GW - 1

WORK PLANS

1995

GROUNDWATER
TECHNOLOGY ®

Groundwater Technology, Inc.
2501 Yale Boulevard, SE, Suite 204, Albuquerque, NM 87106 USA
Tel: (505) 242-3113 Fax: (505) 242-1103

CORRECTIVE MEASURE STUDY REPORT
GIANT REFINING COMPANY
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GTI Project No 053353014

December 21, 1995

Prepared for:

Giant Refining Company
P.O. Box 159
Bloomfield, New Mexico 87413
(505) 632-8013

Groundwater Technology, Inc.
Written/Submitted by

Vernon Hershberger
Vern Hershberger
Staff Engineer

Cymantha Liakos
Cymantha Diaz Liakos
Project Manager

Groundwater Technology, Inc.
Reviewed/Approved by

Sara Brothers
Project Director, New Mexico

Offices throughout the U.S., Canada and Overseas

CONTENTS

1.0 INTRODUCTION ... 1
  1.1 Purpose and Organization of Document ... 1

2.0 DESCRIPTION OF CURRENT CONDITIONS ... 3
  2.1 Site Description and Background ... 3
  2.2 Site History ... 3
  2.3 Previous Site Investigations ... 4
  2.4 Environmental Setting ... 7
    2.4.1 Geology/Hydrogeology ... 7
    2.4.2 Hydrology ... 8
  2.5 Nature and Extent of Contamination ... 9
    2.5.1 Dissolved- and Separate-Phase Hydrocarbons ... 9
    2.5.2 Adsorbed-Phase Contamination ... 9
    2.5.3 Surface Water and Sediment Contamination ... 10
  2.6 Hydrocarbon Mass Estimate Calculations ... 10
    2.6.1 Calculation Considerations ... 10
    2.6.2 August 1994 Plume ... 12
    2.6.3 March 1995 Plume ... 13
  2.7 Actual or Potential Exposure Pathways ... 14
  2.8 Current Status of Remedial Activities ... 15

3.0 ESTABLISHMENT OF CORRECTIVE ACTION OBJECTIVES ... 17
  3.1 Soil CAOs ... 23
  3.2 Groundwater CAOs ... 25
  3.3 Other ARARs ... 27

4.0 EXISTING CORRECTIVE MEASURES/ FIELD AND BENCH-SCALE STUDIES ... 28
  4.1 Vapor Extraction/Air Sparge Pilot Testing ... 28
  4.2. Bacterial Enumeration Studies ... 29

5.0 SCREENING OF CORRECTIVE MEASURE OPTIONS AND DESCRIPTION OF RETAINED CORRECTIVE MEASURE OPTIONS ... 32
  5.1 Corrective Measure Option Screening ... 32
    5.1.1 Description of Rating Considerations ... 33
      5.1.1.1 Applicability to Site. ... 33
      5.1.1.2 Permissibility ... 34
      5.1.1.3 Present Value Costs ... 34
      5.1.1.4 Treatment Time Acceptability ... 34
    5.1.2 Rating Score ... 34
    5.1.3 Retention of Options ... 34

CONTENTS (continued)

5.2 Identification of Retained Corrective Measure Options 34
- *5.2.1 Seepage Control 35*
  - *5.2.1.1 Option 1: Grout Curtain or Sheet Pilings 35*
  - *5.2.1.2 Option 2: Contaminant Source Removal by SVE and IAS 35*
  - *5.2.1.3 Option 3: Enhanced In Situ Bioremediation 35*
- *5.2.2 Separate Phase Hydrocarbon Remediation 36*
  - *5.2.2.1 Option 1: Soil Vapor Extraction. 36*
  - *5.2.2.2 Option 2: SVE and Air Sparging 37*
  - *5.2.2.3 Option 3: Total Fluids Pumping 38*
  - *5.2.2.4 Option 4: Water Table Depression and SVE 38*
- *5.2.3 Soil Remediation 39*
  - *5.2.3.1 Option 1: Risk Assessment 39*
  - *5.2.3.2 Option 2: Soil Vapor Extraction 39*
- *5.2.4 Groundwater Remediation 40*
  - *5.2.4.1 Option 1: Risk Assessment 40*
  - *5.2.4.2 Option 2: In Situ Air Sparging 40*
  - *5.2.4.3 Option 3: Enhanced In Situ Bioremediation 40*
  - *5.2.4.4 Option 4: Contaminant Source Removal/Natural Attenuation 41*

6.0 DEVELOPMENT OF CORRECTIVE MEASURE ALTERNATIVES 42
- 6.1 Seepage Control 42
- 6.2 Separate Phase Hydrocarbon Remediation 42
- 6.3 Soil Remediation 43
- 6.4 Dissolved Phase Groundwater Remediation 44

7.0 JUSTIFICATION AND RECOMMENDATION OF THE CORRECTIVE MEASURE(S) 46
- 7.1 Technical Evaluation Criteria 46
- 7.2 Environmental Evaluation Criteria 50
- 7.3 Human Health Evaluation Criteria 50
- 7.4 Institutional Evaluation Criteria 50
- 7.5 Conceptual Remedial System 50
  - *7.5.1 System Description 50*
  - *7.5.2 Estimated System Costs 54*

8.0 REFERENCES 55

FIGURES

1 Site Location
2 Giant Refining Company and Surrounding Properties
3 Site Plan
4 Soil Boring/Monitoring Well Locations
5 Water Table Contour Map - May 24, 1994
6 Water Table Contour Map - August 2, 1994
7 Water Table Contour Map - March 1, 1995
8 Separate Phase Hydrocarbon Isopleth Map - May 24, 1994
9 Separate Phase Hydrocarbon Isopleth Map - August 2, 1994
10 Separate Phase Hydrocarbon Isopleth Map - March 1, 1995
11 Total Targeted VOC in Groundwater Isopleth Map - May 24 & 25, 1994
12 Total Targeted SVOC in Groundwater Isopleth Map - May 24 & 25, 1994
13 Total Targeted VOC in Groundwater Isopleth Map - August 3 & 4, 1994
14 Total Targeted SVOC in Groundwater Isopleth Map - August 3 & 4, 1994
15 Proposed Remediation System Site Layout Site Map
16 Preliminary Process Flow Diagram for Pulse Sparging/SVE, Section View.

TABLES

3-1 Summary of Regulatory Requirements Applicable to Corrective Action at Giant Refining Company, Bloomfield, New Mexico
3-2 Standards for Soil
3-3 Standards for Groundwater
7-1 Preliminary Estimated Costs for Corrective Measure Implementation, Giant Refining Company, Bloomfield, New Mexico.

APPENDICES

A Hydrocarbon Mass Estimation Calculations
B Laboratory Analytical Results of Bacterial Enumeration Studies
C Corrective Measure Options Screening Matrices

1.0 INTRODUCTION

1.1 Purpose and Organization of Document

This "Corrective Measure Study (CMS) Report" has been prepared pursuant to Attachment II - Corrective Action Plan of the Administrative Order on Consent (Docket No. VI-303-H) dated December 31, 1992 between the United States Environmental Protection Agency (USEPA) Region VI and Giant Refining Company (GRC). The CMS evaluates corrective action alternatives and recommends the corrective measures to be taken at the GRC site. The CMS complies with the following requirements:

- RCRA Corrective Action Plan (Interim Final), EPA/530-SW-88-028 (EPA, June 1988); and
- Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule, Federal Register, July 27, 1990, Volume 55, No. 145.

The objective of the CMS is to identify, screen, and develop alternative(s) for removal, containment, treatment and/or other remediation of contamination at the Solid Waste Management Units (SWMUs) based on the corrective action objectives identified for the site. The alternatives are based on data collected as part of the RCRA Facility Investigation (RFI) and previous investigations performed at the site.

The remainder of this document is organized in the following manner:

- Section 2.0 contains information about the site history, previous investigations, environmental setting, nature and extent of contamination, actual or potential pathways, and current site activities.
- Section 3.0 contains site-specific Corrective Action Objectives (CAOs) for the site based on public health and environmental criteria, site-specific risk-based CAOs for constituents of concern and potential migration routes/exposure pathways, data from the RFI, USEPA guidance, and requirements of any applicable State and Federal statutes;
- Section 4.0 discusses existing corrective measures (e.g. total fluids pumping) and field (e.g. soil vapor extraction/*in situ* air sparging [SVE/IAS] pilot testing) and bench scale studies;
- Section 5.0 screens the recommended technologies and potentially applicable corrective measure technologies, identifies technologies for further evaluation,

and eliminates those technologies which have limitations due to the contaminants, site-specific conditions, and inherent technology limitations.

- Section 6.0 develops more fully the corrective measure alternative(s) retained for further analysis, weighing preliminary/relative life-cycle costs, technical merits, human health and environmental factors.
- Section 7.0 justifies and recommends the corrective measure(s) selected for the site with respect to technical, environmental, human health and institutional criteria.
- Section 8.0 provides a list of references.

Supporting information for the CMS is presented in the attached Appendices, Tables and Figures.

2.0 DESCRIPTION OF CURRENT CONDITIONS

2.1 Site Description and Background

The GRC facility is located at 50 County Road 4990 (Sullivan Road), immediately south of Bloomfield, New Mexico in San Juan County (Figure 1). The site is located on a bluff approximately 100 feet above the south side of the San Juan River, a perennial river that flows to the west. On the bluff and between the river and the process area of the facility is the Hammond Ditch, a manmade channel for irrigation water supply that borders all but the southern portion of the site. Bordering the facility is a combination of federal and private properties (Figure 2). The topography of the site is generally flat with low-lying areas to the east of the process area. The current facility layout is shown in Figure 3.

As shown on Figure 3, the refinery offices are located on the western end of the facility, along with warehouse space, maintenance and shop areas, a drummed chemical storage area, raw water ponds (for temporary storage of fresh water from the San Juan River), and one cooling tower(#1). Process units are located just east of the offices and include: the crude unit, the fluidized catalytic cracking unit, the gas con unit, the treater unit, one cooling tower(#2), reformer/hydrotreater, catalytic polymerization unit, API separator, hydrodesulfurization unit, and wastewater treatment ponds (SOWP and NOWP).

Aboveground storage tanks (ASTs) occupy a large portion of the facility from north of the process units east along Sullivan Road. Up until the end of 1994 when closure activities began, the two clay-lined evaporation ponds east of the tank farms and a spray irrigation area were used to treat and dispose wastewater. Now only double lined evaporation ponds to the southeast are in-use, along with the Class I underground injection well. The fire training and "landfill" areas are located at the eastern end of the facility. South of Sullivan Road are terminals where product trucks are loaded and crude trucks are off-loaded.

2.2 Site History

A complete history of the GRC site, including improvements, expansions, spills, and investigations, is provided in the March 1993 "RCRA Facility Investigation - Task I: Description of Current Conditions" report. The GRC facility was originally constructed as a crude topping unit in the late 1950s by local entrepreneur Kimball Campbell. 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. In November 1980, Plateau applied for a Part A Permit as a generator, storer, treater, and disposer of hazardous waste as a protective filing. Plateau later petitioned for reclassification under a generator-only status (in 1982). Bloomfield Refining Company (BRC) acquired the facility from Suburban Propane (Plateau) on October 31, 1984. Facility ownership was recently transferred to Giant Refining Company on October 4, 1995.

The facility is currently under RCRA interim status for the operation of hazardous waste surface impoundments (SOWP and NOWP) used to treat refinery wastewater. A RCRA Part B application was submitted in 1991 and amended in September 1994. GRC also operates under a discharge plan for the purpose of controlling potential releases to surface and groundwater, a Class I Underground Injection Well Permit, and a New Mexico Air Quality Control permit.

2.3 Previous Site Investigations

Between 1984 and 1991, 14 groundwater monitoring wells, nine recovery wells, and three piezometers were installed as part of the existing New Mexico Oil Conservation Division (NMOCD) discharge plan requirements, a RCRA 3008 Order and Consent Agreement, a RCRA 3013 Administrative Order investigation, and for voluntary recovery of separate-phase hydrocarbons (SPH). Since the current Administrative Order on Consent issued in December 1992, an additional two recovery wells and ten monitoring wells have been installed as part of Interim Measures or the RCRA Facility Investigation (RFI).

RCRA 3008 Order Investigation
After issuance of the April 1985 RCRA 3008 Order and Consent Agreement for alleged violations at the facility under previous ownership, a Closure Plan was submitted to USEPA and the New Mexico Environment Department (NMED) to comply with requirements specified in the Order. This included the closure of the API wastewater ponds (SOWP and NOWP), an onsite "landfill", and the landfill runoff pond. In October 1985, soil samples were collected from each of the oily water ponds for closure characterization. The soil analytical results were consistent with clean closure requirements for the units (E-S, 1986). The landfill runoff pond, created as a result of blockage of an arroyo during construction of the Hammond Ditch, was also sampled in 1985, and again, the results were consistent with the requirements for clean closure for the unit, with final closure approval received in January 1994.

RCRA 3013 Order Investigation
Subsequent to the issuance by USEPA of the 3013 Order requiring an extensive groundwater study at the site (Docket No. RCRA 3013-00-185), a final report on groundwater conditions (E-S, 1987) was submitted to the USEPA on February 6, 1987. Included in this study were an electrical resistivity survey, installation of 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, and a series of slug tests. So that samples could be collected during low-flow conditions, surface water sampling of Hammond Ditch and the San Juan River was performed in April and July 1987, respectively. Results were submitted to USEPA on September 14, 1987.

Off-site Soil Gas Survey and Interim Measures
In 1988, a soil vapor survey was conducted on land owned by the Bureau of Land Management (BLM) adjacent to the facility. A report of findings was submitted in August 1989 (GCL, 1989). During this time,

three piezometers, two recovery wells and one monitoring well were also installed, MW-10 was converted to a recovery well (RW-3), pneumatic skimmer pumps were installed in nine recovery wells, and a product recovery system was started up on January 4, 1989.

A total of 25 soil gas survey locations (three on the GRC property and 22 on the BLM property) taken at five-foot depths were analyzed for benzene, toluene, ethylbenzene, total xylenes, tetrachloroethene, and trichloroethylene using a portable gas chromatograph. The highest concentrations of soil vapors detected were in the onsite survey locations, and a trend of decreasing vapor concentrations extended to the south across Sullivan Road. Vapor concentrations were detected southwest of the site near monitoring well MW-11.

Administrative Order on Consent - Interim Measures

USEPA issued an Administrative Order on Consent on December 31, 1992, requiring the preparation and submittal of an interim measures (IM) plan, followed by an RFI work plan. The IM work plan was submitted to USEPA in February 1993, revised in April 1993, and approved in correspondence dated May 28, 1993. Proposed IMs included the installation of two additional recovery wells (RW-22 and RW-23), surveying and gauging of all wells, deployment of pumping systems in the new wells (if appropriate) and startup operation of hydrocarbon recovery. The IM activities were reported in the "Interim Measures Report" dated March 3, 1994.

Administrative Order on Consent - RCRA Facility Investigation (RFI)

The "Task I: Description of Current Conditions" report was submitted concurrent with the "Task II: RCRA Facility Investigation Work Plan" initially in March 1993. The RFI Work Plan (Task II) was revised pursuant to USEPA comments dated August 27, 1993, resubmitted on October 1, 1993, and approved by USEPA in correspondence dated November 4, 1993.

The RFI work was conducted in five phases, each reported to USEPA in the following submissions during the course of the investigation:

- Phase I - Soil Gas Survey - Correspondence dated February 11, 1994 and RECON™ "Soil Gas Survey" report dated February 2, 1994. Soil gas samples were collected from two depths (3-4 feet and 7.5-10 feet) at 42 locations. No new areas of concern (AOCs) were identified.

- Phase II - Soil Boring Investigation - Correspondence dated March 22, 1994. Soil samples were collected from 10 boring locations and analyzed to identify AOCs. No new AOCs were identified.

- Phase III - Well Installations/Groundwater Sampling - Correspondence dated June 23, 1994 (first event) and September 30, 1994 (second event). Seven monitoring wells (MW-25 through MW-31) were installed to delineate hydrocarbon plumes, and all wells that did not contain separate-phase hydrocarbons (SPH) were sampled (May 1994). A second sampling event (August 1994) was conducted two months later. The primary contaminants of concern are benzene, toluene, ethylbenzene and total xylenes (BTEX).

- Phase IV - Aquifer Testing - Report entitled "Uppermost Aquifer Hydraulic Testing and Modeling" dated July 20, 1994. Aquifer testing was performed in RW-19 (but not completed due to rapid accumulation of SPH) and in RW-22. Transmissivity values calculated from these tests ranged from 230 - 1412 ft^2/day.

- Phase IV - Soil Vapor Extraction/Air Sparging Pilot Studies - Report entitled "Soil Vapor Extraction and Air Sparge Pilot Test Report" dated August 16, 1994. Both soil vapor extraction (SVE) and air sparging technologies were shown to be applicable and effective for the site. SVE effective radius of influence (ROI) for gasoline constituents such as BTEX ranged from 36 feet (upper zone) to 84 feet (lower zone). The effective ROI for sparging was estimated at 50 feet.

- Phase V - Stream Sediment and Surface Water Sampling - Correspondence dated October 14, 1994. Surface water and sediment samples were collected at three locations in the San Juan River. No site-related constituents were detected in any of the samples. Surface water and sediment samples (side and bottom) were collected at 14 locations in the Hammond Ditch. Toluene was detected in three bottom sediment samples at concentrations ranging from 0.005 to 0.012 mg/kg. Phenanthrene was also detected in two sediment samples at 1.2 and 1.3 mg/kg.

The RFI/CMS Report dated November 8, 1994 summarized each phase of the RFI and compiled and evaluated the data collected. The USEPA provided comments on the RFI/CMS Report in correspondence dated March 9, 1995. The "Response to USEPA Comments on the RFI/CMS Report" dated April 13, 1995 was subsequently submitted. In the response, it was indicated that a separate CMS Report would be submitted. Approval of the RFI portion of the order was received on August 26, 1995. Further, groundwater delineation downgradient of MW-34 was left to be included with potential corrective measures.

Offsite Investigation (1995)

A supplementary report entitled "Offsite Monitoring Well Installations/Sampling" dated April 26, 1995 was submitted to USEPA to describe additional delineation efforts (MW-32, MW-33 and MW-34) to the southwest of the facility.

2.4 Environmental Setting

2.4.1 Geology/Hydrogeology

The GRC facility is located within the San Juan Basin, a subprovince of the Colorado Plateau physiographic province. The site is underlain by Quaternary Jackson Lake terrace deposits, consisting of 10 to 15 feet of unsaturated fines (clay and silt) to coarse-grained fluvioglacial outwash and loess. A permeable saturated cobble and sand layer directly overlies the bedrock at the site (the Tertiary Nacimiento Formation). The Nacimiento Formation is an interbedded, black carbonaceous mudstone/claystone with white, medium to coarse-grained sandstones approximately 570 feet thick in this area. The bluff that cropping out along the San Juan River near the site is similarly composed of these materials. Underlying the Nacimiento are the Ojo Alamo, Kirtland Shale, and Fruitland Formations (USEPA, 1987).

Groundwater at the site occurs at depths ranging from 6 to 40 feet below ground surface, increasing in depth from west to east across the site. Groundwater flow direction is generally to the west-northwest, toward the Hammond Ditch and San Juan River. GRC dikes the Hammond Ditch during the non-irrigation season (October 15 through April 15) to maintain the ditch's mounding effect, thereby inhibiting northward groundwater flow. Uppermost groundwater is a perched aquifer that migrates downward then horizontally through permeable sands, silts and a cobble zone atop the impermeable Nacimiento Formation, which is reported to dip toward the north. The perched groundwater emanates as seeps along the bluff and occurs at the interface between the cobble zone and the Nacimiento.

From the aquifer testing conducted as part of the Phase IV RFI, transmissivity, hydraulic conductivity and storativity values were calculated for the uppermost perched aquifer:

Summary of Hydraulic Properties
of the Uppermost Aquifer

Well No.	Transmissivity (Ft^2/day)	Hydraulic Conductivity (Ft/day)	Storativity (Dimensionless)
MP-3	1412	177	0.015
MP-4	746-850	158	0.003
RW-22	230	44	NA

The transmissivity and hydraulic conductivity values calculated for wells MP-3 and MP-4 are relatively high, representing permeable sand and gravel. However, the presence of SPH within the cone-of-depression may reduce the total porosity available for groundwater recovery and accelerate the water level recovery rate. This accelerated recovery may create false or exaggerated high transmissivity values which may be 50 to 100 percent higher than the actual water-only transmissivity value at the saturated zone.

The storativity values calculated for wells MP-3 and MP-4 are indicative of unconfined to semi-confined conditions in the tested saturated zone. The presence of SPH on the water table may have led to the storativity values indicative of semi-confined conditions. No distinct impermeable geologic unit was present above the aquifer which could cause a confining condition.

2.4.2 Hydrology

Surface waters in the vicinity of the facility include the San Juan River (to the north) and the Hammond Ditch. The Town of Bloomfield, and surrounding areas, derive their potable water from the San Juan River, which is controlled by the Navajo Dam (ERM, 1991). The San Juan River level is approximately 75 feet lower than Hammond Ditch, and Hammond Ditch in turn is approximately 25 feet lower than the grade level in the northwestern part of the refinery. Water within Hammond Ditch, an unlined manmade channel used for irrigation and watering of livestock, is not intended for human consumption.

The Hammond Ditch, along with the surface impoundments (fresh and wastewater) that are part of refinery operations, contribute to local groundwater recharge at the site. As the elevation of the Nacimiento Formation increases toward the southern portion of the site, the perched water table dissipates (well MW-6 in this area has been reported dry since 1984). The Hammond Ditch (unlined in the vicinity of GRC) is actively flowing during the irrigation season (April 15 through October 15), but is diked by GRC during the non-irrigation season. When full, the Hammond Ditch creates a mounding effect, reducing groundwater flow to the west. Seepage from the ditch has not been quantified at this time but occurs seasonally as observed by the numerous seeps along the San Juan River bluff.

Stormwater is collected in curbed, concrete-paved process areas connected to sewers leading to the wastewater treatment system. Other sewers outside the paved areas collect stormwater runoff and channel it to the facility's wastewater treatment system. Some areas not served by sewers collect process and stormwater in sumps, which are then emptied by vacuum truck for delivery to the wastewater treatment system. Tank berms and dikes are used to control other stormwater runoff.

TABLE 3-1

SUMMARY OF REGULATORY REQUIREMENTS APPLICABLE TO CORRECTIVE ACTION AT GIANT REFINING COMPANY - BLOOMFIELD, NEW MEXICO

MEDIA/ACTIVITY	REGULATORY CITATION	ENFORCING AGENCY	SUMMARY OF REGULATION
Surface and groundwater quality			
- Groundwater Quality Standards	NMWQCC Regulation Section 3-103/10	~~NMED/GWPRB~~ OCD	- Dissolved pollutant standards apply to groundwater that has TDS levels <10,000 mg/l.
- Surface Water Quality Standards	NMWQCC Regulations 1-100.A.	NMED/SWQB	- Establishes surface water quality standards and non-degradation policy.
- Abatement of Water Pollution	NMWQCC 3-200 Series	~~NMED/GWPRB~~ OCD	- Section 4-103A-D establishes standards for the vadose zone (soil), surface water and groundwater. - Sections4-103E and 4-103F3 establish criteria for proposing that a standard is technically infeasible and allow the responsible party to petition for alternative abatement standards.
Surface and groundwater discharge			
- Planned subsurface effluent discharges of non hazardous waste to infiltration galleries, injection wells, non-household septic systems, surface impoundments, etc. (Note: facility has discharge plan for its evaporation ponds and injection well)	NMWQCC Parts 1, 3, and 5	~~NMED/GWPRB~~ OCD	- Requires the filing of a discharge plan with specified requirements, and established discharge limits. - Requires notification to NMED within 24 hours.
- Accidental releases from pipelines, above-ground storage tanks, underground storage tanks, surface spills, etc.	NMWQCC	~~NMED/GWPRB~~ OCD and/or NMED/SWQB	- Requires NPDES permit to discharge any pollutant to navigable waters.
- Surface effluent discharge to surface waters (including arroyos and ephemeral streams).	CWA 40CFR122.2	EPA Region VI (issuing authority) NMED/SWQB (Review and certification authority)	- Exceptions include wastewater treatment systems (ponds and lagoons) and certain on-site response actions conducted under Superfund.
- Surface effluent discharge via any stormwater convalance system.	CWA 40CFR112 Stormwater NOI	EPA Region VI	- Requires permit for discharges from any stormwater system associated with an industrial activity (includes: industrial facilities, transportation facilities with vehicle maintenance, hazardous waste and TSD facilities, landfills, construction area larger than 5 acres, etc.).
- Discharge of dredged or fill material into wetlands.	CWA Wetlands Permit Section 404	EPA Region VI	- Regulates discharge of dredged or fill material to protect wetland habitats.
- Discharge of dredged material into waters of the U.S.	58 CFR 45008	USACE	- Requires permit to add or re-dispose of dredged material that destroys or degrades waters of the U.S.

TABLE 3-1 (Cont.)

SUMMARY OF REGULATORY REQUIREMENTS APPLICABLE TO CORRECTIVE ACTION AT GIANT REFINING COMPANY - BLOOMFIELD, NEW MEXICO

MEDIA/ACTIVITY	REGULATORY CITATION	ENFORCING AGENCY	SUMMARY OF REGULATION
Groundwater Extraction			
- Extraction of groundwater associated with proposed treatment systems.	NMSEO Articles 1 through 7	NMSEO	- Requires permit to be obtained and if the majority of the extracted groundwater is not returned, water rights need to be purchased.
Air Emissions			
- Air Quality Standards	NMAQCR	NMED/APCB	- TNMHCs < 0.19 ppm for 3-hour average. - Any regulated contaminant <10 tons/year.
- Construction or operation of a stationary or potable source (e.g. vapor extraction system, air stripper, storage tanks, etc.).	NMAQCR Section 702 and 703	NMED/APCB	- Requires air permitting and registration with the State for emissions from vapor treatment systems with the potential to to emit sources >10 lbs/hr or 25 tons/year, and/or a potential to emit any regulated contaminant <10 tons/year.
- Emission sources of contaminants associated with remedial treatment systems.	CAA Title I	NMED/APCB	- Establishes NAAQ for individual areas.
	PSD	NMED/APCB	- Regions which meet the NAAQs may fall within the PSD program which is intended to maintain "clear air zones".
	HAP	NMED/APCB	- HAP is a federal program that applies emission standards and requires permitting for listed chemical compounds, individual compounds >10 tons/year, combination of compounds >25 tons/year.
	Title V operating permits	NMED/APCB (issuing permits) EPA (notification and revisions)	- Federal Law requiring operating permits that will apply to almost all air pollution sources. - While other state and federal provisions requires permits (new source, PSD, other), Title V requires that all former permitting requirements be brought into one comprehensive document.

TABLE 3-1 (Cont.)

SUMMARY OF REGULATORY REQUIREMENTS APPLICABLE TO CORRECTIVE ACTION AT GIANT REFINING COMPANY - BLOOMFIELD, NEW MEXICO

MEDIA/ACTIVITY	REGULATORY CITATION	ENFORCING AGENCY	SUMMARY OF REGULATION
Hazardous Waste			
- Generator, storage, treatment, and disposal	HWMR Section 6	NMED/HRMB	- State program incorporates majority of RCRA subtitle C. - State of New Mexico is a RCRA-authorized state with exception for the HSWA portion.
- Generator, storage, treatment, and disposal	RCRA-HSWA 40 CFR Part 264 subpart C	EPA Region VI	- This statute is designed to provide "craddle to-grave" control of waste by imposing management requirements on generators and transporters of waste and owners of TSD facilities.
- Generator, storage, treatment, and disposal	RCRA-HSWA 40 CFR Part 264 Corrective Action Program Section 3004	EPA Region VI	- Requires TSD owners/operators to take corrective action for all releases from from SWMUs regardless of when the waste was placed in the unit or whether the unit is currently active. - SWMUs can include tanks, lagoons, waste piles, or other types of units.
- Generator, storage, treatment, and disposal	RCRA-HSWA 40 CFR Part 264 Subpart S	EPA Region VI	- Provides provisions for "voluntary" cleanup, phased RCRA facility investigations, range of cleanup levels for site-specific circumstances, and "conditional remedies".
- Corrective Action Management Units and Treatment Units	RCRA - HSWA 40 CFR Subpart S	EPA Region VI	- CAMU and TU are designed to reduce administrative delays and encourage use of innovative remedial technologies by allowing movement of remedial waste without triggering land disposal restrictions and minimum technology requirements (e.g., double liners and leachate collection systems).
- Investigation/Remediation of Waste Sites	CERCLA/NCP Plan 40 CFR300	EPA Region VI NMED/GWPRB (DERA-IRP)	- Establishes protocol for assessment, selection of remedy and remedial actions.

