GW - 28

REPORTS

YEAR(S):

1996

GW-28

RCRA FACILITY INVESTIGATION
PHASE II REPORT
NORTH COLONY LANDFARM
NAVAJO REFINERY
ARTESIA, NEW MEXICO

RECEIVED
MAR 4 1996
Environmental Bureau
Oil Conservation Division

prepared for

Navajo Refining Company
501 East Main Street
P.O. Drawer 159
Artesia, New Mexico 88210

February 1996

RCRA FACILITY INVESTIGATION
NORTH COLONY LANDFARM
NAVAJO REFINERY
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501 East Main Street
Artesia, New Mexico 88210

January 1996

David G. Boyer
Project Manager

Brian P. Sullivan

Brian P. Sullivan
Assistant Project Manager

TELEPHONE
(505) 748-3311

EASYLINK
62905278

Navajo REFINING COMPANY

501 EAST MAIN STREET • P. O. BOX 159
ARTESIA, NEW MEXICO 88211-0159

FAX
(505) 746-6410 ACCTG
(505) 746-6155 EXEC
(505) 748-9077 ENGR
(505) 746-4438 P/L

OIL CONSERVATION DIVISION
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February 28, 1996

Mr. Ronald A. Kern, Environmental Scientist
Hazardous and Radioactive Materials Bureau
New Mexico Environmental Department
525 Camino de Los Marquez
P.O. Box 26110
Santa Fe, NM 87502

Re: Submittal of North Colony Landfarm RFI Phase II Report

Dear Mr. Kern:

Attached with this letter is the North Colony Landfarm (NCL) RCRA Facility Investigation (RFI) Phase II Report, required as per your New Mexico Environment Department (NMED) Hazardous and Radioactive Materials Bureau letter dated December 30, 1994. Two copies of the report are being provided for your use. The report documents environmental investigation activities associated with the execution of the RFI Phase II workplan, which was approved by NMED on April 10, 1995.

The RFI Phase II focused on the investigation of a subsurface hydrocarbon release in the vicinity of the NCL. As has been addressed with the NMED previously, and based on the findings of the investigation, Navajo believes that subsurface contamination under and downgradient of the NCL has resulted from an upgradient release and not from the former waste management activities at the NCL. Nevertheless, with the completion of the Phase II investigation, the magnitude and distribution of the released hydrocarbon material is sufficiently characterized in terms of its magnitude and distribution to recommend appropriate corrective actions, which are described in the report and briefly summarized here.

In brief, the hydrocarbon plume resides within a sporadically distributed, semi-confined water-bearing zone designated as the near-surface saturated zone (NSSZ). The lithology of the NSSZ is perhaps best conceived as an interlacing network of relatively narrow porous seams and channels contained within a surrounding impermeable matrix. Water quality characteristics and potential productivity of the NSSZ preclude it potential use as a drinking water source. Moreover, the NSSZ in the vicinity of the NCL is sufficiently isolated from deeper aquifer zones to an extent which precludes potential contaminant transport to the deeper groundwater resources.

The report concludes that the appropriate corrective action is interception and recovery of the downgradient hydrocarbon plume. Furthermore, due to the lithologic characteristics of the NSSZ, the installation of trenches across the contaminant flow path represents the only effective means of intercepting the plume. Information regarding the placement and operation of proposed interception trenches is provided in the Phase II report. The recovery system would be operated as part of Navajo's ongoing groundwater remediation program under OCD authority.

If you have any questions regarding the NCL Phase II report, please do not hesitate to contact me at (505) 748-3311.

Sincerely,

Phillip L. Youngblood

Phillip L. Youngblood
Director of Environmental Affairs

PLY/sj

Enc.

cc: Mr. Roger Anderson
Environmental Bureau Chief - NMOCD

CERTIFICATION OF STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to be the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

(Signature)

Phillip L. Youngblood
Director of Environmental Affairs
(Printed Name & Title)

2-28-96
(Date)

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1.0 EXECUTIVE SUMMARY

This document presents activities, results and conclusions of the Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for the Navajo Refining Company (NRC) North Colony Landfarm (NCL). The NCL is a RCRA-permitted hazardous waste land treatment unit located at NRC's Artesia, New Mexico refinery. The NCL, which formerly managed several RCRA-listed refinery wastes, has not received such wastes since 1990, but continues to be managed for biodegradation of residual hydrocarbons.

The RFI Phase II was performed as a follow-up to the initial RFI effort conducted at the unit in 1994, and was intended to further characterize and delineate the extent of hydrocarbon contamination in groundwater underlying and downgradient of the NCL. To achieve those objectives, the RFI Phase II involved the completion of a series of 24 soil borings downgradient of the NCL, installation of one upgradient and four downgradient groundwater monitoring wells, environmental analysis of groundwater samples obtained from those wells, and groundwater elevation measurements and aquifer tests conducted to describe key aquifer characteristics.

The findings of the RFI study further verify the initial findings and conclusions of the RFI Phase I investigation. The combined observations and data generated from the two RFI efforts at the NCL yield the following major findings:

1. Observations from soil borings and excavation trenches completed at the NCL indicate that hydrocarbon contamination found in or immediately above the water table underlying the unit originates from a contaminant source which is unrelated to former waste management activities at the NCL. Rather, the evidence suggests that contamination beneath the unit primarily results from migration of hydrocarbon contaminants originating from a previously identified product release located upgradient and sidegradient to the NCL;

2. The near-surface saturated zone (NSSZ) in the vicinity of the NCL consists of a highly variable network of caliche gravel and fine-grained clayey sand and silt seams located at depths ranging between approximately 15 to 35 feet below surface grade. These water-bearing seams are typically limited in vertical and horizontal extent, and are interbedded with extensive zones of relatively tight clays and silts;

3. The bulk of the release (in the form of free-phase product) is found in a subsurface plume that conforms to the prevailing direction of groundwater movement. The boundaries of the product plume have been delineated by a series of soil observation borings and groundwater monitoring wells completed during the RFI Phase II activities; and

4. The NSSZ exists under distinctly semi-confined conditions, and is subject to potentially rapid and highly variable potentiometric fluctuations in response to local precipitation events. Portions of a municipal stormwater ditch located south and west of the NCL are a possible source for transient fluctuations in both the direction of local groundwater movement and the hydraulic potential; which, in turn, has driven hydrocarbon contamination horizontally to points under and beyond the NCL, as well as upwards toward the base of the unit.

The available environmental observations and environmental data indicate that the product plume is contained entirely within the confines of the NSSZ, and poses no threat of contamination to deeper groundwater resources. The NSSZ primarily consists of a highly variable network of relatively low-volume, semi-confined channels contained within a surrounding matrix of low-permeability silts and clays, such that petroleum product is distributed in a discontinuous manner within the delineated plume. Therefore, the construction of interception trenches across the product flow path is recommended as the only feasible option for capture and recovery of released hydrocarbon product.

Based on the location of free-phase product within the NSSZ, and physical constraints imposed by Eagle Creek and various surface and subsurface refinery installations, two separate trench installations are recommended for the interception and recovery of the hydrocarbon product. A primary trench located immediately west of Eagle Creek would recover product and contaminated groundwater. In addition, a secondary trench located east of the creek would serve as a recovery system to collect contamination which migrated beyond the point of the primary trench prior to its installation.

2.0 INTRODUCTION

The following sections provide a brief introduction to the background, scope, goals, and organization for the RFI Phase II investigation reported herein.

2.1 Background to the RCRA Facility Investigation

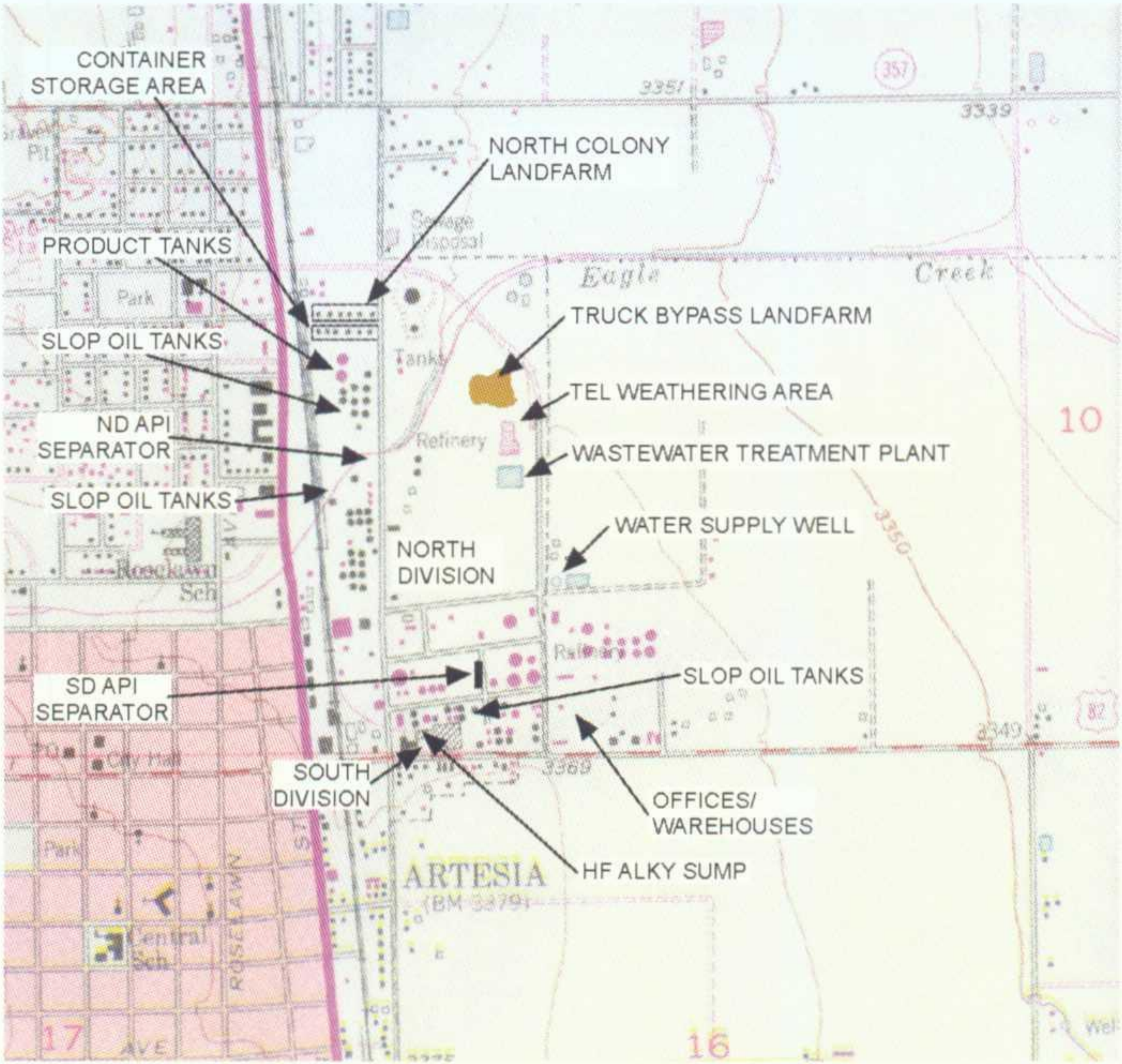
Navajo Refining Company (NRC) operates a petroleum refinery (EPA ID No. NMD 048918817) located at 501 East Main Street, Artesia, New Mexico (Figure 2-1). The refinery is regulated under the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HWSA).

This document addresses the North Colony Landfarm (NCL) which is a land treatment unit located in the northwest portion of the refinery that was operated by Navajo between 1980 and 1990 under the auspices of New Mexico Hazardous Waste Permit No. NMD048918817-1.

Subsequent to the generation of environmental monitoring data which suggested a potential release to subsurface soils underlying the base of the unit, a RCRA Facility Investigation (RFI) was conducted for the NCL. The RFI was performed in 1994 in accordance with the original RFI workplan approved by the New Mexico Environment Department (NMED), and the RFI findings were subsequently presented in the report entitled "RCRA Facility Investigation, North Colony Landfarm, July 1994."

After submittal of the NCL RFI report and review by the NMED, the agency required that a second phase of the RFI be undertaken to collect additional information regarding the extent of hydrocarbon contamination in shallow groundwater beneath the unit. A technical workplan designed to obtain the required environmental information was developed, was incorporated into the original RFI workplan (retitled as the RFI Phase I and Phase II workplan), and was subsequently approved by NMED in April 1995.

This document presents the activities, findings, and conclusions of the RFI Phase II.



NOTE: MAP COMPILED FROM USGS ARTESIA 7.5 MINUTE QUADRANGLE (1975)

	Navajo Refining Company Facility Location Map	
	PROJECT: NCL RFI PHASE II	
	LOCATION: ARTESIA, NEW MEXICO	
Navajo	APPR:	DATE: 2/27/96
	DRAWN BY:	SCALE: AS SHOWN
	DATE:	FIGURE: 2-1

2.2 Scope and Goals of the RFI Phase II

The initial NCL RFI study included the completion of a series of soil borings and trench excavations at the NCL. NMED concluded that the possibility could not be ruled out that a release of unit-applied waste constituents had contaminated the near-surface saturated zone (NSSZ) underlying the unit to some extent. NRC was not able to state with absolute assurance that no release had occurred, although the preponderance of evidence showed that this was not the case. Consequently, NMED required the execution of a second RFI phase for the NCL in order to further characterize and delineate the released hydrocarbon product contaminants in the vicinity of the NCL.

Prior to the performance of the NCL RFI, a significant hydrocarbon release to the NSSZ, which consisted of a refined petroleum product originating from an unrelated source located upgradient (south) of the NCL, was partially characterized. This refined-product release resulted in the presence of free-phase product in groundwater monitoring wells located immediately downgradient of the NCL. In contrast, the evidence for a release of waste constituents from the NCL to the NSSZ is both highly limited and ambiguous, and at most, can be construed to suggest the possibility of a unit release -- which in all likelihood would not have resulted in a detectable impact on NSSZ groundwater; and would otherwise be clearly insignificant in any meaningful sense relative to the predominant product release.

Therefore, as a practical matter, it is recognized that the hydrocarbon contamination subject to further characterization consists of refined petroleum product originating from a point of release that is unrelated to NCL operations. The RFI Phase II activities described in this document were designed to further characterize and delineate the extent of the hydrocarbon product release.

2.3 Organization of the RFI Phase II Report

This RFI Phase II report is organized into eight sections and supporting appendices. Section 3.0 describes the environmental setting of the facility. Section 4.0 provides a summary of the environmental data previously obtained for the subsurface hydrocarbon contamination in the vicinity of the NCL. Section 5.0 details RFI Phase II investigative activities, and Section 6.0 presents the environmental data and observations associated with those activities. Section 7.0 provides interpretive discussion of the investigation results, and Section 8.0 details the conclusions and recommendations of the investigation.

Because this report provides a significant amount of new information in the form of soil borings and groundwater data that delineate the hydrocarbon contamination at the site, it was considered infeasible to produce sections and pages for insertion in the Phase I report submitted in 1994. Therefore, the report was produced as a stand-alone document which is supplemental and complementary to the Phase I report.

3.0 ENVIRONMENTAL SETTING

A detailed description of the local and regional environmental setting in which the facility resides was presented in Section 4.0 of the original RFI report, submitted to NMED on July 26, 1994 (hereafter referred to as the RFI Phase I report). Further description of the facility setting herein focuses on the immediate vicinity of the NCL at which environmental investigation activities associated with the RFI Phase II were conducted.

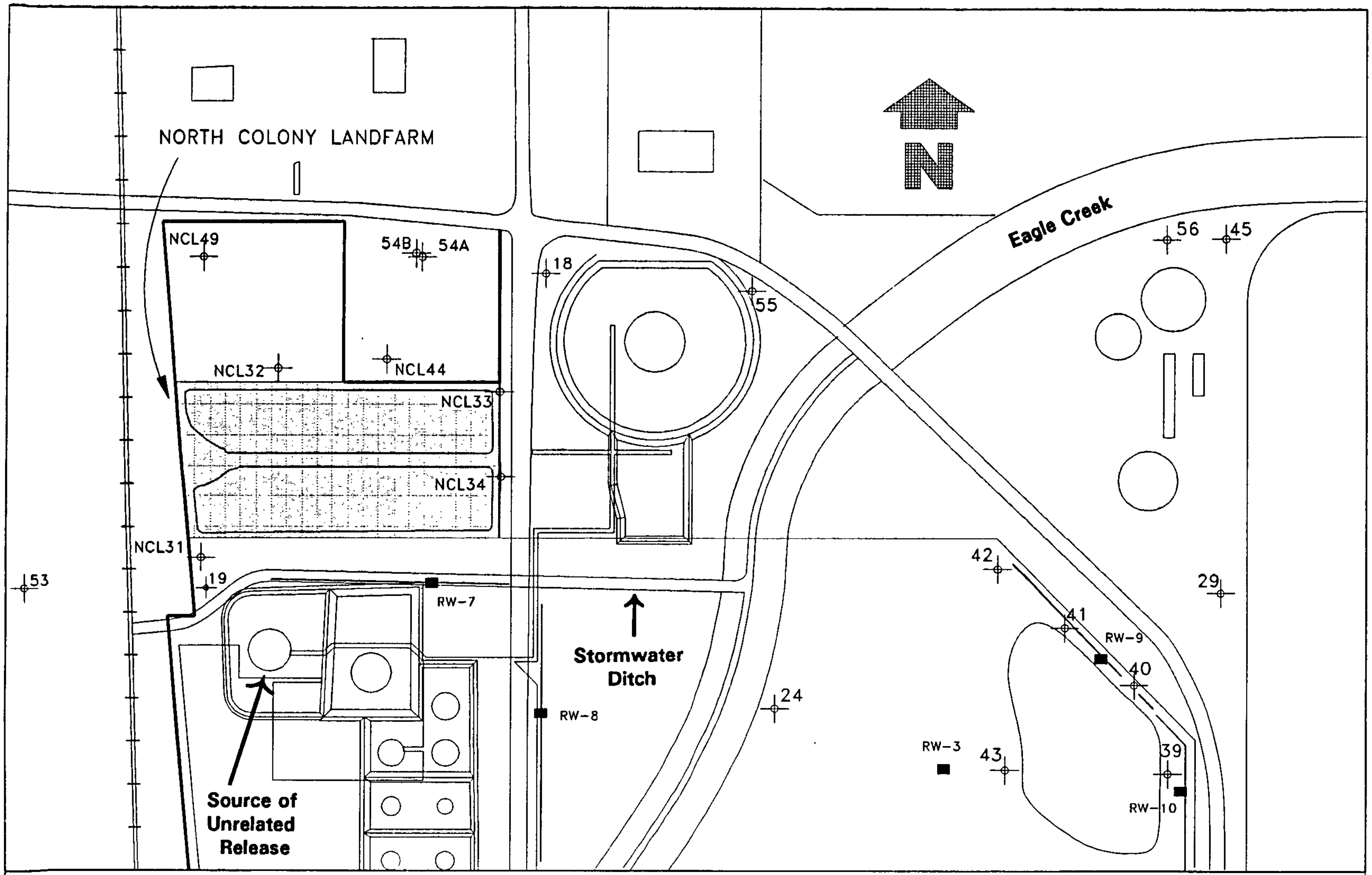
3.1 Topography and Surface Water

A site plan showing the NCL and surrounding facility areas is presented as Figure 3-1. Natural surface drainage in the vicinity of the NCL is to the north and east. The major drainage in the area of the NCL is Eagle Creek, an ephemeral watercourse that runs southwest to northeast through the refinery process area, and thence runs eastward to the Pecos River. Eagle Creek functions as a major stormwater conveyance for the city of Artesia, and also drains a large land area west of the city towards the Sacramento Mountains.

A minor stormwater conveyance which receives runoff from city streets west of the refinery passes immediately to the south of the NCL before it empties into Eagle Creek (Figure 3-1). Groundwater observations obtained during the performance of the RFI Phase I suggested that fluctuations in hydraulic potential and direction of flow in the NSSZ in the vicinity of the NCL may be significantly influenced by this surface drainage feature.

3.2 Groundwater

In the vicinity of the NCL, the uppermost saturated zone (NSSZ) consists of water of variable quality in fractured caliche, clayey sand, silt, and gravel lenses at depths ranging from 15 to 30 feet. Several lines of evidence indicate that hydrocarbon contaminants contained in these formations exist under semi-confined conditions. Groundwater elevations in the vicinity of the landfarm can vary significantly over a short period of time (RFI Phase I report, Section 7.3), and transient infiltration of hydrocarbon-containing groundwater into overlying low-permeability strata via existing preferential pathways (old root channels and the discontinuous network of caliche gravel seams underlying the base of the unit) has also been documented (RFI Phase I report, Section 6.1.1).



LEGEND

⌖ MONITOR WELL

■ RECOVERY WELL LOCATION

FIGURE 3-1. SITE MAP AND WELL LOCATIONS

NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

SCALE IN FEET

0 200 400 600

Drawn by: Walt Foutz Date: 2-23-96

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Although groundwater movement beneath the refinery facility is generally to the east, groundwater level measurements conducted during the RFI Phase I were consistent with the results of previous studies (RFI Phase I report, Section 7.3) which show shallow groundwater movement to the northeast in the vicinity of the NCL. The presence of Eagle Creek (the major surface drainage for the City of Artesia), irrigation of an urban park immediately west of the refinery, and the stormwater drainage ditch located immediately north of the NCL are believed to act as recharge sources that cause a slightly semicircular groundwater mound to exist in the vicinity of the NCL. The configuration of the apparent mound may vary depending on the amount and frequency of local recharge. The groundwater mound dissipates east of the refinery, and eastward movement towards the river resumes (NRC Pond and Ditch RFI Phase II report, 1993).

At the time of the NCL RFI Phase I study, a deep geotechnical boring was completed to a total depth of 100 feet at a location immediately north of the NCL (Figure 3-1). The deep boring profile revealed caliche gravel seams distributed from about 14 to 38 feet, with the first saturated gravel seam being encountered at 21 feet. The NSSZ in this area was primarily underlain by at least 60 feet of dry, hard clays (RFI Phase I report, Appendix D). The RFI Phase I deep boring profile was consistent with borehole logs for two geotechnical borings which were completed south of the NCL in preparation for unrelated facility construction activities (Figure 7-2, RFI Phase I report).

3.3 Identification of Potential Receptors

The community of Artesia is located directly adjacent to the facility. The Preliminary Review conducted at the facility in 1986 concluded that it does not appear likely that subsurface releases of contaminants from the facility could impact the deep aquifers (San Andres and Grayburg Queen formations) used as drinking water sources.

4.0 SOURCE CHARACTERIZATION

A preliminary characterization of NSSZ hydrocarbon contaminants was developed as a result of the NCL RFI Phase I. The significant findings of the original NCL RFI report (July 1994) are summarized as follows:

- The unit is underlain by a near-surface saturated zone consisting of interbedded strata - - primarily clayey sands, silt, and caliche gravel. These saturated zones, which are sporadically distributed beneath the unit, exhibit contamination by a refined hydrocarbon product that originates from a release location situated upgradient of the NCL;

- Groundwater contained in the near-surface saturated zones exists under semi-confined conditions, and exhibits rapid increases in potentiometric levels in response to local precipitation events. As a result, offsite hydrocarbon product entering the near-surface saturated zones beneath the unit was observed to migrate in a vertically upward direction in areas of the unit in which preferential pathways were available;

- Evidence of hydrocarbon contamination below the base of the unit was obtained from 13 soil borings. However, 8 of the 13 soil borings showed that hydrocarbon constituents originating from the unit did not extend to groundwater. For the 5 remaining borings, observations and analytical data were either inconclusive or else suggested an upwards migration of groundwater-borne contaminant towards the base of the unit. Observations and data for one boring of these 5, while also inconclusive, could possibly be construed to suggest a minor release from the unit;

- Heavy metal constituents contained in treatment wastes applied to the unit pose no threat to groundwater.

Overall, the RFI soil borings provide substantial and consistent evidence to indicate that the extensive hydrocarbon contamination encountered beneath the NCL and at other subsurface locations in the immediate vicinity of the unit originate from an unrelated release of refined hydrocarbon product. The hydrocarbon contamination observed in the NSSZ beneath the unit originates from a product storage area located south and upgradient of the NCL. Leaky tanks believed to have been the source for the current hydrocarbon release have either been repaired or replaced, and environmental investigations and corrective actions associated with that release have been undertaken by NRC under the oversight of NMOCD.

After review of the information and evidence developed in the Phase I RFI study, the NMED, in meetings and correspondence, believes it is possible that releases from the NCL have impacted groundwater since NRC can not state with 100 percent certainty that impacts have not taken place. Although the preponderance of evidence indicates that this is not the case, NMED directed NRC to propose and carryout a Phase II RFI workplan to perform further source characterization at the site. The Phase II workplan investigation activities are described in Section 5.0 and the investigation results are presented in Section 6.0.

5.0 UNIT INVES5TIGATION ACTIVITIES

The NCL RFI Phase II program was designed to investigate subsurface conditions to the north and east of the previously known extent of hydrocarbon contaminants. Specifically, the following investigative goals were defined by the workplan:

- delineation of the horizontal and vertical extent of aqueous and free-phase hydrocarbons in the NSSZ;
- define and evaluate hydrogeologic conditions and flow paths;
- identify hydraulic conductivities of the permeable subsurface zones;
- update and expand the groundwater potentiometric contour map; and
- evaluate potential impacts of surface flow, storm runoff, and other transient occurrences on the NSSZ.

Descriptions of the tasks, methods, and procedures used to accomplish the above-listed goals are presented in the following sections.

5.1 Soil Borings

During the performance of the NCL RFI Phase II field activities, a total of 24 soil borings were completed in the vicinity of the NCL. Three of the borings (NCL 95-01, -07, and -16) were subsequently installed as groundwater monitoring wells (Section 5.2). Pursuant to Section 4.1.2.3.1 of the workplan, borings were initially completed on 200-foot centers, modified as necessary for locations of refinery equipment or utilities. When hydrocarbons were encountered, borings intermediate to the primary locations also were completed. These were labeled with a letter modifier (e.g., NCL 95-08A). The locations for the RFI Phase II soil borings are presented in Figure 5-1, which also shows the locations of 7 additional soil borings which were completed in conjunction with compliance activities pre-dating the RFI Phase II.

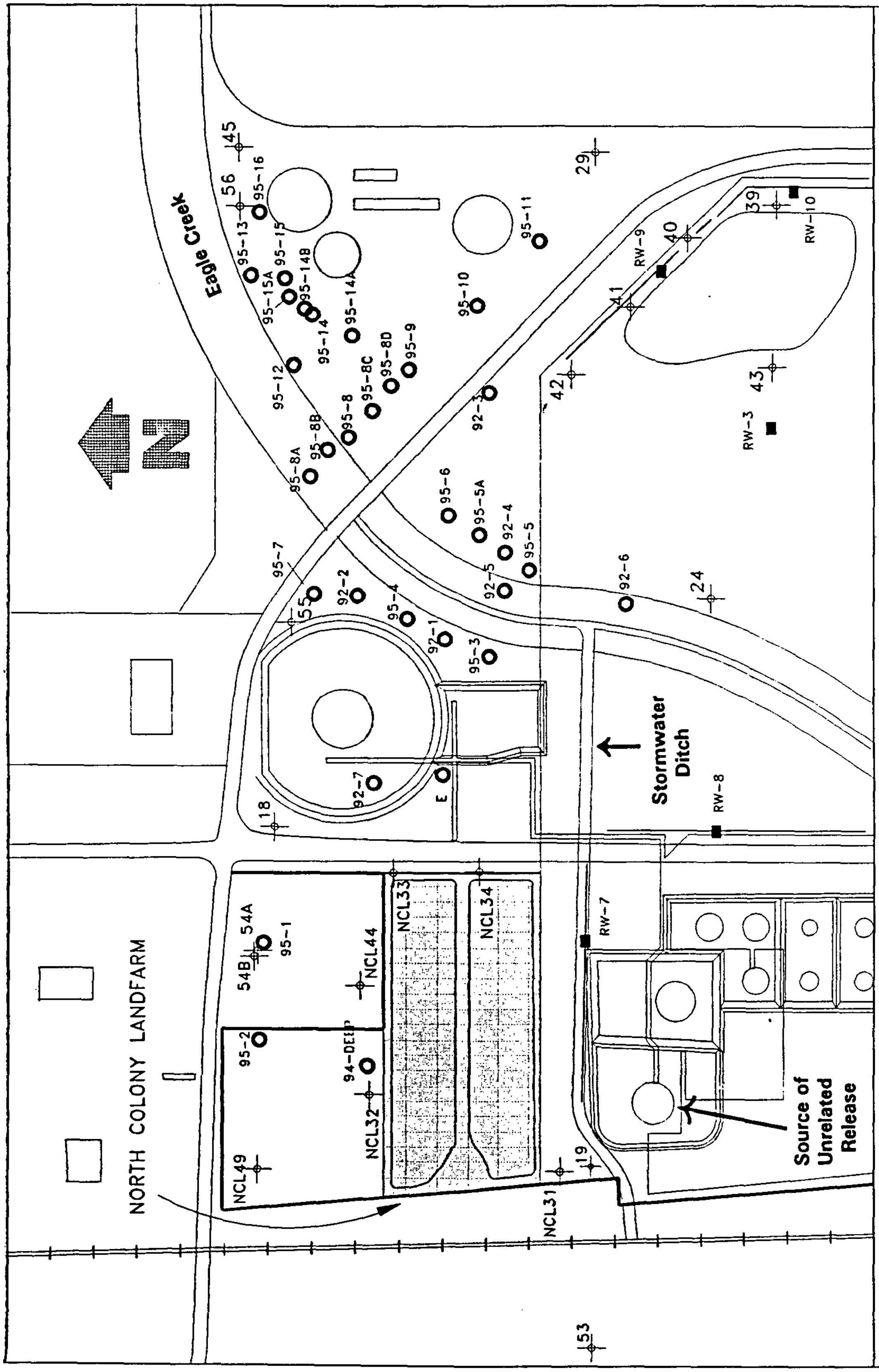

FIGURE 5-1. LOCATION OF EXPLORATORY BORINGS

NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

SCALE IN FEET

0 200 400 600

Drawn by: Walt Foutz Date: 2-23-96

LEGEND

⌖	MONITOR WELL
○	BORING LOCATION
■	RECOVERY WELL LOCATION

NOTE: BORING LOCATIONS APPROXIMATE (TAPED, NOT SURVEYED)

The soil borings were accomplished using a direct push method as described in the February 1995 RFI Phase II workplan (Section 4.1.2.3.1), or the more conventional coring method using a 5-foot, 3-1/2-inch-ID core barrel advanced ahead of an 8-1/4-inch hollow-stem auger flight. In the direct push method, the CME-75 drill rig used its hydraulic system to advance a 2-inch-diameter, 2-foot-long split spoon barrel. No drill cuttings were produced using this method. Depending on specific borings, boring cores were obtained at 2-foot intervals, beginning at 3 to 5 feet, and then continuing again at 8 to 10 feet and consecutive 2-foot intervals thereafter to the final boring depth. If the larger core barrel recovery method was used, samples were collected at 5-foot intervals beginning at a boring depth of 4 feet. Sample cores were recovered for observation, logging, and field measurements of vapor-phase volatiles using a calibrated photoionization detector (PID). Exploratory holes drilled adjacent to primary holes were cored with a 3-1/2-inch-OD solid-stem auger. Logging of these extra holes was performed from drill cuttings and generally only visual observations were recorded, although some samples for PID readings were collected only at depths where hydrocarbons were detected. Final boring depths ranged from approximately 15 to 28 feet. All boreholes were backfilled with bentonite which was hydrated with 5 gallons of fresh water.

Descriptive logs for the RFI Phase II borings are presented in Appendix A. Also presented in the appendix are logs for additional boring locations shown in Figure 5-1 which were completed prior to the execution of the RFI Phase II study. These include seven borings completed by NRC in the study area in August 1992 and the log of the deep boring located adjacent to NCL-32 that was completed in 1994 as part of the NCL Phase I investigation. Logs of two deep geotechnical borings cored prior to construction of new refinery processing unit are included also.

In addition to the physical observations and field PID testing, three groundwater samples were collected at borings NCL 95-01, -02, and -07 within 24 hours of completion of the borings. Collection of those groundwater samples and subsequent analytical data was intended to provide supplementary information regarding the presence/absence of dissolved-phase hydrocarbon contaminants. The analytical data generated from the boring groundwater samples, together with the soil boring visual and PID observations, was subsequently considered during the selection process for RFI Phase II downgradient groundwater monitoring well locations. Further discussion of the groundwater samples collected from RFI Phase II soil borings is provided in Section 5.3.

5.2 Monitor Well Installation

Five new groundwater monitoring wells (MW-53, 54A, 54B, 55, and 56) were installed during the RFI Phase II. MW-53 was installed as an upgradient well, and the remaining wells were located so as to be immediately downgradient of the hydrocarbon product plume. The new well locations are included on Figure 3-1, together with locations of several pre-existing groundwater monitoring wells associated with the refinery's groundwater monitoring network. The new monitoring wells were installed according to the methods and procedures delineated in the February 1995 RFI Phase II workplan. Details of monitoring installation and construction are shown in Appendix A.

Well MW-53 was installed in June 1995 at the request of the NMED to serve as a replacement upgradient well for NCL-31 which is located adjacent to, but off-gradient from, the petroleum product tankfarm from which the hydrocarbon plume originated. Wells MW-54A, 55, and 56 were installed in conjunction with the associated soil borings (NCL 95-01, 95-07, and 95-16, respectively) which were initially cored at the respective monitoring well locations.

Wells MW-55 and 56 were installed in August 1996 immediately after delineation of the hydrocarbon plume was completed. Screen placement in these wells was several feet above the depth where saturation was first encountered. However, the water level inside the boreholes was suppressed by the thinness of the water bearing zones and thick smearing of the plastic clays along the outside hollow stem auger flights. Because of these factors and because the groundwater exhibits semi-confined conditions, the final water level was slightly above the level of the screen. This will not affect use of these two wells for their designed purpose which is the early detection of free-phase hydrocarbons. To prevent this problem from affecting the final well, MW-54 was scheduled for completion with a 15-foot screen.

Well MW-54 installation was delayed due to a lack of access to the property site by the existing landowner. The well was installed in December 1995 after the property was acquired by NRC. During the drilling of this well, a deeper zone of saturation was encountered at 30 feet and the well was completed as a shallow monitor well (MW-54A). A second well (MW-54B) was completed into the slightly deeper zone to sample water and test the hydraulic properties of the lower zone.

The locations and elevations of the monitor wells installed during the NCL investigation were professionally surveyed by John W. West Engineering Company of Hobbs, New Mexico. The location and elevation coordinates of the most recently installed wells were merged with surveyed data previously provided by John D. Jacquess & Associates of Roswell for the Phase I investigation. The resultant data, together with additional information provided by the refinery, were used to produce the base map upon which information generated during this study were plotted.

