 | 4.6 | 5.5 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | 4.5 | 24 | 32 | - | - | - | 11 | 5.6 | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 2.4 | 1.3 | 1.2 | 5 | 3.2 | 3 | 4.9 | 4.4 | 1.2 | 1.7 |
| | GROSS BETA | 17.8 | 2.9 | 7.8 | 15.5 | 15.9 | 15.9 | 14.9 | 20.2 | 7.6 | 8 |
| | POTASSIUM-40 | 8.52 | 11.66 | 12.53 | 7.86 | 8.98 | 9.76 | 10.13 | 7.18 | 7.9 | 12.5 |
| | RADIUM-226 | - | - | - | - | - | - | 0.6 | - | - | 0.7 |
| | STRONTIUM-90 | - | - | - | - | - | - | 0.13 | - | - | - |
| | THORIUM-232 | - | 0.6 | 0.5 | - | - | - | - | - | - | - |
| | TRITIUM | - | - | - | 0.4 | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
(1) Depth is represented in inches below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PS-I03 | PS-I03 | PS-J09 | PS-J09 | PS-J22 | PS-J22 | PS-J22 | PS-J25 | PS-J25 | PS-K23 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 02/20/90 | 02/20/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 |
| | DEPTH (1) | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" |
| | QA | | | | | | D | | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 7.4 | 4.6 | 4.6 | 10.1 | 5.5 | 4.6 | 2.8 | 9.2 | 7.4 | 3.7 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | 0.51 | - | 1.1 | - | - | - | - | - | - | 2.2 |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 2 | 1.3 | 1.3 | 0.9 | 0.9 | 0.9 | 1.4 | 1.3 | 0.8 | 0.9 |
| | GROSS BETA | 7.1 | 6.4 | 5.4 | 5.8 | 7.2 | 4.2 | 7.7 | 5.8 | 5.6 | 7.8 |
| | POTASSIUM-40 | 10.7 | 10.7 | 9.9 | 11.4 | 11.6 | 11.5 | 8.2 | 10.9 | 11.9 | 10.6 |
| | RADIUM-226 | - | 0.6 | 0.5 | - | - | 0.5 | - | 0.6 | - | - |
| | STRONTIUM-90 | - | - | - | - | - | 0.22 | - | - | - | - |
| | THORIUM-232 | - | 0.6 | 0.8 | - | 0.7 | 0.5 | - | - | - | 0.6 |
| | TRITIUM | - | - | - | - | - | - | - | - | - | 0.5 |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
(1) Depth is represented in inches below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PS-K23 | PS-K27 | PS-K27 | PS-L01 | PS-L01 | PS-L01 | PS-L02 | PS-L02 | PS-L19 | PS-L19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 |
| | DEPTH (1) | 18.0" | 0.0" | 18.0" | 0.0" | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" | 18.0" |
| | QA | | | | | D | | | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 6.4 | 6.4 | 5.5 | 2.8 | 7.4 | 14.7 | 2.8 | 1.6 | 5.5 | 1.8 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | 1.2 | - | 1.1 | - | - | - | - | 5.6 | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | 0.2 | - | - | - | - | - | - | - | 0.1 |
| | GROSS ALPHA | 1.2 | 1.7 | 1.1 | 1.6 | 2.2 | 1.1 | 1.3 | 2 | 1.4 | 1.4 |
| | GROSS BETA | 9.2 | 8.7 | 8.6 | 8 | 9.1 | 7.8 | 9.4 | 7.1 | 8.9 | 8.3 |
| | POTASSIUM-40 | 10 | 11.4 | 15.4 | 14.6 | 10.1 | 10.9 | 10.9 | 9.4 | 6.5 | 13.2 |
| | RADIUM-226 | 0.4 | - | 0.9 | 0.6 | 0.4 | - | 0.6 | - | - | - |
| | STRONTIUM-90 | - | - | - | - | - | - | - | - | - | - |
| | THORIUM-232 | 0.6 | 0.5 | - | - | 0.9 | - | - | - | - | - |
| | TRITIUM | - | - | - | 0.4 | 0.8 | 0.7 | - | 0.6 | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
(1) Depth is represented in inches below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PS-M14 | PS-M14 | PS-M17 | PS-M17 | PS-M29 | PS-M29 |
|---|---|---|---|---|---|---|---|
| | DATE | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 | 02/21/90 |
| | DEPTH (1) | 0.0" | 18.0" | 0.0" | 18.0" | 0.0" | 18.0" |
| | QA | | | | | | |
| | ANALYTE | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 1.8 | 1.8 | 5.5 | 2.8 | 1.6 | 1.8 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | - | 9.4 | 480 | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - |
| | GROSS ALPHA | 5.3 | 4.2 | 1.1 | 0.8 | 2.7 | 2.3 |
| | GROSS BETA | 13.7 | 14.1 | 6.2 | 7.1 | 14 | 15.4 |
| | POTASSIUM-40 | 13.2 | 10.5 | 12.1 | 10.9 | 12.1 | 9.6 |
| | RADIUM-226 | - | - | - | - | - | 0.6 |
| | STRONTIUM-90 | - | - | - | - | - | - |
| | THORIUM-232 | - | - | - | 0.8 | - | - |
| | TRITIUM | 0.5 | 0.6 | 0.7 | 0.6 | 0.6 | 0.4 |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
(1) Depth is represented in inches below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | DOG PENS (PS SAMPLES) | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | NA | | |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | NA | | |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | NA | | |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | NA | | |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | NA | | |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | NA | | |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | NA | | |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | NA | | |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | NA | | |
| Lead | 15 | 300 | 13 | 2 | 27.00 | NA | | |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | NA | | |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | NA | | |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | NA | | |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | NA | | |
| Silver | NA | NA | 6 | 1 | 7.00 | NA | | |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | NA | | |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | NA | | |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | NA | | |
| Bismuth-214 | | | ND | | | | | |
| Cesium-137 | | | 1 | 0.05 | 0.20 | 2 | 0.05 | 0.2 |
| Gross Alpha | | | 11 | 0.15 | 1.90 | 55 | 0.6 | 5.3 |
| Gross Beta | | | 13 | 0.4 | 4.70 | 55 | 2.9 | 20.2 |
| Lead-210 | | | ND | | | ND | -- | -- |
| Lead-212 | | | ND | | | ND | -- | -- |
| Lead-214 | | | ND | | | ND | -- | -- |
| Potassium-40 | | | 12 | 2 | 46.40 | 55 | 5.3 | 15.4 |
| Radium-226 | | 0.77# | 10 | 0.05 | 1.40 | 15 | 0.05 | 0.9 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | 3 | 0.025 | 0.22 |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 12 | 0.05 | 0.9 |
| Tritium | | | 3 | 0.1 | 0.50 | 15 | 0.05 | 1.5 |
| Manganese-54 | | | ND | | | ND | -- | -- |
| Gamma Spectral Analysis | | | ND | | | ND | -- | -- |
| Cobalt-60 | | | 1 | 0.17 | 0.17 | ND | -- | -- |

* H.T. Shacklette and J.G. Boerngen, 1984.
\# Average Value from Myrick and Berven, 1983.
NA - Metals Not Analyzed

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-20 | UCD-20 | UCD-20 | UCD-20 | UCD-20 | UCD-20 | UCD-20 | UCD-21 | UCD-21 | UCD-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 10/05/90 | 10/05/90 | 10/05/90 | 10/05/90 | 10/05/90 | 10/05/90 | 10/05/90 | 10/10/90 | 10/10/90 | 10/10/90 |
| | DEPTH | 0.0 | 15.0 | 25.0 | 35.0 | 50.0 | 65.0 | 65.0 | 0.0 | 15.0 | 25.0 |
| | QA | | | | | | | D | | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 10 | 17.6 | 6 | 11.7 | 6 | 9.7 | 8 | 4 | 5.1 | 4.7 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | 12.5 | 13.9 | 18.9 | 15.8 | 21.5 | 19.4 | 19.5 | 12.17 | 19.2 | 20.1 |
| | ARSENIC (TOTAL) | 2.7 | 2 | 3.1 | 3.4 | 3 | 3.4 | 1.8 | 1.2 | 1.4 | - |
| | BARIUM (TOTAL) | 150 | 182 | 130 | 156 | 135 | 98.4 | 95.8 | 136 | 169 | 126 |
| | BERYLLIUM (TOTAL) | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.1 | 0.3 | - | - | 0.1 |
| | CADMIUM (TOTAL) | 14.6 | 16.3 | 18.2 | 18 | 15.5 | 16.3 | 15.8 | 11.7 | 15 | 15.4 |
| | CHROMIUM (TOTAL) | 122 | 87.8 | 99.5 | 97.7 | 80.1 | 110 | 99.7 | 93.9 | 73.4 | 130 |
| | CHROMIUM, HEXAVALENT (+6) | 1 | 0.59 | 0.2 | 3.98 | 0.49 | 1 | - | 0.6 | 0.4 | 0.1 |
| | COBALT (TOTAL) | 22 | 21.1 | 22.6 | 23.6 | 20.3 | 20.6 | 20.7 | 19.1 | 20.3 | 12.8 |
| | COPPER (TOTAL) | 36.6 | 47 | 52.7 | 56.7 | 43.4 | 49.5 | 46.5 | 33.4 | 53.6 | 43.6 |
| | LEAD (TOTAL) | 17 | 15.8 | 15.9 | 19.5 | 17.7 | 16.3 | 14.7 | 20.2 | 20.2 | 16.9 |
| | MERCURY (TOTAL) | 0.24 | 0.05 | - | 0.07 | 0.06 | 0.13 | 0.05 | 0.15 | - | 0.11 |
| | MOLYBDENUM (TOTAL) | 6.13 | 8.96 | 11.4 | 9.68 | 12.3 | 11.7 | 12.1 | 8 | 10.65 | 11.9 |
| | NICKEL (TOTAL) | 215 | 159 | 181 | 204 | 112 | 173 | 174 | 194 | 144 | 122 |
| | THALLIUM (TOTAL) | - | 5.09 | 5.06 | 6.1 | - | 5.67 | - | - | 5.09 | 5.86 |
| | VANADIUM (TOTAL) | 47.7 | 53.6 | 62 | 63.3 | 54.5 | 56.7 | 52.7 | 37.9 | 51 | 49.3 |
| | ZINC (TOTAL) | 231 | 60.9 | 62.7 | 71.5 | 62.3 | 59.8 | 61.7 | 397 | 69.4 | 62.4 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - | - | - | - | - | - | - | - |
| SEMIVOLATILE ORGANICS (ug/Kg) | DIETHYL PHTHALATE | - | - | - | - | - | - | - | - | - | - |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | 200 | - | - | - | - | - | - | 360 | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | - | 1.3 | 0.6 | 1 | 1.1 | 2 | 2.3 | 2.4 | 1.7 | 1.3 |
| | GROSS BETA | 1.5 | 1.1 | 2.5 | 3 | 2 | 1.7 | 2.6 | 2.2 | 2.3 | 3.1 |
| | MANGANESE-54 | 540.08 | - | - | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 20.2 | 10.3 | 11.3 | 6.8 | 10.4 | 7.9 | 9.6 | 12.8 | 12.1 | 11.8 |
| | RADIUM-226 | 0.3 | - | - | 0.4 | 0.7 | - | 0.4 | - | 0.4 | 0.6 |
| | STRONTIUM-90 | 0.17 | - | - | - | 0.3 | - | 0.12 | - | - | - |
| | THORIUM-232 | 0.6 | 0.5 | - | 0.5 | 0.7 | - | - | 0.7 | 0.4 | 0.7 |
| | TRITIUM | - | - | - | - | - | - | - | - | 0.6 | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH represented in feet below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-21 | UCD-21 | UCD-21 | UCD-23 | UCD-23 | UCD-23 | UCD-23 | UCD-23 | UCD-23 | UCD-23 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 10/10/90 | 10/10/90 | 10/10/90 | 10/15/90 | 10/15/90 | 10/15/90 | 10/15/90 | 10/15/90 | 10/15/90 | 10/15/90 |
| | DEPTH | 35 0 | 50 0 | 60 0 | 0 0 | 5 0 | 20 0 | 35 0 | 35 0 | 50.0 | 70 0 |
| | QA | | | | | | | | D | | |
| | ANALYTE | | | | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 5.5 | 10.1 | 11.2 | 15.8 | 18 | 14 | 13.7 | 18.2 | 3.8 | 6.8 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | 17.6 | 10.7 | 17.8 | 10.5 | 11.8 | 12.9 | 8.8 | 10 | - | 6.5 |
| | ARSENIC (TOTAL) | 1.7 | 1.7 | 1 | 1.5 | 1 | 2.9 | 1.2 | 2.2 | 1.3 | - |
| | BARIUM (TOTAL) | 137 | 146 | 185 | 178 | 176 | 108 | 149 | 152 | 60.3 | 126 |
| | BERYLLIUM (TOTAL) | - | - | - | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 |
| | CADMIUM (TOTAL) | 16.2 | 13.1 | 14.5 | 20.7 | 19.3 | 19.9 | 13.9 | 17.5 | 11 | 11.8 |
| | CHROMIUM (TOTAL) | 98.7 | 56.6 | 81.7 | 152 | 81.5 | 88.8 | 36.3 | 77.1 | 70.5 | 47.7 |
| | CHROMIUM, HEXAVALENT (+6) | 0.4 | 0.6 | 0.1 | 0.2 | 0.5 | 0.29 | 0.2 | 0.1 | 0.19 | 0.2 |
| | COBALT (TOTAL) | 20.3 | 28 | 23.2 | 24.7 | 24.8 | 21.9 | 12.2 | 23.7 | 13.7 | 17.2 |
| | COPPER (TOTAL) | 47.4 | 38 | 48.4 | 47.3 | 45.9 | 49.1 | 29.3 | 47.8 | 16.5 | 30 |
| | LEAD (TOTAL) | 13.4 | 19.9 | 14.8 | 61.4 | 21.4 | 16 | 9.5 | 11.7 | 7.21 | 12.4 |
| | MERCURY (TOTAL) | 0.07 | - | 0.28 | 0.07 | 0.07 | 0.16 | - | 0.15 | 0.06 | - |
| | MOLYBDENUM (TOTAL) | 9.61 | 8.78 | 11.1 | 7.6 | 9.4 | 8.8 | 5.7 | 8.5 | - | - |
| | NICKEL (TOTAL) | 206 | 106 | 180 | 303 | 178 | 221 | 64.7 | 199 | 119 | 137 |
| | THALLIUM (TOTAL) | - | - | 6.18 | - | 5.2 | 5.2 | - | - | - | - |
| | VANADIUM (TOTAL) | 55.4 | 52 | 53.3 | 39.8 | 47 | 49.7 | 36.2 | 41.9 | 24.2 | 26.2 |
| | ZINC (TOTAL) | 63.7 | 51.6 | 64 | 66.3 | 59.4 | 58.4 | 47.8 | 55.3 | 25.4 | 45.4 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - | - | - | - | 120 | - | - | - |
| SEMIVOLATILE ORGANICS (ug/Kg) | DIETHYL PHTHALATE | - | - | - | - | - | - | - | - | - | - |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | - | - | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | 1.7 | 2.4 | 1.5 | 2 | 2.2 | 2.2 | 0.8 | 1.8 | 1.4 | 1.2 |
| | GROSS BETA | 2.8 | 3 | 2.4 | 3.4 | 3.8 | 4.7 | 1.4 | 1.6 | 1.4 | 1.7 |
| | MANGANESE-54 | - | - | - | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 14.5 | 17.9 | 12.9 | 1.3 | 2.8 | 4.4 | 2.1 | 1.1 | 3.8 | 1 |
| | RADIUM-226 | 0.4 | 0.7 | 0.4 | 0.6 | 0.7 | 1.4 | 0.5 | 0.4 | 0.9 | 0.4 |
| | STRONTIUM-90 | - | - | - | - | - | - | - | - | - | - |
| | THORIUM-232 | 0.8 | 1 | 0.6 | 0.6 | 1 | 1.4 | 0.6 | 0.4 | 0.8 | 0.4 |
| | TRITIUM | - | - | - | - | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH represented in feet below ground surface.

TABLE 6.16 (Cont.)
SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-24 | UCD-24 | UCD-24 | UCD-24 | UCD-24 | UCD-24 | UCD-24 |
|---|---|---|---|---|---|---|---|---|
| | DATE | 10/18/90 | 10/18/90 | 10/18/90 | 10/18/90 | 10/18/90 | 10/18/90 | 10/18/90 |
| | DEPTH | 0.0 | 5.0 | 10.0 | 10.0 | 40.0 | 50.0 | 60.0 |
| | QA | | | | D | | | |
| | ANALYTE | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 6.9 | 7.3 | 4.5 | 3.9 | 5.8 | 16.1 | 9 |
| METALS (mg/Kg) | ANTIMONY (TOTAL) | 13.1 | 11.7 | 14.4 | 13.8 | 13.8 | 12.6 | 10.4 |
| | ARSENIC (TOTAL) | 5 | 3.6 | 3.9 | 3.8 | 4.9 | 4.2 | 4.4 |
| | BARIUM (TOTAL) | 175 | 184 | 218 | 320 | 186 | 177 | 103 |
| | BERYLLIUM (TOTAL) | - | 0.4 | 0.4 | 0.2 | 0.2 | 0.4 | 0.3 |
| | CADMIUM (TOTAL) | 26.7 | 24 | 25.4 | 23.1 | 26 | 21.4 | 21.8 |
| | CHROMIUM (TOTAL) | 152 | 89.7 | 104 | 104 | 87.8 | 56.9 | 82.5 |
| | CHROMIUM, HEXAVALENT (+6) | 0.49 | 0.8 | 0.2 | 0.1 | 0.49 | 0.48 | 0.1 |
| | COBALT (TOTAL) | 31.5 | 26.3 | 27.9 | 25.5 | 25.4 | 20.7 | 20.4 |
| | COPPER (TOTAL) | 56.8 | 62.3 | 55.6 | 54.6 | 69.5 | 45.8 | 47.4 |
| | LEAD (TOTAL) | 27.1 | 72.7 | 20.9 | 19 | 73.1 | 16.3 | 16.7 |
| | MERCURY (TOTAL) | 0.35 | 0.05 | 0.04 | 0.05 | 0.07 | - | 0.1 |
| | MOLYBDENUM (TOTAL) | 10.2 | 11.3 | 13.7 | 11.9 | 11.6 | 10.6 | 9.2 |
| | NICKEL (TOTAL) | 321 | 183 | 228 | 217 | 197 | 108 | 174 |
| | THALLIUM (TOTAL) | 5 | - | - | - | - | - | - |
| | VANADIUM (TOTAL) | 61.8 | 55.1 | 63.9 | 56 | 58.6 | 44.3 | 49.7 |
| | ZINC (TOTAL) | 72.3 | 71.2 | 72.3 | 63 | 76.2 | 62.9 | 63.1 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - | - | - | - | - |
| SEMIVOLATILE ORGANICS (ug/Kg) | DIETHYL PHTHALATE | - | 1100 | 1200 | - | 810 | 890 | 1200 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/gram) | CESIUM-137 | - | - | 0.1 | - | - | - | - |
| | GROSS ALPHA | 1.1 | 1.8 | 1.1 | 1.2 | 0.6 | 1.2 | 1.6 |
| | GROSS BETA | 3.6 | 1.4 | 2.8 | 1.5 | 3 | 3 | 2.8 |
| | MANGANESE-54 | - | - | - | - | - | - | - |
| | POTASSIUM-40 | 12.8 | 8.66 | 18.5 | 11.9 | 18.1 | 30.9 | 14.6 |
| | RADIUM-226 | - | 0.6 | 0.7 | 0.5 | 0.6 | 0.9 | 0.8 |
| | STRONTIUM-90 | - | - | - | - | - | - | 0.15 |
| | THORIUM-232 | - | 0.5 | 0.8 | 0.6 | 0.7 | 1 | 0.9 |
| | TRITIUM | - | - | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample. DEPTH represented in feet below ground surface.

SUMMARY OF DETECTIONS IN DOG PEN AREA SOILS (LEHR)
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | DOG PEN SAMPLES (UCD) | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | 26 | 2.5 | 21.5 |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | 25 | 0.5 | 5 |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | 27 | 60.3 | 320 |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | 21 | 0.05 | 0.5 |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | 27 | 11 | 26.7 |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | 27 | 36.3 | 152 |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | 26 | 0.1 | 3.98 |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | 27 | 12.2 | 31.5 |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | 27 | 16.5 | 69.5 |
| Lead | 15 | 300 | 13 | 2 | 27.00 | 27 | 7.21 | 73.1 |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | 21 | 0.02 | 0.35 |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | 25 | 2.5 | 13.7 |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | 27 | 64.7 | 321 |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | ND | -- | -- |
| Silver | NA | NA | 6 | 1 | 7.00 | ND | -- | -- |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | 10 | 2.5 | 8.18 |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | 27 | 24.2 | 63.9 |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | 27 | 25.4 | 397 |
| Bismuth-214 | | | ND | | | ND | -- | -- |
| Cesium-137 | | | 1 | 0.05 | 0.20 | 1 | 0.05 | 0.1 |
| Gross Alpha | | | 11 | 0.15 | 1.90 | 26 | 0.15 | 2.4 |
| Gross Beta | | | 13 | 0.4 | 4.70 | 27 | 1.1 | 4.7 |
| Lead-210 | | | ND | | | ND | -- | -- |
| Lead-212 | | | ND | | | ND | -- | -- |
| Lead-214 | | | ND | | | ND | -- | -- |
| Potassium-40 | | | 12 | 2 | 46.40 | 27 | 1 | 30.9 |
| Radium-226 | | 0.77# | 10 | 0.05 | 1.40 | 22 | 0.05 | 1.4 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | 4 | 0.025 | 0.35 |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 23 | 0.25 | 1.4 |
| Tritium | | | 3 | 0.1 | 0.50 | 1 | 0.1 | 0.6 |
| Manganese-54 | | | ND | | | 1 | 540.08 | 540.08 |
| Gamma Spectral Analysis | | | ND | | | ND | -- | -- |
| Cobalt-60 | | | 1 | 0.17 | 0.17 | ND | -- | -- |

* H.T. Shacklette and J.G. Boerngen, 1984.
\# Average Value from Myrick and Berven, 1983.

Title 22 Metals

Because the focus of the shallow soil investigation in the dog pens was on nitrate, chloroform and radiologic constituents, no metal analyses were conducted on the 55 shallow soil samples collected from the dog pens. Metals analyses were conducted on 27 soil samples from monitoring well borings identified in Table 6.15. Fifteen of the Title 22 metals were reported in soil samples analyzed from the monitoring well borings installed in the dog pen area. Selenium and silver were not reported. The maximum concentrations reported for 12 of these metals, including arsenic, barium, cadmium, hexavalent chromium, cobalt, copper, lead, mercury, molybdenum, nickel, vanadium, and zinc, is higher than the maximum reported concentrations for these metals in the background soil samples. Five metals, including antimony, chromium, copper, molybdenum, and nickel, were reported at concentrations higher than published regional concentrations identified by Shacklette and Boerngen (1984). A summary of the reported metal detections is presented in Table 6.16. Hexavalent chromium was reported at levels ranging from not detected (<0.10 mg/Kg) to 3.98 mg/Kg. The mean concentration for hexavalent chromium from these samples is 0.53 mg/Kg. The highest reported levels of hexavalent chromium is found in soil sample UCD-20-35.0.

Radionuclides

Radioisotopes and their maximum reported activities detected in soil samples collected from the dog pen area include:

| RADIOISOTOPE | MAXIMUM REPORTED DETECTION |
|---|---|
| Cesium-137 | 0.20 pCi/g |
| Gross Alpha | 5.30 pCi/g |
| Gross Beta | 20.20 pCi/g |
| Manganese-54 | 540.08 pCi/g |
| Potassium-40 | 30.90 pCi/g |
| Radium-226 | 1.40 pCi/g |
| Strontium-90 | 0.22 pCi/g |
| Thorium-232 | 1.40 pCi/g |
| Tritium | 1.50 pCi/g |

Manganese-54 activity was reported once in samples collected from this area. However, it was not reported in background samples. The maximum reported activity for gross alpha, strontium-90, thorium-232, and tritium are higher than the maximum reported activity in the background samples. Review of Table 6.16 shows that other reported activities of radioisotopes are consistent with background levels.

Nitrates

Nitrate as (N) was reported in 82 soil samples collected from this area. Reported levels of nitrate range from 1.4 mg/Kg to 168.0 mg/Kg. Only two samples had reported concentrations above 50.0 mg/Kg. The two soil samples with the highest reported levels of nitrate were collected from dog pens in areas currently used to house beagles involved in ongoing experiments at the facility. Reported levels of nitrate from other dog pens currently in use, and those that are not in use, are consistent with background levels which range from 2.1 to 39.8 mg/Kg. Levels of nitrate reported in soil samples collected from the two monitoring well borings drilled in areas of former dog pens (MW-20 and MW-21) and two monitoring wells drilled adjacent to the Dog Pen area (MW-23, and MW-24) are also consistent with background levels.

#### 6.4.1.7 North Chemical Dispensing Area (SB-16, -17, -18)

A total of six soil samples was collected from three shallow soil borings (less than 2.0 feet deep) drilled in the North Chemical Dispensing area. All six samples, plus one QA/QC replicate, were submitted for chemical and radiologic analyses. Table 6.17 identifies the soil borings, the depths from which samples were collected, and the samples submitted for chemical and radiologic analyses. Additionally, the table lists analyses requested for the samples. The analytical results for samples identified in Table 6.17 are discussed below and summarized in Table 6.18.

Volatile Organic Compounds

Methylene chloride was reported in one soil sample from SB-18 at 9.7 $\mu$g/Kg. No other detections of VOCs were reported for samples collected from the North Chemical Dispensing area.

Semivolatile Organic Compounds

Semivolatile organic compounds were not detected for samples collected from the North Chemical Dispensing area.

Pesticides and PCBs

Chlordane was reported in three soil samples at concentrations ranging from 33 $\mu$g/Kg to 70 $\mu$g/Kg. No other detections of pesticides or PCBs were reported for samples collected from the North Chemical Dispensing area.

TABLE 6.17
SOIL SAMPLE ANALYSIS
NORTH CHEMICAL DISPENSING AREA
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| SB16 | SB17 | SB18 |
|---|---|---|
| 0.8[1] | 0.8 | 0.8 |
| 1.8 | 1.8 | 1.8 |

Depths in feet below ground surface.
[1] Replicate sample.

Samples submitted for chemical and radiologic testing.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha, Gross Beta
Tritium
Strontium-90
Gamma-Emitters
Diesel
Kerosene

TABLE 6.18
SUMMARY OF DETECTIONS IN NORTH CHEMICAL DISPENSING AREA SOILS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | SB-16 | SB-16 | SB-16 | SB-17 | SB-17 | SB-18 | SB-18 |
|---|---|---|---|---|---|---|---|---|
| | DATE | 03/08/90 | 03/08/90 | 03/08/90 | 03/08/90 | 03/08/90 | 03/08/90 | 03/08/90 |
| | DEPTH | 0.8 | 0.8 | 1.8 | 0.8 | 1.8 | 0.8 | 1.8 |
| | QA | | D | | | | | |
| | ANALYTE | | | | | | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 49 | - | 41 | 40 | 42 | 32 | 30 |
| METALS (mg/Kg) | ARSENIC (TOTAL) | 5.3 | - | 4.8 | 5.6 | 5.4 | 5.2 | 4.9 |
| | BARIUM (TOTAL) | 59 | - | 78 | 60 | 48 | 108 | 113 |
| | BERYLLIUM (TOTAL) | - | - | 2.2 | 4.5 | 5.1 | 2.5 | 1.4 |
| | CADMIUM (TOTAL) | - | - | - | - | - | 0.1 | 0.1 |
| | CHROMIUM (TOTAL) | 63.8 | - | 75.6 | 64.8 | 87.3 | 81.6 | 61.7 |
| | CHROMIUM, HEXAVALENT (+6) | 2.3 | - | 0.7 | 1.7 | 0.5 | 1.6 | 0.6 |
| | COBALT (TOTAL) | 117 | - | 22.8 | 21.6 | 18.5 | 44.2 | 23.4 |
| | COPPER (TOTAL) | 21 | - | 23 | - | - | 23 | 1 |
| | LEAD (TOTAL) | 4.8 | - | 5.2 | 5.1 | 4.2 | 5 | 4.6 |
| | MERCURY (TOTAL) | 0.41 | - | 0.52 | 0.67 | 0.06 | 0.26 | 0.44 |
| | MOLYBDENUM (TOTAL) | 2 | - | - | - | 1 | - | - |
| | NICKEL (TOTAL) | 255 | - | 297 | 247 | 292 | 276 | 219 |
| | VANADIUM (TOTAL) | 52 | - | 44 | 38 | 36 | 36 | 38 |
| | ZINC (TOTAL) | 56 | - | 58 | 62 | 59 | 57 | 56 |
| VOLATILE ORGANICS (ug/Kg) | METHYLENE CHLORIDE | - | - | - | - | - | - | 9.7 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | - | - | 44 | 70 | - | 33 |
| RADIONUCLIDES (pCi/gram) | BISMUTH-214 | - | - | 0.63 | 2.21 | 0.39 | - | - |
| | GROSS ALPHA | 1.4 | 1.4 | - | - | 1.1 | 1 | - |
| | GROSS BETA | 5.6 | 5.6 | 2.8 | 3.9 | 6.8 | 4.8 | 5.8 |
| | LEAD-212 | - | - | 0.53 | - | - | 0.4 | - |
| | LEAD-214 | - | - | 1.04 | - | 0.47 | - | - |
| | POTASSIUM-40 | 7.27 | 7.27 | 11.77 | 13.68 | 13.66 | 13.3 | 5.99 |
| | RADIUM-226 | - | - | 0.7 | 1.31 | 1.07 | - | - |
| | STRONTIUM-90 | - | - | 0.1 | - | - | - | - |
| | THORIUM-232 | - | - | 0.71 | - | - | - | - |
| | TRITIUM | 0.55 | 0.55 | - | - | - | - | - |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.
DEPTH represented in feet below ground surface.

SUMMARY OF DETECTIONS IN NORTH CHEMICAL DISPENSING AREA SOILS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | REGIONAL BACKGROUND RANGE* | | BACKGROUND PHASE II CHARACTERIZATION | | | NORTH CHEMICAL AREA | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | MIN | MAX | NUMB DET | SMALLEST | LARGEST | NUMB DET | SMALLEST | LARGEST |
| Antimony | <1 | 2.2 | 5 | 0.5 | 26.5 | ND | – | – |
| Arsenic | 6.5 | 10 | 8 | 0.5 | 3.00 | 6 | 4.8 | 5.6 |
| Barium | 500 | 700 | 13 | 71.5 | 181.00 | 6 | 48 | 113 |
| Beryllium | <1 | 1 | 7 | 0.05 | 3.64 | 5 | 0.5 | 5.1 |
| Cadmium | -1 | | 13 | 0.5 | 18.10 | 2 | 0.05 | 0.1 |
| Chromium | 70 | 100 | 13 | 3 | 156.00 | 6 | 61.7 | 87.3 |
| Chromium, Hexavalent | NA | NA | 7 | 0.05 | 1.98 | 6 | 0.5 | 2.3 |
| Cobalt | 10 | 70 | 12 | 0.5 | 20.80 | 6 | 18.5 | 117 |
| Copper | 30 | 50 | 13 | 14.1 | 55.00 | 4 | 0.5 | 23 |
| Lead | 15 | 300 | 13 | 2 | 27.00 | 6 | 4.2 | 5.2 |
| Mercury | NA | NA | 8 | 0.02 | 0.19 | 6 | 0.06 | 0.67 |
| Molybdenum | <3 | 3 | 10 | 1 | 11.70 | 2 | 0.5 | 2 |
| Nickel | 15 | 300 | 11 | 5 | 198.00 | 6 | 219 | 297 |
| Selenium | <0.1 | 0.3 | 1 | 0.5 | 3.00 | ND | – | – |
| Silver | NA | NA | 6 | 1 | 7.00 | ND | – | – |
| Thallium | NA | NA | 10 | 1.5 | 32.00 | ND | – | – |
| Vanadium | 100 | 500 | 13 | 6.3 | 58.50 | 6 | 36 | 52 |
| Zinc | 74 | 510 | 13 | 31.6 | 77.40 | 6 | 56 | 62 |
| Bismuth-214 | | | ND | | | 3 | 0.39 | 2.21 |
| Cesium-137 | | | 1 | 0.05 | 0.20 | ND | – | – |
| Gross Alpha | | | 11 | 0.15 | 1.90 | 4 | 0.4 | 1.4 |
| Gross Beta | | | 13 | 0.4 | 4.70 | 7 | 2.8 | 6.8 |
| Lead-210 | | | ND | | | ND | – | – |
| Lead-212 | | | ND | | | 2 | 0.4 | 0.53 |
| Lead-214 | | | ND | | | 2 | 0.47 | 1.04 |
| Potassium-40 | | | 12 | 2 | 46.40 | 7 | 5.99 | 13.68 |
| Radium-226 | | 0.77# | 10 | 0.05 | 1.40 | 3 | 0.05 | 1.31 |
| Strontium-90 | | | 5 | 0.025 | 0.24 | 1 | 0.025 | 0.1 |
| Thorium-232 | | 0.54# | 7 | 0.25 | 1.10 | 1 | 0.35 | 0.71 |
| Tritium | | | 3 | 0.1 | 0.50 | 2 | 0.1 | 0.55 |
| Manganese-54 | | | ND | | | ND | – | – |
| Gamma Spectral Analysis | | | ND | | | ND | – | – |
| Cobalt-60 | | | 1 | 0.17 | 0.17 | ND | – | – |

* H.T. Shacklette and J.G. Boerngen, 1984.
\# Average Value from Myrick and Berven, 1983.

Title 22 Metals

Thirteen of the Title 22 metals were reported in soil samples analyzed from the North Chemical Dispensing area. Antimony, selenium, silver, and thallium were not detected. The maximum concentrations reported for arsenic, beryllium, hexavalent chromium, cobalt, mercury, and nickel are higher than the maximum concentrations reported in the background samples. Two metals, beryllium and cobalt, were reported at concentrations higher than published regional concentrations identified by Shacklette and Boerngen (1984). A summary of the reported metals detections is presented in Table 6.18. Hexavalent chromium was reported at levels ranging from not detected (<0.10 mg/Kg) to 2.30 mg/Kg. The mean concentration for hexavalent chromium from these samples is 1.23 mg/Kg. The highest reported level of hexavalent chromium is found in soil sample SB-16-0.8.

Radionuclides

Radioisotopes and their maximum reported activities detected in soil samples collected from the North Chemical Dispensing area include:

| RADIOISOTOPE | MAXIMUM REPORTED DETECTION |
|---|---|
| Bismuth-214 | 2.21 pCi/g |
| Gross Alpha | 1.40 pCi/g |
| Gross Beta | 6.80 pCi/g |
| Lead-212 | 0.53 pCi/g |
| Lead-214 | 1.04 pCi/g |
| Potassium-40 | 13.68 pCi/g |
| Radium-226 | 1.31 pCi/g |
| Strontium-90 | 0.10 pCi/g |
| Thorium-232 | 0.71 pCi/g |
| Tritium | 0.55 pCi/g |

Bismuth-214, lead-212, and lead-214 activities were not reported in background samples. The maximum reported activity of gross beta and tritium are higher than the maximum activity reported in the background samples. Review of Table 6.18 shows that other activities of reported radioisotopes are consistent with background detections.

Nitrates

Nitrate as (N) was reported in all six samples collected from the North Chemical Dispensing area. Concentrations of nitrate range from 30 mg/Kg to 49 mg/Kg.

Hydrocarbons

Neither diesel nor kerosene was detected for soil samples collected from the North Chemical Dispensing area.

### 6.4.1.8 Old AEC Project Site, Main UC Davis Campus (AEC Samples)

A total of 20 soil samples was collected from ten shallow soil borings (18 to 60 inches deep) drilled in former dog pens and in the area of a reported septic leach system at the Old AEC Project site, located on the main UC Davis campus. Twenty, plus two QA/QC replicates, were submitted for chemical and radiologic analyses. Table 6.19 identifies the sample numbers, the depths from which samples were collected, and the samples submitted for chemical and radiologic analyses. Additionally, the table lists analyses requested for the samples. The analytical results for samples identified in Table 6.19 are discussed below and summarized in Table 6.20.

Pesticides and PCBs

Chlordane was reported in nine soil samples at concentrations ranging from 4.77 $\mu$g/Kg to 67.0 $\mu$g/Kg. No other detections of pesticides or PCBs were reported for samples collected from the Old AEC Project site.

Radionuclides

Soil samples collected from the Old AEC Project site were analyzed for tritium, strontium-90, and carbon-14. Neither tritium nor strontium-90 activity was reported for samples collected from the Old AEC Project site. Carbon-14 activity was reported in one replicate sample at 0.5 pCi/g $\pm$ 0.2.

TABLE 6.19
SOIL SAMPLE ANALYSIS
OLD AEC PROJECT SITE, MAIN CAMPUS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| AEC-1 | AEC-2 | AEC-3 | AEC-4 | AEC-5 | AEC-6 | AEC-8 | AEC-9 | AEC-10 | AEC-11 |
|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.0 | 24.0 |
| 12.0 | 12.0 | 12.0 | 12.0 | 12.0[1] | 12.0 | 12.0 | 12.0 | 60.0 | 60.0[1] |

Depths in inches below ground surface.
1 Replicate sample also submitted.

Samples submitted for chemical and radiologic testing.

**Analytical Requests**

Chlordane
Tritium
Strontium-90
Carbon 14

TABLE 6.20
SUMMARY OF DETECTIONS IN OLD AEC PROJECT SITE, MAIN UC DAVIS CAMPUS SOIL SAMPLES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | AEC-02-00.0A | AEC-02-12.0A | AEC-04-00.0A | AEC-05-00.0A | AEC-06-00.0A | AEC-08-00.0A | AEC-08-12.0A |
|---|---|---|---|---|---|---|---|---|
| | DATE | 02/19/91 | 02/19/91 | 02/19/91 | 02/21/91 | 02/21/91 | 02/21/91 | 02/21/91 |
| | DEPTH | 0.0" | 12.0" | 0.0" | 0.0" | 0.0" | 0.0" | 12.0" |
| | QA | | | | | | | |
| | ANALYTE | | | | | | | |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | 36.8 | 67 | 19.8 | 5.7 | 14.5 | 4.77 | 8.3 |
| RADIONUCLIDES (pCi/gram) | CARBON-14 | - | - | - | - | - | - | - |

| | SAMPLE | AEC-09-00.0A | AEC-09-12.0A | AEC-11-60.0B |
|---|---|---|---|---|
| | DATE | 02/21/91 | 02/21/91 | 02/21/91 |
| | DEPTH | 0.0" | 12.0" | 60.0" |
| | QA | | | D |
| | ANALYTE | | | |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | 7.33 | 12.6 | - |
| RADIONUCLIDES (pCi/gram) | CARBON-14 | - | - | 0.5 |

See Appendix F for complete analytical results. - = Denotes not detected.
D = Duplicate Sample.

DEPTH represented in inches below ground surface.

### 6.4.2 Sediment Sample Chemical Analysis

Two sediment samples were collected, one each from the UC Davis Wastewater Treatment Plant outfall, and the Stormwater Lift Station located at the LEHR facility (Figure 6.15). Both samples were submitted for chemical and radiologic analyses. Table 6.21 identifies the samples and lists the analyses requested for each sample. The analytical results for samples identified in Table 6.21 are discussed below and summarized on Table 6.22.

#### 6.4.2.1 Wastewater Treatment Plant Outfall (OF-1)

Volatile Organic Compounds

VOCs were not detected for the sediment sample collected from the UC Davis Wastewater Treatment Plant outfall.

Semivolatile Organic Compounds

Semivolatile organic compounds were not detected for the sediment sample collected from the UC Davis Wastewater Treatment Plant outfall.

Pesticides and PCBs

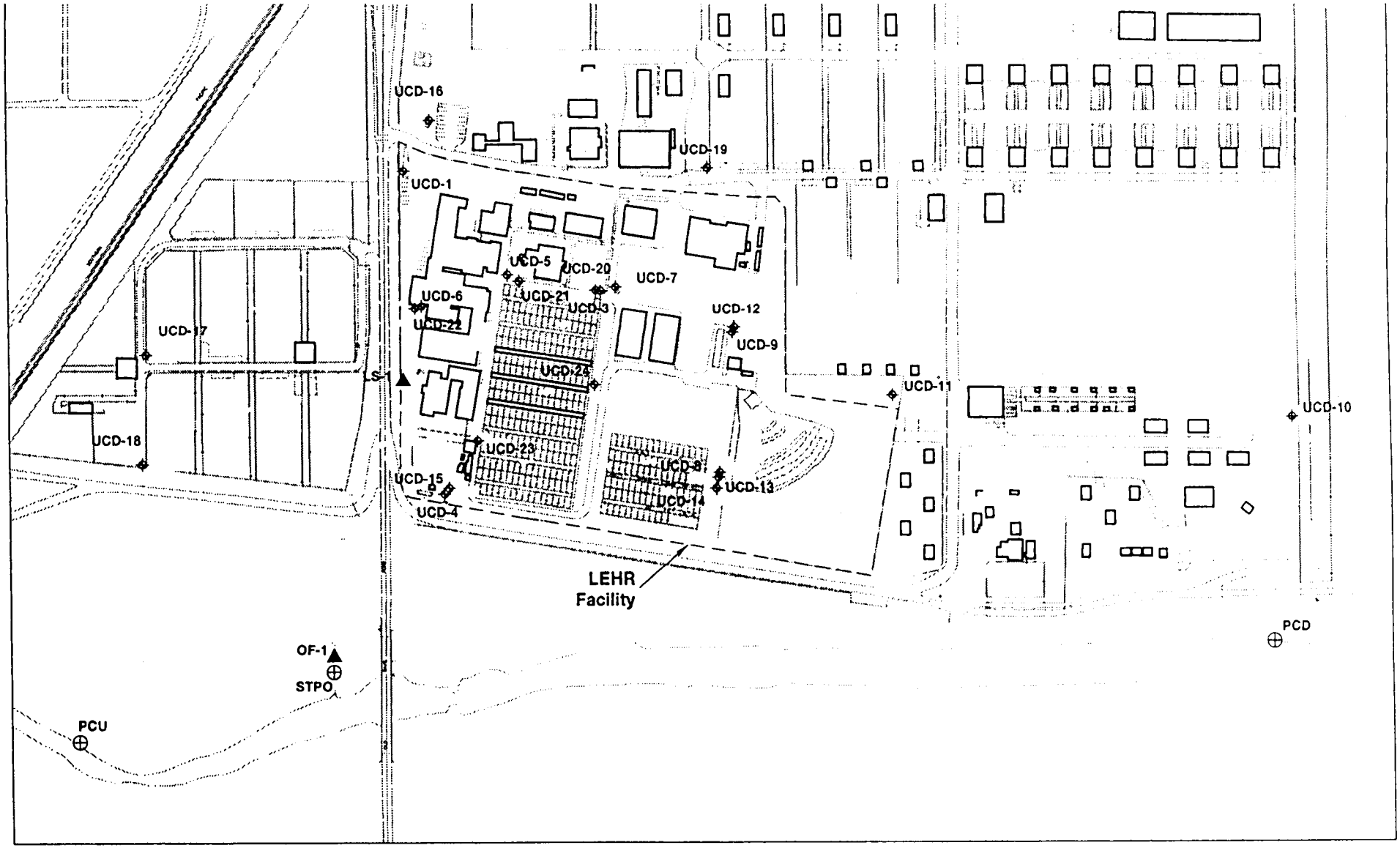
Neither pesticides nor PCBs were detected for the sediment sample collected from the UC Davis Wastewater Treatment Plant outfall.

Title 22 Metals

Reported metals concentrations are consistent with levels reported in the background samples (Section 6.4.1.1) and published regional background concentrations identified by Shacklette and Boerngen (1984). Hexavalent chromium was not reported in the sediment samples collected from the UC Davis Wastewater Treatment Plant outfall.

Radionuclides

No radionuclide activity was reported in the sediment sample collected from the UC Davis Wastewater Treatment Plant outfall.




EXPLANATION

- Monitoring Wells
- Sediment Samples
- Surface Water Samples

0 300
Scale in Feet

N

# LOCATION MAP SURFACE WATER AND SEDIMENT SAMPLES

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-162

FIGURE 6.15

6.86

TABLE 6.21
SEDIMENT SAMPLES ANALYSIS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Sample ID | Date |
|---|---|
| OF 1 | 02/22/90 |
| LS 1 | 02/22/90 |

OF: Wastewater Treatment Plant Outfall
LS: Lift Station

Samples submitted for chemical and radiologic testing.

Analytical Requests

17 CAM Metals
Hexavalent Chromium
Nitrates as (N)
Formaldehyde
Organochlorine Pesticides (EPA 8080)
VOCs (EPA 8240)
Semivolatile Organic Compounds (EPA 8270)
Gross Alpha-Gross Beta
Tritium
Strontium-90
Gamma-Emitters

TABLE 6.22
SUMMARY OF DETECTIONS IN SEDIMENT SAMPLES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE<br>DATE | OF-01<br>02/22/90 | LS-01<br>02/22/90 |
|---|---|---|---|
| | ANALYTE | | |
| NITRATES (mg/Kg) | NITROGEN, NITRATE (AS N) | 3.7 | 6.4 |
| METALS (mg/Kg) | ANTIMONY | - | 6.8 |
| | ARSENIC | 1.1 | 1.2 |
| | BARIUM | 65 | 41 |
| | BERYLLIUM | 0.2 | - |
| | CHROMIUM | 69 | 23 |
| | COBALT | 8 | 2 |
| | COPPER | 32 | 60 |
| | LEAD | 4.3 | 15 |
| | MERCURY | 0.65 | 0.26 |
| | NICKEL | 112 | 37 |
| | SILVER | 5 | - |
| | VANADIUM | 16 | 11 |
| | ZINC | 50 | 12 |
| PESTICIDES AND PCBS (ug/Kg) | CHLORDANE | - | 65 |

See Appendix F for complete analytical results. - = Denotes not detected.

Nitrates

Nitrate as (N) was reported at 3.7 mg/Kg in the sediment sample collected from the UC Davis Wastewater Treatment Plant outfall.

6.4.2.2 Lift Station (LS-1)

Volatile Organic Compounds

VOCs were not detected for the sediment sample collected from the LEHR Stormwater Lift Station.

Semivolatile Organic Compounds

Semivolatile organic compounds were not detected for the sample collected from the LEHR Stormwater Lift Station.

Pesticides and PCBs

Chlordane was reported at 65 $\mu$g/Kg in the sample collected from the LEHR Stormwater Lift Station. No other detections of pesticides or PCBs were reported for the sample collected from the LEHR Stormwater Lift Station.

Title 22 Metals

Reported metals concentrations are consistent with levels reported in the background samples (Section 6.4.1.1) and published regional background concentrations identified by Shacklette and Boerngen (1984). Hexavalent chromium was not reported in the sediment sample collected from the LEHR Stormwater Lift Station.

Radionuclides

No radionuclide activity was reported in the sediment sample collected from the LEHR Stormwater Lift Station.

Nitrates

Nitrate as (N) was reported at 6.4 mg/Kg in the sediment sample collected from the LEHR Stormwater Lift Station.

#### 6.4.2.3 Domestic Septic Tanks (Analysis not Received)

This task element has been deferred to the Planned RI/FS under CERCLA, and is therefore not included as a portion of this report.

### 6.4.3 Surface Water Sample Analysis

This section presents results for quarterly surface water sampling of the South Fork of Putah Creek and the UC Davis Wastewater Treatment Plant outfall. Five rounds of surface water samples were collected in November 1990, February 1991, May 1991, August 1991, and November 1991. Samples were collected from the three locations specified in the Work Plan for the Phase II Site Characterization (Dames & Moore, 1990f): the Wastewater Treatment Plant Outfall tributary (designated STPO); upstream of the LEHR facility (designated PCU); and, downstream of the LEHR facility (designated PCD). These locations are identified on Figure 6.15.

Surface water sampling procedures are described in Appendix A. Samples were shipped by overnight carrier to Controls for Environmental Pollution (CEP) Laboratories in Santa Fe, New Mexico. All samples were analyzed for parameters listed below. Complete analytical results are presented in Appendix H. Detections for each quarter are summarized in the following sections.

#### 6.4.3.1 Fall Quarter, November 1990

Fall 1990 surface water samples were collected on November 9, 1990 from sampling locations STPO, PCU, and PCD (Figure 6.15). A replicate sample was collected at location PCU.

Surface water samples were shipped by overnight delivery to CEP Laboratories on November 9, 1990. All requested analyses were performed on all four surface water samples; however, due to mishandling by the overnight carrier and laboratory error, all four samples exceeded holding times for hexavalent chromium (by 2 days), turbidity (by 1 day), and VOCs EPA Method 624 (by 8 days). Reported detections for Fall 1990 surface water samples are presented in Table 6.23 and are summarized below. Complete results for Fall 1990 surface water samples are presented in Appendix H, Tables H-2a through H-2g.