TABLE 3-1 (Cont.)

SUMMARY OF REGULATORY REQUIREMENTS APPLICABLE TO CORRECTIVE ACTION AT GIANT REFINING COMPANY - BLOOMFIELD, NEW MEXICO

MEDIA/ACTIVITY	REGULATORY CITATION	ENFORCING AGENCY	SUMMARY OF REGULATION
Solid Waste			
- Solid Waste Management and Disposal	NMEIB/SWMR-4 (August 1994)	NMED/SWB	- Establishes operating standards, financial responsibility requirements, and closure standards for landfills. - This regulation brings the State in compliance with RCRA subtitle D requirements.
- Landfill Requirements	SWMR (August 1994)	NMED/SWB	- Sections with pertinent changes to active landfills include: permit application requirements, registration of sitings in wetlands or flood plains, methane monitoring program, groundwater monitoring requirements, etc. - Standards for remediation are less stringent (remediation required when dissolved con-concentrations reach corrective action levels) but more parameters need to be monitored on a regular schedule. - Recently adopted landfill requirements: bring the state program in line with federal program
- Landfill Requirements	RCRA subtitle D Section 7003	EPA Region VI	- EPA uses this regulation to prove that waste generated during investigation and implementation associated with remedial
Pollution Prevention	EO-12856 Section 313	SERC LEPC	- States that by 1999 total releases and off-site transfers of identified toxic chemicals must be reduced 50% at a particular facility and/or agency-wide (DoD facilities) reduction of 50% must be reached. - Each facility that exceeds any EPCRA threshold needs to prepare a PPP responsible party to petition alternative

TABLE 3-1 (Cont.)

SUMMARY OF REGULATORY REQUIREMENTS APPLICABLE TO CORRECTIVE ACTION AT GIANT REFINING COMPANY - BLOOMFIELD, NEW MEXICO

STATE ABBREVIATIONS:

NMWQCC - New Mexico Water Quality Control Commission
NMEIB/USTR - New Mexico Environmental Improvement Board/Underground Storage Tank Regulations
NMAQCR - New Mexico Air Quality Control Regulations
HWMR - New Mexico Hazardous Waste Management Regulations
SWMR - New Mexico Solid Waste Management Regulations
NMED/GWPRB - New Mexico Environment Department Groundwater Protection and Remediation Bureau
NMED/USTB - New Mexico Environmental Department/UST Bureau
NMED/APCB - New Mexico Environmental Department/Air Pollution Control Bureau
NMED/SWQB - New Mexico Environmental Department/Surface Water Quality Bureau
NMED/HRMB - New Mexico Environmental Department/Hazardous and Radioactive Materials Bureau
NMED/SWB - New Mexico Environmental Department/Solid Waste Bureau
NMED/WWMD - New Mexico Environmental Department/Water and Waste Management Division
NMSEO - New Mexico State Engineer's Office
ARAR - Applicable and/or Relevant and Appropriate Requirements

GENERAL ABBREVIATIONS:

TDS - Total Dissolved Solids
mg/l - milligrams per liter
ppm - parts per million
TNMHC - Total Non Methane Petroleum Hydrocarbons
LNAPLS - Light Non-Aqueous Phase Liquids

FEDERAL ABBREVIATIONS:

EPA Region VI - Regional Office for the EPA
CWA - Clean Water Act
NPDES - National Pollutant Discharge Elimination System
CFR - Code of Federal Regulations
NOI - Notice of Intent
USACE - US Army Corps of Engineers
FR - Federal Register
CAA - Clean Air Act
NAAQ - National Standards for Ambient Air Quality
PSD - Prevention of Significant Deterioration
HAP - Hazardous Air Pollutants Program
RCRA - Resource Conservation and Recovery Act of 1976
HSWA - Hazardous and Solid Waste Amendments of 1984
TSD - Treatment, Storage, and Disposal
CERCLA (Superfund) - Comprehensive Environmental Response, Compensation, and Liability Act
NCP - National Contingency Plan
SWMU - Solid Waste Management Unit
CAMU - Corrective Action Management Units
TU - Temporary Units
EPCRA -Emerg Plan. and Com Rt-to-Know
SERC - State Emergency Response Comm.D227

LEPC - Local Emergency Planning Committees
PPA - Pollution Prevention Act
PPP - Pollution Prevention Plan
PRP - Partially Responsible Party

3.1 Soil CAOs

Limited soil data have been collected at the GRC site, since it has been assumed that impacted soils are located in the product processing and storage areas associated with SPH. No state or federal remediation standards for soil exist for releases from aboveground storage tanks in New Mexico. New Mexico Environmental Improvement Board (NM-EIB) Underground Storage Tank (UST) criteria for soils are sometimes used as guidelines for non-UST petroleum-contaminated sites. These criteria are as follows: 100 mg/kg TPH, 50 mg/kg BTEX, and 10 mg/kg benzene. The NMED has recently amended the New Mexico Water Quality Control Commission (NMWQCC) regulations to include standards for the vadose zone (soil), groundwater and surface water. Sections 4-103E and 4-103F establish criteria for demonstrating technical infeasibility, and/or demonstrating that compliance with an alternative standard is technically achievable and cost-benefit justifiable. To this end, the proposed alternate abatement standards (AAS) are technically feasible and justifiable based on site-specific risk assessment.

For comparison purposes, soil criteria/action levels are proposed in a number of EPA documents:

- *EPA Region III Risk-Based Concentrations*, R. L. Smith, 10/20/95.
- *Draft Soil Screening Guidance: Issues Document*, EPA540/R-94/105.
- *Soil Screening Guidance*, EPA/504/R-94/101, December 1994 (Review Draft).
- *Technical Background Document for Soil Screening Guidance*, EPA/540/R-94/106, November 1994 (Review Draft).

Proposed Subpart S action levels (July 27,1990 *Federal Register*) are rarely used, but list the following action levels: 20,000 mg/kg for toluene, 8,000 mg/kg for ethylbenzene and 200,000 mg/kg for total xylenes. For site-specific constituents of concern, the following table provides a comparison of the proposed criteria and risk-based criteria for soils:

TABLE 3-2
STANDARDS FOR SOIL

Constituentt	NMED ST Criteria	Proposed Subpart S Criteria[4]	EPA Region III Risk-Based Criteria[1]	EPA Soil Screening Criteria[2]	Risk-Based Criteria[3]
Benzene	10	Not listed	200/22	22/0.5/0.02/0.002	SPH removal only
Toluene	Not listed	20,000	410,000/16,000	16,000/1,400/2/0.2	SPH removal only
Ethylbenzene	Not listed	8,000	200,000/7,800	7,800/260/5/0.5	SPH removal only
o-Xylene	Not listed	200,000 (total)	1,000,000/160,000	160,000/320/74/7 (total)	SPH removal only
m-Xylene	Not listed	see above	1,000,000/160,000	see above	SPH removal only
p-Xylene	Not listed	see above	Not listed	see above	SPH removal only
Total BTEX	50	Not listed	Not listed	Not listed	SPH removal only
TPH	100	Not listed	Not listed	Not listed	SPH removal only

Concentrations are in mg/kg.

1 - *EPA Region III Risk-Based Concentrations*, R.L. Smith, 10/20/95 - Industrial/Residential criteria.

2 - *Soil Screening Guidance* EPA/504/R - 94/101, December 1994 (Review Draft) - Surface soil ingestion/surface soil inhalation/subsurface with 10 DAF/subsurface with 1 DAF (DAF is dilution and attenuation factor).

3 - CAO from the *Human Health and Ecological Risk Assessment* (December, 1995).

4 - *Federal Register*, July 27, 1990, Proposed Subpart S.

3.2 Groundwater CAOs

Removal of measurable SPH on groundwater is required by the ~~NMED~~ OCD. SPH in excess of 1 foot (apparent thickness) has been measured most recently (March 1995) in one well: RW-19. Well MW-4 and piezometer P-2, in the vicinity of RW-19, contained 0.88 and 0.93 feet of SPH, respectively. Apparent SPH thicknesses have fluctuated significantly based on water table variations and recovery activities.

The only constituents with established maximum contaminant levels (MCLs) are benzene at 0.005 mg/L, toluene at 1 mg/L, and ethylbenzene at 0.7 mg/L. New Mexico has developed Human Health Standards for Groundwater in the *Water Quality Control Commission Regulations*, as amended through October 10, 1995. The maximum allowable concentrations for constituents of concern are shown below, along with MCLs, EPA Region III Risk-Based Concentrations for tap water, and criteria from site-specific evaluation of risk. It should be noted that the shallow aquifer at the GRC site contains total dissolved solids in excess of 1,000 mg/kg, making it unsuitable for domestic use (WQCC regulations, Part 3-103.B), or even irrigation use (Part 3-103.C).

TABLE 3-3
STANDARDS FOR GROUNDWATER

CONSTITUENT	NMED HUMAN HEALTH STANDARD[1]	MCL[2]	EPA REGION III RISK-BASED CRITERIA[3]	PROPOSED SUBPART S CRITERIA[4]	RISK-BASED CRITERIA[5]
Benzene	0.01	0.005	0.00036	Not listed	SPH removal only
Toluene	0.75	1	0.75	10	SPH removal only
thylbenzene	0.75	0.7	1.3	4	SPH removal only
Xylenes, total	0.62	Not listed	1.4 (m-Xylene) 1.4 (o-Xylene) 0.52 (p-Xylene) 12 (mixed Xylenes)	70	SPH removal only
PAHs: total naphthalene plus monomethynaphthalenes	0.03 (0.0007 for benzo-a-pyrene)	0.0002 (benzo-a-pyrene)	see individual constituent criteria (naphthalene=1.5)	Not listed	SPH removal only
Phenanthrene	Not listed	Not listed	Not listed	Not listed	SPH removal only
Phenol	0.005	Not listed	22	20	SPH removal only
2,4-Dimethylphenol	Not listed	Not listed	0.73	Not listed	SPH removal only
Bis(2-ethylhexyl)phthalate	Not listed	Not listed	0.0048	0.003	SPH removal only
Chrysene	Not listed	Not listed	0.0092	Not listed	SPH removal only

1 - *NM WQCC Regulations*, as amended through October 10, 1995.
2 - *National Primary Drinking Water Standards*, EPA 810-F-94-001A, February 1994.
3 - Tap Water Criteria from *EPA Region III Risk-Based Concentrations*, R.L. Smith, 10/20/95.
4 - July 27, 1990 *Federal Register*, July 27, 1990, Proposes Subparts.
5 - COA from *Human Health and Ecological Risk Assessment*, December, *1995.*

As described previously, the amendments to the WQCC regulations dated (October 20, 1995) include allowing for alternative abatement standards (AAS). AAS may be petitioned for on the basis of technological achievability, cost-benefit analysis, or evaluation of hazard to public health and property damage. The risk-based CAOs shown on the above table are proposed as the AAS for the GRC site, based on site-specific risk assessment.

3.3 Other ARARs

All groundwater generated from corrective measures will be discharged to the GRC facility's wastewater treatment system, and ultimately discharged to either the onsite evaporation ponds or the injection well (both are permitted and monitored as required). Other ARARs considered in the CMS include the requirements for air discharges from vapor recovery equipment. From New Mexico Air Quality Control Regulations (NMAQCR) Part 702 no longer require modeling of toluene, ethylbenzene, and xylenes to show that emissions will not exceed one percent of the Occupational Exposure Limit (OEL). From NMAQCR Part 702, Appendix A, and Federal Title 5 Hazardous Air Pollutant Regulations, the following discharge limits will apply:

- 60 lbs/hr Total Non-Methane Hydrocarbons (TNMHCs) in emissions
- 0.19 ppm TNMHCs (ambient air) in dispersed emissions (not currently enforced by NMED).
- 10 lbs/hr Toluene in emissions
- 10 lbs/hr Ethylbenzene in emissions
- 10 lbs/hr Xylenes in emissions
- 25 lbs/hr total combined Toluene, Ethylbenzene and Xylenes

2.5 Nature and Extent of Contamination

2.5.1 Dissolved- and Separate-Phase Hydrocarbons

Two comprehensive groundwater monitoring events (May and August 1994) were conducted during the Phase III RFI to characterize groundwater at the site. SPH has consistently been measured in wells MW-9, MW-27, MW-28, RW-2, RW-14 through RW-19, RW-22, and RW-23. The thickness of SPH varies due to the operation of recovery systems in most of the recovery wells. The recovery systems had been removed from recovery wells for several days prior to the gauging of wells during the May groundwater sampling event. From this gauging information, apparent SPH was thickest (0.8 feet) in RW-2 and nearby wells MW-4 (0.58 feet) and P-2 (0.32 feet). With the completion of the 1995 offsite investigation, the SPH plume has been delineated in all directions. Accumulations of apparent thicknesses of SPH were noted in wells RW-19 (1.99 feet), P-2 (0.93 feet) and MW-4 (0.88 feet). Figure 10 presents the approximate dimensions of the SPH plume from the March 1995 gauging event.

The primary dissolved constituents of concern are benzene, toluene, ethylbenzene and xylenes (BTEX). Semi-volatile organic compounds (SVOCs) were detected in select wells, but BTEX constituents are also always in the same samples and at higher concentrations. Figure 11 and Figure 13 present the distribution of volatile organic compounds (VOCs) in groundwater from the May 1994 and August 1994 sampling events, respectively. Figure 12 and 14 present the distribution of SVOCs in groundwater from the May 1994 and August 1994 sampling events, respectively. The vertical distribution of groundwater impact is effectively limited by the physical characteristics of the underlying Nacimiento Formation. The formation has an extremely low permeability and is known to exhibit an upward vector of groundwater movement from underlying water formations. Dissolved hydrocarbons have been delineated horizontally to the northwest based on topography (the bluff overlooking the San Juan River); to the northeast, east, and south by non-detectable concentrations in monitoring wells; and to the southeast by the absence of the shallow groundwater aquifer (MW-6). Horizontal delineation was essentially completed to the southwest with the supplemental investigation, although MW-34 contains 1,630 μg/L of VOCs. It is anticipated that one additional monitoring well will be installed further downgradient from MW-34 to complete delineation in this area, but this will be down later as part of the CMI.

2.5.2 Adsorbed-Phase Contamination

Soil impacts have been qualitatively characterized and delineated for each source area. These areas were grouped according to geographic distribution in the RFI Report. The area of greatest impact is that associated with the SPH plume in the aboveground tank storage and product process areas of the site. In these areas, limited soil data are available. It is assumed that the zone of water table fluctuation (averaging 1.51 feet, with a standard deviation of 0.68 feet and ignoring the minimal zone for capillary action) comprises the largest zone of impacted soil (see Section 2.6 below for mass hydrocarbon estimate calculations).

2.5.3 Surface Water and Sediment Contamination

The two surface water bodies in the vicinity of the GRC site (Hammond Ditch and the San Juan River) have been adequately characterized as reported in the Phase V RFI report. Neither water body has been significantly impacted from the GRC facility.

2.6 Hydrocarbon Mass Estimate Calculations

Calculations have been made to estimate the mass of hydrocarbons in the subsurface at the GRC site. Typically, chemical analyses of soil and groundwater and the measured or adjusted SPH concentrations are utilized to estimate hydrocarbon mass when the magnitude of a release is unknown.

Hydrocarbon mass is used to evaluate life-cycle costs to closure for capital equipment purchases, vapor abatement equipment selection, and to guide selection of equipment for optimization of removal rates, in order to decrease overall costs to closure. Due to the inherent difficulties in estimating total mass, and the recognition that recovery of the total mass of hydrocarbons released may be technologically limited, estimates of recovered mass should not be used to determine if closure has been obtained.

2.6.1 Calculation Considerations

Typically, the bulk of hydrocarbon mass from leakage sources is found in the SPH plume and in the soil matrix in the leakage areas in the unsaturated zone. The hydrocarbon mass dissolved in groundwater is typically negligible compared to the mass in the plume and the sorbed mass in the unsaturated zone. Limited data exists to characterize the hydrocarbon mass in the unsaturated zone at the GRC site. However, the SPH plume has been adequately characterized and is the basis for calculating the hydrocarbon mass under the facility. A slight overestimation of the areal extent of the SPH plume is assumed to account for the hydrocarbon mass in the unsaturated zone.

Calculation of Areal Extent

The areal extent of the SPH plume was calculated using scaled plume contour maps. These SPH plume contour maps are based on well gauging data. The maps used were Figure 7 in the April 13, 1995, "*Response to USEPA Comments on the Draft RFI/CMS Report*", and Figure 3 in the April 26, 1995, , and Figure 3 in the A *of the Offsite Well Installations/Groundwater Sampling*" report. These two figures have been included and renamed in this document as Figure 9 and Figure 10, respectively. The well gauging data used to make these maps was from well gauging events conducted on August 2, 1994, and March 1, 1995.

Rectangles drawn over the contours were used to estimate the areal extent of the different SPH plume thicknesses. The oversized rectangles fully containing the oblong SPH contour shapes slightly overestimate the areal extent, but this overage is assumed to accommodate for the uncharacterized mass of hydrocarbon sorbed in the unsaturated zone.

Areal extent multiplied by the SPH thickness yields the estimated SPH volume.

SPH Plume Thickness

SPH plume thickness is based on data from the above mentioned well gauging events. In drawing the plume contours, the breadth of the particular SPH contour thickness was interpolated between the available groundwater monitoring well points. Where a sheen of SPH was encountered, a sheen thickness of 0.001 feet is assumed.

Soil Porosity

A soil property analysis was performed as part of the Phase II RFI. Total porosity was determined to be 35 percent. Only a portion of the soil porosity in the saturated zone SPH thickness and in the smear zone will be filled with hydrocarbons, because water and air fill the majority of the pore space volume. In the saturated zone SPH thickness, 20 percent of the 35 percent porosity is assumed to be full of hydrocarbons. In the smear zone, 1 percent of the 35 percent porosity is assumed to be full of hydrocarbons.

Smear Zone Thickness

The smear zone is that depth region in which the groundwater surface fluctuates. As the groundwater level moves up and down, the SPH atop the groundwater surface is smeared through that layer of soil. Some of this SPH gets sorbed to the soil matrix as the SPH moves through it. This residual sorbed hydrocarbon is a significant portion of the total mass.

For the August 1994 calculation, the smear zone thickness was estimated to equal the average historical groundwater elevation fluctuation in all the monitoring wells (1.51 feet) plus a standard deviation of those fluctuations (0.68 feet). Given the course-grained soils at the groundwater interface, the height of the capillary fringe was assumed to be insignificant. Therefore, the smear zone thickness was assumed to be 2.19 feet thick.

Groundwater elevations fell an average of approximately 1.51 feet from the August 2, 1994, to the March 1, 1995 gauging events. This fall in groundwater elevation freed soil sorbed hydrocarbons, thereby increasing the SPH thickness. For the March 1995 mass calculation, the smear zone thickness was estimated to equal the August 1994 smear zone height (2.19 feet) minus the average fall of groundwater elevation from August 1994, to March 1995 (1.51 feet). Therefore, the smear zone thickness was assumed to be 0.68 feet.

2.6.2 August 1994 Plume

The SPH plume was defined from an August 2, 1994 well gauging event. The SPH thicknesses observed were plotted on a scaled site map and SPH contours drawn thereupon. The map shows two separate SPH plumes; a smaller north plume, and a larger south plume. Both the north and south plumes have a 0.01 foot thick contour inside of a sheen (0.001 foot thick) contour. The scaled SPH contour map (Figure 9) was the basis from which the plume areal extent dimensions and SPH thickness are based. This calculation includes the assumptions which have been discussed in Section 2.1.6.1, and the following assumptions:

- 7.48 gallons per ft^3 (conversion factor).
- Density of SPH is 6.2 lbs/gallon.

The hydrocarbon mass is calculated as follows:

= SPH Plume Area (ft^2) x [[plume thickness (ft) x porosity (%) x pore space saturation (%)] + [smear zone thickness (ft) x porosity (%) x pore space saturation (%)]] x 6.2 lbs/gal x 7.48 gal/ft^3

For example, the hydrocarbon mass in the south plume is calculated as follows;

- Areal extent

Total Plume Rectangles Area = [1500 ft x 355 ft] + [1015 ft x 210 ft]

= 745,700 ft^2

Internal 0.01 ft Thick Contour Rectangle Area = 1390 ft x 140 ft

= 194,600 ft^2

Sheen-Only External Ring Area = 745,700 ft^2 - 194,600 ft^2

= 551,100 ft^2

- Mass of hydrocarbons in "internal rectangle"

  = 194,600 ft^2 x [[0.01 ft x 0.35 x 0.20] + [2.19 ft x .35 x 0.01]] x 6.2 lbs/gal x 7.48 gal/ft^3

  ≈ 70,000 lbs

- Mass of hydrocarbons in "external ring"

  = 551,100 ft^2 x [[0.001 ft x 0.35 x 0.20] + [2.19 ft x .35 x 0.01]] x 6.2 lbs/gal x 7.48 gal/ft^3

  ≈ 200,000 lbs

Therefore, the total estimated hydrocarbon mass in the south plume equaled 270,000 pounds. The total in the north plume equaled 76,000 pounds. Therefore, total mass from both plumes on August 2, 1994 is:

≈ 270,000 lbs + 76,000 lbs ≈ 350,000 lbs,
or ≈ 57,000 gal.

2.6.3 March 1995 Plume

The mass of hydrocarbons on March 1, 1995 was estimated by the same process explained above in Section 2.6.1. The total estimated hydrocarbon mass in the south plume equaled 387,000 pounds. The total in the north plume equals 35,000 pounds. Therefore, total mass from both plumes on March 1, 1995 is:

≈ 387,000 lbs + 35,000 lbs ≈ 422,000 lbs,
or ≈ 68,000 gal.

These mass estimates are relatively close together, varying by only 16 percent. See Appendix A for actual calculations of hydrocarbon mass.

2.7 Actual or Potential Exposure Pathways

Actual and potential exposure pathways were assessed in the RFI Report and April 13, 1995 "Response to USEPA Comments on the RFI/CMS Report". In addition the "Human Health and Ecological Risk Assessment" (December 1995) is a baseline risk assessment prepared for GRC, describing potential receptors, migration routes, and contaminant toxicities, and establishes appropriate corrective action objectives for the site.

Groundwater

There are no groundwater wells in the vicinity of the site with the potential for impact, and no future installations are likely, as the shallow groundwater contains TDS above levels allowable for human consumption. The closest water wells identified are on the west side of Highway 44 and across the San Juan River to the north beyond any potential impact from GRC. These are likely used for gray water (lawn watering, car washing, etc.) as most residences are connected to the municipal distribution system. Potable water supply is derived from the deeper Ojo Alamo aquifer and from surface water intakes (upstream in the San Juan River).

Surface Water

The San Juan River is a source of potable water for the surrounding communities. In addition, the San Juan River is used for recreational purposes (i.e., fishing, swimming, rafting). The Hammond Ditch provides a barrier to groundwater migration between the facility and the San Juan River. Seeps from the bluff are a potential source of contamination to the San Juan River. Overland migration of dissolved petroleum constituents to water bodies is limited by the site-wide stormwater runoff control system.

The Hammond Ditch, because it is used for irrigation of agriculture and livestock, may be a potential pathway for transmission of hazardous constituents to sources of food for human consumption. The United States Department of the Interior - Bureau of Reclamation (USDOI - BOR) has proposed a plan to line the Hammond Ditch with impermeable materials to reduce seepage and thereby reduce the salinity of the water downstream (USDOI-BOR, January 1993). This project will eliminate the potential for impacts to the Hammond Ditch from the GRC facility.

Excluding methylene chloride, no VOCs or SVOCs were detected in any surface water samples from either the Hammond Ditch or the San Juan River during the Phase V RFI. These data suggest that the contaminant migration potential in either surface water body is minimal.

Land Use

Public property managed by the Bureau of Land Management borders the facility to the south. Undeveloped public and private lands in addition to several gravel pits border the property to the east and private undeveloped land borders the property to the west. The town of Bloomfield is located immediately

north of the refinery, across the San Juan River, and has a population of approximately 5,000. The majority of the undeveloped land in the vicinity of the refinery is used extensively for oil and gas production and, in some instances, grazing. U.S. Highway 44 is located approximately one-half mile west of the facility. The adjacent property owners are illustrated in
Figure 2.

Endangered/Threatened Species
The portion of the San Juan River in the vicinity of the GRC facility is part of the Upper Colorado River Basin. According to information from the U.S. Fish and Wildlife Service, there are 14 species of native fish fauna in the Upper Basin. Four species, the razorback sucker, Colorado squawfish, humpback chub and bonytail, are on the federal endangered species. These species are endangered due to loss of habitat, proliferation of introduced species and other man-induced disturbances (Maddux, Fitzpatrick & Noonan, 1993). The San Juan River west of Farmington is proposed to be designated as a critical habitat for the Colorado squawfish and the razorback sucker.

Groundwater Fate & Transport Modeling
The "Human Health and Ecological Risk Assessment" report (December 1995) for the GRC site describes various potential receptors, exposure routes and associated risks based on site data, groundwater use and future land use. Since shallow groundwater is not suitable for potable use due to poor water quality (TDS > 1,000 mg/kg) pursuant to New Mexico Water Quality Control Commission (WQCC) regulations (Part 3103B), there is no risk of ingestion of contaminants in groundwater. A potential exposure scenario for use of groundwater as "gray water" (lawn irrigation, car washing, etc.) was considered, although there are currently no downgradient wells identified. Again, existing concentrations, even without SPH removal, did not pose a risk. The risk assessment report provides additional detail on fate and transport modeling conducted.

2.8 Current Status of Remedial Activities

In June 1988, GRC installed two recovery wells (RW-1 and RW-2) and four piezometers were installed, and MW-10 was converted to a third recovery well (RW-3). Air operated skimmer pumps were installed in the three recovery wells and the system was started up in January 1989. Additional hydrocarbon recovery wells (RW-14 through RW-19) were installed in August 1990. Each of these wells contained SPH, was equipped with a recovery pump, and piped to the recovery system. Two additional recovery wells (RW-22 and RW-23) were installed in 1993 as part of the Interim Measure Work Plan implementation. A total of eleven recovery wells comprise and the hydrocarbon recovery system, seven of which are currently active.

Submersible pumping devices set at the water table/SPH interface comprise the recovery system. The pumps are piped to Tank 33 (10,000 gallon capacity) or to a sewer leading to the API separator. Lines leading to Tank 33 are constructed of schedule 80 PVC, while lines from Tank 33 to the API separator are constructed of coated and wrapped, carbon steel. The pumping devices are identically constructed (by the facility) and operate on a timed, cycled pumping rate (estimated at a maximum of 1/2 gallon per minute). These pumps are approximately 3 feet long, 2 3/8-inch diameter PVC or stainless steel with a top fill set at the SPH/water table interface. The pump is allowed to fill, then a timer activates the pumping cycle and compressed air is applied to the pump forcing the liquid to the surface. The facility tried using Ejector System and QED pumping systems, but calcium carbonate build-up made maintenance of these too labor-intensive.

RW-1 and RW-3, the inactive wells, were shut off because they did not contain SPH for several consecutive monitoring events. RW-22 and RW-23 had never been equipped with pumping systems since they did not contain SPH initially. Tank 33 is routinely gauged and emptied to a sewer leading to the API separator. Recovered groundwater is discharged to the facility's wastewater treatment system.

3.0 ESTABLISHMENT OF CORRECTIVE ACTION OBJECTIVES

In order to screen technologies and develop corrective measure alternatives, the Corrective Action Objectives (CAOs) for the GRC site must be established. Table 3-1 identifies the regulatory framework, or applicable or relevant and appropriate requirements (ARARs) within which environmental activities at GRC must be conducted.

Risk screening conducted in conjunction with this CMS indicates that remediation of SPH and associated soils is the primary objective, as it presents a source of continued soil and groundwater contamination. Further remediation of soils and/or groundwater following SPH removal is not necessary to be protective of human health and the environment.

Various proposed and promulgated standards have been identified for soil and groundwater. The standards for soil are summarized in Table 3-2, and the standards for groundwater are summarized in Table 3-3.

