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Final

Interim Remedial Investigation Report

for

Frontier Fertilizer

Davis, California

Volume 1

Submitted to:

U.S. Environmental Protection Agency
Region IX

EPA Contract Number 68-W9-0060
EPA Work Assignment Number 60-28-9L4R

Prepared by
Bechtel Environmental, Inc.

April 1997

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Acronyms and Abbreviations

BTEX - benzene, tuolene, ethylbenzene, and xylene
CAS - Chemical Abstract Service
CLP - Contract Laboratory Program
COCs - chemical of concern
CRQL - contract required quantitation limit
DBCP - 1,2-dibromo-3-chloropropane
DCP - 1,2-dichloropropane
DHS - California Department of Health Services
DNAPL - dense non-aqueous phase liquid
DQO - data quality objective
DTSC - Department of Toxic Substance Control
E & E - Environment & Ecology
EDB - 1,2-dibromoethane
EE/CA - engineering evaluation/cost analysis
EPA - Environmental Protection Agency
FASP - Field Analytical Support Program
FSP - field sampling plan
GTI - Groundwater Technology, Inc.
LSCE - Luhdorff and Scalmanini, Consulting Eng.
M & E - Metcalf & Eddy
MCL - maximum contaminant level
NAPL - non-aqueous phase liquid
ND - non-detect
NPL - National Priorities List
PAR - Preliminary Assessment Report
PCE - tetrachloroethene
ppb - parts per billion
ppm - parts per million
PRG - preliminary remediation goal
QAPP - Quality Assurance Project Plan
QC - quality control
RI - remedial investigation
RPD - relative percent difference
RWQCB - Regional Water Quality Control Board

SQL - sample quantitation limit
STLC - soluble threshold limit concentration
TCE - trichloroethene
TCLP - toxicity characteristic leaching procedure
THP - total petroleum hydrocarbons
USCS - United Soil Classification System
VOC - volatile organic compound
YCDPH - Yolo County Department of Public Health

Executive Summary

This Interim Remedial Investigation Report presents the results of a remedial investigation (RI) conducted at the Frontier Fertilizer site near Davis, California, after the site had been placed on the National Priorities List (NPL) because of pesticide contamination in the soil and groundwater. The chief objectives of the RI were to identify the sources and nature of the contamination, to delineate the extent of the contamination, and to describe the fate and transport of the contaminants in the environment. The report was prepared for the U.S. Environmental Protection Agency (EPA), Region IX, under contract No. 68-W9-0060, as specifically authorized by work assignment No. 60-28-9L4R. The information presented here will be used to support risk assessments and feasibility studies.

Pesticides and other contaminants were released into the environment at the Frontier Fertilizer site. The sources, nature, extent, transport, and fate of these contaminants were investigated during the Remedial Investigation (RI). In addition, data from the interim groundwater remediation system were evaluated to assess the effectiveness of this system.

During the RI, a data quality objectives (DQO) approach was used. This approach was designed to ensure that data of sufficient quality were collected to answer questions that were posed about the site. Data quality varies, depending on the uses and questions. The analytical results, which constitute most of the data, were evaluated for quality. Fewer than 1 percent of the analytical data are rejected (R-flagged), and the remaining data are of sufficient quality to address the DQOs without introducing false negatives.

The Frontier Fertilizer site is underlain by alluvial deposits of silt, clay, sand and gravel. The sand and gravel occur as thin, discontinuous lenses in the vadose zone and upper saturated zone. The hydrogeology is a 3-dimensional flow system, and several simplifications were made to aid in describing the hydrogeology and to discuss current findings within the context of past work. Two discontinuous silty-sand, water-bearing zones are identified: the S-1 zone and the S-2 zone. The S-1 zone, the shallower of the two, lies at a depth of approximately 35 feet. The S-2 zone lies at a depth of approximately 60 feet, and is separated from the S-1 zone by a clay aquitard. A regional aquifer, the A-1 aquifer, underlies the S-2 zone at a depth of approximately 105 feet bgs. This aquifer is laterally continuous across the site.

In the northern portion of the site, there appears to be less clay between the S-2 zone and the A-1 aquifer, which appears to be a pathway for downward contaminant migration. Downward migration of dissolved contaminants takes place as a result of the large drawdowns in the A-1 aquifer from local agricultural pumping during summer months.

RI data and data from the preliminary assessment indicate that a disposal basin was the source of soil and groundwater pesticide contamination at this site. 1,2-dibromoethane (EDB), 1,2-dichloropropane (DCP), and 1,2-dibromo-3-chloropropane (DBCP) were the pesticides consistently detected at concentrations above their respective preliminary remediation goals (PRGs). Extensive soil sampling across the site did not identify other sources of these contaminants. Soil sampling delineated the extent of pesticide contaminants to levels below their

respective PRGs in the soils around the former disposal basin. Approximately 30,000 yd^3 of soil is contaminated with EDB at levels above 21 parts per billion (ppb).

During the remedial investigation, 12 monitoring wells were installed in addition to the existing wells and ten HydroPunch™ borings were drilled to collect groundwater samples. Groundwater samples were also collected quarterly from a sitewide network of wells. These samples, coupled with the HydroPunch samples, were sufficient to delineate the DCP, and DBCP plumes to their respective maximum contaminant levels (MCLs) in each water-bearing zone. There were areas where the EDB plume was not completely delineated. Groundwater flow directions, estimated flow velocities, and plume configurations are consistent. The pesticide plumes in the S-1 and S-2 zones are approximately 600 to 700 feet long, extending from the former disposal basin to some point beyond wells OW-2A and OW-2B. The pesticide plume in the A-1 aquifer appears to be very limited in extent and to be centered near the region where there is greater potential interconnection between the S-2 zone and the A-1 aquifer. The northernmost edge of the dissolved contaminant plume is not delineated by the existing monitoring well network.

The carbon tetrachloride plume in the groundwater was further delineated during the RI, but a source for this contaminant was not identified. Plume configurations for DCP and carbon tetrachloride were compared, and it is readily apparent that the carbon tetrachloride did not originate from the former disposal basin.

Groundwater and soil data indicate a potential dense non-aqueous phase liquid (DNAPL) release. Several key DNAPL indicators were identified in the data set and from site information. The potential presence of a DNAPL in the saturated zone will drive the selection of a remedy and may alter the cleanup strategy at this site. The DNAPL does not appear to be mobile or to extend into the A-1 aquifer, as concentrations in the A-1 aquifer are low and the plume not extensive.

An interim remediation system was installed and began operating in June 1995. This system consists of 17 pumping wells screened in either the S-1 or S-2 zones and 8 injection wells screened across both zones. Extracted water is treated with activated carbon and then injected into the subsurface or discharged to the sanitary sewer. Preliminary analyses of operating data indicate the system will achieve hydraulic containment of the dissolved plumes within the S-1 and S-2 zones, and may cut off or reduce the amount of dissolved pesticides migrating into the A-1 aquifer. Additional data and analyses are needed to confirm or deny these preliminary indications.

Recommendations based on this RI include:

- *Conduct a Focused Feasibility Study for Soils and a Focused Feasibility Study (FFS) for Groundwater.* These should be performed concurrently with an alternative evaluating in-situ cleanup of soils and groundwater.

- *Establish a Database for the Currently Operating Interim Remediation System.* This database will aid in assessing and tracking the operation and effectiveness of the remediation system. It will also help reduce the monitoring effort and maintenance of the system. Information tracked should include operations and maintenance costs, monitoring data, flow rates, and equipment life cycles.
- *Continue Groundwater Monitoring.* The monitoring program should be focused on evaluating the interim remediation system performance and collection of data in support of the FFS. A key aspect of this monitoring program is the concentration trends in the A-1 aquifer wells. Increasing concentrations in the A-1 aquifer wells should be considered a strong indication that the interim remedial measures may not be adequately controlling plume migration in this zone. Increasing concentrations in the downgradient S-1 and S-2 zone monitoring wells are also considered indicators that the interim remediation system may not be achieving the degree of hydraulic containment indicated by preliminary analyses.
- *Abandon and Replace Intermediate Zone Wells That May Provide a Migration Pathway for Dissolved Contaminants to the A-1 Aquifer.* Several S-2 zone wells appear to monitor zones interconnected with the A-1 aquifer. Wells MW-4B, MW-13B, and OW-2B should be abandoned to decrease the possibility that dissolved phase or DNAPL contaminants can migrate along the wellbores to a deeper zone.
- *Evaluate Soil Vapor Inhalation Pathway.* Verify that exposure to soil vapors associated with groundwater is not a threat to human health in the area north of the site. Flux chamber sampling should be conducted and the results of analysis used to evaluate human health risk.
- *Conduct Additional Field Work.* The northern extent of contaminated groundwater should be further delineated. Verify, if possible, the presence of a DNAPL. Based on the results of this additional work this interim report should be finalized and a site wide feasibility study conducted.

Section 1

Introduction

This Interim Remedial Investigation Report presents the results of a remedial investigation (RI) conducted at the Frontier Fertilizer site near Davis, California, after the site had been placed on the National Priorities List (NPL) because of pesticide contamination in the soil and groundwater. The chief objectives of the RI were to identify the sources and nature of the contamination, to delineate the extent of the contamination, and to describe the fate and transport of the contaminants in the environment. The report was prepared for the U.S. Environmental Protection Agency (EPA), Region IX, under contract No. 68-W9-0060, as specifically authorized by work assignment No. 60-28-9L4R. The information presented here will be used to support risk assessment and feasibility studies.