TABLE 6.23
SUMMARY OF DETECTIONS IN SURFACE WATER, FALL QUARTER, NOVEMBER 1990
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PCD | PCU | PCU | STPO |
|---|---|---|---|---|---|
| | DATE | 11/09/90 | 11/09/90 | 11/09/90 | 11/09/90 |
| | QA | | | D | |
| | ANALYTE | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 187 | 198 | 198 | 204 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 32.9 | 23.3 | 25.8 | 32.9 |
| | EC-F (umhos/cm) | 1017 | 1080 | - | 1237 |
| | TEMPERATURE-F (degrees C) | 16 | 16.5 | - | 22.8 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 644 | 642 | 646 | 602 |
| | TURBIDITY (NTU) | 8.42H | 6.49H | 14.1H | 8.96H |
| | TURBIDITY-F (NTU) | 7.5 | 8 | - | 8 |
| | pH-F | 7.37 | 7.2 | - | 7.29 |
| METALS ug/liter) | ANTIMONY (TOTAL) | 70 | 90 | 100 | 110 |
| | BARIUM (TOTAL) | 40 | 40 | 40 | 40 |
| | BERYLLIUM (TOTAL) | 6 | 4 | 6 | 6 |
| | CADMIUM (TOTAL) | 1 | 2 | 2 | 1 |
| | CHROMIUM (TOTAL) | - | 60 | 30 | 110 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | 10 | 10 |
| | LEAD (TOTAL) | 2 | 2 | 2 | 1 |
| | MOLYBDENUM (TOTAL) | 50 | 60 | 50 | 70 |
| | THALLIUM (TOTAL) | 80 | 90 | 90 | 100 |
| | ZINC (TOTAL) | 1190 | 39 | 42 | - |
| ANIONS AND CATIONS ug/liter) | CALCIUM (TOTAL) | 21800 | 18800 | 20100 | 21300 |
| | CHLORIDE | 156000 | 156000 | 148000 | 139000 |
| | MAGNESIUM (TOTAL) | 21000 | 21500 | 21700 | 20800 |
| | NITROGEN, NITRATE (AS N) | 5700 | 7300 | 7300 | 6500 |
| | PHOSPHATE, TOTAL (AS P) | 3200 | 4500 | 4100 | 4400 |
| | POTASSIUM (TOTAL) | 10300 | 10400 | 10400 | 10100 |
| | SODIUM (TOTAL) | 100500 | 104200 | 102200 | 103700 |
| | SULFATE | 77600 | 75700 | 80200 | 73600 |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | 10H | 4.9H | 4.2H | 3.4H |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | ALPHA-BHC | - | - | 0.008 | - |
| | DELTA-BHC | 0.012 | 0.023 | 0.02 | 0.027 |
| RADIONUCLIDES pCi/liter) | GROSS BETA | 8 | 17 | 13 | 20 |
| | STRONTIUM-90 | 4.2 | 2.6 | 4.2 | 5.4 |
| | TRITIUM | 1313 | 1341 | 1094 | 704 |

= Denotes either not detected or not analyzed. See Appendix H for complete analytical results.
) = Duplicate Sample.
H = Exceeded recommended holding time.
' = Measured in field

Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Fall Quarter 1990 surface water samples. Surrogate recoveries for organic analyses were met for approximately 96 percent of quality control samples, and matrix spike and duplicate analyses met acceptance criteria for approximately 93 percent of quality control samples.

Volatile Organic Compounds

Chloroform was the only VOC reported in the Fall 1990 surface water samples by EPA Method 624. Chloroform was reported in the four samples as follows: PCU (4.9 $\mu$g/L), PCU-replicate (4.2 $\mu$g/L), PCD (10 $\mu$g/L), and STPO (7.2 $\mu$g/L). The reported detection limit for chloroform is 1.6 $\mu$g/L.

Semivolatile Organic Compounds

No semivolatile organic compounds were reported for Fall 1990 surface water samples by EPA Method 625.

Pesticides and PCBs

Alpha-BHC and delta-BHC were the only organochlorine pesticide compounds reported in Fall 1990 surface water samples by EPA Method 608. Alpha-BHC was reported only in sample PCU at 0.008 $\mu$g/L, with a reported detection limit of 0.003 $\mu$g/L. Delta-BHC was reported in the four surface water samples, ranging from 0.012 $\mu$g/L (PCD) to 0.027 $\mu$g/L (STPO). No PCB compounds were reported by this method.

Title 22 Metals

Nine of the Title 22 metals were reported in Fall 1990 surface water samples, including antimony, barium, beryllium, cadmium, chromium, lead, molybdenum, thallium, and zinc. Antimony was reported in all four samples, ranging from 70 $\mu$g/L to 110 $\mu$g/L. The reported levels for antimony from the Fall 1990 samples are significantly higher than for subsequent quarters. Barium was reported in all four samples at 40 $\mu$g/L. Cadmium was reported in the four samples at 1$\mu$g/L or 2$\mu$g/L. Chromium was reported in samples PCU (60 $\mu$g/L), PCU-replicate (30 $\mu$g/L), and STPO (110 $\mu$g/L)/L. Lead was reported in the four samples at 1 $\mu$g/L or 2 $\mu$g/L. Molybdenum (ranging from 50 $\mu$g/L to 70 $\mu$g/L) and thallium (ranging from 80 $\mu$g/L to 100 $\mu$g/L) were reported in the four surface water samples. Zinc was reported in three samples, PCU (39 $\mu$g/L), PCU-replicate (42$\mu$g/L), and PCD (1,190 $\mu$g/L). The zinc value of 1,190 $\mu$g/L reported for sample PCD is the largest concentration of zinc reported for the five quarterly surface water samples collected in 1990 and 1991.

Hexavalent chromium (Cr VI) was reported in only PCU-replicate and STPO at 10$\mu$g/L. The detection limit for Cr VI was 10 $\mu$g/L.

Radionuclides

Gross beta, strontium-90, and tritium activity were reported in all four Fall 1990 surface water samples. Gross beta activity ranged from 8$\pm$3 pCi/L in PCD to 20+/-3 pCi/L in STPO. Strontium-90 was reported ranging from 2.6 pCi/L in PCU to 5.4 pCi/L in STPO. Tritium ranged from 704 pCi/L in STPO to 1,341 pCi in PCU. No gamma-producing radionuclides were reported.

Nitrates

Nitrate as (N) was reported in all four surface water samples. Reported values ranged from 5,700 $\mu$g/L in PCD to 7,300 $\mu$g/L in samples PCU and PCU-replicate.

General Chemical Parameters

The results for 14 general chemical parameters for Fall 1990 surface water samples are summarized in Table 6.24. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium.

#### 6.4.3.2 Winter Quarter, February 1991

Winter 1991 surface water samples were collected on February 6, 1991 from the STPO, PCU, and PCD surface water sample locations (Figure 6.15). A replicate sample was collected at location PCU.

Surface water samples were shipped by overnight delivery to CEP Laboratories on February 6, 1990. All requested analyses were performed on the four surface water samples, and all recommended holding times were met. Reported detections for all four Winter 1991 surface water samples are presented in Table 6.25 and are summarized below. Complete results are presented in Appendix H, Tables H-3a through H-3g.

TABLE 6.24
GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES
FALL 1990
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| PARAMETER | LOW | HIGH |
|---|---|---|
| pH (std. units) | 7.20 (PCU) | 7.37 (PCD) |
| EC (μmhos/cm) | 1,017 (PCD) | 1,237 (STPO) |
| Temperature (°C) | 16.0 (PCD) | 22.8 (STPO) |
| Turbidity (NTU) | 6.49 (PCU) | 14.1 (PCU) |
| TDS (mg/L) | 602 (STPO) | 646 (PCU-D) |
| COD (mg/L) | 23.3 (PCU) | 32.9 (STPO and PCD) |
| Alkalinity (mg/L) | 187 (PCD) | 204 (STPO) |
| Chloride (mg/L) | 139.0 (STPO) | 156.0 (PCU and PCD) |
| Sulfate (mg/L) | 73.6 (STPO) | 80.2 (PCU-D) |
| Phosphate (mg/L) | 3.2 (PCD) | 4.5 (PCU) |
| Calcium (mg/L) | 18.8 (PCU) | 21.8 (PCD) |
| Magnesium (mg/L) | 20.8 (STPO) | 21.7 (PCU-D) |
| Sodium (mg/L) | 100.5 (PCD) | 104.2 (PCU) |
| Potassium (mg/L) | 10.1 (STPO) | 10.4 (PCU) |

C = Centigrade
NTU = Nephelometric Turbidity Units
PCU = Putah Creek Upstream
PCD = Putah Creek Downstream
STPO = Sewage Treatment Plant Outfall

TABLE 6.25
SUMMARY OF DETECTIONS IN SURFACE WATER, WINTER QUARTER, FEBRUARY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PCD | PCU | PCU | STPO |
|---|---|---|---|---|---|
| | DATE | 02/06/91 | 02/06/91 | 02/06/91 | 02/06/91 |
| | QA | | | D | |
| | ANALYTE | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 138 | 115 | 117 | 194 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 151 | 90.8 | 101 | 8 |
| | EC-F (umhos/cm) | 622 | 365 | - | 1223 |
| | TEMPERATURE-F (degrees C) | 16.56 | 14.11 | - | 17.94 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 326 | 202 | 233 | 596 |
| | TURBIDITY (NTU) | 37.2 | 52.1 | 58.3 | 6.39 |
| | pH-F | 7.6 | 8.26 | - | 7.28 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 19 | - | - | - |
| | BARIUM (TOTAL) | 70 | 40 | 80 | - |
| | BERYLLIUM (TOTAL) | - | 1 | 1 | - |
| | CADMIUM (TOTAL) | 1 | 1 | 2 | 2 |
| | CHROMIUM (TOTAL) | 11 | - | - | - |
| | COPPER (TOTAL) | - | - | 30 | 30 |
| | LEAD (TOTAL) | 4 | 4 | 7 | - |
| | NICKEL (TOTAL) | - | 50 | 70 | - |
| | ZINC (TOTAL) | 50 | 50 | 60 | 40 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 13700 | 10800 | 12400 | 17900 |
| | CHLORIDE | 62800 | 28600 | 36500 | 142000 |
| | MAGNESIUM (TOTAL) | 7360 | 5970 | 5070 | 17700 |
| | NITROGEN, NITRATE (AS N) | 2000 | 400 | 1200 | 11900 |
| | PHOSPHATE, TOTAL (AS P) | 2800 | 1000 | 1400 | 4700 |
| | POTASSIUM (TOTAL) | 11100 | 6190 | 7750 | 13300 |
| | SODIUM (TOTAL) | 68700 | 35800 | 39000 | 121000 |
| | SULFATE | 51600 | 36200 | 40900 | 66200 |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | - | - | - | 7.4 |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | 4,4'-DDD | - | 0.018 | 0.022 | 0.047 |
| | 4,4'-DDE | 0.005 | 0.005 | - | - |
| | 4,4'-DDT | - | 0.013 | 0.015 | - |
| | ALDRIN | 0.037 | - | - | - |
| | ALPHA-BHC | - | - | 0.006 | 0.013 |
| | BETA-BHC | - | - | 0.024 | - |
| | DIELDRIN | 0.012 | 0.015 | 0.015 | 0.007 |
| | ENDOSULFAN I | 0.062 | 0.103 | 0.093 | - |
| | ENDOSULFAN II | - | 0.007 | 0.006 | - |
| | GAMMA-BHC | - | 0.006 | 0.023 | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | - | 3 | - | 7 |
| | GROSS BETA | 13 | 7 | 15 | 34 |
| | STRONTIUM-90 | - | - | - | 0.8 |

= Denotes either not detected or not analyzed. See Appendix H for complete analytical results.
) = Duplicate Sample.
: = Measured in field

Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Winter Quarter 1991 surface water samples. Surrogate recoveries for organic compound analyses fell within acceptance criteria for all but one quality control sample. Matrix spike and matrix spike duplicate analyses met acceptance criteria for all quality control samples for Winter Quarter 1990 surface water analyses.

Volatile Organic Compounds - EPA Method 624

Chloroform was the only VOC reported in Winter 1991 surface water samples. Chloroform was reported only in sample STPO at 7.4 $\mu$g/L, with a reported detection limit of 1.6 $\mu$g/L.

Semivolatile Organic Compounds - EPA Method 625

No semivolatile organic compounds were reported for Winter 1991 surface water samples by EPA Method 625.

Pesticides and PCBs - EPA Method 608

Ten organochlorine pesticide compounds were reported in Winter 1991, 4,4´-DDD, 4,4´-DDE, 4,4´-DDT, aldrin, alpha-BHC, beta-BHC, dieldrin, endosulfan I, endosulfan II, and gamma -BHC. The values ranged from 0.006 to 0.103 $\mu$g/L. All reported values for these compounds are presented in Table 6.25.

Title 22 Metals

Nine of the Title 22 metals were reported in Winter 1991 samples: antimony, barium, beryllium, cadmium, chromium, copper, lead, nickel, and zinc. Antimony was reported in one sample (PCD) at 19 $\mu$g/L. Barium was reported in PCD (70 $\mu$g/L), PCU (40 $\mu$g/L), and PCU-replicate (80 $\mu$g/L). Beryllium was reported in PCU and PCU-replicate at 1 $\mu$g/L. Cadmium was reported in all four samples at either 1$\mu$g/L or 2$\mu$g/L. Chromium was reported only in sample PCD at 11 $\mu$g/L. Copper was reported in two samples, PCU-replicate and STPO, at 30 $\mu$g/L. Lead was reported in three samples, ranging from at 4 $\mu$g/L to 7 $\mu$g/L. Nickel was reported in PCU (50 $\mu$g/L) and PCU-replicate (70 $\mu$g/L). Zinc was reported in all four samples, ranging from 40 $\mu$g/L to 60 $\mu$g/L.

Hexavalent chromium (Cr VI) was not reported in any Winter 1991 surface water samples. The reported detection limit for Cr VI was 10 $\mu$g/L.

Radionuclides

Gross alpha, gross beta, and strontium-90 activity were reported in the four Winter 1991 surface water samples. Gross alpha activity was reported in samples PCU at $3 \pm 2$ pCi/L and STPO at $7 \pm 3$ pCi/L. Gross beta activity was reported for all four samples, and ranged from 7+/-5 pCi/L in PCU to $34 \pm 4$ pCi/L in STPO. Strontium-90 was reported only in STPO at 0.8+/-0.7 pCi/L. Neither tritium nor gamma-producing radionuclides were reported in Winter 1991 surface water samples.

Nitrates

Nitrate as (N) was reported in the four surface water samples. Reported values ranged from 400 $\mu$g/L in PCU to 11,900 $\mu$g/L in STPO.

General Chemical Parameters

The results for 14 general chemical parameters for Winter 1991 surface water samples are summarized in Table 6.26. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium.

6.4.3.3 Spring Quarter, May 1991

Spring 1991 surface water samples were collected on May 16, 1991 from the STPO, PCU, and PCD surface water sample locations (Figure 6.15). A replicate sample was collected from location STPO.

Surface water samples were shipped by overnight delivery to CEP Laboratories on May 16, 1991. Due to a handling error by Federal Express, samples arrived on May 18, 1991, which caused exceedence of the holding times for Cr VI and turbidity. Each location (including replicate) was resampled for these two parameters on May 21, 1991 for analysis within the recommended holding times. Due to a laboratory error, surface water samples collected for analysis by EPA Method 625 were extracted 1 day beyond their recommended holding time of seven days. All remaining analyses were performed within recommended holding times.

TABLE 6.26
GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES
WINTER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| PARAMETER | LOW | HIGH |
|---|---|---|
| pH (std. units) | 7.28 (STPO) | 8.26 (PCU) |
| EC (μmhos/cm) | 365 (PCU) | 1223 (STPO) |
| Temperature (°C) | 14.1 (PCU) | 17.9 (STPO) |
| Turbidity (NTU) | 6.39 (STPO) | 58.3 (PCU-D) |
| TDS (mg/L) | 202 (PCU) | 596 (STPO) |
| COD (mg/L) | 8 (STPO) | 151 (PCD) |
| Alkalinity (mg/L) | 115 (PCU) | 194 (STPO) |
| Chloride (mg/L) | 28.6 (PCU) | 142 (STPO) |
| Sulfate (mg/L) | 36.2 (PCU) | 66.2 (STPO) |
| Phosphate (mg/L) | 1.0 (PCU) | 4.7 (STPO) |
| Calcium (mg/L) | 10.8 (PCU) | 17.9 (STPO) |
| Magnesium (mg/L) | 5.07 (PCU-D) | 17.7 (STPO) |
| Sodium (mg/L) | 35.8 (PCU) | 121.0 (STPO) |
| Potassium (mg/L) | 6.1 (PCU) | 13.3 (STPO) |

C = Centigrade
NTU = Nephelometric Turbidity Units
PCU = Putah Creek Upstream
PCD = Putah Creek Downstream
STPO = Sewage Treatment Plant Outfall

All reported detections for the four Winter 1991 surface water samples are presented in Table 6.27 and are summarized below. Complete results are presented in Appendix H, Tables H-4a through H-4g.

Volatile Organic Compounds - EPA Method 624

Chloroform, bromodichloromethane, and methylene chloride were the only VOCs reported in Spring 1991 surface water samples. Chloroform was reported in samples PCD (10.0 μg/L), STPO (3.1 μg/L), and STPO-replicate (3.1 μg/L). Bromodichloromethane was reported in samples PCD (4.1 μg/L) and STPO (2.2 μg/L). Methylene chloride was reported in one trip blank (3.4 μg/L) and in samples STPO (5.4 μg/L) and STPO-replicate (5.7 μg/L).

Semivolatile Organic Compounds - EPA Method 625

One semivolatile organic compound, bis (2-ethylhexyl) phthalate, was reported in samples STPO (4.4 μg/L) and STPO-replicate (7.8 μg/L) by EPA Method 625. No other semivolatile compounds were reported for Spring 1991 surface water samples.

Pesticides and PCBs - EPA Method 608

Three organochlorine pesticide compounds, alpha-BHC, beta-BHC, and delta-BHC, were reported in Spring 1991 surface water samples. The compound alpha-BHC was reported in PCD at 0.005 μg/L. Beta-BHC and delta-BHC were reported only in sample STPO-replicate at 0.019 μg/L and 0.13 μg/L, respectively.

Title 22 Metals

Five of the Title 22 metals were reported in Spring 1991 surface water samples: antimony, barium, lead, thallium, and zinc. Antimony was reported in all four samples, ranging from 1 μg/L to 3 μg/L. Barium was reported in PCD (70 μg/L), and PCU (80 μg/L). Thallium was reported in all four samples ranging from 1 μg/L to 4 μg/L. Lead was reported in three of four samples at 1 μg/L. Zinc was also reported in three of four samples at 30 μg/L.

Hexavalent chromium (Cr VI) was reported in the four Spring 1991 surface water samples, ranging from 11 μg/L to 19 μg/L.

TABLE 6.27
SUMMARY OF DETECTIONS IN SURFACE WATER, SPRING QUARTER, MAY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PCD | PCD | PCU | PCU | STPO | STPO | STPO | STPO |
|---|---|---|---|---|---|---|---|---|---|
| | DATE | 05/16/91 | 05/21/91 | 05/16/91 | 05/21/91 | 05/16/91 | 05/16/91 | 05/21/91 | 05/21/91 |
| | QA | | | | | | D | | D |
| | ANALYTE | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 193 | - | 184 | - | 220 | 229 | - | - |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 49.4 | - | 496 | - | 279 | 186 | - | - |
| | EC-F (umhos/cm) | 680 | | 381 | | 982 | | | |
| | TEMPERATURE-F (degrees C) | 23.2 | | 20.7 | | 23.9 | | | |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 459 | - | 277 | - | 558 | 563 | - | - |
| | TURBIDITY (NTU) | - | 25.2 | - | 38.5 | - | - | 4.5 | 4.6 |
| | TURBIDITY-F (NTU) | 28 | | 15 | | 3.5 | | | |
| | pH-F | 8.16 | | 8.75 | | 7.34 | | | |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 3 | - | 2 | - | 1 | 1 | - | - |
| | BARIUM (TOTAL) | 70 | - | 80 | - | - | - | - | - |
| | CHROMIUM, HEXAVALENT (+6) | - | 19 | - | 18 | - | - | 11 | 11 |
| | LEAD (TOTAL) | 1 | - | - | - | 1 | 1 | - | - |
| | THALLIUM (TOTAL) | 1 | - | 4 | - | 1 | 2 | - | - |
| | ZINC (TOTAL) | 30 | - | - | - | 30 | 30 | - | - |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 21700 | - | 25400 | - | 17800 | 17900 | - | - |
| | CHLORIDE | 64800 | - | 13400 | - | 76200 | 76600 | - | - |
| | MAGNESIUM (TOTAL) | 27600 | - | 35300 | - | 21400 | 21500 | - | - |
| | NITROGEN, NITRATE (AS N) | 5700 | - | - | - | 6500 | 6800 | - | - |
| | PHOSPHATE, TOTAL (AS P) | 1600 | - | - | - | 3600 | 3400 | - | - |
| | POTASSIUM (TOTAL) | 8000 | - | 1900 | - | 12900 | 12600 | - | - |
| | SODIUM (TOTAL) | 113000 | - | 19900 | - | 160300 | 157000 | - | - |
| | SULFATE | 54600 | - | 26800 | - | 64800 | 65100 | - | - |
| VOLATILE ORGANICS (ug/liter) | BROMODICHLOROMETHANE | 4.1 | - | - | - | 2.2 | - | - | - |
| | CHLOROFORM | 10 | - | - | - | 3.1 | 3.1 | - | - |
| | METHYLENE CHLORIDE | - | - | - | - | 5.4 | 5.7 | - | - |
| SEMIVOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | - | - | - | - | 4.4H | 7.8H | - | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | ALPHA-BHC | 0.005 | - | - | - | - | - | - | - |
| | BETA-BHC | - | - | - | - | - | 0.019 | - | - |
| | DELTA-BHC | - | - | - | - | - | 0.013 | - | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | - | - | 3 | - | - | 3 | - | - |
| | GROSS BETA | 7 | - | 9 | - | 12 | 16 | - | - |

- = Denotes either not detected or not analyzed. See Appendix H for complete analytical results.
D = Duplicate Sample.
H = Exceeded recommended holding time.
F = Measured in field

Radionuclides

Gross alpha and gross beta activity were reported in Spring 1991 surface water samples. Gross alpha activity was reported in samples PCU and STPO-replicate at $3 \pm 2$ pCi/L. Gross beta activity was reported for all four samples, and ranged from $7 \pm 3$ pCi/L in PCD to 16+/-4 pCi/L in STPO-replicate. Strontium-90, tritium, and gamma-producing radionuclides were not reported in Winter 1991 surface water samples.

Nitrates

Nitrate as (N) was reported in three Spring 1991 surface water samples: PCD at 5,700 $\mu$g/L; STPO at 6,500 $\mu$g/L; and STPO-replicate at 6,800 $\mu$g/L.

General Chemical Parameters

The results for 14 general chemical parameters for Spring 1991 surface water samples are summarized in Table 6.28. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium.

#### 6.4.3.4 Summer Quarter, August 1991

Summer 1991 surface water samples were collected on August 8, 1991 from the STPO, PCU, and PCD surface water sample locations (Figure 6.15). A replicate sample was collected at sample location STPO.

Surface water samples were shipped by overnight carrier to CEP Laboratories on August 8, 1991. All requested analyses were performed on the four samples and all holding times were met. Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Summer Quarter 1991 surface water samples. Surrogate recoveries for organic compound analyses fell within acceptance criteria for all quality control samples. Matrix spike and matrix spike duplicate analyses met acceptance criteria for all but one quality control sample for Winter Quarter 1991 surface water analyses.

TABLE 6.28
GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES
SPRING 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| PARAMETER | LOW | HIGH |
|---|---|---|
| pH (std. units) | 7.34 (STPO) | 8.75 (PCU) |
| EC (μmhos/cm) | 381 (PCU) | 962 (STPO) |
| Temperature (°C) | 20.7 (PCU) | 23.9 (STPO) |
| Turbidity (NTU) | 4.5 (STPO) | 38.5 (PCU) |
| TDS (mg/L) | 277 (PCU) | 563 (STPO-D) |
| COD (mg/L) | 49.4 (PCD) | 496 (PCU) |
| Alkalinity (mg/L) | 184 (PCU) | 229 (STPO) |
| Chloride (mg/L) | 13.4 (PCU) | 76.2 (STPO-D) |
| Sulfate (mg/L) | 26.8 (PCU) | 65.1 (STPO-D) |
| Phosphate (mg/L) | ND (PCU) | 3.6 (STPO) |
| Calcium (mg/L) | 17.8 (STPO) | 25.4 (PCU) |
| Magnesium (mg/L) | 21.4 (STPO) | 35.3 (PCU) |
| Sodium (mg/L) | 19.9 (PCU) | 160.3 (STPO) |
| Potassium (mg/L) | 1.9 (PCU) | 12.9 (STPO) |

C = Centigrade
NTU = Nephelometric Turbidity Units
PCU = Putah Creek Upstream
PCD = Putah Creek Downstream
STPO = Sewage Treatment Plant Outfall

Reported detections for the four Summer 1991 surface water samples are presented in Table 6.29 and are summarized below. Complete results are presented in Appendix H, Tables H-5a through H-5g.

Volatile Organic Compounds - EPA Method 624

Chloroform, bromodichloromethane, dibromochloromethane, and methylene chloride were the only VOCs reported in Summer 1991 surface water samples. Chloroform was reported in samples PCD at 14.0 μg/L, STPO at 5.7 μg/L, and STPO-replicate at 5.8 μg/L. Bromodichloromethane and dibromochloromethane were reported only in sample PCD, at 5.8 μg/L and 3.4 μg/L, respectively. Methylene chloride was reported only in sample STPO at 4.4 μg/L.

Semivolatile Organic Compounds - EPA Method 625

One semivolatile organic compound, di-n-butylphthalate, was reported in samples PCD at 4.4 μg/L, STPO at 4.6 μg/L, and STPO-replicate at 4.4 μg/L. No other semivolatile compounds were reported for Summer 1991 samples.

Pesticides and PCBs - EPA Method 608

Four organochlorine pesticide compounds, delta-BHC, endosulfan-II, gamma-BHC, and heptachlor, were reported in Summer 1991 surface water samples. Delta-BHC was reported in STPO and STPO-replicate at 0.032 μg/L and 0.033 μg/L, respectively. Endosulfan II and gamma-BHC were reported only in sample STPO-replicate at 0.007 μg/L and 0.009 μg/L respectively. Heptachlor was reported in sample STPO at 0.012 μg/L and STPO-replicate at 0.018 μg/L.

Title 22 Metals

Seven of the Title 22 metals were reported in Summer 1991 surface water samples, including antimony, barium, copper, lead, silver, thallium, and zinc. Antimony, barium, lead, and zinc were reported in all four samples. Antimony ranged from 2 μg/L to 3 μg/L, barium ranged from 40 μg/L in STPO-replicate to 120 μg/L in PCD, lead ranged from 3 μg/L in PCU to 7 μg/L in PCD, and zinc ranged from 30 μg/L in PCU to 100 μg/L in STPO. Copper was reported in STPO at 30 μg/L and in PCD at 50 μg/L. Thallium was reported in PCD at 1 μg/L and PCU at 4 μg/L. Silver was reported in STPO and STPO-replicate at 30 and 50 μg/L, respectively.

TABLE 6.29
SUMMARY OF DETECTIONS IN SURFACE WATER, SUMMER QUARTER, AUGUST 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PCD | PCU | STPO | STPO |
|---|---|---|---|---|---|
| | DATE | 08/08/91 | 08/08/91 | 08/08/91 | 08/08/91 |
| | QA | | | | D |
| | ANALYTE | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 194.03 | 246.26 | 217.41 | 215.17 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 25.73 | 23.64 | 23.77 | 20.66 |
| | EC-F (umhos/cm) | 985 | 691 | 1166 | - |
| | TEMPERATURE-F (degrees C) | 28.9 | 25.6 | 27.2 | - |
| | TOTAL DISSOLVED SOLIDS | 568 | 430 | 632 | 615 |
| | TURBIDITY (NTU) | 26 | 28.6 | 7.33 | 4.83 |
| | TURBIDITY-F (NTU) | 29.6 | 26.1 | 3.4 | - |
| | pH-F | 8.81 | 9.2 | 7.26 | - |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 3 | 3 | 2 | 3 |
| | BARIUM (TOTAL) | 120 | 110 | 60 | 40 |
| | CHROMIUM, HEXAVALENT (+6) | 20 | 10 | 10 | - |
| | COPPER (TOTAL) | 50 | - | 30 | - |
| | LEAD (TOTAL) | 7 | 3 | 7 | 4 |
| | SILVER (TOTAL) | - | - | 30 | 50 |
| | THALLIUM (TOTAL) | 1 | 2 | - | - |
| | ZINC (TOTAL) | 40 | 30 | 100 | 70 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 20100 | 25300 | 17900 | 17600 |
| | CHLORIDE | 145760 | 32670 | 156180 | 161360 |
| | MAGNESIUM (TOTAL) | 25300 | 36700 | 20400 | 20600 |
| | NITROGEN, NITRATE (AS N) | 3910 | - | 5220 | 5340 |
| | PHOSPHATE, TOTAL (AS P) | 1500 | - | 3300 | 2700 |
| | POTASSIUM (TOTAL) | 6200 | 3000 | 8300 | 8400 |
| | SODIUM (TOTAL) | 106600 | 49800 | 129100 | 136900 |
| | SULFATE | 55660 | 84560 | 64070 | 71940 |
| VOLATILE ORGANICS (ug/liter) | BROMODICHLOROMETHANE | 5.8 | - | - | - |
| | CHLOROFORM | 14 | - | 5.7 | 5.8 |
| | DIBROMOCHLOROMETHANE | 3.4 | - | - | - |
| | METHYLENE CHLORIDE | - | - | - | 4.4 |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | DI-N-BUTYLPHTHALATE | 4.4 | - | 4.6 | 4.4 |
| | DELTA-BHC | - | - | 0.032 | 0.033 |
| | ENDOSULFAN II | - | - | - | 0.007 |
| | GAMMA-BHC | - | - | - | 0.009 |
| | HEPTACHLOR | - | - | 0.012 | 0.018 |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | 3 | - | - | - |
| | GROSS BETA | 9 | 3 | 11 | 13 |
| | STRONTIUM-90 | 1.8 | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix H for complete analytical results.
D = Duplicate Sample.
F = Measured in field

Hexavalent chromium (Cr VI) was reported in three of four Summer 1991 surface water samples. ranging from 10 $\mu$g/L in STPO and PCU to 20 $\mu$g/L in PCD. The reported detection limit for Cr VI was 10 $\mu$g/L.

Radionuclides

Gross alpha, gross beta, and strontium-90 activity were reported in Summer 1991 surface water samples. Gross alpha and strontium-90 activity was reported only in sample PCD at $3 \pm 2$ pCi/L and 1.8 pCi/L, respectively. Gross beta activity was reported for the four samples ranging from $3 \pm 2$ pCi/L in PCU to $13 \pm 3$ pCi/L in STPO-replicate. Tritium and gamma-producing radionuclides were not reported in Summer 1991 surface water samples.

Nitrates

Nitrate as (N) was reported in three Summer 1991 surface water samples: PCD at 3,910 $\mu$g/L; STPO at 5,220 $\mu$g/L; and STPO-replicate at 5,340 $\mu$g/L. These results are similar to Spring 1991 surface water sample results.

General Chemical Parameters

The results for 14 general chemical parameters for Summer 1991 surface water samples are summarized in Table 6.30. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium.

#### 6.4.3.5 Fall Quarter, November 1991

Fall 1991 surface water samples were collected on November 21, 1991 from the STPO, PCU, and PCD surface water sample locations. A replicate sample was collected at sample location PCD. In addition to an unfiltered metals sample, a filtered metals sample was collected at each surface water location to compare reported concentrations for total metals (unfiltered), and dissolved metals (filtered) in surface water.

TABLE 6.30
GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES
SUMMER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| PARAMETER | LOW | HIGH |
|---|---|---|
| pH (std. units) | 7.26 (STPO) | 9.2 (PCU) |
| EC (μmhos/cm) | 691 (PCU) | 1,166 (STPO) |
| Temperature (°C) | 25.6 (PCU) | 28.9 (PCD) |
| Turbidity (NTU) | 4.8 (STPO-D) | 28.6 (PCU) |
| TDS (mg/L) | 430 (PCU) | 632 (STPO) |
| COD (mg/L) | 20.66 (STPO-D) | 25.73 (PCD) |
| Alkalinity (mg/L) | 194 (PCD) | 246 (PCU) |
| Chloride (mg/L) | 32.7 (PCU) | 161.4 (STPO-D) |
| Sulfate (mg/L) | 55.7 (PCD) | 84.6 (PCU) |
| Phosphate (mg/L) | ND (PCU) | 3.3 (STPO) |
| Calcium (mg/L) | 17.6 (STPO-D) | 25.3 (PCU) |
| Magnesium (mg/L) | 20.4 (STPO) | 36.7 (PCU) |
| Sodium (mg/L) | 49.8 (PCU) | 136.9 (STPO-D) |
| Potassium (mg/L) | 3.0 (PCU) | 3.3 (STPO) |

C = Centigrade
NTU = Nephelometric Turbidity Units
PCU = Putah Creek Upstream
PCD = Putah Creek Downstream
STPO = Sewage Treatment Plant Outfall

All requested analyses were performed on the Fall 1991 surface water samples; however, during overnight delivery, four glass containers containing water samples for PCD and PCD-replicate were broken. Because all analytes were covered by surviving containers for the sample and replicate, the PCD location was not resampled.

Laboratory control samples for all remaining organic and inorganic parameters fell within acceptance criteria for Fall Quarter 1991 surface water samples. Surrogate recoveries for remaining organic compound analyses fell within acceptance criteria for all but one quality control sample. Matrix spike and matrix spike duplicate analyses met acceptance criteria for all quality control samples for Fall Quarter 1991 surface water analyses.

Required holding times for all analyses were met, except for EPA Method 624 (VOCs). The 624 analyses were completed one day after the recommended holding times, after results for surrogate sample analyses were found to be out of the QC limits. Results for re-analysis of the samples were within laboratory QC limits, but were completed 15 days after sampling, one day past the suggested holding time. CEP Laboratories indicated that the data was unaffected by the missed holding time.

Reported detections for the four Fall 1991 surface water samples are presented in Table 6.31 and are summarized below. Complete results for Fall 1991 surface water samples are presented in Appendix H.

Volatile Organic Compounds - EPA Method 624

Chloroform was the only VOC reported in Fall 1991 surface water samples. Chloroform was reported in two samples, PCU at 2.0 $\mu$g/L and STPO at 7.2 $\mu$g/L, with a reported detection limit of 1.6 $\mu$g/L.

Semivolatile Organic Compounds - EPA Method 625

No semivolatile organic compounds were reported for Fall 1991 surface water samples.

TABLE 6.31
SUMMARY OF DETECTIONS IN SURFACE WATER, FALL QUARTER, NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | PCD | PCD-B | PCD-B-F | PCD-F | PCU | PCU-F | STPO | STPO-F |
|---|---|---|---|---|---|---|---|---|---|
| | DATE | 11/21/91 | 11/21/91 | 11/21/91 | 11/21/91 | 11/21/91 | 11/21/91 | 11/21/91 | 11/21/91 |
| | QA | | D | D | | | | | |
| | ANALYTE | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 183 | 200 | - | - | 185 | - | 183 | - |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 32 | 40 | - | - | 27.2 | - | 46.4 | - |
| | EC-F (umhos/cm) | 569 | - | - | - | 373 | - | 1110 | - |
| | TEMPERATURE-F (degrees C) | 16 | - | - | - | 10.5 | - | 20 | - |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 323 | 306 | - | - | 196 | - | 605 | - |
| | TURBIDITY (NTU) | 8.8 | 8.7 | - | - | 8.52 | - | 8.55 | - |
| | TURBIDITY-F (NTU) | 9.28 | - | - | - | 4.7 | - | 4.25 | - |
| | pH-F | 8.55 | - | - | - | 8.36 | - | 7.39 | - |
| METALS (ug/liter) | BARIUM (TOTAL) | - | 60 | 60 | 60 | 80 | 80 | 30 | - |
| | CHROMIUM (TOTAL) | 70 | - | - | - | - | - | 70 | - |
| | LEAD (TOTAL) | 1 | 1 | - | - | - | - | 3 | 1 |
| | MOLYBDENUM (TOTAL) | - | - | - | - | - | - | 71 | 50 |
| | SELENIUM (TOTAL) | - | - | - | - | - | - | 54 | 39 |
| | SILVER (TOTAL) | 80 | - | - | - | - | - | 80 | - |
| | ZINC (TOTAL) | - | - | - | - | - | - | 30 | 30 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 19900 | 20000 | 20100 | 20100 | 20600 | 20300 | 18600 | 18600 |
| | CHLORIDE | 50200 | 57000 | - | - | 8490 | - | 106000 | - |
| | MAGNESIUM (TOTAL) | 28300 | 28500 | 28700 | 28500 | 32100 | 30800 | 23100 | 22800 |
| | NITROGEN, NITRATE (AS N) | 4080 | 3470 | - | - | - | - | 10940 | - |
| | PHOSPHATE, TOTAL (AS P) | 3000 | 3200 | - | - | - | - | 11700 | - |
| | POTASSIUM (TOTAL) | 4800 | 4700 | 4500 | 4600 | 16900 | 1700 | 13800 | 12900 |
| | SODIUM (TOTAL) | 40200 | 38300 | 34700 | 36000 | 23400 | 23800 | 249000 | 286000 |
| | SULFATE | 30000 | 30600 | - | - | 22400 | - | 50400 | - |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | -H | -H | - | - | 2H | - | 7.2H | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | ALPHA-BHC | -H | -H | - | - | -H | - | 0.01H | - |
| | - | - | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | 31 | 25 | - | - | - | - | - | - |
| | GROSS BETA | 62 | 46 | - | - | - | - | 4 | - |

- = Denotes either not detected or not analyzed. See Appendix H for complete analytical results.
D = Duplicate Sample.
H = Exceeded recommended holding time.
F = Measured in field
Filtered samples (XXX-F) were analyzed for metals and cations only.

Pesticides and PCBs - EPA Method 608

Alpha-BHC was the only organochlorine pesticide compound reported in Fall 1991 surface water samples by EPA Method 608. Alpha-BHC was reported in STPO at 0.010 $\mu$g/L, with a detection limit of 0.003 $\mu$g/L.

Title 22 Metals

Eight Fall 1991 surface water samples were analyzed for Title 22 metals. Four samples (STPO, PCU, PCD, and PCD-replicate) were not filtered in the field. Four samples (STPO-F, PCU-F, PCD-F, and PCD-replicate) were filtered in the field. Seven of the Title 22 metals were reported in the eight samples: barium; chromium; lead; molybdenum; selenium; silver; and zinc. Barium was reported in six samples, ranging in concentration from 30 $\mu$g/L to 80 $\mu$g/L, with a reported detection of 30 $\mu$g/L. Chromium was reported in samples PCD and STPO at a concentration of 70 $\mu$g/L. Lead was reported in samples PCD, PCD-replicate, STPO, and STPO-F at values ranging from 1 $\mu$g/L to 3 $\mu$g/L. The reported detection limit for lead is 1 $\mu$g/L. Silver was reported at 80 $\mu$g/L in samples PCD and STPO. Molybdenum, selenium, and zinc were reported in samples STPO and STPO-F. Hexavalent chromium (Cr VI) was analyzed only for unfiltered surface water samples, and was not reported above the detection limit.

Radionuclides

Gross alpha and gross beta activity was reported in Fall 1991 surface water samples. Gross alpha activity was reported for PCD at $31 \pm 6$ pCi/L and PCD-replicate at $25 \pm 5$ pCi/L. Gross beta activity was reported for samples PCD at $62 \pm 8$ pCi/L, PCD-replicate at $46 \pm 8$ pCi/L, and STPO at $4 \pm 3$ pCi/L. Tritium and strontium-90 were not reported in any Fall 1991 samples. No gamma producing-radionuclides were reported from the gamma spectral analysis.

Nitrates

Nitrate as (N) was reported in three of four surface water samples. Reported values ranged from 3,470 $\mu$g/L in PCD-replicate and 4,080 $\mu$g/L in PCD, to 10,490 $\mu$g/L in sample STPO.

General Chemical Parameters

The results for 14 general chemical parameters for surface water samples are summarized in Table 6.32. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium.

TABLE 6.32
REPORTED CONCENTRATION RANGES FOR
GENERAL CHEMICAL PARAMETERS IN SURFACE WATER SAMPLES
FALL 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| PARAMETER | LOW | HIGH |
|---|---|---|
| pH (std. units) | 7.39 (STPO) | 8.55 (PCD) |
| EC (μmhos/cm) | 737 (PCU) | 1110 (STPO) |
| Temperature (°C) | 10.5 (PCU) | 20 (STPO) |
| Turbidity (NTU) | 8.52 (PCU) | 8.8 (PCD) |
| TDS (mg/L) | 196 (PCU) | 605 (STPO) |
| COD (mg/L) | 27.2 (PCU) | 46.4 (STPO) |
| Alkalinity (mg/L) | 183 (PCD & STPO) | 200 (PCD-B) |
| Chloride (mg/L) | 8.49 (PCU) | 106.0 (STPO) |
| Sulfate (mg/L) | 22.4 (PCU) | 50.4 (STPO) |
| Phosphate (mg/L) | ND (PCU) | 11.7 (STPO) |
| Calcium (mg/L) | 18.6 (STPO) | 20.6 (PCU) |
| Magnesium (mg/L) | 22.8 (STPO-F) | 32.1 (PCU) |
| Sodium (mg/L) | 23.4 (PCU) | 286.0 (STPO-F) |
| Potassium (mg/L) | 1.7 (PCU-F) | 16.9 (PCU) |

C = Centigrade
NTU = Nephelometric Turbidity Units
PCU = Putah Creek Upstream
PCD = Putah Creek Downstream
STPO = Sewage Treatment Plant Outfall

### 6.4.4 Groundwater Sample Analysis

Presented below are results for quarterly groundwater sampling of monitoring wells on and around the LEHR facility. Eighteen groundwater monitoring wells were sampled each in November 1990, February 1991, May 1991, August 1991, and November 1991. The actual number of samples varied from quarter to quarter due to dry wells (Table 6.33). Well locations are presented in Figure 6.16.

Groundwater sampling procedures are described in Appendix A. Samples were analyzed for the parameters listed below.

List 1

- 17 Title 22 Metals
- Hexavalent Chromium
- Nitrates as (N)
- Turbidity (Lab)
- Formaldehyde
- Organochlorine Pesticides
- Volatile Organic Compounds
- Semivolatile Organic Compounds
- Gross Alpha
- Gross Beta
- Tritium
- Strontium-90
- Gamma-Emitters
- Phosphate
- Chloride
- Alkalinity
- TDS
- COD
- Calcium
- Magnesium
- Potassium
- Sulfate
- Sodium
- Carbon-14 (for wells UCD-4, -13, -14, -15, -17, -18)
- Temperature (Field)
- EC (Field)
- pH (Field)
- Turbidity (Field)

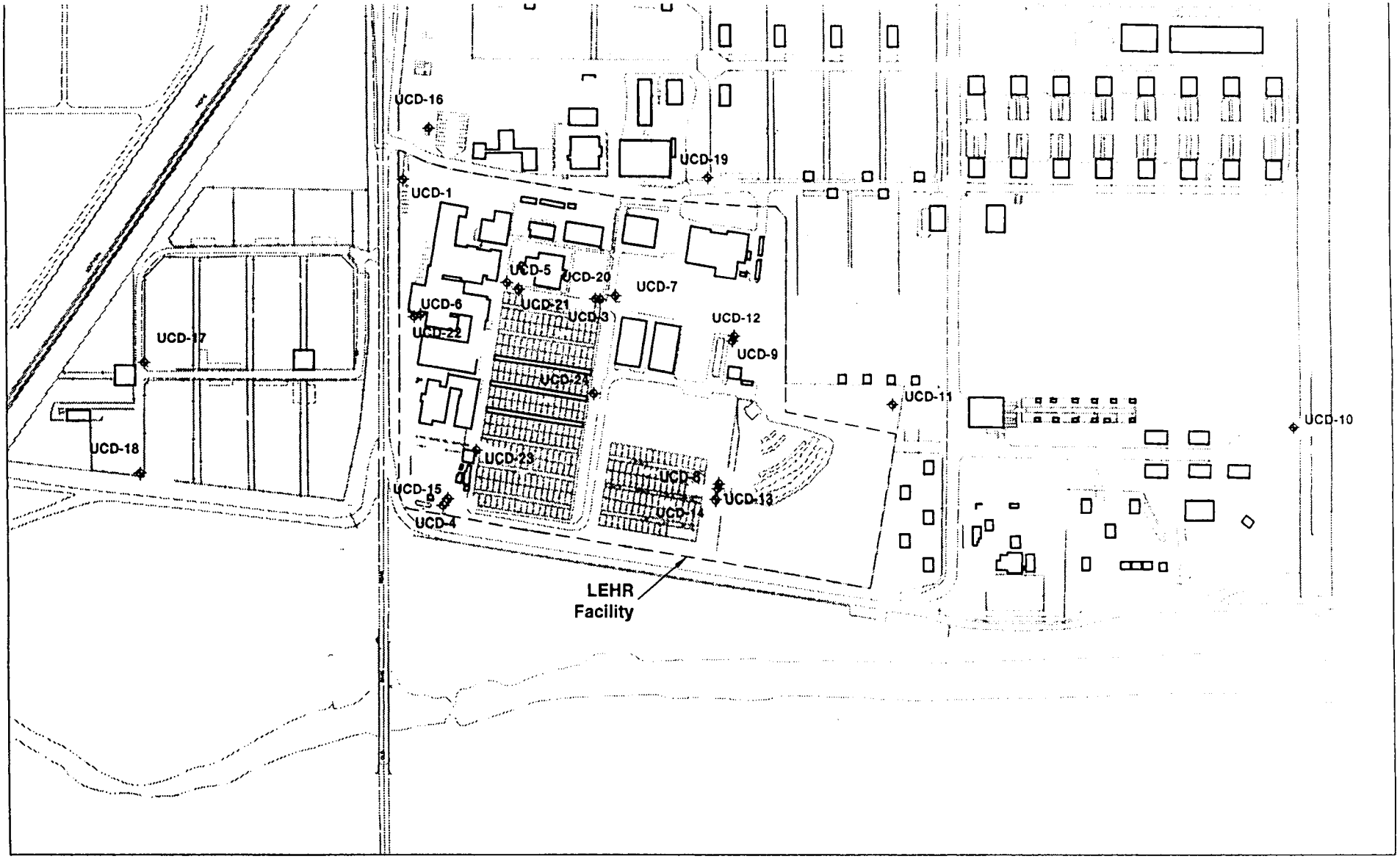
Complete analytical results are presented in Appendix G. Detections for each quarter are presented in tabular form, and discussed below. Anomalous data values were identified during QC review of analytical results and are discussed below for each quarter and noted on data tables.

TABLE 6.33
GROUNDWATER SAMPLING SCHEDULE
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Well | Fall Quarter October/November | Winter Quarter February | Spring Quarter May | Summer Quarter August | Fall Quarter November |
|---|---|---|---|---|---|
| UCD-1 | SB | S | S | DRY | SB |
| UCD-4 | DRY | S | S | DRY | SB |
| UCD-7 | S | S | S | S | S |
| UCD-10 | S | S | S | SP | S* |
| UCD-11 | S | S | S* | DRY | S |
| UCD-12 | SB | S* | S | DRY | S |
| UCD-13 | SB | S | S | DRY | S |
| UCD-14 | S | S | S | S* | S |
| UCD-15 | S* | S | S | S | S |
| UCD-16 | S | S | S | S | S |
| UCD-17 | S | S | S | S | S |
| UCD-18 | DS | S | S | S | S |
| UCD-19 | DS | S | S | SB* | S |
| UCD-20 | DS | S | S | S | S |
| UCD-21 | DS | S | S | S | S |
| UCD-22 | DS | S* | S | S | S* |
| UCD-23 | DS | S | S* | S | S |
| UCD-24 | DS* | S | S | S | S |

Wells UCD-3, -5, -6, -8, and -9 were not sampled during quarterly sampling for the Phase II Investigation.

S - Well purged and sampled with dedicated bladder or submersible pump. A full suite of samples was obtained.
* - Replicated well.
DS - Well was developed with a submersible pump, then sampled with a disposable bailer.
SB - Well was purged and/or sampled by bailer due to low water levels.
DRY - No water in well; no sample obtained.
SP - Only a partial sample suite recovered due to low water levels.




EXPLANATION

Monitoring Wells

0 300

Scale in Feet

N

# LOCATION MAP
# GROUNDWATER MONITORING WELLS

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-150

FIGURE 6.16

6.4.4.1 Fall Quarter, November 1990

Dames & Moore sampled seventeen groundwater monitoring wells between October 29 and November 9, 1990. Seven wells (UCD-7, -10, -11, -14, -15, -16, and -17) were purged and sampled with dedicated pumps. Due to low water levels, two wells (UCD-12 and 13) were purged with dedicated purge pumps and sampled with disposable bailers, and one well (UCD-1) was purged and sampled with a disposable bailer. Well UCD-4 was dry and not sampled. Replicate samples from two monitoring wells (UCD-15 and UCD-24) were obtained by collecting identical sets of sample bottles from each well, and labeling the replicate sample with a fictitious sample identification (UCD-15B and UCD-24B).

Groundwater samples were shipped daily via Federal Express for overnight delivery to CEP Laboratories in Santa Fe, New Mexico. Overnight delivery of three shipments was delayed due to handling errors by Federal Express. Because of these errors, samples for UCD-16 and UCD-17 arrived 3 days after shipping, and samples UCD-10, UCD-15, UCD-15B, UCD-1, and UCD-21 arrived 4 days after shipping.

All requested analyses were performed on November 1990 samples; however, due in part to shipping delays and in part to laboratory error, several samples exceeded their recommended holding times for the analyses listed below:

| Samples | Analysis/Holding Time Exceedence | Delivery or Lab |
|---|---|---|
| UCD-19 | Cr VI by 5 days | Lab |
| UCD-16 and UCD-17 | Turbidity by 1 day | Delivery |
| | Cr VI by 2 days | Delivery |
| | 624 by 8 days | Lab |
| UCD-11 and UCD-23 | Cr VI by 1 day | Lab |
| | Turbidity by 1 day | Lab |
| UCD-22 | Turbidity by 24 days | Lab |
| | Cr VI by 1 day | Lab |
| UCD-10, UCD-15, UCD-15B | Cr VI by 4 days | Delivery |
| | Turbidity by 4 days | Delivery |
| | 624 by 22 days | Lab |
| UCD-1 and UCD-21 | Cr VI by 4 days | Delivery |
| UCD-12 and UCD-18 | Cr VI by 1 day | Lab |
| | Turbidity by 6 days | Lab |
| UCD-13, UCD-14, UCD-20 | Cr VI by 3 days | Lab |
| | Turbidity by 6 days | Lab |
| | Alkalinity by 5 days | Lab |

Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Fall Quarter 1990 groundwater samples. Surrogate recoveries for organic compound analyses were met for approximately 96 percent of quality control samples. Matrix spike and matrix spike duplicate analyses met acceptance criteria for approximately 90 percent of quality control samples.

Reported analytical detections for November 1991 groundwater samples are presented in Table 6.34 and are summarized below. Complete results for Fall 1991 groundwater samples are presented in Appendix G.