5.3 Monitoring Well Development and Groundwater Sampling

Following their installation, groundwater monitoring wells were developed according to the methods described in the February 1995 RFI Phase I and II workplan (Section 4.2.2.7), and groundwater samples were then collected from the wells according to the procedures and methods also described in the workplan (Section 4.2.3). Details of well development for each installation are included with the lithologic logs presented in Appendix A.

During the course of the RFI Phase II field work, groundwater samples were collected from all five newly installed monitoring wells, as well as from MW-18, a previously installed monitoring well (Figure 3-1). Groundwater samples were subject to analysis for the following environmental parameters:

- volatiles (SW-846 Method 8240);
- semivolatiles (SW-846 Method 8270);
- total metals (SW-846, various methods); and
- general water chemistry parameters.

In addition to the groundwater samples collected from the completed monitoring wells, three additional groundwater samples were also obtained from completed soil borings, as described previously in Section 5.1. These latter samples were analyzed for BTEX constituents according to SW-846 Method 8240. Analytical data for all groundwater samples are presented in Section 6-3 with the data sheets reproduced in Appendix B.

5.4 Hydraulic Conductivity Tests

Following monitoring well installation, a series of tests were conducted in order to characterize the NSSZ in terms of key hydrogeological parameters. In order to characterize the *in situ* hydraulic conductivity of the NSSZ in the area of investigation, a standard "slug test" was performed at groundwater monitoring wells MW-54A and MW-54B. Slug tests utilize an object of known volume (a "slug") that is inserted into and removed from the well while measurements are made of time response for water to return to the original static water level. Since dimensions of the slug and wellbore are known, the time required for the water level to stabilize is proportional to the hydraulic conductivity of the formation. Because the slug used to test monitoring wells MW-54A and 54B displaced a relatively small volume of water, the time for the wells to recover was on the order of minutes, and a datalogger was required to provide accurate measurements for the conductivity calculations.

The slug used in this procedure was a section of one-inch PVC pipe with an outside diameter of 1-5/16 inch (0.11 foot) and a length of 6.25 feet. The casing section was filled with clean pea gravel for ballast, sealed at the top and bottom with 1-5/8-inch OD caps, and secured with small stainless steel screws. An eye hook was attached to the top cap and clean rope attached for lowering into the wells. The total volume displaced by the slug was 0.45 gallons.

Data collection equipment included a battery-powered In Situ™ 1000C data logger and an In Situ™ 10-psi pressure transducer. The transducer was placed downhole at a depth below the base of the inserted slug. The test was initiated by activating the data logger and quickly lowering the slug into the well. After the water level stabilized at its static level, the second phase of the test was initiated by withdrawing the slug from the well and recording the rising water level until it returned to the static level.

Depending on aquifer properties, slug test results are evaluated using two procedures. Based on aquifer discharge and recharge response rates that were recorded at the time of the tests, the slug test data was analyzed according to the method of Bouwer and Rice (1976) and Bouwer (1989), and the method of Cooper, et al. (1967).

Equations, slug test parameters, and data graphs associated with the calculation of aquifer hydraulic conductivities are included in Appendix C, and a summary of hydraulic conductivity calculations is presented in Section 6.2.4, Table 6-5.

5.5 Groundwater Elevation Measurements

Two types of groundwater elevation measurements were obtained during the course of the RFI Phase II. Routine measurements of water level elevations were made at wells previously installed at the NCL and in the newly drilled NCL wells. These measurements were made by NRC staff or by their consultant. A second type of measurement was obtained by the installation of a continuous water level data recorder in an unused monitor well adjacent to the landfarm. Both types of measurements are discussed further below.

5.5.1 Periodic Elevation Measurements

A series of routine measurements were obtained immediately following installation at the five monitoring wells which were drilled during the course of the RFI Phase II. These initial measurements were recorded with the other lithologic and hydrologic information on the boring logs reproduced in Appendix A. In addition, NRC refinery staff obtained groundwater elevation data in conjunction with routine sampling of existing NCL monitor wells pursuant to provisions of the NCL RCRA permit. Also, supplementary data for use in the current study was obtained by NRC and consultant staff during this and other refinery hydrologic investigative activities.

5.5.2 Continuous Elevation Measurements

At groundwater monitoring well NCL-19, a down-hole pressure transducer linked to an electronic continuous data recorder was installed in order to obtain a continuous profile of groundwater elevation trends over an extended period of time. The selected monitor well was initially installed as the NCL upgradient monitor well, but was replaced in 1982 by a well drilled a short distance away constructed to RCRA standards (NCL-31). Although unused, the large-diameter well is completed in the NSSZ and provided an ideal location for long-term continuous water level measurements.

The water level data logger and pressure transducer were manufactured by Telog Instruments of Victor, New York. The data logger was a Telog™ series 2102e-20 with a 10-psi pressure transducer which is effective in recording water level fluctuations over a range from 0 to approximately 25 feet. The recorder was set to obtain a water level measurement every ten minutes and has a data storage capacity of 148 days at that frequency of data collection. The water level data recorder was installed in the well in early July 1995 and removed in late December 1995. Installation was accomplished by mounting the unit along the inside of the well casing and lowering the pressure transducer to the bottom of the well, a distance of approximately 20 feet below the ground surface. At the bottom of the well, the transducer was submerged in about 7 feet of water. Operation of the recorder was checked periodically, and water level data from the recorder was downloaded to a portable computer in August, September, October, and December.

6.0 INVESTIGATION RESULTS

This section presents the results of the soils investigation and groundwater testing programs conducted in the vicinity of the NC Landfarm during the RCRA Phase II investigation. Where appropriate, reference is made to the results of the Phase I investigation at the site.

6.1 Soil Boring Results

6.1.1 *Boring Lithology*

The locations of the borings and any detection of free-phase hydrocarbons are shown on Figure 6-1; boring lithologies are presented on the individual logs reproduced in Appendix A.

Soils in the vicinity of the NCL are mainly fine grained at all depths except for the sporadic occurrence of thin discontinuous lenses of coarser grained material. Surface zones above a depth of 8 to 10 feet generally are composed of clayey silts at the surface grading to silty clay and clay at about 8 feet. At 8 feet, zones of caliche begin to be encountered with the caliche exhibiting varying degrees of cementation and hardness. However, caliche zones encountered at that depth were commonly dry, crumbly, and not so well cemented, such that sampling was impeded using the hydraulic push method. Depending on sample location, zones of clay, caliche, and caliche clay continued to total depth with occasional thin zones of coarser material.

Moisture was generally encountered at depths from 12 to 18 feet, although exact depths were difficult to ascertain in the core samples unless a coarse-grained zone was encountered. Where coarser zones were not encountered, softness in an otherwise dry clay sample generally provided an indication of moisture. The moisture was likely released to the cored hole from thin, slightly silty zones in the clays that were not visually observed in the splitspoon cores. Commonly, zones located within a few inches above or below the moist zones were completely free of moisture and logged as dry and crumbly.

Coarse grained material of one type or another was encountered in 9 of the 20 coring boreholes which were logged. This material commonly consisted of a thin zone of small limestone pebbles or gravels in the clay matrix. The larger caliche gravels ranged up to about one inch in diameter and commonly were observed to exhibit varying degrees of cementation with each other. In a zone of saturation, these caliche gravels were a primary source of water to the borehole. The

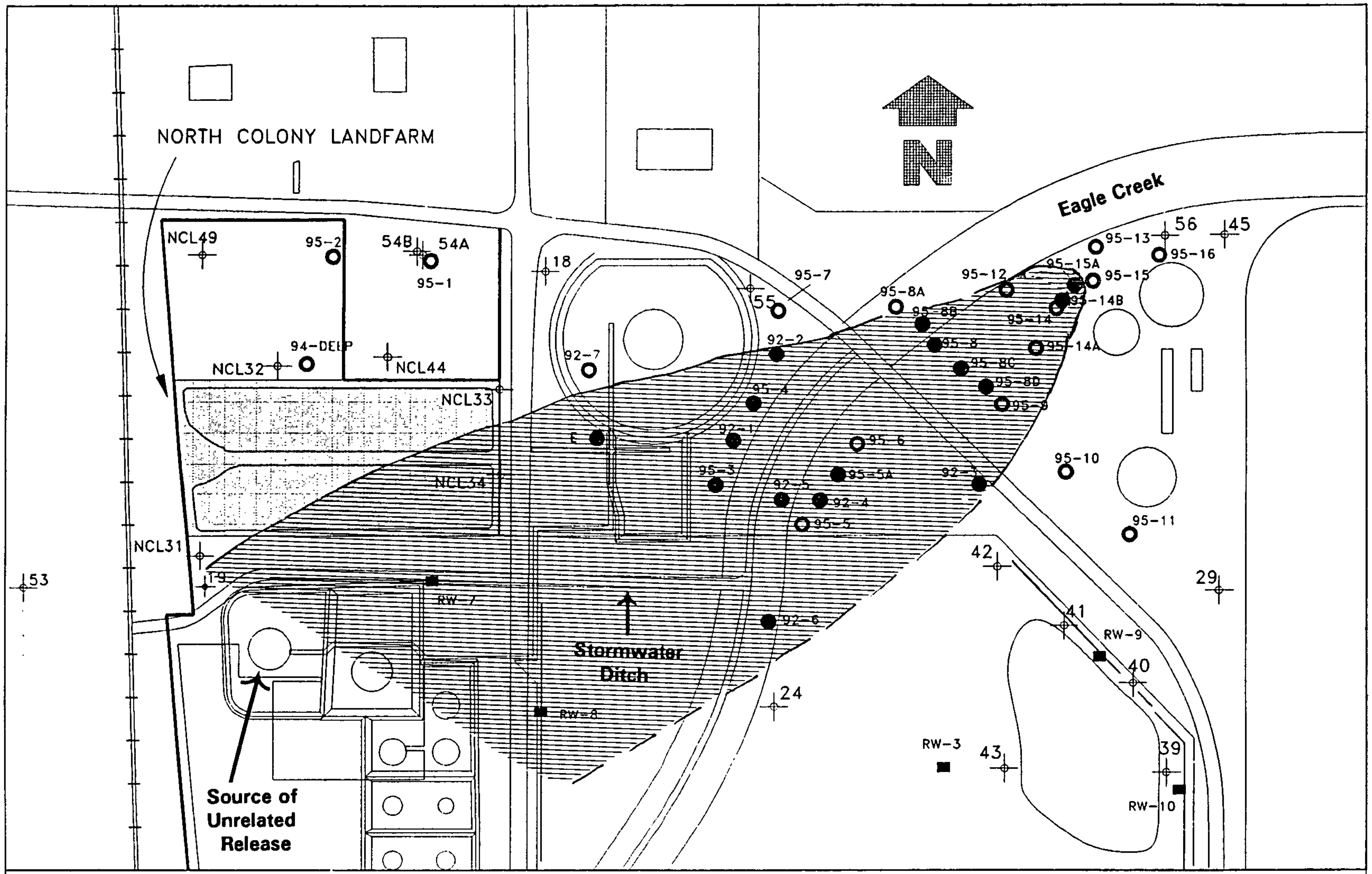

FIGURE 6-1. EXPLORATORY BORINGS WITH FREE-PHASE PRODUCT
NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

LEGEND
- ⌖ MONITOR WELL
- ■ RECOVERY WELL LOCATION
- ○ BORING LOCATION
- ● BORING LOCATION WITH FREE-PHASE PRODUCT
- ≡ APPROXIMATE PLUME LOCATION

SCALE IN FEET
0 200 400 600

NOTE: BORING LOCATIONS APPROXIMATE (TAPED, NOT SURVEYED)

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zones were usually very thin, and in 6 of the 9 borings, the thickness of these zones ranged from 1 to 3 inches. Two of the borings, NCL 95-13 and NCL 95-16, had greater thicknesses of caliche gravel. These wells, located at the far northeast corner of the investigation area (Figure 6-1), had gravel thicknesses of 1 and 1.5 feet at depths of 18 and 19 feet, respectively. Both borings were free of hydrocarbons, and NCL 95-16 was completed as downgradient well MW-56. Since the coarser clayey gravel zones were encountered in relatively few borings at variable depths, they were not considered to be contiguous over the zone of investigation. However, the occurrence of the shallow thin gravel zones was observed to increase in the northeast area of the investigation in the vicinity of the trickling filter used in NRC's wastewater treatment system.

In one boring (NCL 95-08C) larger gravels were encountered in the NSSZ at a depth of 21 feet. The gravels were composed of well-rounded limestone gravels up to 2 inches in diameter. The thickness of this zone is unknown since the hole was drilled with a solid-stem auger and drilling ceased when hydrocarbon was detected in the gravels. This was the only zone of its type encountered during the boring investigation; the orientation of the gravel is unknown, but it likely trends easterly in the same direction as Eagle Creek.

The placement of the newly installed monitor wells was governed by the surface configuration of the site and the location of detected contaminants. Wells MW-54, MW-55, and MW-56 were completed at three of the locations previously bored (NCL 95-01, -07, and -16, respectively), and a replacement upgradient well (MW-53) was also installed. At MW-54, drilled in mid-December 1995, a deeper zone containing coarser grained material was detected at a depth of about 30 feet at the base of what was expected to be a shallow well. Consequently the well was plugged back to a clay zone at 27 feet and completed as MW-54A, the shallow component of a two-well pair. Subsequently, well MW-54B was drilled to a depth of 47 feet. At that location, the material from 38.5 to 44 feet consisted of large rounded limestone gravels similar to those found in boring NCL 95-08C. The gravels were followed by a zone of brown, dry, stiff clay to a total depth of 47 feet. The monitor well was completed with a 10-foot screen with its base set at the bottom of the gravel zone. A geologic cross section was prepared that shows the relationship of the monitor wells to the local geology (Figures 6-2 and 6-3). With the exception of the material at the base of MW-54B, the gravel zones are shown to be infrequent, thin, and discontinuous in both horizontal and vertical directions.

To supplement the amount of RFI subsurface information at the site, seven borings drilled by Navajo in August 1992 are included in Appendix A. These borings show a similar pattern with

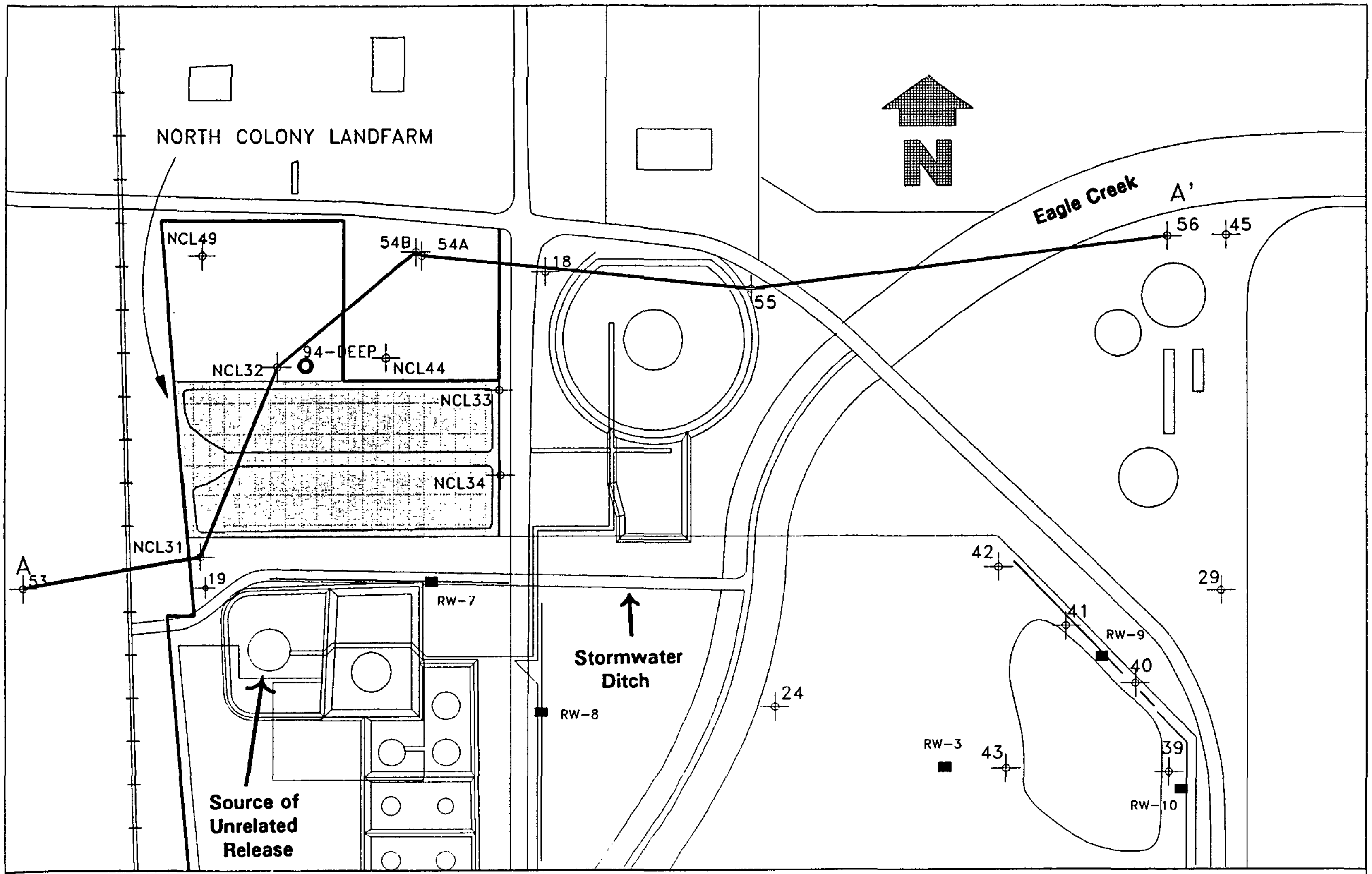

FIGURE 6-2. LOCATION OF CROSS SECTION A-A'

LEGEND
⌖ MONITOR WELL
○ BORING LOCATION
■ RECOVERY WELL LOCATION

NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

SCALE IN FEET
0 200 400 600

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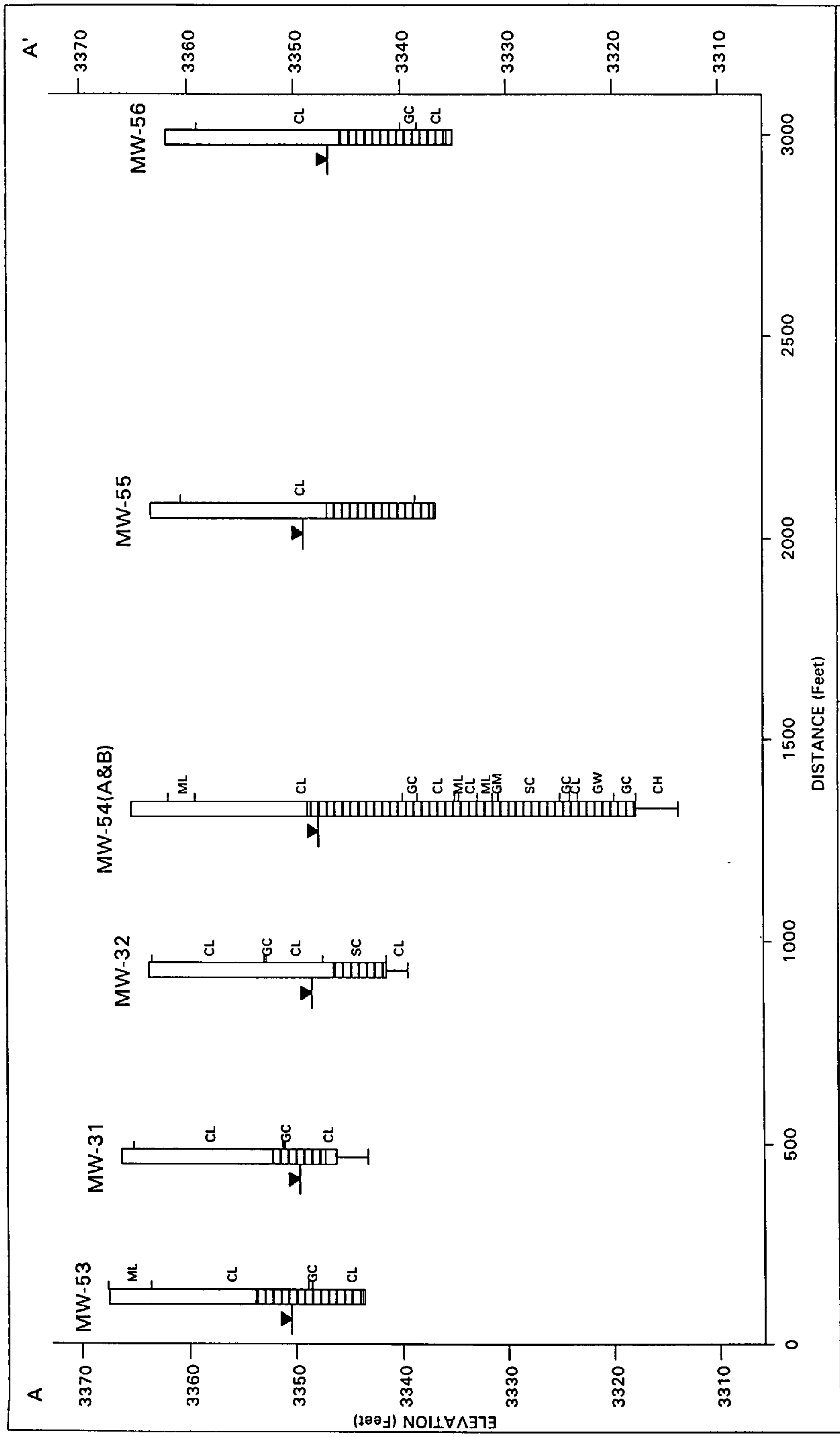

LEGEND

GM	Silty Gravels, Gravel-Sand-Silt Mixtures
GC	Clayey gravels, Gravel-Sand-Clay Mixtures
SM	Silty Sands, Sand-Silt Mixtures
SC	Clayey Sands, Sand-Clay Mixtures
ML	Inorganic Silts, Clayey Fine Sands, Clayey Silts
CL	Inorganic Clays, Gravelly Clays, Sandy Clays, Silty Clays

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Figure 6-3

GEOLOGIC CROSS SECTION
SECTION A-A'
Navajo North Colony Landfarm

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

respect to the occurrence of gravels in the subsurface. Gravels were found in only two of the seven holes with gravels in one being encountered at an elevation 8 feet higher than in the second boring. Although they were encountered at different depths, both zones were relatively thick (about one foot) and free-phase hydrocarbons were reported in the boring exhibiting the shallower gravel zone.

6.1.2 Hydrocarbon Detection

Because the investigation was structured to locate soils that may have been impacted by releases of hydrocarbons from the vicinity of the NCL, hydrocarbons in one form or another were detected in most of the borings. Figure 6-1 shows which of the borings were observed to contain free-phase product. To assist in interpretation of the soil boring observations, Table 6-1 summarizes the occurrence of the hydrocarbons. For each boring, the table includes the total depth, the maximum PID reading and the interval in which it occurred, the observed contaminant range, and whether free-phase product was encountered. The observed contaminant range is based on any detections of hydrocarbons as recorded on the log form including visual, olfactory, and PID evidence of contamination.

In an attempt to determine the thickness of any free-phase product, nine of the boreholes observed to be hydrocarbon contaminated received temporary screen and casing for a 24-hour period. Of those borings receiving a temporary casing, the maximum thickness of any resulting hydrocarbon was 1/8 inch or less. Often only a skim of product and the strong odor of hydrocarbon was found on a bailer lowered into the temporary casing. Information on the temporary well installations is included with the boring logs in Appendix A.

Free-phase contamination was observed in 9 of the 24 borings completed during the Phase II activities (Table 6-1). Some evidence of contamination (discoloration, odor, or elevated PID readings) was also observed in 10 of the remaining borings. No contamination of any form was observed in 5 borings. Of the borings completed by NRC in 1992, 6 of 7 were found to have free-phase product.

Three borings completed during the first round of RFI Phase II drilling in late June 1995 were sampled for free-phase hydrocarbons. Samples were collected at borings NCL 95-01, -02, and -07 within 24 hours of completion of the borings. Analyses were performed for benzene, ethylbenzene, toluene, and xylenes. These analyses, together with the results of the borehole

Table 6-1. Summary of soil boring observations, NCL, RFI Phase II

Boring	Total Depth (ft)	Max PID Reading (ppm)	Max PID Interval (ft)	Observed Contaminant Range(ft)	Free-Phase Product
1995 RFI Phase II Borings					
NCL 95-01	20	908	16-18	15-20	No
NCL 95-02	26	< 10	- -	None	No
NCL 95-03	23	1229	5-7	5-18	Yes
NCL 95-04	24	1098	12-14	3-20	Yes
NCL 95-05	28	1102	10-12	10-27	No
NCL 95-05A	25	NA	NA	NA	Yes
NCL 95-06	26	1154	12-14	13-23	No
NCL 95-07	22	(See Note)	NA	None	No
NCL 95-08	24	1064	12-14	10-20	Yes
NCL 95-08A	15	NA	NA	3-5	No
NCL 95-08B	15	94	8-9	5-15	Yes
NCL 95-08C	25	78	16-18	NA	Yes
NCL 95-08D	25	70	15-17	NA	Yes
NCL 95-09	26	264	16-18	15-22	No
NCL 95-10	26	115	16-18	14-20	No
NCL 95-11	25	NA	NA	15-20	No
NCL 95-12	27	132	12-14	10-27	No
NCL 95-13	22	< 10	- -	None	No
NCL 95-14	22	112	16-18	14-20	No
NCL 95-14A	25	NA	NA	None	No
NCL 95-14B	20	NA	NA	NA	Yes
NCL 95-15	20	118	18-20	10-20	No
NCL 95-15A	20	51	18-20	NA	Yes
NCL 95-16	24	<10	NA	None	No
1992 Navajo Refinery Borings					
NCL 92-01	20	NA	NA	8-19	Yes
NCL 92-02	20	NA	NA	14-20	Yes
NCL 92-03	24	NA	NA	14-24	Yes
NCL 92-04	24	NA	NA	11-24	Yes
NCL 92-05	24	NA	NA	16-24	Yes
NCL 92-06	24	NA	NA	5-24	Yes
NCL 92-07	24	NA	NA	15-24	No

Notes:

NA - Information not available
At NCL 95-07 PID malfunctioned due to moisture or vapor carryover from previous sample.

drilling, were used as a guide to monitor well placement. Ethylbenzene at 0.045 mg/L in boring NCL 95-01 was the only free-phase hydrocarbon detected in the June sampling. Two monitor wells (MW-54A and -54B) were drilled and installed at the location in December 1995 to monitor any northward movement of free-phase constituents.

6.2 Results of the Hydrogeological Investigation

The hydrogeological investigation consisted of several parts. Groundwater elevations in new and existing monitor wells were measured during the study to determine changes in groundwater levels and to produce water level elevation maps needed to establish groundwater flow direction and hydraulic gradient. In addition, a data logger was installed to obtain continuous groundwater level measurements. Localized hydraulic conductivities were determined through the analysis of "slug" test data collected at two of the newly installed wells.

6.2.1 Groundwater Elevations

Groundwater elevations in the vicinity of the NCL were monitored over a 6-month period beginning in late June 1995 by two methods, as detailed in the following section.

6.2.1.1 Periodic Elevation Measurements

The water level elevations in the wells were monitored periodically during the investigation. This provided data used in the construction of the water level contour maps (Section 6.2.2). Also, the water level elevations, and more importantly, the magnitude of water level changes, were used to evaluate the response of the NSSZ under the NCL to hydraulic stress.

Table 6-2 presents a summary of water level changes in monitor wells near the NCL. A general decline in groundwater levels from September to December is indicated. Water level decreases under the landfarm during this time period range from 2.2 to about 4.1 feet. The average decrease is approximately 3.3 feet. By contrast, the decrease from August to December in newly installed wells MW-55 and MW-56 is only about 0.8 feet which may indicate that hydrogeologic conditions in the vicinity of the latter two wells differ from the area of the landfarm. The possible reasons for a change are discussed in Section 6.2.2

Table 6-2. Changes in water levels at monitor wells in the vicinity of the NCL, RFI Phase II.

Well Name	Depth to water (feet)	Date Measured	Depth to Water (feet)	Date Measured	Change in Water Level (feet)
NCL-31	12.60	9/13/95	16.66	12/23/95	-4.06
NCL-32	11.93	9/13/95	15.33	12/23/95	-3.40
NCL-33	13.71	9/13/95	15.93	12/1/95	-2.22
NCL-34	13.65	9/13/95	16.81	12/1/95	-3.16
NCL-44	12.25	9/13/95	15.27	12/23/95	-3.02
NCL-49	17.55	9/13/95	21.31	12/23/95	-3.76
MW-53	14.24	6/29/95	17.10	12/23/95	-2.86
MW-55	15.36	8/9/95	16.15	12/23/95	-0.79
MW-56	14.40	8/9/95	15.19	12/23/95	-0.79

6.2.1.2 Continuous Elevation Measurements

Observations from soil borings and excavation trenches completed during the RFI Phase I yielded strong evidence to indicate that extensive vadose zone contamination beneath the NCL was the result of an unrelated petroleum product release. At many RFI Phase I locations on the unit, environmental observations and data demonstrated the upward migration of contaminants from the NSSZ towards the base of the unit treatment zone. Moreover, inspection of the sidewall profiles of RFI Phase I trench excavations revealed numerous instances in which petroleum product was apparently forced into relatively impermeable clay formations below the unit. During such events, migration of product occurred via restricted preferential pathways.

The observed intrusion of hydrocarbon materials into the relatively tight clays was observed to occur at subsurface elevations which were well above the commonly observed potentiometric elevation of the NSSZ, and the radiative diffusion of hydrocarbons from those preferential pathways into the confining matrix was observed to be very limited. These observations were believed to indicate the occurrence of historic episodes during which the NSSZ experienced a relatively intense but transient increase in hydraulic gradient. This potential mechanism for upward transport of hydrocarbon product towards the base of the NCL was previously considered in the RFI Phase I report.

Although monitoring of groundwater elevations on a periodic basis provides an accurate snapshot of the hydrologic system at fixed point in time, the detection of rapid potentiometric fluctuations, such as might be caused by precipitation, irrigation, pumping, etc., is more appropriately assessed by means of continuous groundwater elevation monitoring. Therefore, the data logger described in Section 5.5.2 was installed adjacent to the NCL in unused MW-19 in early July 1995. Data from the recorder was downloaded and copied into a PC-driven graphical plotting program. The resultant graph is presented in Figure 6-4.

The plotted data clearly show highly variable and rapid fluctuations in water levels over the period of investigation. Water levels declined approximately 3 feet from early July through late December. Of greater importance are the dramatic rises in water levels that were observed on at least six occasions during this period. Water level rises of 1 to 2 feet in a 12-hour period were common. The most spectacular response occurred on September 8, when water levels rose about 3 feet in one day. The return to initial conditions (defined as water level elevations existing at a time immediately preceding the increase), typically took about 10 days (provided no additional stimulus occurred).

Two alternative hypotheses were proposed that could account for the changes in water levels. The first was a response to local precipitation, and the second was a response to irrigation of City of Artesia parks by treated city wastewater effluent. Initial data from mid-July to mid-August tentatively supported the irrigation scenario since the rise in water levels could be interpreted to be a response to periodic irrigation on a schedule from 10 days to 2 weeks apart. However, inquiry found the city irrigates on almost a daily basis and no unusually large applications of the effluent are applied on a schedule which reflects the observed response in MW-19.

Acquisition of rainfall records was constrained by the fact that no official station is maintained within the City of Artesia. However, precipitation is recorded on a daily basis at two sites nearby. The Artesia Municipal Airport, located 5 miles west of the refinery, and the New Mexico State University Agricultural Science Center, 7 miles south of the NCL site, both provided rainfall records. The precipitation data was correlated with the water level elevation data and plotted to determine the impact of precipitation on the groundwater system.

