GW - 1

WORK PLANS

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DISCHARGE PLAN APPLICATION, SITE INVESTIGATION AND ABATEMENT PLAN CMS

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EXECUTIVE SUMMARY

San Juan Refining Company (SJRC), a wholly owned subsidiary of Giant Industries, Arizona Inc., is submitting this Abatement Plan (Plan) to address pending environmental commitments outlined in an EPA 3008(h) Administrative Order for the Bloomfield Refinery. This Plan is designed to integrate the site data and provide a summary of site conditions. The Plan is structured to provide an evaluation of environmental data; examination of feasible environmental remedies; and recommendation of an appropriate abatement program.

This Plan supplements Volume I of the renewal application for SJRC's Groundwater Discharge Plan (GW-1) for the Bloomfield Refinery. Environmental data collected between 1999 and 2001, together with associated plates, and tables are included in this Plan. This Plan includes the revised Corrective Measure Study (CMS) for submission to the U.S. Environmental Protection Agency (EPA) that is SJRC's single remaining commitment under the EPA 3008(h) Administrative Order.

The abatement options described in this Plan are developed from the current conceptual model of the hydrogeochemical framework for the Bloomfield Refinery. This plan presents the current site model in the context of:

- The industrial history of the site, based on documents prepared by previous owners, historic contaminant releases and leaks, and other site activities.
- The evaluation of the physical characteristics of the site, including the site description and history, geology, and hydrology.
- The chemical characteristics of the site, based on historic and current water and sediment sampling events.
- The evaluation and recommendation of the appropriate remedial technologies to address separate-phase hydrocarbons (SPH) and dissolved-phase contamination.

The site conceptual model, which is based on data collected from the Bloomfield Site, was used to assess the feasibility of remedial technologies. The predominant site characteristics have been divided into the areas of groundwater hydrology, SPH, groundwater chemistry, and surface water chemistry.

- Groundwater Hydrology
  - Groundwater flows from east to west within glacial outwash deposits referred to as the Jackson Lake Terrace.
  - The aquifer is considered an unconfined aquifer, with the Nacimiento Formation acting as an aquitard immediately below the Jackson Lake Terrace.
  - Groundwater flow at the Refinery site has remained nearly unchanged over time. Based on data compiled by Hicks Consultants, water levels fluctuated from 2 to 6 feet between 1989 and 1999, and hydraulic gradients of 0.002 to 0.04 have remained constant.
  - Hydraulic conductivity of the Jackson Lake Terrace has been measured, at various locations, to be between 7.13×10^{-6} and 1.00×10^{-4} meters per second.

- SPH
  - A 1999 testing program determined that the observed decline in SPH thickness in older recovery wells was not due to clogging or fouling; rather, it documented the success of the hydrocarbon recovery system.
  - SPH volumes estimated from four sampling rounds distributed over the past decade suggest that 80% of the SPH volume present in 1991 was recovered by 2001.
  - The continued removal and hydraulic containment of SPH appears to have reduced the amount of contaminant mass loading of benzene and other petroleum hydrocarbons to the aquifer.
- Groundwater Chemistry
  - Overall benzene concentrations appear to have been reduced slightly over the past six years with the most reduction occurring along the margins of the plume. There is definite reduction in the center of the plume between 1999 and 2001, but reduction prior to 1999 cannot be assessed because many of the recovery wells had not been installed or sampled at that time.
  - Naphthalene concentrations declined by up to two orders of magnitude between sampling rounds in 1999 and 2001.
  - The concentration of electron acceptors (oxygen, nitrate, sulfate) in the groundwater in wells upgradient from the Refinery storage and processing areas may be sufficient to allow microbial degradation of dissolved phase contaminants.
  - Chromium, barium, and lead were detected above Water Quality Control Commission (WQCC) standards at several wells across the site, but analyses determined that there are no localized areas of consistently elevated levels.
- Surface Water Chemistry
  - Samples collected along Hammond Ditch indicated low concentrations of phenol (in 1986) and lead and zinc (1994).
  - Samples collected from the San Juan River indicated low concentrations of phenol (in 1987) and lead (1994).

Information from these investigations, in accordance with applicable requirements of the New Mexico Hazardous Waste Act; Title 20, Chapter 4, Part 1, New Mexico Administrative Code (20.4.1 NMAC) incorporating Code of Federal Regulations (CFR) Title 40, Parts 260 and 270, were evaluated to establish interim measures to begin treating present contamination. The interim measures initiated included: (1) the installation of an extraction well system designed to recover and treat SPH from the subsurface; and (2) the installation of a sheet piling system, or barrier wall, designed to control the migration of SPH to the San Juan River. This Plan describes these interim measures and proposes a CMS that evaluates several abatement options. The abatement options address contamination control for both surface waters and groundwater. Surface water abatement options include seepage control to the San Juan River and sheet piling/slurry wall construction. Groundwater abatement options include soil vapor extraction, in-situ air sparging, total fluids pumping, water table depression and soil vapor extraction, and enhanced in-situ bioremediation.

Recommended Abatement Option

An abatement plan is recommended that is designed to address both separate-phase and dissolved-phase contamination. The Plan consists of the continued removal and containment of the SPH that is currently being remediated through the operation of both SPH skimmer and total fluids pumps. The pumping array would be modified slightly so that only total fluids pumps are in operation at the site. Total fluids pumping in recovery well (RW)-17, RW-18, and RW-19 is recommended to maintain the source removal efficiency that has been demonstrated over the past decade. Total fluids pumping at seven locations, which form an arc of receptors down gradient of the observed SPH distribution, should provide hydraulic containment for, and some reduction of, the bulk of the dissolved contaminant mass emanating from the SPH. For the remaining dissolved contaminant mass, located primarily in the vicinity of monitor well (MW)-11 and MW-34, a pilot scale in-situ bioremediation system is proposed. Oxygen-release compound and nutrients for aerobic microbial communities may be applied to facilitate the degradation of dissolved-phase contamination in this area. Should this passive system prove cost-efficient and effective at reducing concentrations of hydrocarbons (primarily benzene), it may be upgraded to help reduce contamination in other areas of the site as well. The other area of the site that might benefit most from this system upgrade is the upgradient portion of the benzene plume, beginning at MW-44. As a final line of defense against contaminant migration, the slurry wall and sheet pilings, which were installed between the site and the San Juan River, should be left in place to continue to protect this most sensitive of groundwater receptors.

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TABLES

ACRONYMS

AOC	Administrative Order of Consent
AST	aboveground storage tank
BLM	U.S. Bureau of Land Management
BOD	biological oxygen demand
BRC	Bloomfield Refining Company
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
CFU	colony forming unit
CMS	Corrective Measure Study
COCs	constituents of concern
COD	chemical oxygen demand
COPCs	constituents of potential concern
CUB	contaminant-utilizing bacteria
EPA	U.S. Environmental Protection Agency
GCL	Geoscience Consultants, Ltd.
gpd	gallons per day
gpm	gallons per minute
GTI	Groundwater Technology, Inc.
HMB	Hazardous Materials Bureau
HWB	Hazardous Waste Bureau
IAS	in-situ air sparging
IM	Interim Measure
m/s	meters per second
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
NAPL	non-aqueous phase liquids
ND	non-detect
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMOCD	New Mexico Oil Conservation Division
NOWP	north oily water pond

ORC	oxygen-release compound
PAHs	polynuclear aromatic hydrocarbons
ppb	parts per billion
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SJRC	San Juan Refining Company
SOWP	south oily water pond
SPH	separate-phase hydrocarbons
SVE	soil vapor extraction
SVOCs	semivolatile organic compounds
SWMU	solid waste management unit
TDS	total dissolved solids
THB	total heterotrophic bacteria
TPH	total petroleum hydrocarbons
TSD	treatment, storage, and disposal
VOCs	volatile organic compounds
WQCC	New Mexico Water Quality Control Commission
μg/L	micrograms per liter

1. INDUSTRIAL SITE HISTORY

1.1. Site Location and Access

The Bloomfield Refinery (the Refinery) is located south of Bloomfield, New Mexico, in San Juan County, latitude N36° 41' 87", longitude W107° 58' 70" (see Plate 1). The Abatement Plan Investigation study area (Study Area) consists of the Refinery processing areas, storage tanks, and waste management areas, as well as adjacent areas that exhibit subsurface petroleum hydrocarbons. Previously installed monitor wells define an area south of the Refinery where petroleum hydrocarbons are present in the subsurface, and the San Juan River defines the northern boundary for the Study Area. Plate 2 shows the property owned by San Juan Refining Company (SJRC) with respect to Sections 26, T29N and 27, R11W.

The Refinery is located on a bluff 120 feet above the south side of the San Juan River. Plate 5, a surface geology map, shows the Refinery and the Study Area of this investigation. The top of the bluff is relatively flat and is at an elevation of 5,540 feet above sea level. The geologic units that comprise the Study Area include, in order of increasing depth, San Juan River Alluvium, Quaternary apron deposits, aeolian sand and silt, Jackson Lake Terrace, and the Tertiary Nacimiento Formation. An unnamed arroyo flows toward the San Juan River on the southern and western edges of the Study Area. East of the Study Area, a well-defined arroyo cuts a small canyon from the bluff to the San Juan River. Hammond Ditch, an unlined irrigation ditch, lies on the bluff between the limit of the Jackson Lake Terrace (also called the Nacimiento Cliff in this document) and the Refinery.

1.2. Site Description and History

Plate 4 is a map of the Refinery created in November 1998 and represents conditions as they have existed for most of the time the site has been in operation. Geographic areas defined by Plate 4 are described in Appendix A. Refinery offices are on the western end of the facility, along with warehouse space, maintenance areas, raw water ponds for temporary storage of fresh water from the San Juan River, and one storage yard containing used material (e.g., pipe, valves). Petroleum processing units, located in the northwest portion of the Refinery, include the crude unit, fluidized catalytic cracking unit, catalytic polymerization unit, and hydrodesulfurization unit. Several product storage tanks are present east of the petroleum processing area. The API separator is located in the northwestern portion of the Study Area. The aeration lagoons, formerly known as the north oily water pond (NOWP), the south oily water pond (SOWP), and a part of the API system, were identified by the U.S. Environmental Protection Agency (EPA) as potential Resource Conservation and Recovery Act (RCRA) hazardous waste management units.

In the central portion of the Study Area, aboveground storage tanks (ASTs) occupy a large percentage of Refinery property. South of the Refinery and across Sullivan Road are terminals for loading product and off-loading crude, as well as gas storage and hazardous waste storage.

The eastern portion of the Study Area contains closed and operational wastewater treatment facilities. Until the end of 1994, two clay-lined evaporation ponds and a spray irrigation area were used to treat and dispose of process wastewater. Since that time, two double-lined 5-acre evaporation ponds and a Class I underground injection well have been used to manage all Refinery process wastewater. In late 1998, the former evaporation ponds were converted into new raw water ponds. The spray irrigation area was decommissioned in 1994 with the start up of the Class 1 injection well. It has been overlaid by a parking lot and office complex. The fire training area and the landfill are also located at the eastern end of the facility.

Wells south of the Refinery fence line and west of the crude unloading and product loading area define an area where petroleum hydrocarbons are present in the groundwater. The U.S. Bureau of Land Management (BLM) controls this part of the Study Area. Subsurface hydrocarbons, including both dissolved-phase and separate-phase hydrocarbons, also are present north and west of the processing area, between the San Juan River and the cliff that defines the limit of the Jackson Lake Terrace deposits. This area is owned by SJRC.

The historical and current activities conducted at the Refinery include:

- Petroleum processing
- Crude and product storage
- Crude unloading and product loading
- Waste management (closed units and existing facilities)
- Offices and non-petroleum material storage

A detailed history of the Refinery, including improvements, expansions, spills, and investigations, is provided in the March *1993 RCRA Facility Investigation–Task I: Description of Current Conditions* report (Groundwater Technology, Inc. (GTI)) Local entrepreneur Kimball Campbell originally constructed the facility as a crude topping unit in the late 1950s. O.L. Garretson bought the facility in the early 1960s, renamed it Plateau, Inc., and sold it in 1964 to Suburban Propane of New Jersey. As a protective filing, Plateau applied for a RCRA Part A Permit as a generator of hazardous waste and as a treatment, storage, and disposal (TSD) facility in November 1980. In 1982, Plateau petitioned for reclassification under a generator-only status. Bloomfield Refining Company (BRC) acquired the facility from Suburban Propane (Plateau) on October 31, 1984. Facility ownership was transferred to SJRC on October 4, 1995.

1.3. Identification of Releases and Leaks

Table 1 summarizes various direct product releases and leaks from 1984 to the present. In addition to these documented losses, indirect documentation of product releases discovered during the repair of storage tanks is listed in Table 2 from 1987 to present.

Although records of the product spills prior to 1984 (when BRC acquired the facility) are limited and incomplete, employee recollections of operations under Plateau, Inc. and Suburban Propane indicate that product spills from the tank field and loading operations occurred on numerous occasions over the years.

1.4. Previous Investigations

Between 1984 and 1990, the former owner of the Refinery, BRC, contracted with several environmental consultants to install 13 groundwater monitor wells (MW-1 through MW-13), three recovery wells (RW-1 through RW-3), and three piezometers. Prior to well installation, BRC performed conductivity and soil vapor surveys to assist in placement of the wells. These surveys were conducted in accordance with New Mexico Water Quality Control Commission (WQCC) Discharge Plan requirements, a RCRA 3013 Administrative Order investigation, and a RCRA 3008(h) Order and Consent Agreement.

Elements of the field investigations also supported BRC's effort to recover separate-phase hydrocarbons (SPH). In order to recover SPH, BRC installed six additional SPH recovery wells (RW-14 through RW-19), two monitoring wells (MW-20 and MW-21), and an inoperable air sparging well now labeled MW-24.

In December 1992, BRC signed an Administrative Order of Consent (AOC) with the EPA. The AOC required several work elements, including a RCRA Facility Investigation (RFI) and a Corrective Measure Study (CMS). To fulfill the AOC requirements, BRC contracted with GTI and Layne Environmental to install two recovery wells (RW-22 and RW-23) and ten monitor wells (MW-25 through MW-34).

In 1997, Refinery personnel authorized the installation of three additional monitor wells (MW-40 through MW-42) south of the processing units to monitor hydrocarbon distribution within the Refinery. As a voluntary action to delineate the southern extent of hydrocarbons in the groundwater, Refinery personnel also had four monitor wells (MW-35 through MW-38) installed on BLM property adjacent to the Refinery.

In March 1997, SJRC personnel contracted with Precision Engineering to collect borings in sediment adjacent to the San Juan River. Eleven borings identified hydrocarbons in recent alluvial sediments. These hydrocarbons appear to have flowed from cliffside seeps, through the talus slope, and into the alluvium.

Table 3 summarizes previous site investigations. Sections 1.4.1 through 1.4.6 contain more detailed descriptions of work performed in response to orders and as voluntary initiatives.

1.4.1. RCRA 3008(h) Order Investigation (1985)

Prior to 1982, the refinery operated two wastewater treatment surface impoundments immediately downstream of the API separator. In 1982, the refinery cleaned the two surface impoundments in order to install a synthetic liner. The sludge from the impoundments was disposed of in an off-site hazardous waste disposal facility. However, the remaining contaminated soil in the impoundment was removed and disposed of in the on-site, landfill area.

On November 26, 1985 the refinery and EPA agreed to a *Consent Agreement and Final Order* (RCRA Docket No. VI-501-H) concerning specific RCRA-related activities at the refinery including closure of the landfill area and disposition of the contaminated soil from the impoundments. As of March 5, 1990 all orders of the Agreement were completed with the exception of approval of the closure plan from the New Mexico Environmental Improvement Division (NMEID) for a *Final Closure Plan for the API Wastewater Ponds, Landfill, and Landfill Pond at the Bloomfield Refinery*. This closure plan was submitted to NM EID August 10, 1986. The New Mexico Environment Department (NMED) approved the closure plan for the landfill pond in January 1994; the excavated soil in the landfill area was successfully delisted when EPA granted a one time exclusion for the 2000 cubic yards of classified K051 stockpiled waste (61 *Federal Register* 46380, September 3, 1996). The delisted stockpiled waste was used to create additional storm water runoff diversions and containment at various places on the refinery site.

1.4.2. New Mexico Oil Conservation Division Discharge Plan GW-1 (1984)

In 1983, the New Mexico Oil Conservation Division (NMOCD) required the Refinery to submit a groundwater discharge plan application pursuant to Section 20.6.2.3104 of the New Mexico Administrative Code (NMAC) of the WQCC. The submitted plan described the Refinery's site-specific operational and monitoring plans for the treatment and disposal of wastewater and plans and specifications for the effluent conveyance, collection, treatment, distribution and disposal systems. In 1984, NMOCD approved the submitted groundwater discharge plan, GW-1, and demonstrated that procedures at the Refinery do not violate WQCC regulations.

In 1984, the EPA Region VI had regulatory authority for surface and groundwater issues under RCRA; therefore, the NMOCD restricted application of the WQCC regulations to current Refinery discharges. To date, NMOCD exercises regulatory authority over petroleum hydrocarbons in surface and groundwater and the HWB regulates the management and storage of hazardous waste pursuant to 20.4.1.900 NMAC, Subpart VI 40 CFR 265 and 270.

The groundwater discharge plan is renewed every five years, and a renewal application is being submitted as part of this Plan.

1.4.3. RCRA 3013 Order Investigation (1985)

In April 1985, the EPA issued a 3013 Order requiring a groundwater study at the Refinery (Docket No. RCRA 3013-00-185), as well as an analysis of surface water during low-flow conditions.

According to Engineering Science's final report (Engineering Science, 1987), the groundwater study included the following actions:

- An electrical resistivity survey
- The installation of four groundwater monitoring wells (MW-7 through MW-10)
- Monthly fluid level measurements
- Quarterly groundwater sampling of wells MW-1 through MW-5 and MW-7 through MW-10 for a one-year period
- A series of slug tests

Surface water sampling was performed in Hammond Ditch and the San Juan River in April and July 1987, respectively. Engineering Science submitted the results to the EPA on September 14, 1987.

BRC completed all commitment of the 3013 Order, and the EPA released BRC from the Order after the final report was submitted.

1.4.4. Response to Inquiries from NMOCD (1988)

During the renewal process for Groundwater Discharge Plan GW-1 in 1988, the NMOCD began to exercise their regulatory authority over petroleum hydrocarbons in groundwater. In response to NMOCD, BRC engaged Geoscience Consultants, Ltd., (GCL) to conduct a soil vapor survey on BLM property located adjacent to the Refinery. Results of this study are detailed in a report submitted to NMOCD in August 1989 (GCL, 1989). During this field program, GCL installed three piezometers, two recovery wells, and one monitoring well. GCL also converted MW-10 to a recovery well (RW-3). BRC then installed pneumatic skimmer pumps in nine recovery wells and, on January 4, 1989, implemented a product recovery program.

The GCL report and other documents prepared by BRC were part of the 1989 renewal application for Groundwater Discharge Plan GW-1.

1.4.5. RCRA 3008(h) AOC (1992)

On December 31, 1992, the EPA issued another RCRA 3008(h) AOC. This AOC required several work elements as described below.

1.4.5.1. Interim Measures

An Interim Measure (IM) work plan was submitted to EPA and received EPA approval in May 1993. IMs proposed in the plan included the installation of two additional recovery wells, surveying and gauging of all wells, deployment of pumping systems in the new wells (if appropriate), and startup of a hydrocarbon recovery operation. The *Interim Measures Report*, dated March 3, 1994, describes these activities.

1.4.5.2. RCRA Facility Investigation

In fulfillment of AOC and the RFI requirements, two reports (*Task I: Description of Current Conditions* and *Task II: RCRA Facility Investigation Work*) were submitted to EPA in March 1993. BRC subsequently revised and resubmitted the RFI work plan, and the EPA approved it in November 1993. As detailed in these reports, the RFI work was conducted in six phases:

- Phase I: Soil Gas Survey
- Phase II: Soil Boring Investigation
- Phase III: Well Installation/Groundwater Sampling
- Phase IV: Saturated Zone Testing
- Phase V: Soil Vapor Extraction/Air Sparging Pilot Studies
- Phase VI: Stream Sediment and Surface Water Sampling

As part of Phase IV of the RFI, GTI conducted a vapor extraction/air sparging pilot test. The findings of this pilot test are in Appendix B.

1.4.5.3. Corrective Measure Study

An RFI/CMS summarizing each phase of the RFI and compiling and evaluating the data collected was submitted in November 1994. After reviewing the document, the EPA recommended the submission of a separate CMS along with additional groundwater characterization downgradient of MW-34. BRC submitted the CMS in December 1995.

In 1997 the BRC verbally petitioned the EPA to allow a substantial revision of the CMS in order to address recently identified hydrocarbons in the San Juan River Alluvium and provide a more thorough evaluation of proposed remediation activities. This plan is submitted to fulfill the EPA recommendations, and provides the abatement option designed to address both separate-phase and dissolved-phase contamination.

1.4.6. Discharge Plan Renewal (1994)

In June 1994, NMOCD approved the most recent groundwater discharge plan application for the Refinery. In addition to significant changes in wastewater management (e.g., closure of the spray irrigation area, closure of unlined evaporation ponds, and the installation of newly lined evaporation ponds), Refinery personnel submitted all of the above-referenced GTI reports addressing hydrocarbons in groundwater.

1.5. Comprehensive Groundwater Sample Event (1999)

Between August 1998 and April 1999, Hicks Consultants conducted comprehensive groundwater-sampling events at the Refinery. These comprehensive sampling events called for sampling each of the 44 groundwater wells and five seeps for aromatic and halogenated organic constituents, WQCC metals, total dissolved solids (TDS), and major cations and anions. In addition, some in-field measurements of dissolved oxygen were conducted. Results of sampling and analysis, are provided in Tables 6 - 8.

The Field QA/QC Project Plan, submitted to NMOCD on February 8, 1999, details the sampling protocols. The groundwater sampling events followed the protocol outlined in the QA/QC Project Plan except for the following:

- Samples were not filtered during the April sampling event. Filtered samples were obtained from selected wells during the next sampling exercise.
- The dissolved oxygen probe malfunctioned after roughly half of the wells had been sampled. However, this was deemed relatively unimportant since the wells that were not sampled were those within the processing areas, where more than 6 inches of SPH exist, and it can safely be assumed that dissolved oxygen values approach zero.

1.5.1. Administrative Orders of Consent

As detailed in Section 1.4.5, in 1992, the EPA and BRC entered into an AOC pursuant to the authority of Section 3008(h) of the Solid Waste Disposal Act. The order suggests that petroleum hydrocarbons in the subsurface, both dissolved-phase and SPH, may have originated from the former NOWP and/or SOWP. These ponds were considered potential hazardous waste management units regulated under RCRA. The AOC requires three main work elements:

- The implementation of interim measures to mitigate potential threats to human health or the environment
- An RFI to fully determine the nature and extent of any release(s) of hazardous waste or hazardous waste constituents at or from the Refinery
- A CMS to identify and evaluate alternatives for corrective action(s) to prevent or mitigate any migration of release(s) of hazardous waste or hazardous waste constituents at or from the Refinery

On the understanding that all work elements up to and including the submission of the CMS were complete, the present study was undertaken. This plan contains submission of a revised CMS. Selection of the abatement plan option will presumably result in the termination of the AOC. Depending on the origins of the observed dissolved-phase and SPH, the abatement requirements will be incorporated into either a RCRA requirement, or an amended NMOCD groundwater discharge plan, or both.

1.6. Regulatory Authorities and Considerations

The investigation and abatement of petroleum hydrocarbons and regulated RCRA constituents beneath and adjacent to the Refinery are subject to the following regulations.

1.6.1. The New Mexico Oil Conservation Division

NMOCD regulates disposal of non-domestic wastes resulting from the activities of refineries pursuant to authority granted in the New Mexico Oil and Gas Act and Water Quality Act. NMOCD administers, through delegation by the WQCC, all Water Quality Act regulations pertaining to surface and ground water.

Sections 3104 and 3106 of the WQCC Regulations stipulate, that unless otherwise provided for by the regulations, no person shall cause or allow effluent or leachate to discharge so that it may move directly or indirectly into the groundwater unless such discharge is pursuant to a discharge plan. The Oil and Gas Act (Chapter 70, Article 2, Part 12, B(22)) authorizes the NMOCD to regulate the disposition of non-hazardous waste at oil field facilities to protect public health and the environment. The NMOCD has combined these requirements into one document, (i.e., a discharge plan) that provides protection to groundwater, surface water and the environment through proper regulation of the transfer and storage of fluids at the facility, and disposal of waste liquids and solids.

This plan fulfills the NMOCD requirement to provide a plan (e.g., Groundwater Discharge Plan) to protect the groundwater, surface, and environment.

1.6.2. The New Mexico Environment Department

NMED, pursuant to the New Mexico Hazardous Waste Act, NMSA 1978, 74-4-1 et seq. (Repl. Pamp. 2000) and the New Mexico Hazardous Waste Management Regulations, 20.4.1.100 NMAC et seq., establishes the general and specific standards for the management of hazardous waste at the BRC.

1.6.2.1. Regulated Units

The Part A submitted by BRC to NMED identifies the aeration lagoons (former SOWP and NOWP) as RCRA regulated surface impoundments pursuant to 20.4.1 NMAC, Subpart VI, 40 CFR Part 265. BRC submitted a Part B permit application with subsequent revisions, in compliance with 20.4.1.900, Subpart IX, 40 CFR 270.10(e)(5). Termination of interim status will occur when NMED makes a final administrative disposition on the Part B permit application. Until NMED makes a final administrative disposition on the Part B (40 CFR 270.71), and consistent with 40 CFR 270.10, BRC must comply with the standards specified in 40 CFR Part 265 and the conditions described in its Part A application in the management of the aeration lagoons (former SOWP and NOWP).

1.6.2.2. Solid Waste Management Units

The RCRA Facility Assessment (June 1987) identified 13 solid waste management units (SWMUs), five of which are considered to be RCRA-regulated units: the aeration lagoons (former SOWP and NOWP), the raw water ponds (formerly the evaporation ponds), the landfill, and the landfill ponds. Of these, only the aeration lagoons are currently in use. The status of the aeration lagoons and other SWMUs including active, inactive and closed units are detailed in Appendix A.

1.6.2.3. Generator Status

The Refinery is a large quantity generator of hazardous waste. In accordance with Title 42 of the U.S. Code, hazardous waste generated at the facility is accumulated in the less than 90-day storage area prior to off-site disposal. RCRA waste managed by the Refinery includes API Separator Sludge (K051), Heat Exchange Bundle Cleaning Sludge (K050), Crude Oil Tank Bottoms (K169), Primary Oil/Water/Solids Separator Sludge (F037), Ignitable Waste (D001), and Benzene (D018). Process wastewater entering the Aeration Ponds, effluent and residues generated downstream of the surface impoundments is RCRA exempt pursuant to 40 CFR 261.31(b)(2)(i) - Aggressive Biological Treatment.

1.7. Abatement Objectives

The groundwater abatement strategy presented in Sections 4.0 will address three objectives:

- Examine the extent, magnitude, and fate of hydrocarbons in the adsorbed, dissolved, and residual phase.
- Delineate the extent of contaminants such as volatile organic compounds (VOCs) and metals within the underlying aquifer system.
- Evaluate the efficacy of remedial technologies to restrict the offsite migration of hydrocarbons and VOCs while expediting source removal.

2. PHYSICAL SITE CHARACTERISTICS (SITE CONCEPTUAL MODEL)

2.1. Surface Geology

Plate 5 is a surface geologic map of the Bloomfield, New Mexico area. The Tertiary Nacimiento Formation dominates the surface, forming mesas and broad plateaus. Within the northern and eastern portions of the area shown, the San Jose Formation caps higher mesas. Quaternary alluvium fills the bottom of many tributaries to the San Juan River, such as Canyon Largo, located east of Bloomfield.

The five geologic units listed below crop out at or near the Refinery:

- Quaternary apron deposits
- Tertiary Nacimiento Formation
- Aeolian sand and silt
- Jackson Lake Terrace sand and gravel
- San Juan River Alluvium (north of the Refinery along the San Juan River)

Seven Quaternary alluvial deposits characterize the San Juan River valley:

- Alluvium (Qal)
- Alluvial apron deposits (Qaa), typically adjacent to cliffs along the river
- Post-glacial terrace deposits (Qt)
- Jackson Lake Terrace deposits (Qt2)
- Late Bull Lake Terrace deposits (Qt3)
- Early Bull Lake Terrace deposits (Qt4)
- Pre-Wisconsin Terrace deposits (Qt5)

As Plate 5 shows, the area south of the Refinery is mapped as the Nacimiento Formation. The Nacimiento Formation forms a cliff more than 80 feet high along the south side of the San Juan River between New Mexico Route 44 and the Refinery. With the exception of this dramatic exposure, the Nacimiento Formation is covered by soil, aeolian (windblown) sand, and/or slope wash.

The Refinery lies on a thin aeolian sand and silt unit that caps the Jackson Lake Terrace deposit. Geologic maps show the aeolian unit as part of the Jackson Lake Terrace (see Plate 5). The gravel, cobbles, and aeolian deposits of the Jackson Lake Terrace are exposed along the cliff on the south side of the San Juan River and on both sides of the unnamed arroyo due east of the Refinery fence line. The upper portion of the Jackson Lake Terrace also crops out south of the Study Area at the base of several rolling hills.

Within the Study Area, the apron deposits are restricted to a narrow exposure between the base of the Nacimiento Cliff and the San Juan River Alluvium. Although the San Juan River Alluvium forms a broad plain on the north side of the River, the San Juan River Alluvium is limited to a small sand and gravel bar deposit on the south side of the River within the study area. The Refinery's water intake facility is located on this sand and gravel bar.

2.2. Subsurface Geology

Three lithologic units below the fenced Refinery area are important: the aeolian sand deposit, the Jackson Lake Terrace, and the Nacimiento Formation. Other lithologic units in the Study Area are the quaternary apron deposits north of the Refinery and a small deposit of San Juan River Alluvium. The stratigraphic relationship between these five units is presented in Plates 6, 7, and 8. These plates are discussed later in this section.

The unit directly beneath the Refinery consists of aeolian deposits and limited artificial fill. The aeolian deposits are comprised of fine sand with smaller volumes of silt and clay. Where not augmented by fill, these deposits can be 10 to 15 feet thick. Typically, this unit is unsaturated.

The underlying Jackson Lake Terrace is comprised of unconsolidated and friable glacial outwash deposits of cobbles, gravel, and sand, varying in thickness from 0 to 20 feet. On the northeastern edge of the Study Area, where the unit is relatively thick, pre-Wisconsin erosion into the Nacimiento permitted a greater accumulation of these glacial outwash deposits, and post-Wisconsin erosion is less than in other portions of the Study Area. In the southern portion of the Study Area, post-Wisconsin erosion has removed most of the unit. The lower portion of the Jackson Lake Terrace is generally saturated.

According to Kingsley (1996), the Tertiary Nacimiento Formation consists of high argillaceous, very fine, soft sand or siltstone with interbeds of dense black shale and ranges in color from gray to green. The base of the Nacimiento Formation lies at an elevation of approximately 5,000 feet above sea level near Bloomfield. Therefore, the total thickness of the unit within the Study Area is about 500 feet. Although the sandstone lenses produce sufficient quantities of water for limited domestic use at some locations within the San Juan Basin, the Nacimiento is considered a poor aquifer and a relatively good aquitard. In the Study Area, saturation of the Nacimiento Formation is limited to the uppermost few feet where groundwater infiltrates from the Jackson Lake Terrace.

Quaternary apron deposits exist north of the Refinery at the base of the Nacimiento Formation cliff. This unit consists of large blocks of Nacimiento Formation mixed with aeolian sand and slope wash from the Jackson Lake Terrace. The outcrop is less than 50 feet wide and, therefore, does not appear on Plate 5. This unit is saturated only where water discharges from the Jackson Lake Terrace along the Nacimiento cliff. Water flows over the cliff and into the apron deposits, continuing its vertical flow to the underlying San Juan River Alluvium.

Within the Study Area, the San Juan River Alluvium is restricted to a small sand and gravel bar deposit on which the water intake facility is located. The unit is coarse-grained, highly permeable, and unconsolidated. The water table in this unit is controlled by the stage of the adjacent San Juan River.

Plate 6 is a northeast-southwest cross-section of the area that also presents the 1998 water table. This section shows the erosion of the Nacimiento near MW-1 and a thickening of the Jackson Lake Terrace. Near MW-29, where the top of the Nacimiento is relatively high, the Jackson Lake Terrace thins. Post-Wisconsin erosion has also thinned the Jackson Lake Terrace near MW-11.

Plate 7 is a north-south profile from the San Juan River to the southern boundary of the Study Area. This plate shows that the Jackson Lake Terrace is a separate hydrogeologic unit from the San Juan River Alluvium. As also shown in Plate 7, the saturated thickness of the Jackson Lake Terrace is only 3 to 4 feet where the top of the Nacimiento is relatively high (RW-3). Near Hammond Ditch, the saturated thickness of the Jackson Lake Terrace is greater due to leakage from the ditch.

Plate 8 is an east-west profile along the southern boundary of the Refinery. This cross-section shows relationships similar to those described above. The top of the Nacimiento Formation is high. The Jackson

Lake Terrace is thin on the east side of the Refinery (compare with MW-29 in Plate 6). On the west side of the Refinery, note how leakage from Hammond Ditch and the raw water ponds (P-1 is located adjacent to the raw water ponds) causes elevation of the water table. This cross-section also shows how the water table intercepts the land surface at the man-made drainage west of the Refinery.

Plate 9 displays the surface elevation of the top of the Nacimiento Formation. The Jackson Lake Terrace lies on this erosional surface. The map suggests east-west scouring by glacial outwash streams, especially in the southern portion of the Study Area, defined by the 5,492 feet of elevation. Nacimiento surface elevation above 5,496 feet defines the southern edge of the paleo-channel; small "hills" or "islands" may have existed during initial deposition of the Jackson Lake Terrace. As discussed in more detail later in this report, this erosional surface partially controls the flow of groundwater perched on the Nacimiento Formation.

Appendix C contains the lithologic and well completion logs for all borings at the Refinery.

2.3. Surface Water Flow

The principal surface water body in the area is the San Juan River, which forms the northern border of the Study Area. The San Juan River originates within the San Juan Mountains of Colorado, about 100 miles northeast of Bloomfield. Navajo Dam, which is located about 20 miles upstream from the Refinery, controls the water flow in the river and also supplies water to a trout fishery at the base of the dam. Despite the control exerted by the dam, periodic flooding of low-lying areas adjacent to the San Juan River does occur due to several large drainages (such as Gobanador Wash) that empty into the San Juan River between Navajo Dam and Bloomfield. Additionally, local precipitation, coupled with a large release from the dam, can trigger infrequent, localized flooding.

Navajo Dam also diverts water from the San Juan River for irrigation. Hammond Ditch is one such diversion, flowing from east to west across the northern portion of the Study Area. Water flows through the ditch during the irrigation season, approximately April to October. The Refinery retains water in Hammond Ditch from October to April. A later section of this report discusses the influence of Hammond Ditch leakage to the underlying groundwater.

An unnamed arroyo forms the eastern boundary of the Study Area. This arroyo cuts a small canyon, exposing several rock units. The observed units are, in descending order, the Jackson Lake Terrace (about 15 feet thick) and the Nacimiento Formation (25 feet from the Jackson Lake Terrace contact to the canyon floor).

A second unnamed arroyo forms the southern and western boundary of the Study Area. This second arroyo cuts a smaller canyon south of the Study Area, which exposes the upper portion of the Jackson Lake Terrace. The original channel of this arroyo was modified by the construction of Hammond Ditch and Sullivan Road. The arroyo now flows beneath Hammond Ditch and along the south side of Sullivan Road. A constriction in the arroyo channel is located at the intersection with Hammond Ditch, and floodwaters may temporarily pool here.

Groundwater seeps have created several small surface water bodies within the Study Area. Water flows from numerous seeps along the cliff face between the Refinery and the San Juan River. Small pools of water are common near the cliff face. On the western margin of the Study Area, an excavation near a pipeline exposes the upper portion of the Jackson Lake Terrace and the water table. Within this excavation, a small ephemeral pool of surface water is present, typically during the irrigation season. These seeps and pools support various organisms such as cattails and phreatophytes.

2.4. Groundwater Flow

Potentiometric surface data available for analysis span 14 years (see Table 12), dating from February 1985, when Engineering Science began collecting monthly water level data from monitoring wells. Due to the increased amount of sampling information now available, it is possible to revisit previous studies and more accurately interpret the data collected. Plates 11 through 13 depict the potentiometric surfaces from 1986 to 1999. Plate 11 shows the water table elevation from a 1999 sampling event. Recent well elevation survey data were employed to establish the measuring point elevation at the top of the casing. Plates 11 through 13 employ data from more than 40 groundwater-measuring points (including two dry wells) over the 14-year period and, therefore, represent the most accurate depiction of the water table over the period of this study. Plates 11 through 13 show the following:

- Groundwater flow from east to west
- A gentle hydraulic gradient (0.002) across the Refinery
- A moderate hydraulic gradient (0.006) southeast of the Refinery
- A steep hydraulic gradient (0.04) west and north of Hammond Ditch
- A groundwater "mound" adjacent to the western Raw Water Ponds
- A groundwater "mound" along the length of Hammond Ditch

These maps display a 2-foot contour interval and, for clarity, do not plot the actual head data at each well (see Table 12 for groundwater depths). The maps suggest a groundwater flow divide in the petroleum processing area (near MW-42); north of this divide the groundwater flows toward the Nacimiento seeps, and south of it the groundwater flows west.

Historical interpretation of groundwater flow is incomplete; therefore, Plates 11 through 13 have been used as references for the re-interpretation of earlier data. The eight data points collected in 1986 were re-evaluated to reflect the current, more accurate understanding of the groundwater flow patterns. Plate 14 shows the saturated thickness of the Jackson Lake Terrace and demonstrates the current understanding applied to data collected in the past.

2.4.1. Hydraulic Characteristics

The aeolian sand that covers the Jackson Lake Terrace is not saturated. This well-sorted, permeable unit easily transmits fluid from the land surface to the water table. GTI conducted several tests of airflow in this aeolian unit; however, no tests have been conducted to determine hydraulic conductivity of this unit. For the purpose of this study, a hydraulic conductivity of 1×10^{-8} m/s has been estimated. This value was derived from the average values published in Freeze and Cherry (1999) for silty loess.

Jackson Lake Terrace has been the subject of numerous testing programs. As Table 4 shows, single well tests conducted by Engineering Science and GCL showed lower hydraulic conductivity values than results from multiple well tests conducted by GTI. All of the values appear to be several orders of magnitude lower than a typical clean sand or gravel unit, which, according to Freeze and Cherry (1979), should show a range of hydraulic conductivity between 1×10^{-3} and 1×10^{-2} m/s.

Single well tests do not provide specific yield data. GTI calculated a specific yield of 0.015 (MP-3) and 0.003 (MP-4) from the pumping test of RW-19. Again, these values are lower than typical values for aquifers, which Freeze and Cherry (1983) suggest should yield values of 0.01 to 0.30.

No site-specific data exist for the hydraulic conductivity of the Nacimiento Formation. This unit is not saturated more than several feet below the contact with the overlying Jackson Lake Terrace, which suggests that its vertical hydraulic conductivity is low. Evaluation of this unit in outcrop supports the general characterization that it is a poor aquifer but is a good aquitard.

2.5. Saturated Thickness of the Jackson Lake Terrace

Plate 14 presents the saturated thickness of the Jackson Lake Terrace during the 1999 monitoring event. Thickness is calculated using information from drilling logs and the March 1999 water level measurements. The saturated thickness varies in response to undulations of the erosional surface that forms the top of the Nacimiento Formation (Plate 9). Plate 14 shows saturated thickness greater than 7 feet near Hammond Ditch and in the southern portion of the Study Area (MW-13, MW-26, and MW-4). (See also Plates 7 and 8.)

3. CHEMICAL SITE CHARACTERISTICS (SITE CONCEPTUAL MODEL)

Previous sampling events were evaluated in the development of this Plan. The sampling results are summarized in this section for sediment and soil chemistry, groundwater chemistry, surface water chemistry, sediment sampling, and background water chemistry. An exposure and risk assessment conducted by GTI to identify constituents of potential concern (COPC) is discussed in Section 3.6. It should be noted that the analytical data referenced in this report have been obtained from older, historical documents for which the original data (i.e., analytical results, sampling records, QA/QA records) are no longer available. As such, these data are being presented for historical completeness purposes only since it is not possible, at present, to independently verify these older data.

3.1. Sediment and Soil Chemistry

3.1.1. Hammond Ditch and San Juan River Sediment Samples

Since 1982, numerous field programs have collected sediment samples from Hammond Ditch and the San Juan River. Several programs also collected soil samples in connection with the installation of monitor wells, various SWMU closures, and other investigative programs. Plate 10 shows the soil boring locations. Tables 9, 10, and 11 present the soil sampling results for 1985 and 1994 sampling events.

In 1994, in conjunction with the surface water sampling program for the RFI, GTI obtained sediment samples from 14 locations within Hammond Ditch and 3 locations (SJ-1, SJ-2, and SJ-3) along the San Juan River. The results of the San Juan River sampling program show no difference between upstream (SJ-1 and SJ-2) and downstream (SJ-3) analyses. GTI obtained 28 samples from Hammond Ditch at 14 locations. At each location, GTI collected one sample from the bottom of the ditch and a second sample from the south side of the embankment, presumably near the water. The results, presented in Table 9, reveal no obvious pattern. Of all the VOCs that were tested for, only toluene was detected, and it was found in only three samples: 5B, 7B, and 9B. These three samples are west, north, and east of the flare with sample HD-7B exhibiting the highest concentration of toluene (0.012 mg/kg). Only samples 4B and 9B exhibited phenanthrene. These were concentrations below 2 mg/kg. Samples 4B and 10S contained traces of total petroleum hydrocarbons (TPH) at concentrations of 540 mg/kg and 240 mg/kg, respectively. The remainder of the samples contained no TPH. There was no obvious trend or pattern in the analytical results of inorganic parameters. All inorganic results were well below the criteria that would classify this material as hazardous waste under RCRA.

3.1.2. San Juan River Alluvium

In March 1997, a temporary, artificial low-flow condition was created at the site, due to a U.S. Fish and Wildlife study. During this time, Precision Engineering took eight borings of the San Juan River Alluvium north of the Nacimiento cliff and the Refinery flare, and extracted two samples from them that characterize the area where SPH enters the river.

Samples were obtained from borings SB1-397 and SB2-397, both located along the road between the Refinery and the San Juan River intake ponds. These two borings were located close to the Nacimiento cliff, where groundwater from the Refinery area seeps over the cliff and into the apron deposits adjacent to the cliff and the underlying San Juan River Alluvium. Boring SB2-397 showed TPH concentrations ranging between 1,400 mg/kg (at 6 and 25 feet deep) and 2,500 mg/kg (at 10 feet deep) and Boring SB1-397 showed TPH at 317 mg/kg (at 10 feet deep) (see Table 10).

3.1.3. Samples Near Waste Management Units and Spill Sites

In October 1985, Engineering Science collected 13 soil samples from beneath the synthetic liners of the aeration lagoons (former SOWP and NOWP) (see Table 11). Most of them were composite samples from several locations. Only one of these samples detected VOCs, registering 0.0074 mg/kg of xylene. Chromium and lead analyses from the samples also showed concentrations well below soil screening action level that would classify this material as RCRA hazardous waste.

During the October 1985 field program, Engineering Science also collected soil samples from the landfill (e.g., Quadrant #1 Landfill, Table 11). This material is the visually stained soil that was under the sludge removed from the former NOWP and SOWP prior to conversion to the aeration lagoons. The previous refinery owners removed the sludge from the former NOWP and SOWP and shipped the sludge to a TSD facility for proper disposal.

In 1994, GTI collected 11 samples from 10 borings at or adjacent to potential source areas identified by the EPA during the 1987 inspection and in potential or suspected spill areas. Although neither semivolatile organic compounds (SVOCs) nor TPH were detected, two samples measured total benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations below 0.1 mg/kg, and a third sample detected methylene chloride, a common laboratory contaminant, at 0.11 mg/kg (see Table 10). Results for inorganic parameters, such as lead, showed no pattern with respect to location or concentrations that would classify this material as being a RCRA hazardous waste.

Refinery personnel also collected a soil sample during the installation of MW-41, located due south of the Refinery processing area. It is believed that this sample was obtained within a sand zone at the base of the Jackson Lake Terrace. The sample shows a benzene concentration of 875 parts per billion (ppb) (see Table 10). Other VOCs exceeded 10,000 ppb; TPH was 1,900 mg/kg.

Hicks Consultants collected three soil samples within Refinery boundaries: one adjacent to the southerly aeration lagoon (the former SOWP), one between the flare and Tanks 2 and 3, and one at the location of former Tanks 6 and 7. Because standard soil sampling techniques have not been successful in sampling the Jackson Lake Terrace cobbles, all of the samples were obtained from the aeolian unit that is situated above the Jackson Lake Terrace. Black-stained soil was collected near Tanks 3 and 4 and at the location of former Tanks 6 and 7. Analyses of both soil samples detected p-xylene and m-xylene at concentrations above 200 mg/kg (see Table 10). Neither chromium nor lead was detected.

3.2. Groundwater Chemistry

A table of New Mexico and the EPA groundwater standards are presented in Appendix D.

3.2.1. Separate-Phase Hydrocarbon Distribution

Historical evidence suggests that, during the 1980s, SPH periodically entered Hammond Ditch and also discharged to the seeps along the Nacimiento Formation cliff. Along the cliff, the sand and gravel of the Jackson Lake Terrace is stained with hydrocarbons. This staining provides evidence of historic SPH flow near the cliff.

GCL data from 1988 suggest that SPH was present on the south border of the Refinery; however, this report did not discuss SPH distribution throughout the remainder of the Refinery. This report notes that GCL installed the first three recovery wells in 1988. There are no data related to SPH in monitor wells prior to a 1993 GTI report (*RCRA Facility Investigation, Task 1: Description of Current Conditions*). According to the 1993 GTI report, Refinery staff completed an expansion and upgrade of the hydrocarbon recovery system in 1991. Well logs document the installation of RW-14 through RW-19 in August 1990.

The 1991 data represent the groundwater system immediately before the operation of the expanded recovery system and the year-round maintenance of water in Hammond Ditch. Plate 18 plots these 1991 data and shows the SPH zero isopleth truncating against the Nacimiento Formation cliff.

In 1995, GTI calculated the mass of the hydrocarbon plume as 68,000 gallons. If the hydrocarbons have been released over the 40 years of operation, the resulting rate of release is about 5.5 gallons per day (gpd). In 1966, the Refinery produced 172,200 gpd of refined product; currently the Refinery produces about 475,000 gpd of refined product. Using an average of these two production rates, the average daily loss of 5.5 gallons amounts to approximately 0.002 percent of their daily yield.

In April 1999 (see Plate 16), SPH was detected in seven wells in the study area (MW-9, MW-20, MW-40, MW-41, MW-42, MW-43, and RW-18). Distribution of SPH ranged from 0.01 feet in MW-9 to 1.5 feet in MW-42. There were two different types of hydrocarbon product found in the monitor wells in the Study Area. MW-43 was the only well that exclusively exhibited light carbon chains (C-10 and less) indicative of gasoline. The SPH in the remaining six wells exhibited a degraded diesel (GC) pattern. Until the most recent sampling program, two other wells south of the Refinery also exhibited SPH. In August 1994, GTI detected SPH in MW-27. In March 1995 (Plate 17), GTI measured SPH in MW-26. As Plates 16 and 17 show, zero SPH isopleth now truncates against Hammond Ditch. While these plates consistently show SPH thickness of 1 foot or more in the central Refinery area, within the tank farm area (RW-14 to RW-17), SPH thickness has declined from more than 1 foot in 1991 to zero in 1999. Although the most recent sampling program found no measurable SPH in either of these wells, in 1998 Hicks Consultants measured SPH in MW-26 and MW-27. Laboratory tests of the SPH found in these wells suggested a Jet A source. After the Refinery began to maintain water in Hammond Ditch year round, SPH was no longer observed at cliff side seeps.

In October 1999, SPH was not observed in MW-9. However, the geometry of the SPH did not change significantly over this 6-month period. In March 2000, the continued absence of SPH in RW-17 and RW-19 (sheen) was confirmed.

SPH was reported as being present in the Nacimiento Formation seeps prior to the installation of monitoring wells in 1984. The first comprehensive mapping of SPH occurred in 1991. As Plates 15 through 18 show, the magnitude and extent of SPH has diminished since the implementation of the groundwater recovery system in 1991.

Plates 15 through 18 also indicate hydrocarbon migration north toward the Nacimiento Formation cliff. As Plate 18 shows, SPH had migrated into the Nacimiento Formation cliff before 1991; this concurs with historical evidence that SPH flowed from seeps on the Nacimiento Formation cliff during the 1980s. In the early 1990s, the Refinery owners began maintaining water in Hammond Ditch throughout the year. This helped to contain the continued migration of SPH beyond the ditch. As Plate 17 shows, in 1995 the zero SPH isopleth parallels Hammond Ditch. As Plate 16 shows, in 1999, the zero isopleth parallels Hammond Ditch in a smaller area north of MW-20.

To date, the reduction of SPH within the Study Area has been dramatic. There are several possible reasons for this:

- At some sites, SPH thickness diminishes in response to water level changes not related to groundwater recovery systems. This does not seem to be the case at the Refinery, as groundwater levels throughout the Refinery processing and storage areas generally vary by less than 2 feet.
- In older monitor or recovery wells, clogging of the well screen can sometimes cause an apparent reduction in SPH. In sites showing this phenomenon, emulsified SPH or microbial

growth clogs the upper portion of the well screen. In November 1999, Hicks Consultants oversaw a recovery well rehabilitation program. Wells RW-19 and RW-17 were surged and over-pumped for several hours. The wells were sampled twice after this program, at one month and five months, and no SPH was detected.

In light of these results, it seems likely that the groundwater recovery system has effectively reduced the SPH. The data also point to the conclusion that continued pumping of RW-18, and initiation of recovery at MW-40, MW-43, and, potentially, MW-20 would continue to reduce the SPH mass at the Refinery.

3.2.2. Dissolved-Phase Contaminants

The April 1999 sampling event provides the most complete characterization to date of the general chemistry of the groundwater underlying the Refinery. Forty-four samples were analyzed for over 80 chemical species. Samples were collected from three wells screened within the Nacimiento Formation (MW-7, MW-39, and MW-44) and one well that was screened in both the Jackson Lake Terrace and the underlying Nacimiento Formation. All values above detection limits for currently active monitor and recovery wells and seeps 1, 4, and 5 appear in Table 6.

Following is a discussion of each contaminant identified as potential contaminants of concern based on the 1999 comprehensive sampling event.

3.2.2.1. VOCs

Benzene: The extent, magnitude, and fate of benzene in the groundwater determine the quantitative risk posed to human health and the environment by hydrocarbons in the groundwater. Benzene is soluble and mobile; it is also amenable to metabolic destruction by indigenous microbes. Because benzene behaves in a similar manner to other VOCs, and because its health-based standard is the lowest, it was used as a surrogate for all VOCs.

According to the 1999 sampling results, benzene concentrations ranged from "non-detect" (ND) to 30,000 μg/L. Twenty-nine wells exceeded the WQCC groundwater standard. The highest benzene values were in the northern portion of the Refinery, adjacent to the tank berm associated with Tanks 3, 4, and 5.

Between 1985 and 1999, groundwater samples showed the following trends with regard to benzene:

- Benzene was only periodically detected in wells located upgradient of the Refinery storage and processing areas.
- Benzene concentrations beneath or adjacent to documented petroleum release sites exhibited expected degradation trends.
- Benzene concentrations declined in wells located several hundred feet downgradient from documented hydrocarbon release sites.
- Between 1994 and 1999, the extent of the benzene plume boundaries in the groundwater remained essentially unchanged.
- The extent of dissolved-phase benzene has remained constant over time, but the magnitude of the concentration has declined. Plate 20 shows the benzene concentrations within the Study Area in 2000.

Plate 22 shows that the benzene concentrations within the Refinery crude processing and petroleum storage areas have remained consistent while the benzene concentrations down gradient from these release areas (Plate 23) have decreased over time. Comparing Plate 20 with Plate 21 (benzene isopleth map for 1994 to 1995), however, reveals that the extent of benzene in the groundwater has not changed from 1995 to 2000.

SPH thickness measurements in recovery and monitor wells show that the recovery system has reduced the mass of hydrocarbons beneath the Refinery. Removal of the SPH from the groundwater reduces the source of dissolved-phase benzene and other hydrocarbon constituents. The evaluation of MW-11 in Plate 23 shows a consistent decline in the benzene concentration beginning in 1994, three years after the expansion of the hydrocarbon recovery system and one year after the most recent expansion and upgrade of the system. MW-34, RW-1, and RW-3 show this same relationship. MW-27 also exhibited no benzene.

This study indicates that although the extent of benzene in the Study Area remained unchanged from 1985 to 2000, the magnitude of the benzene concentration has been reduced. Secondly, the continued reduction of the SPH mass by recovery operations will further reduce the magnitude and extent of benzene concentrations within the Study Area. Finally, the additional benzene data over time from Seeps 1 and 2 will allow a prediction of the time required for groundwater restoration in the northern portion of the Study Area.

Despite the presence of more than 1 foot of SPH in the Refinery since the late 1980s, benzene migration has also been limited. The active hydrocarbon recovery operations at the site have undoubtedly helped to minimize this migration. In the southwestern portion of the Study Area, dissolved-phase benzene has not migrated beyond MW-35 or MW-36. The evaluation of electron acceptor distribution (dissolved oxygen, sulfate, nitrate, and iron oxides) shows that the concentration of these constituents is inversely proportional to the concentration of benzene.

Seep 5, a shallow drive-point well west of the Refinery, exhibited benzene concentrations of 20, 56, and 7.9 μg/L in the 1998, April 1999, and October 1999 sampling events, respectively. This well point is about 400 feet downgradient from RW-1 (1,000 μg/L benzene in April 1999 and 540 μg/L benzene in October 1999) and MW-40 (2,300 μg/L benzene in 1999). RW-1 has exhibited decreasing benzene over time and relatively low concentrations of sulfate and other electron acceptors.

Data from MW-12 show that the benzene concentration increased from below detection limits (pre-1999) to 23 μg/L (April and October 1999). Wells upgradient from MW-12 (MW-11, RW-3, and RW-1) exhibit decreasing benzene concentrations, as discussed above. It seems quite likely that RW-12 represents the western (downgradient) edge of hydrocarbons in the groundwater. Here, it is expected that benzene and other hydrocarbons will be detected periodically in samples at low levels.

In the northern portion of the Refinery, dissolved-phase benzene continues to flow from the Nacimiento Formation cliff face into the San Juan River Alluvium. Surface water data indicate that the discharge of groundwater to the river does not result in a measurable degradation of surface water quality. These data support the conclusion that dissolved-phase benzene will continue to migrate to the San Juan River Alluvium until the mass of SPH in the northern Refinery area is further reduced.

Groundwater data suggests that leakage from Hammond Ditch, which is unlined, creates a hydraulic mound that restricts the northern migration of SPH. This same leakage may be reducing the concentration of benzene in the groundwater adjacent to and downgradient from the ditch. In 1999, benzene concentrations of 13,000, 30,000, and 18,000 μg/L in RW-22, RW-23, and MW-9, respectively, were observed; in contrast, Seep 1, which is 350 feet downgradient from these wells and 150 feet downgradient from the ditch, exhibited a benzene concentration of 800 μg/L. Although this decrease in benzene concentrations may be a result of biodegradation, the possibility of dilution cannot be excluded.

1, 2, 4 Trimethylbenzene and 1, 3, 5 Trimethylbenzene were present in most wells and at concentrations higher than 40,000 and 11,000 ppb respectively. Concentrations of 1,2,4 Trimethylbenzene and 1,3,5 Trimethylbenzene above 1,000 µg/L are associated with SPH and high benzene concentrations. Because these compounds typically do not degrade in groundwater, at some sites they are used as a conservative tracer to measure the rate of intrinsic biodegradation of BTEX; however, the Refinery site, these compounds appear to degrade in a manner similar to BTEX, and therefore cannot be used to determine the rate of intrinsic biodegradation.

Napthalene: Although naphthalene is not a carcinogen, it presents a potential risk to human health and the environment. Where crude, diesel, or turbine fuel contacts groundwater, naphthalene is common as a dissolved constituent. It is less mobile in groundwater than benzene, and also more recalcitrant to biodegradation.

There are no chemical data over time that display the temporal variation of naphthalene, and consequently, this study relies entirely on the April and October 1999 sampling events to interpret its presence in groundwater chemistry.

According to the April 1999 event, naphthalene was present in the Study Area in concentrations 1,000 times above the health-based standard (see Plate 31). Naphthalene and 1-methylnaphthalene, as well as other polynuclear aromatic hydrocarbons (PAHs), were present above the WQCC standard (0.03 mg/L for total PAHs) in most of the sampled wells. A comparison of Plate 31 and Plates 15 through 18 indicates that naphthalene was detected in wells that showed SPH either in April 1999 or in past sampling events. The exceptions to this observation, MW-11, MW-34, MW-31, MW-21, MW-27, and MW-28, are discussed below.

MW-34 is located outside the SPH plume, but it shows a high concentration of naphthalene. It is probable that the naphthalene in MW-34 is a relic of a past hydrocarbon release from a nearby oil and gas production well and is unrelated to the Refinery. Near the production well, the dissolved iron concentration is also two orders of magnitude higher than in adjacent monitor wells. The well site shows evidence of past crude oil spills and/or produced water disposal activity, including a warning sign from previous owners. Naphthalene was not detected in this well during the October 1999 sampling event.

MW-11, MW-31, MW-21, MW-27, and MW-28 are located adjacent to the 1999 SPH plume as mapped in Plates 16. The detection of naphthalene in these wells is not surprising. Conversely, MW-27 has exhibited SPH in past sampling events, but showed no naphthalene in the April and October 1999 analyses.

Seeps 5 and 1 (see Plate 16) also exhibit naphthalene. Seep 1 is adjacent to the Nacimiento cliff face where previous reports identify SPH. Therefore, naphthalene in this seep is not surprising. In Seep 5, naphthalene is well below WQCC standards (ND in April 1999 and 12 mg/L in October 1999), and the naphthalene at this location poses no threat to human health or the environment.

Comparing the lower concentrations of sulfate, dissolved oxygen, nitrate, and iron with the background wells suggests the oxidation of hydrocarbons in the southern and western portions of the Refinery. The biologic degradation of naphthalene is a possible explanation for the absence of naphthalene in MW-27.

Methyl tertiary-butyl ether (MTBE) was detected in 12 samples. Four samples, all taken in the southwestern corner of the Study Area, exceeded 100 mg/L. MW-12, a well adjacent to and down gradient from Hammond Ditch, exhibited 140 mg/L of MTBE.

MTBE is not produced at the Refinery. It is stored in a single tank near the product-loading terminal (east of MW-13) and is added to the refined products at the terminal. That MW-13 exhibited MTBE at 18 µg/L and other wells downgradient from MW-13 show concentrations one order of magnitude greater (e.g., MW-11, 160 µg/L and MW-34, 510 µg/L) leads to the conclusion that MTBE was released at or near the loading terminal. Furthermore, the data suggest that the release was a single event that caused a slug of MTBE to enter the groundwater and migrate downgradient. The center of mass of the MTBE slug is at or near MW-34. The March 26, 1996 spill and fire that occurred at the loading terminal may be the source of the MTBE in the groundwater (see Table 1).

Aluminum exceeded the WQCC standard of 5 mg/L in seven wells, showing a maximum concentration of 200 mg/L.

Boron was detected in most wells and was above the 0.75 mg/L standard in six wells.

Barium, chromium, and lead have been detected in groundwater samples. However, the evaluation of lead and chromium data from groundwater sampling at facility wells shows no elevated, localized concentrations; thus, a non-point source origin is indicated. It appears that the former NOWP and SOWP were not the source of a hazardous waste release. Barium was selected for evaluation because the 1999 analyses showed barium exceeding the WQCC standard in 14 wells.

Barium exceeded the WQCC standard of 1.0 mg/L in 17 wells. Because barium is also a hazardous constituent regulated by RCRA, the spatial distribution of barium was examined; however, barium naturally occurs in elevated concentrations in the soils of this region as barium sulfate. Concentrations below 0.06 mg/L were present on the south and west sides of the Refinery.

The barium concentration in the groundwater correlates to high hydrocarbon content and low sulfate concentration. The data suggest that naturally occurring barite ($BaSO_4$) is dissolving in the groundwater in response to the metabolic oxidation of hydrocarbons.

Chromium was found to be above the WQCC standard of 0.05 mg/L in 10 samples. Wells that exceeded this standard include MW-12, MW-37, and MW-38, which are located in the southwestern corner of the Study Area and shown on Plate 27. MW-43, located between the aeration lagoons (former SOWP and NOWP), showed a chromium value of 0.11 mg/L. Previous analyses of solid waste from these units did not show chromium levels above RCRA limits.

In 1999, chromium concentrations were high in three places: the processing area, background well MW-8, and wells MW-37 and MW-38. In the processing area, the chromium concentration of 0.19 mg/L (MW-40 and MW-41) could have resulted from past releases of chromium-containing, process-specific chemicals in process streams. The concentrations of 0.17 and 0.15 mg/L at MW-37 and MW-38, respectively, are unusual in that past samples show little or no evidence of chromium. At MW-8, an anomalous concentration of 10 mg/L is two orders of magnitude higher than concentrations shown in any other analysis, past or present. MW-8 was re-sampled in June 1999; at that time the chromium concentration was 0.8 mg/L. It seems likely that minerals such as magnetite, illmenite, and chromite, which dissolve in anaerobic groundwater, contribute dissolved metals to the groundwater.

Lead ranged in concentration from 0.3 mg/L to less than detection limits. Eleven samples exceeded the WQCC standard of 0.05 mg/L. Lead concentrations exceeded the WQCC standard in wells exhibiting high hydrocarbon concentrations near the processing area of the Refinery.

Lead concentrations (see Plate 29) were similar to those for iron (see Plate 28). The record of analyses demonstrates that lead was detected in about 30% of the analyses. About 20% of the approximately 200 samples exceeded the WQCC standard (0.05 mg/L). Lead concentrations detected in background well MW-1 have exceeded this standard eight times since sampling began in 1984. These data suggest that lead concentrations throughout the Study Area are at or near natural background levels.

A record of analyses exists only for wells MW-1 and MW-4. Table 8 shows that barium and chromium have remained near or below the detection limit in MW-1; however, lead appears to have declined over time. Although a data gap exists in the record for MW-4 between 1989 and 1995, the barium concentration in this well appears to have been consistent over time. During the period of investigation, chromium and lead were near or below the detection limits.

Sulfate serves as an indicator for the ability of the aquifer to attenuate hydrocarbons. Of the electron acceptors oxygen, nitrate, sulfate, and ferric iron, the Refinery historically collected more sulfate data. The April 1999 data show the depletion of electron acceptors, including sulfate, within the zone of high hydrocarbon concentration.

MW-1 and MW-4 provide a relatively complete history of sulfate concentrations in the groundwater at the Refinery. Plate 33 shows the historic concentration of sulfate in MW-1 compared with the other background wells, MW-3, and MW-8. The mean sulfate concentration in MW-1 over time was 681 mg/L (with a standard deviation of 298 mg/L). MW-8, which is further from Hammond Ditch than MW-1, exhibits sulfate concentrations near 1,000 mg/L. In the late 1980s, the sulfate concentration in MW-3 was about 2,000 mg/L; in 1999, long after the closure of the spray irrigation area, the sulfate concentration was approximately 1,000 mg/L.

Plate 34 shows MW-4 and MW-9 sulfate concentrations over time near the documented petroleum release sites. The mean for MW-4 was 6.3 mg/L (with a standard deviation of 3.5 mg/L), and the mean for MW-9 varied between 12 and 117 mg/L. The mean sulfate concentration for the down gradient wells MW-11, RW-1, MW-34, and MW-35 was 44 mg/L. In Plate 34, the sulfate concentration in MW-5 is shown as decreasing since 1992.

Sulfate exceeded the 600 mg/L standard in 12 samples. Values higher than 2,000 mg/L were found in Nacimiento Formation wells. The highest observed value in the Jackson Lake Terrace was 1,600 mg/L in MW-31, which is south of the tank farm releases in the product storage area. Like TDS, higher values of sulfate occurred in the southeastern portion of the Study Area. With the exception of an anomalous value of 1,570 mg/L in RW-3, sulfate generally exhibited concentrations of less than 100 mg/L in wells that showed hydrocarbon concentrations and in wells downgradient from wells that exhibited hydrocarbons. Sulfate is an electron acceptor; the spatial variation observed is similar to that of dissolved oxygen, nitrate, and iron.

Between 1985 and 1999, groundwater samples show the following trends with regard to sulfate:

- Sulfate concentrations were about 600 mg/L in wells upgradient from the Refinery storage and processing areas.
- Sulfate concentrations beneath or adjacent to documented petroleum release sites ranged from 117 mg/L to below the limit of detection.

Sulfate samples were not regularly collected from wells located several hundred feet downgradient from documented hydrocarbon release sites.

Sulfate concentrations have exceeded the 600 mg/L WQCC standard in the southern portion of the Study Area (MW-32 and MW-33) and at other wells where the saturated thickness of the Jackson Lake Terrace is less than 4 feet (MW-31 and RW-3). Near the former spray irrigation area (MW-5, MW-3, and MW-30), sulfate concentrations have also exceeded the WQCC standard. In most wells where hydrocarbons are present, the sulfate concentration has been below 50 mg/L.

The above data point leads to several conclusions. Where the saturated thickness of the Jackson Lake Terrace is less than 4 feet, the background sulfate concentration is about 1,500 mg/L. The sulfate concentration at and near the former spray irrigation area will continue to decline with time. Additionally, in the northern portion of the Study Area, the oxidation of hydrocarbons has caused sulfate to reduce to a lower oxidation state. The sulfate concentration in the Jackson Lake Terrace should remain relatively constant until the oxidation of hydrocarbons is complete. At that time, normal recharge will result in background sulfate concentration levels in the northern Study Area (about 100 mg/L).

Manganese exceeded the 0.2 mg/L standard in all but 2 of the 41 samples where this metal was detected. MW-30 showed the highest concentration (22.5 mg/L).

Nitrate exceeded 10 mg/L (as N) in seven wells. Like sulfate and other electron acceptors, the highest concentrations of nitrate occurred in the southern portion of the Study Area, distant from the elevated levels of hydrocarbons in the groundwater. Nitrate was not detected in most recovery wells; nor was it detected in wells that exhibited SPH.

Chloride data were similar to TDS variations. For wells within the storage and processing areas, the chloride concentration was also similar to the trends observed for TDS, with the exception of an anomalous value of 1,000 mg/L for MW-9 (1986). Plate 26 displays the historic chloride trend in these wells.

Chloride was above the 250 mg/L standard in more than half of the wells tested (23 of 44). The highest concentration was 2,340 mg/L (MW-5); the lowest concentrations of 24.6 and 34.5 mg/L were in Nacimiento Formation wells (MW-39 and MW-7, respectively). Chloride comprised about 30% (by weight) of the TDS in the Jackson Lake Terrace groundwater.

TDS provides a gross characterization of inorganic parameters and the general quality of the groundwater for domestic, agricultural, and industrial purposes. The Refinery's testing program created a historical record of TDS concentration in several wells. MW-1, MW-4, and MW-5 have the most complete record of TDS values over time. In the October 1999 sampling event, TDS, chloride, sulfate, and metal concentrations were not evaluated.

TDS concentrations detected in the April 1999 sampling event are exhibited on Plate 35. Between 1985 and 1999, groundwater samples showed that TDS concentrations remained relatively stable at about 2000 mg/L in wells upgradient from the Refinery storage and processing areas and beneath or adjacent to documented petroleum release sites.

Numerous factors influence the TDS concentration in the groundwater zone. Leakage from Hammond Ditch, from the old raw water ponds, and from the new raw water ponds (re-engineered from the former evaporation ponds) recharges the Jackson Lake Terrace with low-TDS water. At and downgradient from the former spray irrigation area (see Plate 4), TDS concentrations range from over 5,000 mg/L (MW-5) to 3,000–4,000 mg/L (MW-13 and MW-31). All three wells and several adjacent wells (e.g., MW-30) exhibit high TDS values due to discharges from this former disposal area. In the petroleum storage and crude processing areas of the Refinery, spills and other surface releases may have contributed to the observed TDS values of 2,000 mg/L or more. In the southern portion of the Study Area, where the saturated thickness of the Jackson Lake Terrace is less than 2 feet, TDS values are greater than 3,000 mg/L (MW-32 and MW-33).

The following are conclusions that can be drawn from the above data. First, the background TDS concentration of the Jackson Lake Terrace in the southern portion of the Study Area, which is unaffected by the Refinery or Hammond Ditch, is greater than 3,500 mg/L (MW-32 and MW-33). Here, the Jackson Lake Terrace is thin and the water quality is similar to the underlying Nacimiento Formation. Second, TDS concentrations at and downgradient from the former spray irrigation area will continue to decrease over time (see Plate 38). Furthermore, leakage from Hammond Ditch and recharge from the unnamed arroyo in the southern portion of the Study Area contribute low-TDS water to the Jackson Lake Terrace, which results in TDS concentrations between 408 mg/L (MW-1) and 646 mg/L (MW-36). Downgradient from these recharge areas, TDS values decrease and approach background concentrations. Lastly, the background concentration of TDS beneath the Refinery is best represented by MW-8 (2,246 mg/L), and the magnitude and extent of TDS concentrations above 1,000 mg/L will remain static until the recharge regime changes (e.g., lining Hammond Ditch).

Iron commonly exceeds the WQCC standard of 1.0 mg/L in groundwater that contains hydrocarbons. Iron exceeded the standard in 38 of the wells tested. The highest concentration of iron was in MW-41 (326 mg/L) (see Plate 28). Iron is an electron acceptor. In a saturated unit, iron oxides are ubiquitous as staining, grain coatings, and heavy mineral "placer" deposits in alluvial sediments (e.g., magnetite). In the absence of dissolved oxygen or other dissolved-phase electron acceptors, microbes will use the oxygen bounded to the solid iron oxides for respiration. The result is dissolution of the iron oxides and an increase of dissolved iron in groundwater.

3.2.3. Incomplete Characterization of Dissolved-phase Plume

In review of the geotechnical data, two regions of the site are not completely characterized based on the current data. The regions include the 1) upgradient area that represents background water quality, and 2) downgradient area near Seep 5 that represents groundwater quality in the area of aquifer discharge. To remedy these data gaps, a monitor well and sampling program are proposed for the two areas identified on Plate 40. Upon NMED and NMOCD approval, a work plan will be submitted outlining the exact locations of the wells, well installation, and groundwater sampling.

3.3. Surface Water Chemistry

Hicks Consultants did not obtain any surface water samples during their field program. Table 9 presents analytical results of surface water samples obtained in earlier studies. Only Hammond Ditch and the San Juan River were sampled in these studies and are discussed below.

3.3.1. Hammond Ditch

In 1986, Refinery staff collected two sets of surface H_2O samples from Hammond Ditch: one on April 22, 1986 and another on April 28, 1986. Engineering Science summarized the protocol for this sampling event in the *Final Report on the Section 3013 Administrative Order* (1987). Organic constituents were detected in the initial flow sample, which was taken downstream from the Refinery. After seven days of flow, only phenol was detected. Table 9 presents the results of this sampling. In August 1994, GTI sampled 14 locations along Hammond Ditch. The analyses did not detect any VOCs or SVOCs, with the exception of methylene chloride, a common laboratory contaminant. However, lead and zinc were identified in two samples.

3.3.2. San Juan River

In 1987, BRC personnel sampled water from the San Juan River. Samples were obtained upstream from the Refinery and downstream at the New Mexico Highway 44 Bridge. Of the downstream samples, those labeled "near side" were taken on the south side of the bridge; those labeled "far side" were taken on the north side. During the 1994 RFI, GTI re-sampled the San Juan River. Three samples were obtained: (1) SJ-1W, taken due north of the former evaporation ponds, represents upstream conditions; (2) SJ-2W, obtained due north of the San Juan River intake for the Refinery, probably also represents upstream chemistry; and (3) SJ-3W, obtained adjacent to the location where SPH entered the river in the past and the San Juan River Alluvial sediments truncate against the Nacimiento cliff face and the San Juan River, represents downstream conditions. Table 9 presents the results of both the 1987 and the 1994 sampling events. Neither event detected VOCs or SVOCs. The 1987 event detected phenols in upstream and downstream samples and lead in two downstream samples. The lead concentration in samples taken at the New Mexico Highway 44 Bridge was 0.01of EPA's Ambient Water Quality Criteria (6.19 mg/L, for chronic exposure).

3.3.3. Seeps

Hicks Consultants and Refinery personnel sampled several seeps along the cliff north of the Refinery and in a constructed channel due west of the Refinery. Because these samples represent areas where groundwater intersects the ground surface, the results of these sampling events will be discussed below in the groundwater section.

3.4. Sediment Sampling

Sediment sampling from Hammond Ditch detected petroleum hydrocarbons at concentrations below regulatory limits. A sample of hydrocarbon-stained alluvium obtained from the bank of the San Juan River did not exhibit VOCs. Soil samples obtained from below the liners of the former NOWP and SOWP in 1985 (see Table 11) did not exhibit hazardous waste constituents as defined in RCRA.

Hydrocarbon-stained soil is evident where releases of SPH in the petroleum storage areas and crude processing area have been documented. The highest concentrations of aluminum, barium, iron, lead, cobalt, and chromium generally are coincident with the highest concentrations of petroleum hydrocarbons.

3.4.1. Constituents of Concern

In this report, petroleum hydrocarbons and other analytes that exceed WQCC standards are considered to be constituents of concern (COCs). Whereas the provenance of SPH can be clearly associated with releases from the Refinery, the source of other COCs is not readily apparent.

The data analyzed for this study have suggested several conclusions regarding the provenance of SPH: 1) in the southern portion of the Refinery, the sources of SPH were from releases of jet fuel (e.g., March 8, 1991 from Tank 26) and diesel (e.g., May 19, 1985 from Tank 19); and 2) in the central and northern Refinery area, SPH originated from releases of intermediate products (e.g., November 7, 1984, naphtha), diesel (e.g., April 8-9, 1986, east of the crude unit), and gasoline (former Tanks 6 and 7).

The origin of several other constituents can be related to the release of hydrocarbons. The Jackson Lake Terrace was originally deposited under aerobic conditions. During the Late Pleistocene, when precipitation was greater than today, groundwater may have existed in the Jackson Lake Terrace. Such groundwater would have been oxygen rich. If groundwater existed in this unit during recent time, but prior to the construction of Hammond Ditch, this groundwater would also have been oxygen rich. The releases of petroleum hydrocarbons into the groundwater would have depleted the oxygen in the groundwater beneath the Refinery. In such reducing groundwater conditions, mineral oxides (such as hematite, magnetite, illmenite, chromite, and barite) will dissolve and release metals (such as iron, magnesium, chromium, or barium).

Many COCs are above WQCC standards in wells far removed from the Refinery or at locations upgradient from active water treatment units. Except for samples from wells adjacent to Hammond Ditch and the raw water ponds, chloride and TDS exceed WQCC standards. This suggests that the concentrations of chloride and TDS naturally increase with distance from artificial recharge areas.

However, past Refinery activities (the spray irrigation area and the former evaporation ponds) also contributed to increased concentrations of chloride and TDS. Furthermore, the fact that boron and aluminum are above WQCC standards appears to be a natural condition; however, it is also possible that the elevated concentrations of these metals are partially a result of the lack of field filtering during the April 1999 sampling event. Field filtering during the September 1999 sampling event may show that boron and aluminum levels are below WQCC standards. Except where reducing conditions have essentially removed sulfate from the groundwater, sulfate exceeds WQCC standards throughout the southern portion of the Study Area.

3.5. Background Water Chemistry

Prior to the completion of Hammond Ditch and the evaporation ponds used to handle Refinery wastewater, the Jackson Lake Terrace beneath the Refinery property was dry. Although no documentation exists, it is thought that soil borings from the geotechnical investigation of the site, before construction of the Refinery, showed no water. Currently, the water of the Jackson Lake Terrace is derived from Hammond Ditch and the raw water ponds that replaced the evaporations ponds. Because the water of the Jackson Lake Terrace is of an anthropogenic origin, background water conditions would be defined by the absence of water. Nonetheless, a background or reference water quality is needed to gauge the contribution of certain constituents from natural processes. Ideally, an upgradient groundwater sample would serve as background; however, Hicks Consultants contend that drilling upgradient of the site would yield a dry well. A test boring is proposed for the eastern portion of SJRC property, (east of the arroyo as depicted in Plate 40) to determine the location of the water table. If groundwater is detected, the construction of a monitor well will be proposed and sampling conducted to assess background water quality.

3.6. Exposure Assessment and GTI Risk Assessment

GTI identified COPCs in the document *Human Health and Ecological Risk Assessment*, dated December 12, 1995. GTI identified the following chemicals as COPCs:

- In soil:
  - Cadmium
  - Copper
  - Nickel
  - Zinc
  - Benzene
  - Toluene
  - Ethylbenzene
  - Xylenes
  - 2,4 Dimethylphenol
  - 2-Methylnaphthalene
  - 3-Methylphenol
  - Naphthalene
  - Phenol
- In groundwater:
  - Benzene

- Toluene
- Ethylbenzene

The 1995 GTI report identified media of concern (e.g., soil, water, and air), potential human and ecological receptors, and the potential risk associated with exposure to COPCs found at the Refinery. GTI included cadmium, copper, nickel, and zinc in soil as COPCs because these compounds were consistently detected above background levels. The organic compounds in groundwater are COPCs because they exceed numerical standards in several monitoring wells. GTI did not identify any inorganic substances as COPCs in groundwater. GTI also did not detect COPCs in sediments from the San Juan River or in the surface water from Hammond Ditch or the river. Therefore, GTI limited the media of concern to surface soil, the perched groundwater zone, and Hammond Ditch sediments.

4. ABATEMENT ALTERNATIVES

Abatement options for the Refinery area include remedial technologies and environmental management alternatives ranging from soil vapor extraction (SVE) to "no action." The March 1993 *RCRA Facility Investigation – Task I: Description of Current Conditions* report included a pre-investigative evaluation of abatement options. GTI also provided Bloomfield with the following evaluation of abatement alternatives in the original CMS.

4.1. Screening of Abatement Alternatives

As part of the groundwater discharge plan and the CMS process, each abatement alternative was re-evaluated in light of the data collected as part of the RFI, GTI's evaluation in the original CMS, and data from this investigation.

Abatement options were screened and a screening matrix was used to evaluate which technologies would effectively improve water quality by addressing the following remedial objectives:

4.2. Description of Technology Evaluation Parameters

Nine abatement options were screened to address surface water, SPH, and the unsaturated zone, and seven options for the saturated zone. Each technology was evaluated according to three categories of appropriateness: site characteristics, COC characteristics, and technology limitations. Some of the abatement options identified, such as SVE, are applicable to more than one zone. Abatement options such as these are more applicable to the site because one measure can help fulfill more than one objective. Those technologies that were unacceptable in any one of the categories were eliminated. Options that were acceptable in all three areas were retained for further consideration on a more detailed level.