Volatile Organic Compounds (VOCs) - EPA Method 624

Four VOCs, 1,1 dichloroethane (1,1-DCA), 1,1 dichloroethene (1,1-DCE), 1,2 dichloroethane (1,2-DCA), and chloroform, were reported in Fall 1990 groundwater samples. Detections of 1,1-DCA at 24.7 $\mu$g/L, 1,1-DCE at 53.8 $\mu$g/L, and 1,2-DCA at 15.5 $\mu$g/L were reported only in sample UCD-12. Chloroform was reported in five samples, ranging from 2.4 $\mu$g/L in UCD-21 to 2,300 $\mu$g/L in UCD-12.

Semivolatile Organic Compounds - EPA Method 625

Three semivolatile organic compounds, benzyl butyl phthalate, bis (2-ethylhexyl) phthalate, and di-n-butylphthalate, were reported for Fall 1990 groundwater samples by EPA Method 625. Benzyl butyl phthalate was reported in UCD-11 at 6 $\mu$g/L, UCD-18 at 13.4 $\mu$g/L, and UCD-23 at 5 $\mu$g/L. Bis (2-ethylhexyl) phthalate was reported in UCD-7 at 14.8 $\mu$g/L and UCD-19 at 23.6 $\mu$g/L. Di-n-butylphthalate was reported in UCD-19 at 7.6 $\mu$g/L.

Pesticides and PCBs - EPA Method 608

Four organochlorine pesticide compounds were reported in Fall 1990 groundwater samples by EPA Method 608. Aldrin was reported in UCD-12 at 0.004 $\mu$g/L. Alpha-BHC was reported in UCD-7 at 0.003 $\mu$g/L. Dieldrin was reported in UCD-13 at 0.021 $\mu$g/L. Gamma-BHC was reported in samples UCD-15 and UCD-15 duplicate at 0.008 $\mu$g/L and 0.004 $\mu$g/L, respectively.

TABLE 6.34
SUMMARY OF DETECTIONS IN GROUNDWATER, FALL QUARTER, NOVEMBER 1990
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE<br>DATE<br>QA | UCD-01<br>11/02/90 | UCD-07<br>10/29/90 | UCD-10<br>11/08/90 | UCD-11<br>11/05/90 | UCD-12<br>10/31/90 | UCD-13<br>11/01/90 | UCD-14<br>11/01/90 |
|---|---|---|---|---|---|---|---|---|
| | ANALYTE | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 704 | 389 | 704 | 451 | 766 | 836H | 466H |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 24 | 32 | 1.2 | 0 | 38 | 8 | 3.15 |
| | EC-F (umhos/cm) | 1001 | 810 | 1530 | 990 | 2480 | 1039 | 733 |
| | TEMPERATURE-F (degrees C) | 18.1 | 19.1 | 18 | 18.5 | 18.7 | 18.5 | 19 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 818 | 510 | 1300 | 766 | 2000 | 1010 | 694 |
| | TURBIDITY (NTU) | 0 | 0.55 | 2.63H | 0.093H | 81H | 40.5H | 1.91H |
| | TURBIDITY-F (NTU) | 200 | 1.78 | 6 | 0.52 | 28.1 | 27.5 | 3.3 |
| | pH-F | 6.82 | 7.29 | 7.52 | 6.97 | 7.32 | 7.34 | 7.11 |
| METALS | ANTIMONY (TOTAL) | 310 | 100 | 330 | 240 | 260 | 280 | 170 |
| ug/liter) | BARIUM (TOTAL) | 200 | 160 | - | 120 | 400 | 180 | 150 |
| | BERYLLIUM (TOTAL) | - | 1 | 2 | 1 | 1 | - | 2 |
| | CADMIUM (TOTAL) | 2 | - | - | - | 2 | 1 | - |
| | CHROMIUM (TOTAL) | - | - | - | 280 | 140 | 100 | 40 |
| | CHROMIUM, HEXAVALENT (+6) | 80H | 40 | 30H | 400H | 160H | 70H | 30H |
| | LEAD (TOTAL) | - | 1 | - | - | - | - | - |
| | MERCURY (TOTAL) | - | - | - | - | - | - | - |
| | MOLYBDENUM (TOTAL) | 260 | 60 | 250 | 150 | 170 | 210 | 100 |
| | SELENIUM (TOTAL) | - | - | - | 10 | - | - | - |
| | THALLIUM (TOTAL) | 270 | 80 | 250 | 180 | 200 | 220 | 150 |
| | ZINC (TOTAL) | 40 | - | - | - | - | 30 | - |
| NIONS AND CATIONS | CALCIUM (TOTAL) | 46800 | 39500 | 52000 | 37600 | 90100 | 83300 | 53700 |
| g/liter) | CHLORIDE | 35600 | 28100 | 27500 | 45900 | 375000 | 40900 | 30700 |
| | MAGNESIUM (TOTAL) | 88000 | 65900 | 157000 | 73700 | 250000 | 168000 | 89000 |
| | NITROGEN, NITRATE (AS N) | 10300 | 10900 | 11600 | 4700 | 108000 | 15400 | 9400 |
| | PHOSPHATE, TOTAL (AS P) | 300 | - | 200 | 1000 | 500 | 600 | 700 |
| | POTASSIUM (TOTAL) | 1300 | 700 | 1800 | 1700 | 3700 | 2900 | 1300 |
| | SODIUM (TOTAL) | 39100 | 50700 | 157000 | 67900 | 115000 | 57700 | 46300 |
| | SULFATE | 64600 | 45200 | 392000 | 56400 | 167000 | 125100 | 75400 |
| OLATILE ORGANICS | 1,1-DICHLOROETHANE | - | - | - | - | 24.7 | - | - |
| g/liter) | 1,1-DICHLOROETHENE | - | - | - | - | 53.8 | - | - |
| | 1,2-DICHLOROETHANE | - | - | - | - | 15.5 | - | - |
| | CHLOROFORM | - | - | 2.8 | - | 2300 | - | 6 |
| EMI-VOLATILE ORGANICS | BENZYL BUTYL PHTHALATE | - | - | - | 6 | - | - | - |
| g/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | - | 14.6 | - | - | - | - | - |
| | DI-N-BUTYLPHTHALATE | - | - | - | - | - | - | - |
| HLORINATED PESTICIDES | ALDRIN | - | - | - | - | 0.004 | - | - |
| ND PCBS | ALPHA-BHC | - | 0.003 | - | - | - | - | - |
| g/liter) | DIELDRIN | - | - | - | - | - | 0.021 | - |
| | GAMMA-BHC | - | - | - | - | - | - | - |
| ADIONUCLIDES | GROSS ALPHA | 27 | 4 | - | - | 7 | - | - |
| CI/liter) | GROSS BETA | 62 | 9 | - | - | 8 | 9 | 3 |
| | STRONTIUM-90 | - | - | - | - | - | - | - |
| | TRITIUM | - | - | - | 1382 | 1172 | 29066 | 3864 |

= Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
= Duplicate Sample.
= Exceeded recommended holding time
= Measured in field

TABLE 6.34 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, FALL QUARTER, NOVEMBER 1990
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-15 | UCD-15B | UCD-16 | UCD-17 | UCD-18 | UCD-19 | UCD-20 |
|---|---|---|---|---|---|---|---|---|
| | DATE | 11/08/90 | 11/08/90 | 11/09/90 | 11/09/90 | 10/31/90 | 10/30/90 | 11/01/90 |
| | QA | | D | | | | | |
| | ANALYTE | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 297 | 396 | 407 | 352 | 398 | 653 | 704H |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 2 | 4 | 1.2 | 2 | 32 | 20 | 6.3 |
| | EC-F (umhos/cm) | 649 | - | 680 | 670 | 720 | 1217 | 1360 |
| | TEMPERATURE-F (degrees C) | 18.3 | - | 18.4 | 18.8 | 19.2 | 20.3 | 19.5 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 448 | 462 | 486 | 490 | 432 | 786 | 920 |
| | TURBIDITY (NTU) | 0.345H | 0.481H | 0.598H | 0.183H | 279H | 150 | 152H |
| | TURBIDITY-F (NTU) | 0.63 | - | 0.4 | 0.18 | 3.7 | 4 | 17.1 |
| | pH-F | 7.79 | - | 7.37 | 7.37 | 7.69 | 7.54 | 7.53 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 190 | 150 | 190 | 200 | 120 | 120 | 120 |
| | BARIUM (TOTAL) | 160 | 160 | 150 | 150 | 50 | 30 | 130 |
| | BERYLLIUM (TOTAL) | 5 | 5 | 5 | 6 | 3 | 1 | 3 |
| | CADMIUM (TOTAL) | - | - | - | - | 1 | 2 | 1 |
| | CHROMIUM (TOTAL) | 70 | 50 | 150 | 50 | - | 180 | 60 |
| | CHROMIUM, HEXAVALENT (+6) | 10H | 10H | 30H | 20H | 10H | 200H | 70H |
| | LEAD (TOTAL) | - | - | - | - | 1 | 3 | - |
| | MERCURY (TOTAL) | - | - | - | 0.5 | - | - | - |
| | MOLYBDENUM (TOTAL) | 140 | 130 | 120 | 130 | 90 | 90 | 70 |
| | SELENIUM (TOTAL) | - | - | - | - | - | 10 | - |
| | THALLIUM (TOTAL) | 140 | 150 | 150 | 150 | 120 | 110 | 110 |
| | ZINC (TOTAL) | - | - | - | - | - | 40 | - |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 44100 | 44700 | 35300 | 42800 | 32700 | 45200 | 63500 |
| | CHLORIDE | 20500 | 20400 | 19300 | 18800 | 28700 | 21300 | 25900 |
| | MAGNESIUM (TOTAL) | 58300 | 58600 | 57700 | 60800 | 60800 | 103000 | 138000 |
| | NITROGEN, NITRATE (AS N) | 2400 | 2300 | 2700 | 2300 | 2300 | 18900 | 51300 |
| | PHOSPHATE, TOTAL (AS P) | 100 | 300 | 200 | 200 | 200 | - | 1000 |
| | POTASSIUM (TOTAL) | 700 | 700 | 1000 | 600 | 2900 | 4100 | 2900 |
| | SODIUM (TOTAL) | 27400 | 27500 | 21700 | 10400 | 42900 | 77000 | 63900 |
| | SULFATE | 39300 | 39000 | 46000 | 38400 | 50000 | 117000 | 78000 |
| VOLATILE ORGANICS (ug/liter) | 1,1-DICHLOROETHANE | - | - | - | - | - | - | - |
| | 1,1-DICHLOROETHENE | - | - | - | - | - | - | - |
| | 1,2-DICHLOROETHANE | - | - | - | - | - | - | - |
| | CHLOROFORM | - | - | - | - | 10.3 | - | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BENZYL BUTYL PHTHALATE | - | - | - | - | 13.4 | - | - |
| | BIS(2-ETHYLHEXYL)PHTHALATE | - | - | - | - | - | 23.6 | - |
| | DI-N-BUTYLPHTHALATE | - | - | - | - | - | 7.6 | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | ALDRIN | - | - | - | - | - | - | - |
| | ALPHA-BHC | - | - | - | - | - | - | - |
| | DIELDRIN | - | - | - | - | - | - | - |
| | GAMMA-BHC | 0.008 | 0.004 | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | - | - | - | - | 3 | - | - |
| | GROSS BETA | - | - | - | - | - | - | 5 |
| | STRONTIUM-90 | - | 4.9 | - | - | - | - | - |
| | TRITIUM | - | - | - | - | 1818 | 1100 | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
D = Duplicate Sample.
H = Exceeded recommended holding time
F = Measured in field

TABLE 6.34 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, FALL QUARTER, NOVEMBER 1990
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-21 | UCD-22 | UCD-23 | UCD-24 | UCD-24B |
|---|---|---|---|---|---|---|
| | DATE | 11/02/90 | 11/07/90 | 11/05/90 | 11/06/90 | 11/06/90 |
| | QA | | | | | D |
| | ANALYTE | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 627 | 385 | 407 | 539 | 473 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 4 | 17.6 | 18 | 12.8 | 7.2 |
| | EC-F (umhos/cm) | 1442 | 820 | 775 | 1090 | - |
| | TEMPERATURE-F (degrees C) | 20.5 | 20 | 20.8 | 20.1 | - |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 1090 | 580 | 524 | 922 | 900 |
| | TURBIDITY (NTU) | 451 | 226H | 192H | 588 | 627 |
| | TURBIDITY-F (NTU) | 29.5 | 7 | 3.1 | 17 | - |
| | pH-F | 7.41 | 7.5 | 7.63 | 7.41 | - |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 340 | 260 | 190 | 270 | 260 |
| | BARIUM (TOTAL) | 120 | 60 | 80 | 170 | 150 |
| | BERYLLIUM (TOTAL) | - | 1 | 3 | 2 | 1 |
| | CADMIUM (TOTAL) | 1 | 1 | - | 1 | 2 |
| | CHROMIUM (TOTAL) | - | - | - | - | - |
| | CHROMIUM, HEXAVALENT (+6) | 90H | 10H | 20H | 60 | 70 |
| | LEAD (TOTAL) | 1 | - | - | - | - |
| | MERCURY (TOTAL) | - | - | - | - | - |
| | MOLYBDENUM (TOTAL) | 240 | 170 | 140 | 190 | 180 |
| | SELENIUM (TOTAL) | - | - | - | - | - |
| | THALLIUM (TOTAL) | 280 | 200 | 150 | 210 | 200 |
| | ZINC (TOTAL) | 30 | - | - | - | - |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 54800 | 31700 | 32500 | 47300 | 47400 |
| | CHLORIDE | 35800 | 46100 | 43500 | 40800 | 42000 |
| | MAGNESIUM (TOTAL) | 99100 | 48000 | 53700 | 88000 | 85900 |
| | NITROGEN, NITRATE (AS N) | 40100 | 5000 | 3300 | 44700 | 42300 |
| | PHOSPHATE, TOTAL (AS P) | 400 | 200 | 100 | 100 | 300 |
| | POTASSIUM (TOTAL) | 3400 | 5100 | 2200 | 3400 | 3500 |
| | SODIUM (TOTAL) | 94300 | 92100 | 39100 | 73800 | 74800 |
| | SULFATE | 94700 | 43000 | 37000 | 70100 | 74900 |
| VOLATILE ORGANICS (ug/liter) | 1,1-DICHLOROETHANE | - | - | - | - | - |
| | 1,1-DICHLOROETHENE | - | - | - | - | - |
| | 1,2-DICHLOROETHANE | - | - | - | - | - |
| | CHLOROFORM | 2.4 | - | - | - | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BENZYL BUTYL PHTHALATE | - | - | 5 | - | - |
| | BIS(2-ETHYLHEXYL)PHTHALATE | - | - | - | 10 | - |
| | DI-N-BUTYLPHTHALATE | - | - | - | - | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | ALDRIN | - | - | - | - | - |
| | ALPHA-BHC | - | - | - | - | - |
| | DIELDRIN | - | - | - | - | - |
| | GAMMA-BHC | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | 5 | 3 | - | 4 | 5 |
| | GROSS BETA | 6 | 10 | 6 | 6 | 6 |
| | STRONTIUM-90 | - | - | - | - | 2.8 |
| | TRITIUM | - | - | - | 1231 | 1305 |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
- = Duplicate Sample.
- = Exceeded recommended holding time
- = Measured in field

Title 22 Metals

Eleven Title 22 metals, including antimony, barium, beryllium, cadmium, chromium, lead, mercury, molybdenum, selenium, thallium, and zinc were reported in Fall 1990 groundwater samples. Barium was reported in 18 of 19 samples, ranging from 30 $\mu$g/L in UCD-19 to 400 $\mu$g/L in UCD-12. Beryllium was reported in 16 samples and ranged between 1 $\mu$g/L and 6 $\mu$g/L. Total chromium was detected in 10 Fall 1990 samples ranging from 40 $\mu$g/L in UCD-14 to 280 $\mu$g/L in UCD-11. Lead was reported in four samples ranging from 1 to 3 $\mu$g/L. Mercury was reported only in UCD-17 at 0.5 $\mu$g/L. Selenium was reported in UCD-11 and UCD-19 at 10 $\mu$g/L. Zinc was reported in four samples, ranging from 30 $\mu$g/L to 40 $\mu$g/L.

Antimony, thallium, and hexavalent chromium (Cr VI) were reported in all nineteen Fall 1990 groundwater samples. Antimony values ranged from 100 $\mu$g/L in UCD-7 to 340 $\mu$g/L in UCD-21. Thallium was reported between 80 $\mu$g/L in UCD-7 to 280 $\mu$g/L in UCD-21. Reported values for antimony and thallium in Fall 1990 groundwater samples were significantly higher than any values reported for subsequent quarters (see Sections 6.4.4.2 through 6.4.4.5). Hexavalent chromium values ranged from 10 to 40 $\mu$g/L. The highest values for Cr VI were reported in UCD-11 at 400 $\mu$g/L, UCD-19 at 200 $\mu$g/L, and UCD-12 at 160 $\mu$g/L.

Radionuclides

Gross alpha, gross beta, strontium-90, and tritium activity were reported in Fall 1990 groundwater samples. Gross alpha activity was reported for eight Fall 1990 samples ranging from 3+/2 pCi/L to 2 $\pm$ 15 pCi/L. Gross beta activity was reported for ten samples, ranging from 3$\pm$2 pCi/L to 62$\pm$8 pCi/L. Tritium was reported for nine samples, ranging from 1,100 $\pm$ 500 pCi/L (UCD-19) to 29,066 $\pm$ 899 pCi/L (UCD-12). Strontium-90 was reported in UCD-15 at 4.9 $\pm$ 3.2 pCi/L and UCD-24B at 2.6 $\pm$ 1.5 pCi/L. No gamma-producing radionuclides were reported for the gamma spectral analysis.

Nitrates

Nitrate as (N) was reported in all nineteen Fall 1990 groundwater samples. Reported values ranged from 2,300 $\mu$g/L in four samples, to 106,000 $\mu$g/L in UCD-12.

General Chemical Parameters

The range of values for 14 general chemical parameters in wells screened in the first HSU and wells screened in the second HSU are presented in Table 6.35. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate calcium, magnesium, sodium, and potassium. These parameters were reported in nearly all samples and represent the general chemical composition of groundwater in the first and second HSUs.

6.4.4.2 Winter Quarter, February 1991

Dames & Moore sampled eighteen groundwater monitoring wells between February 4 and February 12, 1991. All wells were purged and sampled with dedicated pumps. Replicate samples from two monitoring wells, UCD-12 and UCD-22, were obtained by collecting identical sets of sample bottles from each well, and labeling the replicate samples with a fictitious sample identification, UCD-12B and UCD-22B.

Samples were shipped daily via overnight courier to CEP Laboratories. Requested analyses were performed on all Winter 1991 samples. Holding times were met, except for alkalinity for samples UCD-13 and UCD-14 and Cr VI for samples UCD-10, UCD-11, UCD-12, and UCD-12B. The holding time for alkalinity was exceeded by seven days due to laboratory error. The holding time for Cr VI was exceeded due to a malfunctioning laboratory instrument. Dames & Moore was notified of this problem by CEP and authorized analysis of Cr VI by a colorimetric method one day beyond the recommended holding time.

During the QA review of Winter 1991 data, Dames & Moore found that the reported tritium results for UCD-13 and UCD-14 were transposed in the laboratory reports. This finding was based on comparability of previously collected data, which consistently shows high values of tritium in UCD-13 and low values or non-detection in UCD-14. CEP Laboratories confirmed results presented in the laboratory report. It is therefore unclear whether these two samples were labeled incorrectly, or mishandled during processing. Values reported for remaining parameters for these samples appear to be consistent with past results, and therefore, only tritium results have been affected.

Reported detections for Winter 1991 groundwater samples are presented in Table 6.36 and are summarized below. Complete results for Winter 1991 groundwater samples are presented in Appendix G of this report.

TABLE 6.35
GROUNDWATER CHEMICAL PARAMETERS
FALL QUARTER, NOVEMBER 1990
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | First-HSU Wells [a] | | | | Second-HSU Wells [b] | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Low Value | | High Value | | Low Value | | High Value | |
| pH * (Std. units) | 6.82 | (UCD-1) | 7.69 | (UCD-18) | 7.11 | (UCD-14) | 7.79 | (UCD-15) |
| EC * (μhmo/cm) | 720 | (UCD-18) | 2,840 | (UCD-12) | 649 | (UCD-15) | 810 | (UCD-7) |
| Temperature * (°C) | 18.0 | (UCD-10) | 20.6 | (UCD-23) | 18.3 | (UCD-15) | 19.1 | (UCD-7) |
| Turbidity (NTU) | 0.09 | (UCD-11) | 627 | (UCD-24B) | 0.18 | (UCD-17) | 191 | (UCD-14) |
| TDS (mg/L) | 432 | (UCD-18) | 2,000 | (UCD-12) | 448 | (UCD-15) | 694 | (UCD-14) |
| COD (mg/L) | 0 | (UCD-11) | 38 | (UCD-12) | 1.2 | (UCD-16) | 32 | (UCD-7) |
| Alkalinity (mg/L) | 385 | (UCD-22) | 836 | (UCD-13) | 297 | (UCD-15) | 467 | (UCD-14) |
| Chloride (mg/L) | 21.3 | (UCD-19) | 375.0 | (UCD-12) | 18.8 | (UCD-17) | 30.7 | (UCD-14) |
| Sulfate (mg/L) | 37.0 | (UCD-23) | 392.0 | (UCD-10) | 38.4 | (UCD-17) | 75.4 | (UCD-14) |
| Phosphate (mg/L) | ND | (UCD-19) | 1.0 | (UCD-11) | ND | (UCD-7) | 0.7 | (UCD-14) |
| Calcium (mg/L) | 31.7 | (UCD-22) | 90.1 | (UCD-12) | 35.3 | (UCD-16) | 53.7 | (UCD-14) |
| Magnesium (mg/L) | 48.0 | (UCD-22) | 250.0 | (UCD-12) | 57.7 | (UCD-16) | 89.0 | (UCD-14) |
| Sodium (mg/L) | 39.1 | (UCD-1 & 23) | 157.0 | (UCD-10) | 10.4 | (UCD-17) | 50.7 | (UCD-7) |
| Potassium (mg/L) | 1.3 | (UCD-1) | 5.1 | (UCD-22) | .6 | (UCD-17) | 1.3 | (UCD-14) |

a First-HSU wells include UCD-1, -4, -10, -11, -12, -13, -18, -19, -20, -21, -22, -23, and -24.
b Second-HSU wells include UCD-7, -14, -15, -16, and -17.
* Measured in field.

TABLE 6.36
SUMMARY OF DETECTIONS IN GROUNDWATER, WINTER QUARTER, FEBRUARY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | TB-02 | TB-03 | TB-13 | UCD-01 | UCD-04 | UCD-07 | UCD-10 |
|---|---|---|---|---|---|---|---|---|
| | DATE | 02/04/91 | 02/05/91 | 02/11/91 | 02/07/91 | 02/07/91 | 02/07/91 | 02/11/91 |
| | QA | T | T | T | | | | |
| | ANALYTE | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | - | - | - | 714 | 446 | 446 | 653 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | - | - | - | 0.79 | 8.73 | 1.99 | 1.99 |
| | EC-F (umhos/cm) | - | - | - | 1627 | 1154 | 1220 | 2250 |
| | TEMPERATURE-F (degrees C) | - | - | - | 17.72 | 16.94 | 18.17 | 16.67 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | - | - | - | 804 | 563 | 614 | 1340 |
| | TURBIDITY (NTU) | - | - | - | 46.9 | 3.68 | 1.39 | 85.7 |
| | TURBIDITY-F (NTU) | - | - | - | - | - | - | - |
| | pH-F | - | - | - | 6.94 | 7.26 | 7.51 | 7.23 |
| METALS (ug/liter) | BARIUM (TOTAL) | - | - | - | 180 | 250 | 190 | - |
| | CADMIUM (TOTAL) | - | - | - | - | - | - | 7 |
| | CHROMIUM (TOTAL) | - | - | - | 39 | 15 | 38 | 29 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | - | 90 | 30 | 50 | 20H |
| | COPPER (TOTAL) | - | - | - | - | 30 | - | - |
| | LEAD (TOTAL) | - | - | - | - | - | - | 1 |
| | MERCURY (TOTAL) | - | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | - | - | - | 30 | 30 | - | 30 |
| | ZINC (TOTAL) | - | - | - | 30 | - | - | 30 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | - | - | - | 56100 | 52100 | 43100 | 46600 |
| | CHLORIDE | - | - | - | 18800 | 52700 | 27500 | 28100 |
| | MAGNESIUM (TOTAL) | - | - | - | 144000 | 75600 | 77800 | 143000 |
| | NITROGEN, NITRATE (AS N) | - | - | - | 13200 | 2400 | 20000 | 15800 |
| | PHOSPHATE, TOTAL (AS P) | - | - | - | 200 | 300 | 400 | 400 |
| | POTASSIUM (TOTAL) | - | - | - | 1120 | 1260 | - | 1800 |
| | SODIUM (TOTAL) | - | - | - | 33800 | 34900 | 44000 | 134000 |
| | SULFATE | - | - | - | 66000 | 40700 | 52200 | 458000 |
| VOLATILE ORGANICS (ug/liter) | 1,1,1-TRICHLOROETHANE | - | 9.7 | - | - | - | - | - |
| | CHLOROFORM | - | - | 5.2 | - | - | - | - |
| | METHYLENE CHLORIDE | 3.4 | 3.4 | - | - | - | - | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | - | - | - | 8.1 | - | - | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | 4,4'-DDE | - | - | - | - | - | - | - |
| | ALDRIN | - | - | - | - | - | - | - |
| | ALPHA-BHC | - | - | - | 0.006 | - | - | - |
| | BETA-BHC | - | - | - | - | - | - | - |
| | DIELDRIN | - | - | - | - | - | - | - |
| | ENDRIN | - | - | - | - | - | - | - |
| | ENDRIN ALDEHYDE | - | - | - | - | - | - | - |
| | HEPTACHLOR | - | - | - | - | - | 0.006 | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | - | - | - | - | - | - | 6 |
| | GROSS BETA | - | - | - | - | - | 3 | 10 |
| | STRONTIUM-90 | - | - | - | - | - | - | - |
| | TRITIUM | - | - | - | - | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
H = Exceeded recommended holding time.
F = Measured in field
** = Numbers transposed from original data (see discussion in text)

TABLE 6.36 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, WINTER QUARTER, FEBRUARY 1991
PH PHASE II SITE CHARACTERIZATION
LF LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-11 | UCD-12 | UCD-12B | UCD-13 | UCD-14 | UCD-15 | UCD-16 |
|---|---|---|---|---|---|---|---|---|
| | DATE | 02/11/91 | 02/11/91 | 02/11/91 | 02/12/91 | 02/12/91 | 02/04/91 | 02/04/91 |
| | QA | | | D | | | | |
| | ANALYTE | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 505 | -HA | -HA | -HA | 25.5HA | 359 | 376 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 1.99 | 3.98 | 12 | 7.97 | 5.98 | 7.45 | 124 |
| | EC-F (umhos/cm) | 1472 | 4090 | - | 1865 | 912 | 889 | 887 |
| | TEMPERATURE-F (degrees C) | 16.5 | 17.56 | - | 18.67 | 16.78 | 16.11 | 15 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 757 | 2840 | 2970 | 1050 | 491 | 439 | 455 |
| | TURBIDITY (NTU) | 17.4 | 49.7 | 47.2 | 16.2 | 4.73 | 0.164 | 0.534 |
| | pH-F | 7.79 | 7.63 | - | 7.04 | 7.6 | 7.74 | 7.75 |
| METALS (ug/liter) | BARIUM (TOTAL) | 120 | 560 | 560 | 280 | 120 | 130 | 130 |
| | CADMIUM (TOTAL) | - | 1 | 1 | 1 | 3 | - | - |
| | CHROMIUM (TOTAL) | 377 | 177 | 176 | 56 | - | 11 | 26 |
| | CHROMIUM, HEXAVALENT (+6) | 230H | 80H | 80 | 60 | 20 | 10 | 30 |
| | COPPER (TOTAL) | - | 30 | - | - | - | - | - |
| | LEAD (TOTAL) | - | - | 1 | - | - | - | - |
| | MERCURY (TOTAL) | - | - | - | - | 0.4 | - | - |
| | THALLIUM (TOTAL) | - | 50 | 70 | 80 | 30 | - | - |
| | ZINC (TOTAL) | 30 | 40 | 30 | 40 | 30 | - | - |
| IONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 40400 | 102000 | 100000 | 65700 | 34100 | 38500 | 32200 |
| | CHLORIDE | 52500 | 443000 | 455000 | 41700 | 29600 | 20800 | 20300 |
| | MAGNESIUM (TOTAL) | 97800 | 231000 | 301000 | 148000 | 62300 | 62600 | 56700 |
| | NITROGEN, NITRATE (AS N) | 27800 | 123000 | 119000 | 17500 | 4200 | 3100 | 1800 |
| | PHOSPHATE, TOTAL (AS P) | 500 | 600 | 800 | 400 | 400 | - | 100 |
| | POTASSIUM (TOTAL) | 1420 | 4760 | 4490 | 2080 | 1060 | - | - |
| | SODIUM (TOTAL) | 65800 | 107000 | 101000 | 53300 | 38300 | 27500 | 46600 |
| | SULFATE | 58000 | 52200 | 131000 | 116000 | 48300 | 39000 | 41600 |
| OLATILE ORGANICS (ug/liter) | 1,1,1-TRICHLOROETHANE | - | - | - | - | - | - | - |
| | CHLOROFORM | - | 21000 | 24000 | - | 5.3 | - | - |
| | METHYLENE CHLORIDE | - | - | - | - | - | - | - |
| EMI-VOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | - | - | - | 13 | - | - | - |
| HLORINATED PESTICIDES ND PCBS (g/liter) | 4,4'-DDE | 0.007 | - | - | - | - | - | - |
| | ALDRIN | - | - | 0.006 | - | - | - | - |
| | ALPHA-BHC | - | - | - | - | - | - | - |
| | BETA-BHC | - | 0.007 | 0.012 | - | - | - | - |
| | DIELDRIN | - | 0.005 | 0.005 | 0.025 | - | - | - |
| | ENDRIN | - | - | - | 0.02 | - | - | - |
| | ENDRIN ALDEHYDE | - | - | 0.028 | - | - | - | - |
| | HEPTACHLOR | 0.009 | 0.007 | 0.007 | 0.007 | 0.007 | - | - |
| ADIONUCLIDES (Ci/liter) | GROSS ALPHA | - | - | - | - | - | - | - |
| | GROSS BETA | - | 3 | - | 8 | 7 | 5 | 9 |
| | STRONTIUM-90 | - | - | - | 0.9 | - | - | - |
| | TRITIUM | - | - | - | 28744** | -** | - | - |

= Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
= Trip Blank. Analyzed for volatile organics only.
= Exceeded recommended holding time.
= Measured in field
= Numbers transposed from original data (see discussion in text)

TABLE 6.36 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, WINTER QUARTER, FEBRUARY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-23 | UCD-24 |
|---|---|---|---|
| | DATE | 02/06/91 | 02/05/91 |
| | QA | | |
| | ANALYTE | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 423 | 499 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 52.4 | 2.35 |
| | EC-F (umhos/cm) | 1011 | 1665 |
| | TEMPERATURE-F (degrees C) | 18.17 | 18.39 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 457 | 848 |
| | TURBIDITY (NTU) | 1.034 | 0.387 |
| | pH-F | 7.64 | 7.42 |
| METALS (ug/liter) | BARIUM (TOTAL) | - | 50 |
| | CADMIUM (TOTAL) | - | - |
| | CHROMIUM (TOTAL) | - | 31 |
| | CHROMIUM, HEXAVALENT (+6) | 20 | 40 |
| | COPPER (TOTAL) | - | - |
| | LEAD (TOTAL) | - | - |
| | MERCURY (TOTAL) | - | - |
| | THALLIUM (TOTAL) | - | - |
| | ZINC (TOTAL) | - | - |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 30000 | 45300 |
| | CHLORIDE | 36400 | 28700 |
| | MAGNESIUM (TOTAL) | 63500 | 116000 |
| | NITROGEN, NITRATE (AS N) | 2700 | 51500 |
| | PHOSPHATE, TOTAL (AS P) | 200 | 200 |
| | POTASSIUM (TOTAL) | 1790 | 2600 |
| | SODIUM (TOTAL) | 35800 | 70100 |
| | SULFATE | 36700 | 70000 |
| VOLATILE ORGANICS (ug/liter) | 1,1,1-TRICHLOROETHANE | - | - |
| | CHLOROFORM | - | - |
| | METHYLENE CHLORIDE | - | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | 28.4 | 6.2 |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | 4,4'-DDE | - | - |
| | ALDRIN | - | - |
| | ALPHA-BHC | - | - |
| | BETA-BHC | - | - |
| | DIELDRIN | - | - |
| | ENDRIN | - | - |
| | ENDRIN ALDEHYDE | - | - |
| | HEPTACHLOR | - | - |
| RADIONUCLIDES (pCi/liter) | GROSS ALPHA | - | - |
| | GROSS BETA | - | 6 |
| | STRONTIUM-90 | 0.8 | - |
| | TRITIUM | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
H = Exceeded recommended holding time.
F = Measured in field

Volatile Organic Compounds (VOCs) - EPA Method 624

Three VOCs: 1,1,1 trichloroethane; methylene chloride; and chloroform, were reported in Winter 1991 groundwater samples. Detections of 1,1,1 trichloroethane were only reported in a trip blank, at 9.7 μg/L, for samples shipped on February 5, 1991. Chloroform was reported in five samples and one trip blank, ranging from 2.5 μg/L in UCD-18 to 21,000 μg/L in UCD-12, and 24,000 μg/L in UCD-12B. Methylene chloride was reported in two trip blanks shipped on February 4 and 5, both at 3.4 μg/L, and in UCD-18 at 3.9 μg/L sampled on February 4.

Semivolatile Organic Compounds - EPA Method 625

One semivolatile organic compound, bis(2-ethylhexyl) phthalate, was reported for Winter 1991 groundwater samples by method 625. Bis (2-ethylhexyl) phthalate was reported in eight samples ranging from 3.1 μg/L (UCD-17) to 33.3 μg/L in UCD-22.

Pesticides and PCBs - Method 608

Eight organochlorine pesticide compounds were reported in Winter 1991 groundwater samples by EPA Method 608. The pesticide 4,4´DDE was reported in three samples ranging from 0.006 μg/L in UCD-22 to 0.008 μg/L in UCD-17. Aldrin was reported only in UCD-12 at 0.006 μg/L. Alpha-BHC was reported in UCD-1 and UCD-21 at 0.006 μg/L. Beta-BHC was reported in UCD-12 and UCD-12B at 0.007 and 0.012 μg/L, respectively. Dieldrin was reported in UCD-12 and UCD-12B at 0.005 μg/L and in UCD-13 at 0.021 μg/L. Endrin was reported only in UCD-13 at 0.020 μg/L. Endrin aldehyde was reported only in UCD-12B at 0.028 μg/L. Heptachlor was reported in seven samples, ranging from 0.004 μg/L to 0.008 μg/L.

Title 22 Metals

Eight Title 22 metals, including barium, cadmium, chromium, copper, lead, mercury, thallium, and zinc, were reported in Winter 1991 groundwater samples. Barium was reported in 14 of 20 samples, ranging from 50 μg/L in UCD-24 to 560 μg/L in UCD-12 and UCD-12B. Cadmium was reported in six samples, ranging from 1 μg/L to 7 μg/L. Total chromium was detected in 15 samples, ranging from 11 μg/L in UCD-15 to 377 μg/L in UCD-11. Copper was reported at 30 μg/L in UCD-12 and UCD-17. Lead was only reported in UCD-10 and the replicate sample for UCD-12 at 1 μg/L; mercury was reported only in UCD-14 at 0.4 μg/L. Thallium was reported in seven samples, ranging from 30 μg/L to 80 μg/L. Zinc was reported in seven samples, ranging from 30 μg/L to 40 μg/L. Hexavalent chromium (Cr VI) was reported in 18 of 20 Winter 1991 groundwater sample. The highest values for Cr VI were reported in samples from UCD-11 at 230 μg/L and UCD-19 at 290 μg/L.

Radionuclides

Gross alpha, gross beta, strontium-90, and tritium activity were reported in Winter 1991 groundwater samples. Gross alpha activity was reported for four samples ranging from 3 $\pm$ 2 pCi/L to 6 $\pm$ 5 pCi/L. Gross beta activity was reported for twelve samples, ranging from 3 $\pm$ 2 pCi/L to 10$\pm$5 pCi/L. Strontium-90 was reported in samples UCD-13 at 0.9 pCi/L and UCD-23 at 0.8 pCi/L. Tritium was reported in only UCD-13 at 28,744 pCi/L. No gamma-producing radionuclides were reported for the gamma spectral analysis.

Nitrates

Nitrate as (N) was reported in all twenty Winter 1991 groundwater samples. Reported values ranged from 1,000 $\mu$g/L in UCD-22 to 123,000 $\mu$g/L in UCD-12.

General Mineral Parameters

The ranges of values for 14 general chemical parameters in wells screened in the first HSU and in wells screened in the second HSU are presented in Table 6.37. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate calcium, magnesium, sodium, and potassium. These parameters were reported for nearly all samples and represent the general chemical composition of groundwater in the first and second HSUs.

Based on comparability with analytical results for other quarterly groundwater sampling, several values reported for Winter 1991 appear to be anomalously low. Alkalinity values for samples UCD-12, UCD-12B, UCD-13 were non-detected, and UCD-14 had a concentration of 25.5 mg/L. Calcium was not detected in UCD-17.

#### 6.4.4.3 Spring Quarter, May 1991

Dames & Moore sampled eighteen groundwater monitoring wells between May 13 and May 21, 1991. All wells were purged and sampled with dedicated pumps. Replicate samples from two monitoring wells, UCD-11 and UCD-23, were obtained by collecting identical sets of sample bottles from each well and labeling the replicate samples with a fictitious sample identification, UCD-11B and UCD-23B.

TABLE 6.37
GENERAL CHEMICAL PARAMETERS
GROUNDWATER
WINTER QUARTER, FEBRUARY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | FIRST-HSU WELLS | | SECOND-HSU WELLS | |
|---|---|---|---|---|
| Parameter | Low | High | Low | High |
| pH (std. units) | 6.94 (UCD-1) | 7.79 (UCD-11) | 7.51 (UCD-7) | 7.75 (UCD-16) |
| EC (μmhos/cm) | 926 (UCD-18) | 4090 (UCD-12) | 887 (UCD-16) | 1220 (UCD-7) |
| Temperature (°C) | 16.39 (UCD-20) | 19.0 (UCD-22) | 15.0 (UCD-16) | 18.17 (UCD-7) |
| Turbidity (NTU) | 0.197 (UCD-22) | 49.7 (UCD-12) | 0.056 (UCD-17) | 4.73 (UCD-14) |
| TDS (mg/L) | 443 (UCD-18) | 2840 (UCD-12) | 439 (UCD-15) | 614 (UCD-7) |
| COD (mg/L) | 0.78 (UCD-22) | 120 (UCD-19) | 1.57 (UCD-17) | 124.0 (UCD-16) |
| Alkalinity (mg/L) | 376 (2 wells) | 765 (UCD-19) | 359 (UCD-15) | 446 (UCD-7) |
| Chloride (mg/L) | 26.3 (UCD-22) | 102.2 (UCD-12) | 17.7 (UCD-17) | 29.6 (UCD-14) |
| Sulfate (mg/L) | 35.6 (UCD-18) | 458.0 (UCD-10) | 39.0 (UCD-15) | 48.3 (UCD-14) |
| Phosphate (mg/L) | 0.1 (3 wells) | 0.8 (UCD-12) | ND (UCD-15) | 0.4 (2 wells) |
| Calcium (mg/L) | 26.3 (UCD-12) | 102.0 (UCD-12) | 32.2 (UCD-16) | 43.1 (UCD-7) |
| Magnesium (mg/L) | 57.2 (UCD-22D) | 301.0 (UCD-12D) | 56.7 (UCD-16) | 77.8 (UCD-7) |
| Sodium (mg/L) | 32.4 (UCD-18) | 134.0 (UCD-10) | 27.5 (UCD-15) | 44.0 (UCD-14) |
| Potassium (mg/L) | 1.12 (UCD-1) | 4.76 (UCD-12) | ND (4 wells) | 1.06 (UCD-14) |

Samples were shipped daily to CEP Laboratories. Requested analyses were performed on all Spring 1991 groundwater samples. Due to laboratory error, holding times were missed. The recommended holding time for EPA Method 624 was exceeded by seven days for three trip blanks and samples UCD-4, UCD-19, UCD-20, UCD-22, UCD-23, and UCD-23B. Samples for UCD-1, UCD-7, UCD-10 exceeded recommended holding times for EPA Method 624 by one day; mercury by ten days; and extraction for EPA Method 625 by one day. Recommended holding times for all other analyses were met.

Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Spring Quarter 1991 groundwater samples. Surrogate recoveries for organic compound analyses fell within acceptance criteria for approximately 95 percent of quality control samples. Matrix spike and matrix spike duplicate analyses met acceptance criteria for all but three quality control samples for Spring Quarter 1991 groundwater analyses.

Reported detections for Spring 1991 groundwater samples are presented in Table 6.38 and are summarized below. Results for Spring 1991 groundwater samples are presented in Appendix G of this report.

Volatile Organic Compounds (VOCs) - EPA Method 624

Five VOCs, 1,1 dichloroethane (1,1-DCA), 1,1 dichloroethene (1,1-DCE), 1,2 dichloroethane (1,2-DCA), chloroform, and methylene chloride, were reported in Spring 1991 samples. Detections of 11-DCA at 23 $\mu$g/L, 1,1-DCE at 3.9 $\mu$g/L, and 1,2-DCA at 19 $\mu$g/L were only reported in the sample from UCD-12. Chloroform was reported in three samples and one trip blank, ranging from 2.7 $\mu$g/L in UCD-21 to 18,000 $\mu$g/L in UCD-12. Methylene chloride was reported only in three trip blanks, ranging from 3.4 $\mu$g/L to 4.6 $\mu$g/L.

Semivolatile Organic Compounds - EPA Method 625

One semivolatile organic compound, bis(2-ethylhexyl) phthalate, was reported for Spring 1991 groundwater samples by method 625. Bis (2-ethylhexyl) phthalate was reported in five samples ranging from 4.6 $\mu$g/L in UCD-19 to 24.3 $\mu$g/L in UCD-11.

Pesticides and PCBs - EPA Method 608

Two organochlorine pesticide compounds, delta-BHC and gamma-BHC, were reported in Spring 1991 groundwater samples by EPA Method 608. Delta-BHC and gamma-BHC were only reported in sample UCD-12 at 0.129 $\mu$g/L and 0.0437 $\mu$g/L, respectively.

TABLE 6.38
SUMMARY OF DETECTIONS IN GROUNDWATER, SPRING QUARTER, MAY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | TB-12 | TB-13 | TB-14 | TB-15 | TB-16 | UCD-01 | UCD-04 | UCD-07 | UCD-10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 05/16/91 | 05/21/91 | 05/21/91 | 05/21/91 | 05/20/91 | 05/20/91 | 05/15/91 | 05/20/91 | 05/20/91 |
| | QA | T | T | T | T | T | | | | |
| | ANALYTE | | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | - | - | - | - | - | 690 | 675 | 415 | 640 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | - | - | - | - | - | 207 | 78.8 | 113 | 232 |
| | EC-F (umhos/cm) | - | - | - | - | - | 1138 | 817 | 971 | 1820 |
| | TEMPERATURE-F (degree C) | - | - | - | - | - | 18.6 | 19.6 | 18.7 | 18.7 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | - | - | - | - | - | 813 | 792 | 676 | 1310 |
| | TURBIDITY (NTU) | - | - | - | - | - | 297 | 1.75 | 2.11 | 23.6 |
| | TURBIDITY-F (NTU) | - | - | - | - | - | 200 | 6 | 3.2 | 88 |
| | pH-F | - | - | - | - | - | 7.22 | 7.32 | 7.61 | 7.79 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | - | - | - | - | - | 3 | 5 | 31 | 4 |
| | BARIUM (TOTAL) | - | - | - | - | - | 160 | 230 | 190 | - |
| | CHROMIUM (TOTAL) | - | - | - | - | - | - | - | 70 | 40 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | - | - | - | 20 | 260 | 90 | 20 |
| | MOLYBDENUM (TOTAL) | - | - | - | - | - | 70 | 30 | 30 | 50 |
| | NICKEL (TOTAL) | - | - | - | - | - | - | - | - | - |
| | SELENIUM (TOTAL) | - | - | - | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | - | - | - | - | - | 2 | 7 | 11 | 6 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | - | - | - | - | - | 51600 | 46400 | 36800 | 45300 |
| | CHLORIDE | - | - | - | - | - | 18200 | 13400 | 28300 | 24800 |
| | MAGNESIUM (TOTAL) | - | - | - | - | - | 125000 | 84000 | 91900 | 500A |
| | NITROGEN, NITRATE (AS N) | - | - | - | - | - | 12400 | 2400 | 37400 | 15600 |
| | PHOSPHATE, TOTAL (AS P) | - | - | - | - | - | 400 | 400 | 200 | 400 |
| | POTASSIUM (TOTAL) | - | - | - | - | - | 1300 | 600 | 800 | 1400 |
| | SODIUM (TOTAL) | - | - | - | - | - | 40700 | 39400 | 64700 | 168000 |
| | SULFATE | - | - | - | - | - | 41900 | 70500 | 41500 | 413000 |
| VOLATILE ORGANICS (ug/liter) | 1,1-DICHLOROETHANE | - | - | - | - | - | - | -H | - | - |
| | 1,1-DICHLOROETHENE | - | - | - | - | - | - | -H | - | - |
| | 1,2-DICHLOROETHANE | - | - | - | - | - | - | -H | - | - |
| | CHLOROFORM | - | - | 5 | 4.9 | - | - | -H | - | - |
| | METHYLENE CHLORIDE | 3.4 | 3.7 | - | - | 4.6 | - | -H | - | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | - | - | - | - | - | -H | - | -H | -H |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | DELTA-BHC | - | - | - | - | - | - | - | - | - |
| | GAMMA-BHC | - | - | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | - | - | - | - | - | - |
| | GAMMA SPECTRAL ANALYSIS | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | - | - | - | - | - | - | - | - | - |
| | GROSS BETA | - | - | - | - | - | 17 | - | 4 | 4 |
| | STRONTIUM-90 | - | - | - | - | - | 4.3 | - | 5.7 | 3.6 |
| | TRITIUM | - | - | - | - | - | - | - | - | - |

- Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
H = Exceeded recommended holding time.
A = Anomalous value possible due to error in sample handling or analysis.
F = Measured in field

TABLE 6.38 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, SPRING QUARTER, MAY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-11 | UCD-11B | UCD-12 | UCD-13 | UCD-14 | UCD-15 | UCD-16 | UCD-17 | UCD-18 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 05/21/91 | 05/21/91 | 05/14/91 | 05/21/91 | 05/21/91 | 05/13/91 | 05/14/91 | 05/13/91 | 05/13/91 |
| | QA | | D | | | | | | | |
| | ANALYTE | | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 524 | 514 | 834 | 840 | 675 | 368 | 384 | 373 | 391 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 6.1 | - | - | 40.9 | 101 | 2.2 | 269 | 8.7 | - |
| | EC-F (umhos/cm) | 1026 | - | 2730 | 1350 | 1078 | 636 | 557 | 692 | 770 |
| | TEMPERATURE-F (degree C) | 18.5 | - | 19.2 | 19.1 | 18.5 | 17.9 | 18.2 | 18 | 18 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 9190A | 1830 | 2080 | 1070 | 881 | 443 | 603 | 429 | 489 |
| | TURBIDITY (NTU) | 1.55 | 1.97 | 10 | 1.05 | 2.4 | 0.023 | 0.03 | 0.077 | 1.53 |
| | TURBIDITY-F (NTU) | 3.5 | - | 11 | 5 | 2.5 | 0.3 | 0.2 | 0.15 | 6 |
| | pH-F | 7.66 | - | 7.44 | 7.16 | 7.69 | 7.64 | 7.67 | 7.43 | 7.58 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 5 | 7 | 20 | 11 | 9 | 5 | 2 | 31 | 2 |
| | BARIUM (TOTAL) | 150 | 150 | 500 | 220 | 270 | 140 | 120 | 130 | 60 |
| | CHROMIUM (TOTAL) | 330 | 320 | 200 | 100 | 70 | - | - | - | - |
| | CHROMIUM, HEXAVALENT (+6) | 340 | 330 | 200 | 80 | 50 | 20 | 30 | 20 | 20 |
| | MOLYBDENUM (TOTAL) | 40 | 50 | 60 | - | 50 | - | - | - | - |
| | NICKEL (TOTAL) | - | - | - | - | - | - | - | - | - |
| | SELENIUM (TOTAL) | 10 | 10 | - | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | 9 | 10 | 31 | 14 | 12 | 5 | 7 | 6 | 5 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 39000 | 39200 | 103000 | 66100 | 55400 | 34200 | 35000 | 34100 | 29200 |
| | CHLORIDE | 48600 | 48700 | 39900 | 42400 | 38200 | 19000 | 17700 | 16700 | 25500 |
| | MAGNESIUM (TOTAL) | 101000 | 101000 | 320000 | 163000 | 133000 | 64000 | 62800 | 63500 | 74900 |
| | NITROGEN, NITRATE (AS N) | 24300 | 24600 | 122000 | 17400 | 9900 | 3000 | 4200 | 2500 | 7600 |
| | PHOSPHATE, TOTAL (AS P) | 400 | 100 | 100 | 500 | 400 | - | - | 100 | - |
| | POTASSIUM (TOTAL) | 1200 | 1200 | 5600 | 3000 | 900 | 500 | 700 | 400 | 1700 |
| | SODIUM (TOTAL) | 77800 | 77800 | 130300 | 60800 | 51200 | 34400 | 47500 | 37700 | 43900 |
| | SULFATE | 45000 | 45200 | 12800 | 91000 | 86400 | 35600 | 39700 | 34900 | 34200 |
| VOLATILE ORGANICS (ug/liter) | 1,1-DICHLOROETHANE | - | - | 23 | - | - | - | - | - | - |
| | 1,1-DICHLOROETHENE | - | - | 3.9 | - | - | - | - | - | - |
| | 1,2-DICHLOROETHANE | - | - | 19 | - | - | - | - | - | - |
| | CHLOROFORM | - | - | 18000 | - | - | - | - | - | - |
| | METHYLENE CHLORIDE | - | - | - | - | - | - | - | - | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | 10 | 24.3 | - | 11 | 17.5 | - | - | - | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | DELTA-BHC | - | - | 0.129 | - | - | - | - | - | - |
| | GAMMA-BHC | - | - | 0.0437 | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | 1652 | 1131 | - | - | - | - |
| | GAMMA SPECTRAL ANALYSIS | - | - | 11 | - | - | - | - | - | - |
| | GROSS ALPHA | - | - | 7 | - | - | - | - | - | - |
| | GROSS BETA | - | - | 9 | - | - | - | - | - | - |
| | STRONTIUM-90 | - | - | - | - | - | - | - | - | - |
| | TRITIUM | - | - | - | 26186 | 7728 | - | - | - | - |

- Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
H = Exceeded recommended holding time.
A = Anomalous value possible due to error in sample handling or analysis.
F = Measured in field

TABLE 6.38 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, SPRING QUARTER, MAY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE<br>DATE<br>QA | UCD-19<br>05/15/91 | UCD-20<br>05/15/91 | UCD-21<br>05/14/91 | UCD-22<br>05/15/91 | UCD-23<br>05/15/91 | UCD-23B<br>05/15/91<br>D | UCD-24<br>05/14/91 |
|---|---|---|---|---|---|---|---|---|
| | ANALYTE | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 421 | 476 | 650 | 379 | 425 | 421 | 506 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 257 | 244 | 2.6 | 6.7 | 30.7 | 26.2 | 60.1 |
| | EC-F (umhos/cm) | 1078 | 449 | 1205 | 749 | 774 | - | 1080 |
| | TEMPERATURE-F (degree C) | 19.6 | 19.2 | 20.1 | 19.8 | 20.3 | - | 21.1 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 555 | 687 | 1010 | 469 | 497 | 500 | 867 |
| | TURBIDITY (NTU) | 2.08 | 6.41 | 6.35 | 0.424 | 2.25 | 3.14 | 0.308 |
| | TURBIDITY-F (NTU) | 6.5 | 0.9 | 11.5 | 1.1 | 4.5 | - | 1.6 |
| | pH-F | 7.46 | 7.45 | 7.38 | 7.56 | 7.52 | - | 7.33 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 6 | 5 | 5 | 65 | 3 | 5 | 4 |
| | BARIUM (TOTAL) | 40 | 70 | 80 | - | 30 | 30 | 90 |
| | CHROMIUM (TOTAL) | 260 | 50 | 60 | - | - | - | 30 |
| | CHROMIUM, HEXAVALENT (+6) | 10 | 60 | 70 | - | - | - | 30 |
| | MOLYBDENUM (TOTAL) | 50 | 30 | 30 | 30 | 30 | 40 | 30 |
| | NICKEL (TOTAL) | - | - | - | - | 30 | 30 | - |
| | SELENIUM (TOTAL) | 10 | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | 11 | 8 | 11 | 6 | 7 | 7 | 10 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 43900 | 36400 | 53200 | 27300 | 34200 | 34200 | 45700 |
| | CHLORIDE | 57400 | 12400 | 23100 | 39600 | 34900 | 35000 | 25700 |
| | MAGNESIUM (TOTAL) | 123700 | 96000 | 128000 | 54300 | 82400 | 82500 | 117000 |
| | NITROGEN, NITRATE (AS N) | 12800 | 31900 | 53200 | 2200 | 5500 | 6200 | 56800 |
| | PHOSPHATE, TOTAL (AS P) | 300 | 200 | 300 | 200 | 200 | 500 | 600 |
| | POTASSIUM (TOTAL) | 1800 | 2500 | 2000 | 2200 | 1400 | 1400 | 1600 |
| | SODIUM (TOTAL) | 76100 | 59500 | 108000 | 88000 | 43800 | 43900 | 79300 |
| | SULFATE | 35200 | 50200 | 74400 | 34800 | 29000 | 28700 | 58100 |
| VOLATILE ORGANICS (ug/liter) | 1,1-DICHLOROETHANE | -H | - | - | -H | -H | -H | - |
| | 1,1-DICHLOROETHENE | -H | - | - | -H | -H | -H | - |
| | 1,2-DICHLOROETHANE | -H | - | - | -H | -H | -H | - |
| | CHLOROFORM | -H | - | 2.7 | -H | -H | -H | 3.5 |
| | METHYLENE CHLORIDE | -H | - | - | -H | -H | -H | - |
| SEMI-VOLATILE ORGANICS (ug/liter) | BIS(2-ETHYLHEXYL)PHTHALATE | 4.6 | - | - | - | - | - | - |
| CHLORINATED PESTICIDES AND PCBS (ug/liter) | DELTA-BHC | - | - | - | - | - | - | - |
| | GAMMA-BHC | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | - | - | - | - |
| | GAMMA SPECTRAL ANALYSIS | - | - | - | - | - | - | - |
| | GROSS ALPHA | - | 10 | 4 | - | - | - | - |
| | GROSS BETA | - | 17 | 6 | 4 | - | - | - |
| | STRONTIUM-90 | - | - | - | - | - | - | - |
| | TRITIUM | - | - | - | - | - | - | - |

- Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
H = Exceeded recommended holding time.
A = Anomalous value possible due to error in sample handling or analysis.
F = Measured in field

Title 22 Metals

Eight Title 22 metals, including antimony, barium, chromium, molybdenum, nickel, selenium, and thallium, were reported in Spring 1991 groundwater samples. Antimony was reported in all samples, ranging from 2 $\mu$g/L in UCD-16 and UCD-18 to 65 $\mu$g/L in UCD-22. Barium was reported in 18 of 20 samples, ranging from 30 $\mu$g/L in UCD-23 and UCD-23B to 500 $\mu$g/L in UCD-12. Total chromium was detected in 11 samples, ranging from 30 $\mu$g/L in UCD-24 to 340 $\mu$g/L in UCD-11. Molybdenum was reported in 15 samples, ranging from 30.1 $\mu$g/L in seven samples to 70 $\mu$g/L in UCD-1. Nickel was reported in UCD-23 and UCD-23B at 30 $\mu$g/L. Selenium was reported in three samples at the detection limit of 10 $\mu$g/L. Thallium was reported in all 20 samples, ranging from 2 $\mu$g/L in UCD-1 to 30 $\mu$g/L in UCD-12.