4.0 EXISTING CORRECTIVE MEASURES/ FIELD AND BENCH-SCALE STUDIES

4.1 Vapor Extraction/Air Sparge Pilot Testing

Vapor extraction/air sparge pilot testing was conducted as part of the Phase IV RFI. A complete discussion of the procedures and findings was provided in previous submittals. The key findings were as follows:

- Induced vacuum as a result of venting from a single 2-inch well (VEW-1S) in the shallow zone (5 to 13 feet below grade) at the site was measured in wells up to 57 feet away from the vent well. At the maximum applied vacuum of 42 inches of water column, induced vacuum response was low (less than 0.19 inches water column), reflecting the low permeability sediments (clay) characteristic of this zone. Maximum soil vapor flow from the test well was 115 scfm. Calculated *effective* radii of influence for the shallow zone ranged from 2 feet (for removal of diesel products) to 36 feet for removal of gasoline (xylene/ethylbenzene) products.

- Induced vacuum response measured while venting from a single 2-inch well (VEW-1D) in the deep zone (16 to 26 feet below grade) at a maximum applied vacuum of 21 inches water column ranged from 1.9 to 4.0 inches of water at distances of 19 to 57 feet from the vent well. Extrapolation of the observed data indicate that significant response (greater than 1% of the applied vacuum) would occur as far away as 175 feet from the vent well. Greater response to venting in the deep zone is probably attributable to the high permeability sands and gravels occurring at this depth. Maximum soil vapor flow from the deep test well was 131 scfm. Calculated *effective* radii of influence for the deep zone ranged from 3 feet (for diesel) to 84 feet for removal of gasoline components.

- Aquifer sparging effectiveness was evaluated based on observed induced pressure and VOC concentrations while sparging at applied pressures of 3 to 5 psi. At 5 psi maximum air flow into well AS-1 (2-inch diameter) was 19.5 scfm. A conservative value of 50 feet was selected as the effective radius of influence for the sparge test, based on the observed pressure responses.

- Based on the results of the combined pilot test, a net negative vacuum was observed in all monitor points while venting at near maximum vacuum (18 inches water column) and sparging at approximately 120% (5 psi) above breakthrough pressure. This indicates that any vapors generated as a result of sparging can be captured and contained by the vacuum system. For the combined test, vacuum measured in the monitor points was generally reduced by more than one-half (when compared to the vacuum measured in these same points while venting only) as a result of sparge pressure, further confirming the effectiveness of sparging at the site.

- Hydrocarbon mass removal rates ranged from 0.20 lb/hr total fuel for the shallow zone to 5.5 lb/hr total fuel while venting and sparging on the deep zone. Elevated concentrations of methane ranging from 18 to 68% were also detected in the vented effluent, and oxygen levels ranged from 4.3 to 18%.

4.2 Bacterial Enumeration Studies

Bacterial enumeration studies were conducted on groundwater samples collected from five wells at the site to determine the density of total heterotrophic bacteria (THB) and contaminant-utilizing bacteria (CUB). Appendix B contains the laboratory analytical results of this sampling event. Petroleum hydrocarbons, particularly BTEX compounds and low molecular weight hydrocarbons ($<C_{30}$), are generally biodegradable. The concentration of petroleum hydrocarbons can limit biodegradation. In particular, biodegradation is usually not considered feasible within zones of SPH (until it is removed) or if the concentration of petroleum hydrocarbons are greater than 20,000 mg/kg. SPH is present at the GRC site and therefore, before bioremediation is considered, the SPH should be removed.

If the contaminant is inherently degradable, the next parameter of concern in determining the feasibility of bioremediation is whether the density of bacteria capable of degrading the contaminant is sufficient. This is usually done by measuring the density of THB, as well as the population density of 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 10^5 CFU/ml are considered high and measurement below 10^3 CFU/ml are considered low.

Upon preliminary review, the microbial data from the GRC site suggest that bioremediation is feasible, however bacteria counts from groundwater are low to moderate. THB counts for wells MW-11, MW-26, MW-30, MW-31, and MW-34 ranged from 1.3×10^3 CFU/ml to 5.9×10^4 CFU/ml. CUB counts for the same wells ranged from 3.2×10^2 CFU/ml to 4.7×10^4 CFU/ml. Bacterial counts for each well are summarized in the following table:

Bacterial Enumeration Study

Well Number	CUB (CFU/ml)	THB (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

The individual microbial data were compared with the chemical data to determine if a correlation between the hydrocarbon concentrations and the bacterial counts could be established. Total volatile hydrocarbon concentrations were detected in each of the above monitoring wells. However, a correlation between the bacteria counts and hydrocarbon concentrations could not be established. This indicates that factors other than hydrocarbons alone are limiting biological activity in the saturated zone.

Groundwater samples from the five wells were also analyzed for inorganic parameters, dissolved oxygen, and pH. An evaluation of the inorganic analytical results shows that ammonia and orthophosphate are present in the groundwater but at concentrations below which viable bacteria populations can be supported. pH measurements were within the accepted aerobic bioremediation range of pH = 6 to 8. Dissolved oxygen concentrations are also very low and indicate that anaerobic conditions may be present which further inhibits aerobic biodegradation. A review of historical analytical data shows elevated nitrate levels in MW-5 (an upgradient monitoring well), as compared to wells located within the hydrocarbon plume. This well may indicate that anaerobic biodegradation of hydrocarbons under denitrifying conditions has been or is occurring. This conclusion is supported by the high methane levels measured during the vapor extraction/air sparge pilot test. Moderate levels of sulfate are present in the plume area. Sulfate can serve as a terminal electron acceptor under highly reducing conditions. The moderately high sulfate measurements indicate that this mechanism is probably not occurring to any great extent at the site.

The limited availability of dissolved oxygen and corresponding low inorganic nutrients appear to be the inhibiting factors for effective biodegradation of the hydrocarbons at the site. However, the presence of the heterotrophic bacteria and the high percentage of contaminant utilizing bacteria in relation to the heterotrophic bacteria indicates that the base bacterial population for effective biodegradation exists. A remediation system consisting of soil vapor extraction and air sparging would provide sufficient oxygen for aerobic conditions. The increased oxygen would enhance the bacteria populations, thereby increasing the hydrocarbon degradation rate. Nutrient addition is anticipated to be required for sustaining the increased biodegradation rate.

Required nutrient addition (i.e., nitrogen and phosphorus) is estimated by using the mass ratio of 100 hydrocarbon/10 nitrogen/1 phosphorous and monitoring rates of transport in the field. Atmospheric oxygen would be provided to the vadose zone and saturated zone by a vapor extraction and air sparging system, respectively. These systems would be designed using the radii of influence determined by the vapor extraction/air sparge pilot test.

5.0 SCREENING OF CORRECTIVE MEASURE OPTIONS AND DESCRIPTION OF RETAINED CORRECTIVE MEASURE OPTIONS

Corrective measure options include remedial technologies such as Soil Vapor Extraction, and environmental management alternatives such as No Action. The March 1993 "RCRA Facility Investigation - Task I: Description of Current Conditions" report included a pre-investigative evaluation of corrective measures. A reevaluation of corrective measure alternatives was conducted as part of the CMS process, giving consideration to data collected as part of the RFI.

5.1 Corrective Measure Option Screening

Initial screening for corrective measure options was accomplished by utilizing technology or corrective measure option screening matrices (Tables C-1, C-2, C-3, and C-4 in Appendix C). These matrix tables identify and rate the corrective measure options which address one or more of the four corrective action objectives (CAOs) at GRC. There is a matrix for each of the following four objectives at GRC:

1. Seepage control (to the San Juan River)
2. SPH remediation
3. Soil remediation
4. Groundwater remediation.

Some of the corrective measures identified, such as soil vapor extraction, are applicable to more than one objective. Corrective measure options such as these are perhaps more applicable than the individual matrix screening score indicates, because one measure can help fulfill more than one objective.

The basic mechanism for the screening process is a rating system where each potential technology is assigned a numerical value with regard to the following considerations:

1. applicability to the site
2. permissibility (in terms of regulation and impact on refinery operations)
3. relative cost
4. treatment time acceptability.

In order to evaluate a corrective measure option's applicability, the following information elements should be considered:

1. Type of contaminants
2. Magnitude of contamination
3. Media which require corrective action
4. Levels necessary for closure (CAOs)

The first three applicability elements were determined in the RFI and are summarized in Section 2.0. The CAOs are identified in Section 3.0. The contaminants at the site are primarily BTEX in the dissolved, separate, and adsorbed phases.

Nine corrective measure options were screened for seepage control, eight corrective measure options were screened for SPH remediation, ten corrective measure options were screened for soil remediation, and eight corrective measure options were screened for groundwater remediation. A screening matrix was used to streamline the evaluation process by organizing and recording rating scores (Tables C-1 through C-4 in Appendix C).

Once each technology is rated, a simple summation enables the reviewer to eliminate those technologies that show low overall rating scores. Options that show high overall rating scores are retained for further consideration on a more detailed level.

A description of the rating considerations is provided below.

5.1.1 Description of Rating Considerations

5.1.1.1 ***Applicability to Site.*** The applicability of a corrective measure option to remediate contamination at any specific site is evaluated with regard to the inherent advantages and disadvantages. Factors which affect a corrective measure option's applicability include contaminant type (e.g., volatility, biodegradability), soil conditions (e.g., grain-size and permeability), groundwater conditions (e.g., hardness, depth, saturated thickness, etc.), surrounding conditions (e.g., interference with buildings, structures or other treatment activities, and availability of water/sewer/power), and degree of difficulty for installation and maintenance. This rating gives a numerical value to the relative applicability of the corrective measure option to the specific site. This is a subjective rating based upon the perceived advantages and disadvantages of the technology applicability as well as any additional professional judgement the author may add. Applicability scoring ranges from 0 for inapplicable to 5 for completely applicable.

5.1.1.2 Permissibility. The permissibility of a corrective measure option relates to the anticipated degree of difficulty in getting permits/approval from state regulatory authorities. It also relates to the anticipated degree of difficulty in getting approval from the refinery company management to approve such things as facility modifications, and use of facilities, which could interfere with production. Permissibility scoring ranges from 0 for impermissible to 3 for easily permissible.

5.1.1.3 Present Value Costs. This rating gives a relative numerical value to the estimated present value of the combined capital and operating costs incurred in implementing the corrective measure option. Cost rating ranges from 1 for highest cost to 5 for lowest cost.

5.1.1.4 Treatment Time Acceptability. This rating gives a numerical value to the potential of the corrective measure technology to perform the desired site remediation within an acceptable time frame. Treatment time scoring ranges from 1 for longest treatment time to 3 for most rapid treatment time.

5.1.2 Rating Score

The rating score is simply the arithmetic scoring of the columns entitled "Applicability" (A), "Permissibility" (P), "Present Value Cost (C)", and "Treatment Time" (T).

The formula for the Rating Summation calculation is:

Rating Summation = $AxPx(C+T)$

Scores can range from 0 for worst choice to 120 for excellent choice.

5.1.3 Retention of Options

A final decision on whether or not to retain a specific listed technology as a candidate for application is made based upon the relative value of the Rating Score. Those corrective measure options with the highest Rating Scores relative to others were retained for further consideration. The retained corrective measure options are identified and described below.

5.2 Identification of Retained Corrective Measure Options

The following sections contain a brief description of retained corrective measure options which are applicable for one or more of the four CAOs at GRC. The descriptions should aid in understanding the applicability of each option to the site. The corrective measure options are listed and discussed below along with the CAOs to which they apply. Some of the corrective measure options identified, such as soil vapor extraction, are applicable to more than one CAO. The retained corrective measure options are evaluated for final selection in Section 6.0.

5.2.1 Seepage Control

Petroleum impacted groundwater under the GRC site flows toward the San Juan River through seeps at the base of the bluff on the northwest side of the site. To prevent impact on the river, the petroleum impacted groundwater flow from the seeps must be mitigated. To do this, seep flows must be slowed, or contaminant levels reduced. Controlling seep flows is more difficult and expensive than reducing contaminant levels in flows reaching those seeps. One option, grout curtains or sheet pilings, was retained for slowing the flow to the seeps. To reduce contaminant concentrations reaching the seeps, two retained corrective measure options were retained.

5.2.1.1 Option 1: Grout Curtain or Sheet Pilings. Installation of a grout curtain or a chain of sheet pilings would have the intended effect of physically restricting groundwater flow to the seeps of concern west of the northern plume. This could be effective for the short-term, however, groundwater would eventually flow around the ends of the grout curtain/sheet piling chain and find other seeps. Furthermore, the grout curtain and sheet piling chain would be an impermeable barrier diminishing the effectiveness of sparging and soil vapor extraction activities in the area. Implementation of this corrective measure option would entail drilling pressure grouting points along the western boundary of the northern plume. Construction of these barriers requires the use of specialized heavy equipment making this technique capital cost expensive. However, once installed, little operation and maintenance would be required making this option only moderately expensive relative to the other corrective measure options listed in Table C-1. No water quality improvement would be achieved with this alternative.

5.2.1.2 Option 2: Contaminant Source Removal by SVE and IAS. Contaminant source removal would have the intended effect of removing the upgradient sources of hydrocarbon contamination which contribute to the contaminated groundwater migrating toward the seeps. Implementation of this corrective measure option would entail the implementation of SVE and *in situ* air sparging (IAS) technologies to remove and degrade SPH and soil sources. The lack of water handling operations makes this technique less expensive than the other unretained corrective measure options listed in Table C-1. The water quality improvement with this alternative will be more gradual.-1. The water quality improvement

5.2.1.3 Option 3: Enhanced In Situ Bioremediation. Enhanced *in situ* bioremediation is the injection of nutrients, such as nitrogen, and phosphorous, into groundwater to promote the biodegradation of contaminants before they reach the seeps. Again, no water handling is involved so this technique will be less expensive to implement. Bacterial enumeration studies conducted at the site have concluded that site conditions (bacteria populations, contaminant type, temperature, pH, geology) are amenable to bioremediation. However, these studies have also noted that the low oxygen, nitrogen and phosphorus levels in groundwater are limiting for optimal bioremediation effectiveness. If these growth factors (O, N, and P) are amended to the subsurface, bioremediation may have a significant effect on reducing hydrocarbon contaminants and meeting CAOs.

Nutrient addition would be best evaluated after the SPH plume has been removed by other treatment options (pumping and IAS/SVE) because more dilute (less bio-toxic) hydrocarbon concentrations are more readily bioremediated. Water soluble agricultural fertilizers would be used to provide the necessary nutrients in a cost-effective manner. Treatment time of the non-volatile hydrocarbons would be appreciably enhanced by *in situ* bioremediation. The degree of biodegradation of all hydrocarbons could be monitored by monitoring carbon dioxide levels before and after nutrient addition. If an increase in carbon dioxide levels is observed some time after nutrient addition, then further nutrient addition will be implemented. Contaminant biodegradation is also limited by oxygen so this option should be implemented in conjunction with other oxygenating options such as IAS and SVE.

Nutrient addition to groundwater is permissible in New Mexico with a Groundwater Discharge Permit issued by the NMED Groundwater Bureau. Typically the permit conditions require the installation of down-gradient sentinel wells to monitor for the presence of nitrogen and phosphorus escaping the treatment area. The proximity to the San Juan River makes the onsite containment of nutrients important. Nitrogen and phosphorus are problematic pollutants for rivers and lakes causing algae blooms and eventual eutrophication. Therefore, any nutrient addition must be gradually dosed in small quantities. Doses of the water soluble fertilizer can be mixed with water and poured down into existing monitor wells, sparging wells or SVE wells on the up-gradient side of the treatment area. Dispersion of the nutrients in groundwater must be carefully monitored in treatment areas near the seeps.

5.2.2 *Separate Phase Hydrocarbon Remediation*

The extent of SPH has been defined during well gauging events. SPH comprises the largest portion of the total mass of contamination which is estimated to range from 57,000 to 68,000 gallons of hydrocarbons. The SPH must be eliminated to promote water quality improvement and bring the site to closure. To accomplish those ends, three retained corrective measure options are discussed below.

5.2.2.1 Option 1: Soil Vapor Extraction. Soil vapor extraction (SVE) is a process in which soil vapors are vacuumed out of the subsurface. This is accomplished by the installation of vapor extraction wells connected to a vacuum blower. SVE is most effective in course-grained soils impacted with volatile contaminants. These are the type of conditions which exist at the GRC site. At GRC the primary contaminants detected were BTEX, all constituents which are readily volatilized and biodegraded. Only a few semi-volatile compounds at low concentrations have been detected. This contaminant profile renders the GRC site a particularly good candidate for SVE. SVE would have the intended dual effect of removing volatilized hydrocarbon contaminants from the unsaturated zone, and stimulating endemic hydrocarbon degrading aerobic bacteria.

Active venting of soil vapors alone promotes continuous but slow volatilization of hydrocarbon contaminants from the surface of SPH. SVE coupled with sparging, as discussed in Section 5.2.2.2, promotes more rapid volatilization of hydrocarbons from the SPH. Pilot testing results from the RFI indicate that SVE is feasible for the GRC site. Pilot testing is discussed more fully in Section 4.1.

The induced flow of air through the vented soil formation stimulates aerobic soil bacteria to more rapidly degrade organic contaminants. Organic contaminants are converted into carbon dioxide and water by the bacteria. The rate of biodegradation can be calculated based on oxygen uptake and carbon dioxide production data. 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, the monitoring of carbon dioxide can be used to determine the mass of contaminants being degraded. Also, monitoring carbon dioxide production is an effective way to assure that bioremediation is proceeding efficiently. 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 some other condition in the system.

As with carbon dioxide production, oxygen uptake is a direct measure of biodegradation. While more difficult to measure, respirometry tests can be conducted periodically to evaluate the rate of biodegradation. *In situ* respirometry tests are conducted utilizing an inert tracer, such as helium, to monitor air permeability and oxygen uptake in the subsurface.

5.2.2.2 Option 2: SVE and Air Sparging. Air sparging is a process in which ambient air is injected into groundwater in the subsurface. This is accomplished by the installation of multiple sparging wells connected to a pressure blower. SVE, as discussed in Section 5.2.2.1, coupled with air sparging, would provide accelerated removal of SPH from the subsurface. SPH removal would be accomplished by volatilization and biodegradation.

Sparged air essentially strips volatile contaminants from the saturated zone. These stripped contaminants are carried into the unsaturated zone were they can be captured by the SVE system. Additionally, sparging injects air directly into groundwater, thereby supplying a greater amount of oxygen to the subsurface than SVE alone. This additional oxygen promotes more rapid hydrocarbon biodegradation, particularly in the saturated zone and smear zone. The hydrocarbon biodegradation process is described in more detail in Section 5.2.2.1 above.

Given the relatively thin saturated zone (<1 to 10 feet), multiple sparge points would be required to get sufficient coverage of the SPH plumes. Pilot testing results suggest that both IAS and SVE are feasible technologies for the GRC site.

*5.2.2.3 **Option 3: Total Fluids Pumping.*** Total fluids pumping is a process used to pump SPH and petroleum impacted groundwater out of the subsurface for treatment above grade. This is accomplished by pumping wells installed within the dissolved-hydrocarbon plume.

Total fluids pumping from seven recovery wells is currently employed at GRC. It is used to pump SPH and petroleum impacted groundwater to the existing refinery wastewater treatment plant. However, the system employed is not effective in controlling plume migration, as drawdown in the recovery wells is minimal. Until recently, increasing the flow rates has been limited by the capacity of the facility's water treatment system. However, with the new injection well operational, flow rates are no longer limited by the wastewater treatment system's capacity. High water hardness makes the recovery system maintenance cost- and labor-intensive.

*5.2.2.4 **Option 4: Water Table Depression and SVE.*** Water table depression coupled with SVE is a process in which the water table is lowered, thereby creating a smear zone on the soil matrix that the SPH falls through. This smear zone creates a larger SPH surface area for both the SVE flow to remove volatiles, and for hydrocarbon degrading bacteria to feed. This is accomplished by simultaneous pumping and SVE from pumping wells and SVE wells located close together. SVE, as discussed in Section 5.2.2.1, coupled with water table depression would provide accelerated removal of SPH from groundwater. SPH removal would be accomplished by both volatilization and biodegradation.

The smear zone in the soils matrix acts somewhat like the combination of a crude air stripping matrix and a fixed film bioreactor. SVE flow passing through the porous smear zone soil matrix will pull off more volatile contaminants than SVE over the flat plane surface of a SPH plume laying on groundwater. A thin SPH coating on soil grains in the smear zone will be more diluted (less toxic) and more accessible to oxygen which will enhance the biodegradation process (described in more detail in Section 5.2.2.1).

Significant groundwater depression would be rather difficult to create because the unlined Hammond Ditch is hydraulically connected to the site and the limited thickness of the saturated zone. Pumping a high volume would be necessary to compensate for in-flow from the Hammond Ditch, and multiple recovery wells would be needed to achieve drawdown in the thin saturated zone. Pilot testing results suggest that SVE is a feasible technology for the GRC site, which could be relatively easily enhanced locally (in the SPH plume areas) by water table depression provided the volume of the water generated is not unmanageable and the number of recovery wells required is not impractical.

5.2.3 *Soil Remediation*

Hydrocarbon contamination sorbed to soil is also generally a significant portion of the overall mass of contamination. Contaminated soil is often a continuing contributing source of groundwater contamination. This soil source must be eliminated to allow water quality improvement and bring the site to closure. To accomplish those ends, two corrective measure options are considered below.

5.2.3.1 Option 1: Risk Assessment. Risk assessment is a process by which scientists evaluate the potential risks to human health and the environment which may exist due to the presence of contamination. Various exposure scenarios, migration route and contaminant toxicities are considered in developing risk-based cleanup criteria. A risk-assessment can provide a scientific basis for choosing not to remediate a contaminated site or a contaminated medium at a site where the existing contamination does not significantly threaten human health or the environment. For the GRC site, risk assessment is not intended to eliminate the need for active remediation, but instead, to support alternative abatement standards (AASs) which are both technically achievable and protective of human health and the environment. A risk assessment has been conducted for the GRC site in order to establish site-specific CAOs for soils (and groundwater). The primary CAO from this study is removal of SPH.

5.2.3.2 Option 2: Soil Vapor Extraction. SVE is a process in which soil vapors are vacuumed out of the subsurface. This is accomplished by the installation of vapor extraction wells connected to a vacuum blower. SVE is most effective in course-grained soils impacted with volatile contaminants. These are the type of conditions which exist at the GRC site. SVE would have the intended dual effect of removing volatilized hydrocarbon contaminants from the unsaturated zone, and stimulating endemic hydrocarbon degrading aerobic bacteria.

Active venting of soil vapors alone promotes continuous removal of volatile hydrocarbons sorbed to the soil matrix. The induced flow of air through the vented soil formation also stimulates aerobic soil bacteria to more rapidly degrade organic contaminants. This stimulation is accomplished through the increased supply of oxygen. Organic contaminants are converted into carbon dioxide and water by the bacteria as discussed in greater detail in Section 5.2.2.1.

Pilot testing results from the RFI (in Section 4.1) indicate that SVE is feasible for the GRC site.

5.2.4 Groundwater Remediation

A small portion of petroleum hydrocarbons is semi-soluble to soluble in water. This hydrocarbon portion typically migrates farther from the pollution source than SPH. Analytical results from groundwater sampling events at the GRC facility indicate dissolved phase hydrocarbon contaminants outside the SPH plume boundaries. The mass of hydrocarbons in the dissolved phase is small relative to the masses in SPH and soil. Five corrective measure options to address the dissolved phase contamination are discussed below.

5.2.4.1 Option 1: Risk Assessment. Risk assessment is a process in which scientists evaluate the potential risks to human health and the environment which may exist due to existing levels of contamination. A risk-assessment can provide a scientific basis for choosing not to remediate contaminated site or a contaminated medium at a site where the existing contamination does not significantly threaten human health or the environment. A risk assessment has been conducted for the GRC site in order to establish site-specific CAOs for groundwater. The primary CAO from this study is removal of SPH.

5.2.4.2 Option 2: In Situ Air Sparging. In situ air sparging (IAS) is a process in which ambient air is injected into groundwater in the subsurface. This is accomplished by the installation of multiple sparging wells connected to a pressure blower. IAS would remove dissolved phase contaminants by volatilization and biodegradation.

Sparged air sparging bubbles essentially strips volatile contaminants from impacted groundwater. These stripped contaminants are carried into the unsaturated zone were they could be captured by the SVE system. Additionally, sparging injects air directly into groundwater, thereby supplying a greater amount of oxygen to the subsurface than SVE alone. This additional oxygen promotes more rapid hydrocarbon biodegradation. The hydrocarbon biodegradation process is described in more detail in Section 5.2.2.1.

Given the relatively thin saturated zone, multiple sparge points would be required to get sufficient coverage of the dissolved-hydrocarbon plume, especially considering that approximately 50 acres are impacted. Pilot testing results suggest that both IAS and SVE are feasible technologies for the GRC site.

5.2.4.3 Option 3: Enhanced In Situ Bioremediation. Enhanced *in situ* bioremediation is the injection of nutrients, such as nitrogen, and phosphorous, into groundwater to promote the biodegradation of contaminants. No water handling is involved so this technique will be less expensive to implement than groundwater recovery and treatment. Bacterial enumeration studies conducted at the site have concluded that site conditions (bacteria populations, contaminant type, temperature, pH, geology) are amenable to bioremediation. However, these studies have also noted that the lack of oxygen, nitrogen and phosphorus levels in groundwater are limiting for optimal bioremediation effectiveness. If these growth factors (O, N, and P) are provided, bioremediation may have a significant effect on reducing hydrocarbon contaminants.

Nutrient addition would be best evaluated after the SPH plume has been removed by other treatment options (pumping and IAS/SVE) because more dilute (less bio-toxic) hydrocarbon concentrations are more readily bioremediated. Water soluble agricultural fertilizers would be used to provide the necessary nutrients in a cost-effective manner. Treatment time of the non-volatile hydrocarbons would be appreciably enhanced by *in situ* bioremediation. The degree of biodegradation of all hydrocarbons could be monitored by monitoring carbon dioxide levels before and after nutrient addition. If an increase in carbon dioxide levels is observed sometime after nutrient addition then further nutrient addition will be implemented. Contaminant biodegradation is also limited by oxygen, so this option should be implemented in conjunction with other oxygenating options such as IAS and SVE.

Nutrient addition to groundwater is permissible in New Mexico with a Groundwater Discharge Permit issued by the NMED Groundwater Bureau. Typically the permit conditions require the installation of down-gradient sentinel wells to monitor for the presence of nitrogen and phosphorus escaping the treatment area. The proximity to the San Juan River makes the onsite containment of nutrients important. Nitrogen and phosphorus are problematic pollutants for rivers and lakes causing algae blooms and eventual eutrophication. Therefore, any nutrient addition must be gradually dosed in small quantities. Doses of the water soluble fertilizer can be mixed with water and poured down into existing monitor wells, sparging wells or SVE wells on the up-gradient side of the treatment area. Dispersion of the nutrients in groundwater must be carefully monitored in treatment areas near the seeps.

5.2.4.4 Option 4: Contaminant Source Removal/Natural Attenuation. Contaminant source removal would remove the upgradient sources of hydrocarbon contamination (SPH and associated soil contamination) which contribute to the contaminated groundwater. This corrective measure option would entail the implementation of other remediation technologies, such as sparging and vapor extraction, to remove and degrade SPH and soil sources. The lack of water handling operations makes this technique less expensive than the other unretained corrective measure options listed in Table C-4. The water quality improvement with this alternative will be more gradual, relying on natural attenuation to diminish the contaminants still remaining in the dissolved phase. The risk assessment (Option 1) is typically conducted in concert with this alternative to demonstrate acceptable risk of residual contamination to potential receptors.

6.0 DEVELOPMENT OF CORRECTIVE MEASURE ALTERNATIVES

Corrective measure alternatives are developed in this section to address the four CAOs at the GRC site. The alternatives developed below are derived from the one or two highest rated corrective measure options screened and retained in Section 5.0.

6.1 Seepage Control

Of all the alternatives for seepage control in Table C-1, Contaminant Source Removal scored highest. This is because of high applicability and permissibility, and low cost. It is highly applicable because it has the greatest chance for the long-term ability to prevent hydrocarbon contaminants from reaching the river. Contaminant Source Removal is an alternative that relies upon the successful implementation of SPH and soil remediation. SPH and soil remediation are not anticipated to be unusually difficult, which supports this alternative's high applicability. SPH and soil remediation must be performed in any case to meet CAO requirements. This fact explains the medium to low cost rating.