1.1 SITE BACKGROUND AND SETTING

The Frontier Fertilizer site was first developed in the 1950s as an area to store agricultural equipment. In the 1970s, the site was used to store, mix, and distribute pesticides and fertilizer for local agriculture. Pesticide handling was discontinued during the 1980s when it was discovered that the levels of pesticides in the wastewater, which had been placed in an unlined disposal basin, were toxic. This discovery occurred when an employee's pet dog died after drinking some water ponded in the basin.

1.1.1 Location

The Frontier Fertilizer site is located at 4303 and 4309 Second Street in Davis, Yolo County, California. The geographic coordinates of the site are 38° 33' 9.5" N latitude and 121° 42' 7.0" W longitude (Township 8 North, Range 2 East, Section 12, Mt. Diablo Baseline and Meridian, Davis, California, 7.5-minute quadrangle). The location of the site is shown in Figure 1-1.

1.1.2 Site Description

The Frontier Fertilizer site is in a currently undeveloped area at the eastern edge of the city of Davis, California. The site consists of several warehouses, shops, a pole barn, a labor camp complex, a tomato grading station, several sumps and culverts, and a disposal basin area. The 18-acre site is bounded on the south by Second Street and Interstate I-80, and on the north, west, and east by agricultural fields. Construction of the Mace Ranch Park industrial and residential development is proposed for most of the agricultural land surrounding the site. The nearest residence is approximately 0.2 mile north of the site. The site layout is shown in Figure 1-2.

1.1.2.1 Topography and Surface Drainage

The site is situated in the Central Valley, which has a very minor relief. Surface elevations vary on the order of 5 feet over a distance of several thousand feet. Creeks and drainage are downcut

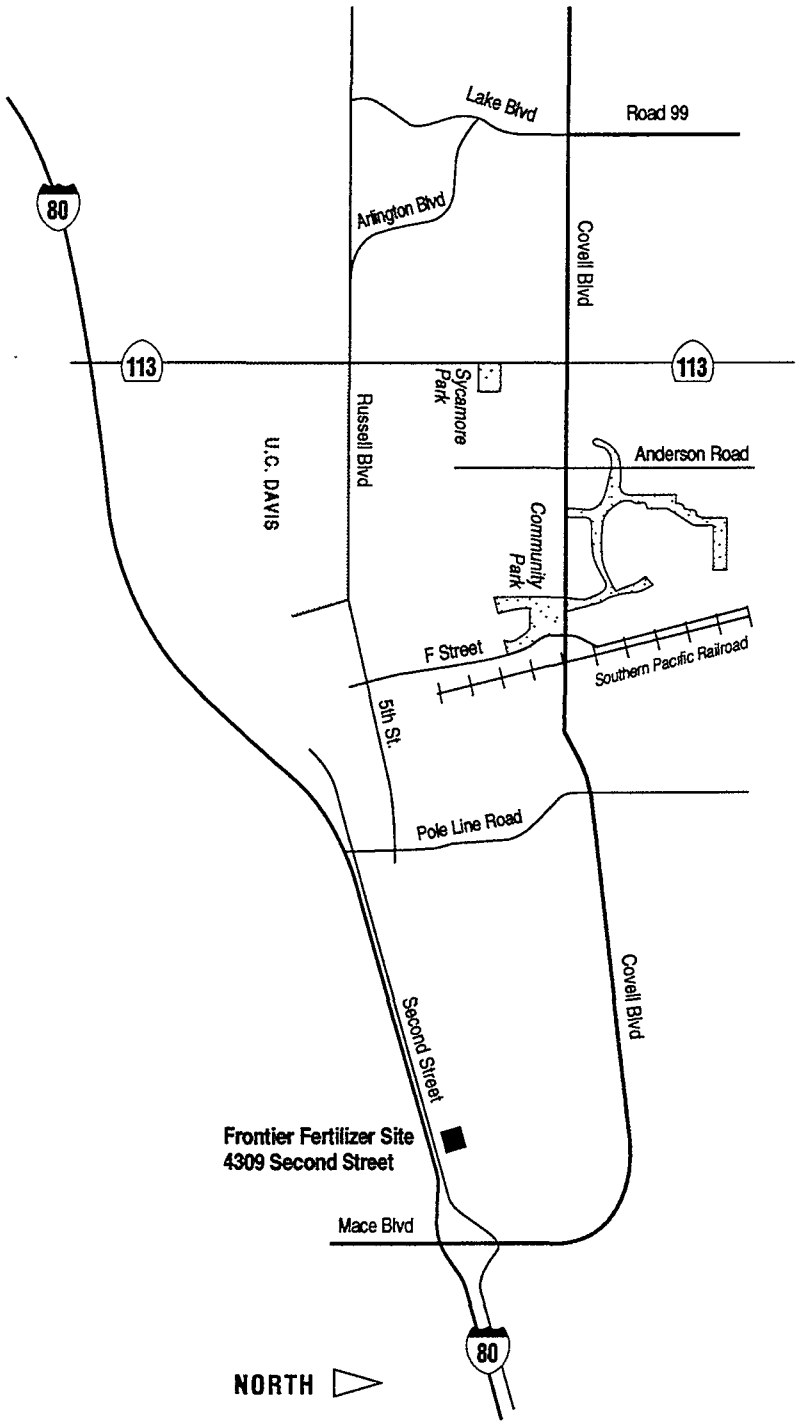

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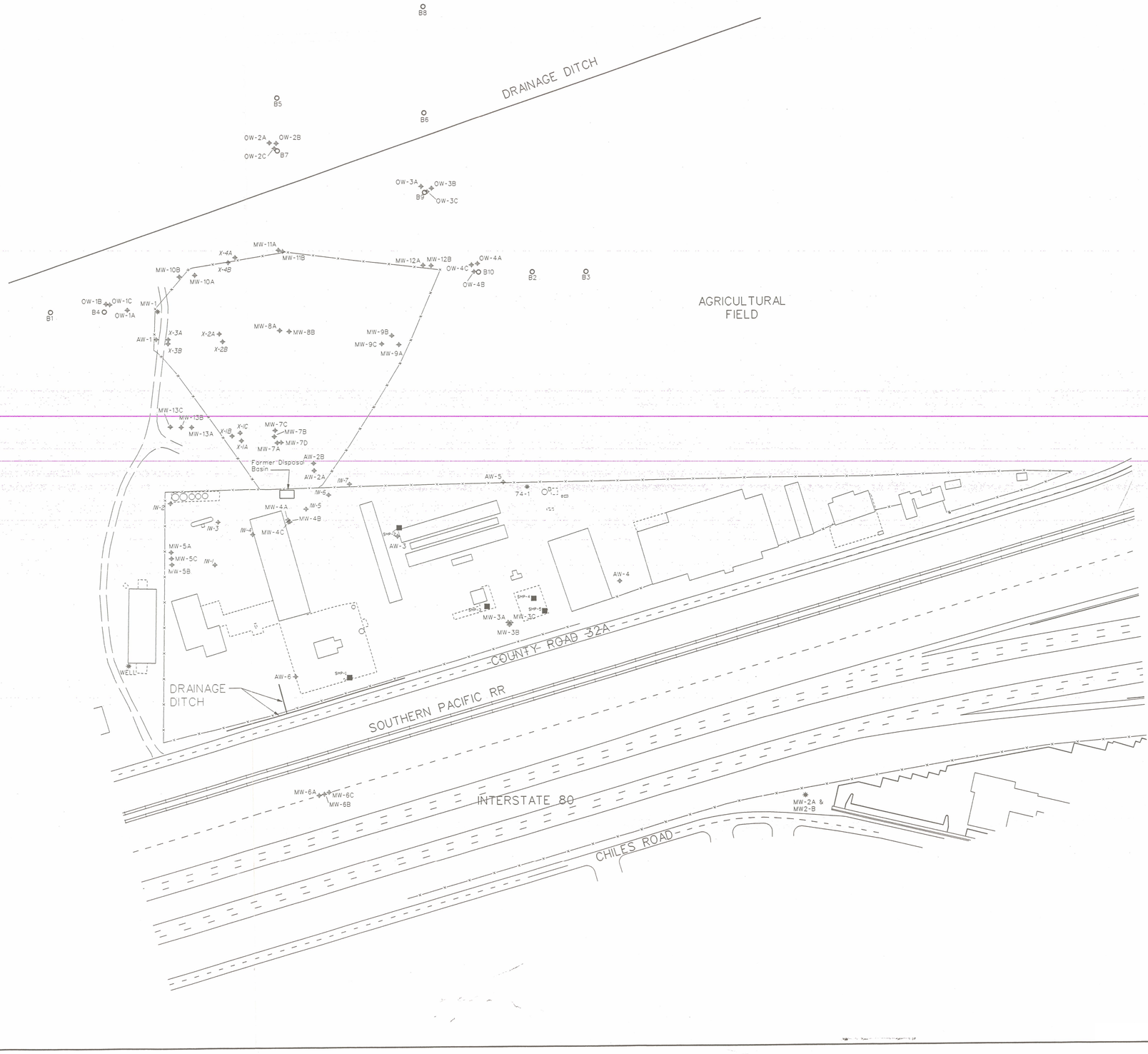
Figure 1-1 Site Location Map



EXPLANATION

- Groundwater Well
- B6 HydroPunch Boring
- Abandoned Groundwater Well
- SMP-1 Approximate Sump Location

N

100 50 0 100 200 FT

APPROXIMATE SCALE IN FEET

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FRONTIER FERTILIZER
DAVIS, CALIFORNIA

SITE FEATURES

1399-0309 1 of 1

Job Number	Drawing No.	Rev
20376	FIGURE 1-2	B

34x22 'D' SIZE

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into the land surface by several feet, with relatively steep banks and levees. A map of the site topography is shown in Figure 1-3.