Hexavalent chromium (Cr VI) was reported in seventeen to twenty Spring 1991 groundwater samples. The highest values for Cr VI were reported for UCD-11 and UCD-11B at 330 and 340 $\mu$g/L, UCD-4 at 260 $\mu$g/L, and UCD-12 at 200 $\mu$g/L.

Radionuclides

Detections were reported for all six radiochemical analyses for Spring 1991 groundwater samples. Gross alpha activity was reported for three samples, ranging from 4 $\pm$ 2 pCi/L to 10 $\pm$ 5 pCi/L. Gross beta activity was reported for seven samples, ranging from 4 $\pm$ 2 pCi/L to 17 $\pm$ 5 pCi/L. Tritium was reported in only UCD-13 at 26,168 $\pm$ 846 pCi/L and in UCD-14 at 7,728 $\pm$ 617 pCi/L. Strontium-90 was reported in UCD-1 at 4.3 $\pm$ 0.8 pCi/L, UCD-7 at 5.7 $\pm$ 0.9 pCi/L, and UCD-10 at 3.8 pCi/L. Gamma producing radionuclides were reported only in UCD-12 at 11 $\pm$ 4 pCi/L.

Nitrates

Nitrate as (N) was reported in all twenty Spring 1991 groundwater samples. Reported values ranged from 2,200 $\mu$g/L in UCD-22 to 122,000 $\mu$g/L in UCD-12.

General Mineral Parameters

Results for 14 general chemical parameters are summarized in Table 6.39. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium.

TABLE 6.39
GENERAL CHEMICAL
GROUNDWATER
SPRING QUARTER, MAY 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | FIRST-HSU WELLS | | SECOND-HSU WELLS | |
|---|---|---|---|---|
| **Parameter** | **Low** | **High** | **Low** | **High** |
| pH (std. units) | 7.16 (UCD-13) | 7.79 (UCD-10) | 7.43 (UCD-17 | 7.69 (UCD-14) |
| EC (μmhos/cm) | 449 (UCD-20) | 2,730 (UCD-12) | 557 (UCD-16) | 1,078 (UCD-14) |
| Temperature (°C) | 18.0 (UCD-18) | 21.1 (UCD-24) | 17.9 (UCD-15) | 18.7 (UCD-7) |
| Turbidity (NTU) | 0.3 (UCD-24) | 297.0 (UCD-1) | 0.23 (UCD-15) | 2.4 (UCD-14) |
| TDS (mg/L) | 469 (UCD-22) | 2080 (UCD-12) | 429 (UCD-17) | 881 (UCD-14) |
| COD (mg/L) | ND (3 wells) | 257 (UCD-19) | 2.2 (UCD-15) | 429 (UCD-17) |
| Alkalinity (mg/L) | 379 (UCD-22) | 840 (UCD-13) | 368 (UCD-15) | 675 (UCD-14) |
| Chloride (mg/L) | 12.4 (UCD-20) | 57.4 (UCD-19) | 16.7 (UCD-17) | 38.2 (UCD-14) |
| Sulfate (mg/L) | 12.8 (UCD-12) | 413 (UCD-10) | 34.9 (UCD-17) | 86.4 (UCD-14) |
| Phosphate (mg/L) | ND (UCD-18) | 0.6 (UCD-24) | ND (2 wells) | 0.4 (UCD-14) |
| Calcium (mg/L) | 27.3 (UCD-22) | 103.0 (UCD-12) | 34.1 (UCD-16) | 55.4 (UCD-14) |
| Magnesium (mg/L) | 54.3 (UCD-22) | 320.0 (UCD-12) | 628 (UCD-16) | 133.0 (UCD-14) |
| Sodium (mg/L) | 43.8 (UCD-23) | 166.0 (UCD-10) | 34.4 (UCD-14) | 64.7 (UCD-7) |
| Potassium (mg/L) | 0.6 (UCD-4) | 5.6 (UCD-12) | 0.4 (UCD-17) | 0.9 (UCD-14) |

Based on comparability with analytical results for other quarterly groundwater sampling, the magnesium value for sample UCD-10 at 0.5 mg/L appears to be anomalously low and the TDS value for UCD-11 at 9,190 mg/L appears to be anomalously high.

6.4.4.4 Summer Quarter, August 1991

Dames & Moore sampled 13 groundwater monitoring wells between August 5 and August 14, 1991. Monitoring wells UCD-1, UCD-4, UCD-11, UCD-12, and UCD-13 were dry, and no groundwater samples were collected. Eleven wells were purged and sampled with dedicated pumps. Due to low water levels, wells UCD-10 and UCD-19 were purged and sampled using a disposable bailer. Because of slow recharge and low initial water levels in UCD-10, only samples for Method 624 (VOCs), formaldehyde, and tritium were collected. Replicate samples were collected from two locations (UCD-14 and UCD-19) by collecting identical sets of sample bottles from each well and labeling the replicate samples with fictitious sample identifications UCD-14B and UCD-19B.

Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Summer Quarter 1991 surface water samples. Surrogate recoveries for organic compound analyses fell within acceptance criteria for all quality control samples. Matrix spike and matrix spike duplicate analyses met acceptance criteria for all but one quality control sample for Winter Quarter 1991 surface water analyses.

Samples were shipped daily to CEP Laboratories. Requested analyses were performed on all Summer 1991 samples. All recommended holding times were met except for alkalinity for samples UCD-19B, which was exceeded by two days due to laboratory error.

Reported detections for Summer 1991 groundwater samples are presented in Table 6.40 and are summarized below. Results for Summer 1991 groundwater samples are presented in Appendix G of this report.

Volatile Organic Compounds (VOCs) - EPA Method 624

Two VOCs, chloroform and methylene chloride, were reported in Summer 1991 samples. Chloroform was reported in four samples, ranging from 1.6 $\mu$g/L in UCD-22 to 4.8 $\mu$g/L in UCD-14 and UCD-14B. The highest detections of chloroform are generally reported for monitoring well UCD-12, which was dry for this quarterly sampling round. Methylene chloride was reported only in one trip blank at 12.0 $\mu$g/L.

TABLE 6.40
SUMMARY OF DETECTIONS IN GROUNDWATER, SUMMER QUARTER, AUGUST 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | TB-22 | UCD-07 | UCD-10 | UCD-14 | UCD-14B | UCD-15 | UCD-16 | UCD-17 | UCD-18 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 08/06/91 | 08/12/91 | 08/05/91 | 08/12/91 | 08/12/91 | 08/05/91 | 08/05/91 | 08/05/91 | 08/06/91 |
| | QA | T | | | | D | | | | |
| | ANALYTE | | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | - | 403 | - | 813 | 612 | 344 | 367 | 354 | 449 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | - | - | - | - | 31.6 | 27 | 28.2 | 26.6 | 24.1 |
| | EC-F (umhos/cm) | - | 839 | 2080 | 1132 | - | 781 | 808 | 744 | 922 |
| | TEMPERATURE (degrees C) | - | 19.3 | 21.4 | 19.5 | - | 19.3 | 18.7 | 18.7 | 19.7 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | - | 613 | - | 860 | 822 | 460 | 466 | 6730A | 535 |
| | TURBIDITY (NTU) | - | 2.55 | - | 1.273 | 1.112 | 0.052 | 0.073 | 0.054 | 877 |
| | TURBIDITY-F (NTU) | - | 3.8 | 200 | 3.2 | - | 0.15 | 0.13 | 0.14 | 200 |
| | pH-F | - | 7.55 | 7.49 | 7.42 | 1.112 | 7.75 | 7.75 | 7.78 | 7.55 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | - | 4 | - | 7 | 8 | 3 | 3 | 3 | 5 |
| | BARIUM (TOTAL) | - | 210 | - | 270 | 260 | 160 | 150 | 150 | - |
| | CHROMIUM (TOTAL) | - | 60 | - | 70 | 60 | - | 50 | - | - |
| | CHROMIUM, HEXAVALENT (+6) | - | 40 | - | 50 | 50 | 10 | 30 | 20 | 30 |
| | LEAD (TOTAL) | - | 1 | - | 1 | - | - | - | - | - |
| | NICKEL (TOTAL) | - | - | - | - | - | - | - | - | 30 |
| | SELENIUM (TOTAL) | - | - | - | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | - | 6 | - | 9 | 10 | 5 | 5 | 4 | 6 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | - | 39600 | - | 51800 | 51200 | 39300 | 34800 | 38200 | 31700 |
| | CHLORIDE | - | 26100 | - | 35300 | 36500 | 20700 | 20000 | 18800 | 26700 |
| | MAGNESIUM (TOTAL) | - | 85600 | - | 134000 | 133000 | 66900 | 65500 | 65700 | 80200 |
| | NITROGEN, NITRATE (AS N) | - | 20100 | - | 8420 | 8390 | 2350 | 4100 | 2180 | 6790 |
| | PHOSPHATE, TOTAL (AS P) | - | - | - | - | - | 400 | 400 | 400 | 1000 |
| | POTASSIUM (TOTAL) | - | 800 | - | 1000 | 1000 | 800 | 850 | 550 | 2000 |
| | SODIUM (TOTAL) | - | 34000 | - | 30800 | 30200 | 20700 | 34500 | 19200 | 23700 |
| | SULFATE | - | 40900 | - | 102000 | 96400 | 8110 | 69800 | 38500 | 35300 |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | - | - | - | 4.8 | 4.8 | - | - | - | - |
| | METHYLENE CHLORIDE | 12 | - | - | - | - | - | - | - | - |
| CHLORINATED PESTIDES AND PCBS (ug/liter) | ALPHA-BHC | - | - | - | - | - | 0.004 | - | - | - |
| | HEPTACHLOR | - | - | - | - | - | 0.02 | 0.019 | 0.018 | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | 1003 | 862 | - | - | - | - |
| | GROSS ALPHA | - | - | - | - | - | - | - | - | 6 |
| | GROSS BETA | - | - | - | - | - | - | - | - | 22 |
| | TRITIUM | - | - | - | 4557 | 5482 | - | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
D = Duplicate Sample.
A = Anomalous value possible due to error in sample handling or analysis.
F = Measured in field

TABLE 6.40 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, SUMMER QUARTER, AUGUST 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-19 | UCD-19B | UCD-20 | UCD-21 | UCD-22 | UCD-23 | UCD-24 |
|---|---|---|---|---|---|---|---|---|
| | DATE | 08/13/91 | 08/13/91 | 08/06/91 | 08/06/91 | 08/07/91 | 08/07/91 | 08/06/91 |
| | QA | | D | | | | | |
| | ANALYTE | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 595H | 598H | 542 | 633 | 378 | 421 | 484 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 4.72 | - | 24 | 23.6 | 26.8 | 26.6 | 26.5 |
| | EC-F (umhos/cm) | 1152 | - | 1408 | 1702 | 910 | 954 | 1458 |
| | TEMPERATURE (degrees C) | 20.3 | - | 21 | 21.3 | 21.3 | 22.6 | 20.6 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 793 | 752 | 845 | 1030 | 523 | 532 | 893 |
| | TURBIDITY (NTU) | 390 | - | 260 | 56.5 | 32.9 | 880 | 1370 |
| | TURBIDITY-F (NTU) | 200 | - | 200 | 200 | 30 | 200 | 200 |
| | pH-F | 7.6 | 406 | 7.41 | 7.32 | 7.45 | 7.57 | 7.39 |
| METALS (ug/liter) | ANTIMONY (TOTAL) | 10 | 7 | 7 | 7 | 3 | 4 | 7 |
| | BARIUM (TOTAL) | 40 | 40 | 130 | 110 | 30 | 40 | 120 |
| | CHROMIUM (TOTAL) | 280 | 290 | 90 | 90 | - | - | 90 |
| | CHROMIUM, HEXAVALENT (+6) | 200 | 200 | 70 | 90 | 80 | 60 | 50 |
| | LEAD (TOTAL) | - | - | - | - | - | - | - |
| | NICKEL (TOTAL) | - | - | - | - | - | 50 | - |
| | SELENIUM (TOTAL) | 10 | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | 8 | 9 | 10 | 10 | 5 | 5 | 8 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 39200 | 39600 | 52200 | 53300 | 27800 | 30800 | 15000A |
| | CHLORIDE | 12300 | 12600 | 16000 | 22600 | 37500 | 32300 | 26800 |
| | MAGNESIUM (TOTAL) | 119000 | 120000 | 135100 | 135000 | 60400 | 78900 | 45700 |
| | NITROGEN, NITRATE (AS N) | 11200 | 11000 | 34200 | 46700 | 3470 | 4170 | 54900 |
| | PHOSPHATE, TOTAL (AS P) | 300 | 300 | 800 | 700 | 700 | 900 | 800 |
| | POTASSIUM (TOTAL) | 1600 | 1600 | 1700 | 2000 | 1400 | 1100 | 1400 |
| | SODIUM (TOTAL) | 51700 | 50300 | 39800 | 85900 | 54700 | 28600 | 58600 |
| | SULFATE | 75000 | 80500 | 70100 | 88800 | 38300 | 28100 | 67800 |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | - | - | - | 2.6 | 1.6 | - | - |
| | METHYLENE CHLORIDE | - | - | - | - | - | - | - |
| CHLORINATED PESTIDES AND PCBS (ug/liter) | ALPHA-BHC | - | - | - | 0.02 | - | - | - |
| | HEPTACHLOR | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | - | - | - | - |
| | GROSS ALPHA | 4 | 4 | 4 | 3 | - | 5 | 4 |
| | GROSS BETA | 10 | 16 | 6 | 6 | 8 | 17 | 10 |
| | TRITIUM | - | - | - | - | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. Analyzed for volatile organics only.
D = Duplicate Sample.
A = Anomalous value possible due to error in sample handling or analysis.
F = Measured in field

Semivolatile Organic Compounds - Method 625

No semivolatile organic compounds were reported for Summer 1991 groundwater samples by EPA Method 625.

Pesticides and PCBs - EPA Method 608

Two organochlorine pesticide compounds, alpha-BHC and heptachlor, were reported in Summer 1991 groundwater samples by EPA Method 608. Alpha-BHC was reported in sample UCD-15 at 0.004 $\mu$g/L and in UCD-21 at 0.020 $\mu$g/L. Heptachlor was reported in UCD-15 at 0.020 $\mu$g/L, UCD-16 at 0.019 $\mu$g/L, and UCD-17 at 0.018 $\mu$g/L. No other pesticide or PCB compounds were reported for Summer 1991 groundwater samples by this method.

Title 22 Metals

Seven Title 22 metals, including antimony, barium, chromium, lead, nickel, selenium, and thallium, were reported in Spring 1991 groundwater samples. Antimony was reported in 14 samples, ranging from 3 $\mu$g/L in four samples to 10 $\mu$g/L in UCD-19. Barium was reported in 13 of 14 samples, ranging from 30 $\mu$g/L in UCD-22 to 270 $\mu$g/L in UCD-14. Total chromium was detected in 9 samples, ranging from 50 $\mu$g/L in UCD-16 to 290 $\mu$g/L in UCD-19. Lead was reported in UCD-7 and UCD-14 at 1 $\mu$g/L. Nickel was reported at 30 $\mu$g/L in UCD-18 and 50 $\mu$g/L in UCD-23. Selenium was reported in only one sample, UCD-19, at the detection limit of 10 $\mu$g/L. Thallium was reported in 14 samples, ranging from 5 $\mu$g/L, in four samples, to 10 $\mu$g/L, in three samples.

Hexavalent chromium (Cr VI) was reported in all fourteen Summer 1991 groundwater samples. The highest values for Cr VI were reported for UCD-19 and UCD-19B at 200 $\mu$g/L.

Radionuclides

Detections were reported for four radiochemical analyses for Summer 1991 groundwater samples. Gross alpha activity was reported for seven samples, ranging from $3 \pm 2$ pCi/L to $6 \pm 5$ pCi/L. Gross beta activity was reported for eight samples ranging from $6 \pm 3$ pCi/L to $22 \pm 7$ pCi/L. Tritium was reported in only UCD-14 and UCD-14B at 4,557 $\pm$ 822 pCi/L and 5,482 $\pm$ 839 pCi/L, respectively. The highest activity reported for tritium are generally from UCD-13, which was dry during Summer 1991. Carbon-14 was reported in only UCD-14 and UCD-14B at 1,002 $\pm$ 466 pCi/L and 662 $\pm$ 461 pCi/L, respectively.

Nitrates

Nitrate as (N) was reported in all fourteen Summer 1991 groundwater samples. Reported values ranged from 2,160 $\mu$g/L in UCD-17 to 54,900 $\mu$g/L in UCD-24.

General Mineral Parameters

The ranges of values for 14 general chemical parameters in wells screened in the first HSU and wells screened in the second HSU are presented in Table 6.41. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium. These parameters were reported in nearly all samples and represent the general chemical composition of groundwater in the first and second HSUs.

Based on comparability with analytical results for other quarterly groundwater sampling, the TDS value reported for UCD-17 of 6,730 mg/L appears to be anomalously high, and the calcium value reported for UCD-24 at 15,000 $\mu$g/L appears to be anomalously low.

6.4.4.5 Fall Quarter, November 1991

Dames & Moore sampled 18 groundwater monitoring wells between November 18 and November 26, 1991. Sixteen wells were purged and sampled with dedicated pumps. Due to low groundwater levels, wells UCD-1 and UCD-4 were purged and sampled with disposable bailers. Replicate samples from two monitoring wells, UCD-10 and UCD-22, were obtained by collecting identical sets of sample bottles from each well, and labeling the replicate set with a fictitious identification, UCD-10B and UCD-22B.

Samples were shipped daily to CEP Laboratories. Requested analyses were performed on all Fall 1991 samples. Recommended holding times for all analyses were met, except for the alkalinity holding time, which was exceeded by one day for samples UCD-12, UCD-13, and UCD-14.

Laboratory control samples for all organic and inorganic parameters fell within acceptance criteria for Fall Quarter 1991 groundwater samples. The laboratory encountered poor recovery for Method 608 and 624 surrogate samples. Method 608 surrogates were run after dilution and fell within acceptance criteria. Method 624 surrogates were re-run and fell within acceptance criteria. Matrix spike and matrix spike duplicate analyses met acceptance criteria for all quality control samples for Fall Quarter 1991 groundwater analyses.

Reported detections for Fall 1991 groundwater samples are presented in Table 6.42 and are summarized below. Complete results for Fall 1991 groundwater samples are presented in Appendix G of this report.

TABLE 6.41
GENERAL CHEMICAL PARAMETERS
GROUNDWATER
SUMMER QUARTER, AUGUST 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | FIRST-HSU WELLS | | SECOND-HSU WELLS | |
|---|---|---|---|---|
| Parameter | Low | High | Low | High |
| pH (std. units) | 7.32 (UCD-21) | 7.60 (UCD-19) | 7.42 (UCD-14) | 7.78 (UCD-17) |
| EC (μmhos/cm) | 910 (UCD-22) | 2,080 (UCD-10) | 744 (UCD-17) | 1,132 (UCD-14) |
| Temperature (°C) | 19.7 (UCD-18) | 21.4 (UCD-10) | 18.7 (UCD-16 & 17) | 19.5 (UCD-14) |
| Turbidity (NTU) | 32.9 (UCD-22) | 1370 (UCD-24) | 0.052 (UCD-15) | 2.55 (UCD-7) |
| TDS (mg/L) | 523 (UCD-22) | 1030 (UCD-21) | 460 (UCD-15) | 860 (UCD-14) |
| COD (mg/L) | ND (UCD-19B) | 76.8 (UCD-22) | ND (2 wells) | 31.6 (UCD-14B) |
| Alkalinity (mg/L) | 378 (UCD-22) | 633 (UCD-21) | 344 (UCD-15) | 613 (UCD-14) |
| Chloride (mg/L) | 12.3 (UCD-19) | 37.5 (UCD-22) | 18.8 (UCD-17) | 36.5 (UCD-14B) |
| Sulfate (mg/L) | 28.1 (UCD-23) | 88.1 (UCD-21) | 8.1 (UCD-15) | 102.0 (UCD-14) |
| Calcium (mg/L) | 27.8 (UCD-22) | 53.3 (UCD-21) | 34.8 (UCD-16) | 51.8 (UCD-14) |
| Magnesium (mg/L) | 45.7 (UCD-24) | 135.1 (UCD-20) | 65.5 (UCD-16) | 134.0 (UCD-14) |
| Sodium (mg/L) | 23.7 (UCD-18) | 85.9 (UCD-21) | 19.2 (UCD-17) | 34.5 (UCD-16) |
| Potassium (mg/L) | 1.1 (UCD-23) | 2.0 (2 wells) | 0.6 (UCD-15) | 1.0 (UCD-14) |

TABLE 6.42
SUMMARY OF DETECTIONS IN GROUNDWATER, FALL QUARTER, NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | TB-29 | TB-30 | TB-31 | TB-35 | TB-36 | TB-37 | UCD-01 | UCD-04 | UCD-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 11/18/91 | 11/18/91 | 11/18/91 | 11/19/91 | 11/20/91 | 11/20/91 | 11/26/91 | 11/26/91 | 11/19/91 |
| | QA | T | T | T | T | T | T | | | |
| | ANALYTE | | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | - | - | - | - | - | - | 760 | 575 | 425 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | - | - | - | - | - | - | 27.2 | 41.6 | 19.2 |
| | EC-F (umhos/cm) | - | - | - | - | - | - | 1470 | 1172 | 921 |
| | TEMPERATURE-F (degrees C) | - | - | - | - | - | - | 16.94 | 16.94 | 17.67 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | - | - | - | - | - | - | 733 | 540 | 482 |
| | TURBIDITY (NTU) | - | - | - | - | - | - | 213 | 153 | 1.84 |
| | TURBIDITY-F (NTU) | - | - | - | - | - | - | 132.7 | 189.4 | 3.48 |
| | pH-F | - | - | - | - | - | - | 6.86 | 7.82 | 7.6 |
| METALS (ug/liter) | BARIUM (TOTAL) | - | - | - | - | - | - | 190 | 300 | 170 |
| | BERYLLIUM (TOTAL) | - | - | - | - | - | - | 1 | 1 | 1 |
| | CHROMIUM (TOTAL) | - | - | - | - | - | - | 60 | - | 30 |
| | CHROMIUM, HEXAVALENT (+6) | - | - | - | - | - | - | 40 | 10 | 30 |
| | NICKEL (TOTAL) | - | - | - | - | - | - | - | - | - |
| | SELENIUM (TOTAL) | - | - | - | - | - | - | - | - | - |
| | THALLIUM (TOTAL) | - | - | - | - | - | - | 8 | 6 | 7 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | - | - | - | - | - | - | 58400 | 59500 | 39100 |
| | CHLORIDE | - | - | - | - | - | - | 16600 | 51700 | 23100 |
| | MAGNESIUM (TOTAL) | - | - | - | - | - | - | 147000 | 99200 | 75000 |
| | NITROGEN, NITRATE (AS N) | - | - | - | - | - | - | 11900 | 3030 | 9400 |
| | PHOSPHATE, TOTAL (AS P) | - | - | - | - | - | - | 830 | 530 | - |
| | POTASSIUM (TOTAL) | - | - | - | - | - | - | 1200 | 1600 | 800 |
| | SODIUM (TOTAL) | - | - | - | - | - | - | 29600 | 32500 | 27000 |
| | SULFATE | - | - | - | - | - | - | 40100 | 30200 | 36100 |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | - | - | - | - | 3 | - | - | - | - |
| | METHYLENE CHLORIDE | 2.8 | 2.9 | 4.1 | 3 | - | 2.9 | - | - | - |
| | TRICHLOROETHENE | - | - | - | - | - | - | - | - | - |
| CHLORINATED PESTICIDES (ug/liter) | DIELDRIN | - | - | - | - | - | - | - | - | - |
| | ENDRIN | - | - | - | - | - | - | - | - | - |
| | GAMMA-BHC | - | - | - | - | - | - | - | 0.005 | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | - | - | - | - | - | - | - | 7 | - |
| | GROSS BETA | - | - | - | - | - | - | 6 | 16 | - |
| | TRITIUM | - | - | - | - | - | - | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. analyzed for volatile organics only.
D = Duplicate Sample.
F = Measured in field

TABLE 6.42 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, FALL QUARTER, NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-10 | UCD-10B | UCD-11 | UCD-12 | UCD-13 | UCD-14 | UCD-15 | UCD-16 | UCD-17 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 11/25/91 | 11/25/91 | 11/25/91 | 11/20/91 | 11/20/91 | 11/20/91 | 11/18/91 | 11/18/91 | 11/18/91 |
| | QA | | D | | | | | | | |
| | ANALYTE | | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 675 | 680 | 525 | 815H | 885H | 415H | 350 | 366 | 360 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 26.8 | 19.2 | 32 | 51.2 | 19.2 | 18 | 8 | 32 | 24 |
| | EC-F (umhos/cm) | 1945 | - | 1284 | 3290 | 1970 | 1007 | 644 | 720 | 674 |
| | TEMPERATURE-F (degrees C) | 17.11 | - | 17.5 | 17.81 | 17.11 | 16.56 | 16.56 | 18.22 | 17.83 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 1240 | 1260 | 684 | 1730 | 947 | 459 | 395 | 416 | 392 |
| | TURBIDITY (NTU) | 3.76 | 3.81 | 3.65 | 38.5 | 8.67 | 1.77 | 0.706 | 1.74 | 0.331 |
| | TURBIDITY-F (NTU) | 28 | - | 7.03 | 26.2 | 12.73 | 11.58 | 0.13 | 0.3 | 0.5 |
| | pH-F | 7.05 | - | 7.75 | 7.7 | 7.91 | 7.95 | 7.88 | 7.67 | 7.88 |
| METALS (ug/liter) | BARIUM (TOTAL) | - | - | 140 | 410 | 250 | 150 | 160 | 150 | 150 |
| | BERYLLIUM (TOTAL) | - | - | - | 1 | - | - | - | - | - |
| | CHROMIUM (TOTAL) | 70 | 60 | 340 | 220 | 100 | - | - | 40 | 40 |
| | CHROMIUM, HEXAVALENT (+6) | 40 | 40 | 30 | 190 | 80 | 20 | 10 | 40 | 22 |
| | NICKEL (TOTAL) | - | - | - | - | - | - | - | - | - |
| | SELENIUM (TOTAL) | - | - | 31 | 23 | - | - | - | - | - |
| | THALLIUM (TOTAL) | 13 | 13 | - | 23 | 13 | - | 9 | 6 | - |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 51400 | 50900 | 41500 | 93100 | 67900 | 35100 | 36000 | 23700 | 36400 |
| | CHLORIDE | 29800 | 29800 | 50100 | 265000 | 31500 | 27380 | 19800 | 21000 | 18700 |
| | MAGNESIUM (TOTAL) | 176000 | 174000 | 108000 | 311000 | 184000 | 78900 | 60800 | 58700 | 60400 |
| | NITROGEN, NITRATE (AS N) | 15600 | 16000 | 24400 | 100400 | 15900 | 4650 | 2410 | 3330 | 2810 |
| | PHOSPHATE, TOTAL (AS P) | - | - | - | - | 610 | 580 | 112 | - | 172 |
| | POTASSIUM (TOTAL) | 1600 | 1600 | 1500 | 4100 | 1900 | 1100 | 800 | 700 | 600 |
| | SODIUM (TOTAL) | 102000 | 105000 | 48600 | 86000 | 36200 | 51600 | 19400 | 28800 | 19200 |
| | SULFATE | 457000 | 489000 | 41100 | 82700 | 73300 | 40400 | 33100 | 41900 | 33400 |
| VOLATILE ORGANICS (ug/liter) | 1,1-DICHLOROETHANE | - | - | - | 27 | - | - | - | - | - |
| | 1,1-DICHLOROETHENE | - | - | - | 51 | - | - | - | - | - |
| | 1,2-DICHLOROETHANE | - | - | - | 20 | - | - | - | - | - |
| | BROMODICHLOROMETHANE | - | - | - | 2.4 | - | - | - | - | - |
| | CHLOROFORM | - | - | - | 21000 | 1.7 | 4.1 | - | - | - |
| | METHYLENE CHLORIDE | - | - | - | - | - | - | 3 | 2.9 | - |
| | TRICHLOROETHENE | - | - | - | - | - | - | - | - | - |
| CHLORINATED PESTICIDES (ug/liter) | DIELDRIN | - | - | - | 0.004 | 0.03 | - | - | - | - |
| | ENDRIN | - | - | - | - | 0.01 | - | - | - | - |
| | GAMMA-BHC | - | - | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | - | 1815 | - | - | - | - |
| | GROSS ALPHA | - | 5 | 3 | - | 3 | - | - | - | - |
| | GROSS BETA | 5 | 3 | 6 | - | - | - | - | - | 4 |
| | TRITIUM | - | - | - | - | 24578 | 652 | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. analyzed for volatile organics only.
D = Duplicate Sample.
F = Measured in field

TABLE 6.42 (cont.)
SUMMARY OF DETECTIONS IN GROUNDWATER, FALL QUARTER, NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | SAMPLE | UCD-18 | UCD-19 | UCD-20 | UCD-21 | UCD-22 | UCD-22B | UCD-23 | UCD-24 |
|---|---|---|---|---|---|---|---|---|---|
| | DATE | 11/18/91 | 11/19/91 | 11/18/91 | 11/18/91 | 11/19/91 | 11/19/91 | 11/18/91 | 11/19/91 |
| | QA | | | | | | D | | |
| | ANALYTE | | | | | | | | |
| MISCELLANEOUS ANALYTES | ALKALINITY TOTAL(AS CACO3) (mg/liter) | 380 | 701 | 591 | 661 | 420 | 410 | 449 | 501 |
| | CHEMICAL OXYGEN DEMAND (mg/liter) | 16 | 20.6 | 32 | 18 | 43.2 | 12.8 | 48 | 28.8 |
| | EC-F (umhos/cm) | 770 | 1268 | 1378 | 1520 | 985 | - | 903 | 1451 |
| | TEMPERATURE-F (degrees C) | 18.67 | 18.44 | 19.39 | 19.5 | 19.33 | - | 19.89 | 17.89 |
| | TOTAL DISSOLVED SOLIDS (mg/liter) | 428 | 783 | 864 | 946 | 518 | 471 | 479 | 896 |
| | TURBIDITY (NTU) | 12.5 | 0.91 | 17.9 | 1.42 | 2.38 | 2.08 | 7.18 | 1.83 |
| | TURBIDITY-F (NTU) | 19.5 | 2.42 | 10 | 1.6 | 2.38 | - | 2.9 | 1.62 |
| | pH-F | 7.66 | 7.56 | 7.63 | 7.37 | 7.58 | - | 7.64 | 7.53 |
| METALS (ug/liter) | BARIUM (TOTAL) | 80 | 50 | 160 | 140 | 30 | 30 | 50 | 120 |
| | BERYLLIUM (TOTAL) | 1 | - | 1 | 1 | 1 | - | - | - |
| | CHROMIUM (TOTAL) | - | 290 | 110 | 100 | - | - | - | 40 |
| | CHROMIUM, HEXAVALENT (+6) | 40 | 290 | 100 | 80 | - | 10 | 10 | 40 |
| | NICKEL (TOTAL) | - | - | - | - | - | - | 30 | - |
| | SELENIUM (TOTAL) | - | 31 | - | 12 | - | - | - | - |
| | THALLIUM (TOTAL) | 5 | 9 | 12 | 7 | - | - | 7 | 8 |
| ANIONS AND CATIONS (ug/liter) | CALCIUM (TOTAL) | 29900 | 48300 | 47200 | 55600 | 28900 | 28800 | 33400 | 46000 |
| | CHLORIDE | 20600 | 11300 | 22400 | 19700 | 29500 | 30400 | 18660 | 20600 |
| | MAGNESIUM (TOTAL) | 68200 | 134000 | 128000 | 137000 | 58300 | 57500 | 81800 | 120200 |
| | NITROGEN, NITRATE (AS N) | 4600 | 11900 | 46400 | 45300 | 4640 | 4120 | 5420 | 50100 |
| | PHOSPHATE, TOTAL (AS P) | 209 | 301 | 175 | 143 | 208 | 132 | 170 | 345 |
| | POTASSIUM (TOTAL) | 1200 | 1400 | 1900 | 1700 | 1500 | 1500 | 1400 | 1400 |
| | SODIUM (TOTAL) | 29900 | 44300 | 39500 | 65900 | 46200 | 45300 | 27500 | 50200 |
| | SULFATE | 32600 | 60800 | 50000 | 59200 | 27100 | 27200 | 26700 | 54440 |
| VOLATILE ORGANICS (ug/liter) | CHLOROFORM | - | - | - | 2.7 | - | - | - | - |
| | METHYLENE CHLORIDE | - | - | - | - | - | - | - | - |
| | TRICHLOROETHENE | - | - | 3.1 | - | - | - | - | - |
| CHLORINATED PESTICIDES (ug/liter) | DIELDRIN | - | - | - | - | - | - | - | - |
| | ENDRIN | - | - | - | - | - | - | - | - |
| | GAMMA-BHC | - | - | - | - | - | - | - | - |
| RADIONUCLIDES (pCi/liter) | CARBON-14 | - | - | - | - | - | - | - | - |
| | GROSS ALPHA | - | - | 3 | - | - | - | - | 3 |
| | GROSS BETA | - | - | 6 | - | - | 5 | - | 4 |
| | TRITIUM | - | - | - | 9752 | - | - | - | - |

- = Denotes either not detected or not analyzed. See Appendix G for complete analytical results.
T = Trip Blank. analyzed for volatile organics only.
D = Duplicate Sample.
F = Measured in field

Volatile Organic Compounds (VOCs) - EPA Method 624

Three VOCs, methylene chloride, chloroform, and trichloroethene, were reported in Fall 1991 groundwater samples. Methylene chloride was reported in five travel control blanks and two groundwater samples, UCD-15 and UCD-16, ranging from 2.8 μg/L to 4.1 μg/L, with a reported detection limit of 2.8 μg/L. Chloroform was reported in one travel control blank and in four samples, UCD-12, UCD-13, UCD-14, and UCD-21, ranging from 1.7 μg/L in UCD-13 to 21,000 μg/L in UCD-12. The reported detection limit for chloroform was 1.6 μg/L. Trichloroethene was reported in sample UCD-20 at 3.1 μg/L, with a reported detection limit of 1.9 μg/L.

Semivolatile Organic Compounds - EPA Method 625

No semivolatile organic compounds were reported for Fall 1991 groundwater samples by this method.

Pesticides and PCBs - EPA Method 608

Three organochlorine pesticide compounds, dieldrin, endrin, and gamma-BHC, were detected in Fall 1991 groundwater samples by EPA Method 608. Gamma-BHC was reported in UCD-4 at 0.010 μg/L, with a reported detection limit of 0.004 μg/L. Dieldrin was reported in UCD-12 (0.004 μg/L) and UCD-13 (0.030 μg/L), with a reported detection limit of 0.002 μg/L. Endrin was reported in UCD-13 at 0.010 μg/L, with a reported detection limit of 0.006 μg/L. No PCB compounds were reported for Fall 1991 groundwater samples by this method.

Title 22 Metals

Six Title 22 metals, including barium, beryllium, chromium, nickel, selenium, and thallium were reported in Fall 1991 groundwater samples. Barium was reported in 18 of 20 samples, ranging from 30 μg/L in UCD-22 and 22B, to 410 μg/L in UCD-12. Beryllium was reported in eight samples, including UCD-18, the upgradient well, at a reported concentration of 1 μg/L. Total chromium was detected in 14 groundwater samples ranging from 30 μg/L in UCD-7 to 340 μg/L in UCD-12. Nickel was reported only in UCD-23 at 30μg/L. Selenium was reported in four samples, UCD-11, UCD-12, UCD-19, and UCD-21, ranging from 12 μg/L to 31 μg/L. Thallium was reported in 14 samples, ranging from 5 μg/L in upgradient well UCD-18 to 23 μg/L in UCD-12.

Hexavalent chromium (Cr VI) was reported in all but one Fall 1991 groundwater sample (UCD-22). Reported values for Cr VI ranged from 10 μg/L in UCD-15, -22B and -23, to 290 μg/L in UCD-19.

Radionuclides

Carbon-14, gross alpha, gross beta, and tritium activity were reported in Fall 1991 groundwater samples. Strontium-90 activity was not reported in any Fall 1991 groundwater samples. No gamma-producing radionuclides were reported for the gamma spectral analysis.

Carbon-14 was reported only in UCD-13 at a value of 1,815 $\pm$ 352 pCi/L. Gross alpha activity was reported for UCD-4, -10B, -11, -13, -20, and -24. Reported activities ranged from 3 $\pm$ 2 pCi/L to 7 $\pm$ 5 pCi/L. Gross beta activity was reported for samples from eight wells, and ranged from 3 $\pm$ 2 pCi/L to 16$\pm$3 pCi/L. Tritium was reported for three wells; UCD-13 at 24,576 pCi/L, UCD-14 at 652 $\pm$ 534 pCi/L, and UCD-21 at 9,752 $\pm$ 942 pCi/L. Although tritium has been reported in UCD-13 and UCD-14 in previous rounds, this is the first reported detection of tritium in UCD-21.

Nitrates

Nitrate as (N) was reported in all twenty Fall 1991 groundwater samples. Reported values ranged from 2,410 $\mu$g/L in UCD-15 to 100,400 $\mu$g/L in UCD-12.

General Chemical Parameters

Ranges of values for 14 general chemical parameters in wells screened in the first HSU and wells screened in the second HSU are presented in Table 6.43. These parameters include pH (field), EC (field), temperature (field), turbidity, TDS, COD, alkalinity, chloride, sulfate, phosphate, calcium, magnesium, sodium, and potassium. These parameters were reported in nearly all Fall 1991 groundwater samples and represent the general chemical composition of groundwater in the first and second HSUs.

### 6.4.5 Statistical Analysis

Preliminary statistical analyses were performed on chemical and radiologic analytical results from soil and water samples collected during the Phase II Site Characterization. Section 6.4.5.1 describes statistical methods used to evaluate the soil chemical and radiologic results. Section 6.4.5.2 describes statistical methods used to analyze variance of groundwater sample results for selected chemical parameters. The statistical analysis was used to evaluate the data and to begin to develop preliminary site-specific background criteria. As noted in Chapter 9.0, it is recommended that additional sampling be conducted to obtain more statistically supported background ranges.

TABLE 6.43
GENERAL CHEMICAL PARAMETERS –
GROUNDWATER –
FALL QUARTER, NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | First-HSU Wells [a] | | | | Second-HSU Wells [b] | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Low Value | | High Value | | Low Value | | High Value | |
| pH * (Std. units) | 6.86 | (UCD-1) | 7.97 | (UCD-13) | 7.67 | (UCD-16) | 7.95 | (UCD-14) |
| EC * (μhmo/cm) | 770 | (UCD-18) | 3,290 | (UCD-12) | 644 | (UCD-15) | 1,007 | (UCD-14) |
| Temperature * (°C) | 16.94 | (UCD-1) | 19.89 | (UCD-23) | 16.56 | (UCD-14&15) | 18.22 | (UCD-16) |
| Turbidity (NTU) | 0.91 | (UCD-19) | 213 | (UCD-1) | 0.33 | (UCD-17) | 1.84 | (UCD-7) |
| TDS (mg/L) | 428 | (UCD-18) | 1,730 | (UCD-12) | 395 | (UCD-15) | 482 | (UCD-7) |
| COD (mg/L) | 12.8 | (UCD-22B) | 51.2 | (UCD-12) | 8 | (UCD-15) | 32 | (UCD-16) |
| Alkalinity (mg/L) | 380 | (UCD-18) | 885 | (UCD-13) | 350 | (UCD-15) | 425 | (UCD-7) |
| Chloride (mg/L) | 11.3 | (UCD-19) | 265.0 | (UCD-12) | 18.7 | (UCD-17) | 27.4 | (UCD-14) |
| Sulfate (mg/L) | 26.7 | (UCD-23) | 489.0 | (UCD-10B) | 33.1 | (UCD-15) | 41.9 | (UCD-16) |
| Phosphate (mg/L) | ND | (6 samples) | 0.83 | (UCD-1) | ND | (UCD-7&16) | 0.580 | (UCD-14) |
| Calcium (mg/L) | 28.6 | (UCD-22B) | 93.1 | (UCD-12) | 23.7 | (UCD-16) | 39.1 | (UCD-7) |
| Magnesium (mg/L) | 57.5 | (UCD-22B) | 311.0 | (UCD-12) | 58.7 | (UCD-16) | 78.98 | (UCD-14) |
| Sodium (mg/L) | 27.5 | (UCD-23) | 105.0 | (UCD-10B) | 19.2 | (UCD-17) | 51.6 | (UCD-14) |
| Potassium (mg/L) | 1.2 | (UCD 1&18) | 4.1 | (UCD-12) | 0.6 | (UCD-17) | 1.1 | (UCD-14) |

a First-HSU wells include UCD-1, -4, -10, -11, -12, -13, -18, -19, -20, -21, -22, -23, and -24.
b Second-HSU wells include UCD-7, -14, -15, -16, and -17.
* Measured in field.

#### 6.4.5.1 Statistical Analysis of Soil Data

Soil samples are collected from discrete locations and cannot be duplicated. Replicate samples are collected from adjacent locations for 10 percent of the soil samples collected, but cannot be considered true duplicate samples. Therefore, limited statistical analyses can be applied to the analyses of any chemical or radiologic data without true duplicate sample results.

The "student-t" test was used to calculate the upper 95-percent confidence limits (CL) for each chemical and radiologic parameter observed in the background soil samples (UCD-17 and -18). Table 6.44 compares the background upper 95-percent CL value with the means from each area of interest for all parameters detected. The upper 95-percent CLs are used to compare the average values of one sample population (e.g., background nitrate concentrations) with another population (e.g., Strontium-90 Leach Field nitrate concentrations). When a parameter is not detected in background samples, the upper 95-percent CLs were not calculated, and any detection of that parameter is considered to be elevated compared to background soils. Background values for organic compounds are not listed because they were not detected in background soil samples. Therefore, any detection of organics is considered statistically significant. Not-detected results were calculated as one-half the detection limit concentration for individual parameters in the statistical analysis process.

Deficiencies exist in this statistical approach. Chemical and radiologic constituents are not normally or log-normally distributed in soils, but are distributed based on the variations in the sedimentary deposits. To more properly evaluate data, all stratigraphic units should be identified and sampled to compare chemical parameters on similar materials. Further evaluation of the stratigraphic units and lateral and vertical extent of site constituents is planned for the site-wide soil investigation. Additional statistical analysis of soil analytical results will be conducted during that investigation.

Table 6.44 presents comparisons of the mean analytical values from each area compared with the upper 95-percent CL value obtained from background samples. This table suggests that several Title 22 metal concentrations are "significantly" elevated above background levels.

The absolute differences between the mean metal concentration in soil and the background 95-percent CL values were within 1.5 times the background values for the metals analyzed, with the exception of arsenic, beryllium, hexavalent chromium, copper, mercury, nickel, and silver. The concentration of selenium and thallium appeared to be greater in the background samples than on-site.