The high permissibility score was based on the absence of any hydrocarbon contaminants in the San Juan River water or sediments based on sampling performed as part of the RFI. After source reduction is completed, it may take another year for remaining dissolved phase contaminants to naturally attenuate in groundwater. Monitoring of hydrocarbon concentrations in the seeps will be incorporated into the facility's groundwater monitoring program. Concentrations are expected to diminish over time once contaminant sources are removed.

The effectiveness of Enhanced *In Situ* Bioremediation (nutrient addition) will be tested after the SVE and sparging efforts have diminished the SPH plumes. If higher carbon dioxide concentrations in the vadose zone are observed indicating enhanced hydrocarbon biodegradation, nutrient addition to groundwater may be implemented to more rapidly attain the CAOs. Nutrient concentrations in groundwater would be monitored to insure that nutrients will not leave the treatment areas.

6.2 Separate Phase Hydrocarbon Remediation

The highest rated corrective measure options on Table C-2 were SVE and IAS/SVE. These two corrective measure options were highly rated in applicability for several reasons. Pilot testing data show that both techniques are feasible in the sand and cobble soil layer in and above groundwater. SVE and IAS/SVE are well suited for the hydrocarbon contaminants, which are primarily the volatile BTEX constituents. IAS would greatly enhance the effectiveness of SVE in eliminating SPH. However, where the saturated zone thickness is thin, this may require numerous IAS wells to get overlapping radii of influence.

Pulsing the SVE and IAS systems improves effective radius-of-influence because it prevents flow channeling in the subsurface. Channeling is the development of preferential flow pathways. Channeling limits air and soil gas flow to the channels created in a constant pressure flow system. Regions in the subsurface far from the flow channels don't experience direct volatilization nor do they receive adequate air flow to stimulate biodegradation. Pulsing varies flow pressure in the subsurface which causes minute amounts of heaving and subsidence. This minute heaving and subsidence causes old channels to close and new ones to form during each pulse cycle. Therefore, pulsing would also be beneficial for SVE and IAS systems in thick or thin saturated zones.

Nearly all the corrective measure options listed in Table C-2 were permissible. The corrective measure options involving groundwater pumping would require a Groundwater Appropriation Permit from the New Mexico State Engineers Office, while SVE and IAS/SVE would not. An air permit will be required from the New Mexico Environment Department because unabated hydrocarbon air emissions from the combined SVE systems are likely to exceed 10 pounds per hour and 25 tons per year. Abatement of SVE emissions is not anticipated to be necessary, given that in New Mexico the required abatement threshold for total non-methane hydrocarbons (TNMHC) mass emission rate is 60 pounds per hour. Discharge mass emission thresholds for other air pollutants are discussed in Section 3. With an NMED Air Pollution Control permit, three SVE systems could legally exhaust nearly 20 pounds per hour each to the atmosphere.

Cost for the SVE and IAS systems per unit of contamination removed would be less than the other corrective measure technologies because of lack of water handling and the associated lower maintenance and pumping energy. Capturing the SPH plume with water pumping corrective measure options would require the extraction and treatment of a large volume of water. Water is much more massive than soil gas and therefore requires more energy to move. Water pumping and treatment of hard water is also maintenance intensive.

Treatment time with pulsed SVE and pulsed IAS will be shorter than steady flow SVE and IAS, and considerably shorter than the pump and treat options.

6.3 Soil Remediation

SVE ranked highest amongst the 10 soil remediation corrective measures options. It did so because it was deemed highly applicable, completely permissible, relatively low in cost, and could meet the CAO within a moderate treatment time. Risk assessment, which is already being performed for the GRC site, ranked second because of high applicability, low cost and rapid "treatment time". Risk assessment is not intended to eliminate the need for active remediation, but instead, to support alternative abatement standards (AASs) which are both technically achievable and protective of human health and the environment. The AASs are proposed to delineate areas requiring remediation (versus monitoring) and to determine when cleanup has been completed. Therefore, the risk assessment alternative has been selected in concert with other corrective measure options selected.

SVE was highly applicable for several reasons. The bulk of hydrocarbon contaminants in soil have been determined to be BTEX constituents which are all volatile and prone to venting. SVE pilot testing has shown SVE to be feasible in the lower sand and cobble layer and to be somewhat feasible in the silty upper lithologic unit. Furthermore, since the GRC site is an active refinery, contaminated soil excavation options would be disruptive, hazardous, and could damage existing buildings and structures (piping, tanks, etc.). As stated in Section 6.2, SVE is dually applicable for SPH remediation as well.

Environmental regulatory authorities have approved the installation of SVE systems at many hydrocarbon impacted sites in New Mexico. An air permit will be required from the New Mexico Environment Department because unabated hydrocarbon air emissions from the combined SVE systems are likely to exceed 10 pounds per hour and 25 tons per year. Abatement of SVE emissions is not anticipated to be necessary, given that in New Mexico the required abatement threshold TNMHC mass emission rate is 60 pounds per hour. Discharge mass emission thresholds for other air pollutants are discussed in Section 3.0.

SVE system cost relative to the soil excavation and treatment options is much less. SVE would also cost less than the other listed *in situ* options such as steam stripping and *in situ* soil washing. The time necessary to remediate mostly volatile contaminants in coarse-grained soils should be relatively short.

6.4 Dissolved Phase Groundwater Remediation

Contaminant Source Removal/Natural Attenuation and IAS were the two highest rated corrective measures options retained in Section 5.0. A Risk Assessment is already being performed for the GRC site to support AASs which are both technically achievable and protective of human health and the environment. The AASs are proposed to delineate areas requiring active remediation (versus monitoring) and to determine when cleanup has been completed. Therefore, the risk assessment alternative has been selected in concert with other corrective measure options selected. A corrective measure alternative incorporating Contaminant Source Removal and IAS has been selected to address groundwater at the GRC site.

Contaminant Source Removal was rated moderately to highly applicable because it serves to eliminate the contaminant sources which, if not abated, will continue to contribute dissolved phase contaminants to groundwater. These contaminant sources include SPH and impacted soil. IAS ranked high in applicability because sparging can strip the mostly volatile dissolved contaminants out of groundwater and into the SVE flow zone.

Both options were deemed highly permissible given the context of their application. Contaminant Source Reduction involves the use of pulsed SVE/IAS, which are commonly permissible corrective measure technologies. IAS when coupled with SVE to prevent fugitive emissions is commonly permissible.

The cost of both of these options is low to moderate because there is no costly/maintenance intensive water handling functions, and because the pulsed SVE/IAS is redundantly applicable for remediating SPH and impacted soils as well.

Treatment time for these two options should be moderate to rapid if both options are simultaneously employed. This is because IAS can rapidly strip out dissolved contaminants from groundwater in and around the plumes. If Contaminant Source Reduction prevents the further addition of the dissolvable contaminants, this will enable natural attenuation of dissolved contaminants outside of the plume treatment areas to proceed at a moderate pace.

The necessity and effectiveness of Enhanced *In Situ* Bioremediation (nutrient addition) will be evaluated after the SVE and sparging efforts have diminished the SPH plumes. If higher carbon dioxide concentrations in the vadose zone are observed indicating enhanced hydrocarbon biodegradation, nutrient addition to groundwater may be implemented to attain the CAOs, if necessary. Nutrient concentrations in groundwater would be monitored to insure that nutrients will not leave the treatment areas.

7.0 JUSTIFICATION AND RECOMMENDATION OF THE CORRECTIVE MEASURE(S)

Pulsed SVE coupled with pulsed IAS are the recommended corrective measures for the GRC site. This is because pulsed SVE/IAS will address all four objectives at the GRC site. Pulsed SVE/IAS will enhance the volatilization and biodegradation of SPH, thereby contributing to its removal from and the subsurface. Pulsed SVE will vent volatile hydrocarbons from the soil, and enhance the biodegradation of sorbed hydrocarbons in the vadose zone. Pulsed IAS will strip sorbed hydrocarbons from the saturated zone into the SVE flow zone. In the ways described above, pulsed SVE/IAS is also the means by which contaminant source reduction will be achieved for satisfying the seepage control CAO. Enhanced *In Situ* Bioremediation will be evaluated following SPH removal and, if implemented, carefully monitored to ensure proper (nitrogen and phosphorus fertilizers) dosages.

Given the large size of the site and in the interest of maximum cost-effectiveness, the pulsed IAS/SVE systems would be concentrated in and around the two SPH plumes. Pulsed SVE/IAS is recommended and justified with respect to technical, safety, environmental, human health, and institutional criteria in the following sections.

7.1 Technical Evaluation Criteria

Performance: Successful performance of SVE and IAS has been confirmed by the pilot testing conducted during the RFI on site. The remedial objectives can be met by proper application (number and location of SVE and IAS wells, correct size blowers, proper well design and engineering), proper pulse durations, and time (system will have to operate a minimum of one year to meet CAOs). In addition to measuring the amount of SPH, dissolved and vapor-phase hydrocarbons removed, consideration should be given to the amount of biodegradation occurring as the result of adding oxygen to the formation. Measurements of CO_2 in the vadose zone and dissolved oxygen in groundwater can be helpful in estimating the rate of biodegradation.

The pulsed SVE and IAS process is illustrated in section view in Figure 15. The sparge blower is connected to two or more sparge well networks. Pulsing effects would be created by the alternate opening and closing of two solenoid actuated valves which shift sparging flow back and forth between two sparge piping trunklines. The two trunklines feed the two separate well networks. Simultaneously, the SVE blower connected to two or more SVE well networks exerts a similarly pulsed vacuum to remove contaminant soil gases. Pulsing effects would be created by the alternate opening and closing of two solenoid valves shifting SVE flow back and forth between two trunklines. The general mechanics and advantage of pulsing are discussed in greater detail in Section 6.2.

The proposed skid-mounted SVE and IAS pulsing system is to be alternately operated in three different equipment compounds serving five different SVE/IAS well network zones. The proposed locations of the three equipment compounds and the five SVE/IAS well network zones is portrayed on Figure 16.

Given the pilot test results and the limited size of the proposed SVE/IAS system, off-gas treatment is not anticipated to be necessary. No water handling or treatment is necessary. Final system design will include blowers, filters, safety interlocks, and a control panel for the equipment.

Reliability:

Conceptually, the combined pulsed SVE and pulsed IAS system is relatively simple. Simple equipment systems are generally more reliable than complex systems. The only controls are an adjustable timer which activates motorized and solenoid valves. SVE and IAS systems are more reliable than groundwater pumping/treatment systems, especially given the high water hardness at the site.

The design and application for SVE and IAS is not new. Most of the equipment can be purchased as skid-mounted, pre-engineered packages, and is of industrial grade. Construction can be modular allowing rapid and inexpensive system modification during site remediation. The SVE and sparging system equipment can be purchased pre-designed from a number of vendors. Factory warranties for moving parts are available, and training is available for the technicians performing the operation and maintenance.

Start-up testing and monitoring will be conducted in part to insure system reliability. For instance, if soil vapor concentrations are high at the onset of operation, air sparging and SVE pulsing could be implemented after concentrations begin to taper off. This could prevent the exceedance of regulatory air emission limits.

Implementability:

In situ remediation is the option best-suited for the active refinery site. An *in situ* system can be constructed without adverse operational impact on the facility. The system will require at least two treatment compounds since the two SPH plumes are located a considerable distance apart. Right-of-way permitting and archaeological surveying will be required for any construction on the BLM property. Only one compound is needed for the smaller north plume, but two compounds would be more cost-effective for the long extended south plume. There is sufficient room at the site for any compounds needed. Piping between wells and the treatment compounds could be constructed below ground or above ground utilizing existing pipe racks. Power for electrical needs is readily available. Permits for building and operation are not anticipated to pose significant problems. Duration of operation is estimated to be between one and four years.

Safety: All operational equipment will be confined to fenced treatment compounds. Aboveground piping will be used wherever practical. Existing overhead piping racks will be utilized, where possible, to carry remediation system piping. Excavation hazards will consist of minor trenching runs only where aboveground piping is not practical. Exposure to VOCs during excavation activities should not be a factor because of the depth to SPH. The remedial equipment will have safety interlocks to prevent exposure to untreated air or water. Explosion-proof (XP-rated) equipment will be provided per Hazard Area Classification requirements identified in the design phase. The emissions will be below occupational exposure levels for the chemicals of concern at the sites, primarily BTEX. All personnel working on or monitoring the equipment will be required to read the Site Safety and Health Plan (SSHP) and to have OSHA training. In addition, the GRC facility holds site-specific safety training for all site workers before work begins.

In the event of a release from the remedial equipment, response actions per the SSHP will be enacted. GRC maintains a rigorous response training program for facility workers. Fire department emergency response crews and site personnel will be informed about the operation of the equipment and of the location of master shut-down switches. The site safety procedures will be reviewed by representatives of GRC prior to commencing additional field work, construction, or operation of the remedial systems.

TABLE 7-1
PRELIMINARY ESTIMATED COSTS FOR CORRECTIVE MEASURE IMPLEMENTATION
GIANT REFINING COMPANY
BLOOMFIELD, NEW MEXICO

DIRECT CAPITAL	ASSUMPTIONS	COST
	1000 cfm SVE Blower unit (1)	$40,000
	300 cfm IAS Blower unit (1)	$20,000
	(40) x 4-inch diameter SVE wells, 20-35 feet deep (installed air rotary)	$162,000
	75 x 2-inch diameter IAS wells, 25-40 feet deep (installed air rotary)	$354,400
	System Installation	$375,000
	Abandonment of system	$35,000
INDIRECT CAPITAL		
	Engineering expenses: Design Drafting Admin	$50,000 $8,000 $6,000
	Legal Fees and Permits	$6,000
	Startup and shake down	$15,000
	Contingency	$20,000
OPERATION AND MAINTENANCE		
	Operating labor costs	$40,000
	Maintenance materials and labor	$12,000
	Auxiliary materials and energy	$20,000
	Purchased services	$10,000
TOTAL ESTIMATED COST		$1,173,400

7.2 Environmental Evaluation Criteria

The proposed corrective measure consists of *in situ* systems to remove SPH, and reduce VOCs and SVOCs. All discharges will meet the facility's permit requirements. The combined SVE/IAS pulsed system is the best option to meet remedial objectives in a cost-effective and timely fashion.

7.3 Human Health Evaluation Criteria

In situ treatment technologies are inherently more protective of human health than *ex situ* technologies, which require use of heavy machinery and often lead to exposure to dust and vapors from the excavations. Exposure to chemicals will be mitigated by strict adherence to OSHA standards set forth in the SSHP. Air monitoring will be conducted during all field activities, such as construction and sampling, to ensure worker safety. Fire codes will be enforced for the handling of flammable liquids. Recovered vapors will be discharged at or below established human health standards.

7.4 Institutional Evaluation Criteria

The selected remedial alternative, SVE and IAS, will be capable of achieving the CAO of SPH removal. It is the best available technology that can meet the site-specific AASs, which are protective of human health and the environment. The corrective measure will comply with the ARARS identified in Section 3.0.

7.5 Conceptual Remedial System

7.5.1 System Description

Given the distance that the north and south plumes are separated, and given the large size of the south plume, one skid-mounted SVE/sparging system alternated between three equipment compounds is proposed. Three equipment compounds will remediate 5 different zones above the two plumes. Dividing the remediation effort into five zones is necessary to minimize the piping friction losses associated with long pipe runs. The zones also provide flexibility in staying below the 60 pound per hour vapor abatement threshold. The following summarizes the typical pulsed SVE/IAS system design capacity and expected usage.

Component	Maximum Capacity	Initial Capacity
Pulsing Sparge blower unit	500 scfm	300 scfm
Pulsing SVE blower unit	1500 scfm	1000 scfm

Calculation of hydrocarbon mass remaining in the subsurface ranges from 350,000 to 422,000 pounds. From the pilot test data, it is expected that soil vapor flow rates will be approximately 130 scfm per deep zone well under an applied vacuum of 21 inches of water. SVE modeling using Groundwater Technology's proprietary software program, Vent-ROI Version 3.0, yielded an effective radius of influence of 84 feet under 21 inches of water vacuum. The TNMHC concentration in the pilot test SVE flow was 11,000 mg/M^3. The flow and TNMHC concentrations produce a mass emission rate of approximately 5 pounds per hour per well.

In March of 1995 the areal extent of the south SPH plume was approximately 20 acres or approximately 870,000 square feet, and the north plume was approximately 4.5 acres or approximately 200,000 square feet. Assuming each SVE well has an 84-foot radius of influence, 32 wells are necessary to provide adequate coverage over the entire south plume, and 8 wells over the entire north plume. However, if the complete 40 well systems were to be operated at the maximum potential capacity (5 lbs/hr/well) initially, the high initial combined SVE mass emission rate would well exceed the 60 pound per hour vapor abatement threshold. Given the exponential decline in vapor concentrations typically observed in the first few months of SVE operation, the system would need vapor abatement for at least the first two or three months.

To avoid the more rigorous regulation for emissions sources with potential emissions above 60 pounds per hour (NMAQCR 702 Parts 2 and 3 would apply, instead of just Part 2) and to avoid the cost and complications with vapor abatement, an alternative approach could be incorporated. The alternate approach proposed involves alternating one mobile skid-mounted SVE/IAS remediation system between 5 separate remediation zones. The first zone would consist of the smaller 4.5 acre northern SPH plume. The larger 20 acre southern plume would be divided into 4 separate zones.

Three remediation equipment compounds would be installed to service all 5 zones with the one skid-mounted system. Figure 16 shows the locations of the 5 proposed zones and the three equipment compounds. One equipment compound is proposed for the northern plume (Zone 1). The other two equipment compounds would be located between Zone 2 and Zone 3 and between Zone 4 and Zone 5 on the southern plume. Locating equipment compounds between two zones allows that equipment compound to be connected to the zone well systems on either side. This enables pulsed SVE and sparge flows to be alternated back and forth between the adjoining zones' well systems. Figure 15 graphically illustrates the proposed alternating zone pulsed SVE/sparging flow arrangement. Zone 1 has no adjoining zones so alternating SVE and sparge pulses would be vented to atmosphere. The equipment compound locations also save construction costs, costs of associated requirements (e.g., power drops, access roads, etc.) and physical space inside the refinery facility.

Eight SVE wells and 15 sparging wells are proposed for each of the five zones. Given flow and emissions levels similar to those of the pilot tests, mass emission levels would be safely maintained below 60 pounds per hour. The single well combined SVE/sparging pilot test at 131 scfm at 21 inches of water vacuum produced a mass emission rate of approximately 5.5 lbs/hour. Therefore, an eight-well single SVE zone system or an alternately pulsed 16-well dual SVE zone system under equivalent vacuums and well flows is estimated to emit below 44 pounds of TNMHC per hour. Given this predicted mass emissions rate, no vapor abatement equipment would be required by the NMED Air Bureau. The Air Bureau will require application for an Air Quality Permit, which would likely require a regular stack emissions monitoring program.

If concurrent sparging and vapor extraction activities would create emission levels above the 60 pound per hour limit (most likely in Zone 3), then sparging activity could be delayed until the high initial SVE-only emissions levels taper off. Startup testing at each zone will help determine if sparging activities must be delayed until SVE-only emissions fall below some safe amount. For instance, SVE-only flow concentrations must diminish to a point where the particular zone SVE well system is emitting less than 25 pounds per hour, then the pulsed sparge system will be incorporated to elevate the emission rate to 50 pounds per hour. Sparging strips volatile contaminants from the saturated zone, and combined IAS/SVE operation can double the pre-sparging SVE only level. However, pilot test vapor concentrations only increased from approximately 5 pounds per hour for SVE-only, to 5.5 pounds per hour for simultaneous sparging and venting.

The NMED Air Bureau allows progressive equipment/system implementation to accommodate this vapor concentration decrease phenomenon. The Air Bureau only requires that the process be implemented in an enforceable manner. The Air Pollution Control Division defines enforceability in terms of physical equipment/system limitations, but not with system adjustment (e.g. progressively decreased dilution flows). The SVE and sparging flows will initially be limited to 1000 scfm and 300 scfm, respectively. These flows will be limited by the sheaves (belt drive wheels) mounted on the respective blowers and motor axles. Positive displacement blowers are most durable when operated at less than approximately three quarters of their maximum revolutions per minute (rpm).

The proposed initial sparging blower output (300 scfm) is less than a third of the proposed initial SVE blower flow (1,000 scfm) to insure adequate SVE capture of sparge induced volatiles. This translates to approximately 20 scfm of sparging flow for each of the 15 proposed sparge wells in each of the zones. A sparging effective radius of influence of 50 feet was determined from pilot testing results. At 5 psi and approximately 100 cfm with only a 5 foot overlying water column, pilot test results indicated 2 inches of mounding 47 feet away from the sparging well.

GRC proposes that the 1,000 scfm SVE/300 scfm sparging system be installed at the north plume (Zone 1) first. The north plume is closest to the groundwater seeps of concern. After the sparging/SVE operation in Zone 1 yields less than 20 pounds per hour, the skid-mounted system would be moved/switched to another equipment compound in order to continue maximum hydrocarbon removal from zones not yet vented/sparged. As with the first zone, the subsequent zone's SVE-only initial emissions levels may preclude the concurrent implementation of sparging.

After all the zones mass emissions levels fall below 20 pounds per hour, the blower/motor sheaves may be replaced with ones that produce greater blower rpm and flows to offset the decreasing vapor concentrations allow greater flows. Sparging flows could safely be increased to 400 scfm.and SVE flows to 1,200 scfm. Additionally, if toward the end of the remediation effort, SVE mass emissions remain flat (asymptotic levels) without the CAOs being fully attained, a SVE/sparge system could be installed in each of the three equipment compounds to more rapidly attain the CAOs.

The effectiveness of Enhanced *In Situ* Bioremediation (nutrient addition) may be tested after SVE and sparging have diminished the SPH plumes, if necessary. If higher carbon dioxide concentrations in the vadose zone are observed indicating enhanced hydrocarbon biodegradation, nutrient addition would be implemented to more rapidly attain CAOs. Nutrient concentrations in groundwater must be monitored to insure that nutrients will not leave the treatment areas. Bacterial enumeration studies conducted at the site have concluded that site conditions (bacteria populations, contaminant type, temperature, pH, geology) are amenable to bioremediation. However, these studies have also noted that the lack of oxygen, nitrogen and phosphorus levels in soil groundwater are limiting for optimal bioremediation effectiveness. If these growth factors (O, N, and P) are amended, bioremediation may have a significant effect on reducing hydrocarbon contaminants.

Nutrient addition would be best evaluated after the SPH plume has been removed by other treatment options (pumping and IAS/SVE) because more dilute (less bio-toxic) hydrocarbon concentrations are more readily bioremediated. Water soluble agricultural fertilizers would be used to provide the necessary nutrients in a cost-effective manner. Treatment time of the non-volatile hydrocarbons would be appreciably enhanced by *in situ* bioremediation. The degree of biodegradation of all hydrocarbons could be monitored by monitoring carbon dioxide levels before and after nutrient addition. If an increase in carbon dioxide levels is observed sometime after nutrient addition then further treatment would be employed Contaminant biodegradation is also limited by oxygen so this option should be implemented in conjunction with other oxygenating options such as IAS and SVE.

Nutrient addition to groundwater is permissible in New Mexico with a Groundwater Discharge Permit issued by the NMED Groundwater Bureau. Typically the permit conditions require the installation of down-gradient sentinel wells to monitor for the presence of nitrogen and phosphorus escaping the treatment area. The proximity to the San Juan River makes the containment of nutrients on site important. Nitrogen and phosphorus are problematic pollutants for rivers and lakes causing algae blooms and eventual eutrophication. Therefore, any nutrient addition must be gradually dosed in small quantities. Doses of the water soluble fertilizer can be mixed with water and poured down into existing monitor wells, sparging wells or SVE wells on the up-gradient side of the treatment area. Dispersion of the nutrients in groundwater must be carefully monitored in treatment areas near the seeps.

7.5.2 *Estimated System Costs*

In order to estimate cost, information was applied from other direct discharge systems that Groundwater Technology has designed, constructed and implemented in New Mexico. The total estimated cost for the entire proposed reclamation effort is $1,173,400. Preliminary estimated installation, capital equipment, and operation and maintenance cost breakdowns are summarized in Table 7-1.

8.0 REFERENCES

Engineering-Science, Inc., *A Final Report on Section 3013 Administrative Order Work Elements*, February 8, 1987.

Federal Register, Proposed Subpart S action levels, July 27, 1990.

Groundwater Technology, Inc., *RCRA Facility Investigation, Task I: Description of Current Conditions*, March 1993.

Groundwater Technology, Inc., *RCRA Facility Investigation, Task II: Draft Work Plan (Revision 1)*, October 1, 1993.

Groundwater Technology, Inc., *Interim Measures Report*, March 3, 1994.

Groundwater Technology, Inc., correspondence dated March 22, 1994 (Soil Boring Investigation).

Groundwater Technology, Inc., correspondence dated June 23, 1994 (Well Installations/Groundwater Sampling - first event)

Groundwater Technology, Inc., *Uppermost Aquifer Hydraulic Testing and Modeling* dated July 20, 1994.

Groundwater Technology, Inc., *Soil Vapor Extraction and Air Sparge Pilot Test Report* dated August 16, 1994.

Groundwater Technology, Inc., correspondence dated September 30, 1994 (Groundwater Sampling - second event)

Groundwater Technology, Inc., correspondence dated October 14, 1994 (Stream Sediment and Surface Water Sampling).

Groundwater Technology, Inc., correspondence dated April 26, 1995 (Results of Offsite Well Installations/Groundwater Sampling).

Groundwater Technology, Inc., correspondence dated April 13, 1995 (Response to USEPA Comments on the RFI/CMS Report).

Groundwater Technology, Inc., correspondence dated April 13, 1995 (Response to USEPA Comments on the RFI/CMS Report).

Groundwater Technology, Inc., *Human Health and Ecological Risk Assessment*, December 1995.

Maddux, H.R., Fitzpatrick, L.A., & Noonan, W.R. *Colorado River Endangered Species Critical Habitat - Draft Biological Support Document*, US Fish and Wildlife Service, September 3, 1993.

New Mexico Water Quality Control Commission Regulations, as amended through October 10, 1995.

New Mexico Water Quality Control Commission Regulations - Regulation Amendments Proposed by the N.M. Environment Department Ground Water Protection and Remediation Bureau, April 22 1994 Official Draft.

New Mexico Environmental Improvement Board (NM-EIB) - Underground Storage Tank (UST) Regulations, Part 12.

"Proposed Revisions to the *Water Quality Standards for Interstate and Intrastate Streams in New Mexico*", New Mexico Municipal League-Municipal Water Quality Association, July 6 1993.

RECON^R *Soil Gas Survey* report dated February 2, 1994.

Tierra Environmental Co., Inc., *A Feasibility Study Class I Injection Well and Facilities*, July 14, 1992.

United States Department of the Interior - Bureau of Reclamation, "San Juan River Unit - Hammond Project Portion, New Mexico (Colorado River Water Quality Improvement Program)", Preliminary Draft - Planning Report/Environmental Assessment (PR/EA), January 1993.

United States Environmental Protection Agency - EPA Contract No. 68-01-7251, Work Assignment No. 92-6L-20.0, Project No. W68446, *Preliminary Review Report/Visual Site Inspection*, August 25, 1987.