Regional topography shows surface drainage flows from west to east, but most overland flow is locally focused to creek beds and irrigation drainage ditches. There is a drainage ditch along County Road 32 immediately adjacent to the site and a drainage ditch north of the site. These two features provide local control over surface runoff, but the very low relief at the site permits intermittent ponding.

1.1.2.2 Meteorology and Climate

Table 1-1 presents monthly temperature, precipitation, relative humidity, and prevailing winds measured at the Sacramento airport, approximately 15 miles north of Frontier Fertilizer. Monthly average temperatures range from 45°F in January to 76°F in July. Rainfall monthly averages range from trace amounts in July to 3.6 inches in January. The prevailing wind direction ranges from southeast through south-southwest to southwest for all months except October and November. In October and November, the prevailing wind direction is from the north-northwest.

1.1.2.3 Demography and Land Use

The future land use map is shown in Figure 1-4. This figure illustrates that the Frontier Fertilizer property will be incorporated into a light industrial business park. Single-family residences are planned just to the north of the drainage ditch that currently divides the wheat field north of the site.

1.1.3 Regional Geologic and Hydrogeologic Setting

The site is located in the Central Valley geomorphic province. The valley is asymmetrical and was formed as a crustal block rotated downward in the west. The same block rotated upward in the east to form the Sierra Nevada Mountains. As the block subsided, sediments from the Sierra Nevada and Coastal ranges filled the valley to thicknesses greater than 50,000 feet.

The area is underlain, from oldest to youngest, by pre-Cenozoic basement rocks, Mesozoic marine sedimentary rocks of the Great Valley Sequence, Tertiary marine and nonmarine sedimentary rocks, and Quaternary sediments. The Great Valley Sequence contains economic oil and gas resources. Mesozoic and Tertiary deposits are several thousand feet thick along the western edge of the Central Valley. Pliocene Tehama Formation rocks are the youngest Tertiary unit in the area. This formation underlies the Pleistocene Modesto-Riverbank and Red Bluff formations. Surficial Quaternary deposits are alluvial, as shown in Figure 1-5.

EXPLANATION

Contour (feet msl)

Survey Point

0 Approx. Scale in Feet 500

N

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Site Topography

Job Number	Drawing No	Rev
20376	FIGURE 1-3	A

Table 1-1 Meteorological Data at the Sacramento Airport

	Temperature					Precipitation[1] (inches)							Rel. Humidity		Wind (knots)			Sky Cond.
	Means			Extremes		Rainfall				Snowfall[2]			Percent		Prevail		Max	
Month	Max	Min	Ave	Max	Min	Ave	Max	Min	24 hr Max	Ave	Max	24 hr Max	AM	PM	Dir.	Speed	Gust	
Jan	53	38	45	70	20	3.6	9.1	0.2	3	T	T	T	90	70	SE	8	46	Ovct
Feb	60	41	51	76	23	2.8	8.8	0.1	2.6	T	2	2	88	59	SE	8	40	Ovct
Mar	64	43	54	88	26	2.4	7.1	0.1	1.8	T	T	T	84	51	SW	9	41	Ovct
Apr	71	46	59	93	32	1.3	4.2	0	2.2	T	T	T	78	43	SW	9	39	Clear
May	80	50	65	105	34	0.4	3.1	0	1.5	0	0	0	71	36	SW	10	44	Clear
Jun	87	55	72	115	41	0.1	0.6	0	0.5	0	0	0	67	31	SW	11	39	Clear
Jul	93	58	76	114	48	T	0.8	0	0.8	0	0	0	68	28	SSW	9	32	Clear
Aug	91	58	75	109	48	0.1	0.6	0	0.6	0	0	0	73	29	SSW	9	29	Clear
Sep	87	56	72	108	43	0.3	2.8	0	1.8	0	0	0	75	31	SW	9	33	Clear
Oct	78	50	64	101	35	1	7.5	0	3.8	0	0	0	80	39	NNW	9	35	Clear
Nov	63	43	53	87	26	2.4	7.4	T	2.4	0	0	0	87	57	NNW	8	49	Clear
Dec	53	38	46	72	18	2.8	13	0	2.9	T	T	T	90	70	SE	8	44	Ovct

T = Trace amounts (0.05 < T <0.5 inch)
1 = 24 hr max precipitation and snowfall are daily totals (midnight to midnight)
2 = Navy stations report hail as snowfall – from National Weather Service from July 1948 to December 1995
Ovct = Overcast

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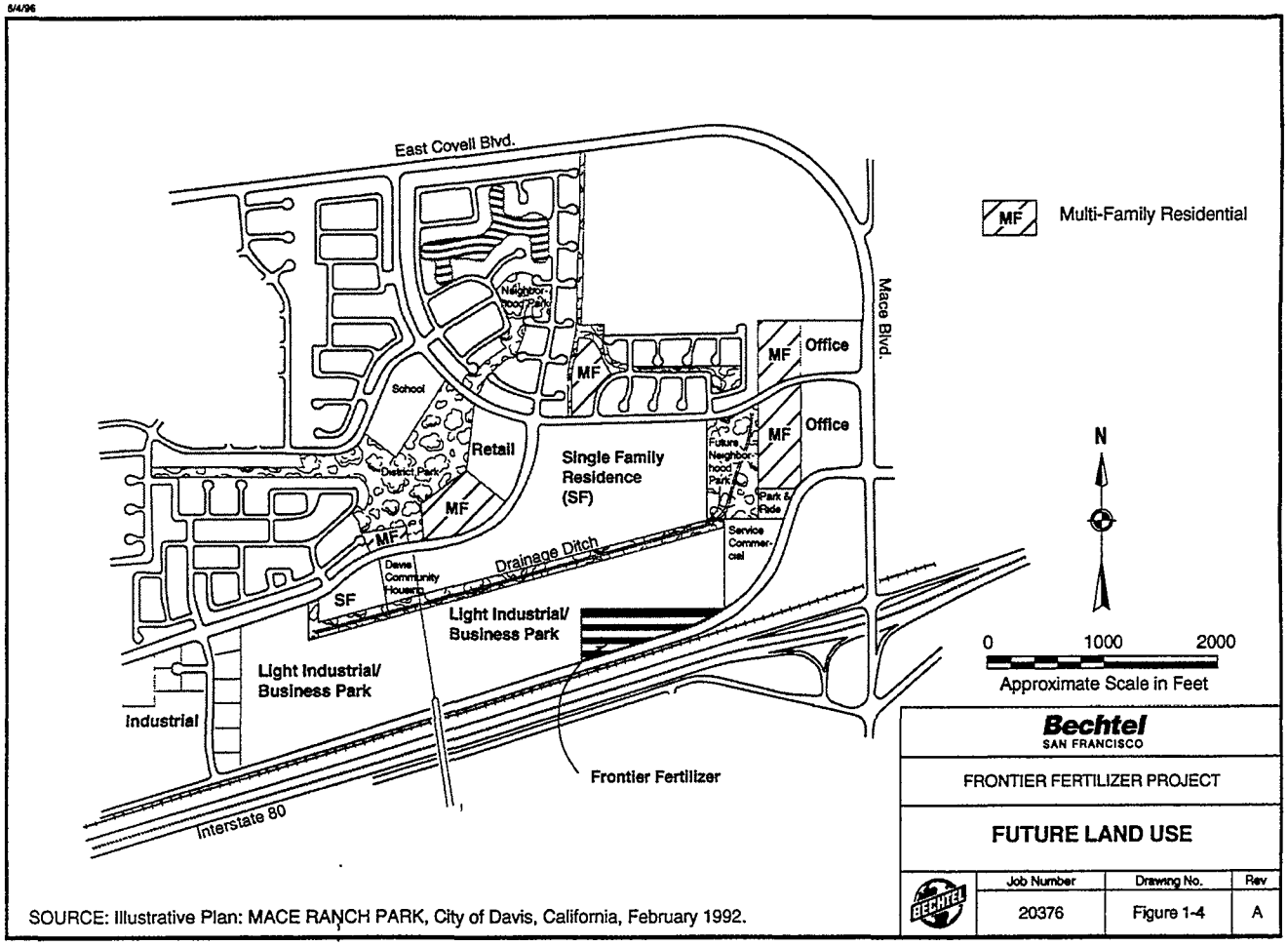


SOURCE: Illustrative Plan: MACE RANCH PARK, City of Davis, California, February 1992.