TABLE 6.44
AVERAGE CONCENTRATIONS VS. 95% UPPER CONFIDENCE LIMIT
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Analyte | Background 95% Upper Confidence Limit | Northern Area Downgradient of LEHR | Radium-226 Seepage Pit | Strontium-90 Leach Field | North Chemical Dispensing Area | Southwest Chemical Dispensing Area | Dog Pens | | AEC |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | PS-Samples | UCD-SB Samples | |
| Nitrate | 21.13 | 11.25 | 105.56 | 23.76 | 39.0 | 42.66 | 14.10 | 9.38 | — |
| Cesium-137 | 0.082 | ND | 0.062 | 0.052 | ND | ND | 0.067 | 0.054 | — |
| Cobalt-60 | 0.01 | ND | ND | ND | ND | ND | ND | ND | — |
| Gross Alpha | 1.33 | 1.21 | 1.09 | 0.94 | 0.88 | 1.35 | 1.77 | 1.47 | — |
| Gross Beta | 2.63 | 4.14 | 4.75 | 3.88 | 5.04 | 4.63 | 8.59 | 2.46 | — |
| Potassium-40 | 23.59 | 8.41 | 8.73 | 8.07 | 10.42 | 8.67 | 10.42 | 10.76 | — |
| Radium-226 | 0.88 | 0.45 | 0.50 | 0.20 | 0.48 | 0.17 | 0.25 | 0.50 | — |
| Strontium-90 | 0.10 | 1.55 | 0.10 | 0.40 | 0.04 | 0.11 | 0.04 | 0.07 | — |
| Thorium-232 | 0.72 | 0.43 | 0.51 | ND | 0.40 | 0.46 | 0.38 | 0.64 | — |
| Bismuth-214 | ND | ND | 1.48 | 0.34 | 1.08 | 0.90 | ND | ND | — |
| Lead-210 | ND | ND | 0.81 | ND | ND | ND | ND | ND | — |
| Lead-212 | ND | 0.72 | 0.53 | 0.42 | 0.47 | 0.61 | ND | ND | — |
| Lead-214 | ND | 0.56 | 0.93 | 0.44 | 0.76 | ND | ND | ND | — |
| Manganese-54 | ND | ND | ND | ND | ND | ND | ND | 540.08 | ND |
| Carbon-14 | — | ND | — | — | — | — | — | — | 0.26 |
| Thallium-208 | ND | 0.57 | ND | ND | ND | ND | ND | ND | ND |
| Tritium | 0.26 | 0.13 | 0.11 | ND | 0.23 | 1.19 | 0.25 | 0.12 | — |
| Antimony | 12.7 | 10.76 | 3.07 | ND | ND | ND | — | 13.77 | — |
| Arsenic | 1.8 | 1.38 | 2.08 | 3.63 | 5.2 | 2.98 | — | 2.49 | — |
| Barium | 139.2 | 64.62 | 119.60 | 93.93 | 77.67 | 108.11 | — | 154.02 | — |
| Beryllium | 0.87 | 0.28 | 0.47 | 0.31 | 2.7 | 0.82 | — | 0.21 | — |
| Cadmium | 10.69 | 4.55 | 4.22 | 0.14 | 0.7 | 1.20 | — | 17.89 | — |
| Chromium (Total) | 80.78 | 48.61 | 47.37 | 64.78 | 72.47 | 61.65 | — | 91.18 | — |

TABLE 6.44 (continued)
AVERAGE CONCENTRATIONS VS. 95% UPPER CONFIDENCE LIMIT
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Analyte | Background 95% Upper Confidence Limit | Northern Area Downgradient of LEHR | Radium-226 Seepage Pit | Strontium-90 Leach Field | North Chemical Dispensing Area | Southwest Chemical Dispensing Area | Dog Pens | | AEC |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | PS-Samples | UCD-SB Samples | |
| Chromium VI | 0.69 | 0.23 | 1.31 | 1.49 | 1.23 | 0.31 | — | 0.53 | — |
| Cobalt | 15.17 | 13.55 | 27.41 | 28.73 | 41.25 | 20.35 | — | 21.87 | — |
| Copper | 4.81 | 33.06 | 15.27 | 5.77 | 11.5 | 23.80 | — | 46.47 | — |
| Lead | 15.47 | 10.52 | 7.20 | 5.90 | 4.82 | 5.74 | — | 22.51 | — |
| Mercury | 0.08 | 0.08 | 0.05 | 0.13 | 0.39 | 0.18 | — | 0.09 | — |
| Molybdenum | 5.36 | 10.15 | 2.26 | ND | 0.83 | 5.70 | — | 9.47 | — |
| Nickel | 135.6 | 109.42 | 166.37 | 175.47 | 264.3 | | — | 178.51 | — |
| Selenium | 1.04 | ND | ND | ND | ND | ND | — | ND | — |
| Silver | 3.17 | 1.97 | ND | ND | ND | 16.54 | — | ND | — |
| Thallium | 17.30 | 3.66 | 1.09 | ND | ND | 0.93 | — | 3.59 | — |
| Vanadium | 36.60 | 28.68 | 32.25 | 15.74 | 40.67 | 24.62 | — | 49.77 | — |
| Zinc | 54.62 | 43.58 | 63.59 | 60.09 | 58.0 | 55.78 | — | 79.89 | — |

— = Not analyzed
ND = Not detected

= Value exceeds 95-percent upper confidence limit for background area samples.

Average soil nitrate concentration in the Radium-226 Seepage Pit was approximately five times the upper 95-percent CL observed in background soils. Soils nitrate results in the North and Southwest Chemical Dispensing areas were nearly double the upper 95-percent CLs in background samples. Soil samples from the dog pen area and the Northern Area downgradient of LEHR had average soil nitrate concentrations within the background 95-percent CLs.

No volatile, semivolatile or chlorinated organic compounds were detected in background soil samples. Therefore, every detection of volatile, semivolatile or chlorinated organic compound in soil on-site is considered to be statistically significant.

Several radionuclides were not detected in background soils, and therefore detections on-site would be considered statistically significant. The radionuclides not detected in background soils include bismuth-214, lead-214, -212, -210, manganese-54, and thallium-208, even though several of these isotopes are known to occur naturally from the radioactive decay of minerals.

Gross beta activity was consistently elevated in all areas tested with the exception of the deep soil borings in the dog pen area. Gross alpha activity was slightly elevated in samples from the Southwest Chemical Dispensing area and the dog pen area. Thorium-232, potassium-40, cesium-137 and radium-226 concentrations in all areas were within the 95-percent CL of the background samples. Three areas exceeded 95-percent CLs of background for strontium-90, including the Northern Area Downgradient of the LEHR facility, the Strontium-90 Leach Field and the Southwest Chemical Dispensing area.

#### 6.4.5.2 Statistical Analysis of Groundwater Data

Groundwater from the first and second HSU was sampled during five quarterly sampling rounds from November 1990 to November 1991. Given the repeated sampling of these wells, the analysis of variance (ANOVA) procedure can be applied to the data to detect significant differences between wells for a given analyte. Data below the detection limits does not constitute a known quantity and violates the assumptions of parametric ANOVA.

When a chemical parameter is analyzed for, but is not detected, the standard ANOVA test must be modified (EPA, 1989). The Kruskall-Wallis nonparametric ANOVA was used to compare total chromium concentrations in the second HSU, because this test can tolerate a moderate number of nondetects, by treating nondetects as tied observations. USEPA guidance (USEPA, 1989) recommends use of this test when between 10 and 50 percent of the observations are nondetects. The procedure to calculate the nonparametric ANOVA test, treating nondetects as tied observations, is presented in USEPA (1989) and in Gilbert (1987).

Prior to applying statistical tests to the groundwater data, the metals data were tabulated by analyte for each well and each quarter, as shown in Chapter 7.0 to observe trends in the data. Several metals including antimony, beryllium, molybdenum and thallium, were reported at higher concentrations in both the first- and second-HSU monitoring wells during the first sampling event. In the four subsequent sampling events, these metals were either not detected or were detected at similar concentrations in all wells. This suggests some anomalous trend such as laboratory error or increased turbidity may account for the unusually high values in the first-quarter data for metals analysis.

For the groundwater data, there are far fewer than 50% detections for almost all organic chemicals and radionuclides. There were important exceptions; for example, wells UCD-12 and UCD-21 had detections of chloroform in four of the five quarters of sampling. When two out of 20 wells have repeated detections, and the remaining 18 wells are non-detect, statistics are not needed to state that the 2 wells contain significantly more chloroform.

Another example is for tritium, which is consistently detected in only one well, UCD-13. Without further analysis, UCD-13 is significantly elevated with respect to tritium, and the lack of detections in remaining wells makes further statistical analysis unnecessary.

Selected groundwater parameters which have an adequate percentage of detections were analyzed by ANOVA. These parameters include nitrate, hexavalent chromium, and total chromium. Each parameter was analyzed by HSU. The first-HSU wells included UCD-1, -4, -10, -11, -12, -13, -18, -19, -20, -21, -22, -23, and -24. The second HSU included wells UCD-7, -14, -15, and -17. The ANOVA results are included as Table G-7 in Appendix G.

Using analytical results of soil and groundwater samples collected during the Phase II investigation, the results of analysis of variance suggest statistically different nitrate concentrations between wells in the first and second HSUs, with greater than 99 percent probability. Concentrations of hexavalent chromium are also statistically elevated in both the first and second HSU with greater than 99 percent probability. Total chromium concentration is also statistically different in wells from the first HSU, but not in the second HSU. There was a large number of non-detectable concentrations reported for total chromium in the second HSU; however, non-parametric ANOVA also yielded no significant differences with 95 percent probability.

## 6.5 GROUNDWATER MODEL RESULTS

A numerical model has been developed to simulate groundwater movement beneath the LEHR facility. The objective of the model is to illustrate flow relationships between the first and second HSUs. To meet this objective, specific goals were set for the model, including the simulation of seasonal fluctuations in water levels observed for both hydrostratigraphic units. The three-dimensional flow model

MODFLOW, was used and included two layers: Layer 1, representing the first HSU, and Layer 2, representing the second HSU. This system allowed evaluation of hydraulic interaction between the two zones.

Data and assumptions used to construct the model are summarized in Section 6.5.1 and discussed in more detail in Appendix A. Sample input files are listed in Appendix L. A description of model evaluation is summarized in Section 6.5.2 and also discussed in Appendix A. Results of the simulations are also discussed in Section 6.5.2.

### 6.5.1 Data Description

Parameters evaluated include hydraulic conductivity (both vertical and horizontal), storativity, elevation of the bottom of Layer 1, thickness of Layer 2, precipitation recharge, and Putah Creek recharge. Hydraulic conductivities for both layers were based on slug tests conducted in wells located across the site. Slug test results, discussed in Section 6.2, and hydraulic conductivities estimated during the Contaminant Pathways Analysis (Dames & Moore, 1990c), were used in the model. A value of $6 \times 10^{-4}$ cm/sec ($2 \times 10^{-5}$ ft/sec) was used for most of Layer 1 (see Appendix A for detailed discussion.) A value of $9.1 \times 10^{-3}$ cm/sec ($3 \times 10^{-4}$ ft/sec) was used for Layer 2. Vertical hydraulic conductivities for Layer 1 were based on model results obtained during calibration. Vertical hydraulic conductivity for Layer 2 was assumed to be 50 percent of the horizontal hydraulic conductivity. Site-specific values for storage coefficients or specific yield have not been measured, so these parameters were estimated based on Dames & Moore's experience with similar material in the area (0.20 and 0.001 for layers 1 and 2, respectively).

Elevation of the bottom of Layer 1, 80 feet bgs, was based on the discussion of the hydrostratigraphy presented in Section 6.2 and assumed constant over the model domain. Layer 2 thickness (50 feet) was also based on the discussion of hydrostratigraphy in Section 6.2 and assumed constant over the model domain. Recharge from precipitation was assumed to be nine inches per year. This assumed that 50 percent of the mean annual rainfall recharges groundwater, and was based on an initial mean annual average rainfall of 18 inches (this value has been updated to 17.0 inches per year, as presented in Section 2.4).

#### 6.5.1.1 Recharge from Irrigation and Evapotranspiration

Estimation of recharge from Putah Creek to the first HSU is based on observations of stream flow and the relationship between the water table and the base of the streambed. Throughout the studies at the site, groundwater levels have always been lower than the base of the creek. Putah Creek ends before discharging into any other water bodies, implying that all of its flow either infiltrates or evaporates. Therefore, it was assumed that all of the flow occurring at Old Davis Road infiltrates by the time the

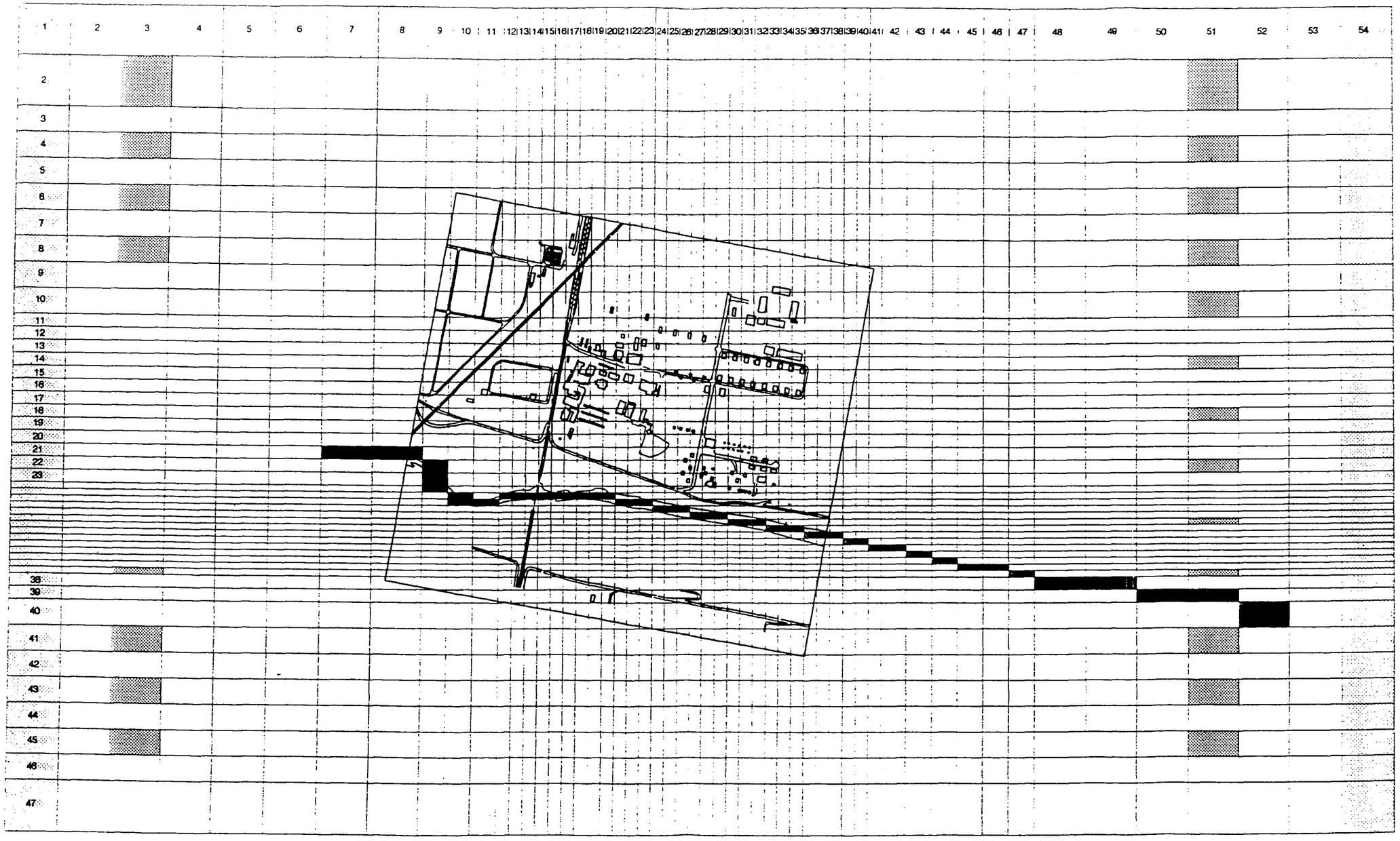
creek becomes dry downstream. No data were available to estimate the amount of potential underflow (in the downstream direction) that may continue for some distance; however, assuming infiltration to groundwater allows a more conservative estimate of recharge. Assumptions made in estimating stream recharge include: no flow west of the site; a constant rate of infiltration over the entire saturated reach; and negligible evaporation (a conservative assumption to maximize infiltration). The rate of infiltration is assumed to be constant over time. This assumption is based on the observation that the water table is always below the base of the streambed and that the reconnaissance showed a loss of 2 cfs over 12,000 feet. This also implies that infiltration rates depend only on flow and creek bottom conductance. Irrigation recharge and evapotranspiration are not included in the model.

#### 6.5.1.2 Boundary Conditions

Boundary conditions used for the model were based on two-layer interpretation of the site hydrostratigraphy, dominant flow direction to the northeast, available stream flow measurements, and Layer 2 groundwater gradient observed on-site during Spring 1991. Spring 1991 levels were selected because they are the highest measured during the investigation. General head boundaries were set both east and west, a gradient of 0.0013 was established by the model at steady state. The bottom of Layer 2 was set as a no-flow boundary based on the clay found at the bottom Layer 2. No-flow boundaries were also set along the north and south cells (first and last rows) of the model. Pumping well locations and rates were selected based on the location of existing supply wells and assumed flow rates. Flow rates were assumed because these wells are not gauged or metered. Well locations and rates were then modified iteratively to achieve an appropriate calibration and simulation of water levels over time. Comparisons of measured and simulated water levels over time, as discussed in Section 6.5.2 and Appendix A, resulted in the configuration shown in Figure 6.17.

### 6.5.2 Flow Model Results

The evaluation of the model was an iterative process that compared modeled results with water levels measured in the field. Initial steady-state simulations with no stress (such as no pumping) were conducted to evaluate the gradient over the site. Steady-state simulations were then conducted with one well located at the eastern edge of the site pumping at 1,000 gpm to evaluate local pumping affects on water levels. Transient simulations were then conducted with additional pumping wells to simulate changes of water levels seen on-site. The transient simulation was then set to a one-year simulation to compare modeled water levels with actual water levels.



EXPLANATION

General Head Boundarys (Layers 1 and 2)

"Regional" Pumping Wells (Layer 2 Only)

Stream Recharge

0 800
Scale in Feet

N

**NUMERICAL MODEL SETUP, GRID ORIENTATION AND BOUNDARY CONDITIONS**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

FIGURE 6.17

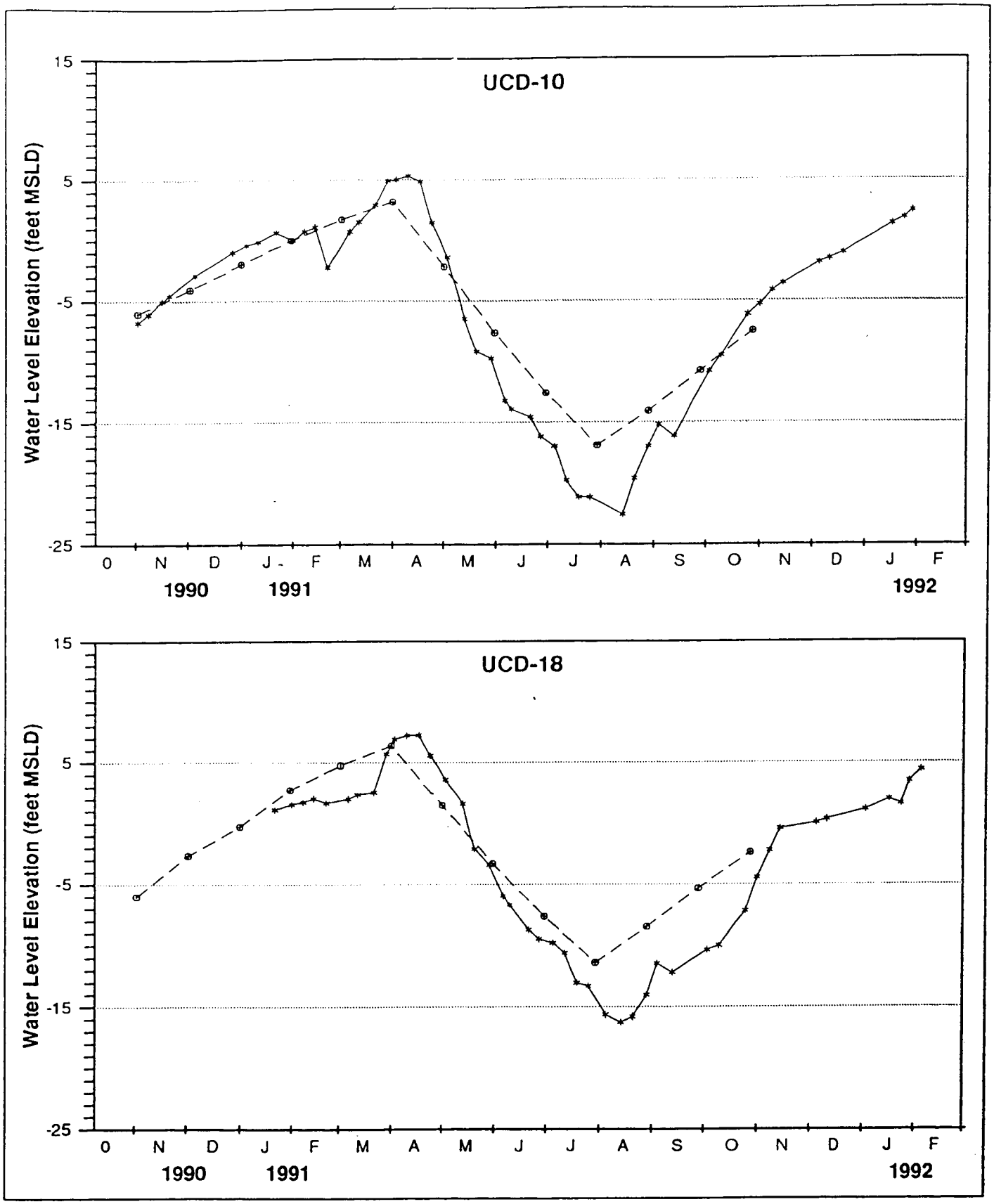
DAMES & MOORE

10805-454-044 DOE-180

Calibration runs that compare simulated water levels to measured water levels over a period of one year are shown in Figures 6.18 and 6.19. Simulated versus measured water levels were compared at a single location over time due to the large changes observed in water levels. As illustrated in Figures 6.18 and 6.19, the calibration compared water levels at cells which corresponded to wells located on-site. In addition, changes in vertical gradients over time between layers were also reviewed as illustrated in Figure 6.20. Simulated changes in water levels for both layers were obtained by pumping from Layer 2 in the model. The difference in head between layers (vertical gradients) was calibrated by modifying the leakance between zones (i.e., vertical hydraulic conductivity). Changes in water level over time (i.e., rate of recovery of drawdown) were calibrated by changing horizontal hydraulic conductivity and pumping rates in Layer 2. Calibration results suggest that seasonal changes in water levels in the upper zone are due, in part, to pumping and recovery from the lower zone. To simulate groundwater levels that were most similar to measured groundwater levels, a vertical hydraulic conductivity for Layer 1 of $7.6 \times 10^{-5}$ cm/sec ($2.5 \times 10^{-6}$ ft/sec) and a vertical hydraulic conductivity of $1.5 \times 10^{-1}$ cm/sec ($5 \times 10^{-3}$ ft/sec) for Layer 2 were used. An expanded discussion on calibration is presented in Appendix A.

Parameters estimated during calibration were then used in a simulation which included sequential six-month periods of recovery and recharge and 6 month periods of regional pumping. The model was set up in this manner to simulate the seasonal changes in water levels observed over time. Pumping well locations are shown in Figure 6.17. Example input data and output are listed in Appendix L. Simulated water levels after 20 years (end of the pumping) are shown in Figures 6.21 and 6.22 for Layer 1 and 2, respectively. As shown on the figures, water levels are about -10 to -12 feet MSL beneath the site, and groundwater levels in Layer 2 are lower than levels in Layer 1.

Flow model results also illustrate a groundwater mound under the south fork of Putah Creek, as would be expected with a losing stream (i.e., water infiltrating from the creek to the aquifer). The results of the simulations suggest that the groundwater mound persists in the first HSU throughout the year due to continued recharge from Putah Creek. A constant infiltration rate from the creek was assumed in the model. However, spatial and temporal variations in infiltration, and leakance between the first and second HSUs would cause the shape and height of the mound to fluctuate.




EXPLANATION

Actual Water Levels

Simulated Water Levels

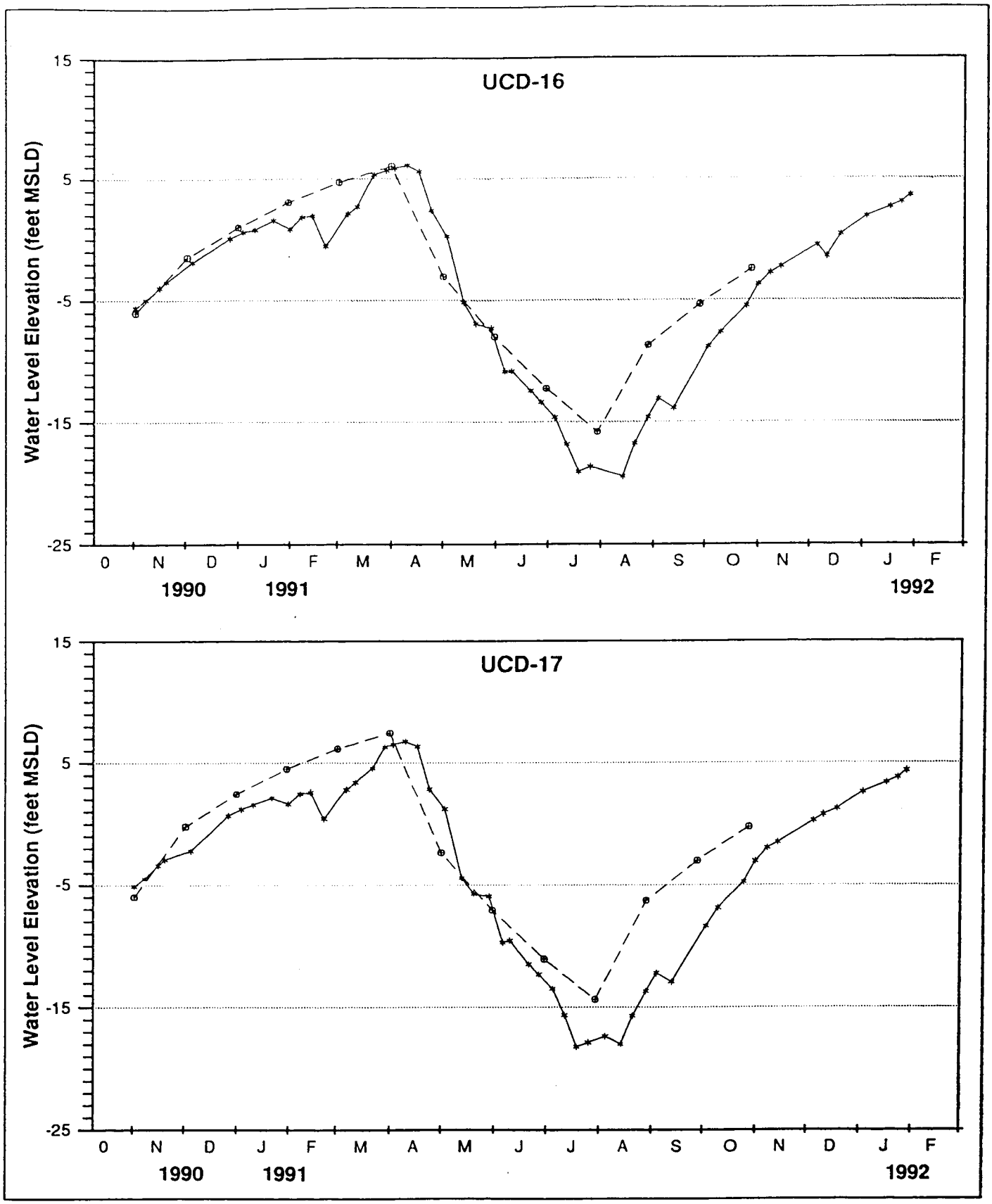
**COMPARISON OF WATER LEVELS FIRST HYDROSTRATIGRAPHIC UNIT FOR UCD-10 AND UCD-18**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-66

FIGURE 6.18




EXPLANATION

Actual Water Levels

Simulated Water Levels

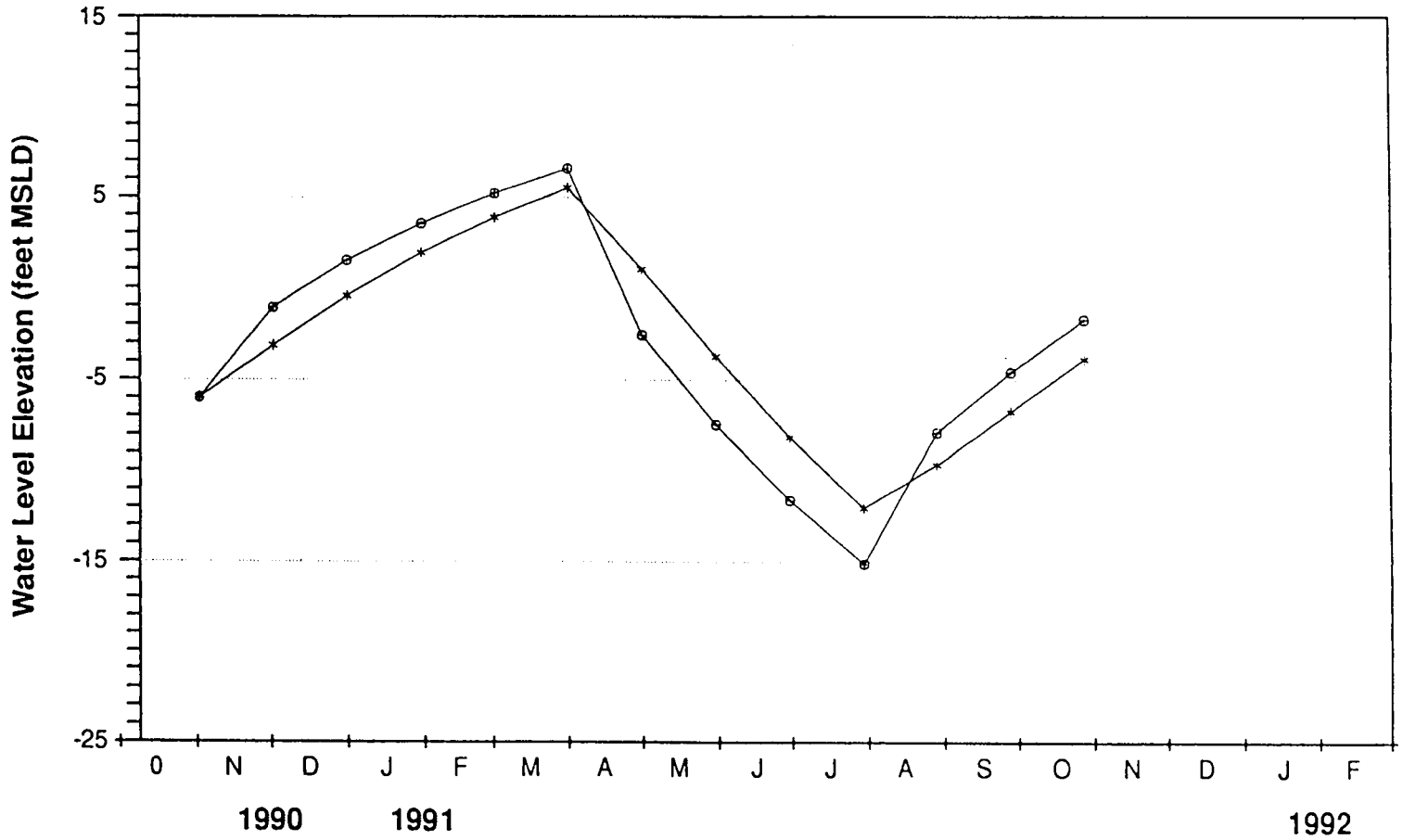
**COMPARISON OF WATER LEVELS SECOND HYDROSTRATIGRAPHIC UNIT FOR UCD-16 AND UCD-17**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-67

FIGURE 6.19




EXPLANATION

UCD-4

UCD-15

**SIMULATED WATER LEVELS**
**FIRST & SECOND HYDROSTRATIGRAPHIC UNITS**
**FOR UCD-4 AND UCD-15**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

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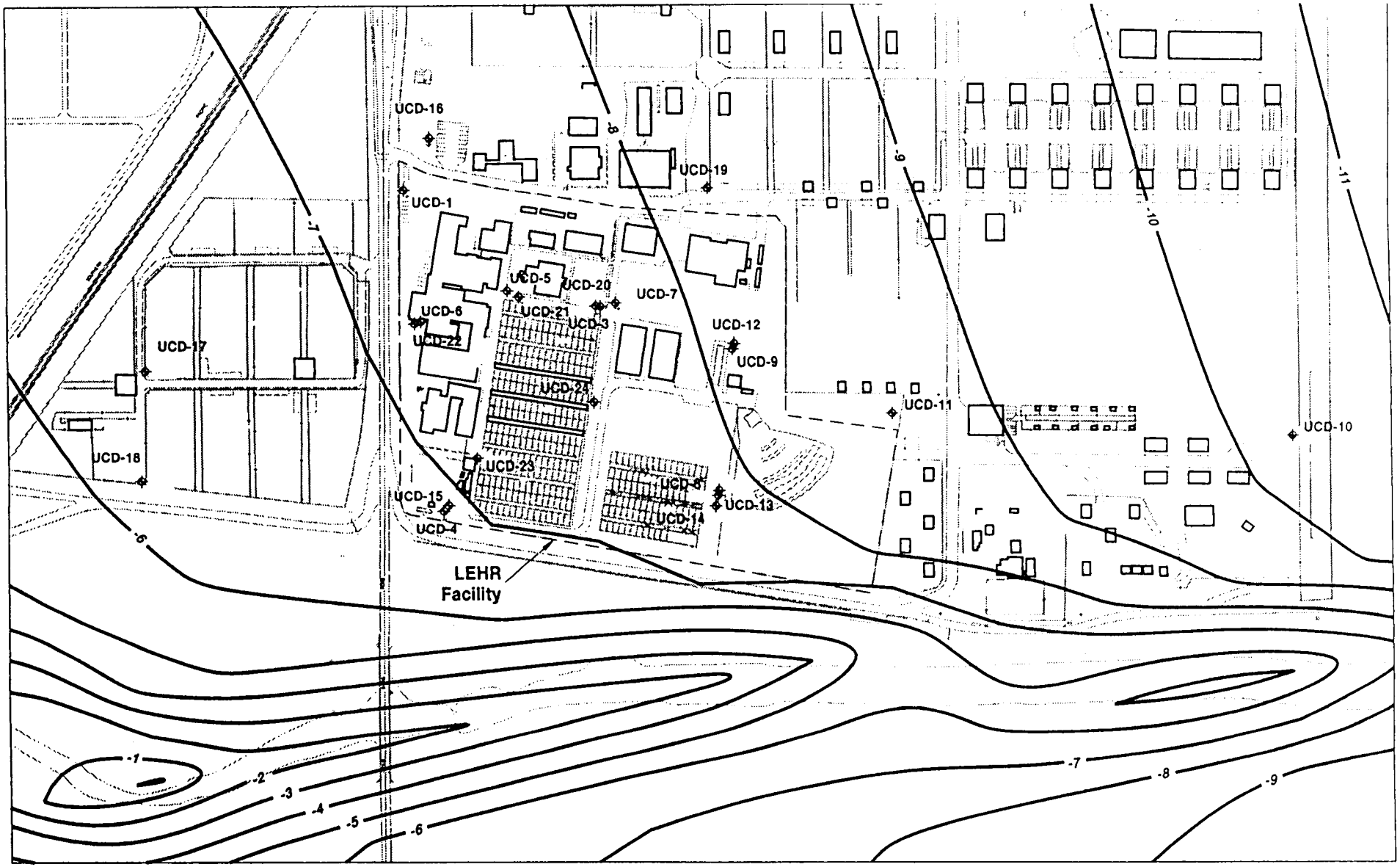
10805-454-044 DOE-68

FIGURE 6.20




EXPLANATION

Monitoring Wells

Groundwater Contours

Interval = 1 Foot

0 300

Scale in Feet

N

# SIMULATED WATER LEVELS FIRST HYDROSTRATIGRAPHIC UNIT YEAR 20, END OF PUMPING

Phase II Site Characterization

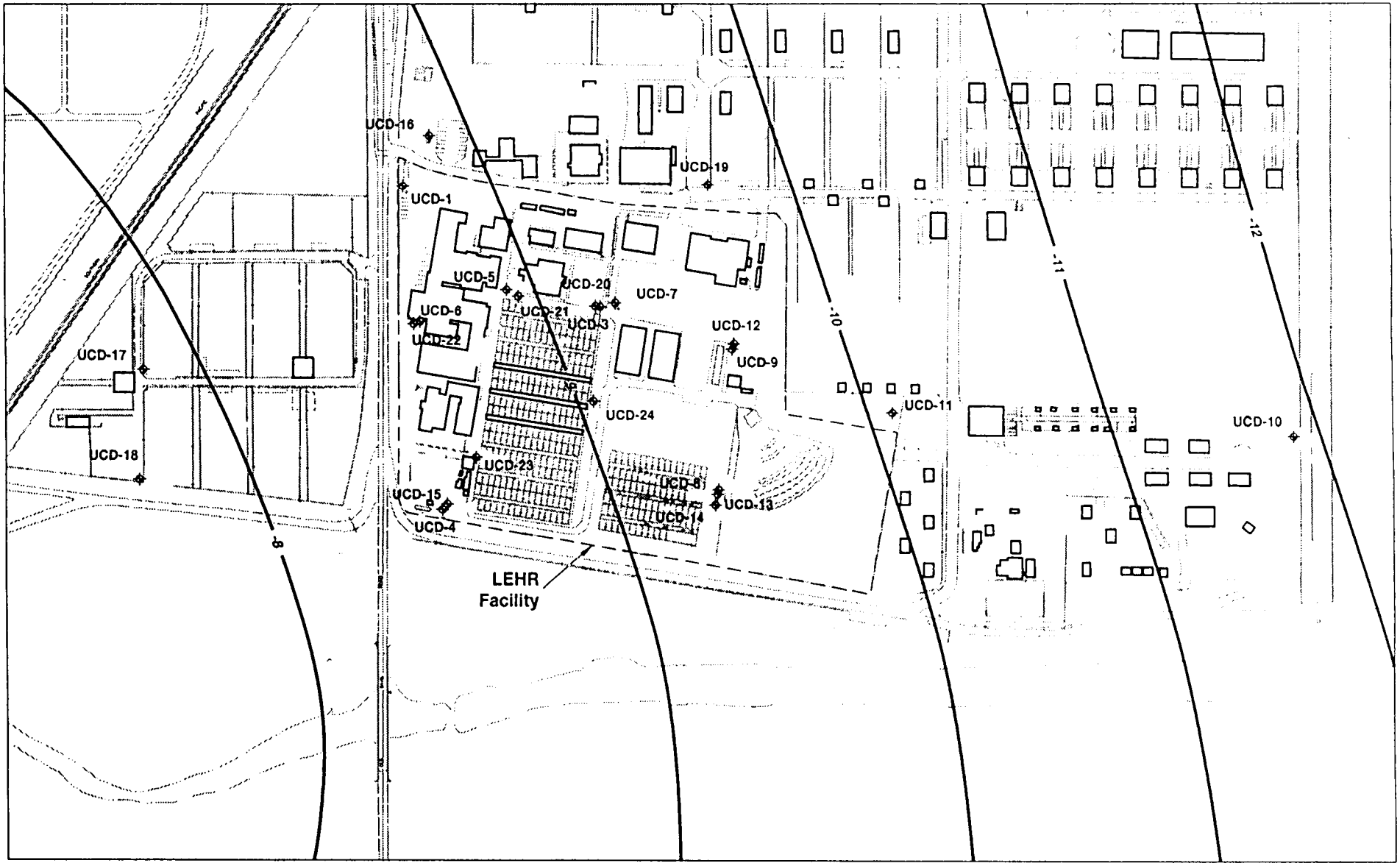
LEHR Environmental Restoration

FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-110

FIGURE 6.21




EXPLANATION

Monitoring Wells

Groundwater Contours
Interval = 1 Foot

0 300
Scale in Feet

N

# SIMULATED WATER LEVELS
# SECOND HYDROSTRATIGRAPHIC UNIT
# YEAR 20, END OF PUMPING

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-114

FIGURE 6.22

The flow model appears to present reasonable results for aquifer simulation. However, as with any modeling exercise, the results need to be evaluated based on the limitations of the model. For example, flow simulations do not completely mimic the variation observed in water levels for the first HSU. The model assumes homogenous properties resulting in a leakance that does not vary over the model domain. Varying gradients observed in the first HSU suggest a spatial variation in leakance between zones. In addition, the model was constructed over an area using limited site data. Properties measured on-site over a few points were assumed to be constant over the model domain. Changes in background hydrostratigraphy not addressed in the model (i.e., variations in depth and thickness of clay and gravel layers) may affect groundwater flow off-site.

The model produces changes in water levels in response to pumping over the length of the simulation which are consistent with changes in water levels observed in monitoring wells. Although these simulations address only groundwater flow, the changes in gradients (both direction and magnitude) observed at the site imply that the flow direction may be variable over time.

# 7.0 DISCUSSION

Chapter 7.0 discusses the components of a site conceptual model. The site conceptual model presents information on waste sources, pathways, and receptors, based on results of the current and previous investigations. The conceptual site model includes all known and suspected sources of contamination, types of contaminants, and affected media and known and potential routes of migration. The principal mechanical components of the site conceptual model include surface water, the shallow alluvial soils, the first and second HSUs, as well as off-site and regional activities, such as irrigation and rainfall, which influence groundwater levels and chemical movement. The secondary components of the model include chemical mobility and degradation and radionuclide decay as it relates to results presented in this report.

The stratigraphy is discussed in Section 7.1, and the hydrogeology is discussed in Section 7.2. Distribution of chemicals and radionuclides in soils and groundwater, and chemical mobility are discussed in Section 7.3.

## 7.1 STRATIGRAPHY

The LEHR facility is located in the Sacramento Valley, a large asymmetrical structural trough. The valley has been filled with sediments derived from both marine and continental sources. Older sediments (Jurassic to Eocene) were deposited primarily in marine environments, whereas younger sediments (Eocene to Recent) were deposited in lacustrine, fluvial and alluvial fan environments.

The LEHR facility and the surrounding area are located on alluvial deposits associated with the distal portion of the Putah Creek alluvial fan. These deposits are derived from the sedimentary and metamorphic rocks of the Coast Range Geomorphic Province to the west. Sediments which form these alluvial fan deposits consist primarily of silt and clay with sand and gravel found locally. Surface soils developed on these alluvial fan deposits are relatively young and weakly developed.

The major geologic units identified on the LEHR facility, from youngest to oldest, are summarized below. Most of these units contain gradational sequences and more than one lithology. The units appear to be relatively flat lying, reflecting their original depositional setting.

The surficial soils consist predominantly of fine sandy silt alluvium with some areas of silty fine sand and silty clay. Alluvial soils in the Sacramento Valley are relatively thick and do not contain significant accumulations of translocated clays, salts, or cementing agents, such as silica and iron, which could potentially limit infiltration or act as perching layers. These soils extend to depths of approximately 10 feet bgs and grade into the underlying alluvial material. Much of the soil at the site is covered by

buildings or paving, has been disturbed by deep-rooted vegetation, or disturbed by excavation of burial trenches and landfill cells. This disturbance tends to either limit surface water infiltration, as in the case of paving, or may increase infiltration, as in the case of uncompacted backfill.

The surficial soils grade into a sequence of interbedded silty clay, silt, clay, and silty sand that extends to a depth of about 80 feet bgs. This fine-grained unit is typically 70 feet thick and contains some lenses of coarse sand and gravel, most of which cannot be traced between investigation locations, as seen in UCD-4 and UCD-23. These lenses, both saturated and unsaturated, can act as local relatively high-permeability conduits for transport of water and chemicals. Groundwater is present in this unit at depths ranging, seasonally, from approximately 45 to 70 feet bgs. This unit grades into the underlying cobble and gravel unit. The first HSU is defined as the saturated portion of this sequence.

Cobbles and gravels, defined as the second HSU, are present at approximately 80 feet bgs. The thickness of this unit ranges from 40 feet in UCD-15 to 52 feet in UCD-17. The unit consists of well-rounded cobbles and gravel, consisting of chert, metamorphic, and volcanic clasts. The source area for these materials is interpreted to be the Coast Ranges to the west. Because of its lithology, this unit is much more permeable than the overlying material and would transport chemicals and water more rapidly.

Silty clay underlies the cobbles and gravels and is the lowest unit encountered by the investigations to date. The top of this clayey unit ranges from approximately 120 to 135 feet bgs. The contact between this clayey unit and the overlying cobble and gravel unit is sharp and is interpreted to be erosional. Maximum penetration into the silty clay has been about five feet. An evaluation of the competency of this unit to act as an aquitard between the second HSU and the next deeper water bearing zone was not conducted as part of this Phase II investigation.

## 7.2 HYDROGEOLOGIC MODEL

Groundwater in the non-marine sediments is used for agricultural, stock, domestic, and municipal purposes. The base of fresh water in the Davis area is approximately 2,600 feet bgs (California Division of Oil and Gas, 1982). According to Department of Water Resource records, private and municipal wells near the LEHR facility are screened at depths ranging from less than 100 to more than 1,400 feet bgs.

The hydrogeology of the upper 140 feet beneath the site is defined by two HSUs. The first HSU is comprised of fine-grained sediments, primarily silts and clays with rare sand and gravel lenses. This HSU is present at depths ranging from 45 to 70 feet bgs, depending upon season, and extends to approximately 80 feet bgs. The first HSU is characterized by hydraulic conductivity of approximately $10^{-4}$ cm/sec ($3.3 \times 10^{-6}$ ft/sec), whereas the vertical hydraulic conductivity, as estimated from numerical modeling, is approximately $10^{-5}$ cm/sec ($3.3 \times 10^{-7}$ ft/sec). Hydrographs for wells which penetrate this

first HSU show seasonal fluctuations in water levels on the order of 25 feet, with the high occurring in the spring and the low occurring in late summer. This wide range in groundwater levels allows soils in the middle portion of the first HSU to become saturated on a seasonal basis. Groundwater gradient is influenced by the seasonal changes in groundwater elevation and is apparently also influenced by leakage from Putah Creek. Groundwater flow is typically toward the northeast with a groundwater high underlying and adjacent to the creek. However, local incongruencies in gradient are noted at extremes in water levels. These incongruencies may be the result of local variations in hydraulic conductivity which react differently to transient events, such as extreme rainfall, or sporadic pumping.

The second HSU is present at depths ranging from approximately 80 to 135 feet bgs. It is characterized by coarse-grained material with a lateral hydraulic conductivity of about $10^{-2}$ cm/sec ($3.3 \times 10^{-4}$ ft/sec). As with the first HSU, this second HSU also shows seasonal changes in hydraulic head on the order of 25 feet, but does not demonstrate the wide range in gradients. Second-HSU gradients are primarily to the northeast at about 0.0015 ft/ft, but are occasionally toward the east. Solutes migrating from the first HSU to the second HSU are diluted when they reach the second HSU.

Comparison of hydrographs from wells screened in the two HSUs suggest a hydraulic connection between layers. Water levels in both zones show the same rise in the fall and winter, and decline in the spring and summer. Both HSUs also show response to nearby pumping, as exhibited in late January and February 1991. The interconnection between the two units is supported by the lack of an observed aquitard between the two units and by results from three-dimensional groundwater numerical simulation which indicate that pumping from the second HSU causes movement of water from the first to the second HSU.

Hydrographs and simulated water levels show changes in vertical gradients between zones. During periods of regional water level decline, April through August, vertical gradients are primarily down from first to the second HSU. During periods of regional water level rise, August through March, vertical gradients reverse and are primarily upward from second to the first HSU. Periods of rainfall, as seen in March 1991, recharge the first HSU faster than the regional recharge affects the second HSU, causing transient reversal in vertical gradient. Similarly, the apparent pumping of off-site wells can cause temporary reversals of vertical gradients as seen in the continuous groundwater elevation data collected in January and February 1991, when the second HSU responded to pumping faster than the first HSU.

The reach of Putah Creek adjacent to LEHR is inundated throughout the year. Based on visual observations during the year, wastewater treatment plant flow data, and Putah Creek stream gauge data, it appears that much of the Putah Creek flow through this reach is derived from outfall from the UC Davis wastewater treatment plant. Within two miles downstream of the LEHR facility, Putah Creek is dry for the majority of the year. The results of the numerical modeling and the groundwater gradient

information suggest that the creek acts as a continual source of recharge to the first HSU. This recharge creates a groundwater high beneath the creek which serves as a lateral barrier to groundwater movement in the first HSU. The modeling indicates that recharge from the creek has a direct impact on the second HSU only at regional steady-state periods.

Sources for site constituents are present in: surficial soil; trenches, pits, leach fields, and landfill cells that have been excavated into or through the surface soils; and seepage pits and dry wells that extend through the surface soils. Off-site sources for solutes include: surface application of fertilizers, pesticides, and stock animal waste; landfill cell No. 3 and septic systems which have been excavated into or through the surface soils; and water of Putah Creek.

Factors which affect the migration of these chemicals in the vadose zone include: movement of soil pore water by gravity and soil suction; movement by infiltration of rainfall and irrigation water; movement of leachate from septic systems and waste burial cells; and infiltration from Putah Creek. The moderate permeability of the surficial soils and subsurface materials, the absence of identified perching layers, and the presence of lenses of relatively high-permeability material — all facilitate the downward migration of solutes through the vadose zone.

Upon reaching the saturated zone of the first HSU, both on-site and off-site solutes move vertically due to seasonal changes in water level in conjunction with the vertical gradients. Generally, water levels and vertical gradients in the first HSU move downward for five months of the year, and upward for seven months of the year. Local pumping may have an affect on vertical and lateral gradient in the first HSU, as seen in February 1991. Chemicals in the first HSU may also move laterally, generally toward the northeast, with leakage from Putah Creek serving as a groundwater high, and therefore acting as a barrier, along the southern boundary of the site. It is expected that this leakage from Putah Creek causes the local groundwater gradient in the first HSU south of the creek to be toward the southeast. Constituents present in water of Putah Creek can move with the leakance into the first HSU and subsequently migrate to the northeast, across the LEHR site, or southeast, away from the site. Based on UC Davis Main Wastewater Treatment Plant NPDES Self Monitoring Reports, Putah Creek is dry for much of the year upstream of the UC Davis wastewater treatment plant outfall; therefore, it does not serve as a continual source of recharge west of the site. This may have some affect on groundwater quality and groundwater gradient in the first HSU to the west of the LEHR facility.

The hydraulic connection between the first and second HSUs provides a mechanism for solute transport into the second HSU. Solutes that migrate downward from the first HSU into the second are diluted when they mix with water of the second HSU. The higher transmissivity of the second HSU enables greater lateral movement of the solutes than in the first HSU. The dominant direction of movement in the second HSU is northeast, although eastern and southeastern flows have been observed.