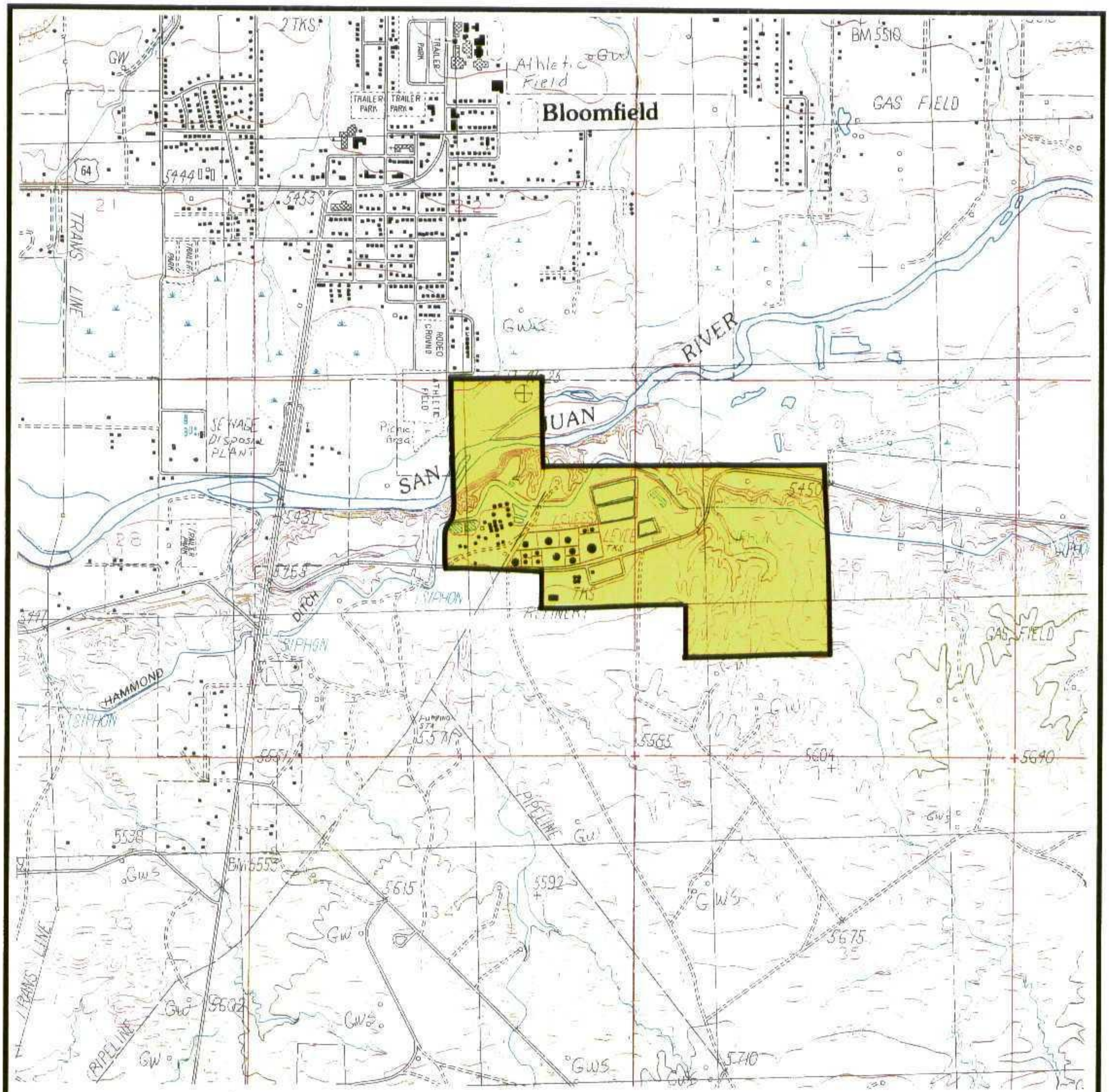
Smith, R.L., *EPA Region III Risk-Based Concentrations*, October 20, 1995.

United States Environmental Protection Agency, *National Primary Drinking Water Standards*, EPA 810-F-94-001A, February 1994.

United States Environmental Protection Agency, *Draft Soil Screening Guidance: Issues Document*, EPA/540/R-94/105, December 1994.

United States Environmental Protection Agency, *Soil Screening Guidance*, EPA/540/R-94/101, December 1994 (Review Draft).

United States Environmental Protection Agency, *Technical Background Document for Soil Screening Guidance*, EPA/540/R-94/106, November 1994 (Review Draft).



LEGEND

SITE BOUNDARY

BLOOMFIELD, N. MEX.QUADRANGLE
PROVISIONAL EDITION
1985
36107-F8-TF-024

QUADRANGLE LOCATION

N

1000 0 2000

SCALE IN FEET

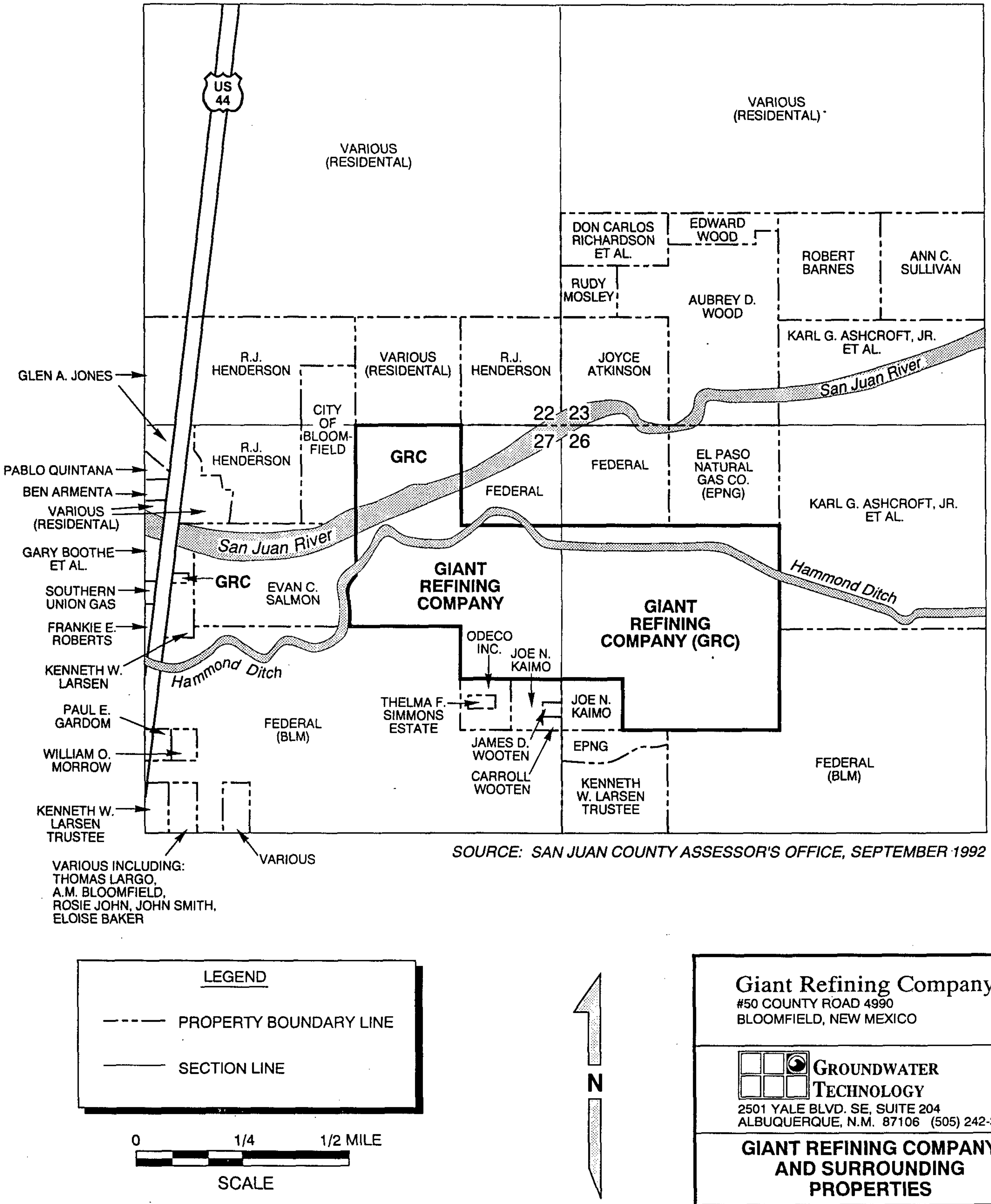
Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, N.M. 87106 (505) 242-3113

SITE LOCATION

DESIGNED BY: CD	DETAILED BY: JU	CHECKED BY:
DATE: 12/19/95		FILE: SITELOC 12/95
PROJECT NO.: 053353014		CONTRACT:
DRAWING: FIGURE 1		REVISION: –

T29N R11W, SEC. 22, 23, 26 & 27



SOURCE: SAN JUAN COUNTY ASSESSOR'S OFFICE, SEPTEMBER 1992

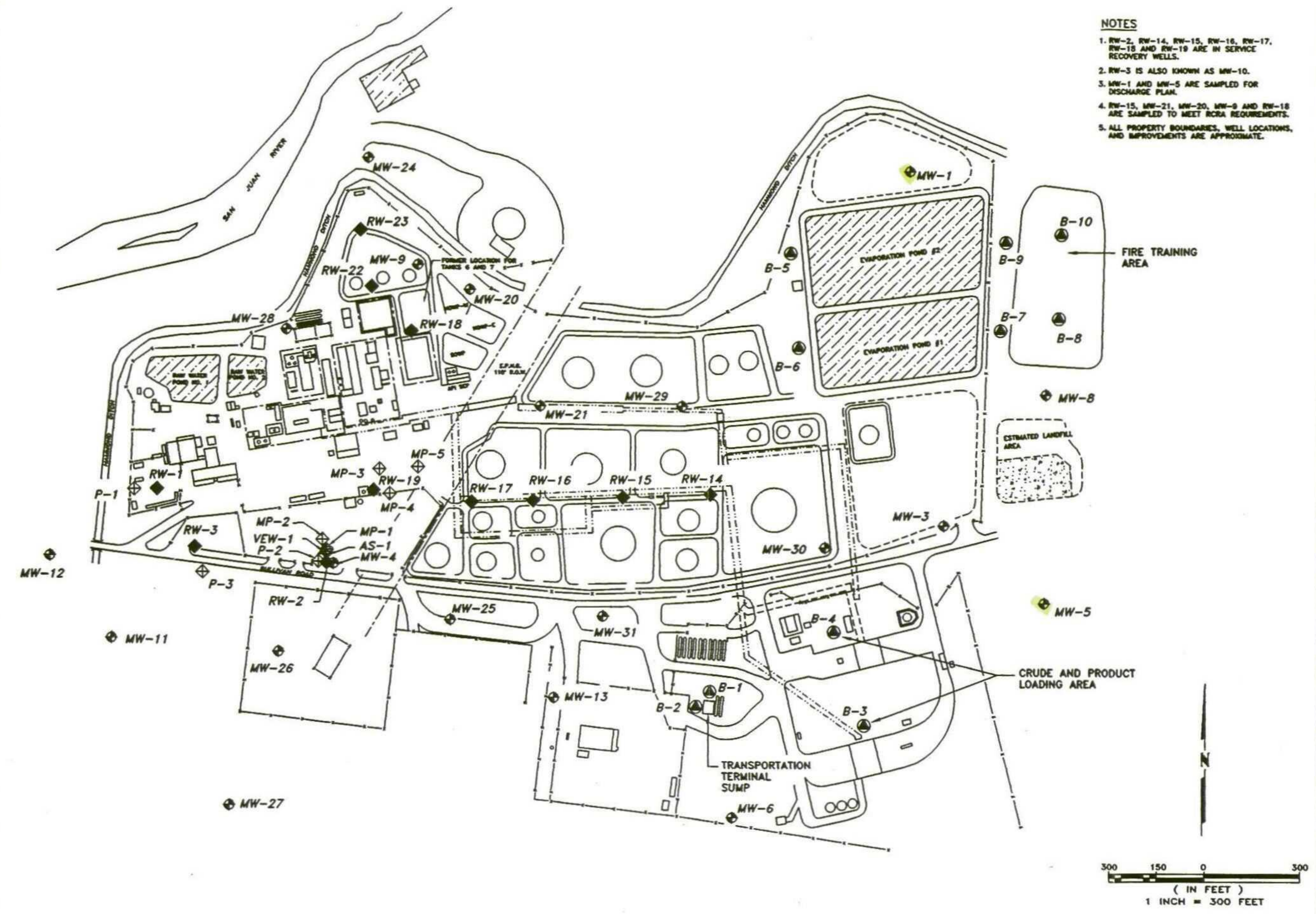
NOTE:
LOCATIONS OF PROPERTY BOUNDARIES, IMPROVEMENTS, AND NATURAL FEATURES ARE APPROXIMATE.

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, N.M. 87106 (505) 242-3113

GIANT REFINING COMPANY AND SURROUNDING PROPERTIES

DESIGNED BY: PS	DETAILED BY: JU	CHECKED BY:
DATE: 12/19/95	FILE: PropOwner 12/95	
PROJECT NO.: 053353014	CONTRACT:	
DRAWING: FIGURE 2	REVISION: –	



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

—··—··—	PIPEWAY
– – – – – –	UNDERGROUND PIPEWAY
—x—	FENCE
⊕ MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
● B-1	SOIL BORING
⊕ P-1	PIEZOMETER

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym. Liakos	12/17
CLIENT:	

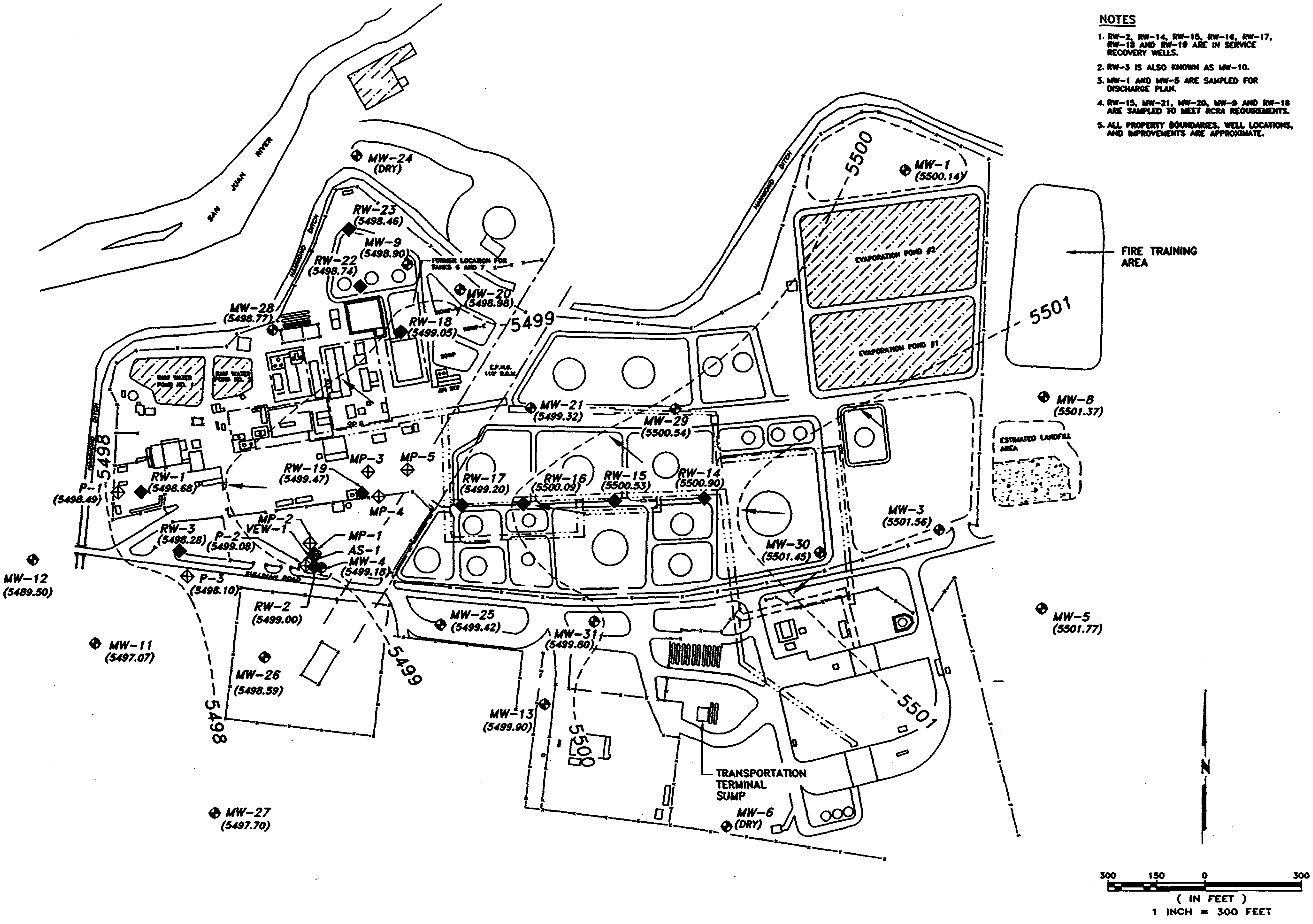
Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SOIL BORING/ MONITORING WELL LOCATIONS

DESIGNED BY:	DRAFTED BY: J. ML	CHECKED BY: CL

DATE: 12/18/95	FILE: MW-LOCA
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 4	REVISION:



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

—·—··—	PIPEWAY
— — — —	UNDERGROUND PIPEWAY
——x——	FENCE
MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
P-1	PIEZOMETER
(5501.37)	WATER TABLE ELEVATION IN FEET ABOVE MSL
— —	INFERRED WATER TABLE ELEVATION CONTOUR
——→	INFERRED GROUND-WATER FLOW DIRECTION

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Liakos	12/19
CLIENT:	

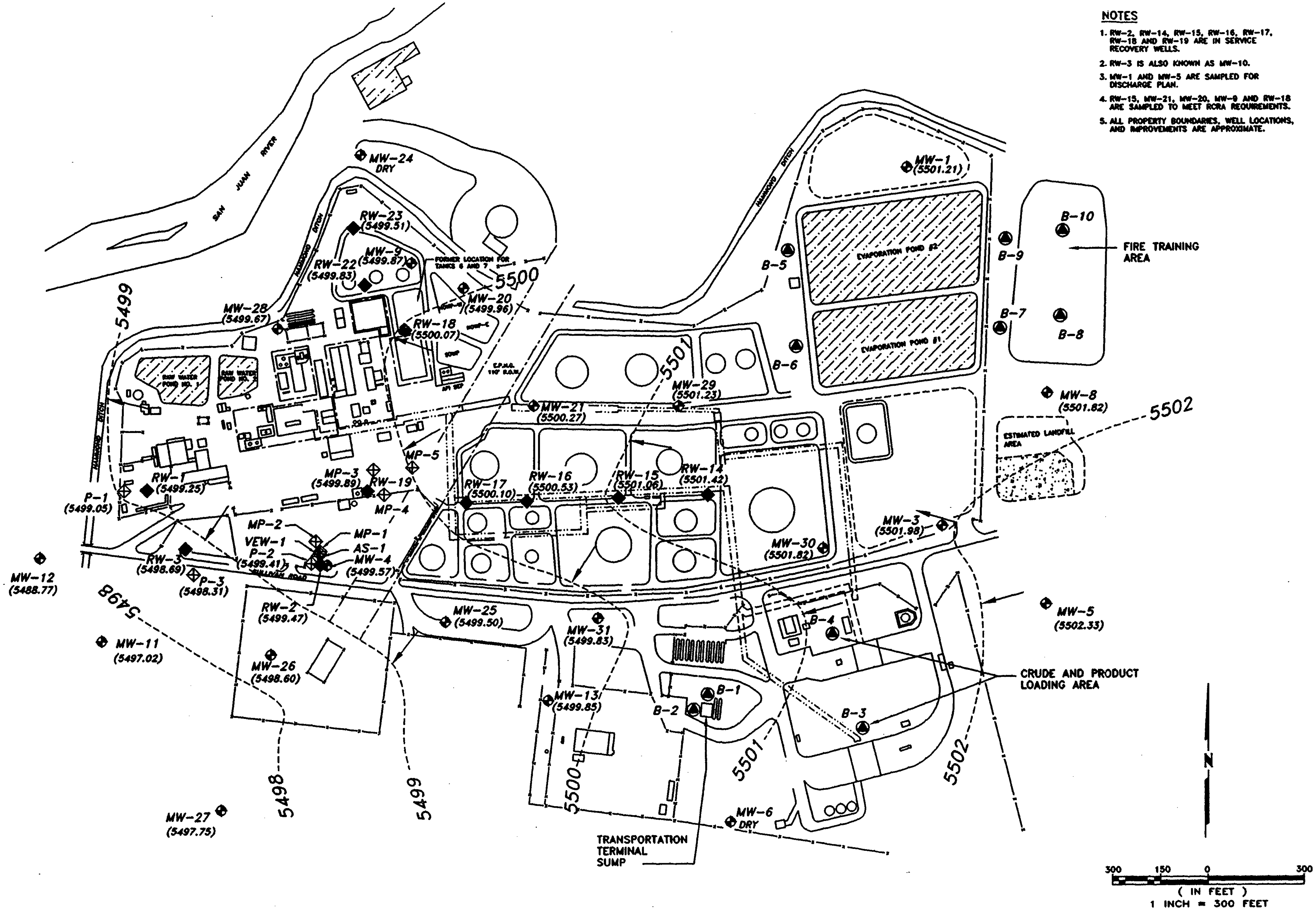
Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

WATER TABLE CONTOUR MAP
MAY 24, 1994

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	Ch

DATE: 12/18/95	FILE: WTCM0594
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 5	REVISION:



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

-·-·-·- PIPEWAY

------- UNDERGROUND PIPEWAY

—x— FENCE

⊕ MW-1 MONITORING WELL

◆ RW-1 RECOVERY WELL

⊕ P-1 PIEZOMETER

(5499.05) WATER TABLE ELEVATION IN FEET ABOVE MSL

–·–·– INFERRED WATER TABLE ELEVATION CONTOUR

← INFERRED GROUND-WATER FLOW DIRECTION

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Liakos	12/19
CLIENT:	

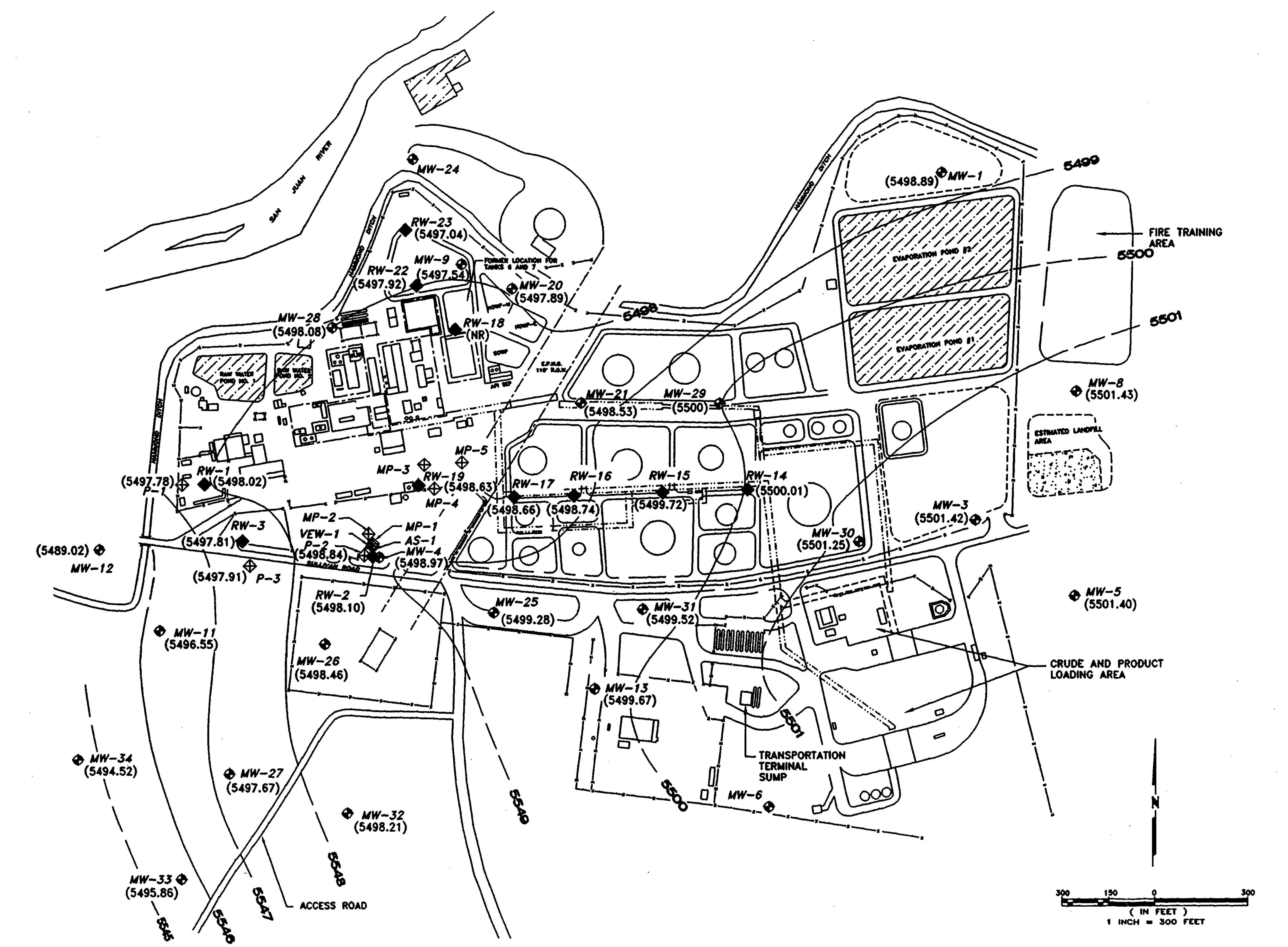
Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

WATER TABLE CONTOUR MAP
AUGUST 2, 1994

DESIGNED BY:	DRAFTED BY: J. ML	CHECKED BY: CL
DATE: 12/18/95		FILE: WTCM0894
PROJECT NO.: 053353014		CONTRACT:
DRAWING:		REVISION:

FIGURE 6



NO.	DATE	BY	REVISION

LEGEND

-·-·-·- PIPEWAY

- - - - - - UNDERGROUND PIPEWAY

—x— FENCE

⊕ MW-1 MONITORING WELL

◆ RW-1 RECOVERY WELL

⊕ P-1 PIEZOMETER

— — INFERED WATER TABLE ELEVATION CONTOUR (feet +M.S.L.)

(5501.25) WATER TABLE ELEVATION (feet +M.S.L.)

(NR) NOT RECORDED

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Leakos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

WATER TABLE CONTOUR MAP

MARCH 1, 1995

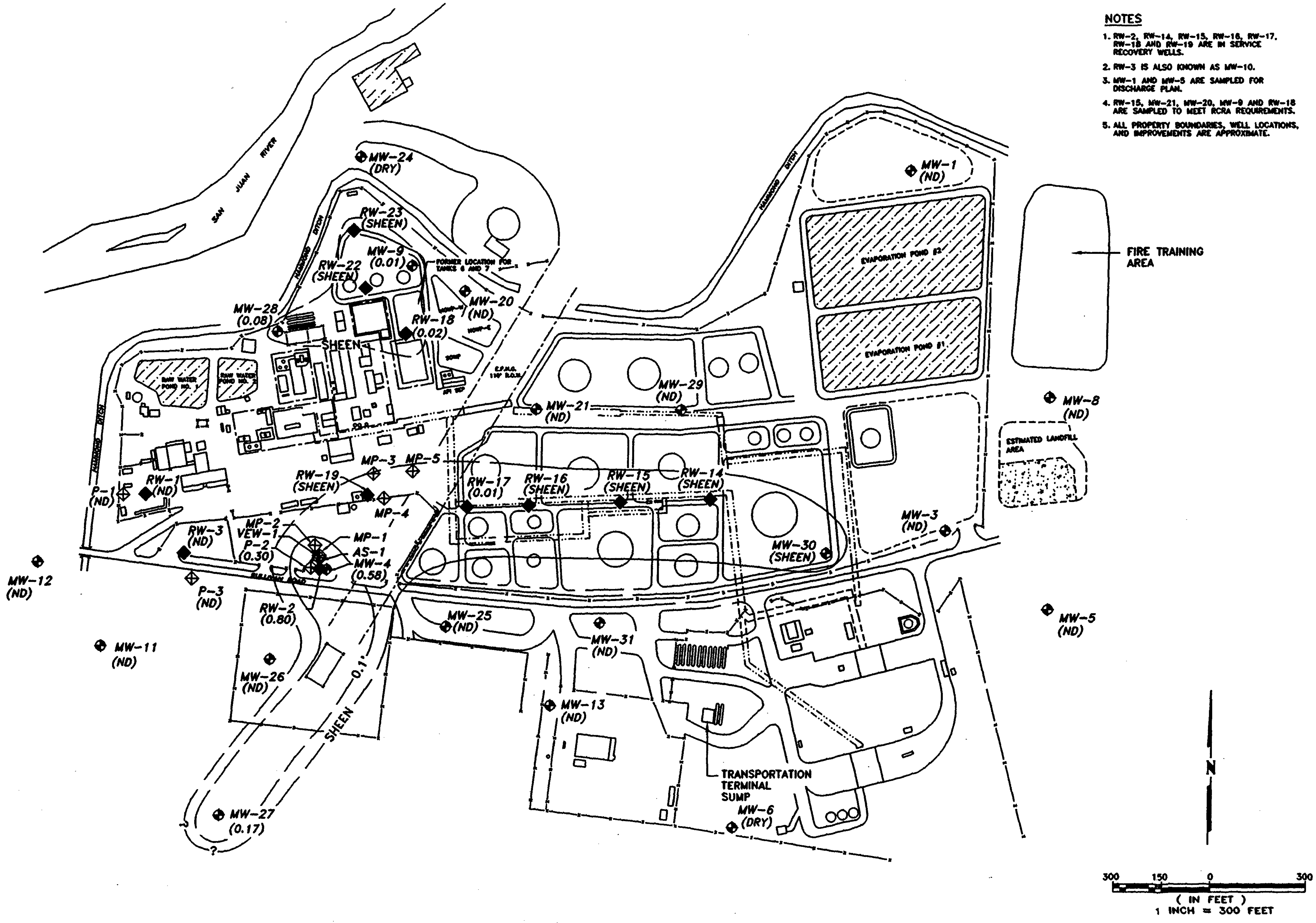
DESIGNED BY:	DRAFTED BY:	CHECKED BY:
CL	PJWH	CL

DATE:	FILE:
12/18/95	3014GW1
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 7	REVISION:

NO.	DATE	BY	REVISION

NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.