Figure 1-4 Future Land Use Map

SEDIMENTARY AND METASEDIMENTARY ROCKS

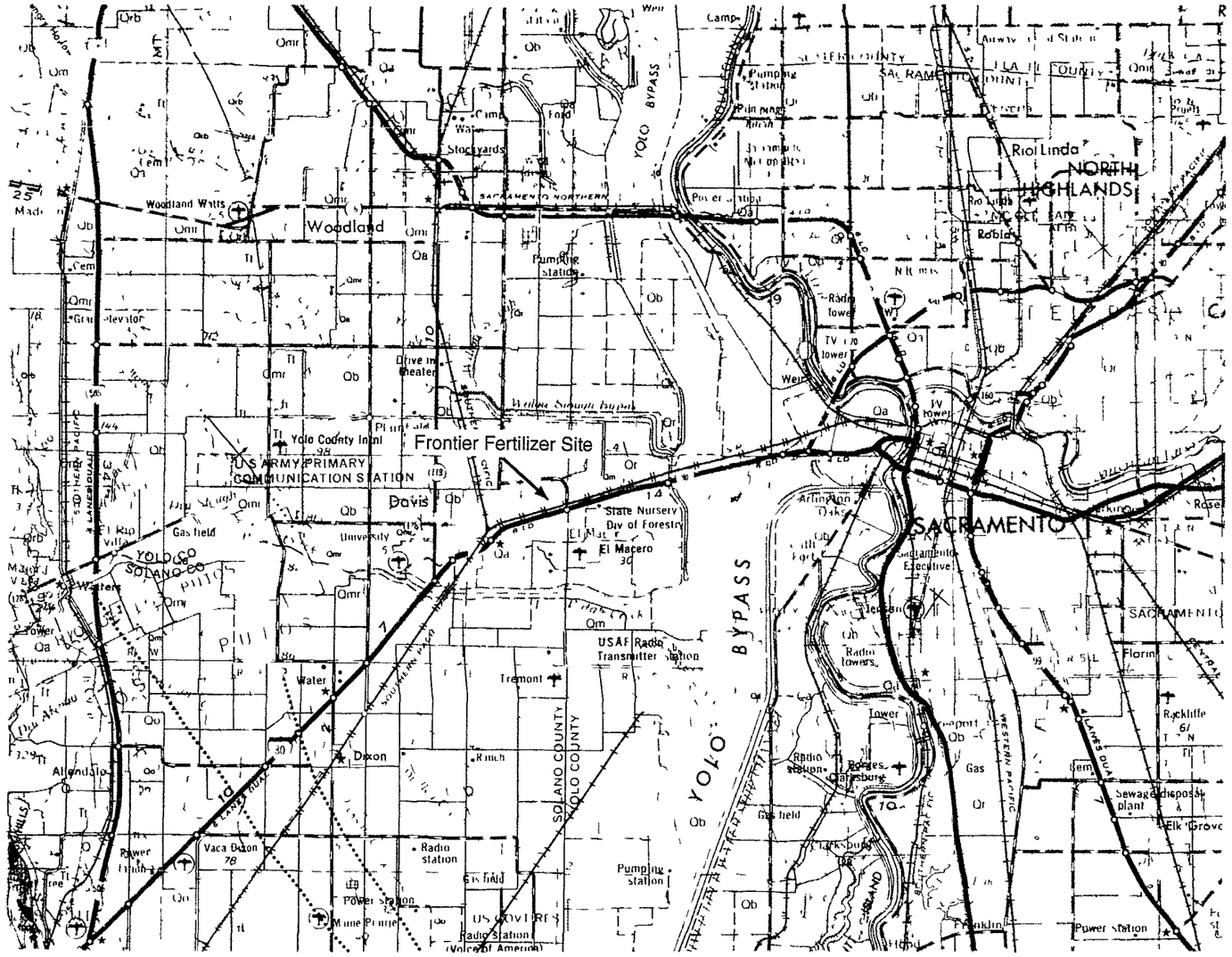
CENOZOIC

QUATERNARY

Qa	Alluvium
Qt	Mine and dredge tailings
Qla	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)*
Qr	Riverbank Formation *(Alluvium)*
Qmr	Modesto-Riverbank Formations *(Arkosic alluvium)*
Qmz	Montezuma Formation *(Poorly consolidated clayey sand)*
Qtl	Turlock Lake Formation *(Sand, silt, and gravel)*
Qrb	Red Bluff Formation *(Gravel in reddish, silty or sandy matrix)*
Qmm	North Merced Gravel *(Thin pediment veneer)*

TERTIARY

Tt	Tehama Formation *(Sand, silt, and volcaniclastic rocks)*
Tl	Laguna Formation *(Consolidated alluvial deposits)*
Tsp	San Pablo Group *(Marine sandstone and shale)*
Tm	Mehrten Formation *(Andesitic conglomerate, sandstone, and breccia)*
Tvs	Valley Springs Formation *(Rhyolitic tuff and sedimentary rocks)*
Tmk	Markley Sandstone *(Marine)*
Tn	Nortonville Shale *(Marine)*
Td	Domengine Sandstone *(Marine)*
Tc	Capay Formation *(Marine sandstone)*
Tg	"Auriferous" Gravels
Ti	Ione Formation *(Quartzose sandstone and kaolinitic clay)*
Tmz	Martinez Formation *(Marine quartzose sandstone)*



Source. Geologic Map of the Sacramento Quadrangle, California, 1:250,000
Published 1981

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Geologic Map

Job Number	Drawing No	Rev
20376	FIGURE 1-5	A

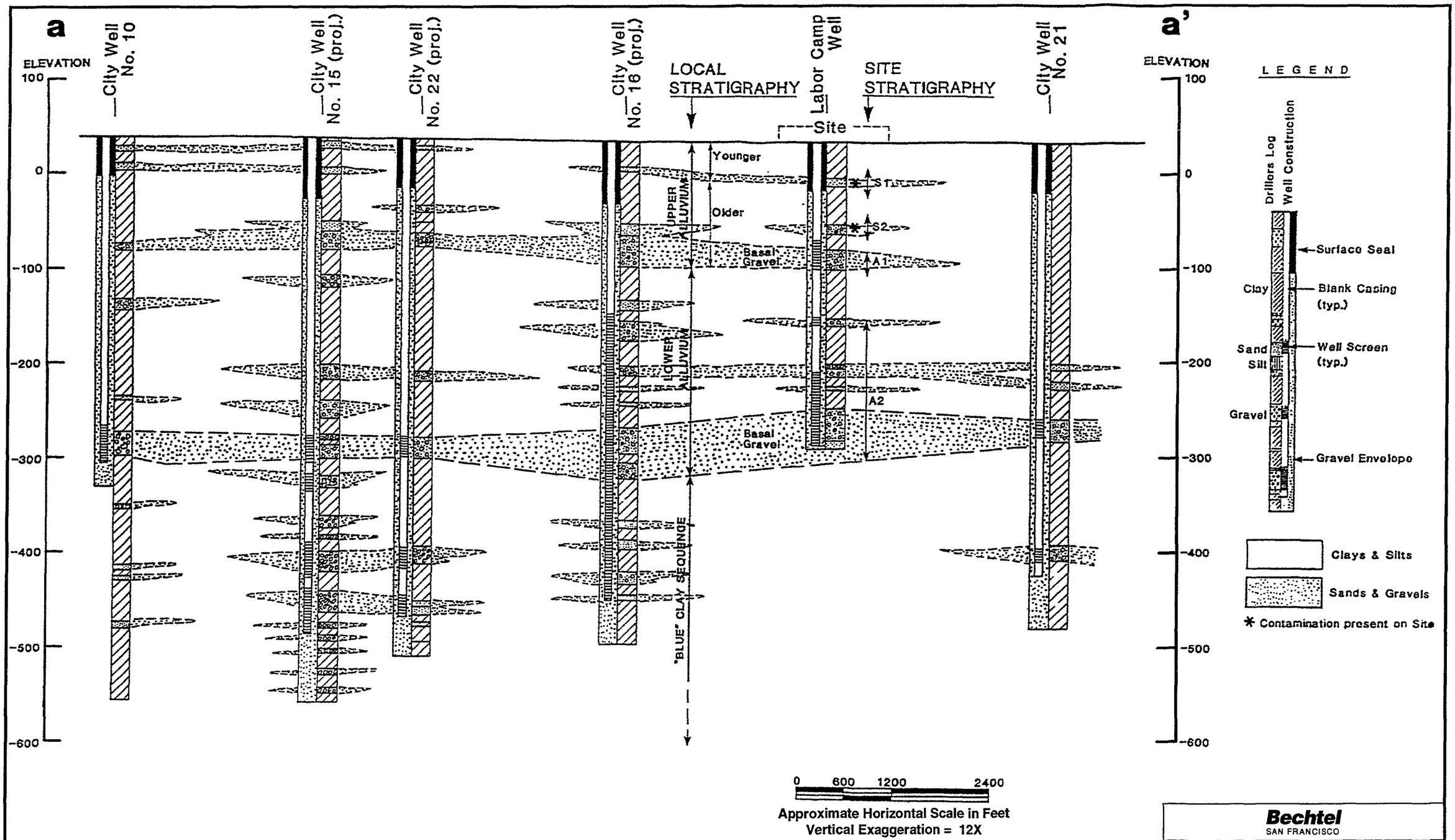
Only the Quaternary alluvial deposits are of interest to the RI because groundwater and soil contamination is limited to these deposits. Quaternary alluvial deposits are further divided into upper alluvium (approximately 140 feet thick), lower alluvium (approximately 200 feet thick), and blue clay (at least 300 feet thick). The upper alluvium contains a regionally extensive aquifer zone called the A-1 aquifer, as shown in Figure 1-6. This aquifer is pumped by agricultural and water supply wells, but most local wells use the more prolific and deeper A-2 aquifer. The strata overlying the A-1 aquifer are saturated, and water occurs in discontinuous silty sand lenses. These sand lenses vary in extent and thickness, but in general are not considered water-producing zones for agricultural or municipal uses. The uppermost sandy zone is called the S-1 zone, and the lower zone is called the S-2 zone. Silt and clay constitute the intervening geologic material between the sands and the A-1 aquifer. These low-permeability materials are considered confining units, or aquitards. In summary, the region is underlain by extensive alluvial deposits, with the coarser channel-lag deposits serving as aquifers within a matrix of finer overbank and floodplain deposits acting as aquitards.