As indicated by the numerical modeling, leakance from Putah Creek does not have a significant affect on the second HSU, and therefore, an effective lateral barrier beneath Putah Creek probably does not exist. The second HSU appears to show some influence from local pumping; therefore, local gradients may change temporarily in response to these pumping events. At this point, the magnitude of downward vertical gradients within the second HSU are not known.

## 7.3 DISTRIBUTION OF CHEMICALS AND RADIONUCLIDES IN SOILS AND GROUNDWATER

Section 7.3 discusses regional and on-site chemical data, both past and present, in order to identify possible impacts of LEHR activities on soil and groundwater quality. This section also discusses factors affecting the current distribution of radioactive and stable chemicals in and around the LEHR facility. Section 7.3.1 presents some of the potential and expected mobility of chemicals and radionuclides which may move with water or be retarded by soils and aquifer materials. Section 7.3.2 summarizes and discusses the distribution of chemicals and radionuclides in soils reported in the Phase II Site Characterization and previous studies. Section 7.3.3 discusses the site-wide distribution of chemicals in groundwater and surface water for the five quarters of monitoring between November 1990 and November 1991.

A detailed discussion of every analyte reported in groundwater is not presented. Instead, those analytes which are reported more than one time in the same downgradient wells will be emphasized. Those analytes which are reported only once in the five quarters of sampling will receive less discussion.

### 7.3.1 Chemical Mobility

Chemicals and radionuclides are potentially mobile under both saturated and unsaturated conditions. The mobility of every chemical species is dependent primarily on two factors: first, the velocity of water movement through the soils; and secondly, the interaction between chemical species (solutes) and soil solids. These two interactive forces can be referred to as retardation factors *(R)*. The velocity of solute movement is then compared to the velocity of water flow. For example, strongly adsorbed solutes move through the soil with a slower net velocity than does water; therefore, this solute is given an $R > 1$; where a nonadsorbed solute, such as tritium, moves through the soil with the same velocity as water, it is given a value of $R = 1$. In the following discussion, no distinction will be made between radioactive and stable inorganic ions or molecules because their mobility in soils is not affected by radioactive emissions.

Adsorption of inorganic radioactive and non-radioactive solutes at the LEHR facility is directly related to the electrostatic interaction between dissolved and solid surfaces. The surfaces of primary and

secondary minerals in the Sacramento Valley are negatively charged for the most part, and tend to attract positively charged cations, and repel negatively charged anions.

The most mobile inorganic solutes include nitrate and chloride, which are anions with a single negative charge, and are not retained by soils. Anions with multiple negative charges include sulfate, selenate, hexavalent chromium (Cr VI), arsenate, vanadate, carbonate, molybdate, and phosphate. Carbonate, molybdate, and phosphate function as weak acids and can be adsorbed to some soil surfaces, especially coatings of iron and aluminum oxides, often forming strong covalent bonds.

Cations, in general, tend to adsorb to negatively charged surfaces more strongly than anions via electrostatic attraction. Sodium, the most weakly retained cation, possesses a single positive charge. Other cations, such as ammonium and potassium, are more strongly adsorbed to the clay minerals in this area, because their ionic radii allows them to be adsorbed almost irreversibly into the interlayers of montmorillonite and vermiculite clays. Cations with multiple charges, listed in order of increasing strength of adsorption, include magnesium, calcium, strontium, and barium.

Metal cations include, in alphabetic order, beryllium, cadmium, copper, cobalt, iron (Fe III), lead, manganese (Mn IV), mercury, nickel, radium, silver, thallium, trivalent chromium (Cr III), and zinc. The mobility of these metals is affected by their oxidation state and the composition of the soil solution. When Cr III is oxidized to Cr VI, and Mn IV and Fe III are reduced to Mn II and Fe II, the mobility of each metal is greatly increased. A change in oxidation state can also affect the mobility of non-metals, such as ammonium ($NH_4$), and sulfide ($S^{-2}$). Reducing conditions in soils are the result of microbial activity and/or flooding, which catalyzes changes in oxidation state, converting these compounds to nitrate ($NO_3$) and sulfate ($SO_4$), thus increasing their mobility.

Another key factor influencing the mobility of the multivalent cations and metals is the composition of the soil solution itself. When an inorganic or organic anion reacts with a polyvalent cation to form an ion pair or complex, the positive charge of the cation is reduced, causing increased mobility of that complex, and sometimes increased solubility of a metal. Geochemically important examples of soluble inorganic complexes include $CdCl^+$, $AlF_3^0$, $AuCN^0$, $CaCl^+$ and $CaSO_4^0$. Organic anions or ligands such as citrate, oxalate, and acetate are formed in nature as a result of microbial breakdown of organic matter in soils. These organic ligands have a strong affinity for polyvalent metals, and numerous studies have documented the effect of citrate and oxalate increasing the solubility and the mobility of metals (Pb, Zn, Al, Fe, Cr, Cu), which would be immobile without the presence of these organic ligands. In the agricultural fertilizer industry, organic ligands such as EDTA (ethylenediaminetetraacetic acid) are used to supply a soluble form of iron, copper, and zinc to crops under neutral pH conditions which would otherwise precipitate and immobilize these elements.

The mobility of organic constituents previously identified at the LEHR facility (primarily chlordane and chloroform), depends on different soil and chemical characteristics. The most important soil characteristic controlling adsorption of organic chemicals by soils is the organic matter content of the soil. Dissolved organic chemicals are only slightly soluble in polar solvents such as water, and form only weak hydrogen bonds with charged mineral surfaces. However, soil organic matter tends to adsorb organic chemicals because of its slightly non-polar surface. It should be emphasized that the retardation of organic chemicals is very strongly dependent on the organic matter content of the soil, and although the first five feet of soil typically contains large quantities of organic matter (1 to 5%), subsurface soils and aquifer material usually contain much less organic matter, well below 1 percent in most cases.

The second chemical characteristic which influences the mobility and transport of an organic chemical is its aqueous solubility. Each organic chemical species has some solubility in polar solvents (water) as well as in nonpolar solvents (benzene, acetone, octanol) because the functional groups which compose the organic molecule are themselves differentially polar and nonpolar. Chlordane for example, is a very nonpolar compound with a low water solubility (9 $\mu$g/L), and would have a low mobility in soils with organic matter, whereas chloroform is only slightly nonpolar and is more soluble in water (8,000,000 $\mu$g/L) and, therefore, chloroform tends to be more mobile than chlordane in soils (Montgomery and Welkom, 1990).

A third factor which influences the mobility and transport of an organic chemical is the potential rate of degradation of that chemical by soil microorganisms. Chlordane may persist in surface soils anywhere from approximately one to four years and from two to eight years in groundwater (Howard, et al., 1991). Chloroform can be degraded in approximately 0.25 to 0.5 years in soil and up to 50 years in groundwater (Howard, et al., 1991).

In summary, the mobility of inorganic, radioactive and organic solutes in soils is dependent upon a number of factors, including the interaction of solutes with soil solids, oxidation state of the chemical species, and the composition of the soil solution. For organic solutes, soil organic matter content, aqueous solubility, and biological degradation of the organic solute affects their mobility in soils. The mobile solutes of environmental and human health concern at the LEHR facility include tritium, nitrate as N, hexavalent chromium, and chloroform, whereas strontium, radium, and chlordane are much less mobile in soils. Chloroform is more mobile than chlordane and may persist in groundwater for a longer period of time. The presence and distribution of these chemicals in soil and groundwater at the LEHR facility are discussed below in Sections 7.3.2 and 7.3.3.

### 7.3.2 Distribution of Chemicals in Soils

During the Phase II investigation, 275 soil samples were collected and 188 primary and 24 replicate soil samples were analyzed for parameters identified in Chapters 5.0 and 6.0. Soil sampling was conducted in seven areas of interest: Background/Offsite areas, the Strontium-90 Leach Field, the Radium-226 Seepage Pit area, the Southwest Chemical Dispensing area, the dog pen area, the North Chemical Dispensing area, and the Old AEC Project area. A review of analytical results for each of these areas was presented in Sections 6.4.1.1 through 6.4.1.8.

This section presents a discussion of trends observed during the Phase II Site Characterization in soil chemical data for the site. Data from previous studies are also discussed in relation to the Phase II results. Because soil sampling in Phase II was focused on selected locations, this evaluation of soil chemistry is limited to those areas. Comparisons between the areas of interest and background are qualitative rather than quantitative, because statistically, the number and locations of background soil samples analyzed in Phase II does not completely describe background geochemical conditions. An analysis of groundwater data is presented below in Section 7.3.3.

#### 7.3.2.1 General Parameters

Soil data reported for general chemical parameters from the analysis of Phase II soil samples are limited to soil nitrate analyses. Soil pH was analyzed on some soil samples collected during the SWAT Investigation (Dames & Moore, 1990b). The pH ranged approximately from seven to nine in samples tested during the SWAT Investigation.

Nitrogen (N) in soil is derived from biological activity rather than mineral weathering; therefore, natural sources of nitrogen are generated near the surface where soil biological activity is the greatest. In undisturbed vegetation, nitrate is the most limiting soil nutrient to plants; therefore, the concentration of soil nitrate as N in undisturbed areas is expected to be below 10 mg/Kg.

If non-fertilized background soil nitrate concentrations are considered to be less than 10 mg/Kg nitrate as N, several areas on the LEHR facility contain elevated nitrate concentrations. The background soil samples from UCD-17 and -18 have reported concentrations of nitrate as N between 15 mg/Kg and 26.1 mg/Kg in the first 20 feet bgs. From 20 to 65 feet bgs, reported concentrations of nitrate as N ranged from 2.1 mg/Kg to 10 mg/Kg, with the exception of one sample collected from UCD-18 at 55 feet bgs near the groundwater table, with a reported concentration of 39.8 mg/Kg. This suggests that these soils have been impacted by some form of nitrogen loading.

Application of nitrogen fertilizer for agricultural crops and sewage septic systems are two potentially large sources of nitrogen which is applied to land in and around the LEHR facility. Background soil samples collected from UCD-17 and UCD-18 are located on land that is presently used by the Equestrian Center for boarding horses with a population density of approximately one horse per acre. This land was previously used for agriculture. Animal feces or previous agricultural fertilization could account for the elevated concentrations of nitrate in near-surface soils in this area.

There are probably at least four potential sources of nitrate in the LEHR facility area. Those sources are: the Disposal Trenches; the Old UC Davis landfill; animal urine directly on to soils; and several septic systems. These septic systems include the Radium-226 Seepage Pits, the Strontium-90 Leach Fields, seven domestic septic tanks, the former wastewater treatment plant, and the current UC Davis Wastewater Treatment Plant.

There are several areas at the LEHR facility that have reported soil nitrate as (N) concentrations in excess of 20 mg/Kg. These areas include the Radium-226 Seepage Pits, the Strontium-90 Leach Field, and the North and Southwest Chemical Dispensing area. The Radium-226 Seepage Pits have the highest reported concentrations of nitrate in the areas studied to date. The nitrate appears to be restricted to the upper 15 feet of soil based on data from soil borings SB-25 and -28, which contained an average concentration of 168 mg/Kg and 559 mg/Kg in the samples collected from 0 to 15 feet bgs interval. The nitrate as (N) concentration in samples collected below 20 feet bgs was low, ranging from 0.7 mg/Kg to 28.9 mg/Kg. Since nitrate is mobile in soils, higher concentrations could be expected at depth.

The distribution of soil nitrate in the Strontium-90 Leach Fields suggests an opposite trend from the Radium-226 Seepage Pits. The concentration of nitrate as (N) reported in samples collected and analyzed from 0 to 15 feet bgs averaged 9.2 mg/Kg from soil borings SB-22, -23, and -24. From 20 to 30 feet bgs, nitrate as (N) concentration in samples collected and analyzed from SB-22 and -24 averaged 54 mg/Kg, indicating an increase in nitrate concentrations with depth. The observed nitrate distribution may be due to differences in local vertical hydraulic conductivities.

The concentration of nitrate as (N) reported in samples collected and analyzed from the active Dog Pen area surface soils (0 to 1.5 feet bgs) ranges from not detectable ($<0.5$ mg/Kg) to 168 mg/Kg. In the Inactive Dog Pen area, reported concentrations of nitrate as (N) ranged from 3.8 mg/Kg to 18.2 mg/Kg, with an average of 9.4 mg/Kg. Previous documentation indicates that feces were removed in the active dog pens daily, leaving only urine, which contains ammonia, a potentially volatile source of nitrogen in the dog pen area. This suggests that only the active dog pens would be contributing nitrates to soils on an ongoing basis.

The North and the Southwest Chemical Dispensing areas contain elevated concentrations of nitrate in soil. Nitrate as (N) concentrations in soil samples collected from the upper 0 to 1.5 feet in the North Chemical Dispensing area range from 30 mg/Kg to 49 mg/Kg, with an average of 39 mg/Kg. In the Southwest Chemical Dispensing area, nitrate as (N) concentrations reported from samples analyzed ranged from 0.23 mg/Kg to 220 mg/Kg, with an average of 41.4 mg/Kg. The higher concentrations of nitrate as (N) were detected in samples from the upper 10 feet of soil, with only one sample greater than 10 mg/Kg below 10 feet bgs in the Southwest Chemical Dispensing area.

Soil samples collected from the burial trenches or the landfill during previous investigations were not analyzed for nitrate. Septage, as well as chemicals and animal carcasses may have been buried in these landfills and trenches. Organic forms of nitrogen from septage or animal remains may be converted to nitrate by biological activity; therefore, the landfills, buried trenches and the various septic systems are potential sources of nitrate at the LEHR facility.

#### 7.3.2.2 Organic Compounds in Soils

Five organic compounds were reported in Phase II soil samples; methylene chloride, chlordane, bis(2-ethylhexyl)phthalate, diethylphthalate, and di-n-butylphthalate. Methylene chloride was reported in at least one sample from all six areas at the LEHR facility, including the Background/Off-site area. Samples from the AEC area were not analyzed for methylene chloride. Reported detections of methylene chloride are sporadic within each area, and values are relatively consistent between samples and areas. In addition to detections reported for Phase II soil samples, methylene chloride was reported in one sample from the Radium-226 Seepage Pit area and one sample from the Dog Pen area at low levels in the Rockwell Investigation (1984). The sporadic nature of the detections and the low values of methylene chloride ($< 10.0$ $\mu$g/Kg), a volatile laboratory extractant, may indicate laboratory contamination during sample preparation or analysis.

Diethyl phthalate was reported in five samples from the Dog Pen area and di-n-butyl phthalate was reported in seven samples in the Southwest Chemical Dispensing area. The compound bis(2-ethylhexyl)phthalate was reported in one sample each in the Radium-226 Seepage Pit area and in the Dog Pen area for the Rockwell Investigation (1984). Bis(2-ethylhexyl)phthalate was also reported in Phase II groundwater samples (see Section 7.3.3.3). The phthalate compounds are plasticisers and common laboratory compounds. Detections may have been the result of analytical laboratory or sample contamination or the breakdown of plastic products.

Chlordane was reported in 17 samples from the Dog Pen area, 3 samples from the North Chemical Dispensing area, and in 9 samples from the Old AEC Project area. All detections were from samples collected between 0 and 1.5 feet bgs. Chlordane was used both on the main facility and on the

AEC area to control fleas on the research dogs (DOE, March 1988). The literature suggests that chlordane is adsorbed strongly to soils and soil organic matter, as presented in Table 7.1 (Montgomery and Welkom, 1990).

Additional organic chemicals were observed in the burial trenches (Wahler, 1989), but were not detected in soil samples collected during the Phase II Site Characterization. A sealed container with 68 percent heptachlor, 4.1 percent carbophenathion, and 0.38 percent dieldrin was observed in Trench T-24 (Wahler, 1989). Therefore, other occurrences of pesticides in soils may be expected in the landfill or burial trenches.

#### 7.3.2.3 Metals

Phase II soil samples collected from on-site areas and the Background/Offsite area were analyzed for Title 22 metals (the AEC samples were not analyzed for metals). Metal concentration ranges in soils on-site were generally consistent with those collected for the Background/Offsite area (see Section 6.5.1). The nickel concentration in soils appears to be higher in some on-site areas compared with background. This may be due to the natural spatial variability of nickel rather than any known disposal of nickel wastes at the site. Hexavalent chromium may be another exception, and the relationship between soil and groundwater concentrations is discussed in detail in Section 7.3.3. Statistical comparisons between metal concentrations in background versus on-site soils may not be meaningful because only two background locations, UCD-17 and -18, were sampled, and only 13 samples were submitted for analysis (for further discussion, see Section 6.5.5).

Reported metal concentrations from across the site were also compared to regional background values for surficial (0-12 inches bgs) soils tabulated by Shacklette and Boerngen (1984), and presented in Tables 6.5, 6.8, 6.10, 6.12, 6.14, 6,16, and 6.18. Soil concentrations of seven metals, antimony, beryllium, cadmium, chromium, copper, molybdenum, and selenium consistently fall outside of the regional background ranges.

TABLE 7.1
ADSORPTION AND DEGRADATION OF SELECTED ORGANIC COMPOUNDS
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Analyte | Soil Adsorption Coefficient log $K_{oc}$[1] | Half-Life[2] | |
|---|---|---|---|
| | | In Aerobic Soil | In Groundwater |
| Chlordane | 5.15 | 40-190 weeks | 2-8 years |
| Chloroform | 1.64 | 4-26 weeks | 4-2,500 weeks |
| Heptachlor | 4.34 | 1-5 days | 60-260 days |
| Bis(2-ethylhexyl)phthalate | 5.0 | 5-23 days | 40-400 days |

1 Montgomery, J.H., and L.M. Welkom, 1990. Groundwater Chemicals Desk Reference, Lewis Pressi, Michigan.

2 Howard, P.H., Boethling, R.S., Jarvis, W.F., and W.M. Meylan, 1991. Handbook of Environmental Degradation Rates, Lewis Press, Michigan.

Concentrations of metals in background and onsite soil samples are relatively consistent, and therefore, are not expected to be the result of past or present site activities. The fact that some of the metal concentrations seem to be elevated with respect to published regional background concentrations may reflect the composition of the bedrock material present in the Coast Ranges, rather than site activities. Sediments on the site are derived primarily from the weathering and transportation of sediments from the Coast Ranges which have relatively high concentrations of heavy metals (Burau, et al., 1981). The solubility and mobility of these metals in soils is dependent on several factors, including pH and oxidation state, and is discussed further in Section 7.3.3.

#### 7.3.2.4 Radionuclides in Soils

Numerous radionuclides are known to have been used, processed, or disposed at the LEHR facility. Radium-226, krypton-85, cobalt-60, and strontium-90 were used at the LEHR facility, and plutonium-241 and americium-241 were used at the TPHRL facility for various research practices (DOE, March 1988). Plutonium-241, americium-241, vanadium-48, and ytterbium-169 are known to have been processed through the Imhoff treatment system (DOE, March 1988). Hydrogen-3 (tritium) and carbon-14 were known to have been disposed on-site, however, whether these chemicals were used on site or not is unclear. Traces of cesium-137 were observed in areas of suspected waste burial sites during the Rockwell Investigation (1984). Fourteen radionuclides, as well as gross alpha, and gross beta were reported in Phase II soil samples. A summary of radionuclides known to have been present on site, and of radionuclides measured in Phase II soil samples, is presented in Table 7.2.

Background Radionuclides

Several radionuclides in soils occur naturally in significant quantities, including: tritium, carbon-14, potassium-40, thorium-232, uranium-235, and uranium-238. Tritium and carbon-14 are generated continuously in small quantities in the atmosphere through extra-terrestrial cosmic ray interactions with atmospheric nitrogen (Gregory, 1966). The radionuclides are incorporated in atmospheric water and carbon dioxide. Both nuclides can also enter the biota and produce a low-level of background radioactivity in soil, air, water and bio-mass. Decay of the tritium and carbon-14 produces beta particles and stable hydrogen and nitrogen. Background tritium activity reported in soils ranged from 0.1 pCi/g to 0.5 pCi/g; carbon-14 was not measured in background soil samples.

TABLE 7.2
CHARACTERISTICS OF SELECTED RADIONUCLIDES
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Radionuclide | Half-Life | Daughter Products | Modes of Decay[1] | Number of Reported Detections in Soil | Highest Value Reported in Phase II Soil Samples (pCi/g) |
|---|---|---|---|---|---|
| Radium-226 | 1,600 years | $^{222}Rn$, $^{218}Po$, $^{214}Pb$ | $\alpha$ | 85 | 1.40 |
| Lead-214 | 26.8 minutes | $^{214}Bi$, $^{214}Po$, $^{210}Pb$, $^{210}Bi$, $^{210}Po$, $^{206}Pb$ | $\beta^-$ | 13 | 1.14 |
| Bismuth-214 | 20 minutes | $^{214}Po$, $^{210}Pb$, $^{210}Bi$, $^{210}Po$, $^{206}Pb$ | $\beta^-$ $\alpha$ | 18 | 3.03 |
| Lead-210 | 22.3 years | $^{210}Bi$, $^{210}Po$ $^{206}Pb$ | $\beta^-$, $\alpha$ | 1 | 0.81 |
| Thorium-232 | $1.41 \times 10^{10}$ years | $^{228}Ra$, $^{228}Ac$, $^{228}Th$, $^{224}Ra$, $^{220}Rn$, $^{216}Po$, $^{212}Pb$ | $\beta^-$ | 18 | 1.44 |
| Actinium-228 | 6.1 hours | $^{228}Th$, $^{224}Ra$, $^{220}Rn$, $^{216}Po$, $^{221}Pb$ | $\beta^-$ | 1 | 0.82 |
| Lead-212 | 10.6 hours | $^{212}Bi$, $^{212}Po$, $^{208}Tl$, $^{208}Pb$ | $\beta^-$ | 52 | 0.93 |
| Thallium-208 | 3.1 minutes | $^{208}Pb$ | $\beta^-$ | 3 | 0.6 |
| Carbon-14 | 5,730 years | $^{14}N$ | $\beta^-$ | 2 | 0.5 |
| Cesium-137 | 30.2 years | $^{137}Ba$ | $\beta^-$ | 6 | 0.26 |
| Cobalt-60 | 5.3 years | $^{60}Ni$ | $\beta^-$ | 1 | 0.17 |
| Manganese-54 | 312 days | $^{54}Cr$ | EC | 1 | 540.08 |
| Potassium-40 | $1.28 \times 10^9$ years | $^{40}Ar$ | $\beta^+$, $\beta^-$, EC | 165 | 46.4 |
| Strontium-90 | 28.8 years | $^{90}Y$ | $\beta^-$ | 36 | 19.0 |
| Tritium | 12.3 years | $^{2}H$ | $\beta^-$ | 18 | 5.55 |

[1] Reference: CRC Handbook of Chemistry and Physics, 62nd Edition, CRC Press, 1981-1982.

EC - orbital electron capture
$\beta^+$ - positron emission
$\beta^-$ - negative beta emission
$\alpha$ - alpha emission

Potassium-40 activity was reported in most (165 detections) Phase II soil samples. The highest average activity of potassium-40 was measured in background soils, at 17.4 pCi/g. Potassium-40 is one of three naturally-occurring potassium isotopes and the only one that exhibits radioactivity. Decay of potassium-40 releases the stable elements calcium-40 and argon-40. Potassium itself is the eighth most common element in the earth's crust and is widely distributed in all types of rocks and minerals. Some deposits containing large quantities of fine-grained sediments such as clays, will show somewhat high background activity of beta and gamma emissions from potassium-40 decay (Gregory, 1966).

Thorium-232 was reported in 7 of 13 background soil samples, with the highest background activity reported at 1.1 pCi/g. Other thorium isotopes are short-lived products of the decay of thorium-232, uranium-235, and uranium-238. The thorium-232 decay series is a cascade of alpha, and beta emissions, with associated gamma emissions, and ultimately yields the stable isotope, lead-208. Thorium-232 activity was measured in soil samples collected both on and off-site. The reported activity of actinium-228, lead-212, and thallium-208 activity may be attributable to the decay of thorium-232 (Table 7.2), which is present in background soils.

Uranium has three naturally-occurring isotopes of mass numbers: 238, 235, and 234. They represent 99.28 percent, 0.714 percent, and 0.0058 percent respectively of total uranium. All three are unstable and are sources of radioactivity. No measurable activity of uranium-235 or any of its decay series were found in this study. Although no uranium-238 activity was reported, a number of possible decay products, radium-226, lead-214, bismuth-214, and lead-210, were measured on-site.

The highest activity of radium-226 reported in the Phase II study, 1.40 pCi/g, was obtained from a background soil sample. None of the other uranium-238 decay products (lead-210, -214, and bismuth-214) were measured in the 13 background samples. The relatively small number of background locations and samples submitted for measurement may explain why no other uranium-238 decay products were measured in the background samples.

Radionuclides On-site

Radionuclides were used at the LEHR facility to study the health effects of injected radionuclides, primarily radium-226 and strontium-90 on a population of beagles. Additionally, the beagles were exposed to an external source of x-rays from cobalt-60 (a beta emitter).

Soil and water samples were measured for these and other radionuclides specified in Chapter 6.0. In addition to measurements for gross alpha, gross beta and specific radionuclides, soil samples were scanned for their gamma spectrum in order to measure other radionuclides which were not specifically

requested. The activity of specific radionuclides were then determined for any peaks observed in the gamma spectral analysis.

The distribution of radionuclides in soils along with estimates of background activities were presented in Section 6.4. Based on Phase II data, the range of background activity for radium-226 in soils varied from 0.05 to 1.4 pCi/g. The highest measurement on-site was 1.4 pCi/g in UCD-23 in the sample from 20.0 feet bgs. Previous studies, which included the Radium-226 Seepage Pits and the Strontium-90 Leach Field and other areas, have not reported radium-226 activity in excess of 1.23 pCi/g (Wahler, 1988, 1989). Rockwell (1989) reported radium-226 activity at 0.204 pCi/g in the Seepage Pit area, to 3.94 pCi/g in the Southwest Chemical Disposal area.

Tritium activity was reported in 18 of the 212 Phase II soil samples from four on-site areas and the background/off-site area. The highest activity of tritium, 2.61 pCi/g to 5.55 pCi/g, was reported from samples collected and analyzed from well boring UCD-15 in the Southwest Chemical Dispensing area. Remaining measurements were sporadic, but within the range of background tritium activity in soil (0.1 pCi/g to 0.5 pCi/g). This soil data do not suggest a large source for tritium; however, based on constant elevated activity of tritium reported in groundwater in UCD-13, it is inferred that a tritium source does exist. Carbon-14 activity was also measured in two Phase II soil samples at very low activity levels (<0.5 pCi/g), although previous studies have detected much higher activities, above 500 pCi/g (Rockwell, 1984).

The background activity of strontium-90 ranged from non-detectable (<0.025 pCi/g to 0.24 pCi/g). Phase II soil samples measured exceeded this range in the Radium-226 Seepage Pits, 0.61 pCi/g, and the Southwest Chemical Dispensing area, 0.7 pCi/g. One sample collected and measured from UCD-19 in the north area of the site reported 19 pCi/g strontium-90, although a replicate sample collected from the same depth at 70 feet bgs, and directly below at 73 feet bgs, did not measure strontium-90 activity. Additionally, no strontium-90 activity has been reported in groundwater samples collected from UCD-19, which is screened from 55 to 70 feet bgs. The Strontium-90 Leach Field, the North Chemical Dispensing area, and the Dog Pen area have reported strontium-90 activity within background ranges.

Previous investigations (Rockwell, 1984; Wahler, 1989) reported strontium-90 activity in soil samples collected from the Radium-226 Seepage Pits and in the Strontium-90 Leach Field ranging from 0.6 pCi/g to 1.71 pCi/g. However, the highest reported strontium-90 activity (17.3 pCi/g) was from bone samples from dogs buried in the southwest chemical dispensing area (Rockwell, 1984). In the landfill burial trenches, one of three soil samples collected had a reported activity of strontium-90 of 1.14 pCi/g (Dames & Moore, 1991b). Strontium-90 would be expected in trenches where bones of dogs were buried, since strontium is incorporated into bones. Also, the soils in the vicinity of the LEHR facility

contain abundant carbonates, which would tend to precipitate strontium-90, severely retarding its mobility in soils.

Several additional radionuclide peaks were reported in samples collected on-site that were not measured in the background soil samples from UCD-17 and UCD-18. These radionuclides include bismuth-214, lead-212, lead-214 and lead-210, and manganese-54. Of these nuclides, all but manganese-54 are daughter products of the uranium-238 decay series and may have come from natural radioactive decay of uranium or from radium-226 used on-site.

Bismuth-214 was reported at 0.39 pCi/g to 3.03 pCi/g in samples collected from the Radium-226 Seepage Pits, and the North and Southwest Chemical Dispensing areas. Bismuth-214 has a half-life of 20 minutes and is a daughter product of radium-226, which has a much longer half-life of 1,600 years (Table 7.2). Therefore, the relatively high measurements of the daughter product, bismuth-214, and the relatively low activity of the parent compound radium-226 seems anomalous. However, it is possible that decay of radium-226 to gaseous radon-222 resulted in vapor phase transport through soils, resulting in measurement of daughter product without the parent compound.

Bismuth-214, lead-214 and lead-212 activity was reported in samples collected from the Strontium-90 Leach Field at levels of < 1.0 pCi/g. These daughter products were not reported in samples collected and measured from the Dog Pen soil samples. Previous investigations have not identified any of these daughter products in soils (Rockwell, 1984; Wahler, 1988, 1989).

One measurement of manganese-54 at 540 pCi/g, was reported in one surface soil sample collected from the former Dog Pens. The measurement is somewhat surprising, given the relatively short half-life of this isotope ($t_{½}$ = 330 days, Table 7.2). Because there has only been one measurement on- or off-site in Phase II and previous investigations, it is not known if this measurement is reliable.

Elevated activities of carbon-14 in soils have been reported in samples measured from two previous studies, including the Rockwell (1984) Investigation and the SWAT Investigation (Dames & Moore, 1990b). Two previous measurements of carbon-14 at 1,160 pCi/g and 794 pCi/g, were reported in the Southwest Disposal area. Samples collected adjacent to Landfill cell No. 3 (UCD-10 55 feet bgs), and the other in the AEC area five feet bgs reported levels less than 1 pCi/g of carbon-14 activity.

Previous investigations have identified cesium-137 activity in soil samples collected and measured from the burial trenches as high as 15.1 pCi/g (UC Davis, 1988), and in the Strontium-90 Leach Field up to 6.2 pCi/g (Wahler, 1989). The Phase I investigation reported several measurements in soils collected from the Strontium-90 Leach Field and concluded that the levels of cesium-137 activity declined with depth. In Phase II, six measurements of cesium-137 have been reported in soil samples collected

on-site, in the Strontium-90 Leach Field, the Dog Pens, and the Radium-226 Seepage Pits, with a maximum activity of 0.25 pCi/g.

The half-life of cesium-137 is 30 years (Table 7.2), which suggests that any cesium-137 discharged to the burial trenches or the Strontium-90 Leach Field may still have relatively high activity. The mobility of dissolved cesium in soils is moderately retarded similar to potassium; therefore, it would be expected that cesium-137 would be retained by both ion-exchange resins in the Imhoff Treatment System and by soils.

### 7.3.3 Distribution of Chemicals in Groundwater

A discussion of the site-wide distribution of chemicals in groundwater, and possible sources for these constituents, is presented in this section. Information gained from previous studies, distribution of constituents in soils, and the chemical mobility of these constituents in soils are integrated into this discussion. The discussion is broken into four parts: Section 7.3.3.1 General Inorganic Parameters (pH, TDS, nitrate, etc.); Section 7.3.3.2 Metals; Section 7.3.3.3 Organic Chemicals; and Section 7.3.3.4 Radionuclides.

A detailed discussion of every analyte reported in groundwater is not presented. Instead, those analytes which are reported more than one time in the same downgradient wells will be emphasized. Those analytes which are reported only once in the five quarters of sampling will receive less discussion.

#### 7.3.3.1 General Inorganic Parameters

pH

Groundwater pH values measured in the field ranged from 6.8 to 7.8. At these pH values, the solubility of most metals is low (see Section 7.4.3.2) under equilibrium conditions. The pH in the first and second HSUs is roughly equivalent.

TDS

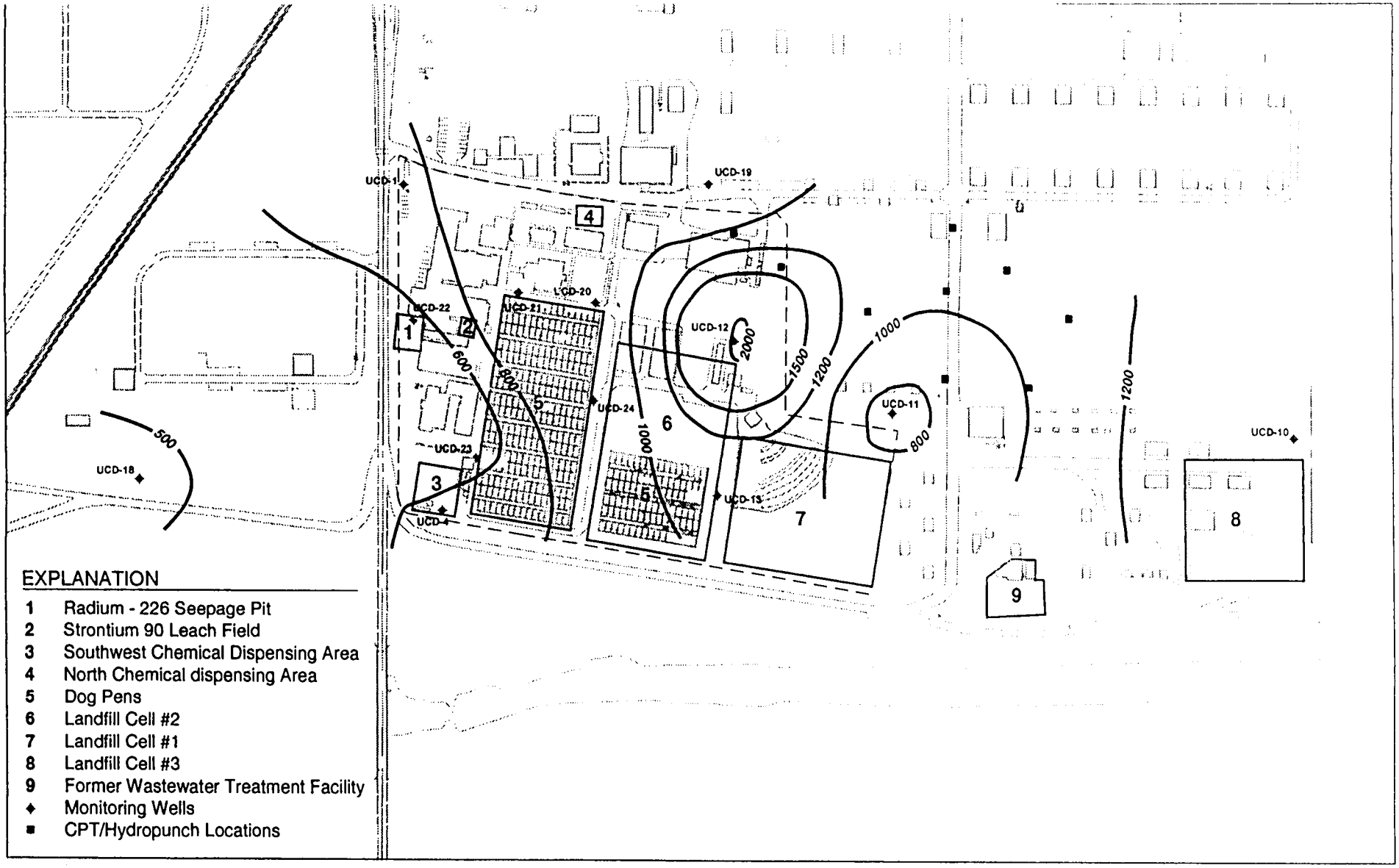
Total dissolved solid (TDS) values reported in groundwater samples in the first HSU exceed TDS values reported in the second HSU. In addition to natural transport of soluble salts from surface soils during recharge, groundwater samples from the first HSU may have been impacted by site activities. Also, silts present in the first HSU have a much higher cation exchange capacity than the sands and gravels in the second HSU, which also contributes to higher TDS in the first HSU. The concentrations

of TDS in the second HSU are lower than the first HSU despite the interconnections between the two water-bearing units.

Figure 7.1 shows a concentration contour map of TDS in the first HSU throughout the site. Data from five quarters of groundwater sampling in Phase II and Hydropunch™ data collected and presented in 1991 (Dames & Moore, 1991d) were used to model the distribution of TDS in groundwater throughout the site.

As shown on Figure 7.1, the lowest concentration of TDS is in the background well (UCD-18), and the highest concentrations are adjacent to the Landfill cell No. 2. Despite the high concentration of TDS in UCD-12, note the relatively low TDS concentration in the adjacent wells, including UCD-11, which is located "downgradient" of UCD-12. As discussed in Section 7.2, lateral flow in the first-HSU is moderate to slow. Therefore, the distribution of elevated TDS in the first HSU appears to be locally, rather than regionally distributed, and is probably affected by landfill wastes and septage.

Figure 7.2 shows a TDS concentration contour in the second HSU throughout the site. The TDS concentration increases to the northeast. Considering that the two water bearing zones are hydraulically connected, dissolved solids from the LEHR facility and other waste facilities may move downward, through the first HSU into the second HSU, and then migrate at a higher rate laterally downgradient toward the northeast.




0 300
Scale in Feet

N

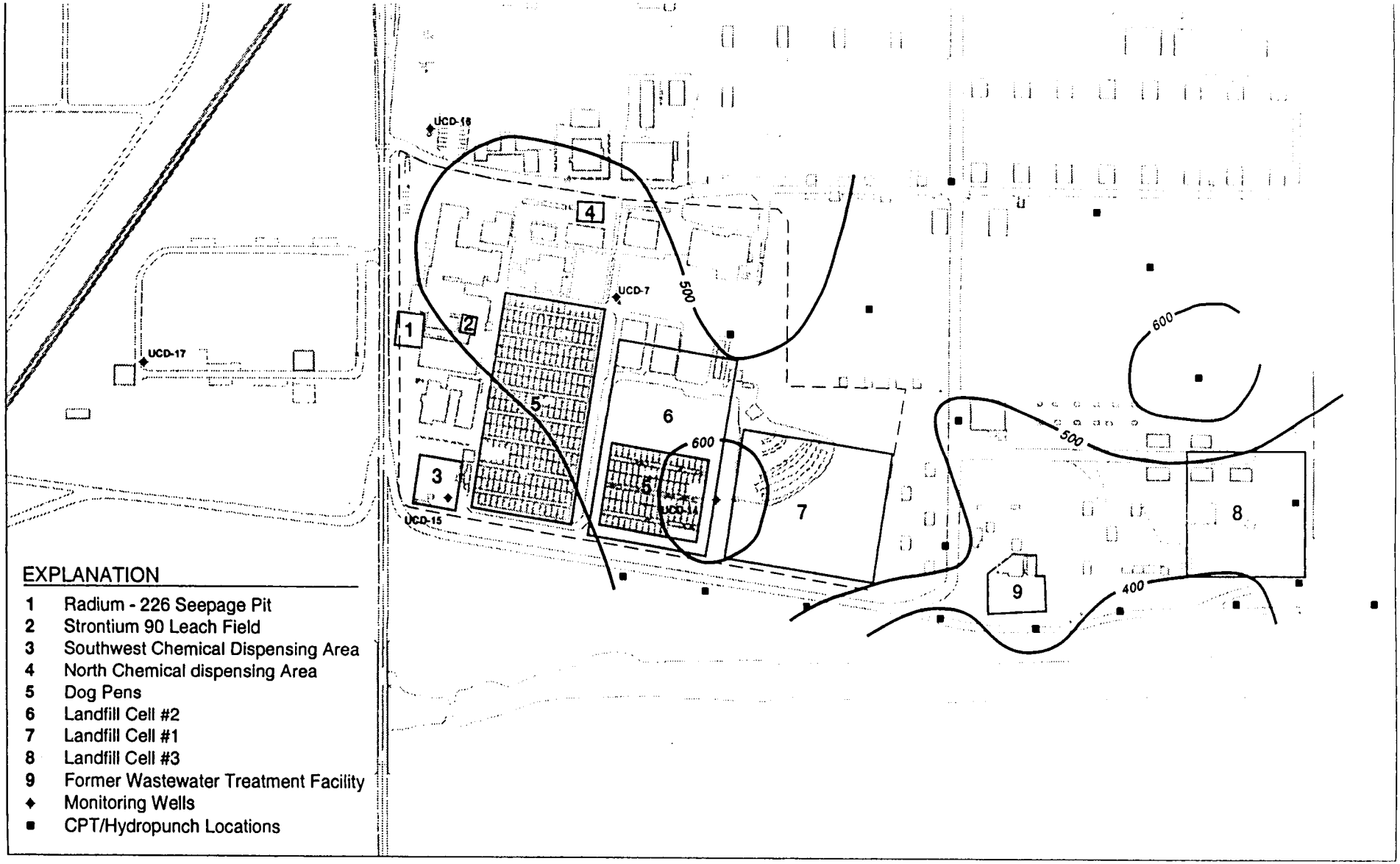
# GROUNDWATER CONCENTRATION CONTOURS FIRST HYDROSTRATIGRAPHIC UNIT TOTAL DISSOLVED SOLIDS (mg/L)

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-174

FIGURE 7.1




0 300
Scale in Feet

N

**GROUNDWATER CONCENTRATION CONTOURS**
**SECOND HYDROSTRATIGRAPHIC UNIT**
**TOTAL DISSOLVED SOLIDS (mg/L)**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-175

FIGURE 7.2

Turbidity

During the first and fourth Quarterly Sampling Rounds, turbidity values were elevated for first-HSU wells installed during the Phase II investigation. In wells UCD-18 through -24, the first-quarter water sample was collected with disposable bailers, immediately after wells were installed and developed (Table 6.33). The use of a bailer can increase surging and disturbance of suspended solids in groundwater samples, when compared to a dedicated pump which minimizes disturbance of suspended particles surrounding the well. The high turbidity observed in these wells in the first-quarter samples could have been caused by the rapid removal of the submersible pump used during well development or by incomplete development. This situation was eliminated in subsequent sampling rounds by the installation of dedicated pumps.

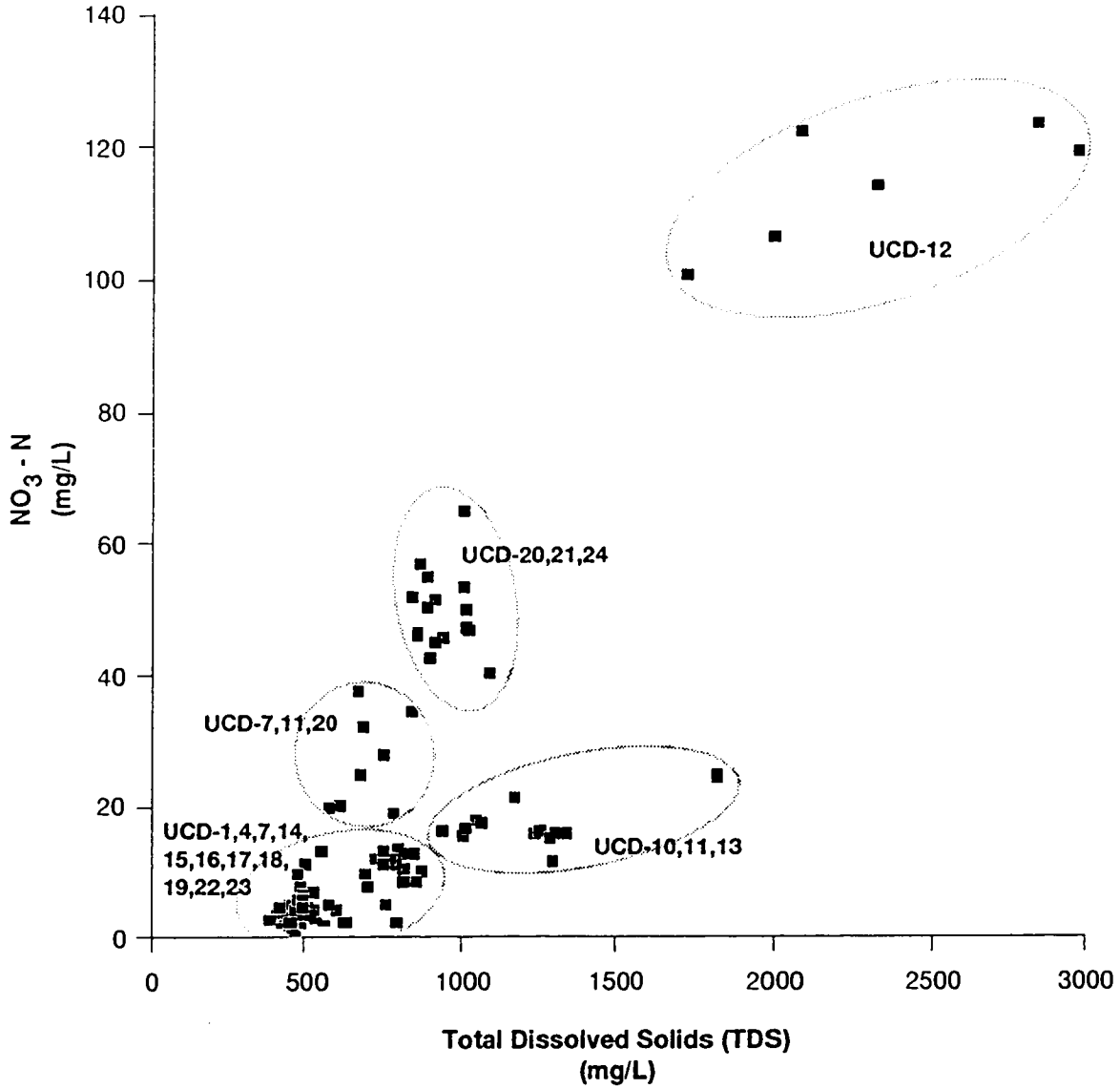
In the fourth round of water sampling (August 1991), high turbidity values were observed in all first HSU wells despite the use of dedicated pumps for obtaining samples. As discussed in Section 6.12 water levels dropped over 10 feet in most first HSU wells to minimum levels in August 1991. Because of the low water levels, very low flow rates were encountered during the August 1991 sampling round. Lower flow rates were caused by water moving through less conductive material which may have resulted in more turbid samples. When water levels rose in November 1991 turbidity values declined once again.

Anions

The anion of primary concern at the LEHR facility is nitrate, because of its elevated concentration in groundwater throughout the site. Nitrate concentrations in groundwater appear to correlate with the concentration of TDS. Figure 7.3 shows the relation between TDS and nitrate concentration for all Phase II groundwater samples. Although the correlation between the two parameters is not perfectly linear, there is a general trend indicating that elevated TDS is associated with high concentrations of nitrate.

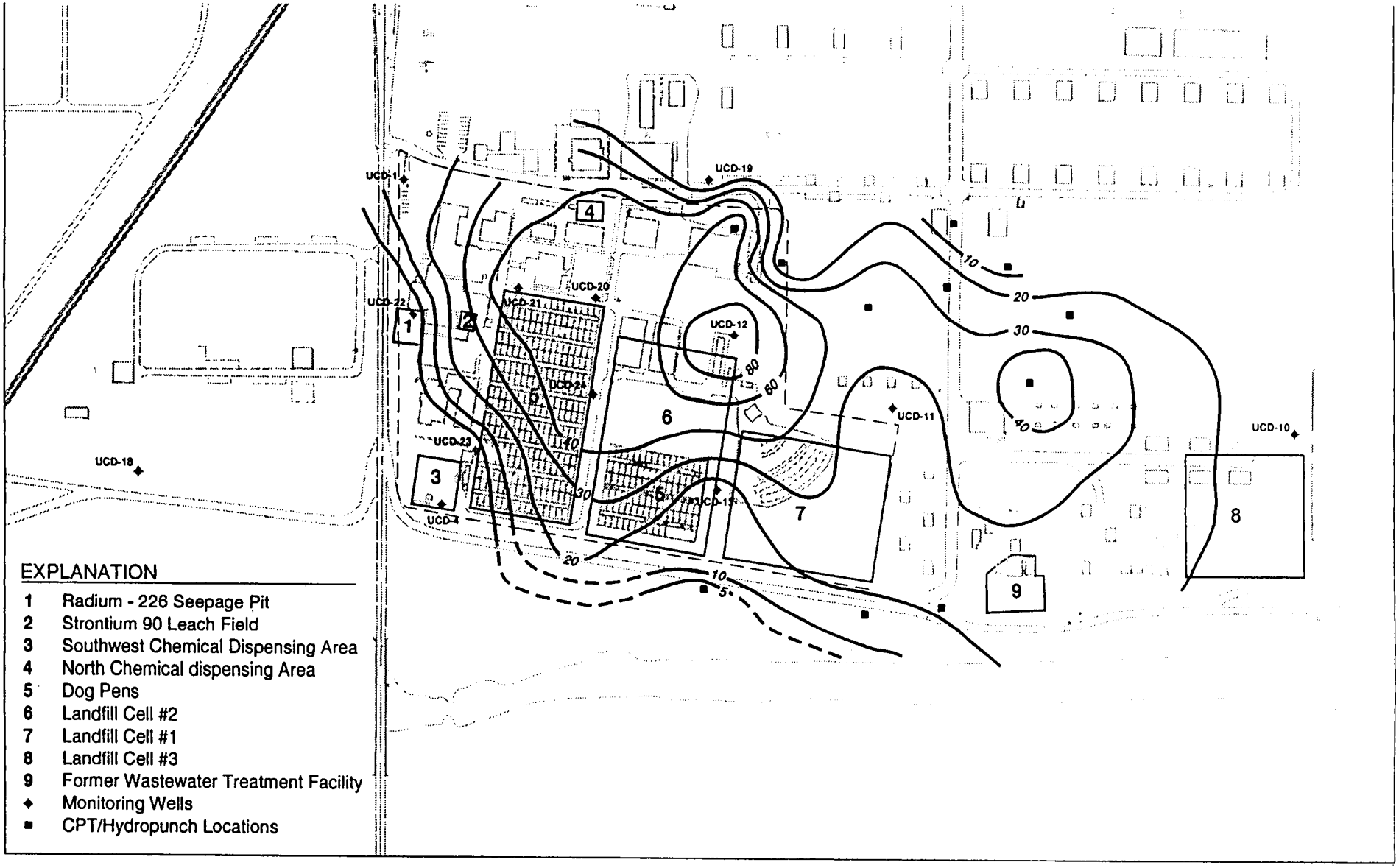
Figure 7.4 shows the distribution of nitrate concentrations in the first HSU. Background concentrations reported in samples collected from UCD-18 suggest that background nitrate as (N) concentrations vary from approximately 2 mg/L to 7 mg/L, with the average for the five quarters of less than 5 mg/L.