LEGEND

- —·—·—·— PIPEWAY
- — — — — — UNDERGROUND PIPEWAY
- —— x —— FENCE
- ⊕ MW-1 MONITORING WELL
- ◆ RW-1 RECOVERY WELL
- ⊕ P-1 PIEZOMETER
- (ND)= NOT DETECTED
- (0.01)= SPH THICKNESS IN FEET
- — — — SPH THICKNESS CONTOUR IN FEET DASHED WHERE APPROXIMATE

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Leakos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

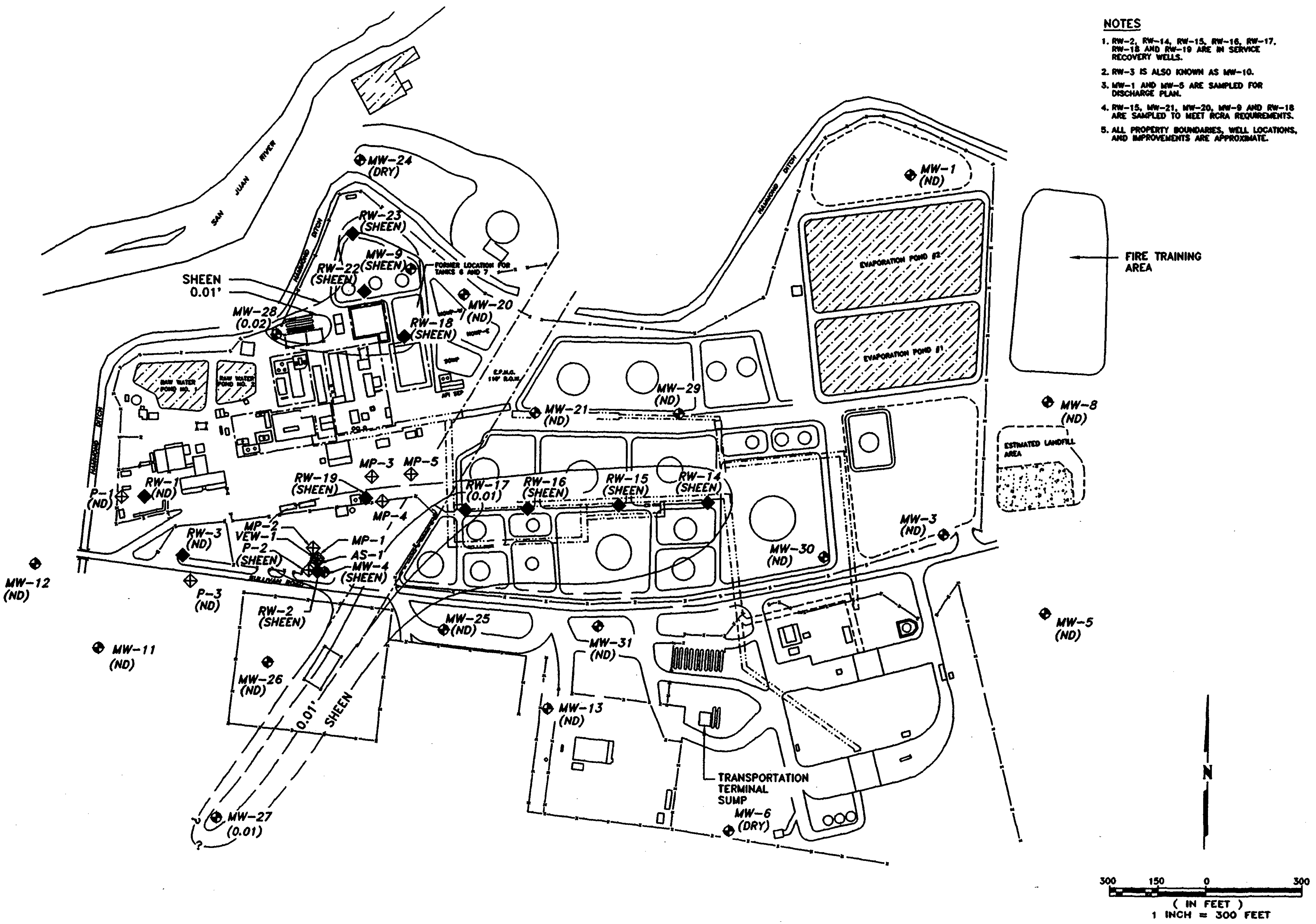
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SEPARATE PHASE HYDROCARBON ISOPLETH MAP

MAY 24, 1994

DESIGNED BY:	DRAFTED BY: J. ML	CHECKED BY: CL

DATE: 12/18/95	FILE: PSH-0594
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 8	REVISION:



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

-·-·-·- PIPEWAY
- - - - - UNDERGROUND PIPEWAY
—x— FENCE
⊕ MW-1 MONITORING WELL
◆ RW-1 RECOVERY WELL
⊕ P-1 PIEZOMETER
(ND)= NOT DETECTED
(0.01)= SPH THICKNESS IN FEET
— — — SPH THICKNESS CONTOUR IN FEET DASHED WHERE APPROXIMATE

ATTENTION

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Lukos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

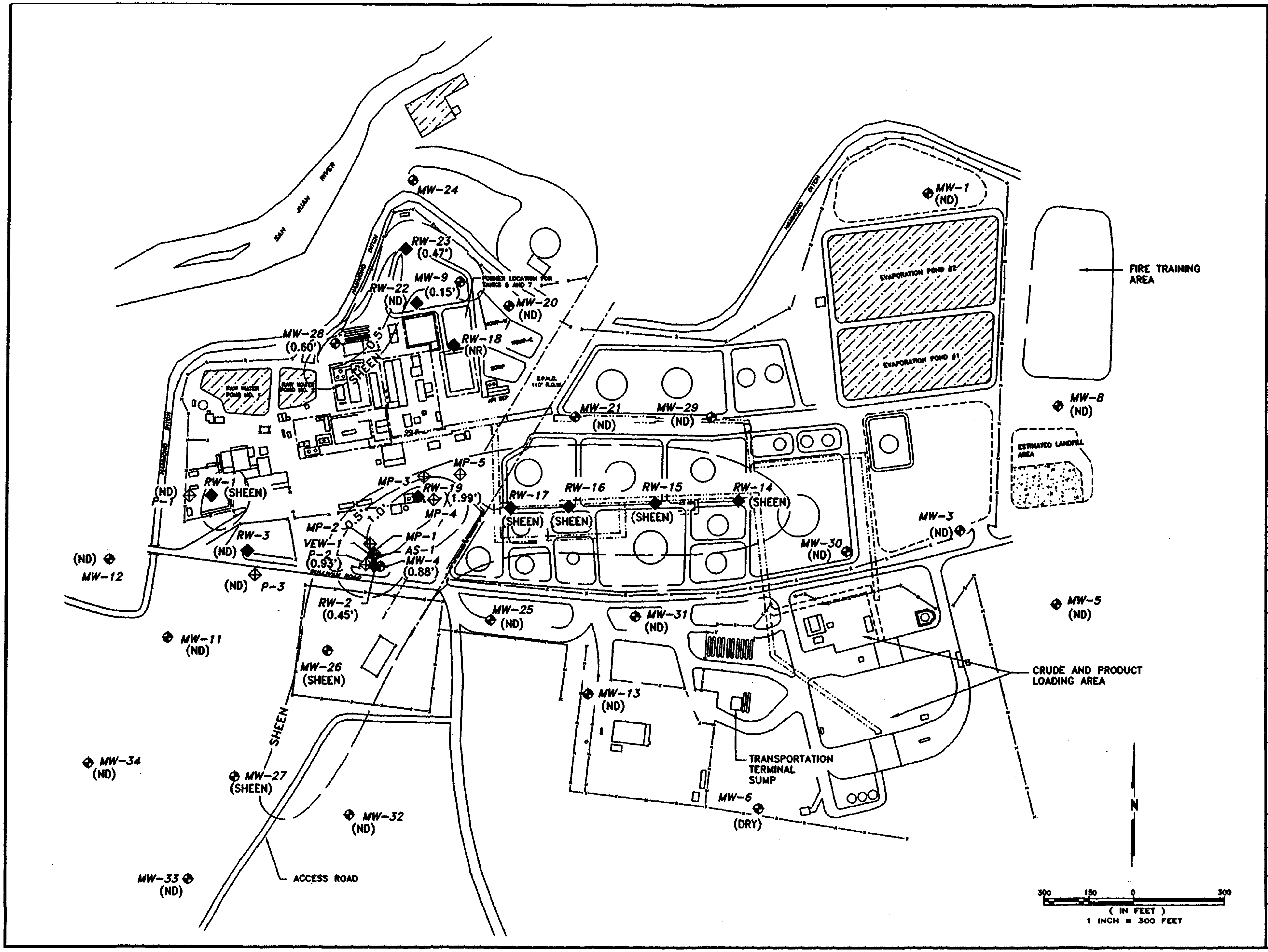
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SEPARATE PHASE HYDROCARBON ISOPLETH MAP

AUGUST 2, 1994

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	Cl

DATE:	FILE:
12/18/95	PSH-0894
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 9	REVISION:



NO.	DATE	BY	REVISION

LEGEND

—··—··—	PIPEWAY
– – – – – –	UNDERGROUND PIPEWAY
—x—	FENCE
MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
P-1	PIEZOMETER
SPH	SEPARATE PHASE HYDROCARBON
— —	SPH THICKNESS CONTOUR (feet)
(0.01')	SPH THICKNESS (feet)
(ND)	NOT DETECTED
(NR)	NOT RECORDED

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cynn Liakos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

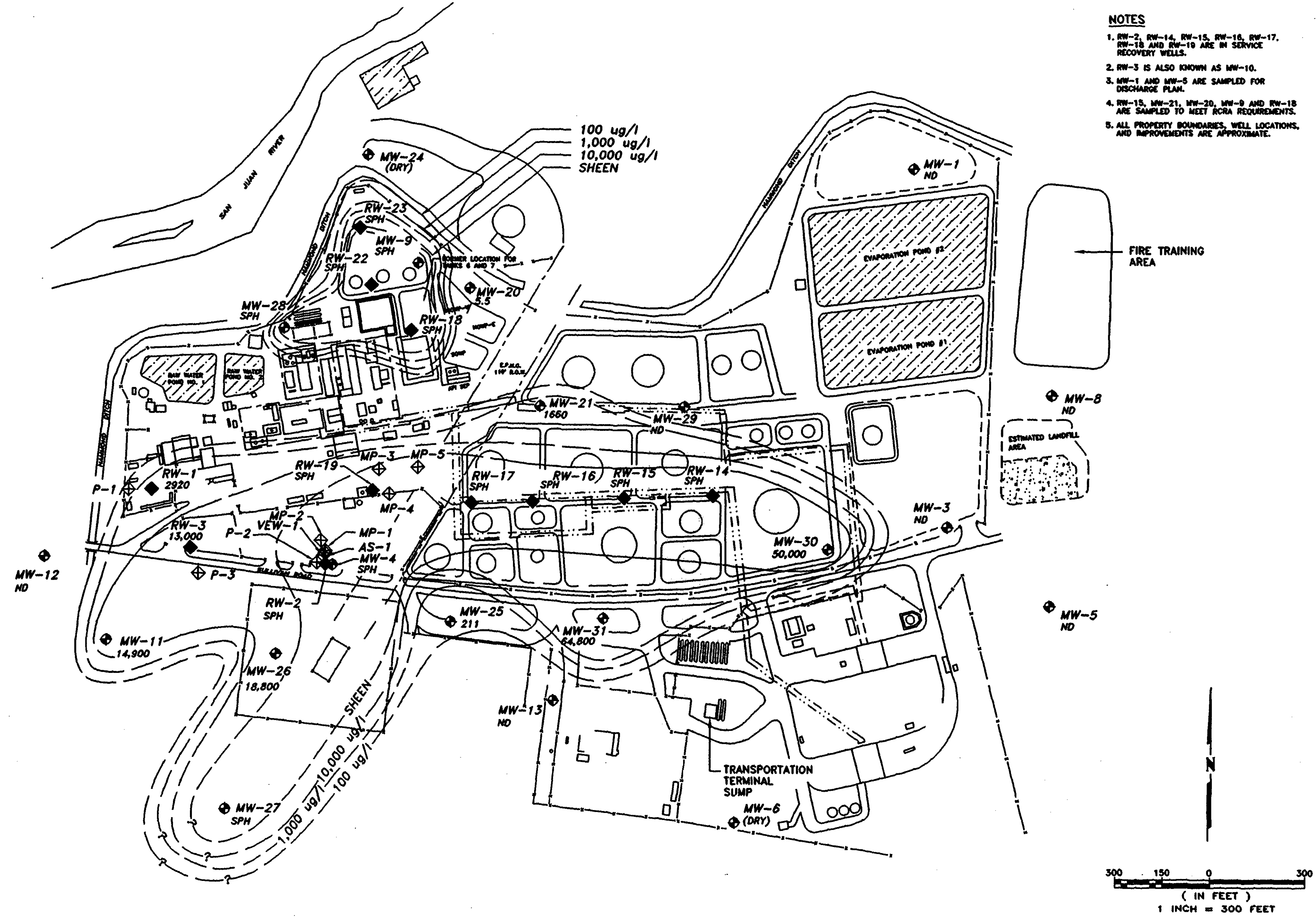
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SEPARATE PHASE HYDROCARBON ISOPLETH MAP

MARCH 1, 1995

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
CL	PJWH	CL

DATE: 12/18/95	FILE: 3014GW1
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 10	REVISION:



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

— · · — · · —	PIPEWAY
— — — —	UNDERGROUND PIPEWAY
—— x ——	FENCE
⊕ MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
⊕ P-1	PIEZOMETER
ND	NOT DETECTED
VOC	VOLATILE ORGANIC COMPOUNDS
SPH	SEPARATE-PHASE HYDROCARBONS
— — ——	VOC ISOPLETH IN ug/l DASHED WHERE APPROXIMATE. CONTOUR INTERVALS ARE 10,000, 1,000, AND 100 ug/l.

VOC CONCENTRATION IN ug/l

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Liakos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

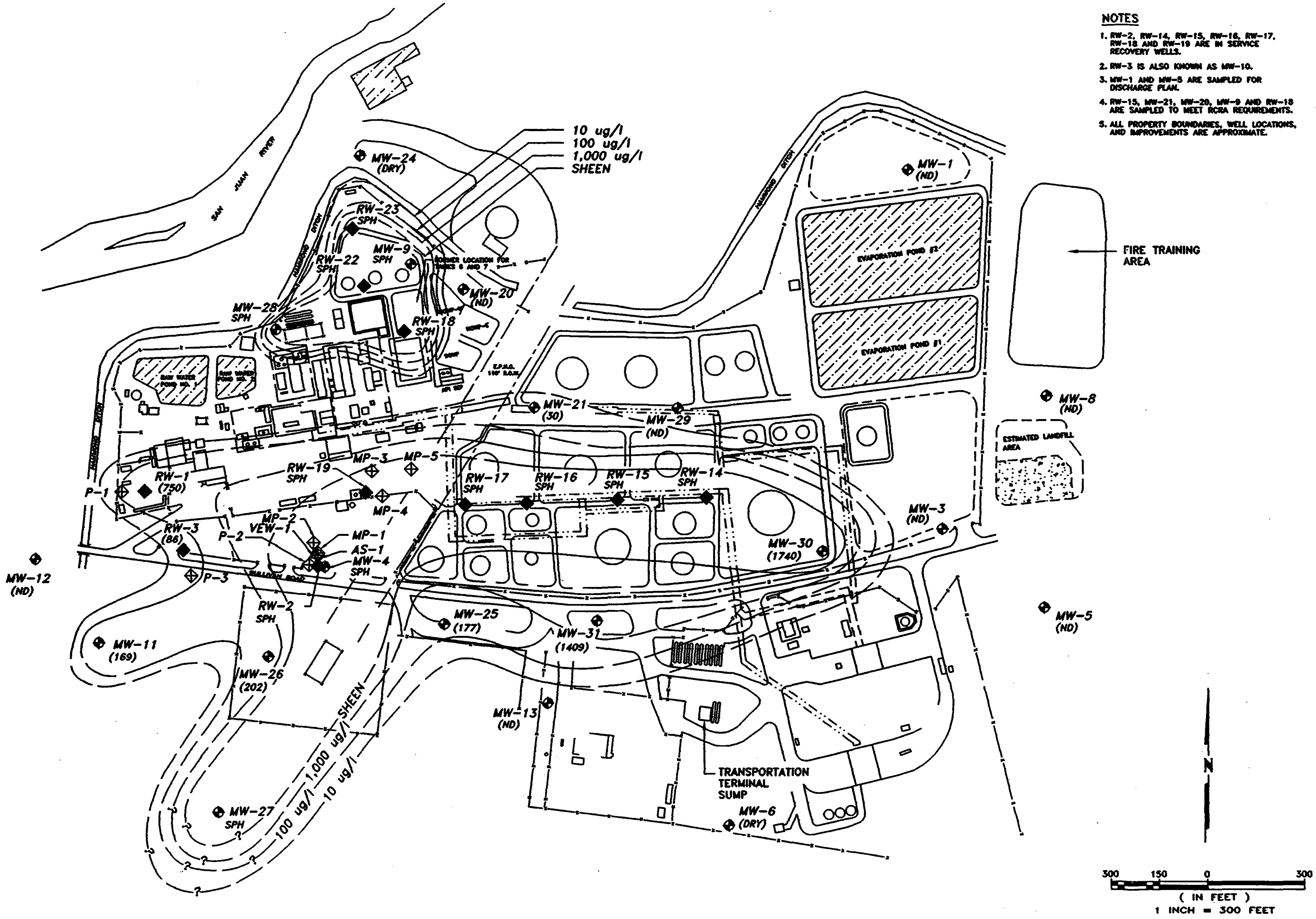
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

TOTAL TARGETED VOC IN GROUNDWATER ISOPLETH MAP

MAY 24 & 25, 1994

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	CL

DATE: 12/18/95	FILE: TVOC0594
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 11	REVISION:



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

—··—··—	PIPEWAY
— — — —	UNDERGROUND PIPEWAY
——x——	FENCE
MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
P-1	PIEZOMETER
SVOC	SEMI-VOLATILE ORGANIC COMPOUNDS
(169)	SVOC CONCENTRATION IN ug/l
ND	NOT DETECTED
SPH	SEPARATE-PHASE HYDROCARBONS
— — ——	SVOC ISOPLETH IN ug/l DASHED WHERE APPROXIMATE. CONTOUR INTERVALS ARE 1,000, 100, AND 10 ug/l.

SVOC CONCENTRATION IN ug/l

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Leakos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE. SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

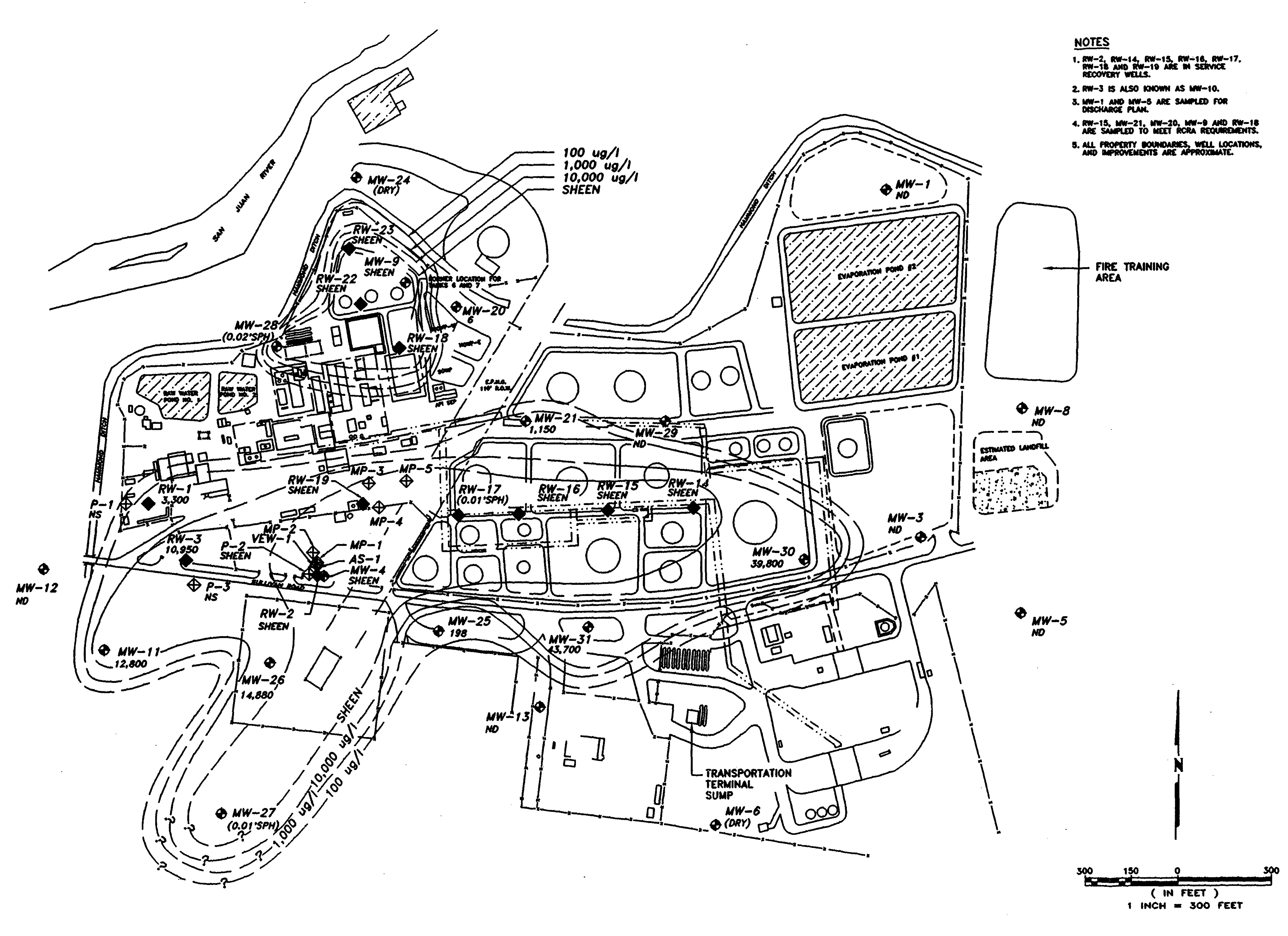
TOTAL TARGETED SVOC IN GROUNDWATER ISOPLETH MAP

MAY 24 & 25, 1994

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	CL

DATE: 12/18/95	FILE: SVOC0594
PROJECT NO.: 053353014	CONTRACT:
DRAWING:	REVISION:

FIGURE 12



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

— · · — · · —	PIPEWAY
— — — —	UNDERGROUND PIPEWAY
——x——	FENCE
⊕ MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
⊕ P-1	PIEZOMETER
ND	NOT DETECTED
VOC	VOLATILE ORGANIC COMPOUNDS
SPH	SEPARATE-PHASE HYDROCARBONS
— — ——	VOC ISOPLETH IN ug/l DASHED WHERE APPROXIMATE. CONTOUR INTERVALS ARE 10,000, 1,000, AND 100 ug/l.

VOC CONCENTRATION IN ug/l

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cynn Leakos	12/19
CLIENT:	

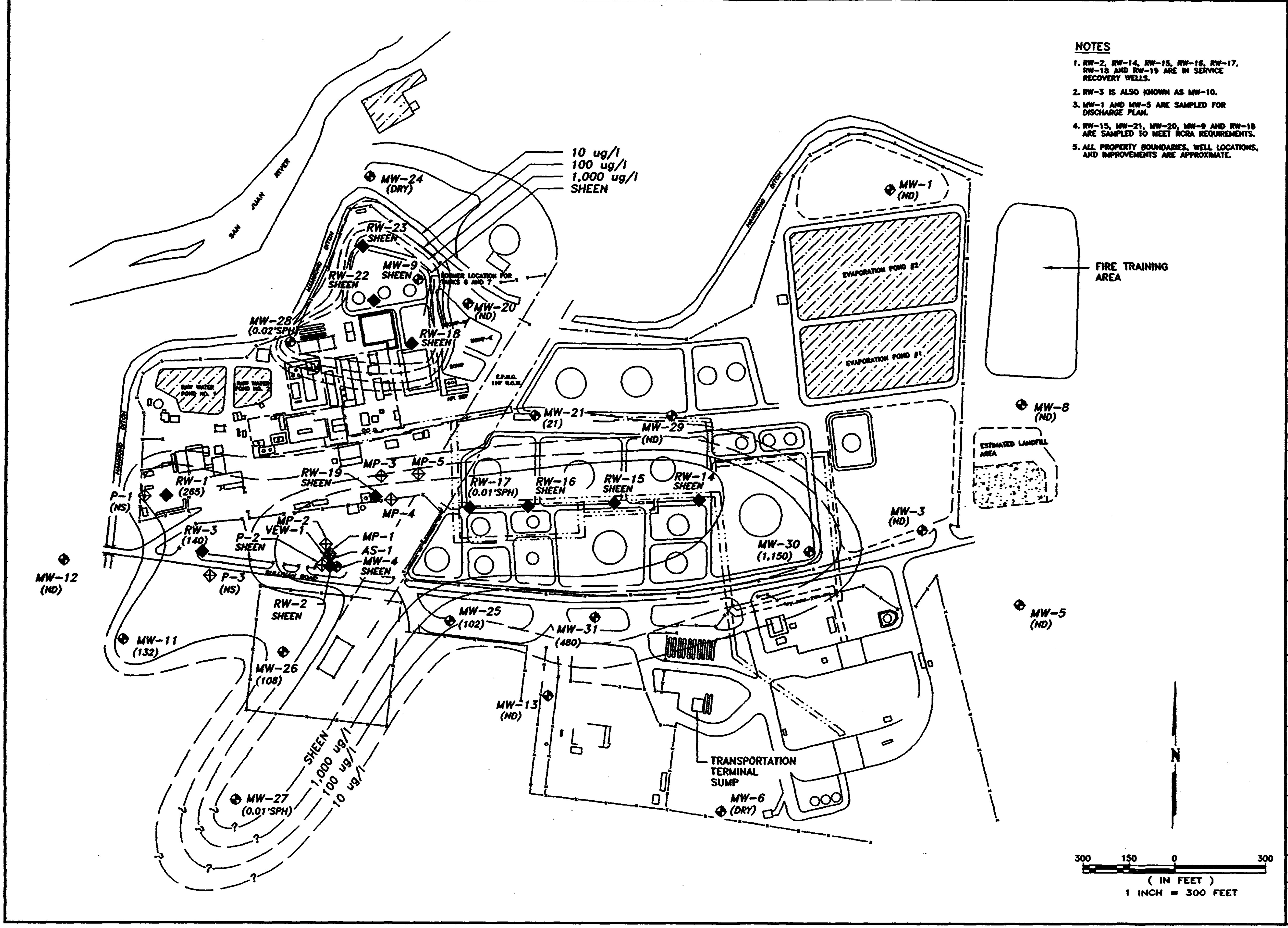
Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

TOTAL TARGETED VOC
IN GROUNDWATER
ISOPLETH MAP
AUGUST 3 & 4, 1994

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	CL

DATE:	FILE:
12/18/95	TVOC0894
PROJECT NO.:	CONTRACT:
053353014	
DRAWING:	REVISION:
FIGURE 13	



NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.