1.1.4 Operational History

The site was first operated as a farming headquarters by the C. Bruce Mace Ranch Company in 1950. Grain warehouses and barns for machinery storage were the first buildings erected. A labor camp for Mexican nationals was constructed between 1952 and 1954. Site development continued from east to west, finally occupying 14 acres in 1970. In 1970, the 14-acre site was sold to Anderson Farms, Inc. The next major improvement of the site and its operations occurred in 1972, when a tomato grading station and a wash rack to rinse off tomato trucks were installed in the south-central area. In addition, Barber-Rowland Company (Barber-Rowland) moved onto the 4 acres to the west of the original 14 acres, completing the spatial expansion of the site.

The arrival of Barber-Rowland in 1972 marked the beginning of fertilizer and pesticide operations on the site. In 1982, Frontier Fertilizer took over the fertilizer and pesticide operations from Barber-Rowland. Frontier's operations were terminated in 1987. The site is presently used by Los Rios Farms, Inc.

During site operations by Barber-Rowland and Frontier Fertilizer, fertilizers and pesticides were stored in containers or sold in bulk or mixed and placed in 500- to 1,000-gallon trailers that were attached to a purchaser's truck for transport to the farm. If a pesticide container or trailer was returned with residual material inside, the excess pesticide and container rinsate were poured onto the ground or into at least one unlined disposal basin located near the northwest corner of the site (Figure 1-2). In addition, used pesticide, insecticide, and herbicide containers were stored, crushed, and disposed of on site and at other locations off site. Frontier Fertilizer operations were confined to the western end of the property.



Source: Luhdorff and Scalmanini, November 1987.

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GEOLOGIC CROSS-SECTION
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Job Number	Drawing No.	Rev.
20376	Figure 1-6	A

According to California Department of Health Services (DHS) records, on July 27, 1983, an employee's dog came in contact with liquid in the disposal basin. The dog died of pesticide poisoning while being examined by a veterinarian. Yolo County Department of Public Health (YCDPH) personnel visited the site on August 2, 1983, and observed the 20-foot by 15-foot by 4-foot deep basin, with approximately 1,500 gallons of fluid ("dark, oily liquids") in it. YCDPH personnel returned 2 days later to collect fluid samples, but the pit had been pumped out. Soil samples collected from the base of the pit had 1,676 parts per million (ppm) disyston and 1,056 ppm 1,2-dibromethane (EDB). In September 1983, YCDPH, under the guidance of DHS, specified that corrective action be taken at the site.

Soil samples taken by YCDPH on March 2, 1984 indicated that soil contamination by EDB, 1,2-dichloropropane (DCP), 1,2-dibromo-3-chloropropane (DBCP), and other pesticide- and herbicide-related compounds existed at the site. EDB was used as a soil fumigant to kill nematodes. Its use in California was discontinued in 1982. EDB was typically purchased from manufacturers as a powder, or in a 5 percent solution in water. DBCP was employed as a nematicide until its use was discontinued in California in 1977. DBCP was typically purchased from manufacturers in powder or in 7.5 percent solutions in water. DCP is still employed in California as a nematicide and for weed control.

In May 1984, the Frontier case was referred to the Yolo County District Attorney's office for action. A temporary restraining order was issued on January 6, 1984 by the Honorable James Rouch, Judge of the Superior Court, requiring Frontier to cooperate with interested agencies in hazardous waste cleanup. More sampling was done during 1984, and Frontier's plan for corrective action was discussed. On January 11, 1985, the FBI and EPA investigated the site under a search warrant, to determine whether site waste storage and disposal practices violated federal laws. On March 30, 1985, the DHS notified Mr. John Anderson, owner of Frontier Fertilizer, that the facility had been evaluated for inclusion on the Priority Ranking List of hazardous waste sites within the state of California.

The first remedial measures began on the site on April 12, 1985. Frontier contracted Laugenour and Meikle, Civil Engineers, of Woodland, California, to excavate soil from the pesticide disposal basin area, and to land-farm the excavated soil over a 15-acre site nearby. This action was under the supervision of the Regional Water Quality Control Board (RWQCB) and DHS. The dimensions of the excavation were 25 feet by 45 feet by 20 feet deep, and approximately 1,100 yd^3 of soil was transported to the treatment area. The excavation did not remove all of the contaminated soils from the disposal basin area, but it did help to mitigate the immediate threat posed by the disposal basin. Based on analyses of soil samples collected during excavation, a total of approximately 59 pounds of EDB was removed by excavation.

In response to a Cleanup and Abatement Order issued by the RWQCB, Frontier Fertilizer contracted Luhdorff and Scalmanini, Consulting Engineers (LSCE), of Woodland, California, to conduct a soil and groundwater investigation of the site. Twenty-four monitoring wells were

installed on or near the site between June 1985 and March 1986. A Preliminary Assessment Report (PAR) was submitted to the DHS in November 1987 (Luhdorff and Scalmanini, 1987).

The LSCE report did not completely define the extent of soil and groundwater contamination on the site, particularly to the north. The most contaminated groundwater detected in the LSCE investigation was north of the site in MW-7B, with 24,000 parts per billion (ppb) EDB. The DHS issued a remedial action order to Frontier on September 11, 1987. In a February 29, 1988 letter, the DHS issued a notice of final determination of non-compliance to the responsible parties named in the remedial action order.

1.1.5 Summary of Previous Investigations

Four investigations were conducted previously at Frontier Fertilizer. The first was carried out by LSCE for Frontier Fertilizer. The second was conducted by Groundwater Technology, Inc. (GTI) for RAMCO Enterprises, Inc. The third, performed by Metcalf and Eddy (M&E), was an investigation for the State of California Environmental Protection Agency Department of Toxic Substances Control (DTSC). The most recent, conducted by Ecology and Environment, was a preliminary assessment for EPA. These investigations are discussed below.

1.1.5.1 Investigation Conducted by LSCE for Frontier Fertilizer

The Frontier Fertilizer Company and its consultant, LSCE, in response to cleanup and abatement orders issued by the RWQCB, conducted activities to investigate air, soil, and groundwater contamination on and adjacent to the site from 1984 to 1988. These activities included an initial characterization of the site, excavations and land farming of contaminated soil from a former disposal basin on the site, development of health and safety plans for investigative activities, development of quality assurance and quality control (QA/QC) plans for sampling and analytical activities associated with the investigation, onsite air monitoring, onsite and offsite soil sampling, and construction and sampling of 24 onsite and offsite monitoring wells.

In 1987, Frontier Fertilizer's environmental consultant, LSCE, submitted a PAR to the DHS. The report presented the results of soil sampling on site and of the installation and sampling of 24 groundwater monitoring wells on site. Figure 1-2 shows well locations and Table 1-2 presents a list of wells installed by LSCE. The most contaminated soil around the disposal basin had been excavated in 1985, but that excavation did not remove all of the contaminated vadose zone soil. Three water-bearing zones, separated by semiconfining layers or clay and silty clay, were identified by LSCE. The shallowest, S-1, extends from approximately 30 to 50 feet bgs and consists of medium- to fine-grained sands. The intermediate zone, S-2, extends from approximately 60 to 90 feet bgs and consists of fine sands to silty sands. The deepest zone, A-1, extends from 110 to 130 feet bgs and consists of gravels to coarse sands. The most contaminated well, MW-7B, is screened in the S-1 zone and contained 24,000 ppb of EDB. Since MW-7B is

the northernmost S1 well, the extent of the groundwater plume was not defined by LSCE (Luhdorff and Scalmanini, 1987).