As shown on Figure 7.4, there are local areas with higher nitrate concentrations in the first HSU. This is consistent with the observed distribution of TDS in the first HSU. Samples collected from UCD-12 consistently show the highest nitrate as (N) concentrations (90 to 100 mg/L). Nearly all groundwater samples from the first HSU collected from wells located east of the Dog Pen area have nitrate as (N) levels exceeding the background range of 2 mg/L to 7 mg/L.




**TDS vs $NO_3$ - N**
**GROUNDWATER SAMPLES**
**NOVEMBER 1990 - NOVEMBER 1991**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993




0 300
Scale in Feet

N

# GROUNDWATER CONCENTRATION CONTOURS FIRST HYDROSTRATIGRAPHIC UNIT NITRATE AS N (mg/L)

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-176

FIGURE 7.4

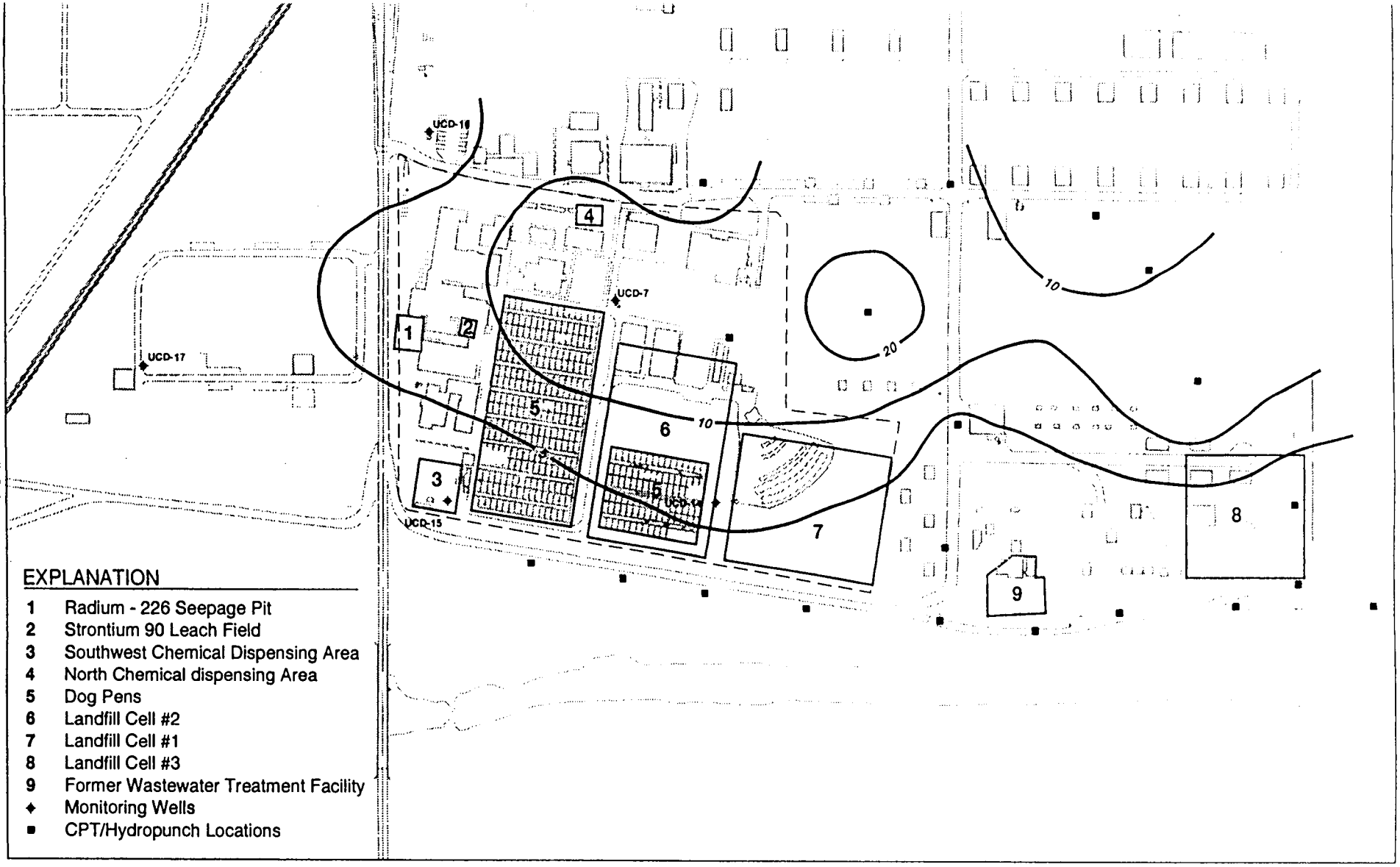
Regional sources of nitrate include agricultural fertilization and wastewater effluent, which may have impacted groundwater (Dames & Moore, 1990d). Soils data show elevated concentrations of nitrate in the upper 15 feet of soil near the Radium-226 Dry Wells. Review of nitrate analyses from the first HSU shows the highest concentrations of nitrate in groundwater from UCD-12, located directly adjacent to and downgradient of Waste Burial Trenches and Landfill cell No. 2.

Other potential sources of nitrate at the LEHR facility include the Dog Pens, the Strontium-90 Leach Field, various septic tanks, waste burial trenches, and Landfill cells No. 1 and No. 2. The North and Southwest Chemical Dispensing areas, and the Radium-226 Dry Wells, do not appear to have significantly contributed to nitrate in groundwater at this time. However, since nitrate is not strongly adsorbed to soils, the high concentration of nitrate found in the Radium-226 Dry Well area from 5 to 15 feet bgs represents a concentrated mass of mobile material that may impact groundwater. Given the moderate permeability of the soils on the site, and the extensive paving at the site, mobilization of nitrate may be limited by the residual amount of rainfall passing through the soils in the paved areas.

Another potential source of nitrate is wastewater treatment plant effluent. Previous work has documented that samples collected and analyzed from this effluent have concentrations of nitrate as N that exceeded 10 mg/L (see Section 7.3.4).

Figure 7.5 shows the distribution of nitrate concentration contour in the second HSU. The nitrate as N concentration in the background or upgradient (southwestern) portion of the site is between 2 and 7 mg/L. Figure 7.5 shows elevated concentrations of nitrate in the northeast portion of the site, downgradient from UCD-12. As discussed in Section 7.2, the hydraulic gradient is to the northeast, which suggests that a non-retarded solute, similar to nitrate, would move to the northeast. In addition, nitrate would trend to migrate vertically with the water in the first HSU.

The concentration of chloride in the background upgradient portion of the site is approximately 26 mg/L in the first HSU and 18 mg/L in the second HSU. Chloride concentrations on-site are greatly elevated in UCD-12, where the concentration of chloride exceeds 260 mg/L three of five quarters, reaching a maximum value of 443 mg/L in February 1991. The reported maximum concentration of chloride in the second HSU was 40 mg/L in the deep wells, reflecting the dilution of solutes concentrations as water moves from the first to the second HSU.




0 300
Scale in Feet

N

# GROUNDWATER CONCENTRATION CONTOURS SECOND HYDROSTRATIGRAPHIC UNIT NITRATE AS N (mg/L)

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-177

FIGURE 7.5

Reported sulfate concentrations in samples collected from the first HSU range from approximately 40 mg/L to 100 mg/L with the exception of UCD-10, located at the eastern boundary of the LEHR facility, which averaged over 400 mg/L sulfate. Background concentrations of sulfate in samples collected from the first HSU range from 32 mg/L to 50 mg/L. The higher reported concentration of sulfate in groundwater samples from UCD-10 may be from wastes high in sulfur buried in the vicinity. Sulfate reported in samples collected from the second HSU was similar to the first HSU, varying from approximately 40 mg/L to 100 mg/L in all deeper wells. Background concentrations of sulfate in the second HSU range from 33 mg/L to 42 mg/L.

From the preceding discussion, the concentrations of nitrate, chloride and sulfate increase downgradient of the LEHR facility and are elevated when compared to background. Background concentrations of nitrate, chloride, and sulfate are slightly higher in the first HSU (UCD-18) compared with the second HSU (UCD-17).

Cations

Cations in groundwater were measured to develop an understanding of the entire groundwater chemical composition. Calcium, magnesium, and sodium are the major cations in solution; potassium concentrations are consistently low.

The concentrations of the cations, calcium, magnesium, sodium, and potassium detected in groundwater samples increase downgradient from the LEHR facility, exceeding background concentrations. Reported background concentrations of these cations in the first HSU groundwater samples are generally higher than those collected from the second HSU.

The calcium concentrations reported in samples collected from the first HSU vary from approximately 29 mg/L to 100 mg/L, with highest values observed in UCD-12. Background concentrations reported in samples analyzed in the first HSU range from 29 mg/L to 33 mg/L. Calcium reported in samples analyzed from the second HSU vary from approximately 30 mg/L to 50 mg/L. Background calcium concentrations in samples analyzed in the second HSU range from 34 mg/L to 43 mg/L.

Magnesium concentrations reported in samples analyzed in the first HSU range from approximately 50 mg/L to 320 mg/L, with the highest values observed in UCD-12. Background concentrations in samples analyzed in the first HSU range from 60 mg/L to 80 mg/L. Magnesium concentrations reported in samples analyzed from the second HSU range from approximately 60 mg/L to 150 mg/L. Background concentrations in samples analyzed in the second HSU range from 60 mg/L to 65 mg/L.

Sodium concentrations reported in samples from the first HSU range from approximately 20 mg/L to 160 mg/L, with the highest values observed in UCD-10. Background concentrations in samples analyzed in the first HSU range from 24 mg/L to 42 mg/L. Sodium concentrations reported in samples collected from the second HSU range from approximately 10 mg/L to 60 mg/L. Background concentrations in samples analyzed in the second HSU range from 10 mg/L to 38 mg/L.

Potassium concentrations in samples analyzed in the first HSU range from 0.6 mg/L to 5.1 mg/L. Background concentrations in the first HSU range from 1.2 mg/L to 2.9 mg/L. Potassium concentrations in samples analyzed in the second HSU range from 0.4 mg/L to 1.3 mg/L. Background concentrations in samples analyzed in the second HSU range from 0.4 to 0.6 mg/L.

Elevated concentrations of soluble salts reported in many wells, UCD-12 in particular, may be the result of proximity to landfill materials. When slightly soluble minerals (e.g., calcium, magnesium carbonates) come into contact with saline water, minerals tend to dissolve until equilibrium between the mineral and the saline water is reached (Nordstrom and Munoz, 1986). In those areas where the groundwater has been impacted by sodium, chloride, or nitrate, the excess salinity may have increased the solubility of calcium and magnesium carbonates. In the first HSU, UCD-10, -12, -13, -20, and -21, groundwater samples have TDS values two to four times background, and higher reported concentrations of calcium and magnesium than background. A similar effect of salts increasing the solubility of other minerals including barium sulfate ($BaSO_4$) is discussed in Section 7.3.3.2.

#### 7.3.3.2 Metals

The results of analyses of metals in groundwater are shown in Table 7.3. As previously discussed in Section 7.3.3.1, the presence of suspended solids in the November 1990 first quarter groundwater samples may have increased the measured concentrations of several metals. Additionally, variations in laboratory detection limits between quarters may result in apparent non-detections of metals in one round as compared to values reported in other rounds. Antimony, beryllium and cadmium were reported more frequently in the first quarter (November 1990), and at generally higher concentrations, than in subsequent quarters. The reported detections of beryllium and cadmium downgradient were similar to background upgradient wells (UCD-17 and -18).

Previous investigations reported lead concentrations as high as 200 $\mu$g/L (Wahler, 1987). Phase II sampling reported very few detections of lead which never exceeded 3 $\mu$g/L. These results suggest that the previous water samples were not filtered prior to analysis.

| | UCD-Well# | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 4 | 10 | 10 (D) | 11 | 11 (D) | 12 | 12 (D) | 13 | 18 | 19 | 19 (D) | 20 | 21 | 22 | 22 (D) | 23 | 23 (D) | 24 | 24 (D) | 7 | 14 | 14 (D) | 15 | 15 (D) | 16 | 17 | MCL |
| | First HSU (µg/L) | | | | | | | | | | | | | | | | | | | | Second HSU (µg/L) | | | | | | | (µg/L) |
| **ANALYTE/Quarter#** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANTIMONY | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| 1 | 310 | | 330 | | 240 | | 260 | | 280 | 120 | 120 | | 120 | 340 | 260 | | 190 | | 270 | 260 | 100 | 170 | | 190 | 150 | 190 | 200 | 5 |
| 2 | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | 5 |
| 3 | 3 | 5 | 4 | | 5 | 7 | 20 | | 11 | 2 | 6 | | 5 | 5 | 65 | | 3 | 5 | 4 | | 31 | 9 | | 5 | | 2 | 31 | 5 |
| 4 | | | | | | | | | | 5 | 10 | 7 | 7 | 7 | 3 | | 4 | | 7 | | 4 | 7 | 6 | 3 | | 3 | 3 | 5 |
| 5 | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | 5 |
| ARSENIC | | | | | | | | | | | | | | | | | | | | | | | | | | | | 50 |
| 1 | (10) | | (10) | | (10) | | (10) | | (10) | (10) | (10) | | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | 50 |
| 2 | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | 50 |
| 3 | (10) | (10) | (10) | | (10) | (10) | (10) | | (10) | (10) | (10) | | (10) | (10) | (10) | | (10) | (10) | (10) | | (10) | (10) | | (10) | | (10) | (10) | 50 |
| 4 | | | | | | | | | | (10) | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | | (10) | (10) | (10) | (10) | | (10) | (10) | 50 |
| 5 | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | 50 |
| BARIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1000 |
| 1 | 200 | | (30) | | 120 | | 400 | | 180 | 50 | 30 | | 130 | 120 | 60 | | 80 | | 170 | 150 | 160 | 150 | | 160 | 160 | 150 | 150 | 1000 |
| 2 | 180 | 250 | (30) | | 120 | | 560 | 560 | 280 | (30) | (30) | | 130 | 120 | (30) | (30) | (30) | | 50 | | 190 | 120 | | 130 | | 130 | 130 | 1000 |
| 3 | 160 | 230 | (30) | | 150 | 150 | 500 | | 220 | 60 | 40 | | 70 | 80 | (30) | | 30 | 30 | 90 | | 190 | 270 | | 140 | | 120 | 130 | 1000 |
| 4 | | | | | | | | | | (30) | 40 | 40 | 130 | 110 | 30 | | 40 | | 120 | | 210 | 270 | 260 | 160 | | 150 | 150 | 1000 |
| 5 | 190 | 300 | (30) | (30) | 140 | | 410 | | 250 | 80 | 50 | | 160 | 140 | 30 | 30 | 50 | | 120 | | 170 | 150 | | 160 | | 150 | 150 | 1000 |
| BERYLLIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 1 | (1) | | 2 | | 1 | | 1 | | (1) | 3 | 1 | | 3 | (1) | 1 | | 3 | | 2 | 1 | 1 | 2 | | 5 | 5 | 5 | 6 | 1 |
| 2 | (1) | (1) | (1) | | (1) | | (1) | (1) | (1) | (1) | (1) | | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | (1) | | (1) | | (1) | (1) | 1 |
| 3 | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | | (1) | | (1) | (1) | 1 |
| 4 | | | | | | | | | | (1) | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | | (1) | (1) | (1) | (1) | | (1) | (1) | 1 |
| 5 | 1 | 1 | (1) | (1) | (1) | | 1 | | (1) | 1 | (1) | | 1 | 1 | 1 | (1) | (1) | | (1) | | 1 | (1) | | (1) | | (1) | (1) | 1 |
| CHROMIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | 50 |
| 1 | (30) | | (30) | | 280 | | 140 | | 100 | (30) | 160 | | 60 | (30) | (30) | | (30) | | (30) | (30) | (30) | 40 | | 70 | 50 | 150 | 50 | 50 |
| 2 | 39 | 15 | 29 | | 377 | | 177 | 178 | 56 | (10) | 298 | | 78 | 58 | (10) | (10) | (10) | | 31 | | 38 | (10) | | 11 | | 26 | 25 | 50 |
| 3 | (30) | (30) | 40 | | 330 | 320 | 200 | | 100 | (30) | 260 | | 50 | 60 | (30) | | (30) | (30) | 30 | | 70 | 70 | | (30) | | (30) | (30) | 50 |
| 4 | | | | | | | | | | (30) | 280 | 290 | 90 | 90 | (30) | | (30) | | 90 | | 60 | 70 | 60 | (30) | | 50 | (30) | 50 |
| 5 | 60 | (30) | 70 | 60 | 340 | | 220 | | 100 | (30) | 290 | | 110 | 100 | (30) | (30) | (30) | | 40 | | 30 | (30) | | (30) | | 40 | 40 | 50 |
| CHROMIUM, HEX | | | | | | | | | | | | | | | | | | | | | | | | | | | | NA |
| 1 | 80 | | 30 | | 400 | | 160 | | 70 | 10 | 200 | | 70 | 90 | 10 | | 20 | | 60 | 70 | 40 | 30 | | 10 | 10 | 30 | 20 | NA |
| 2 | 90 | 30 | 20 | | 230 | | 80 | 80 | 60 | 10 | 290 | | 90 | 60 | (10) | (10) | 20 | | 40 | | 50 | 20 | | 10 | | 30 | 30 | NA |
| 3 | 20 | 260 | 20 | | 340 | 330 | 200 | | 80 | 20 | 10 | | 60 | 70 | (10) | | (10) | (10) | 30 | | 90 | 50 | | 20 | | 30 | 20 | NA |
| 4 | | | | | | | | | | 30 | 200 | 200 | 70 | 90 | 60 | | 60 | | 50 | | 40 | 50 | 50 | 10 | | 30 | 20 | NA |
| 5 | 40 | 10 | 40 | 40 | 30 | | 190 | | 80 | 40 | 290 | | 100 | 80 | (10) | 10 | 10 | | 40 | | 30 | 20 | | 10 | | 40 | 22 | NA |

**D - Duplicate sample**
**( ) - Non detect, number in parenthese is the reported detection limit**
**NA - Not available**

PhII/Tbl7.3

| | UCD-Well# | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 4 | 10 | 10 (D) | 11 | 11 (D) | 12 | 12 (D) | 13 | 18 | 19 | 19 (D) | 20 | 21 | 22 | 22 (D) | 23 | 23 (D) | 24 | 24 (D) | 7 | 14 | 14 (D) | 15 | 15 (D) | 16 | 17 | MCL (µg/L) |
| | First HSU (µg/L) | | | | | | | | | | | | | | | | | | | | Second HSU (µg/L) | | | | | | | |
| ANALYTE/Quarter# | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CADMIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 |
| 1 | 2 | | (1) | | (1) | | 2 | | 1 | 1 | 2 | | 1 | 1 | 1 | | (1) | | 1 | 2 | (1) | (1) | | (1) | (1) | (1) | (1) | 10 |
| 2 | (1) | (1) | 7 | | (1) | | 1 | 1 | 1 | (1) | (1) | | (1) | (1) | 1 | (1) | (1) | | (1) | | (1) | 3 | | (1) | | (1) | (1) | 10 |
| 3 | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | | (1) | | (1) | (1) | 10 |
| 4 | | | | | | | | | | (1) | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | | (1) | (1) | (1) | (1) | | (1) | (1) | 10 |
| 5 | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | (1) | | (1) | | (1) | (1) | 10 |
| COBALT | | | | | | | | | | | | | | | | | | | | | | | | | | | | NA |
| 1 | (50) | | (50) | | (50) | | (50) | | (50) | (50) | (50) | | (50) | (50) | (50) | | (50) | | (50) | (50) | (50) | (50) | | (50) | (50) | (50) | (50) | NA |
| 2 | (30) | (30) | (10) | | (10) | | (10) | (30) | (30) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (30) | (30) | | (10) | | (10) | (10) | NA |
| 3 | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | | (30) | | (30) | (30) | NA |
| 4 | | | | | | | | | | (50) | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | | (50) | (50) | (50) | (50) | | (50) | (50) | NA |
| 5 | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | (50) | (50) | | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | (50) | | (50) | | (50) | (50) | NA |
| COPPER | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1300 |
| 1 | (30) | | (30) | | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | 1300 |
| 2 | (30) | 30 | (30) | | (30) | | 30 | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | | (30) | | (30) | 30 | 1300 |
| 3 | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | | (30) | | (30) | (30) | 1300 |
| 4 | | | | | | | | | | (30) | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | 1300 |
| 5 | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | | (30) | | (30) | (30) | 1300 |
| LEAD | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | (1) | | (1) | | (1) | | (1) | | (1) | 1 | 3 | | (1) | 1 | (1) | | (1) | | (1) | (1) | 1 | (1) | | (1) | (1) | (1) | (1) | 50 |
| 2 | (1) | (1) | 1 | | (1) | | (1) | 1 | (1) | (1) | (1) | | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | (1) | | (1) | | (1) | (1) | 50 |
| 3 | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | | (1) | (1) | | (1) | | (1) | (1) | 50 |
| 4 | | | | | | | | | | (1) | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | | 1 | 1 | (1) | (1) | | (1) | (1) | 50 |
| 5 | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | (1) | (1) | | (1) | (1) | (1) | (1) | (1) | | (1) | | (1) | (1) | | (1) | | (1) | (1) | 50 |
| MERCURY | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| 1 | (0.4) | | (0.4) | | (0.4) | | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | 0.5 | 2 |
| 2 | (0.4) | (0.4) | (0.4) | | (0.4) | | (0.4) | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | | (0.4) | 0.4 | | (0.4) | | (0.4) | (0.4) | 2 |
| 3 | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | | (0.4) | | (0.4) | (0.4) | 2 |
| 4 | | | | | | | | | | (0.4) | (0.4) | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | | (0.4) | | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | 2 |
| 5 | (0.4) | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | | (0.4) | (0.4) | (0.4) | | (0.4) | (0.4) | (0.4) | (0.4) | (0.4) | | (0.4) | | (0.4) | (0.4) | | (0.4) | | (0.4) | (0.4) | 2 |
| MOLYBDENUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | NA |
| 1 | 260 | | 250 | | 150 | | 170 | | 210 | 90 | 90 | | 70 | 240 | 170 | | 140 | | 190 | 180 | 60 | 100 | | 140 | 130 | 120 | 130 | NA |
| 2 | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | NA |
| 3 | 70 | 30 | 50 | | 40 | 50 | 60 | | (30) | (30) | 50 | | 30 | 30 | 30 | | 30 | 40 | 30 | | 30 | 50 | | (30) | | (30) | (30) | NA |
| 4 | | | | | | | | | | (50) | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | | (50) | (50) | (50) | (50) | | (50) | (50) | NA |
| 5 | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | (50) | (50) | | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | (50) | | (50) | | (50) | (50) | NA |

**D - Duplicate sample**

**( ) - Non detect, number in parenthese is the reported detection limit**

**NA - Not available**

| ANALYTE/Quarter# | UCD-Well# 1 | 4 | 10 | 10 (D) | 11 | 11 (D) | 12 | 12 (D) | 13 | 18 | 19 | 19 (D) | 20 | 21 | 22 | 22 (D) | 23 | 23 (D) | 24 | 24 (D) | 7 | 14 | 14 (D) | 15 | 15 (D) | 16 | 17 | MCL (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First HSU (µg/L) | | | | | | | | | | | | | | | | | | | | Second HSU (µg/L) | | | | | | | |
| NICKEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | 100 |
| 1 | (30) | | (30) | | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | 100 |
| 2 | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | | (30) | | (30) | (30) | 100 |
| 3 | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | 30 | 30 | (30) | | (30) | (30) | | (30) | | (30) | (30) | 100 |
| 4 | | | | | | | | | | 30 | (30) | (30) | (30) | (30) | (30) | | 50 | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | 100 |
| 5 | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | 30 | | (30) | | (30) | (30) | | (30) | | (30) | (30) | 100 |
| SELENIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 |
| 1 | (10) | | (10) | | 10 | | (10) | | (10) | (10) | 10 | | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | 10 |
| 2 | (10) | (10) | (10) | | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | (10) | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | 10 |
| 3 | (10) | (10) | (10) | | 10 | 10 | (10) | | (10) | (10) | 10 | | (10) | (10) | (10) | | (10) | (10) | (10) | | (10) | (10) | | (10) | | (10) | (10) | 10 |
| 4 | | | | | | | | | | (10) | 10 | (10) | (10) | (10) | (10) | | (10) | | (10) | | (10) | (10) | (10) | (10) | | (10) | (10) | 10 |
| 5 | (10) | (10) | (10) | (10) | 31 | | 23 | | (10) | (10) | 31 | | (10) | 12 | (10) | (10) | (10) | | (10) | | (10) | (10) | | (10) | | (10) | (10) | 10 |
| SILVER | | | | | | | | | | | | | | | | | | | | | | | | | | | | 50 |
| 1 | (30) | | (30) | | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | 50 |
| 2 | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | | (30) | | (30) | (30) | 50 |
| 3 | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | | (30) | | (30) | (30) | 50 |
| 4 | | | | | | | | | | (30) | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | 50 |
| 5 | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | | (30) | | (30) | (30) | 50 |
| THALLIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| 1 | 270 | | 250 | | 180 | | 200 | | 220 | 120 | 110 | | 110 | 280 | 200 | | 150 | | 210 | 200 | 80 | 150 | | 140 | 150 | 150 | 150 | 2 |
| 2 | 30 | 30 | 30 | | (30) | | 50 | 70 | 80 | (30) | (30) | | (50) | (30) | (30) | (30) | (30) | | (30) | | (30) | 30 | | (30) | | (30) | (30) | 2 |
| 3 | 2 | 7 | 6 | | 9 | 10 | 31 | | 14 | 5 | 11 | | 8 | 11 | 6 | | 7 | 7 | 10 | | 11 | 12 | | 5 | | 7 | 6 | 2 |
| 4 | | | | | | | | | | 6 | 8 | 9 | 10 | 10 | 5 | | 5 | | 8 | | 6 | 9 | 10 | 5 | | 5 | 4 | 2 |
| 5 | 8 | 6 | 13 | 13 | (5) | | 23 | | 13 | 5 | 9 | | 12 | 7 | (5) | (5) | 7 | | 8 | | 7 | (5) | | 9 | | 6 | (5) | 2 |
| VANADIUM | | | | | | | | | | | | | | | | | | | | | | | | | | | | NA |
| 1 | (50) | | (50) | | (50) | | (50) | | (50) | (50) | (50) | | (50) | (50) | (50) | | (50) | | (50) | (50) | (50) | (50) | | (50) | (50) | (50) | (50) | NA |
| 2 | (100) | (100) | (100) | | (100) | | (100) | (100) | (100) | (100) | (100) | | (100) | (100) | (100) | (100) | (100) | | (100) | | (100) | (100) | | (100) | | (100) | (100) | NA |
| 3 | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | | (30) | | (30) | (30) | NA |
| 4 | | | | | | | | | | (50) | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | | (50) | (50) | (50) | (50) | | (50) | (50) | NA |
| 5 | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | (50) | (50) | | (50) | (50) | (50) | (50) | (50) | | (50) | | (50) | (50) | | (50) | | (50) | (50) | NA |
| ZINC | | | | | | | | | | | | | | | | | | | | | | | | | | | | NA |
| 1 | 40 | | (30) | | (30) | | (30) | | 30 | (30) | 40 | | (30) | 30 | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | NA |
| 2 | 30 | (30) | 30 | | 30 | | 40 | 30 | 40 | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | 30 | | (30) | | (30) | (30) | NA |
| 3 | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | | (30) | (30) | | (30) | | (30) | (30) | NA |
| 4 | | | | | | | | | | (30) | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | | (30) | (30) | (30) | (30) | | (30) | (30) | NA |
| 5 | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | (30) | | (30) | (30) | (30) | (30) | (30) | | (30) | | (30) | (30) | | (30) | | (30) | (30) | NA |

**D - Duplicate sample**
**( ) - Non detect, number in parenthese is the reported detection limit**
**NA - Not available**

TABLE 7.4
SUMMARY OF DETECTIONS OF METALS IN
GROUNDWATER NOVEMBER, 1990 TO NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Parameter | Number of Samples | Number of Detections | Lowest | Highest | MCL |
|---|---|---|---|---|---|
| | | | µg/L | | |
| Antimony (Total) | 93 | 53 | 2.0 | 340.0 | 5 |
| Barium (Total) | 93 | 81 | 30.0 | 560.0 | 1000 |
| Beryllium (Total) | 93 | 24 | 1.0 | 6.0 | 1.0 |
| Cadmium (Total) | 93 | 16 | 1.0 | 7.0 | 10 |
| Chromium (Total) | 93 | 58 | 11.0 | 377.0 | 50 |
| Chromium, Hexavalent (+6) | 93 | 87 | 10.0 | 400.0 | NA |
| Copper (Total) | 93 | 3 | 30.0 | 30.0 | 1300 |
| Lead (Total) | 93 | 8 | 1.0 | 3.0 | 50 |
| Mercury (Total) | 93 | 2 | 0.4 | 0.5 | 2 |
| Molybdenum (Total) | 93 | 34 | 30.0 | 260.0 | ND |
| Nickel (Total) | 93 | 5 | 30.0 | 50.0 | 100 |
| Selenium (Total) | 93 | 10 | 10.0 | 31.0 | 10 |
| Thallium (Total) | 93 | 75 | 2.0 | 280.0 | 2 |
| Zinc (Total) | 93 | 11 | 30.0 | 40.0 | NA |

Antimony

Background concentrations of antimony in groundwater samples ranged from less than 10 $\mu$g/L to 200 $\mu$g/L in both the first and second HSU. Downgradient wells sampled in the first quarter (November 1990) reported high concentrations of antimony, ranging from 100 to 340 $\mu$g/L. Excess turbidity may have contributed to these high values as discussed previously. No antimony was detected in groundwater samples collected during the second and fifth quarters.

In the third and fourth quarters, detections were reported in all wells at 2 to 65 $\mu$g/L — well below those reported in the first quarter. The downgradient wells did not appear to have consistently higher concentrations than the upgradient wells, UCD-17 and UCD-18. In the third quarter the upgradient well UCD-17 had the second highest concentration suggesting that groundwater in the region contains antimony. There is relatively little information on antimony in groundwater (Hem, 1989) or soils (Alloway, 1990).

Barium

Background concentrations of barium reported in samples collected from the second HSU (UCD-17) ranged from 130 $\mu$g/L to 150 $\mu$g/L. Background barium concentrations in samples collected from the first HSU (UCD-18) were lower, ranging from nondetectable, $<30.0$ $\mu$g/L, to 80 $\mu$g/L.

In the first HSU, barium was reported in samples from nearly every well, ranging from $<30$ $\mu$g/L to a high of 560 $\mu$g/L in UCD-12. Well UCD-10, located east of the LEHR facility, was the only well in the first HSU with no reported detections of barium. In the previous discussion of the distribution of anions, it was noted that the sulfate concentration reported in UCD-10 was 5 to 10 times higher than any other well on- or off-site. Given the low solubility of barium sulfate, these data suggest that excess sulfate in groundwater may have caused precipitation of barium in the vicinity of UCD-10 in the first HSU.

In samples collected from the second HSU, barium concentrations ranged from 120 $\mu$g/L to 270 $\mu$g/L. The highest concentrations were reported in samples from UCD-14, which also had the highest average TDS concentration in the second HSU (Figure 7.2).

Molybdenum

Molybdenum was detected in groundwater in samples collected from the first and third quarters (Table 7.3). The detections reported from the first quarter appeared to be affected by turbidity, as first-round results were two to five times higher than values reported in subsequent rounds. The range of

reported results was from 30 $\mu$g/L to 70 $\mu$g/L in the second round of sampling, much lower than the first round where concentrations ranged from 70 $\mu$g/L to 260 $\mu$g/L (Table 7.3)

Thallium

Reported detections of thallium in groundwater, like molybdenum, appear to be significantly elevated in the first round, where concentrations varied from double to five times higher than subsequent rounds. If the second through fifth rounds only are considered, background concentrations in the first HSU ranged from 5 to 6 $\mu$g/L and from 4 to 6 $\mu$g/L in the second HSU. Concentrations of thallium in the first HSU ranged from nondetectable ($<5$ $\mu$g/L) to 80 $\mu$g/L. The wells with the consistently highest concentrations were UCD-12, -13, -20, and -21 downgradient of former disposal areas (Table 7.3).

In the second HSU, thallium concentrations varied from $<5$ $\mu$g/L to 30 $\mu$g/L. Wells UCD-15, -16, and -17 appeared to have slightly lower concentrations than UCD-7 and -14, which are downgradient of the LEHR facility.

Selenium

Reported detections of selenium in groundwater are limited to four wells (UCD-11, -12, -19, and -21), all in the first HSU. These reported detections of selenium are in downgradient wells, which are also elevated in TDS and salts. Wells UCD-11 and -19 had repeated reported detections of selenium ranging from 10 $\mu$g/L to 31 $\mu$g/L.

Selenium is known to occur in sediments derived from the Coast Ranges west of the site, which are the source of alluvium, the parent material for soils and subsoils on the site. Reported concentrations of selenium in soils on site suggest that soil samples are near the regional range of selenium concentrations in soils (see Section 7.3.2). Well-documented studies have shown that saline alkaline agricultural drainage water contains substantial selenium from Coast Range soils (BLM, 1984). The current groundwater monitoring results suggest reported detections of selenium are limited to the somewhat saline, high-TDS water of the first HSU downgradient of the LEHR facility. No detections of selenium have been reported in groundwater samples from the second HSU.

Chromium

Elevated concentrations of total and hexavalent chromium have been observed in groundwater in previous studies at LEHR (Rockwell, 1984, Wahler, 1989, Dames & Moore, 1990b and 1990d). Concentrations of total chromium in soils are consistent with regional values (Shacklette and Boerngen, 1986). Analysis of hexavalent chromium (Cr VI) in soils has shown detectable concentrations ranging

from .05 mg/Kg to 1.98 mg/Kg Cr VI in background soils, and up to 7 mg/Kg Cr VI in soil near the Strontium-90 Leach Field. Methodological problems in the extraction procedure for soils may render soils analysis less reliable than water analysis for Cr VI.[1]

The mobility of trivalent chromium (Cr III) and Cr VI, was discussed briefly in Section 7.3.1. In soils and groundwater the mineral chromium oxide ($Cr(OH)_3$) controls the solubility of Cr III in soils. Cr VI is not present in minerals, but may be oxidized from Cr III in soils under certain conditions (Robertson, 1975, Bartlett and James, 1979). There are a variety of conditions required for Cr III to be converted to Cr VI in soils, and Cr VI concentrations in natural systems are limited by the small amount of dissolved Cr III occurring in most neutral (pH 6 to 8) soils. Once the oxidation of Cr III to Cr VI takes place, the mobility of Cr VI (an anion $CrO_4^{-2}$), in soils and groundwater is greatly enhanced.

To demonstrate the low solubility of Cr III in equilibrium with soils, the concentration of Cr III controlled by $Cr(OH)_3$ (solid) was predicted by the use of equilibrium constants and the solution composition of a typical second-HSU groundwater sample. Using the solution composition data from UCD-19 collected on November 18, 1991, the equilibrium concentration of Cr III was calculated. Using the Debye-Hyckel equation to predict the activity coefficient (Hem, 1989), an equilibrium solubility product, $K_{sp} = 1 \times 10^{-30.20}$ for $Cr(OH)_3$ (Dragun, 1988), a pH of 7.53, and an ionic strength of 0.015965 moles/L, the equilibrium concentration of Cr III was calculated to be 0.0018 $\mu$g/L (ppb). Total chromium, and Cr VI measured on this sample was 290 $\mu$g/L. Equilibrium calculations for Cr III were not performed on all groundwater samples, but Cr III concentration would not exceed 100 ppb unless the pH of the water sample fell below pH 6.0, which did not occur throughout the sampling period. Therefore, the chromium observed in the groundwater sample from UCD-19 must have been primarily composed of Cr VI, or a Cr III complex of some kind.

If Cr III concentration in neutral groundwater is so low that it can be neglected, it is likely that all chromium in these water samples is present as Cr VI. Figure 7.6 shows a plot of the total chromium concentration versus Cr VI measured in all groundwater samples. The line on this graph represents a 1:1 ratio of Cr VI to Total Cr, rather than any statistical regression analysis. Although the correlation is not perfectly linear, this figure shows that most chromium present in groundwater samples is present as Cr VI, allowing for analytical error for both total chromium and Cr VI. Those outlying points which fall well above the line (Cr VI > Cr total) are likely laboratory error. Points below the line (Cr VI < Cr total) may be caused by the partial reduction of Cr VI to Cr III, via exceedence of holding time, perhaps in combination with analytical error, and analysis of sediments smaller than 0.45$\mu$m.

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[1] Personal communication, Robert Stephens, Chief of Hazardous Materials, DTSC, 1992.

There are several possible sources of the soluble chromium:

- Wastewater effluent may have contained Cr VI from past disposal (acidic $K_2CrO_4$);
- Solid waste containing laboratory cleaning solutions (e.g., chromerge), which was added to landfills or waste trenches; and
- Enhanced mobilization of Cr III, via organic matter complex formation, and subsequent oxidation to Cr VI, in soils.

Although there is no direct evidence for these possible sources, continued monitoring of sewage effluent may provide information on the first alternative. For the third alternative, there is good experimental evidence for the oxidation of Cr III to Cr VI in the presence of beta-manganese oxides (Bartlett and James, 1979, Rai, et al., 1986, Eary and Rai, 1987), but fewer specific studies which identify organic matter complication of Cr III as a mechanism for increasing Cr III solubility (James and Bartlett, 1983). Under normal conditions, Cr III concentrations are insignificant due to the low solubility of $Cr(OH)_3$. Without some mechanism of enhanced solubility of chromium, the conversion of Cr III to Cr VI would not be expected to have a significant impact on groundwater quality.

Figure 7.7 shows the distribution of total chromium concentration in the first HSU. This figure suggests that chromium concentration in the first-HSU groundwater is elevated throughout much of the northeastern portion of the LEHR facility. This distribution pattern of chromium may be consistent with several point sources of soluble chromium, or with a regional conversion of Cr III to Cr VI.

Figure 7.8 shows the distribution of total chromium in the second HSU. The concentration of total chromium in the second-HSU is roughly equal to the concentrations found in the first HSU. This may suggest that the highest concentrations of Cr VI have yet to be detected in the first-HSU groundwater. Note that no first-HSU data is available directly downgradient or near the elevated concentration in the second HSU.

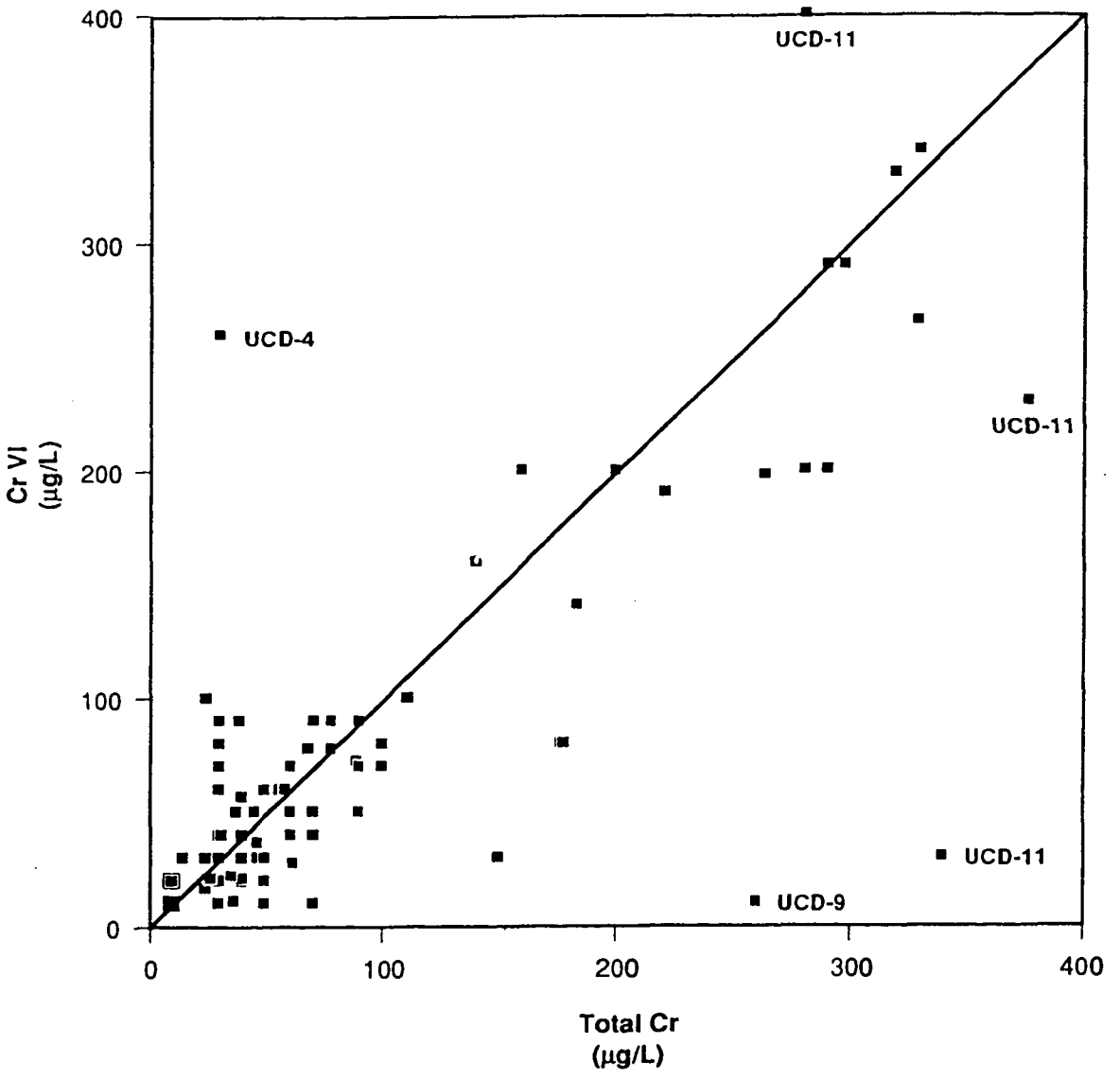
#### 7.3.3.3 Organics

Table 7.5 summarizes the detections of organic compounds in groundwater and blank samples. Note the low concentrations ($< 10\ \mu g/L$) of methylene chloride, chloroform and trichloroethane in travel blanks. These are common volatile laboratory contaminants that may enter laboratory water through vapor transport during preparation of samples. Low concentrations of these constituents should not be confused with the consistent presence of high concentrations of chloroform in first-HSU groundwater samples.

Previous investigations, including extensive Hydropunch™ sampling and analysis, have reported a wide variety of volatile chemicals throughout the first HSU. The volatile organic chemicals reported more than once include chloroform, 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,2-DCA), benzene, ethylbenzene, chlorobenzene, and xylene. In the Phase II work, high concentrations of chloroform were reported in every sample collected from UCD-12 and range from 2,300 $\mu$g/L to 24,000 $\mu$g/L. In other wells, the highest reported detection of chloroform was 10.3 $\mu$g/L only slightly higher than the highest detection reported in one of the travel blanks 5.2 $\mu$g/L.

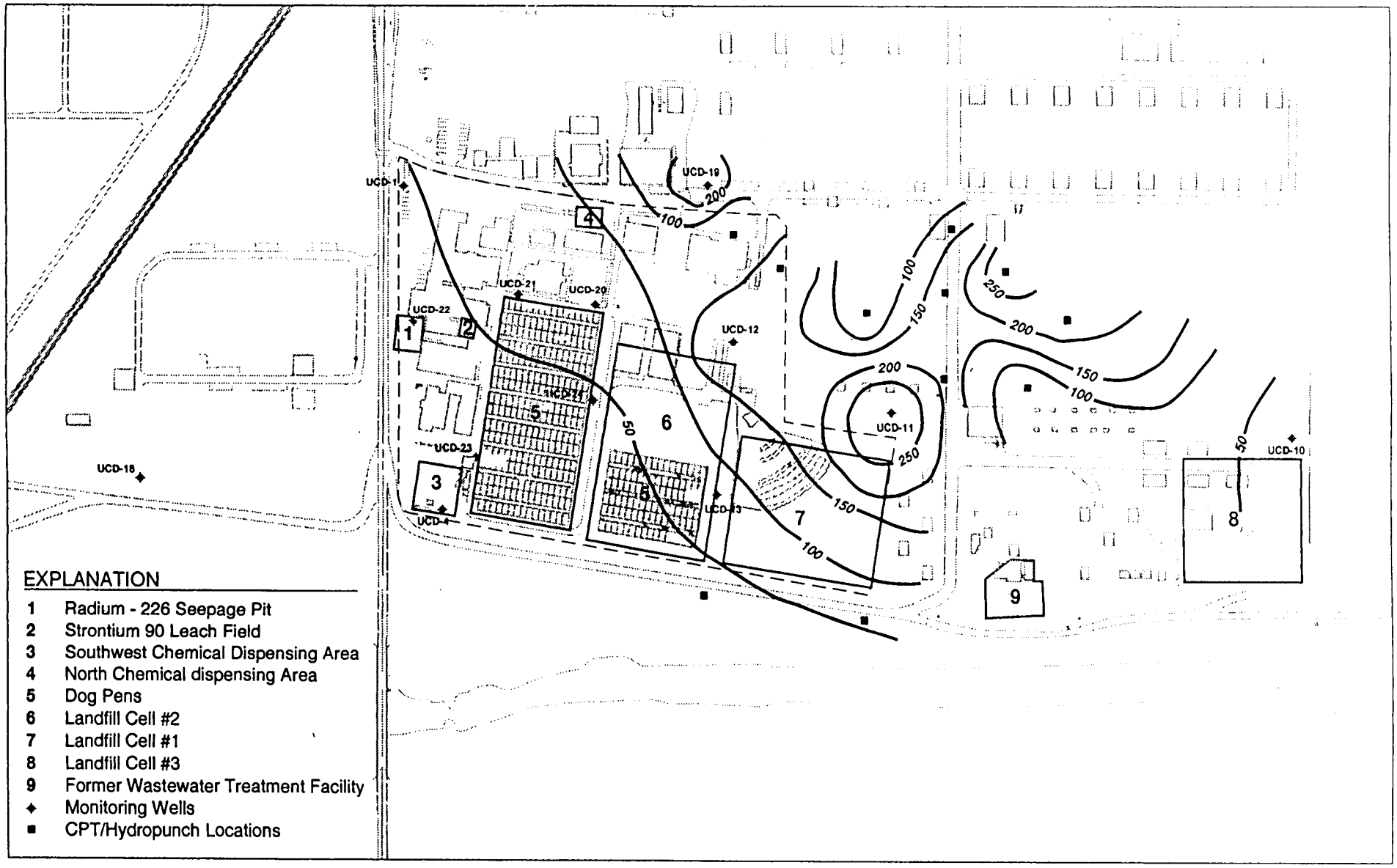
Few, sporadic detections of semi-volatile phthalates were reported throughout the site. Phthalates are plasticisers which are used in PVC well construction and laboratory plasticware. Given the lack of a consistent trend of the detections of these semivolatiles, interpretation is difficult, other than to note the range of concentrations given in Table 7.5.

Given the frequency and concentrations of organic chemicals in groundwater, the organic chemical of principal concern is chloroform in the first HSU. As noted in Section 7.3.2, chloroform is weakly adsorbed to soils, and that may explain its presence in the first HSU. The observation of buried containers of pesticides noted previously may also cause concern for their presence in groundwater, although Table 7.2 suggests these chemicals are more strongly retained by soils. Several reported detections of chlorinated organic pesticides, including aldrin, dieldrin, BHC, and heptachlor, were reported in groundwater samples in both the first and second HSU. However, these detections were sporadic and not repeated in most wells. It should be noted that these pesticides and others have been reported in the surface water samples collected during the Phase II Site Characterization.