A description of the rating considerations is provided below. Note that the evaluation of various remediation technologies does not imply that any remediation technology is required to meet the abatement objectives at the Refinery. A "no action" alternative is also a reasonable solution, if it will meet the abatement objectives.

4.2.1. Site Characteristics

Site data, including current operations, geology, and hydrology, were reviewed to identify any conditions that would limit or promote the use of particular abatement technologies at the Refinery. Technologies that were precluded by site conditions were not retained for further consideration.

4.2.2. COC Characteristics

Abatement options were considered despite the characteristics of the COCs that may limit the effectiveness or feasibility of particular technologies. Methods that were limited in remediating petroleum hydrocarbons were eliminated.

4.2.3. Technology Limitations

Each abatement option was evaluated on: (1) how developed the technology was; (2) how the technology had performed at similar sites; and (3) any inherent construction, operation, or maintenance problems. Technologies that had performed poorly or had not been fully demonstrated at sites similar to the Refinery were not retained for further consideration.

4.2.4. Retention of Options

A final decision on whether to retain a specific listed technology as a candidate for application was made based on the three criteria identified in Section 4.2.3. Abatement options unsuitable for the Refinery due to site or waste characteristics or inherent technology limitations were not retained for further consideration. Tables 17 through 20 summarize the results of the screening process. The retained abatement options are described in Section 4.5 - 4.7.

4.3. Evaluation of Abatement Alternatives

This section presents a detailed evaluation of retained abatement alternatives based on how well they address the three abatement objectives listed in Section 4.2. Each alternative was examined in terms of characteristics and environmental concerns specific to the Refinery. Section 4.3.6 outlines the rating system methodology applied and Tables 17 through 25 summarize the evaluation.

Due to the extent of the release at the Refinery, a "no action" alternative is not acceptable. For purposes of quantitative comparison, monitored natural attenuation (MNA) has been referred to as the baseline, or zero, option and all other alternatives have been rated relative to this option.

As directed in the AOC, each corrective action alternative was evaluated according to the following criteria: technical, environmental, human health, institutional, and cost.

4.3.1. Technical Considerations

Technical evaluation of abatement options is based on performance, reliability, and ease of implementation.

Performance includes the ability of a particular method to meet the objective, any waste or site characteristic that would impede the effectiveness of a given method, and the useful life of the method in question.

Reliability considerations include the operation and maintenance requirements for each alternative, including the frequency and complexity of maintenance operations, and the availability of labor and materials. This category also includes the demonstrated reliability of each method at similar sites.

Ease of implementation concerns the ease of installation, the time required to achieve a given level of response, the constructability of the system (including the location of utilities, the depth to water, any heterogeneities, and the location), and external factors such as required permits, equipment availability, and location of treatment and disposal facilities. Ease of implementation also includes a consideration of the time needed for the method to begin functioning effectively and the time required to reach a desired level of remediation. This length of time was approximated using professional judgment.

4.3.2. Environmental Considerations

Environmental considerations include short- and long-term beneficial and adverse effects, adverse effects on environmentally sensitive areas, and the analysis of measures to mitigate adverse effects.

4.3.3. Human Health Considerations

Human health factors include mitigation of short- and long-term potential exposure and the ability of a particular method to be protective of human health both during and after implementation. The AOC also takes into account potential exposure pathways and potentially affected populations in this area of evaluation. GTI performed a complete risk assessment for the site and discussed these and other risk assessment factors associated with all aspects of the site (see Section 4.2). Because of this, only new exposure routes created by the abatement were included in this area of evaluation.

4.3.4. Institutional Considerations

This area of evaluation considers the effects of federal, state, and local standards as well as regulations and community relations on the design, operation, and timing of each abatement alternative.

4.3.5. Cost

A two-tiered cost estimate for each abatement option was developed. The first component of the estimate is for the year in which the method is implemented. The cost includes all construction, engineering design, and legal and regulatory costs associated with installing the system and initiating operation. It also includes the first year's expenses for operation and maintenance, labor and materials, energy, professional and laboratory fees, disposal costs, and administrative costs. The second component of the cost estimate is an annual cost for every year following the first. The annual cost includes operation and maintenance, energy, professional and laboratory fees, disposal costs, and administrative costs.

The costs developed during this evaluation are estimates and may not match actual costs of implemented corrective action alternatives. However, they can be used as an evaluation tools in determining corrective action alternatives that are most cost-effective for the Refinery.

4.3.6. Rating System

The AOC provides the criteria for evaluating different abatement options, but does not specify what importance each element should carry. Therefore a simple rating system was established, applying appropriate weighting factors to those considerations deemed most important at the Refinery.

The alternatives for each abatement option were evaluated relative to MNA. If a measure provided higher benefits than MNA in a particular category, it was assigned a value of "+1." If the measure proved to be less beneficial than MNA, it was assigned a value of "-1." If the measure provided similar benefits, or provided additional benefits but also created adverse effects of the same magnitude, the measure was assigned a value of "0." By definition, MNA was assigned a "0" for every category.

In addition to the relative comparisons, each evaluation criteria was assigned a weighting factor based on relative importance at the Refinery. For example, protection of human health was deemed more important than cost of implementation. Thus, the human health category was assigned a larger weighting factor than the cost category. Table 25 lists the assigned weighting factors and the justification for each factor.

Tables 17 through 20 display the results of the rating and evaluation for each of the abatement alternatives. The recommended remedial system selected was based on the relative merit of each alternative.

4.4. Remedial Objectives of Abatement Alternatives

The remedial objectives of the abatement alternatives are to: provide contaminant mass reduction (SPH source removal); and minimize the discharge of contaminated groundwater to the San Juan River (reduction of dissolved-phase VOC concentrations).

4.5. SPH Removal (Source Control)

Based on the evaluation of investigations summarized above, and described in this Plan, several abatement options, based on technical and regulatory considerations, are currently in use.

4.5.1. Design of SPH Removal System (Interim Measures)

SPH recovery activities began in June 1988 when Refinery owners installed skimmer pumps in several wells at the SPH/water table interface. Well fluids are piped through coated and wrapped carbon steel sewer lines to the API separator and recovered SPH returns to the refining process. Recovered groundwater discharges to the wastewater treatment system through the API separator, to the wastewater aeration lagoons, to the lined evaporation ponds south of the former spray irrigation area, and is then discharged to the Class I injection well.

The skimmer pumps are approximately 3-foot-long, 2 3/8-inch diameter PVC or stainless steel with top-fill ports set at the SPH/water table interface. The pumps operate on a timed cycle, with an average pumping rate estimated at a maximum of 0.5 gpm. Each pump fills for a set time; a timer then activates the pumping cycle, and a compressor applies air to the pump, forcing the liquid to the surface.

4.5.2. Configuration of SPH Recovery System

The configuration of the system has evolved over a period of years.

In ***June 1988,*** two recovery wells (RW-1 and RW-2), three piezometers, and one monitoring well (MW-10) were installed. MW-10 was converted to a third recovery well (RW-3), and air-operated skimmer pumps were installed in the three recovery wells. The system began operation in January 1989.

In ***August 1990,*** additional hydrocarbon recovery wells (RW-14 through RW-19) were installed. Each well was equipped with a recovery pump to pipe SPH to the recovery system. Two additional recovery wells (RW-22 and RW-23) were installed in 1993 as part of the IM work plan implementation.

By ***June 1999,*** 4 of the 11 recovery wells described above, were no longer in use. Refinery personnel discontinued hydrocarbon recovery in RW-1 and RW-3 because no SPH was recorded in consecutive monitoring events. RW-22 and RW-23 never contained SPH and consequently were never equipped with pumping systems.

The remaining seven wells (RW-2 and RW-14 through RW-19) were in operation during the late 1990s. RW-17 and RW-19 were equipped to pump only SPH; the remaining wells pump both water and SPH. The pumps yielded approximately 0.5 to 2 gpm per recovery well.

As of ***June 2001,*** the SPH recovery system is operating almost as it was in 1999. RW-2, RW-14 through RW-16, and RW-18 are pumped for total fluids, while RW-17 and RW-19 are pumped for SPH only. One additional well, RW-43, is also pumped for SPH in an attempt to increase source removal efficiency. All wells continue to yield between 0.5 and 2 gpm. On June 16, 2001, all pumps were temporarily deactivated to allow aquifer conditions to stabilize, and a field study was conducted to monitor the static thickness of SPH in both the recovery wells and surrounding monitor wells. These activities, conducted in the same fashion as they have been throughout the lifespan of the recovery system, indicated that SPH was present only in RW-17, RW-18, and RW-19. The observed SPH thicknesses for these wells were 0.5, 0.75, and 0.5 foot, respectively. An interpretation of these three values (as illustrated in Plates15-18) reveals that the extent of SPH has been reduced from that existing in 1999.

4.5.3. Performance of SPH Recovery System (Interim Measures)

SPH comprises the largest portion of the total mass of petroleum hydrocarbons under the Refinery. GTI and Hicks Consultants both used well gauging events to estimate the extent of SPH. Hicks Consultants generated isopleths of product thickness and GTI evaluated SPH thickness to estimate total volume of SPH that may have underlain the site during 1994 and 1995. For these SPH volume calculations, GTI estimated the extent of SPH by using rectangles to delineate the areas where measurable thickness of product was observed compared with areas where only sheen was present. GTI used assumed thickness for sheen and measurable product areas as 0.001 and 0.01 foot, respectively. The basis for this assumption is not well documented. The assumed SPH thickness estimates do not necessarily correspond well with site conditions since SPH thickness interpretations by Hicks Consultants indicate isopleths ranging from 0 to 1 foot. This disparity is attributed to the assumption that accounts for the surface tension effects occur between SPH and the surrounding aquifer matrix and well materials. The surface tension effects typically lead to smearing of SPH within the borehole and overestimates of product thickness.

GTI estimated the SPH mass residing in the smear zone (the zone across which the water table fluctuates as well as the difference in product saturation between this zone and the water table. The thickness of the smear zone was taken as the historical average fluctuation in all monitor wells plus a standard deviation of this fluctuation. The resulting thickness was 2.2 feet. Mass residing in the vadose zone was accounted for by conservatively overestimating the SPH extent through the use of rectangles to delineate SPH areas that appear to resemble a more oblate shape.

The mass of SPH recovered by pumping can be estimated as the difference in volumes estimated for different time intervals. For consistency, SPH mass recovery calculations performed, for the purpose of this report, use similar methodology to that used by GTI in previous investigations. SPH isopleth interpretations by Hicks Consultants have been superimposed with GTI's SPH delineation rectangles, as shown in Plates 15 through 18. Hicks SPH isopleth interpretations were used because they provide a consistent and historical testimony of SPH conditions. However, the Hicks delineation of SPH appears to be more conservative based on the disparity of 1995 volumes currently calculated as 91,500 gallons (Hick's delineation) and 65,000 gallons (GTI delineations).

The resulting calculations provide a general estimate of the total volume of SPH that has underlain the site between 1991 and 2001. Based on these estimates, the SPH recovery system has effectively reduced SPH mass by nearly 80% since 1991. The reduction of SPH is evidenced by the persistent reduction in the extent of the SPH plume as illustrated in Plates 15-18. The SPH mass removal estimates are:

- 1991: 111,214 gallons
- 1995: 91,439 gallons (18% SPH removal)
- 1999: 31,966 gallons (71% SPH removal)
- 2001: 22,201 gallons (81% SPH removal)

The absolute magnitude of the SPH volumes may not be exceptionally accurate due to both the simplifying nature of the calculations and the difficulty in collecting detailed field estimates of SPH thickness. The calculated estimates of SPH reduction are considered reasonable approximations of site conditions that provide a basis for assessing the performance of the SPH recovery system. Regardless of the actual volume, the remaining SPH must be removed, or at least contained, to improve water quality and to meet the abatement objectives. To meet this goal, five abatement options for SPH remediation are presented in the following section.

4.6. SPH Removal Technologies

This section summarizes the proposed options, as well as the design and results expected from SPH removal technologies: total fluids pumping, SVE, and in-situ air sparging (IAS), water table depression and SVE, and sheet pilings/slurry wall.

4.6.1. Total Fluids Pumping

Design: Total fluids pumping is used to bring SPH and hydrocarbon-impacted groundwater to the surface for treatment or disposal. This is accomplished by installing pumping wells within the SPH plume. The recovery wells pump SPH and hydrocarbon-impacted groundwater first to the existing Refinery API separator, then to the aeration lagoons, and, finally, to the injection well. Pumping is most effective in saturated zones with high hydraulic conductivities such as those measured at the Refinery. In the past, drawdown in each pumping well has been relatively low, limited by the capacity of the facility's water treatment system. Since the installation of the injection well in 1995, however, each pump can discharge 1.5 to 2 gpm.

Results: Total fluids pumping will meet the objective of removing SPH from the source area. Total fluids pumping is a commonly used and well-proven technology. Well gauging events indicate that the seven recovery wells currently engaged in total fluids pumping at the Refinery (see Section 4.5.2) have demonstrated significant SPH removal over the past decade and should continue to do so if this method is chosen as the primary source treatment mechanism. In addition to source removal, the method also provides some hydraulic containment by inducing hydraulic gradients that either slow or reverse the direction of groundwater flow in the vicinity of the pumping wells.

Because a system is already in place, this abatement option has several advantages. First, there would be no time delay associated with implementing this active method to reduce the source area. Similarly, there would be no costs associated with its installation. The costs incurred would be those associated with the annual operation, maintenance, and performance monitoring. Based on data from previous years, the approximate annual cost for total fluids pumping is $5,000. Finally, because the system has been active for the past ten years, pumping should be acceptable to regulatory agencies.

The only identified limitations to this abatement option:

- Bringing impacted groundwater to the surface creates additional exposure pathways. While the refinery has the ability to treat both the SPH and the water onsite (thus reducing the risk of accidental release during transport), risk is still associated with onsite disposal and possible accidental release to other portions of the Refinery property.
- The equipment required for pumping has a limited lifespan and requires three to four hours of weekly maintenance in order to operate effectively.
- The hardness in the water at the Refinery will require frequent cleaning of the pumps in order to maintain pumping efficiency.
- The mass removal efficiency may decrease over time to a level that may become cost-prohibitive.

4.6.2. Soil Vapor Extraction

Design: SVE is a process in which soil vapors are vacuumed out of the subsurface through vapor extraction wells connected to a vacuum blower. Active venting of soil vapors promotes continuous removal of volatile hydrocarbons that are sorbed to the soil matrix. The induced flow of air through the vented soil formation also increases the dissolved oxygen concentration available to hydrocarbon-degrading bacteria.

SVE is most effective in coarse-grained soils impacted with volatile contaminants, similar to that which exists at the Refinery. Pilot testing results from the RFI indicate that SVE is feasible for use in eliminating hydrocarbons at the Refinery.

Preliminary designs of a SVE system by GTI include one that uses five treatment zones serviced by three remediation equipment compounds. Each of the five zones will consist of eight SVE wells. Initial extraction rates will be restricted, based on air quality emission limits, to prevent the need for air emission abatement technology. As soil vapor concentrations decrease over time, the extraction rates can increase accordingly.

Results: SVE has proven successful in reducing SPH at sites similar to the Refinery. However, an SVE system has drawbacks; it will require installation of approximately 40 wells, and the equipment will have a limited useful life.

SVE will reduce the risk of having SPH in the subsurface, but it will also introduce the potential for exposure through air emissions. The maximum flow rate will be dictated by the allowable emissions limits for VOCs. Limiting the flow rate will preclude the need for air emission control equipment, but installing a SVE will increase the regulatory burden of the site by adding air quality to the list of regulatory considerations.

Based on GTI's preliminary design without the IAS system, the approximate capital and maintenance costs for the first year will be $799,000. GTI estimated annual operation and maintenance costs thereafter at $82,000.

4.6.3. Soil Vapor Extraction and In-Situ Air Sparging

Design: Air sparging is a process in which ambient air is injected into the groundwater through multiple wells connected to a pressure blower. SVE, as discussed above, coupled with IAS can accelerate the removal of hydrocarbons from the subsurface.

Together, SVE and air sparging will remove SPH by volatilization and by encouraging hydrocarbon biodegradation through an increased oxygen supply. Sparged air bubbles strip volatile hydrocarbons from the impacted groundwater. The volatilized hydrocarbons then flow into the unsaturated zone and are captured by an SVE system. Additionally, sparging injects air directly into the groundwater, thereby supplying a greater amount of oxygen to the subsurface than SVE alone.

Given the relatively thin saturated zone at the Refinery (<1 to 10 feet), multiple sparge points would be required to create sufficient coverage of the SPH plumes. Pilot testing results suggest that both SVE and IAS are feasible technologies for the Refinery. Initial designs include 40 extraction wells and 75 sparging wells, organized into five treatment zones. To prevent the need for air emission controls, extraction and sparging rates will be limited by the vapor concentrations released.

Results: SVE coupled with IAS will remove SPH from the subsurface more quickly than SVE alone, possibly reducing hydrocarbon concentrations to non-detectable levels within three to ten years. Pilot tests demonstrate that SVE and IAS are feasible at the Refinery, but, due to the thin unsaturated zone, the number of IAS wells required to adequately cover the impacted area will be rather large.

The SVE/IAS system will require regular, but simple, maintenance for efficient operation. These technologies are in use at numerous other sites and are generally reliable if carefully maintained. This abatement option will require the installation of over 100 extraction and injection wells in addition to the vacuums, blowers, and associated equipment. Because well drilling near the Refinery has proven to be relatively difficult, it may require many months to install all 100 wells and begin system operation.

SVE/IAS systems typically have a limited useful life. Initial reductions in SPH mass may be quite impressive, but it is common knowledge that nearly all extraction systems reach an asymptotic level below which only minor reductions can be made. In addition, all pumps and vacuums will eventually stop functioning. Thus, the cost of such a system must be weighed against the productive life of the system and the importance of reduction rates.

While this type of system will probably remove contaminants much faster than MNA, it will also introduce a new pathway for exposure by releasing volatilized hydrocarbons into the atmosphere. Although the flow rates will be limited to maintain air emissions below acceptable regulatory levels, releasing hydrocarbons into the air in any concentration creates a new pathway for possible human exposure or environmental impairment.

This option involves active remediation methods, and while MNA requires decades to remove hydrocarbons from the subsurface, this method would require less than ten years. However, since the SPH plume poses no threat to human health or the environment, the time required to reduce the hydrocarbon mass is relatively unimportant. Thus, this option and MNA should be equally acceptable to the regulatory agencies. SVE/IAS will create the same response within the community as MNA or a "no action" alternative because there will be neither visible efforts along the riverbed nor any immediate improvements to the water quality.

As an initial design for this remedial approach, GTI proposed five treatment zones, each containing 8 extraction wells and 15 injection wells. GTI estimated the initial capital costs, including the first year's operation and maintenance, at $1,173,400; thereafter, annual operation and maintenance costs would be approximately $82,000.

4.6.4. Water Table Depression and SVE

Design: Water table depression coupled with SVE is a process in which the water table is lowered through pumping, thereby creating or exposing a smear zone (an unsaturated zone through which the SPH travels as the water table is lowered). A portion of the SPH is sorbed to the soil matrix in the smear zone and then removed using SVE. The increased smear zone creates a larger SPH surface area for the SVE flow to remove volatiles and on which hydrocarbon-degrading bacteria can feed. SVE flow, passing through the porous smear zone in the soil matrix, will pull more volatile contaminants off the flat plane surface of the SPH plume lying on the groundwater than SVE alone. A thin SPH coating on soil grains in the smear zone will be more diluted (and therefore less toxic) and more accessible to hydrocarbon degraders. Using SVE coupled with water table depression would result in faster removal of SPH from the groundwater than using SVE alone.

As discussed above, SVE is a feasible technology for the Refinery and could be enhanced locally (in the SPH plume areas) by water table depression. However, the permeability of the Jackson Lake Terrace is so great that in order to depress the water table sufficiently to provide a reasonable benefit to SVE (>2 feet), large volumes of water (5 to 10 gpm per well) would have to be discharged. This discharge could overwhelm the existing wastewater disposal system.

Results: In addition to the merits of stand-alone SVE, water table depression increases the smear zone, thereby increasing the surface area of volatile hydrocarbons. The physical limitations associated with the equipment are essentially the same as those discussed for SVE. The system will have a limited useful life and will require weekly maintenance to operate efficiently.

Due to infiltration, the high transmissivity of the Jackson Lake Terrace, and the thickness of the saturated zone, depressing the water table will require aggressive pumping. While this method would reduce the source area faster than MNA, the system's ability to enhance stand-alone SVE results will depend upon its ability to sustain a flow rate greater than the infiltration rate.

This remedy will reduce the inherent risk of hydrocarbons in the subsurface faster than MNA, but it will also introduce two new exposure pathways. In addition to the air emissions associated with the extraction system, depressing the water table will involve bringing large quantities of groundwater containing dissolved-phase hydrocarbons to the surface. The potential risks to human health and the environment associated with disposing of this water are far greater than those posed by leaving the water in place.

The pumping system already in place may be sufficient to depress the water table, but it will probably need augmentation. Initial cost estimates for this option include only capital costs for the SVE system. Based on GTI's estimates and pumping costs from previous years, the first year of SVE and water table depression will cost approximately $799,000. Annual maintenance thereafter will be approximately $82,000. Additional capital costs may be involved if the current pumping system is not sufficient to lower the water table to the required level.

4.6.5. Sheet Pilings-Slurry Wall

Design: Installation of sheet pilings and a bentonite slurry wall physically restricts the seepage of SPH into the San Juan River. Sheet pilings driven into the Nacimiento Formation approximately 5 to 10 feet from the San Juan River's edge minimizes construction impact to the river and effectively seals off the perched groundwater zone. A sealant applied between the pilings creates an impermeable barrier. The sheet pilings extend around the perimeter of the riverbank to the outlet of the water make-up ponds (see Plate 39). The sheet piling and the slurry wall effectively prevents any SPH migration to the west, into the San Juan River.

Results: Installing impermeable sheet piling and a bentonite slurry wall along the western edge of the gravel bar has the immediate and long-lasting effect of preventing dissolved-phase hydrocarbons and SPH in the groundwater from entering the river, as was the case in early 1999. Since there are no moving parts, the pilings require no maintenance and will have a long and useful life.

As demonstrated in the analyses, there is no current threat to human health posed by hydrocarbons in the sediment of the San Juan River. However, because the river is used for recreation and fishing the sheet piling will reduce any potential risk of future hydrocarbon exposure in the river.

Installing sheet piling is an active and "visible" abatement alternative that immediately protects against the likelihood of future hydrocarbon exposure. Thus, it should be acceptable to environmental regulators and the surrounding community.

As described in plans submitted to the NMOCD, the design of the sheet piling system includes the sheet piling installed at a depth of approximately 22 feet, extending from the perimeter of the riverbank to the outlet of the water make-up ponds. Only negligible costs are associated with this option after the first year.

4.7. Dissolved-Phase Contaminant Mass Reduction

Hydrocarbon-impacted groundwater under the Refinery flows toward the San Juan River through seeps. These seeps are located at the base of the bluff on the northwest side of the site. The result is a zone of alluvium containing dissolved-phase hydrocarbons and SPH that recently impacted the river during a season of low flow. To prevent future impact on the river, remedial technologies designed to minimize hydrocarbon-impacted groundwater flow in the alluvium from discharging into the river were investigated. These technologies are designed to improve water quality by providing hydraulic containment of the SPH and VOC plume and/or by reducing dissolved-phase hydrocarbon concentrations. The three dissolved phase abatement technologies investigated are described in the following sections.

4.7.1. Total Fluids Pumping

Total fluids pumping is used to bring impacted groundwater to the surface for treatment or disposal. As with the removal of SPH, mass removal efficiency is relatively high when the system is first engaged, but may decrease rapidly after only a few years of pumping. Mass removal of contaminants in the dissolved phase is usually less efficient than removal of nonaqueous-phase liquids (NAPL) because of tailing and rebound phenomena. When concentrations in groundwater are reduced to relatively low values, chemical gradients are formed that may induce desorption of sorbed contaminants or the dissolution of a residual NAPL phase. In both cases, an irreducible concentration in groundwater may be reached that, while relatively low, may still be above cleanup goals. When pumping is terminated, these concentrations may also increase rapidly to some higher level.

Total fluids pumping is relatively efficient; however, when the hydraulic conductivity of the saturated sediment is high, such as at the Refinery, both tailing and rebound are minimized for several reasons:

- It is more likely that the total fluids pumping has removed the SPH
- Groundwater velocities are more uniform
- These sediments are usually low in organic carbon, which serves as the reservoir of adsorbed hydrocarbons.

The system in operation appears to have removed some of the dissolved-phase contamination. The benzene concentrations of September 2000, illustrated in Plate 20, appear to have decreased slightly from those of April 1999. A comparison with older data was not made because benzene concentrations appear to have increased between 1995 and 1999. This may have occurred because wells with high concentrations in 1999, (such as RW-15, -22, -23, and MW-39) were not sampled in 1995. A more dramatic decrease in contaminant concentration, up to three orders of magnitude, occurred for naphthalene levels between the 1999 and 2000 (Plates 31 and 30, respectively).

4.7.2. In-Situ Bioremediation

Historic groundwater data and bacterial enumeration studies demonstrate that in-situ bioremediation is feasible and is already occurring at the Refinery. It has been well documented that in-situ bioremediation is effective in degrading petroleum hydrocarbons in soil and groundwater. Well gauging events from 1995 through 1999 demonstrate that the hydrocarbon plume at the Refinery is stable and is 'in fact' shrinking. The only anticipated change in environmental conditions affecting hydrocarbon migration at the site is the proposed lining of Hammond Ditch and the evaporation ponds. This change should reduce the recharge to the subsurface, slowing hydrocarbon migration and thus allowing in-situ bioremediation processes in any given area more time to degrade the petroleum products in a smaller area around the Refinery.

4.7.2.1. Bacterial Enumeration Studies

Petroleum hydrocarbons, particularly BTEX compounds and hydrocarbons of low molecular weight, are generally biodegradable. Extremely high concentrations of petroleum hydrocarbons, however, can hinder biodegradation. In particular, biodegradation is generally not optimal if petroleum hydrocarbon concentrations are greater than 20,000 mg/L, or if SPH is present.

Effective bioremediation requires a sufficient density of hydrocarbon-degrading bacteria. As part of the original CMS investigation undertaken by GTI, groundwater samples from wells MW-11, MW-26, MW-30, MW-31, and MW-34 were submitted for bacterial enumeration studies to determine the density of total heterotrophic bacteria (THB) and contaminant-utilizing bacteria (CUB). These tests are qualitative in nature, as the measurement of either the THB or CUB is somewhat imprecise. However, these measurements can indicate the relative health of the subsurface bacterial community. In general, population densities of THB or CUB above 1×10^5 colony forming units (CFU)/mL are considered high; densities below 1×10^3 CFU/mL are considered low.

Bacterial counts from the groundwater at the Refinery range from low to moderate. THB counts for the five wells tested ranged from 1.3×10^3 to 5.9×10^4 CFU/mL. CUB counts ranged from 3.2×10^2 to 4.7×10^4 CFU/mL. Table 26 summarizes the bacterial counts for each well.

Volatile hydrocarbons were detected in each of the tested monitoring wells. GTI compared the microbial data with the chemical data to determine whether there was a correlation between hydrocarbon concentrations and bacterial counts. However, GTI was unable to establish such a correlation. GTI concluded that factors other than hydrocarbons alone are limiting biological activity in the saturated zone.

GTI also submitted groundwater samples from the five wells for analysis of inorganic parameters, dissolved oxygen, and pH. The inorganic analytical results showed that ammonia and orthophosphate were present in the groundwater but at concentrations lower than optimal to support an extensive bacteria population. Measurements of pH were within the accepted aerobic bioremediation range (pH = 6-8). Dissolved oxygen concentrations were lower than optimal and indicated that anaerobic conditions may be present. A review of the historical analytical data showed elevated nitrate levels in MW-5, an upgradient monitor well, compared with wells located within the hydrocarbon plume. From this GTI concluded that anaerobic biodegradation of the hydrocarbons under denitrifying conditions may be occurring. GTI also stated that high methane levels measured during the vapor extraction/air sparge pilot test suggest the occurrence of reducing conditions. Moderate levels of sulfate were also present in the plume area, and sulfate can serve as a terminal electron acceptor under highly reducing conditions. However, GTI concluded that, due to the high sulfate concentrations, this mechanism was probably not occurring at the site.

According to GTI, the limited availability of dissolved oxygen and the low levels of inorganic nutrients appear to be inhibiting factors for effective biodegradation of the hydrocarbons at the site. However, the presence of the THB and the high percentage of CUB in relation to the total heterotrophs indicate that the base bacterial population for biodegradation does indeed exist.

The only costs associated with bioremediation are labor and analytical costs for monitoring. A year of semiannual sampling, followed by annual sampling thereafter is recommended. In addition, 15 wells and 3 seeps should be monitored for BTEX constituents and 5 wells for MNA parameters. Based on this preliminary sampling plan, the cost for the first year will be $22,500. Annual costs thereafter will be approximately $13,250.

4.7.3. Enhanced In-situ Bioremediation

Enhanced in-situ bioremediation is the injection of nutrients, such as nitrogen and phosphorous, and an electron donor (oxygen) into the groundwater to promote the biodegradation of hydrocarbons. Bacterial enumeration studies conducted at the Refinery have concluded that site conditions (bacteria populations, contaminant type, temperature, pH, and geology) are amenable to bioremediation. However, these studies have also demonstrated that the oxygen, nitrogen, and phosphorus levels in the groundwater are lower than optimal for bioremediation. If these growth factors are enhanced, bioremediation could have a significant effect on reducing dissolved-phase hydrocarbons prior to discharging to the river.

A cost-effective and relatively simple implementation for introducing oxygen and nutrients to the shallow aquifer is to inject a combination of nutrient mix (water-soluble fertilizer that contains a ratio of 100:10:1 carbon, nitrogen and phosphorus) combined with the addition of oxygen-release compound (ORC). ORC is one method of enhancing the conditions favoring bioremediation by way of introducing oxygen. ORC is a patented product supplied by Regenesis Bioremediation Products and has been available commercially for several years. Because of its simplicity, this technology has been applied at more than 1,000 sites across the country. ORC is designed to release oxygen upon hydration. The compound is a dry mixture of magnesium peroxide and magnesium oxide that produces oxygen upon contact with water. There are also low levels of phosphates (food grade potassium phosphate) in the product, which are the same materials that are used to support microbial growth for bioremediation. The byproducts of the reaction are magnesium oxide, peroxide, and hydroxide. Each of these compounds is safe to ingest in small quantities (a suspension of magnesium hydroxide in water is ordinary Milk of Magnesia). In general, ORC is useful for enhancing the remediation of compounds, such as benzene, that naturally degrade biologically in an aerobic environment.

The degree of hydrocarbon biodegradation can be monitored by evaluating the redox chemistry (oxygen, nitrate, sulfate, eH, pH, temperature, biological oxygen demand [BOD], chemical oxygen demand [COD], carbon dioxide, methane, and bacteria concentrations) before and after the addition of the ORC and nutrients. The dissolved-phase contaminants are potentially converted into carbon dioxide and water by the degrading bacteria. The rate of biodegradation can be calculated based on oxygen uptake, carbon dioxide production, and water production. Carbon dioxide is a direct result of the biodegradation of organic material by microorganisms in soil and groundwater. In general, approximately 30 - 60% of organic carbon degraded by bacteria is released as carbon dioxide. Because of this direct relationship between biodegradation and carbon dioxide production, monitoring of carbon dioxide provides data reflecting the mass of hydrocarbon degradation. Monitoring carbon dioxide production is also an effective way to check that bioremediation is proceeding efficiently and to calibrate the appropriate amount of nutrient addition. For example, a significant reduction in carbon dioxide production can indicate an imbalance in the biological system. This imbalance can result from a lack of nutrients or oxygen, from the presence of microbial-inhibiting substances, or from some other condition in the system. An increase in the rate of carbon dioxide production following nutrient addition will indicate that the lack of such nutrients was a partial cause of this imbalance. Nutrient addition will be adjusted based on the response in carbon dioxide levels following the initial nutrient input.

Nutrient addition to the groundwater is permissible in New Mexico with a groundwater discharge permit issued by the NMOCD. Typically, the permit conditions require installation of downgradient sentinel wells to monitor for the presence of nitrogen and phosphorus escaping the treatment area.

Enhanced bioremediation will meet the objective of removing hydrocarbons from the saturated zone, but it will likely require more time than the mechanical remediation systems. Enhanced bioremediation requires no operation or maintenance, but it increases the sampling requirements. Optimizing nutrient addition may require more frequent sampling for a larger number of parameters, including carbon dioxide. This method will also require careful monitoring of the nutrient levels in the groundwater reaching the river in order to prevent undesirable eutrophication effects.

The in-situ bioremediation design would consist of an array of injection points that would deliver the nutrients and ORC to the aquifer. The placement of the array would be ideally situated downgradient of the SPH region and provide adequate distance from the river so that enough time is provided for microbial processes to degrade the contaminants as the dissolved-phase groundwater plume passes through the conditioned aquifer area.

An in-situ bioremediation pilot study is proposed (see Plate 39). The pilot study would implement a localized field application of the proposed enhanced bioremediation remediation techniques. The pilot study would provide the data necessary to demonstrate the feasibility of using ORC and nutrients to effectively reduce the concentrations of the dissolved phase plume.

Upon NMED and NMOCD approval, a work plan would be provided that outlines the design of the pilot study and includes array configuration and location, a sampling program, and data evaluation criteria.

4.8. Recommended Abatement Plan

A combination SPH skimmer and total fluids pumping system has been in place and operating at the site for the past decade. Both skimmer and total fluids pumps have been operated in various configurations through time to facilitate both separate and dissolved phase hydrocarbon removal. Volume estimations based on four separate snapshots of the SPH plume indicate that approximately 80% of the mass present in 1991 recovered by year 2001. Isoconcentration maps of benzene distribution through time are more difficult to interpret, but suggest that benzene has been reduced, at least over the past two years.

While these snapshots demonstrate the significant progress of the current system, the most recent data suggest that the pumping configuration can be modified for more efficient mass recovery of the remaining contamination. In addition, it is proposed that segments of the dissolved-phase plume not fully captured by pumping may benefit from enhanced bioremediation. Finally, an impermeable barrier is already established to protect the most sensitive area of the site, the San Juan River, from further impact of SPH that may migrate off site in that direction. A detailed summary of this proposed three-component mitigation system is provided in the following sections.

4.8.1. Source Control Technologies

Source control technologies include SPH removal and containment. This section summarizes the design and results for each technology to control the source of the SPH.

SPH Removal Design: The most recent round of SPH thickness observations indicates SPH in only wells RW-17, RW-18, and RW-19. Total fluids pumps should be installed at these three locations for the most efficient SPH recovery. Skimmer pumps are currently operating in RW-18, RW-19, and RW-43, so the design of the proposed system is similar to what is already being implemented.

Results: Historically, skimmer pumps have been used at this site to target the SPH source. The success of this pumping is demonstrated by the observation of SPH in only three relatively closely spaced wells at a maximum observed thickness of 0.75 foot. Skimmer pumps are triggered into operation by sensors that detect a measurable thickness of the SPH. Because of the success of historical pumping, the remaining SPH thickness may be too small to reliably trigger skimmer pumps into operation if their use were continued. Total fluids pumps, on the other hand, operate at a steady 1 to 2 gpm and are also less likely to fail as a result of pumping NAPL. Total fluids pumps should result in a shorter time to complete SPH removal with a lower degree of maintenance. As a result, total operating costs will be reduced. Annual monitoring should continue, however, to ensure that the configuration is operating at maximum efficiency.

SPH Containment Design: Sheet pilings and a bentonite clay slurry wall have already been installed between the western edge of the gravel bar and the San Juan River. This barrier was constructed after some SPH was observed at the seeps along Jackson Terrace. The base of the slurry wall was placed within the low permeability Nacimiento Formation that underlies the more permeable sand and gravel. The sheet pilings are located just behind the slurry wall, only 5 to 10 feet from the river's edge, and extend to the water make-up ponds. Both barriers should be left in place so they will continue to prevent any seepage of SPH into the San Juan River.

Results: SPH contamination has been observed at the seeps along Jackson Terrace. Analyses have indicated that there is no threat to human health posed by hydrocarbons in the sediment of the San Juan River. It is important to maintain this status since the river is used for both recreation and fishing.

4.8.2. Dissolved-Phase Contaminant Mass Reduction

Design: A two-fold method of reducing the dissolved-phase contaminant distribution is proposed. A series of additional total fluids pumps will operate in tandem with enhanced in-situ bioremediation to mitigate the contamination resulting from dissolution of the SPH. The wells proposed for targeting the dissolved-phase plume through the installation of total fluids pumps are RW-2, RW-23, MW-26, MW-40, MW-28, and MW-20. These wells form an arc around, and approximately 300 to 400 feet downgradient of, the three wells proposed for SPH removal. The enhanced bioremediation needs to be conducted at the pilot scale to determine whether a full-scale ORC injection will provide significant, cost-effective contaminant reduction. The best placement of this treatment zone, based on the interpretation of the most recent benzene concentrations, is in the vicinity of MW-11. This relatively large lobe in the benzene distribution may be recovered with additional total fluids pumps if the enhanced bioremediation pilot proves ineffective or inefficient. If the pilot study suggests that ORC injection reduces concentrations more quickly than total fluids pumping, then the system may be expanded to include an ORC barrier downgradient of the total fluids pumps, as well as an injection line in the vicinity of MW-30. This application upgradient may serve to reduce the length of total fluids of pumping required.

Results: The combined effect of using both total fluids pumping and enhanced bioremediation will likely reduce the dissolved-phase contaminant faster and more effectively. A reduced benzene distribution and severe naphthalene reduction over just the past couple of years is a testament to the efficacy of total fluids pumping alone. Augmenting this recovery with the aerobic biodegradation of compounds such as benzene should reduce the time of cleanup and, therefore, the total cost of remediation and monitoring. Studies have shown that while current site conditions are not ideal for in-situ bioremediation, they are favorable and may show significant benefit from enhancement. There are compounds available that, when added to the system, could improve the conditions favoring biodegradation without further detriment to water quality. A pilot-scale treatment study is the best method of determining whether treatment on a much larger scale would prove cost-effective.

4.9. Monitoring Program

This section presents a summary of the monitoring program suggested for the three components of the mitigation system. For SPH recovery, refinery personnel will measure water levels and SPH thickness in the following 17 wells on an annual basis: MW-9, -20, -21, -24, -28, and -39 through -43 as well as RW-1 through -3, -18, -19, and -22. This measurement program will monitor the efficacy of the SPH removal system.

For SPH containment, the efficacy of the hydraulic barrier between the San Juan River and the alluvial sediments will be monitored with two permanent piezometers. Refinery staff will install these steel drive-point wells with a small backhoe. Each well will be installed with approximately 1 foot of screen above the water table. Semi-annually, Refinery personnel will measure water levels and SPH thickness in each of these two wells. Annually, Refinery personnel will sample each well for BTEX and naphthalene.

For dissolved-phase contaminant reduction, annual sampling is sufficient to document the natural attenuation process, based on the consistency of the groundwater chemistry over the past 15 years of sampling.

Refinery personnel will use 14 wells and 3 seep monitoring points to monitor natural attenuation of hydrocarbons. Refinery personnel will sample the following wells for BTEX and naphthalene on an annual basis:

- (1) MW-1; (2) MW-3; (3) MW-4; (4) MW-8; (5) MW-9; (6) MW-11; (7) MW-12; (8) MW-17; (9) MW-27; (10) MW-34; (11) MW-35; (12) MW-36; (13) RW-1; (14) RW-15;
- (1) Seep 2; (2) Seep 3; (3) Seep 5

Refinery personnel will also collect field measurements of dissolved oxygen, nitrate, and conductance from each of these wells. To complement the field measurements of dissolved oxygen and nitrate, Refinery personnel will sample the following wells for sulfate and iron: (1) MW-8; (2) MW-11;
(3) MW-34; (4) MW-35; (5) RW-15

Every five years, prior to discharge plan renewal, Refinery personnel will sample the 14 wells identified above for the following parameters: WQCC metals, SW846-8260A compounds (VOCs), and SW846-8270B PAH. In addition, pH, conductivity, TDS, chloride, sulfate, and nitrate will be analyzed in the 14 wells.

Hammond Ditch recharges the Jackson Lake Terrace throughout the study area; therefore, SJRC does not propose sampling of Hammond Ditch because contaminants cannot migrate from the Jackson Lake Terrace into the ditch. The two piezometers installed, to gauge the efficacy of the hydraulic barrier between the San Juan River and the alluvial sediments, should provide adequate monitoring of potential contaminant migration into the San Juan River. If contaminants are observed in the piezometer on the San Juan River side of the barrier, Refinery personnel will collect San Juan River samples around the perimeter of the barrier.

5. CLOSURE PLAN

No significant changes to the Refinery that would result in the closure of a process or an environmental unit are expected during the next five years. Therefore, a closure plan for the Refinery is not necessary at this time. If the Refinery schedules a particular processing or environmental unit for closure, Refinery staff will submit a unit-specific closure plan 60 days prior to the scheduled closure. The Refinery will not permanently close any environmental or process unit without notifying the NMOCD and HWMB.

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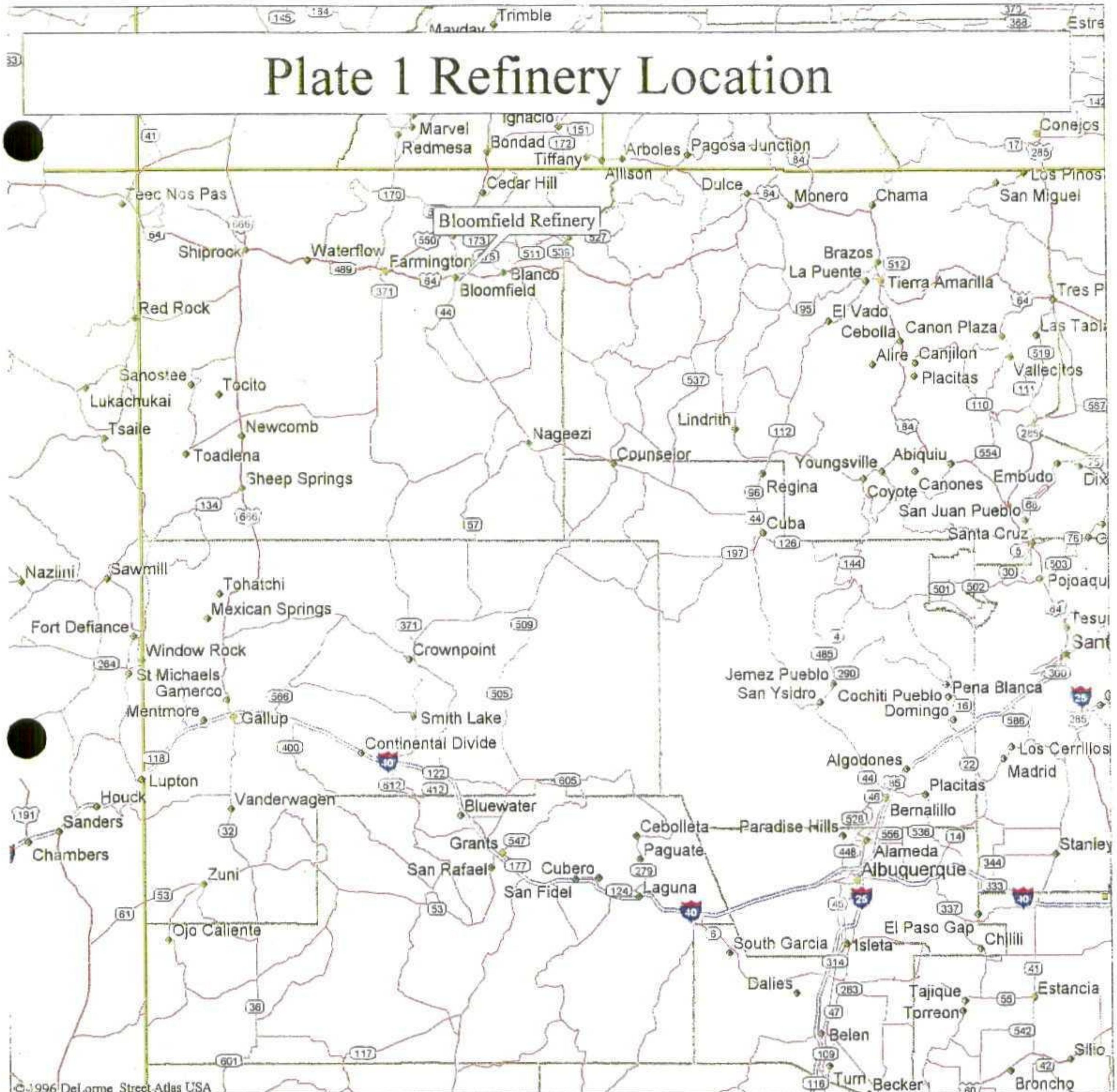
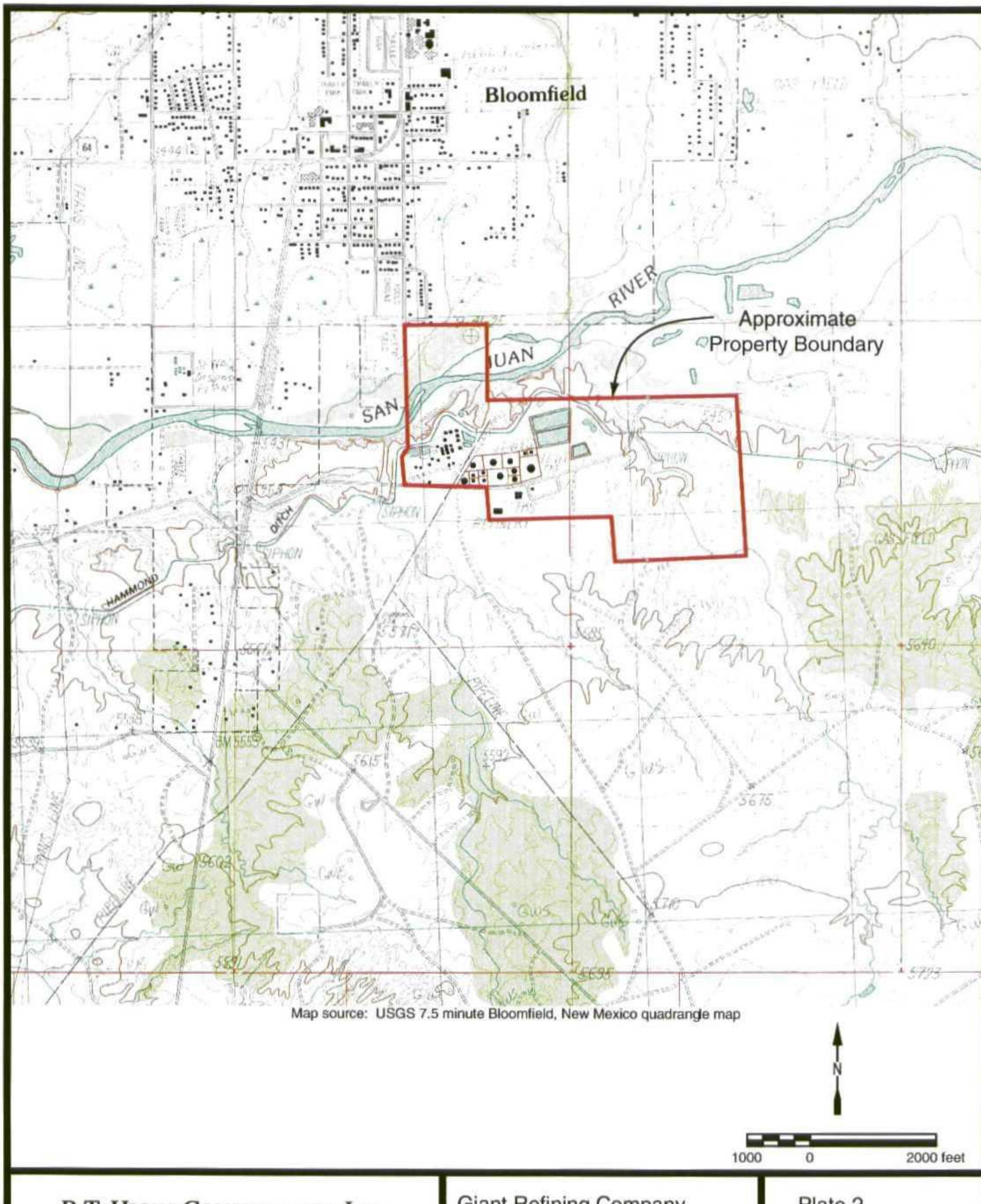
Plate 1 Refinery Location



Mag 8.00
Thu Jul 01 17:50 1999
Scale 1:1,600,000 (at center)
20 Miles
50 KM

- Major Road
- Major Highway
- Interstate/Limited Access
- Point of Interest
- County Seat
- State Capital
- Small Town
- Large City
- City
- County Boundary
- State Boundary
- Population Center
- River/Canal



Map source: USGS 7.5 minute Bloomfield, New Mexico quadrangle map

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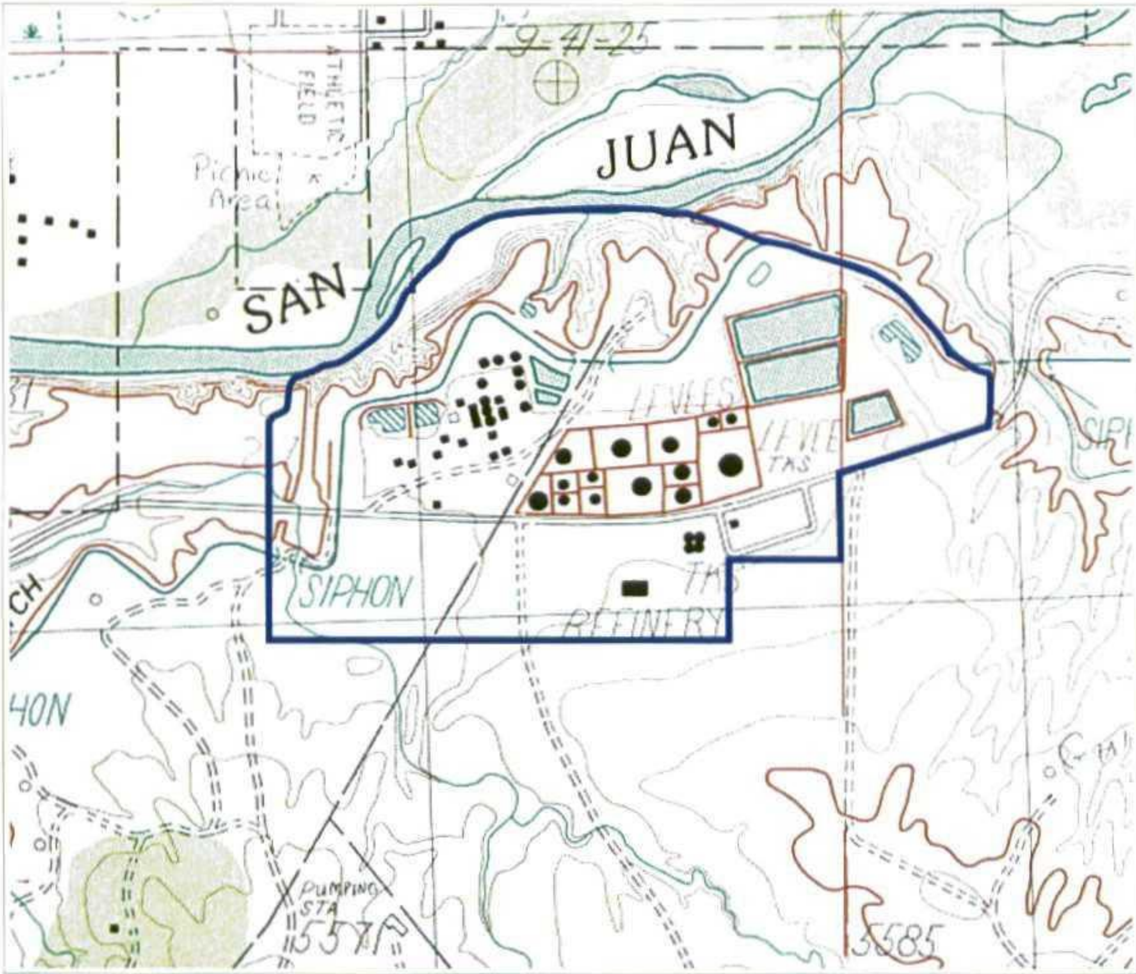
Giant Refining Company

Plate 2

Location of Bloomfield Refinery



Map source: USGS 7.5 minute Bloomfield, New Mexico quadrangle map

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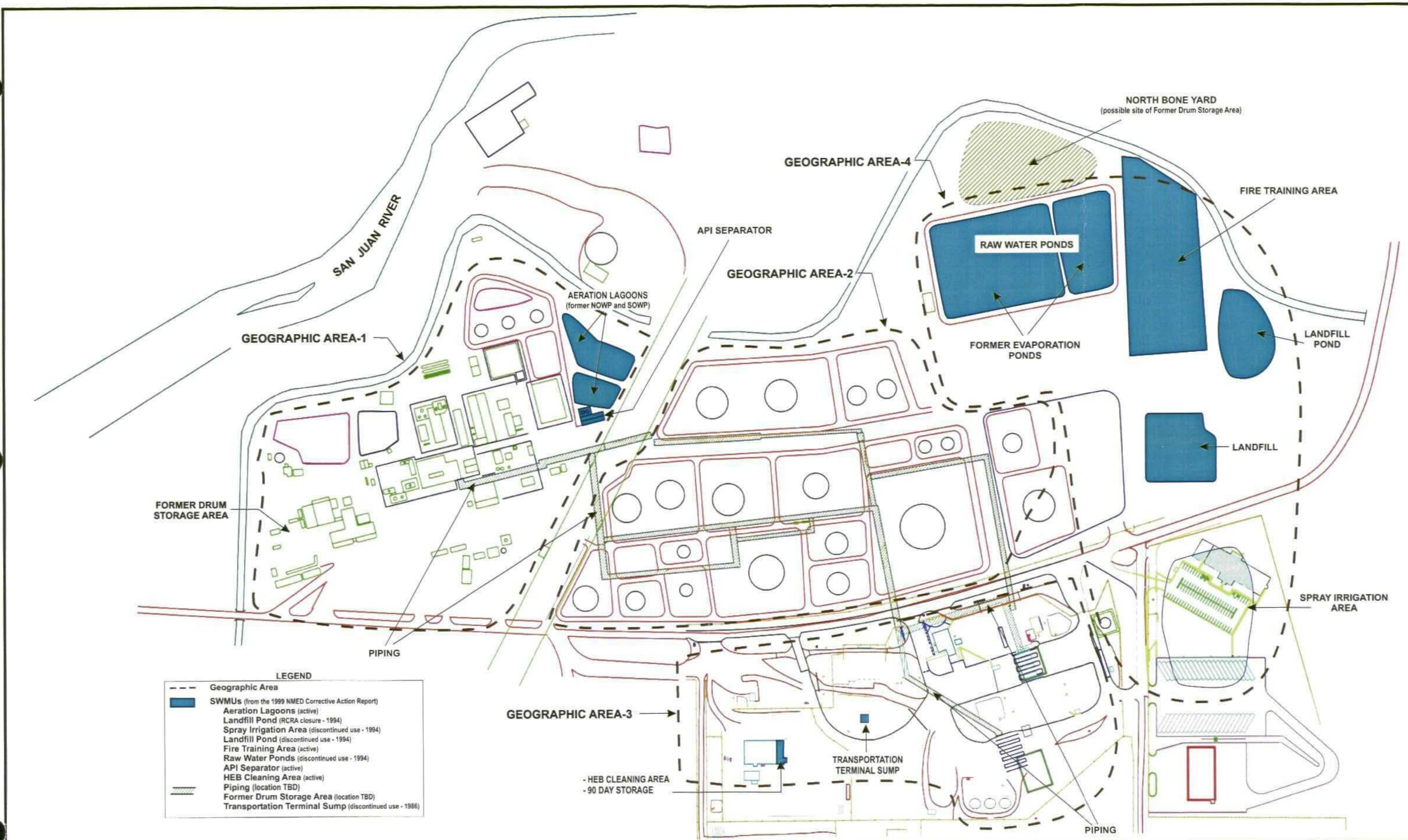
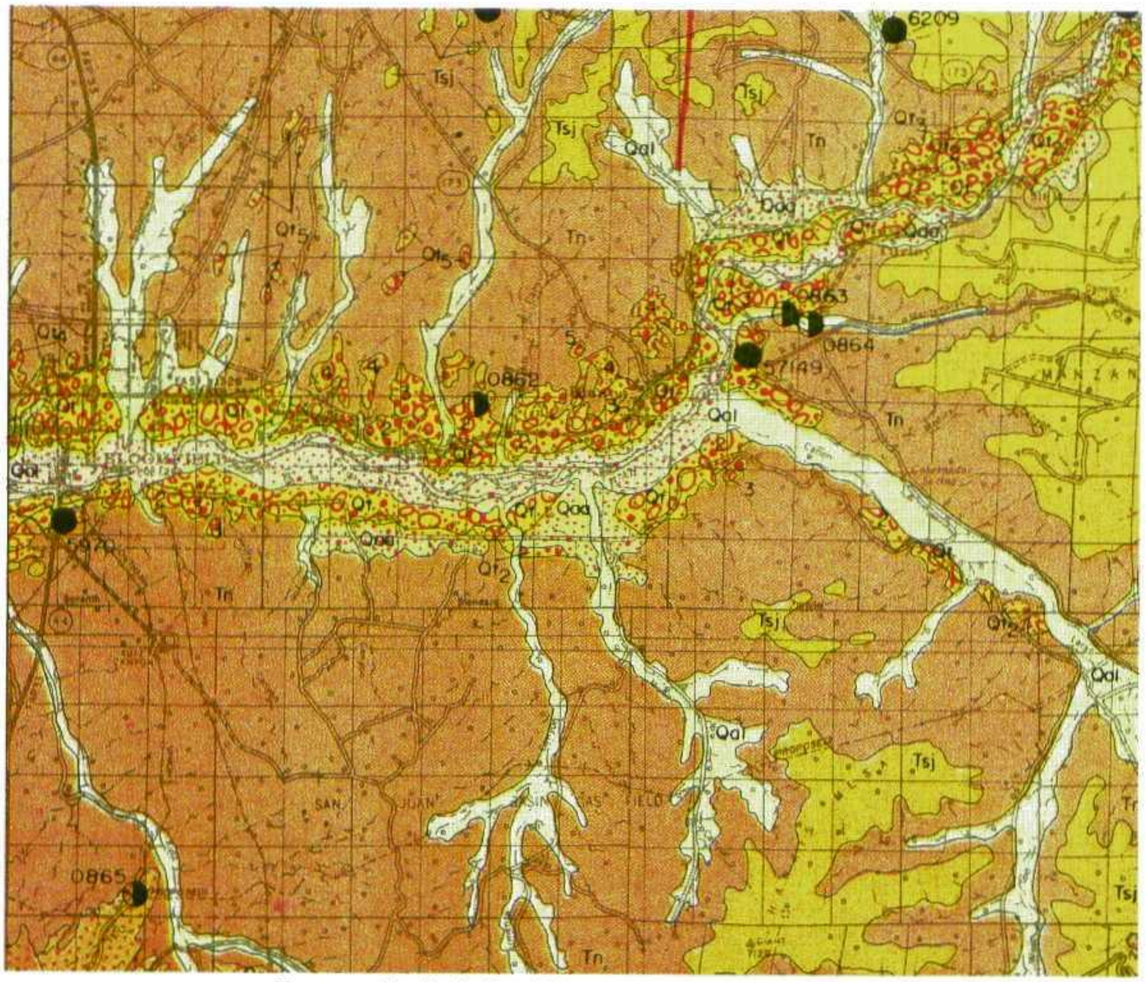
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery Study Area	



WESTON	Giant - Bloomfield Refinery	Plate 4
	Bloomfield Refinery Site Map	Modified - August 2001 NOT TO SCALE



Map source: New Mexico State Highway Department Aztec Quadrangle Map

Legend

Qal	Alluvium
Qaa	Alluvial apron deposits typically adjacent to cliffs along River
Qt	Post-glacial terrace deposits
Qt 2	Jackson Lake terrace deposits
Qt 3	Late Bull Lake terrace deposits
Qt 4	Early Bull Lake terrace deposits
Qt 5	Pre-Wisconsin terrace deposits
Tn	Nacimiento Formation

N

1.5 0 3 miles

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Bloomfield Refinery

Surface Geology Map

Plate 5

PLATE 6

NE-SW Profile Bloomfield Refinery

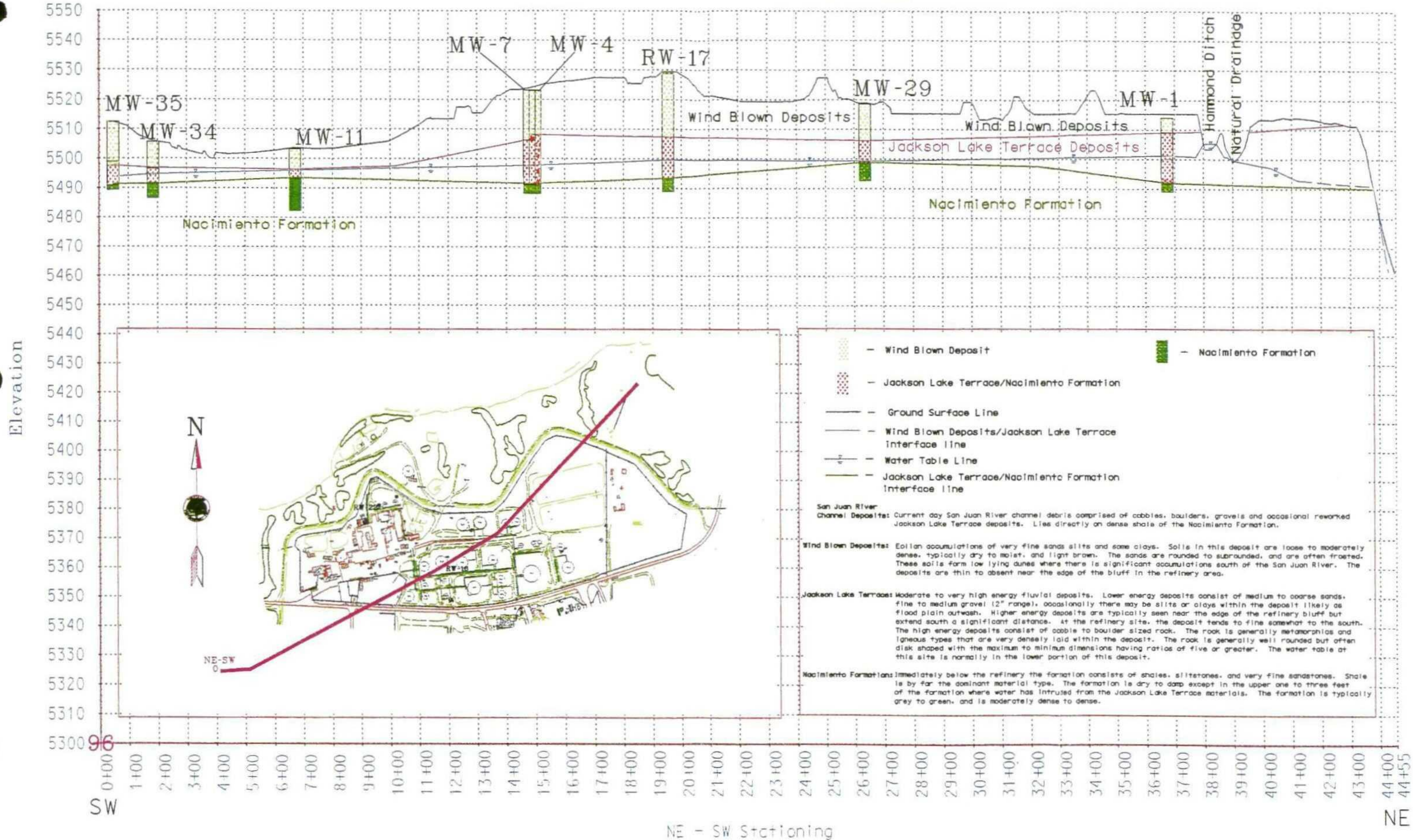

PLATE 7

N-S Profile Bloomfield Refinery

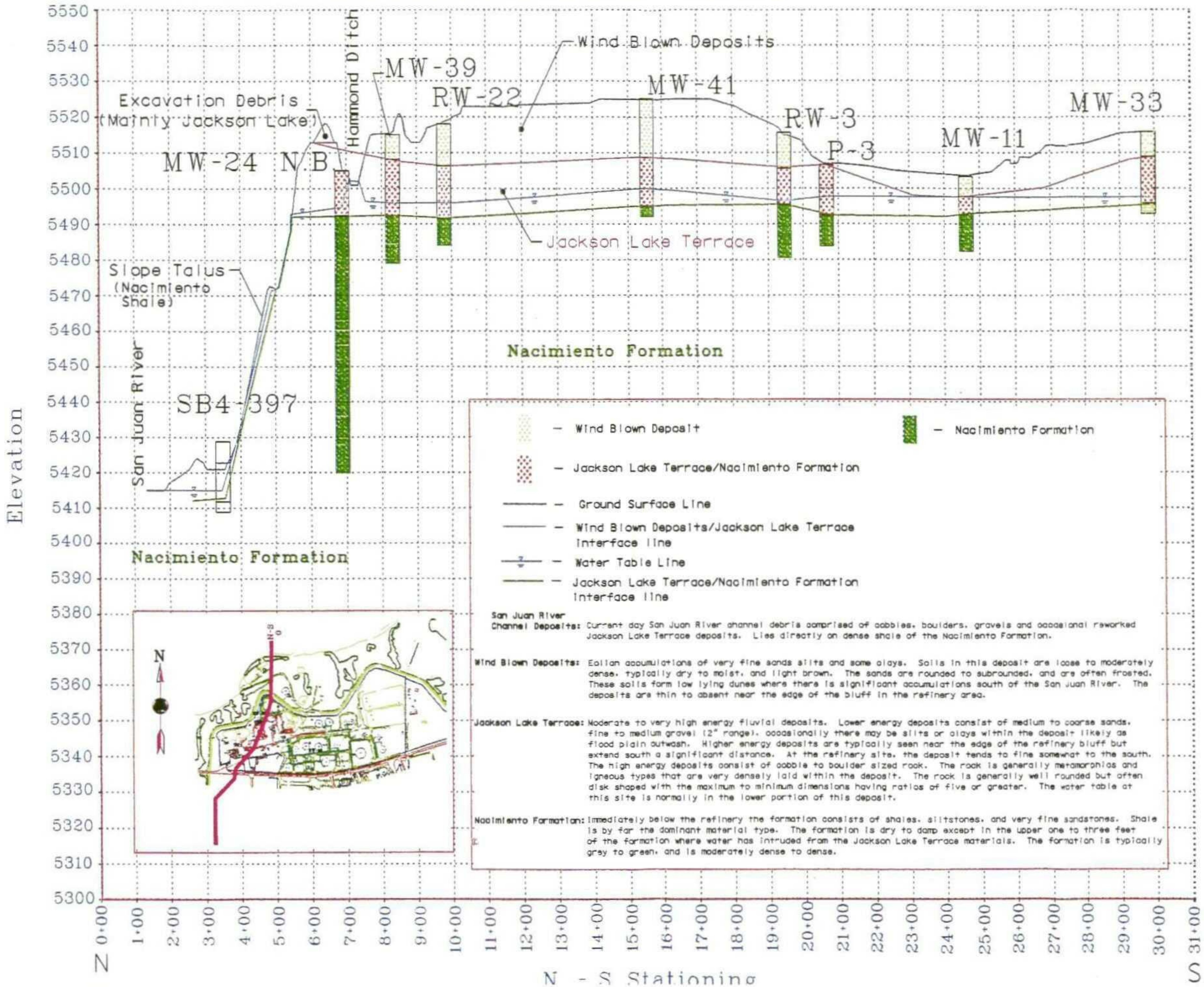

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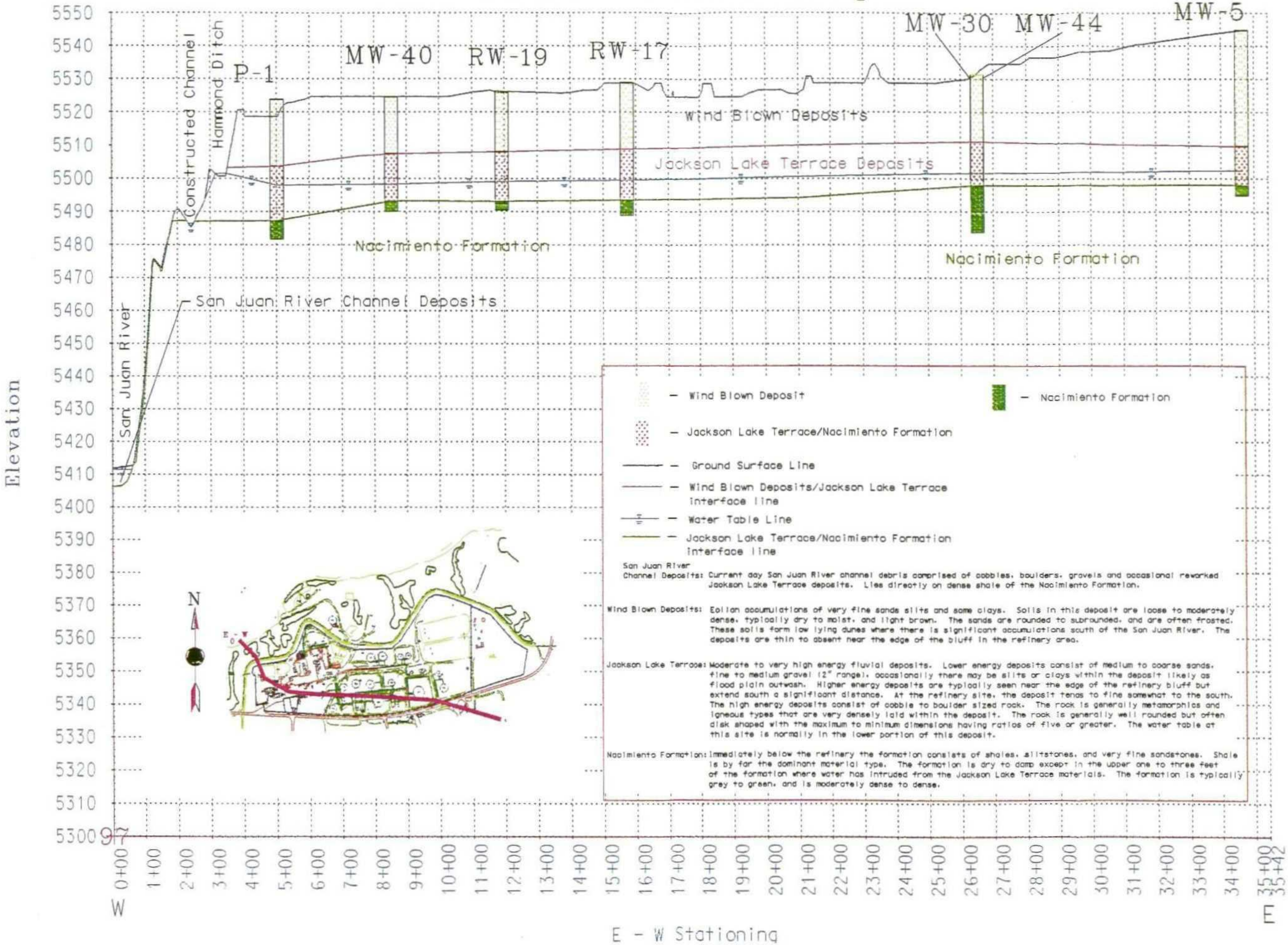
PLATE 8

E-W Profile Bloomfield Refinery



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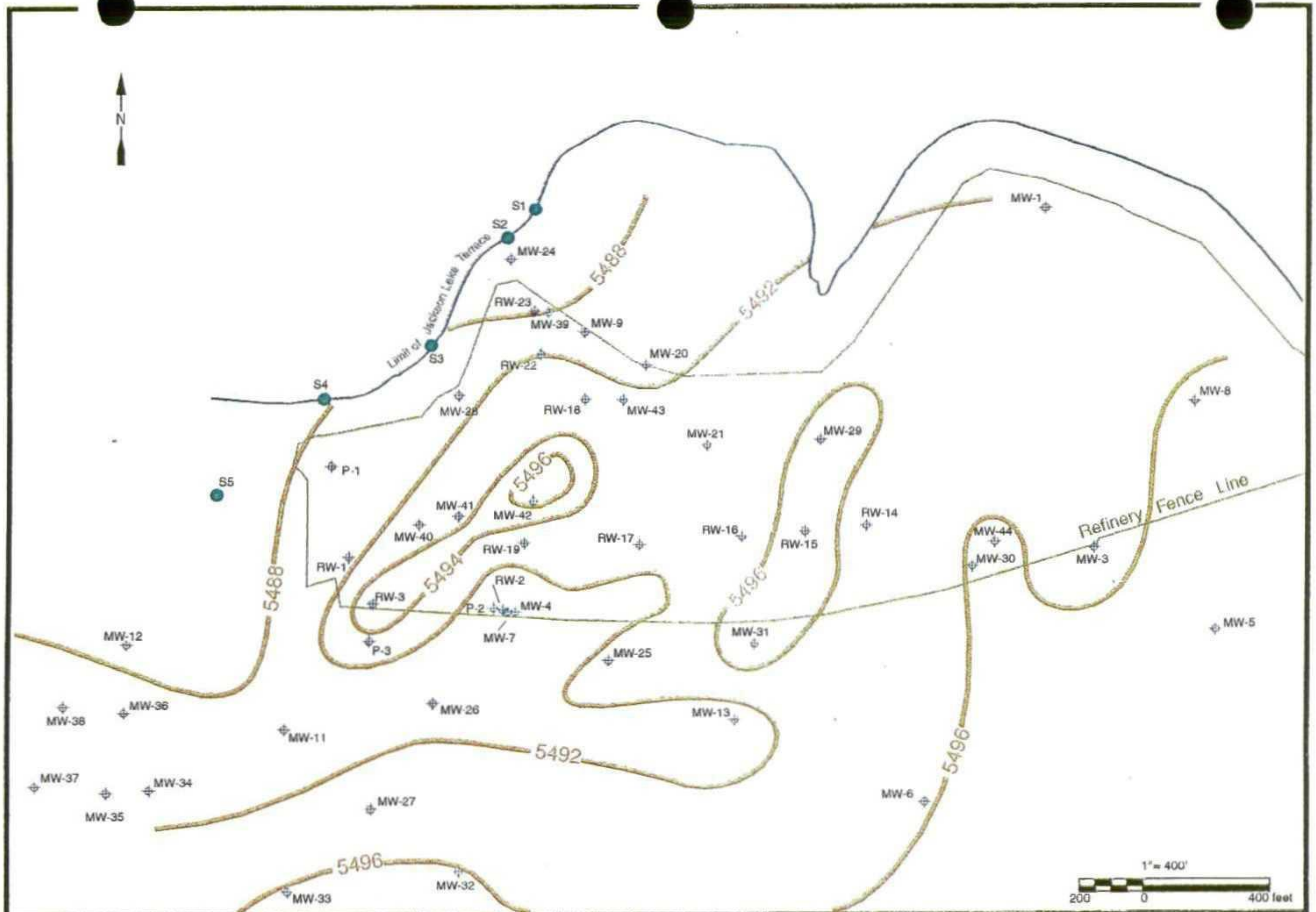

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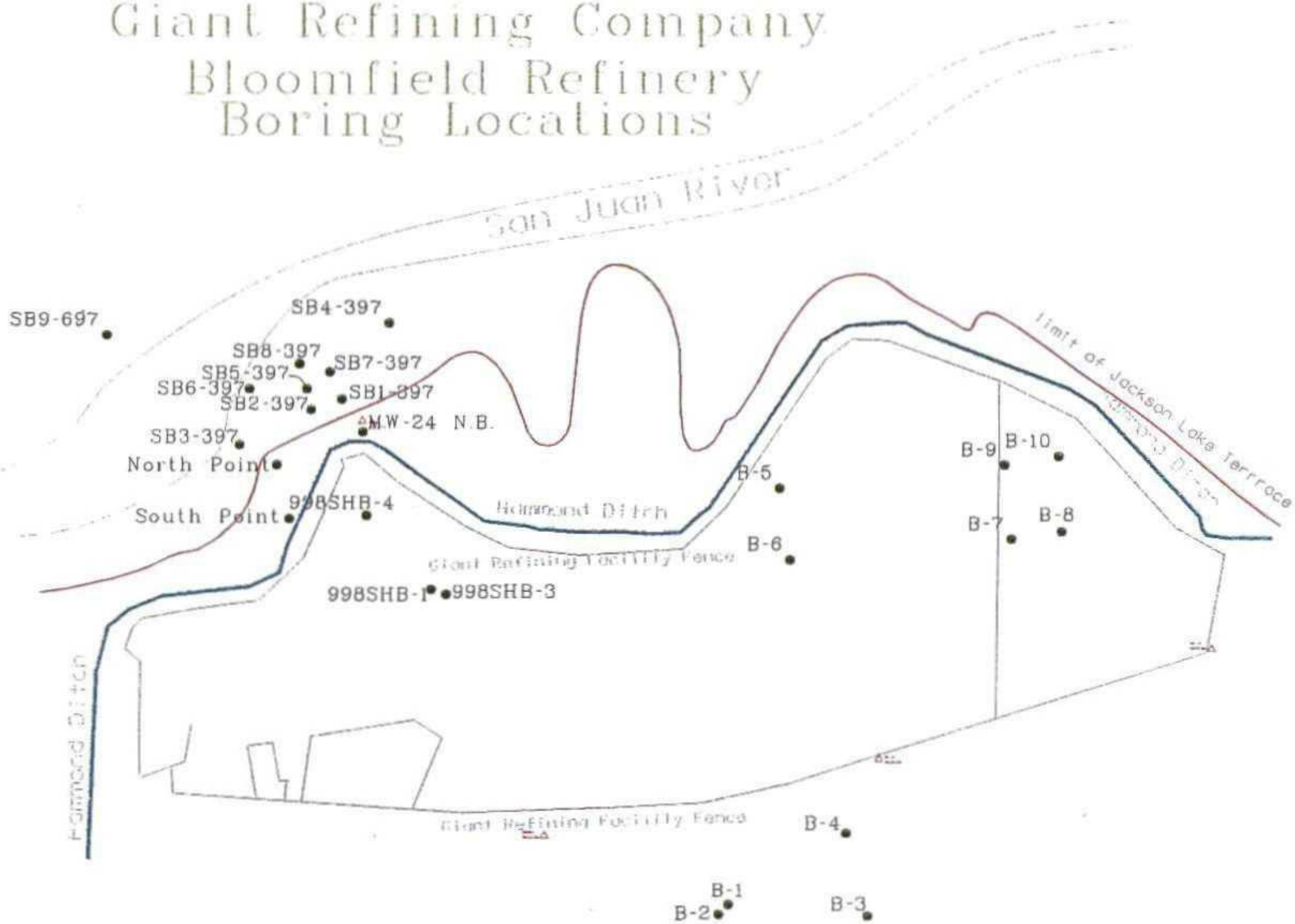
Bloomfield Refinery