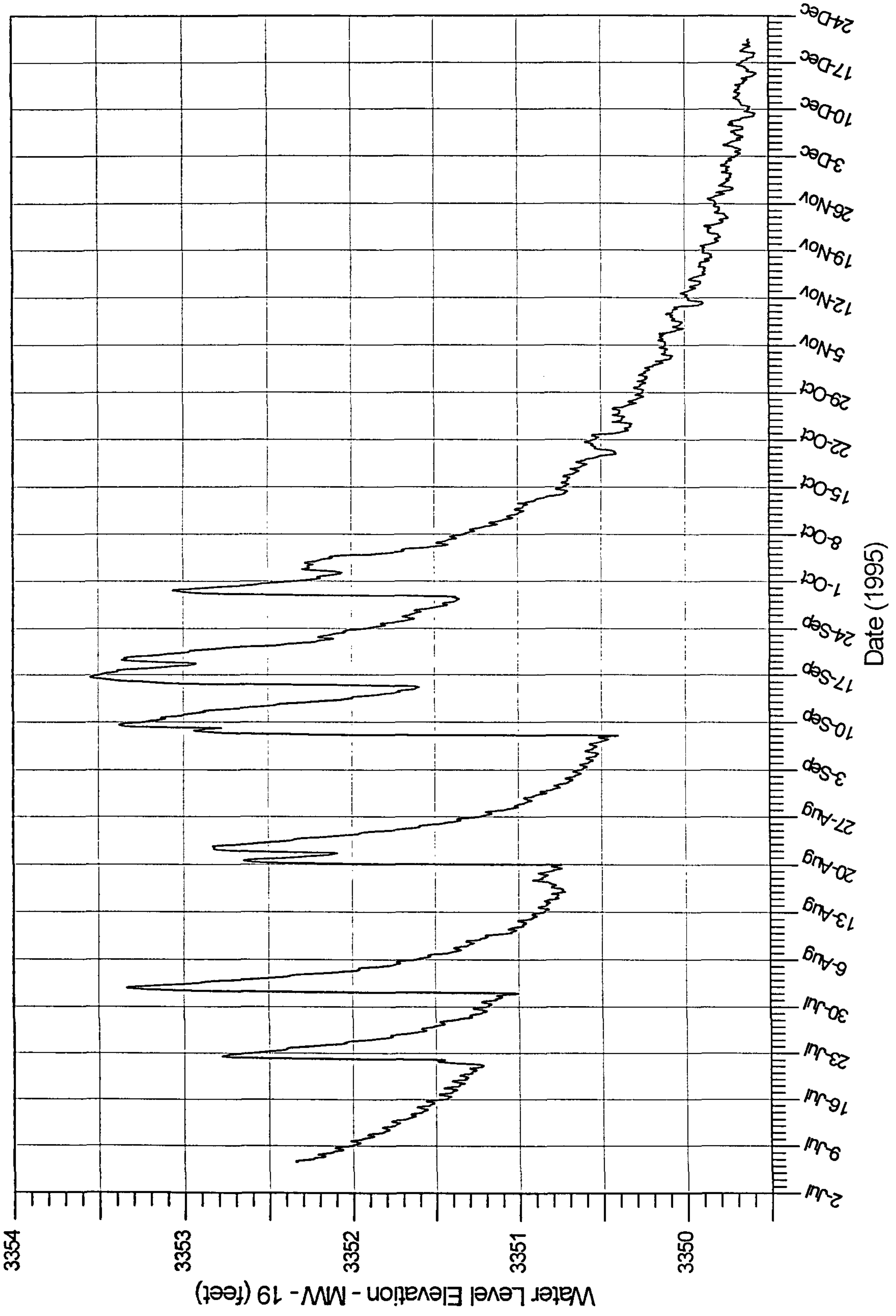

Figure 6-4. Water Level Elevations, MW-19, July-December 1995

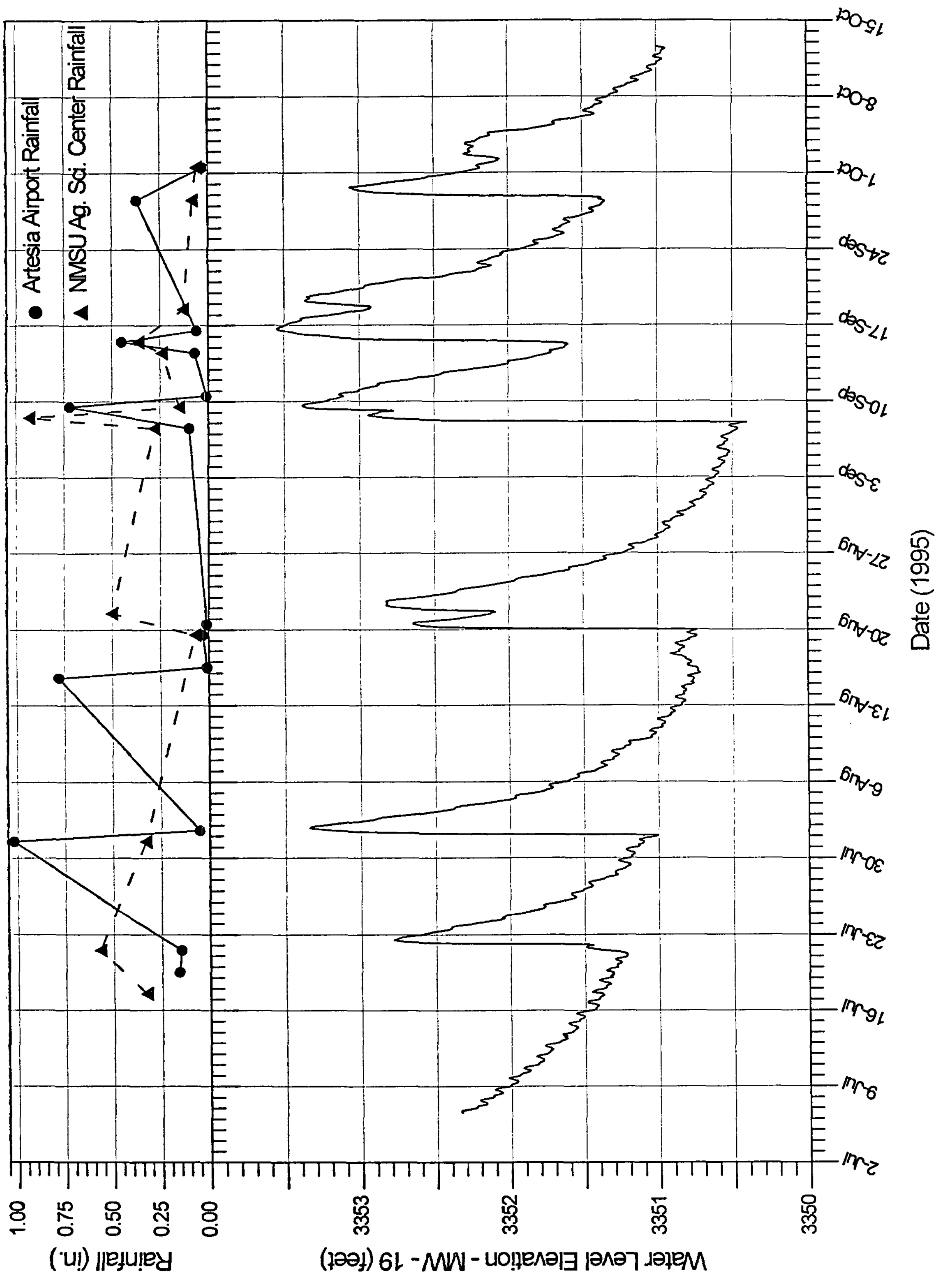

Figure 6-5. Water Level-Rainfall Relationship, MW-19, July-October 1995

The resultant graph of water levels and precipitation is shown in Figure 6-5. An obvious correlation can be seen between precipitation events and water level increases. Because summer precipitation in the Southwestern United States is primarily convective in nature, rainfall occurs from finite-diameter storm cells that commonly drop the majority of their moisture close to the cell. This effect often produces heavy rainfall in one location while very little is deposited a few miles away. Therefore, while neither the Artesia airport or university station records correlate completely with the increases seen in the monitor well, the combination of both produces excellent correlation of precipitation and water level increases.

However, the exact location of the source of infiltration to the subsurface remains unknown. The City of Artesia is directly upgradient from the NCL and no obvious nearby infiltration source, such as a retention basin or city park pond was identified. A shallow unlined city stormwater drainage ditch is located adjacent to NCL, but limited trenching performed along the ditch during the NCL Phase I investigation and reported in Appendix E of that report found that clay overburden present in the ditch location was similar to that observed directly under the landfarm. However, since the ditch is concreted in the city and concentrates rainfall runoff, it is possible that a relatively small permeable recharge area may exist at the juncture of the lined and unlined portion of the ditch. This is given some credence by the fact that both highway and railroad structures occur at the same location and the ditch was no doubt excavated at that locale to remove the overlying clay and provide foundation structural stability. This, combined with stormwater scouring at the exit point of the concreted ditch, may provide a permeable temporary storage site and serve as a source of subsurface infiltration. If this location is not the source of the water, the next possible upgradient source is Eagle Creek in an area in the city where it has been modified from an incised channel into a broad swale that serves as a park planted with grass, landscaped, and irrigated with wastewater effluent. If the recharge is from Eagle Creek and the direction of flow remains constant, the closest upgradient location for such infiltration to occur is at distance of about 4,000 feet in the vicinity of the 10th Street crossing of Eagle Creek.

6.2.2 Groundwater Flow Direction and Gradient

Prior to the preparation of groundwater contour maps, surface and casing elevation data for the existing and new wells were compared to verify the correct elevations. After analysis of data from several well elevation surveys conducted during this and previous investigations, the data from the survey of the most recently installed wells was adjusted downwards slightly. This adjustment eliminated inconsistencies between the surveys and matched data from the more extensive survey of the NCL conducted in 1994.

The depth-to-water elevations measured during the Phase II study were used to produce two groundwater contour maps which show groundwater conditions under two widely varying sets of hydrologic circumstances. The measurements and the maps show groundwater levels in late summer during a time of somewhat frequent rainfall, and again in late December after a prolonged dry period.

Water level contour maps for September 13 and December 23, 1995, were constructed using the groundwater elevation information shown in Table 6-3. The resultant maps are shown in Figures 6-6 and 6-7, respectively. Water flow is generally northeasterly on both maps, although contours at the north end of the maps show movement to be more easterly. The northeasterly direction of flow in this area of the refinery follows the orientation of Eagle Creek in the vicinity of the landfarm. Groundwater movement in other areas of the refinery has been shown to flow in a more easterly direction.

The groundwater contour maps presented in Figures 6-6 and 6-7 show several features which are critical to understanding the groundwater system in the vicinity of the NCL. The water level map for September 13 shows potentiometric surface elevations under the NCL ranging from 3350.5 to 3353.5 feet while the range for December 23 is from 3348 to 3349.5 ft. On September 13, water level elevations under the NCL decrease by 3 feet over a horizontal distance of approximately 620 feet from the vicinity of the southwest corner of the landfarm to the northeast corner. This results in an average hydraulic gradient of about 0.0048 feet/feet across the landfarm. On December 23, water levels under the landfarm decrease by 1.5 feet from southwest to northeast across a distance of approximately 720 feet, which produces a gradient of about 0.0021 feet/feet.

Additional comparison between the December 23 maps shows the numeric value of hydraulic gradient to be decreasing from west to east. The gradient decreases from 0.0025 feet/feet in the vicinity of NCL-31 to 0.0011 feet/feet near MW-56. This means that the driving force for water and contaminant movement is lessened by a factor of two as water moves northeastward, which in turn reduces groundwater seepage velocities. The information shown on the maps is presented in tabular form in Table 6-4, which summarizes the hydraulic gradient changes.

Table 6-3. Groundwater elevations at monitor wells in the vicinity of the NCL, RFI Phase II

Well Name	TOC Elevation (feet)	9-13-95 Depth to Water (feet)	Water Level Elevation (feet)	12-23-95 Depth to Water (feet)	Water Level Elevation (feet)
18	3364.13	--	--	16.52	3347.61
19	3366.70	--	--	17.07	3349.63
NCL-31	3366.30	12.60	3353.70	16.66	3349.64
NCL-32	3363.72	11.93	3351.79	15.33	3348.39
NCL-33	3363.71	13.71	3350.00	--	--
NCL-34	3364.77	13.71	3351.06	--	--
NCL-44	3363.25	12.25	3351.00	15.27	3347.98
NCL-49	3369.91	17.55	3352.36	21.31	3348.60
53	3367.53	--	--	17.10	3350.43
54A	3365.24	--	--	17.47	3347.77
54B	3365.22	--	--	17.44	3347.78
55	3363.43	--	--	16.15	3347.28
56	3361.91	--	--	15.19	3346.72

Notes:

Elevations are corrected elevations as follows:
Elevations for wells 53, 54A, 54B, 55 and 56 (J.West survey) corrected by subtracting 0.14 ft.
Elevation for well 19 (Navajo information) corrected by adding 0.08 ft.
Elevation in MW-34 corrected for product thickness.

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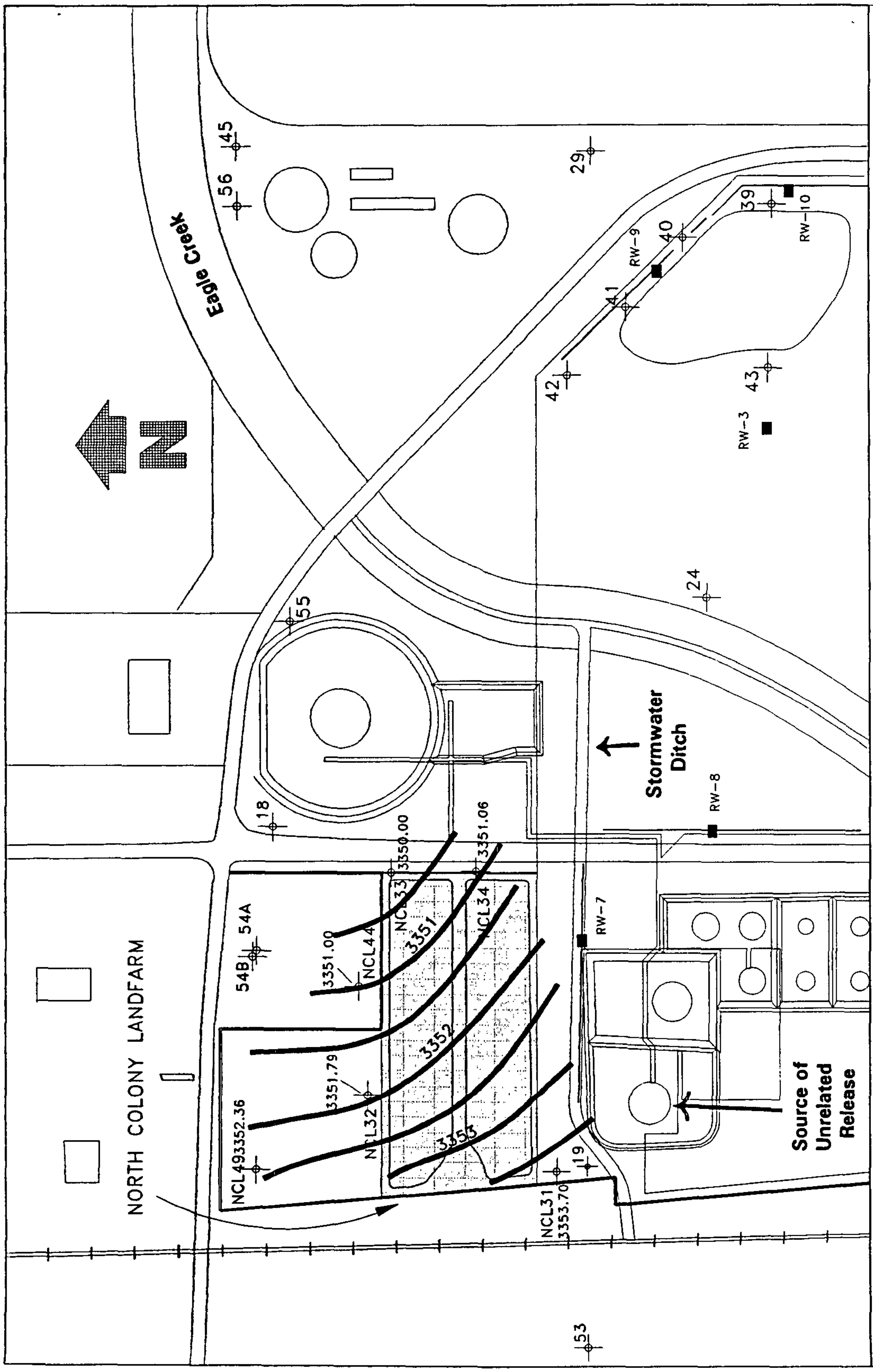

FIGURE 6-6. WATER LEVEL CONTOUR MAP, SEPTEMBER 13, 1995

NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

LEGEND

⌖	MONITOR WELL
■	RECOVERY WELL LOCATION
3350.00	WATER LEVEL ELEVATION (ft msl)
	CONTOUR INTERVAL 0.5 FT

SCALE IN FEET
0 200 400 600

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Date: 2-23-96

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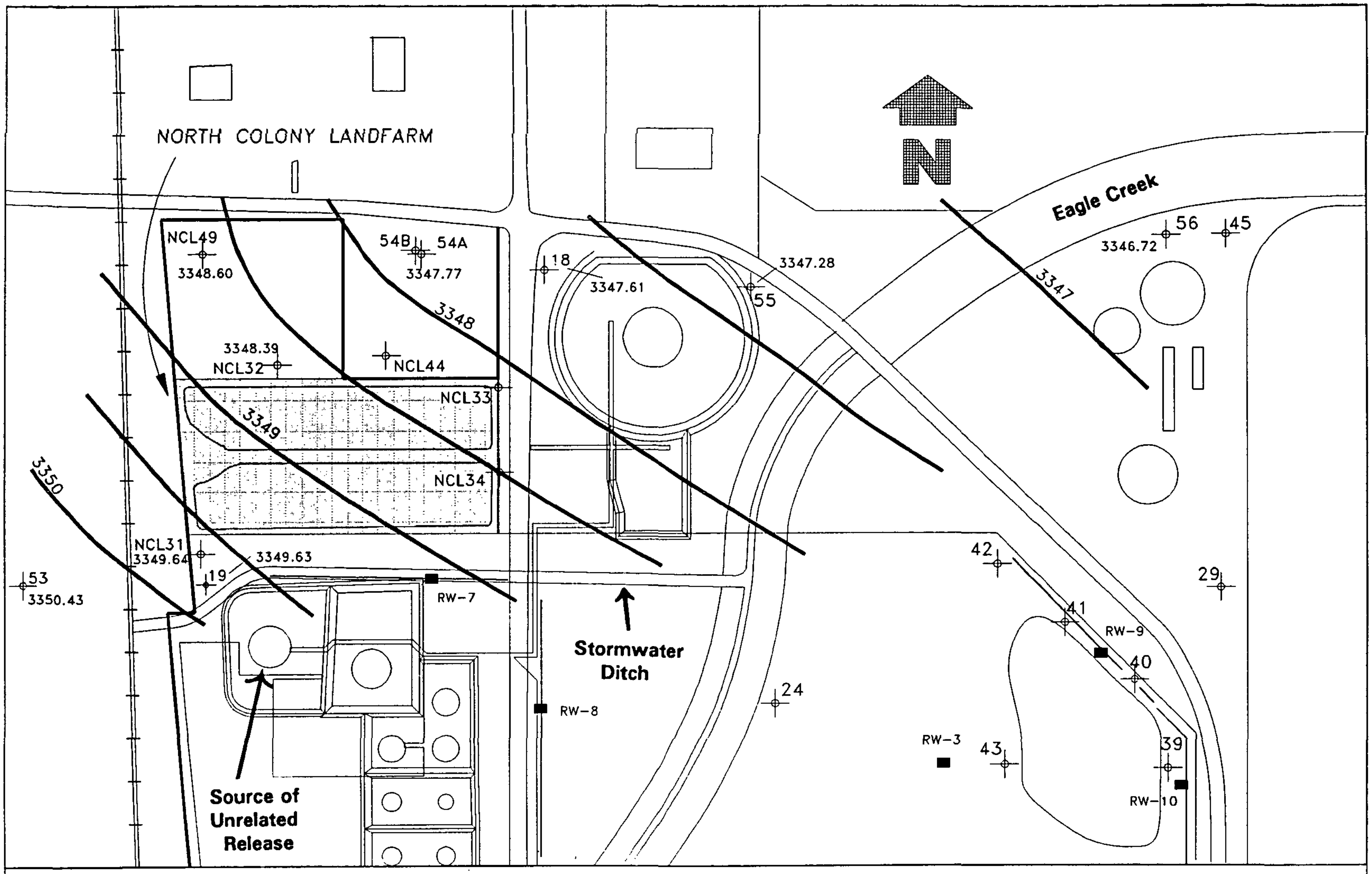

FIGURE 6-7. WATER LEVEL CONTOUR MAP, DECEMBER 23, 1995
NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

LEGEND

⌖	MONITOR WELL
■	RECOVERY WELL LOCATION
3350.00	WATER LEVEL ELEVATION (ft msl)
	CONTOUR INTERVAL 0.5 FT

SCALE IN FEET
0 200 400 600

Drawn by: Walt Foutz Date: 2-23-96

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Table 6-4. Observed values of groundwater hydraulic gradient in the vicinity of the North Colony Landfarm, RFI Phase II

Date	Gradient (ft/ft)	Descriptive location
9/13/95	0.0048	Average across area of landfarm
12/23/95	0.0025	Vicinity of NCL-31
12/23/95	0.0021	Average across area of landfarm
12/23/95	0.0014	Between NCL-33 and MW-55
12/23/95	0.0011	Between MW-55 and MW-56

Several explanations are possible for the reduction in hydraulic gradient from southwest to northeast across the area. Two of the most likely reasons are an increase in hydraulic conductivity or an increase in the thickness of the transmissive zones. An increase in one or both of these allows an increased flow of water at the same gradient, or movement of the same mass of water with less hydraulic pressure required as a driving force. Based on review of the boring logs, it appears that material of greater permeability is present in the vicinity of MW-56 and that zones containing this material are thicker.

Two other possible reasons for the changing hydraulic gradients are worth noting. Steep gradients can occur near a source of recharge where a high hydraulic potential (either a pressure or elevation head) is quickly reduced due to friction losses as the water passes through the porous material. If the source of recharge to the NSSZ is near the NCL, the reduction in hydraulic head as the water moves into the NSSZ and downgradient can produce gradient changes of the type observed. Also, flat gradients can occur in areas where groundwater withdrawal has lowered groundwater elevations upgradient from the location where the flat gradient is observed. In the vicinity of the NCL several product and contaminated groundwater recovery efforts are being pursued (Figure 6-1) which likely have the effect of lowering nearby water levels.

6.2.3 Vertical Flow Gradients

Groundwater elevations in the paired wells MW-54A and -54B were compared to determine whether a vertical gradient was present. The elevation of groundwater in MW-54B, the deeper well, was at a slightly higher elevation (3347.78 feet) than groundwater in MW-54A

(3347.77 feet). This indicates a very slight upward vertical gradient. However, the values differ by such a small value (0.01 feet) that they could be affected by normal errors in surveying, measurement, or both. Therefore, it is concluded that occurrence of a positive or negative vertical gradient can not be definitely ascertained at this location using the current set of measurements.

6.2.4 Hydraulic Conductivity Tests

A series of tests was conducted on December 22, 1995, to determine the in situ hydraulic conductivity of the saturated zones opposite newly drilled monitor wells MW-54A and MW-54B. The wells were tested using the "slug test" procedure. The sealed length of pipe of known volume was quickly inserted in the well, and the subsequent displacement and time for recovery of water levels were registered on a data recorder. The equipment and methodology used in conducting the test was described in Section 5-4. This section describes the procedures used in analyzing the data and compares the results to earlier hydraulic conductivity testing performed in the vicinity of the NCL.

Depending on aquifer properties, slug test results are evaluated using one of two procedures. H. Bouwer and R.C. Rice (Bouwer and Rice, 1976) developed a procedure for analysis of slug test data from unconfined aquifers. Water in confined (artesian) aquifers is analyzed using a procedure developed by H. Cooper and others in 1967 (Cooper, et al., 1967). The Bouwer and Rice methodology was later judged applicable to confined and semi-confined aquifers (Bouwer, 1989). Because of its simplicity, the Bouwer and Rice slug test method is a frequently used evaluation tool in groundwater studies. At the paired MW-54 wells, the use of both the Bouwer and Rice and the Cooper methods were appropriate for evaluation of information collected during the current investigation.

The Bouwer and Rice equation and test parameters used in calculating the hydraulic conductivities are presented in Appendix C which also includes graphs of the slug test data. Data collected during the two tests conducted at each well are graphically displayed on a semi-logarithmic plot with displacement plotted on the vertical logarithmic axis and time plotted on the horizontal axis. For the straight line portion of each graph, two points are selected for inclusion in the equation and then hydraulic conductivity (K) was calculated. The resultant values are shown on each graphical plot (Appendix C) and summarized in Table 6-5.

The Cooper method for determining transmissivity is also graphical in nature. In this method, the vertical axis is linear and plots the ratio of displacement at time *t* to the maximum displacement at time *t* = 0. Time is plotted on the logarithmic horizontal axis. Curve fitting is performed using a specified set of type curves from which the aquifer parameters can be determined. The Cooper method produced good curve matches in the deeper well (MW-54B), but was unsuitable for analysis of transmissivity in the shallow well. Because water in MW-54B was confined entirely within the formation due to the method of well construction, it responded in true artesian fashion to hydraulic pressure changes during the test. These conditions enabled use of the Cooper curve matching technique with excellent results. The aquifer parameters derived from these tests also are included in Table 6-5.

Table 6-5. Results of slug-test evaluation, NCL monitor wells MW-54A and MW-54B, RFI Phase II

Test ID	Well	Test Type	K (ft/min.)	K (cm/sec)	T (ft^2/min.)	b (calc) feet	Comment - Section of Curve Used in Matching
0	MW-54B	Slug-In	**0.008135**	**4.13E-03**	1.50E-01	18.4	Early time, steep
0	MW-54B	Slug-In	0.001267	6.44E-04	1.50E-01	118.0	Latter, flatter
1	MW-54B	Slug-Out	**0.008136**	**4.13E-03**	1.32E-01	16.2	Early, steep
1	MW-54B	Slug-Out	0.003118	1.58E-03	1.32E-01	42.2	Latter, flatter
1	MW-54B	Slug-Out	0.001626	8.26E-04	1.32E-01	80.9	Very late, flattest
2	MW-54A	Slug-In	**0.00078**	**3.96E-04**	N/A	N/A	Later, flatter
3	MW-54A	Slug-Out	**0.001094**	**5.56E-04**	N/A	N/A	Later, flatter
4	MW-54A	Slug-In	**0.000782**	**3.97E-04**	N/A	N/A	Later, flatter
K (avg.), MW-54B = 0.00814 ft/minute, 4.15E-03 cm/second							
K (avg.), MW-54A = 0.000938 ft/minute, 4.78E-04 cm/second							

Notes:

Test date: December 22, 1995
K = Hydraulic Conductivity
T = Transmissivity
b = Aquifer thickness = T/K
Bold - indicates values used to calculate average K

A technique to compare the results of the two methods is to divide the transmissivity (units of feet squared per minute) by the hydraulic conductivity (units of feet per minute) to determine the theoretical saturated aquifer thickness. If the calculated thickness is close to the actual value (as determined by the lithologic log and screen placement), the hydraulic conductivity values may be accepted as a realistic estimate of conductivity in the formation zone opposite the screen. In this instance, the calculated thickness using early-time hydraulic conductivity data ranges between 16 and 18 feet, which is close to the actual thickness of the interval tested.

6.2.5 Groundwater Movement and Flow Rate

The seepage velocity of the groundwater system can be determined from the hydraulic conductivity, hydraulic gradient, and effective porosity of the aquifer. Hydraulic conductivity determinations were discussed above. The hydraulic gradient is typically measured from a groundwater contour map or a potentiometric surface map such as presented in Figures 6-6 and 6-7. The September and December 1995 groundwater-flow gradients (Table 6-4) were used in the calculation of a range of seepage velocities for comparison and evaluation.

The effective porosity can be estimated from the intrinsic porosity of the aquifer. Although the intrinsic porosity is the actual pore volume of the aquifer matrix, it is usually not representative of the actual porosity that governs the flow of water through the matrix because of the influence of isolated pore spaces, grain angularity, and other factors. The effective porosity of the aquifer is a corrected porosity that more closely represents true flow conditions. Effective porosity can be several orders of magnitude lower than the intrinsic porosity in consolidated aquifers, but the effective porosity of an unconfined alluvial aquifer is typically 10 to 100 percent of the intrinsic porosity (Fetter, 1988). In alluvial sediments, this usually results in an effective porosity of 0.25 to 0.30. The 1982 Geraghty & Miller study determined intrinsic porosity in the very low permeability clay core samples taken during monitor well installation. The values for four samples range from 0.33 to 0.49, with an average of 0.44. In the absence of site-specific porosity data for the permeable zones, the effective porosity was assumed to be 0.25, which is representative of porosities found in this lithologic environment.

The seepage velocity of the groundwater system in the vicinity of the NCL was calculated using an effective porosity of 25 percent according to the following equation:

$$\mathbf{v = Ki/n_e}$$

where:

$\mathbf{v}$ = seepage velocity (ft/min),
$\mathbf{K}$ = hydraulic conductivity (ft/min),
$\mathbf{i}$ = hydraulic gradient (ft/ft), and
$\mathbf{n_e}$ = effective porosity (unitless)

The hydraulic conductivities (K) determined from slug tests conducted for the current investigation were compared with hydraulic conductivities determined during the 1982 Geraghty & Miller study. That study concentrated on evaluating laboratory permeability of the clay cores; field tests to determine in situ hydraulic conductivity were not conducted. K values for the clay cores were on the order of 10^{-6} cm/sec. However, a sample from MW-38, a well located east of the NCL near NRC's TEL Weathering Area, resulted in a calculated K of 10^{-3} cm/sec based on a grain size analysis of the sample. This value is intermediate between the two values determined for the MW-54 wells.

The range of seepage velocities for the permeable zones in the vicinity of the NCL is shown in Table 6-6. Included in the table are hydraulic conductivity data for the two MW-54 wells and the MW-38 well. Seepage velocities in fine-grained material similar to that observed in MW-54A are on the order of 2 to 10 feet per year. By way of contrast, seepage velocities in the zone intercepted by deeper well MW-54B are about 10 times those calculated for MW-54A. Estimated seepage velocities for MW-38 are intermediate to those determined in the MW-54 pair.

The wide range in seepage velocities reflects the complexity of the hydrologic system in the vicinity of the NCL. Significant flow occurs only in the coarser grained water-bearing seams that are typically limited in vertical and horizontal extent, and are interbedded with extensive zones of low permeability silts and clays. High permeability zones do not predominate in the vicinity of the hydrocarbon-impacted soils. The lower permeability materials, together with the presence of thick clay zones which greatly restrict vertical downward movement of contaminants, act to contain much of the released product. However, where hydrocarbon fluids have reached a higher permeability zone, movement is expedited. For example, the location of the maximum extent of hydrocarbon material northeast of the tank farm (probable source of the release) is about 1600 feet downgradient. If the release occurred up to 20 years ago, the seepage velocity needed to

Table 6-6. Estimated range of seepage velocities for permeable lithologic zones in the vicinity of the NCL, RFI Phase II

Date	Gradient	Location	Seepage Velocity (ft/min)	Seepage Velocity (ft/year)
Seepage Velocities using K = 9.38E-4 ft/min (K at MW-54A, 12/95)				
9/13/95	0.0048	Average gradient across Landfarm	1.8E-5	9.5
12/23/95	0.0025	Vicinity of NCL-31	9.4E-6	4.9
12/23/95	0.0021	Average gradient across Landfarm	7.9E-6	4.1
12/23/95	0.0014	Between NCL-33 and MW-55	5.3E-6	2.8
12/23/95	0.0011	Between MW-55 and MW-56	4.1E-6	2.2
Seepage Velocities using K = 1.96E-3 ft/min (K at MW-38, 12/82 NCL report, Geraghty & Miller)				
9/13/95	0.0048	Average gradient across Landfarm	3.8E-5	20
12/23/95	0.0025	Vicinity of NCL-31	2.0E-5	10
12/23/95	0.0021	Average gradient across Landfarm	1.6E-5	8.7
12/23/95	0.0014	Between NCL-33 and MW-55	1.1E-5	5.8
12/23/95	0.0011	Between MW-55 and MW-56	8.6E-6	4.5
Seepage Velocities using K = 8.14E-3 ft/min (K at MW-54B, 12/95)				
9/13/95	0.0048	Average gradient across Landfarm	1.6E-5	82
12/23/95	0.0025	Vicinity of NCL-31	8.1E-5	43
12/23/95	0.0021	Average gradient across Landfarm	6.8E-5	36
12/23/95	0.0014	Between NCL-33 and MW-55	4.6E-5	24
12/23/95	0.0011	Between MW-55 and MW-56	3.6E-5	19

Seepage velocities calculated using:

$v = Ki/n_e$

where:

v = seepage velocity (ft/min),
K = hydraulic conductivity (ft/min),
i = hydraulic gradient (ft/ft), and
n_e = effective porosity (unitless) = 0.025 (assumed)

move the product (assuming product moves at the same rate as the groundwater) is 80 feet per year, which is met only in zones of coarse grained materials. The occasional and sporadic occurrence of coarser permeable materials in the area of the release limits the types of hydrocarbon recovery operations that can be successfully used in the area to recovery trenches which bisect the infrequently distributed permeable zones.

6.3 Groundwater Quality

6.3.1 Groundwater Analytical Results

The laboratory analytical results of the groundwater sampling analyses are presented in Appendix B and summarized in Table 6-7. Groundwater samples were analyzed for volatile and semivolatile organic constituents, metals, and general water chemistry parameters.

For all groundwater samples, concentrations for target organic and inorganic constituents were below Safe Drinking Water Act final or proposed health-based concentration limits (Table 6-7). All target organic volatiles and semi-volatiles were below reported detection limits, except for a detection of ethylbenzene at a concentration of 0.006 mg/L, which, essentially, is at the detection limit. General chemistry parameters for the well network indicate poor water quality characteristics, with total dissolved solids ranging from 1,970 to 4,900 mg/l, and total sulfates ranging from 745 to 2,170 mg/l. The analytical results indicate that the downgradient well network is appropriately situated outside the boundary of the hydrocarbon product plume, and can provide early detection of any dissolved-phase hydrocarbon constituents.

Table 6-7. Summary of laboratory analytical data for groundwater monitoring wells sampled during the NCL, RFI Phase II

	Monitoring Well					
	MW-18	MW-53	MW-54A	MW-54B	MW-55	MW-56
	6/29/95	6/29/95	12/22/95	12/22/95	8/9/95	8/9/95
Volatiles (1,2)						
benzene (0.005 mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
toluene (1.0 mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
ethylbenzene (0.70 mg/L)	<0.005	<0.005	0.006	<0.005	<0.005	<0.005
xylenes (10 mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
other	NA	<0.005 to <0.2	<0.005 to <0.2	<0.005 to <0.2	<0.005 to <0.1	<0.005 to <0.1
Semivolatiles (3)	NA	<0.01 to <0.025	<0.05 to <0.63	<0.01 to <0.03	<0.01 to <0.025	<0.01 to <0.025
Metals (1,4)						
chromium (0.10 mg/L)	NA	0.007	<0.005	<0.005	0.014	0.013
lead (0.015 mg/L)	NA	<0.01	<0.01	<0.01	<0.01	<0.01
General Chemistry (1)						
pH	NA	7.4	7.7	8.1	7.1	6.9
total dissolved solids	NA	2,500	1,970	2,100	2,160	4,900
sulfates (400 mg/L)	NA	1130	745	1000	901	2170

Notes:

All concentrations are reported in mg/L.

(1) Values, in parentheses, where shown, are Safe Drinking Water Act final or proposed health-based concentration limits (mg/L).

(2) Volatile constituent analyses included 30 additional Method 8240 constituents; data sheets are reproduced in Appendix B.

(3) Semivolatile constituent analyses included 65 Method 8270 constituents; data sheets are reproduced in Appendix B.

(4) Analyses included 19 metals, evaluated as total metal concentrations; data sheets are reproduced in Appendix B.

7.0 DISCUSSION

The combined results of the RFI Phase I and Phase II studies provide a coherent framework from which to view the subsurface environmental setting in the vicinity of the NCL. The findings of the Phase I study suggested that the NSSZ was variable in lithology and distributions, and likely existed under semi-confined hydraulic conditions. The results of the Phase II effort have subsequently provided strong confirmation of the initial suppositions regarding the nature of the NSSZ.

The Phase II soil borings demonstrate that the NSSZ is a highly variable network of interconnected, but sporadically distributed saturated zones. This fact is perhaps most clearly demonstrated by observations made at Phase II boring locations NCL 95-14 and 14B (Appendix A, Figure 5-1, and Table 6-1), which were separated by a distance of about 4 feet. Despite their near proximity, the borings were strikingly dissimilar in terms of the occurrence of hydrocarbons. Specifically, NCL 95-14 yielded no evidence of free-phase hydrocarbon product whereas NCL 95-14B yielded free-phase product.

The variable nature of the NSSZ hydraulic system is further indicated by the broad range of estimated seepage velocities for the NSSZ which were obtained using various wells evaluated over different groundwater elevation measurement dates (Table 6-6). The wide range in seepage velocities reflects the complexity of the hydrologic system in the vicinity of the NCL. Seepage velocity is controlled by the permeability of less frequently encountered high-permeability gravel and sand zones that finger out in advance of the main body of the plume. Under the assumed subsurface regime, hydrocarbon product behind the leading edge of the plume gradually infiltrates remaining available pore space via more restricted and tortuous pathways.