NO.	DATE	BY	REVISION

LEGEND

— · · — · · —	PIPEWAY
— — — —	UNDERGROUND PIPEWAY
—— x ——	FENCE
⊕ MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
⊕ P-1	PIEZOMETER
SVOC	SEMI-VOLATILE ORGANIC COMPOUNDS
(108)	SVOC CONCENTRATION IN ug/l
ND	NOT DETECTED
SPH	SEPARATE-PHASE HYDROCARBONS
— — ——	SVOC ISOPLETH IN ug/l DASHED WHERE APPROXIMATE. CONTOUR INTERVALS ARE 1,000, 100, AND 10 ug/l.

SVOC CONCENTRATION IN ug/l

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Liakos	12/19
CLIENT:	

Giant Refining Company
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

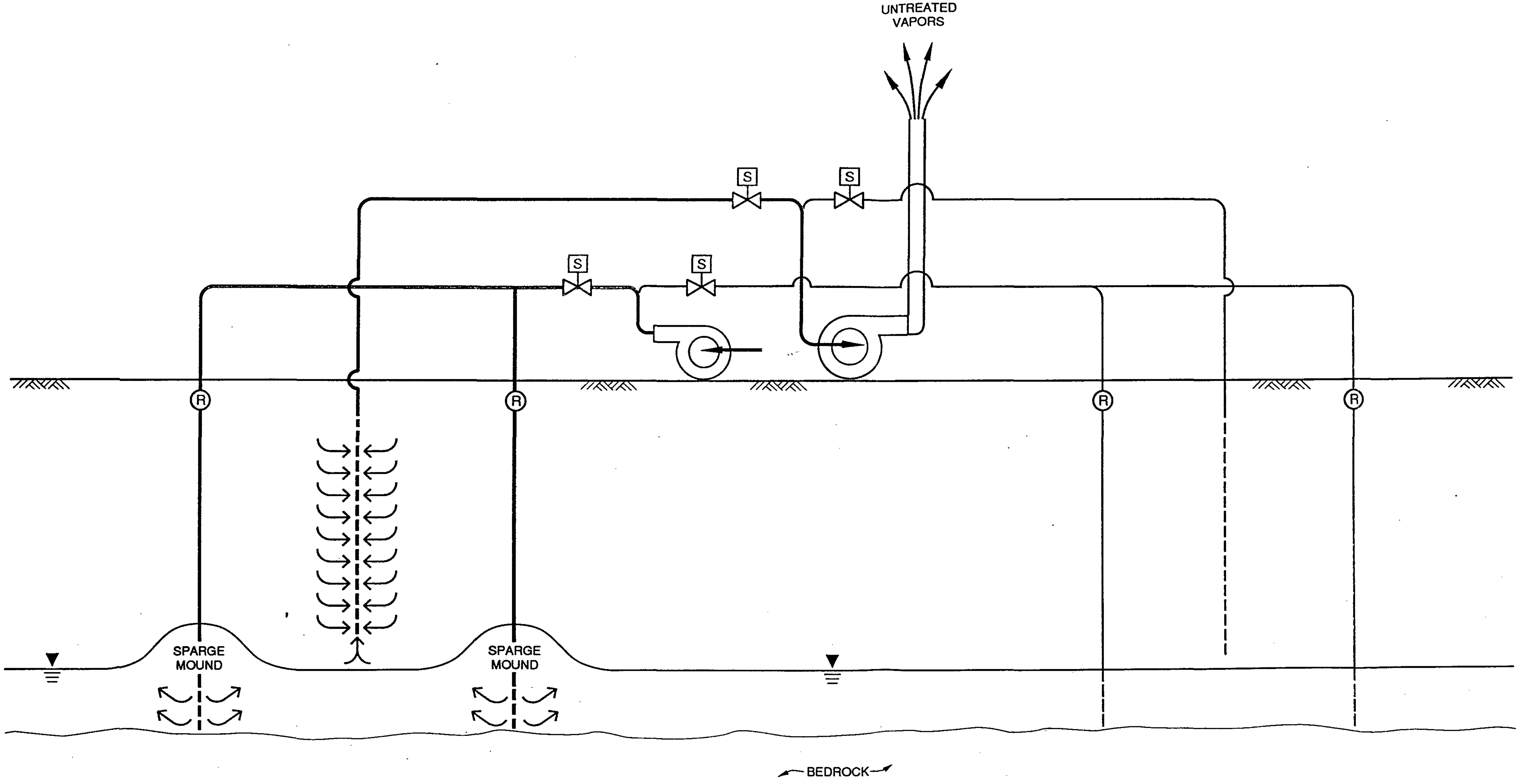
GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

TOTAL TARGETED SVOC IN GROUNDWATER ISOPLETH MAP

AUGUST 3 & 4, 1994

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
	J. ML	Cl

DATE: 12/18/95	FILE: SVOC0894
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 14	REVISION:



NO.	DATE	BY	REVISION

LEGEND

▨	SOIL VAPOR EXTRACTION (SVE) FLOW
—	ACTIVE SVE LINE
■	SPARGE FLOW
—	ACTIVE SPARGE LINE
S	SOLENOID VALVE
Ⓡ	SPARGE WELL PRESSURE REGULATOR

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED, OR COPIED ("USE") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

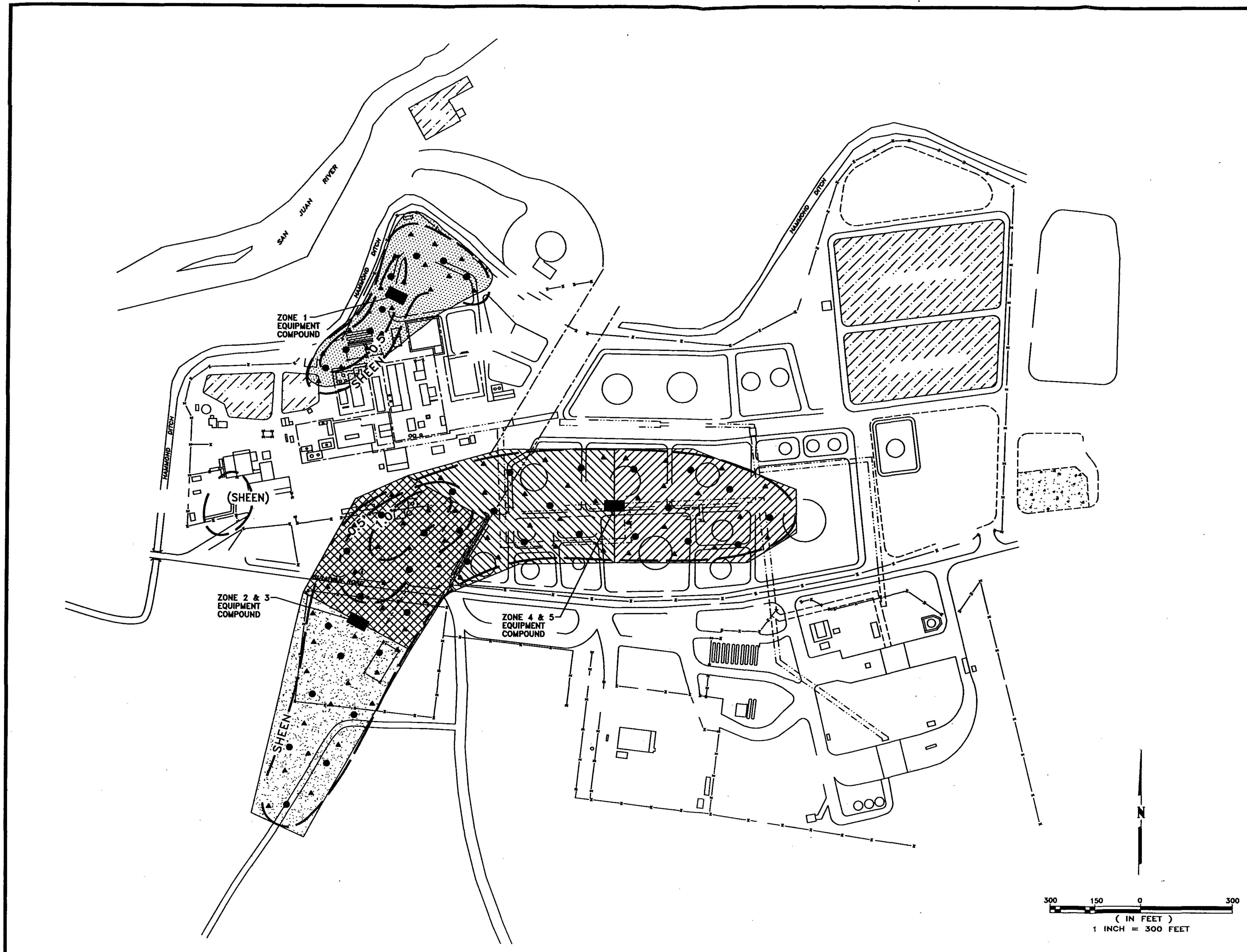
SIGNATURE	DATE
PDG MGR:	
PROJECT ENGR:	
PROJECT MGR: Cym Liakos	12/19
CLIENT:	

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, N.M. 87106 (505) 242-3113

PRELIMINARY PROCESS FLOW DIAGRAM PULSE SPARGING / SVE

SECTION VIEW BLOOMFIELD CMS

DESIGNED BY: VH	DETAILED BY: JU	CHECKED BY:
DATE: 8/9/95	FILE: BloomfieldCMS/VB	
PROJECT NO.: 053353014	CONTRACT:	
DRAWING: FIGURE 15	REVISION: –	



NO.	DATE	BY	REVISION

LEGEND

—··—··—	PIPEWAY
– – – – – –	UNDERGROUND PIPEWAY
—x—	FENCE
▲	PROPOSED SPARGE WELL
●	PROPOSED SVE WELL
SPH	SEPARATE PHASE HYDROCARBON
⌣ ⌢	SPH THICKNESS CONTOUR (feet)
▒	ZONE 1
░	ZONE 2
▩	ZONE 3
▧	ZONE 4
▨	ZONE 5

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR: Cym Liakos	12/19
CLIENT:	

#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

PROPOSED REMEDIATION SYSTEM LAYOUT SITE MAP

DESIGNED BY:	DRAFTED BY:	CHECKED BY:
CW+VH	PJWH/RMS	CL

DATE: 8/8/95	FILE: 3014REM
PROJECT NO.: 053353014	CONTRACT:
DRAWING: FIGURE 16	REVISION:

APPENDIX A

HYDROCARBON MASS CALCULATIONS

GROUNDWATER TECHNOLOGY

ENGINEERING GRID

PROJECT Bloomfield PROJECT NUMBER 023353014.

SUBJECT Mass of Contamination Calcs. BY VPH DATE 5/15/95

March '95 Plume PAGE 1 OF 4

Given:

- 3/1/95 Plume dimensions (See Figure 3) for area + SPH thickness
- Total soil porosity = 35%
- 7.48 gal = 1 c.f. (conversion)

Assume:

- 1% oil to air saturation in the smear zone
- 20% oil to water saturation in saturated zone SPH thickness
- Water table drop avg. 1.51 ft from 8/2/94 to 3/1/95
- Smear Zone Ht. (3/1/95) = Smear Zone Ht (8/2/94) - Avg W.T. drop
- Sat. Zone Contamin Thickness = SPH Thickness
- Oversize rectangles surrounding plume contours will account for contamination mass in source leakage paths
- Sheen Thickness ≈ 0.001'
- SPH density = 6.2 lbs/gal

GROUNDWATER TECHNOLOGY

ENGINEERING GRID

PROJECT Bloomfield

PROJECT NUMBER

SUBJECT

BY

DATE 5/15/95

PAGE 2 OF 4

Calculate: Mass of HC Contamination

Step 1 Plume Areas

South Plume:

Total Plume Area = Sheen area + 0.5' thick area + 1.0' thick area

Total Area = (1535' x 385') + (925' x 370') = 933,000 sf

1.0' thick area = 310' x 140' = 43,400 sf

0.5' thick area = (500' x 260') - 1.0 thick area

= 130,000 - 43,400 = 86,600 sf

Sheen Area = Total Area - (1.0 + 0.5' thick areas)

= 933,000 - 130,000 = 803,000 sf

North Plume:

Total Area = 650' x 350' = 228,000

0.5' thick area = 460' x 125' = 57,500 sf

Sheen Area = Total Area - 0.5' thick

= 228,000 - 57,500 = 170,500 sf

GROUNDWATER
TECHNOLOGY

ENGINEERING GRID

PROJECT ______ PROJECT NUMBER ______

SUBJECT ______ BY ______ DATE ______

PAGE 3 OF 4

Step 2 Saturated Zone HC Contamination Volume/Mass

= Area(s) × SPH thickness × porosity × % HC saturation

South Plume:

= ((43,400 sf × 1.0') + (86,600 × 0.5') + (803,000 × .001')) ×
× 0.35 × 0.20

= (43400 cf + 43,300 cf + 803 cf) × 0.07

= 6,125 cf of HC ≈ 45,800 gal. ≈ 284,000 lbs

North Plume:

= ((57,500 sf × 0.5') + (170,500 sf × .001')) × 0.35 × 0.20

= (2880 sf + 170 sf) × 0.07

= 214 cf of HC ≈ 1600 gal. ≈ 9,920 lbs

PROJECT ______ PROJECT NUMBER ______

SUBJECT ______ BY ______ DATE ______

PAGE 4 OF ______

Step 3 Smear Zone Vol./Mass of HC Contamination

= Total Area × Smear Thickness × % soil porosity × HC Satur. %

where

Smear Zone Thickness (3/1/95) = Smear Thickness (8/2/94) − Avg W.T. drop

= 2.19′ − 1.51′ = 0.68 ft

South Plume:

= 933,000 sf × 0.68′ × 0.35 × 0.01

= 2220 cf ≈ 16,600 gal ≈ 103,000 lbs of HC contam.

North Plume:

= 228,000 sf × 0.68′ × 0.35 × 0.01

= 540 cf ≈ 4040 gal. ≈ 25,000 lbs

Step 4 Total HC Contamination

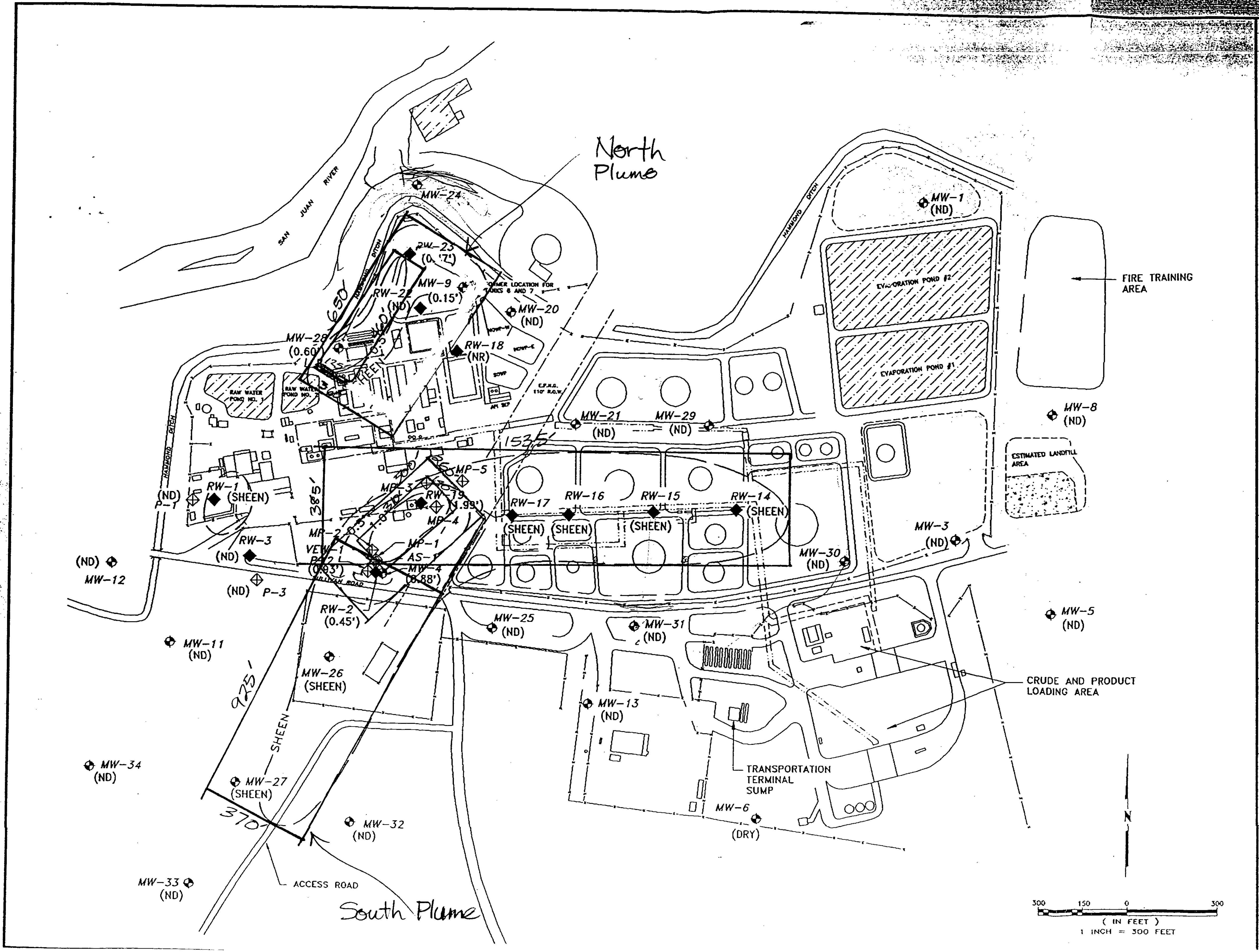
South Plume:

16,600 gal + 45,800 gal = 62,400 gal ≈ 387,000 lbs

North Plume:

1600 gal + 4040 gal = 5640 gal ≈ 34,900 lbs

Totals = 68,040 gal. ≈ 422,000 lbs



NO.	DATE	BY	REVISION

LEGEND

-·-·-·-	PIPEWAY
- - - - - -	UNDERGROUND PIPEWAY
—x—	FENCE
⊕ MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
⊕ P-1	PIEZOMETER
SPH	SEPARATE PHASE HYDROCARBON
— —	SPH THICKNESS CONTOUR (feet)
(0.01')	SPH THICKNESS (feet)
(ND)	NOT DETECTED
(NR)	NOT RECORDED

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR:	
CLIENT:	

Bloomfield Refining Company
A Gary-Energy Corporation Subsidiary
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SEPARATE PHASE
HYDROCARBON
ISOPLETH MAP
MARCH 1, 1995

DESIGNED BY: CL	DRAFTED BY: PJWH	CHECKED BY:

DATE: 04/25/95	FILE: 3014GW1
PROJECT NO.: 023353014	CONTRACT:
DRAWING: FIGURE 3	REVISION:

[redacted]

GROUNDWATER TECHNOLOGY

ENGINEERING GRID

PROJECT Bloomfield CMS PROJECT NUMBER 3014/72

SUBJECT Mass of Contamination Calculation - August '94 Plume BY VPH DATE 5/10/95

PAGE 1 OF 5

Given: * 8/2/94 Plume Dimensions scaled from (Figure 7 in RFI Response dated 4/13/95) for Area and SPH Thickness

* Total Soil Porosity = 35%

* 7.48 gal. = 1 cf (conversion)

Assume: * 1% oil to air saturation in the smear zone.

* 20% oil to water saturation in saturated Zone's SPH thickness

* Smear Zone Ht. = Mean GW Fluctuation + Stnd. Dev.

* Saturated Zone Contam Thickness = SPH Thickness

* Oversized rectangles surrounding plume contours will account for contamination mass in source leakage paths

* Sheen thickness ≈ 0.001'

* Density of SPH = 6.2 lbs/gal.

PROJECT ______________________ PROJECT NUMBER ______________

SUBJECT ______________________ BY ____________ DATE 5/10/95

PAGE 2 OF 5

<u>Calculate:</u> Mass of HC Contamination

<u>Step 1</u> Plume Areas

<u>South Plume:</u>

Total Plume Area = Sheen Area + .01' thick area.

∴ Sheen Area = Total Area − .01' thick area

Total Area = (1015' × 210') + (355' × 1500')

= 745,700 sf

.01' thick Area = 1390' × 140' = 194,600 sf

Sheen Area = 745,100 − 194,600 = 551,100 sf

<u>North Plume:</u>

Total Area = 500' × 425' = 212,500 sf

.01' thick Area = 195' × 95' = 18,530 sf

Sheen Area = 212,500 − 18530 = 194,000 sf

PROJECT
SUBJECT
PROJECT NUMBER
BY Vern H. DATE 5/10/95
PAGE 3 OF 5

Step 2 Saturated Zone Volume of HC Contamination

= Area(s) × SPH thickness × porosity % × HC saturation %

South Plume:

.01' thick area sheen area

= ((194,600 sf × .01') + (551,100 × .001')) × (0.35 × 0.2)

= (2000 cf + 600 cf) × 0.07

= 180 cf of HC ≈ 1300 gal.

North Plume:

= (18,530 sf × .01') + (194,000 sf × .001') × 0.35 × 0.2

= (200 cf + 200 cf) × 0.07

= 28 cf of HC ≈ 210 gal.

GROUNDWATER TECHNOLOGY

ENGINEERING GRID

PROJECT ______________________

PROJECT NUMBER ______________

SUBJECT ______________________

BY Vern H. DATE 5/10/95

PAGE 4 OF 5

Step 3 Smear Zone Volume of HC Contamin.

= Total Area × Smear Zone Thickness × % porosity × HC saturat %

where

Smear Zone Thickness = Mean GW Fluctuation + Stnd Dev.

see attached Spreadsheet calc. for Stnd Dev. + mean values = 1.51' + 0.68' = 2.19 ft.

South Plume:

= 745,700 sf × 2.19 ft × 0.35 × 0.01

= 5,700 cf ≈ 43,000 gal.

North Plume:

= 212,500 sf × 2.19 ft × 0.35 × 0.01

= 1,600 cf ≈ 12,000 gal.

GROUNDWATER TECHNOLOGY

ENGINEERING GRID

PROJECT ____________________ PROJECT NUMBER ____________

SUBJECT ____________________

BY Vern H DATE 5/10/95

PAGE 5 OF 5

Step 5 Convert HC Vol. to Mass of HC Contamin.

South Plume:

$= (1{,}300 \text{ gal.} + 43{,}000 \text{ gal.}) \times 6.2 \frac{\text{lbs}}{\text{gal}}$

= 270,000 lbs of HC Contaminants

Answer 1

North Plume:

$= (210 \text{ gal.} + 12{,}000 \text{ gal.}) \times 6.2 \frac{\text{lbs}}{\text{gal.}}$

= 76,000 lbs of HC Contaminants

Answer 2

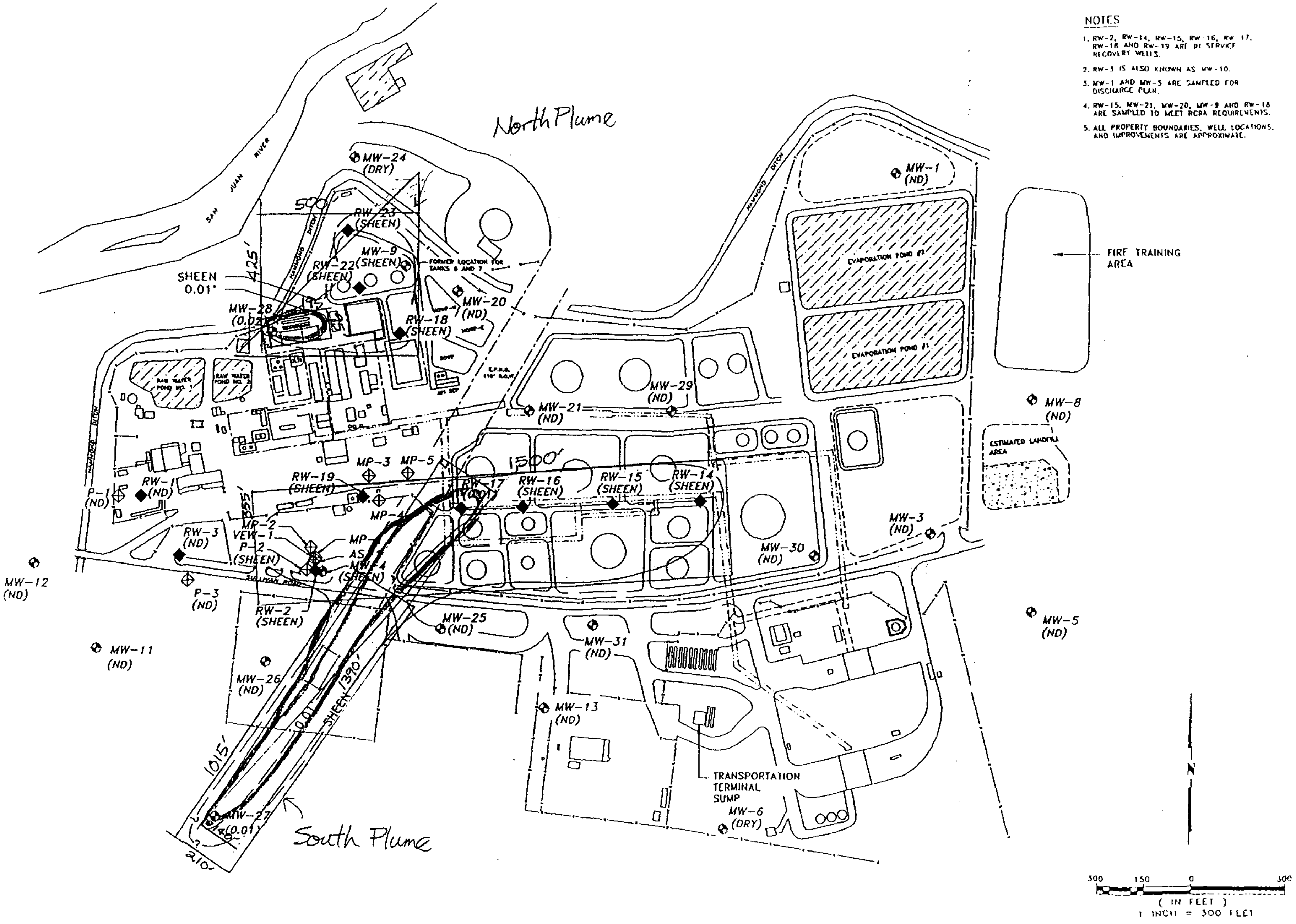
Total Mass HC Contamin. = 350,000 lbs

or 57,000 gal.

	Bloomfield Refinery		
	Groundwater Fluctuations		
		(feet)	
		2.32	
		0.94	
		1.26	
		0.93	
		2	
		1.15	
		2.44	
		1.23	
		1.27	
		1.71	
		1.3	
		1.1	
		0.4	
		0.64	
		0.99	
		0.31	
		1.41	
		1.34	
		1.79	
		1.43	
		2.6	
		2.75	
		2.07	
		1.74	
		1.91	
		2.82	
		2.03	
		1.23	
		0.57	
Standard Deviation =		0.682068	
	Mean =	1.506207	

NOTES

1. RW-2, RW-14, RW-15, RW-16, RW-17, RW-18 AND RW-19 ARE IN SERVICE RECOVERY WELLS.
2. RW-3 IS ALSO KNOWN AS MW-10.
3. MW-1 AND MW-5 ARE SAMPLED FOR DISCHARGE PLAN.
4. RW-15, MW-21, MW-20, MW-9 AND RW-18 ARE SAMPLED TO MEET RCRA REQUIREMENTS.
5. ALL PROPERTY BOUNDARIES, WELL LOCATIONS, AND IMPROVEMENTS ARE APPROXIMATE.