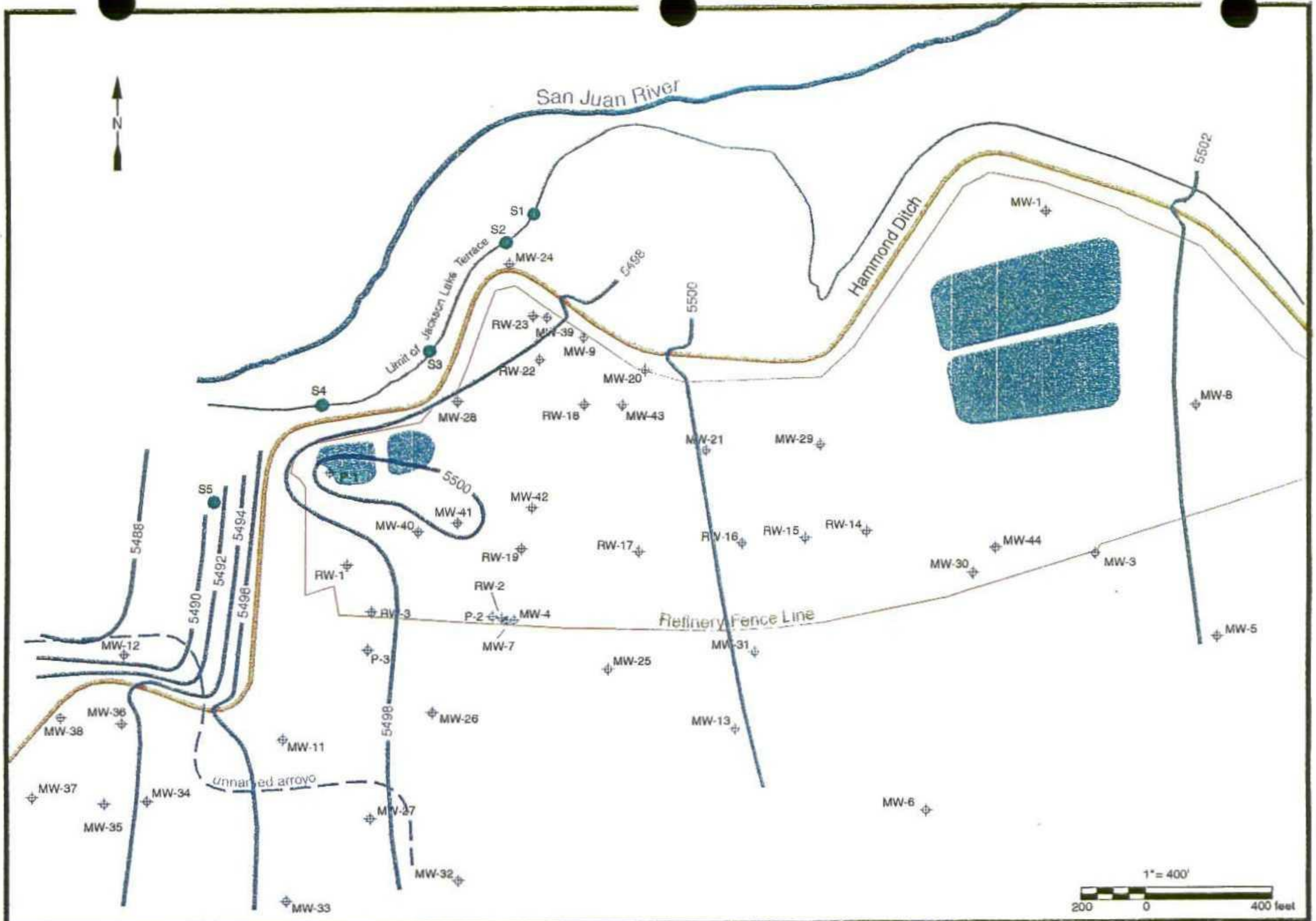
Top of Nacimiento Elevation Map

Plate 9

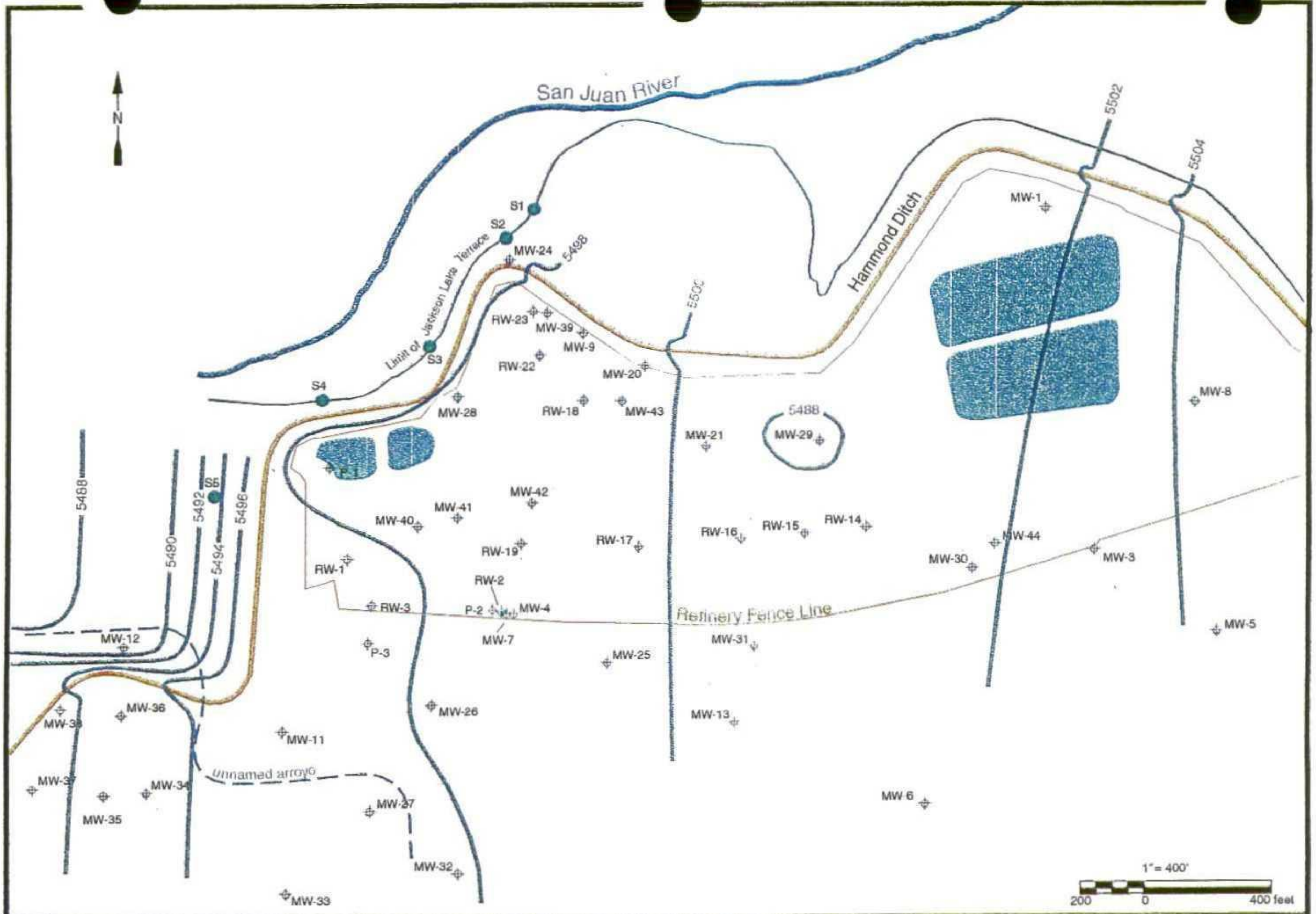
Plate 10

Giant Refining Company
Bloomfield Refinery
Boring Locations

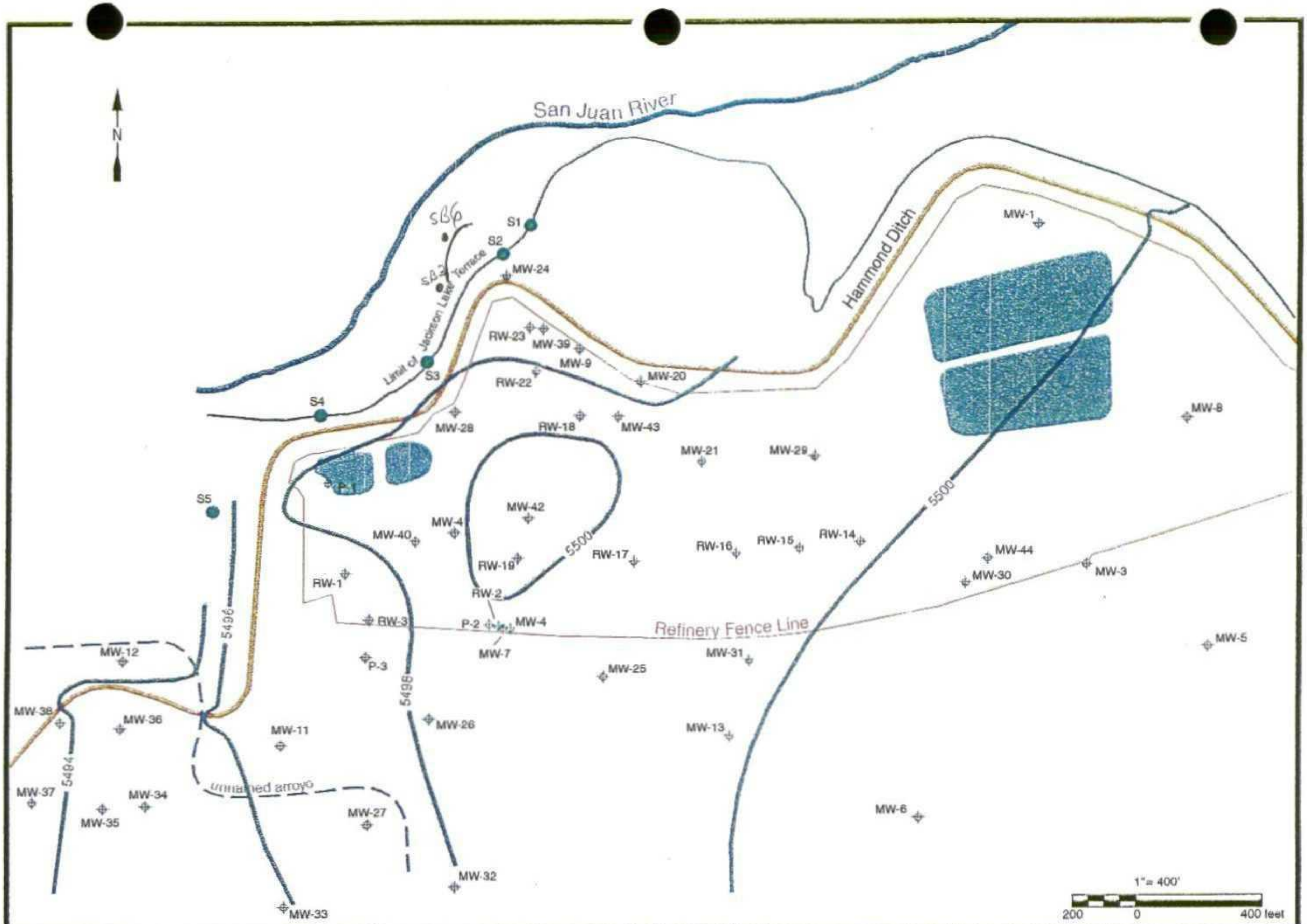




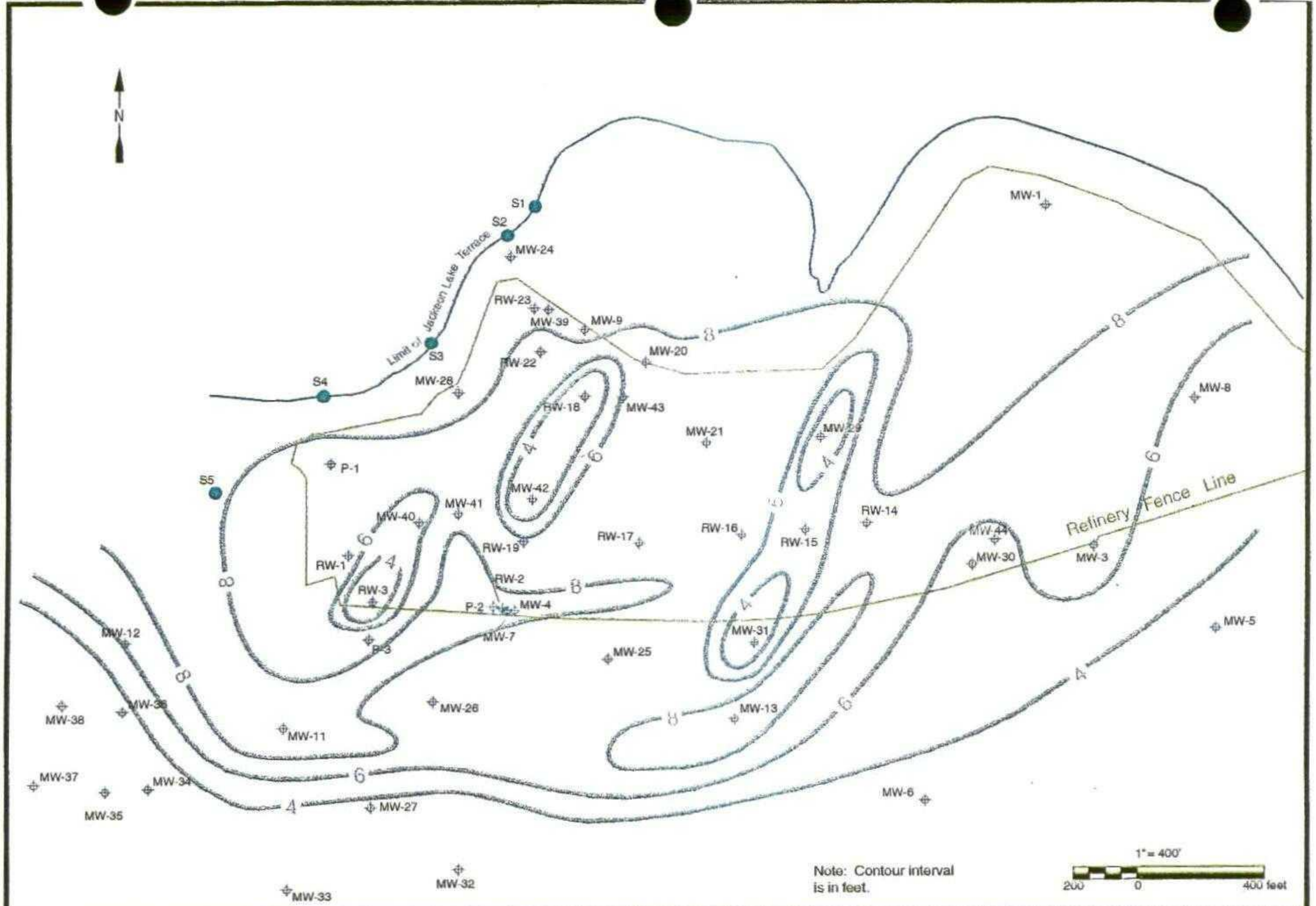
R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505 266 5004 Fax: 505 266 7738	Bloomfield Refinery	Plate 11
	April 1999 Potentiometric Surface Map	



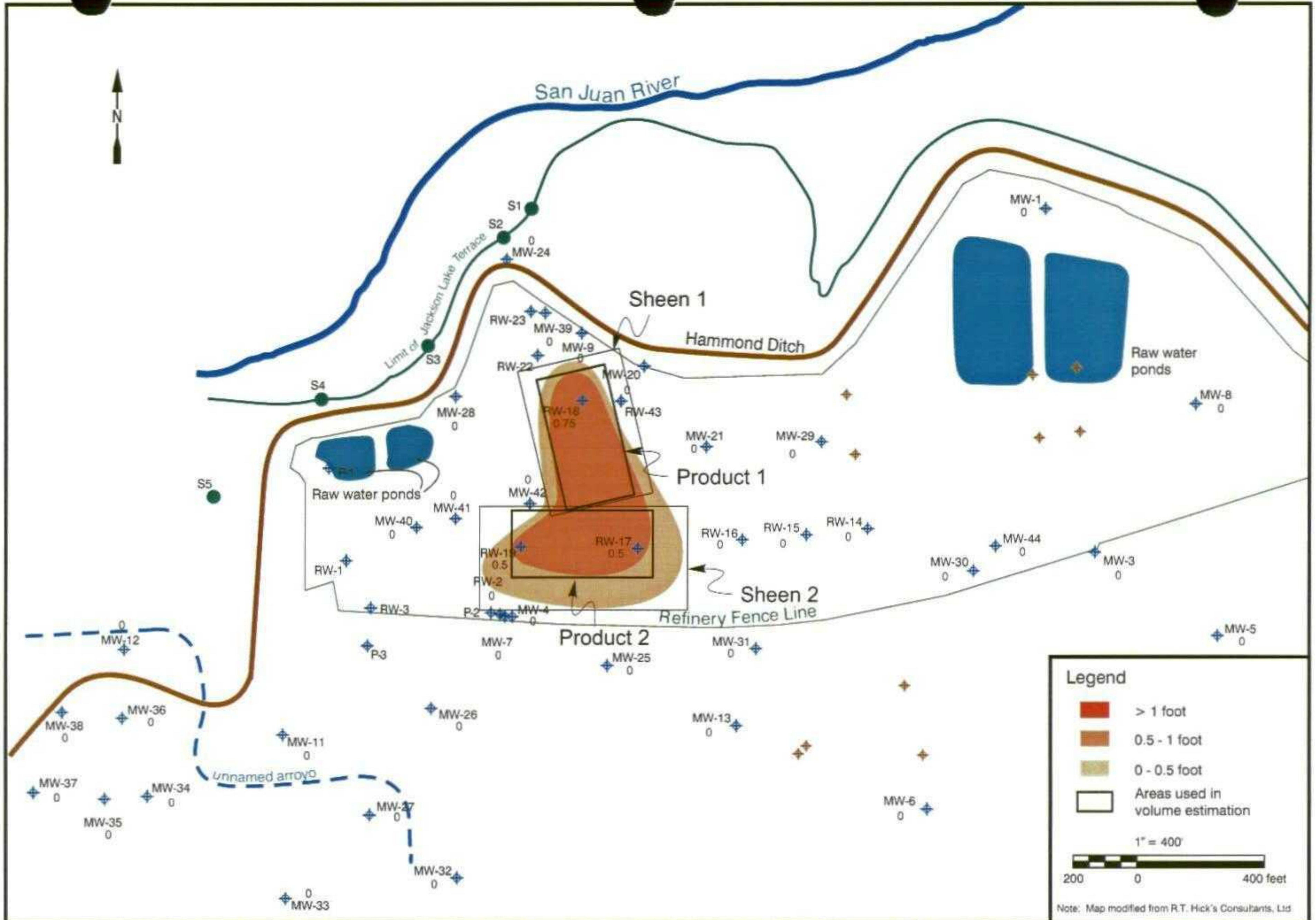
R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery	Plate 12
	October 1998 Potentiometric Surface Map	



R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery	Plate 13
	March 1995 Potentiometric Surface Map	



R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery	Plate 14
	Saturated Thickness of the Jackson Lake Terrace	



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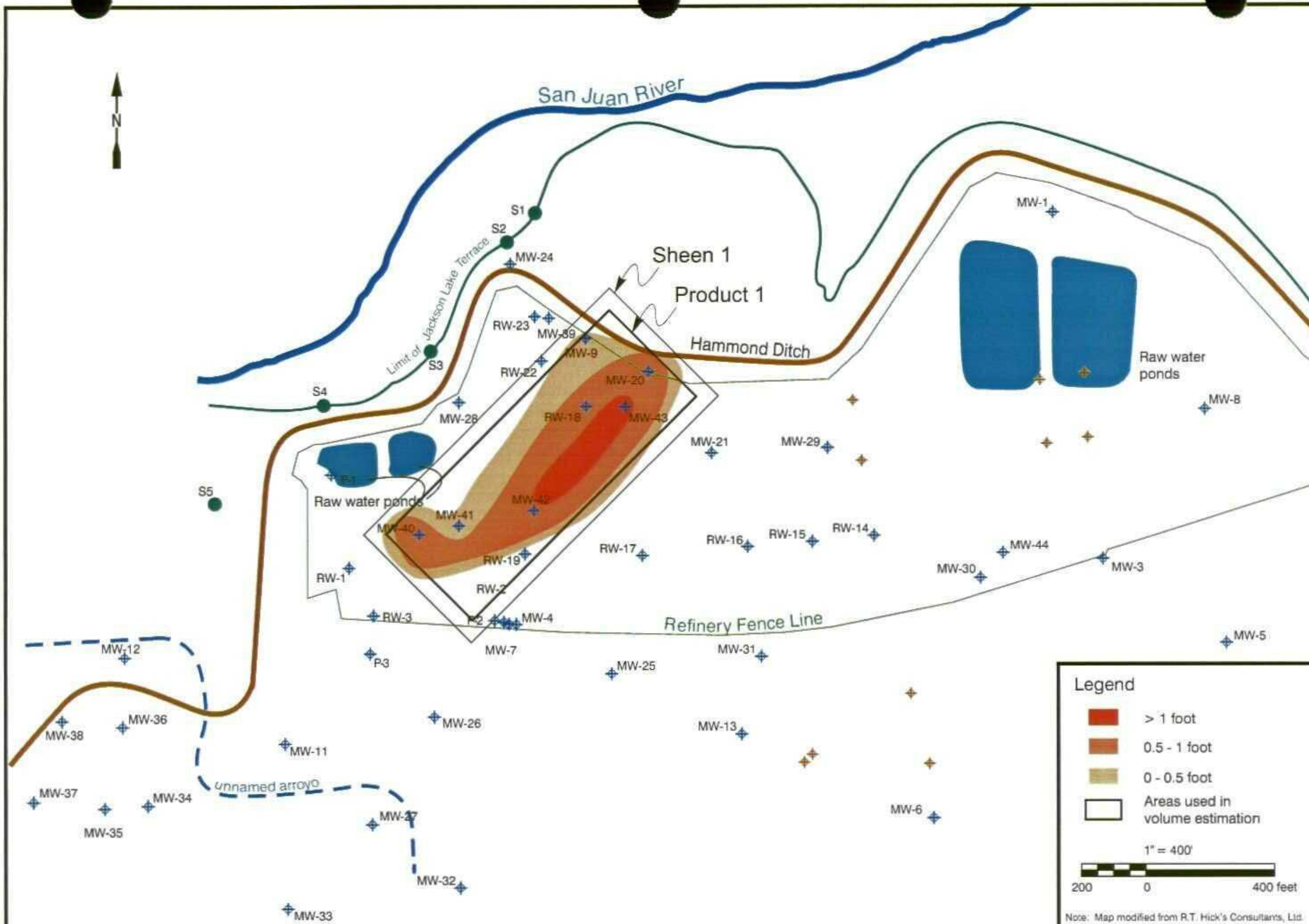
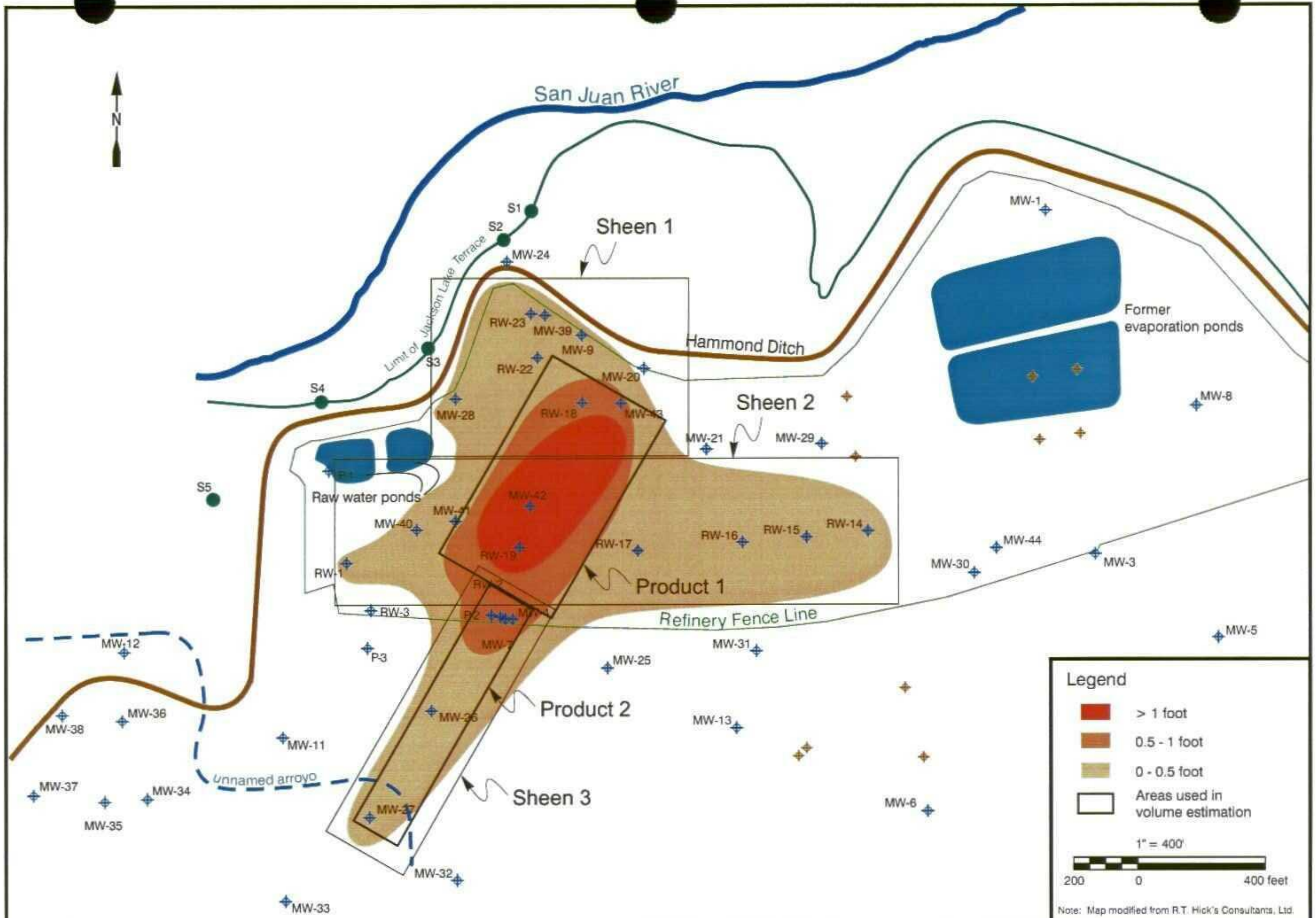
GIANT - Bloomfield Refinery

Plate 15

Separate Phase Hydrocarbon Isopleth Map - June, 2001



WESTON	GIANT - Bloomfield Refinery	Plate 16
	Separate Phase Hydrocarbon Isopleth Map - April, 1999	



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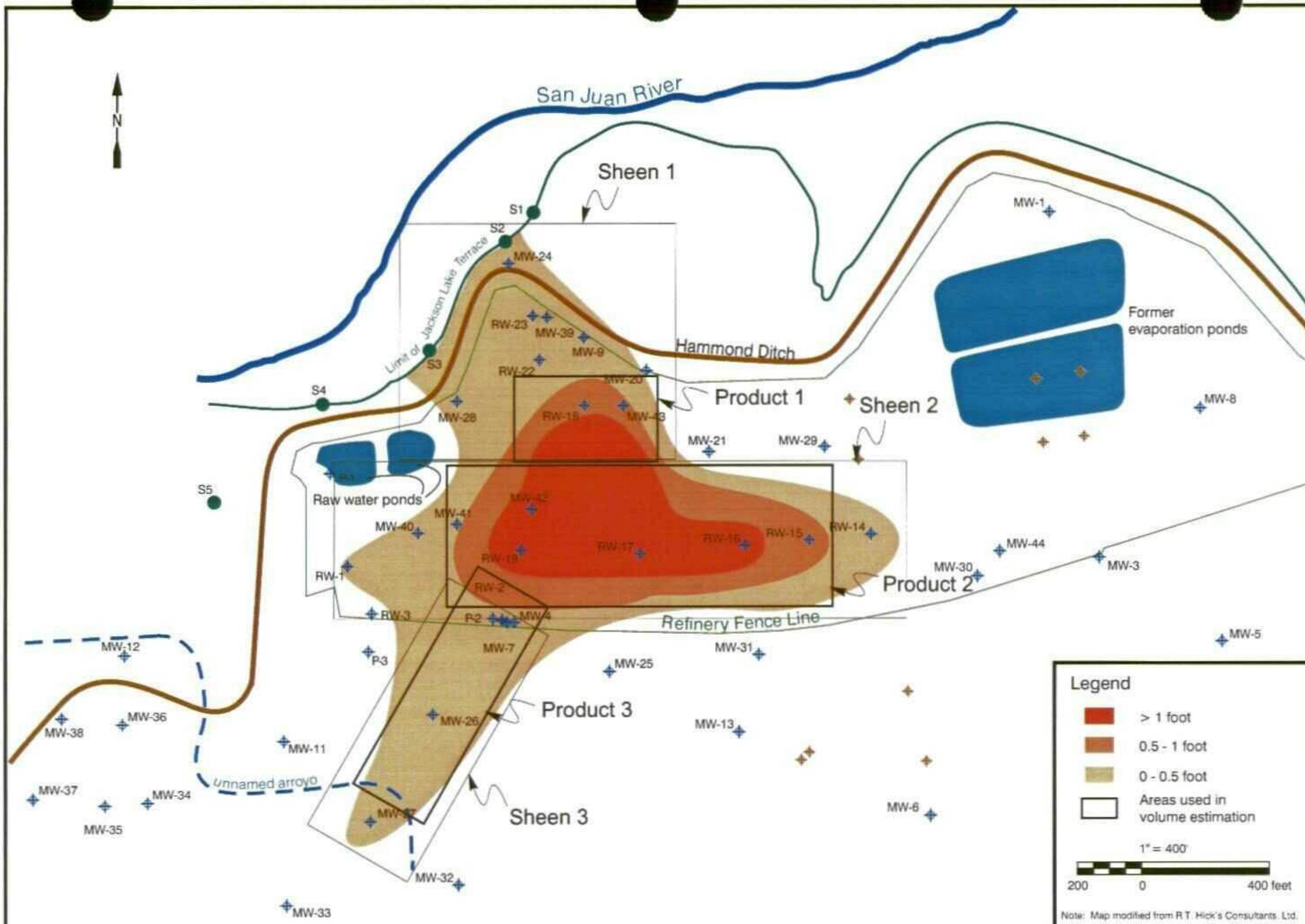
GIANT - Bloomfield Refinery

Plate 17

Separate Phase Hydrocarbon Isopleth Map - March, 1995



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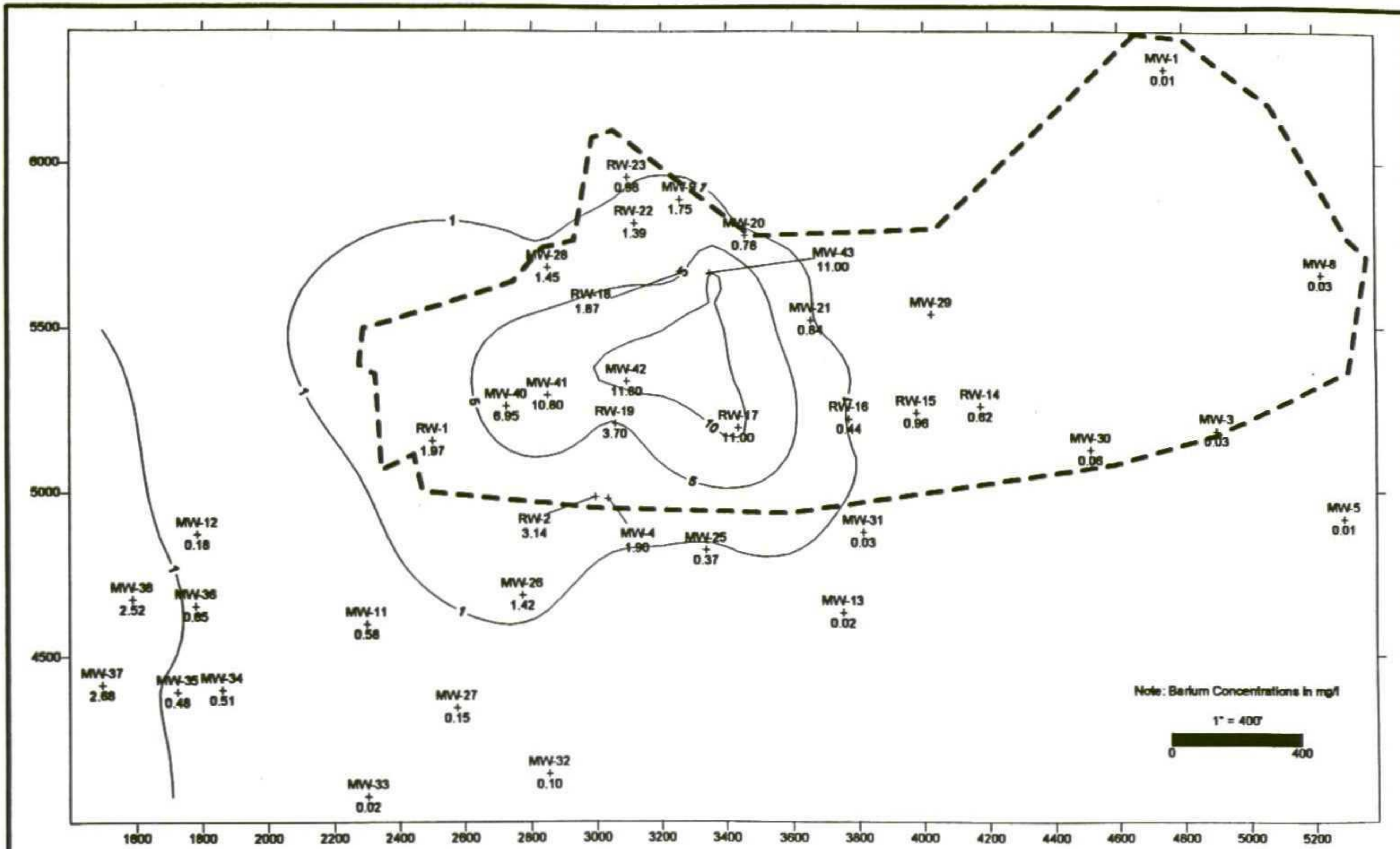
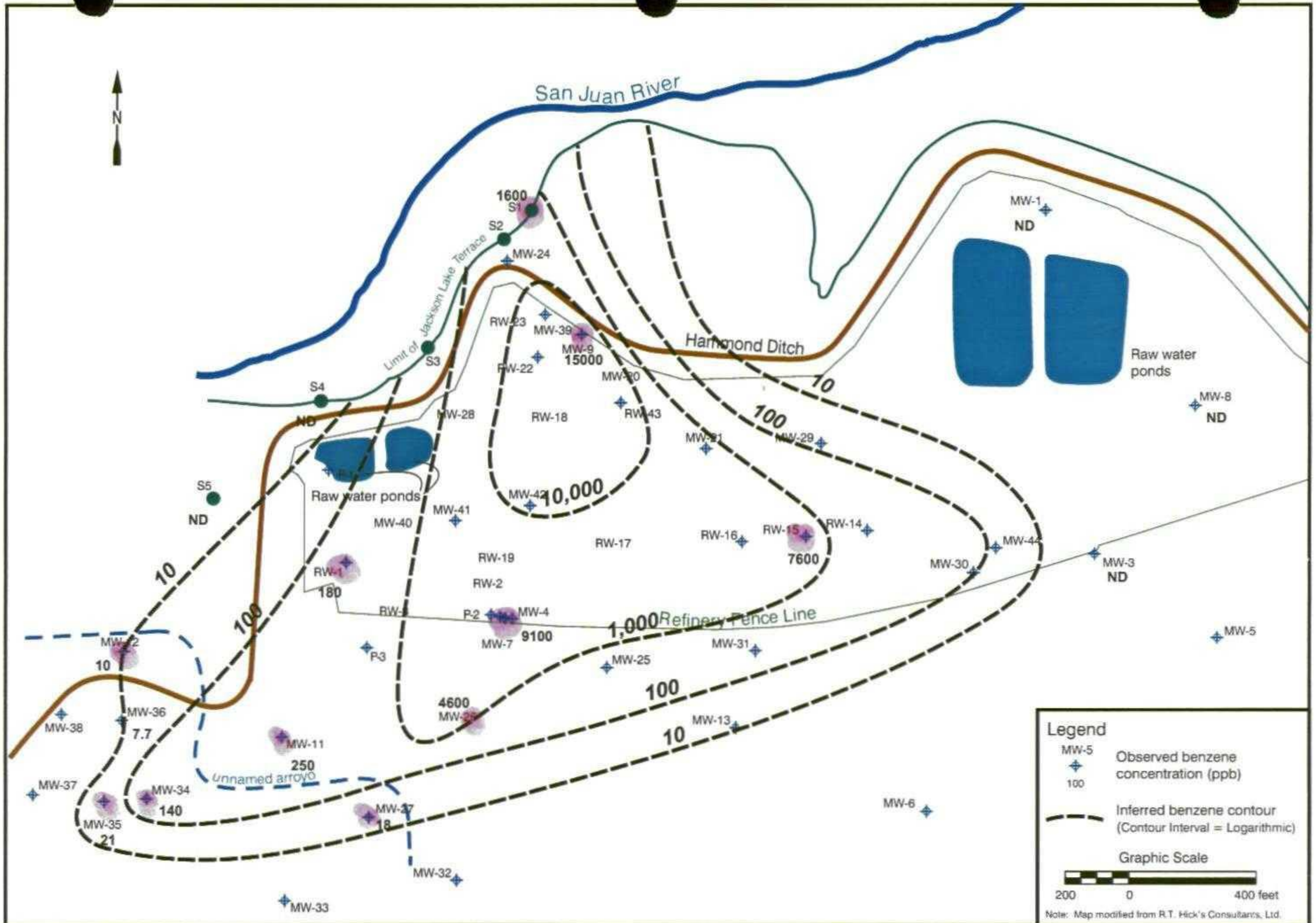
GIANT - Bloomfield Refinery	Plate 18
Separate Phase Hydrocarbon Isopleth Map - Pre 1991	



R.T. Hicks Consultants, LTD.	Bloomfield Refinery	Plate 19
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Barium Concentrations April 1999	



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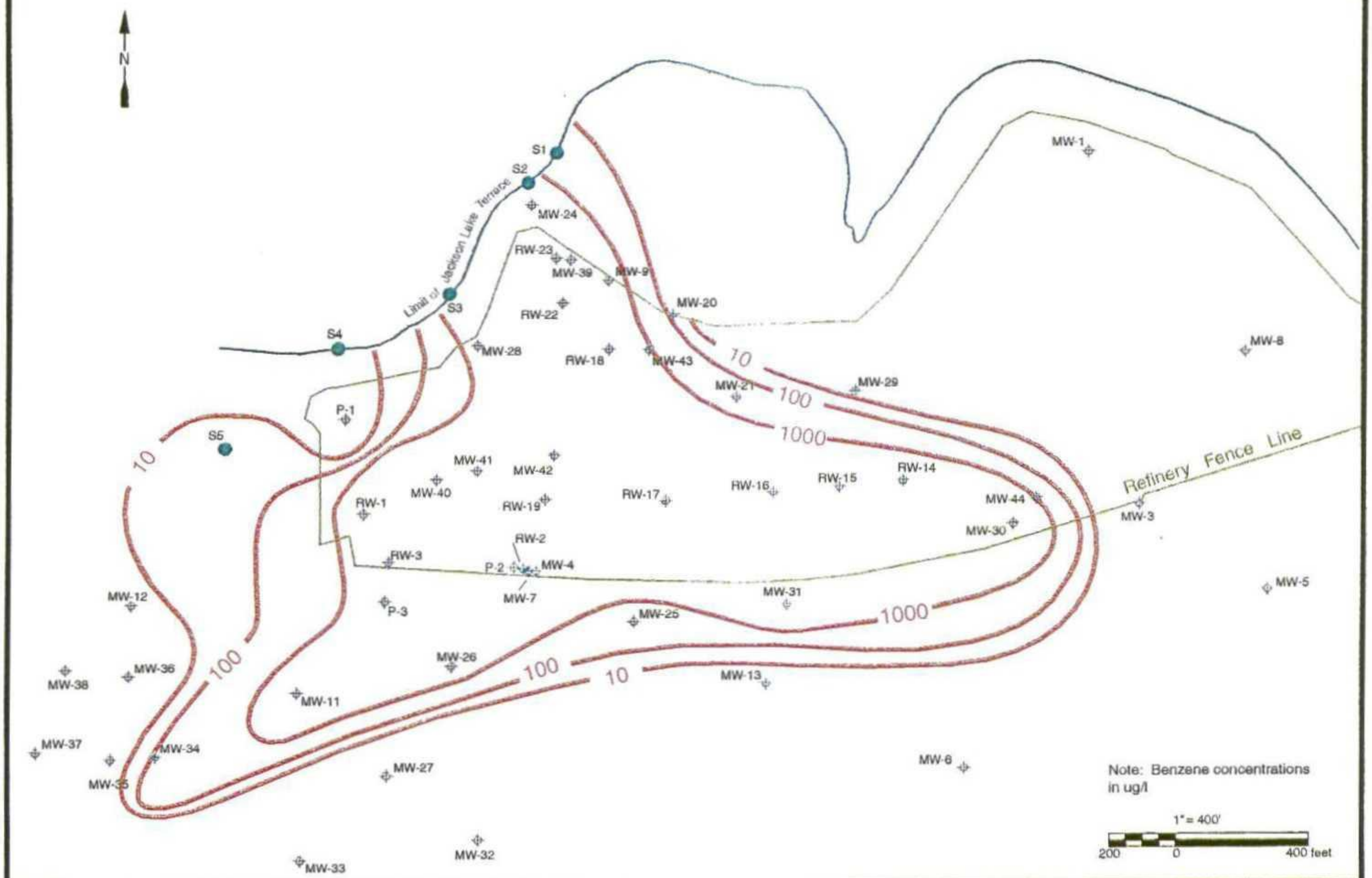
WESTON	GIANT - Bloomfield Refinery	Plate 20
	Benzene Concentrations September 2000	



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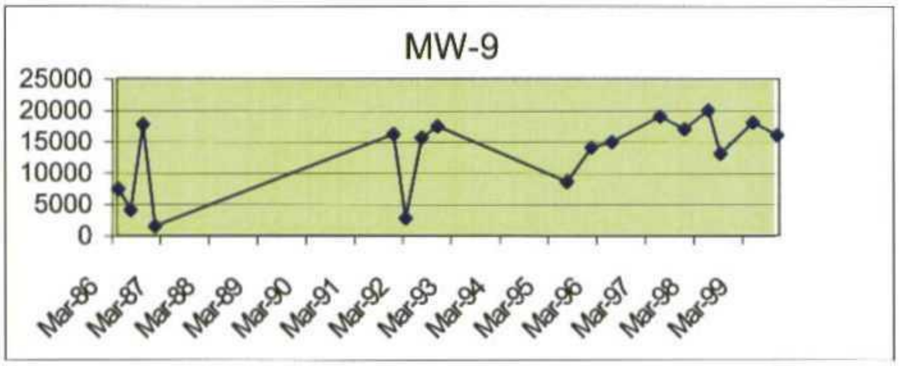
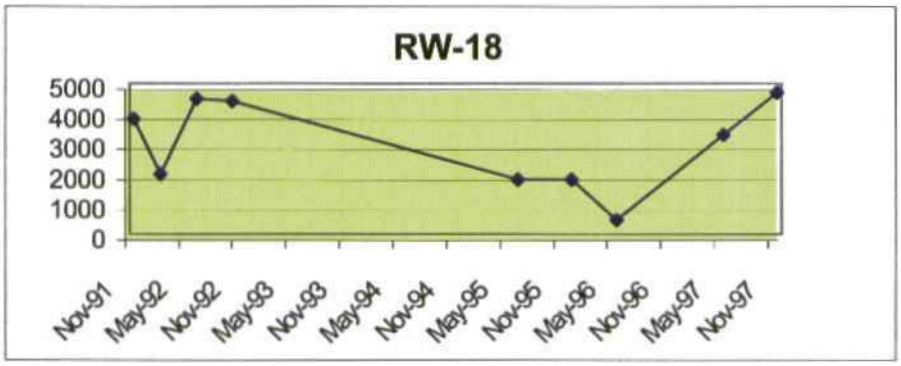
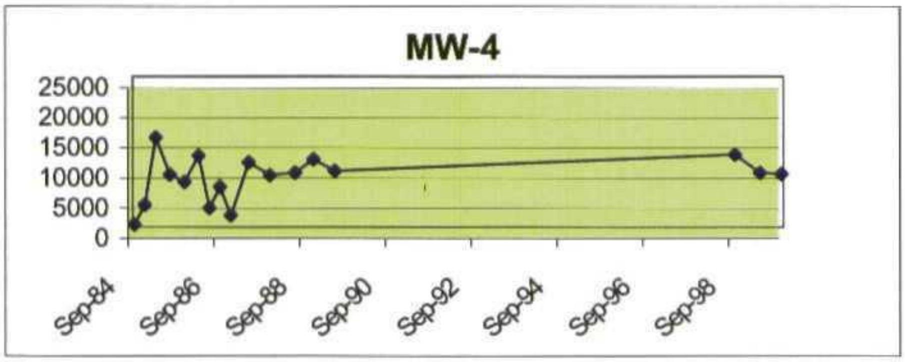
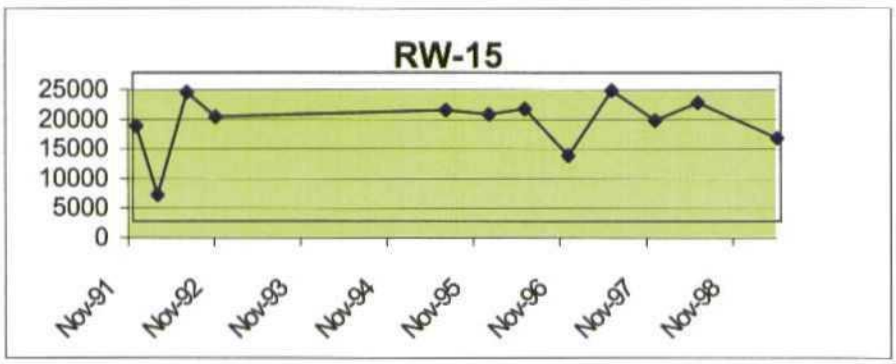
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Benzene Concentrations 1994 - 1995	

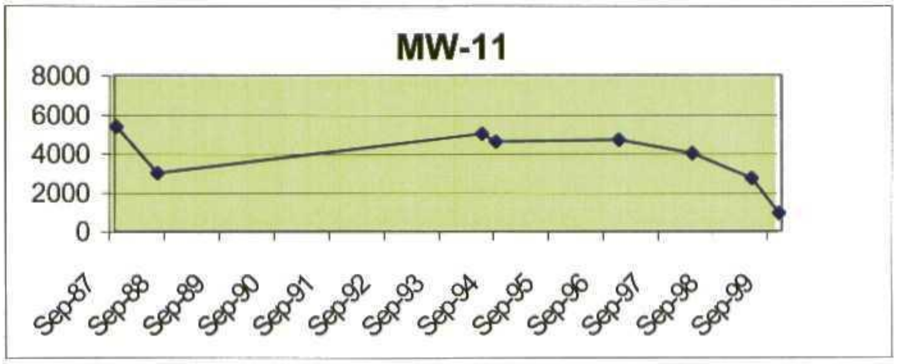


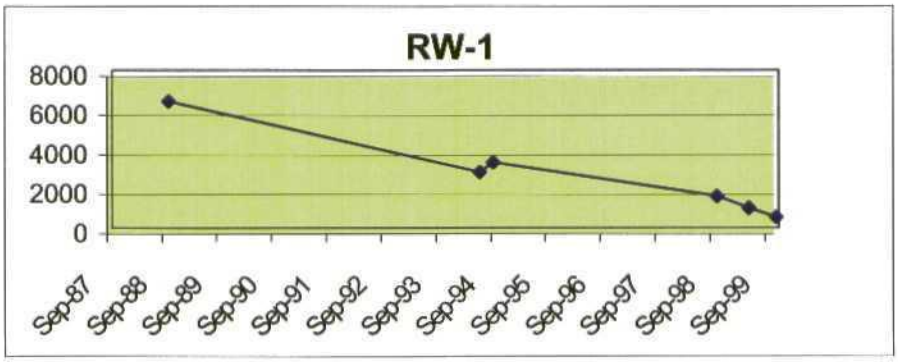


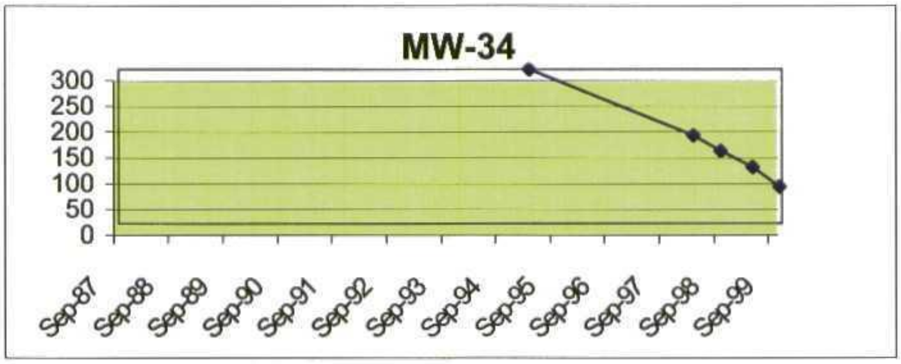


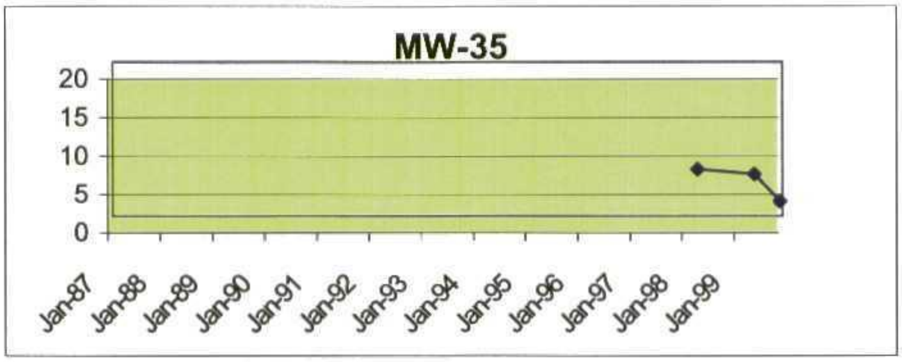


Giant Bloomfield Refinery	Plate 22
Benzene Concentrations (ug/l) Over Time in Central Refinery Area	

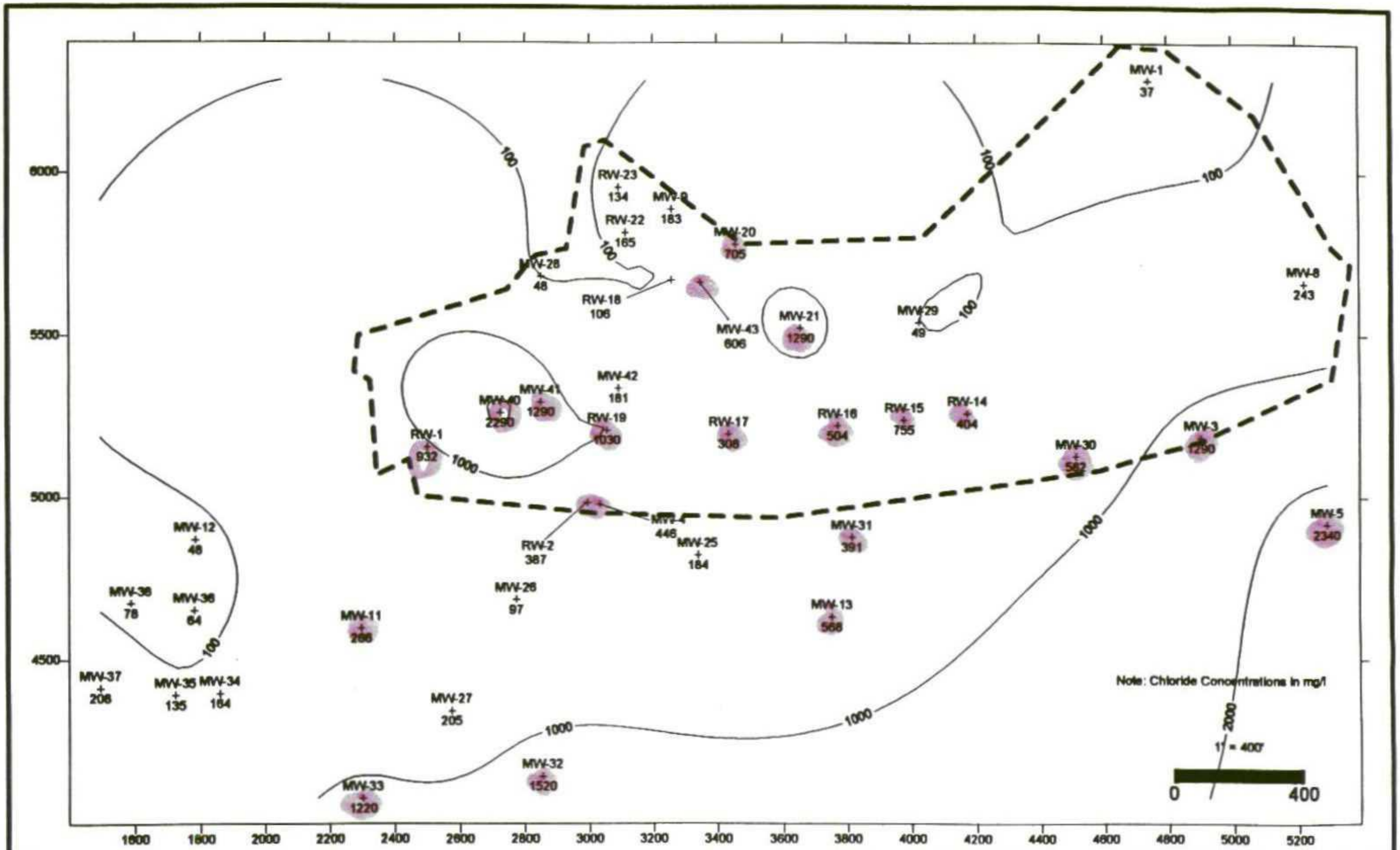








Bloomfield Refinery	Plate 23
Benzene Concentrations (ug/l) Over Time in Southwestern and Western Study Area	



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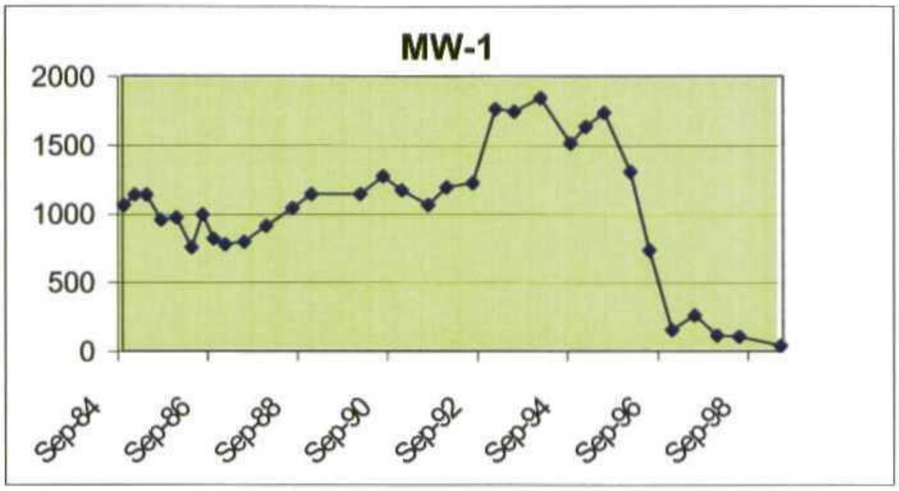
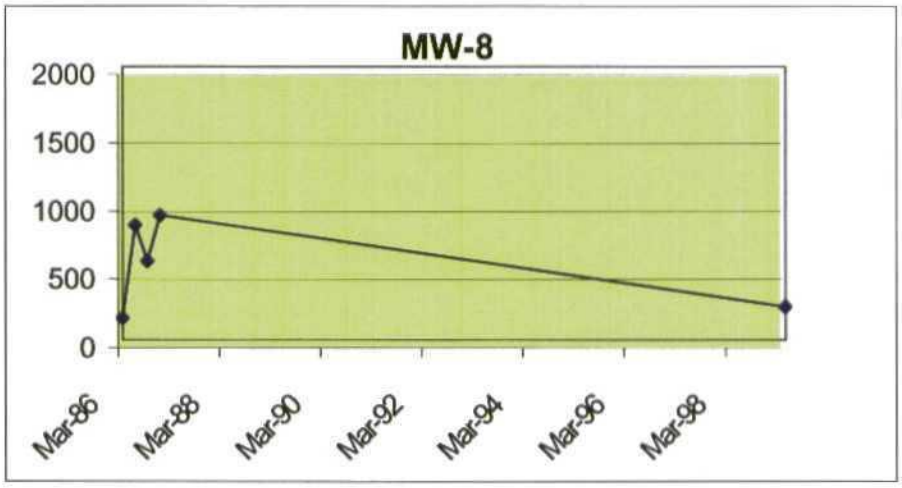
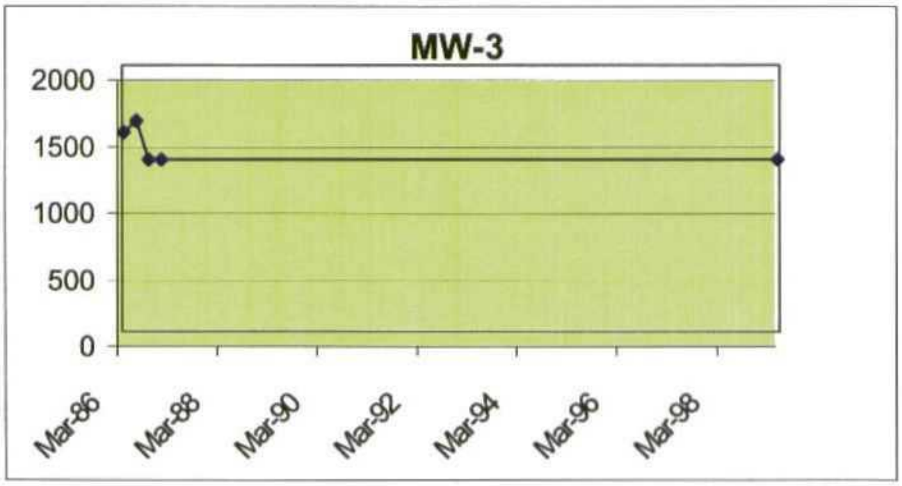
Bloomfield Refinery

Plate 24

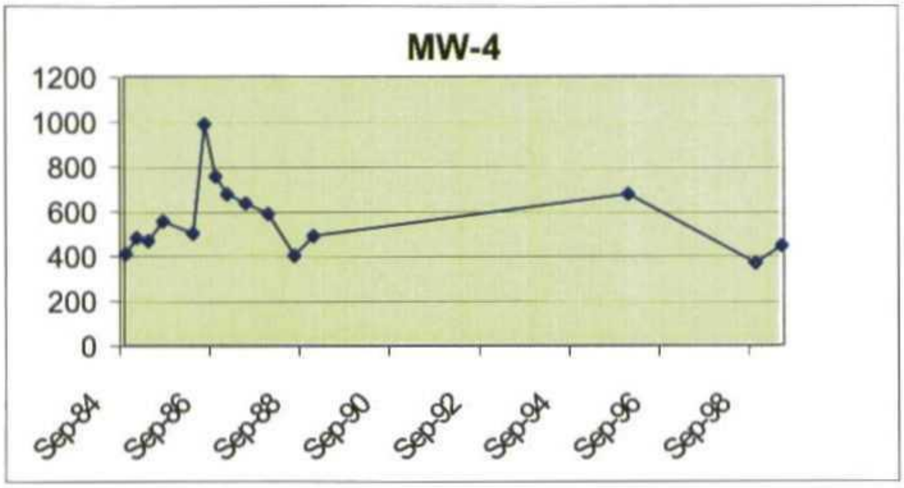
Chloride Concentrations April 1999

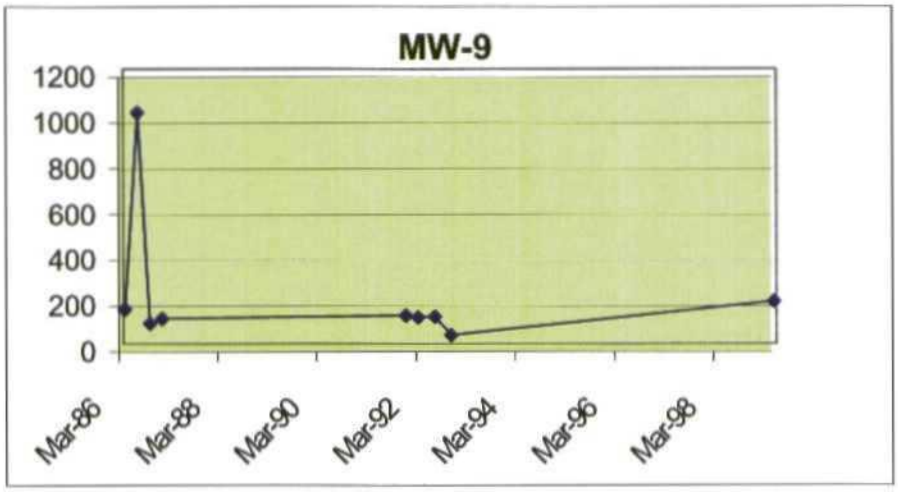


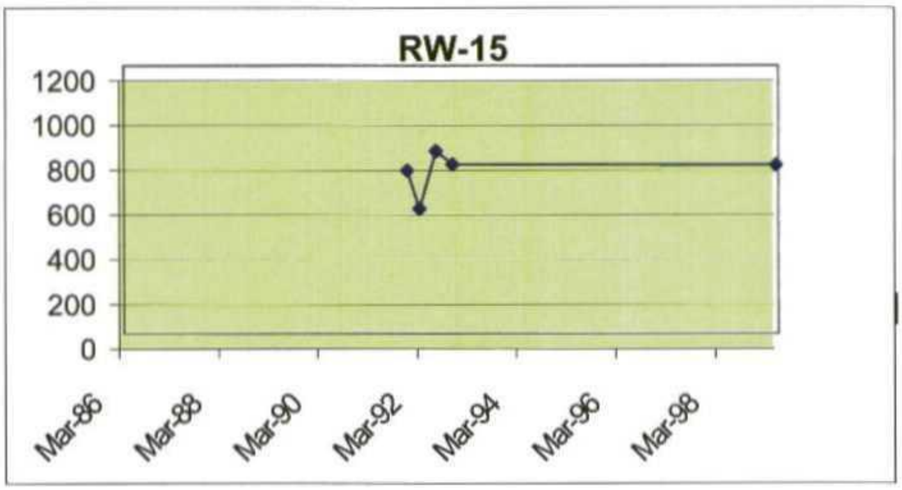




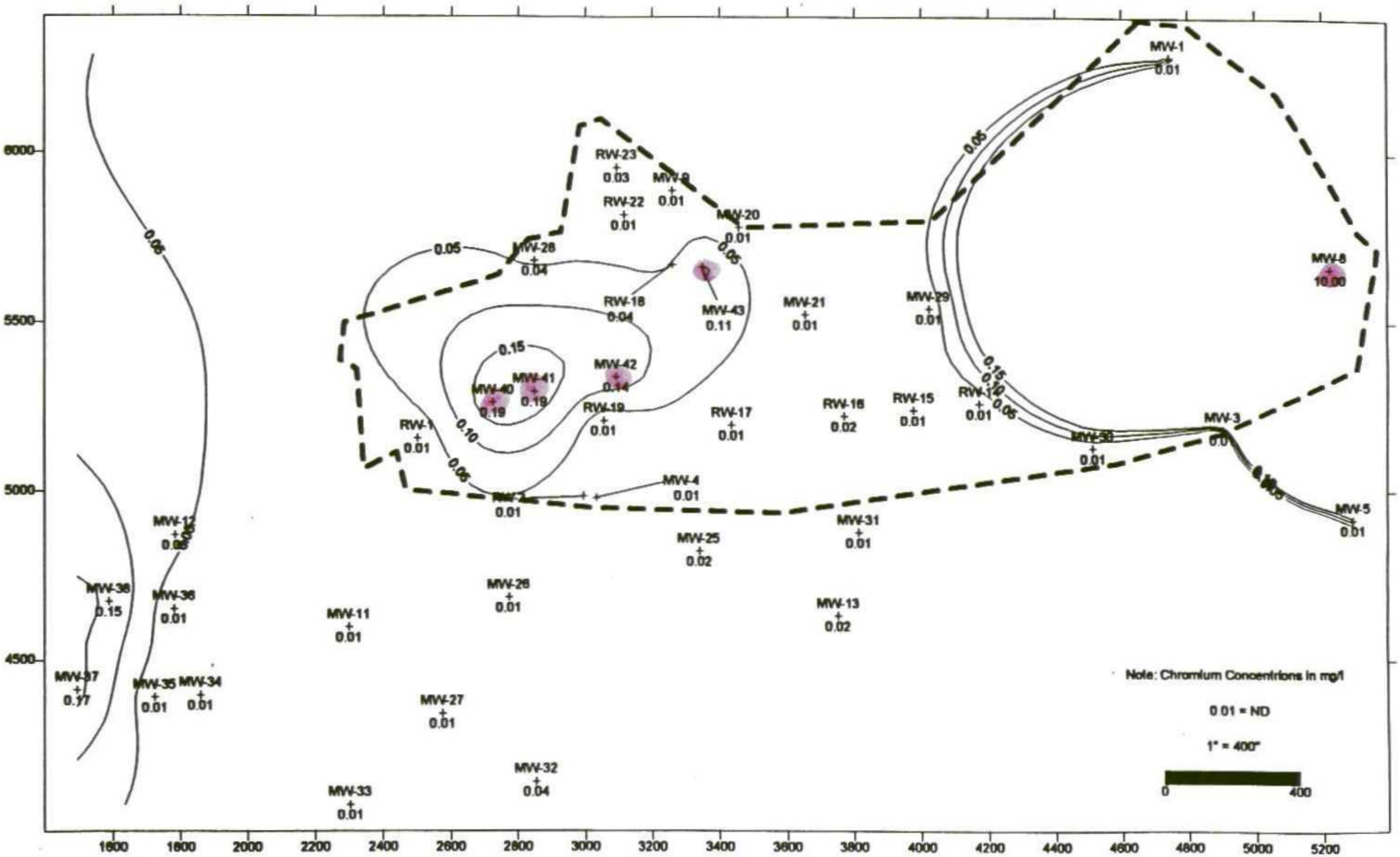
Bloomfield Refinery	Plate 25
Chloride Concentrations (mg/l) Over Time in Background Wells	







Bloomfield Refinery	Plate 26
Chloride Concentrations (mg/l) Over Time in Central Refinery Wells	



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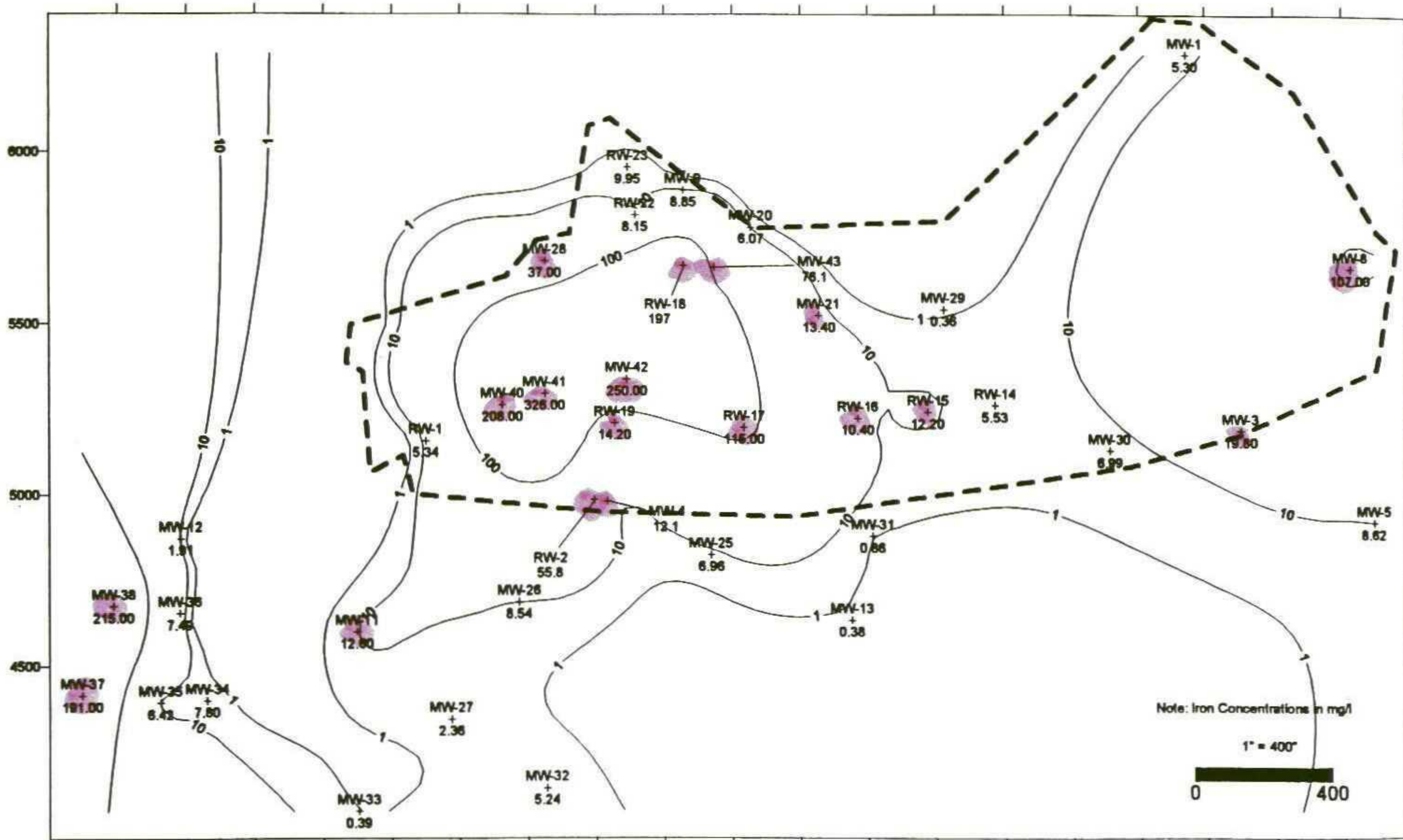
Bloomfield Refinery

Chromium Concentrations April 1999

Plate 27



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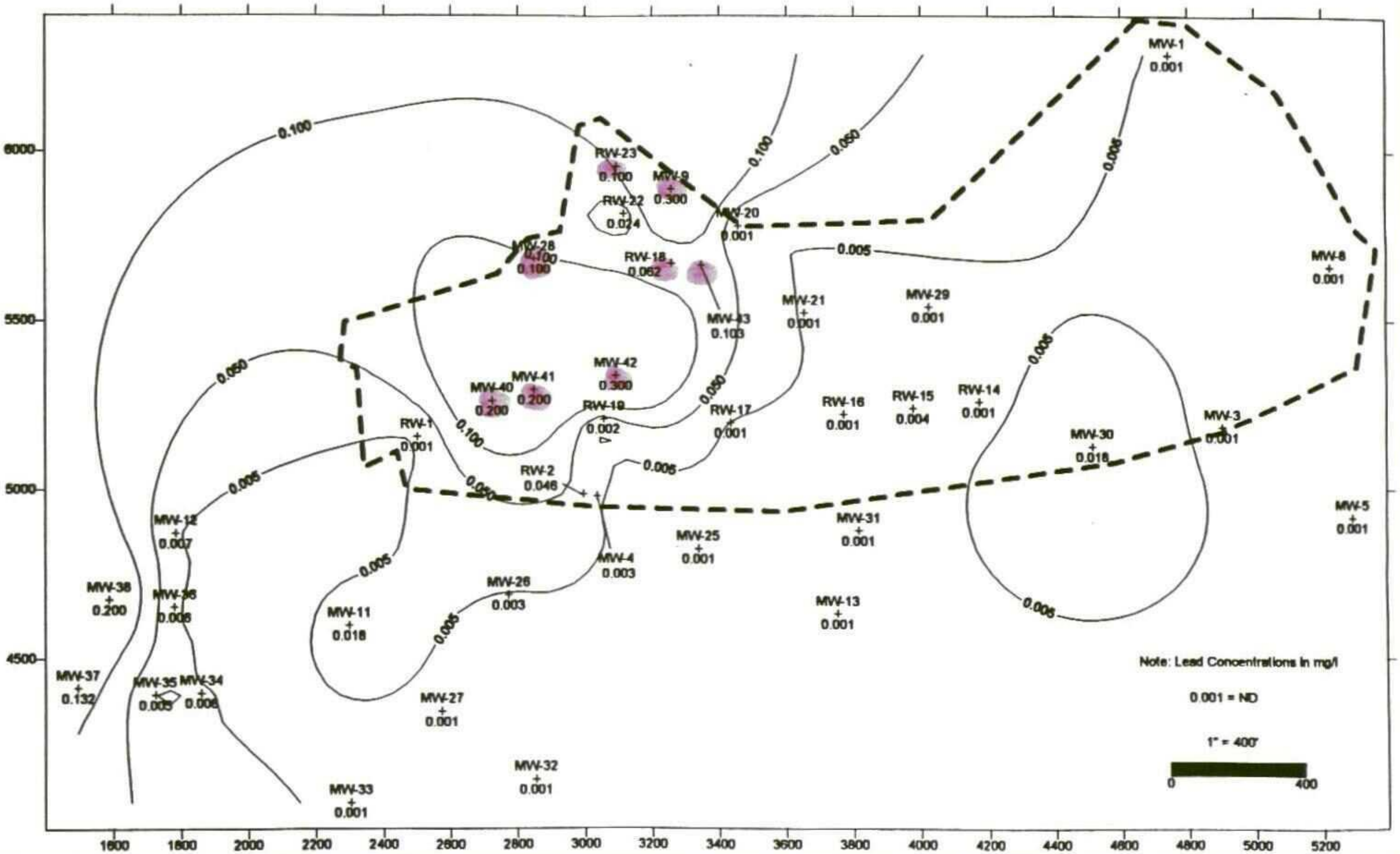
Bloomfield Refinery

Plate 28

Iron Concentrations April 1999



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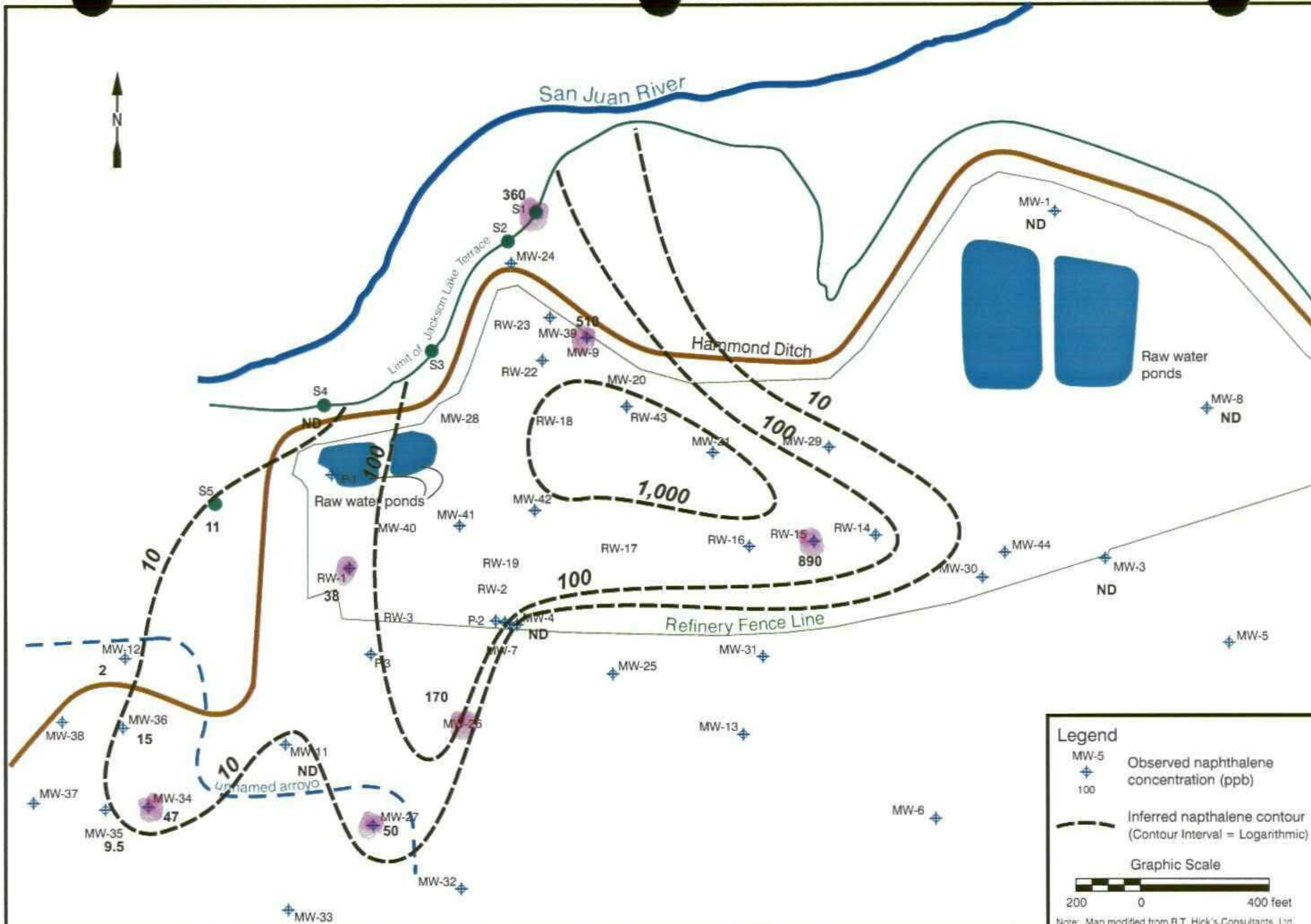
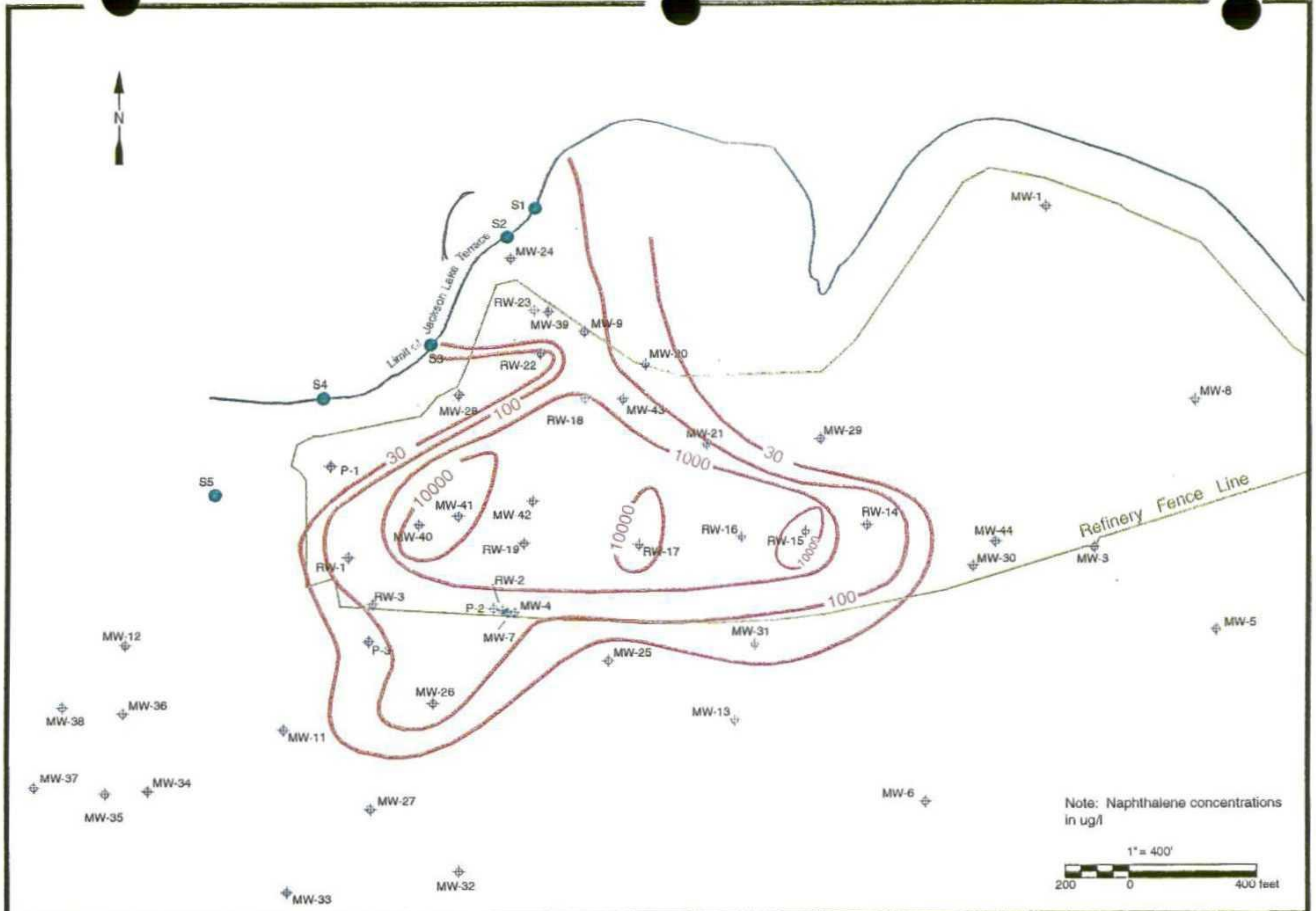
Bloomfield Refinery