Significant groundwater flow occurs only in the coarse grained water-bearing seams that are typically limited in vertical and horizontal extent, and which are interbedded with extensive zones of low permeability silts and clays. High permeability zones do not predominate in the vicinity of the hydrocarbon-impacted soils. The lower permeability materials, together with the presence of thick clay zones which greatly restrict vertical downward movement of contaminants, act to contain the released product. However, where hydrocarbon fluids have reached a higher permeability zone, movement is expedited. The occasional and sporadic occurrence of coarser permeable materials in the area of the release limits the types of hydrocarbon recovery operations that can be successfully used in the area to recovery trenches which bisect the infrequently distributed permeable zones.

The other key finding of the Phase II effort involves the apparent validation of the semi-confined nature of the NSSZ, which was originally postulated on the basis of RFI Phase I results. The continuous groundwater elevation monitoring data presented in Figures 6-4 and 6-5 are highly consistent with the Phase II soil boring program results, as well as with the observed hydrocarbon contaminant profiles in the vadose zone above the NSSZ. The significance of this finding is that the driving force to move contaminants horizontally beneath the unit and vertically upwards has been confirmed.

Although it is not possible to conclusively demonstrate that a release of hydrocarbons from the NCL has not occurred, now that a driving force mechanism has been verified and its magnitude confirmed, there is a much greater likelihood that the hydrocarbon contaminants observed at depth in the vadose zone beneath the landfarm are from a hydrocarbon release unrelated to surface activities at NCL. Even if a release from the landfarm has occurred, it is not possible to quantify any contribution by the NCL, or to distinguish between any contaminants which may have been contributed by the NCL and contaminants contained in the upgradient release.

The NSSZ does not represent a feasible drinking water source, due to its poor quality and limited productivity potential. Potential for human exposure to hydrocarbon-impacted groundwater is further diminished due to the semi-confined nature of the contaminants within the NSSZ, and the significant interval of impermeable strata intervening between the NSSZ and lower groundwater zones.

8.0 RECOMMENDATIONS

Due to the variable, disjunct nature of the NSSZ, the construction of interception trenches across the path of the petroleum product plume represents the only feasible corrective measures alternative. Based on the configuration of the free-phase product plume and its relationship to above-ground features, two interception trenches are recommended for the containment and recovery of the hydrocarbon product.

The proposed location of the trenches will likewise intercept and recover any releases from the NCL that may have migrated vertically downwards and contacted the plume. The magnitude of any releases from the NCL has been evaluated previously and are, at worst, minimal. In addition to removing free-phase product, the trenches will recover dissolved-phase hydrocarbons through pumping of the groundwater. This will result in a change in the hydraulic gradient and the direction of flow, and the creation of a zone of capture in the area of the trenches. The new monitor wells installed along the northern and eastern boundaries of the hydrocarbon plume will allow for timely detection of changes in water quality, and the data collected will assist in making any necessary modifications to the trench recovery system proposed for installation.

The proposed system consists of primary and secondary recovery trenches. Locations for the proposed trenches are presented in Figure 8-1. The primary trench will be located in the area west of Eagle Creek in which the occurrence of free-phase hydrocarbon in the boreholes was most frequently encountered. The location of this trench will supplement the existing recovery operations at RW-7 and RW-8. It will also have the likely benefit of reducing the magnitude of the hydraulic head spikes under the landfarm by intersecting and draining non-continuous permeable channels which otherwise would contribute to the pressure spikes.

The secondary trench will be located near the leading tip of the plume and is expected to recover lesser amounts of hydrocarbon and contaminated water since not all borings in that area were found to have been impacted by the product. The location of this trench is also dictated by existing refinery structures and pipeline and utility considerations. However, by cutting off the source of product and water, the trench is expected to cause downgradient fluid movement to

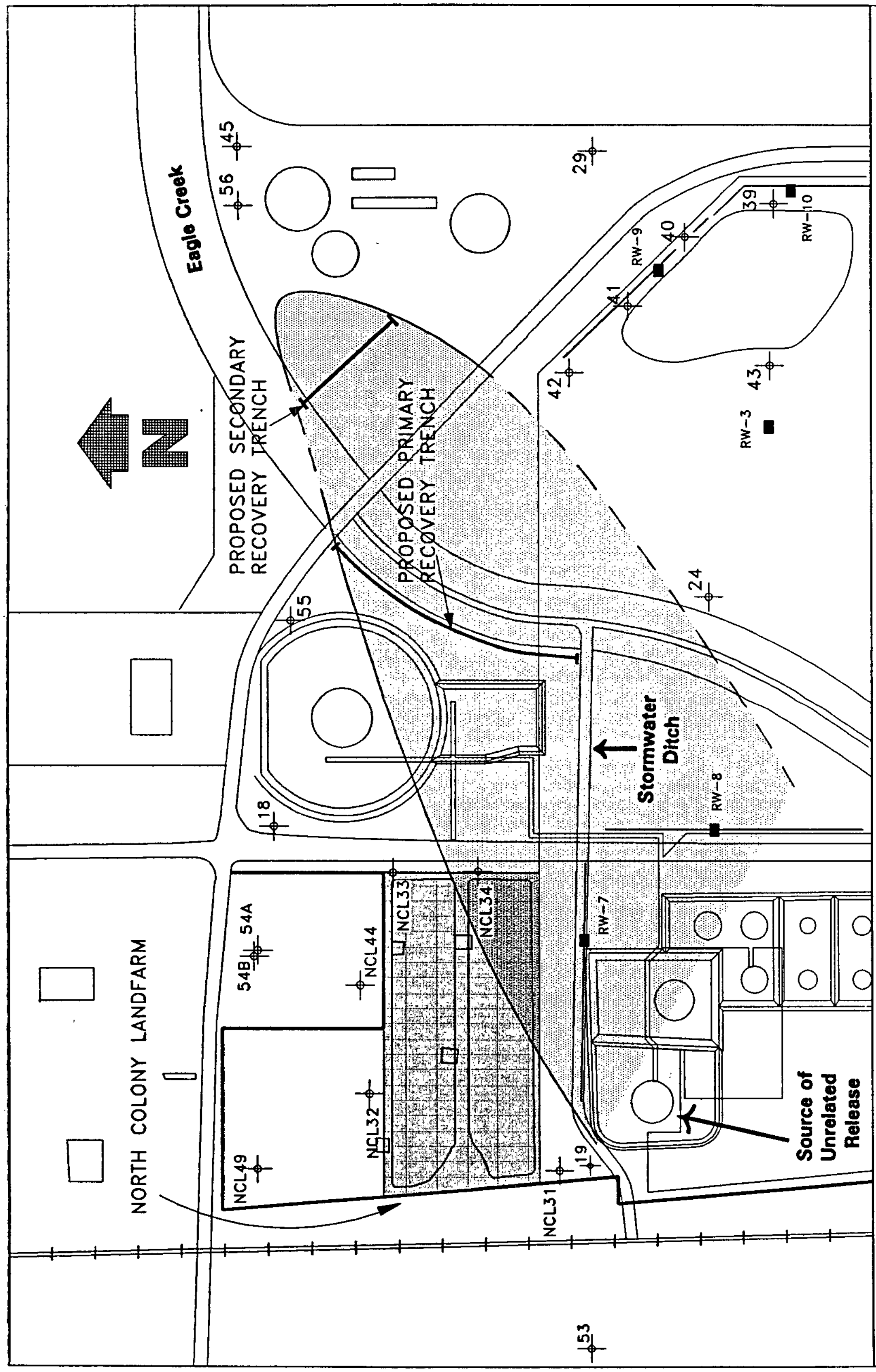

FIGURE 8-1. APPROXIMATE LOCATION OF TANK FARM FREE-PHASE HYDROCARON PLUME

NORTH COLONY LANDFARM
NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

SCALE IN FEET
0 200 400 600

LEGEND

⌖ MONITOR WELL
■ RECOVERY WELL LOCATION
▨ **APPROXIMATE PLUME LOCATION**

Drawn by: Walt Foutz Date: 2-23-96

greatly decrease and it should significantly diminish hydrocarbon movement. The presence of new monitor well MW-56 will provide timely notice of imminent approach of any hydrocarbon constituents.

The construction of both new recovery trenches is expected to be similar to the nearby existing trenches. Briefly, a trench several feet in width is dug with a trackhoe to the base of the zone of contamination. Several wide-diameter slotted steel culverts are vertically emplaced as "wet wells" and the trench backfilled with porous gravel. Pumps, oil skimmers, and other product recovery equipment are installed in the wet wells. Because the water zones are semi-confined, product migrating to the trench moves upward through the gravel to the water surface where it can be removed. Pumping of water from the wet wells moves the product in the trench to the skimmers, modifies the hydraulic gradient so that groundwater flow is directed to the trenches, and recovers dissolved-phase hydrocarbons from the plume.

The recovered water and product from the new trenches will be managed in a manner similar to other recovery operations at the refinery. Oil will be directed to the slop oil system from where it will reenter the refinery process stream. Water produced from the recovery system will be combined with water from the other systems where it will be stripped of hazardous constituents to below New Mexico Water Quality Control Commission Ground Water Standards. The treated water is expected to be reinjected into the NSSZ in other areas of the refinery to aid in hydrocarbon product recovery.

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APPENDIX A

LITHOLOGIC LOGS

Appendix A

Appendix A

APPENDIX A1

SHALLOW BORING LITHOLOGIC LOGS

LOG OF BORING NCL 95-01

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 06/23/95	Drilling Method:	: Hydraulic push
Time Started	: 1345	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 06/23/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Blows per 2 ft.	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	Contact depth	PID Interval (ft)	PID (ppm)
0	1		1.5	▥	ML	Clayey silt, brown, lighter with depth, calcite grains			
							2.5	0 - 5	3
	2	43	2	▨	CL	Clay, light brown to chalk color, dry, crumbly, plastic when wetted			
5									
								5 - 10	1
	3	19	2			Clay, light brown, slightly moist at bottom, some fine-grained caliche zones at 9 ft. (zones approx. 2 in. thick, chalk color)			
10	4	53	2			Clay, light brown, dry, crumbly, plastic when wetted			
	5	37	2			Clay, light brown, dry 12-12.5 ft., plastic 12.5 to 14 ft.		10 - 15	5
15	6		2			Clay, light brown, some chalk color zones, some with dark brown (iron?) staining, slightly moist and plastic at 14 ft., water on drive shoe			
	7	54	2			Silty clay, moist at 16 ft., chalky clay at 17 ft., slight hydrocarbon (?) odor	16	15 - 20	908
	8		2			Clay, light brown, slightly moist, some chalky coloring but no caliche	18		
20									
25									
30									

Notes:
Depth to water (DTW) 17.8 ft. @ 1800 hr.; DTW 13.8 ft. @1700 hr., 6/24/95, hole caved to 15 ft. BTEX water sample taken 6/24/95. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

2-29-1996 \mtech3\navajo\ncl 95\nc95-01.ge3

LOG OF BORING NCL 95-02

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 06/23/95
Time Started : 1600
Date Completed : 06/23/95
Hole Diameter: : 2"

Drilling Method: : Hydraulic push
Sampling Method: : 2'x3/4"ID Splitspoon
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	Blows per 2 ft.	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	Contact depth	PID Interval (ft)	PID (ppm)
0						Clay, black, soft, no H/C odor			
	1		1.5						
						Clay, light brown, some caliche flakes		0 - 5	7
	2		2						
5									
						Clay, light brown, some calcite crystals			
	3		2					8 - 10	7
10									
					CL				
						Clay, light brown to chalk color, plastic, slightly moist			
	4		2					13 - 15	4
15									
						Moist at 18.2 ft., otherwise same as above			
	5		2					18 - 20	6
20									
	6		2						
						Clay, light brown to chalk color, slightly moist, plastic, expansive at 22 ft.	22	20 - 24	6
	7		2						
					CH				
	8		1						
25						Increasing fine gravel 25 to 25.8 ft.			
	9		1					25 - 26	5
					GC	25.8-26.1 ft. Fine gravel, slightly moist, punch refusal	25.8		
30									

Notes: Moisture on probe at 26 ft, no free water, but moisture entering hole at conclusion of drilling. DTW 14.6 ft. @1715, 6/24 Total depth (TD) 17.2 ft. BTEX water sample taken 6/24/95, pH=7, EC=3000 umhos @22C. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

2-29-1996 \mtech3\navajo\ncl 95\nc95-02.ge3

LOG OF BORING NCL 95-03

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 06/24/95	Drilling Method:	: Hydraulic push
Time Started	: 0730	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 06/24/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Blows per 2 ft.	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	Contact depth	PID Interval (ft)	PID (ppm)
0						No information			
5	1		2	▨		Clay, medium brown, hard, slightly plastic, grading to gray at 6.5 ft., hydrocarbon (H/C) odor below transition		5 - 7	1229
	2		2	▨		Clay, gray with some lighter colored areas, dry, crumbly, strong H/C odor		7 - 9	996
10	3		2	▨	CL	Clay, dark gray to black, caliche clay from 10.5 - 11 ft, dry, crumbly, H/C odor		9 - 11	1088
	4		2	▨				11 - 13	717
	5		2	▨		Increasing moisture from 14 to 15 ft.	14.8	13 - 15	852
15					GC	14.8 - 15 ft. Caliche gravel and clay, gravel to 1/2 in., H/C product along side of splitspoon	15		
	6		0 & 2	▥	ML	Clayey silt, dark gray, H/C odor. Less gray and decreasing odor from 17 to 17.5 ft.		15 - 17	679
	7		0 & 2	▨		Clay, light brown, plastic	17.5	17 - 19	136
20	8		2	▨	CL	Clay, light brown, slightly reddish, uniform, hard, no odor		19 - 21	53
	9		2	▨				21 - 23	55
25									
30									

Notes:
No recovery 15-17 and 17-19 ft., moved over 0.5 ft., pushed to 15 ft. DTW 13.8 ft. @1600, 6/24, product thickness too thin to measure. Hole collasped below 14 ft. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals .

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LOG OF BORING NCL 95-04

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 06/24/95	Drilling Method:	: Hydraulic push
Time Started	: 1000	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 06/24/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Blows per 2 ft.	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	Contact depth	PID Interval (ft)	PID (ppm)
0						No information			
	1		2	▨	CL	Clay, dark brown, plastic, no odor		3 - 5	27
5				▨					
	2		2	▨		Clay, light brown to chalk color, some brown mottling		8 - 10	19
10	3		2	▨		Clay, chalky color to 11 ft., brown-stained 11-11.5 ft., 11.5-12 ft. strong H/C odor		10 - 12	59
	4		2	▨		Clay, gray and black. 13-14 ft., silty clay, gray and black with calcite crystals from 13.5-14 ft., strong H/C odor.		12 - 14	1098
15	5		2	▨		Silty clay, gray. 15.5-16 ft., clay, medium brown, some gray and caliche mottling, 3/4 in. rock at 15.5 ft. H/C product on outside of core.		14 - 16	946
	6		2	▨		Silty clay, gray-brown with H/C odor. 17-18 ft., clay, brown to chalk color, some silt, H/C odor		16 - 18	870
	7		2	▨		Silty clay with H/C odor. 19.5-20 ft., caliche clay, some gravel, slight H/C odor.		18 - 20	1033
20	8		2	▨		Clay, medium brown to chalk color, brown from 20.5 to 21.5 ft., moist, no H/C odor.		20 - 22	45
	9		2	▨		Clay, light brown to chalk color, some silt, moist at 22 ft., no H/C odor		22 - 24	29
25									
30									

Notes:
Product and water at 15.6 ft. @1600 6/24, total depth 17.6 ft.
Product thickness too thin to measure. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water.
Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

LOG OF BORING NCL 95-05

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 06/24/95
Time Started : 1115
Date Completed : 06/24/95
Hole Diameter: : 2"

Drilling Method: : Hydraulic push
Sampling Method: : 2'x3/4"ID Splitspoon
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	Blows per 2 ft.	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	Contact depth	PID Interval (ft)	PID (ppm)
0						No information			
5	1		2	▨	CL	Silty clay, dark brown with some chalky color, no odor		4 - 6	18
	2		2	▨		Clay,medium to light brown, no odor		8 - 10	17
10	3		2	▨		Clay, dark brown, discoloring to dark gray and black. 10.6-12 ft., black hydrocarbon-impregnated soil, no liquid, strong H/C odor.		10 - 12	1102
	4		2	▨		Silty clay, gray with black mottling, strong H/C odor, dry.		12 - 15	609
15	5		2	▨		Same as above, some interior areas have light brown coloring, some visible grains (calcite?) that are crushable.		15 - 17	560
	6		2	▨		Same as above.		17 - 19	859
20	7	93	2	▨		Same as above. 20.5-21 ft., clay, gray, plastic, H/C odor.		19 - 21	585
	8		2	▨		Same as above, H/C odor.		21 - 23	545
	9		2	▨		Clay, grading to light gray with more silt. 24.7-25 ft., clay grading to brown at 25 ft., green reduction zone at 24.8 ft., slight H/C odor.		23 - 25	282
25	10		1	▨		Clay, gray, slight odor		25 - 26	323
	11		2	▨		Clay, light brown to light gray, reduction zone 27.0-27.1 ft., no odor		26 - 28	120
30									

Notes:
Water at 18.0 ft. @1530 6/25, caved below 20 ft. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

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LOG OF BORING NCL 95-05A

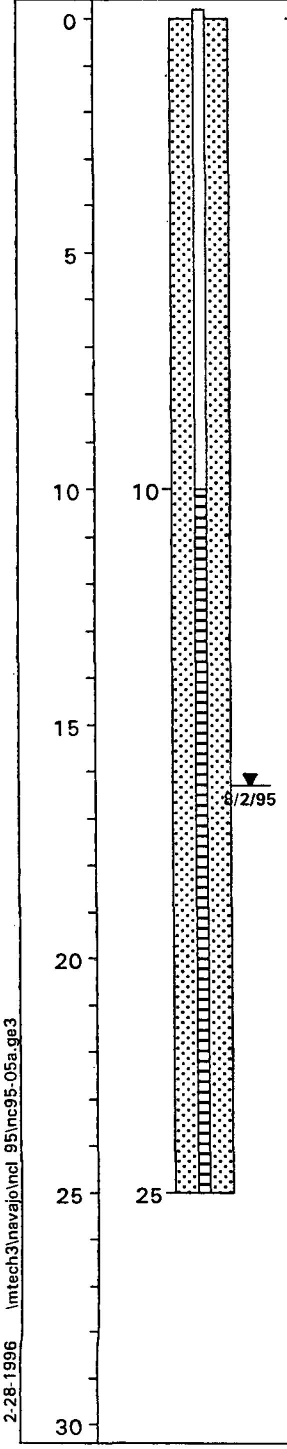
(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 07/31/95
Time Started : 1330
Date Completed : 07/31/95
Hole Diameter: : 3.5 "

Drilling Method: : Solid Stem Auger
Sampling Method: : None
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	NCL 95-05A ELEV:	DESCRIPTION	



NCL 95-05A located approximately midway between NCL 95-05 and NCL 95-06. Bored 25 ft., installed 15 ft. of screen and 10 ft. of temporary PVC casing for H/C product search. Hole was not logged. Drillers reported product on drill augers.

Depth to water 16.3 ft. BLS on 8/2/95. No product seen in bailer.

Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water.

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LOG OF BORING NCL 95-06

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 06/24/95	Drilling Method:	: Hydraulic push
Time Started	: 1340	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 06/24/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Blows per 2 ft.	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	Contact depth	PID Interval (ft)	PID (ppm)
0						No information			
	1		0.7	▨	CL	Clay, light brown to chalk color, dry, crumbly, some silt, no PID reading			
5									
	2		1.2			Clay, dark brown, slightly moist, no odor		8 - 10	55
10	3		1.6			Same as above		10 - 12	45
	4		2			Same as above. 13-13.2 ft. Rreduction zone, black. 13.2-14 ft. Clay, dark gray, some silt, dry, crumbly, strong H/C odor.		12 - 14	1154
15	5		2			Same as above. Grading to light gray clay from 14.3-16 ft., hydrocarbon odor throughout.		14 - 16	1111
	6		2			Clay, light gray with H/C odor. 17.2-18 ft., clay, gray with caliche.		16 - 18	765
	7	93	2			Clay, gray with caliche, darker at 20 ft.		18 - 20	600
20	8		2			Clay, light gray, more plastic at 20.9 ft., H/C odor decreasing with depth.		20 - 22	590
	9		2			Clay, light gray. 22.5-24 ft., clay, brown, becoming lighter with depth. H/C odor to 22.5 ft., slight or none below 22.5 ft.		22 - 24	929
25	10		2			Clay, light brown, plastic, no H/C odor, moist at 25.6 ft.		24 - 26	90
30									

Notes:
Dry at 18.6 ft. @1500 6/25, caved below. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

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LOG OF BORING NCL 95-07 (MW-55)

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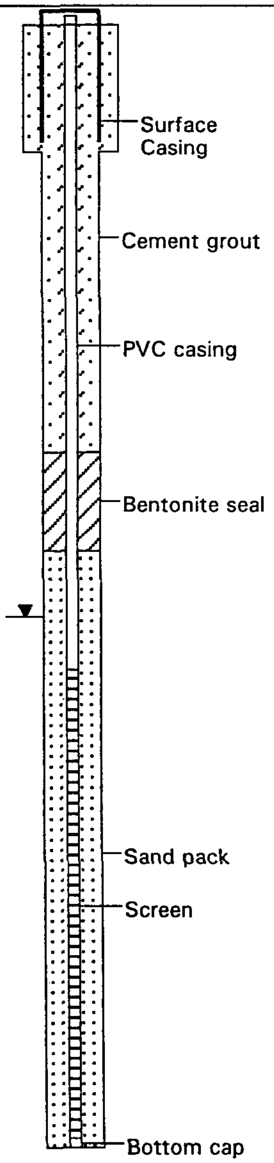
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 06/25/95	Drilling Method:	: Hydraulic push
Time Started	: 1215	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 06/25/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	DESCRIPTION	GRAPHIC	USCS
0		No information		
5	1	Clay, brown with white streaks, lighter brown at 4.2 ft., no odor, 1.2 ft. recovery		CL
	2	Clay, brown to chalk color, dry, crumbly, caliche clay at 8 ft., some brown staining on core surface, 1.7 ft. recovery		
10	3	Clay, light brown with soft zones every few inches, extensive small crystals where soft, 2 ft. recovery		
	4	Clay, light brown, fewer zones with crystals, 1 ft. recovery		
15	5	Clay, light brown, no caliche zones, lighter color and softer at 16 ft., 2 ft. recovery		
	6	Clay, very light brown, hard, 2 ft. recovery		
	7	Clay, brown, some lighter color zones, no caliche, 2 ft. recovery		
20	8	Same as above, 2 ft. recovery,		
25				
30				

Notes:
No odor in any core sample
Depth to water at 17.3 ft. BLS @1600 6/25.
Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from drill cuttings at designated intervals. On 8/08/95, hole was redrilled and completed as MW-55 with DTW of 12.3 ft. BLS.

Well: MW-55
ELEV: 3363.57



Well Construction Information

DRILLING INFORMATION

Date completed : 8/08/95
Hole diameter : 8 1/4 in.
Depth Hole BLS : 23.9 ft.
Drilling Method : HSA
Drilled by : Pool Environmental
Logged by : D. G. Boyer

CASING, SCREEN & CAP

Material, joints : PVC, threaded
Diameter : 2 in. ID
Screen type : Johnson Slotted
Screen length : 10 ft.
Screen opening : 0.010 slot
Scrn. placement : 13.7 - 23.7 ft. BLS
Bottom Cap : 0.2 ft PVC
Protector Casing : Above-ground steel
Lock Key # : P-493

SEALS & SAND PACK

Cement seal type: Cement with 5 % : powered bentonite
Seal placement : 0 - 9.1 ft. BLS
Annular seal type: Med. bentonite : chips, ("Pure Gold")
Seal placement : 9.1 - 11.2 ft. BLS
Sand pack type : 10-20 CSSI silica
Sand placement : 11.2 - 23.9 ft. BLS

ELEVATIONS

Ground elevation: 3360.75 ft.
Inner casing, top : 3363.57 ft.
Outer casing, top: 3363.97 ft.

NOTES

PID Readings (ppm):

0-3 ft.	Not measured
3-5 ft.	30
8-10 ft.	49
10-12 ft.	45
12-14 ft.	29
14-16 ft.	34
16-18 ft.	22
18-20 ft.	18
20-22 ft.	18

(Note: PID likely impacted by moisture or exhibited carry-over from previous sample)

COMPLETION NOTES:

Driller bailed 22 gallons 8/8
Developed with pump 8/9/95
Purged 30 gallons prior to sampling, pumped at 1.5 gpm with pump intake at 20 ft.
Purge info. @25gal, 0855: 22 C, 2800 umhos, pH 7
Depth to water prior to sampling: 15.36 ft. below top inner casing.

Navajo

LOG OF BORING NCL 95-08

(Page 1 of 1)

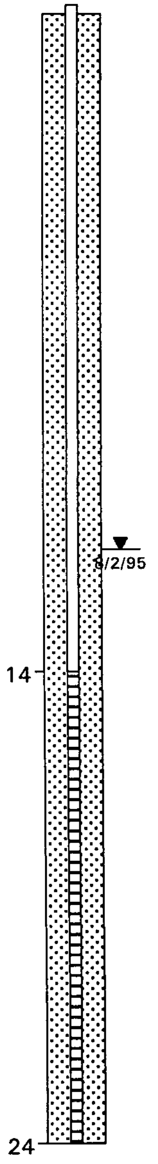
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 06/25/95
Time Started : 1330
Date Completed : 06/25/95
Hole Diameter: : 2"

Drilling Method: : Hydraulic push
Sampling Method: : 2'x3/4"ID Splitspoon
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0					No information		
5	1	1.5	▨		Clay, brown, firm, crumbly	3 - 5	15
	2	1.4	▨		Same as above	8 - 10	16
10	3	2	▨	CL	Same as above. 10.4-12 ft., clay, light gray, hydrocarbon (H/C) odor	10 - 12	1092
	4	2	▨		Clay, gray, H/C odor. H/C product and water squeezed out of core at approx. 13.5 ft.	12 - 14	1064
15	5	2	▨		Silt Clay, gray, saturated, strong H/C odor, clay forms cohesive ribbons when rolled in fingers	14 - 16	933
	6	2	▨		Clay, gray, firm, slightly crumbly, H/C odor, lighter color at 18 ft.	16 - 18	1011
	7	2	▨		Clay, gray, H/C odor. Core surface moist at 19.5 ft., dry below. Surface color green, interior is brown.	18 - 20	310
20				GC	Thin gravel zone at 20.2 ft.		
	8	2	▨		Clay, gray grading to brown below.	20 - 22	465
	9	2	▨	CL	Clay, brown, firm, uniform. 23.7 - 24 ft., silty clay, light brown, no H/C odor.	22 - 24	52
25							
30							

NCL 95-08
ELEV:



Notes:
Water depth 12.4 ft. BLS @1535 6/25.
Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.
On 8/1/95, cored 24 ft. and installed 15 ft. of 2 in. PVC temporary casing with 10 ft. of screen. At 1200 on 8/2 measured DTW of 11.4 ft. with 1/16 to 1/8 in. H/C product.
Plugged back holes with medium bentonite chips, hydrated with 5 gallons fresh water.

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LOG OF BORING NCL 95-08A

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RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/95	Drilling Method:	: Solid Stem Auger
Time Started	:	Sampling Method:	: Cuttings
Date Completed	: 08/03/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 3.5 "	Logged By:	: D.G. Boyer

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0	1	▨	CL	Clay, blue gray from 3-5 ft., possible H/C odor.	3 - 5	0
5	2	▨		Clay, light brown, no odor	8 - 10	0
10	3	▨		Clay, light brown, no odor. Water at approx. 12 ft.		
15						
20						
25						
30						

Notes:
Hole located 109 ft. west of NCL 95-08. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

LOG OF BORING NCL 95-08B

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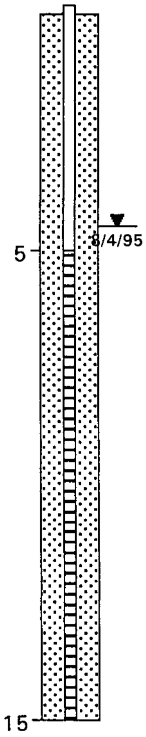
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/95	Drilling Method:	: Solid Stem Auger
Time Started	:	Sampling Method:	: Cuttings
Date Completed	: 08/03/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 3.5 "	Logged By:	: D.G. Boyer

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0	1			Clay, blue gray from 3-5 ft.		
5	2		CL	Clay, darker color, strong H/C odor	6 - 7 8 - 9	6 94
10	3			Clay, dark gray, water and product. Sandy at bottom.	10 - 12	51
			SC			
15						
20						
25						
30						

NCL 95-08B
ELEV:



Notes:
NCL 95-08B located approximately 60 ft. west of NCL 95-08.
Installed 10 ft. of temporary PVC screen for H/C product search.
On 8/4 DTW 4.5 ft. BLS with product skim seen on bailer.
Plugged back hole with medium bentonite chips,
hydrated with 5 gallons fresh water. Photoionization Detector (PID)
readings are from jar headspace analysis of grab samples
taken from the splitspoon at the designated intervals.

Navajo

LOG OF BORING NCL 95-08C

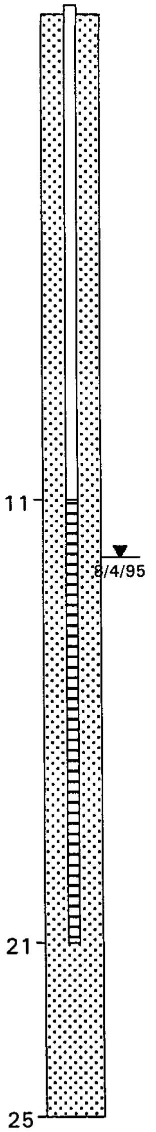
(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/95	Drilling Method:	: Solid Stem Auger
Time Started	:	Sampling Method:	: Cuttings
Date Completed	: 08/03/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 3.5 "	Logged By:	: D.G. Boyer

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0	1	▨	CL	Clay, brown		
5	2	▨		Clay, brown		
10	3	▨		Clay, brown		
15	4	▨		Clay, brown. 18 to 20 ft., clay, blue gray	16 - 18	78
					18 - 20	77
20		▨		Clay, blue gray.		
	5	▨	GC	Cobble zone beginning at 21 ft.		
25						
30						

NCL 95-08C
ELEV:



Notes:
NCL 95-08C located approximately 80 ft. east of NCL 95-08. Installed 10 ft. of temporary PVC screen for H/C product search. Casing base set at 21 ft. due to gravels, 8/3 DTW 12.8 ft. with H/C product. 8/4 DTW 12.3 ft. BLS with 1/8 in. H/C product. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

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LOG OF BORING NCL 95-08D

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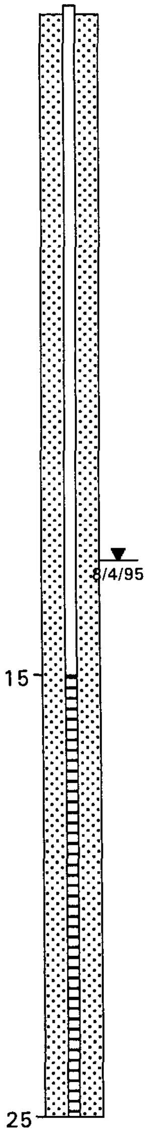
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/95	Drilling Method:	: Solid Stem Auger
Time Started	:	Sampling Method:	: Cuttings
Date Completed	: 08/03/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 3.5 "	Logged By:	: D.G. Boyer

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0	1	▨		Clay, brown		
5	2	▨		Clay, brown		
10	3	▨	CL	Clay, brown		
15	4	▨		Clay, blue gray. 17 - 20 ft., Clay, brown, saturated 19 - 20 ft.	15 - 17	70
20	5	▨		Clay, brown, no cobble zone.		
25						
30						

NCL 95-08D
ELEV:



Notes:
NCL 95-08D located approximately 140 ft. east of NCL 95-08, and approximately 60 ft. west of NCL 95-09.
Installed 10 ft. of temporary PVC screen for H/C product search.
8/4 DTW 12.4 ft. BLS with skim H/C product.
Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

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LOG OF BORING NCL 95-09

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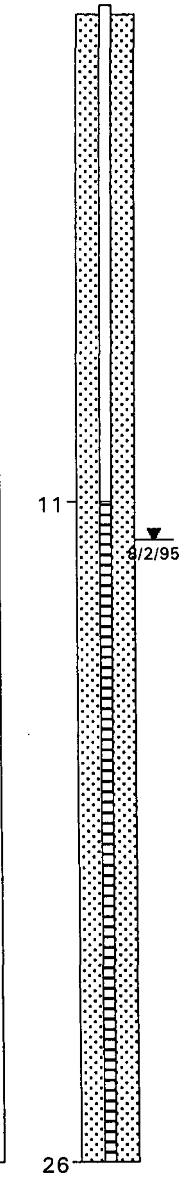
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 07/31/95	Drilling Method:	: Hydraulic push
Time Started	: 1530	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 07/31/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0					No information		
5	1	0.2		CL	Clay, dark brown, slightly moist, plastic (sample from cuttings, no recovery in splitspoon)		
	2	1.4			Silty clay, light gray and brown, grading to caliche clay at bottom, no odor	8 - 10	0
10	3	1.5			Caliche clay, brown and gray mottling, grading to chalk color at bottom, no odor	10 - 12	0
	4	2			Caliche clay, chalk to light brown color, moist at 12 ft., crystals (calcite?) in matrix, no odor	12 - 14	0
15	5	2			Caliche clay, chalk to light brown color, dry, crumbly, orange brown staining from 14-14.5 ft., becoming gray to dark gray with depth. 15.2 - 15.4 ft., black streaks, H/C odor.	14 - 16	40
	6	1.7			Clay, dark gray. 16.4 - 17.7 ft., clay, light gray, dry, very hard (used rig hammer to drive), H/C odor.	16 - 18	264
	7	2			Same as above. 18.5 - 19.4 ft., clay, gray, firm, H/C odor. 19.4 - 20 ft., clay, gray and brown, becoming softer at 20 ft., very stong H/C odor.	18 - 20	103
20	8	1.2			Same as above. 20.5 - 21.2 ft., clay, becoming light gray to light brown and soft at bottom.	20 - 22	92
	9	2			Clay, light brown, moist, soft, plastic, wet at 22 ft., no odor.	22 - 24	16
25	10	2			Clay, brown, slightly plastic. 25.1 - 26 ft., clay with silt, slightly moist, no odor.	24 - 26	5
30							

NCL 95-09
ELEV:



Notes:
Location is 200 ft. SE of NCL 95-08 along north side of Truck Bypass road. Placed 15 ft. 3/4 in. screen in hole for water/product test. Water depth 11.9 ft. BLS @1130 8/2/95, no product or odor noted from pipe. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

LOG OF BORING NCL 95-10

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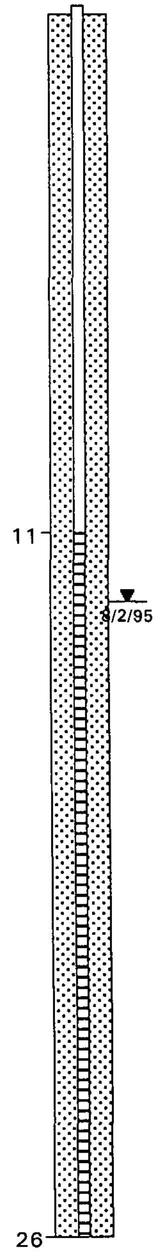
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/01/95	Drilling Method:	: Hydraulic push
Time Started	: 0730	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 08/01/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0					No information		
5	1	1.4	▨	CL	Silty clay, dark brown, plastic with occassional white flakes	3 - 5	0
	2	1.2	▨		Caliche clay, white, no odor	8 - 10	2
10	3	2	▨		Caliche clay, chalk color, dry, crumbly, no odor	10 - 12	2
	4	0.9	▨		Same as above. 12.4 - 12.9 ft., caliche clay, becoming soft, cohesive, slightly moist.	12 - 14	4
15	5	1.5	▨		Caliche clay, soft, becoming dark brown at 15.4 ft. Possible slight H/C odor.	14 - 16	6
	6	1.5	▨		Clay, light brown with caliche inclusion zones from 16.5 - 16.7 ft. then brown again, soft, strong H/C odor. Moist at top.	16 - 18	115
	7	2	▨		Clay, brown with gray zones, strong H/C odor. 18.7 - 20 ft., Clay and caliche clay, mottled, some gray staining, slight H/C odor.	18 - 20	80
20	8	2	▨		Clay, silty, brown with some gray. 20.3 - 20.8 ft., clay, light brown. 20.8 - 22 ft., clay, brown to light brown.	20 - 22	4
	9	1.9	▨		Silty clay, light brown, mottled, soft. 23.8 - 23.9 ft., clayey gravel, wet, no odor.	22 - 24	1
				GC	~~23.8 - 24.2 ft. Clayey gravel, wet.~~		
25	10	1.7	▨	CL	24.2 - 25.7 ft., clay, soft to 25.1 ft., then harder.	24 - 26	2
30							

NCL 95-10
ELEV:



Notes:
Located 200 ft. SE of NCL 95-09.
Placed 15 ft. 3/4 in. screen in hole for water/product test.
Water depth 12.5 ft. BLS 8/2/95, no product or odor.
Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

Navajo

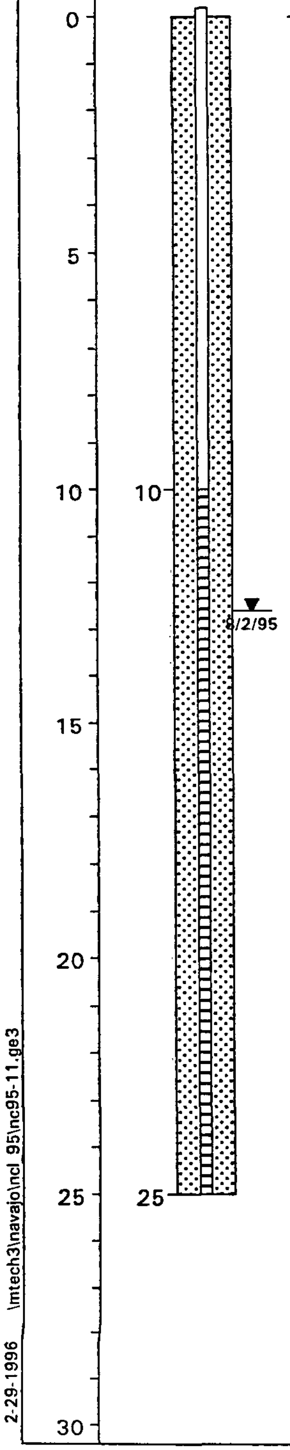
LOG OF BORING NCL 95-11

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/01/95	Drilling Method:	: Solid Stem Auger
Time Started	: 0930	Sampling Method:	: None
Date Completed	: 08/01/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 3.5 "	Logged By:	: D.G. Boyer

Depth in Feet	NCL 95-11 ELEV:	DESCRIPTION	



NCL 95-11 located 200 ft. southeast of NCL 95-06. Cored to 25 ft. Hole was not logged but cuttings observed. Discolored clay soil about 15 - 18 ft. Clay with H/C odor but no fluid at 20 ft. Clean, damp clay at total depth. Installed 15 ft. of screen and 10 ft. of temporary PVC casing for H/C product search.