Table 1-2 Agencies That Have Installed Wells at Frontier Fertilizer

Agency	Wells
Luhdorff and Scalmanini for Frontier Fertilizer	AW-1, QW-2, AW-3, AW-4, AW-5, AW-6, MW-1, MW-2A, MW-2B, MW-3A, MW-3B, MW-3C, MW-4A, MW-4B, MW-4C, MW-5A, MW-5B, MW-5C, MW-6A, MW-6B, MW-6C, MW-7A, MW-7B, MW-7C
Groundwater Technology, Inc. for RAMCO	MW-7D, MW-8A, MW-8B, MW-8B, MW-9A, MW-9B, MW-9C, MW-10A, MW-10B, MW-11A, MW-11B, MW-12A, MW-12B
Metcalf and Eddy for California EPA, DTSC	MW-13A, MW-13B, MW-13C
Ecology and Environment, Inc. for U.S. EPA	IW-1, IW-2, IW-3, IW-4, IW-5, IW-6, X-1A, X-1B, X-1C, X-2A, X-2B, X-3A, X-3B, X-4A, X-4B
Bechtel National, Inc. for U.S. EPA	OW-1A, OW-1B, OW-1C, OW-2A, OWP2B, OW-2C, OW-3A, OW-3B, OW-3C, OW-4A, OW-4B, OW-4C

1.1.5.2 Investigation Conducted by GTI for RAMCO Enterprises, Inc.

GTI was contracted by RAMCO Enterprises, Inc., to complete an RI of the Frontier Fertilizer site in Davis, California. The work performed by GTI included soil sampling and analysis, installation of 12 additional monitoring wells screened in discrete water-bearing zones, and gauging and sampling of all 36 monitoring wells that contained water. Figure 1-2 shows well locations and Table 1-2 presents a list of wells installed by GTI.

A feasibility study of remediation alternatives is included in the GTI report. The alternatives were screened for engineering feasibility, ability to meet cleanup goals, and the safety of the public health. Excavation of soil and treatment by a combination of enhanced biological degradation and ventilation were recommended for the unsaturated zone contamination. Four to eight pumping wells were recommended for control and treatment of groundwater contamination, half screened in S-1 and half screened in S-2 (Groundwater Technology, 1990).

1.1.5.3 Investigation Conducted by M&E for the State of California

M&E was retained by the California EPA to conduct a focused RI in support of an interim remedial measure at the Frontier Fertilizer site. The scope of the focused RI was:

- Further delineation of contaminant migration at the site by installing a cluster of three groundwater monitoring wells (MW-13) approximately 200 feet west of the previously defined hot spot (MW-7 well cluster)
- Determination of the aquifer hydraulic properties beneath the site by conducting a series of step drawdown and long-term pumping tests in the S-1 and S-2 zones
- Monthly water level measurements from August 1991 through April 1992
- Groundwater sampling and analyses at the MW-7 and MW-13 well clusters.

The state's field activities confirmed the presence of three water-bearing zones of S-1, S-2, and A-1 defined by previous investigations. The water level measurements showed that groundwater flow at the site is influenced by seasonal variations as well as pumping of the nearby domestic, municipal, and agricultural water supply wells. High levels of EDB, DBCP, and DCP were detected in the MW-7 well cluster, and groundwater sampling at the MW-13 well cluster indicated the migration of contaminants from the MW-7 site to the MW-13 site. The results of the aquifer hydraulic tests indicated relatively high ground velocity in the S-1 and S-2 zones ranging from approximately 1 ft/day to 5 ft/day. The mean transmissivity and mean storage coefficients for the S-1 and S-2 zones were determined at 970 gpd/ft and 1,360 gpd/ft and 0.004 and 0.002, respectively (Metcalf and Eddy, 1992).

1.1.5.4 Preliminary Assessment Conducted by Ecology and Environment for EPA

In 1993, the EPA Emergency Response Section contracted with Ecology and Environment to investigate pesticide soil and groundwater contamination at Frontier Fertilizer. The purpose of this investigation was to collect soil samples to determine levels of pesticide contamination remaining in the soil and to attempt to locate a source for the carbon tetrachloride contamination. Analytical data was used to determine if a removal action was warranted for any source area on site. Removal options considered included soil vapor extraction and soil excavation. EPA determined that soil containing levels of EDB, DBCP, and DCP above 1,000 ppb would be considered for removal action (Ecology and Environment, 1994).

Based on the results of this study, EPA determined that pesticide contamination was present at levels above 1,000 ppb in soil around the site of the former disposal basin, but that the contamination was not extensive. Near the surface, EDB, DBCP, and DCP contamination was isolated to a few small areas. At depths greater than 20 feet, EDB and DCP contamination became more widespread. Soil contamination sources were not found at other locations investigated in this study.

Soil Investigation. EPA collected soil samples during two phases of site work. Phase I took place from March 3 through March 18, 1993. Phase I sampling focused on the former pesticide disposal basin area. Samples were collected from four depths on a 20-foot-square grid.

Background samples were taken at location F27 near the southwest corner of the site. Phase II samples were collected from the disposal basin area, from the labor camp area next to the concrete sump suspected of being a source of carbon tetrachloride contamination, and from other locations near pesticide-handling areas. Background samples were collected at location F56 west of the site at the edge of a cultivated field.

Samples were collected from four depth intervals at each soil sample location. Depth intervals were 1-2 feet bgs, 8-9 feet bgs, 18-19 feet bgs, and 26-27 feet bgs. Depths at some locations differed slightly from these figures owing to equipment problems or sample retrieval difficulties.

Phase I samples were only analyzed on site in the EPA Field Analytical Support Program (FASP) mobile laboratory. Phase II samples were analyzed on site in the EPA FASP laboratory and off site at EPA Contract Laboratory Program (CLP) facilities, as described below. Selected Phase II samples were also sent to the EPA Region IX laboratory in Las Vegas, Nevada, for confirmation analysis.

During Phase I, a total of 105 soil samples and two soil vapor samples from the pesticide disposal basin area were collected. The samples were analyzed for selected volatile organic compounds (VOCs) using FASP modified EPA Method 8010.

The Phase I soil samples were analyzed for the following compounds:

- Carbon tetrachloride
- DCP
- 1,3-dichloropropane
- EDB
- DBCP

During Phase II, a total of 141 soil samples were collected. Two water samples were collected from underground concrete tanks. All samples were analyzed on site in the FASP laboratory for VOCs by FASP-modified EPA Methods 8010 and 8020. Analyses for the pesticides EDB, DBCP, and DCP were performed as part of the 8010 analysis.

A total of 71 Phase II soil samples and two water samples were analyzed on site in the FASP laboratory for organochlorine pesticides by FASP-modified Method 8080. The 1-foot and 8-foot samples at each sampling location were chosen for this analysis. Near surface samples were considered most likely to have been impacted by these contaminants.

A total of 76 Phase II soil samples were analyzed by American Technical & Analytical Services, Inc. for organophosphorus pesticides by EPA Method 8141. These samples are identified above in the list of Phase II samples by the suffix "-O". A total of 65 Phase II soil samples were also

analyzed by American Technical & Analytical Services, Inc. for carbamate/urea pesticides by EPA Method 632. These samples are identified above by the suffix "-C".

Groundwater Investigation. Groundwater sampling and analysis were also conducted as part of the EPA preliminary assessment. Between August 24 and September 1, 1993, selected groundwater monitoring wells were sampled. A total of 25 of the 39 wells associated with the site at that time were sampled. Wells were selected from all areas of the contaminated groundwater and all three water-bearing zones. The objective of the sampling event was to determine whether contamination levels had changed or spread since the previous sampling. Of particular concern was whether contamination was entering the A-1 aquifer. Figure 1-2 shows well locations.

Sampling of groundwater monitoring wells had been previously performed by several parties, including the DTSC and RAMCO Enterprises, Inc. The most recent previous round of sampling had been conducted in December 1992 by DTSC. The following monitoring wells screened in the S-1 sand were sampled:

MW-3A	MW-8A	MW-9A	MW-10A	MW-11A
MW-12A	MW-13A	MW-5B	MW-6B	MW-7B

The following monitoring wells screened in the S-2 sand were sampled:

MW-3B	MW-5C	MW-6C	MW-7C	MW-8B
MW-10B	MW-11B	MW-12B	MW-13B	

The following monitoring wells screened in the A-1 aquifer were sampled:

MW-2B	MW-3C	MW-4C	MW-7D	MW-9C
MW-13C				

Analytical results of samples collected during this investigation were interpreted by EPA to indicate that concentrations of most contaminants decreased in most wells since the last time they were sampled. One exception was well MW-7C, which is screened in the S-2 zone. Concentrations of EDB increased from 4,500 ppb to 13,000 ppb. Concentrations of DBCP increased from 5.2 ppb to 26 ppb. Concentrations of DCP increased from 1,800 ppb to 34,000 ppb.