Lead Concentrations April 1999

Plate 29



WESTON MANAGERS DESIGNERS CONSULTANTS	GIANT - Bloomfield Refinery	Plate 30
	Naphthalene Concentrations September 2000	



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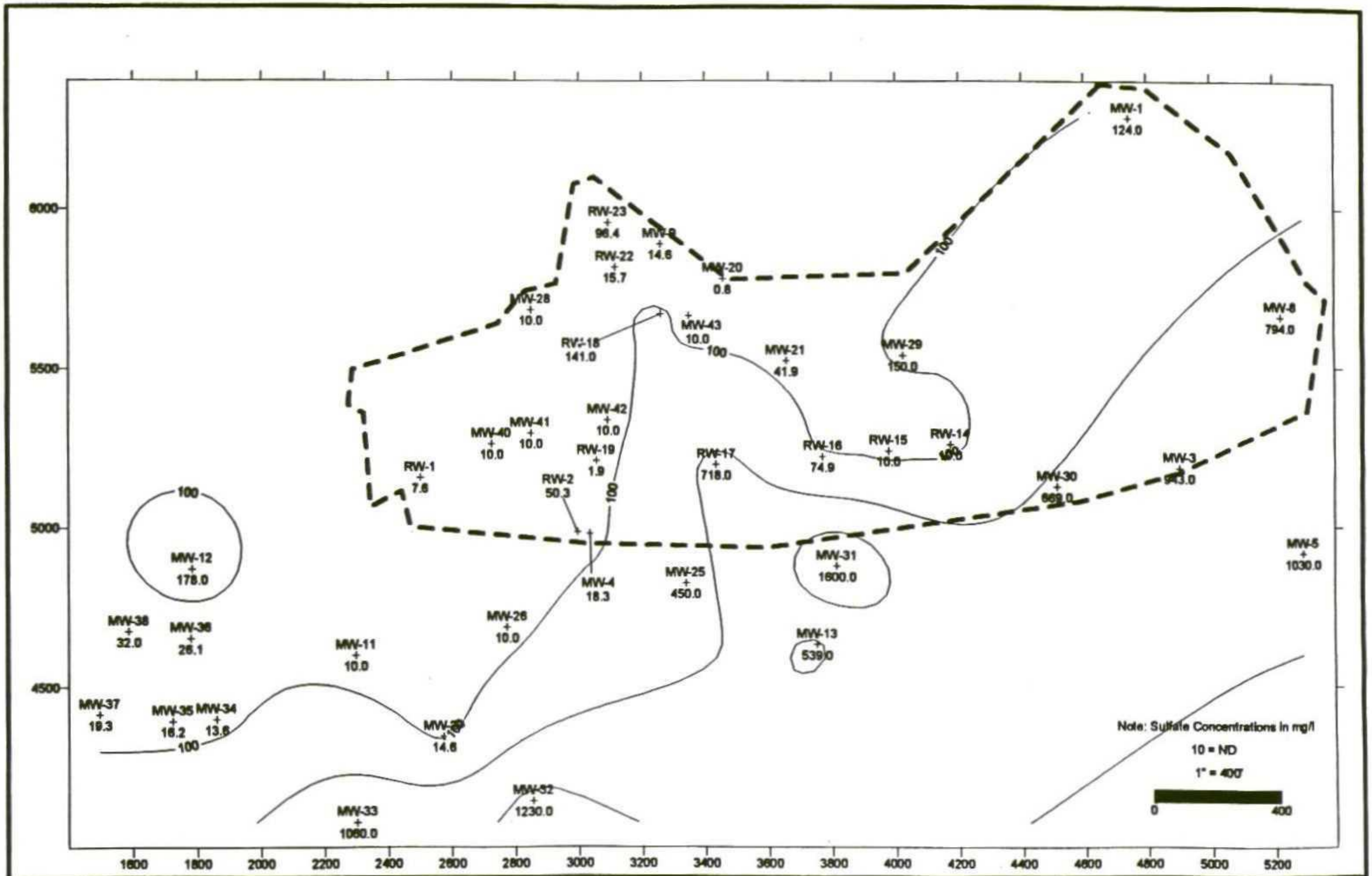
Bloomfield Refinery	Plate 31
Naphthalene Concentrations April 1999	June 1999



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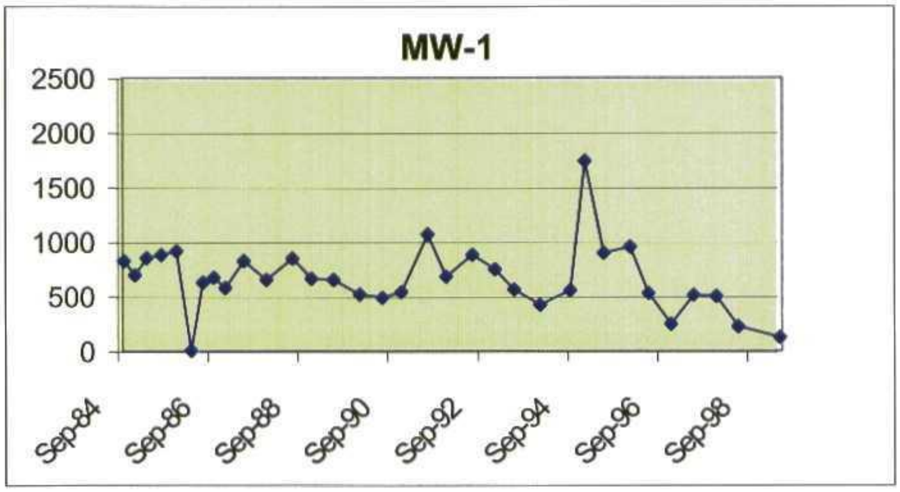
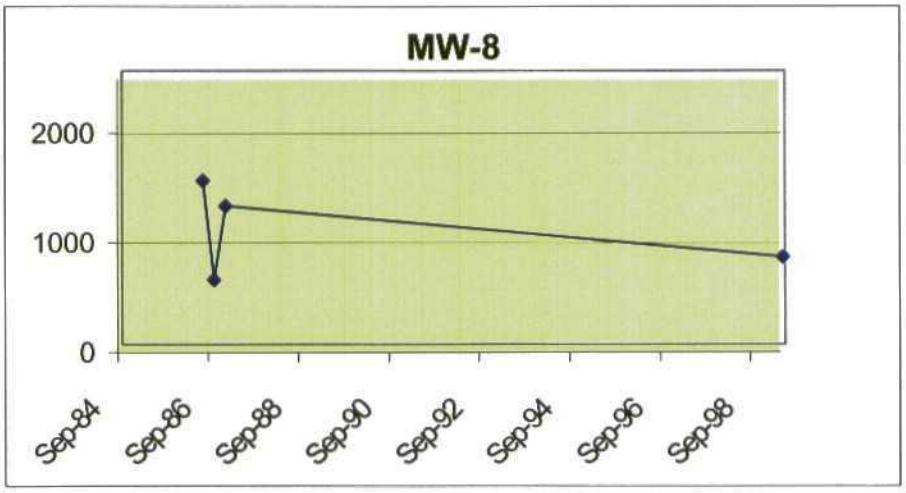
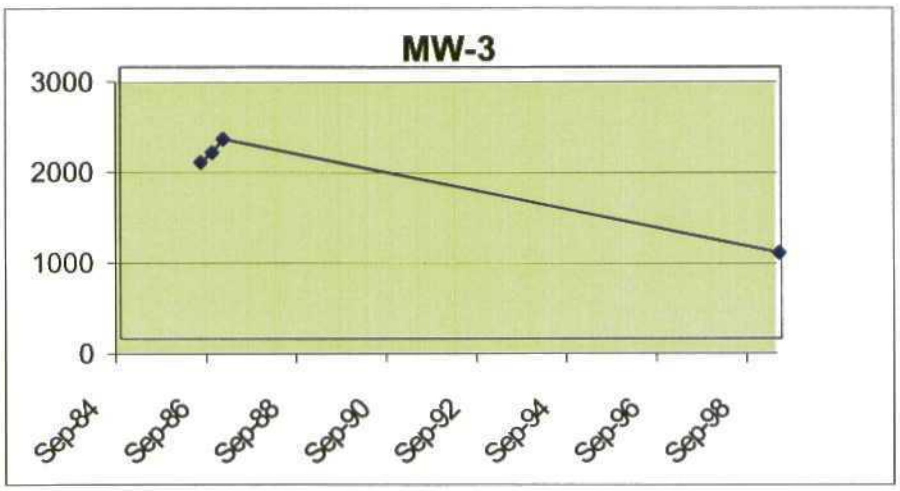
Bloomfield Refinery

Plate 32

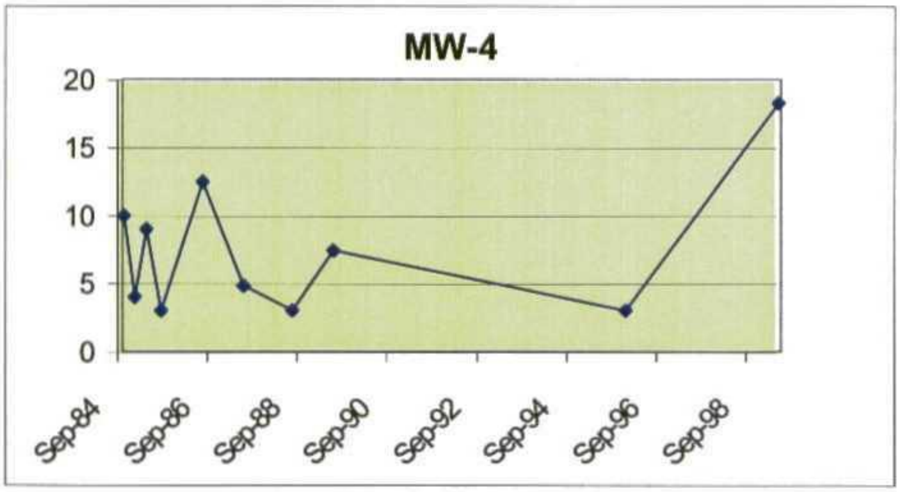
Sulfate Concentrations April 1999

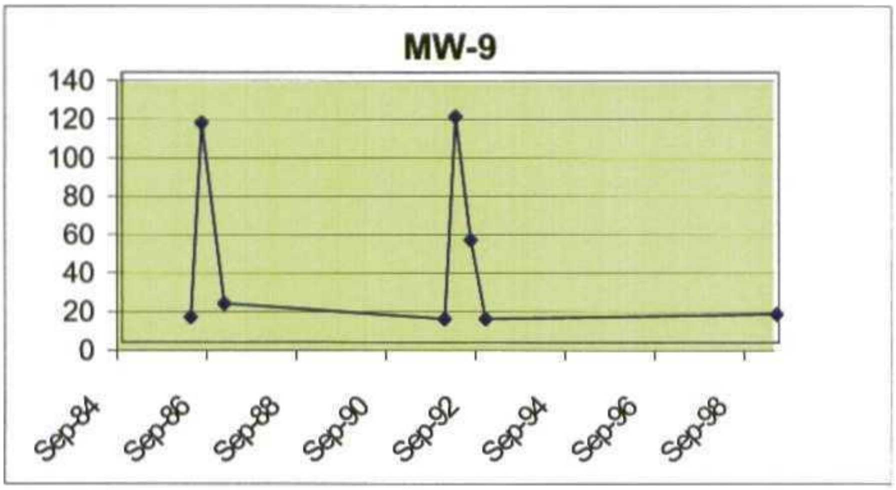


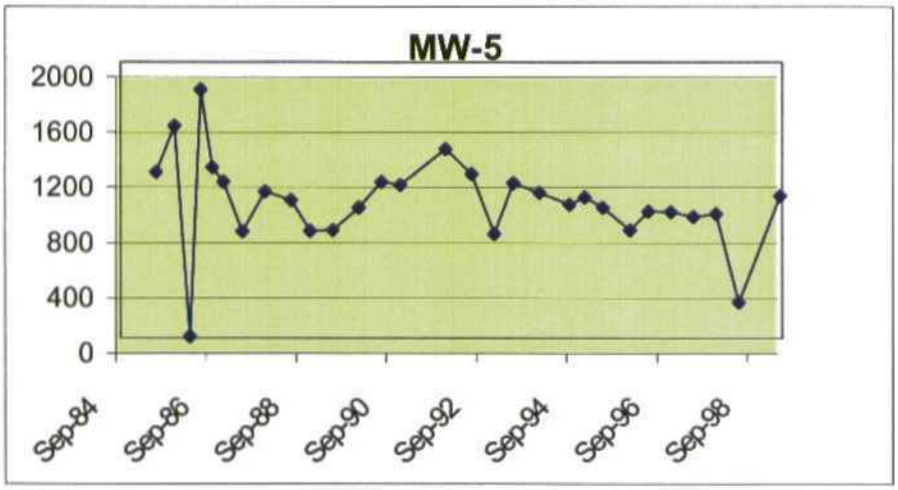




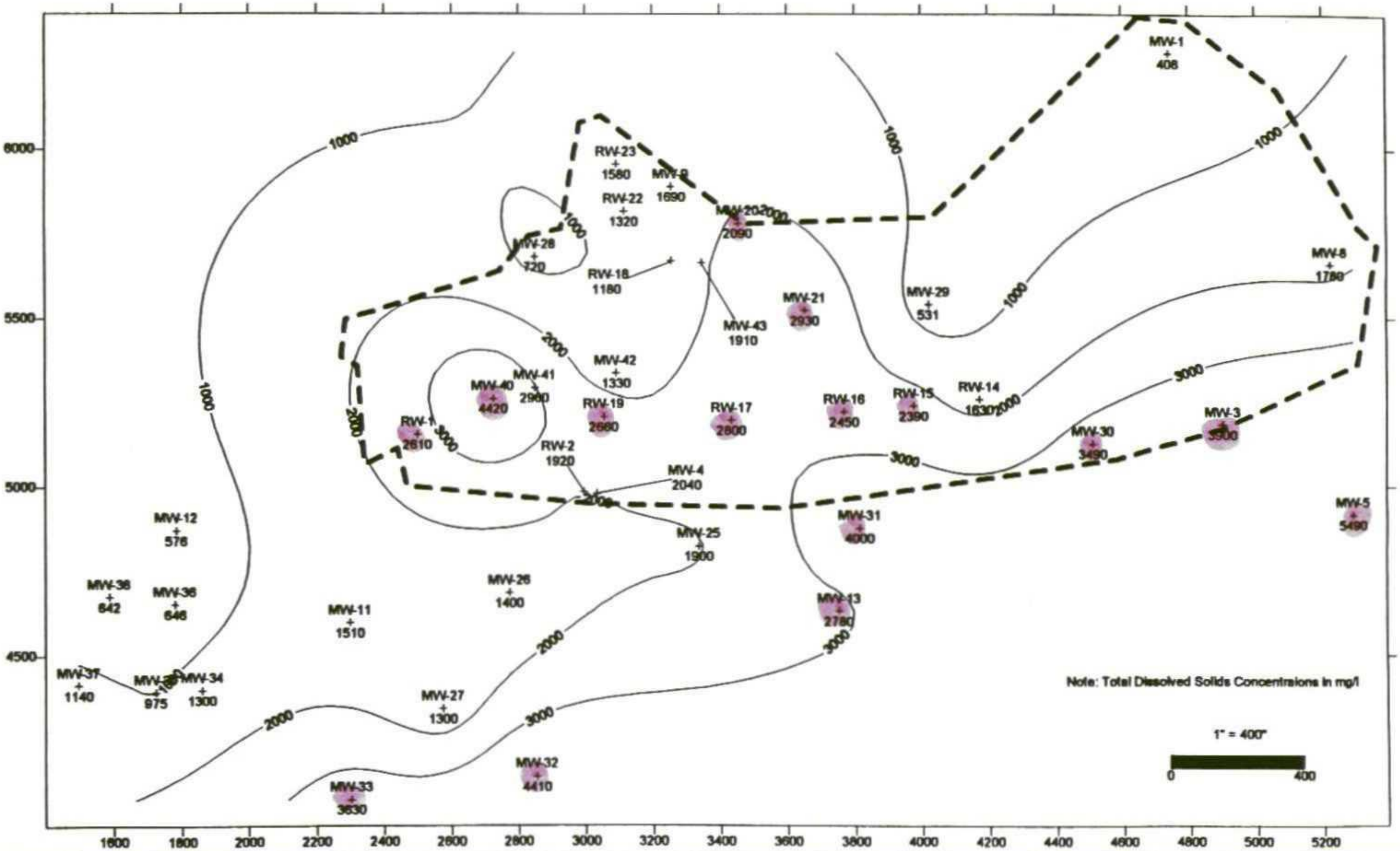
Bloomfield Refinery	Plate 33
Sulfate Concentrations (mg/l) Over Time in Background Wells	







Bloomfield Refinery	**Plate 34**
Sulfate Concentrations (mg/l) Over Time in Central Refinery Area and Spray Irrigation Area	



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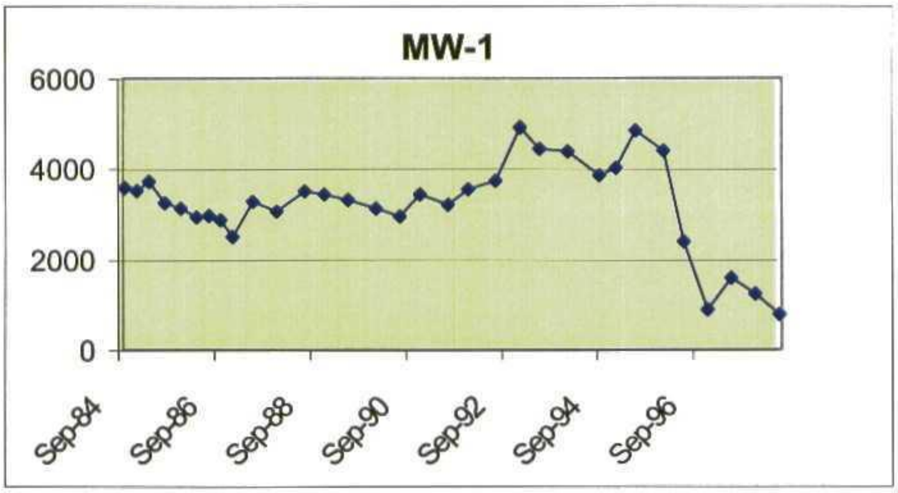
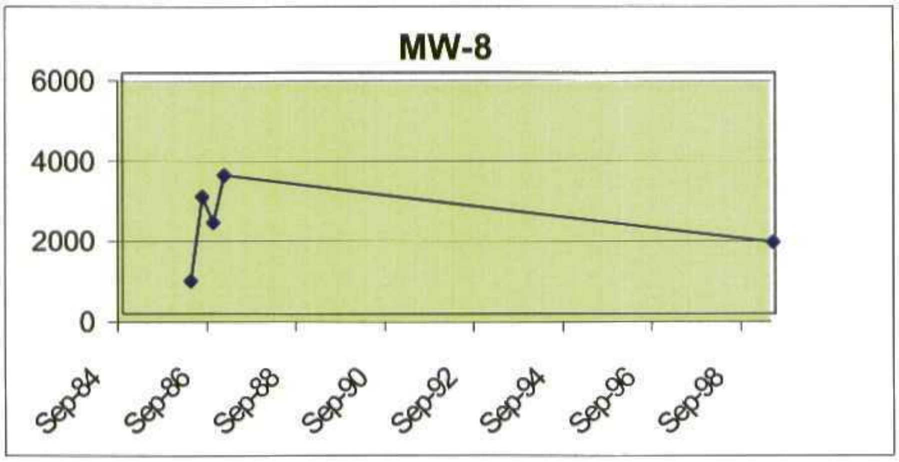
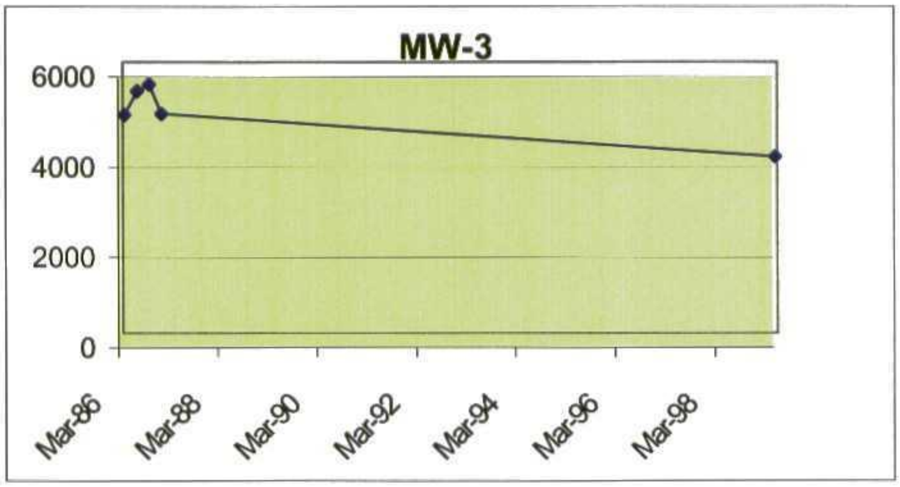
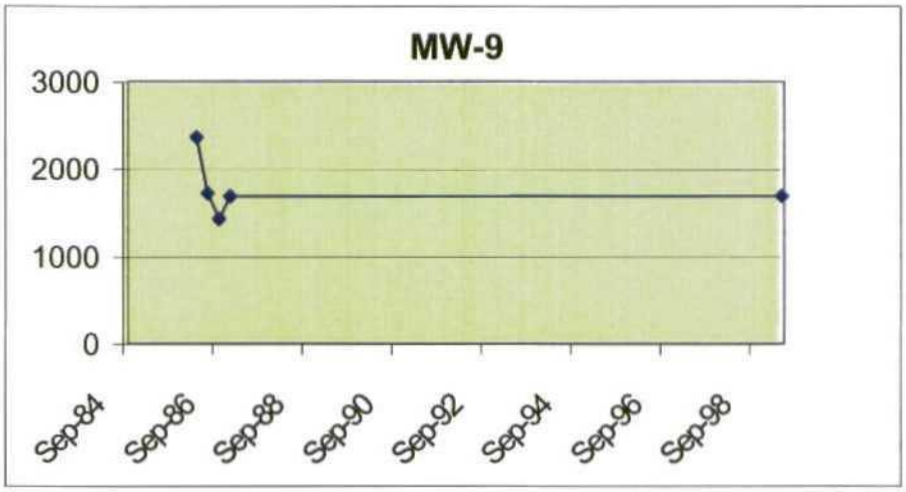
	Total Dissolved Solids Concentrations April 1999	

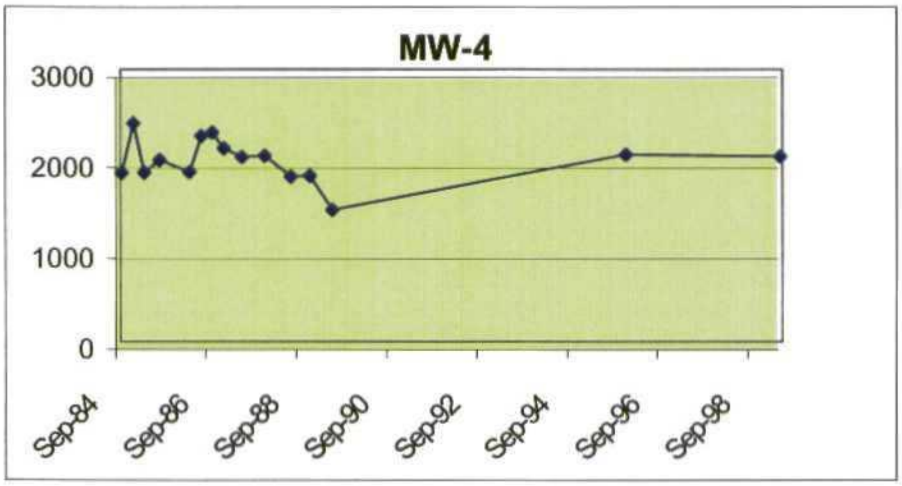


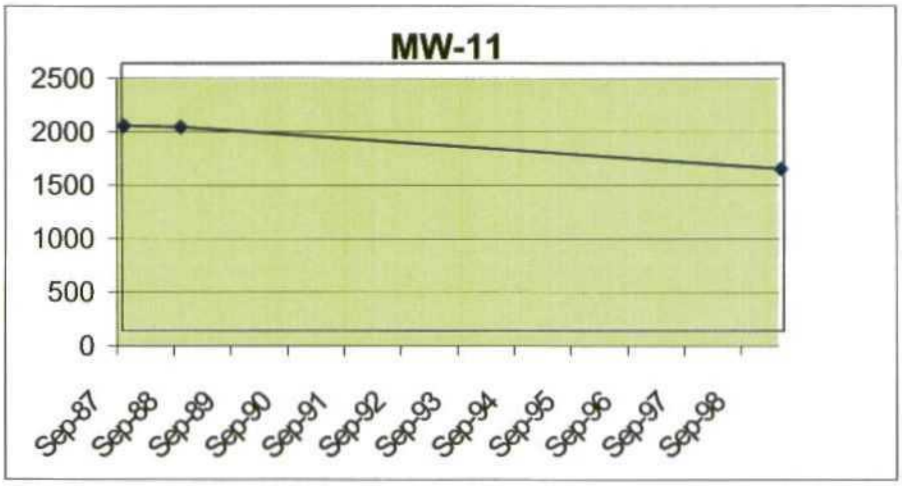




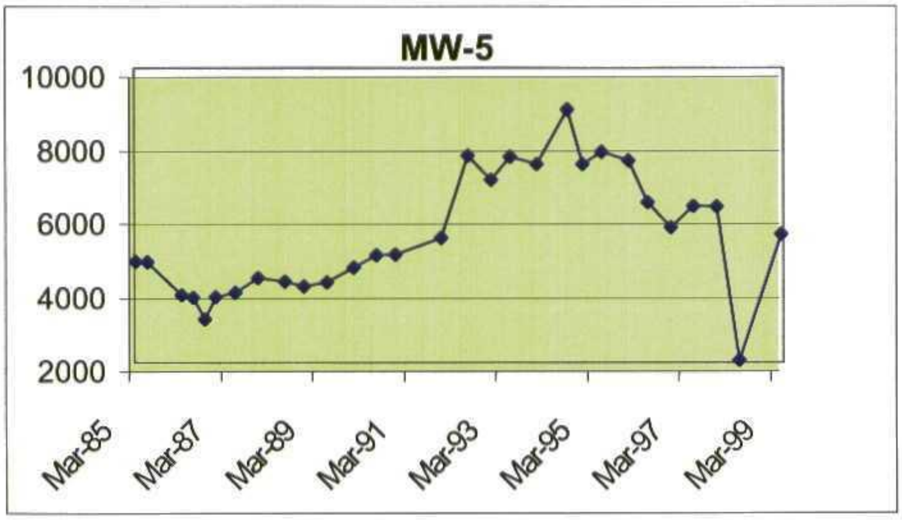
Bloomfield Refinery	Plate 36
TDS Concentrations (mg/l) Over Time in Background Wells	



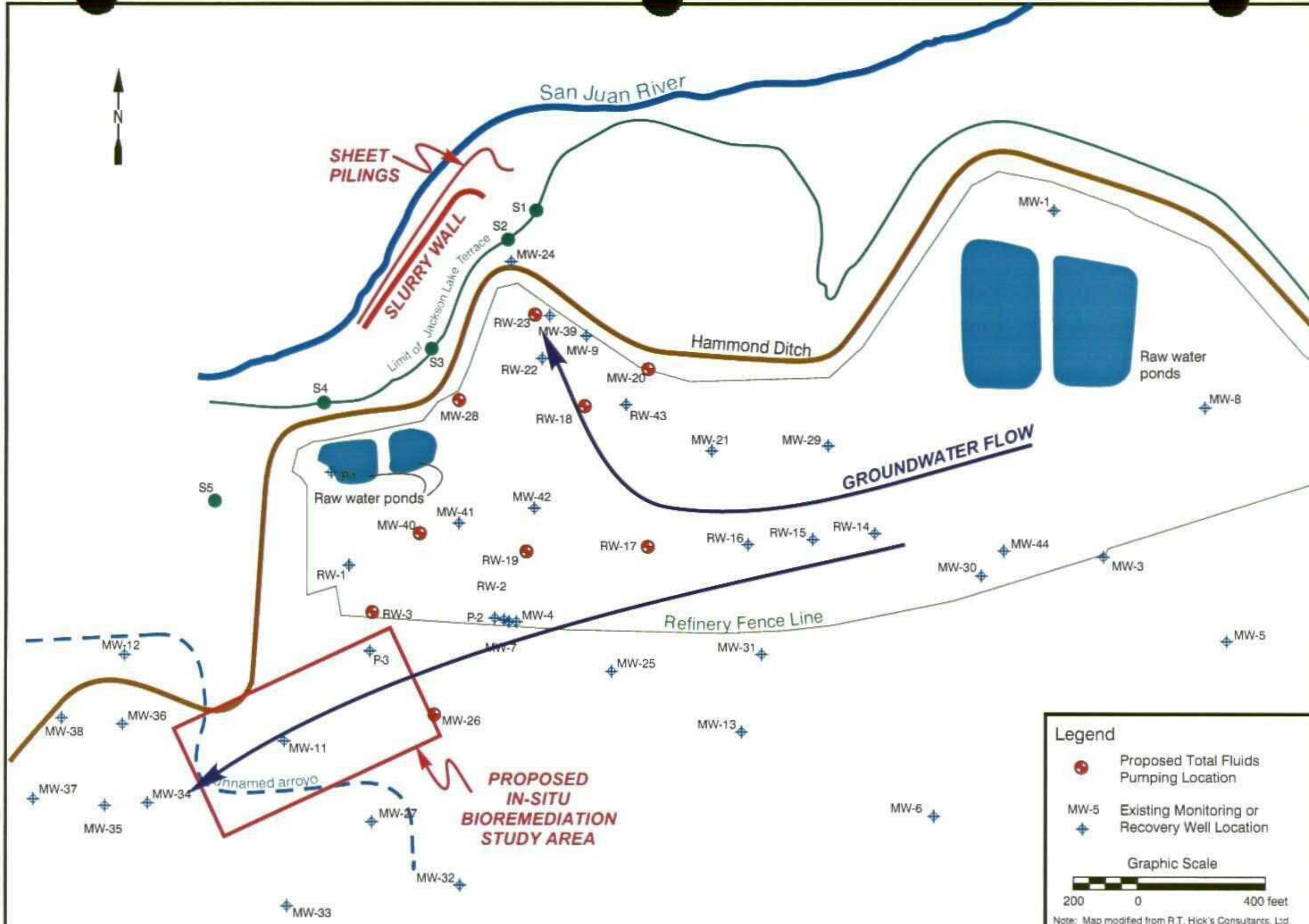




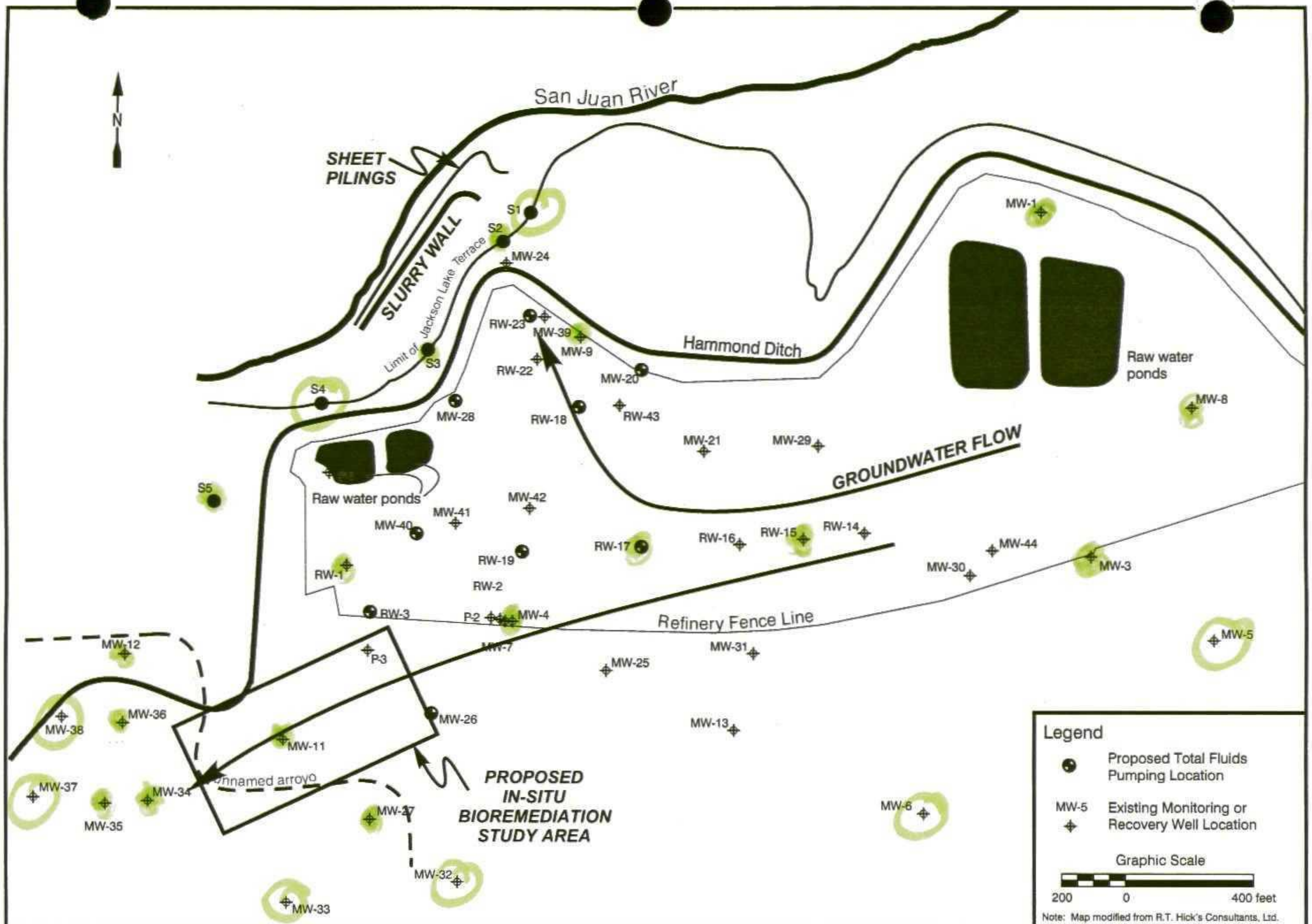
Bloomfield Refinery	Plate 37
TDS Concentrations (mg/l) Over Time in Central Refinery Wells	



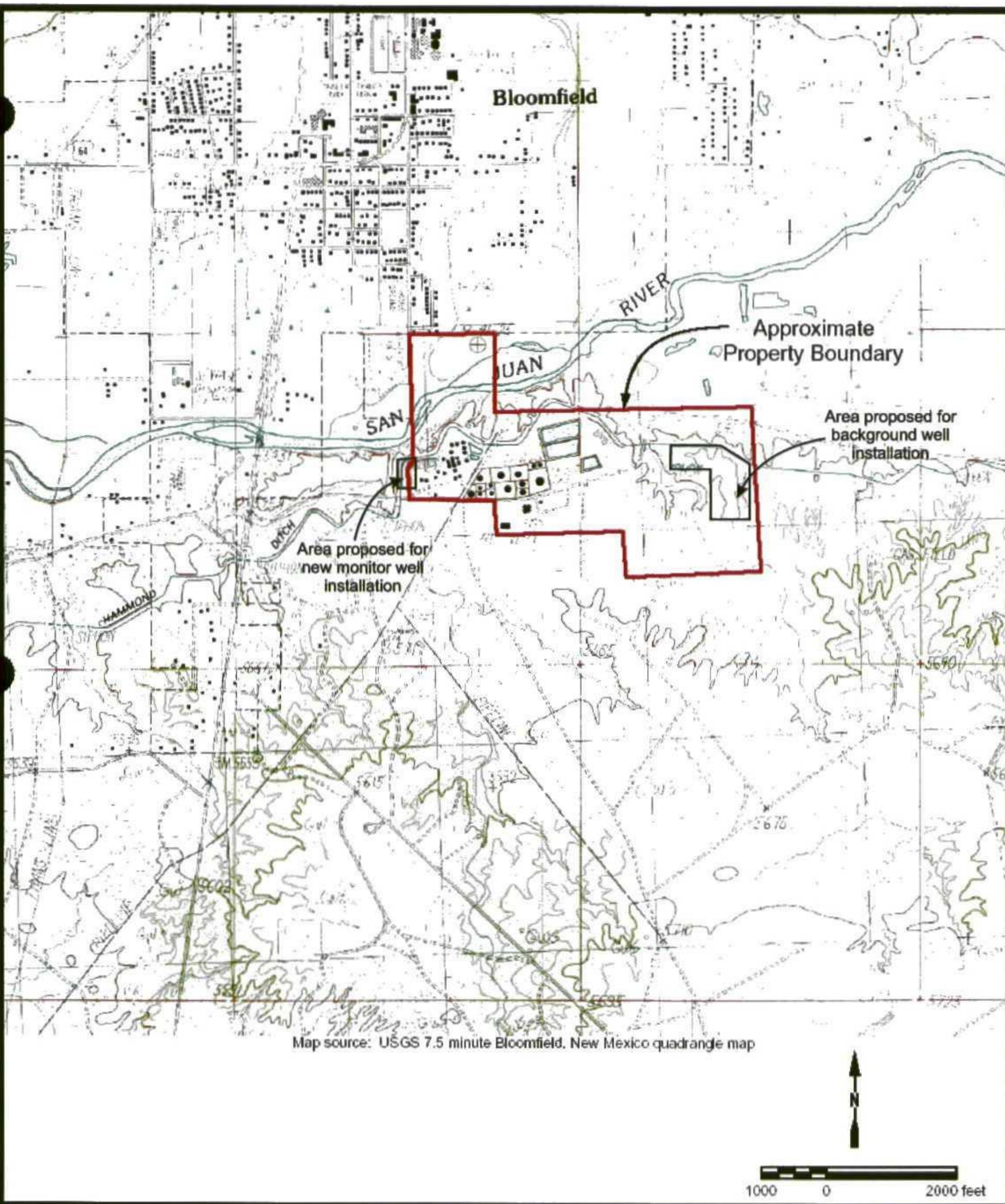
Bloomfield Refinery	Plate 38
TDS Concentrations (mg/l) Over Time in MW-5	



GIANT - Bloomfield Refinery	Plate 39
Abatement Recommendations	



WESTON MANAGERS DESIGNERS/CONSULTANTS	GIANT - Bloomfield Refinery	Plate 39
	Abatement Recommendations	



Map source: USGS 7.5 minute Bloomfield, New Mexico quadrangle map

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Giant Refining Company	Plate 40
Location of Bloomfield Refinery	

Table 1
Direct Product Releases or Leaks

Date	Incident	Location	Action
11/07/84	880 barrels of Naphtha were spilled; 80 barrels were not recovered.	An unspecified Storage Tank	The spill was contained in the tank dike, cleaned up, and returned to the system.
05/19/85	140 barrels of diesel fuel were spilled; 80 barrels were not recovered	Inside Tank 19 dike	The product was removed from the tank; a vacuum truck was used to recover the product from inside the diked area.
04/8 – 04/09/86	200 barrels of diesel'fuel were spilled from leaking, rundown piping; 150 barrels were not recovered.	The lower piperack east of the crude unit	The diesel rundown was routed to a slop tank; a vacuum was used to recover the fuel and the area was sanded.
02/24/87	290 barrels of regular gasoline were spilled during blending; 5 barrels were not recovered.	Inside an unspecified tank dike	The spill was cleaned up with a vacuum truck; signage was added to alert personnel to spill hazards.
08/27/89	100 barrels of gasoline blend/water mixture were spilled; 1 barrel was not recovered.	Inside Tank 22 dike	The spill was cleaned up with a vacuum truck.
03/08/91	180 barrels of kerosene (Jet A) were spilled during transfer; 60 barrels were not recovered.	Inside Tank 26 dike	The spill was cleaned up with a vacuum truck.
06/15/95	100 barrels of wastewater were spilled when an injection well pump shut off; 20 barrels were not recovered.	The evaporation ponds, contained within a dike	The spill was cleaned up with a vacuum truck.
03/25/96	A level sensor on a truck failed during loading; a short caused a subsequent fire.	The loading rack area	No cleanup was needed as the incident occurred on a concrete pad; fire consumed the spill.
10/22/97	100 barrels of crude were spilled when a truck unloaded without supervision; the tank overfilled; 2 barrels were not recovered.	The unloading area, contained within the dike	The oil was vacuumed with a truck; the soil was treated in place.
01/09/98	70 barrels of water, sulfur, and iron chelate were spilled from a concrete pad; 2 barrels spilled into Hammond Ditch; 20 barrels were not recovered.	Hammond Ditch, south of Sullivan Road	The excess water was vacuumed up; the soil was allowed to dry; TCLP samples were taken
01/20/98	1,831 barrels of process wastewater leaked when a line broke; 10 barrels were not recovered	Due west of the north lined evaporation pond.	A dike was built to contain leaks; the flow of the leak was diverted until the line was repaired.
03/03/00	500 bbl of reformate spilled and contained by berms	Tanks 3, 4, 5	The liquid was removed and off loaded into the API separator. The contaminated soil was removed from the spill area and land farmed. Closure by OCD was 8/17/00.

Table 2
Indirect Product Releases or Leaks Discovered During Storage Tanks Repairs

Date	Location	Action
1987	Tanks 6 and 7	The tanks were decommissioned due to excessive leaks and repairs needed.
02/91	Tank 17:–	The floor was repaired with 120 mils of fiberglass.
05/88	Tank 18	Five holes were patched in the epoxy-coated floor.
07/85	Tank 19	Twenty-eight holes in the floor were repaired; June 1990 – Sixty pits/holes in the floor were repaired; June 1991 – The floor was replaced.
11/90	Tank 20	Five holes were repaired.
06/92	Tank 23	One hole in the floor was repaired.
05/86	Tank 24	Two coats of epoxy were added to the floor to repair leaks.
03/86	Tank 25	Two coats of epoxy were added to the floor to repair leaks.
02/89	Tank 26	The floor was coated with fiberglass/epoxy to repair leaks.
01/90	Tank 29	The floor was replaced.
12/89	Tank 30	Several holes in the floor were repaired; March 1992 – The holes in the floor were repaired.
03/92	Tank 31	A portion of the floor was replaced due to corrosion.

Table 3
Previous Site Investigations

Date	Title	Author	Summary
8/5/1985	RCRA 3013 Final Workplan	Bloomfield Refining Company	A Comprehensive Groundwater Study Proposal to determine the extent of the hydrocarbon plume. Monitor wells MW-1 through MW-6 installed in February 1984 in preparation for the workplan submittal.
6/2/1986	Report on Subsurface Hydrocarbon Data	Bloomfield Refining Company	This study first identified hydrocarbons outside of the refinery boundaries. Bloomfield Refining Company installed monitoring wells MW-7 through MW-10.
8/20/1986	Final Closure Plan for the API Wastewater Ponds, Landfill, and Landfill Pond at the Bloomfield Refinery	Engineering Science	This study provides data on waste material and underlying soils associated with these solid waste management units. All analytical results were consistent with clean closure for all of the subject areas.
2/6/1987	A Final Report on Section 3013 Administrative Order Work Elements	Engineering Science	Identification of hydrocarbons in the unsaturated zone.
4/4/1988	Site Investigation and Remedial Action Conceptual Design for the Bloomfield Refining Company	Geoscience Consultants, Ltd. (GCL)	Computer modeling determined that a three well recovery system would be optimal to minimize further hydrocarbon migration.
8/3/1989	Final Report on Soil Vapor Survey, Well Installation and Hydrocarbon Recovery System	Geoscience Consultants Ltd. (GCL)	Hydrocarbons are evident south of the site on BLM land. The study proposed a recovery well system to minimize hydrocarbon migration from the refinery.
2/11/1992	Interim Measures Work Plan	Groundwater Technology (GTI)	The proposed Interim Measures were: two additional recovery wells, implement a pumping system, survey wells, gauge liquid levels in the wells, startup tests for the two new recovery wells and monitoring of all new equipment.
3/29/1993	RCRA Facility Investigation (RFI)-Task 1 and Task II	GTI	The report describes surface and subsurface conditions and provides a draft work plan to conduct the RFI.
2/2/1994	RFI-Phase I-Soil Gas Survey	GTI (subcontracted to Burlington Environmental)	The highest level of hydrocarbon is the area around the flare, the roadway south of Tanks 11 and 12, and the area surrounding Tanks 24 and 28.
4/22/1994	RFI- Phase II-Soil Boring Investigation	GTI (Drilling contracted to Western Technologies)	The area around the product loading area was not found to be significantly impacted by a product release or to be a hydrocarbon source area.
6/23/1994	RFI-Phase III-Well Installation/1st Groundwater Sampling Event	GTI	All wells not containing SPH were sampled (16). See analytical table for specific results.

Date	Title	Author	Summary
9/30/1994	RFI-Phase III- 2nd Groundwater Sampling Event	GTI	All wells not containing SPH were sampled (16). See analytical table for specific results.
7/30/1994	RFI- Phase IV-Uppermost Aquifer Hydraulic Testing and Modeling	GTI	Values calculated for transmissivity and hydraulic conductivity were indicative of a high-permeability saturated zone. Fast accumulation of SPH in the cone-of-depression during pumping indicated that dual liquid removal is an alternative for the collection of the SPH.
8/16/1994	RFI-Phase IV-Soil Vapor Extraction/Air Sparging Pilot Studies	GTI (Subcontracted drilling to Layne Environmental Services)	Calculated effective radii of influence for the shallow zone ranged from 2 feet to 36 feet. Any vapors generated as a result of sparging can be captured and contained by the vacuum system. Hydrocarbon mass removal rates ranged from .20 lb./hr to 5.5 lb./hr.
8/14/1994	RFI-Phase V-Stream and Sediment Sampling	GTI	Stream and sediment sample analysis show no significant impact to the Hammond Ditch or the San Juan River.
12/21/1995	Human Health and Ecological Risk Assessment	GTI	There are no unacceptable risks to human health and environment unless the shallow unsaturated zone is used for potable water.
12/21/1995	Corrective Measures Study	GTI	A summary using the previous investigations to determine the best course of action at the GRC site. The study recommended air sparging, SPH recovery and vapor extraction.

Table 4
Measured Hydraulic Conductivity

Measured K Values		Location	Source	Method
ft/sec	m/sec			
1.65 E-4	5.03 E-5	MW-1	Engineering-Science (1987)	Slug Tests
3.30 E-4	1.00 E-4	MW-2 (near MW-29)		
1.29 E-4	3.84 E-5	MW-4		
2.23 E-4	6.80 E-5	MW-10 (RW-3)	Geoscience Consultants (3/88)	Pumping Test 1
1.95 E-4	5.94 E-5	MW-10 (RW-3)		Pumping Test 2
4.49 E-5	1.36 E-5	MW-10 (RW-3)		Recovery Test 1
6.25 E-5	1.91 E-5	MW-10 (RW-3)		Recovery Test 2`
2.34 E-5	7.13 E-6	MW-11		Recovery
2.04 E-3	6.22 E-4	MP-3 (near RW-19)	Groundwater Technology (7/94)	Pumping Test RW-19
1.83 E-3	5.58 E-4	MP-4 (near RW-19)		Pumping Test RW-19
5.09 E-4	1.55 E-4	RW-22		Pumping Test RW-22

Table 5
Groundwater Sampling Event
September 2000

Method	SW-846 5030A/ 8021B	5030A/ 8021B	5030A/ 8021B	5030A/ 8021B	5030A/ 8021B	5030A/ 8021B	RSK 147	EPA 300.0	EPA 300.0	EPA 4.1.1/ 200.71 CP
Liquid Reporting Limit (μg/L)[a]	5	750	700	620[b]	620[b]	30[c]	100	600,000	10,000	1,000
Location	Benzene	Toluene	Ethylbenzene	o-Xylene	mp-Xylenes	Napthalene	Methane	Sulfate	Nitrate	Iron
SEEP #1	1600	ND	720	ND	97	360	—	—	—	—
SEEP #4	ND	ND	ND	ND	ND	ND	—	—	—	—
SEEP #5	ND	ND	ND	ND	24	11	—	—	—	—
MW-1	ND	ND	ND	ND	ND	ND	—	130	1.4	—
MW-3	ND	ND	ND	ND	ND	ND	—	980	41	—
MW-4	9100	ND	850	ND	ND	ND	—	ND	ND	—
MW-8	ND	ND	ND	ND	ND	ND	ND	830	12	0.07
MW-9	15000	260	940	340	4400	510	—	13.6	ND	—
MW-11	250	ND	15	ND	160	ND	3.7	46	ND	15.3
MW-12	10	ND	2.3	ND	31	2.0	—	2100	ND	—
MW-26	4600	ND	1000	ND	4300	170	—	1.0	ND	—
MW-27	18	ND	9.9	ND	64	50	—	49	ND	—
MW-34	140	ND	17	ND	85	47	3.9	55	ND	5.72
MW-35	21	ND	4.6	ND	100	9.5	ND	120	ND	2.77
MW-36	7.7	ND	15	ND	150	15	—	90	ND	—
RW-1	180	ND	18	ND	25	38	—	346	ND	—
RW-15	7600	14000	3300	4600	14000	890	0.79	2.26	ND	3.42

a Based on EPA Region 6 Human Health Medium-Specific Screening Levels (2001) and NM WQCC Regulations (1999). Analytical detection limits are required to be lower than reporting limits.
b Regulatory limits for individual isomers combined into a "total" limit for these compounds.
c Total naphthalene plus monomethylnaphthalenes regulatory limit is <30 μg/L for aqueous samples.

Table 6
Groundwater Sample Event, April 1999
Modified Skinner List SW-846 Method 8260, Volatile Organics[b]

Liquid Reporting Limit (µg/L)	1.5	610	5.0	4.3	6.1	5	100	1900	1000	0.16	5	60	5	60	750	39	5	39	750	10,000	10,000	100	0.055	
Location	Chloromethane	Acetone	1,1-Dichloroethene	Methylene Chloride	1,4-Dioxane	1,1-Dichloroethane	Trans-1,2-Dichloroethene	2-Butanone (MEK)	Carbon Disulfide	Chloroform	1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene	Trichloroethane	Toluene	1,2-Dibromoethane	Tetrachloroethene	Chlorobenzene	Ethylbenzene	o-Xylene [a]	m&p-Xylenes [a]	Styrene	1,1,2,2-Tetrachloroethane	% Moisture
SEEP #1	—	—	—	—	—	—	—	—	—	—	—	—	800.00	—	—	—	—	—	1400.00	—	1100.00	—	—	—
SEEP #4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.00	—	—	—	1.50	—	8.90	—	—	—
SEEP #5	—	—	—	—	—	—	—	—	—	—	—	—	56.00	—	—	—	—	—	10.00	—	330.00	—	—	—
MW-1	—	—	—	—	—	—	—	—	—	—	—	—	2.80	—	—	—	—	—	2.50	—	30.00	—	—	—
MW-3	—	—	—	—	—	—	—	—	—	—	—	—	4.70	—	—	—	—	—	4.70	—	29.00	—	—	—
MW-4	—	—	—	—	—	—	—	—	—	—	160.00	—	8900.00	—	—	—	—	—	600.00	—	330.00	—	—	—
MW-8	—	—	—	—	—	—	—	—	—	—	—	—	1.60	—	—	—	—	—	2.00	—	23.00	—	—	—
MW-9	—	—	—	—	—	—	—	—	—	—	330.00	—	18000.00	—	690.00	—	—	—	1000.00	510.00	6300.00	—	—	—
MW-11	—	—	—	—	—	—	—	—	—	—	—	—	2700.00	—	—	—	—	—	330.00	—	8900.00	—	—	—
MW-12	—	—	—	—	—	—	—	—	—	—	—	—	23.00	—	—	—	—	—	5.00	—	130.00	—	—	—
MW-26	—	—	—	—	—	—	—	—	—	—	77.00	—	4200.00	—	—	—	—	—	800.00	—	7900.00	—	—	—
MW-27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28.00	—	—	—
MW-34	—	30.00	—	—	—	—	—	—	—	—	—	—	110.00	—	—	—	—	—	6.20	—	80.00	—	—	—
MW-35	—	—	—	—	—	—	—	—	—	—	—	—	5.50	—	—	—	—	—	—	—	59.00	—	—	—
MW-36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	54.00	—	—	—
RW-1	—	—	—	—	—	—	—	—	—	—	21.00	—	1000.00	—	260.00	—	—	—	130.00	87.00	430.00	—	—	—
RW-15	—	—	—	—	—	—	—	—	—	—	—	—	14000.00	—	25000.00	—	—	—	6900.00	9400.00	36000.00	—	—	—

NOTES: [a]Regulatory limits for individual isomers combined into a "total" limit for these compounds.
– Not detected above Reporting Limit
[b]Analytical results for other analytes and sampling locations can be found in Discharge Plan Application. Site Investigation and Abatement Plan - Giant Bloomfield Refinery (R. T. Hicks Consultants, Ltd., 1999)

Reporting Limit varies with sample % moisture.
Reporting Limit for aqueous samples was 1.0 µg/L for all analytes except 1.4 Dioxane (100 µg/L) and Acetone and 2-Butanone (10 µg/L).

Table 7
Groundwater Analytical Results - Organic Parameters (1984 - 1998)

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	Date										
MW-1	11/23/1998		3.8		1.3						
MW-1	5/28/1998	ND	ND	ND	ND						
MW-1	11/17/1997	ND	ND	ND	ND						
MW-1	5/23/1997	ND	ND	ND	ND						
MW-1	11/20/1996	ND	ND	ND	ND						
MW-1	5/31/1996	ND	0.3	ND	0.4						
MW-1	12/7/1995	ND	ND	ND	ND						
MW-1	5/22/1995	ND	ND	ND	ND						
MW-1	12/21/1994	ND	ND	ND	ND						
MW-1	8/3/1994	ND	ND	ND	ND						
MW-1	5/25/1994	ND	ND	ND	ND						
MW-1	12/13/1993	ND	ND	ND	ND						
MW-1	5/14/1993	ND	ND	ND	ND						
MW-1	12/11/1992		ND	ND	ND						
MW-1	6/9/1992	ND	ND	1.4	ND						
MW-1	11/7/1991	ND	ND	ND	ND						
MW-1	6/5/1991	ND	ND	ND	ND						
MW-1	11/14/1990	ND	ND	ND	1.1	12.8					
MW-1	6/19/1990	ND	ND	ND	ND	11.3					
MW-1	12/1/1989	ND	3.75	ND	ND						
MW-1	5/25/1989	ND	ND	ND	ND						
MW-1	11/18/1988	0.75	2.68	NT	NT						
MW-1	6/3/1988	ND	ND								
MW-1	11/17/1987	ND	ND								
MW-1	5/28/1987	ND	ND								
MW-1	12/16/1986	ND	ND	ND	ND	18	0.002				
MW-1	9/18/1986	ND	ND	ND	ND	24					
MW-1	6/23/1986	ND	ND	ND	ND	24	ND				
MW-1	3/26/1986	ND	ND	ND	ND	18					
MW-1	11/8/1985	ND	ND								
MW-1	7/10/1985	ND	ND								
MW-1	3/21/1985	ND	ND								
MW-1	12/13/1984	15	ND								
MW-1	9/1/1984	ND	ND								
MW-1	1984-85	ND	ND	ND	ND						
MW-2	12/16/1986	ND	ND	ND	ND	15					
MW-2	9/18/1986	ND	ND	ND	ND	23					
MW-2	6/23/1986	ND	ND	ND	ND	27					
MW-2	3/26/1986	ND	ND	ND	ND	18					

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
MW-3	8/3/1994	ND		ND	ND						
MW-3	5/24/1994	ND	ND	ND	ND						
MW-3	12/16/1986	ND	ND	ND	ND	12					
MW-3	9/18/1986	ND	ND	ND	ND	16					
MW-3	6/23/1986	ND	3	ND	30	17					
MW-3	3/26/1986	ND	ND	ND	ND	29					
MW-4	9/29/1998								8.4	ND	0.056
MW-4	9/2/1998	12000	ND	980	4110						
MW-4	5/25/1989	9200	9800	1100	10700						
MW-4	11/18/1988	11130	8916	NT	NT						
MW-4	6/3/1988	8900	930	ND	ND						
MW-4	11/17/1987	8500	23	NT	NT						
MW-4	5/28/1987	10700	7100	NT	NT						
MW-4	12/16/86	1910	1780	4480							
MW-4	9/18/86	6650	407	140							
MW-4	6/23/1986	3100	290	70	NT						
MW-4	3/26/86	11800	7500	107	ND						
MW-4	11/8/1985	7460	2000								
MW-4	7/10/1985	8640	1740								
MW-4	3/21/1985	14810	1920								
MW-4	12/13/1984	3640	4470								
MW-4	9/1/1984	419	296								
MW-5	5/28/1998	ND	ND	ND	ND						
MW-5	11/17/1997	ND	ND	ND	ND						
MW-5	5/23/1997	ND	ND	ND	ND						
MW-5	11/20/1996	ND	ND	ND	ND						
MW-5	5/31/1996	ND	ND	ND	ND						
MW-5	12/7/1995	ND	ND	ND	ND						
MW-5	5/22/1995	ND	ND	ND	ND						
MW-5	12/21/1994	ND	ND	ND	ND						
MW-5	8/3/1994	ND	ND	ND	ND						
MW-5	5/25/1994	ND	ND	ND	ND						
MW-5	12/13/1993	ND	ND	ND	ND						
MW-5	5/14/1993	ND	ND	ND	ND						
MW-5	12/11/1992	ND	ND	ND	ND						
MW-5	6/9/1992	ND	ND	ND	1.2						
MW-5	11/7/1991	ND	ND	ND	ND						
MW-5	11/14/1990	ND	ND	ND	ND	8.6					
MW-5	6/19/1990	ND	ND	ND	ND	7.4					
MW-5	12/1/1989	10.8	92	9.8	22.3						
MW-5	5/25/1989	ND	ND	ND	ND						

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
MW-5	11/18/1988	ND	1.86	NT	NT						
MW-5	6/3/1988	ND	ND								
MW-5	11/17/1987	ND	ND								
MW-5	5/28/1987	ND	ND								
MW-5	12/16/86	ND	ND	ND	ND	9	ND				
MW-5	9/18/86	ND	ND	ND	ND	20					
MW-5	6/23/86	ND	ND	ND	ND	21					
MW-5	3/26/86	ND	ND	ND	ND	14					
MW-5	11/8/85	ND	ND								
MW-5	6/10/85	ND	ND								
MW-5	3/21/85	ND	ND								
MW-5	1984-85	ND	ND	ND	ND						
	MW-6 was removed										
MW-7	9/2/1998	8.6	5.6	3.2	16.5						
MW-7	12/16/1986	9	ND	ND	ND	2					
MW-7	9/18/1986	58	6	4		4					
MW-7	6/23/1986	ND	ND	ND		4					
MW-7	3/26/1986	15	53	7		11					
MW-8	5/26/1995	ND	ND	ND	ND						
MW-8	8/3/1994	ND		ND	ND						
MW-8	5/24/1994	ND	ND	ND	ND						
MW-8	12/16/1986	ND	ND	ND	ND	8	ND				
MW-8	9/18/86	ND	ND	ND	ND	8	ND				
MW-8	6/23/86	ND	ND	ND	ND	13	ND				
MW-8	3/26/86	ND	ND	107	ND	5	ND				
MW-9	11/24/1998	23000	270	900		89	270				
MW-9	8/27/1998	13000	2700	1000	9600			naphth			
MW-9	5/28/1998	20000	360	840	5590	75	430				
MW-9	11/18/1997	17000	760	830	6070	71	<5				
MW-9	5/22/1997	19000	510	770	7480						
MW-9	5/31/1996	14900	951	766	4125	67	34				
MW-9	12/8/1995	14000	1600	ND	5590	PSH	PSH				
MW-9	6/15/1995	8510	4910	747	5670						
MW-9	10/16/1992	17500	700	2200	7300	48.9	35.5				
MW-9	6/10/1992	15600	4800	1100	6800	97.7	49				
MW-9	2/7/1992	2740	1570	610	2940	109	54.5				
MW-9	11/1/1991	16200	8700	309	10820	63.3	40.75				
MW-9	12/16/1986	1490	754	504	ND	275					
MW-9	9/18/1986	17700	10600	15		240					

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
MW-9	6/23/1986	4000	1700	710		180					
MW-9	3/26/1986	7400	6300	3200	ND	143					
	MW-10 (AKA RW-3)										
MW-10	12/16/1986	14100	7400	30	ND	114					
MW-10	9/18/1986	41	54	ND	NA	125					
MW-10	6/23/1986	ND	ND	ND	NA	76					
MW-10	3/26/1986	93	ND	ND	ND	34					
MW-11	11/23/1998	780	100	130	80						
MW-11	3/25/1998	4000	ND	360	8600						
MW-11	11/20/1996	4700	ND	460	9700						
MW-11	8/3/1994	4600		400	7800						
MW-11	5/24/1994	5000	ND	500	9400						
MW-11	9/9/1988	44400	840	63	3406						
MW-11	6/3/1988	3000	460								
MW-11	9/30/1987	5400	ND								
MW-12	9/2/1998	ND	ND	ND	ND			ND			
MW-12	3/9/1998	ND	ND	ND	1.8						
MW-12	11/20/1996	ND	ND	ND	ND						
MW-12	8/3/1994	ND		ND	ND						
MW-12	5/24/1994	ND	ND	ND	ND						
MW-12	6/3/1988	ND	ND	NT	NT						
MW-12	9/30/1987	ND	ND								
MW-13	8/26/1998	ND	ND	ND	ND						
MW-13	8/3/1994	ND		ND	ND						
MW-13	5/24/1994	ND	ND	ND	ND						
MW-13	9/9/1988	0.23	0.24	0.29	1.56						
MW-20	11/23/1998	34	1.9	7.1	3.4	26	220				
MW-20	9/29/1998								1.5	ND	0.0064
MW-20	8/27/1998	13	1.2	10	2.5			naphth			
MW-20	5/28/1998	370	21	61	234	41	410				
MW-20	11/18/1997	160	310	51	200	36	<5				
MW-20	5/22/1997	110	18	38	ND						
MW-20	11/20/1996	18	ND	4.2	ND						
MW-20	5/31/1996	47	17	23	320	23	109				
MW-20	12/8/1995	14	0.83	2.2	1.1						
MW-20	6/15/1995	0	1	3	3						
MW-20	8/3/1994	6		ND	ND						
MW-20	5/24/1994	5.5	ND	ND	ND						
MW-20	12/13/1993	56.3	ND	5.02	2.16						

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
MW-20	5/14/1993	27	2	5	3	17.9	66				
MW-20	10/16/1992	22	ND	5	2	15.1	29				
MW-20	6/10/92	17	3	8	12	97.8	75				
MW-20	2/7/92	201	35	11	51	21.3	41				
MW-20	11/8/1991	2	ND	ND	4	19.6	37				
MW-21	11/23/1998	770		200	12	38	300				
MW-21	8/27/1998	25	ND	39	7						
MW-21	5/28/1998	300	ND	390	ND	32	690				
MW-21	11/17/1997	700	ND	170	470	26	240				
MW-21	5/22/1997	450	ND	34	110						
MW-21	11/20/1996	2400	ND	420	230						
MW-21	5/31/1996	917	2	930	ND	21	112				
MW-21	12/8/1995	490	1300	230	920						
MW-21	6/15/1995	982	ND	85	2						
MW-21	8/3/1994	930		170	ND						
MW-21	5/24/1994	1400	ND	260	ND						
MW-21	12/13/1993	253	ND	57	67						
MW-21	5/14/1993	895	ND	210	117	23.8	50				
MW-21	10/16/1992	3010	ND	420	90	14.9	48				
MW-21	6/10/92	1940	ND	450	630	14.6	42				
MW-21	2/7/1992	10	20	5	26	12.9	51				
MW-21	11/8/1991	1	ND	11	1	12.2	65				
MW-25	8/27/1998	8.9	ND	17	9.7						
MW-25	8/4/1994	120		55	23						
MW-25	5/24/1994	88	ND	42	81						
MW-26	8/26/1998	4700	ND	680	7100			naphth			
MW-26	8/4/1994	4000		880	10000						
MW-26	5/24/1994	4700	ND	1100	13000						
MW-27	11/24/1998	24	9.7	7.9	6.2						
MW-28	9/2/1998	10000	28000	2400	24700			low			
MW-29	9/29/1998								ND	ND	ND
MW-29	8/27/1998	ND	ND	ND	ND						
MW-29	8/4/1994	ND		ND	ND						
MW-29	5/24/1994	ND	ND	ND	ND						
MW-30	11/24/1998	6500	3200	2000	2500						
MW-30	8/4/1994	7300	13000	2800	15800						

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
MW-30	5/24/1994	7800	20000	3500	18700						
MW-31	9/29/1998								0.14	ND	ND
MW-31	8/27/1998	220	72	47	288						
MW-31	8/4/1994	9500	17000	2100	15100						
MW-31	5/24/1994	13000	26000	2500	23300						
MW-32	8/20/1998	ND	ND	ND	ND						
MW-32	11/20/1996	ND	ND	ND	ND						
MW-32	3/2/1995	ND	ND	ND	ND			ND			
MW-33	8/26/1998	ND	ND	ND	ND						
MW-33	11/20/1996	ND	ND	ND	ND						
MW-33	3/2/1995	ND	ND	ND	ND			ND			
MW-34	9/25/1998	140	8.6	22	364						
MW-34	3/9/1998	170	32	20	220						
MW-34	3/2/1995	300	30	ND	1300						
MW-35	3/9/1998	6.1	ND	2.9	54						
MW-36	9/2/1998	ND	210	56	650						
MW-36	3/9/1998	ND	ND	8.8	37						
MW-37	9/29/1998								3.5	ND	ND
MW-37	8/26/1998	ND	ND	ND	ND						
MW-37	3/9/1998	ND	ND	1.5	13						
MW-38	9/2/1998	ND	ND	2.5	10.5						
MW-38	3/9/1998	ND	ND	3.7	9.6						
MW-39	11/24/1998	3500	16000	3400	5000						
MW-39	10/28/1998	2000	7800	2200	12900						
MW-40	9/2/1998	1000	890	1100	1800			naphth			
MW-43	10/27/1998	5900	4600	480	3850						
MW-44	10/28/1998	ND	1.1	ND	1.1						
RW-1	9/2/1998	1600	ND	ND	ND						
RW-1	8/3/1994	3300		ND	ND						
RW-1	5/24/1994	2800	ND	80	40						

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
RW-1	9/9/1988	6400	70	540	14800						
RW-2	9/9/1988	11000	10200	2900	28800						
RW-3	8/3/1994	7200	ND	950	2800						
RW-3	5/24/1994	8300	ND	1100	3600						
RW-3	9/9/1988	12000	62	2.86	5403						
RW-15	11/23/1998	11000	17000	2500	4300	65	300				
RW-15	5/28/1998	20000	24000	4600	23720	58	760				
RW-15	11/17/1997	17000	20000	3400	14000	49	78				
RW-15	5/22/1997	22000	21000	3200	18700						
RW-15	11/20/1996	11000	4800	660	7400						
RW-15	5/31/1996	18900	24300	1840	19050	32	209				
RW-15	12/8/1995	18000	22000	2500	14600						
RW-15	6/15/1995	18700	28200	2870	17890						
RW-15	10/16/1992	17600	2500	25200	15200	26.3	180				
RW-15	6/10/92	21700	3800	27300	20900	29.9	157				
RW-15	2/7/92	4430	3850	1540	4410	40.8	115				
RW-15	11/8/1991	16100	1780	23700	18760	27.2	204				
RW-18	11/24/1998	2400		5300							
RW-18	11/18/1997	4700	140	1200	380000	50	180				
RW-18	5/22/1997	3300	ND	700	1100						
RW-18	5/31/1996	461	1070	819	5890	PSH	74				
RW-18	12/8/1995	1800	170	ND	700						
RW-18	6/15/1995	1810	17.4	498	94.6						
RW-18	10/16/1992	4410	440	ND	370	46.9	68				
RW-18	6/10/92	4500	1800	ND	3200	88	75				
RW-18	2/7/92	1990	150	361	1401	63.6	45				
RW-18	11/8/1991	3830	ND	ND	ND	48.9	40				
RW-22	8/27/1998	5300	6100	920	7200						
RW-23	8/27/1998	16000	4300	2600	17500			naphth			
P-1	9/9/1988	102200	34	1.43	866						
P-2	9/9/1988	4800	1430	900	7530						
P-3	9/9/1988	19400	4.35	ND	35100						
SEEP	11/20/1996	5900	ND	960	8320						

	Parameter	B	T	E	X	TOC	TOX	SVOCs	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	**Date**										
SEEP	6/15/1995	16.5	13.1	9.3	68.9						
SEEP	.12/13/1993	1620	960	198	3077						
SEEP	11/17/1993	946	408	ND	2233						
SEEP	6/29/1992	3000	1180	ND	6460						
SEEP MW	12/13/1993	17400	28600	3910	26900						
SEEP MW	11/17/1993	4200	5060	604	8200						
SEEP 1	8/27/1998	1000	ND	1400	2200						
SEEP 2	8/27/1998	7000	ND	880	7030	* These were sampled differently;					
SEEP 2	8/20/1998	4700	ND	780	4990	The 8/27 Value is Probably More Accurate					
SEEP 3	8/27/1998	3700	ND	1700	10480						
SEEP 4	9/29/1998	ND	ND	ND	ND						
SEEP 5	10/28/1998	20	5	5	120						

Table 8
Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L	.		mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
1	3/19/1984													ND
1	9/1/1984		7.2	3582	1059		7.2						825	0.125
1	12/13/1984		7.2	3512	1135		ND						700	0.18
1	1984-85		7.41	3516	1070.5		5.725						815.5	0.086
1	3/21/1985		7.35	3726	1135		0.3						855	0.04
1	7/10/1985		7.5	3246	953		15.4						882	ND
1	11/8/1985		7.9	3120	973		2						920	ND
1	3/26/1986		7.3	2936	750								7.5	0.085
1	6/23/1986		7.25	2960	994.7		0.1						630	0.065
1	9/18/1986		7.27	2866	814								673	0.15
1	12/16/1986		7.19	2498	774		2.9						579	ND
1	5/28/1987			3272	794								827.6	0.2
1	11/17/1987			3050	910								655	ND
1	6/3/1988			3500	1040								851	ND
1	11/18/1988			3430	1140		4.03						665	ND
1	5/25/1989			3308									653.46	0.05
1	12/1/1989			3120	1142.85								515.61	ND
1	6/19/1990	.		2952	1269.1								491.3	0.007
1	11/14/1990			3440	1170								539	ND
1	6/5/1991			3200	1060		2.54				0.05	1.27	1070	ND
1	11/7/1991			3540	1190		20.6						684	ND
1	6/9/1992			3730	1220								882	ND
1	12/11/1992			4920	1760		20.2						747	ND
1	5/14/1993		6.8	4440	1740		6.91				2.04		563	ND
1	12/13/1993		7	4380	1840		6.44				ND	3.17	420	ND
1	5/25/1994			NT	NT		NT				NT	NT	NT	NT
1	8/3/1994			3856	1510		1.5				2.6	2.8	559	ND
1	12/21/1994			4024	1630		4.6				1.5	0.6	1740	ND
1	5/22/1995		7	4850	1730		3				4.8	10	899	ND
1	12/7/1995		7.16	4400	1300		15				3.9	10	960	ND
1	5/31/1996		7.3	2390	728		7.6				0.6	7.6	531	ND
1	11/20/1996		7.6	882	152		?				1	1.8	246	ND
1	5/23/1997		7.62	1590	260		17.3				0.6	1.8	511	ND
1	11/17/1997		7.4	1230	110		8.7				1.1	1.6	502	ND
1	5/28/1998			778	105		12.6				0.2	0.4	226	0.06
1	11/23/1998	954	7.2	600	52			3.6	1/0/1900		0.5		202	

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02			
	MCL			2		0.005	0.1							0.05
	RCRA		0.05	1		0.01	0.05							0.01
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05
1	3/19/1984		ND	0.2		0.003	0.01			20.9	1.38			
1	9/1/1984		ND	1	ND	0.014	ND			57	1.7			
1	12/13/1984		0.054	ND	0.25	ND	0.07			128	1.05			
1	1984-85		0.016	0.25	0.266	0.01	0.018			46.268	0.943			
1	3/21/1985		0.01	ND	0.69	0.027	ND			0.07	0.5			
1	7/10/1985		ND	ND	0.13	ND	ND			ND	0.52			
1	11/8/1985		ND	ND	0.1	ND	ND			0.08	0.33			
1	3/26/1986		ND			0.05	ND							
1	6/23/1986		0.077	ND		ND	ND			ND	0.25			
1	9/18/1986		0.05			ND	ND							
1	12/16/1986		ND	0.55		ND	ND			ND	1.11			
1	5/28/1987		ND	ND	0.7	0.023	ND			0.14	1.51			
1	11/17/1987		ND	ND	0.32	ND	ND			ND	1.45			
1	6/3/1988		ND	ND	0.25	ND	ND			ND	0.85			
1	11/18/1988		ND	ND	0.32	ND	ND			ND	2.11			
1	5/25/1989		ND	ND	0.03	ND	ND			ND	ND			
1	12/1/1989		0.0005	ND	0.28	0.0073	ND			0.68	1.17			
1	6/19/1990		0.0092	ND	0.31	ND	ND			ND	0.59			
1	11/14/1990		0.0008	ND	ND	ND	ND			14.38	2.3			
1	6/5/1991		ND	ND	0.32	ND	ND			ND	1.04			
1	11/7/1991		ND	ND	0.35	ND	0.02			ND	2.79			
1	6/9/1992		ND	ND	0.39	ND	ND			ND	0.27			
1	12/11/1992		ND	ND	0.55	ND	ND			0.14	3.29			
1	5/14/1993		ND	ND	0.35	ND	ND			ND	3.71			
1	12/13/1993		ND	ND	0.47	ND	ND			ND	3.7			
1	5/25/1994		NT	NT	NT	NT	NT			NT	NT			
1	8/3/1994		0.006	ND	0.48	ND	ND			0.05	2.43			
1	12/21/1994		0.006	ND	0.19	ND	ND			0.096	4.94			
1	5/22/1995		ND	ND	0.4	0.002	ND			1	7.2			
1	12/7/1995		ND	ND	0.71	0.003	ND			0.19	9.22			
1	5/31/1996		ND	0.01	0.34	0.007	ND			0.2	0.17			
1	11/20/1996		ND	ND	ND	ND	ND			2.1	0.505			
1	5/23/1997		ND	0.02	0.2	ND	ND			ND	0.665			
1	11/17/1997		ND	0.01	0.2	ND	ND			ND	0.781			
1	5/28/1998		ND	0.01	ND	ND	ND			ND	0.04			
1	11/23/1998				0.3						0.3			

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01					
	MCL								0.2			0.006	0.004	0.002
	RCRA													
	NMWQ							0.005	0.2					
1	3/19/1984								ND					
1	9/1/1984							0.024	ND					
1	12/13/1984							0.065	ND					
1	1984-85							0.055	ND					
1	3/21/1985							0.13	ND					
1	7/10/1985							ND	ND					
1	11/8/1985							0.096	0.04					
1	3/26/1986							0.009	ND					
1	6/23/1986							0.017	0.1					
1	9/18/1986							0.19	0.07					
1	12/16/1986							0.012	ND					
1	5/28/1987							0.123	0.0056					
1	11/17/1987							0.02	ND					
1	6/3/1988							0.021	0.022					
1	11/18/1988							0.05	ND					
1	5/25/1989							0.214	ND					
1	12/1/1989							0.151	ND					
1	6/19/1990							0.231	ND					
1	11/14/1990							0.5	ND					
1	6/5/1991							0.022	ND					
1	11/7/1991							0.022	ND					
1	6/9/1992							0.04	ND					
1	12/11/1992							0.01	ND					
1	5/14/1993							ND	ND					
1	12/13/1993							ND	ND					
1	5/25/1994							ND	NT					
1	8/3/1994							ND	ND					
1	12/21/1994							ND	ND					
1	5/22/1995							ND	ND					
1	12/7/1995							ND	ND					
1	5/31/1996							ND	ND					
1	11/20/1996							ND	ND					
1	5/23/1997							ND	ND					
1	11/17/1997							ND	ND					
1	5/28/1998							ND	ND					
1	11/23/1998													