Depth to water 12.6 ft. BLS on 8/2/95; no product but H/C odor on water level probe.

Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water.

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LOG OF BORING NCL 95-12

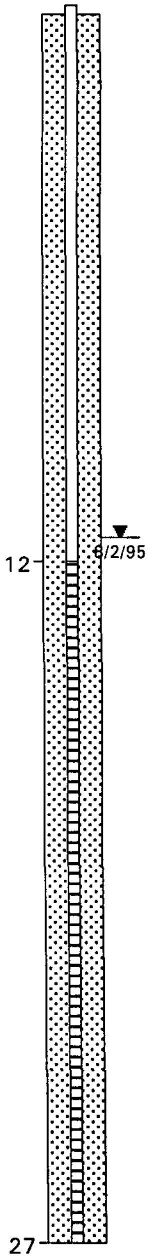
(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/01/95	Drilling Method:	: Hydraulic push
Time Started	: 1100	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 08/01/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0					Note: Samples from 3 to 24 ft. taken with splitspoon using pickup truck-mounted sampler. Samples from 24 to 27 ft. taken using CME-75 truck mounted drill. No sample information first 3 ft.		
	1	2	▨	CL	Silty clay, dark brown, hard, white flakes in matrix.	3 - 5	0
5	2	0	▨		No recovery.		
	3	2	▨		Silty clay, light brown with caliche streaks and inclusions, hard, no odor.	8 - 10	0
10	4	2	▨		Clay, gray, very strong H/C odor throughout.	10 - 12	97
	5	2	▨		Same as above with gray and brown discoloration, H/C odor throughout.	12 - 14	132
15	6	2	▨		Same as above, clay very hard with caliche.	14 - 16	100
	7	2	▨		Same as above, clay very hard with caliche.	16 - 18	119
	8	2	▨		Same as above, clay very hard with caliche.	18 - 20	125
20	9	2	▨		Clay, gray and brown with less H/C odor.	20 - 22	15
			▥	ML	Clayey silt, gray-brown.		
	10	2	▨	CL	22.5 -23.1 ft., silty clay, gray-brown. 23.1 - 23.8 ft., clay, dark gray with gravel, saturated.	22 - 24	No PID
	11	0		GC	23.8 - 24 ft. clayey gravel, gravels small (<1/4 in.), H/C odor.		
25					No recovery.		
	12	1.5	▨	CL	Sandy clay, gray H/C odor. 25.2 -26.1 ft., clay, light brown, medium soft. 26.1 - 26.5 ft., sandy clay, light brown, dry.	25 - 27	5
30					Notes: Placed 15 ft. 3/4 in. screen in hole for water/product test. Water depth 11.5 ft. BLS @ 1130 8/2/95, strong odor of product on bailer, but none seen. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.		

NCL 95-12
ELEV:



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LOG OF BORING NCL 95-13

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RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 07/31/95
Time Started : 1630
Date Completed : 07/31/95
Hole Diameter: : 2"

Drilling Method: : Hydraulic push
Sampling Method: : 2'x3/4"ID Splitspoon
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0					No information.		
5	1	1.3	▨	CL	Silty clay, dark brown, white flakes, no odor.	3 - 5	1
	2	1.8			Clay, light brown with hard caliche streaks, no odor	8 - 10	0
10	3	2			Same as above	10 - 12	0
	4	2			Same as above	12 - 14	1
15	5	2			Same as above, becoming softer at 15 ft.	14 - 16	1
	6	1.5			16 - 17.3 ft. Clay, light brown, soft. 17.3 - 17.5 ft., gravelly clay, white, saturated, septic odor, gravel size < 1/2 in.	16 - 18	1
	7	1.1	▒	GC	18 - 19.5 ft. Clayey gravel, light brown, saturated No recovery	18 - 20	2
20	8	1.9	▨	CL	Silty clay, light brown becoming soft and moist at 20.8 ft. 21.5 - 21.9 ft., caliche clay, chalk white, soft, moist, septic odor.	20 - 22	2
25							
30							

Notes:
Hole located 200 ft. northeast of NCL 95-12, 7 ft. north of white wastewater pipeline marker, approximately 40 ft. east of 2 pipeline shutoff values.
Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

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Navajo

LOG OF BORING NCL 95-14

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RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/02/95	Drilling Method:	: Hydraulic push
Time Started	: 0830	Sampling Method:	: 2'x3/4"ID Splitspoon
Date Completed	: 08/02/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 2"	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0					No information.		
5	1	1.5	▨	CL	Clay, dark brown with white flakes, soft, plastic, no odor.	3 - 5	0
	2	2	▨		Same as above. 9 - 10 ft., transition to caliche clay, stiffer, light brown, no odor	8 - 10	0
10	3	2	▨		Caliche clay, light brown, no odor, caliche pebbles in clay at 12 ft.	10 - 12	0
	4	0.3, 2	▨		Caliche clay, frequent caliche inclusions, moist at 12 ft., no odor, no recovery for PID. No recovery for 14-16 or 16-18 ft., pulled out and moved over 3 ft. 12 - 14 ft., Caliche clay, chalk white, small pebbles at 12.5 ft., no odor	12 - 14	0
15	5	2	▨		Caliche clay, chalk white. 15.5 - 16 ft., clay, light brown, slight odor	14 - 16	12
	6	2	▨		Clay, light brown, medium stiff, some gray zones from 16.4 - 16.8 and 17.6 - 17.9 ft., moderate odor.	16 - 18	112
	7	1.8	▥	ML	Clayey silt, saturated. Used hammer at 19 ft.	18 - 20	5
			▒	GC	19.1 - 19.2 ft. small gravel zone, size <1/2 in.		
20			▨	CL	19.2-20.2 ft.,caliche clay, inclusions, poss. slight odor		
	8	2	▒	GC	20.2 - 20.6 ft., clayey gravel, saturated, gravel to 3/4 in. in splitspoon.	20 - 22	2
			▨	CL	Caliche clay, becoming harder with depth. Slight odor on auger near water zone, none in clay on auger tip.		
25							

Notes:
Hole located approximately 1/2 distance between NCL 95-09 and NCL 95-13. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals. On 8/3 redrilled hole 4 ft. north for monitor well, encountered product.

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LOG OF BORING NCL 95-14A, 95-14B, 95-15A

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/95	Drilling Method:	: Solid Stem Auger
Time Started	:	Sampling Method:	: Cuttings
Date Completed	: 08/03/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 3.5 "	Logged By:	: D.G. Boyer

Depth in Feet	GRAPHIC	USCS	DESCRIPTION
0			
5			Notes, NCL 95-14A: Cored to 25 ft., no log record made, hole clean of hydrocarbons. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water.
10			Notes, NCL 95-14B: Redrilled NCL 95-14 at a location 4 ft. north for monitor well installation; encountered free product. No log record made. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water.
15			Notes, NCL 95-15A: Cored to 20 ft. No log record made but observed blue gray clay at approximately 18 ft. PID 51 PPM at 18 - 20 ft. Lowered bailer, product on water, strong odor. Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water.
20			Location Notes: NCL 95-14A located 93 ft. south of NCL 95-14. NCL 95-15 located 79 ft. south of NCL 95-13. NCL 95-15A located 48 ft. west of NCL 95-15. NCL 95-14 located 58 ft. southwest of NCL 95-15A. NCL 95-14A located 99 ft. south of NCL 95-14. NCL 95-14B located 4 ft. north of NCL 95-14. NCL 95-09 located 148 ft. south of NCL 95-14A. NCL 95-16 located 103 ft. southeast of NCL 95-13.
25			
30			

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Navajo

LOG OF BORING NCL 95-15

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RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/02/95	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/02/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D.G. Boyer

Depth in Feet	Samples	Recovery (ft)	GRAPHIC	USCS	DESCRIPTION	PID Interval (ft)	PID (ppm)
0	1	N/A			Location was to be replacement site for well to be installed at NCL 95-14 Sample from cuttings. Saturated from 1 - 5 ft. with diesel (?) hydrocarbons.		
5	2	2	▨	CL	Silty clay, dark brown with white streaks, stained at top and bottom, no odor. 5.5 - 7 ft., clay, dark gray to black, hard, slight septic odor.	5 - 7	5
					No recovery		
10	3	5	▨	CL	Silty clay, gray, strong H/C odor, dry, crumbly. 12.2 - 13 ft., same as above with caliche. 13 - 15 ft., caliche clay, chalk white, no obvious odor.	12 - 14	32
15	4	5	▨		Caliche clay, chalk color, dry crumbly with brownish zones. 16.6 - 19.1 ft., caliche clay, light gray, soft, strong H/C odor. 19.1 - 20 ft., sandy clay, light brown and gray, strong H/C odor.	18 - 20	118
20							
25							
30							

Notes:
Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from the splitspoon at the designated intervals.

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LOG OF BORING NCL 95-16 (MW-56)

(Page 1 of 1)

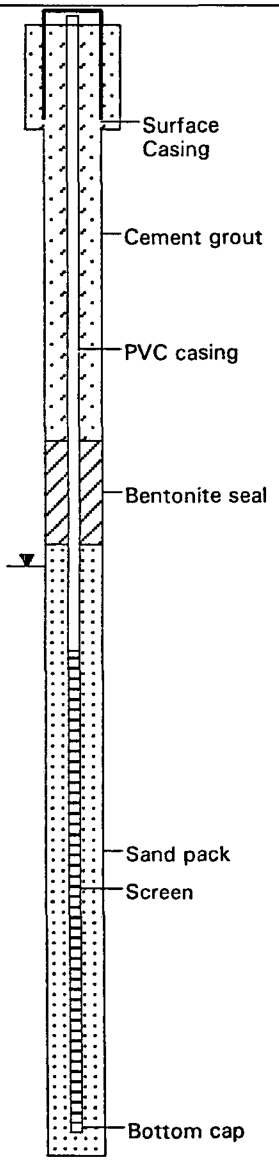
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 08/07/95
Time Started : 1315
Date Completed : 08/07/95
Hole Diameter: : 8 1/4 in. OD

Drilling Method: : Hollow Stem Auger
Sampling Method: : 5 ft. core barrel
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	DESCRIPTION	USCS
0		No information - cored with solid stem auger, 0 - 4 ft.	
5	1	Clay, dark brown with white flecks, stiff, plastic, no odor, 2 ft. recovery	CL
10	2	Same as above. 10.1 - 11.2 ft., caliche clay, chalk and light brown mottling, stiff, slightly damp, no odor. 11.2 - 11.8 ft., same as above, very stiff, no odor, 2.8 ft. recovery.	
15	3	Caliche clay, brown, dry crumbly, no odor. 16.6 - 17.8 ft., gravelly, 2 in. water in hole. 3.8 ft. recovery.	
20	4	19 - 20.6 ft. Clayey gravel to gravell clay, light gray to white, caliche gravel to 1 in.	GC
		20.6 - 24 ft. Silty clay, light brown to chalk color with occassional gravel, 5 ft. recovery	CL
25			
30			

Well: MW-56
ELEV: 3362.05



Notes:
NCL 95-16 located 10 ft. N. of Drum Storage Area wall, 103 ft. SE of 95-13, and 232 ft. SW of MW-45.
Depth to water at 12.1 ft. BLS @1345 8/08.
Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from drill cuttings at designated intervals. On 8/08/95, hole was bailed by drillers to develop.

Well Construction Information

DRILLING INFORMATION

Date completed : 8/07/95
Hole diameter : 8 1/4 in.
Depth Hole BLS : 24 ft.
Drilling Method : HSA
Drilled by : Pool Environmental
Logged by : D. G. Boyer

CASING, SCREEN & CAP

Material, joints : PVC, threaded
Diameter : 2 in. ID
Screen type : Johnson Slotted
Screen length : 10 ft.
Screen opening : 0.010 slot
Scrn. placement : 13.4 - 23.4 ft. BLS
Bottom Cap : 0.2 ft PVC
Protector Casing : Above-ground steel
Lock Key # : P-493

SEALS & SAND PACK

Cement seal type: Cement with 5 % : powered bentonite
Seal placement : 0 - 8.8 ft. BLS
Annular seal type: Med. bentonite : chips, ("Pure Gold")
Seal placement : 8.8 - 11.0 ft. BLS
Sand pack type : 10-20 CSSI silica
Sand placement : 11.0 - 24 ft. BLS

ELEVATIONS

Ground elevation: 3359.13 ft.
Inner casing, top : 3362.05 ft.
Outer casing, top: 3362.42 ft.

NOTES

PID Readings (ppm):

0-4 ft.	Not measured
7-9 ft.	0
12-13 ft.	0
15-16 ft.	2
17-18 ft.	2
20-21 ft.	2
23-24 ft.	4

COMPLETION NOTES:

Driller bailed 6.9 gallons 8/8
Developed with pump 8/9/95
Purged 30 gallons prior to sampling, pumped at 1.6 gpm with pump intake at 20 ft.
Purge info. @30 gal, 0940: 23 C, 4700 umhos, pH 7
Depth to water prior to sampling: 14.4 ft. below top inner casing.

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LOG OF BORING NCL 92-01

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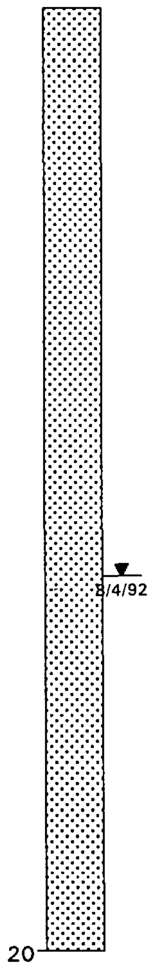
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/03/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION
0	1	▨	CL	0 - 4', Brown loam (clay)
5	2	▨		4' - 7' 10", Silty clay, brownish-red
		▨		7' 10" - 9', Silty clay, gray, strong odor, no free product
10	3	▨		9' - 14', Gray clay, odor, starting to see free product in last foot.
	4	▨		14' - 14' 6", Gray clay, same as above with free product
15		░	GC	14' 6" - 15' 8", Gravel (1 in.), free product, water
		▨	CL	15' 8" - 19', Clay, gray with free product
20				
25				
30				

NCL 92-01
ELEV:



Notes:
Measured open hole on 8/04/92, total depth 17' 3".
Fluid cut 5' 6.75", water cut 5' 2", (prod. thickness 4.75")
Bailed approx. 13 gallons, recovered 10 ml oil

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LOG OF BORING NCL 92-02

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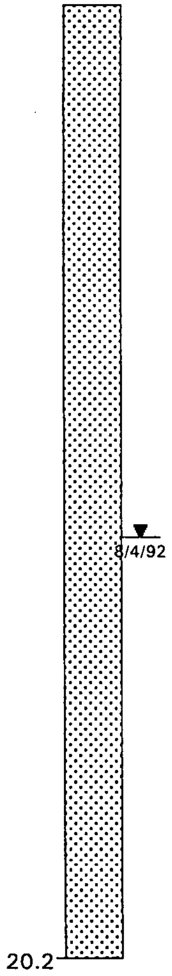
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/03/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION
0	1	▨	CL	0 - 4' 2", Dark brown loam
5	2	▦		4' 2" - 5' 7", Caliche-like rock, off-white with nodules, chalky
		▨	CL	5' 7" - 9' 8", Brown loam
10	3	▨		9' 8" - 12' 6", Brown loam with gypsum nodules, grades into tan then white caliche, damp.
		▦		12' 6" - 14', Caliche, white, damp, plastic
15	4	▨	CL	14' - 14' 1", Gray with odor and plastic 14' 1" - 15' 4", Clay, red, damp, slight odor 15' 4" - 20', Clay, gray with product
20				
25				
30				

NCL 92-02
ELEV:



Notes:
Measured open hole on 8/04/92, total depth 20' 2".
Fluid cut 9' 0.12", water cut 8' 10", (prod. thickness 2")
Bailed approx. 15 gallons, recovered 70 ml oil

LOG OF BORING NCL 92-03

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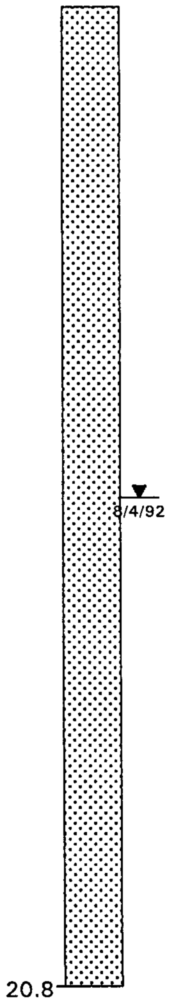
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/03/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION
0				
	1			0 - 4', Brown loam with roots
5				4' - 6' 2", Brown loam, very few roots last foot
	2			6' 2" - 9', White to light gray, clayey, silty, with some gravel. No odor, some roots.
10				
	3		CL	9' - 14', Same as above, gypsum crystals, increasing with depth.
15				
	4			14' - 19', Same as above, light gray grading to dark gray in bottom, very slight odor of hydrocarbon, no free product.
				19' - 20.6', Dark gray, as above.
20				
	5			20.6' - 24', Drilled extremely fast, no detection of free product, but some water; odor of hydrocarbon.
25				
30				

NCL 92-03
ELEV:



Notes:
Measured open hole on 8/04/92, total depth 20' 10".
Water cut 10' 5.75", bailed approx. 15 gallons, skim of oil.

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Navajo

LOG OF BORING NCL 92-04

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RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/03/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/03/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION	NCL 92-04 ELEV:
0	1	▨	CL	0 - 5', Brown loam, no roots	░
5	2	▨	CL	5' - 9', Loam, tan, clayey, caliche with nodules	░
10	3	▨	CL	9' - 11' 2", Same as above.	░
		▨	CL	11' 2" - 14', Dark gray, strong H/C odor	░
15	4	▨	CL	14' - 19', Same as above, free product on last 1".	░
20	5	▨	CL	19' - 21' 4", Same as above, free product.	░
		░	GC	21' 4" - 22' 6", 2 " gravel, as above, with water.	░
		▨	CL	22' 6" - 24', Dark gray, strong H/C odor.	░
25					24
30					

Notes:
Measured open hole on 8/04/92, bailed 8 bailers, no oil.
(No water measurement recorded)

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LOG OF BORING NCL 92-05

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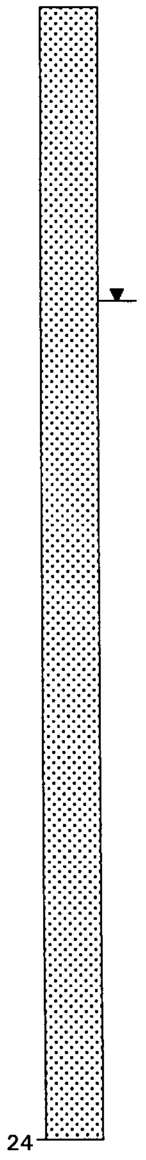
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/05/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/05/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore

Depth in Feet	Samples	GRAPHIC	USCS	DESCRIPTION
0	1			0 - 2', Brown sandy loam 2' - 3', Brown sandy loam with gravel 3' - 4', Brown sandy loam with H/C odor and color
5	2			4' - 9', Sandy, silty clay with plasticity, strong odor and gray-dark gray color, no free product.
10	3		CL	9' - 14', Sandy clay, gray-dark gray, strong odor, no free product.
15	4			14' - 16' 1", Same as above with 1/4" gravel (water zone?), no free product. 16' 1" - 19', Sandy clay, light brown with caliche nodules
20	5			19' - 24', Same as above, nodules getting larger.
25				Notes: Cored in Eagle Draw Measured open hole on 8/06/92, total depth 20', fluid cut 13' 8", water cut 13' 9.25", (product thickness approx. 1.25"), skim of oil.
30				

NCL 92-05
ELEV:



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LOG OF BORING NCL 92-06

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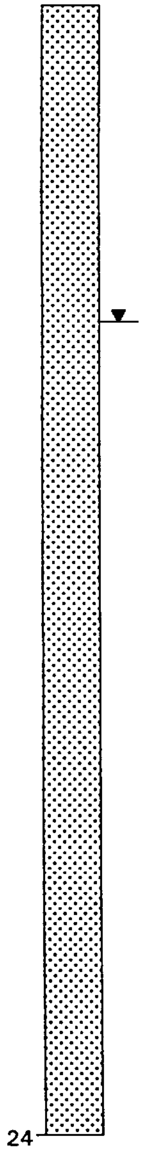
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/05/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/05/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore

Depth in Feet	Samples	USCS	DESCRIPTION
0	1	CL	0 - 2', Dark brown sandy loam
			2' - 5', Light brown sandy clay
5	2		5' - 6', Light gray sandy clay,H/C odor
			6' - 9', Same as above, getting sandier.
10	3		9' - 12', Sandy gray clay, with H/C odor.
			12' - 13', As above with 1/8" gravel
			13' - 14', Drilling break, no recovery.
15	4		14' - 19', Sandy gray clay with H/C odor, water in last 1 ft.
20	5		19' - 24', Sandy gray clay with water, H/C odor.
25			
30			

NCL 92-06
ELEV:



Notes:
Cored in Eagle Draw
Measured open hole on 8/06/92, total depth 18' 11", fluid cut 12' 10.25", water cut 12' 10.13", skim of oil.

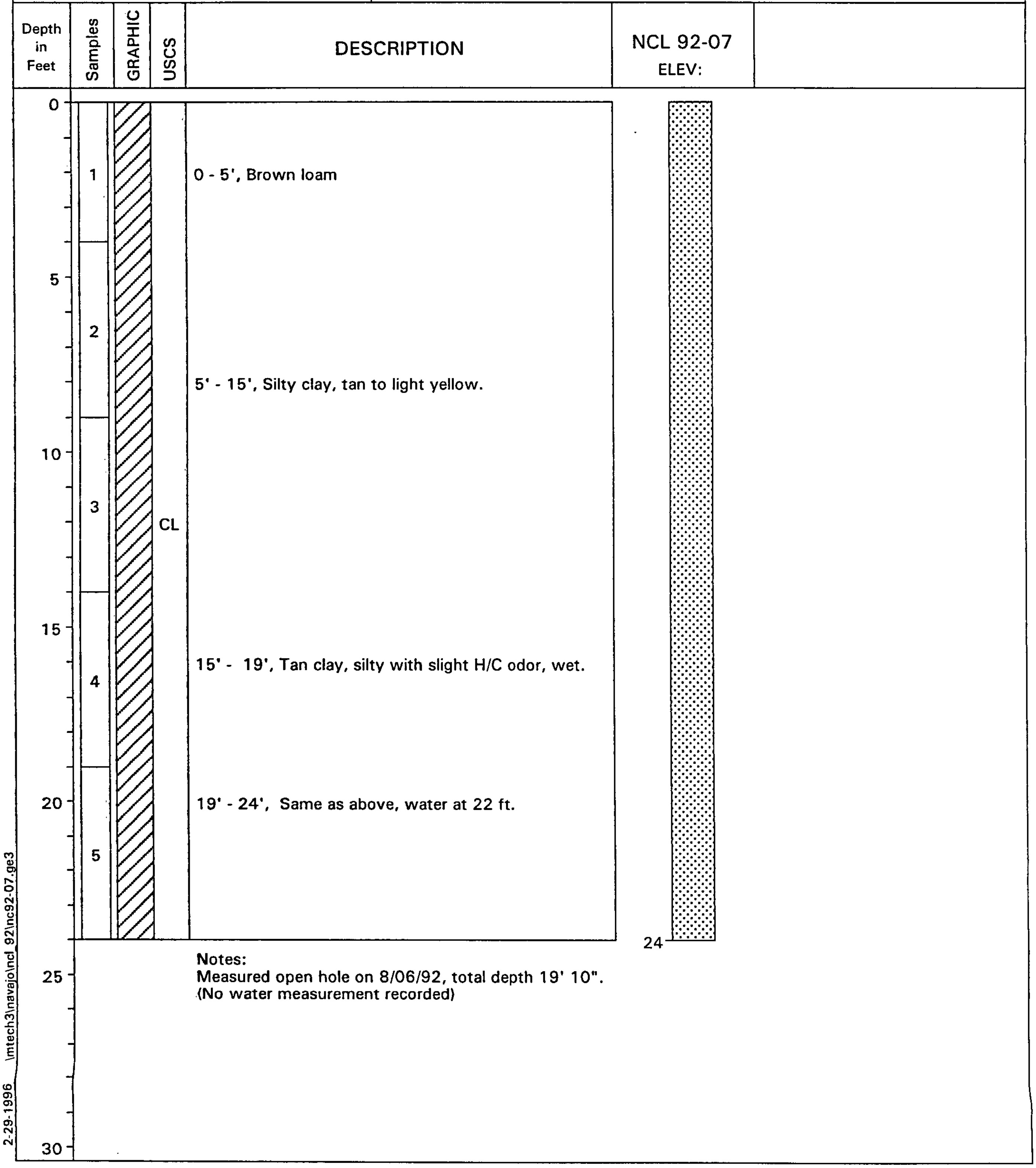
Navajo

LOG OF BORING NCL 92-07

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 08/05/92	Drilling Method:	: Hollow Stem Auger
Time Started	:	Sampling Method:	: 5 ft. core barrel
Date Completed	: 08/05/92	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in.	Logged By:	: D. Moore



0 - 5', Brown loam

5' - 15', Silty clay, tan to light yellow.

15' - 19', Tan clay, silty with slight H/C odor, wet.

19' - 24', Same as above, water at 22 ft.

Notes:
Measured open hole on 8/06/92, total depth 19' 10".
(No water measurement recorded)

2-29-1996 \mtech3\navajo\ncl 92\nc92-07.ge3

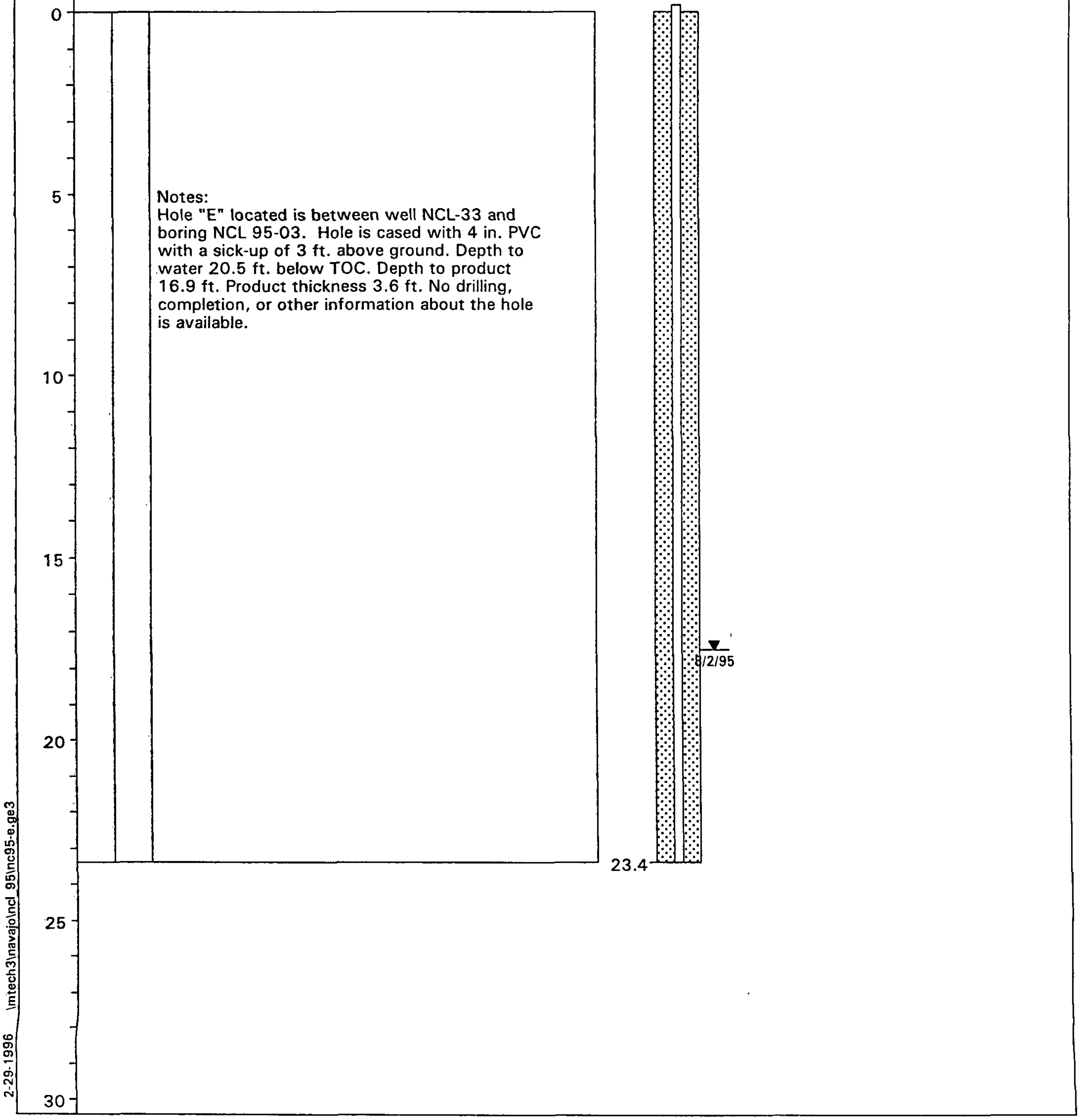
LOG OF BORING NCL 95-E

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: Unknown	Drilling Method:	: Unknown
Time Started	: N/A	Sampling Method:	: N/A
Date Observed	: 06/24/95	Drilled By:	: Unknown
Hole Diameter:	: N/A	Information By:	: D.G. Boyer

Depth in Feet	GRAPHIC	USCS	DESCRIPTION	ELEV:	



Notes:
Hole "E" located is between well NCL-33 and boring NCL 95-03. Hole is cased with 4 in. PVC with a sick-up of 3 ft. above ground. Depth to water 20.5 ft. below TOC. Depth to product 16.9 ft. Product thickness 3.6 ft. No drilling, completion, or other information about the hole is available.