NO.	DATE	BY	REVISION

LEGEND

– – – –	PIPEWAY
- - ‧ - -	UNDERGROUND PIPEWAY
- - x - -	FENCE
MW-1	MONITORING WELL
◆ RW-1	RECOVERY WELL
⊕ P-1	PIEZOMETER
(ND)=	NOT DETECTED
(0.01)=	SPH THICKNESS IN FEET
– – ——	SPH THICKNESS CONTOUR IN FEET DASHED WHERE APPROXIMATE

ATTENTION

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS") HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USED") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC.. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC.. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

SIGNATURE	DATE
PROJECT GEO:	
PROJECT ENGR:	
PROJECT MGR:	
CLIENT:	

Bloomfield Refining Company
A Gary Energy Corporation Subsidiary
#50 COUNTY ROAD 4990
BLOOMFIELD, NEW MEXICO

GROUNDWATER TECHNOLOGY
2501 YALE BLVD. SE, SUITE 204
ALBUQUERQUE, NEW MEXICO 87106
(505) 242-3113

SEPARATE PHASE HYDROCARBON ISOPLETH MAP
AUGUST 2, 1994
PHASE 3 RFI

DESIGNED BY:	DRAFTED BY: J. MI	CHECKED BY:

DATE: SEPT. 28, 1994	FILE: PSH-0894
PROJECT NO.: 023353014	CONTRACT
DRAWING: FIGURE 7	REVISION:

APPENDIX B

LABORATORY ANALYTICAL RESULTS OF BACTERIAL ENUMERATION STUDIES

RECEIVED
JUL 10 1995

GROUNDWATER
TECHNOLOGY ®

REMEDIATION TECHNOLOGY LABORATORY
Groundwater Technology, Inc.
4080 Pike Lane, Suite B, Concord, CA 94520 USA
Tel: (510) 671-2116 Fax: (510) 687-0843

June 30, 1995

Cymantha Liakos
Groundwater Technology, Inc.
2501 Yale Boulevard SE# 204
Albuquerque, NM 87106

Subject: Bacteria Enumeration Test Results
Project#: 023353014
Project Name: BRC

Dear Ms. Liakos:

Enclosed please find the test results for the sample(s) received by the Remediation Technology Laboratory on 6/2/95.

Analytical work for this project has undergone a rigorous Quality Assurance/Quality Control procedure to ensure quality and accuracy. Your reference number for correspondence regarding these results is R7232 and your contact person is Nathan R. Hicks.

If you have any questions regarding this analysis, or if we can be of further assistance, please feel free to call us.

Sincerely,
Groundwater Technology, Inc.

David Cacciatore
Project Manager

Enclosure(s)

Offices throughout the U.S., Canada and Overseas

REMEDIATION TECHNOLOGY LABORATORY

4080 Pike Lane Concord, CA 94520 510-671-2116

Results of Bacteria Enumeration

Project Name:	BRC	Sampling Date:	5/31/95, 6/1/95
Client Number:	023353014	Date Received:	6/2/95
Site Location:	Bloomfield, NM	Date Completed:	6/22/95
Project Manager:	Cymantha Liakos	Report Date:	6/29/95
Matrix:	Water	Log-In Number:	R7232

Lab No.	Sample ID	Contaminant Utilizing Bacteria[a]	Total Heterotrophic Bacteria
R7232-1	MW-30	3.2×10^2	1.3×10^3
R7232-2	MW-31	4.9×10^3	7.9×10^3
R7232-3	MW-26	1.1×10^4	5.1×10^4
R7232-4	MW-34	4.7×10^4	5.9×10^4
R7232-5	MW-11	5.2×10^3	6.8×10^3

(a) Contaminant =GASOLINE

Plate counts reported in colony-forming units per mL of water. Spread plate technique based on Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, American Society of Agronomy, Soil Science Society of America, 1982, Madison, WI, Chapter 37; Standard Methods for the Examination of Water and Wastes, AWWA, APHA, WPCF, 1989, 17th edition, Method 9215C. Results in parentheses do not fall within the range of 30-300 colonies per plate and are therefore reported as estimated counts.

GTEL ENVIRONMENTAL LABORATORIES INC

4080 PIKE LANE, SUITE C
CONCORD, CA 94520
(510) 685-7852
(800) 423-7143

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

28363

Company Name: Groundwater Technology
Phone #: 505-242-3113
FAX #: 505-242-1103
Company Address: 2501 Yale Blvd SE #204 ABQ NM 87106
Site Location: #50 County Rd 4990 Bloomfield NM
Project Manager: Cynantha Liakos
Client Project ID: (#) 023353014.34
(NAME) BRC
I attest that the proper field sampling procedures were used during the collection of these samples.
Sampler Name (Print): Charles Madewell

Field Sample ID	GTEL Lab # (Lab Use only)	# CONTAINERS	Matrix: WATER	SOIL	AIR	SLUDGE	PRODUCT	OTHER	Method Preserved: HCl	HNO₃	H₂SO₄	ICE	UNPRESERVED	OTHER (Specify)	Sampling: DATE	TIME
MW-30	R7232-1	2	X									X			5/31/95	1440
MW-31	-2	2	X									X			6/1/95	0745
MW-26	-3	2	X									X			↓	0830
MW-34	-4	2	X									X			↓	1015
MW-11	-5	2	X									X			↓	1200

ANALYSIS REQUEST

Field Sample ID	BTEX 602 ☐ 8020 ☐ with MTBE ☐	BTEX Gas Hydrocarbons PID/FID ☐ with MTBE ☐	Hydrocarbons GC/FID Gas ☐ Diesel ☐ Screen ☐	Hydrocarbon Profile (SIMDIS) ☐	Oil and Grease 413.1 ☐ 413.2 ☐ SM-503 ☐	TPH/IR 418.1 ☐ SM 503 ☐	EDB by 504 ☐ DBCP by 504 ☐	EPA 503.1 ☐ EPA 502.2 ☐	EPA 601 ☐ EPA 8010 ☐	EPA 602 ☐ EPA 8020 ☐	EPA 608 ☐ 8080 ☐ PCB only ☐	EPA 624/PPL ☐ 8240/TAL ☐ NBS (+15) ☐	EPA 625/PPL ☐ 8270/TAL ☐ NBS (+25) ☐	EPA 610 ☐ 8310 ☐	EP TOX Metals ☐ Pesticides ☐ Herbicides ☐	TCLP Metals ☐ VOA ☐ Semi-VOA ☐ Pest ☐ Herb ☐	EPA Metals - Priority Pollutant ☐ TAL ☐ RCRA ☐	CAM Metals TTLC ☐ STLC ☐	Lead 239.2 ☐ 200.7 ☐ 7420 7421 ☐ 6010 ☐	Organic Lead ☐	Corrosivity ☐ Flash Point Reactivity	OTHER: THB + GUB - Gasoline	OTHER	OTHER
MW-30																						X		
MW-31																						X		
MW-26																						X		
MW-34																						X		
MW-11																						X		

TAT
Priority (24 hr) [ ]
Expedited (48 hr) [ ]
7 Business Days [ ]
Other Standard Business Days [ ]

Special Handling
GTEL Contact ____
Quote/Contract # ____
Confirmation # ____
P.O. # ____

QA/QC Level
Blue [ ] CLP [ ] Other [ ] ____

SPECIAL DETECTION LIMITS

SPECIAL REPORTING REQUIREMENTS

FAX ☐

REMARKS:

Lab Use Only Lot #: Storage Location

Work Order #: R7232

CUSTODY RECORD

Relinquished by Sampler: Chuck Madewell	Date 6-1-95	Time 1430	Received by:
Relinquished by:	Date	Time	Received by:
Relinquished by:	Date 6/2/95	Time 1200	Received by Laboratory: Steph Cleese BTL Waybill #

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Midwest Region
4211 May Avenue
Wichita, KS 67209
(316) 945-2624
(800) 633-7936
(316) 945-0506 (FAX)

RECEIVED
JUN 19 1995

June 16, 1995

Cymantha Liakos
GROUNDWATER TECHNOLOGY, INC
2501 Yale Blvd Se #204
Albuquerque, NM 87106

RE: GTEL Client ID:	023353014
Login Number:	W5060001
Project ID (number):	023353014
Project ID (name):	BRC/#50 COUNTY RD 4990/BLOOMFIELD/NM

Dear Cymantha Liakos:

Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 06/01/95 under Chain-of-Custody Number(s) 42620.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes. This report is to be reproduced only in full.

GTEL is certified by the State of Kansas under Certification Numbers E-103, E-1113.

If you have any questions regarding this analysis, or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,
GTEL Environmental Laboratories, Inc.

Justin Ward, Project Coordinator for

Terry R. Loucks
Laboratory Director

ANALYTICAL RESULTS
Metals

GTEL Client ID: 023353014
Login Number: W5060001
roject ID (number): 023353014
Project ID (name): BRC/#50 COUNTY RD 4990/BLOOMFIELD/NM

Method: EPA 6010A
Matrix: Aqueous

GTEL Sample Number	W5060001-01	--	--	--
Client ID	MW-30	--	--	--
Date Sampled	05/31/95	--	--	--
Date Prepared	06/05/95			
Date Analyzed	06/15/95	--	--	--
Dilution Factor	1.00	--	--	--

Analyte	Reporting Limit	Units	Concentration:			
Iron	100	ug/L	1700	--	--	--

otes:

ilution Factor:

Dilution factor indicates the adjustments made for sample dilution.

EPA 6010A:

Digestion for Total Metals by EPA Method 3010A. "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, Third Edition including Update 1.

Project ID (Number): 023353014.34
Project ID (Name): BRC
#50 County Rd. 4990
Bloomfield, NM
Work Order Number: W5-06-0001
Date Reported: 06-16-95

ANALYTICAL RESULTS

Inorganics in Water

		GTEL Sample Number	01			
		Client Identification	MW-30			
		Date Sampled	05-31-95			
		Date Analyzed	06-01 to 06-13-95			
Analyte	Method	QL* & Units	Concentration			
Ammonia-N	EPA 350.1	0.08 mg/L	**0.60**			
Nitrate-N	EPA 353.1	0.05 mg/L	**0.73**			
Orthosphosphate	EPA 365.3	0.05 mg/L	<0.05			
Sulfate	EPA 375.4	5 mg/L	**1100**			

* Quantitation Limit

NA Not applicable

GTEL ENVIRONMENTAL LABORATORIES INC

4211 MAY AVE.
WICHITA, KS 67209
(316) 945-2624
(800) 633-7936

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

42620

Company Name: Groundwater Technology
Phone #: 505-242-3113
FAX #: 505-242-1103
Company Address: 2501 Yale Blvd SE #204 Albq NM 87106
Site Location: 350 County Rd 4990 Bloomfield, NM
Project Manager: Cynthia Liakos
Client Project ID: (#) 02 335 3014.34
(NAME) BRC
I attest that the proper field sampling procedures were used during the collection of these samples.
Sampler Name (Print): Charles Madewell

Field Sample ID	GTEL Lab # (Lab Use only)	# CONTAINERS	Matrix: WATER	SOIL	AIR	SLUDGE	PRODUCT	OTHER	Method Preserved: HCl	HNO3	H2SO4	ICE	UNPRESERVED	OTHER (Specify) Filtered	Sampling: DATE	TIME	BTEX 602 ☐ 8020 ☐ with MTBE ☐	BTEX/Gas Hydrocarbons PID/FID ☐ with MTBE ☐	Hydrocarbons GC/FID Gas ☐ Diesel ☐ Screen ☐	Hydrocarbon Profile (SIMDIS) ☐	Oil and Grease 413.1 ☐ 413.2 ☐ SM-503 ☐	TPH/IR 418.1 ☐ SM 503 ☐	EDB by 504 ☐ DBCP by 504 ☐	EPA 503.1 ☐ EPA 502.2 ☐	EPA 601 ☐ EPA 8010 ☐	EPA 602 ☐ EPA 8020 ☐	EPA 608 ☐ 8080 ☐ PCB only ☐	EPA 624/PPL ☐ 8240/TAL ☐ NBS (+15) ☐	EPA 625/PPL ☐ 8270/TAL ☐ NBS (+25) ☐	EPA 610 ☐ 8310 ☐	EP TOX Metals ☐ Pesticides ☐ Herbicides ☐	TCLP Metals ☐ VOA ☐ Semi-VOA ☐ Pest ☐ Herb ☐	EPA Metals - Priority Pollutant ☐ TAL ☐ RCRA ☐	CAM Metals TTLC ☐ STLC ☐	Lead 239.2 ☐ 200.7 ☐ 7420 ☐ 7421 ☐ 6010 ☐	Organic Lead ☐	Corrosivity ☐ Flash Point ☐ Reactivity ☐	OTHER: Ammonia - Nitrogen	Orthophosphate	Nitrate & Sulfate	Dissolved IRON
MW-30	60001 W50503770	5	X							X	X	X		X	5/31/95	1440																						X	X	X	X
~~MW-31~~		5	X							X	X	X		X		1615																						X	X	X	X
~~MW-26~~	CAM	5	X						CAM	X	X	X		X																						CAM		X	X	X	X
~~MW-34~~		5	X							X	X	X		X																								X	X	X	X
~~MW-11~~		5	X							X	X	X		X																								X	X	X	X

TAT
Priority (24 hr) ☐
Expedited (48 hr) ☐
7 Business Days ☐
Other ______ Business Days ☐

Special Handling
GTEL Contact ______
Quote/Contract # ______
Confirmation # ______
P.O. # ______

QA/QC Level
Blue ☐ CLP ☐ Other ☐ ______

SPECIAL DETECTION LIMITS

SPECIAL REPORTING REQUIREMENTS

FAX ☐

REMARKS:

Lab Use Only Lot #: 4/0
Storage Location
Work Order #:

CUSTODY RECORD

Relinquished by Sampler: Charles Madewell	Date 5-31-95	Time 1700	Received by:
Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by Laboratory:

#

GTEL
ENVIRONMENTAL
LABORATORIES, INC.

Midwest Region
4211 May Avenue
Wichita, KS 67209
(316) 945-2624
(800) 633-7936
(316) 945-0506 (FAX)

RECEIVED
JUN 19 1995

June 16, 1995

Cymantha Liakos
GROUNDWATER TECHNOLOGY, INC
2501 Yale Blvd Se #204
Albuquerque, NM 87106

RE: GTEL Client ID:	023353014
Login Number:	W5060019
Project ID (number):	023353014
Project ID (name):	BRC/#50 COUNTY RD 4990/BLOOMFIELD/NM

Dear Cymantha Liakos:

Enclosed please find the analytical results for the samples received by GTEL Environmental Laboratories, Inc. on 06/02/95 under Chain-of-Custody Number(s) 42621.

A formal Quality Assurance/Quality Control (QA/QC) program is maintained by GTEL, which is designed to meet or exceed the EPA requirements. Analytical work for this project met QA/QC criteria unless otherwise stated in the footnotes. This report is to be reproduced only in full.

GTEL is certified by the State of Kansas under Certification Numbers E-103, E-1113.

If you have any questions regarding this analysis, or if we can be of further assistance, please call our Customer Service Representative.

Sincerely,
GTEL Environmental Laboratories, Inc.

Justin Ward, Project Coordinator for
Terry R. Loucks
Laboratory Director

ANALYTICAL RESULTS
Metals

GTEL Client ID: 023353014
Login Number: W5060019
roject ID (number): 023353014
roject ID (name): BRC/#50 COUNTY RD 4990/BLOOMFIELD/NM

Method: EPA 6010A
Matrix: Aqueous

GTEL Sample Number	W5060019-01	W5060019-02	W5060019-03	W5060019-04
Client ID	MW-31	MW-26	MW-34	MW-11
Date Sampled	06/01/95	06/01/95	06/01/95	06/01/95
Date Prepared	06/05/95	06/05/95	06/05/95	06/05/95
Date Analyzed	06/15/95	06/15/95	06/15/95	06/15/95
Dilution Factor	1.00	1.00	1.00	1.00

Analyte	Reporting Limit	Units	Concentration:			
Iron	100	ug/L	1800	3900	210	16000

Notes:

ilution Factor:

Dilution factor indicates the adjustments made for sample dilution.

EPA 6010A:

Digestion for Total Metals by EPA Method 3010A. "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, Third Edition including Update 1.

W5060019-01:

The results for all samples indicate dissolved iron.

W5060019-02:

The sample was filtered as per client request. The results indicate the dissolved concentration at the time of filteration.

Project ID (Number): 023353014.34
Project ID (Name): BRC
#50 County Rd. 4990
Bloomfield, NM
Work Order Number: W5-06-0019
Date Reported: 06-16-95

ANALYTICAL RESULTS

Inorganics in Water

		GTEL Sample Number	01	02	03	04
		Client Identification	MW-31	MW-26	MW-34	MW-11
		Date Sampled	06-01-95	06-01-95	06-01-95	06-01-95
		Date Analyzed	06-02 to 06-13-95	06-02 to 06-13-95	06-02 to 06-13-95	06-02 to 06-13-95
Analyte	Method	QL* & Units	Concentration			
Ammonia-N	EPA 350.1[a]	0.08 mg/L	**0.35**	**0.34**	**0.20**	**0.39**
Nitrate-N	EPA 353.1	0.05 mg/L	**0.13**	**0.08**	**0.07**	**0.13**
Orthophosphate	EPA 365.3	0.05 mg/L	<0.05	<0.05	**0.19**	<0.05
Sulfate	EPA 375.4	5 mg/L	**88**	15	**23**	**16**

a Distillation by EPA 350.2

* Quantitation Limit

NA Not applicable

GTEL ENVIRONMENTAL LABORATORIES INC

4211 MAY AVE.
WICHITA, KS 67209
(316) 945-2624
(800) 633-7936

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

42621

Company Name: Groundwater Technology
Phone #: 505 [illegible]
FAX #: 505 [illegible]
Company Address: 2501 Yale Blvd SE #204 Albq NM 87106
Site Location: #50 County Rd 4990 Bloomfield N.M.
Project Manager: Cynthia Linkok
Client Project ID: (#) [illegible]
(NAME) BRC
I attest that the proper field sampling procedures were used during the collection of these samples.
Sampler Name (Print): Charles Maxwell

Field Sample ID	GTEL Lab # (Lab Use only)	# CONTAINERS	Matrix: WATER	Matrix: SOIL	Matrix: AIR	Matrix: SLUDGE	Matrix: PRODUCT	Matrix: OTHER	Method Preserved: HCl	Method Preserved: HNO3	Method Preserved: H2SO4	Method Preserved: ICE	Method Preserved: UNPRESERVED	Method Preserved: OTHER (Specify) Filtered	Sampling: DATE	Sampling: TIME	BTEX 602 ☐ 8020 ☐ with MTBE ☐	BTEX/Gas Hydrocarbons PID/FID ☐ with MTBE ☐	Hydrocarbons GC/FID Gas ☐ Diesel ☐ Screen ☐	Hydrocarbon Profile (SIMDIS) ☐	Oil and Grease 413.1 ☐ 413.2 ☐ SM-503 ☐	TPH/IR 418.1 ☐ SM 503 ☐	EDB by 504 ☐ DBCP by 504 ☐	EPA 503.1 ☐ EPA 502.2 ☐	EPA 601 ☐ EPA 8010 ☐	EPA 602 ☐ EPA 8020 ☐	EPA 608 ☐ 8080 ☐ PCB only ☐	EPA 624/PPL ☐ 8240/TAL ☐ NBS (+15) ☐	EPA 625/PPL ☐ 8270/TAL ☐ NBS (+25) ☐	EPA 610 ☐ 8310 ☐	EP TOX Metals ☐ Pesticides ☐ Herbicides ☐	TCLP Metals ☐ VOA ☐ Semi-VOA ☐ Pest ☐ Herb ☐	EPA Metals - Priority Pollutant ☐ TAL ☐ RCRA ☐	CAM Metals TTLC ☐ STLC ☐	Lead 239.2 ☐ 200.7 ☐ 7420 ☐ 7421 ☐ 6010 ☐	Organic Lead ☐	Corrosivity ☐ Flash Point ☐ Reactivity ☐	OTHER: Ammonia - nitrogen	OTHER: Ortho-phosphate *	OTHER: Nitrate and Sulfate	OTHER: Dissolved IRON
MW-31	01	5	X							X	X	X		X	6/1/95	0745																							X	X	X	X
MW-26	02	5	X							X	X	X		X		0830																							X	X	X	X
MW-34	03	5	X							X	X	X		X		1015																							X	X	X	X
MW-11	04	5	X							X	X	X		X		1200																							X	X	X	X
	(U505016																																								

TAT
Priority (24 hr) ☐
Expedited (48 hr) ☐
7 Business Days ☐
Other Standard
Business Days ☐

Special Handling
GTEL Contact
Quote/Contract #
Confirmation #
P.O. #

QA/QC Level
Blue ☐ CLP ☐ Other ☐

SPECIAL DETECTION LIMITS

SPECIAL REPORTING REQUIREMENTS

FAX ☐

REMARKS: * MW-26 not filtered, please filter in lab

Lab Use Only Lot #:
Storage Location [illegible]
Work Order #: [illegible]

CUSTODY RECORD

Relinquished by Sampler: Charles Maxwell	Date 6-1-95	Time 1630	Received by:
Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by Laboratory:

APPENDIX C

CORRECTIVE MEASURE OPTIONS SCREENING MATRICES

GROUNDWATER
TECHNOLOGY

Giant Refining Company, Bloomfield, New Mexico

CORRECTIVE MEASURE OPTIONS SCREENING MATRIX

TABLE C-1. *SEEPAGE* CONTROL ALTERNATIVES

CORRECTIVE MEASURE OPTIONS	APPLICABILITY 0 - 5 A	PERMISSIBILITY 0 - 3 P	PRESENT VALUE COST (high) 1 - 5 (low) C	TREATMENT TIME 1 - 3 T	RATING SCORE 0 - 120 A*P*(C+T)	RETAIN? (yes/no)	COMMENTS
Dewater Pumping	2	2	2	2	16.00	NO	Seeps hydraulically connected to Hammond Ditch which is unlined.
Grout Curtain or Sheet Piling	4	2	3	3	48.00	NO	Would raise water table, interfering with SVE.
Air Curtain	1	2	1	1	4.00	NO	Saturated thickness is too thin requiring too many points to get significant mounding.
Interceptor Trench	4	2	2	2	32.00	NO	Hammond Ditch contribution would require excessive pumping.
Pumping to Reverse Gradient	2	2	1	1	8.00	NO	Hammond Ditch contribution would require excessive pumping.
Clean Water Curtain Injection	1	1	1	1	2.00	NO	Too complicated, and would compete with refinery production for water allocation.
Contaminant Source Removal	5	3	3	2	75.00	YES	Addresses the contaminants, not both the water and the contaminants which is more cost-effective.
Enhanced In-Situ Bioremediation	3	2	4	2	36.00	YES	Injection of nutrients will enhance in-situ biodegradation of contaminants.
No Action/Natural Attenuation and Monitoring	3	1	5	1	18.00	NO	Probably not acceptable to environmental regulators because of river pollution concerns.

Giant Refining Company, Bloomfield, New Mexico

CORRECTIVE MEASURE OPTIONS SCREENING MATRIX

TABLE C-2. *SEPARATE PHASE HYDROCARBON (SPH)* REMEDIATION ALTERNATIVES

CORRECTIVE MEASURE OPTIONS	APPLICABILITY 0 - 5 A	PERMISSIBILITY 0 - 3 P	PRESENT VALUE COST (high) 1 - 5 (low) C	TREATMENT TIME 1 - 3 T	RATING SCORE 0 - 120 A*P*(C+T)	RETAIN? (yes/no)	COMMENTS
Skimming Pumps	3	3	4	1	45.00	NO	Limited radius of influence would require many wells and a long time.
Dual Pump System (groundwater & SPH)	3	3	3	2	45.00	NO	No need to pump SPH and water separately because the refinery WW trmt. plant has an O/W separator available.
Soil Vapor Extraction (SVE)	5	3	4	2	90.00	YES	Pilot testing shows SVE to be feasible.
SVE and In-Situ Air Sparging (IAS)	4	3	3	3	72.00	YES	The thin saturated thickness would require many IAS points, but enhanced volatilization would speed up treatment time. Pilot testing shows both SVE and IAS to be feasible.
High-Vacuum Dual Phase Extraction	2	3	2	2	24.00	NO	Hammond Ditch contribution would require excessive pumping.
Total Fluids Pumping	3	3	4	2	54.00	YES	This is already being implemented, although not effective in controlling plume migration. Long term O & M required.
Water Table Depression and SVE	4	3	2	3	60.00	YES	Increases surface area, enhancing SVE, but would require lots of pumping to maintain water table depression.
No Action/Natural Attenuation and Monitoring	1	0	5	1	0.00	NO	NMED requires removal of all measurable SPH.

Giant Refining Company, Bloomfield, New Mexico

CORRECTIVE MEASURE OPTIONS SCREENING MATRIX

TABLE C-3. *SOIL* REMEDIATION ALTERNATIVES

CORRECTIVE MEASURE OPTIONS	APPLICABILITY 0 - 5 A	PERMISSIBILITY 0 - 3 P	PRESENT VALUE COST (high) 1 - 5 (low) C	TREATMENT TIME 1 - 3 T	RATING SCORE 0 - 120 A*P*(C+T)	RETAIN? (yes/no)	COMMENTS
Risk Assessment (determine exposure levels)	4	2	4	3	56.00	YES	Process already underway.
Soil Vapor Extraction (SVE)	5	3	3	2	75.00	YES	Pilot testing shows that SVE is feasible.
Bioventing	2	2	3	2	20.00	NO	N/A if employ SVE for SPH removal.
Excavation & Disposal/ Ex-Situ Treatment	1	1	1	3	4.00	NO	Would interfere with refinery operations, expensive.
In-Situ Soil Washing	1	2	2	1	6.00	NO	Contaminants/soils not applicable, expensive.
Chemical Fixation/Stabilization	1	2	1	2	6.00	NO	Contaminants/soils not applicable, expensive.
Vitrification	0	0	1	2	0.00	NO	Contaminants/soils not applicable, expensive.
Steam-Injection Stripping	3	1	2	3	15.00	NO	Contaminants are volatile enough at low temperatures.
Enhanced Bioremediation	2	2	3	1	16.00	NO	Difficult to uniformly distribute nutrients in soil in-situ.
No Action/Natural Attenuation and Monitoring	1	0	5	1	0.00	NO	NMED requires remediation of TPH impacted soil >1,000 ppm.

Giant Refining Company, Bloomfield, New Mexico

CORRECTIVE MEASURE OPTIONS SCREENING MATRIX

TABLE C-4. *GROUNDWATER* REMEDIATION ALTERNATIVES

CORRECTIVE MEASURE OPTIONS	APPLICABILITY 0 - 5 A	PERMISSIBILITY 0 - 3 P	PRESENT VALUE COST (high) 1 - 5 (low) C	TREATMENT TIME 1 - 3 T	RATING SCORE 0 - 120 A*P*(C+T)	RETAIN? (yes/no)	COMMENTS
Risk Assessment (determine exposure levels)	4	2	4	3	56.00	YES	Process already underway.
Altered Water Mgmt. Practices (i.e., decrease leakage from evap. & water ponds).	3	0	3	1	0.00	NO	Not practical for refinery operations. May not effect water table significantly.
Pump, Treat, & Reinject Groundwater	3	2	3	1	24.00	NO	A deep water injection well is available, however, technique not viable till source reduction complete.
Pump, Treat, & Reinfiltrate Groundwater	2	1	2	1	6.00	NO	Would require a large infiltration gallery, and technique not viable till source reduction complete.
In-Situ Air Sparging (IAS)	4	3	3	2	60.00	YES	Pilot testing shows IAS to be feasible. The thin saturated thickness would require many IAS points.
Enhanced In-Situ Bioremediation	4	2	4	1	40.00	YES	Injection of nutrients will enhance in-situ biodegradation of contaminants.
Contaminant Source Removal	3	3	5	3	72.00	YES	Source reduction enhances every aspect of site restoration.
No Action/Natural Attenuation and Monitoring	3	1	5	1	18.00	YES	With source reduction, dissolved contaminants will naturally attenuate slowly.

Giant Refining Company, Bloomfield, New Mexico

CORRECTIVE MEASURE OPTIONS SCREENING MATRIX

LEGEND

APPLICABILITY
0 = Not applicable, available or implementable
1 = Not widely used and probably not applicable
2 = Widely used but probably not applicable ,or not widely used and may not be applicable
3 = Widely used but may not be applicable, or not widely used but probably applicable
4 = Widely used and probably applicable, or not widely used but proven and applicable
5 = Widely used, proven and applicable

PERMISSIBILITY
0 = Not permissible
1 = Probably not permissible
2 = Probably permissible
3 = No permitting problems anticipated

TREATMENT TIME
1 = Treatment time longer than desired
2 = Acceptable treatment time
3 = Rapid treatment time

PRESENT VALUE COST
1 = very high relative to other technologies
2 = high relative to other technologies
3 = moderate relative to other technologies
4 = low relative to other technologies
5 = very low relative to other technologies