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
2	3/26/1986			2796	200								11	0.12
2	6/23/1986			3650	1204.6								1750	ND
2	9/18/1986			3598	993								1104	0.08
2	12/16/1986			3664	1012		NT				NT	NT	1372	ND
3	3/26/1986			4836	1500								29.5	0.14
3	6/23/1986			5362	1584								1950	0.07
3	9/18/1986			5514	1290								2056	0.18
3	12/16/1986			4860	1290								2204	ND
4	3/19/1984													0.042
4	9/1/1984		7.1	1860	410		0.02						10	0.088
4	12/13/1984		6.9	2408	481		ND						4	0.22
4	3/21/1985		7.01	1860	466		ND						9	0.015
4	7/10/1985		7.4	2004	556		ND						3	ND
4	6/23/1986		6.85	2266	989.7		ND				NT	NT	12.5	0.066
4	5/28/1987			2038	635		0.035				NT	NT	4.8	0.14
4	11/17/1987			2050	588								ND	ND
4	6/3/1988			1820	401		0.14						3	ND
4	11/18/1988			1830	490		0.09				NT	NT	ND	ND
4	5/25/1989			1454	NT		ND				NT	NT	7.41	0.03
4	11/8/1995		7.7	2060	675		ND						3	ND
4	9/2/1998	3600			369	ND	ND			ND			ND	ND
4	12/16/86		6.73	2128	675		ND						ND	ND
4	3/26/86		6.84	1868	500								0	0.074
4	9/18/86		6.7	2308	754								ND	ND
4	9/2/1998													

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02			
	MCL			2		0.005	0.1							0.05
	RCRA		0.05	1		0.01	0.05							0.01
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05
2	3/26/1986		ND			0.06	ND							
2	6/23/1986		0.094			ND	ND							
2	9/18/1986		0.08			0.03	ND							
2	12/16/1986		ND	NT	NT	ND	ND			ND	NT			
3	3/26/1986		ND			0.12	ND							
3	6/23/1986		0.15			0.015	ND							
3	9/18/1986		0.21			ND	ND							
3	12/16/1986		ND			0.11	ND							
4	3/19/1984		0.018	1.8		ND	ND			57.7	7.62			
4	9/1/1984		ND	4	ND	ND	0.1			43.7	7.8			
4	12/13/1984		0.118	7	0.32	ND	0.28			132	25.4			
4	3/21/1985		0.005	2.5	0.89	ND	ND			6.8	5.2			
4	7/10/1985		ND	ND	0.05	ND	ND			12	5			
4	6/23/1986		0.07	3.54	ND	ND	ND			12	3.5			
4	5/28/1987		ND	9.88	0.97	0.018	ND			0.17	5.29			
4	11/17/1987		ND	1.8	0.59	ND	ND			4.59	4.77			
4	6/3/1988		ND	1.4	0.47	ND	ND			6.44	3.51			
4	11/18/1988		ND	1.8	0.57	ND	ND			5.95	3.73			
4	5/25/1989		ND	1.4	0.5	ND	ND			0.92	3.59			
4	11/8/1995		ND	1.5	ND	ND	ND			0.34	2.8			
4	9/2/1998	ND	ND	2.05	0.52	ND	ND	ND	ND	7.39	4.16	ND	3.4	0.08
4	12/16/86		ND	2.3	0.7	ND	ND			18.6	5.7			
4	3/26/86		ND			0.06	ND							
4	9/18/86		0.08			ND	ND							
4	9/2/1998			2.05	0.52					7.39	4.16		3.4	0.08

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01					
	MCL								0.2			0.006	0.004	0.002
	RCRA													
	NMWQ							0.005	0.2					
2	3/26/1986							0.063	ND					
2	6/23/1986							0.023	0.1					
2	9/18/1986								0.18					
2	12/16/1986							0.012	ND					
3	3/26/1986								ND					
3	6/23/1986								0.25					
3	9/18/1986								0.17					
3	12/16/1986								0.07					
4	3/19/1984								ND					
4	9/1/1984							0.55	ND					
4	12/13/1984							0.12	ND					
4	3/21/1985							0.005	ND					
4	7/10/1985							0.08	ND					
4	6/23/1986							0.43	0.5					
4	5/28/1987							0.278	ND		7.5			
4	11/17/1987							0.73	0.005					
4	6/3/1988							0.069	ND					
4	11/18/1988							0.101	ND					
4	5/25/1989							0.25	ND					
4	11/8/1995							0.037	0.03					
4	9/2/1998	536	ND	159	56.3					ND		ND	ND	ND
4	12/16/86							0.096	ND					
4	3/26/86							0.633	ND					
4	9/18/86							0.085	ND					
4	9/2/1998	536		159	56.3									

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
5	5/28/1987			3902	1112								772.4	0.2
5	11/17/1987			4300	1310								1060	ND
5	6/3/1988			4200	1300								1000	ND
5	11/18/1988			4080	1480		27.8				NT	NT	777	0.07
5	5/25/1989			4196									781.03	0.06
5	12/1/1989			4594	1715.62								946.45	0.044
5	6/19/1990			4918	1751.4								1131.6	0.005
5	11/14/1990			4930	1640								1110	ND
5	11/7/1991			5390	1770		24.1				NT	NT	1370	ND
5	6/9/1992			7634	3070								1190	0.11
5	12/11/1992			6960	2820		6.57				NT	NT	754	ND
5	5/14/1993		6.7	7600	3100		21.12				4.06		1120	ND
5	12/13/1993		6.8	7390	3190		7.47				0.08	3.52	1050	ND
5	5/25/1994													NT
5	8/3/1994			8878	2490		18.7				ND	2.8	966	0.16
5	12/21/1994			7390	3170		24				0.17	5.6	1020	ND
5	5/22/1995		7	7720	3180		19.3				0.2	1.2	943	ND
5	12/7/1995		7.16	7500	2600		16				ND	5	780	ND
5	5/31/1996		7	6350	2260		14.5				0.6	3.5	918	0.72
5	11/20/1996		7.1	5660	2810		?				ND	1	912	ND
5	5/23/1997		7.07	6250	2690		13.5				0.4	3.4	879	ND
5	11/17/1997		6.64	6240	2530		12.2				0.3	2.2	902	ND
5	5/28/1998			2060	848		3.9				0.5	2.9	259	0.05
5	11/8/85		7.7		1588		8						1540	ND
5	12/16/86		7.28	3788	1118		36						1132	ND
5	1984-85		7.41	4746	1402		24				NT	NT	1299	0.015
5	3/19/84													0.02
5	3/21/85		7.22	4758	1257		29							0.046
5	3/26/86		7.23	3840	1100								14	0.16
5	6/10/85		7.6	4746	1360		35						1200	ND
5	6/23/86		7.18	3778	1339.6		12.5						1800	0.055
5	9/18/86		7.19	3184	1151								1237	ND
5	11/23/1998	12000	7.4	6600	3090			1/22/1900			0.3		1070	
7	3/26/1986			6076	60								5.5	ND
7	6/23/1986			6406	80								2400	0.24
7	9/18/1986			6348	20								5802	0.05

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02			
	MCL			2		0.005	0.1							0.05
	RCRA		0.05	1		0.01	0.05							0.01
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05
5	5/28/1987		ND	ND	0.24	0.026	ND			0.14	0.09			
5	11/17/1987		ND	ND	0.54	ND	ND			ND	ND			
5	6/3/1988		ND	ND	0.48	ND	ND			ND	1.45			
5	11/18/1988		ND	ND	0.45	ND	ND			ND	ND			
5	5/25/1989		ND	ND	0.41	ND	ND			ND	ND			
5	12/1/1989		0.0006	ND	0.58	0.0039	ND			ND	ND			
5	6/19/1990		0.0126	ND	0.06	ND	ND			ND	ND			
5	11/14/1990		ND	ND	ND	ND	ND			ND	ND			
5	11/7/1991		ND	ND	0.48	ND	0.03			ND	0.12			
5	6/9/1992		ND	ND	0.63	ND	ND			ND	9.11			
5	12/11/1992		0.01	ND	0.76	ND	0.02			3.72	0.6			
5	5/14/1993		0.008	ND	0.48	ND	ND			0	0.32			
5	12/13/1993		ND	ND	0.58	ND	0.02			0.5	0.46			
5	5/25/1994		NT	NT	NT	NT	NT							
5	8/3/1994		0.007	ND	0.55	0.004	ND			0.06	0.24			
5	12/21/1994		0.027	ND	0.41	0.002	ND			0.071	0.142			
5	5/22/1995		ND	ND	0.5	ND	ND			ND	0.1			
5	12/7/1995		ND	ND	0.81	ND	ND			0.08	0.24			
5	5/31/1996		ND	0.03	0.54	ND	ND			0.72	0.58			
5	11/20/1996		ND	0.03	0.6	ND	0.04			6.2	0.187			
5	5/23/1997		ND	ND	0.5	ND	ND			0.2	0.155			
5	11/17/1997		ND	0.02	0.5	ND	ND			ND	0.302			
5	5/28/1998		ND	0.02	0.3	ND	ND			ND	0.105			
5	11/8/85		ND	ND	ND	ND	ND			0.089	0.045			
5	12/16/86		ND	0.01		0.01	ND			ND	ND			
5	1984-85		0.004	ND	0.48	0.015	ND			0.061	0.128			
5	3/19/84		ND	0.3		ND	0.04			70.6	0.915			
5	3/21/85		0.011	ND	1.29	0.046	ND			0.095	0.098			
5	3/26/86		ND			0.1	ND							
5	6/10/85		ND	ND	0.15	ND	ND			ND	0.24			
5	6/23/86		0.087	ND		ND	ND			0.05	0.025			
5	9/18/86		0.07			ND	ND							
5	11/23/1998				0.62					0.18	0.05			
7	3/26/1986		ND			0.05	ND							
7	6/23/1986		0.36			0.03	0.052							
7	9/18/1986		0.22			ND	ND							

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01					
	MCL								0.2			0.006	0.004	0.002
	RCRA													
	NMWQ							0.005	0.2					
5	5/28/1987							0.334	ND					
5	11/17/1987							ND	0.016					
5	6/3/1988							0.064	0.03					
5	11/18/1988							0.16	ND					
5	5/25/1989							0.362	ND					
5	12/1/1989							0.006	ND					
5	6/19/1990							0.102	ND					
5	11/14/1990							0.03	0.01					
5	11/7/1991							0.002	ND					
5	6/9/1992							0.02	ND					
5	12/11/1992							0.04	ND					
5	5/14/1993							ND	ND					
5	12/13/1993							ND	ND					
5	5/25/1994							ND						
5	8/3/1994							ND	ND					
5	12/21/1994							ND	5					
5	5/22/1995							ND	ND					
5	12/7/1995							0.37	ND					
5	5/31/1996							ND	ND					
5	11/20/1996							ND	ND					
5	5/23/1997							ND	ND					
5	11/17/1997							ND	ND					
5	5/28/1998							ND	ND					
5	11/8/85							0.02	0.04					
5	12/16/86							0.021	ND		1.3			
5	1984-85							0.008	0.013					
5	3/19/84								ND					
5	3/21/85							0.004	ND					
5	3/26/86							0.006	ND					
5	6/10/85							ND	ND					
5	6/23/86							0.007	0.2					
5	9/18/86							0.034	0.24					
5	11/23/1998													
7	3/26/1986							ND	ND					
7	6/23/1986							0.006	0.25					
7	9/18/1986							0.036	0.1					

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
8	12/16/1986			3450	913		NT				NT	NT	1270	ND
8	5/24/1994													
8	8/3/1994													
8	5/26/1995													
8	3/26/86			806	160								4	ND
8	6/23/86			2910	840								1500	0.055
8	9/18/86			2284	576								586	ND
9	3/26/1986			2360	149								13	ND
9	6/23/1986			1718	1009.7								114	0.059
9	9/18/1986			1428	89								ND	ND
9	12/16/1986			1684	109		NT				NT	NT	20	ND
9	11/1/1991		7	NT	123		ND				NT	NT	12	ND
9	2/7/1992		7.3		114		ND						117	ND
9	6/10/1992		7		117		ND						53	0.03
9	10/16/1992		7	NT	38		ND				NT	NT	12	0.02
9	6/15/1995													
9	12/8/1995		7.2											
9	5/31/1996		6.9											
9	5/22/1997		6.89				0.2				1	1.6		
9	11/18/1997		7.03											
9	5/28/1998						ND				ND	5.1		
9	8/27/1998						ND							0.011
9	11/24/1998	2800	6.7								0.6			
10	3/26/1986			1546	245								5.3	ND
10	6/23/1986			2820	569.8								165	0.059
10	9/18/1986			2408	587								ND	0.05
10	12/16/1986			3272	457		NT				NT	NT	10	ND
11	9/30/1987		7.04	1910	337.5		0.389						181	0.32
11	9/9/1988			1900	NT		0.06				NT	NT	30	NT
11	5/24/1994													
11	8/3/1994													
11	6/1/1995						0.13				0.39		16	
12	9/30/1987			658	7.9		0.181						248	0.12
12	9/2/1998	571												

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02			
	MCL			2		0.005	0.1							0.05
	RCRA		0.05	1		0.01	0.05							0.01
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05
8	12/16/1986		ND	NT	NT	ND	ND			NT	NT			
8	5/24/1994													
8	8/3/1994													
8	5/26/1995													
8	3/26/86		ND			0.01	ND							
8	6/23/86		0.072			ND	ND							
8	9/18/86		0.03			ND	ND							
9	3/26/1986		ND			0.01	ND							
9	6/23/1986		ND			ND	ND							
9	9/18/1986		0.02			ND	ND							
9	12/16/1986		ND	NT	NT	ND	ND			NT	NT			
9	11/1/1991		0.013	1.6	NT	ND	ND			5.38	3.22			
9	2/7/1992		0.01	1.1		0	0.03			0.15	1.97			
9	6/10/1992		0.009	1.77		ND	ND			6.63	3.05			
9	10/16/1992		0.008	1.1	NT	ND	ND			3.23	2.19			
9	6/15/1995													
9	12/8/1995													
9	5/31/1996													
9	5/22/1997													
9	11/18/1997													
9	5/28/1998													
9	8/27/1998						ND							
9	11/24/1998													
10	3/26/1986		ND			0.02	ND							
10	6/23/1986		0.053			ND	ND							
10	9/18/1986		0.05			ND	ND							
10	12/16/1986		ND	NT	NT	ND	ND			NT	NT			
11	9/30/1987		ND	6.72	ND	0.018	0.2			32	4.71			
11	9/9/1988		NT	NT	NT	NT	NT			NT	NT			
11	5/24/1994													
11	8/3/1994													
11	6/1/1995									16				
12	9/30/1987		ND	ND	ND	ND	0.064			8.2	0.38			
12	9/2/1998													

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01					
	MCL								0.2			0.006	0.004	0.002
	RCRA													
	NMWQ							0.005	0.2					
8	12/16/1986							0.042	0.1					
8	5/24/1994							ND						
8	8/3/1994							ND						
8	5/26/1995							ND						
8	3/26/86							ND	ND					
8	6/23/86							0.005	ND					
8	9/18/86							0.097	ND					
9	3/26/1986							0.304	ND					
9	6/23/1986							0.372	0.4					
9	9/18/1986							0.17	ND					
9	12/16/1986							0.16	ND					
9	11/1/1991							0.115	NT					
9	2/7/1992							0.11						
9	6/10/1992							0.33						
9	10/16/1992							0.18	NT					
9	6/15/1995													
9	12/8/1995													
9	5/31/1996													
9	5/22/1997													
9	11/18/1997													
9	5/28/1998													
9	8/27/1998													
9	11/24/1998													
10	3/26/1986							0.147	ND					
10	6/23/1986							0.186	ND					
10	9/18/1986							0.065	0.05					
10	12/16/1986							0.055	ND					
11	9/30/1987							ND	ND					
11	9/9/1988							0.06	NT					
11	5/24/1994							0.032						
11	8/3/1994							0.024						
11	6/1/1995													
12	9/30/1987								ND					
12	9/2/1998													

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
13	9/9/1988			3220			13.1				NT	NT	728	NT
13	5/24/1994													
13	8/3/1994													
13	8/26/1998				492	ND	27.9						994	0.003
20	11/8/1991		7.2	NT	193		ND				NT	NT	20	ND
20	10/16/1992		7	NT	361		0.02				NT	NT	215	ND
20	5/24/1994													
20	8/3/1994													
20	12/8/1995		7.22											
20	5/31/1996		7.1											
20	5/22/1997		7.07											
20	11/18/1997		6.82											
20	8/27/1998				633	ND	ND			ND			161	0.004
20	2/7/92		7.2		739		ND						37	ND
20	6/10/92		7.1		554		2.43						117	ND
20	11/23/1998	2998	7											
21	11/8/1991		7.2	NT	481		ND				NT	NT	416	ND
21	2/7/1992		7.1		420		ND						443	ND
21	10/16/1992		7	NT	797		ND				NT	NT	210	ND
21	5/24/1994													
21	8/3/1994													
21	12/8/1995		7.2											
21	5/31/1996		7											
21	11/17/1997		6.99											
21	6/10/92		7.3		626		0.17						165	ND
21	11/23/1998	4323	6.8											
25	5/24/1994													ND
25	8/4/1994													0.004
26	5/24/1994													0.0059
26	8/4/1994													0.004
26	6/1/1995						0.08				0.34		15	
27	11/24/1998												27.2	
28	9/2/1998	1130												
29	5/24/1994													0.0057
29	8/4/1994													0.014
29	8/27/1998				322	ND	4.2			ND			607	ND

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02			
	MCL			2		0.005	0.1							0.05
	RCRA		0.05	1		0.01	0.05							0.01
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05
13	9/9/1988		NT	NT	NT	NT	NT			NT	NT			
13	5/24/1994													
13	8/3/1994													
13	8/26/1998	ND	ND	ND	0.9	ND	ND	ND	ND	0.2	1.56	0.06	5.2	0.06
20	11/8/1991		0.005	ND	NT	ND	0.02			0.59	3.86			
20	10/16/1992		0.005	ND	NT	ND	ND			0.81	5.2			
20	5/24/1994													
20	8/3/1994													
20	12/8/1995													
20	5/31/1996													
20	5/22/1997													
20	11/18/1997													
20	8/27/1998	ND	ND	0.48	0.7	ND	ND	ND	ND	2.9	4.28	ND	11.4	ND
20	2/7/92		0.007	0.7		0.003	0.06			2.52	7.9			
20	6/10/92		ND	0.7		ND	ND			1.73	5.68			
20	11/23/1998													
21	11/8/1991		ND	ND	NT	ND	ND			0.81	6.23			
21	2/7/1992		0.011	ND		ND	ND			1	5.55			
21	10/16/1992		0.005	ND	NT	ND	ND			2.49	6.8			
21	5/24/1994													
21	8/3/1994													
21	12/8/1995													
21	5/31/1996													
21	11/17/1997													
21	6/10/92		ND	ND		ND	ND			1.71	5.69			
21	11/23/1998													
25	5/24/1994		ND				ND		ND					
25	8/4/1994		ND				ND		ND					
26	5/24/1994		ND				ND		ND					
26	8/4/1994		ND				ND		ND					
26	6/1/1995									3.9				
27	11/24/1998	0.5		0.09	0.32					12.4	1.94		2.9	
28	9/2/1998													
29	5/24/1994		ND				ND		ND					
29	8/4/1994		ND				ND		ND					
29	8/27/1998	ND	ND	ND	0.4	ND	ND	0.02	0.03	ND	0.433	0.12	4.4	ND

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01					
	MCL								0.2			0.006	0.004	0.002
	RCRA													
	NMWQ							0.005	0.2					
13	9/9/1988							0.03	NT					
13	5/24/1994							ND						
13	8/3/1994							ND						
13	8/26/1998	796	ND	331	101					3.2		ND	ND	0.2
20	11/8/1991							ND	NT					
20	10/16/1992							ND	NT					
20	5/24/1994							ND						
20	8/3/1994							ND						
20	12/8/1995													
20	5/31/1996													
20	5/22/1997													
20	11/18/1997													
20	8/27/1998	502	ND	123	54.2					2.3		ND	ND	0.1
20	2/7/92							0.02						
20	6/10/92							ND						
20	11/23/1998													
21	11/8/1991							ND	NT					
21	2/7/1992							ND			5.4			
21	10/16/1992							ND	NT					
21	5/24/1994							0.013						
21	8/3/1994							0.011						
21	12/8/1995													
21	5/31/1996													
21	11/17/1997													
21	6/10/92							0.01						
21	11/23/1998													
25	5/24/1994		ND					ND						
25	8/4/1994		ND					ND						
26	5/24/1994		0.035					0.01						
26	8/4/1994		0.03					0.009						
26	6/1/1995													
27	11/24/1998	351	0.03	159	24.8									
28	9/2/1998										5.2			
29	5/24/1994		0.037					ND						
29	8/4/1994		0.05					ND						
29	8/27/1998	508	ND	153	35.2					1.1	1.2	ND	ND	0.1

Well	Parameter.	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
30	5/24/1994													.0087
30	8/4/1994													0.007
30	6/1/1995						0.73				0.6		1100	
31	5/24/1994													ND
31	8/4/1994													ND
31	6/1/1995						0.13				0.35		88	
31	8/27/1998				325	ND	14.5			ND			614	ND
34	3/9/1998						0.07				0.2		23	
36	9/2/1998	1380			87.3	ND	ND			ND			135	0.1
37	8/27/1998				136	ND	0.6			ND			193	ND
38	9/2/1998	821			2.6	ND	ND			ND			9.2	0.06
39	9/2/1998	9900			2310	ND	ND			ND			ND	0.1
RW-1	9/9/1988			3130									4.5	
RW-1	5/24/1994			NT									NT	
RW-1	8/3/1994													
RW-1	9/2/1998													ND
RW-15	11/8/1991		7.3	NT	730		ND				NT	NT	2	ND
RW-15	10/16/1992		7.2	NT	758		ND				NT	NT	3	0.001
RW-15	5/31/1996		7.1											
RW-15	5/22/1997		7.01											
RW-15	11/17/1997		7.13											
RW-15	11/23/1998													
RW-15	2/7/92		7.4		558		ND						4	ND
RW-15	6/10/92		7.2		818		ND						5	ND
RW-15	11/23/1998	3578	7.3											
RW-18	11/8/1991		7.1	NT	228		ND				NT	NT	24	ND
RW-18	10/16/1992		7.1	NT	240		ND				NT	NT	?	0.002
RW-18	5/31/1996		6.9											
RW-18	5/22/1997		7.19											
RW-18	11/18/1997		6.9											
RW-18	2/7/92		7.1		200		ND						34	ND
RW-18	6/10/92		7.1		239		ND						3	0.02
RW-18	11/24/1998	2700	7.5											
RW-2	9/9/1988			1983									ND	
RW-23	8/27/1998													0.022

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02			
	MCL			2		0.005	0.1							0.05
	RCRA		0.05	1		0.01	0.05							0.01
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05
30	5/24/1994		0.011				0.015		.034					
30	8/4/1994		0.01				ND		ND					
30	6/1/1995									1.7				
31	5/24/1994		ND	ND	ND	ND	ND			ND	ND			
31	8/4/1994		ND	ND	ND	ND	ND			ND	ND			
31	6/1/1995									1.8				
31	8/27/1998	ND	ND	0.04	0.9	ND	ND	ND	ND	0.2	0.576	ND	6.1	ND
34	3/9/1998									0.21				
36	9/2/1998	90.3	0.07	4.15	0.1	ND	0.15	0.06	0.19	122	9.54	0.08	13.3	ND
37	8/27/1998	ND	ND	0.1	0.3	ND	ND	ND	ND	0.4	1.51	ND	2.8	0.07
38	9/2/1998	65.4	ND	0.66	0.1	ND	0.04	0.02	0.09	64.3	1.53	ND	9.4	ND
39	9/2/1998	170	0.24	8.28	0.3	0.008	0.25	0.19	0.32	259	11.2	0.18	28.5	0.08
RW-1	9/9/1988													
RW-1	5/24/1994													
RW-1	8/3/1994													
RW-1	9/2/1998						ND							
RW-15	11/8/1991		ND	0.8	NT	ND	ND			2.61	4.59			
RW-15	10/16/1992		ND	0.7	NT	ND	ND			1.94	4.72			
RW-15	5/31/1996													
RW-15	5/22/1997													
RW-15	11/17/1997													
RW-15	11/23/1998													
RW-15	2/7/92		0.007	0.6		ND	0.06			10.1	3.05			
RW-15	6/10/92		ND	0.6		ND	ND			ND	1.13			
RW-15	11/23/1998													
RW-18	11/8/1991		ND	1.1	NT	ND	ND			0.06	4.69			
RW-18	10/16/1992		ND	1	NT	ND	ND			0.45	4.37			
RW-18	5/31/1996													
RW-18	5/22/1997													
RW-18	11/18/1997													
RW-18	2/7/92		0.006	1.2		ND	0.03			10.4	4.24			
RW-18	6/10/92		ND	1.15		ND	ND			4.39	4.48			
RW-18	11/24/1998													
RW-2	9/9/1988													
RW-23	8/27/1998						ND							

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01					
	MCL								0.2			0.006	0.004	0.002
	RCRA													
	NMWQ							0.005	0.2					
30	5/24/1994		.039					0.08						
30	8/4/1994		0.02					ND						
30	6/1/1995													
31	5/24/1994							0.11						
31	8/4/1994							0.034						
31	6/1/1995													
31	8/27/1998	702	ND	262	182					6.7		ND	ND	0.2
34	3/9/1998													
36	9/2/1998	166	ND	203	39.6					ND		ND	ND	ND
37	8/27/1998	352	ND	88.3	18.7					0.8		ND	ND	0.1
38	9/2/1998	81.4	ND	107	24.7					ND		ND	ND	ND
39	9/2/1998	1330	0.9	319	163					ND		ND	0.009	ND
RW-1	9/9/1988							0.34						
RW-1	5/24/1994							ND						
RW-1	8/3/1994							ND						
RW-1	9/2/1998													
RW-15	11/8/1991							0.059	NT					
RW-15	10/16/1992							0.26	NT					
RW-15	5/31/1996													
RW-15	5/22/1997													
RW-15	11/17/1997													
RW-15	11/23/1998													
RW-15	2/7/92							0.14						
RW-15	6/10/92							0.14						
RW-15	11/23/1998													
RW-18	11/8/1991							0.044	NT					
RW-18	10/16/1992							ND	NT					
RW-18	5/31/1996													
RW-18	5/22/1997													
RW-18	11/18/1997													
RW-18	2/7/92							0.07						
RW-18	6/10/92							0.14						
RW-18	11/24/1998													
RW-2	9/9/1988							0.13						
RW-23	8/27/1998													

Table 9
Surface Water and Sediment Analyses

Stream Sample Analytical Results - 7/14/82 & 7/28/82 (Refinery)

Parameter	Units	HD Downstream	HD Upstream at siphon	HD 150 yds S of Sullivan Rd	HD 150 yds S of Sullivan Rd (NMOCD)
Sulfate	mg/l	56.7	57.3	30	51
Cl	mg/l	6.5	3.9	40	5
B	mg/l	0.07	0.03		0.03
F	mg/l			0.2	0.22
Oil & Grease	mg/l			0.8	1.2
TDS	mg/l	186	184	5494	4180
TOC	mg/l	5.4	4.6	18	3.6
Mn	mg/l	0.05	0.05		
Co	mg/l	0.05	0.05		<0.05
Pb	mg/l	<0.005	<0.005		<0.005
U	mg/l	NA	NA		
Phenols	mg/l	0.013	0.191	<0.1	0.0295
Cn	mg/l	0.002	NA	4	ND
Benzene	ug/l	<1	<1	0.2	<1
Toluene	ug/l	<1	<1	1.3	<1
M-Xylene	ug/l	<1	<1	0.8	<1
Ethylbenzene	ug/l	<1	<1	0.09	NA
Aliphatic hydrocarbons		ND	ND	ND	ND

Surface Water Analytical Results - 4/22/86 (Refinery)

Parameter	Units	HD near Sullivan Rd	HD near API Ponds	HD near API Waste Ponds	HD near Sullivan Rd
Benzene	mg/l	0.006	ND	ND	ND
Toluene	mg/l	0.003	ND	ND	ND
Anthracene	mg/l	0.006	ND	ND	ND
Benzo(a)anthracene	mg/l	0.003	ND	ND	ND
Chrysene	mg/l	0.005	ND	ND	ND
Fluoranthene	mg/l	ND	0.001	ND	ND
Naphthalene	mg/l	0.013	ND	ND	ND
Phenanthrene	mg/l	0.007	ND	ND	ND
Pyrene	mg/l	0.008	ND	ND	ND
Phenols	mg/l	0.002	0.002	0.003	0.002
Pb	mg/l	ND	ND	NA	NA
CN	mg/l	ND	ND	NA	NA

Surface Water Analytical Results - 7/24/87 (Refinery)

Parameter	Units	SJ Hwy 44 Bridge near side	SJ Hwy 44 Bridge near middle	SJ Hwy 44 Bridge far side	SJ Upstream
Benzene	mg/l	ND	ND	ND	ND
Toluene	mg/l	ND	ND	ND	ND
Anthracene	mg/l	ND	ND	ND	ND
Benzo(a)anthracene	mg/l	ND	ND	ND	ND
Chrysene	mg/l	ND	ND	ND	ND
Fluoranthene	mg/l	ND	ND	ND	ND
Naphthalene	mg/l	ND	ND	ND	ND
Phenanthrene	mg/l	ND	ND	ND	ND
Pyrene	mg/l	ND	ND	ND	ND
Phenols	mg/l	0.018	ND	0.013	0.018
Pb	mg/l	0.061	0.054	ND	ND
CN	mg/l	0.066	0.038	0.053	0.044
TDS	mg/l	238	228	248	232
Cl	mg/l	4.96	4.96	4.96	4.46
Sulfate	mg/l	64.5	75	64.9	62.4
TOC	mg/l	5	5	6	5

Stream Sample Analytical Results - 8/11/94 (GTI)

Parameter	Meth chlorid	SVOCs	Lead	Zinc	TPH	Ammonia as N	Tot Ammonia	BOD	TOC	NO3+NO4	TKN	COD	Phosphorus	TDS	TSS
UNITS	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SJ-1W	13	ND	ND	ND	ND	<0.05	NA	9.8	3.3	<0.05	<0.1	4.5	0.58	220	130
SJ-2W	ND	ND	ND	ND	ND										
SJ-2WD	ND	ND	ND	ND	ND										
SJ-3W	ND	ND	ND	ND	ND										
HD-1W	ND	ND	ND	ND	ND										
HD-2W	9	ND	ND	ND	ND										
HD-3W	32	ND	ND	ND	ND										
HD-4W	ND	ND	ND	ND	ND										
HD-5W	47	ND	ND	ND	ND										
HD-6W	15	ND	ND	ND	ND										
HD-7W	29	ND	ND	0.03	ND										
HD-8W	37	ND	ND	ND	ND										
HD-9W	ND	ND	0.004	0.02	ND										
HD-9WD	ND	ND	ND	ND											
HD-10W	ND	ND	0.003	0.03	ND										
HD-11W	ND	ND	ND	ND	ND										
HD-12W	ND	ND	ND	ND	ND										
HD-13W	ND	ND	ND	ND	ND										
HD-14W	ND	ND	ND	ND	ND	NA	<0.05	NA	NA	<0.01	<0.1	2.7	0.23	170	6

Sediment Sample Analytical Results - 7/14/82 (Refinery)

Parameter	Units	HD near API wastewater pond
Sulfate	mg/l	125
Cl	mg/l	109
B	mg/l	
F	mg/l	0.6
Oil & Grease	mg/l	NA
TDS	mg/l	NA
TOC	mg/l	NA
Mn	mg/l	NA
Co	mg/l	NA
Pb	mg/l	NA
U	mg/l	NA
Phenols	mg/l	NA
Cn	mg/l	NA
Benzene	ug/l	NA
Toluene	ug/l	NA
M-Xylene	ug/l	NA
Ethylbenzene	ug/l	NA
Aliphatic hydrocarbons		NA

Sediment Sample Analytical Results - 8/10/94 (GTI)
S = Sides, B = Bottom

Parameter	Meth chlorid	Toluene	Phenanthrene	As	Be	Cr	Cu	Pb	Ni	Se	Zn	TOC	TPH
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/k	mg/kg	mg/kg	mg/k	%	mg/kg
SJ-1S	0.011	ND	ND	16	ND	8.6	5.8	ND	4.9	ND	16	0.1	ND
SJ-2S	0.011	ND	ND	11	ND	ND	5.6	ND	4.5	ND	19	0.2	ND
SJ-3S	0.012	ND	ND	ND	ND	ND	ND	ND	1.8	ND	10	0.1	ND
HD-1S	ND	ND	ND	16	ND	6.1	6.8	ND	5.3	ND	26	0.4	ND
HD-1B	0.007	ND	ND	ND	0.9	9.6	16	ND	10	11	45	0.7	ND
HD-2S	ND	ND	ND	ND	ND	6	6.6	ND	5.6	ND	26	1	ND
HD-2B	ND	ND	ND	ND	0.9	9.4	17	12	9.8	ND	43	0.6	ND
HD-3S	0.057	ND	ND	16	1.2	13	21	14	13	ND	55	1.4	ND
HD-3B	0.009	ND	ND	ND	1.1	11	26	ND	12	ND	60	0.9	ND
HD-4S	0.01	ND	ND	ND	ND	8.2	14	ND	5.2		69	0.9	ND
HD-4B	0.006	ND	1.3	ND	0.7	8.8	180	ND	8.7		64	0.7	540
HD-5S	0.007	ND	ND	10	ND	7.1	13	11	7.4		43	1.1	ND
HD-5B	0.006	0.006	ND	13	0.9	13	18	12	11		56	0.4	ND
HD-6S	ND	ND	ND	ND	0.6	18	14	ND	9.3		43	0.6	ND
HD-6B	0.005	ND	ND	10	1	12	18	ND	12		44	0.6	ND
HD-7S	ND	ND	ND	ND	0.6	7.9	12	11	7.8		37	0.9	ND
HD-7B	ND	0.012	ND	ND	1	12	19	16	12		53	0.6	ND
HD-8S	ND	ND	ND	15	0.8	15	35	18	9.1		180	0.8	ND
HD-8B	ND	ND	ND	12	1	20	17	ND	11		58	0.4	ND
HD-9S	ND	ND	ND	ND	ND	16	12	ND	6.7		44	0.7	ND
HD-9B	ND	0.005	1.2	ND	1	17	18	12	11		56	0.7	240
HD-10S	0.009	ND	ND	ND	ND	9.4	17	11	5.6		59	0.4	ND
HD-10B	0.006	ND	ND	13	0.9	12	16	ND	9.8		38	0.6	ND
HD-11S	ND	ND	ND	10	ND	8.1	11	ND	6.2		38	0.7	ND
HD-11B	ND	ND	ND	15	1	14	17	11	11		51	0.6	ND
HD-12S	ND	ND	ND	12	0.6	12	11	ND	8.8		47	1.1	ND
HD-12B	ND	ND	ND	15	1.3	17	19	15	13		58	0.7	ND
HD-13S	ND	ND	ND	ND	ND	9.2	15	ND	7.8		36	0.6	ND
HD-13B	ND	ND	ND	10	0.9	9.5	17	11	10		39	0.8	ND
HD-14S	ND	ND	ND	ND	ND	6.7	11	ND	6		29	0.3	ND
HD-14B	ND	ND	ND	ND	1.1	11	18	11	12		50	0.8	ND

San Juan River Sediment Samples - 10/28/98 (Hicks)

Parameter	Units	SJ-1	SJ-2
Acetone	mg/kg	0.05	
Benzene	mg/kg	0.028	
Ethylbenzene	mg/kg	0.35	
m,p-Xylene	mg/kg		0.18
Barium	mg/kg	121	130
Beryllium	mg/kg		
Cadmium	mg/kg		0.25
Chromium	mg/kg	3.5	5
Lead	mg/kg	11.1	3.4

Table 10
Soil Sampling Results

Soil Samples - February 1994 (GTI)

Parameter	Units	B-1/2.5-4.5	B-2/10-12	B-3/6-8	B-4/8-10	B-4/10-12
Acetone	mg/kg	ND	ND	ND	ND	0.13
Benzene	mg/kg	ND	ND	ND	0.012	ND
Ethylbenzene	mg/kg	ND	ND	ND	0.004	ND
m,p-Xylene	mg/kg	ND	ND	ND	0.031	ND
o-Xylene	mg/kg	ND	ND	ND	0.022	ND
Toluene	mg/kg	ND	ND	ND	0.023	0.0065
Methylene Cl	mg/kg	ND	ND	0.11	ND	ND
SVOCs	mg/kg	ND	ND	ND	ND	ND
TPH	mg/kg	ND	ND	ND	ND	ND
Beryllium	mg/kg	0.66	0.53	0.54	0.53	0.76
Cadmium	mg/kg	4.5	3	3.2	3.1	4
Chromium	mg/kg	9.7	8.5	8	9.9	11
Copper	mg/kg	12	8.9	8.8	8.2	11
Lead	mg/kg	ND	ND	ND	ND	11
Nickel	mg/kg	9.8	7	7.4	7.2	10
Thallium	mg/kg	25	15	15	19	23
Zinc	mg/kg	46	34	35	32	44

Parameter	Units	B-5/2-4	B-6/2-4	B-7/6-8	B-8/8-10	B-9/2-4	B-10/10-12
Acetone	mg/kg	ND	ND	ND	ND	ND	ND
Benzene	mg/kg	ND	ND	ND	ND	ND	ND
Ethylbenzene	mg/kg	ND	ND	ND	ND	ND	ND
m,p-Xylene	mg/kg	ND	ND	ND	ND	ND	ND
o-Xylene	mg/kg	ND	ND	ND	ND	ND	ND
Toluene	mg/kg	ND	ND	ND	ND	ND	ND
Methylene Cl	mg/kg	ND	ND	ND	ND	ND	ND
SVOCs	mg/kg	ND	ND	ND	ND	ND	ND
TPH	mg/kg	ND	ND	ND	ND	ND	ND
Beryllium	mg/kg	ND	0.54	ND	0.57	ND	1.2
Cadmium	mg/kg	2.3	3.2	1.8	3.2	0.77	2.3
Chromium	mg/kg	7.2	8.1	5.7	9.3	ND	6
Copper	mg/kg	6.5	9.1	5.3	7.1	ND	ND
Lead	mg/kg	ND	ND	ND	ND	ND	ND
Nickel	mg/kg	5.9	6.8	4.8	7	1.6	4.7
Thallium	mg/kg	16	20	14	21	ND	13
Zinc	mg/kg					8	22

Soil Sample Analytical Results - 3/11/97 (Precision Engineering)

Parameter	Units	MW-41	SB1-397-10.5	SB2-397-6.0	SB2-397-10.0	SB2-397-25
Benzene	ppb	875	ND	ND	270	777
Toluene	ppb	13000	72	392	2050	3610
Ethylbenzene	ppb	11100	83.7	3090	17900	ND
m,p-Xylenes	ppb	40600	139	10400	103500	97200
o-Xylene	ppb	20200	324	948	2140	5900
TPH	mg/kg	1900	317	1400	2520	1390

Soil Samples - 8/20/98 (Hicks-Hand Auger)

Parameter	Units	HA1 4FT (SHB 1)	HA2 7FT (SHB 4)	HA2 4FT (SHB-4)
Benzene	mg/kg	0.074	0.052	
Ethylbenzene	mg/kg	0.089	0.2	59
m,p-Xylene	mg/kg	0.26	0.68	410
o-Xylene	mg/kg	0.15	0.24	150
Toluene	mg/kg	0.16	0.17	18

Soil Samples - 9/98 (Hicks-Soil Borings)

Parameter	Units	SHB2 5' (MW-43)	SHB2 13' (MW-43)	SHB1 12.8	SHB1 5	SHB1 9
Benzene	mg/kg	0.71		0.5		
Ethylbenzene	mg/kg	1.9		3.3	38	3.4
m,p-Xylene	mg/kg	9.2	0.011	14	200	16
o-Xylene	mg/kg	3		3.8	42	3.9
Toluene	mg/kg	1.8		2.4	21 ?	2.1

Parameter	Units	SHB4 18'	SHB3 7.5	SHB3 11	SHB3 20
Benzene	mg/kg	27	0.5	0.22	0.09
Ethylbenzene	mg/kg	27			0.051
m,p-Xylene	mg/kg				
o-Xylene	mg/kg				
Toluene	mg/kg	29	0.28	0.18	0.1

Table 11
Soil Sampling Results

Soil Sample Analytical Results - 10/16/85 (Engineering Science)

Parameter Units	Phenols mg/kg	Cr mg/kg	Pb mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylenes mg/kg	MEK mg/kg
L1&L2, 0-6" Quadrant #1-Landfill	ND	11	10	ND	ND	ND	ND	NA
L3&L4, 6-12" Quadrant #1-Landfill	ND	8.9	9.8	ND	ND	ND	ND	NA
L5&L6, 0-6" Quadrant #2-Landfill	ND	9.9	9	ND	ND	ND	ND	NA
L7&L8, 6-12" Quadrant #2-Landfill	ND	7.6	6.7	ND	ND	ND	ND	NA
L9&L10, 0-6" Quadrant #3-Landfill	ND	7.8	7.6	ND	ND	ND	ND	NA
L11&L12, 6-12" Quadrant #3 Landfill	ND	7.4	7	ND	ND	ND	ND	NA
L13&L14, 6-12" Quadrant #4 Landfill	ND	9.1	8.2	ND	ND	ND	ND	NA
L15&L16, 6-12" Quadrant #4 Landfill	ND	7	7.7	ND	ND	ND	ND	NA
LP1&LP2,0-6" Points 1&2 @ Landfill Pond	ND	6.2	9	ND	ND	ND	ND	NA
LP3&LP4,6-12" Points 1&2 @ Landfill Pond	ND	8.1	8.5	ND	ND	ND	ND	NA
LP5&LP6,0-6" Points 3&4 @ Landfill Pond	ND	7.8	8.9	ND	ND	ND	ND	NA
LP7&LP8,6-12" Points 3&4 @ Landfill Pond	ND	10	12	ND	ND	ND	ND	NA
LP9&LP10, 0-6" Points 5&6 @ Landfill Pond	ND	8	12	0.0013	ND	ND	ND	NA
LP11&LP12, 6-12" Points 5&6 @ Landfill Pond	ND	7.8	13	ND	ND	ND	ND	NA

Soil Sample Analytical Results - 10/16/85 (Engineering Science)

Parameter Units	Phenols mg/kg	Cr mg/kg	Pb mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylenes mg/kg	MEK mg/kg
LP13&LP14, 0-6" S. Evap Pond Landfill Pond	ND	2.3	4	ND	ND	ND	ND	ND
MS1&MS2, Mystery Sample	ND	2.4	4	ND	ND	ND	ND	0.053
APS1&APS2, 0 6" NE&SE of SOWP	ND	4.4	5	ND	ND	ND	0.0074	NA
APS3&APS4, 6 12" NE&SE of SOWP	ND	5.3	5	ND	ND	ND	ND	NA
APS5&APS6, 0 6" N&S of SOWP	ND	5.5	5	ND	ND	ND	ND	NA
APS7&APS8, 6 12" N&S of SOWP	ND	14	4	ND	ND	ND	ND	NA
APS9 & APS10, 0-6" NW & SW of SOWP	ND	6.8	5..1	ND	ND	ND	ND	NA
APS11&APS12, 6-12" NW & SW of SOWP	ND	27	5.9	ND	ND	ND	ND	NA
APS13, 0-6" SE near influent SOWP	ND	4.9	6	ND	ND	ND	ND	ND
APN1&APN2, 0-6" NE & SE of NOWP	ND	7.8	4	ND	ND	ND	ND	NT
APN3&APN4, 6-12" NE&SE of NOWP	ND	3.2	3	ND	ND	ND	ND	NA
APN5&APN6, 0-6" NE&SE of NOWP	ND	3.6	5	ND	ND	ND	ND	NA
APN7&APN8, 6-12" N&S of NOWP	ND	2.3	3	ND	ND	ND	ND	NA
APN9&APN10, 0-6" NW&SW of NOWP	ND	2.9	3	ND	ND	ND	ND	NA

Soil Sample Analytical Results - 10/16/85 (Engineering Science)

Parameter Units	Phenols mg/kg	Cr mg/kg	Pb mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylenes mg/kg	MEK mg/kg
APN11&APN12, 6-12" NW&SW of NOWP	ND	12	4	ND	ND	ND	ND	NA

Table 12
Groundwater Depth and SPH Over Time

	Source	MW-1			MW-3			MW-4			MW-5		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.85			5535.74			5523.24			5545.51		
Date													
2/23/85	ES 1986	16.7		5499.15	33.7		5502.04	25		5498.24	42.35		5503.16
3/18/85	ES 1986	16.63		5499.22	33.3		5502.44	24.98		5498.26	41.6		5503.91
4/11/85	ES 1986	16.78		5499.07	33.12		5502.62	25		5498.24	41.43		5504.08
5/31/85	ES 1986	16.1		5499.75	33.11		5502.63	24.5		5498.74	41.46		5504.05
6/14/85	ES 1986	15.97		5499.88	33.22		5502.52	24.5		5498.74	41.7		5503.81
6/26/85	ES 1986	15.83		5500.02	33.36		5502.38	24.57		5498.67	41.86		5503.65
7/10/85	ES 1986	15.57		5500.28	33.37		5502.37	24.5		5498.74	41.8		5503.71
8/2/85	ES 1986	15.57		5500.28	33.37		5502.37	24.52		5498.72	41.73		5503.78
9/17/85	ES 1986	15.43		5500.42	33.6		5502.14	24.5		5498.74	42.1		5503.41
10/9/85	ES 1986	15.74		5500.11	33.43		5502.31	24.6		5498.64	41.8		5503.71
10/24/85	ES 1986	16.54		5499.31	33.57		5502.17	24.76		5498.48	42		5503.51
11/8/85	ES 1986	17.05		5498.8	33.65		5502.09	24.7		5498.54	42.01		5503.5
12/17/85	ES 1986	17.42		5498.43	34		5501.74	24.9		5498.34	42.2		5503.31
1/8/86	ES 1986	16.18		5499.67	34		5501.74	24.95		5498.29	42.33		5503.18
1/24/86	ES 1986	17.02		5498.83	33.81		5501.93	24.94		5498.3	42.34		5503.17
2/20/86	ES 1986	16.84		5499.01	33.42		5502.32	24.95		5498.29	41.8		5503.71
3/21/86	ES 1986	16.67		5499.18	32.96		5502.78	25		5498.24	40.87		5504.64
3/26/86	ES 1986	16.7		5499.15	32.94		5502.8	24.99		5498.25	40.86		5504.65
4/4/86	ES 1986	16.7		5499.15	32.87		5502.87	25.09		5498.15	40.53		5504.98
4/18/86	ES 1986	16.92		5498.93	32.87		5502.87	24.88		5498.36	40.68		5504.83
5/5/86	ES 1986	16.34		5499.51	32.93		5502.81	24.98		5498.26	40.83		5504.68
5/21/86	ES 1986	15.72		5500.13	33		5502.74	24.9		5498.34	40.75		5504.76
6/4/86	ES 1986	15.36		5500.49	32.9		5502.84	24.9		5498.34	40.93		5504.58
6/23/86	ES 1986	14.56		5501.29	32.8		5502.94	24.85		5498.39	40.97		5504.54
7/8/86	ES 1986	14.43		5501.42	32.89		5502.85	24.86		5498.38	41.23		5504.28
8/4/86	ES 1986	15.52		5500.33	32.93		5502.81	24.63		5498.61	41.33		5504.18
9/2/86	ES 1986	15.54		5500.31	32.91		5502.83	24.52		5498.72	41.52		5503.99
9/18/86	ES 1986	15.74		5500.11	33.08		5502.66	24.32		5498.92	41.58		5503.93
10/8/86	ES 1986	15.94		5499.91	33.72		5502.02	24.17		5499.07	41.64		5503.87
11/7/86	ES 1986	16.32		5499.53	33.13		5502.61	24.11		5499.13	41.62		5503.89
12/8/86	ES 1986	16.32		5499.53	33.07		5502.67	24.02		5499.22	42.67		5502.84
12/16/86	ES 1986	16.32		5499.53	33.05		5502.69	24.02		5499.22	41.69		5503.82
2/15/89	GCL 1989												
10/21/91	DP Files	16.69		5499.16	34.84		5500.9	25.65	0.58	5498.054	43.48		5502.03
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	17.21		5498.64	34.13		5501.61	25	0.54	5498.672	42.75		5502.76
5/24/94	GTI 1994	15.64		5500.21	34.32		5501.42	25.72	0.58	5497.984	43.36		5502.15

	Source	MW-1			MW-3			MW-4			MW-5		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.85			5535.74			5523.24			5545.51		
Date													
8/2/94	GTI 1994	14.57		5501.28	33.9		5501.84	24.89	0.001	5498.351	42.8		5502.71
3/1/95	DP Files	16.89		5498.96	34.46		5501.28	25.27	0.88	5498.674	43.73		5501.78
5/22/95	DP Files	15.64		5500.21							43.98		5501.53
12/7/95	DP Files	17.65		5498.2							44.45		5501.06
5/23/96	DP Files	16.7		5499.15							46.42		5499.09
5/31/96	DP Files	10.7		5505.15									
11/21/96	TLS 1/97	17.74		5498.11				26.16	0.58	5497.544	45.56		5499.95
11/17/97	DP Files	17.5		5498.35							44.17		5501.34
8/27/98	DP Files												
10/27/98	DP Files	15.54		5500.31	33.42		5502.32	24.72		5498.52			
2/2/99	DP Files	14.29		5501.56	33.9		5501.84	24.96		5498.28	43.55		5501.96
4/26/99	DP Files	14.3		5501.55	33.8		5501.94	24.95		5498.29	43.5		5502.01

	Source	MW-6			MW-7			MW-8			MW-9		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5549.84			5523.12			5531.33			5519.63		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986				26.07		5497.05	29.17		5502.16	21.55		5498.08
3/26/86	ES 1986				26.07		5497.05	29.15		5502.18	21.5		5498.13
4/4/86	ES 1986				25.32		5497.8	29.26		5502.07	21.48		5498.15
4/18/86	ES 1986				26.17		5496.95	29.3		5502.03	20.8		5498.83
5/5/86	ES 1986				26.81		5496.31	29.39		5501.94	21.08		5498.55
5/21/86	ES 1986				25.23		5497.89	29.29		5502.04			
6/4/86	ES 1986				25.24		5497.88	29.23		5502.1	20.53		5499.1
6/23/86	ES 1986												
7/8/86	ES 1986				26.22		5496.9	28.9		5502.43	20.2		5499.43
8/4/86	ES 1986				25.32		5497.8	29		5502.33	20.3		5499.33
9/2/86	ES 1986				25.14		5497.98	28.91		5502.42	20.15		5499.48
9/18/86	ES 1986												
10/8/86	ES 1986				24.13		5498.99	29.15		5502.18	20.28		5499.35
11/7/86	ES 1986				24.61		5498.51	29.22		5502.11	20.14		5499.49
12/8/86	ES 1986				24.69		5498.43	29.02		5502.31	20.56		5499.07
12/16/86	ES 1986				21.99		5501.13	31.97		5499.36	20.4		5499.23
2/15/89	GCL 1989												
10/21/91	DP Files				24.15		5498.97	30.5		5500.83	21.65	0.05	5498.02
11/1/91	DP Files										22		5497.63
2/7/92	DP Files										22.4	0.1	5497.31
6/10/92	DP Files										20.8	0.03	5498.854
10/16/92	DP Files										21.04	0.03	5498.614
5/4/94	DP Files	49.63		5500.21	25		5498.12	29.86		5501.47	22.2	0.12	5497.526
5/24/94	GTI 1994	dry			25.21		5497.91	29.8		5501.53	20.88	0.01	5498.758

	Source	MW-6			MW-7			MW-8			MW-9		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5549.84			5523.12			5531.33			5519.63		
Date													
8/2/94	GTI 1994	dry			25.37		5497.75	29.35		5501.98	19.9	0.001	5499.731
3/1/95	DP Files	49.63		5500.21	25.37		5497.75	29.74		5501.59	22.19	0.15	5497.56
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files										21.1		5498.53
11/21/96	TLS 1/97										21.84	0.02	5497.806
11/17/97	DP Files										21.67		5497.96
8/27/98	DP Files										19.62		5500.01
10/27/98	DP Files				25.89		5497.23	27		5504.33	21.22		5498.41
2/2/99	DP Files				26		5497.12	28.93		5502.4	21.77		5497.86
4/26/99	DP Files				25.34		5497.78	28.93		5502.4	21.34		5498.29

	Source	RW-1			P-1			RW-2			P-2		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation:	KA 1998	5524.94			5523.88			5523.44			5523.28		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989	29.15	0.17	5495.926	28.49	0.04	5495.422	26.62	0.042	5496.854	26.52		5496.76
10/21/91	DP Files	27.65		5497.29	26.43		5497.45	24.73	0.31	5498.958	25	0.38	5498.584
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	28.02		5496.92	26.75		5497.13	24.41	0.92	5499.766	24.65	0.01	5498.638
5/24/94	GTI 1994	27.33		5497.61	26		5497.88	25.21	0.8	5498.87	25.02	0.32	5498.516

	Source	RW-1			P-1			RW-2			P-2		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5524.94			5523.88			5523.44			5523.28		
Date													
8/2/94	GTI 1994	26.76		5498.18	25.44		5498.44	24.14	0.001	5499.301	24.45	0.001	5498.831
3/1/95	DP Files	27.99		5496.95	26.71		5497.17	25.4	0.45	5498.4	24.79	0.93	5499.234
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	27.64		5497.3	26.3		5497.58	25.96	0.05	5497.52	25.71	0.66	5498.098
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	27.25		5497.69				23.89		5499.55			
2/2/99	DP Files	27.42		5497.52				24.2		5499.24			
4/26/99	DP Files	27.3		5497.64				24.3		5499.14			

	Source	RW-3			P-3			MW-11			MW-12		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5514.91			5507.05			5506.6			5497.98		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986	19.21		5495.7									
3/26/86	ES 1986	19.2		5495.71									
4/4/86	ES 1986	19.26		5495.65									
4/18/86	ES 1986	19.17		5495.74									
5/5/86	ES 1986	19.03		5495.88									
5/21/86	ES 1986	18.81		5496.1									
6/4/86	ES 1986	18.71		5496.2									
6/23/86	ES 1986												
7/8/86	ES 1986	18.69		5496.22									
8/4/86	ES 1986	18.49		5496.42									
9/2/86	ES 1986	18.33		5496.58									
9/18/86	ES 1986												
10/8/86	ES 1986	18.17		5496.74									
11/7/86	ES 1986	17.82		5497.09									
12/8/86	ES 1986	18.58		5496.33									
12/16/86	ES 1986												
2/15/89	GCL 1989	20.95		5493.96	11.78		5495.27						
10/21/91	DP Files	19.37		5495.54	9.33		5497.72	10.46			9.91		5488.07
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	19.14		5495.77	9.32		5497.73	10.32		5496.28	9.72		5488.26
5/24/94	GTI 1994	18.68		5496.23	9.21		5497.84	9.82		5496.78	8.92		5489.06

	Source	RW-3			P-3			MW-11			MW-12		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5514.91			5507.05			5506.6			5497.98		
Date													
8/2/94	GTI 1994	18.27		5496.64	9		5498.05	9.87		5496.73	9.65		5488.33
3/1/95	DP Files	19.15		5495.76	9.4		5497.65	10.34			9.4		5488.58
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	18.86		5496.05	9.35		5497.7	10.3		5496.3	10.7		5487.28
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	17.88		5497.03	7.27		5499.78	8.75		5497.85	8.54		5489.44
2/2/99	DP Files	18.6		5496.31	9.4		5497.65	9.89		5496.71	8.4		5489.58
4/26/99	DP Files	18.6		5496.31	9.4		5497.65	9.89		5496.71	8.4		5489.58

	Source	MW-13			RW-14			RW-15			RW-16		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation:	KA 1998	5538.54			5533.97			5533.26			5531.92		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989	38.05		5500.49									
10/21/91	DP Files	38.95		5499.59	33.93	0.38	5500.344	33.66	0.52	5500.016	32.99	1.13	5499.834
11/1/91	DP Files							33.8	0.4	5499.78			
2/7/92	DP Files							34.7	0.87	5499.256			
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	38.36		5500.18	33.49	0.01	5500.488	33.11	0.15	5500.27	32.24	0.03	5499.704
5/24/94	GTI 1994	38.64		5499.9	33.23	0.001	5500.741	32.91	0.001	5500.351	32	0.001	5499.921

	Source	MW-13			RW-14			RW-15			RW-16		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5538.54			5533.97			5533.26			5531.92		
Date													
8/2/94	GTI 1994	38.69		5499.85	32.71	0.001	5501.261	32.38	0.001	5500.881	31.56	0.001	5500.361
3/1/95	DP Files	38.87		5499.67	34.12	0.01	5499.858	33.72	0.01	5499.548	33.35	0.01	5498.578
5/22/95	DP Files			5538.54									
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	33.36		5505.18	35.03	0.41	5499.268	34.19		5499.07	35.57	0.76	5496.958
11/17/97	DP Files							33.5		5499.76			
8/27/98	DP Files	39.45		5499.09						5533.26			
10/27/98	DP Files	37.7		5500.84	32.18		5501.79	32.42		5500.84	31.49		5500.43
2/2/99	DP Files	38.8		5499.74	32.56		5501.41	32.35		5500.91	31.55		5500.37
4/26/99	DP Files	38.8		5499.74	32.37		5501.6	32.17		5501.09	31.48		5500.44

	Source	RW-17			RW-18			RW-19			MW-20		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.33			5526			5526.94			5516.34		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files	31.65	1.13	5499.584	28.61	0.94	5498.142	28.2	0.68	5499.284	17.93		5498.41
11/1/91	DP Files				29.21	1.13	5497.694				18.33		5498.01
2/7/92	DP Files				29.95	1.34	5497.122				18.69		5497.65
6/10/92	DP Files										17.51		5498.83
10/16/92	DP Files										17.43		5498.91
5/4/94	DP Files	31.4	1.94	5500.482	27.75	5.65	5502.77	27.95	0.01	5498.998	18.55		5497.79
5/24/94	GTI 1994	31.27	0.01	5499.068	27.05	0.02	5498.966	27.8		5499.14	17.48		5498.86

	Source	RW-17			RW-18			RW-19			MW-20		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.33			5526			5526.94			5516.34		
Date													
8/2/94	GTI 1994	30.37	0.01	5499.968	26.01	0.001	5499.991	27.38	0.001	5499.561	16.5		5499.84
3/1/95	DP Files	31.8	0.01	5498.538	26.01	0.01	5499.998	28.14	1.99	5500.392	18.57		5497.77
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files										17.8		5498.54
11/21/96	TLS 1/97	32.12	0.75	5498.81	27.44	0.12	5498.656	28.68	0.59	5498.732	18.47		5497.87
11/17/97	DP Files				27		5499				18.25		5498.09
8/27/98	DP Files										15.94		5500.4
10/27/98	DP Files	30.43		5499.9	27.18	0.63	5499.324	27.41		5499.53	17.94	0.4	5498.72
2/2/99	DP Files	30.65		5499.68	27.33	0.08	5498.734	27.92		5499.02	18.75	0.82	5498.246
4/26/99	DP Files	30.7		5499.63	27.2	0.25	5499	27.64		5499.3	17.85	0.18	5498.634

	Source	MW-21			RW-22			RW-23			MW-24		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5519.87			5520.94			5517.65			5505.05		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files	19.39		5500.48									
11/1/91	DP Files	19.85		5500.02									
2/7/92	DP Files	20.34		5499.53									
6/10/92	DP Files	19.5		5500.37									
10/16/92	DP Files	19.12		5500.75									
5/4/94	DP Files	19.98		5499.89	23.15	0.01	5497.798	20.6	0.39	5497.362	14.85		5490.2
5/24/94	GTI 1994	19.3		5500.57	22.31	0.001	5498.631	19.28	0.001	5498.371	dry		

	Source	MW-21			RW-22			RW-23			MW-24		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5519.87			5520.94			5517.65			5505.05		
Date													
8/2/94	GTI 1994	18.35		5501.52	21.22	0.001	5499.721	18.23	0.001	5499.421	dry		
3/1/95	DP Files	20.09		5499.78		0.01	5520.95				14.85		5490.2
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files	20		5499.87									
11/21/96	TLS 1/97	20.35		5499.52	22.82	0.41		20.03	0.01	5497.628			
11/17/97	DP Files	20		5499.87									
8/27/98	DP Files	17.76		5502.11	20.94		5500	17.7					
10/27/98	DP Files	19.08		5500.79	21.81		5499.13	19.15			dry		
2/2/99	DP Files	19.58		5500.29	22.6		5498.34	20.14					
4/26/99	DP Files	19.35		5500.52	22.43		5498.51	19.9					

	Source	MW-25			MW-26			MW-27			MW-28		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.45			5514.3			5514.92			5524.34		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994	31.03		5499.42	15.95		5498.35	17.69	0.17	5497.366	25.81	0.08	5498.594

	Source	MW-25			MW-26			MW-27			MW-28		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.45			5514.3			5514.92			5524.34		
Date													
8/2/94	GTI 1994	30.95		5499.5	15.94		5498.36	17.52	0.01	5497.408	24.87	0.02	5499.486
3/1/95	DP Files	31.17		5499.28	25.25	0.01	5489.058	24.49	0.01	5490.438	26.29	0.61	5498.538
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	32.04	0.38	5498.714	16.42	0.03	5497.904	17.91	0.01	5497.018			
11/17/97	DP Files												
8/27/98	DP Files	31.52		5498.93	16.22		5498.08						
10/27/98	DP Files	31.17		5499.28	16.13	0.12	5498.266	17.25		5497.67	25.35		5498.99
2/2/99	DP Files	30.96		5499.49	15.9	0.2	5498.56	17.25		5497.67	25.9		5498.44
4/26/99	DP Files	30.96		5499.49	15.76		5498.54	17.32		5497.6	25.69		5498.65

	Source	MW-29			MW-30			MW-31			MW-32		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5520.14			5533.33			5532.71			5521.99		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994	21.01		5499.13	31.97	0.001	5501.361	32.37		5500.34			

	Source	MW-29			MW-30			MW-31			MW-32		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5520.14			5533.33			5532.71			5521.99		
Date													
8/2/94	GTI 1994	20.32		5499.82	31.6		5501.73	32.34		5500.37			
3/1/95	DP Files	21.55		5498.59	32.17		5501.16	32.65		5500.06	24.01		5497.98
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97							33.36		5499.35	24.48		5497.51
11/17/97	DP Files												
8/27/98	DP Files	19.6		5500.54				32.74		5499.97	24.44		5497.55
10/27/98	DP Files	20.75		5499.39	31.6		5501.73	32.5		5500.21	24.25		5497.74
2/2/99	DP Files	20.58		5499.56	31.41		5501.92	32.25		5500.46	23.81		5498.18
4/26/99	DP Files	20.58		5499.56	31.38		5501.95	32.23		5500.48	23.81		5498.18

	Source	MW-33			MW-34			MW-35			MW-36		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5518.16			5505.59			5515.28			5513.17		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

	Source	MW-33			MW-34			MW-35			MW-36		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation:	KA 1998	5518.16			5505.59			5515.28			5513.17		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files	22.6		5495.56	13.71		5491.88						
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	21.47		5496.69	13.5	0.18	5492.234						
11/17/97	DP Files												
8/27/98	DP Files	26.69		5491.47				21.42		5493.86			
10/27/98	DP Files	21.38		5496.78	12.88		5492.71	21.17		5494.11	19.04		5494.13
2/2/99	DP Files	21.14		5497.02	13.35		5492.24	21.55		5493.73	19.91		5493.26
4/26/99	DP Files	21.24		5496.92	16.35		5489.24	21.55		5493.73	19.91		5493.26

	Source	MW-37			MW-38			MW-39			MW-40		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.87			5515.57			5517.65			5523.54		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

	Source	MW-37			MW-38			MW-39			MW-40		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.87			5515.57			5517.65			5523.54		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files												
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97												
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	22.29		5493.58	21.67		5493.9	22.8		5494.85	24.71		5498.83
2/2/99	DP Files	23		5492.87	22.94		5492.63	22.6		5495.05	25.33	0.5	5498.61
4/26/99	DP Files	23		5492.87	22		5493.57	21.52		5496.13	25.3	0.13	5498.344

	Source	MW-41			MW42			MW-43			MW-44		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.34			5523.88						5531.29		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

	Source	MW-41			MW42			MW-43			MW-44		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.34			5523.88						5531.29		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files												
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97												
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	25.18	2.06	5499.808	25.18	0.03	5498.724				34.15		5497.14
2/2/99	DP Files	25.54	2.16	5499.528	25.17	1.09	5499.582	21.56	1.42		33.9		5497.39
4/26/99	DP Files	23.15	0.03	5500.214	25.29	0.98	5499.374	20	1.06		32.17		5499.12

	Source	MP-1			MP-2			MP-3			MP-4		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.25			5523.95			5525.52			5525.52		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

	Source	MP-1			MP-2			MP-3			MP-4		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation -	KA 1998	5523.25			5523.95			5525.52			5525.52		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files												
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	25.27	1.04	5498.812	26.12	1.13	5498.734	27.08	1.12	5499.336	27.23	1.28	5499.314
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	23.48	0.001	5499.771				25.16		5500.36	26.12	0.94	5500.152
2/2/99	DP Files	23.7		5499.55				25.75	0.65	5500.29	25.67	0.59	5500.322
4/26/99	DP Files	23.7		5499.55				25.75	0.83	5500.434	25.67	0.59	5500.322

	Source	MP-5			AS-1		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5525.2			5523.45		
Date							
2/23/85	ES 1986						
3/18/85	ES 1986						
4/11/85	ES 1986						
5/31/85	ES 1986						
6/14/85	ES 1986						
6/26/85	ES 1986						
7/10/85	ES 1986						
8/2/85	ES 1986						
9/17/85	ES 1986						
10/9/85	ES 1986						
10/24/85	ES 1986						
11/8/85	ES 1986						
12/17/85	ES 1986						
1/8/86	ES 1986						
1/24/86	ES 1986						
2/20/86	ES 1986						
3/21/86	ES 1986						
3/26/86	ES 1986						
4/4/86	ES 1986						
4/18/86	ES 1986						
5/5/86	ES 1986						
5/21/86	ES 1986						
6/4/86	ES 1986						
6/23/86	ES 1986						
7/8/86	ES 1986						
8/4/86	ES 1986						
9/2/86	ES 1986						
9/18/86	ES 1986						
10/8/86	ES 1986						
11/7/86	ES 1986						
12/8/86	ES 1986						
12/16/86	ES 1986						
2/15/89	GCL 1989						
10/21/91	DP Files						
11/1/91	DP Files						
2/7/92	DP Files						
6/10/92	DP Files						
10/16/92	DP Files						
5/4/94	DP Files						
5/24/94	GTI 1994						

	Source	MP-5			AS-1		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5525.2			5523.45		
Date							
8/2/94	GTI 1994						
3/1/95	DP Files						
5/22/95	DP Files						
12/7/95	DP Files						
5/23/96	DP Files						
5/31/96	DP Files						
11/21/96	TLS 1/97						
11/17/97	DP Files						
8/27/98	DP Files						
10/27/98	DP Files				23.32		5500.13
2/2/99	DP Files				23.52		5499.93
4/26/99	DP Files				23.52		5499.93

Table 13
Separate Phase Hydrocarbon Volume Calculations - 2001

Area				
Sheen Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Sheen 1	length	1.171	468.4	153,635
	width	0.82	328	
Sheen 2	length	1.638	655.2	214,906
	width	0.82	328	
Total Area				**368,541**
Product Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Product 1	length	1.054	421.6	92,246
	width	0.547	218.8	
Product 2	length	1.109	443.6	94,043
	width	0.53	212	
Product Only Area				**186,289**
Sheen Only Area				**182,252**

SPH Volume					
	Groundwater		**Smear Zone**		**Total SPH (gal)**
	Product Only	**Sheen Only**	**Product Only**	**Sheen Only**	
Area	186,289	182,252	186,289	182,252	
Thickness	0.01	0.001	2.19	2.19	
Porosity	0.35	0.35	0.35	0.35	
Saturation	0.2	0.2	0.01	0.01	
Volume (ft^3)	130	13	1428	1397	
Volume (gal)	975	95	10,681	10,449	
Total SPH					**22,201**

Table 14
Separate Phase Hydrocarbon Volume Calculations - 1999

Area				
Sheen Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Sheen 1	length	2.726	1090.4	521,647
	width	1.196	478.4	
Total Area				**521,647**
Product Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Product 1	length	2.473	989.2	378,666
	width	0.957	382.8	
Product Only Area				**378,666**
Sheen Only Area				**142,982**

SPH Volume					
	Groundwater		**Smear Zone**		**Total SPH (gal)**
	Product Only	**Sheen Only**	**Product Only**	**Sheen Only**	
Area	378,666	142,982	378,666	142,982	
Thickness	0.01	0.001	2.19	2.19	
Porosity	0.35	0.35	0.35	0.35	
Saturation	0.2	0.2	0.01	0.01	
Volume (ft^3)	265	10	2902	1096	
Volume (gal)	1,983	75	21,710	8,198	
Total SPH					**31,966**

Table 15
Separate Phase Hydrocarbon Volume Calculations - 1995

Areas				
Sheen Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Sheen 1	length	2.029	811.6	455,470
	width	1.403	561.2	
Sheen 2	length	4.438	1775.2	819,432
	width	1.154	461.6	
Sheen 3	length	2.414	965.6	270,368
	width	0.7	280	
Total Area				**1,545,270**
Product Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Product 1	length	1.796	718.4	294,831
	width	1.026	410.4	
Product 2	length	2.15	860	136.568
	width	0.397	158.8	
Product Only Area				**431,399**
Sheen Only Area				**1,113,871**

SPH Volume					
	Groundwater		**Smear Zone**		**Total SPH (gal)**
	Product Only	**Sheen Only**	**Product Only**	**Sheen Only**	
Area	431,399	1,113,871	431,399	1,113,871	
Thickness	0.01	0.001	2.19	2.19	
Porosity	0.35	0.35	0.35	0.35	
Saturation	0.2	0.2	0.01	0.01	
Volume (ft^3)	302	78	3307	8538	
Volume (gal)	2,259	583	24,734	63,863	
Total SPH					**91,439**

Table 16
Separate Phase Hydrocarbon Volume Calculations - 1991

Area				
Sheen Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Sheen 1	length	2.168	867.2	643,809
	width	1.856	742.4	
Sheen 2	length	4.492	1796.8	885,463
	width	1.232	492.8	
Sheen 3	length	2.231	892.4	323,049
	width	0.905	362	
Total Area				**1,852,321**
Product Rectangles		**Inches**	**Feet**	**Area (ft^2)**
Product 1	length	1.123	449.2	120,565
	width	0.671	268.4	
Product 2	length	3.027	1210.8	536,142
	width	1.107	442.8	
Product 3	length	1.965	786	201,216
	width	0.64	256	
Product Only Area				**857,924**
Sheen Only Area				**994,398**

SPH Volume					
	Groundwater		**Smear Zone**		**Total SPH (gal)**
	Product Only	**Sheen Only**	**Product Only**	**Sheen Only**	
Area	857,924	994,398	857,924	994,398	
Thickness	0.01	0.001	2.19	2.19	
Porosity	0.35	0.35	0.35	0.35	
Saturation	0.2	0.2	0.01	0.01	
Volume (ft^3)	601	70	6,576	7,622	
Volume (gal)	4,492	521	49,188	57,013	
Total SPH					**111,214**

Table 17
Corrective Measure Options Screening:
San Juan River Seepage Control (Surface Water) Alternatives

Corrective Measure Option	Compatible With - Site	Compatible With - COC's	Technical Limitations?	Retain? (Yes/No)	Comments
Dewater Pumping	N	Y	Y	No	Alluvium is hydraulically connected to the San Juan River
Grount Curtain or Sheet Piling	Y	Y	N	Yes	Immediate short-term results
Air Curtain	Y	Y	Y	No	Addresses dissolved hydrocarbons in alluvium, no immediate improvement
Intercepter Trench	N	Y	Y	No	Infiltration from San Juan River would required excessive pumping.
Pumping to Reverse Gradient	N	Y	Y	No	Infiltration from San Juan River would required excessive pumping.
Clean Water Curtain Injection	N	Y	Y	No	Technically complicated, Would increase water costs or compete with refinery processes for water allocation.
SVE & IAS Source Removal	Y	Y	Y	No	Addresses hydrocarbons in alluvium, no immediate improvement in river
Enhanced In-Situ Bioremediation	Y	Y	Y	No	Addresses hydrocarbons in alluvium, no immediate improvement in river
No Action/Natural Attenuation and Monitoring	Y	Y	Y	No	Addresses hydrocarbons in alluvium, no immediate improvement in river

Table 18
Corrective Measure Options Screening:
Separate-Phase Hydrocarbon Recovery Alternatives

Corrective Measure Option	Compatible With - Site	Compatible With - COC's	Technical Limitations?	Retain? (Yes/No)	Comments
Skimming Pumps	Y	Y	N	No	Limited radius of influence would require many wells and a long time.
Dual Pump System (Groundwater & SPH)	Y	Y	N	No	No need to pump SPH and water separately because the refinery waste water treatment plant has an O/W separator.
Soil Vapor Extraction (SVE)	Y	Y	N	Yes	Pilot testing shows SVE to be feasible.
SVE and In-Situ Air Sparging (IAS)	Y	Y	Y	Yes	The thin saturated thickness would require many IAS points, but enhanced volatilization will reduce treatment time.
High-Vacuum Dual Phase Extraction	N	Y	Y	No	Thickness of saturated zone may require excessive pumping, would increase amount of water to be disposed through injection well - very expensive
Total Fluids Pumping	Y	Y	N	Yes	Already being implemented.
Water Table Depression and SVE	Y	Y	Y	Yes	Infiltration from Hammond Ditch and other Refinery sources would require excessive pumping, but increased surface area would enhance SVE.
No Action/Natural Attenuation and Monitoring	Y	Y	N	Yes	NMED generally requires removal of all measureable SPH, may not be permissable as stand alone remedy. Would require decades to remove all SPH.

Table 19
Corrective Measure Options Screening:
Soil Abatement (Sorbed COCs in Unsaturated Zone) Alternatives

Corrective Measure Option	Compatible With - Site	Compatible With - COC's	Technical Limitations?	Retain? (Yes/No)	Comments
Soil Vapor Extraction (SVE)	Y	Y	N	Yes	Pilot testing shows that SVE is feasible, relatively short abatement time
Bioventing	Y	Y	N	No	Difficult access in refinery area, further subsurface investigation required
Excavation & Disposal/ Ex-Situ Treatment	N	Y	N	No	Refinery building and tanks make area inaccesible, disposal is costly, increased exposure with ex-situ treatment
In-Situ Soil Washing	N	N	Y	No	Not compatible with constituents of concern and soils properties
Chemical Fixation/Stabilization	N	N	Y	No	Not compatible with constituents of concern and soils properties
Vitrification	N	N	Y	No	Not compatible with constituents of concern and soils properties
Steam-Injection Stripping	Y	Y	N	No	Constituents are volatile enough at ambient temperatures, no added benefit.
Enhanced Bioremediation	Y	Y	Y	No	Difficult to uniformly distribut nutrients in soil, may be other limiting factors, increased monitoring burden
No Action/Natural Attenuation and Monitoring	Y	Y	N	Yes	Historic data demonstrates effective natural attenuation is already occurring, long time frame required

Table 20
Corrective Measure Options Screening:
Groundwater Abatement (Dissolved-Phase COCs in Saturated Zone) Alternatives

Corrective Measure Option	Compatible With -		Technical Limitations?	Retain? (Yes/No)	Comments
	Site	COC's			
Altered Water Mgmt. Practices (decrease leakage from ponds)	N	Y	Y	No	Lining pond would create silting problem as material settles out, leakage allows TDS to remain relatively constant, lining ponds allows less throughput limiting refinery operations
Pump, Treat & Reinject Groundwater	Y	Y	Y	No	Not viable until SPH removal is complete.
Pump, Treat & Reinfiltrate Groundwater	N	Y	Y	No	Would require large infiltration gallery, not viable until SPHremoval is complete.
Geo-Cleanse	N	Y	Y	No	Not recommended for use with SPH thicker than 6", access in Refinery area may be difficult
In-Situ Air Sparging (IAS)	Y	Y	N	Yes	Thin saturated zone will require many IAS points, pilot tests show IAS to be feasible, relatively short abatement period, high maintenance.
Enhanced In-Situ Bioremediation	Y	Y	N	Yes	Injection of nutrients will enhance in-situ biodegradation of hydrocarbons, increased monitoring burden nutrient addition may be difficult to calibrate, low maintenance
Contaminant Source Removal/Natural Attenuation	Y	Y	N	Yes	Contributes to all abatement objectives, natural attenuation will proceed more rapidly once SPH is reduced
No Action/Natural Attenuation and Monitoring	Y	Y	N	Yes	Historic data show natural attenuation is already occurring at the site, long abatement period required, low maintenance

Table 21
Evaluation of Corrective Measure Alternatives
Seepage Control to San Juan River (Surface Water)

Corrective Measure Alternative		Sheet Piling	SVE & IAS Source Removal	Enhanced In-Situ Bioremediation	No Action/ Natural Attenuation & Monitoring
Technical					
	Performance	1	0	1	0
	Reliability	0	-1	-1	0
	Implementability	1	-1	-1	0
	Total	2	-2	-1	0
	Importance Factor	2	2	2	2
	Overall Rating	4	-4	-2	0
Environmental					
	Rating	1	1	-1	0
	Importance Factor	3	3	3	3
	Overall Rating	3	3	-3	0
Human Health					
	Rating	1	0	0	0
	Importance Factor	3	3	3	3
	Overall Rating	3	0	0	0
Institutional					
	Rating	0	-1	-1	0
	Importance Factor	1	1	1	1
	Overall Rating	0	-1	-1	0
Estimated Cost					
	Rating	-1	-1	-1	0
	Importance Factor	1	1	1	1
	Overall Rating	-1	-1	-1	0
Total Rating		9	-3	-7	0

Table 22
Evaluation of Corrective Measure Alternatives
Abatement of Separate-Phase Hydrocarbon in Unsaturated Zone

Corrective Measure Alternative		SVE	SVE & IAS	Total Fluids Pumping	Water Table Depression and SVE	No Action/ Natural Attenuation & Monitoring
Technical						
	Performance	1	1	1	1	0
	Reliability	-1	-1	-1	-1	0
	Implementability	-1	-1	0	-1	0
	Total	-1	-1	0	-1	0
	Importance Factor	2	2	2	2	2
	Overall Rating	-2	-2	0	-2	0
Environmental						
	Rating	-1	-1	-1	-1	0
	Importance Factor	3	3	3	3	3
	Overall Rating	-3	-3	-3	-3	0
Human Health						
	Rating	0	0	0	-1	0
	Importance Factor	3	3	3	3	3
	Overall Rating	0	0	0	-3	0
Institutional						
	Rating	0	0	1	0	0
	Importance Factor	1	1	1	1	1
	Overall Rating	0	0	1	0	0
Estimated Cost						
	Rating	-1	-1	-1	-1	0
	Importance Factor	1	1	1	1	1
	Overall Rating	-1	-1	-1	-1	0
Total Rating		-6	-6	-3	-9	0

Table 23
Evaluation of Corrective Measure Alternatives
Abatement of Sorbed COCs in Unsaturated Zone (Soil Remediation)

Corrective Measure Alternative		SVE	No Action/ Natural Attenuation & Monitoring
Technical			
	Performance	1	0
	Reliability	-1	0
	Implementability	-1	0
	Total	-1	0
	Importance Factor	2	2
	Overall Rating	-2	0
Environmental			
	Rating	-1	0
	Importance Factor	3	3
	Overall Rating	-3	0
Human Health			
	Rating	0	0
	Importance Factor	3	3
	Overall Rating	0	0
Institutional			
	Rating	0	0
	Importance Factor	1	1
	Overall Rating	0	0
Estimated Cost			
	Rating	-1	0
	Importance Factor	1	1
	Overall Rating	-1	0
Total Rating		-6	0

Table 24
Evaluation of Corrective Measure Alternatives
Abatement of Dissolved-Phase COCs in Saturated Zone

Corrective Measure Alternative		SVE & IAS	Enhanced In-Situ Bioremediation	Source Removal/Natural Attenuation	No Action/ Natural Attenuation & Monitoring
Technical					
	Performance	1	1	1	0
	Reliability	-1	-1	-1	0
	Implementability	-1	-1	0	0
	Total	-1	-1	0	0
	Importance Factor	2	2	2	2
	Overall Rating	-2	-2	0	0
Environmental					
	Rating	-1	-1	-1	0
	Importance Factor	3	3	3	3
	Overall Rating	-3	-3	-3	0
Human Health					
	Rating	0	0	0	0
	Importance Factor	3	3	3	3
	Overall Rating	0	0	0	0
Institutional					
	Rating	0	-1	1	0
	Importance Factor	1	1	1	1
	Overall Rating	0	-1	1	0
Estimated Cost					
	Rating	-1	-1	-1	0
	Importance Factor	1	1	1	1
	Overall Rating	-1	-1	-1	0
Total Rating		-6	-7	-3	0

Table 25
Relative Weighting for Evaluation Criteria

Criteria	Weighting Factor	Rationale
Technical	2	Performance and reliability determine effectiveness of method, time required for remediation and probability of exposure through new pathways.
Environmental	3	Purpose of remediation is to reduce/prevent exposure to natural environment. Proximity of San Juan River creates sensitive natural environment near release site.
Human Health	3	Proximity to town of Bloomfield and number of employees at Refinery make protection of human health extremely important.
Institutional	1	Relative popularity with regulators is unimportant as long as method is approved. Community opinion of the Refinery is already very high; choice of method will have little influence on this.
Cost Estimate	1	Method should be cost effective, but all measures will be expensive due to long cleanup time; more costly method may be most protective.