2-29-1996 \mtech3\navajo\ncl 95\nc95-e.ge3

APPENDIX A2

MONITOR WELL CONSTRUCTION LOGS

Navajo

LOG OF BORING MW-53

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

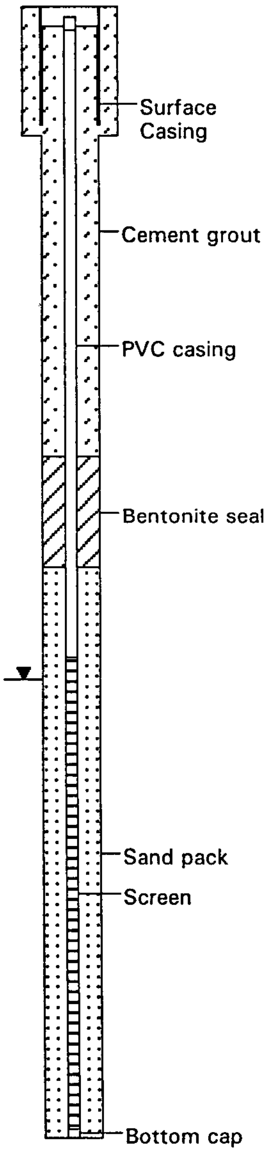
Date Started: : 06/25/95
Time Started : 0900
Date Completed : 06/25/95
Hole Diameter: : 2"

Drilling Method: : Hydraulic push
Sampling Method: : 2'x3/4"ID Splitspoon
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	DESCRIPTION	GRAPHIC	USCS
0		No information		
	1	Silt, light brown, grading to silty clay at 4 ft.	▥	ML
5		4 - 4 ft., clay, brown, white calcite (?) streaks, dry, crumbly, no odor, 1.3 ft. recovery	▨	CL
	2	Clay, light brown to chalk color, small calcite (?) crystals, no odor, 1.5 ft. recovery	▨	
10	3	Same as above with increasing caliche clay, no odor, 1.5 ft. recovery	▨	
	4	Clay, light brown, slightly plastic, becoming crumbly at 12.4 ft., pebble (1/2 in.) at 14 ft., no odor, 2 ft. recovery.	▨	
15	5	Caliche gravel and light brown clay, dry. At 15.2 ft., clay, brown, plastic At 15.6 ft., gravel and caliche to 16 ft., size to 3/4 in., no odor, 2 ft. recovery.	▨	
	6	Same as above. At 16.4 ft., clay, light brown to gray, hard, slightly plastic. At 17.5 ft., silty clay, brown, moist, expansive in split spoon, no odor, 2 ft. recovery. Clay, brown, slightly plastic.	▨	
	7	18.7 - 19.1 ft., clayey gravel, dry	▩	GC
20		19.1 - 20 ft., clay, brown, soft (no moisture), occasional gravel, no odor, 2 ft. recovery.	▨	CL
	8	Clay, light brown, slightly plastic, but generally hard, no odor, 2 ft. recovery.	▨	
	9	Clay, light brown, occasional small gravel, caliche zones (0.1 - 0.2 ft. thick) at 22.2, 22.7 and 23.8 - 24 ft., clay expanded in spoon, no odor, 2 ft. recovery.	▨	
25	10	Clay, light brown, occasional small gravel and caliche zones, no odor, 2 ft. recovery.	▨	
30				

Notes:
Completed hydraulic push at 1000, began auger drilling at 1015. Water on bit at 20 ft, none seen in hole. Auger hole drilled to 24 ft. No PID measurements. Depth to water at 14.24 ft. BLS @ 0915 6/29.

Well: MW-53
ELEV: 3367.67



Well Construction Information

DRILLING INFORMATION
Date completed : 6/25/95
Hole diameter : 8 1/4 in.
Depth Hole BLS : 24
Drilling Method : HSA
Drilled by : Pool Environmental
Logged by : D. G. Boyer

CASING, SCREEN & CAP
Material, joints : PVC, threaded
Diameter : 2 in. ID
Screen type : Johnson Slotted
Screen length : 10 ft.
Screen opening : 0.010 slot
Scrn. placement : 13.8 - 23.8 ft. BLS
Bottom Cap : 0.2 ft PVC
Protector Casing : Flush-mount steel
Lock Key # : P-493

SEALS & SAND PACK
Cement seal type: Cement with 5 % : powered bentonite
Seal placement : 0 - 9.5 ft. BLS
Annular seal type: Med. bentonite : chips, ("Pure Gold")
Seal placement : 9.5 - 11.9 ft. BLS
Sand pack type : 10-20 CSSI silica
Sand placement : 11.9 - 24 ft. BLS

ELEVATIONS
Ground elevation : 3367.71 ft.
Inner casing, top : 3367.67 ft.
Outer casing, top: 3367.87 ft.

NOTES

PID Readings (ppm):

0-3 ft.	Not measured
3-5 ft.	11
8-10 ft.	16
10-12 ft.	9
12-14 ft.	8
14-16 ft.	93
16-18 ft.	96
18-20 ft.	21
20-22 ft.	21
22-24 ft.	18
24-26 ft.	15

(Note: PID likely impacted by moisture or exhibited carry-over from previous sample)

COMPLETION NOTES:
Driller bailed well 6/25/95 to develop. Developed with pump 6/29/95. Purged 30 gallons prior to sampling, pumped approx. 0.5 gpm.
Purge info. @30 gal, 1030: 24 C, 2600 umhos, pH 7
Depth to water prior to sampling: 14.24 ft. below top inner casing.

2-29-1996 \mtech3\navajo\ncl 95\mw-53.ge3

LOG OF BORING MW-54A

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

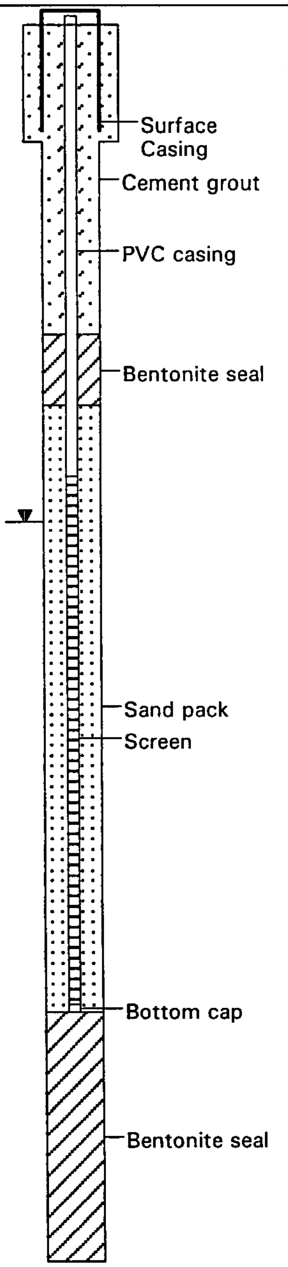
Date Started: : 12/14/95
Time Started : 1300
Date Completed : 12/14/95
Hole Diameter: : 8 1/4 in. OD

Drilling Method: : Hollow Stem Auger
Sampling Method: : 5 ft. core barrel
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	DESCRIPTION	USCS
0		Cored with solid stem auger, 0-5 ft. 0-2.5 ft. Clayey silt, brown, some roots, dry. Log from cuttings.	ML
		2.5-5 ft. Silty clay, light brown, dry	CL
5	1	Clay and caliche. Silty clay, light brown, very dry. Caliche inclusions in clay, chalk color with very small crystals. 2.2 ft. recovery.	
10	2	Clay with caliche 11.9-12.7 ft. Clay, light brown to brown, slightly moist, soft 12.7-14.7 ft. Same as above with caliche gravel to 1 1/4 in. 4.7 ft. recovery.	
15	3	15-16.4 ft. Silty clay, light brown, slightly damp. 16.4-18 ft. Same as above, color alternating brn and lt. brn, H/C odor, black streaks at 16.4 ft. 18-18.8 ft. Clay, light brown, no odor. 3.8 ft. recovery.	
20	4	20-20.4 ft. Clay, light brown, saturated, cohesive, plastic. 21.3-22 ft. Silty clay.	
		22-23.4 ft. Clayey caliche gravels, generally small (<1/2") but some >3", saturated.	GC
		23.4-25 ft. Clay with occassional gravel. 5 ft. recovery..	CL
25	5	25-26.9 ft. Silty clay, moist with occassional gravel.	
		26.9-27.3 ft. Clayey silt, wet, some small gravel.	ML
		27.3-29 ft. Silty clay, brown, moist.	CL
		29-30.4 ft. Silty clay w/some sand and v. fine gravels. 5 ft. recovery.	ML
30	6	30.4-31 ft. Silty gravel	GM
		31-33 ft. Silty sand, light brown, very fine grained with some clay and gravel, saturated. 33-35 ft. Sand increasing with gravels. River gravels at 35 ft., flat to 3 in. 5 ft. sample recovery	SM
35			
40			

Notes:
6 in. smear of product on auger when retreived. Backfilled hole to 27.5 ft. with *medium bentonite chips.*
Depth to water at 14.1 ft. BLS @1130 12/15
Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from drill cuttings at designated intervals.

Well: MW-54A
ELEV: 3365.38



Well Construction Information

DRILLING INFORMATION
Date completed : 12/14/95
Hole diameter : 8 1/4 in.
Depth Hole BLS : 35
Drilling Method : HSA
Drilled by : Pool Environmental
Logged by : D. G. Boyer

CASING, SCREEN & CAP
Material, joints : PVC, threaded
Diameter : 2 in. ID
Screen type : Johnson Slotted
Screen length : 15 ft.
Screen opening : 0.010 slot
Scrn. placement : 12.7 - 27.7 ft. BLS
Bottom Cap : 0.2 ft PVC
Protector Casing : Above-ground steel
Lock Key # : P-493

SEALS & SAND PACK
Cement seal type: Cement with 5 % : powered bentonite
Seal placement : 0 - 8.7 ft. BLS
Annular seal type: Med. bentonite : chips, ("Pure Gold")
Seal placement : 8.7 - 10.7 ft. BLS
Sand pack type : 10-20 CSSI silica
Sand placement : 10.7 - 27.7 ft. BLS

ELEVATIONS
Ground elevation: 3361.96 ft.
Inner casing, top : 3365.38 ft.
Outer casing, top: 3365.66 ft.

NOTES

PID Readings (ppm):
(Readings from NCL 95-01)

0-5 ft.	3
5-10 ft.	1
10-15 ft.	5
15-20 ft.	908

COMPLETION NOTES:

12/15/95
Developed with pump, purged approx. 120 gallon to clean, test @ 1.3 gpm with 4' drawdow

12/22/95
Purged 6 gallons prior to sampling, @ 1310: 2500 umhos, pH 7
Depth to water prior to sampling: 17.47 ft. below top inner casing.

LOG OF BORING MW-54B

(Page 1 of 1)

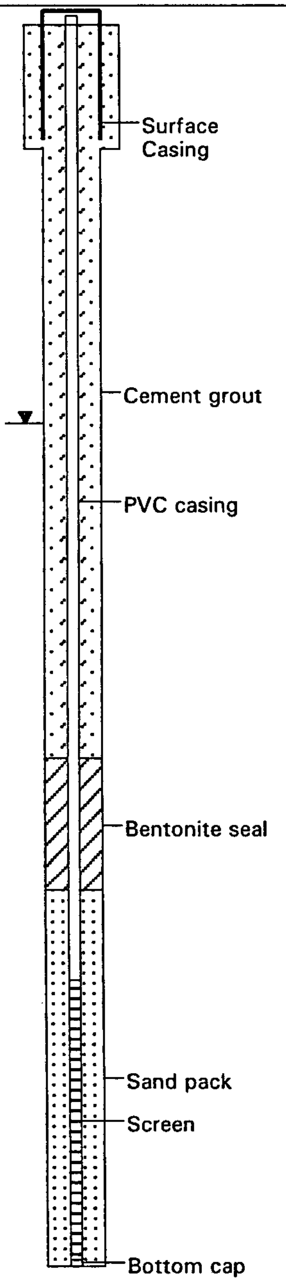
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started:	: 12/19/95	Drilling Method:	: Hollow Stem Auger
Time Started	: P.M.	Sampling Method:	: 5 ft. core barrel
Date Completed	: 12/20/95	Drilled By:	: Pool Environmental
Hole Diameter:	: 8 1/4 in. OD	Logged By:	: D.G. Boyer

Well: MW-54B
ELEV: 3365.36

Depth in Feet	Samples	DESCRIPTION	USCS
5		Located 12 ft. NE of MW-54A, drilled with 12 in. OD HSA to 30 ft., no boring log record. Left auger in ground for temp. protection/surface casing.	
10		Followed in hole with 8 1/4 in. auger with 5 ft. core barrel (Size 12 in.OD, 9 1/2 in.ID). Installed well with base at 44 ft.	
30	1	29-32.5 ft. Silty clay, light brown, slightly moist, plastic, occ. gravel (to 2") every 18 in., no odor, becoming slightly sandy,wet @43.5 ft	CL
		32.5-34.6 ft. Clayey sand, light brn. 4 ft. recovery.	SC
35	2	34.6-36.8 ft. Sandy clay, very fine-grained sand.	SC
		36.8-37.8 ft. Gravels with clay. River gravel, smooth, rounded, gray to 3 in., saturated. 4 ft. recovery.	GC
		37.8-38.5 ft. Sandy clay.	CL
40	3	38.5-42 ft. Gravels, clean, pea-sized up to 3 in.(mainly 3/4-1 1/2 in.)	GW
		42-44 ft. Clayey gravel.	GC
45	4	44-48 ft. Clay, brown, stiff, dry. 5 ft. recovery	CH

Notes:
Auger jammed w/rock @ 41.5 ft., pulled out core barrel, cleaned, reentered hole.



Well Construction Information

DRILLING INFORMATION

Date completed	: 12/20/95
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 48
Drilling Method	: HSA
Drilled by	: Pool Environmental
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 10 ft.
Screen opening	: 0.010 slot
Scrn. placement	: 33.8 - 43.8 ft. BLS
Bottom Cap	: 0.2 ft PVC
Protector Casing	: Above-ground steel
Lock Key #	: P-493

SEALS & SAND PACK

Cement seal type:	Cement with 5 % : bentonite, tremied
Seal placement	: 0 - 26 ft. BLS
Annular seal type:	Liquid bentonite : grout
Seal placement	: 26 - 30.6 ft. BLS
Sand pack type	: 10-20 CSSI silica
Sand placement	: 30.6 - 44 ft. BLS

ELEVATIONS

Ground elevation:	3362.05 ft.
Inner casing, top :	3365.36 ft.
Outer casing, top:	3365.59ft.

NOTES

No PID Readings taken.

COMPLETION NOTES:

Installed well with base at 44 ft. Upon completion, used 17 bags sand to 32 ft. When pulled outer auger, bridged sand rises to 30.6 ft. Added 5 ft. liquid bentonite grout. Cemented to surface with cement grout, mixed in grout tank at ratio of 3 bags cement with 1 cup bentonite powder.

12/21/95
Developed with pump.

12/22/95
Purged 15 gallons prior to sampling, @ 1219: 2400 umhos, pH 7
Depth to water prior to sampling: 17.44 ft. below top inner casing.

2-29-1996 \mtech3\navajo\ncl 95\mw-54b.ge3

Navajo

LOG OF BORING MW-55 (NCL 95-07)

(Page 1 of 1)

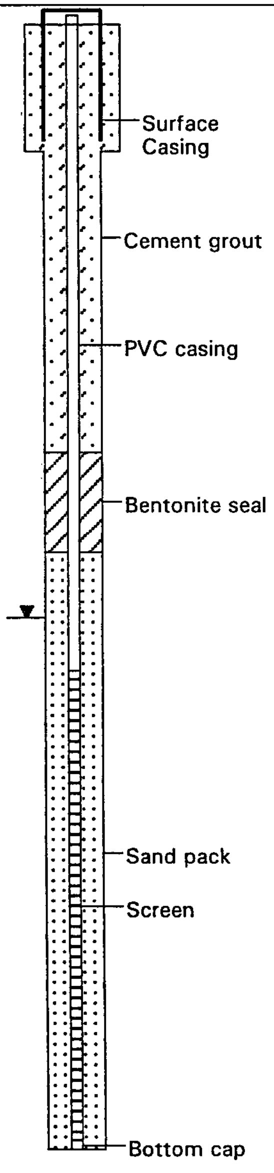
RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

Date Started: : 06/25/95
Time Started : 1215
Date Completed : 06/25/95
Hole Diameter: : 2"

Drilling Method: : Hydraulic push
Sampling Method: : 2'x3/4"ID Splitspoon
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	DESCRIPTION	GRAPHIC	USCS
0		No information		
5	1	Clay, brown with white streaks, lighter brown at 4.2 ft., no odor, 1.2 ft. recovery	▨	CL
	2	Clay, brown to chalk color, dry, crumbly, caliche clay at 8 ft., some brown staining on core surface, 1.7 ft. recovery	▨	
10	3	Clay, light brown with soft zones every few inches, extensive small crystals where soft, 2 ft. recovery	▨	
	4	Clay, light brown, fewer zones with crystals, 1 ft. recovery	▨	
15	5	Clay, light brown, no caliche zones, lighter color and softer at 16 ft., 2 ft. recovery	▨	
	6	Clay, very light brown, hard, 2 ft. recovery	▨	
	7	Clay, brown, some lighter color zones, no caliche, 2 ft. recovery	▨	
20	8	Same as above, 2 ft. recovery,	▨	
25				
30				

Well: MW-55
ELEV: 3363.57



Notes:
No odor in any core sample
Depth to water at 17.3 ft. BLS @1600 6/25.
Plugged back hole with medium bentonite chips, hydrated with 5 gallons fresh water. Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from drill cuttings at designated intervals. On 8/08/95, hole was redrilled and completed as MW-55 with DTW of 12.3 ft. BLS.

Well Construction Information

DRILLING INFORMATION
Date completed : 8/08/95
Hole diameter : 8 1/4 in.
Depth Hole BLS : 23.9 ft.
Drilling Method : HSA
Drilled by : Pool Environmental
Logged by : D. G. Boyer

CASING, SCREEN & CAP
Material, joints : PVC, threaded
Diameter : 2 in. ID
Screen type : Johnson Slotted
Screen length : 10 ft.
Screen opening : 0.010 slot
Scrn. placement : 13.7 - 23.7 ft. BLS
Bottom Cap : 0.2 ft PVC
Protector Casing : Above-ground steel
Lock Key # : P-493

SEALS & SAND PACK
Cement seal type: Cement with 5 % : powered bentonite
Seal placement : 0 - 9.1 ft. BLS
Annular seal type: Med. bentonite : chips, ("Pure Gold")
Seal placement : 9.1 - 11.2 ft. BLS
Sand pack type : 10-20 CSSI silica
Sand placement : 11.2 - 23.9 ft. BLS

ELEVATIONS
Ground elevation: 3360.75 ft.
Inner casing, top : 3363.57 ft.
Outer casing, top: 3363.97 ft.

NOTES

PID Readings (ppm):

0-3 ft.	Not measured
3-5 ft.	30
8-10 ft.	49
10-12 ft.	45
12-14 ft.	29
14-16 ft.	34
16-18 ft.	22
18-20 ft.	18
20-22 ft.	18

(Note: PID likely impacted by moisture or exhibited carry-over from previous sample)

COMPLETION NOTES:

Driller bailed 22 gallons 8/8
Developed with pump 8/9/95
Purged 30 gallons prior to sampling, pumped at 1.5 gpm with pump intake at 20 ft.
Purge info. @25gal, 0855: 22 C, 2800 umhos, pH 7
Depth to water prior to sampling: 15.36 ft. below top inner casing.

LOG OF BORING MW-56 (NCL 95-16)

(Page 1 of 1)

RFI Phase II
North Colony Landfarm
Navajo Refining Company
Artesia, New Mexico

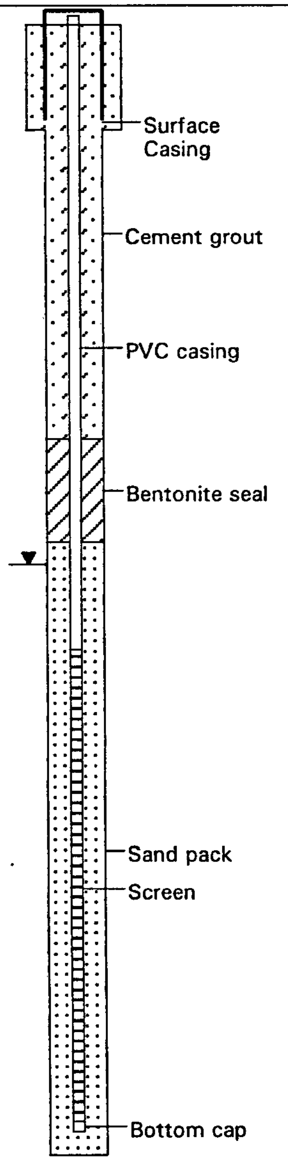
Date Started: : 08/07/95
Time Started : 1315
Date Completed : 08/07/95
Hole Diameter: : 8 1/4 in. OD

Drilling Method: : Hollow Stem Auger
Sampling Method: : 5 ft. core barrel
Drilled By: : Pool Environmental
Logged By: : D.G. Boyer

Depth in Feet	Samples	DESCRIPTION	GRAPHIC	USCS
0		No information - cored with solid stem auger, 0 - 4 ft.		
5	1	Clay, dark brown with white flecks, stiff, plastic, no odor, 2 ft. recovery	▨	CL
10	2	Same as above. 10.1 - 11.2 ft., caliche clay, chalk and light brown mottling, stiff, slightly damp, no odor. 11.2 - 11.8 ft., same as above, very stiff, no odor, 2.8 ft. recovery.	▨	
15	3	Caliche clay, brown, dry crumbly, no odor. 16.6 - 17.8 ft., gravelly, 2 in. water in hole. 3.8 ft. recovery.	▨	
20	4	19 - 20.6 ft. Clayey gravel to gravelly clay, light gray to white, caliche gravel to 1 in.	░	GC
		20.6 - 24 ft. Silty clay, light brown to chalk color with occassional gravel, 5 ft. recovery	▨	CL
25				
30				

Notes:
NCL 95-16 located 10 ft. N. of Drum Storage Area wall, 103 ft. SE of 95-13, and 232 ft. SW of MW-45.
Depth to water at 12.1 ft. BLS @1345 8/08.
Photoionization Detector (PID) readings are from jar headspace analysis of grab samples taken from drill cuttings at designated intervals. On 8/08/95, hole was bailed by drillers to develop.

Well: MW-56
ELEV: 3362.05



Well Construction Information

DRILLING INFORMATION

Date completed	: 8/07/95
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 24 ft.
Drilling Method	: HSA
Drilled by	: Pool Environmental
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 10 ft.
Screen opening	: 0.010 slot
Scrn. placement	: 13.4 - 23.4 ft. BLS
Bottom Cap	: 0.2 ft PVC
Protector Casing	: Above-ground steel
Lock Key #	: P-493

SEALS & SAND PACK

Cement seal type:	Cement with 5 % : powered bentonite
Seal placement	: 0 - 8.8 ft. BLS
Annular seal type:	Med. bentonite : chips, ("Pure Gold")
Seal placement	: 8.8 - 11.0 ft. BLS
Sand pack type	: 10-20 CSSI silica
Sand placement	: 11.0 - 24 ft. BLS

ELEVATIONS

Ground elevation:	3359.13 ft.
Inner casing, top :	3362.05 ft.
Outer casing, top:	3362.42 ft.

NOTES

PID Readings (ppm):

0-4 ft.	Not measured
7-9 ft.	0
12-13 ft.	0
15-16 ft.	2
17-18 ft.	2
20-21 ft.	2
23-24 ft.	4

COMPLETION NOTES:

Driller bailed 6.9 gallons 8/8
Developed with pump 8/9/95
Purged 30 gallons prior to sampling, pumped at 1.6 gpm with pump intake at 20 ft.
Purge info. @30 gal, 0940: 23 C, 4700 umhos, pH 7
Depth to water prior to sampling: 14.4 ft. below top inner casing.

APPENDIX A3

SUPPLEMENTAL LITHOLOGIC BORING LOGS

BORING LOG

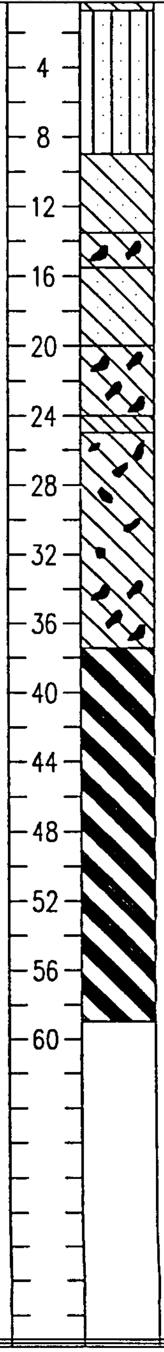
PROJECT: 622093002-252 (NR-DB)
CLIENT: Navajo Refinery
BORING NUMBER: Deep Boring
EXCAVATED POND:
FIRST ENCOUNTERED WATER: 21.0'
DATE COMPLETED: 05/12/94

SHEET: 1 of 2
DRILLED BY: Precision Eng.
LOGGED BY: PWC
SURF. ELEV:
TOTAL DEPTH: 100'

DESCRIPTION

DEPTH (ft.) | SYMBOL | SAMPLE | WELL DESIGN

0-0.5'	Top Soil - brown clayey sand, roots and root systems, moist, dense.
0.5-9.0'	SITLY SAND, tan, dry, loose to medium dense. -carbonate replacement beginning @ 5.0' -milky white carbonate sands and pebbles increase in frequency with depth
9.0-13.5'	CLAYEY SAND, brown with milky white carbonate mottling, slightly moist, dense.
13.5-15.5'	CLAYEY SAND interbedded with carbonate gravels, brown and white with grey hydrocarbon motting associated with gravel seam, moist, medium dense sand. -gravel provides pathway for moisture -hydrocarbon smell moderate
15.5-20.0'	CLAYEY SAND, brown, moist to slightly moist, dense. -hydrocarbon odor disappears from soil @ 16.5'
20.0-24.0'	CLAYEY SAND interbedded with carbonate gravel seams, brown and white, very moist to saturated @ 21.0', dense.
24.0-25.0'	SITLY CLAY, brown, moist, firm.
25.0-37.5'	CLAY interbedded with carbonate gravel seams, clay is brown, gravel is white, clay is moist with saturation along gravel seams, clay is firm to stiff, gravel seams are typically less then 6" in thickness and interbedded with the clay between 1.0-2.0' intervals. -Note: saturated zones appear to be interconnected from 20.0-37.5'
37.5-59.0'	CLAY, brown, dry, very stiff. -occasionally carbonate pebbles and gravel are noted in the column, dry.



KWBES

BORING LOG

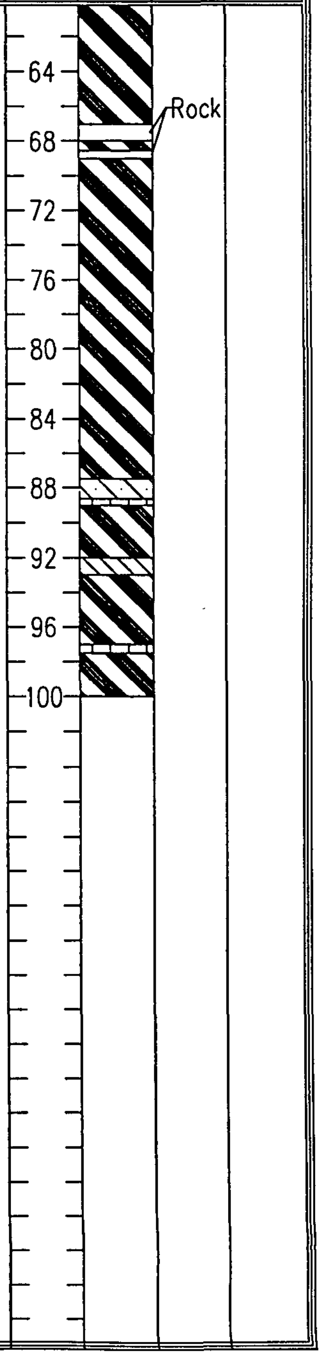
PROJECT: 622093002-252 (NR-DB)
CLIENT: Navajo Refinery
BORING NUMBER: Deep Boring
EXCAVATED POND:
FIRST ENCOUNTERED WATER: 21.0'
DATE COMPLETED: 05/12/94

SHEET: 2 of 2
DRILLED BY: Precision Eng.
LOGGED BY: PWC
SURF. ELEV:
TOTAL DEPTH: 100'

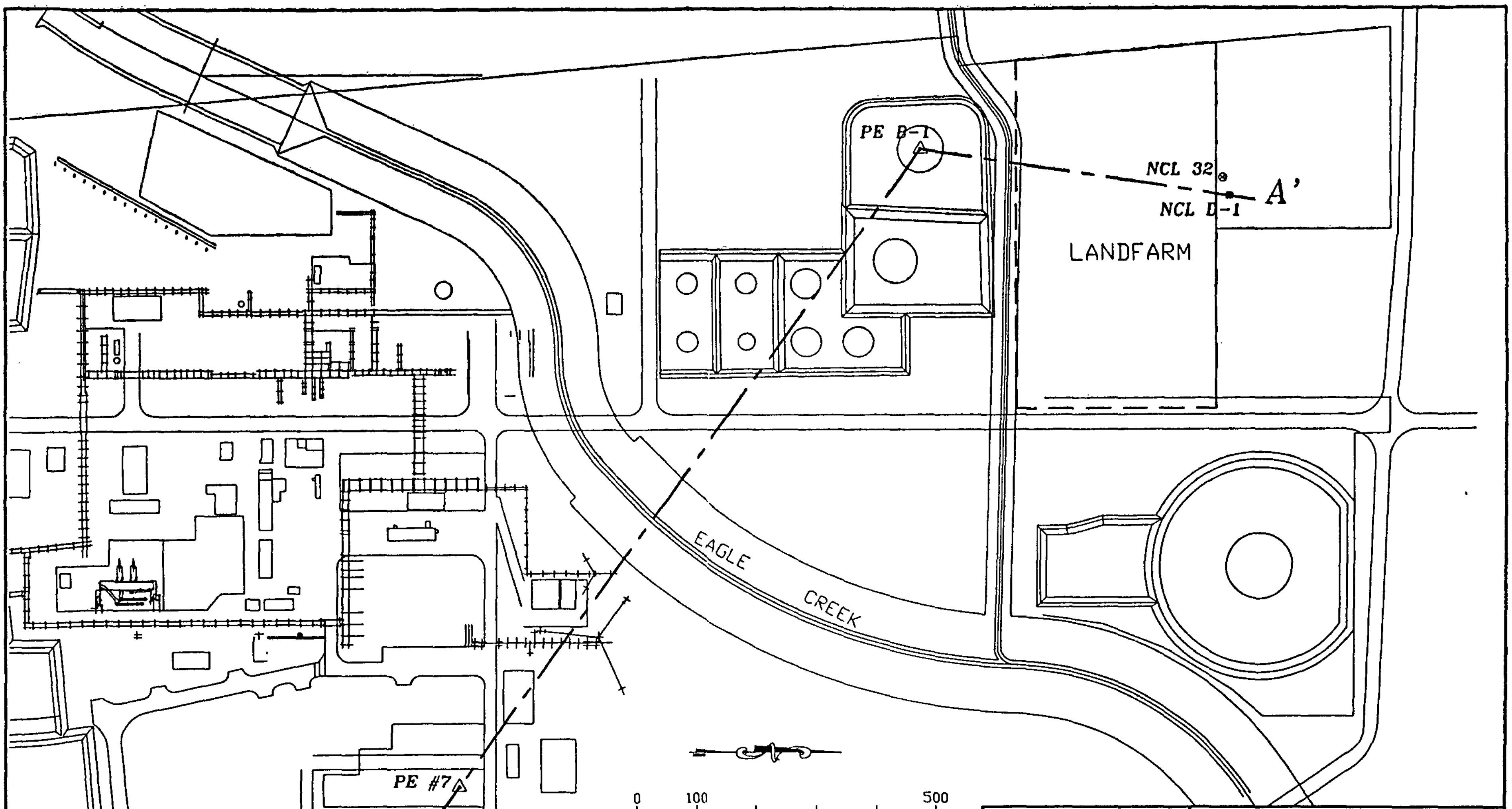
DESCRIPTION

DEPTH (ft.) | SYMBOL | SAMPLE | WELL DESIGN

59.0-67.0'	CLAY, greenish grey grading to brown, dry, very hard. -occasionally carbonate pebbles noted in column, dry
67.0-68.0'	Carbonate Rock, white, auger refusal, drilled with bit, dry.
68.0-68.5'	CLAY, brown, dry, very hard.
68.5-69.0'	Carbonate Rock, white, auger refusal, drilled with bit, dry.
69.0-87.5'	CLAY, brown, dry, hard. -occasionally carbonate pebbles noted in column, dry
87.5-88.5'	CLAYEY SAND, brown, dry, very dense.
88.5-89.0'	SILTY SAND, brown, dry, very dense.
89.0-92.0'	CLAY, brown, dry, hard.
92.0-93.0'	SITLY CLAY, brown, slightly moist, firm.
93.0-97.0'	CLAY, brown, dry, hard.
97.0-97.5'	SILTY SAND, brown, slightly moist, very dense.
97.5-100.0'	CLAY, brown, dry, hard.