**TOTAL Cr vs. CrVI**
**GROUNDWATER SAMPLES**
**NOVEMBER 1990 - NOVEMBER 1991**

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993




0 300
Scale in Feet

N

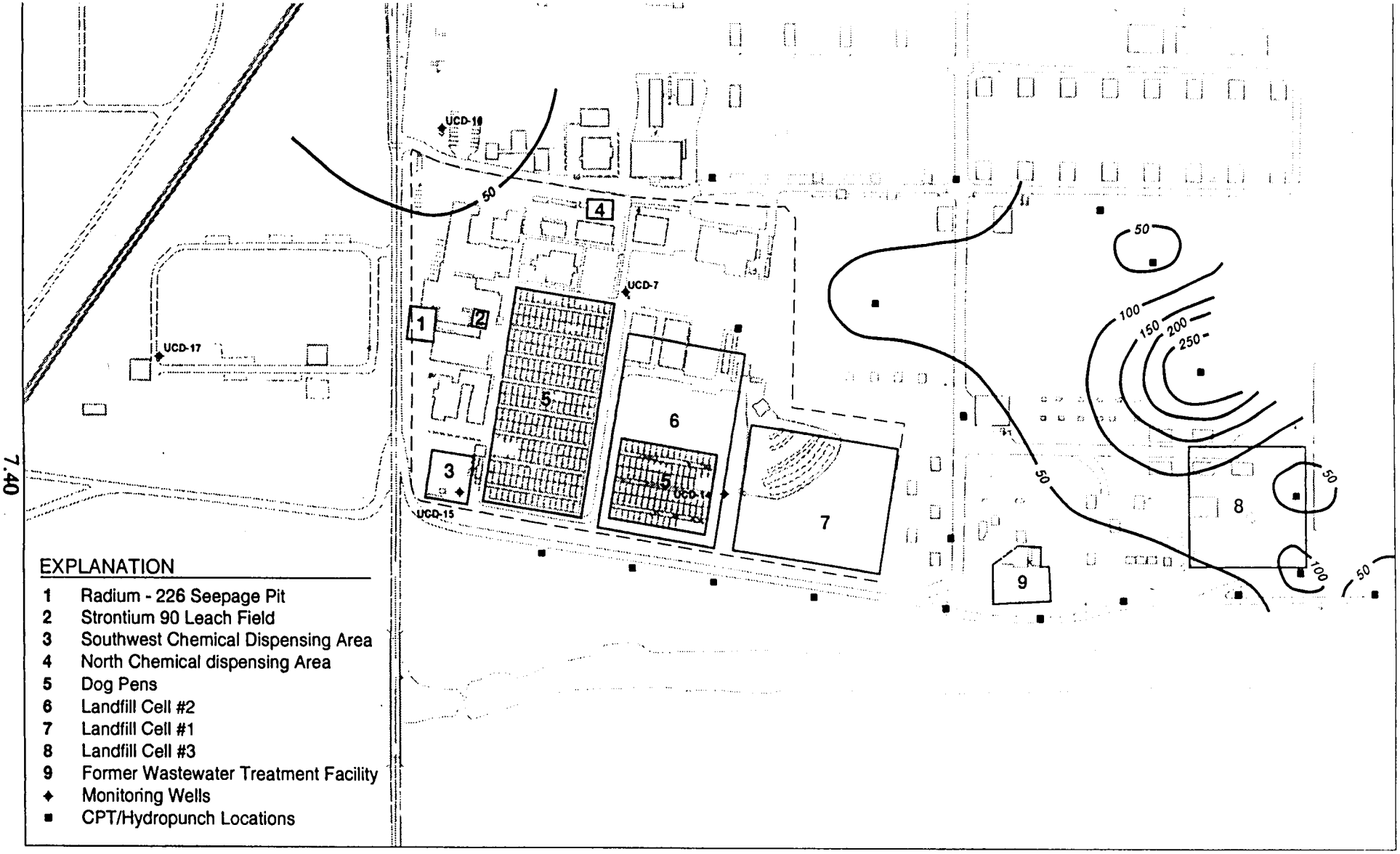
# GROUNDWATER CONCENTRATION CONTOURS FIRST HYDROSTRATIGRAPHIC UNIT TOTAL CHROMIUM (ug/L)

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-178

FIGURE 7.7




0 300
Scale in Feet

N

# GROUNDWATER CONCENTRATION CONTOURS SECOND HYDROSTRATIGRAPHIC UNIT TOTAL CHROMIUM (ug/L)

Phase II Site Characterization
LEHR Environmental Restoration
FEBRUARY 1993

DAMES & MOORE

10805-454-044 DOE-179

FIGURE 7.8

TABLE 7.5
SUMMARY OF DETECTIONS OF ORGANIC COMPOUNDS IN
GROUNDWATER NOVEMBER, 1990 TO NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Parameter | Number of Samples | Number of Detections | Lowest Detection | Highest Detection | Highest Detection in Travel Blank | MCL |
|---|---|---|---|---|---|---|
| | | | µg/L | | | |
| 1,1-Dichloroethane | 94 | 3 | 23.000 | 27.000 | ND | 5 |
| 1,1-Dichloroethene | 94 | 3 | 3.900 | 53.800 | ND | 6 |
| 1,2-Dichloroethane | 94 | 3 | 15.500 | 20.000 | ND | 0.5 |
| Bromodichloromethane | 94 | 1 | 2.400 | 2.400 | ND | 100 |
| Chloroform | 94 | 21 | 1.600 | 24000.000 | 5.2 | 100 |
| Methylene Chloride | 94 | 3 | 2.900 | 3.900 | 4.6 | 5 |
| Trichloroethene | 94 | 1 | 3.100 | 3.100 | 9.7 | 5 |
| Benzyl Butyl Phthalate | 93 | 3 | 5.000 | 13.400 | ND | NA |
| bis(2-Ethylhexyl) Phthalate | 93 | 16 | 3.100 | 33.300 | ND | 4 |
| di-N-Butylphthalate | 93 | 1 | 7.600 | 7.600 | ND | NA |
| 4,4'-DDE | 93 | 3 | 0.006 | 0.008 | ND | NA |
| Aldrin | 93 | 2 | 0.004 | 0.006 | ND | 0.05 |
| Alpha-BHC | 93 | 5 | 0.003 | 0.020 | ND | 0.7 |
| Beta-BHC | 93 | 2 | 0.007 | 0.012 | ND | 0.3 |
| Delta-BHC | 93 | 1 | 0.129 | 0.129 | ND | NA |
| Dieldrin | 93 | 6 | 0.004 | 0.030 | ND | NA |
| Endrin | 93 | 2 | 0.010 | 0.020 | ND | 0.2 |
| Endrin Aldehyde | 93 | 1 | 0.028 | 0.028 | ND | NA |
| Gamma-BHC | 93 | 4 | 0.004 | 0.043 | ND | 4 |
| Heptachlor | 93 | 10 | 0.004 | 0.020 | ND | 0.01 |

ND = Not detected. NA = Not available.

#### 7.3.3.4 Radionuclides

A wide variety of radionuclides have been identified in soils; however, only tritium, carbon-14 and strontium-90 have been reported in groundwater. Additionally, gross alpha, gross beta and gamma activity have been reported in groundwater. Tritium is expected to be as mobile as water, where strontium-90 is expected to be rather strongly adsorbed to soils, as discussed above in Section 7.3.1. The mobility of carbon-14 is quite unpredictable, since it may enter the atmosphere as carbon dioxide, be immobilized through incorporation into soil organic matter, or be mobilized in groundwater by its incorporation into bicarbonate.

Table 7.6 summarizes the measurements of radionuclides in groundwater samples collected during the Phase II investigation. Only one groundwater sample from upgradient background wells reported any measurements of radionuclides; this was tritium in UCD-18. Tritium was reported in UCD-18 in the first quarter (Fall 1990), but has not been repeated, possibly due to excess turbidity in the samples. Measurements of tritium activity in first-quarter samples were also reported in UCD-11, -19, -20, and -24 one time only. Repeated measurements of tritium activity were only reported in groundwater samples obtained from UCD-13 and UCD-14.

Strontium-90 was reported in seven different wells during the five quarters of groundwater sampling. There were no detections in the Summer or Fall 1991 sampling rounds. Two of the seven detections were not reported in their duplicate samples, and two of the detections were near the detection limit. However, there were no repeated detections in any well, and no well pairs reported detections in both first and second HSU wells.

Gross alpha and gross beta activity reported in groundwater samples are elevated throughout the first HSU, compared to background. Gross alpha activity was detected in samples collected in every well in the first HSU up to 27 pCi/L. From the second HSU, only one sample reported a detection of 4 pCi/L gross alpha during the five quarters of sampling. Background gross alpha activity in samples collected from the first HSU range from <2 pCi/L to 6 pCi/L and no gross alpha activity was measured in background well from the second HSU.

Background activity of gross beta ranges from <3 pCi/L to 22 pCi/L in the first HSU and was reported only once at 4 pCi/L in one background sample from the second HSU. Reported gross beta activity ranges from <3 pCi/L to 62 pCi/L in the first HSU with repeated detections from every well. In the second HSU, reported gross beta levels were also detected in every well ranging from <3 pCi/L to 9 pCi/L.

TABLE 7.6
SUMMARY OF MEASUREMENTS OF RADIONUCLIDE ACTIVITY IN GROUNDWATER, NOVEMBER 1990 TO NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| Parameter | Number of Samples | Number of Measurements | Lowest | Highest | MCL (pCi/L) |
|---|---|---|---|---|---|
| | | | pCi/L | | |
| Carbon-14 | 17 | 5 | 662.0 | 1815.0 | NA |
| Gamma Spectral Analysis | 93 | 1 | 11.0 | 11.0 | NA |
| Gross Alpha | 93 | 28 | 3.0 | 27.0 | 15 |
| Gross Beta | 93 | 47 | 3.0 | 62.0 | 50 |
| Strontium-90 | 93 | 7 | 0.8 | 5.7 | 8 |
| Tritium | 94 | 17 | 652.0 | 29066.0 | 20,000 |

NA = Not available.

The radionuclide carbon-14 has been consistently reported in samples in first-HSU well UCD-13, and second-HSU well UCD-14. These wells are located adjacent to the Dog Pen area and former Landfill Cell No. 2. Carbon-14 activity was only reported in samples from wells UCD-4, -13, -14, -15, -17, and -18. As discussed in Section 7.3.2, carbon-14 has been reported in soils in the Southwest Disposal Area, upgradient from UCD-14. Since carbon-14 may be as mobile as the bicarbonate ion, the migration through soils to groundwater is possible.

### 7.3.4 Distribution of Chemicals in Surface Water

A discussion of the distribution of chemicals in the South Fork of Putah Creek located south of the site is presented in this section. Samples were collected quarterly from the outfall of the UC Davis Wastewater Treatment Plant (STPO), upstream of the outfall (PCU), and downstream of the outfall (PCD). A duplicate sample was also collected each quarter. The discussion is broken into four parts: Section 7.3.4.1 General Inorganic Parameters; Section 7.3.4.2 Metals; Section 7.3.4.3 Organic Chemicals; and Section 7.3.3.4 Radionuclides.

#### 7.3.4.1 General Inorganic Parameters

Nitrate

Nitrate was reported in all surface water samples except PCU Spring 1991 and PCU Summer 1991. Highest nitrate values for each quarter (except Fall 1990) were reported for samples STPO ranging from 6.5 mg/L to 11.9 mg/L. For Fall 1990, the highest values were reported for samples PCU and PCU-B at 7.3 mg/L. Nitrate levels in surface water appears elevated, but are generally within the range of groundwater upgradient of LEHR.

TDS

In general, TDS values were highest for STPO and PCD samples and lowest for PCU samples. Highest TDS values for each quarter, except Fall 1990, were reported for STPO samples and range from 563 mg/L to 632 mg/L. Lowest TDS values were consistently reported for samples PCU which range from 196 mg/L to 646 mg/L. The highest value for Fall 1990 was reported at 646 mg/L in sample PCU. Similar to nitrate, TDS in surface water is slightly elevated but varies within the range of background values upgradient of LEHR.

pH

Reported surface water pH values range from 7.20 to 9.20. The lowest and most consistent pH values were reported for STPO and range from 7.26 to 7.34. Values for samples PCD and PCU measured from 7.37 and 7.20, respectively, in Fall 1990 to 8.81 (PCD) and 9.20 (PCU) for Summer 1991 samples. The increase in surface water pH appears to be related to low flow rates observed in the summer, and may be related to biologic activity in the effluent from the wastewater treatment facility. Effluent contains nitrate, and possibly ammonia (not analyzed), and therefore may be subject to denitrification and ammonia volatilization which are both alkaline-producing reactions.

Cations and Anions

Concentrations of cations and anions vary widely between surface water samples. In general, samples STPO and PCD are significantly higher in sodium and chloride than samples from the PCU sample location. In contrast, PCU samples are higher in calcium and magnesium than samples from STPO and PCD. These trends are consistent for each quarter except Fall 1990 where concentrations of TDS, cations, and anions are similar for all samples.

#### 7.3.4.2 Metals

A summary of metal detections for all five quarters is presented in Table 7.7. In general, metal detections in surface water are relatively sporadic. Only lead, barium, and zinc were reported in at least one sample reported in all five quarters. As observed in results for groundwater samples, antimony and thallium were reported at significantly higher values for Fall 1990 samples than in subsequent quarters. Turbidity was not reported significantly higher in Fall 1990 samples; the reason for the anomalously high values is not clear.

Hexavalent chromium was reported in nine surface water samples and ranged from 10 $\mu$g/L to 20 $\mu$g/L. Total chromium was reported in six surface water samples ranging from 11 $\mu$g/L to 110 $\mu$g/L. Unlike groundwater samples, there does not appear to be a correlation between total chromium and hexavalent chromium concentrations in surface water (see Section 7.3.3.2).

For the Fall Quarter 1991, one unfiltered and one filtered surface water sample were analyzed for Title 22 metals. Overall, the results reported for the filtered samples had fewer detections and lower concentrations of several metals.

TABLE 7.7
SUMMARY OF METALS DETECTIONS IN SURFACE WATER
NOVEMBER 1990 THROUGH NOVEMBER 1991
PHASE II SITE CHARACTERIZATION
LEHR ENVIRONMENTAL RESTORATION

| | Quarter | | | | | | |
|---|---|---|---|---|---|---|---|
| **Metal** | **Fall 1990** | **Winter 1991** | **Spring 1991** | **Summer 1991** | **Fall 1991 (unfiltered)** | **Fall 1991 (filtered)** | **MCL (μg/L)** |
| Antimony | 4 (70-110) | 1 (19) | 4 (1-3) | 4 (2-3) | — | — | 5 |
| Barium | 4 (40) | 3 (40-70) | 2 (70-80) | 4 (40-120) | 3 (30-60) | 3 (60-80) | 1000 |
| Beryllium | 4 (4-6) | 2 (1) | — | — | — | — | 1 |
| Cadmium | 4 (1-2) | 4 (1-2) | — | — | — | — | 10 |
| Total Chromium | 3 (10-110) | 1 (11) | — | — | 2 (70) | — | 50 |
| Hexavalent Chromium | 2 (10) | — | 4 (11-19) | 3 (10-20) | — | — | NA |
| Copper | — | 2 (30) | — | 2 (30-50) | — | — | 1300 |
| Lead | 4 (1-2) | 3 (4-7) | 3 (1) | 4 (3-7) | 3 (1-3) | 1 (1) | 50 |
| Molybdenum | 4 (50-70) | — | — | — | 1 (71) | 1 (50) | NA |
| Nickel | — | 2 (50-70) | — | — | — | — | 100 |
| Selenium | — | — | — | — | 1 (54) | 1 (38) | 10 |
| Silver | — | — | — | 2 (30-50) | 2 (80) | — | 50 |
| Thallium | 4 (80-100) | — | 4 (1-4) | 2 (1-2) | — | — | 2 |
| Zinc | 3 (37-1,190) | 4 (40-60) | 3 (30) | 4 (30-100) | 1 (30) | 1 (30) | NA |

NA = Not available.
ND = Not detected.

| | |
|---|---|
| 3 | = number of detections |
| (10-20) | = range of values in μg/L |

#### 7.3.4.3 Organics

The only semivolatile organic compounds reported in surface water were bis (2-ethylhexyl) phthalate (4.1 μg/L in PCD and 2.2 μg/L in STPO both Spring 1991), and di-ni-butylphthalate at 4.4 μg/L in PCD, 4.6 μg/L in STPO. and 4.4 μg/L in STPO-B (all Summer 1991). The detections of semivolatile compounds were sporadic and not repeated in subsequent sampling rounds.

Twelve chlorinated pesticides were reported in at least one surface water sample collected between Fall 1990 and Fall 1991. The twelve chlorinated pesticides and their maximum reported concentrations were: 4,4-DDD (0.047 μg/L); 4,4-DDE (0.0005 μg/L); 4,4-DDT (0.015 μg/L); aldrin (0.037 μg/L); alpha-BHC (0.01 μg/L); beta-BHC (0.024 μg/L); delta-BHC (0.033 μg/L); dieldrin (0.015 μg/L); endosulfan 1 (0.103 μg/L); endosulfan II (0.007 μg/L); gamma-BHC (0.023 μg/L); and heptachlor (0.018 μg/L). The most detections were reported in samples collected in Winter 1991, when 22 detections of ten compounds were reported. In contrast, only five detections of two compounds were reported for Fall 1990 samples, three detections of three compounds were reported for Spring 1991 samples, six detections of four compounds for Summer 1991 samples, and one detection of one compound for Fall 1991. These detections were near detection limits.

#### 7.3.4.4 Radionuclides

Tritium, strontium-90, gross alpha, and gross beta, were reported in surface water samples. Tritium was measured only in first-quarter samples ranging from 704 pCi/L in STPO to 1,341 pCi/L in PCU. Strontium-90 activity was reported in all first-quarter samples at levels ranging up to 5.4 pCi/L, but subsequently has only been reported in sample STPO at 0.8 pCi/L in February 1991, and in PCD at 1.8 pCi/L in August 1991.

Gross beta activity was reported in all surface water samples for all five quarters except sample PCU for Fall 1991. Gross beta activity ranged from 7 pCi/L (PCU, Winter 1991) to 62 pCi/L (PCD, Fall 1991). Gross alpha was reported in 7 surface water samples. Values ranged from 3 pCi/L (4 samples) to 31 (PCD, November 1991).

### 7.3.5 Summary

The current stratigraphic model indicates that the upper 50 feet of soils and subsoils are composed of relatively fine silt material. Within the first HSU, lateral groundwater gradients are lower than vertical gradients. Channels consisting of sandy silts have been identified within the first HSU. These local zones of relatively higher-permeability material may provide hydraulic and solute pathways within the first HSU and connections between the first and second HSUs. These stratigraphic conditions can promote enhanced mobility of constituents which are typically strongly adsorbed (including heptachlor and strontium-90), possibly leading to movement of these constituents from the first to the second HSU.

Surface water is the primary source of recharge during the summer, and contains detectable concentrations of nitrate, metals (antimony, barium, lead, thallium, and zinc), chloroform, and chlorinated organic pesticides. The concentrations of these analytes are relatively low and cannot explain the elevated concentrations of salts and some metals reported in the first HSU. Due to discharge from the wastewater treatment plant outfall, the surface water is a constant source of recharge that continues throughout the year, and is an important hydrologic component.

Chemicals, radionuclides, and septage in subsurface soils, unlined burial trenches, and surface water are potential sources of solutes identified in the first HSU. During periods of downward hydraulic gradients, the mobile solutes, such as nitrates and hexavalent chromium, appear to be carried from the relatively saline, high-TDS first HSU to the second HSU, which has much lower TDS. Upon entering the second HSU, the concentrations of solutes are diluted substantially, and begin to migrate at an accelerated rate in the lateral direction. During recharge, the upward hydraulic gradient carries relatively clean water from the second HSU into the more saline first HSU. Concentrations of very soluble materials may actually increase during these periods because the higher water levels dissolve more of the soluble wastes, which are more concentrated near the surface.

# 8.0 SUMMARY AND CONCLUSIONS

Chapter 8.0 presents a summary of the major findings and Dames & Moore's conclusions based on interpretation of the available data. Section 8.1 presents a summary of our findings, and Section 8.2 presents our conclusions.

## 8.1 SUMMARY

Dames & Moore prepared this Phase II Site Characterization Report at the request of EMO and the DOE to present the results of investigations at the LEHR facility at the University of California in Davis, California. The scope of the Phase II Site Characterization was presented in the Phase II Site Characterization Work Plan, dated August 31, 1990 (Work Plan).

Dames & Moore initiated the Phase II Site Characterization in February 1990. The majority of the work completed was conducted in 1990. Quarterly groundwater and surface water monitoring is ongoing. Some tasks outlined in the Work Plan have been initiated but not completed.

Environmental impacts from past operations have been evaluated based on a review of data. Potential source areas exist at the site from past disposal practices associated with LEHR research, and from UC Davis campus activities. On-site special waste systems, which primarily processed excrement from research animals, and shallow waste burial trenches were reported to be the primary source of radionuclides in soil and groundwater. The old landfill operated by UC Davis, trenches used for chemical disposal, chemical dispensing areas, and former septic systems, are known potential sources. It is likely that other potential disposal areas and potential environmental risks exist at the LEHR facility that have not been addressed as part of the Phase II investigation, but will be included in the on-going activities.

The LEHR facility is located in the southeastern portion of the Sacramento Valley at an average elevation of approximately 50 feet above mean sea level. Subsurface materials consist of marine and continental sediments. Locally, sediments appear to have been deposited in a fluvial depositional system that exhibits gradational variations in stratigraphy.

Groundwater is encountered beneath the site at depths ranging from approximately 45 to 70 feet bgs and has been divided into two zones: the first hydrostratigraphic unit (HSU) consisting of fine-grained sediment varying from very fine-grained sandy silt to sandy clay; and the second HSU consisting of coarse sand and cobble gravel. Groundwater elevations fluctuate up to 25 feet per year.

The south fork of Putah Creek flows along the southern border of the site and is separated from the creek by a levee. Data from the DWR indicates that flows in Putah Creek average from 0.17 cfs to 148 cfs in recent years (1989 to present). Putah Creek is a losing stream, and has been demonstrated to be in hydraulic communication with the first HSU.

At least 12 previous environmental studies have been conducted at the LEHR facility for both UC Davis and the DOE. Two surveys, the Initial Assessment Survey (Rockwell, 1984), and the Environmental Survey Preliminary Report (DOE, 1988), presented documentation of potential environmental impacts from past operations at the LEHR facility. The Phase I Investigation (Wahler, 1988, and 1989) was an initial investigation of environmental impacts from past LEHR activities. An evaluation of LEHR groundwater wells for high turbidity levels was conducted in 1990 (Dames & Moore, 1990a). Two studies, the SWAT investigation (Dames & Moore, 1990b), and the Old UC Davis Landfill Additional Characterization (Dames & Moore, 1991a) addressed impact from the former UC Davis landfill. A Contaminant Pathway Analysis (Dames & Moore, 1990c) was conducted to assess health risk exposure from the LEHR facility area for UC Davis' LRDP. Other environmental studies included an Evaluation of Potential Nitrate and Hexavalent Chromium Sources (Dames & Moore, 1990d), a Waste Burial Trench Investigation (Dames & Moore, 1991b), sampling of sediment and surface water in Putah Creek (Dames & Moore, 1990e) and a CEQA Preliminary Study for Characterization activities (Dames & Moore, 1991c). These previous investigations are discussed in Chapter 3.0.

Seven of the nine tasks planned for the Phase II Site Characterization have been substantially completed. The Literature Review and Survey task developed baseline site data and established survey control on the site to the State Geodetic Standard, respectively. Ten of the 14 planned groundwater monitoring wells have been completed, and quarterly groundwater and surface water samples are being collected from site wells and Putah Creek on an ongoing basis. Forty-eight shallow (1.5 to 5 foot), intermediate (10 foot), and deep (30 foot) soil borings were completed, and 275 soil samples were collected and 188 soil samples (plus 24 replicate samples) were analyzed for chemical and radiologic parameters. Two sediment samples were collected and analyzed from surface water collection and discharge points (LS-1 and OF-1). Aquifer analysis was conducted by completing rising and falling head permeability tests (slug tests) in 10 wells, analyzing the data, and inputting information into a computer transport model to estimate potential migration of organic, inorganic, and radiological constituents. Septic tank investigation and waste characterization tasks have not been completed.

The hydrogeology at the LEHR facility was further characterized by drilling and installation of 10 new groundwater monitoring wells, quarterly sampling of 10 new and 8 existing groundwater monitoring wells, 10 well permeability tests, and surface water monitoring. Comparison of hydrographs of wells from both HSU's suggests hydraulic interconnection between the two zones. Vertical gradients between the two zones vary seasonally from a downward gradient between the months of April and

August to an upward gradient between the months of August and April. Lateral gradients in the first HSU were calculated to be from 0.0001 to 0.0015 ft/ft to the northeast, and the lateral gradient in the second HSU is 0.0015 ft/ft to the east-southeast. Estimated hydraulic conductivity for the first HSU ranges from $1.9 \times 10^{-5}$ cm/sec ($6.2 \times 10^{-7}$ ft/sec) to $9.1 \times 10^{-3}$ cm/sec ($3.0 \times 10^{-4}$ ft/sec), and hydraulic conductivities for the second HSU are from $7.3 \times 10^{-3}$ cm/sec ($2.4 \times 10^{-4}$ ft/sec) to $1 \times 10^{-2}$ cm/sec ($3.3 \times 10^{-4}$ ft/sec) . Surface water monitoring of Putah Creek indicates that the water table is continually being recharged by the creek. It is unknown at this time what effect the current drought conditions have on groundwater flow directions or gradients.

Two hundred seventy-five soil samples were collected and 212 soil samples were analyzed from shallow, intermediate and deep soil borings for the Phase II Site Characterization. Results reported from analysis of soil samples for local background (UCD-17 and UCD-18) reported concentrations of antimony, beryllium, copper, molybdenum and selenium above published regional background concentrations. Tritium activity was reported in 18 soil samples collected and analyzed from on-site and off-site (background) locations. Background levels of radium-226 activity varied from 0.05 pCi/g to 1.4 pCi/g and strontium-90 activity ranged from non-detectable to 0.24 pCi/g. Methylene chloride was reported in ten samples, at concentrations ranging from 9.1 $\mu$g/Kg to 19.6 $\mu$g/Kg.

Twenty-five soil samples from the Strontium-90 Leach Field area were collected and analyzed. Results reported from this sampling indicated that hexavalent chromium was detected above background concentrations. No strontium-90 activity was reported in soil samples collected. Bismuth-214 activity was reported in soils analyzed from the Strontium-90 Leach Field area, but not in background soil. Nitrate levels decreased with depth and ranged from 1.8 mg/Kg to 92.0 mg/Kg. The volatile constituent methylene chloride was detected in six samples at concentrations from 11.2 $\mu$g/Kg to 22.9 mg/Kg.

Forty-seven soil samples from the Radium-226 Seepage Pit area were collected and analyzed. Results reported from this sampling indicated that hexavalent chromium was detected above regional background concentrations. Strontium-90 activity reported in soil samples analyzed exceeded background. Activity of the radionuclides bismuth-214, lead-210 and tritium were reported in soil samples measured from the seepage pit area, but not in background/off-site samples. Nitrate concentrations were reported from 0.70 mg/Kg to 736.0 mg/Kg, with the highest concentrations reported from samples collected between 5.0 and 15.0 feet bgs. Methylene chloride was reported in 13 samples at concentrations ranging from 10.7 $\mu$g/Kg to 44.2 $\mu$g/Kg.

Twenty-one soil samples from the Southwest Chemical Dispensing area were collected and analyzed. The organic compounds methylene chloride and di-n-butylphthalate were detected in nine samples and six samples, respectively, at concentrations ranging from 8.8 $\mu$g/Kg to 37.6 $\mu$g/Kg, and 100 $\mu$g/Kg to 220 $\mu$g/Kg, respectively. Five samples analyzed for hexavalent chromium and seven samples

for chromium were above background. Activity of the radionuclides bismuth-214 and tritium were reported in soil samples measured from the Southwest Chemical Dispensing area, but not in background soil and thorium-232 activity was reported above background concentrations in soil. Six soil samples were reported to contain nitrate at concentrations exceeding background, ranging from 0.23 mg/Kg to 220.0 mg/Kg.

One hundred nine soil samples from the Dog Pens at the LEHR facility were collected and analyzed. Hexavalent chromium and chromium were reported at concentrations up to 3.98 mg/Kg and 152 mg/Kg, respectively. Nitrate was reported in concentrations ranging from 1.4 mg/Kg to 168 mg/Kg with 12 samples above background. Chlordane was reported in concentrations ranging from 0.5 $\mu$g/Kg to 480.0 $\mu$g/Kg, with three samples having reported concentrations at or exceeding 200.0 $\mu$g/Kg. Methylene chloride and diethylphthalate were reported in one sample and five samples from the dog pens, respectively.

In the North Chemical Dispensing area, six soil samples were collected and analyzed. One sample had reported concentrations of methylene chloride and three samples had reported concentrations of chlordane at maximum concentrations of 9.7 $\mu$g/Kg and 70 $\mu$g/Kg, respectively. Hexavalent chromium and chromium were reported in all six samples and three samples, respectively, at concentrations up to 2.3 mg/Kg, and 97 mg/Kg, respectively. Nitrate was reported in all six samples collected from the North Chemical Dispensing area at concentrations ranging from 30.0 mg/Kg to 49.0 mg/Kg, all above background.

Twenty samples from dog pens at the former AEC site on the UC Davis main campus were collected and analyzed. Chlordane was reported in nine samples at concentrations ranging from 4.77 $\mu$g/Kg to 67.00 $\mu$g/Kg, and carbon-14 activity was reported in one replicate sample at 0.5 pCi/g.

Two samples of sediment from the stormwater lift station and the waste water treatment plant outfall were collected and analyzed. Only one organic compound, chlordane, was reported in lift station sediment. Nitrate was reported at concentrations of 3.7 mg/Kg and 6.4 mg/Kg in outfall sediment and lift station sediment, respectively. No metals were reported at concentrations significantly above background, and no radionuclides were measured in lift station or outfall sediments.

Five quarterly rounds, consisting of four samples per round, of surface water samples have been collected from Putah Creek. Chloroform was reported in samples analyzed from all five rounds, at a maximum concentration of 14 $\mu$g/L in sample PCD from Summer Quarter 1991. At least one of the pesticides, alpha-BHC, beta-BHC, or delta-BHC were detected in each of the five monitoring rounds with the highest reported concentration of delta-BHC at 0.033 $\mu$g/L in the STPO from Summer Quarter 1991. Nitrate was reported in all samples in all quarters at concentrations ranging from 400 $\mu$g/L to

11,900 $\mu$g/L, with the highest concentration in the STPO sample. Gross alpha and gross beta activity reported in all samples, except samples collected in Fall Quarter 1991, at levels up to 31 pCi/L and 62 pCi/L, respectively. Strontium-90 activity was measured in three rounds, and tritium activity was measured in one round at levels up to 18 pCi/L and 1,341 pCi/L, respectively. Metals reported in surface water samples in all rounds were below background.

Five quarterly rounds of groundwater sample collection and analysis were conducted between November 1990 and November 1991. Results reported from groundwater sample analysis for volatile organics show consistent detections of 1,1-dichloroethane, 1,1-dichloroethene, and 1,2-dichloroethane in well UCD-12 at concentrations up to 27 $\mu$g/L, 53.8 $\mu$g/L and 20 $\mu$g/L, respectively. Chloroform was reported in UCD-12 and UCD-21 in four out of five sampling rounds, and in all five sampling rounds, respectively. Maximum concentrations of chloroform were reported at 24,000 $\mu$g/L in the UCD-12 sample from Winter Quarter 1991. The semi-volatile organic bis(2-ethylhexyl)phthalate was reported in a variety of wells at concentrations up to 13.4 $\mu$g/L; however, only three wells, UCD-13, UCD-19, and UCD-24, had repeated detections of bis(2-ethylhexyl)phthalate, and there were no reported detections in the Summer or Fall 1991 Quarters. Other organic parameters were reported, but were not detected on a consistent basis (consecutive rounds or repetitive wells).

Nitrate was reported in all wells sampled in all quarters. Wells UCD-1, -7, -10, -11, -12, -13, -19, -20, -21, and -24 had reported concentrations of nitrates above background in most quarterly monitoring rounds (four or five of sampling rounds). Highest concentrations of nitrate were reported in the UCD-12 sample at 231 mg/L from Winter Quarter 1991.

Antimony, beryllium, molybdenum, and thallium were consistently reported in groundwater samples collected at concentrations exceeding regional background concentrations. However, these five metals were also reported as detected at similar concentrations in background wells (UCD-17 and UCD-18). Selenium was detected 10 times in 5 sampling quarters in downgradient groundwater wells, but was never reported as detected in groundwater samples analyzed from background groundwater monitoring wells. Chromium was reported above background in most quarterly sampling rounds in wells UCD-11, -12, -13, -19, -20, and -21, and more than once in wells UCD-7 and -14. Hexavalent chromium was reported above background concentrations in most quarterly sampling rounds in wells UCD-1, -11, -12, -13, -19, -20, -21, and more than once in wells UCD-7 and -14.

Measurable gross alpha, gross beta, tritium, strontium-90 and carbon-14 activity was reported in groundwater samples analyzed. Gross alpha activity were reported in most quarterly sampling rounds in wells UCD-20, -21, and -24, with the highest activity of 27 pCi/L in the UCD-1 sample from Fall Quarter 1990. Gross beta activity were reported above measurement detection in most quarterly sampling rounds in wells UCD-1, -7, -10, -12, -13, -20, -21, -22, and -24, with the highest activity of 62 pCi/L

in the sample from UCD-1 from Fall Quarter 1990. Tritium activity has been reported in most quarterly sampling rounds in wells UCD-13 and UCD-14, with highest activity in the sample from UCD-13 from Fall 1990. Strontium-90 activity has been reported in the Fall 1990, Winter 1991, and Spring 1991 quarterly sampling rounds in wells UCD-15 and -24, UCD-13 and -23, and UCD-1, -7, and -10; however no repeated results were reported. Carbon-14 activity was reported in groundwater samples collected from UCD-13 and -14 in Spring 1991 and Fall 1991 Quarters, and Spring and Summer 1991 Quarters, respectively. However, these wells are the only wells where carbon-14 was measured.

## 8.2 CONCLUSIONS

The conclusions outlined below are based upon data reported from previous investigations and from the Phase II Investigation including soil, groundwater and surface water samples collected and analyzed in the vicinity of the LEHR facility. The data collected on the LEHR facility were compared to regulatory criteria, off-site sample data (background), and published data from the literature. Statistical comparisons between on-site and off-site data were made where possible. The conclusions focus on the adequacy of the available data in assessing known or potential sources of chemicals associated with past activity at the LEHR facility.

### 8.2.1 Soils

Soil data received for samples collected and analyzed from the LEHR facility during the Phase II Investigation was compared: (1) to results from previous investigations; (2) to background soil concentrations; and (3) to published literature values. As discussed in Section 6.4, a statistical comparison between background soil data and soil data from each area of interest was performed. Soil data were also compared to regulatory values, such as TTLC values. Based upon these evaluations, Dames & Moore developed the conclusions presented below.

#### 8.2.1.1 Organic Compounds

Methylene chloride was reported in soil samples collected and analyzed both on- and off-site during the Phase II investigation. Reported concentrations of methylene chloride were similar in soil samples collected in all areas across the site. Considering that methylene chloride is a common lab contaminant, and was reported in on-site and background soil samples at similar concentrations, methylene chloride reported in soils is not considered to be a result of previous activity at the LEHR facility.

Detectable concentrations of diethylphthalate and di-n-butylphthalate were reported in soil samples collected and analyzed from the Dog Pen area and the Southwest Chemical Dispensing area, respectively.

These constituents are common plasticizers, and their presence in soils is not considered to be the result of past activity at the LEHR facility; however, phthalates are a breakdown product of plastics, and plastics have been identified in waste burial trenches.

Chlordane was reported in several soil samples collected and analyzed from the Dog Pen area. Two soil samples analyzed have reported concentrations of chlordane that exceed 10 percent of the TTLC. STLC analyses were not performed. Chlordane was used as an insecticide for laboratory animals at LEHR and the presence in soil is assumed to be a result of that activity.

#### 8.2.1.2 Metals

Concentrations of metals were reported in all soil samples collected and analyzed both on- and off-site at the LEHR facility. Metal concentrations reported in soil samples analyzed on-site were generally within the same range of concentrations reported in soil samples analyzed from background locations. Results of analysis for antimony, beryllium, cadmium, chromium, copper, molybdenum and selenium in samples collected both on-site and in background locations were reported at concentrations in excess of literature values for surface samples from the Western United States (Shacklette and Boerngen, 1984).

With one exception, results of metals analyses reported in soils did not approach the TTLC value. Nickel concentrations in soils were reported at concentrations that exceed 10 percent of the TTLC value. The highest nickel concentration reported in off-site soils was approximately 10 percent of the TTLC, where the highest nickel concentrations reported in on-site soils approached 20 percent of the TTLC. Without additional background data, the significance of nickel in soil on-site is not well understood.

#### 8.2.1.3 Nitrate

Concentrations of nitrate reported in on-site soil samples from the Radium-226 Seepage Pit area exceed concentrations reported in background soil. Concentrations of nitrate in on-site soil collected in the Strontium-90 Leach Field area, the Dog Pens, the North Chemical Dispensing Area, and the Southwest Chemical Dispensing area were reported at slightly greater concentrations than reported in background soils. The average and maximum concentrations of nitrate reported in the Southwest Chemical Dispensing area and North Chemical Dispensing area are less than nitrate concentrations reported in samples from the Radium-226 Seepage Pit and the Strontium-90 Leach Field areas. The average nitrate concentrations reported in soils from these two areas are double the nitrate concentrations reported in off-site soil. Nitrate in soil in the Dog Pens, the North Chemical Dispensing Area and the Southwest Chemical Dispensing area may have impacted groundwater.

Elevated nitrate concentrations reported in soil samples collected and analyzed from the Radium-226 Seepage Pit area appear to be restricted to the upper 15 feet bgs. In the Strontium-90 Leach Field, elevated concentrations of nitrate were reported in soil samples collected and analyzed from approximately 20 to 30 feet bgs. Nitrate is mobile in soils, and these areas appear to have impacted groundwater.

#### 8.2.1.4 Radionuclides

Detectable radionuclide activity was reported in nearly all on- and off-site soil samples collected and measured during the Phase II Investigation. Some of the radionuclides used at the LEHR facility, such as radium-226 and its daughter products, were reported in most background soil samples measured. Despite extensive sampling in the Radium-226 Seepage Pits and other areas of interest on-site, reported activity of radium-226 in soil samples on-site was similar to off-site.

Radionuclides used at the LEHR facility with very low background or published regional background activity include strontium-90, cesium-137, tritium, carbon-14 and cobalt-60. Previous investigations reported strontium-90 activity in soil samples collected and measured from the Southwest Chemical Dispensing area above background (as defined by published data). In the Phase II investigation soil sampling, only one soil sample was reported with elevated strontium-90 activity, however, this measurement of strontium-90 was not confirmed in results from a split sample.

Previous investigations in the Waste Burial Trench area reported significant activity of cesium-137. Phase II investigation soil samples were not collected from the trench area, however, those areas sampled during the Phase II investigation had few reported measurements of cesium-137 activity on-site, and similar measurements were reported off-site. Previous investigations have reported tritium and carbon-14 activity in samples collected from the Southwest Chemical Dispensing area and adjacent to the Dog Pen area. Tritium activity reported in soil samples collected during the Phase II investigation was similar in samples collected both on- and off-site.

Other radionuclides measured in soil samples collected during the Phase II Investigation include thorium-232, actinium-228, lead-212, thallium-208, potassium-40, and manganese-54. Thorium-228, actinium-228, lead-212, and thallium-208 are all daughter products of thorium-232, and activities reported on-site were roughly equivalent to activities reported in background and regional soils. Potassium-40 is also a naturally occurring radionuclide with the highest reported activity measured in an off-site sample. Measurable activity of manganese-54 was reported in a surface soil sample from the Dog Pen area. Manganese-54 does not occur naturally, and there is no information suggesting that this radioisotope was a decay product of any radionuclide used at LEHR.

Scans for gross alpha, gross beta, and gamma spectral analysis were performed on all soil samples submitted for measurement from the LEHR facility during the Phase II investigation. Although gross beta activity appears to be marginally greater in on-site soil samples compared to off-site soil samples measured, this cannot be verified until more background data str collected.

Radionuclide activity measured in soils collected during the Phase II investigation suggest that, in general, activity measured in soil samples collected on-site is similar to soil samples collected and measured off-site. Results reported from previous studies show soil radionuclide activity in the Waste Burial Trench area and the Southwest Chemical Dispensing area higher than reported in the Phase II Investigation.

### 8.2.2 Hydrostratigraphy

Groundwater flow in both the first and second HSUs is dominantly toward the northeast. However, transient changes in gradient do occur. Putah Creek locally recharges the first HSU, and creates a groundwater high in the first HSU beneath the creek. This groundwater high appears to serve as a lateral flow barrier in the first HSU. Vertical gradients exist between the two HSUs investigated at the LEHR facility. The vertical gradients vary seasonally; from April to August vertical gradients are downward, and from August to April vertical gradients are upward. The first and second HSUs are not hydraulically separated, and site constituents detected in the first HSU are likely to migrate vertically downward into the second HSU, and then migrate laterally.

### 8.2.3 Groundwater

Groundwater data received for samples collected and analyzed from the LEHR facility during the Phase II investigation were compared to results received from previous investigations, and to background groundwater concentrations. A qualitative analysis was performed for the consistency of detections in each well over time. A statistical analysis of variance (ANOVA) was conducted for total chromium, hexavalent chromium, and nitrate concentrations in groundwater. The high frequency of non-detectable values limited the ability to conduct ANOVA on all constituents.

#### 8.2.3.1 Organic Compounds

Results from previous investigations have reported volatile, semivolatile and chlorinated organic compounds in groundwater samples. In five quarters of groundwater sampling conducted during the Phase II investigation, consistent reports of volatile constituents include: chloroform; 1,1 dichloroethane; 1,1 dichloroethene; and 1,2,dichloroethane. The detections of all four of these compounds were reported at concentrations that exceed respective MCLs in samples collected from the first HSU in wells

downgradient of Landfill Units 1 and 2. These results suggest an impact to groundwater from previous activities conducted at the LEHR facility.

Previous investigations reported the semivolatile organic compound bis(2-ethylhexyl)phthalate in groundwater samples collected during two rounds of sampling. In the five rounds of quarterly water sampling conducted during the Phase II investigation, several other phthalate compounds were reported, including di-n-butylphthalate, diethylphthalate and bis(2-ethylhexyl)phthalate. Laboratory plasticware contains phthalates, which suggests that laboratory contamination may have resulted in the sporadic detections reported in upgradient and downgradient wells. However, phthalates are a breakdown product of plastics, and plastics have been identified in waste burial trenches. These constituents will be further evaluated during the planned site-wide soil and groundwater investigation.

Phase II investigation groundwater analyses results show detectable concentrations of heptachlor, aldrin, dieldrin, endrin, BHC (alpha, beta, delta, and gamma) and 4,4,DDE. Detections of one or more of these chlorinated pesticides were reported in samples collected from upgradient well UCD-17 and were sporadically reported in groundwater samples collected from on-site groundwater wells. Repeated detections of chlorinated pesticides were reported from wells UCD-12 and UCD-13, downgradient of past disposal areas. Exploration trenching conducted during previous investigations intercepted sealed containers filled with heptachlor and dieldrin in this area. Given that the use of agrichemicals in the region is prevalent, and chlorinated pesticides were reported in upgradient wells, this data are not conclusive with respect to potential impacts from former LEHR facility operations.

#### 8.2.3.2 General Inorganic Parameters

Groundwater samples collected in wells from both the first and second HSU have higher reported concentrations of TDS and alkalinity downgradient of LEHR than upgradient. Specifically, calcium, magnesium, sodium, potassium, chloride, nitrate, and sulfate are reported at higher concentrations in most downgradient wells compared to upgradient wells, in both the first and second HSU. Waste burial areas appear to have impacted the salinity of groundwater below the LEHR facility in both the first and second HSU.

During the Phase II investigation, nitrate was reported in groundwater samples collected from the first and second HSU wells upgradient of LEHR at concentrations below the MCL. In the first HSU downgradient of LEHR, samples collected from wells UCD-1, -10, -11, -12, -13, -19, -20, and -21 have reported concentrations of nitrate consistently above the MCL. In the second HSU, downgradient wells UCD-7 and -14 have reported concentrations of nitrate, but only samples from well UCD-7 have reported concentrations that exceed the MCL. The waste burial activities conducted at LEHR appear to have increased nitrate concentrations in groundwater.

8.2.3.3 Metals

Previous investigations reported detectable concentrations of Cr VI and lead in groundwater samples from the LEHR facility. During five quarters of groundwater sampling conducted during Phase II investigation, lead was reported in less than 10 percent of the samples analyzed, and all concentrations the reported were far below 10 percent of the MCL.

Hexavalent chromium was reported in all upgradient and downgradient wells sampled during the Phase II investigation. Samples collected and analyzed during previous investigations had reported elevated Cr VI concentrations in the northeastern portions of the LEHR facility. Concentrations of Cr VI reported in groundwater during the Phase II investigation consistently exceeded the MCL in samples collected from UCD-1, -11, -12, -13, -19, -20, -21, and -24 in the first HSU. In the second HSU, UCD-7 and UCD-14 have concentrations of Cr VI that exceed the MCL in approximately half of the reported detections.

The source of the Cr VI in groundwater has not been identified; however, possible sources include laboratory cleaning solutions discharged to soils or surface water and material buried in the landfill. The consistent detections of Cr VI reported below the MCL, and the relatively high concentration of total chromium in both off-site and on-site soils suggests that some Cr VI is present in groundwater upgradient of the LEHR facility. Chemical dispensing, septage or landfilling at the LEHR facility may have increased concentrations of Cr VI in groundwater.

Other metals consistently reported in groundwater samples analyzed for the Phase II Investigation include barium, selenium, and thallium. Barium was reported in samples from all upgradient wells, and all but one downgradient well, with less than 10 percent nondetects reported throughout the five quarters of monitoring. This indicates that barium is a background component of groundwater. Reported concentrations of barium are at less than half the MCL concentration. Selenium was consistently reported in two downgradient wells in the first HSU. Four water samples collected and analyzed had reported concentrations of selenium above the MCL. Thallium was reported in all upgradient and downgradient wells. Reported concentrations of thallium were above the MCL, including samples collected from upgradient wells.

The concentrations of barium and thallium reported in groundwater throughout the region around the LEHR facility appear to be elevated in both the first and second HSU. Reported detections of selenium in downgradient wells is limited to selected wells.

#### 8.2.3.4 Radionuclides

Results reported from previous investigations of groundwater showed consistent tritium, carbon-14, radium-226 and thorium-232 activity in three groundwater samples, but have not been reported in subsequent investigations. Tritium activity was reported in groundwater samples collected from several first and second HSU wells both up- and downgradient of the LEHR facility during the first quarter water samples of the Phase II investigation. In subsequent quarters, tritium was consistently reported in samples collected from first HSU well UCD-13 only. In the second HSU, groundwater samples collected and measured from UCD-14 had reported tritium activity. Wells UCD-13 and -14 are adjacent to each other in the vicinity of waste burial trenches, therefore, elevated tritium in this area appears to be the result of past disposal activity. All tritium activity reported was below the MCL.

Carbon-14 has been analyzed in only six wells for three of five quarters of groundwater sampling. Reported carbon-14 activity was confined to two wells, UCD-13 and -14, where carbon-14 activity was measured in all but one water sample. As discussed previously, tritium and carbon-14 are expected to be mobile in soils; therefore, if contained in buried wastes, these constituents could easily have moved through soils into groundwater. All other radionuclide activity measured was either similar between on-site and background groundwater, or was not measured consistently over time. All reported results were below MCLs.

### 8.2.4 Surface Water

Water data received from samples collected from Putah Creek during the Phase II investigation were compared to results received from previous investigations, to upgradient concentrations, and to published literature. Water levels were also compared to well values.

Sampling and analysis results received from the sewage treatment outfall and surface water from Putah Creek suggest that surface water discharge contributes salts, organic compounds, metals, and radionuclides at relatively low concentrations, which eventually recharge groundwater. Reported concentrations rarely exceed MCLs.

#### 8.2.4.1 Organic Compounds

Reported results show low concentrations of chloroform, phthalates and several chlorinated pesticides below MCLs in surface water samples collected both up and downgradient of the LEHR facility. Two water samples collected reported bis(2-ethylhexyl)phthalate and heptachlor at their MCL concentration. The phthalate compounds are plasticizers and common laboratory compounds. Detections

may have been the result of analytical laboratory or sample contamination or the breakdown of plastic products.

#### 8.2.4.2 General Inorganic Parameters

Reported concentrations of general mineral parameters in surface water were slightly saline and had seasonal high pH values. The higher pH values were reported in samples collected in the summer quarter, when water temperature and biologic activity are expected to be the highest. The chemical oxygen demand reported in these samples was consistently reported at low concentrations. Reported nitrate concentrations varied from below, to slightly above the MCL.

#### 8.2.4.3 Metals

Results reported from metals analysis suggests that low concentrations of barium, lead, and zinc were present in surface water every quarter. Sporadic detections of antimony, thallium, and Cr VI were reported in surface water samples analyzed, although concentrations did not exceed MCLs in the second through the fifth quarters.

#### 8.2.4.4 Radionuclides

Activity of three radionuclides were reported in surface water, tritium, carbon-14, and strontium-90. All reported measurements were below the MCLs. Scans of gross alpha and gross beta activity were reported in all five sampling rounds.

# 9.0 RECOMMENDATIONS

Based on findings and conclusions presented in this Phase II Site Characterization Report, Dames & Moore recommends further evaluation of the impact of target constituents on soil, water and air at the LEHR facility. Specifically, potential contaminant sources, pathways for migration, potential human and environmental receptors and geologic and hydrologic properties should be thoroughly evaluated. Additionally, alternative remedial options and human and environmental risks associated with the remedial options should also be identified. This work can be accomplished by following the remedial investigation and feasibility study (RI/FS) process developed by the United States Environmental Protection Agency (EPA) to comply with provisions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). An RI/FS investigation may include the following recommended studies.

Prior to conducting further evaluation, statistically based background data need to be developed. Dames & Moore recommends that additional background soil, groundwater, and surface water studies be conducted to develop statistically-based background levels for constituents of concern.

Additional soil investigations should be conducted to evaluate the contents and impacts from the Dog Pen area; disposal in trenches in the Southwest Disposal Area; chemical and radiologic constituents in the Radium-226 Seepage Pit area, the Strontium-90 Leach Fields, disposal trenches and pits along the southern border of the site, the old wastewater treatment facility, and the landfill cells. The domestic septic systems at LEHR and the two waste treatment systems (the radium-226 and strontium-90 septic tanks) should also be further evaluated to assess impacts on soil and groundwater.

In addition to chemical and radiological testing, Dames & Moore recommends that additional physical testing be conducted for on-site soils. These tests may include soil texture, laboratory and field permeability, moisture content, mineralogy, and infiltration rates. The soil physical data will be used to evaluate chemical and solute transport parameters in the vadose zone and in contaminant transport modeling and risk assessment evaluations.

Additional groundwater investigation should be conducted to evaluate vertical extent (which includes the third HSU) of impact from past disposal practices on groundwater below the LEHR facility and the lateral extent of impact downgradient. The interaction between the leakance from Putah Creek and the first HSU should be quantified in order to evaluate chemical loading from surface water. An evaluation of private wells located near the LEHR facility should be conducted to assess pumping rates and construction.

Surface water and groundwater monitoring should be continued, although the total number of analytical parameters requested can be decreased. Surface water run-off from the LEHR facility and internal drainage patterns should also be evaluated to assess potential impacts on various source areas. Further investigation of aquifer parameters should be conducted to support chemical fate and transport modeling. Additional investigative methods may include pump tests, slug tests and long term constant water level monitoring of selected wells, and evaluation of nearby privately-owned wells.

In order to conduct air dispersion modeling for risk assessment purposes, additional site-specific meteorologic data are required. Dames & Moore recommends that site-specific meteorologic data be collected during the Site-Wide Soil Investigation to support risk assessment activities.

An ecological/biological study, including flora and fauna associated in and around the site, should be conducted to aid in developing data for an endangerment assessment.

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