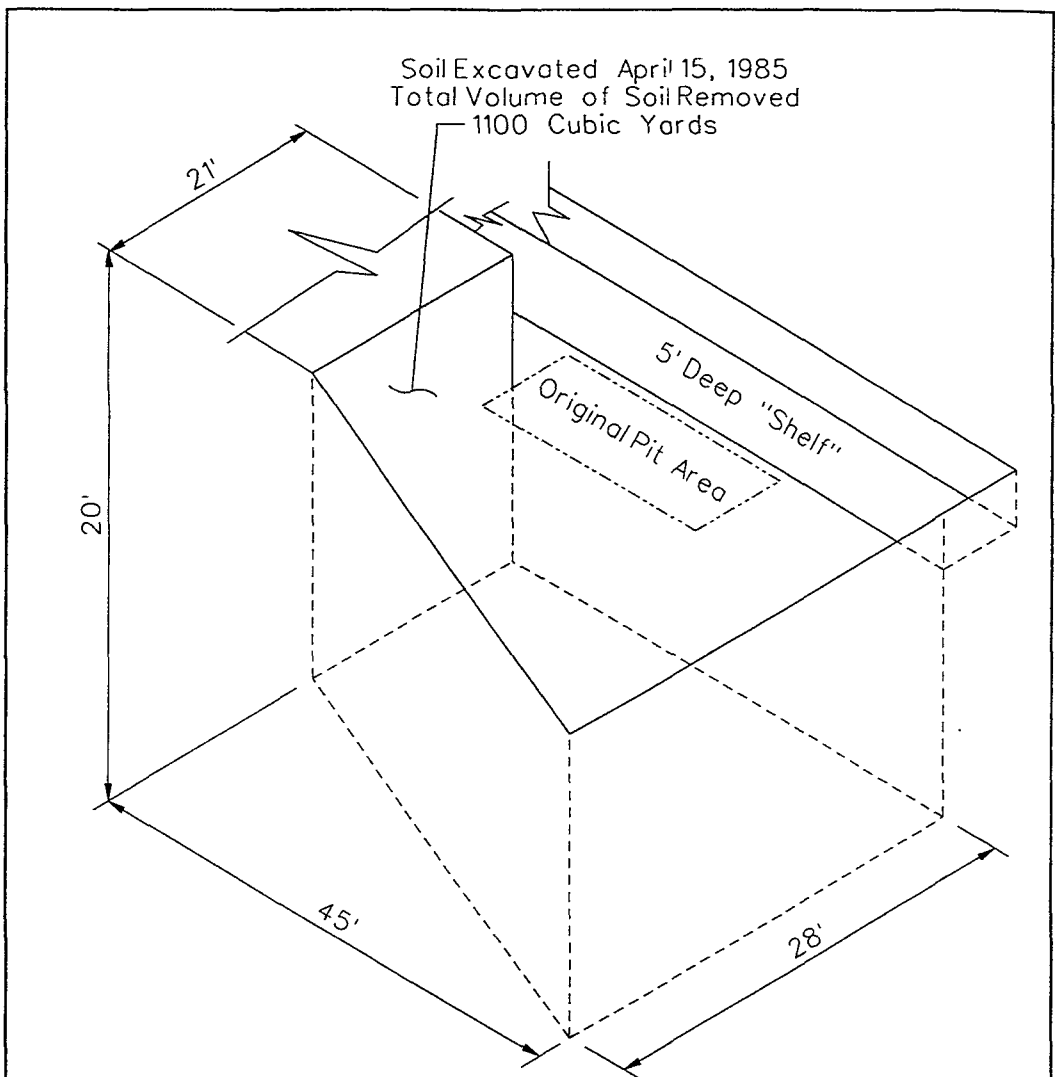
Wells screened in the A-1 aquifer were uncontaminated except for well MW-4C which contained 0.05 ppb of EDB. Well MW-7D, an A-1 well in the center of the plume, did not contain detectable levels of contaminants.

1.1.6 Previous Remedial Activities

1.1.6.1 Soil Removal Conducted by Frontier Fertilizer

Frontier Fertilizer implemented preliminary remedial action at the site during April 1985 as a result of soil sampling activities which had been completed between August 1983 and November 1984. The remedial action consisted of the removal of soil from the pesticide disposal basin northeast of the pole barn, and land farming of the excavated soil.

Following a pilot treatment study, the RWQCB and DHS approved plans to proceed with preliminary remedial action at the site. On April 11 to April 15, 1985, the pesticide disposal basin was excavated to a depth of 20 feet, and approximately 1,100 yd^3 of soil was excavated and transported to the treatment site. Figure 1-7 is a schematic representation of the original pit area and the April 1985 excavation. The excavated soil was hauled to the treatment site, where it was



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Bechtel SAN FRANCISCO		
FRONTIER FERTILIZER DAVIS, CALIFORNIA		
SOIL EXCAVATION DIAGRAM		
Job Number	Drawing No.	Rev.
20376	FIGURE 1-7	

unloaded in windrows approximately 75 feet apart, graded until smooth, and laser-leveled to an applied soil thickness of 1.5 inches. After the soil had been spread, the field was disked. The soil was disked again the following week, and disked a third time after about a month (Luhdorff and Scalmanini, 1987).

1.1.6.2 Groundwater Extraction and Treatment Conducted by the State

The DTSC began a removal action in early 1993 by installing a groundwater pumping system in MW-7B and MW-7C and a treatment system on site, as shown in Figure 1-8. This system was designed to draw down the water levels in the two extraction wells by several feet at a flow rate of 0.25 gpm in each well. Wells MW-7B and MW-7C were selected for extraction wells because the concentrations of pesticides were highest in them and they are approximately 100 feet downgradient from the former pesticide disposal basin. This system operated until May 1995, when it was replaced by a larger system, installed by EPA (URS Consultants, 1993).

1.1.6.3 Groundwater Extraction and Treatment Conducted by EPA

In July 1995, EPA installed a groundwater pump and an activated carbon treatment system at Frontier Fertilizer. Pumps were installed in 17 wells, and nine wells were plumbed as injection wells. These wells are shown in Figure 1-8.

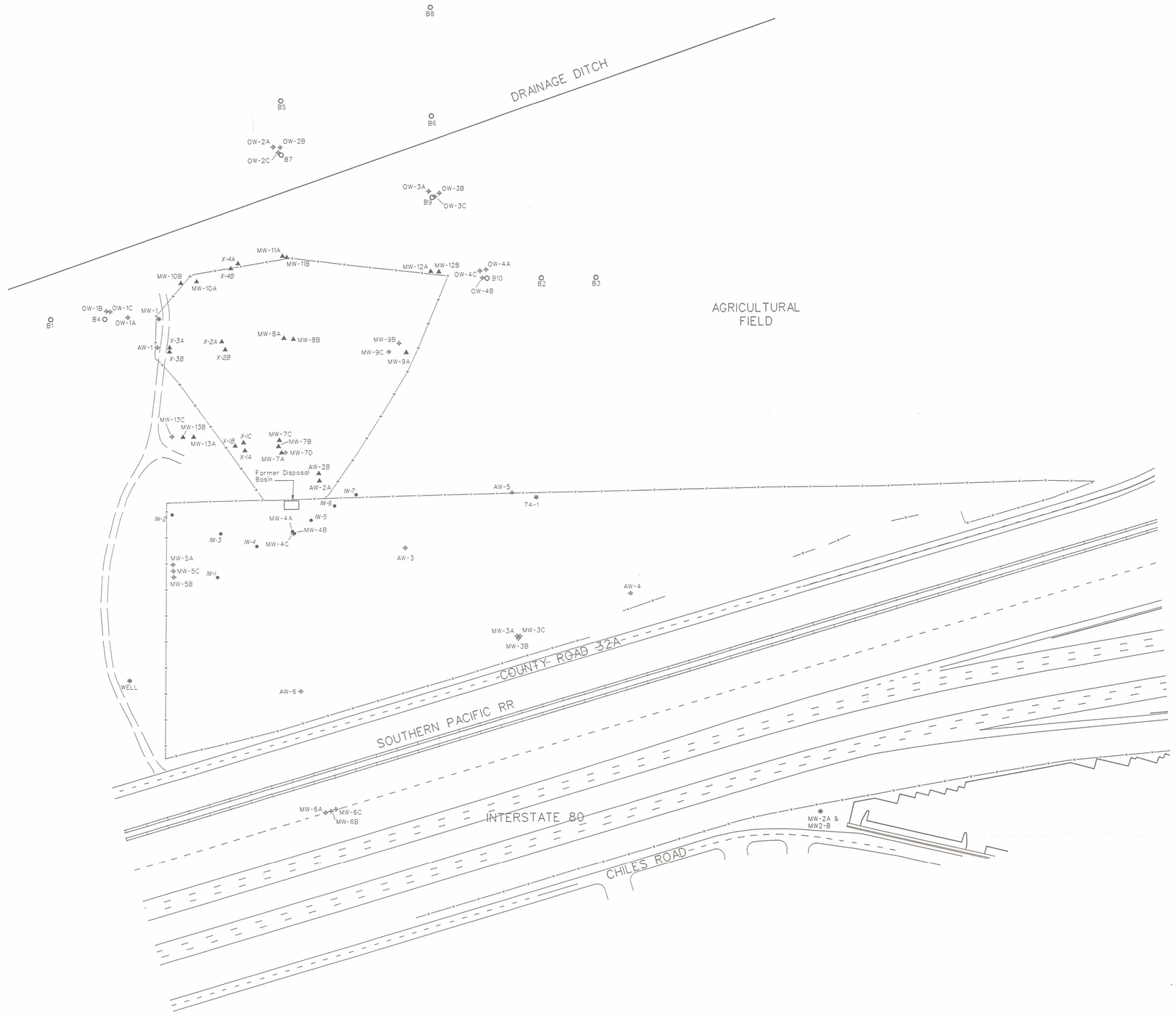
Ecology and Environment (E&E) has been monitoring the treatment system and recording flows through it. Initially, the 17 wells were pumping approximately 28 gpm. Flows have increased gradually since July 1995 to about 50 gpm (72,000 gallons per day) as of April 1996.