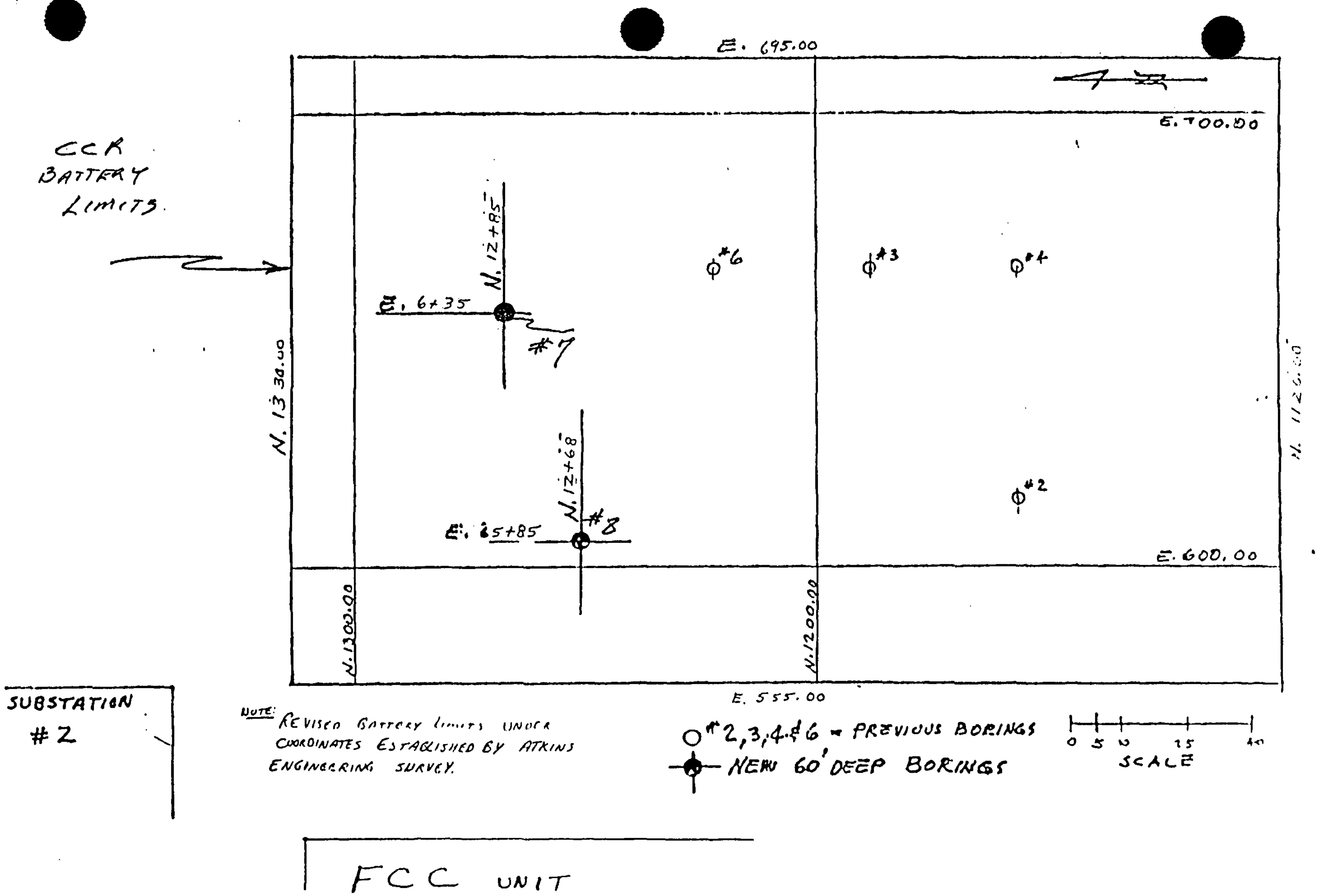
KWBES



RE/SPEC INC.
3824 JET DRIVE
P.O. BOX 725
RAPID CITY
SOUTH DAKOTA
57709
PH. (605) 394-6400

CROSS-SECTION LOCATION
NAVAJO DEEP BORINGS

PROJECT: 327-94-006
LOCATION: NAVAJO REFINERY, ARTESIA, NM
APPR:
DATE:
DRAWN BY: TLH
SCALE:
DATE: 7/21/94
FIGURE: FIGURE 7-1



NOTE: REVISED BATTERY LIMITS UNDER COORDINATES ESTABLISHED BY ATKINS ENGINEERING SURVEY.

Precision Engineering Location Sketch Map for Boring PE #7 (Refer to Figure 7-1)

SHEET 1 OF *8*

PRECISION ENGINEERING, INC.

File No. 89-117

ing Location: SEE SITE PLAN

LOG OF TEST BORINGS

Location Artesia, NM

Elevation Existing

Boring Number: SEVEN

Water Level 14.5 Date: 4/09/90

LAB #	DEPTH	BLOWS/N	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	%M	LL	PI	CLASS.
	0.0 - 4.0		\-\	2.5		CLAY, SILTY, SOFT, MOIST, ORANGE BROWN TO DARK BROWN, HYDROCARBON ODOR	11.4			
	4.0 - 7.0		\-\	5		CLAY, SILTY, FIRM, MOIST, BROWN w/WHITE GYPSIFEROUS MOTTLING, STRONG HYDROCARBON ODOR GRADES FROM ABOVE INTO MOTTLED MATERIAL				
	7.0 - 12.0		\-\	10		CLAY, GREY TO BLACK, VERY STIFF, HYDROCARBON ODOR, MOIST BLUE-GRAY, HARD				
	12.0-13.0		o o			SAND, SILTY, MODERATELY DENSE, BLUE-GREY, HYDROCARBON ODOR				
	13.0-19.0		\-\	15		CLAY, GREY TO BLUE, STIFF, HYDROCARBON ODOR SCATTERED FINE GRAVEL ENCOUNTERED HIGH MOISTURE CONDITIONS @ 19.0' WET				
	19.0-50.0		\\\	20		CLAY, STIFF, BROWN TO PINK, WEAK CARBONATE INDURATION (CCI 1 OR LESS), LESS CARBONATE PRODUCES DARKER RED COLOR IN CLAY, WATER BEARING TO APPROX 23'. WATER APPEARS PERCHED. CONTINUED ON NEXT PAGE				

Size & Type of Boring: 5-5/8" OD Hollow Stemmed Auger

Logged By: PJ

EET 2 OF *8*

PRECISION ENGINEERING, INC.

File No. 89-117

ring Location: SEE SITE PLAN

LOG OF TEST BORINGS

Location Artesia, NM

Elevation Existing

Boring Number: SEVEN

Water Level 14.5

Date: 4/09/90

LAB #	DEPTH	BLOWS/N	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	%M	LL	PI	CLASS.
			\\\\	25		CARBONATE NODULES IN THE CLAY MATRIX APPEAR TO	11.4			
			\\\\			BE DERIVED AS THE RESULT OF A DEGRADING				
			\\\\			GEOMORPHIC SURFACE.				
			\\\\			CARBONATE INDURATION VARIES SIGNIFICANTLY BUT				
			\\\\			GENERALLY HAS CCI OF 1 TO 2 WHERE PRESENT.				
			\\\\			INDURATED ZONES ARE .25 TO 1 FOOT THICK. MORE				
			\\\\			COMMONLY .25'.				
			\\\\							
			\\\\							
			\\\\	30						
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\	35						
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			\\\\	45						
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			\\\\							
			\\\\			CONTINUED ON NEXT PAGE				
			\\\\							

Size & Type of Boring: 5-5/8" OD Hollow Stemmed Auger

Logged By:

SHEET 3 OF 8

PRECISION ENGINEERING, INC.

File No. 89-117

ring Location: SEE SITE PLAN

LOG OF TEST BORINGS

Location Artesia, NM

Elevation Existing

Boring Number: SEVEN

Water Level 14.5

Date: 4/09/90

LAB #	DEPTH	BLOWS/N	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	%M	LL	PI	CLASS.
			\\\\	50						
13153	50.0-51.5	8-9-16	\\\\		S	CLAY, SLIGHTLY SILTY, SANDY, WET, REDDISH	21.0	35	20	CL/A-6
			\-\		S	BROWN, VERY STIFF, CCI OF BOTTOM 4" OF SAMPLE				
			\\\\		S	IS 1-2. POCKET PENETROMETER AVERAGE (PPA) .75				
			\-\							
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\	55						
13154	55.0-56.4	SHELBY	\-\		U	RECOVERY 94%, PPA=1.0, CC1=0	31.7	44	27	CL/A-7-6
			\\\\		U					
			\-\		U					
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\	60						
13155	60.0-61.5	6-9-9	\-\		S	STIFF, CCI 0-1, SCATTERED CALCAREOUS NODULES	26.6	52	35	CH/A-7-6
			\\\\		S					
			\-\		S					
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\	65						
13156	65.0-66.5	6-8-8	\-\		S	PPA-1.5, CCI 0-1	28.7	28	12	CL/A-6
			\\\\		S					
			\-\		S					
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\							
			\-\							
			\\\\	70						
13157	70.0-71.1	SHELBY	\o\		U	CLAY, SLIGHTLY SANDY, REDDISH LIGHT BROWN,	17.9	31	17	CL/A-6
			\\\\		U	MOIST, SOME CALCAREOUS NODULES PISOLITE SIZE,				
			\o\			CCI OF THE MASS 0-1, PPA=1.5				
			\\\\							
			\o\							
			\\\\							
			\o\							
			\\\\			CONTINUED ON NEXT PAGE				
			\o\							

Size & Type of Boring: 5-5/8" OD Hollow Stemmed Auger

Logged By: PLJ

SHEET 4 OF 8 PRECISION ENGINEERING, INC. File No. 89-117

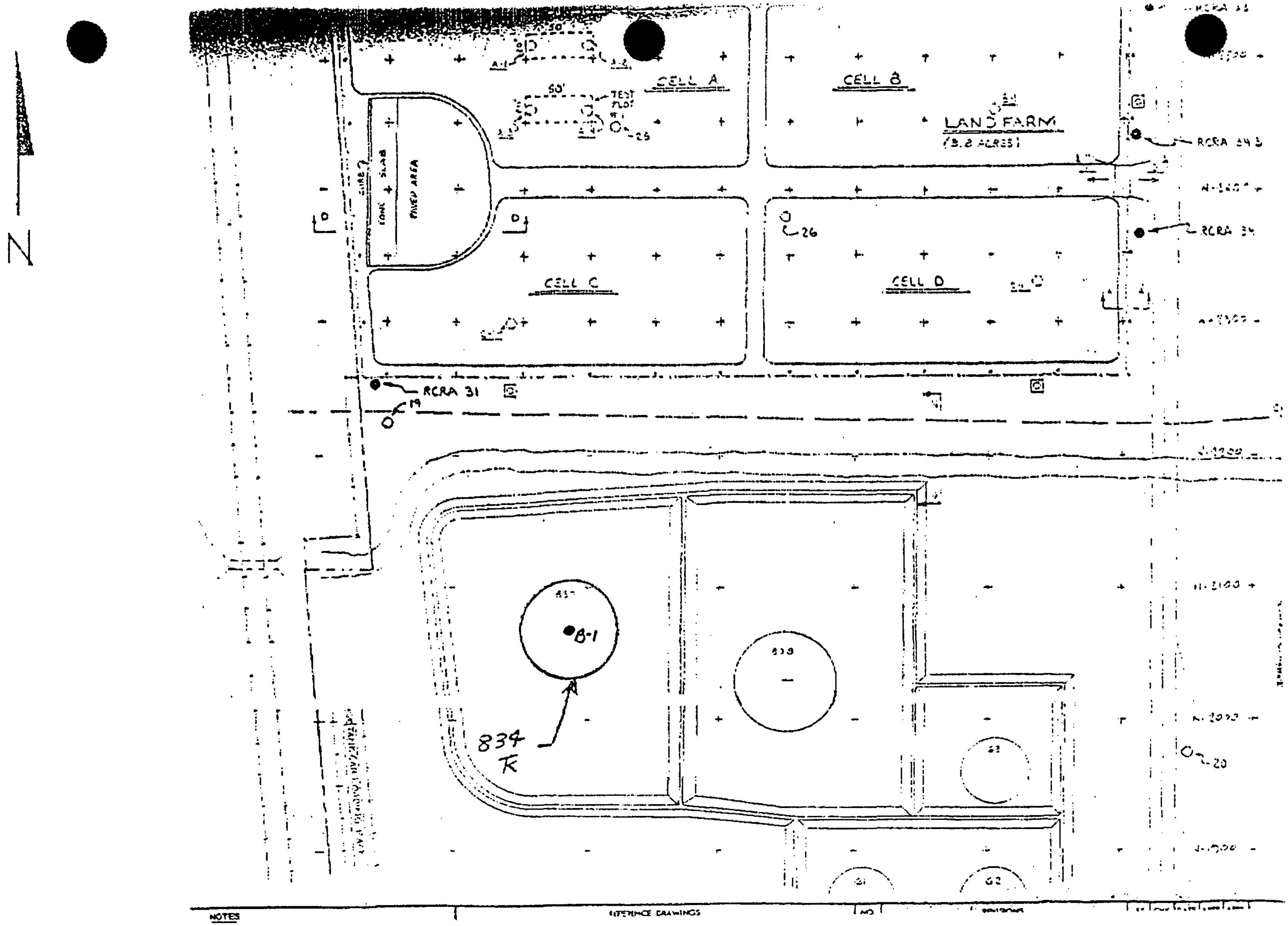
[illegible]ring Location: SEE SITE PLAN LOG OF TEST BORINGS Location Artesia, NM

Elevation Existing

Boring Number: SEVEN Water Level 14.5 Date: 4/10/90

LAB #	DEPTH	BLOWS/N	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	%M	LL	PI	CLASS.
			\\\\	75						
13158	75.0-75.9	(	\o\		S	CLAY, SANDY AS DESCRIBED BEFORE, PPA=3.0	19.1	30	18	CL/A-6
		(8-9-16	\\\\		S					
	75.9-76.5	(	o\o		S	SAND, CLAYEY, RUST RED, MOIST, MEDIUM DENSE	17.5	22	10	SC/A-4
			o\o			PPA=1.5				
			o\o							
	78.0		o\o							
			\\\\			CLAY, HARD, REDDISH BROWN, ALTERNATING LAYERS				
			\\\\			OF CARBONATE CEMENTATION 3-4" THICK AT 12-18"				
			\\\\	80		FREQUENCY, NODULAR CARBONATE THROUGHOUT, CCI				
13159	80.0-81.2	10-22-100	\\\\		S	OF NODULES 3, PPA OF CLAY 2.25, PPA OF INDUR-	24.0	28	10	CL/A-4
		(2.5)	\\\\		S	ATED MATERIAL >5. CARBONATE CAUSES "SILTY"				
			\\\\		S	FEEL.				
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\	85						
13160	85.0-86.5	14-16-18	\\\\		S	HARD, CCI 0-1, SCATTERED CALCAREOUS NODULES	12.7	40	25	CL/A-6
			\\\\		S	PPA=2.25				
			\\\\		S					
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\	90						
13161	90.0-90.5	SHELBY	\\\\		U	HARD PPA=2.0, POOR SAMPLE, CARBONATE NODULES	30.0	40	22	GC/A-2-6
13162NR	90.5-90.8	100(3.0")	\\\\		S	PRESENT, CLASSIFICATION GOVERNED BY CARBONATE				
			\\\\			NODULES IN CLAY MATRIX.				
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\							
			\\\\	95						
13163	95.0-96.5	10-15-18	\\\\		S	PPA=2.25, WHERE CARBONATE INDURATED CCI=2	17.6			
			\\\\		S					
			\\\\		S					
			\\\\							
			\\\\							
			\\\\							
13164	100.0-100.7	SHELBY	\\\\		U	CCI 2, PPA=2.25, POOR SAMPLE-CARBONATE NODULES	28.0	78	49	CH/A-7-6
13165	100.0-102.2	14-15-20	\\\\		S	PPA=2.75, CCI 1, SOME BLUE-GREY MOTTLING	22.5	39	15	CL/A-6
	TD-102.2		\\\\		S	APPEARS SILTIER THAN ABOVE				

Size & Type of Boring: 5-5/8" OD Hollow Stemmed Auger Logged By: WHK



Precision Engineering Location Sketch Map for Boring B-1. (Refer to Figure 7-1)

SHEET 1 OF 2

PRECISION ENGINEERING, INC.

File No. 93-118

Boring Location Center point of Tank

LOG OF TEST BORINGS

Location ARTESIA, N.M.

Elevation EXISTING

Boring Number: ONE

Water Level 10.9 (see note) Date: 08/25/93

LAB #	DEPTH	BLOWS/N	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	%M	LL	PI	CLASS.
	0.0 - 1.5	3-3-4	//////		S	**CLAY**, SILTY, FIRM, DARK GREY, WET, STRONG				CL
			//////		S	HYDROCARBON ODOR				
			//////							
			//////							
	4.0		/-//-/			**CLAY**, SILTY, SANDY, STIFF, LIGHT GREY				
	5.0 - 6.5	5-7-11	/-//-/	5	S	HYDROCARBON ODOR, MOIST, CRUMBLES EASILY,				CL
			/-//-/		S	PPR=2.75				
			/-//-/							
			/-//-/							
			/-//-/							
	10.0 - 11.5	4-10-16	/-//-/	10	S	AS ABOVE WITH VISIBLE CARBONATE NODULES,				
			/-//-/		S	CRUMBLY, SLIGHTLY MORE SAND, CCI=2, PPR>4.5,				
			/-//-/			STRONG HYDROCARBON ODOR, VERY STIFF				
	13.5		/-//-/			DARK GREY ZONE FROM 13.5-14.5'				
			/-//-/							
	15.0 - 16.5	7-7-9	/-//-/	15	S	WHITE AND LIGHT GREY MOTTLED, WETTER THAN				CL
			/-//-/		S	ABOVE, LESS SAND, HAS HYDROCARBON ODOR, CCI=3				
			/-//-/			VERY EASILY CRUMBLED DESPITE CCI				
	18.0		/¯//¯/			**CLAY**, VERY STIFF, THIN CARBONATE GRAVEL				
			/¯//¯/			(CALICHE) ZONES ARE WATER BEARING, GRAVEL 1-3"				
	20.0 - 21.2	10-12-11	/¯//¯/	20	S	THICK SPACED APPROX. 8"., RED BROWN COLOR,				CL
			/¯//¯/		S	CCI=1, PPR=2.5, VERY STIFF, WEAK HYDROCARBON				
			/¯//¯/			ODOR.				
	23.0		/¯//¯/			OUT OF WATER BEARING GRAVELS @ 23.0??				
			//////			**CLAY**, FIRM, RED BROWN, WET (NOT WATER BEARING)				
	25.0-26.5	4-4-7	//////	25	S	SOME SCATTERED CARBONATE PISOLITES IN CLAY				CL
			//////		S	LITTLE OR NO SAND AND SILT				
			//////							
			//////							
			//////							
	30.0 - 31.5	3-3-4	//////	30	S	AS ABOVE, NO HYDROCARBON ODOR, WET, (NOT WATER				CL
			//////		S	BEARING)				
			//////							
			//////							
			//////							
			//////	35						
			//////							
			//////							
			//////							
			//////							
	40.0 - 41.5	7-6-5	/://:/	40	S	**CLAY**, SANDY, WET BUT NOT WATER BEARING, RED				CL
			/://:/		S	BROWN, NO ODOR, PPR=2.75, CCI=0				
			/://:/							
			//////			LITTLE SAND AT 44'				
			//////			CONTINUED				

Size & Type of Boring: 7-5/8" OD Hollow Stemmed Auger

Logged By: WHK

SHEET 2 OF 2

PRECISION ENGINEERING, INC.

File No. 93-118

Boring Location Center point of Tank

LOG OF TEST BORINGS

Location ARTESIA, NM

Elevation EXISTING

Boring Number: ONE-CONTINUED

Water Level 10.9 (NOTE) Date: 8/25/93

LAB #	DEPTH	BLOWS/N	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	%M	LL	PI	CLASS.
			//////	45	S	CONTINUED FROM PAGE 1				
			//////		S					
			//////							
			//////							
			//////							
	50.0 - 51.5	4-4-5	//////	50	S	PPR=3.25,CCI=3, OCCATIONAL CARBONATE NODULES				CL
			//////		S	BUT RARE, WET BUT NOT WATER BEARING				
			//////							
			//////							
			//////							
			//////	55						
			//////							
			//////							
			//////							
			//////							
	60.0 - 61.5	4-4-5	//////	60	S	VERY SLIGHLY SANDY, AS ABOVE, NO ODOR, PPR=3.0				CL
			//////		S	FIRM				
			//////							
			//////							
			//////							
			//////	65						
			//////							
			//////							
			//////							
			//////							
	70.0 - 71.5	6-11-9	/://:/	70	S	CLAY, SANDY, STIFF, RED BROWN, SOME CARBONATE				CL
			/://:/		S	LENSES, CCI=0, PPR=1.25, WET BUT NOT WATER				
			/://:/			BEARING				
			/://:/							
			/://:/							
			/://:/	75						
			/://:/							
			/://:/							
			/¯//¯/			CLAY, HARD, RED BROWN, WET, WATER BEARING				
			/¯//¯/			CARBONATE GRAVELS FORM PARTINGS IN THE CLAY				
	80.0 - 81.5	5-23-18	/¯//¯/	80	S	BODY				CL
			/¯//¯/		S					
			/¯//¯/							
	TOTAL DEPTH 81.5'					NOTE: WATER LEVEL ENCOUNTERED AT 18' AT TIME OF DRILLING, 16 HOURS LATER WATER LEVEL MEASURED AT 10.9'. BORING PLUGGED AFTER WATER MEASUREMENTS WITH 6% BENTONITE/CEMENT GROUT INJECTED BY 1" TREMMIE AT 80'. GROUTED TO THE SURFACE, COVERED WITH CUTTINGS.				

Size & Type of Boring: 7-5/8" OD Hollow Stemmed Auger

Logged By: WHK

WELL COMPLETION DIAGRAMS

Well #1 MW-31 (NCL) **Sample Log** Page 1 of

Project Navajo Refinery Location SW corner of Colony Landfarm

Drilling Contractor D. Anderson Driller Richard Helper Eddie

Rig Type Hollow stem Hole Diameter 8 inches Drilling Fluid N/A

Type of Sample split spoon & Shelby Date and Time Drilling Began 10/19/82 1:30pm Date and Time Drilling End 3:00

Geraghty and Miller Representative J. Dauchy and T. Bouvette

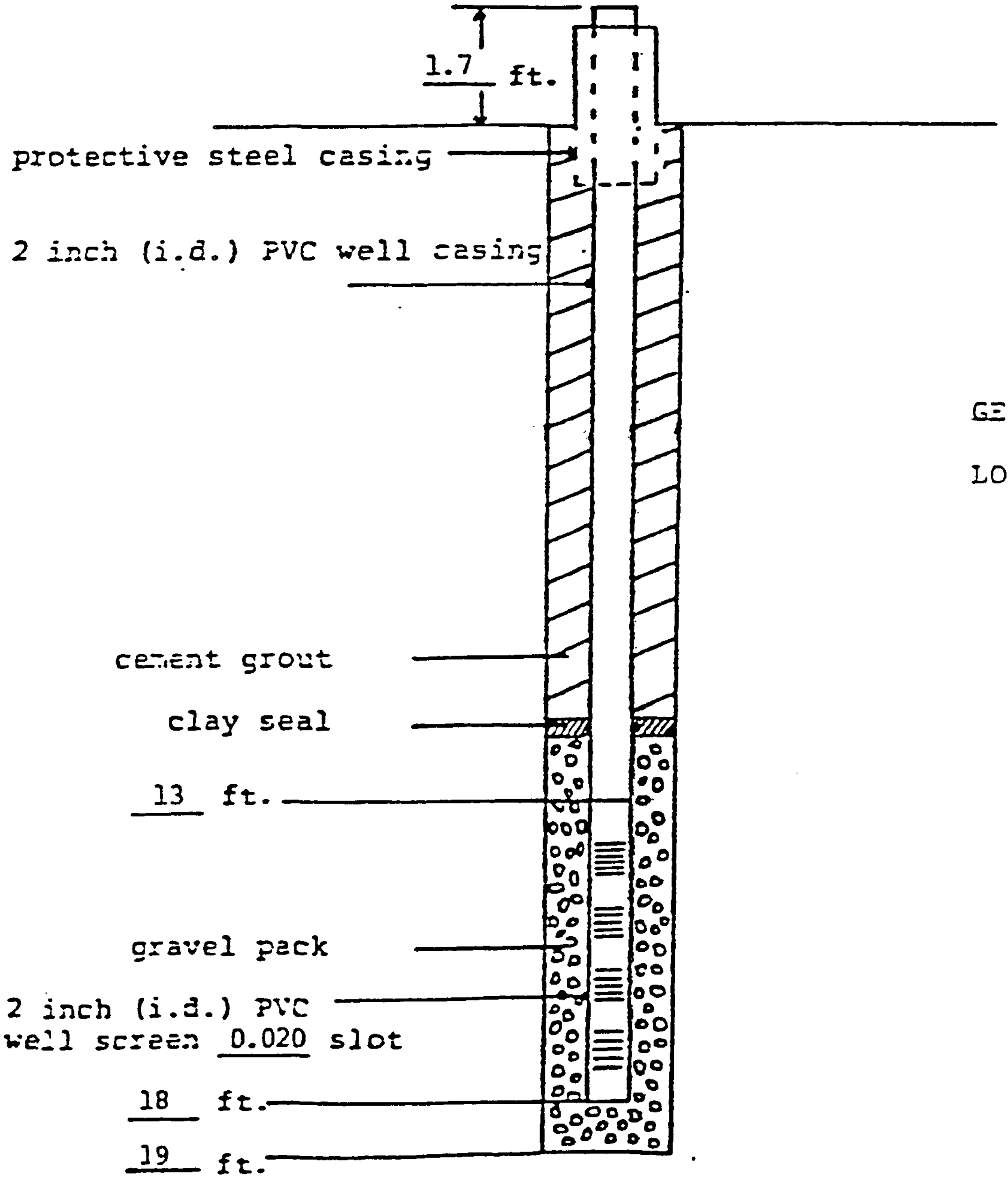
Blows per 6 inches	% Recovery	Sample Description	Depth Feet to Feet
		Fill - brown topsoil with gravel and concrete	0 - 2
		brittle brown silty clay, poorly sorted with white pebbles	2 - 3
		brittle brown silty clay, dense no pebbles	3 - 7
		tan silty clay, plastic, moist	7 - 8½
9 - 11-16	split spoon 8½ - 10	gray silty clay w/gyp. & unweather anhydrite poorly sorted, organic smell	8½ - 14
6 - 6 - 8	split spoon 14 - 15½	dolmite gravel water bearing seams (2") interbed w/gray brown silty clay, saturated	14 - 16
4 - [illegible] - 5	split spoon 17½ - 19	brown brittle sandy silty clay w/red & white coarse grains	16 - 20
	Shelby tube 20 - 22	red clay, well sorted, unsaturated	20 - 22

DETAILS OF WELL CONSTRUCTION

DATE 10/22/82 WELL #1

PROJECT Navajo Refinery LOCATION

WATER LEVEL MEASUREMENT Beld 10.5 Wet 0.34 DTW 10.16



GEOLOGIC

LOG

All measurements are referred to land surface except depth to water which is measured from top of casing

Geraghty & Miller Inc.

Well #2 MW-32(NCL) **Sample Log** Page 2 of

Project Navajo Refinery Location NCR ~~SE corner of Telephone Storage~~

Drilling Contractor D. Anderson Driller Richard Helper Eddie

Rig Type Hollow stem Hole Diameter 8" inches Drilling Fluid N/A

Type of Sample split spoon & shelby Date and Time Drilling Began 10/20/82 7:20 am Date and Time Drilling End 9:00 a

Geraghty and Miller Representative J. Dauchy - T. Bouvette

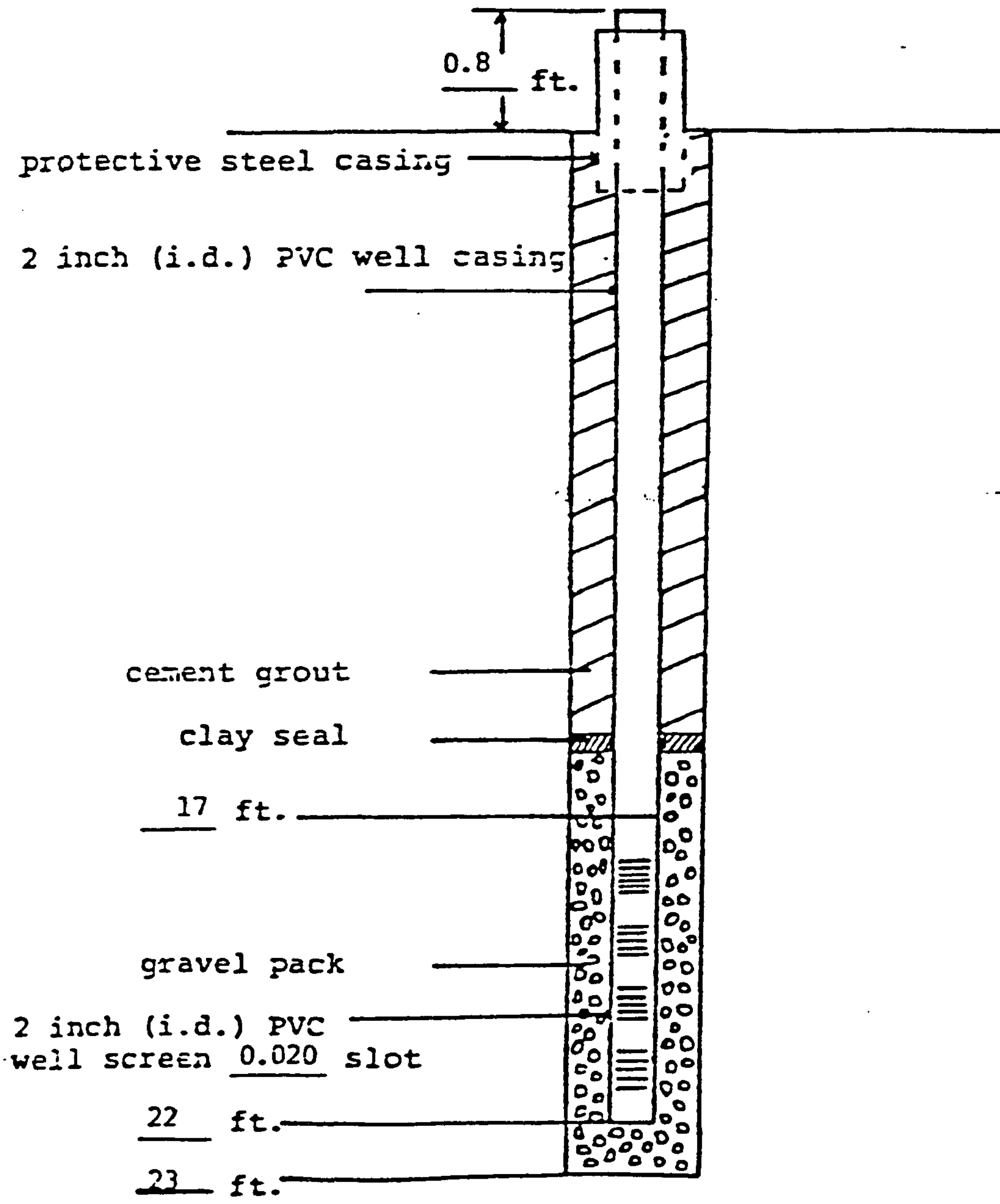
Blows per 6 inches	% Recovery	Sample Description	Depth Feet to Feet
		dark brown topsoil	0 - 2½
		light brown silty clay w/unweather anhydrite, poorly sorted	2½ - 4
3 - 4 - 5	split spoon 5 - 6½	tan silty clay, brittle, poorly sorted	4 - 6
		red silty clay	6 - 6½
5 - 6-10	split spoon 1- - 11½	light brown silty clay, mottled, poorly sorted	6½ - 10½
	organic smell	pebble seam wet, dolmite gravel, 2"	10½
		tan silty clay, same as above	10½ - 13
5 - 8 -12	split spoon 15 - 16½	gray silty clay, well sorted less dense organic smell	13 - 16
9 -16-17	split spoon 17½ - 19	anhydritic sand & pebble seams interbed with brownish red sandy silty clay	16 - 22
6 - 7- 9	split spoon 20 - 21½		
7 - 8-9	split spoon 22½ - 24	red clay, well sorted, dry & hard	22½ - 24

DETAILS OF WELL CONSTRUCTION

DATE 11/22/82 WELL #2

PROJECT Navajo Refinery LOCATION

WATER LEVEL MEASUREMENT Held 10.0 Wet 0.30 DTW 9.7



GEOLOGIC

LOG

All measurements are referred to land surface except depth to water which is measured from top of casing

Geraghty & Miller, Inc.