Table 26
Bacterial Enumeration Study

Well Number	CUB[a] (CFU/ml[b])	THB[c] (CFU/ml)
MW-11	5.2×10^3	6.8×10^3
MW-26	1.1×10^4	5.1×10^4
MW-30	3.2×10^2	1.3×10^3
MW-31	4.8×10^3	7.9×10^3
MW-34	4.7×10^4	5.9×10^4

[a] CUB = contaminant-utilizing bacteria
[b] CFU/mg = colony forming units per milligram
[c] THB = total heterotrophic bacteria

APPENDIX A
SOLID WASTE MANAGEMENT UNITS AT BLOOMFIELD REFINERY

This Appendix A provides summary information for the following units identified as a Solid Waste Management Unit (SWMU) in the New Mexico Environment Department (NMED) Hazardous Materials Bureau (HMB) *Annual Unit Audit for 1999 Corrective Action Units.*

- SWMU No. 1, Aeration Lagoons
- SWMU No. 2, Former Drum Storage Area
- SWMU No. 3, Underground Piping
- SWMU No. 4, Transportation Terminal Sump
- SWMU No. 5, Heat Exchanger Bundle Cleaning Area
- SWMU No. 6, Underground Piping
- SWMU No. 7, Raw Water Ponds
- SWMU No. 8, Landfill
- SWMU No. 9, Landfill Pond
- SWMU No. 10, Fire Training Area
- SWMU No. 11, Spray Irrigation Area
- SWMU No. 12, API Separator

The process areas at the Refinery are divided into four geographic areas (Plate 4) for ease of reference.

Area 1 is located on the west end corner of the site and includes the following SWMUs:

- API Separator and Aeration Lagoons: The wastewater treatment system includes both the API separator and the aeration lagoons (formerly the south oily water pond [SOWP] and north oily water pond [NOWP]). The API separator is a double-chambered, steel reinforced concrete tank that acts as a physical separator of water and oil. Oil is skimmed in the separator and returned to the refinery process, water underflows a weir to the aeration lagoons, and sludge accumulates in the bottom. The aeration lagoons treat approximately 80 gallons per minute (gpm) of water.
- Former Drum Storage Area: The former drum storage area is either the north bone yard or the warehouse west of the refinery area where chemicals and lubricating oils used in the refinery processes were stored.

Area 2 of the Refinery consists of the main Aboveground Storage Tank (AST) farm and minimal underground piping.

- Underground Piping: Underground piping are thought to be located in geographic areas 2 and 3 and are grouped with the transport and loading product area and the AST farm.

Area 3 is the portion of the site to the south of Sullivan Road and includes the following solid waste management units:

- Transportation Terminal Sump: The transportation terminal sump was an earthen sump located to the south of the liquid propane gas (LPG) bullets in the southern portion of the refinery and was used as a truck cleaning area at one time. The area was backfilled with soil in 1986 and is no longer in use.
- Heat Exchanger Bundle (HEB) Cleaning Area: The HEB cleaning area is located to the south of Sullivan Road in a room on the east end of the auxiliary warehouse. The room is fully enclosed with sheet metal walls and a concrete floor. A concrete sump in the floor of the cleaning area collects sludges generated during cleaning of the bundles.
- Underground Piping: Underground piping are thought to be located in geographic areas 2 and 3 and are grouped with the transport and loading product area and the AST farm.

Area 4 includes the following units:

- Raw Water Ponds (formerly evaporation ponds): Prior to 1995, treated wastewater from the aeration ponds was transferred first to the south raw water pond, then into the north raw water pond, both of which are located to the east of the AST area. The earthen dikes and bottoms of the ponds are lined with four to six inches of bentonite. However, the raw water ponds were decommissioned in 1995 when the Class 1 injection well became operational.
- Landfill: The landfill is a low-lying area to the east of the process area where sludges and excavated soil from the aeration lagoons were placed in 1982.
- Fire Training Area: The fire training area is located to the east of the north raw water pond in the northeast corner of the site. The area is used to practice extinguishing fires similar to those that might occur at the Refinery and includes a fuel tank. Diesel, gasoline, and other fuels are used to set fires for training. The tanks and vessels are located throughout the training area. The fire training area is covered with gravel.
- Spray Irrigation Area: The spray irrigation area, a fenced 10-acre parcel of land, was located to the southeast of the refinery. This area received treated process wastewater from the raw water ponds that was sprayed through stationary sprinkler heads onto the flat, bermed irrigation area. Spray irrigation ceased in 1995 after the Class 1 injection well became operational.

SWMU No. 1: SOWP and NOWP

The Oily Water Ponds (SOWP and NOWP), now designated as the aeration lagoons (see Photos 1 and 8) were identified as a SWMU during a Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) conducted at the Giant Refining Company – Bloomfield Refinery (Bloomfield) in 1987, and were identified as a RCRA unit in September of 1990 with the new toxicity characteristic (TC) rule for benzene (D018). The aeration lagoons were designated as corrective action unit 12 for NMED - HMB *Annual Unit Audit for 1999 - Corrective Action Units* but are SWMU No. 1 for the purpose of this Plan. In some reports the aeration lagoons (formerly oily water ponds) are designated as SOWP and NOWP, in others, as SOWP, north oily water pond west (NOWP-W) and north oily water pond east (NOWP-E). For clarity's sake, in this Plan the aeration lagoon(s) will be given whatever designation is given in the supporting document. The reader can assume that when NOWP is given it includes both the W and E sections of the NOWP.

In 1982 the SOWP and the NOWP were cleaned out and lined with 100 mil high density polyethylene (HDPE) liners. The liquids were removed and were disposed of off-site. The solids and obviously impacted soils were land filled on-site in the landfill area (SWMU No. 8). A French drain system, consisting of a 4-inch diameter PVC perforated pipe draining to a nearby observation well, was installed beneath the ponds to detect leakage.

In an early investigation report, water samples taken from both aeration lagoons (SOWP and the NOWP) report no inorganics in the aqueous phase of the samples. However, metals were present in the high concentration phases of the south and northeast pond (SOWP: chromium [240 parts per million (ppm)], zinc [160 ppm] and lead [91 ppm]). Lower concentrations were found in the northeast pond sample as well as a concentration of aluminum (27,600 ppm). Numerous organic compounds were present in both aqueous and high concentration phases of the liquid sample as cited in the 1994 RFA.

Soil samples taken in 1985, in response to a closure plan for the units, were consistent with clean closure. During the 1987 Environmental Protection Agency (EPA) assessment, it was noted that migration of contaminants to soils, and surface and groundwater was minimized by the good condition of the liners, the absence of pond water overtopping, and the presence of the leak detection system. No further investigation or remediation was proposed at that time.

In September of 1990, BRC submitted a Part A application in response to the new TC rule for benzene. A Part B application was filed in September of 1991.

In 1990 the facility began using aerators in the SOWP and the NOWP, which averaged 91% removal of benzene concentrations. Additional aerators were added in May 1991 and July 1992. Monthly samples collected between August 1992 and February 1993 indicate non-detectable benzene concentrations in the effluent from the NOWP in five of the seven sampling events. Benzene was detected during the December 1992 and February 1993 samplings at 0.022 mg/l and 0.040 mg/l, respectively (RFI, Task I, March 1993; 19). Soil samples were collected on the perimeter of the site and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals. Based on soil sample results, Bloomfield recommended no further action (NFA) for this SWMU.

In 1992, in the Order of Consent, the NOWP and the SOWP were cited for having only one (1) down gradient monitoring well in place. Another source reports both MW-9 and MW-20 as monitoring the site. Both MW-9 and MW-20 are monitored quarterly. Also in 1992, BRC filed a closure plan for three surface impoundments: the SOWP, NOWP-W, and NOWP-E. No results were found regarding this filing.

In 1994 the SOWP and the NOWP were double lined to meet the minimal technical requirements for hazardous waste treatment impoundments.

SWMU No. 2, Former Drum Storage Area

The former drum storage area(s) (FDSA) (see Photo 2) was identified as a SWMU during a RFA conducted at the Giant Refining Company – Bloomfield Refinery (Bloomfield) in June 1987 and is designated as SWMU No. 2 for the purpose of this Plan. Several areas where drums were stored at the refinery were noted during the 1984 EPA inspection, including the north bone yard and warehouse yard. SWMU No. 2, Former Drum Storage Area, is either the area located north of the evaporation ponds and known as the north bone yard or is another storage area located in the warehouse yard in the south part of the refinery.

In the 1984 EPA inspection, the contents of several drums from the north bone yard and/or the warehouse yard were sampled and analyzed. Samples detected numerous organic compounds including aromatic solvents, chlorobenzene, 1,1,1 trichloroethane, and phenols. One drum showed levels of metals, including chromium (57.1 ppm), zinc (270 ppm) and arsenic (2.5 ppm). Samples from a drum in the transportation terminal detected very high levels of aromatic solvents (144,130 ppm), chlorobenzene (620 ppm) alkanes (48.7 ppm) and substituted benzene (90,000 ppm).

North Bone Yard

In July 1987, BRC removed the drums from this area and moved them to the area west of the refinery offices. Since that time, only empty drums have been stored in the bone yard. In April of 1988, BRC upgraded the drum storage areas and constructed the drum storage shed with curbed, concrete flooring a collection trough with covering on 3 sides. In December 1990, BRC further limited any potential for hazardous release from storage drums by converting to bulk storage.

Based on this, Bloomfield recommends NFA for this SWMU.

Warehouse Yard

Drum storage for materials used in the refinery processes had been consolidated in the warehouse yard, a fenced area, west of the refinery office.

SWMU NO. 3 Underground Piping

The NMED *Annual Unit Audit for 1999 Corrective Action Units* identified both SWMU 3 and 6 as the Underground Piping SWMU. The Underground Piping, SWMU 3 and 6, thought to be located in geographic area 2 or 3, are grouped with the transport and loading product area and AST farm. Product releases from the main AST farm, geographic area 2, are believed to be a source of subsurface contamination at the refinery. Although the underground piping is associated with the AST, the piping was not identified nor was the piping suspected to be a release location during the RFA conducted at the refinery in June 1987. However, during a RCRA facility investigation (RFI) conducted at Bloomfield in March 1993, two Underground Piping SWMUs are identified. One unit is in geographic area 2 Underground Piping (minimal) and another in geographic area 3, Underground Piping. (RFA, Section 1.4, Areas and Hazardous Waste Constituents of Concern, page 7). No additional information is provided in this RFI, or in records, correspondence, or in any regulatory documents such as the RCRA Part A or Part B, Corrective Measure Study, site maps or figures as to specific location or sampling and analysis results.

Therefore, Bloomfield recommends no further action for SWMU 3 and 6 because (1) uncertainty exists in correspondence, records and regulatory documents as to the existence of these SWMUs and (2) they cannot be located.

SWMU No. 4 Transportation Terminal Sump

The transportation terminal sump was identified as a SWMU during a RFA conducted at Bloomfield in June 1987 and is designated as SWMU No. 4 for the purpose of this Plan. At one time this area was used as a truck cleaning area. However, the sump was backfilled with soil in 1986 and has not been in use since that time.

In the1984 EPA sampling investigation, the water samples from this sump separated into an aqueous phase and a high concentration oily phase. Both water and soil samples were taken. Inorganic contaminants were detected in the soil (cadmium, 2.2 ppm), and in the oily portion of the water (chromium, 40 ppm; cadmium, 1.3 ppm) sample. Organic contaminants [polynuclear aromatics, aromatic solvents, alkanes, substituted benzenes, and unknowns (RFA Appendix F 1987)] were detected in both water and soil samples.

Two soil borings (B-1 and B-2) were subsequently installed in the area during the Phase II RFI. Samples were collected continuously from the surface to 12 feet at each location and screened with a PID. Samples were selected from the 2.5 – 4.5 foot interval from B-1, based on detectable PID reading (3.5 units), and from the 10-12 foot interval from B-2. Samples were analyzed for VOCs, SVOCs, total petroleum hydrocarbons (TPH) and PPM. No concentrations of the organic parameters were detected in either sample, and metal concentrations were within background ranges.

Because the sump was backfilled in 1986 and based on soil sample results, Bloomfield requests NFA for this SWMU.

SWMU No. 5, Heat Exchanger Bundle Cleaning Area.

The HEB Cleaning Area was identified as a SWMU during a RFA conducted at Bloomfield in June 1987 and designated as SWMU No. 5 for the purpose of this Plan. In the 1987 EPA Corrective Measure Evaluation (CME) the HEB Cleaning Area was identified as a potential SWMUs.

Heat exchanger bundles (see Photo 3) are periodically cleaned to remove scale deposits. Historically, cleaning was done in the process area and in an abandoned truck terminal located in the southern part of the refinery, geographic area 3.

The 1987 EPA inspection/assessment deemed it unlikely that the HEB cleaning area would be a source area for transmittal of hazardous constituents to soil, surface water, or groundwater because of the location and the good structural condition of the unit. The cleaning area is well outside the flood plain. The cleaning area is a fully enclosed room with sheet metal walls and a concrete floor. The sump in the cleaning area is approximately 4 feet wide, 50 feet long and 4 feet deep and covered by perforated steel plates. A concrete sump in the floor of the cleaning area collects sludge generated during cleaning of the bundles.

According to the 1987 Phase II RFA, the sump is cleaned once every 3 years and the cleaning sludge is shipped off site for disposal.

Monitoring well MW-13 is located down gradient (to the west) of this area. MW-13 was sampled during both of the Phase III RFA events, and no targeted VOCs or SVOCs were detected.

SWMU No. 6 Underground Piping

The NMED *Annual Unit Audit for 1999 Corrective Action Units* identified both SWMU 3 and 6 as the Underground Piping SWMU. The Underground Piping, SWMU 3 and 6, thought to be located in geographic area 2 or 3, are grouped with the transport and loading product area and AST farm. Product releases from the main AST farm, geographic area 2, are believed to be a source of subsurface contamination at the refinery. Although the underground piping is associated with the AST, the piping was not identified nor was the piping suspected to be a release location during the RFA conducted at the refinery in June 1987. However, during a RFI conducted at Bloomfield in March 1993, two Underground Piping SWMUs are identified. One unit is in geographic area 2 Underground Piping (minimal) and another in geographic area 3, Underground Piping. (RFA, Section 1.4, Areas and Hazardous Waste Constituents of Concern, page 7). No additional information is provided in this RFI, or in records, correspondence, or in any regulatory documents such as the RCRA Part A or Part B, Corrective Measure Study, site maps or figures as to specific location or sampling and analysis results.

Therefore, Bloomfield recommends no further action for SWMU 3 and 6 because (1) uncertainty exists in correspondence, records and regulatory documents as to the existence of these SWMUs and (2) they cannot be located.

SWMU NO. 7, Evaporation Ponds (north and south)

The Evaporation Ponds (north and south), formerly known as raw water ponds, were identified as a SWMU during a RFA conducted at Bloomfield in June 1987 and designated as SWMU No. 12 for the purpose of this Plan.

Prior to construction and startup of the Class I injection well, treated wastewater from the NOWP was transferred first to the south evaporation pond, and then to the north evaporation pond. The earthen dikes and the bottoms of the ponds are lined with 4-6 inches of bentonite. The units were inspected daily to insure no overtopping of the ponds occur. Water was removed from the ponds through evaporation or transferred to the spray irrigation area to the southeast of the refinery. Investigations done to determine the seepage rate of the ponds, groundwater and soil sampling and analysis indicate that water seeps from the ponds at a rate of approximately 10 to 20 gpm.

Monitoring Well 1 (MW-1) located north of the ponds is sampled on a semi-annual basis. Concentrations of hydrocarbon contamination historically have been low to non-detectable. MW-1 was sampled and analyzed during both events of the Phase III RFA and results indicated no detectable concentrations of targeted VOCs or SVOCs. Soil borings collected around the perimeter of the ponds were sampled for VOCs, SVOCs, and TPH. The results of this test indicate that no significant impact occurred.

In 1990 the evaporation ponds were included in the original Part A, but were withdrawn as a result of the subsequent sampling. In 1992 BRC confirmed through analysis that the water and sediments were not characteristically hazardous under current characteristic definitions.

These ponds were decommissioned in 1995 with the start up of the injection well and are no longer used.

SWMU No. 8, Landfill

The Landfill (see Photo 4) was identified as a SWMU during a RFI conducted at Bloomfield in June 1987 and designated as SWMU No. 8 for the purpose of this Plan.

In 1982 Plateau cleaned the aeration ponds (formerly SOWP and NOWP) to install a 100 mil synthetic HDPE liner. Approximately 90,000 gallons of sludge were removed by vacuum and disposed of in an offsite hazardous waste disposal facility. This sludge was mainly accumulated windblown dirt and debris. Visually contaminated soil from the Aeration Ponds was removed and disposed of in an unlined, dedicated on-site landfill in October 1984. Bloomfield assumed the contaminated soil was not hazardous based on testing. As part of subsequent closure activities, the contaminated soil, approximately 2,000 cubic yards, was excavated in November 1989 and stockpiled at the landfill area.

In April 1991 Bloomfield petitioned the EPA for an exclusion for this discrete volume of contaminated soil stored in the landfill area. Specifically, in its petition, Bloomfield requested that EPA grant a one-time exclusion for 2,000 cubic yards of excavated soil stored in the on-site waste pile. The soil was classified as K051-API separator sludge from the petroleum refining industry. Bloomfield petitioned the EPA to exclude this discrete volume of excavated soil because (1) they did not believe that the waste met the criteria for which listed and (2) they believed that the waste did not contain any other constituents that would render it hazardous.

In support of this petition, Bloomfield submitted: (1) descriptions of its wastewater treatment processes and the excavation activities associated with the petitioned waste; (2) results from total constituent analyses for the eight TC metals; (3) results from the Toxicity Characteristic Leaching Procedure (TCLP, SW-846 Method 1311) for the eight TC metals; (4) results from the Oily Waste Extraction Procedure (OWEP-SW-846 Method 1330) for the eight TC metals; (5) results from the Extraction Procedure

Toxicity Test (EP- SW-846 Method 1310) fro the eight metals listed in 40 CFR 261.24 from representative samples of the stockpiled waste; (6) results from the total oil and grease analyses from representative samples of the stockpiled waste; (7) test results and information regarding the hazardous characteristics of ignitability, corrosivity, and reactivity; and (8) results from total constituent and TCLP analyses for certain VOCs and SVOCS from representative samples of the stockpiled waste.

In making the delisting determination, EPA agreed with Bloomfield that the landfill waste is non-hazardous with respect to the original listing criteria and further determined that disposal in a Subtitle D landfill is the most reasonable scenario for Bloomfield's petitioned waste

SWMU No. 9, Landfill Pond

The Landfill pond was identified as a SWMU during a RFA conducted at Bloomfield in June 1987 and designated as SWMU No. 9 for the purpose of this Plan.

The NMED approved the closure plan for the landfill pond, January 1994. The approved plan for the landfill pond is contained in the *Final Closure Plan for the API Wastewater Ponds, Landfill, and Landfill Pond at the Bloomfield Refinery,* dated July 1986.

The landfill pond was a natural depression resulting from blockage of an existing arroyo during construction of the Hammond Ditch. Water in the landfill pond originated primarily from the Hammond Ditch, located just east and north of this area. Closure sampling included thirteen sediment samples collected from the landfill pond in 1985 at depths ranging from the sediment surface to 12 inches. Samples were analyzed for benzene, toluene, xylene, phenols, total lead, and total chromium. The only compound detected was benzene in one sample at a 1.3 µg/kg concentration.

SWMU No. 10, Fire Training Area

The fire training area (see Photo 5) was identified as a SWMU during the RFA conducted at Bloomfield in June 1987, and designated as SWMU No. 10 for the purpose of this Plan.

During the 1987 RFA, black oily stains were noted on the ground around several of the tanks holding diesel fuel, gasoline and other fuels that are used to set fires for training. While the fire training area is outside of the floodplain, the report notes that it has limited containment features and it is possible for runoff from this area to be transported to surface waters, including Hammond Ditch. It was also noted during the 1987 RFA that it is possible that organic compounds used during training exercises may leach to soil and groundwater.

In response to these concerns, four soil borings (designated B-7, B-8, B-9 and B-10) were installed in this area during the Phase II RFI in 1987. Samples were collected continuously from the surface between 10 and 12 feet at each location and were screened with a PID. No detectable PID readings were observed at the B-7, B-9, or B-10 locations, while one detectable PID reading (1 unit) was observed at the B-8 location. Samples were selected from the 6-8 foot interval based on a noted change in lithology in B-7 and the detectable PID reading in B-8. The 2-4 foot interval was selected from B-9 due to the nature of the suspected source (surface spills). The 10-12 foot interval was selected from B-10 due to a noted change in lithology (the surface changes from silty sand to clay and cobbles). Samples were analyzed for VOCs, SVOCs, TPH and PPM. No concentrations of VOCs, SVOCs or TPH were detected in any of the soil samples. Metal concentrations were within background ranges.

The Fire Training Area is an active site.

SWMU No. 11, Spray Irrigation Area

The spray irrigation area (see Photo 6) was identified as a SWMU during the RFA conducted at Bloomfield in June 1987 and designated as SWMU No. 11 for the purpose of this Plan.

Since 1981 wastewater from the north solar evaporation pond was applied to the 10 acre parcel in the southeast portion of the refinery. Noted in the 1984 Ground Water Discharge Plan the spray irrigation area, bordered by an earthen berm, was reportedly used primarily from March to October.

Soil samples were collected on the site in 1984 and analyzed for VOCs, SVOCs, and metals. The samples detected no organics in the soils. Water sampling from the monitoring well (MW-5) showed some metals as well as low levels of organic contaminants. Ethyl Benzene, xylene and alkanes were also detected.

The spray irrigation area was decommissioned in 1995 when the Class 1 injection well was put into service. No further action is proposed for the spray irrigation area.

SWMU No. 12, API Separator

The API Separator (see Photos 7 and 8) was identified as a SWMU during the RFA conducted at Bloomfield in June 1987 and became a RCRA regulated site in September of 1990 with the new hazardous waste listing for benzene (D018). The API separator is designated as SWMU No. 12 for the purpose of this Plan.

According to the 1987 RFA, the API separator was included in the 1980 Part A Hazardous Waste Permit Application because of its hexavalent chromium and lead levels (K051).

Sludge from the API separator has been sampled several times. In March 1982, the then owner, Plateau sampled the sludge on 5 separate occasions as part of its delisting petition. Sludges were analyzed for chromium for EPA toxic characteristics. Chromium levels were reportedly below EPA's maximum concentration of 50 mg/L for the metal (Stockham, 1982, cited in RFA, 1987).

In March of 1984 the EPA sampled the sludge from the API separator during its sampling investigation and analyzed it for both organics and inorganics. Numerous organics were present in the sample, as were detectable levels of metal.

During the 1987 visit the separator appeared to be in good structural condition. The RFA does mention concern regarding performance of the separator as sludge was reportedly carried into the first pond downstream. In response to this concern the facility cleans out the separator every two years and shipped offsite to a permitted hazardous waste disposal facility (HWDF).

During the 1987 visit the sludge was sampled and high levels of organic compounds and metals were detected in the sludge. Reactive sulfide levels of 4,300 ppm were present.

The API separator is an active unit at the refinery.

Photo 1
Aeration lagoons, facing north

Photo 2
Former drum storage area, facing north

Photo 3
A clean heat exchanger bundle at the <90 day storage unit, facing north

Photo 4
Old landfill and monitor well 8, facing north

Photo 5
Fire training area, facing northwest

Photo 6
Former spray irrigation area with overlying office buildings, facing southeast

Photo 7
API separator, facing west

Photo 8
API separator (foreground) and aeration lagoons (background), facing northeast

APPENDIX B
GTI VAPOR EXTRACTION/AIR SPARGING PILOT TEST

GTI conducted vapor extraction/air sparging pilot test as part of the Phase IV RFI. Previous submittals from GTI provide a complete discussion of the procedures and findings from this pilot test. The significant findings are listed below:

- Venting VEW-1S, a 2-inch well completed in a zone from 5–13 feet below grade, produced measurable induced vacuum in wells up to 57 feet away. At a maximum applied vacuum of 42 inches of water column, induced vacuum response was less than 0.19 inch, reflecting the low permeability clay characteristic of this zone. Maximum soil vapor flow from the test well was 115 standard cubic feet per minute (scfm). Calculated effective radii of influence for this shallow zone ranged from 2 feet (for removal of diesel products) to 36 feet (for removal of gasoline products).

- Venting VEW-1D, a 2-inch well completed in a zone from 16–26 feet below grade, produced measurable induced vacuum in wells 19–57 feet from the vent well. At a maximum applied vacuum of 21 inches of water column, the induced vacuum ranged from 1.9–4.0 inches. High permeability sands and gravel in the deep zone may account for the greater response to venting at this depth. Maximum soil vapor flow from the deep test well was 131 scfm. Calculated effective radii of influence for this deeper zone ranged from 3 feet (for removal of diesel products) to 84 feet (for removal of gasoline components).

- GTI evaluated saturated zone sparging effectiveness based on observed induced pressure and VOC concentrations while sparging at applied pressures of 3–5 psi. At 5 psi, maximum airflow into AS-1, a 2-inch diameter well, was 19.5 scfm. Based on observed pressure responses during the sparge test, GTI proposed a conservative value of 50 feet as the effective radius of influence.

- During the combined pilot test, GTI measured a net negative vacuum in all monitor points while venting at 18 inches of water column and sparging at 5 psi, approximately 120% above breakthrough pressure. This indicates that the vacuum system has the capacity to contain all vapors generated through sparging. Due to sparge pressure, the vacuum measured in the monitor points during the combined test was generally less than one-half of the vacuum measured while venting only.

- Hydrocarbon mass removal rates reached 0.20 lb/hr total fuel for venting in the shallow zone. Removal rates rose to 5.5 lb/hr total fuel while venting and sparging in the deep zone. Oxygen levels ranged from 4.3%–18% in the vented effluent. Concentrations of methane ranged from 18%–68%.

TABLE 3.5

WELL LOG FOR MONITORING WELL NUMBER 1

Drilling Date: February 8, 1984
Location: 29.11.27.24221

Depth in Feet	Description
0-5	Light brown clayey sand, coarse, poorly sorted, quartzose, and slightly calcareous
5-10	Yellowish gray sandy pebbles and cobbles, poorly sorted, rounded to subrounded
10-12	Yellowish gray pebbly sand, very coarse, poorly sorted, felospathic and noncalcareous
12-22	Dark gray pebbly and sandy cobbles, some quartz pebbles, most are volcanic, subrounded cobbles and pebbles, some clay, a little water at about 16 feet
22-25	Gray-green clayey sand becoming light yellow clayey sandstone and sandy claystone

TABLE 3.6

WELL LOG FOR MONITORING WELL NUMBER 2

Drilling Date: February 7, 1984
Location: 29.11.27.24321

Depth in Feet	Description
0-5	Light yellow brown silty sandy clay, very calcareous
5-10	Light yellow brown clayey sand, subrounded to subangular, moderately to poorly sorted, very calcareous
10-15	Light brown pebbly sand, clayey, very calcareous, cobbles at 15 feet
15-20	Gray sandy pebbles, poorly sorted coarse quartzose sand, pebbles are dark gray and volcanic
20-25	Dary gray cobbles, some quartz pebbles, mostly volcanic, some sand
25-26	Yellow gray clayey sandstone and sandy claystone

TABLE 3.7

WELL LOG FOR MONITORING WELL NUMBER 3

Drilling Date: February 8, 1984
Location: 29.11.27.24443

Depth in Feet	Description
0-5	Yellow brown sandy silt and clay, very calcareous quartzose
5-10	Yellow brown sand, calcareous, silty and clayey, quartzose
10-15	Yellow brown sand, silty and clayey, fine-grained, very calcareous, quartzose
15-27	Light brown clay, sandy, very clacareous, becoming pebbly with depth
27-35	Gray yellow brown cobbly sand, coarse, poorly sorted, silty and clayey, volcanic pebbles, small amount of water at about 35 feet
35-40	Gray cobbles, pebbly and sandy, coarse sand, yellow gray clayey sandstone at about 40 feet

TABLE 3.8

WELL LOG FOR MONITORING WELL NUMBER 4

Drilling Date: February 9, 1984
Location: 29.11.27.23344

Depth in Feet	Description
0-5	Yellow gray-brown sandy silt and clay, calcareous
5-10	Yellow brown silty sandy clay and clayey silt, very slightly calcareous
10-15	Reddish yellow-brown clayey sandy silt, silty clay, fine-grained quartzose sand, noncalcareous
15-19	Light brown coarse sand with clay and pebbles, calcareous
19-25	Gray pebbly sand, very coarse, poorly sorted, some clay and silt, subrounded to subangular, quartzose, pebbles rounded, slightly calcareous
25-30	Gray cobbles and pebbles, subrounded to rounded, volcanic; at about 28 feet, hydrocarbon smell and color
30-32	Gray cobbly sand, with hydrocarbon smell and color, coarse-grained, sand is quartzose and feldspathic, subrounded and subangular quartz grains are clear
32	Yellow gray clayey sandstone

TABLE 3.9

WELL LOG FOR MONITORING WELL NUMBER 5

Drilling Date: February 6, 1984
Location: 29.11.26.31112

Depth in Feet	Description
0-5	Pale yellow brown clay, silty, some sand, calcareous
5-10	Pale yellow brown clayey sand and quartzose silt, poorly sorted, calcareous
10-15	Yellow brown sand, subrounded quartzose sand slightly calcareous
15-20	Yellow brown sand, clayey, moderately coarse-grained, very calcareous
20-25	Yellow brown sand, clayey, silty, fine- to medium-grained, moderately sorted, noncalcareous
25-35	Yellow brown sand, silty and slightly clayey, fine- to medium-grained, well sorted, subangular, noncalcareous, becoming more clayey with depth
35-37	Yellow brown pebbly and cobbly sand, clayey, calcareous
37-47	Dark gray sandy and clayey cobbles and pebbles, water at 42 feet
47-50	Dark gray cobbles with greenish clay
50-54	Green-gray pebbly clay

TABLE 3.10

WELL LOG FOR MONITORING WELL NUMBER 6

Drilling Date: February 7, 1984
Location: 29.11.27.42144 or 42233

Depth in Feet	Description
0-15	Pale yellow brown sand, clayey and silty, subangular, poorly sorted, quartzose, very calcareous, becoming more clayey with depth
15-20	Pale yellow brown silt, sandy and clayey, silt is coarse, sand is very fine, moderate sorting, quartzose and calcareous
20-25	Pale yellow sand, slightly clayey, subrounded, well sorted, quartzose, noncalcareous
25-35	Pale yellow sand, coarse- to medium-grained, quartzose, noncalcareous
35-41	Pale yellow sand, clayey, fine-grained, silty, quartzose, slightly calcareous
41-49	Gray-black cobbles and pebbles, volcanic
49-52	Gray-green clayey sandstone and sandy claystone

TABLE 3.1

WELL LOG FOR MONITORING WELL NUMBER 7

Drilling Date: February 25

Depth in Feet	Description
0-1	Gravel fill
1-5	Brown sandy silt and clay with small gravels
5-10	Brown sandy silt and clay, more firm and sticky
10-15	Lighter brown sandy silt and sticky clay
15-20	Lighter brown sandy silt and clay, larger cobbles and pebbles
20-25	Sand with cobbles and pebbles
25-30	Sand
30-35	Greenish clay with pebbles, top of Nacimiento estimated at 32 feet
35-40	Greenish clay, few pebbles
40-45	Green to gray clay, smooth drilling
45-50	Green to gray clay, smooth drilling
50-65	Sticky gray to green clay

Elevation of Top of Pipe: 5524.09 feet

Total Depth of Casing: 62.11 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap, followed by a 10 foot section of 6" I.D. stainless steel screen, in turn followed by 6" I.D. schedule 40 PVC casing to the top of pipe. Sand was added to 45 feet below grade, bentonite to 41 feet below grade, and grout to the surface.

TABLE 3.2

WELL LOG FOR MONITORING WELL NUMBER 8

Drilling Date: February 28, 1986

Depth in Feet	Description
0-20	Light brown sandy clay, similar to that found on the ground surface
20-34	Cobbles and pebbles
34	Green-gray clay and sandstone, intermixed with small pebbles and sand. Top of Nacimiento.

Elevation of Top of Casing: 5531.12 feet

Total Depth of Casing: 34.94 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap, followed by 20 feet of 6" I.D. stainless steel screen, followed by 6" I.D. schedule 40 PVC to the surface. The screened section of the hole was sanded to within 7 feet of the surface, a bentonite seal (1/2 bucket) was added and concrete was used for a surface seal.

TABLE 3.3

WELL LOG FOR MONITORING WELL NUMBER 9

Drilling Date: March 3, 1986

Depth in Feet	Description
0-5	Fill material, some rock
5-10	Sticky reddish brown silty clay
10-15	Lighter color silty clay, some pebbles
15-20	Lighter color silty clay, some pebbles
20-25	Cobbles, pebbles, sand
25-30	Cobbles, greenish clay, top of Nacimiento

Elevation of Top of Casing: 5519.70 feet

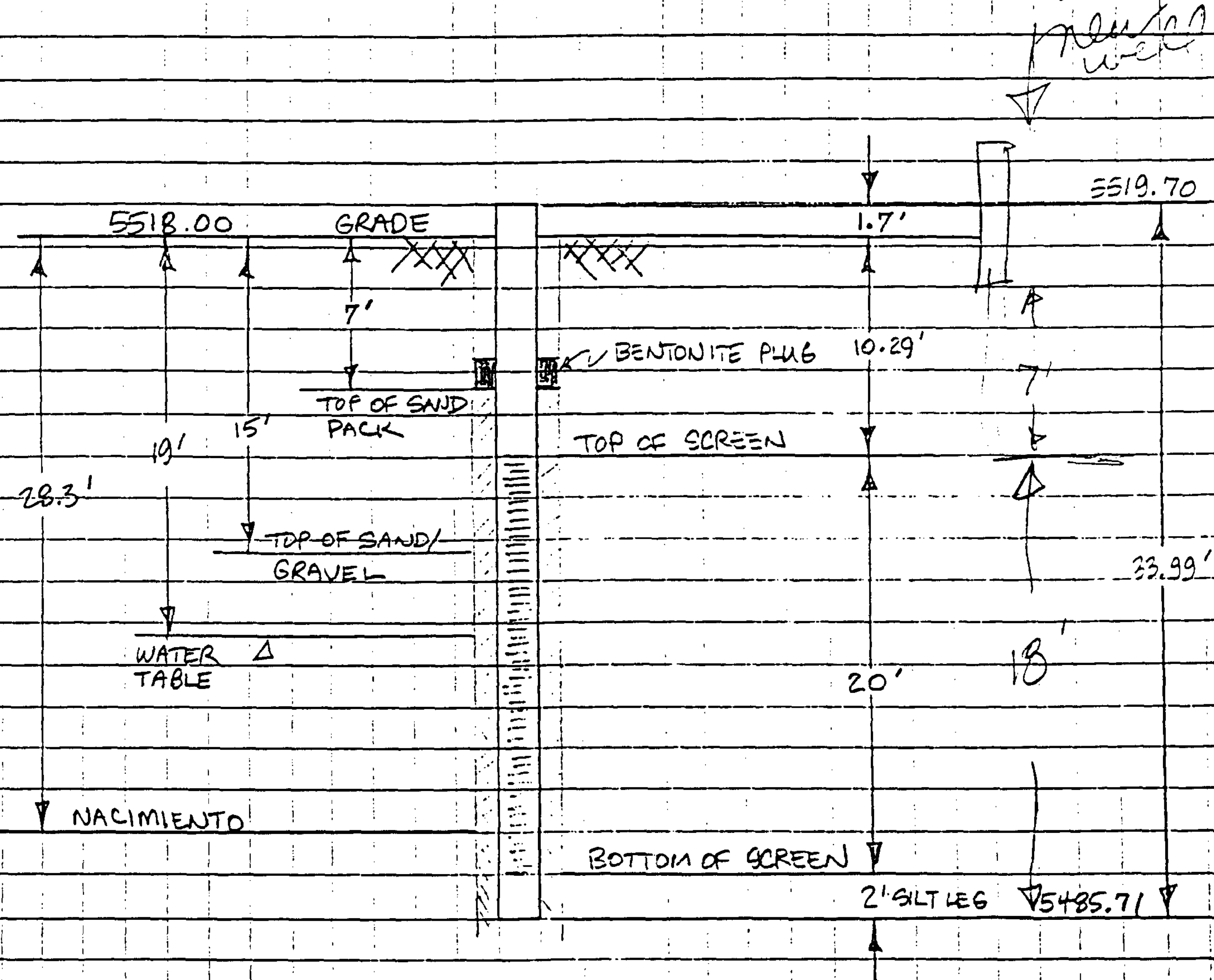
Total Depth of Casing: 33.99 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap followed by 20 feet of 6" I.D. stainless steel screen, followed by 6" I.D. schedule 40 PVC to the surface. The screened section of the hole was sanded to within 7 feet of the surface, a bentonite seal (1/2 bucket) was added and concrete was used for a surface seal.

CALCULATION SHEET MW-9

CONSTRUCTION COMMENTS: DRILLED UTILIZING DRILLING MUD THEN THOROUGHLY DEVELOPED. BOTTOM OF CASING TO THE TOP OF SCREEN IS 6" I.D. STAINLESS STEEL, REST OF CASING TO SURFACE IS 6" SCH. 40 PVC. TOP OF CASING HAS CONCRETE SURFACE SEAL AND STEEL PIPE, WITH LOCKING LID, CASING PROTECTOR (NOT SHOWN).

LOCATION: NEAR TANK 5, NORTHWEST OF NOWP.



INITIALS CA PROJECT No. GROUNDWATER MONITORING - SOWF & NOWF

DATE 9-17-91 SUBJECT MW-9

DATE OF INSTALLATION: 3-3-86 SHEET 1 OF 1

TABLE 3.4

WELL LOG FOR MONITORING WELL NUMBER 10

Drilling Date: March 4, 1986

Depth in Feet	Description
0-5	Topsoil, roadbase, reddish brown sandy clay
5-10	Reddish brown silty, sandy clay
10-15	Cobbles, pebbles
15-20	Gravel, cobbles, pebbles
20-25	Greenish clay at 23 feet, top of Nacimiento
25-30	Greenish clay, Nacimiento
30-35	Nacimiento, color changed from yellow-green to blue-gray

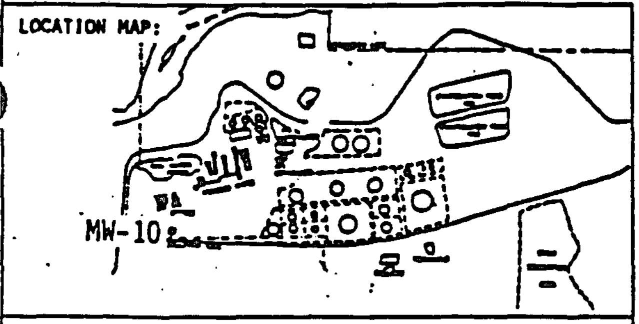
Elevation of Top of Casing: 5516.86 feet

Total Depth of Casing: 33.93 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap, followed by 20 feet of 6" I.D. stainless steel screen, followed by 6" I.D. schedule 40 PVC to the surface. The screened section of the hole was sanded to within 7 feet of the surface, a bentonite seal (1/2 bucket) was added and concrete was used for a surface seal.

LITHOLOGIC LOG (SOIL)

LOCATION MAP:



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: MW-10 (RW-3)
SITE COORDINATES (ft.):
N ___ E ___
GROUND ELEVATION (ft. MSL): ~5516
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Auger
DRILLING CONTR.: Earl & Sons, Inc.
DATE STARTED: 4 March 1986 DATE COMPLETED: 4 March 1986
FIELD REP.: Engineering-Science, Inc.
COMMENTS:

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-5' Topsoil, Roadbase, Sandy Clay
5					5'-10' Silty, Sandy Clay
10					10'-15' Cobbles and Pebbles
15					15'-20' Gravel, Cobbles, and Pebbles
20					20'-30' Green Clay: Nacimiento Formation
25					30'-35' Nacimiento Formation - Yellow-green to blue-gray.
30					
35		T.D. 35'			
40					
45					

LITHOLOGIC LOG

LOCATION MAP:

___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: BRC-11

SITE COORDINATES (ft.):

N ________ E ________

GROUND ELEVATION (ft. MSL): ________

STATE: NEW MEXICO COUNTY: SAN JUAN

DRILLING METHOD: AIR CASING DRIVER ROTARY

DRILLING CONTR.: BEEMAN

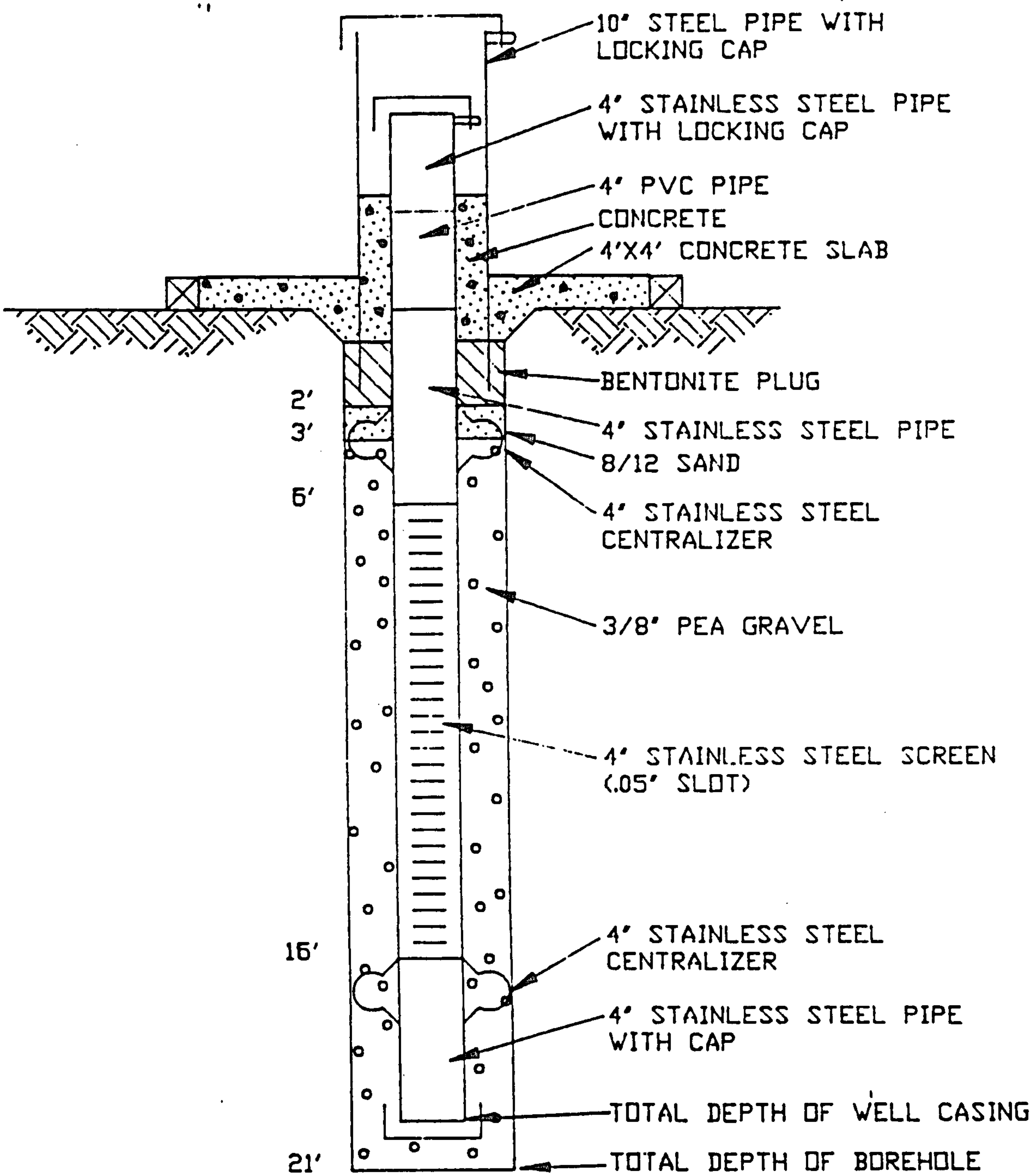
DATE STARTED: 7-31-87 DATE COMPLETED: 7-31-87

FIELD REP.: KASZUBA/SELKE

COMMENTS: STEAM CLEANED RIG AND ALL TOOLS PRIOR TO DRILLING.

LOCATION DESCRIPTION: TD-21'

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
5				0- 5'	0 - 5' SAND, mod yelsh brn (10YR5/4), fine to med. gr. sand w/minor crs gr. sand and pebble gravel (up to 1"). Unconsolidated, moderately well sorted, subrounded, no odor.
10				5-10'	5 -10' GRAVELLY SAND, olive gray (5Y4/1), fine to med. gr. sand w/minor crs gr. sand unconsolidated, mod. well sorted, subrounded, gravel clasts (½" to 2") subrounded. Moderate degradation odor.
15				10-12½'	10 -12.½' SANDY CLAY, lt. olive gray (5Y5/2), fine to med. gr. sand in clay matrix no odor.
				12½-15'	12½-15' SANDY CLAY, as above.
20				15-21'	15 -21' SANDY CLAY, yelsh gray (5Y7/2), fine gr. sand in clay matrix, clay chips up to 1½" from moderately consolidated clay (or weathered shale).
25					NOTE: Saturation from ~7-8' to ~12½'
30					
35					
40					
45					
50					



MONITOR WELL BRC-11

LITHOLOGIC LOG

LOCATION MAP:

___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: BRC-12

SITE COORDINATES (ft.):

N ______ E ______

GROUND ELEVATION (ft. MSL): ______

STATE: NEW MEXICO COUNTY: SAN JUAN

DRILLING METHOD: AIR CASING DRIVER ROTARY

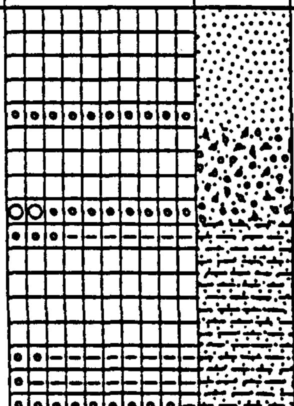
DRILLING CONTR.: BEEMAN BROTHERS

DATE STARTED: 8-1-87 DATE COMPLETED: 8-1-87

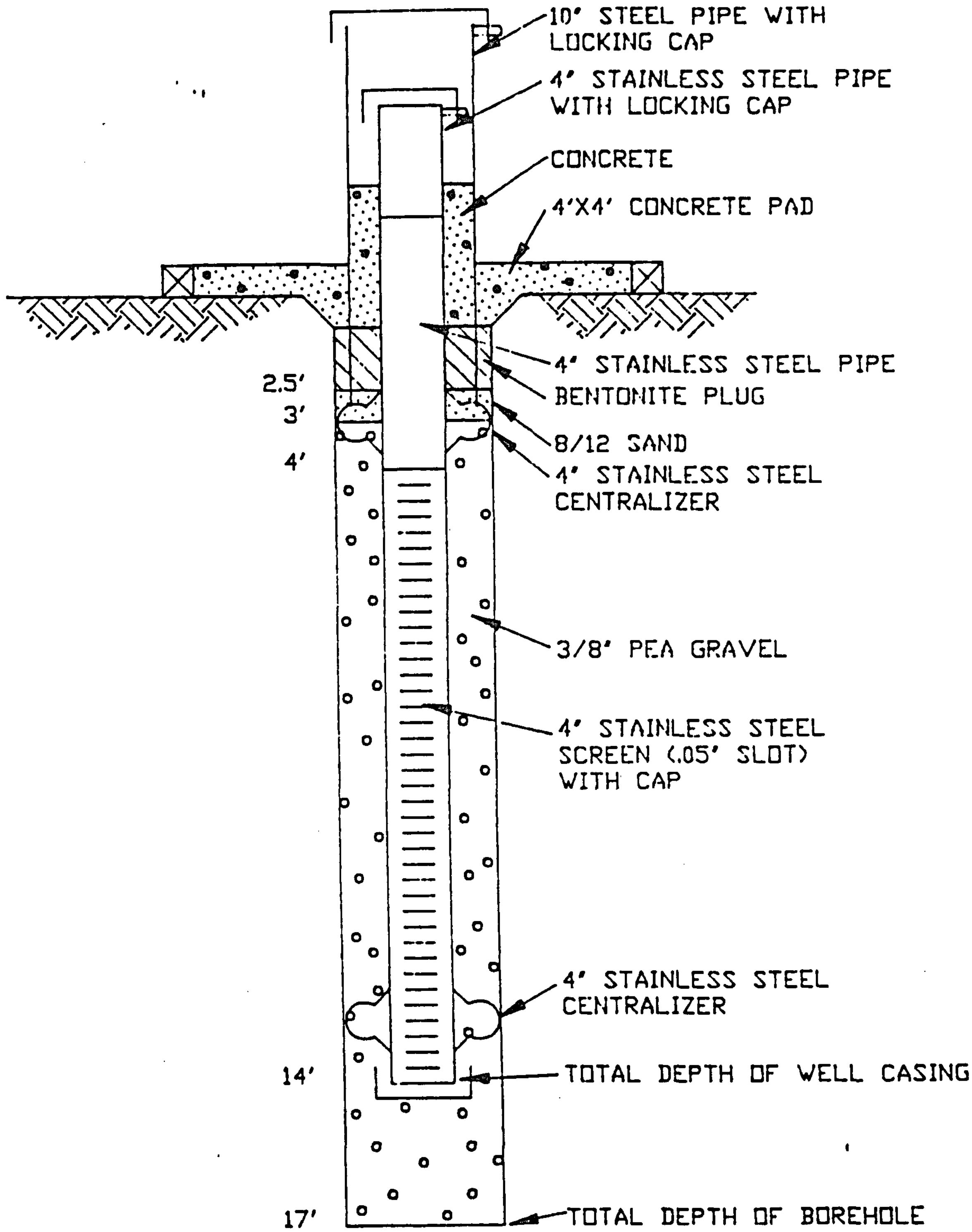
FIELD REP.: KASZUBA

COMMENTS: SATURATED FROM ~5'--12'. TD=17'. STEAM-CLEANED ALL TOOLS PRIOR TO DRILLING.

LOCATION DESCRIPTION: ______



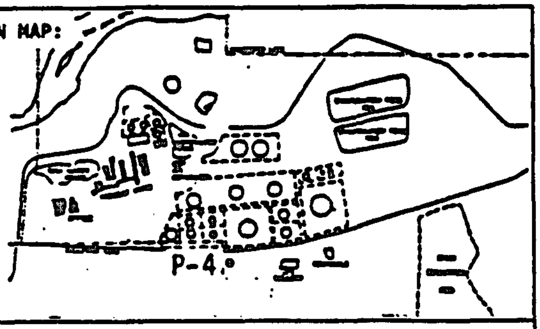
Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
5				0- 5'	0- 5' SAND, mod yellowish brwn (10YR5/4), fine-to med-grained sand, unconsolidated, well-sorted, subrounded. No HC odor. Saturated @ ~5'.
				5- 9'	5- 9' SAND, as above. Saturated. Gravelly sand @ 9'. Subrounded gravel, 2" dia.
10				9-10'	9-10' SANDY CLAY, dusky yellow (5Y6/4), fine-to med-gr sand in clay matrix. No HC odor. Saturated.
				10-15'	10-15' SANDY CLAY, as above. Minor chips of clay (shale), ~10%. Saturated to ~12'.
15				15-16'	15-16' SANDY CLAY, as above. Clay chips up to ¼" (moderately consolidated clay or weathered shale). Contains <10% gypsum. No HC odor.
				16-17'	16-17' CLAYEY SAND, dusky yellow (5Y6/4), sand is fine-grained, well-sorted, No HC odor.
20					
25					
30					
35					
40					
45					
50					



MONITOR WELL BRC-12

LITHOLOGIC LOG (SOIL)

LOCATION MAP:

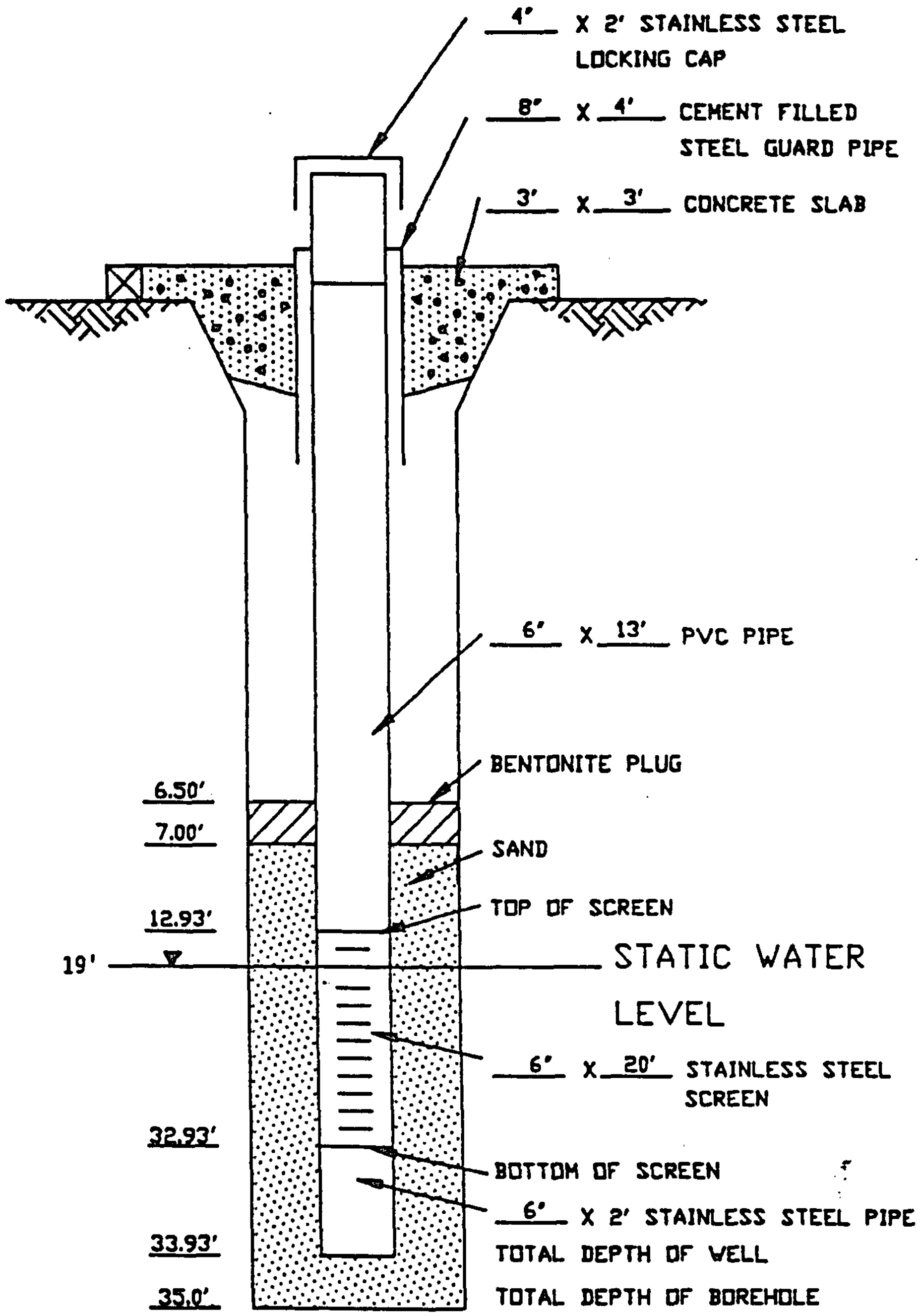


___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC   LOCATION ID: P-4 (MW-13)
SITE COORDINATES (ft.):
N ______ E ______
GROUND ELEVATION (ft. MSL): 5538.42
STATE: New Mexico   COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 2 September 1988   DATE COMPLETED: 3 September 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 9, 1988; 37.91' from TOC.

LOCATION DESCRIPTION: ______

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-27' Silt and Clay - Moderate brown (5 YR 4/4) to light brown (5 YR 5/6).
5					
10					
15					
20					
25			1233		27'-30' Sand - Very pale or (5 YR 8/2) fine to coarse grained, angular to subangular predominantly quartz.
30					30'-40' Gravel and Sand - Light gray (N7). Sand is medium to coarse grained, subrounded to rounded. Gravel is subangular to rounded, up to 3" diameter.
35					
40			1415		41'-43' Clay - Pale olive (10 Y 6/2), plastic.
					43'-45' Gravel and Sand - As above.
45			1420		45'-51' Shale: Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2).
50					
		T.D. 51'	1455		



COMPLETION DIAGRAM
RECOVERY WELL MW-13 (RW-3)
(RECONSTRUCTED FROM VERBAL DESCRIPTION
SUPPLIED BY ENGINEERING-SCIENCE, 1987)

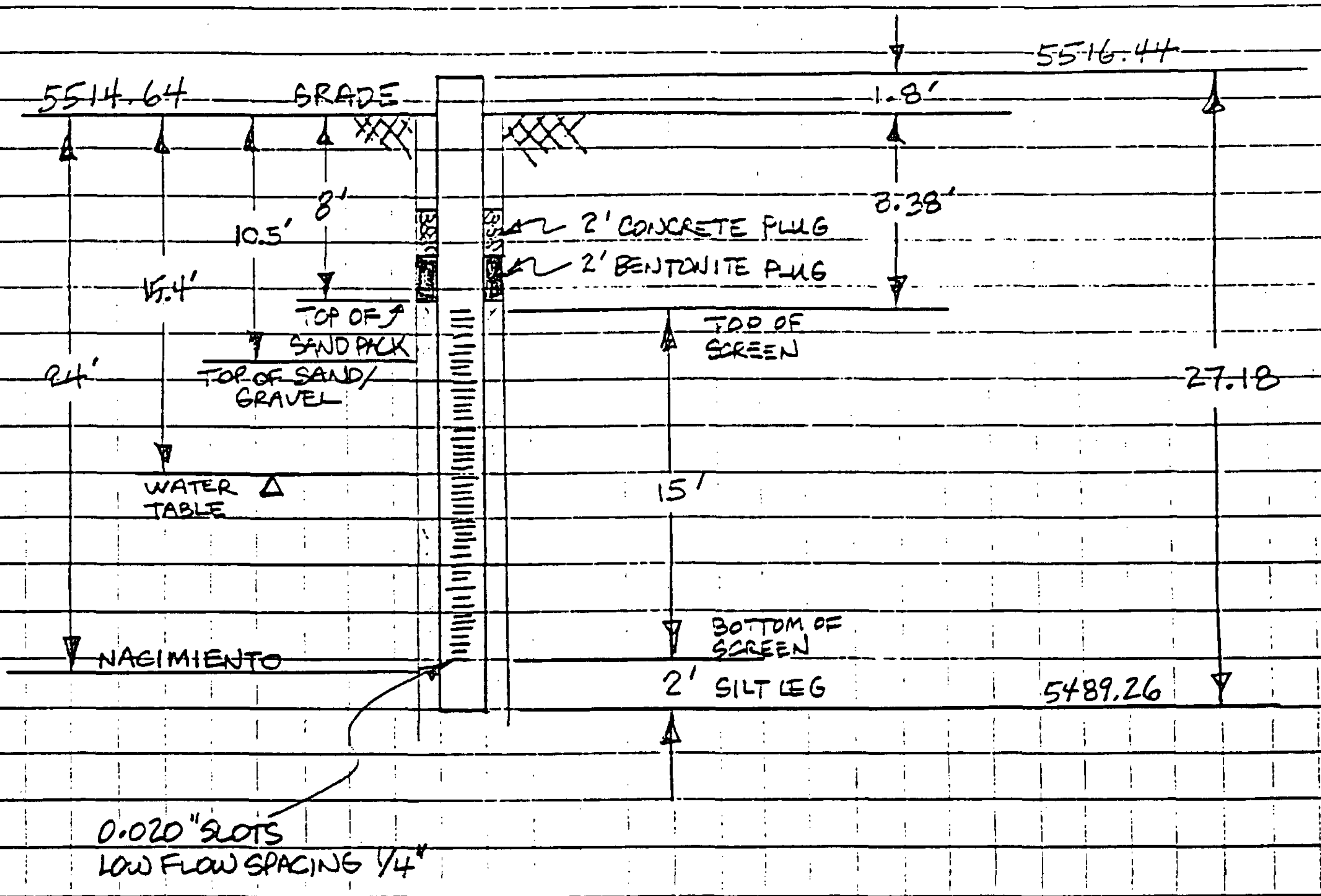
MW-20

CALCULATION SHEET

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLASS CASING SET TO DEPTH INSIDE DRIVEN CASING; ANNULAR SPACE FILLED WITH 30/40 SAND AS DRIVEN CASING REMOVED; 50 LBS. OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE.

LOCATION: NORTH SIDE OF NOWP-CENTERED.

CONCRETE PAD SURFACE SEAL (NOT SHOWN)



INITIALS CLA PROJECT No. GROUNDWATER MONITORING - SOWP & NOWP

DATE 9-16-91 SUBJECT MW-20

DATE OF INSTALLATION: 9-13-91 SHEET 1 OF 2

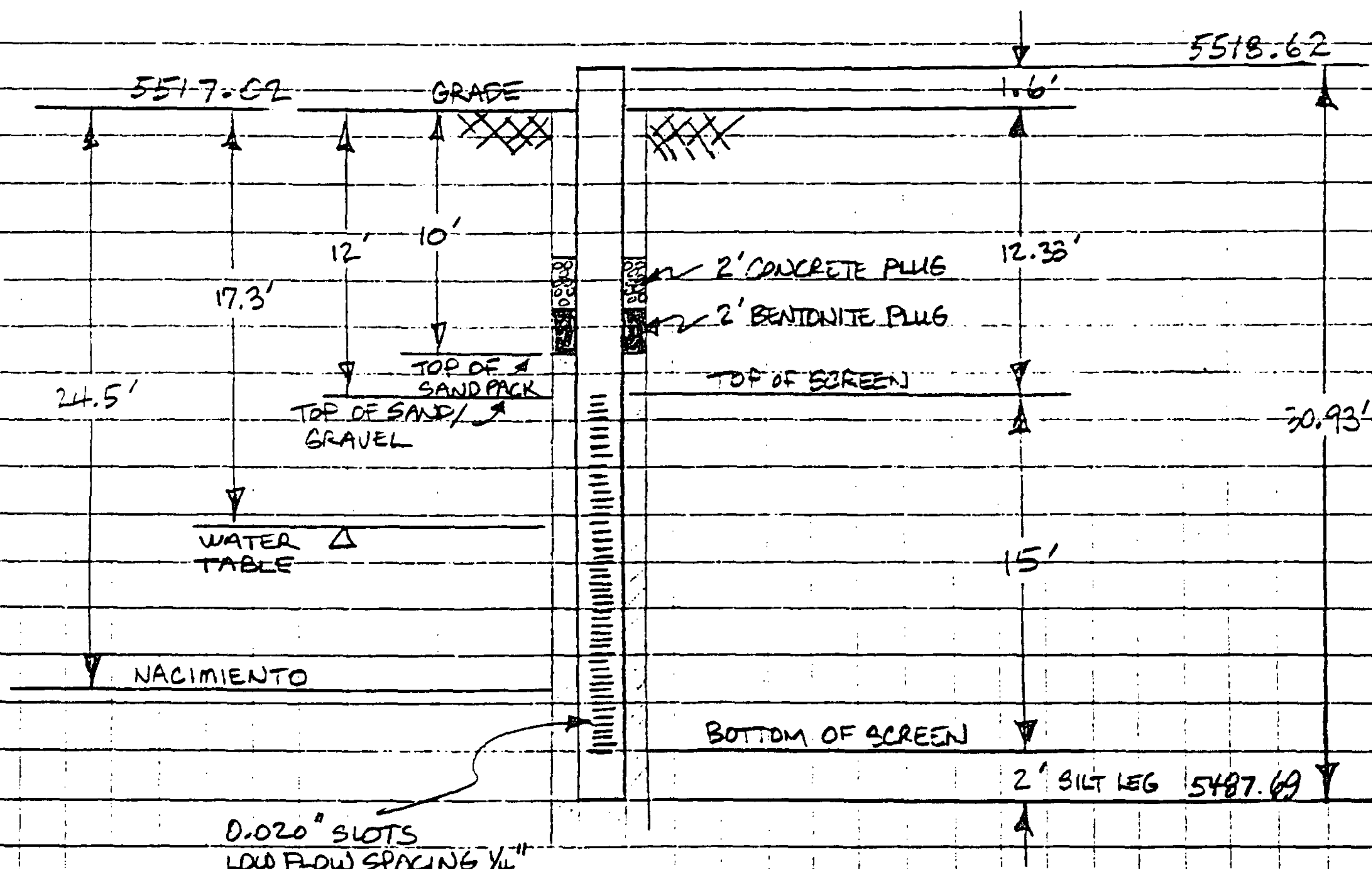
CALCULATION SHEET

MW-21

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLASS CASING SET TO DEPTH INSIDE DRIVEN CASING; ANNULAR SPACE FILLED WITH 30/40 SAND AS DRIVEN CASING REMOVED; 50 LBS OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE.

LOCATION: ALONG PIPERACK SW FROM TK 11

CONCRETE PAD SURFACE SEAL (NOT SHOWN)



INITIALS: CH   PROJECT No. GROUNDWATER MONITORING - SOWP & NOWP

DATE: 9-16-91   SUBJECT: MW-21, UPGRADIENT FROM SOWP & NOWP

DATE OF INSTALLATION: 9-16-91   SHEET 2 OF 2

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well MW-25

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5527.45 Total Hole Depth 38 ft. Diameter 11 in.
Top of Casing 5530.45 Water Level Initial 28 ft. Static
Screen: Dia 6 in. Length 14 ft. Type/Size FRE 0.020 in.
Casing: Dia 6 in. Length 24/2 ft. Type FRE
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/11/94 Permit #
Checked By License No.

See Site Map
For Boring Location

COMMENTS:

Start @ 1000 hrs. 2 ft. silty leg instaled from 36 feet to 38 feet.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0 – 6	0 (at 5 ft)			ML	Brown clayey SILT (dry-moist)
6 – 10.5	0 (at 10 ft)			SM/SC	Brown fine poorly-graded silty/clayey SAND (moist)
10.5 – 24	0 (at 15 ft); 0 (at 20 ft)			SP	Tan fine poorly-graded SAND (moist)

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well **MW-25**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24						SP	
		120					
26						SP / GM	Tan fine-coarse, poorly-graded SAND with gravel and cobbles (moist)
							Dark gray-stained at 28 feet.
28							*Groundwater encountered at 28 feet 5/11/94*
30		550					Dark gray-stained cobbles (little fines)
						GP	
32							
34						CL	Brown silty clay lens at 34 feet (moist)
						SP	Tan very fine poorly-graded SAND (dry)
							Encountered weathered limestone at 35 feet (dry)
36							
38							End of boring at 38 feet (1110 hrs.). Installed well screened from 22 to 36 feet on 5/11/94.
40							
42							
44							
46							
48							
50							
52							
54							
56							

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Well MW-26

Project: BRC	Owner: Bloomfield Refining Co.
Location: 50 County Road 4990, Bloomfield, New Mexico	Proj. No. 023353014
Surface Elev. 5512.54	Total Hole Depth 23 ft.
Diameter 15 in.	Top of Casing 5514.54
Water Level Initial 15 ft.	Static
Screen: Dia 6 in.	Length 14 ft.
Type/Size FRE 0.020 in.	Casing: Dia 6 in.
Length 9/2 ft.	Type FRE
Fill Material 10/20 Co. Silica	Rig/Core Drill Systems 180
Drill Co. Layne	Method Air Percussion
Driller Gabby Rodriquez	Log By Jerry May
Date 05/12/94	Permit #
Checked By	License No.

See Site Map For Boring Location

COMMENTS:

Start @ 0730 hrs. Silt leg installed from 21 feet to 23 feet.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0				SM	Tan fine poorly-graded silty SAND (moist)
5	22			SP	Tan fine poorly-graded SAND (moist)
8				SP	Tan fine-coarse SAND with a little pea gravel and cobbles (dry)
10	37				
11				GP	Cobbles with some fines (dry)
13				SP	Tan fine-coarse poorly-graded SAND (dry)
14				GP	Gray-stained cobbles with some fines dry-wet
15					*Groundwater encountered at 15 feet on 5/12/94*
16					Dark gray-stained silty clay lens at 16 feet
19					Dark gray-stained silty clay lens at 19 feet
20					Encountered weathered limestone (moist)
22					Dry at 22 feet
23					End of boring at 23 feet (0820 hrs.). Installed well screened from 7 to 21 feet on 5/12/94.

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well MW-28

Project BRC Owner Bloomfield Refining Co.

Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014

Surface Elev. 5521.52 Total Hole Depth 33 ft. Diameter 10 in.

Top of Casing 5524.52 Water Level Initial 25 ft. Static

Screen: Dia 4 in. Length 15 ft. Type/Size FRE 0.020 in.

Casing: Dia 4 in. Length 20/2 ft. Type FRE

Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180

Drill Co. Layne Method Air Percussion

Driller Gabby Rodriguez Log By Jerry May Date 05/13/94 Permit #

Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 1020 hrs. Installed silt leg from 33 to 35 feet.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0						SM	Tan fine poorly-graded silty SAND (dry-moist)
4		124				SM	Gray-stained/tan fine poorly-graded silty SAND (moist)
8		452				CL	Black-stained silty CLAY (moist)
12		365				SM	Tan fine poorly-graded silty SAND (moist)
17		333				SP/GM	Tan fine-coarse poorly-graded SAND with gravel and cobbles
24		2507					

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Well **MW-28**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		2507					(Dark gray-stained at 24 feet)
		3226					∇ *Groundwater encountered at 25 feet on 5/13/94*
26							
28						SP/GM	
30							
32							Encountered weathered limestone
		174					
34							
							End of boring at 35 feet (1100 hrs). Installed well screened from 18 to 33 feet on 5/13/94.
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

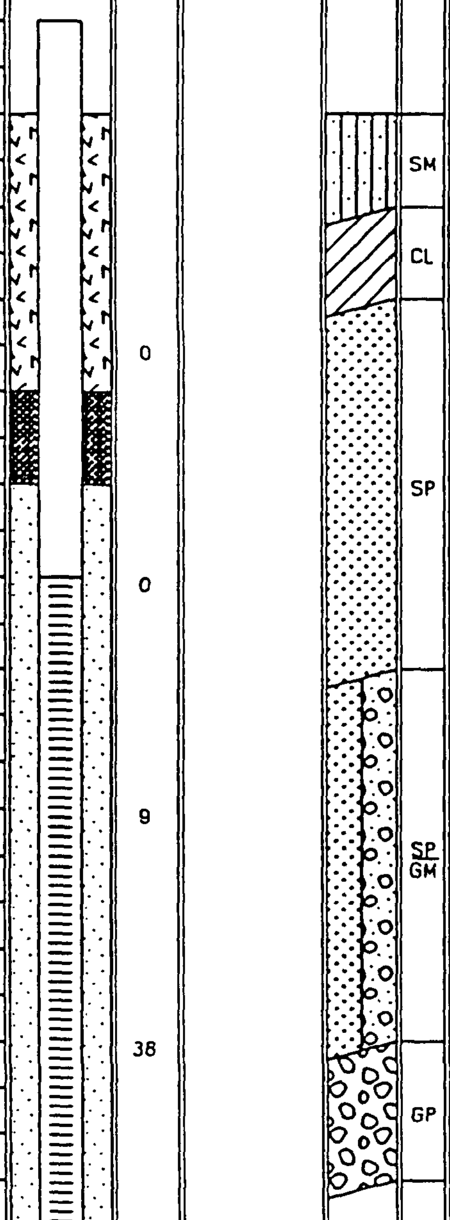
Monitoring Well MW-29

Project: BRC	Owner: Bloomfield Refining Co.
Location: 50 County Road 4990, Bloomfield, New Mexico	Proj. No. 023353014
Surface Elev. 5518.55	Total Hole Depth 26 ft.
Diameter 10 in.	Top of Casing 5521.55
Water Level Initial 20 ft.	Static
Screen: Dia 4 in.	Length 14 ft.
Type/Size FRE 0.020 in.	Casing: Dia 4 in.
Length 12/2 ft.	Type FRE
Fill Material 10/20 Co. Silica	Rig/Core Drill Systems 180
Drill Co. Layne	Method Air Percussion
Driller Gabby Rodriguez	Log By Jerry May
Date 05/12/94	Permit #
Checked By	License No.

See Site Map For Boring Location

COMMENTS:

Start @ 1445 hrs. Installed silt leg 24 to 26 feet.



Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0				SM	Tan fine poorly-graded silty SAND (moist)
2				CL	Tan silty CLAY (moist)
4				SP	Tan fine poorly-graded SAND (moist)
5	0				
10	0				
12				SP GM	Tan fine-coarse poorly-graded SAND with gravel and cobbles
15	9				
20	38				*Groundwater encountered at 20 feet on 5/12/94*
21				GP	Cobbles with some fines (wet)
23					Encountered weathered limestone (dry)

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Well MW-29

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
26							End of boring at 26 feet (1510 hrs). Installed well screened from 10 to 24 feet.
28							
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well MW-30

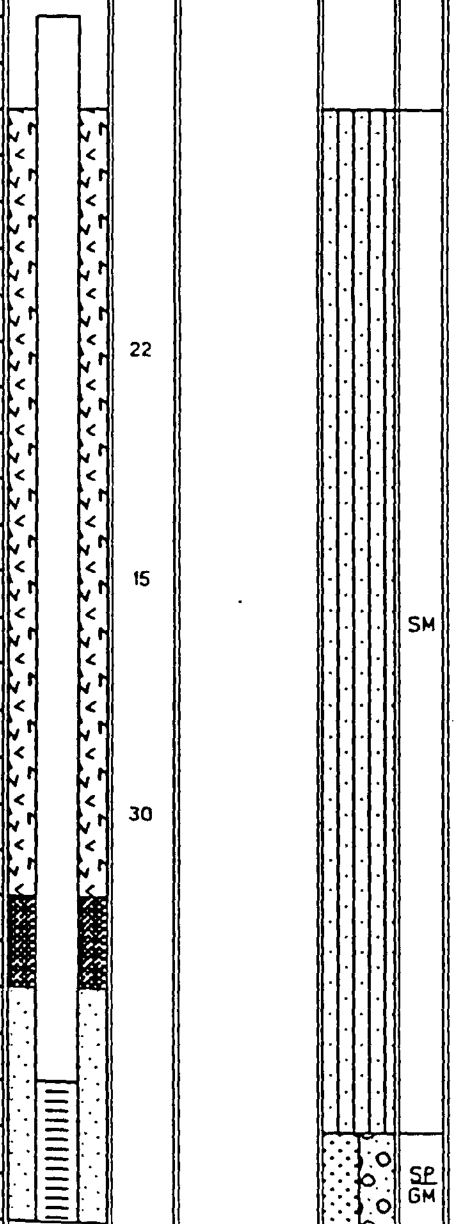
Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5530.42 Total Hole Depth 38 ft. Diameter 10 in.
Top of Casing 5533.42 Water Level Initial 31 ft. Static
Screen: Dia 4 in. Length 15 ft. Type/Size FRE 0.020 in.
Casing: Dia 4 in. Length 23/2 ft. Type FRE
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriquez Log By Jerry May Date 05/13/94 Permit #
Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 0720 hrs. Installed silt leg from 36 to 38 feet.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Tan fine poorly-graded silty SAND (moist)
2							
4							
5		22					(Same as above)
6							
8							
10		15					(Same as above)
11						SM	
12							
14							
15		30					(Same as above)
16							
18							
20							
22							Tan fine-coarse poorly-graded SAND with pea gravel and co
23						SP GM	
24							



Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well **MW-30**

Project BRC — Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico — Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
25		62					(Same as above)
27						SP / GM	
30		620					Dark gray-stained cobbles with some fines (moist-very moist)
31							▽ *Assume groundwater encountered at 31 feet on 5/13/94*
32						GP	
34							(Some clay and silt at 34 feet)
35		203					Encountered weathered limestone (dry)
38							End of boring at 38 feet (0800 hrs). Installed well screened from 21 to 36 feet.