The injection system uses wells IW-1 through IW-7, well MW-4A, and well MW-4B. All the injection wells use the head buildup within the casing as the injection pressure head. The discharge from the treatment system is routed to the injection wells and to the sanitary sewer. Approximately 30 to 40 percent of the discharge is employed in the injection system, with the remainder discharged to the sanitary sewer.

Extracted groundwater is treated using three activated carbon vessels in series. These vessels hold 2,000 pounds of carbon, and reportedly one vessel was exhausted for every million gallons of water treated (CET Environmental Services, 1996). Influent concentrations are typically between 1,500 µg/l and 2,000 µg/l for EDB, between 2,500 µg/l and 6,000 µg/l for DCP, and between 10 µg/l and 75 µg/l for DBCP. Effluent concentrations are typically less than 0.05 µg/l for EDB, less than 1 µg/l for DCP, and less than 0.05 µg/l for DBCP.

1.1.6.4 Site Security Measures

In June 1996, EPA implemented new site access procedures to secure the site. These measures included agreements with Anderson Farms, new locks, and a plan to replace the existing main



EXPLANATION

- MW-9C — Monitoring Well
- B6 — HydroPunch Boring
- ▲ — Extraction Well
- • — EPA Injection Well
- ✱ — Abandoned Well

NOTES:

1) Wells MW-4A and MW-4B were converted to injection wells.

2) Currently pumping extraction wells as of 6/96 include: MW-12A, MW-12B, MW-11A, MW-11B, MW-8A, MW-8B, MW-7A, MW-7B, AW-2A, AW-2B, X-3A, X-3B, X-4A, X-4B, X-2A, X-2B.

N

100 50 0 100 200 FT
APPROXIMATE SCALE IN FEET

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DAVIS, CALIFORNIA

STATE AND EPA's GROUNDWATER EXTRACTION SYSTEMS
1999-0309 2 of 4

Job Number	Drawing No.	Rev.
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34x22 'D' SIZE

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site gate with a keypad-activated security gate. These measures are expected to reduce the likelihood of future illegal disposal of hazardous materials at Frontier Fertilizer.

1.2 REMEDIAL INVESTIGATION ORGANIZATION

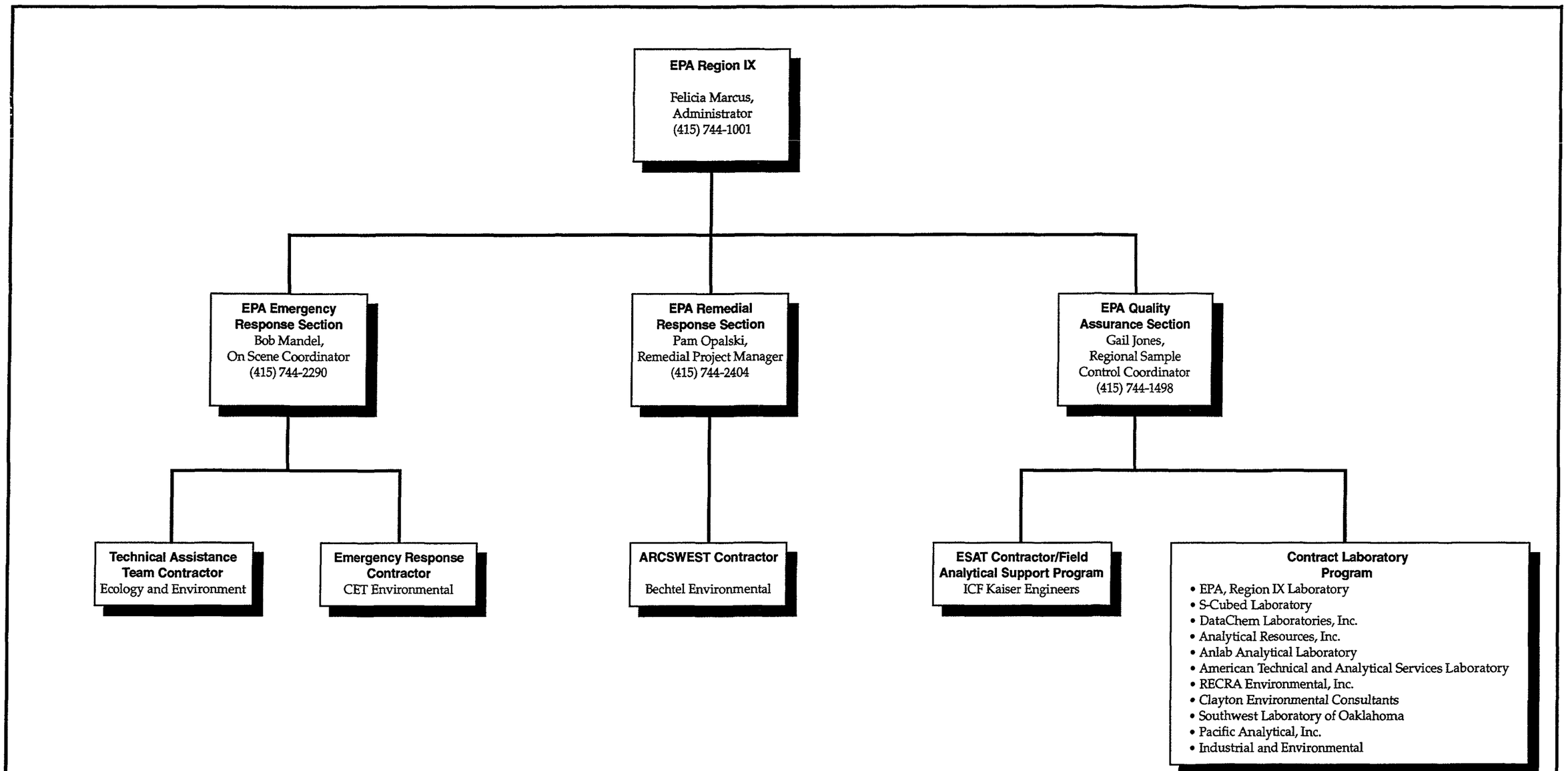
Figure 1-9 shows the remedial investigation organization. Three EPA sections were involved in the investigation effort. The Emergency Response Section and its contractors planned and conducted the preliminary assessment and designed and constructed the groundwater extraction, treatment, and injection system that is currently in operation. The Remedial Response Section planned and executed the remedial investigation. The Quality Assurance Management Section reviewed and approved work plans, procured and oversaw data validation services, and procured and oversaw analytical laboratory services.

1.3 REPORT ORGANIZATION

Section 2 of this report describes the remedial investigation methodology. Section 3 presents the results of the investigation and discusses the nature and extent of contamination. Section 4 discusses contaminant fate and transport, including a site conceptual model. Finally, Section 5 provides conclusions and recommendations.

1.4 INVESTIGATION SCHEDULE

Figure 1-10 presents a schedule of EPA led investigative activities at Frontier Fertilizer. EPA began it's investigation in early 1993 with a preliminary assessment. This assessment was followed by several rounds of groundwater monitoring and ultimately by a remedial investigation during Summer 1995. Groundwater monitoring and operation and maintenance of the groundwater treatment system are ongoing activities.



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PROJECT ORGANIZATION

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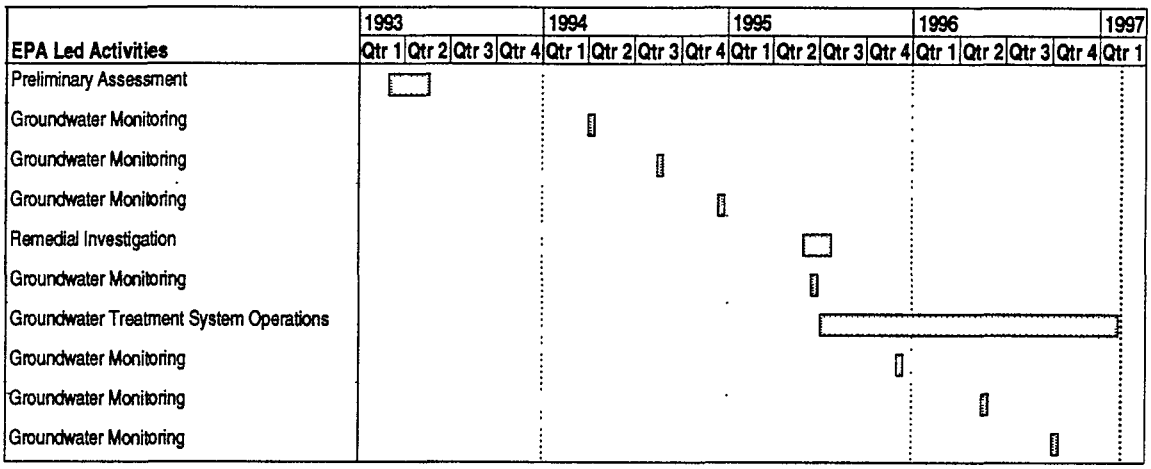

Figure 1-10 Investigation Schedule

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