Depth scale: 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well MW-31

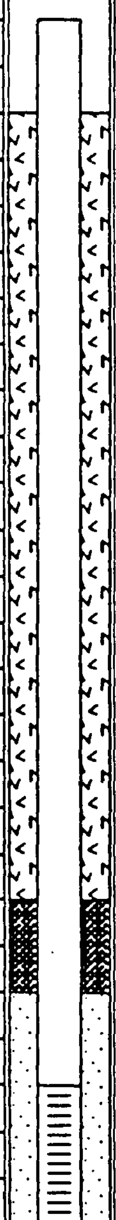
See Site Map
For Boring Location

Project BRC   Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico   Proj. No. 023353014
Surface Elev. 5530.17   Total Hole Depth 37 ft.   Diameter 10 in.
Top of Casing 5532.17   Water Level Initial 30 ft.   Static
Screen: Dia 4 in.   Length 14 ft.   Type/Size FRE 0.020 in.
Casing: Dia 4 in.   Length 23/2 ft.   Type FRE
Fill Material 10/20 Co. Silica   Rig/Core Drill Systems 180
Drill Co. Layne   Method Air Percussion
Driller Gabby Rodriguez   Log By Jerry May   Date 05/12/94   Permit #
Checked By   License No.

COMMENTS:

Start @ 1200 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Tan fine poorly-graded silty SAND (moist)
2							
4							
		NA					
6							
						SM	
8							
10		0					
12							
14							Tan fine poorly-graded SAND (moist)
		0					
16							
18							
						SP	
20		119					
22							
24							



Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well **MW-31**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
		85				SP	
26							Fine-coarse poorly-graded SAND with gravel and cobbles (moist)
28						SP GM	
30		91					▽ *Groundwater encountered at 30 feet on 5/12/94.*
							Gray-stained cobbles with a little fines (wet)
32		2026				GP	(Dark gray-stained at 32 feet)
34							Encountered weathered limestone (moist-dry)
		539					
36							
							End of boring at 37 feet (1225 hrs). Installed well screened from 21 to 35 feet on 5/12/94.
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

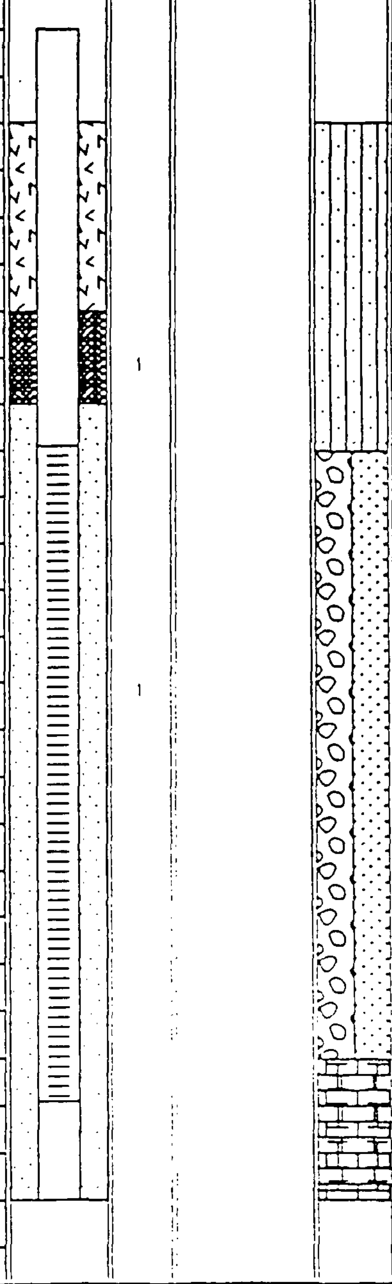
Monitoring Well MW-33

Project	Bloomfield Refining Company
Owner	Bloomfield Refining Company
Location	50 County Road 4990, Bloomfield, NM
Proj. No.	023353014
Surface Elev.	5515.86
Total Hole Depth	23 ft.
Diameter	9 in.
Top of Casing	5518.46
Water Level Initial	19 ft.
Static	Dry ft.
Screen: Dia	4 in.
Length	14 ft.
Type/Size	FRE/0.020 in.
Casing: Dia	4 in.
Length	11.6 ft.
Type	FRE
Fill Material	10/20 Silica Sand
Rig/Core	Drill Systems 180
Drill Co.	Layne
Method	Air Hammer Percussion
Driller	G. Rodriguez
Log By	E. Shannon
Date	02/23/95
Permit #	
Checked By	ELS 3-14-95
License No.	

See Site Map For Boring Location

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							0-7 ft.: Brown medium to fine SAND, little silt, little coarse to fine gravel, occasional cobbles, dry.
2							
4						SM	
5		1					
6							
7							7-20 ft.: Coarse to fine GRAVEL/COBBLES, some coarse to fine well graded sand, trace silty, dry.
8							
10							
12		1					
13						GP/SP	
14							
16							
18							
19						▽	*Cuttings damp at 19'*
20							20-22.8 ft.: Tanish brown SILT/weathered LIMESTONE, dry.
22							
22.8							22.8-23 ft.: Gray LIMESTONE, weathered, dry.
24							End of boring at 23 feet. Set MW-33 with screened interval from 6.9-20.9 feet below grade.



Drilling Log

GROUNDWATER TECHNOLOGY

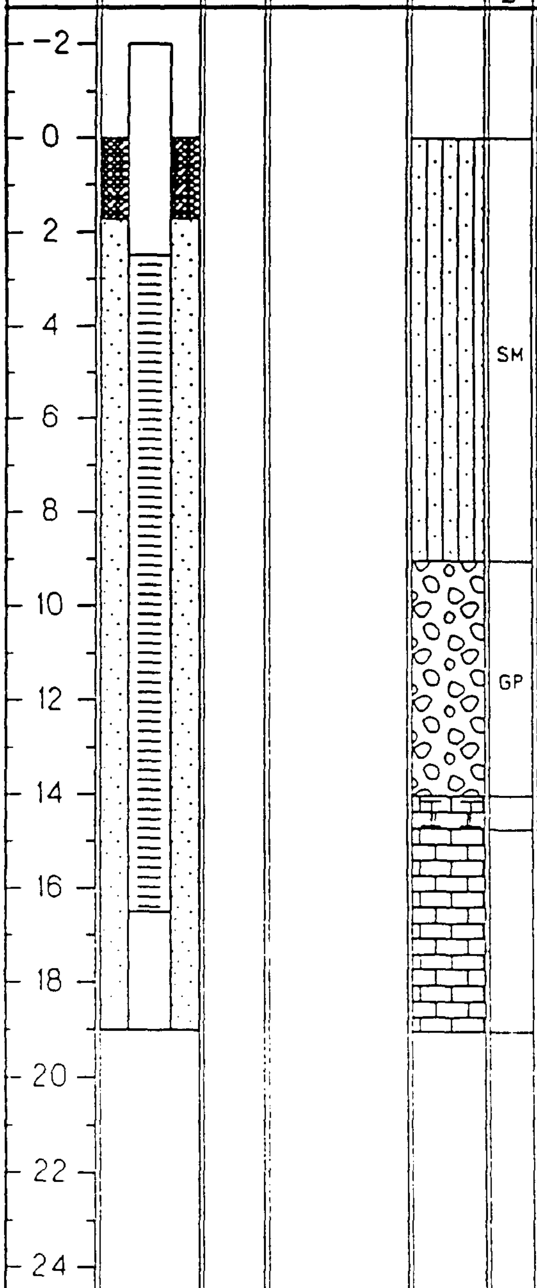
Monitoring Well MW-34

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, NM* Proj. No. *023353014*
Surface Elev. 5505.53 Total Hole Depth *19 ft.* Diameter *10 in.*
Top of Casing 5508.23 Water Level Initial *12 ft.* Static
Screen: Dia *4 in.* Length *14 ft.* Type/Size *FRE/0.020 in.*
Casing: Dia *4 in.* Length *7.8 ft.* Type *FRE*
Fill Material *10/20 Silica Sand* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Hammer Percussion*
Driller *G. Rodriguez* Log By *E. Shannon* Date *02/23/95* Permit #
Checked By ES 3-14-95 License No.

See Site Map For Boring Location

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0–9						SM	0–9 ft.: Brown coarse to fine poorly graded SAND, little coarse to fine gravel, little silt, occasional cobbles.
9–14						GP	9–14 ft.: Coarse to fine GRAVEL/COBBLES, some coarse to fine sand, trace silt, dry. Wet at 12', gray-staining.
14–14.7							Yellowish brown SILT/weathered LIMESTONE, dry.
14.7–19							14.7–19 ft.: Gray LIMESTONE.
19							End of boring at 19 feet. Set MW-34 with screened interval from 2.5–16.5 feet below grade.



PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

FILE #: 97-028
ELEVATION: 5512.39
TOTAL DEPTH: 23.1'
LOGGED BY: TM
DATE: 4-29-97
STATIC WATER: 20.5
BORING ID: MW-35
PAGE: 1

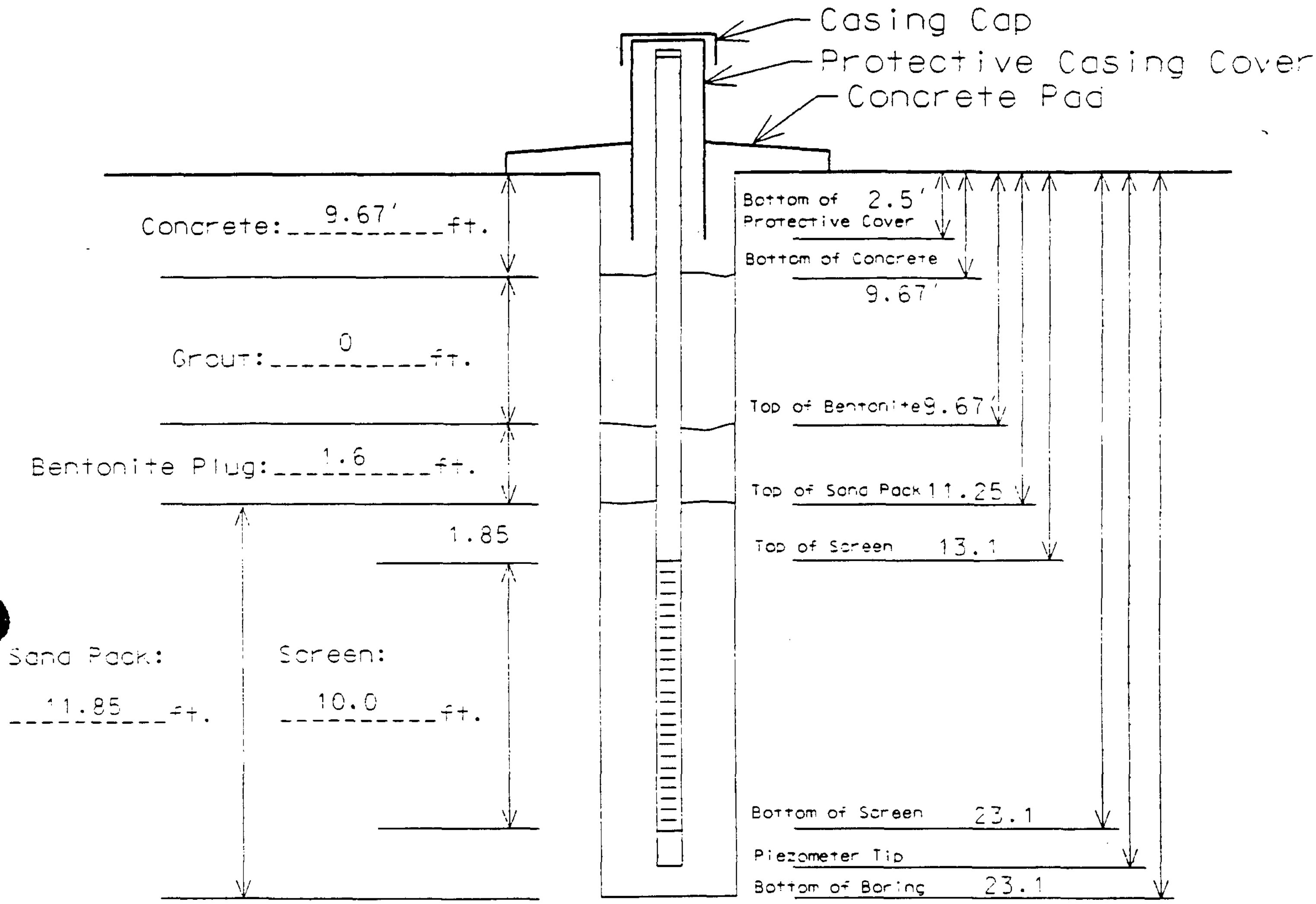
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-6.5	****--***		C	**SAND**, VERY FINE TO FINE, SILTY, DAMP, LIGHT BROWN TO BROWN, LOOSE, NO ODOR,	0
	****--***		C	(MORE DAMP AT 2.0' TO 3.5')	
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***	5.0	C		
	****--***		C		
	****--***		C		
6.5-8.5	*********		C	**SAND**, FINE, SOME COARSE, TAN, DAMP, NO ODOR	0
	*********		C		
	*********		C		
8.5-13.5	***000***		C	**SAND**, FINE, FINE GRAVEL, SOME COARSE COMING UP FLIGHTS, DAMP, MODERATELY DENSE,	
	000		C	BROWN	
	000		C		
	000		C		
	000	10	C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
13.5-15.0	0000**000		C	**GRAVEL**, COARSE, SOME FINE, SOME COBBLES, SANDY, FINE, MORE COBBLY AT 15.0',	0
	0000**000		C	VERY DAMP	
	0000**000	15	C		
15.0-21.5	0000**000		C	**COBBLES**, GRAVELLY, COARSE, SOME FINE, SLIGHTLY SANDY, FINE, DAMP, VERY SLOW	
	0000**000		C	DRILLING, NO ODOR	
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000	20	C		
	0000**000		C		
	0000**000		C		
21.5	0000**000		C	**VERY WEAKLY WATER BEARING 20.5' TO 21.5'**	0
21.5-23.1	=========		C	**NACIMIENTO FORMATION**	0
	=========		C	**SHALE**, SANDY, GREEN, DAMP, DENSE, NO WATER IN SAMPLE OR ON SPLIT SPOON, NOT WATER	
TOTAL DEPTH	=========		C	BEARING	

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-35



Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards, Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: ---------------

Riser Type/Size: 2" SCH 40, PVC

Water: --------

Locking Expandable Casing Plug? YES

Site Northing: 4392.54

Other: --------

Bottom Cap Used? YES

Site Easting: 1723.01

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5512.39

PRECISION ENGINEERING, INC.
505-523-7674

PRECISION ENGINEERING, INC.

LOCATION: BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5510.56
TOTAL DEPTH: 21.0'
LOGGED BY: TM
DATE: 4-29-97
STATIC WATER: 19.5
BORING ID: MW-36
PAGE: 1

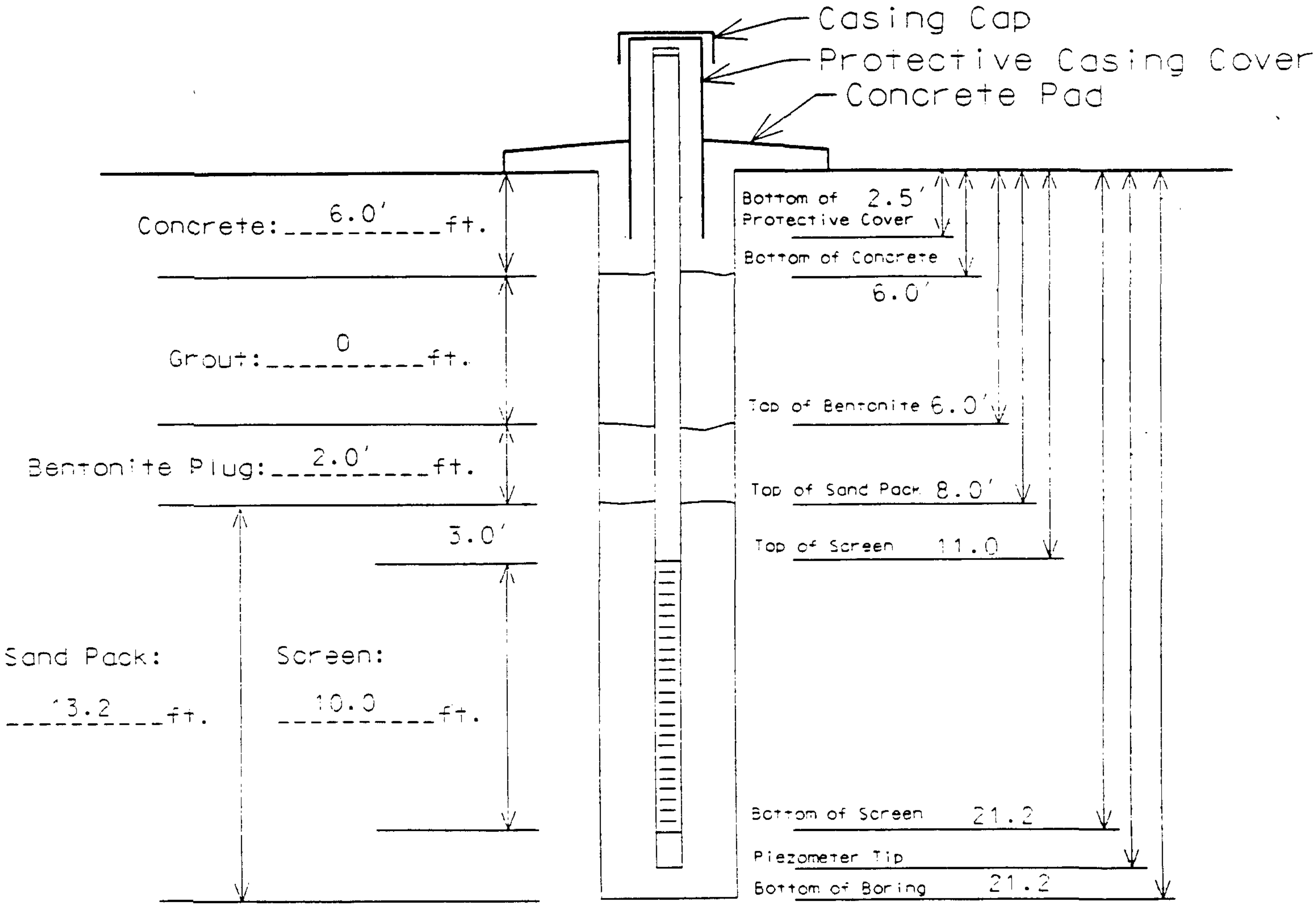
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.5	****--***		C	**SAND**, FINE, SLIGHTLY SILTY, LOOSE, DAMP, LIGHT BROWN, NO ODOR	0
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***	5.0	C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
7.5	****--***		C		
7.5-12.0	000000000		C	**GRAVEL**, COARSE, SOME FINE, VERY COBBLY, VERY SLOW DRILLING, DAMP	0
	000000000		C		
	000000000		C		
	000000000		C		
	000000000	10	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
12.0-19.5	000000000		C	**COBBLES**, GRAVELLY, COARSE, VERY HARD DRILLING, DAMP TO DRY	
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000	15	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
19.5	000000000		C		
19.5-20.5	***000***	20	C	**SAND**, FINE, GRAVELLY, FINE TO COARSE, EASIER DRILLING, NO ODOR, WEAKLY WATER	0
20.5	***000***		C	BEARING	
20.5-21.5	=========		C	**NACIMIENTO FORMATION**	0
21.5	=========		C	SHALE, SANDY, GREEN, DAMP, DENSE, NOT WATER BEARING	
TOTAL DEPTH					

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-36



Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards, Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: ————————

Riser Type/Size: **2" SCH 40. PVC**

505-523-7674

Water: ————

Locking Expandable Casing Plug? YES

Site Northing: 4652.99

Other: ————

Bottom Cap Used? YES

Site Easting: 1779.57

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5510.56

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

LOCATION: BLOOMFIELD REFINERY
SEE BORING PLAN

FILE #: 97-028
ELEVATION: 5513.04
TOTAL DEPTH: 25.0'
LOGGED BY: TM
DATE: 5-1-97
STATIC WATER: 21.0
BORING ID: MW-37
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-7.0	****--***		C	**SAND**, FINE, SILTY, DAMP, LOOSE, RED BROWN	0
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***	5.0	C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
7.0-11.0	***--/***		C	**SAND**, VERY FINE, SILTY, SLIGHTLY CLAYEY, DAMP, MODERATELY DENSE, RED BROWN, SOME	0
	--/		C	FINE GRAVEL AT 10.0'	
	--/		C		
	--/		C		
	--/		C		
	--/	10	C		
	--/		C		
11.0	***--/***		C		
11.0-11.5	000O0O000		C	**GRAVEL**, COARSE, SOME FINE, SOME COBBLES, SLOW DRILLING, DAMP	0
11.5-12.5	***--//**		C	**SAND**, FINE, SILTY, CLAYEY, DAMP, RED BROWN, NO ODOR	0
12.5	***--//**		C		
12.5-17.0	oooOOOooo		C	**GRAVEL**, COARSE, COBBLES, SLOW DRILLING, DENSE, DAMP	0
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo	15	C		
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo		C		
17.0-22.0	OOOoooOOO		C	**COBBLES**, GRAVELLY, COARSE, VERY SLOW DRILLING, NO ODOR, DENSE, DAMP,	
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO	20	C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
22.0	OOOoooOOO		C	WEAKLY WATER BEARING 21.0-22.0	
22.0-25.0	=========		C	**NACIMIENTO FORMATION**	0
	=========		C	GREEN, FISSLE, DAMP, NO ODOR, NOT WATER BEARING	

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

FILE #: 97-028
ELEVATION: 5513.04
TOTAL DEPTH: 25.0'
LOGGED BY: TM
DATE: 5-1-97
STATIC WATER: 21.0
BORING ID: MW-37
PAGE: 2

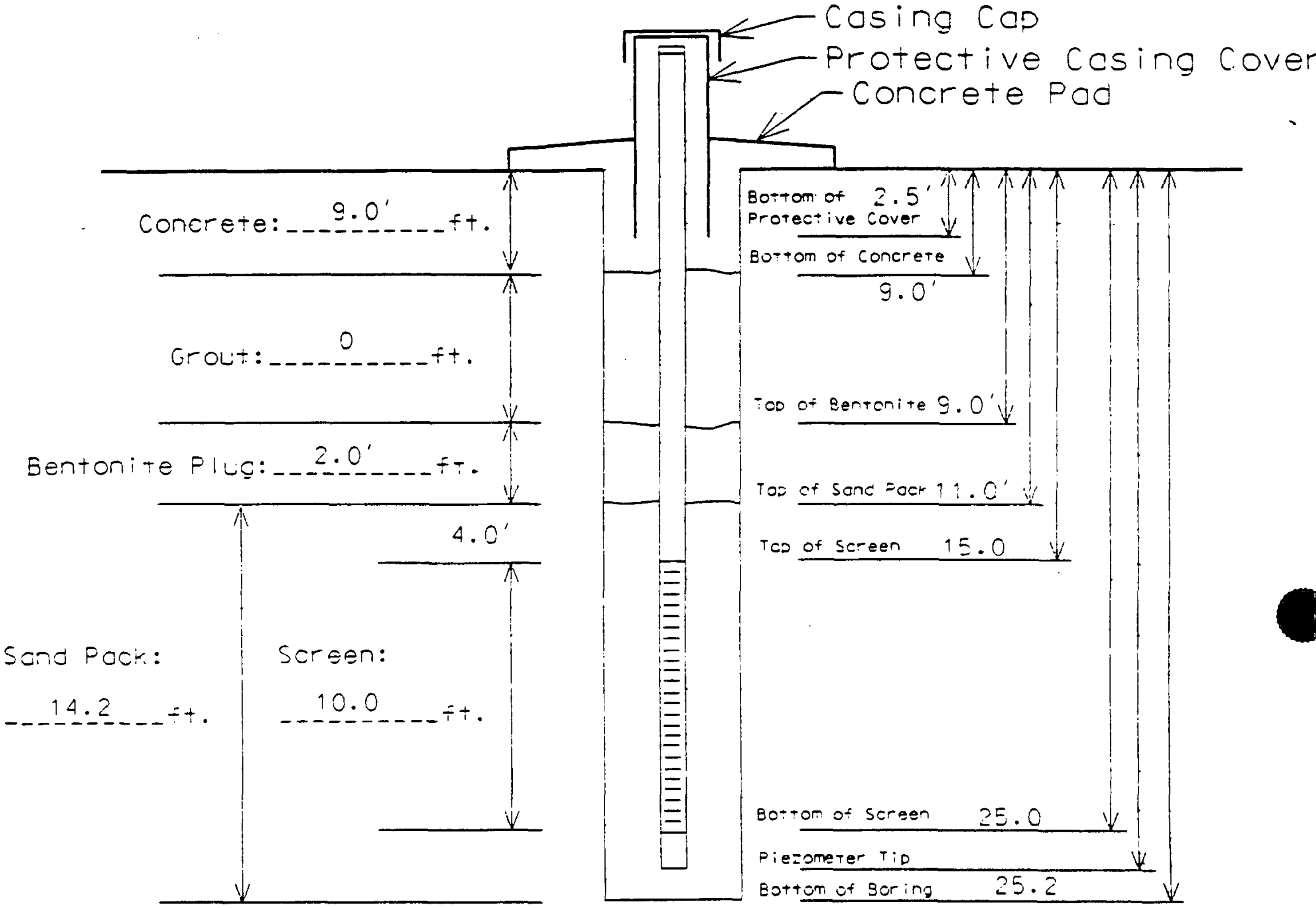
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
22.0-25.0	=========		C	**NACIMIENTO FORMATION**	
	=========		C	GREEN, FISSLE, DAMP, NO ODOR, NOT WATER BEARING	
	=========		C		
25.0	=========	25	C		
TOTAL DEPTH					
		30			
		35			
		40			
		45			

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-37



Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards, Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: ----------

Riser Type/Size: 2" SCH 40. PVC

PRECISION ENGINEERING, INC.

505-523-7674

Water: --------

Locking Expandable Casing Plug? YES

Site Northing: 4413.84

Other: --------

Bottom Cap Used? YES

Site Easting: 1496.01

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5513.04

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

FILE #:	97-028
ELEVATION:	5512.87
TOTAL DEPTH:	23.5'
LOGGED BY:	TM
DATE:	4-29-97
STATIC WATER:	21.0
BORING ID:	MW-38
PAGE:	1

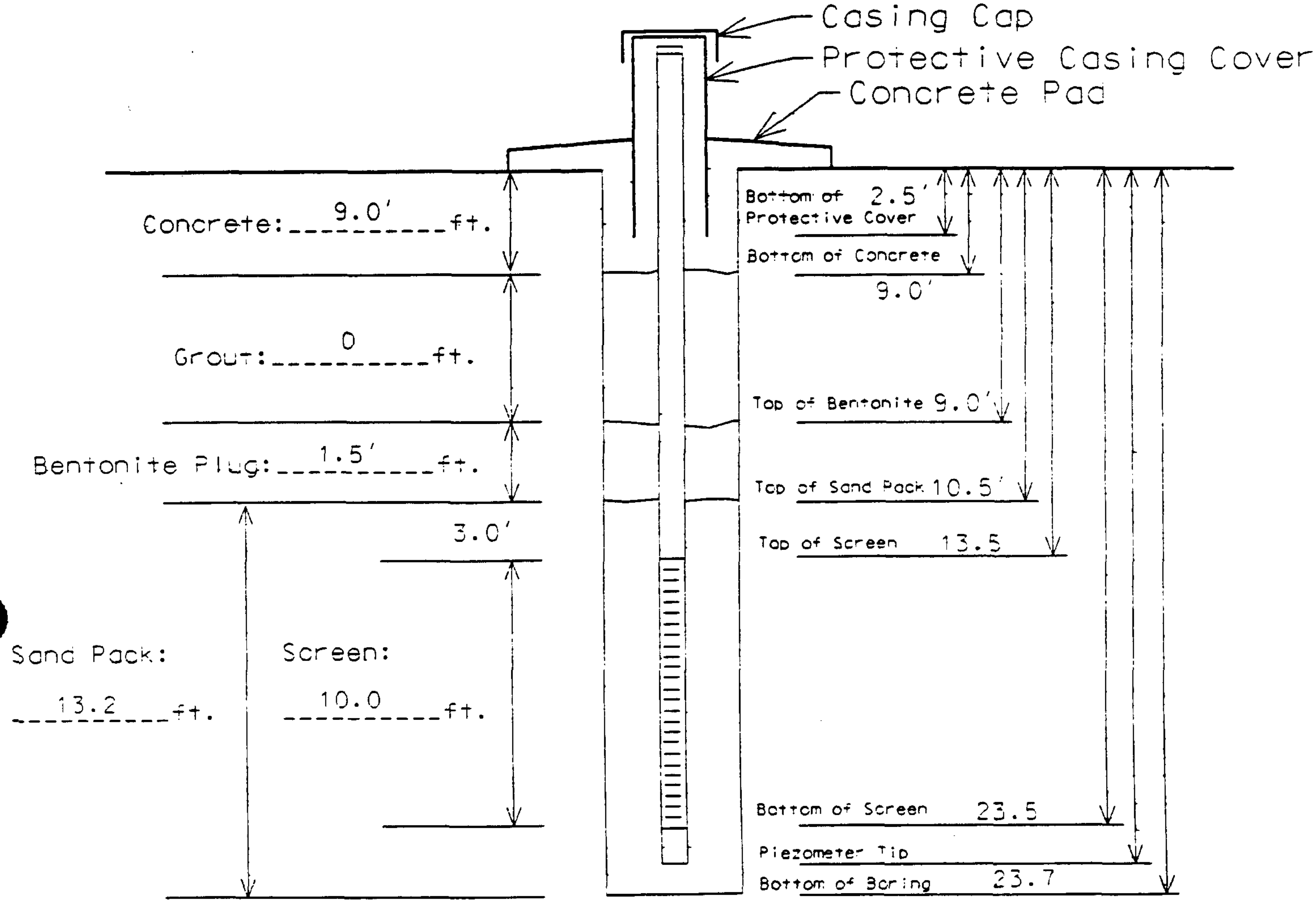
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.5	***--00**		C	**SAND**, FINE, SILTY, DAMP, BROWN, LOOSE, SOME FINE GRAVEL	0
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**	5.0	C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
	***--00**		C		
7.5-11.5	***000***		C	**SAND**, FINE, GRAVELLY, COARSE, SOME FINE, LIGHT BROWN, DAMP, MODERATELY DENSE, NO ODOR	0
	000		C		
	000		C		
	000		C		
	000	10	C		
	000		C		
	000		C		
11.5	***000***		C		
11.5-22.0	000000000		C	**COBBLES**, GRAVELLY, COARSE, VERY HARD, SLOW DRILLING, NO ODOR, DAMP	0
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000	15	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000	20	C		
	000000000		C		
	000000000		C		
	000000000		C		
22.0	000000000		C	WEAKLY WATER BEARING 21.0	0
22.0-23.5	=========		C	**NACIMIENTO FORMATION**	0
TOTAL DEPTH	=========		C	**SHALE**, VERY SANDY, DAMP, NOT WATER BEARING, DENSE	

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-38



Boring Diameter: 8-5/8"

- Sand Type: 16-40
- Bentonite: 3/8 CHIPS
- Cement/Grout: ----------------
- Water: -------
- Other: -------
- Bollards. Type/Size: 3" STEEL
- Screen Type/Size: 0.010
- Riser Type/Size: 2" SCH 40. PVC
- Locking Expandable Casing Plug? YES
- Bottom Cap Used? YES
- Site Northing: 4674.24
- Site Easting: 1587.4

PRECISION ENGINEERING, INC.
505-523-7674

Project #: 97-028 Project Name: BLOOMFIELD REFINING Elevation: 5512.87

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

PROJECT: Bloomfield Refinery
CMS Wells & Borings

FILE #: 98-149
ELEVATION: 5522 ft
TOTAL DEPTH: 36 ft
LOGGED BY: WHK
DATE: 9-28-98
STATIC WATER: 18 ft
BORING ID: MW-39
PAGE: 1 of 5

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0 - 1.5	*-**-**-*			**Sand**, fine, silty, EOLIAN	
1.5 - 3.0	0*00*00*0			**Gravel**, sandy	
	0*00*00*0				
3.0 - 4.5	*-**/**-*			**Sand**, silty, clayey, moist, loose, brown	
	*-**/**-*	5.0		more clayey, soft, wet, black	
	*-**/**-*				
7.0	*-**/**-*				
	0*00*00*0			**Gravel**, sandy, moist, moderately dense, grey-black, JACKSON LAKE	
	0*00*00*0				
	0*00*00*0	10			
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*00*00*0	15		more cobbly at 14'	
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*0*0*0*0			water bearing at 18', sandier from 18-20'	
	0*0*0*0*0	20			
	0*00*00*0			gravel & cobbles, moist, very dense, black	
22.0	0*00*00*0				
	SSS*S*SSS			Sandstone, slightly sandy, moist, dense, NACIMIENTO	
	SSS*S*SSS				
	SSS*S*SSS	25			
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS	30			
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS	35			
36.0	SSS*S*SSS				
total depth					
		40			
		45			

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4.25" ID HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5526.21
TOTAL DEPTH: 34.5'
LOGGED BY: TM
DATE: 3-11-9
STATIC WATER: NOT F
BORING ID: MW-40
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-17.0	//**-0///		C	CLAY, SANDY, FINE, SILTY, FIRM, SOME FINE GRAVEL, DARK BROWN TO BLACK, DAMP, SLIGHT	
	//**-0///		C	ODOR	
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///	5.0	C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C	GRAB SAMPLE-NO CHANGE	
	//**-0///		C	CLAY, SILTY, SANDY, MOIST, DARK BROWN, FIRM, NO ODOR	
	//**-0///		C		
	//**-0///	10	C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///	15	C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
17.0	//**-0///		C		
17.0-17.5	***00/***		C	SAND, FINE, SOME COARSE, RED-BROWN, VERY DAMP TO MOIST, MODERATELY DENSE, SLIGHTLY	
17.5	***00/***		C	CLAYEY, NO ODOR	
17.5-19.5	---//*---		C	SILT, CLAYEY, SANDY, FINE, DARK BROWN, MOIST, NO ODOR	
	---//*---		C		
19.5	---//*---		C		
19.5-31.5	000000000	20	C	COBBLES, GRAVELLY, (FINE TO COARSE), SOME SMALL BOULDERS, NO ODOR, VERY SLOW	
	000000000		C	DRILLING	
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5526.21
TOTAL DEPTH: 34.5'
LOGGED BY: TM
DATE: 3-11-97
STATIC WATER: NOT FOUND
BORING ID: MW-40
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
	000000000		C	COBBLES, GRAVELLY, (FINE TO COARSE), SOME SMALL BOULDERS, NO ODOR, VERY SLOW	
	000000000		C	DRILLING	
	000000000		C		
	000000000	25	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C	EASIER DRILLING, LESS AUGER SCRAPING	
	000000000		C		
	000000000		C		
31.5	000000000	30	C		
31.5-33.5	SSSSSSSSS		C	NACIMIENTO FORMATION	
	SSSSSSSSS		C	DENSE. AUGER NOT SCRAPING	
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
33.5-34.5	SSSSSSSSS		S	NACIMIENTO FORMATION	
	SSSSSSSSS		S	BLACKISH COLOR, TURNING MORE WHITE 36.0 FEET, NO WATER IN HOLE OR SAMPLE AS OF	
34.5	SSSSSSSSS	35	S	4:40 PM, SLIGHT ODOR IN SAMPLE	
TOTAL DEPTH				10-12-97	
				DISCOVERED 2.5 FEET OF WATER IN HOLE AFTER PULLING AUGER	

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5525.13
TOTAL DEPTH: 33.0'
LOGGED BY: TM
DATE: 3-12-9
STATIC WATER: NOT F
BORING ID: MW-41
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.0	///--*///		C	CLAY, SILTY, SANDY, FINE, MOIST, SOFT	
	///--*///		C	0.0-0.5 FEET MORE BLACK	
	///--*///		C	0.5-5.0 FEET DARK GREY, FAINT ODOR, ODOR SEEMS OLD, SOME FINE GRAVEL	
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///	5.0	C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
7.0	///--*///		C		
7.0-12.0	***--/***		C	SAND, FINE, SILTY, SLIGHTLY CLAYEY, LOOSE, VERY DAMP, GREY BROWN, NO ODOR	
	--/		C		
	--/		C		
	--/		C		
	--/		C		
	--/	10	C		
	--/		C		
	--/		C		
	--/		C		
12.0	***--/***		C		
12.0-16.0	///--////		C	CLAY, SLIGHTLY SILTY, MOIST, GREY BROWN, NO ODOR	
	///--////		C		
	///--////		C		
	///--////		C		
	///--////		C		
	///--////	15	C		
	///--////		C		
16.0	///--////		C		
16.0-16.5	***0/****		C	SAND, FINE, SOME COARSE, SLIGHTLY CLAYEY, GREY BROWN, VERY DAMP, NO ODOR	
16.5-17.5	000000000		C	COBBLES, VERY SLOW DRILLING, AUGER SCRAPING	
17.5	000000000		C		
17.5-18.5	**********		C	SAND, FINE, DAMP, GREY BROWN, NO ODOR, EASY DRILLING	
18.5	**********		C		
18.5-30.0	000000000		C	COBBLES, VERY SLOW DRILLING, SOME SMALL BOULDERS	
	000000000		C		
	000000000	20	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5525.13
TOTAL DEPTH: 33.0'
LOGGED BY: TM
DATE: 3-12-97
STATIC WATER: NOT FOUND
BORING ID: MW-41
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
	000000000		C	COBBLES. VERY SLOW DRILLING. SOME SMALL BOULDERS	
	000000000		C		
	000000000		C		
	000000000	25	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
30.0	000000000	30	C		
30.0-33.0	SSSSSSSSS		C	NACIMIENTO. GREYISH BROWN. DAMP. VERY SLIGHT ODOR	
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
33.0	SSSSSSSSS		C		
TOTAL DEPTH					

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

PROJECT: Bloomfield Refinery
CMS Wells & Borings

FILE #: 98-149
ELEVATION: 5536 ft
TOTAL DEPTH: 47.5 ft
LOGGED BY: WHK
DATE: 10-01-98
STATIC WATER: 34 ft
BORING ID: MW-44

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0 - 5.0	*-/**-/**			**Sand**, fine, silty, slightly clayey, moist-wet, loose, light brown, Qe	
	*-/**-/**	5.0			
9.0	*-/**-/**				
9.0-10.0	/-//-//-/	10		**Clay**, silty, sandy(fine), wet, soft, brown	
10.0-15.0	*-*****-*			**Sand**, fine, slightly silty, damp, loose, brown	
	*-*****-*	15			
20.2	*-**/**-*	20		some clay at 19'	
	0*00*00*0			**Gravel**(up to 3"), sandy, damp, moderately dense, interbeds of sand(medium-coarse) brown to grey no odor appears to be natural color	
	0*00*00*0	25			
	0*00*00*0			some cobble or boulder material	
	0*00*00*0	30			
33.5	0*00*00*0				
	SSSSSSSSS	35		Sandstone, argillaceous, liesgaing banded, dense, yellow brown orange banded in random patern, fine to medium, NACIMIENTO water bearing at 34'	
	SSSSSSSSS	40			
	SSSSSSSSS	45			
47.5	SSSSSSSSS				

total depth

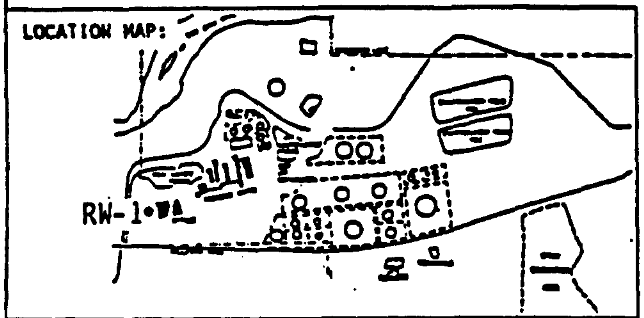
SIZE AND TYPE OF BORING: 4.25" HSA

LOGGED BY: WHK

LITHOLOGIC LOG (SOIL)

Page 1 of 1

LOCATION MAP:

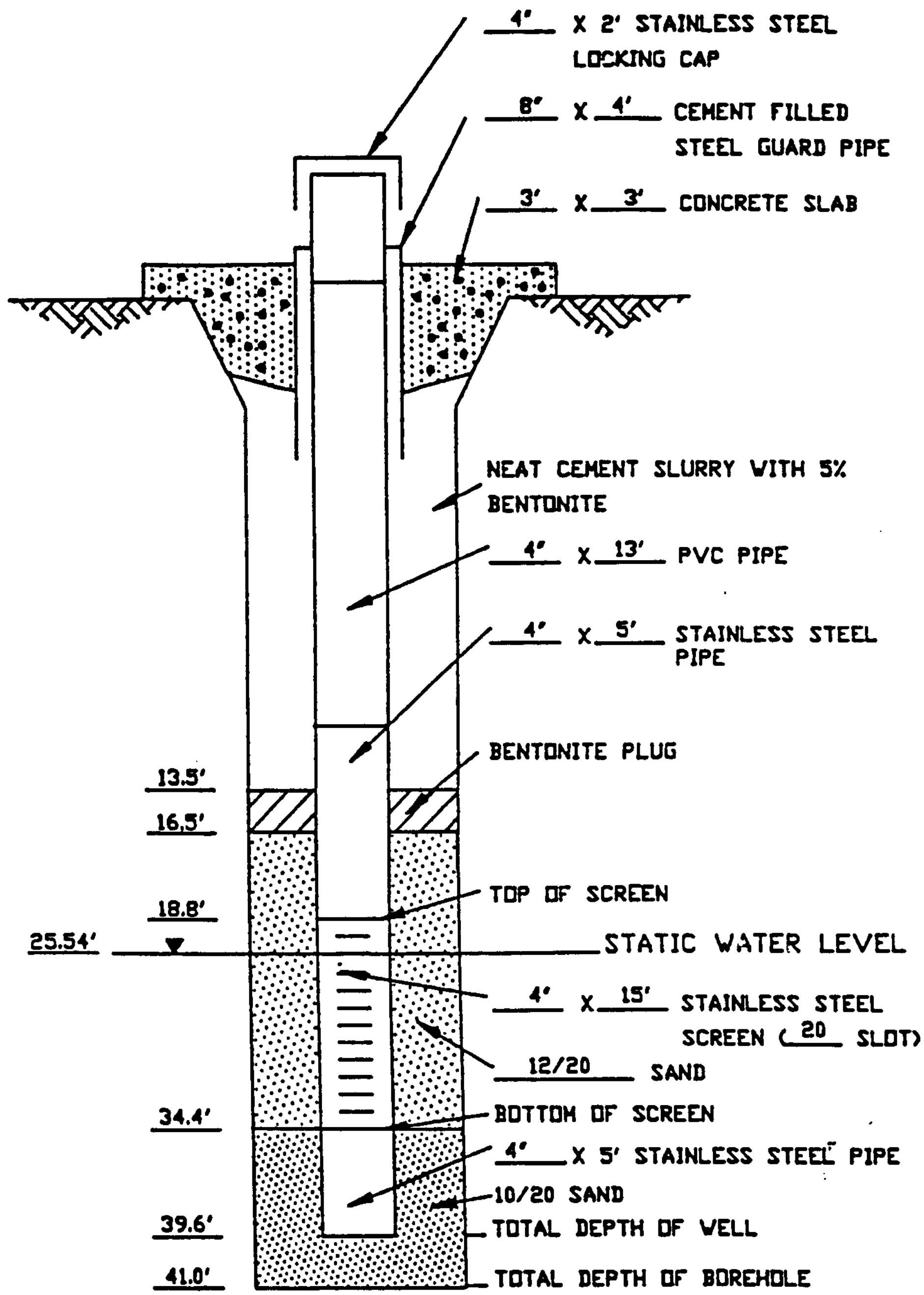


___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: RW-1
SITE COORDINATES (ft.):
N ___ E ___
GROUND ELEVATION (ft. MSL): 5525.92
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 30 August 1988 DATE COMPLETED: 31 August 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 2, 1988: 26.65 from TOC.

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-18' Silt and Sand - Dark yellowish brown (10 YR 4/2) to grayish brown (5 YR 3/2). Minor to strong hydrocarbon odor.
5			1642		
10			1646		
15			1710		
20			1720		18'-34' Sand and Gravel - Medium dark gray (N4). Sand is medium to very coarse grained, subangular to subrounded. Gravel is subrounded to well rounded, to 2" diameter. Strong hydrocarbon odor.
25			1725		
30			1730		
35			1738		34'-41' Shale - Nacimiento Formation - Dusky yellow (5 YR 6/4) to light olive gray (5 Y 6/1) shale.
40			1758		
		T.D. 41'			
45					

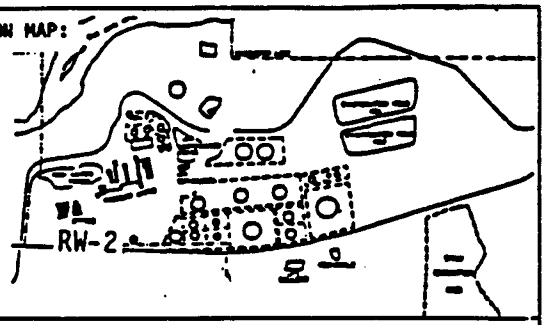


COMPLETION DIAGRAM

RECOVERY WELL RV-1

LITHOLOGIC LOG (SOIL)

LOCATION MAP:

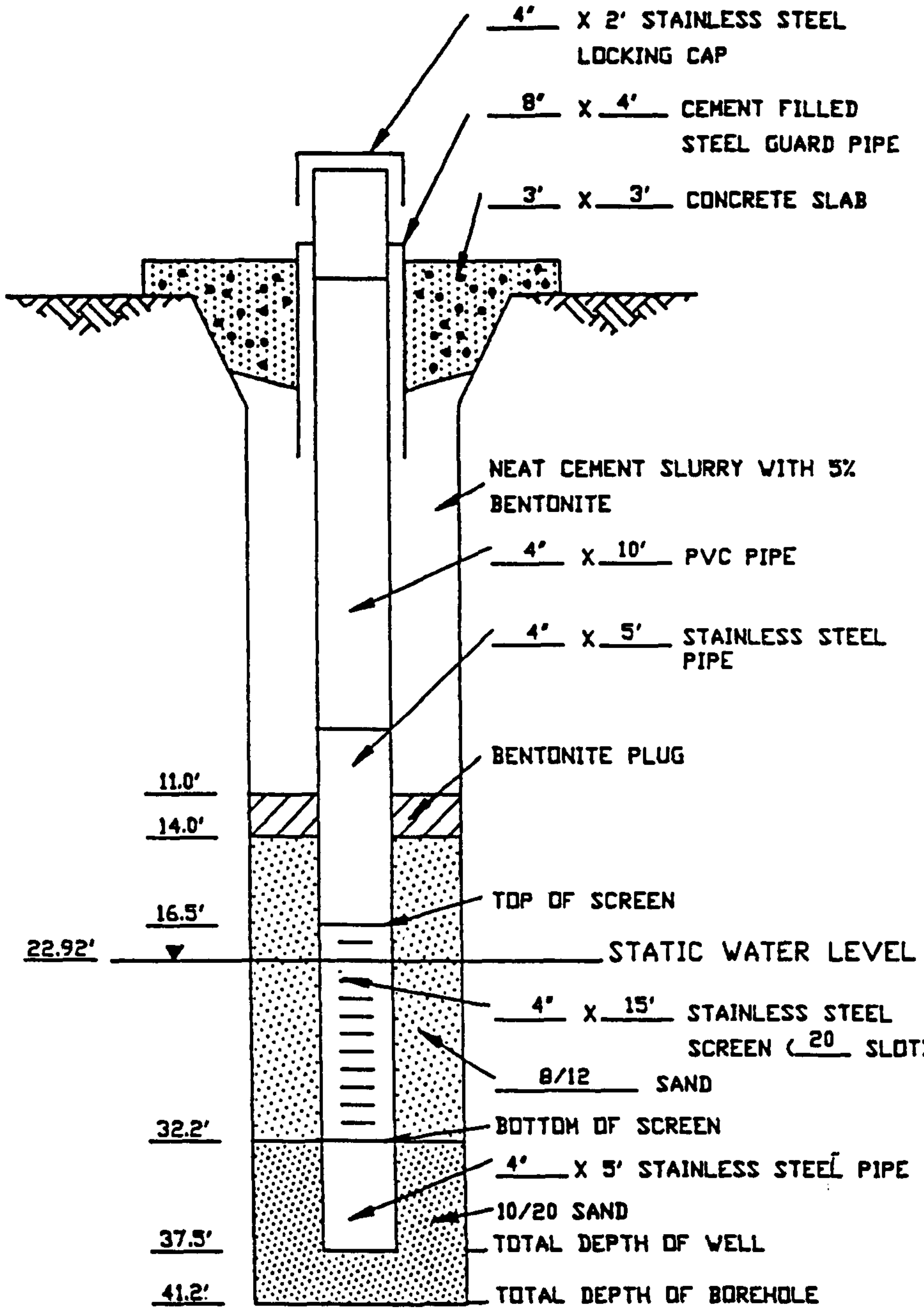


___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: RW-2
SITE COORDINATES (ft.):
N ______ E ______
GROUND ELEVATION (ft. MSL): 5523.48
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 29 August 1988 DATE COMPLETED: 29 August 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 2, 1988: 23.42 from TOC.

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-10' Silt and Clay - Medium dark gray (N4) to brownish gray (5 YR 4/1). Slightly effervescent in HCl. Faint hydrocarbon odor.
5			0948		
10			0953		10'-15' Sand and Silt - Moderate brown (5 YR 4/4), very fine grained and well sorted.
			0958		15'-32' Sand and Gravel - Olive gray (5 Y 4/1) to brownish gry (5 YR 4/1). Sand is medium to very coarse grained, subangular to subrounded. Gravel is subangular to well rounded, to 2" diameter. Noticeable hydrocarbon odor below 25'.
20			1024		
25			1029		
30			1033		32'-41.2' Shale - Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2).
35			1050		
40			1100		
		T.D. 41.2'			
45					



COMPLETION DIAGRAM

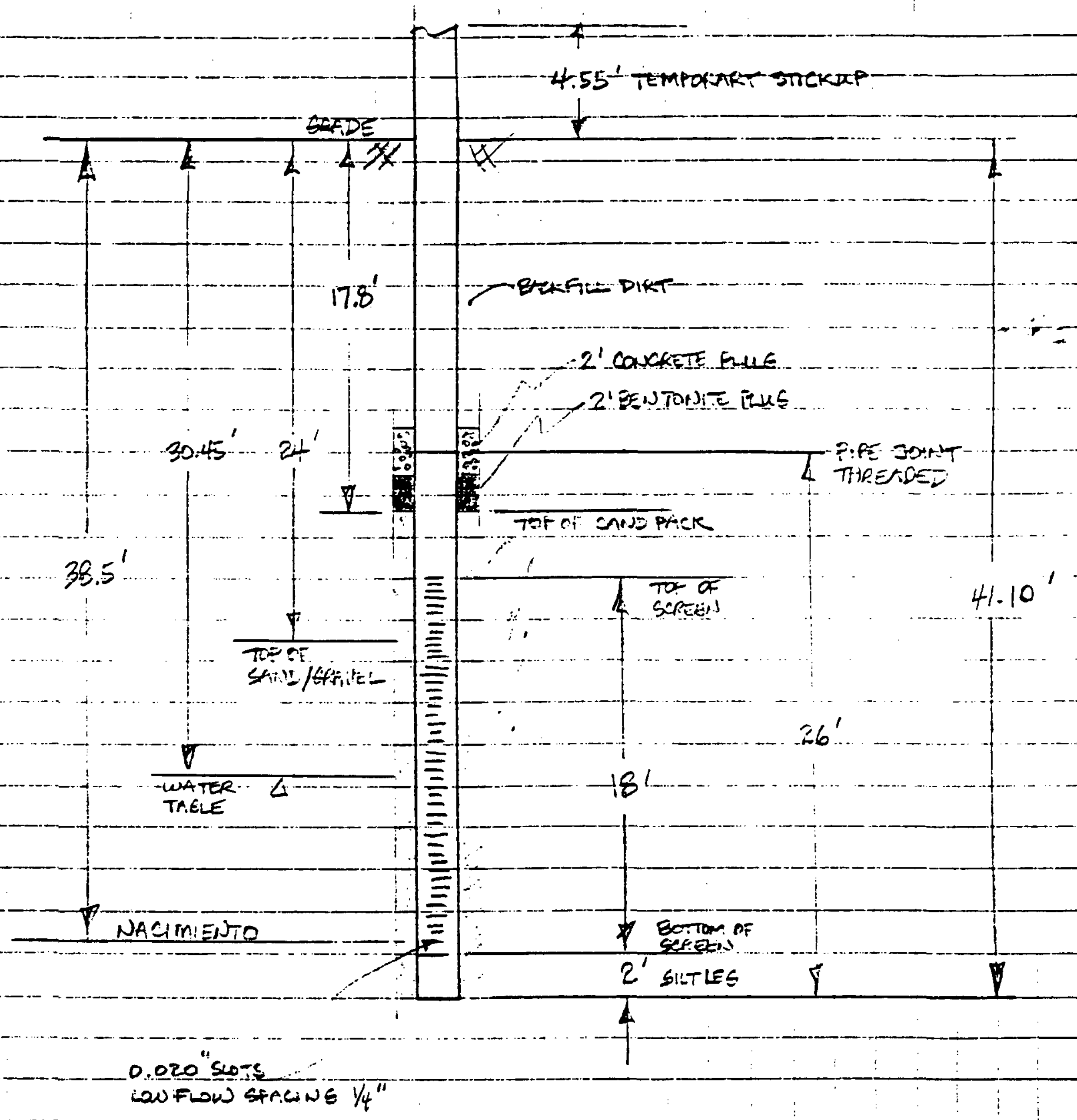
RECOVERY WELL RW-2

RW-14

CALCULATION SHEET

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLAS CASING SET TO DEPTH INSIDE DRIVEN CASING.; ANNULAR SPACE FILLED WITH 10/20 SAND AS DRIVEN CASING REMOVED 50 LBS. OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE.

LOCATION: END OF ROAD BETWEEN TANKS 19 & 29.



BY: CH PROJECT: GROUNDWATER RECOVERY - PHASE II AE 91-6

DATE: 8-9-90 SUBJECT: RECOVERY WELL 14

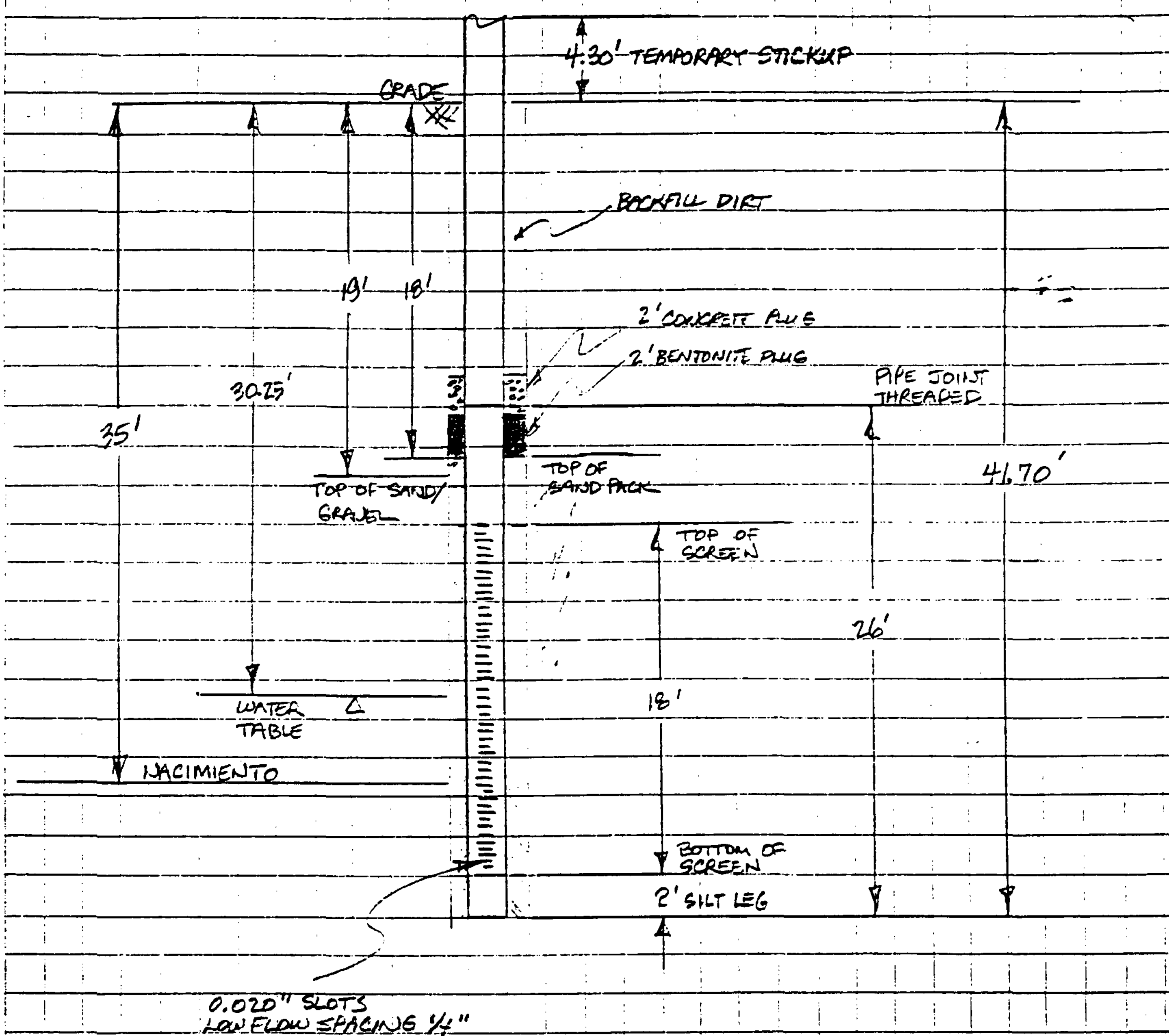
DATE OF INSTALLATION: 8-6-90 SHEET 1 OF 6

RW-15

CALCULATION SHEET

CONSTRUCTION COMMENTS : SAME AS RW-14

LOCATION : ROADWAY BETWEEN TANKS 18 & 28



INITIALS: CH PROJECT No. GROUNDWATER RECOVERY - PHASE II, AFE 9146

DATE: 8-9-90 SUBJECT: RECOVERY WELL 15

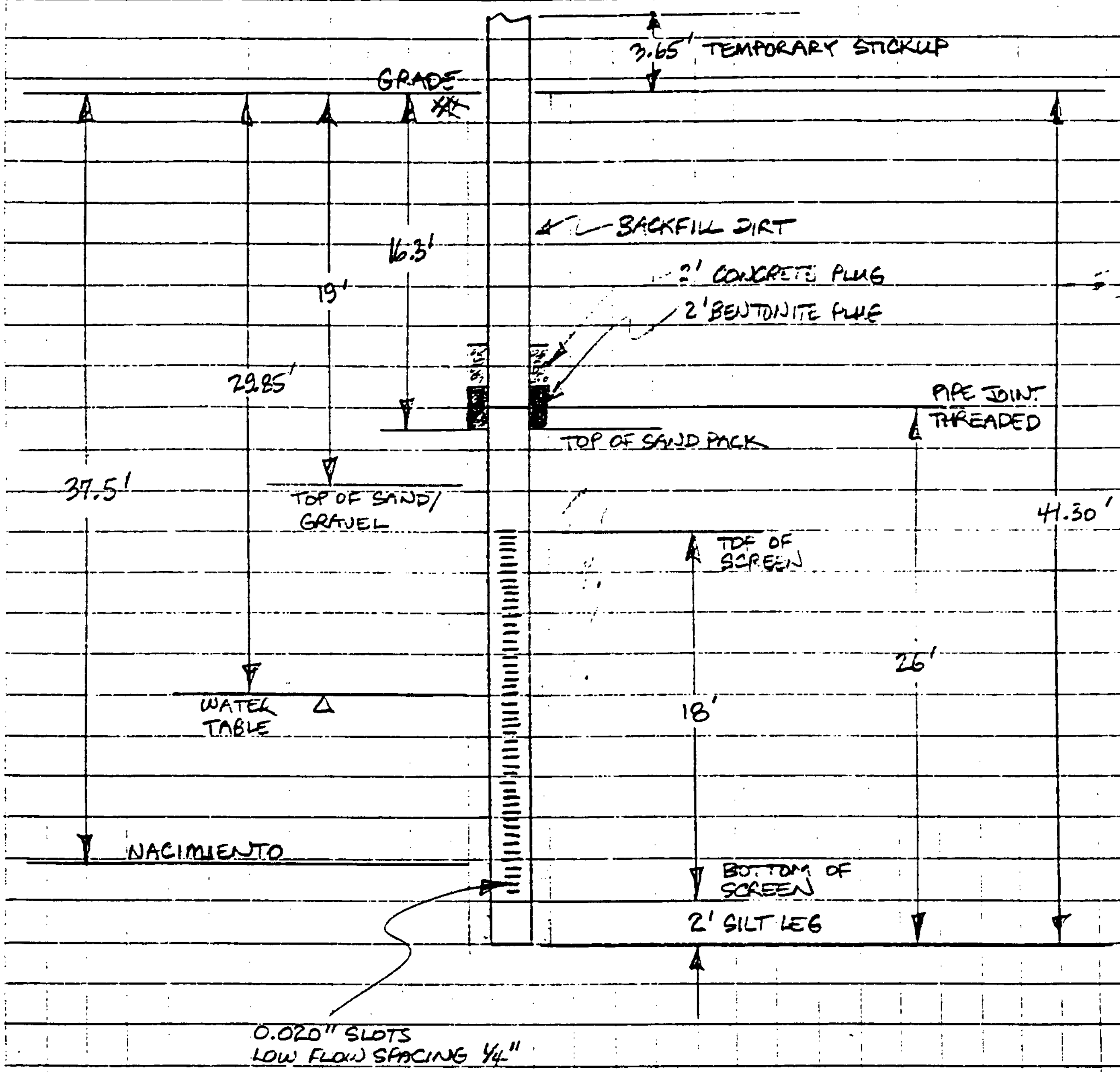
DATE OF INSTALLATION : 8-7-90 SHEET 2 OF 6

RW-16

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: ROADWAY BETWEEN TANKS 26 & 18



INITIALS GH PROJECT No. GROUNDWATER RECOVERY- PHASE II, AFE 9146

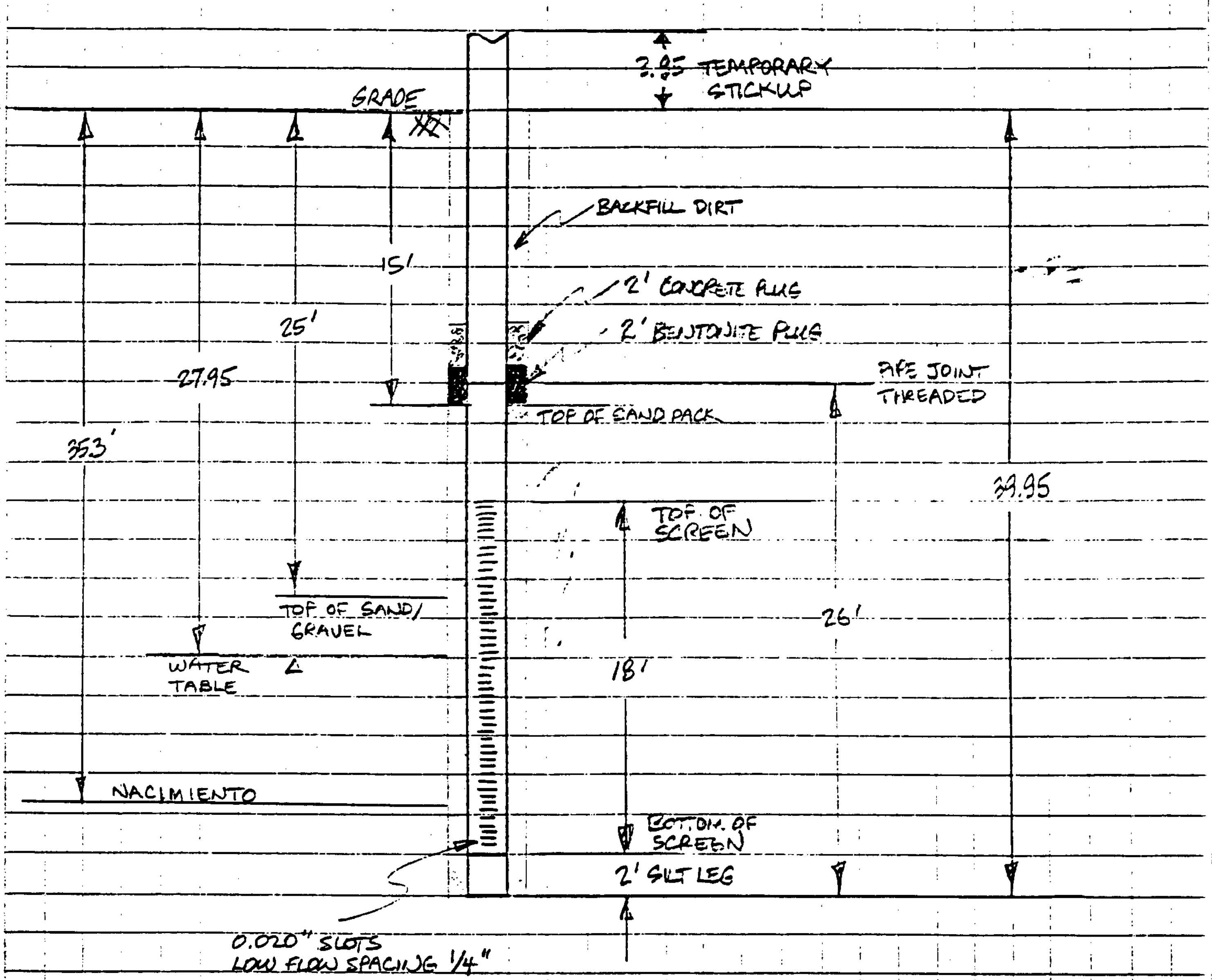
DATE 8-9-90 SUBJECT RECOVERY WELL 16

DATE OF INSTALLATION: 8-7-90 SHEET 3 OF 6

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: ROAD BETWEEN TANK 17 & 24



INITIALS CH PROJECT No. GROUNDWATER RECOVERY - PHASE II, AFE 9146

DATE 8-9-90 SUBJECT RECOVERY WELL 17

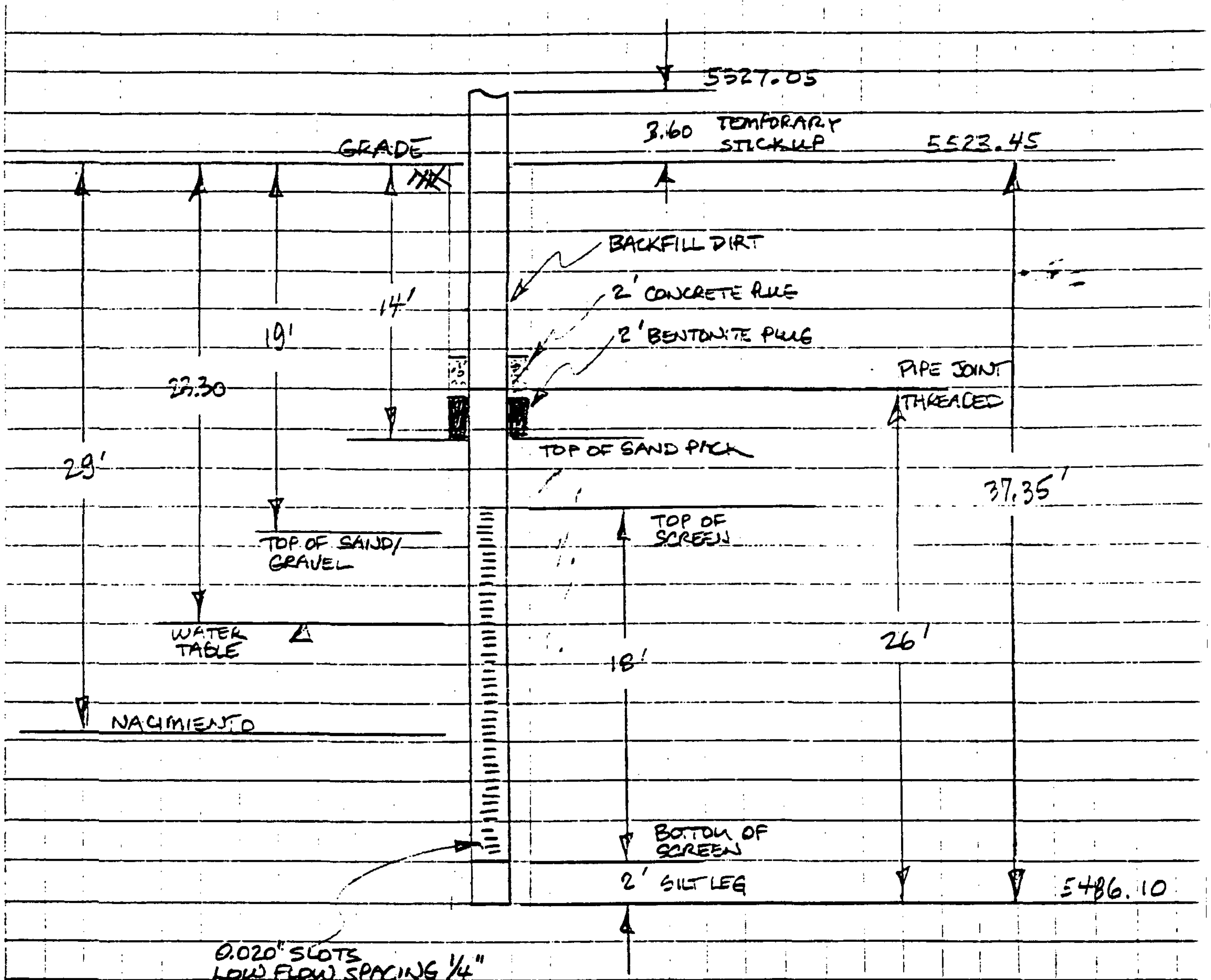
DATE OF INSTALLATION: 8-7-90 SHEET 4 OF 6

RW-18

CALCULATION SHEET

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGL CASING SET TO DEPTH INSIDE DRIVEN CASING.; ANNULAR SPACE FILLED WITH 10/20 SAND AS DRIVEN CASING REMOVED; 50 LBS OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE. CONCRETE PAD SURFACE SEAL (NOT SHOWN)

LOCATION: WEST OF SOWP & NOWP, NORTH OF CAT/POLY



GROUNDWATER MONITORING - SOWP & NOWP

INITIALS CH PROJECT NO. GROUNDWATER RECOVERY - OVERALL FACILITY

DATE 8-9-90 SUBJECT RECOVERY WELL 18

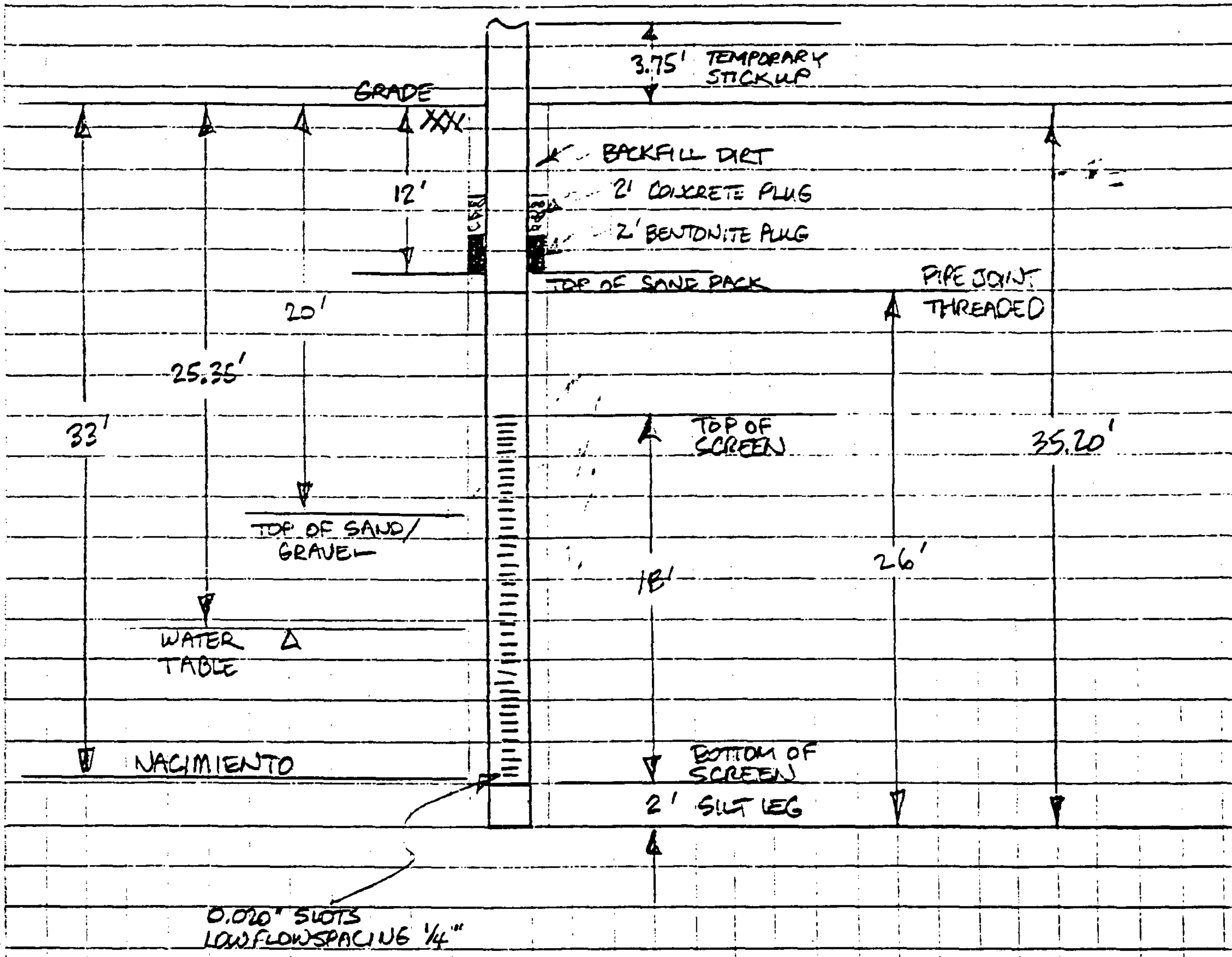
DATE OF INSTALLATION: 8-9-90 SHEET 5 OF 6

RW-19

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: NEAR NE CORNER FIRE EQUIP. BLDG.



INITIALS CH PROJECT No. GROUNDWATER RECOVERY - PHASE II, AFE 9146

DATE 8-9-90 SUBJECT RECOVERY WELL 19

DATE OF INSTALLATION: 8-8-90 SHEET 6 OF 6

Drilling Log

GROUNDWATER TECHNOLOGY

Recovery Well RW-22

Project *Bloomfield/50 CR4990* Owner *Bloomfield Refining Co.*
Location *Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. *5518.05 ft.* Total Hole Depth *34 ft.* Diameter *10 in.*
Top of Casing *5521.05 ft.* Water Level Initial *19 ft.* Static
Screen: Dia *6 in.* Length *16 ft.* Type/Size *FRE/0.020 in.*
Casing: Dia *6 in.* Length *17/2 ft.* Type *FRE*
Fill Material *12/20 Co. Silica* Rig/Core *Speedstar 15-THH*
Drill Co. *Beeman Bros.* Method *Air Percussion*
Driller *Leo Beeman* Log By *Jerry May* Date *07/19/93* Permit #
Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 1230 hrs. 2 ft silt leg instaled from 31 to 33 feet

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							
1						ML	Tan SILT (moist)
4							Same as above
5		214					
10		46					Same as above
12						GW	Gray COBBLES (trace or no fines)
15		NA					
18						SP	Light gray-stained poorly-graded fine SAND with trace of gravel (moist-wet)
19		1,450					*Groundwater encountered at 19' on 7/19/93*
21						GW	Dark-gray-stained COBBLES with trace fines (moist)
24							

Drilling Log

GROUNDWATER TECHNOLOGY

Recovery Well RW-23

Project *Bloomfield/50 CR4990* Owner *Bloomfield Refining Co.*
Location *Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. *5515.74 ft.* Total Hole Depth *33 ft.* Diameter *10 in.*
Top of Casing *5517.74 ft.* Water Level Initial *19 ft.* Static
Screen: Dia *6 in.* Length *16 ft.* Type/Size *FRE/0.020 in.*
Casing: Dia *6 in.* Length *15/2 ft.* Type *FRE*
Fill Material *12/20 Co. Silica* Rig/Core *Speedstar 15-THH*
Drill Co. *Beeman Bros.* Method *Air Percussion*
Driller *Leo Beeman* Log By *Jerry May* Date *07/19/93* Permit #
Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 1630 hrs. 2 ft. silt leg installed from 31 to 33 feet

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0					
1				GW	Gravel with fines (dry)
2					Brown silty CLAY (moist, medium plasticity)
4				CL	
5	0				
6					
7					Gravel and COBBLES (no fines)
8					
10	32				
11					Same as above with little fines
12				GW	
14					
15	54				Gravel and COBBLES with trace of fines (dry)
16	74				Gray-stained, same as above
18	2,914				Black-stained GRAVEL with some fines (moist)
19					▽ *Groundwater encountered at 19 feet on 7/19/93*
20					
21				GM	
22					
24	105				

Drilling Log

GROUNDWATER TECHNOLOGY

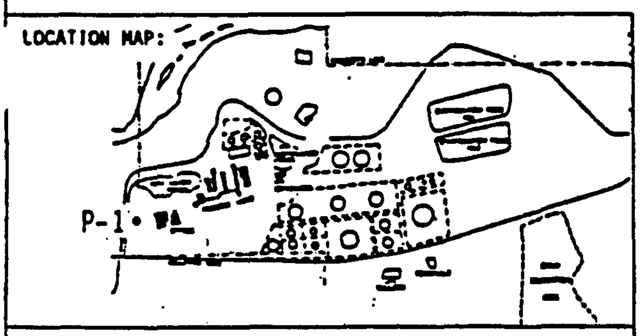
Recovery Well RW-22

Project Bloomfield/50 CR4990 Owner Bloomfield Refining Co.
Location Bloomfield, New Mexico Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
		1,146				GW	
26							
							Encountered weathered limestone (moist)
28							(Dry at 28 feet)
30		858					
32							
		96					
34							End of boring at 34 feet (1355 hrs.). Installed recovery well screened from 15 to 31 feet on 7/19/93.
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

LITHOLOGIC LOG (SOIL)

LOCATION MAP:



____1/4 ____1/4 ____1/4 ____1/4 S____ T____ R____

SITE ID: BRC LOCATION ID: P-1
SITE COORDINATES (ft.):
N E
GROUND ELEVATION (ft. MSL): 5524.62
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 30 August 1988 DATE COMPLETED: 30 August 1988
FIELD REP.: W.S. Dubyk
COMMENTS: This well replaced by P-1a on August 31, 1988.

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-20' Silt and Clay - Dark yellowish brown (10 YR 4/2) to grayish brown (5 YR 3/2). Weak hydrocarbon odor.
5			1135		
10			1140		
15			1145		
20			1200		20'-36.5' Sand and Gravel - Dark gray (N3) to grayish black (N2). Sand is fine to very coarse grained, subangular to rounded. Gravel is subangular to well rounded, to 2" diameter. Very strong to intense hydrocarbon odor.
25			1205		
30			1210		
35			1220		36.5'-42.0' Shale - Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2) shale.
40					
			1225 1240		
		T.D. 42'			
45					
50					

Drilling Log

GROUNDWATER TECHNOLOGY

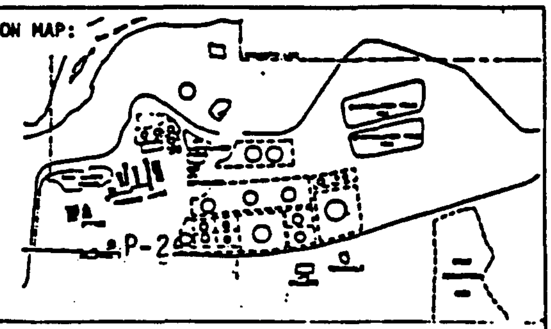
Recovery Well RW-23

Project Bloomfield/50 CR4990 Owner Bloomfield Refining Co.
Location Bloomfield, New Mexico Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		105					Gravel and some tan fines (moist)
26						GM	
28							
		17					Light gray weathered limestone (dry)
30							
32							
		0					End of boring at 33 feet (1750 hrs). Installed recovery well screened from 15 to 31 feet on 7/19/93.
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

LITHOLOGIC LOG (SOIL)

LOCATION MAP:

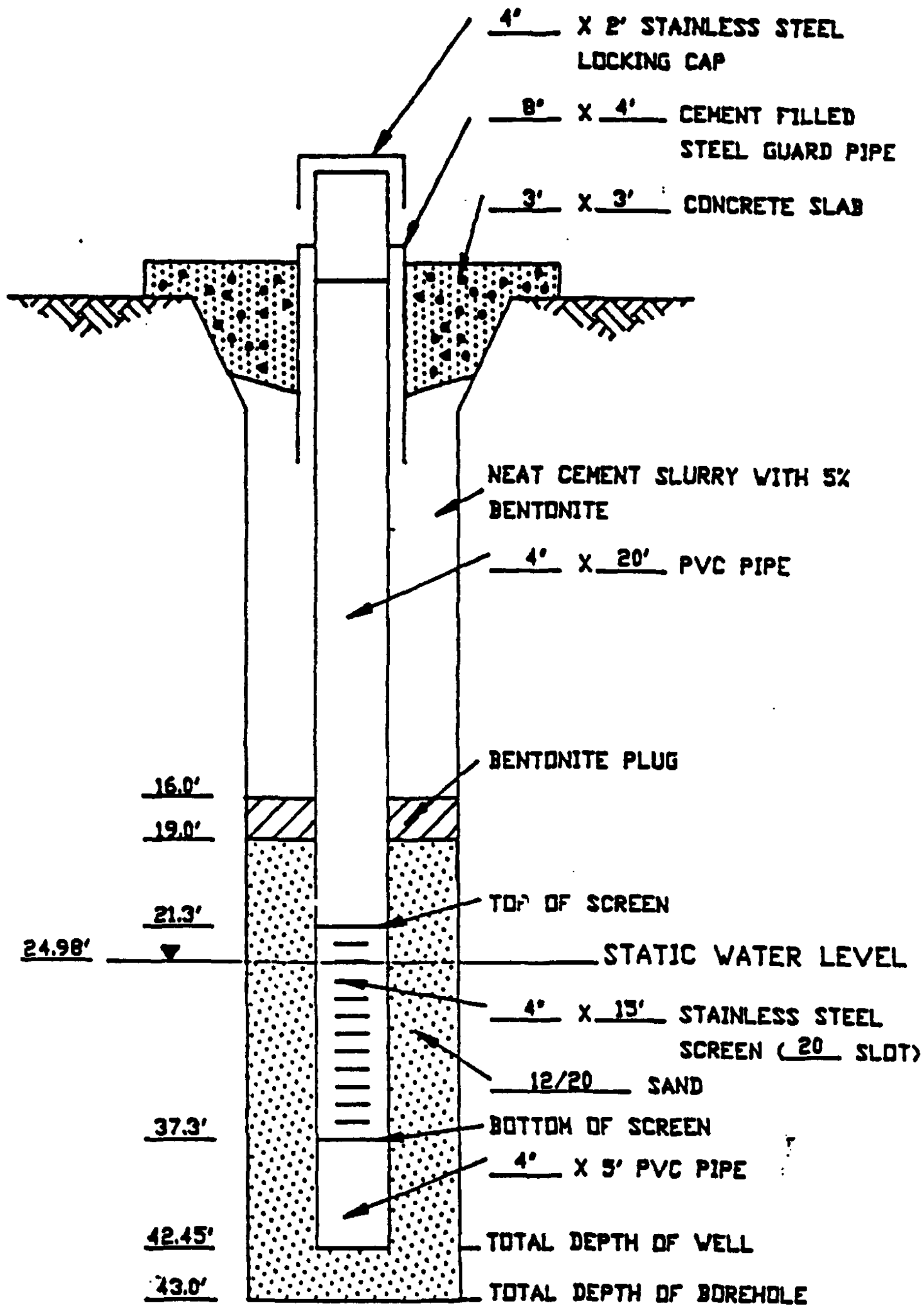


___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

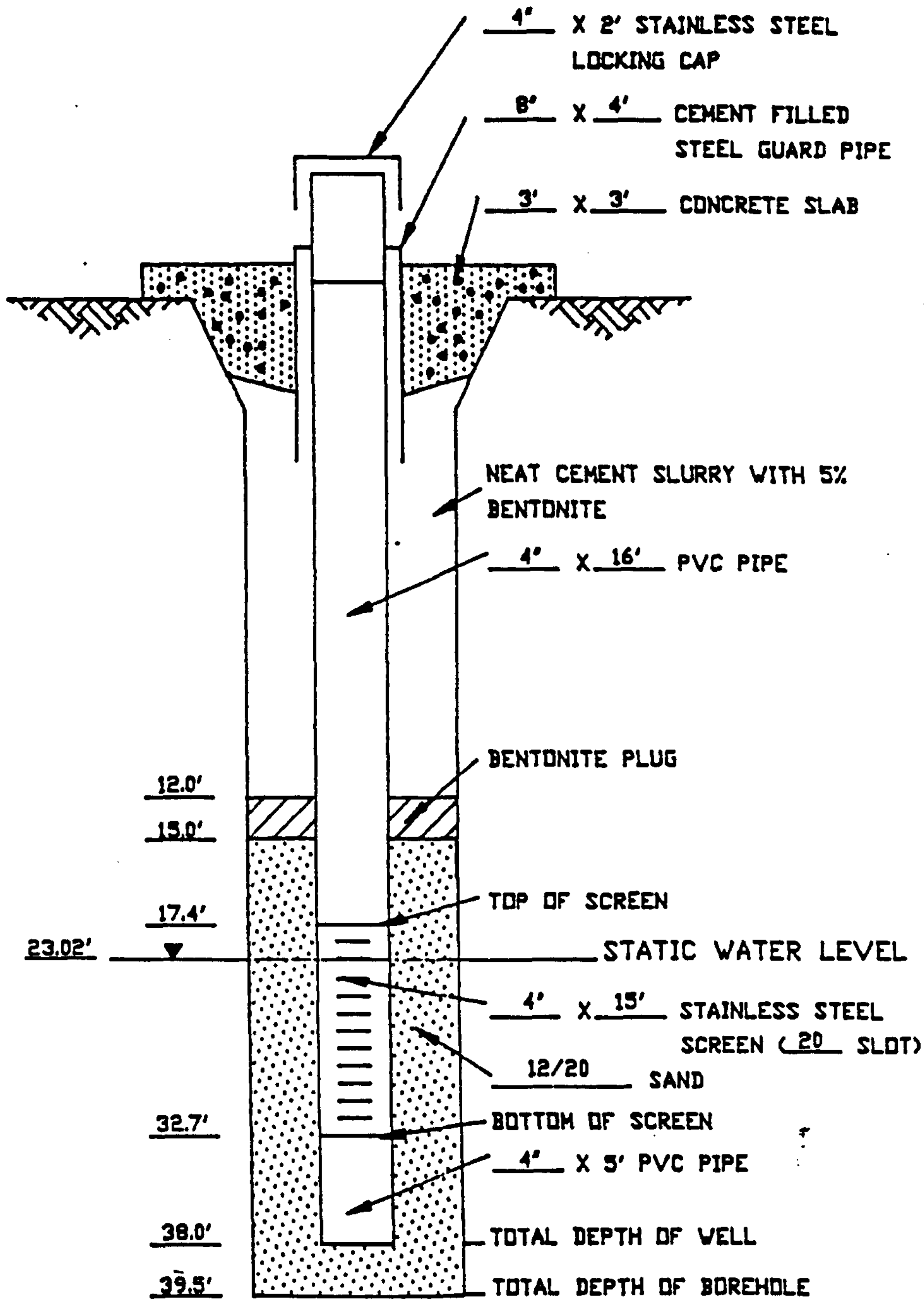
SITE ID: BRC LOCATION ID: P-2
SITE COORDINATES (ft.):
N ___ E ___
GROUND ELEVATION (ft. MSL): 5523.73
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 29 August 1988 DATE COMPLETED: 29 August 1988
FIELD REP.: W.S. Dubyk
COMMENTS: This well replaced by P-2a. Static on September 2, 1988: 23.75 from TOC.

LOCATION DESCRIPTION: ___

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-13' Silty and Clay - Dark gray (N3) to grayish black (N2) to dark yellowish brown (10 YR 4/2). Intense hydrocarbon odor.
5			1650		
10			1656		
					13'-31.5' Sand and Gravel - Moderate yellowish brown (10 YR 5/4) to medium gray (N5). Sand is medium to very coarse grained, subangular to subrounded. Gravel is subangular to well rounded, to 2" diameter. Strong hydrocarbon odor below 25'.
15			1710		
20			1720		
25			1730		
30			1734		
					31.5'-39.5' Shale - Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2).
35			1752		
40		T.D. 39.5'	1808		
45					
50					



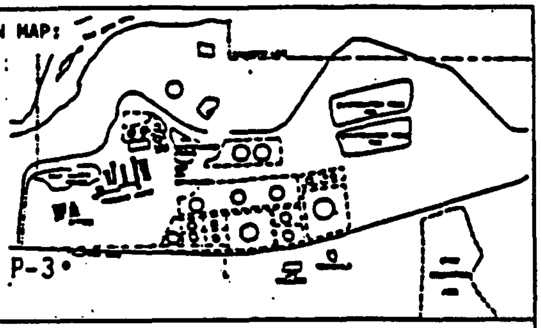
COMPLETION DIAGRAM
PIEZOMETER P-1



COMPLETION DIAGRAM
PIEZOMETER P-2

LITHOLOGIC LOG (SOIL)

LOCATION MAP:

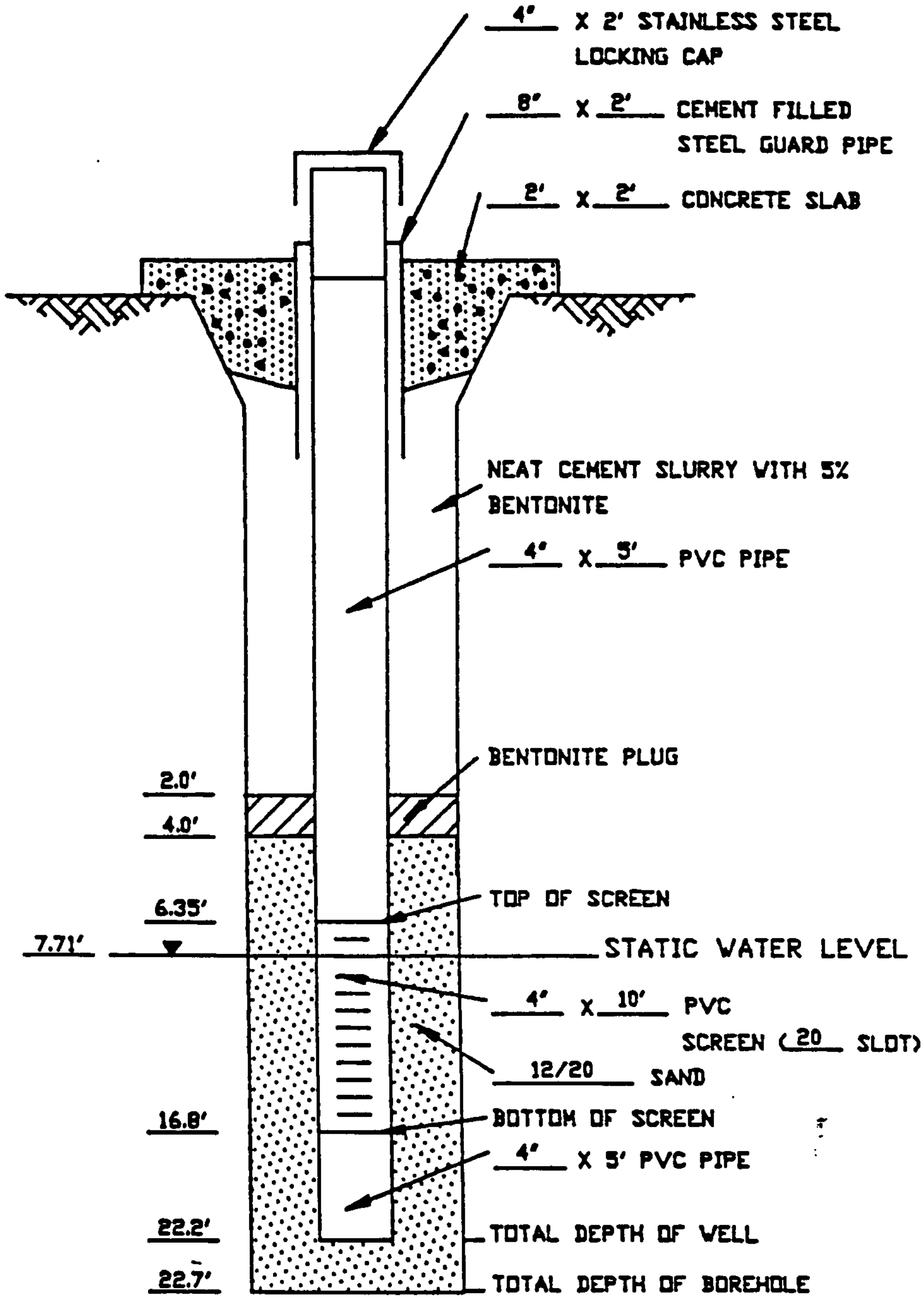


____1/4 ____1/4 ____1/4 ____1/4 S____ T____ R____

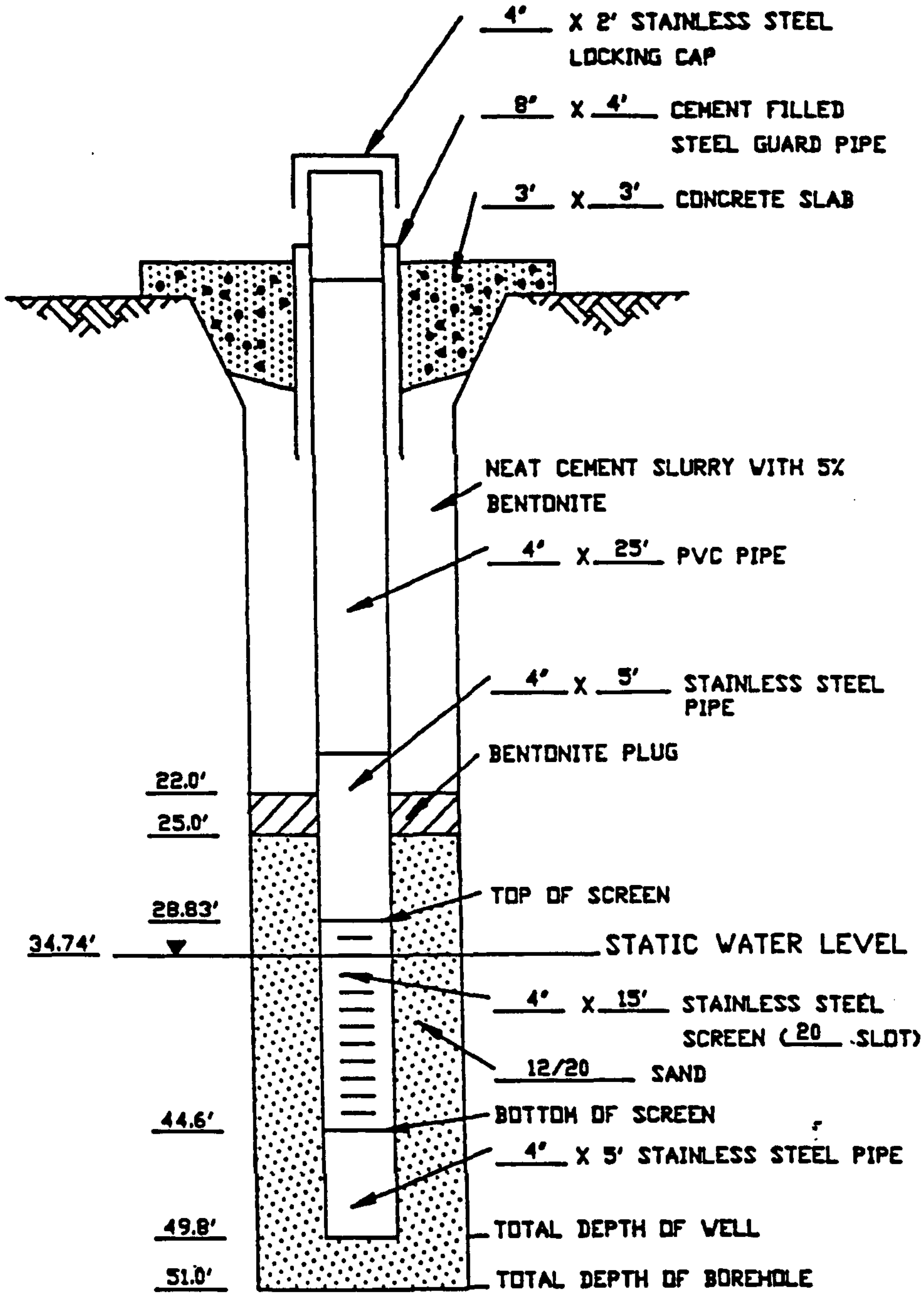
SITE ID: BRC LOCATION ID: P-3
SITE COORDINATES (ft.):
N ____ E ____
GROUND ELEVATION (ft. MSL): 5507.20
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 1 September 1988 DATE COMPLETED: 1 September 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 2, 1988; 8.30' from TOC.

LOCATION DESCRIPTION: ____

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-14' Sand and Gravel - Medium gray (N5) to dark gray (N3). Sand is medium to coarse grained, subangular to subrounded. Gravel is subrounded to rounded, to 2" diameter. Strong hydrocarbon odor.
5			0902		
10			0913		
					14'-22.7' Shale: Nacimiento Formation - Dusky yellow (5 YR 6/4) to light olive gray (5 Y 6/1) shale.
15			0920		
20			0925		
			1000		
25					
		T.D.22.7'			
30					
35					
40					
45					
50					



COMPLETION DIAGRAM
PIEZOMETER P-3



COMPLETION DIAGRAM
PIEZOMETER P-4

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point MP-1

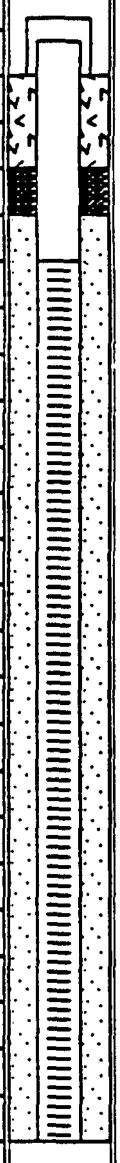
Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. ______ Total Hole Depth 30 ft. Diameter 10 in.
Top of Casing ______ Water Level Initial 25 ft. Static ______
Screen: Dia 2 in. Length 25 ft. Type/Size PVC 0.020 in.
Casing: Dia 2 in. Length 5 ft. Type PVC
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/13/94 Permit # ______
Checked By JAM License No. ______

See Site Map
For Boring Location

COMMENTS:

Start @ 1315 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							See drilling log VEW-1 for lithology
2							
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							



Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point **MP-1**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
25							∇ *Groundwater encountered at 25 feet on 5/13/94*
26							
28							
30							End of boring at 30 feet (1335 hrs). Installed well screened from 5 to 30 feet on 5/13/94.
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point MP-2

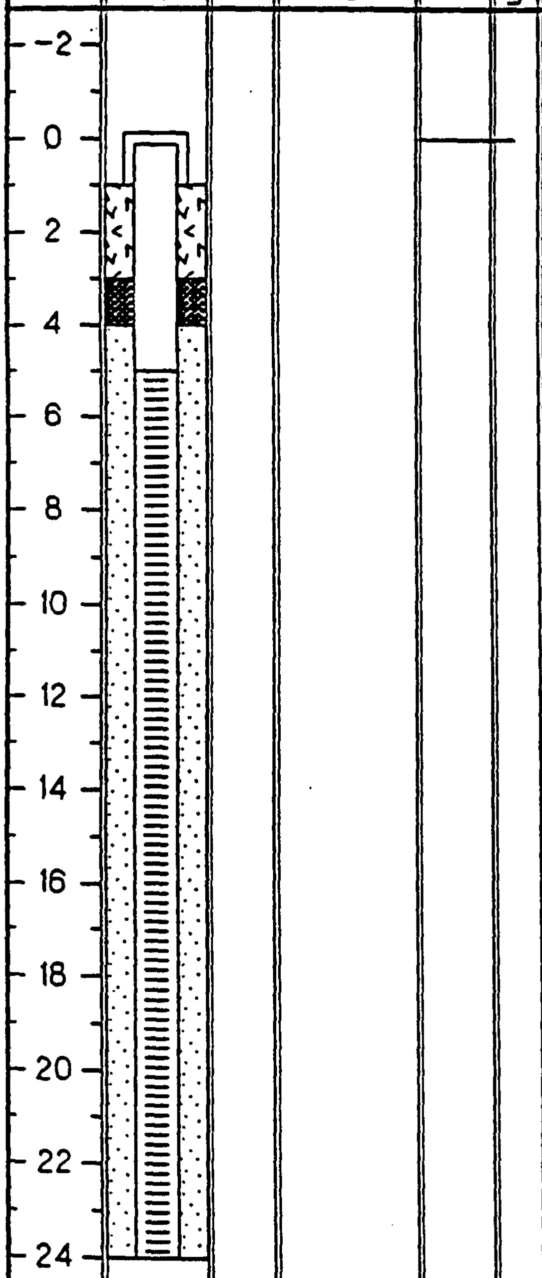
Project BRC
Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico
Proj. No. 023353014
Surface Elev.
Total Hole Depth 30 ft.
Diameter 10 in.
Top of Casing
Water Level Initial 24 ft.
Static
Screen: Dia 2 in.
Length 25 ft.
Type/Size PVC .020 in.
Casing: Dia 2 in.
Length 5 ft.
Type PVC
Fill Material 10/20 Co. Silica
Rig/Core Drill Systems 180
Drill Co. Layne
Method Air Percussion
Driller Gabby Rodriguez
Log By Jerry May
Date 05/16/94
Permit #
Checked By JAM
License No.

See Site Map For Boring Location

COMMENTS:

Start at 1615 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



See well VEW-1 for lithology

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Point **MP-2**

Project BRC Owner Bloomfield Refining Company

Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							▽ *Groundwater encountered at 24 feet on 5/16/94*
26							
28							
30							End of boring at 30 feet (1640 hrs). Installed well screened from 5 to 30 feet on 5/16/94.
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point MP-

Project BRC Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. ____ Total Hole Depth 31 ft. Diameter 10 in.
Top of Casing ____ Water Level Initial 28 ft. Static ____
Screen: Dia 2 in. Length 20 ft. Type/Size PVC .020 in.
Casing: Dia 2 in. Length 11 ft. Type PVC
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/17/94 Permit # ____
Checked By JAM License No. ____

See Site Map
For Boring Location

COMMENTS:

Start at 0950 hrs.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0				SM	Tan, fine, poorly-graded silty SAND (dry)
5	62			SM	(Same as above)
10	70			SM/SC	Tan, fine, poorly-graded silty/clayey SAND (moist)
15	238			CL	Brown/gray-stained, silty CLAY (moist, low-medium plasticity)
20	61			SP	Tan, fine-coarse, poorly-graded SAND (moist)
22				SP/GP	(Same with gravel and cobbles at 22 +/- feet)
24					

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point MP-3

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
		516					Tan, fine-coarse, poorly-graded SAND with gravel and cobbles
26							
		2415	MP-3 -27			SP GP	(Gray-stained at 27 feet)
28						∇	*Groundwater encountered at 28 feet on 5/17/94*
							Sample MP-2-27 collected at 27' for lab analysis
30							
							Encountered weathered limestone at 31 feet.
32							End of boring at 31 feet (1125 hrs). Installed well screened from 11 to 31 feet on 5/17/94.
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point MP-4

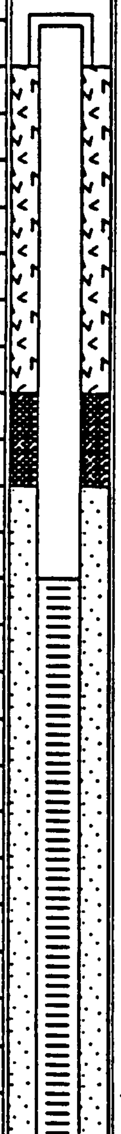
Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *32 ft.* Diameter *10 in.*
Top of Casing ______ Water Level Initial *28 ft.* Static ______
Screen: Dia *2 in.* Length *20 ft.* Type/Size *PVC 0.020 in.*
Casing: Dia *2 in.* Length *12 ft.* Type *PVC*
Fill Material *10/20 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/17/94* Permit # ______
Checked By JAM License No. ______

See Site Map For Boring Location

COMMENTS:

Start at 0845 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							See well MP-3 for lithology
2							
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							



GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Point MP-4

Project BRC Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
26							
28							∇ *Groundwater encountered at 28 feet on 5/17/94*
30							
32							Encountered weathered limestone at 32 feet. End of boring at 32 feet (0910 hrs). Installed well screened from 12 to 32 feet on 5/17/94.
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

Air Sparge Well AS-1

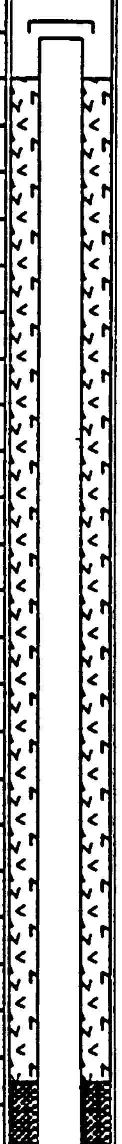
Project: BRC	Owner: Bloomfield Refining Company
Location: 50 County Road 4990, Bloomfield, New Mexico	Proj. No. 023353014
Surface Elev. ______	Total Hole Depth: 32 ft.
Diameter: 10 in.	Top of Casing ______
Water Level Initial: 24 ft.	Static ______
Screen: Dia 2 in.	Length 2 ft.
Type/Size: PVC .020 in.	Casing: Dia 2 in.
Length: 29 ft.	Type: PVC
Fill Material: 10/20 Co. Silica	Rig/Core: Drill Systems 180
Drill Co.: Layne	Method: Air Percussion
Driller: Gabby Rodriquez	Log By: Jerry May
Date: 05/16/94	Permit # ______
Checked By: JAM	License No. ______

See Site Map For Boring Location

COMMENTS:

Start at 1200 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							(See well VEW-1 for lithology)
2							
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							∇

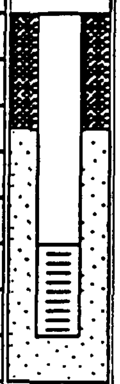


Drilling Log

GROUNDWATER TECHNOLOGY

Air Sparge Well AS-1

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							∇ *Groundwater encountered at 24 feet on 5/16/94*
26							
28							
30							Encountered weathered limestone at 31 feet
32							End of boring at 32 feet (1225 hrs). Installed well screened from 29 to 31 feet on 5/16/94.
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

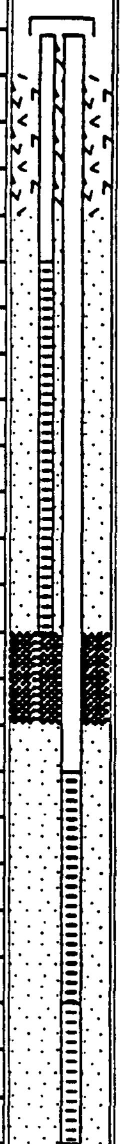
Vapor Extraction Well VEW-1

Project BRC Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. ____ Total Hole Depth 26 ft. Diameter 10 in.
Top of Casing ____ Water Level Initial 24 ft. Static ____
Screen: Dia 2 in. Length See comments Type/Size PVC 0.020" & 0.040 in.
Casing: Dia 2 in. Length See comments Type PVC
Fill Material 10/20 & 6/16 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/16/94 Permit # ____
Checked By JMM License No. ____

See Site Map For Boring Location

COMMENTS:

Start at 1410 hrs. Set nested well. Deep well screened from 21 to 26 feet (0.020 in. slot, 10/20 sand) and 16 to 21 feet (0.040 in. slot, 6/16 sand). Shallow well screened from 5 to 13 feet (0.040 in. slot, 6/16/ sand)



Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0				SM	Tan, fine, poorly-graded, silty SAND (dry-moist)
5	357			CL	Brown, silty CLAY (moist, low plasticity)
10	21				(Tan, same as above)
15	343			SM	Gray-stained, fine poorly-graded, silty SAND (moist)
17					(Cobbles at 17 feet)
20	610			GP	Gravel and cobbles with some fines (moist)
24	2048			SP	

Drilling Log

GROUNDWATER TECHNOLOGY

Vapor Extraction Well **VEW-1**

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		2048	VEW-1 -24			SP	Gray-stained, fine-coarse, poorly-graded SAND with gravel and cobbles (moist-wet)
							Groundwater encountered at 24 feet on 5/16/94
							Sample VEW-1-24 collected at 24'
26						GM	End of boring at 26 feet (1500 hrs). Installed nested wells screened from 5 to 13 feet and from 16 to 26 feet (see comments) on 5/16/94.
28							
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-01

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *North of Transportation Terminal Sump* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *12 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/22/94* Permit # ______
Checked By ______ License No. ______

See Site Map For Boring Location

COMMENTS:

Posthole to 2.5'. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Silty Sand, medium stiff, light brown to brown, moist, no odor, trace clay
2						
	3.5		2/2/3			
4						
			2/2/2			
6	3.1		2/4/4		ML	
8	0		2/3/3			
10	0		4/3/3			
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-02

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *West of Transportation Terminal Sump* Proj. No. *023353014*
Surface Elev. ____ Total Hole Depth *12 ft.* Diameter ____
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia ____ Length ____ Type/Size ____
Casing: Dia ____ Length ____ Type ____
Fill Material ____ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/22/94* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Posthole to 2'. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Silty Sand, medium stiff, light brown to brown, moist, no odor, trace clay
2	0					
4	0		1/3/3			
6	0		3/4/4		ML	
8	0					
10	0		3/3/3			
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-03

Project: Bloomfield Refining Company   Owner: Bloomfield Refining Company
Location: Adjacent to Crude/Product Loading Area   Proj. No. 023353014
Surface Elev. ____   Total Hole Depth: 12 ft.   Diameter ____
Top of Casing ____   Water Level Initial ____   Static ____
Screen: Dia ____   Length ____   Type/Size ____
Casing: Dia ____   Length ____   Type ____
Fill Material ____   Rig/Core: B55
Drill Co.: Western Technology   Method: Split Spoon/Hollow Stem Auger (7")
Driller: Rob   Log By: Tim Busby   Date: 02/23/94   Permit # ____
Checked By ____   License No. ____

See Site Map
For Boring Location

COMMENTS:

Posthole to 2'. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Light brown to brown Sandy Silt, little clay, moist, no odor
2	0		3/5/2			
4	0		3/4/3			
6	0		3/3/2		ML	
8	0		3/4/4			
10	0		3/3/4			
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-04

See Site Map For Boring Location

Project Bloomfield Refining Company Owner Bloomfield Refining Company
Location by Tank 44, Adjacent to Crude/Product Loading Area Proj. No. 023353014
Surface Elev. ______ Total Hole Depth 12 ft. Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core B55
Drill Co. Western Technology Method Split Spoon/Hollow Stem Auger (7")
Driller Rob Log By Tim Busby Date 02/23/94 Permit # ______
Checked By ______ License No. ______

COMMENTS:

Posthole to 2'. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Light brown to brown Sandy Silt, moist, no odor
2	5.2		3/3/4			
4	15.7		3/2/1			Light brown to brown Sandy Silt, little clay
6	22		3/5/6		ML	Light brown to brown sandy silt, moist, no odor
8	45					
10	18.8		3/4/5			Light brown to brown Sandy Silt, little clay
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-05

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *West of Evaporation Pond #2* Proj. No. *023353014*
Surface Elev. ____ Total Hole Depth *8 ft.* Diameter ____
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia ____ Length ____ Type/Size ____
Casing: Dia ____ Length ____ Type ____
Fill Material ____ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Posthole to 2'. Hit cobble layer @ 5'. Poor recovery @ 6': No sample collected at 6'. Terminated boring. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-5': Light brown to brown Silty Sand, some clay, moist, no odor
2	0		2/2/5		ML	
4	0		26/34/31			
5						Light brown to gray Sand and gravel and cobbles, moist, no odor
6	0		40/37/39		GW	
8						Total Depth @ 8 feet.
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-06

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *West of Evaporation Pond #1* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *10 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ______
Checked By ______ License No. ______

See Site Map For Boring Location

COMMENTS:

Shelby sample collected @ 4-5'; Cobble layer @ ~ 5.5'. Cuttings collected @ 6'. Try to sample @ 8 because driller thinks we're thru layer. 9" into sample blow count=27, bouncing on cobble. No groundwater encountered. Boring filled with cement/bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0					ML	0-5.5': Light brown to brown Silty Sand, trace clay, moist, no odor
2	0		12/8/8			
4	4		10/11			
6	2				GW	5.5-10': Light brown to tan, Sand and gravel and cobbles, very coarse, poorly graded, moist, no odor
8	0					
10	0					Total Depth @ 10 feet.
12						
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring **B-07**

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *Southwestern section of Fire Training Area* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *12 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ______
Checked By ______ License No. ______

See Site Map For Boring Location

COMMENTS:

Post hole to 2'. No groundwater encountered. Boring backfilled with cement/bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-7': Light brown to brown Sandy Silt, moist, no odor
2	0		2/2/1			
4	0		6/5/4		ML	
6	0		12/13/12			
						7-12': Light brown to brown Silty Sand, trace silt, moist, no odor
8	0					
10	0		5/6/7		SM	
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-08

Project: Bloomfield Refining Company	Owner: Bloomfield Refining Company
Location: Southeastern section of Fire Training Area	Proj. No. 023353014
Surface Elev.	Total Hole Depth: 12 ft.
Diameter	
Top of Casing	Water Level Initial
Static	
Screen: Dia	Length
Type/Size	
Casing: Dia	Length
Type	
Fill Material	Rig/Core: B55
Drill Co. Western Technology	Method: Split Spoon/Hollow Stem Auger (7")
Driller: Rob	Log By: Tim Busby
Date: 02/23/94	Permit #
Checked By	License No.

See Site Map
For Boring Location

COMMENTS:

Post hole to 2'. No groundwater encountered. Boring backfilled with cement/bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0					0-7.5': Light brown to brown Sandy Silt, moist, no odor
2	0		3/3/4		
4	0		6/5/7	ML	
6	1		8/13/16		
7.5				CL	7.5-8': Clay, trace sand, brown, moist, no odor
8	0		6/8/9		8-12': Silty Sand, light brown to brown, moist, no odor
10	0		6/10/13	SM	
12					Total Depth @ 12 feet.
14					
16					
18					
20					
22					
24					

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-09

See Site Map
For Boring Location

COMMENTS:

Post hole to 2'. No groundwater encountered. Bag samples only @ 8 & 10'. No odor. Boring backfilled with cement/bentonite.

Project: Bloomfield Refining Company   Owner: Bloomfield Refining Company
Location: Northeastern section of Fire Training Area   Proj. No.: 023353014
Surface Elev.: ____   Total Hole Depth: 10 ft.   Diameter: ____
Top of Casing: ____   Water Level Initial: ____   Static: ____
Screen: Dia ____   Length ____   Type/Size ____
Casing: Dia ____   Length ____   Type ____
Fill Material: ____   Rig/Core: B55
Drill Co.: Western Technology   Method: Split Spoon/Hollow Stem Auger (7")
Driller: Rob   Log By: Tim Busby   Date: 02/23/94   Permit #: ____
Checked By: ____   License No.: ____

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-7.5': Silty Sand, light brown to brown, moist, no odor
2	0		4/3/3			
4	0		4/6/5		ML	
6	0		5/4/12			
					CL	7.5-8': Clay, brown, moist, no odor, cobbles from 8-10'
8	0					
					GW	8-10': Cobbles
10	0					Total Depth @ 10 feet.
12						
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER TECHNOLOGY

Soil Boring B-10

See Site Map
For Boring Location

Project Bloomfield Refining Company Owner Bloomfield Refining Company
Location Northwestern section of Fire Training Area Proj. No. 023353014
Surface Elev. ____ Total Hole Depth 12 ft. Diameter ____
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia ____ Length ____ Type/Size ____
Casing: Dia ____ Length ____ Type ____
Fill Material ____ Rig/Core B55
Drill Co. Western Technology Method Split Spoon/Hollow Stem Auger (7")
Driller Rob Log By Tim Busby Date 02/23/94 Permit # ____
Checked By ____ License No. ____

COMMENTS:

Post hole to 2'. No groundwater encountered. Boring backfilled with cement/bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-11': Silty Sand, light brown to brown, moist, no odor
2	0					
4	0		6/7/7			
6	0		4/5/7		ML	
8	0		5/7/4			
10	0		6/6/23			
					CL	11-12': Clay and cobbles, brown, moist, no odor
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

PRECISION ENGINEERING, INC.

PROJECT: Bloomfield Refinery
"I stigation

LOG OF TEST BORINGS

FILE #: 96-181
ELEVATION:
TOTAL DEPTH: 85'
LOGGED BY: Kingsley
DATE: 12/10/1996
STATIC WATER: 10.2'
BORING ID: MW24N Bore
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION COLOR GRAINSIZE ETC.)	PID (ppm)
0-10.2	0000000000		▼	Cobbles, gravelly, sandy, very dense, rounded and disked, composed of chrystalline	
	o00oc000o0		▼	intrusives and high density metamorphic rocks, dry to 10.2 feet where the soil	
	000o000o00			becomes water bearing. Generally light colored rocks and light brown fine grained	
	o00oo000o0		▼	soils.	
10.2-12.5	000o0c0oo0			As above but water bearing. Materials coated black and have hydrocarbon odor.	
12.5	o00oo000oo		▼	Odor is of older tetted hydrocarbon. Sheen on water, no free hydrocarbon observed	
12.5-39.0	**********		▼	Sandstone, fine, poorly cemented, argillaceous, hand sample crumbles, grey blue,	
	**********		▼	wet but not water bearing, weak hydrocarbon odor, mod. dense, massive (no jointing)	
	**********		▼	Yellow brown color at 13.0', no hydrocarbon odor, slightly less moisture.	
	**********	20	▼	Blue grey at 15.0', no hydrocarbon odor. Sandstone dries white to light grey.	
	**********		▼	Sample recovery 100%. Cores are high quality. Core rate using carbide NWD4 bit	
	**********		▼	approx. 1'/min	
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼	Thin (<1cm) carbonaceous shale seams, appears coaly, random orientation but	
	**********		▼	typically near flat lying. No free water, samples moist.	
39.0	**********		▼		
42.0	----------	40	▼	Shale, damp to moist, no water at interface of sandstone above and shale, blue grey	
42.0	----------		▼	to steel grey, crumbles easily in hand samples but dense in situ. Core rate 3"/min	
42.0-85.0	**********		▼	No jointing observed in cores. Recovery 100%. Occasional sandstone stringer	
	**********		▼	16" or less in thickness (rare). Cores are high quality. Some carbonaceous zones	
	**********		▼	Sandstone, fine, weakly cemented, argillaceous, sample crumbles with difficulty,	
	**********		▼	grey to light brown, some calcite filling along flat lying bedding planes, moist	
	**********		▼	dense, more cemented than sandstone above. Core rate 7"/min.	
	**********		▼	Some shale in very thin lenses >60'.	
	**********		▼		
	**********		▼		
	**********	60	▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********		▼		
	**********	80	▼		
	**********		▼		
85.0	**********		▼		
TD					

LOGGED BY: Kingsley

SIZE AND TYPE OF BORING: 8-5/8 od HSA to 12.5', NWD4 core to 85'

PRECISION ENGINEERING, INC.

PROJECT: Bloomfield Refinery
uff estigation

LOG OF TEST BORINGS

FILE #: 96-181
ELEVATION:
TOTAL DEPTH: 80
LOGGED BY: Kingsley
DATE: 12/11-12/1996
STATIC WATER: 11.7
BORING ID: N Point Bore
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0-11.7	00oo00ooO		▼	Cobbles. gravelly. sandy. very dense. rounded and disked. composed of chrystalline	
	o00uu00oo			intrusives and high density metamorphic rocks. dry to 11.7 feet where the soil	
	00co00ooO			becomes water bearing. Generally light colored rocks and light brown fine grained	
	o00ooo0Coo		▼	soils.	
11.7-12.0	00oo00ooO			As above but water bearing. Materials coated black and have hydrocarbon odor.	
12.0	o00ooCOoo		▼	Odor is of older fetted hydrocarbon. No sheen observed. no free hydrocarbon.	
12.0-34.7	*********		▼	Sandstone. fine. poorly cemented. argillaceous. hand sample crumbles. grey blue.	
	*********			wet but not water bearing. weak hydrocarbon odor to 13.0. >13.0 no odor. mod. dense	
	*********			Yellow brown color at 13.0'. no hydrocarbon odor. slightly less moisture.	
	*********	20	▼	Auger drill to 20.0'. Rotary drill using NWD4 core with carbide bit to TD.	
	*********		▼	21'-23' carbonaceous shale laminae in the sandstone <5mm. >25' sandstone is	
	*********		▼	yellow streaked (limonitic banding).	
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
34.7	*********		▼		
7-52.0	---------		▼	Shale. damp to moist. no water at interface of sandstone above and shale. blue grey	
	---------		▼	to steel grey. crumbles easily in hand samples but dense in situ. Core rate 2"/min	
	---------	40	▼	No jointing observed in cores. Recovery 100%. Cores are high quality.	
	---------		▼		
	---------		▼		
	---------		▼		
	---------		▼		
	---------		▼		
52.0	---------		▼		
52.0-80.0	*********		▼	Sandstone. fine. moderately cemented. argillaceous. sample difficult to crumble.	
	*********		▼	grey to light brown. some calcite filling along flat lying bedding planes. moist	
	*********		▼	dense. more cemented than sandstone above. Core rate 5"/min.	
	*********	60	▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼	mud volume virtually unchanged during the coring.	
	*********		▼	significantly more dense at 73'. Core rate 3"/min.	
	*********		▼		
	*********		▼		
	*********		▼		
80.0	*********	80	▼		
TD					

LOGGED BY: Kingsley

SIZE AND TYPE OF BORING: 8-5/8 od HSA to 20'. NWD4 core to 80'

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

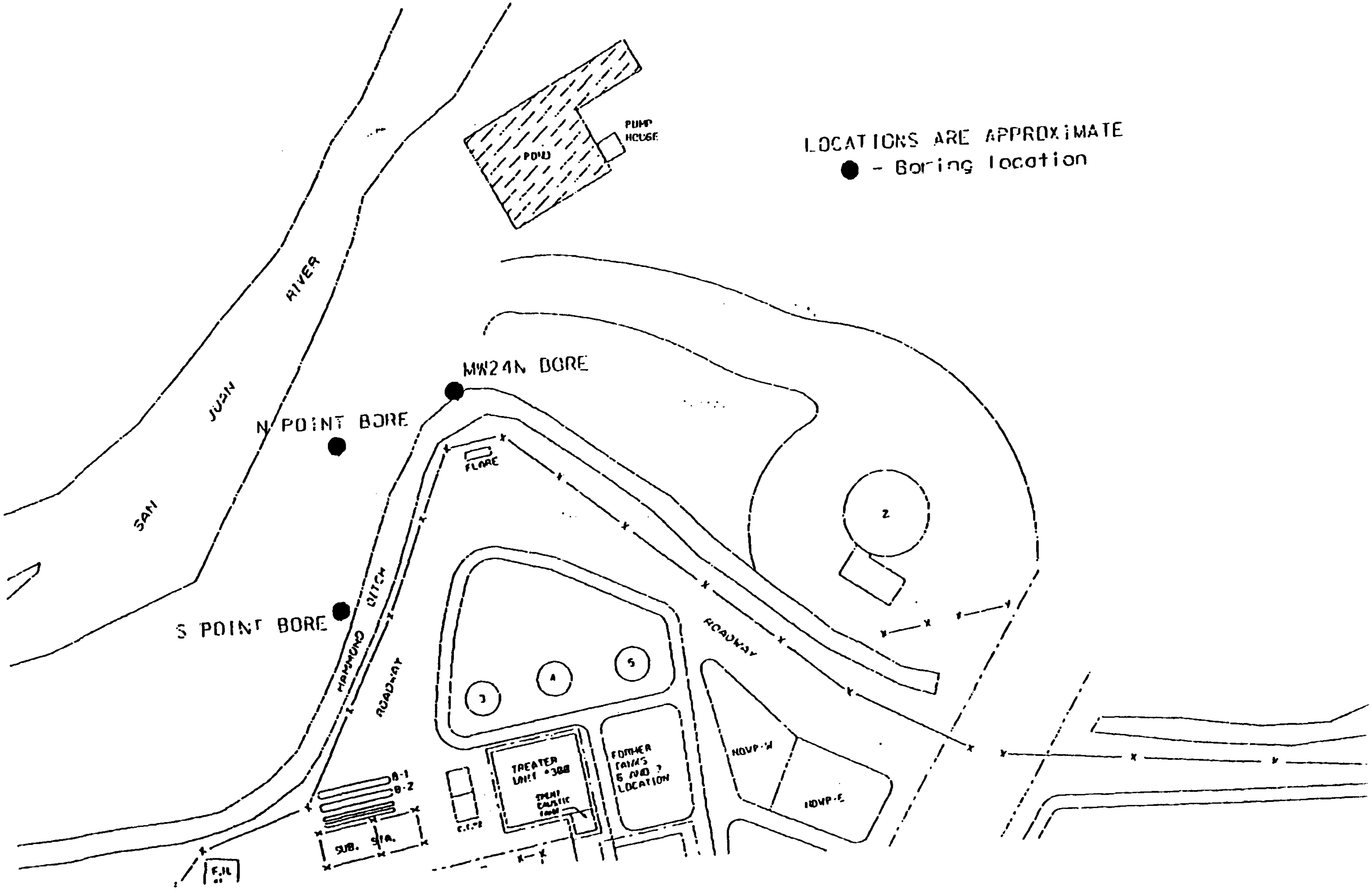
PROJECT: Bloomfield Refinery
'f .tigation

FILE #:	96-101
ELEVATION:	
TOTAL DEPTH:	85
LOGGED BY:	Kingsley
DATE:	12/13/1996
STATIC WATER:	19.5
BORING ID:	S Point Bore
PAGE:	1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION COLOR GRAINSIZE ETC.)	PID (ppm)
0-19.5	00o00000o0		▼	Cobbles, gravelly, sandy, very dense, rounded and disked, composed of chrystalline	
	o00oo00oo			intrusives and high density metamorphic rocks, dry to 19.5 feet where the soil	
	00oo00oo0			becomes water bearing. Generally light colored rocks and light brown fine grained	
	o00oo00oo		▼	soils.	
	00oo00oo0				
	o00oo00oo		▼		
	00oo00oo0		▼		
	o00oo00oo				
19.5-22.0	00oo00oo0			As above but water bearing. Materials coated black and have hydrocarbon odor.	
	o00oo00oo	20	▼	Odor is of older fetted hydrocarbon. Slight sheen observed, no free hydrocarbon.	
22.0	00oo00oo0		▼		
22.0-36.0	*********		▼	Sandstone, fine, poorly cemented, argillaceous, hand sample crumbles, grey blue,	
	*********		▼	wet but not water bearing, weak hydrocarbon odor to 22.6, >22.6 no odor, mod. dense	
	*********		▼		
	*********		▼	Auger drill to 25.0'. Rotary drill using NWD4 core with carbide bit to TD.	
	*********		▼		
	*********		▼	Some limonitic banding >30'.	
.0	*********		▼		
.0-50.5	---------		▼	Shale, damp to moist, no water at interface of sandstone above and shale, blue grey	
	---------	40	▼	to steel gray, crumbles easily in hand samples but dense in situ. Core rate 2"/min	
	---------		▼	No jointing observed in cores. Recovery 100%. Cores are high quality.	
	---------		▼		
	---------		▼		
	---------		▼		
50.5	---------		▼		
50.5-85.0	*********		▼	Sandstone, fine, moderately cemented, argillaceous, sample difficult to crumble,	
	*********		▼	grey to light brown, some calcite filling along flat lying bedding planes, moist	
	*********		▼	dense, more cemented than sandstone above. Core rate 4.5"/min.	
	*********		▼		
	*********	60	▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼	mud volume virtually unchanged during the coring.	
	*********		▼	more dense at 75'. Core rate 3.5"/min.	
	*********		▼		
	*********		▼		
	*********		▼		
	*********	80	▼		
	*********		▼		
85.0	*********		▼		
TD					

LOGGED BY: Kingsley

SIZE AND TYPE OF BORING: 8-5/8 od HSA to 25.0' NWD4 core to 85'


LOCATIONS ARE APPROXIMATE
● - Boring location
PUMP HOUSE
POND
SAN JUAN RIVER
MW24N BORE
N POINT BORE
S POINT BORE
HAMMOND DITCH
ROADWAY
FLARE
2
3
4
5
TREATER UNIT #388
SPENT CAUSTIC TANK
FORMER TANKS 6 AND 7 LOCATION
B-1
B-2
SUB. STA.
ROADWAY

PRECISION ENGINEERING, INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5464.8
TOTAL DEPTH: 31.5'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 6.0'/16 HRS
BORING ID: SB1-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-6.1	***000***		C	SAND, GRAVELLY, SOME GREY SANDSTONE, LOOSE, (SLOPE TALUS)	0.0-10.0
	000		C		0
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	5.0	C		
	000		C		
6.1	***000***		C		
6.1-30.3	===**====		C	SHALE, SLIGHTLY SANDY, DARK GREY, WET (NOT WATER BEARING), DENSE	
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	10	C		
	===**====		C	OLD HYDROCARBON ODOR (DEGRADED)	302
	===**====		C	SLIGHTLY MORE FISSLE AT 12 FEET, DRY GREATER THAN 11 FEET	11.0-31.5
	===**====		C		0
	===**====		C	12.0-13.0 FEET-BROWNER AND SANDY, DRY	
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	15	C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	20	C	SHALE, DARK GREY, HARD, DRY FISSLE, SLIGHTLY SANDY	
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

LOCATION:

FILE #: 97-028
ELEVATION: 5464.80
TOTAL DEPTH: 31.5'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 6.0'/16 HRS
BORING ID: SB1-397
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
	----**----		C		23.0-31.5
	----**----		C		0
	----**----		C		
	----**----		C		
	----**----	25	C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----		C		
	----**----	30	C	SHALE-HARD FISSLE. SOME SANDY STRINGERS APPROXIMATELY 3 FOOT THICK AT 22'-25'	
30.3	----**----		C		
30.3-31.5	SSSSSSSSS		C	SANDSTONE, WHITE, DENSE, DRY, FINE	
TOTAL DEPTH			C	SOME CUTTINGS OBSERVED AT 20'-25' THAT WERE SATURATED, THEN DRIES OUT.	
			C	SAME OBSERVED WHEN DRILLING 25'-30'.	
			C	SUSPECT WATER AT 10.5'-11.0' RUNNING DOWN BORE HOLE. ANNULUS IS SATURATING	
			C	CUTTINGS.	

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5446.64
TOTAL DEPTH: 37.0'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 28.0'/16 HRS
BORING ID: SB2-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-6.0	***000***		C	NOTE: SEEP AT SURFACE OF PAD	0.0-2.0
	000		C	SAND. GRAVELLY. WET/MOIST. LOOSE. BROWN. BLACK IN ZONES. HAS (POOR) HYDROCARBON	0
	000		C	ODOR-OLD SMELL	
	000		C		2.0-5.0
	000		C		5
	000		C		
	000		C		
	000		C		
	000		C		
	000	5.0	C		
	000		C		
6.0	***000***		C		
6.0-17.0	***000***		C	SAND. FINE. GRAVELLY. FLUID BEARING. JET BLACK. STRONG HYDROCARBON ODOR-OLD FETTED.	
	000		C	LOOSE	
	000		C	NOT WATER BEARING GREATER THAN 15.0'	
	000		C	MORE CLAY GREATER THAN 15.0'	
	000		C		
	000		C		
	000		C		
	000	10	C		
	000		C		537
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	15	C		
	000		C		975
	000		C		
	000		C		
17.0	***000***		C		
17.0-23.5	SSSSSSSSS		C	SANDSTONE. LIGHT GREY/WHITE. HARD. WET. LAMINATED. SHOWS SOME ANGULAR DISCONTINUITY	
	SSSSSSSSS		C	(NOT WATER BEARING)	
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS	20	C		
	=S=S=S=S=		C	SHALE AND SANDSTONE IN RANDOM DISCONTINUOUS LAYERS AND DIPS-SUSPECT TOPPLED BLOCK	
	=S=S=S=S=		C	FROM ADJACENT CLIFF FACE	1331
	=S=S=S=S=		C		
	=S=S=S=S=		C		
	=S=S=S=S=		C		67
	=S=S=S=S=		C		

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5446.64
TOTAL DEPTH: 37.0'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 28.0'/16 HRS
BORING ID: SB2-397
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
23.5	=S=S=S=S=		C		
23.5-29.0	*********		C	SAND, MEDIUM, WET, LOOSE, DARK GREY, OLD HYDROCARBON ODOR FETTED, NOT WATER BEARING	
	*********		C		
	*********	25	C		
	*********		C		571
	*********		C		
	*********		C		1037
	*********		C		
	*********		C		
	*********		C		
	*********		C	WATER BEARING AT 28.0', BLACK, HYDROCARBON ODOR (OLD)	449
29.0	*********		C		
29.0-32.5	SSSSSSSSS		C	NACIMIENTO FORMATION	773
	SSSSSSSSS	30	C	SANDSTONE, HARD, MOIST, ARGILLACEOUS, LIGHT BROWN	
	SSSSSSSSS		C		155
	SSSSSSSSS		C		40
	SSSSSSSSS		C		48
	SSSSSSSSS		C		
32.5	SSSSSSSSS		C		22
5-37.0	=========		C	SHALE, GREY-GREEN, HARD, DRY/DAMP, FISSLE	32.0-37.0
	=========		C		0
	=========		C		
	=========		C		
	=========	35	C		
	=========		C		
	=========		C		
	=========		C		
37.0	=========		C		
TOTAL DEPTH				WATER AT 28.0' IN AUGER AFTER 16 HOURS	

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING. INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5419.09
TOTAL DEPTH: 10.0'
LOGGED BY: WHK
DATE: 3-14-97
STATIC WATER: 4.0'
BORING ID: SB3-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION COLOR GRAINSIZE ETC.)	PID (ppm)
0.0-1.0	****0****		C	SAND. LOOSE. BROWM. MOIST. (FILL) GRAVELLY	
1.0	****0****		C		
1.0-2.2	///**-///		C	CLAY. SANDY. SILT. BLACK-GREY. OLD HYDROCARBON ODOR. WET. NEARLY WATER BEARING	109
2.2	///**-///		C		
2.2-6.0	*********		C	SAND. FINE-MEDIUM. WELL SORTED. BLACK. WET. WATER BEARING GREATER THAN 4.0 FEET	
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********	5.0	C		
	*********		C		1068
6.0	*********		C		
6.0-10.0	SSSSSSSSS		C	NACIMIENTO FORMATION	16.5
	SSSSSSSSS		C	SANDSTONE. ARGILLACEOUS. FINE. DENSE. GREENGREY. WET. NO ODOR	
	SSSSSSSSS		C		
	SSSSSSSSS		C		0
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS	10	C	MOIST AT 10.0 FEET	0
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING. INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5428.88
TOTAL DEPTH: 20.0'
LOGGED BY: WHK
DATE: 3-14-97
STATIC WATER: 11.5'
BORING ID: SB4-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION COLOR GRAINSIZE ETC.)	PID (ppm)
0.0-6.0	///--*0//		C	CLAY. SILTY. SANDY. SOME LARGE COBBLES. BOULDER INFILL	0.0-20.0
	///--*0//		C	LARGE COBBLE (BOULDER) 4.5-6.0. BROWN	0
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//	5.0	C		
	///--*0//		C		
6.0	///--*0//		C		
6.0-9.5	*********		C	SAND. FINE. LIGHT BROWN. LOOSE. MOIST	
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
9.5	*********		C		
5-17.0	***000***	10	S	SAND. GRAVELLY. DENSE. BROWN. MOIST. WATER BEARING AT 11.5 FEET	
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000	15	S		
	000		S		
	000		S	GLASS FRAGMENT. HIGHLY WEATHERED FOUND AT 16.0 FEET	
	000		S		
17.0	***000***		S		
17.0-20.0	=========		S	NACIMIENTO FORMATION	
	=========		S	SHALE. BLACK/GREY. MOIST. HARD. FISSLE. LITTLE TO NO SAND	
	=========		S		
	=========		S		
	=========		S		
	=========	20	S		
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING. INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5423.26
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 4.0'
BORING ID: SB5-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE.CONDITION.COLOR.GRAINSIZE.ETC.)	PID (ppm)
0.0-11.5	*********		C	SAND. FINE. LOOSE. MOIST. BROWN	
	*********		C		
	*********		C		
	*********		C		
	*********		C		60
	*********		C		
	*********		C		
	*********		C	BLACK. WATER BEARING AT 4.0'	
	*********		C		603
	*********	5.0	C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********	10	C		
	*********		C	SOME SHEEN	1056
	*********		C		
11.5	*********		C		
11.5-13.5	***00****		C	SAND. MEDIUM GRAINED. SOME COBBLES. DENSE. FLOWS. BLACK	
	00*		C		
	00*		C		231
13.5	***00****		C		
13.5-15.0	***00****		C	SAND. MEDIUM. GRAVELLY. GREY (DARK). NO ODOR. LOOSE	
	00*		C		
15.0	***00****	15	C		0
15.0-17.5	=========		C	SHALE. GREY. HARD. DAMP. FISSLE. (APPEARS DRY). LITTLE SAND	
	=========		C		
	=========		C		
	=========		C		0
17.5	=========		C		
TOTAL DEPTH				NO SHEEN-ANY DEPTH	

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

LOCATION: SEE SITE PLAN

FILE #: 97-028
ELEVATION: 5422.69
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 4.67'
BORING ID: SB6-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-14.5	*********		C	SAND. FINE. DAMP. BROWN. MODERATELY DENSE. BLACK. FINE AND COARSE GRAVEL	
	*********		C		
	*********		C		0
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C	BLACK AT 4.0 FEET	
	*********	5.0	C	WATER BEARING AT 4.67 FEET-NO SHEEN (NO SEPARATE PHASE)	
	*********		C	GRAVELLY AT 5.0 FEET. GRAVEL UP TO 2 INCHES IN SIZE	981
	*********		C	LITTLE TO NO SILT	
	*********		C		
	*********		C		
	*********		C		
	*********		C		511
	*********		C		
	*********		C		970
	*********		C		
	*********	10	C		
	*********		C		13
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		50
	*********		C		
	*********		C		
14.5	*********		C		
14.5-17.5	SSSSSSSSS	15	C	NACIMIENTO FORMATION	
	SSSSSSSSS		C	SANDSTONE. FINE. GREY-BLUE. DENSE. MOIST-WET. NOT WATER BEARING. FRESH SAMPLE LOOKS	3
	SSSSSSSSS		C	DRY	
	SSSSSSSSS		C		
	SSSSSSSSS		C		0
17.5	SSSSSSSSS		C		
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5423.17
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 5.0'
BORING ID: SB7-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-1.0	///000///		C	CLAY, GRAVELLY, DRY-DAMP, SOFT, BROWN, NO ODOR	0.0-17.5
1.0	///000///		C		0
1.0-5.0	**********		C	SAND, FINE, LOOSE, MOIST, BROWN, NO ODOR	
	**********		C		
	**********		C		
	**********		C		
	**********		C		
	**********		C		
	**********		C		
5.0	**********	5.0	C		
5.0-16.3	***000***		C	SLIGHTLY GRAVELLY GREATER THAN 4.0'	
	000		C	SAND, FINE-MEDIUM, WATER BEARING, GRAVELLY, LOOSE, BROWN, NO ODOR	
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	10	C		
	000		C		
	000		C		
	000		C		
	000		C	BOULDER AT 11.5'-12.9'	
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	15	C		
	000		C		
	000		C		
16.3	***000***		C		
16.3-17.5	----------		C	SHALE, GREY-BLUE, HARD, FISSLE, MOIST, APPEARS DRY	
17.5	----------		C		
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5421.52
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 4.0'
BORING ID: SB8-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-4.5	**0000***		C	SAND. FINE. LOOSE. BROWN. VERY COBBLEY. MOIST	0.0-17.5
	0000*		C		0
	0000*		C		
	0000*		C		
	0000*		C		
	0000*		C		
	0000*		C		
	0000*		C		
4.5	**0000***		C		
4.5-9.0	***///***	5.0	C	SAND. CLAYEY. WATER BEARING. LIGHT GREY. VERY LOOSE. NO ODOR	
	///		C	WATER BEARING GREATER THAN 4.0 FEET	
	///		C		
	///		C		
	///		C		
	///		C		
	///		C		
	///		C		
9.0	***///***		C		
9.0-13.5	***000***		C	SAND. COBBLEY. WATER BEARING. NO ODOR. MODERATELY DENSE. GREY-BROWN	
	000	10	C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
13.5	***000***		C		
13.5-16.5	***00****		C	SAND. FINE. SLIGHTLY GRAVELLY. WATER BEARING. GREY. NO ODOR	
	00*		C		
	00*	15	C		
	00*		C		
	00*		C		
16.5	***00****		C		
16.5-17.5	=========		C	NACIMIENTO FORMATION	
17.5	=========		C	SHALE. BLACK. FISSLE. DENSE. MOIST. NOT WATER BEARING	
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

'OCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

FILE #: 97-028
ELEVATION: 5420.0
TOTAL DEPTH: 15.0'
LOGGED BY: TM
DATE: 6-13-97
STATIC WATER: 4.2'
BORING ID: SB9-697
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-1.0	****-/***		C	**SAND**, VERY FINE TO FINE, SLIGHTLY SILTY, CLAYEY, MOIST TO WET, BROWN, NO ODOR	ALL SAMPLES
	****-/***		C		0
1.0-9.0	***-/o***		C	**SAND**, VERY FINE TO FINE, SILTY, CLAYEY, GRAVELLY, FINE TO COARSE, COBBLY, WET	
	-/o		C	BROWN, NO ODOR	
	-/o		C		
	-/o		C	WATER BEARING @ 4.2'	
	-/o		C		
	-/o		C		
	-/o		C		
	-/o	5.0	C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
9.0	***-/o***		C		
0-14.0	OOOooooOOO		C	**COBBLES**, GRAVELLY, FINE TO COARSE, NO ODOR	
	OOOooooOOO	10	C		
	OOOooooOOO		C		
	OOOooooOOO		C		
	OOOooooOOO		C		
	OOOooooOOO		C		
	OOOooooOOO		C		
	OOOooooOOO		C		
	OOOooooOOO		C		
14.0	OOOooooOOO		C		
14.0-15.0	/////////		C	**NACIMIENTO FORMATION**	
15.0	/////////	15	C	**CLAY**, WHITISH GREY, DENSE, VERY MOIST TO WET, NO ODOR	
TOTAL DEPTH					

LOGGED BYTM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

TABLE OF NEW MEXICO AND THE U. S. EPA'S GROUNDWATER STANDARDS

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
General Properties				
non-aqueous phase liquid (NAPL)	NP			
petroleum				
floating product	NP			
undesirable odor (a)	NP			
pH (units) (a)	6 - 9	6.5 - 8.5		
total dissolved solids (TDS) (a)	1000	500		
turbidity		tt		
Biological Contaminants				
giardia lambia	tt	Zero		
legionella	tt	Zero		
total coliform	<5%+	Zero		
viruses	tt	Zero		
Inorganic Contaminants				
aluminum	5.0 (i)	0.05 - 0.2 (a)		
ammonia				30
antimony		0.006	0.006	
arsenic	0.1	0.05	0.05	
asbestos-fibers/liter (longer than 10 um)		7 million	7 million	
barium	1.0	2	2	
beryllium		0.004	0.004	
boron	0.75 (i)			0.06
bromate		0.01 (p)	Zero (p)	
cadmium	0.01	0.005	0.005	
chlorate				0.01

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
chloride (a)	250	250		0.01
chlorine				1
chlorine dioxide				0.08
chlorite		1.0 (p)	0.08 (p)	
chromium	0.05	0.1	0.1	
cobalt (i)	0.05			
copper		1.3 (al)	1.3	
cyanide	0.2	0.2	0.2	
fluoride	1.6	4.0		
fluoride (a)		2		
iron (a)	1.0	0.3		
lead	0.05	0.015 (al)	Zero	
manganese (a)	0.2	0.05		
mercury	0.002	0.002	0.002	
molybdenum	1.0 (i)			0.05
nickel	0.2 (i)	0.1	0.1	
nitrate - N	10	10	10	
nitrite - N		1	1	
nitrate + nitrite (as N)		10	10	
selenium	0.05	0.05	0.05	
silver	0.05	0.05	0.05	
silver (a)		0.1		
sodium				20
strontium				17
sulfate	600 (a)	250 (a) / 400 (p)	400	
thallium		0.002	0.0005	
vanadium				0.02
zinc (a)	10.0	5		
Radioactive Contaminants				
Gross alpha (pCi/L) *		15	Zero	
Gross beta & photon emitters (mrem/yr) **		4	Zero	

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
radium 226 (pCi/L)		20 (p)	Zero	
radium 228 (pCi/L)		20 (p)	Zero	
radium 226 + 228 (pCi/L)	30	5	Zero	
radon 222 (pCi/L)		300 (p)	Zero	
uranium	5	0.02 (p)	Zero	
Benzenes				
benzene	0.01	0.005	Zero	
Alkyl Benzenes				
methylbenzene (toluene)	0.75	1 (p) / 0.04 (a)	1	
ethylbenzene	0.75	0.7 (p) / 0.03 (a)	0.7	
dimethyl benzene isomers (xylenes)	0.62	10 (p) / 0.02 (a)	10	
vinylbenzene (styrene)		0.1	0.1	
trimethyl benzene isomers				
propyl benzene isomers				
butyl benzene isomers				
Chlorinated Benzenes				
chlorobenzene	tox	0.1	0.1	
o-dichlorobenzene	tox	0.6	0.6	
m-dichlorobenzene	tox			
p-dichlorobenzene	tox	0.075 (p) / 0.005 (a)	0.075	
1,2,4-trichlorobenzene		0.07	0.07	
1,3,5-trichlorobenzene				0.04
1,2,4,5-tetrachlorobenzene	tox			
pentachlorobenzene	tox			
hexachlorobenzene	tox	0.001	Zero	
Toluenes				
o-chlorotoluene				0.1
p-chlorotoluene				0.1
2,4-dinitrotoluene (2,4-DNT)	tox			

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
2,4,6-trinitrotoluene (TNT)				0.002
isopropyltoluene				
Nitrogenated Benzenes				
aminobenzene (aniline)				
nitrobenzene	tox			
1,3-dinitrobenzene				0.001
Phenols (hydroxybenzenes)	0.005 (a)			
phenol (carbolic acid)	tox			4
2-chlorophenol				0.04
2,4-dichlorophenol	tox			0.02
2,4-dinitro-o-creosol	tox			
2,4-dimethylphenol				
2-methylphenol				
4-methylphenol				
2-nitrophenol				
dinitrophenols	tox			
2,4,5-trichlorophenol	tox			
2,4,6-trichlorophenol	tox			
2,4,6-trichlorophenol	tox			
pentachlorophenol	tox	0.001 (p) / 0.03 (a)	Zero	
p-cresol				
Polycyclics				
acenapthene				
anthracene	tox			
benz(a)anthracene		0.0001 (p)	Zero	
benzo(a)pyrene	0.0007	0.0002	Zero	
benzo(b)fluoranthene		0.0002 (p)	Zero	
benzo(k)fluoranthene	tox	0.0002 (p)	Zero	
chrysene		0.0002 (p)	Zero	
dibenz(a)anthracene		0.0003 (p)	Zero	
diphenylhydrazine	tox			

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
fluoranthene	tox			
fluorene	tox			
indeno(1,2,3-c,d)pyrene		0.0004 (p)	Zero	
naphthalene	tox			0.3
naphthalenes ****	0.03			
phenanthrene	tox			
polychlorinated biphenyls (PCBs)	0.001			
PCBs as decachlorobiphenyl		0.0005	Zero	
pyrene	tox			
Methanes				
chloromethane (methyl chloride)	tox			0.003
dichloromethane (methylene chloride)	0.1	0.005	Zero	
trichloromethane (chloroform)	0.1		Zero (p)	
tetrachloromethane (carbon tetrachloride)	0.01	0.005	Zero	
bromomethane (methyl bromide)	tox			0.01
bromochloromethane				0.09
bromodichloromethane	tox		Zero (p)	
chlorodibromomethane			Zero (p)	0.1
tribromomethane (bromoform)	tox		Zero (p)	
trihalomethanes (THMs) ***		0.1/0.08 (p)	Zero	
fluorotrichloromethane (Freon 11)	tox			2
dichlorodifluoromethane (Freon 12)	tox			1
Ethanes				
1,2-dibromoethane (ethylene dibromide, EDB)	0.0001	0.00005	Zero	
1,1-dichloroethane	0.025			
1,2-dichloroethane (ethylene dichloride, EDC)	0.01	0.005	Zero	
1,1,1-trichloroethane (TCA)	0.06	0.2	0.2	
1,1,2-trichloroethane	0.01	0.005	0.003	
1,1,1,2-tetrachloroethane				0.07

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
1,1,2,2-tetrachloroethane	0.01			
hexachloroethane	tox			
Ethenes (Ethylenes)				
chloroethane (vinyl chloride)	0.001	0.002	Zero	
1,1-dichloroethene	0.005	0.007	0.007	
cis-1,2-dichloroethene	tox	0.07	0.07	
trans-1,2-dichloroethene	tox	0.1	0.1	
trichloroethene (TCE)	0.1	0.005	Zero	
tetrachloroethene (perchloroethylene, PCE)	0.02	0.005	Zero	
Propanes & Propenes				
1,2-dichloropropane (propylene dichloride, PDC)		0.005	Zero	
1,2,3-trichloropropane				0.04
1,2-dibromo-3-chloropropane (DBCP)		0.0002	Zero	
dichloropropenes	tox			
1,3-dichloropropene	tox			0.01
Aldehydes, Ethers, Furans, & Ketones				
acetone				
bis (2-chloroethyl) ether	tox			
bis (2-chloroisopropyl) ether	tox			0.3
bis (chloromethyl) ether	tox			
dibenzofuran				
p-dioxane (diethylene dioxide)				0.568
formaldehyde (methanal)				1
isophorone	tox			0.1
methyl ethyl ketone (MEK, 2-butanone)				0.1
methyl tertiary butyl ether (MTBE)	0.1 (a)			0.04
tetrahydrofuran				

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
Nitrosamines				
N-nitrosodiethylamine	tox			
N-nitrosodimethylamine (NDMA)	tox			
N-nitrosodibutylamine	tox			
N-nitrosodiphenylamine	tox			
N-nitrosopyrrolidine	tox			
Phthalate Esters				
dibutyl phthalate	tox			
di-2-ethylhexyl phthalate	tox	0.006	Zero	
diethyl phthalate	tox			
dimethyl phthlate	tox			
Explosives				
dinitrophenols	tox			
2,4-dinitrotoluene (2,4-DNT)	tox			
hexahydro-1,3,5-trinitro-s-triazine (RDX)				0.002
HMX				0.4
nitroglycerin (glycerol trinitrate)				0.005
nitroguanidine				0.7
2,4,6-trinitrotoluene (TNT)				0.002
Other Organics				
acrolein	tox			
acrylamide		tt	Zero	
acrylonitrile	tox			0.004
benzidine	tox			
chloral hydrate		tt (p)	0.04 (p)	
chloramine				0.3

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
dibromoacetonitrile				0.02
dichloroacetic acid				0.003
dichloroacetonitrile				0.006
dichlorobenzidine	tox			
di(2-ethylhexyl)adipate		0.4	0.4	
diisopropyl methylphosphonate				0.6
epichlorohydrin (1-chlor-2,3-epoxypropane)		tt	Zero	
ethylene glycol (1,2-ethanediol)				7
Haloacetic Acids ****		0.06 (p)		
dichloroacetic acid			Zero (p)	
trichloroacetic acid			0.3 (p)	
hexachlorobutadiene	tox			0.001
hexachlorocyclopentadiene	tox	0.05 (p) / 0.008 (a)	0.05	
n-hexane				4.0
Other Pesticides				
acifluorfen				0.1
alachlor		0.002	Zero	
aldicarb		0.003 (p)	0.001	
aldicarb sulfone		0.002 (p)	0.001	
aldicarb sulfoxide		0.004 (p)	0.001	
aldrin	tox			0.001
ametryn				0.06
ammonium sulfamate				2
arsenal (imazapyr)				
atrazine		0.003	0.003	
baygon				0.003
bentazon				0.02
bromacil				0.09
butylate				0.35
carbaryl				0.7
carbofuran		0.04	0.04	

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
carboxin				0.7
chloramben				0.1
chlordane	tox	0.002	Zero	
chlorothalonil				0.5
chlorpyrifos				0.02
cyanazine				0.01
2,4-D (2,4-dichlorophenoxyacetic acid)		0.07	0.07	
dacthal				4
dalapon		0.2	0.2	
DDT (dichloro diphenyl trichloroethane)	tox			
4,4'-DDD				
4,4'-DDE				
diazinon				0.0006
dicamba				0.2
dieldrin	tox			0.002
dimethrin				2
dinoseb		0.007	0.007	
dioxin		0.00000005	Zero	
diphenamid				0.2
diquat		0.02	0.02	
disulfoton				0.0003
diuron				0.01
endosulfan	tox			
endothall		0.1	0.1	
endrin	tox	0.002	0.002	
ethylene thiourea				0.001
fenamiphos				0.002
fluometuron				0.09
fonofos				0.01
glyphosate		0.7	0.7	
heptachlor	tox	0.0004	Zero	
heptachlor epoxide		0.0002	Zero	
hexazinone				0.2
lindane (gamma-BHC)	tox	0.0002	0.0002	

PARAMETER	NEW MEXICO (ppm)	EPA MCL (ppm)	EPA MCLG (ppm)	EPA HA (ppm)
alpha-BHC	tox			
beta-BHC	tox			
delta-BHC				
malathion				0.2
maleic hydrazide				4
methomyl				0.2
methoxychlor		0.04	0.04	
methyl chlorophenoxyacetic acid (MCPA)				0.011
methyl parathion				0.002
metolachlor				0.1
metribuzin				0.2
oxamyl (vydate)		0.2	0.2	
paraquat				0.03
picloram		0.5	0.5	
prometon				0.1
pronamide				0.05
propachlor				0.09
propazine				0.01
propham				0.1
simazine		0.004	0.004	
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)				0.07
tebuthiuron				0.5
terbacil				0.09
terbufos				0.0009
toxaphene	tox	0.003	Zero	
2,4,5-TP (silvex)		0.05	0.05	
trifluralin				0.005

Abbreviations

al Action Level that, if exceeded, requires water treatment
BHC benzene hexachloride, also called hexachlorocyclohexane
DDD 1,1'-(2,2-dichloroethylidene) -bis/4-chlorobenzene

DDE 1,1'-(2,2-dichloroetheneylidene) -bis/4-chlorobenzene
HA Health Advisory
HMX octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
MCL Maximum Contaminant Level
MCLG Maximum Contaminant Level Goal
mg/L milligrams per liter
mrem/yr millirem per year
mrem ede/yr dose committed over a 50-year period to a "reference man" from an annual intake rate of 2 liters drinking water per day
MTBE methyl tertiary butyl ether, a synonym for 2-methoxy-2-methyl propane (the standard includes other ether-based gasoline additives)
NP the contaminant shall Not be Present
pCi/L picocuries per liter
tox a numerical standard has not been established, but the contaminant is listed in a narrative standard of "toxic pollutant" defined in WQCC regulations
2,4,5-TP 2,4,5-trichlorophenoxpropionic acid
tt Treatment Technique that public water system operators must adhere to instead of a numerical standard
um micrometer
U.S. EPA Uniter States Environmental Protection Agency
WQCC New Mexico Water Quality Control Commission

Footnotes

* The proposed standard excludes radon 222, radium 226 and uranium activity
** This standard excludes radium 228 activity. Units for the existing standard are mrem/yr. U.S. EPA has proposed to change the units to mrem ede/yr.
*** The "THMs" standard applies to the sum of chloroform, dichlorobromomethane, dibromochloromethane, and bromoform.
**** This standard applies to the sum of naphthalene and monomethylnaphthalene isomers.
***** This standard applies to the sum of mono-, di-, and trichloroacetic acids, and mono- and dibromoacetic acids.

Use and Applicability of Standards

All New Mexico standards are adopted by the WQCC except for the MTBE and petroleum (floating product and undesirable odor) standards, which are adopted by the New Mexico Environmental Improvement Board.

U.S. EPA's MCLGs are set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety. MCLGs do not take treatment costs into considerartion and are not enforceable. Health-based proposed MCLs and final enforceable MCLs are set as close to MCLGs as feasible with use of best technology, treatment techniques and other means.

U.S. EPA's HAs serve as informal technical guidance to assist Federal, State and Local officials responsible for protecting public health when emergency spills or contamination situations occur. They are not to be construed as legally enforceable Federal standards and are subject to change as new information becomes available. All HAs listed are for lifetime exposures except for p-dioxane (10 day) and n-hexane (7 year).