Well #3 MW-33 (NCL) **Sample Log** Page 3 of

Project Navajo Refinery Location NE of Colony @ Entrace Gate

Drilling Contractor D. Anderson Driller Richard Helper Eddie

Rig Type Hollow stem Hole Diameter 8" inches Drilling Fluid N/A

Type of Sample split spoon & Shelby Date and Time Drilling Began 10/20/82 10:00 am Date and Time Drilling End 11.30

Geraghty and Miller Representative J. Dauchy T. Bouvette

Blows per 6 inches	% Recovery	Sample Description	Depth Feet to Feet
		Brown topsoil	0 - 4
	Shelby tube 10 - 11	poorly sorted light brown silty clay w/unweathered anhydrite	4 - 13
	organic smell	gray brittle silty clay with white & red coarse grains	13 - 14½
3 - 7 - 8	split spoon 15 - 16½	anhydrite sand interbedded in white clay silty clay and red & tan silty clay	14½ - 17
5 - 5 - 7	split spoon 17 - 18½	red clay	17 - 19½

DETAILS OF WELL CONSTRUCTION

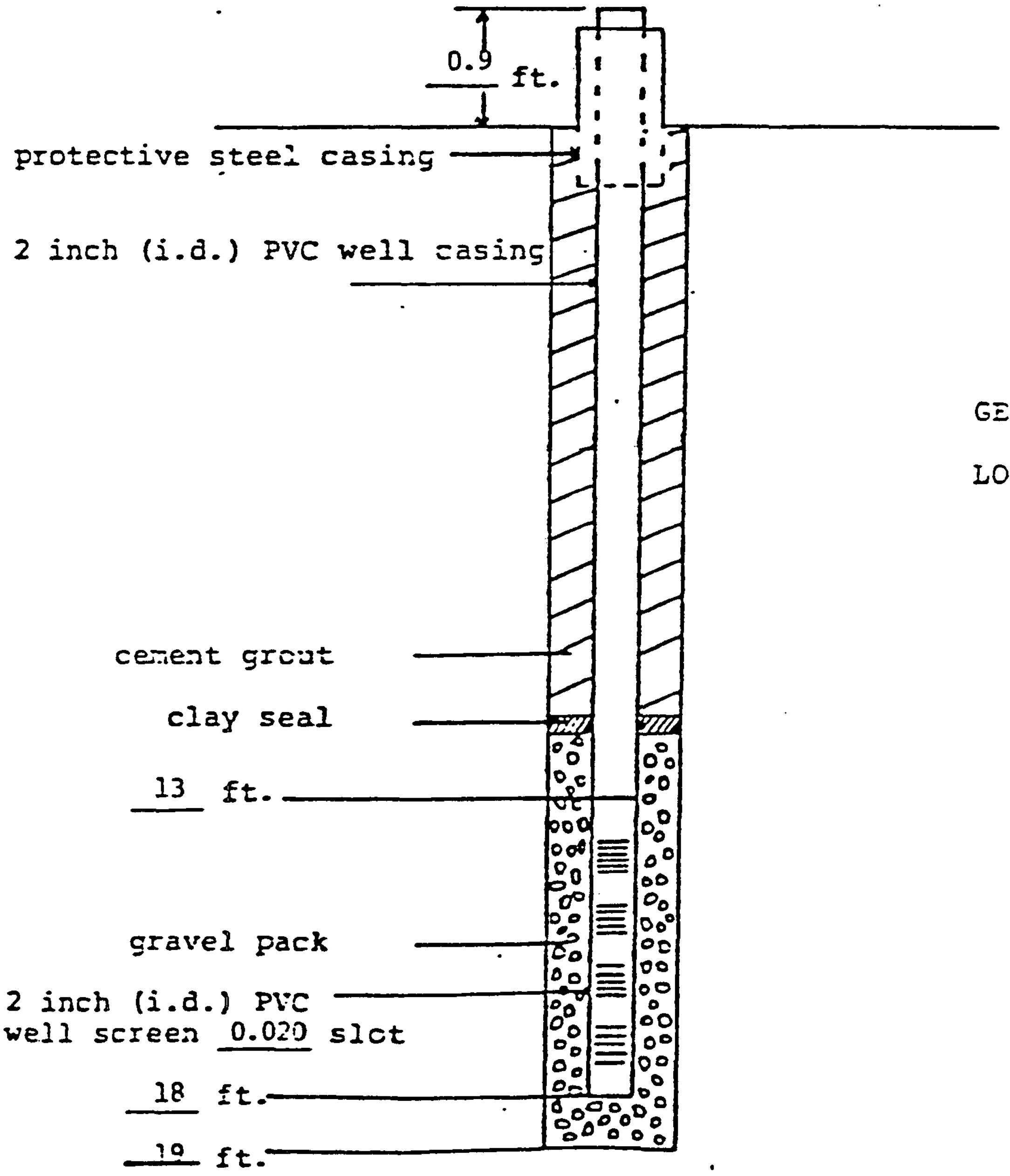
DATE 10/22/82

WELL #3

PROJECT Navajo Refinery

LOCATION

WATER LEVEL MEASUREMENT Held 10.0 Wet 0.19 DTW 9.81



GEOLOGIC

LOG

All measurements are referred to land surface except depth to water which is measured from top of casing

Well #4 MW-34 (NCL) **Sample Log** Page 4 of

Project Navajo Refinery Location East fence of Colony

Drilling Contractor D. Anderson Driller Richard Helper Eddie

Rig Type Hollow stem Hole Diameter 8" inches Drilling Fluid N/A

Type of Sample split spoon & shelby Date and Time Drilling Began 10/20/82 2:10 pm Date and Time Drilling End 3:30

Geraghty and Miller Representative J. Dauchy T. Bouvette

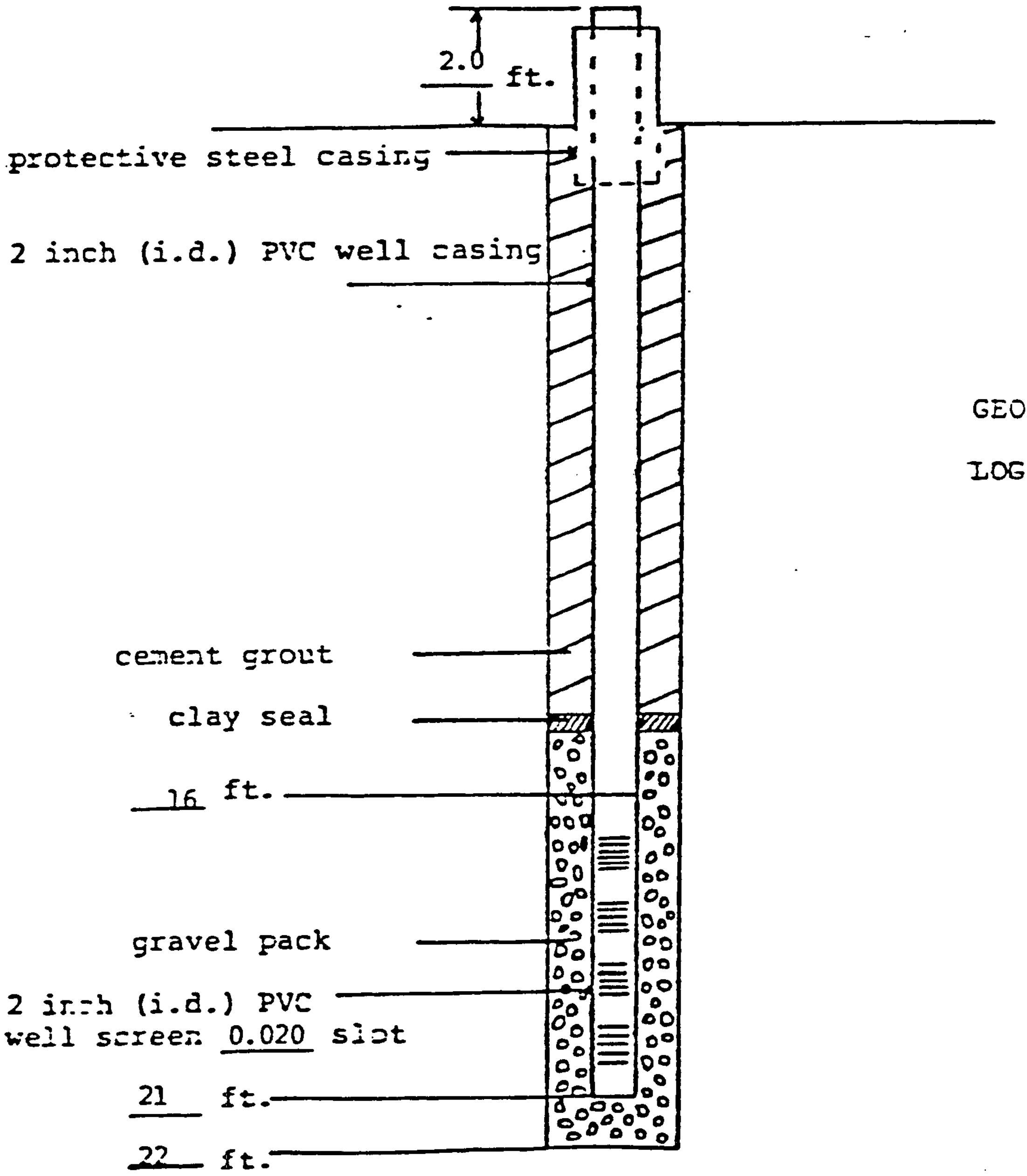
Blows per 6 inches	% Recovery	Sample Description	Depth Feet to Feet
		brown topsoil & fill	0 - 6
	organic smell	gray brown mottled silty clay w/unweather anhydrite, poorly sorted	6 - 10
7 - 12 -16	split spoon 10 - 11½	very brittle gyp in silty clay w/unweathered anhydrite	10 - 16
	shelby tube 15 - 17	water bearing anhydritic sand inter lain in gray silty clay & gyp	16 - 20
		~~gray clay, well sorted~~	20 - 22

DETAILS OF WELL CONSTRUCTION

DATE 10/22/82 WELL #4

PROJECT Navajo Refinery LOCATION

WATER LEVEL MEASUREMENT Held 11.3 Wet 0.70 DTW 10.60



GEOLOGIC

LOG

All measurements are referred to land surface except depth to water which is measured from top of casing

Appendix B

Appendix B

APPENDIX B

WATER QUALITY DATA SHEETS

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Mr. David Boyer
RE/SPEC
4775 Indian School Road
NE Ste. 300
Albuquerque, New Mexico 87110-3927

July 13, 1995

Dear Mr. Boyer,

On June 29, 1995, seven water samples and one trip blank were received, cool and intact, by Inter-Mountain Laboratories - College Station. The samples were identified by project name "RFI Phase III." Analyses for BTEX by Method 8240, general water chemistry, and Metals were performed as requested on the accompanying chain of custody and the updated analysis request faxed on July 4, 1995.

It is the policy of this laboratory to employ, whenever possible, preparatory and analytical methods which have been approved by regulatory agencies. The methods used in the analysis of the sample reported here are found in "Test Methods for Evaluating Solid Waste", SW-846, USEPA, Final Update I, July 1992. All reports in this package reference the methods utilized.

Methods used for each analysis are listed on the reports. All detection limits are practical quantitation limits (PQLs). PQLs have been corrected for dilutions and sample volume analyzed.

Sample "NCL Boring 7" had one surrogate out for Method 8240. The sample was analyzed multiple times and still had the same surrogate out. No target analytes were detected.

Quality Control reports have been included for your information and use. These reports appear at the end of the analytical package and may be identified by title. If there are any questions regarding the information presented in this package, feel free to call at your convenience.

Sincerely,

Ulonda M Rog

Ulonda M. Rogers

Enclosures

Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name NAVAJO RFI Phase III	Project Location ARTESIA NM	ANALYSES / PARAMETERS
Sampler: (Signature) NCL Phase II	Chain of Custody Tape No.	

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers	BTEX 8240	Metals As, Cr, Ni, Pb	Water Chemistry		Remarks
NCL Boring #1	6/24/95	1645	0695G00971	Water	2	✓				Rush - 10 work days
NCL Boring # 2	"	1715	972	"	2	✓				" "
NCL Boring 7	6/25/95	1605	973	"	2	✓				" "
* ~~OCD 7AR~~	~~6/26/95~~	~~1530~~	~~974~~	~~"~~	~~4~~	✓	✓	✓		
* ~~OCD 7C~~	~~"~~	~~1610~~	~~975~~	~~"~~	~~2~~		✓	✓		
* ~~OCD MW-10~~	~~"~~	~~1745~~	~~976~~	~~"~~	~~1~~		✓			
* ~~MW-15~~	~~6/27/95~~	~~1630~~	~~977~~	~~"~~	~~5~~	✓		✓		
TRIP BLANK	—	—	978	"	1	✓				
* NOT NCL Phase II DWB										Recd cool & Intact

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
	6/28/95	8:45am		6/29/95	900
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by laboratory: (Signature)	Date	Time

Inter-Mountain Laboratories, Inc.

☐ 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

☐ 1714 Phillips Circle
Gillette, Wyoming 82716
Telephone (307) 682-8945

☐ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

☐ 1160 Research Dr.
Bozeman, Montana 59715
Telephone (406) 586-8450

☐ 11183 SH 30
College Station, TX 77845
Telephone (409) 776-8945

☒ 3304 Longmire Drive
College Station, TX 77845
Telephone (409) 774-4999

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project : RFI Phase III
Sample ID: NCL Boring #1
Laboratory ID: 0695G00971
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH <2

Report Date: 07/06/95
Date Sampled: 06/24/95
Date Received: 06/29/95
Date Extracted: 07/02/95
Date Analyzed: 07/02/95
Time Analyzed: 4:49 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Benzene	ND	0.025
Ethylbenzene	0.045	0.025
Toluene	ND	0.025
Xylenes (total)	ND	0.025

ND - Analyte not detected at stated limit of detection

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	97%	86 - 118%
Toluene-d8	102%	88 - 110%
Bromofluorobenzene	102%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**
Project :	RFI Phase III
Sample ID:	NCL Boring #2
Laboratory ID:	0695G00972
Sample Matrix:	Water
Preservative:	Cool, HCl
Condition:	Intact, pH<2

Report Date:	07/06/95
Date Sampled:	06/24/95
Date Received:	06/29/95
Date Extracted:	07/02/95
Date Analyzed:	07/02/95
Time Analyzed:	5:28 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Benzene	ND	0.005
Ethylbenzene	ND	0.005
Toluene	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	100%	86 - 118%
Toluene-d8	97%	88 - 110%
Bromofluorobenzene	89%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**
Project :	RFI Phase III
Sample ID:	NCL Boring 7
Laboratory ID:	0695G00973
Sample Matrix:	Water
Preservative:	Cool, HCl
Condition:	Intact, pH<2

Report Date:	07/06/95
Date Sampled:	06/25/95
Date Received:	06/29/95
Date Extracted:	07/02/95
Date Analyzed:	07/02/95
Time Analyzed:	10:21 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Benzene	ND	0.005
Ethylbenzene	ND	0.005
Toluene	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	112%	86 - 118%
Toluene-d8	88%	88 - 110%
Bromofluorobenzene*	74%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.
* Low recovery due to matrix interferences.

Analyst

Review

QUALITY CONTROL REPORTS

- * *Duplicate Analyses*
- * *Matrix Spike Analyses*
- * *Method Blank Analyses*

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - MATRIX SPIKE / SPIKE DUPLICATE ANALYSIS

EPA Method 8240 - VOLATILE ORGANICS

Laboratory ID:	0695G0972	Report Date:	07/06/95
Sample Matrix:	Water	Date Sampled:	06/24/95
Preservative:	Cool, HCl	Date Received:	06/29/95
Condition:	Intact, pH <2	Date Analyzed:	07/02/95
		Time Analyzed:	9:02 PM/9:39 PM

MATRIX SPIKE ANALYSIS

Analyte	Spiked Sample Result (mg/L)	Sample Result (mg/L)	Spike Added (mg/L)	Percent Recovery	QC Limits Recovery
Benzene	0.045	ND	0.050	89%	76 - 127
Toluene	0.042	ND	0.050	84%	76 - 125
Ethyl benzene	0.047	ND	0.050	94%	37 - 162
Xylenes	0.131	ND	0.150	87%	50 - 150

MATRIX SPIKE DUPLICATE ANALYSIS

Analyte	Duplicate Result (mg/L)	Percent Recovery	Original Spike Result (mg/L)	RPD	QC Limits	
					RPD	Rec.
Benzene	0.046	92%	89%	3%	11%	76 - 127
Toluene	0.041	83%	84%	1%	13%	76 - 125
Ethyl Benzene	0.048	96%	94%	2%	13%	37 - 162
Xylenes	0.149	99%	87%	13%	13%	50 - 150

ND - Analyte not detected at stated limit of detection

Spike Recovery: 0 out of 10 outside QC Limits
RPD: 0 out of 5 outside QC Limits

Quality Control:

Surrogate	Spike Recovery	Duplicate Recovery	Recovery Limits
Dibromofluoromethane	117%	118%	86 - 118%
Toluene-d8	90%	90%	88 - 110%
Bromofluorobenzene	99%	92%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK
EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0702B
Sample Matrix: Water

Report Date: 07/06/95
Date Extracted: 07/02/95
Date Analyzed: 07/02/95
Time Analyzed: 2:59 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.025
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.005
Carbon disulfide	ND	0.005
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.010
Chloroform	ND	0.005
Chloromethane	ND	0.010
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.005
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.005
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

ADDITIONAL DETECTED COMPOUNDS

Sample ID:	Method Blank	Report Date:	07/06/95
Laboratory ID:	MB0702B	Date Sampled:	07/02/95
Sample Matrix:	Water	Date Analyzed:	07/02/95
		TimE Analyzed:	2:59 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L) *
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	103%	86 - 118%
Toluene - d8	98%	88 - 110%
Bromofluorobenzene	92%	86 - 115%

Reference: Method 8240B: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994

Comments: * Methylene chloride is a common laboratory contaminate.

Analyst

Review

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Mr. David Boyer
RE/SPEC
4775 Indian School Road NE, Ste. 300
Albuquerque, New Mexico 87110-3927

July 18, 1995

Dear Mr. Boyer,

On June 30, 1995, seven water samples and one trip blank were received, cool and intact, by Inter-Mountain Laboratories - College Station. The samples were identified by project name "RFI Phase III." Analyses for Volatiles by Method 8240, general water chemistry, and Metals were performed as requested on the accompanying chain of custody and the updated analysis request faxed on July 4, 1995.

It is the policy of this laboratory to employ, whenever possible, preparatory and analytical methods which have been approved by regulatory agencies. The methods used in the analysis of the sample reported here are found in "Test Methods for Evaluating Solid Waste", SW-846, USEPA, Final Update I, July 1992. All reports in this package reference the methods utilized.

Methods used for each analysis are listed on the reports. All detection limits are practical quantitation limits (PQLs). PQLs have been corrected for dilutions and sample volume analyzed.

The volatiles analysis was done at our Bozeman, MT lab. The column they use changes the elution of various compounds slightly. Bromofluorobenzene (one of the surrogates) and an unknown peak co-eluted on this column. Surrogate recoveries are high since the ion used for quantitation was also present in the unknown. MW-18 was the only sample without the interference.

Quality Control reports have been included for your information and use. These reports appear at the end of the analytical package and may be identified by title. If there are any questions regarding the information presented in this package, feel free to call at your convenience.

Sincerely,

Ulonda M Rog

Ulonda M. Rogers

Enclosures

Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name NCL RFI Phase II
NAVAJO REFINING CO

Project Location ARTESIA, NM

Sampler: (Signature) W A Boyd

Chain of Custody Tape No.

ANALYSES / PARAMETERS

	Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers	8240 BTEX+MEK+CS2	8270 Full Suite	Met-5s As, Cr, Pb, Ni	7000 series Water Chem	Remarks
*	~~MW-4A~~	~~6/28/95~~	~~1030~~	~~0695G00981~~	~~Water~~	~~6~~	✓	✓	✓	✓	A&B ~~tor~~
*	~~MW-4C~~	~~"~~	~~1120~~	~~982~~	~~"~~	~~4~~	✓		✓	✓	
*	~~Pipe Effluent~~	~~"~~	~~1340~~	~~983~~	~~"~~	~~5~~	✓	✓	✓	✓	~~will call w/ metals~~
*	~~MW-22A~~	~~"~~	~~1535~~	~~984~~	~~"~~	~~2~~			✓	✓	
*	~~MW-7A~~	~~"~~	~~1650~~	~~985~~	~~"~~	~~2~~	✓		✓	✓	
	NCL Up Grad Well	6/29/95	1030	986	" Full suite 8240	5	✓	✓	✓	✓	will call w/ metals
	MW-18 (NCL)	"	1110	987	" Rush!	2	✓				BTEX ONLY for 8240
	Trip Blank	—	—	988	"	2	✓				
*	NOT NCL RFI Phase II DAB										
											recd. cool intact

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
W A Boyd	6/29/95	1330		6/30/95	0900

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

Relinquished by: (Signature)	Date	Time	Received by laboratory: (Signature)	Date	Time

Inter-Mountain Laboratories, Inc.

☐ 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

☐ 1714 Phillips Circle
Gillette, Wyoming 82716
Telephone (307) 682-8945

☐ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

☐ 1160 Research Dr.
Bozeman, Montana 59715
Telephone (406) 586-8450

☐ 11183 SH 30
College Station, TX 77845
Telephone (409) 776-8945

☒ 3304 Longmire Drive
College Station, TX 77845
Telephone (409) 774-4999

25423

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project : Artesia, NM
Sample ID: NCL Up Gradient Well
Laboratory ID: 0695G00986
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH<2

Report Date: 07/18/95
Date Sampled: 06/29/95
Date Received: 06/30/95
Date Extracted: 07/12/95
Date Analyzed: 07/12/95
Time Analyzed: 1:39 AM

Analyte	Concentration	Detection Limit (mg/L)
Acetone	ND	0.025
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.020
Carbon disulfide	ND	0.005
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.010
Chloroform	ND	0.005
Chloromethane	ND	0.010
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.005
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.005
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project : Artesia, NM
Sample ID: NCL Up Gradient Well
Laboratory ID: 0695G00986

Report Date: 07/18/95
Date Sampled: 06/29/95
Date Analyzed: 07/12/95
Time Analyzed: 1:39 AM

Tentative Identification	Retention Time (Minutes)	Concentration*
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
1,2-Dichloroethane-d4	94%	86 - 118%
Toluene-d8	105%	88 - 110%
Bromofluorobenzene	**118%**	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above. One surrogate recovery is out of acceptance limit due to matrix interference.

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
183 SH 30 College Station, Texas 77845
ne (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: NCL Up Gradient Well
Laboratory ID: 0695G00986
Sample Matrix: Water
Condition: Intact
Preservative: Cool

Report Date: 07/03/95
Date Sampled: 06/29/95
Date Received: 06/30/95
Date Extracted: 06/30/95
Date Analyzed: 07/03/95
Time Analyzed: 10:49 AM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.010
Acenaphthylene	ND	0.010
Anthracene	ND	0.010
Benzo(a)anthracene	ND	0.010
Benzo(b)fluoranthene	ND	0.010
Benzo(k)fluoranthene	ND	0.010
Benzo(g,h,i)perylene	ND	0.010
Benzo(a)pyrene	ND	0.010
Benzoic acid	ND	0.010
Benzyl alcohol	ND	0.010
Bis(2-chloroethoxy)methane	ND	0.010
Bis(2-chloroethyl)ether	ND	0.010
Bis(2-chloroisopropyl)ether	ND	0.025
Bis(2-ethylhexyl)phthalate	ND	0.025
4-Bromophenyl phenyl ether	ND	0.010
Butyl benzyl phthalate	ND	0.010
p - Chloroaniline	ND	0.010
p - Chloro - m - cresol	ND	0.010
2 - Chloronaphthalene	ND	0.010
2 - Chlorophenol	ND	0.010
4-Chlorophenyl phenyl ether	ND	0.010
Chrysene	ND	0.010
o - Cresol	ND	0.010
m,p - Cresol	ND	0.010
Di - n - butylphthalate	ND	0.025
Dibenz(a,h)anthracene	ND	0.010
o - Dichlorobenzene	ND	0.010
m - Dichlorobenzene	ND	0.010
p - Dichlorobenzene	ND	0.010
3,3 - Dichlorobenzidine	ND	0.010
2,4 - Dichlorophenol	ND	0.010
Diethyl phthalate	ND	0.010
2,4 - Dimethylphenol	ND	0.010
Dimethyl phthalate	ND	0.010

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: NCL Up Gradient Well
Laboratory ID: 0695G00986

Report Date: 07/03/95
Date Sampled: 06/29/95
Date Analyzed: 07/03/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.025
2,4 - Dinitrophenol	ND	0.025
2,4 - Dinitrotoluene	ND	0.010
2,6 - Dinitrotoluene	ND	0.010
Di-n-octyl phthalate	ND	0.025
Fluoranthene	ND	0.010
Fluorene	ND	0.010
Hexachlorobenzene	ND	0.010
Hexachlorocyclopentadiene	ND	0.025
Hexachloroethane	ND	0.010
Hexachlorobutadiene	ND	0.010
Ideno(1,2,3-cd)pyrene	ND	0.010
Isophorone	ND	0.010
2 - Methylnaphthalene	ND	0.010
Naphthalene	ND	0.010
Mono-Naphthalene	ND	0.010
o - Nitroaniline	ND	0.010
m - Nitroaniline	ND	0.010
p - Nitroaniline	ND	0.010
Nitrobenzene	ND	0.010
o - Nitrophenol	ND	0.010
p - Nitrophenol	ND	0.010
n - Nitrosodimethylamine	ND	0.010
n - Nitrosodiphenylamine	ND	0.010
n-Nitroso-di-n-propylamine	ND	0.010
Pentachlorophenol	ND	0.025
Phenanthrene	ND	0.010
Phenol	ND	0.010
Pyrene	ND	0.010
1,2,4 - Trichlorobenzene	ND	0.010
2,4,5 - Trichlorophenol	ND	0.010
2,4,6 - Trichlorophenol	ND	0.010

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE HYDROCARBONS
ADDITIONAL DETECTED COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**	Report Date:	07/03/95
Project:	Artesia, NM	Date Sampled:	06/29/95
Sample ID:	NCL Up Gradient Well	Date Analyzed:	07/03/95
Laboratory ID:	0695G00986		

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L)
None detected at reported limits of detection.		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	33%	21 - 110%
Phenol - d5	35%	10 - 110%
Nitrobenzene - d5	44%	35 - 114%
2 - Fluorobiphenyl	58%	43 - 116%
2,4,6 - Tribromophenol	48%	10 - 123%
Terphenyl - d14	72%	33 - 141%

References:

Method 3510: Separatory Funnel Liquid-Liquid Extraction.
Method 8270: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

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iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: NCL Up Grad Well
Lab ID: 0495W05741/0695G00986
Matrix: Water
Condition: Intact

Report Date: 07/13/95
Receipt Date: 06/30/95
Sample Date: 06/29/95

Parameter	Concentration	PQL	Method
pH (Lab)	7.4 s.u.	0.1	SW-846 9040
Conductivity (Lab)	2750 µmhos/cm	1	SW-846 9050
Total Dissolved Solids (180° C)	2500 mg/L	10	EPA 160.1
Total Alkalinity (as CaCO3)	409 mg/L	1	EPA 310.1
Total Hardness (as CaCO3)	1460 mg/L	1	Calculation
Fluoride	1.1 mg/L	0.1	EPA 340.2

Calcium	308 mg/L	15.37 meq/L	1 mg/L	SW-846 6010A
Magnesium	169 mg/L	13.91 meq/L	1 mg/L	SW-846 6010A
Potassium	2 mg/L	0.04 meq/L	1 mg/L	SW-846 6010A
Sodium	145 mg/L	6.31 meq/L	1 mg/L	SW-846 6010A
[illegible]carbonate	498 mg/L	8.16 meq/L	1 mg/L	EPA 310.1
[illegible]rbonate	ND*	0.00	1 mg/L	EPA 310.1
Chloride	132 mg/L	3.72 meq/L	1 mg/L	SW-846 9251
Sulfate	1130 mg/L	23.53 meq/L	5 mg/L	SW-846 9036
Major Cation Sum	35.63 meq/L		N/A	Calculation
Major Anion Sum	35.42 meq/L		N/A	Calculation
Cation/Anion Balance	0.30 % Diff		N/A	Calculation

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

[illegible]eviewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: NCL Up Grad Well
Lab ID: 0495W05741/0695G00986
Matrix: Water
Condition: Intact

Report Date: 07/21/95
Receipt Date: 06/30/95
Sample Date: 06/29/95

Parameter	Concentration	PQL	Method
Total Metals			
Total Aluminum	1.0 mg/L	0.1	SW-846 6010A
Total Arsenic	ND*	0.005 mg/L	SW-846 7061A
Total Barium	0.07 mg/L	0.01	SW-846 6010A
Total Beryllium	ND*	0.005 mg/L	SW-846 6010A
Total Boron	0.39 mg/L	0.05	SW-846 6010A
Total Cadmium	ND*	0.001 mg/L	SW-846 7131A
Total Chromium	0.007 mg/L	0.005	SW-846 7191
Total Cobalt	ND*	0.02 mg/L	SW-846 6010A
Total Copper	ND*	0.01 mg/L	SW-846 6010A
Total Iron	0.73 mg/L	0.05	SW-846 6010A
Total Lead	ND*	0.01 mg/L	SW-846 7421
Total Manganese	2.17 mg/L	0.01	SW-846 6010A
Total Mercury	ND*	0.001 mg/L	SW-846 7471A
otal Molybdenum	ND*	0.05 mg/L	SW-846 6010A
Total Nickel	ND*	0.05 mg/L	SW-846 7520
Total Selenium	ND*	0.005 mg/L	SW-846 7742
Total Silver	ND*	0.01 mg/L	SW-846 7761
Total Uranium	ND*	0.3 mg/L	SW-846 6010A
Total Vanadium	ND*	0.02 mg/L	SW-846 6010A
Total Zinc	ND*	0.02 mg/L	SW-846 6010A

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

eviewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project : Artesia, NM
Sample ID: MW-18 (NCL)
Laboratory ID: 0695G00987
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH<2

Report Date: 07/18/95
Date Sampled: 06/29/95
Date Received: 06/30/95
Date Extracted: 07/12/95
Date Analyzed: 07/12/95
Time Analyzed: 2:16 AM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Benzene	ND	0.005
Toluene	ND	0.005
Ethylbenzene	ND	0.005
m,p-Xylene	ND	0.005
o-Xylene	ND	0.005

ND - Analyte not detected at stated limit of detection

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
1,2-Dichloroethane-d4	92%	86 - 118%
Toluene-d8	104%	88 - 110%
Bromofluorobenzene	113%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project :	Artesia, NM	Report Date:	07/18/95
Sample ID:	Trip Blank	Date Sampled:	NA
Laboratory ID:	0695G00988	Date Received:	06/30/95
Sample Matrix:	Water	Date Extracted:	07/12/95
Preservative:	Cool, HCl	Date Analyzed:	07/12/95
Condition:	Intact, pH<2	Time Analyzed:	2:54 AM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Benzene	ND	0.005
Toluene	ND	0.005
Ethylbenzene	ND	0.005
m,p-Xylene	ND	0.005
o-Xylene	ND	0.005
Methyl ethyl ketone	ND	0.020
Carbon disulfide	ND	0.005

ND - Analyte not detected at stated limit of detection

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
1,2-Dichloroethane-d4	90%	86 - 118%
Toluene-d8	103%	88 - 110%
Bromofluorobenzene	113%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

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QUALITY CONTROL REPORTS

- *Duplicate Analyses*
- *Matrix Spike Analyses*
- *Method Blank Analyses*

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK
EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0711
Sample Matrix: Water

Report Date: 07/18/95
Date Extracted: 07/11/95
Date Analyzed: 07/11/95
Time Analyzed: 10:29 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.025
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.020
Carbon disulfide	ND	0.005
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.010
Chloroform	ND	0.005
Chloromethane	ND	0.010
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.005
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.005
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

ADDITIONAL DETECTED COMPOUNDS

Sample ID:	Method Blank	Report Date:	07/18/95
Laboratory ID:	MB0711	Date Extracted:	07/11/95
Sample Matrix:	Water	Date Analyzed:	07/11/95
		Time Analyzed:	10:29 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L) *
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
1,2-Dichloroethane-d4	97%	86 - 118%
Toluene-d8	101%	88 - 110%
Bromofluorobenzene	113%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - MATRIX SPIKE / SPIKE DUPLICATE ANALYSIS

EPA Method 8240 - VOLATILE ORGANICS

Laboratory ID:	B955266 Spike and Spike Duplicate	Report Date:	07/18/95
Sample Matrix:	Water	Date Sampled:	NA
Preservative:	Cool, HCl	Date Received:	NA
Condition:	Intact, pH <2	Date Analyzed:	07/12/95
		Time Analyzed:	6:04 AM/6:41 AM

MATRIX SPIKE ANALYSIS

Analyte	Spiked Sample Result (mg/L)	Sample Result (mg/L)	Spike Added (mg/L)	Percent Recovery	QC Limits Recovery
1,1 - Dichloroethene	0.022	ND	0.020	110%	61 - 145
Trichloroethene	0.021	ND	0.020	105%	71 - 120
Benzene	0.023	ND	0.020	115%	76 - 127
Toluene	0.023	ND	0.020	115%	76 - 125
Chlorobenzene	0.022	ND	0.020	110%	75 - 130

MATRIX SPIKE DUPLICATE ANALYSIS

Analyte	Duplicate Result (mg/L)	Percent Recovery	Original Spike Result (mg/L)	RPD	QC Limits	
					RPD	Rec.
1,1 - Dichloroethene	0.022	110%	110%	0%	14%	61 - 145
Trichloroethene	0.021	105%	105%	0%	14%	71 - 120
Benzene	0.023	115%	115%	0%	11%	76 - 127
Toluene	0.023	115%	115%	0%	13%	76 - 125
Chlorobenzene	0.023	115%	110%	4%	13%	75 - 130

ND - Analyte not detected at stated limit of detection

Spike Recovery: 0 out of 10 outside QC Limits
RPD: 0 out of 5 outside QC Limits

Quality Control:

Surrogate	Spike Recovery	Duplicate Recovery	Recovery Limits
1,2-Dichloroethane-d4	101%	98%	86 - 118%
Toluene-d8	102%	101%	88 - 110%
Bromofluorobenzene	106%	112%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

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Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
[illegible]183 SH 30 College Station, Texas 77845
[illegible]ne (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID:	Method Blank	Report Date:	07/03/95
Laboratory ID:	MB240	Date Extracted:	06/30/95
Sample Matrix:	Water	Date Analyzed:	07/03/95
		Time Analyzed:	9:19 AM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.010
Acenaphthylene	ND	0.010
Anthracene	ND	0.010
Benzo(a)anthracene	ND	0.010
Benzo(b)fluoranthene	ND	0.010
Benzo(k)fluoranthene	ND	0.010
Benzo(g,h,i)perylene	ND	0.010
Benzo(a)pyrene	ND	0.010
Benzoic acid	ND	0.010
Benzyl alcohol	ND	0.010
Bis(2-chloroethoxy)methane	ND	0.010
Bis(2-chloroethyl)ether	ND	0.010
Bis(2-chloroisopropyl)ether	ND	0.025
Bis(2-ethylhexyl)phthalate	ND	0.025
4-Bromophenyl phenyl ether	ND	0.010
Butyl benzyl phthalate	ND	0.010
p - Chloroaniline	ND	0.010
p - Chloro - m - cresol	ND	0.010
2 - Chloronaphthalene	ND	0.010
2 - Chlorophenol	ND	0.010
4-Chlorophenyl phenyl ether	ND	0.010
Chrysene	ND	0.010
o - Cresol	ND	0.010
m,p - Cresol	ND	0.010
Di - n - butylphthalate	ND	0.025
Dibenz(a,h)anthracene	ND	0.010
Dibenzofuran	ND	0.010
o - Dichlorobenzene	ND	0.010
m - Dichlorobenzene	ND	0.010
p - Dichlorobenzene	ND	0.010
3,3 - Dichlorobenzidine	ND	0.010
2,4 - Dichlorophenol	ND	0.010
Diethyl phthalate	ND	0.010
2,4 - Dimethylphenol	ND	0.010
Dimethyl phthalate	ND	0.010

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS (cont)

Sample ID: Method Blank
Laboratory ID: MB240
Report Date: 07/03/95
Date Analyzed: 07/03/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.025
2,4 - Dinitrophenol	ND	0.025
2,4 - Dinitrotoluene	ND	0.010
2,6 - Dinitrotoluene	ND	0.010
Di-n-octyl phthalate	ND	0.025
Fluoranthene	ND	0.010
Fluorene	ND	0.010
Hexachlorobenzene	ND	0.010
Hexachlorocyclopentadiene	ND	0.025
Hexachloroethane	ND	0.010
Hexachlorobutadiene	ND	0.010
Ideno(1,2,3-cd)pyrene	ND	0.010
Isophorone	ND	0.010
2 - Methylnaphthalene	ND	0.010
Naphthalene	ND	0.010
o - Nitroaniline	ND	0.010
m - Nitroaniline	ND	0.010
p - Nitroaniline	ND	0.010
Nitrobenzene	ND	0.010
o - Nitrophenol	ND	0.010
p - Nitrophenol	ND	0.010
n - Nitrosodimethylamine	ND	0.010
n - Nitrosodiphenylamine	ND	0.010
n-Nitroso-di-n-propylamine	ND	0.010
Pentachlorophenol	ND	0.025
Phenanthrene	ND	0.010
Phenol	ND	0.010
Pyrene	ND	0.010
1,2,4 - Trichlorobenzene	ND	0.010
2,4,5 - Trichlorophenol	ND	0.010
2,4,6 - Trichlorophenol	ND	0.010

ND - Analyte not detected at stated limit of detection

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
183 SH 30 College Station, Texas 77845
one (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE HYDROCARBONS

ADDITIONAL DETECTED COMPOUNDS

Sample ID:	Method Blank	Report Date:	07/03/95
Laboratory ID:	MB240	Date Analyzed:	07/03/95

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
None detected at reported limits of detection.		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	44%	21 - 110%
Phenol - d5	42%	10 - 110%
Nitrobenzene - d5	61%	35 - 114%
2 - Fluorobiphenyl	82%	43 - 116%
2,4,6 - Tribromophenol	54%	10 - 123%
Terphenyl - d14	105%	33 - 141%

References:

Method 3510: Separatory Funnel Liquid-Liquid Extraction.
Method 8270B: Gas Chromatography / Mass Spectrometry for Semivolatile Organics Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

Review

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METRIX SPIKE
EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID:	Matrix Spike	Report Date:	07/03/95
Laboratory ID:	0694G00981	Date Sampled:	06/28/95
Sample Matrix:	Water	Date Received:	06/30/95
Condition:	Intact	Date Extracted:	06/30/95
Preservative:	Cool	Date Analyzed:	07/03/95
		Time Analyzed:	1:04 PM

Analyte	Spike Concentration (mg/L)	Sample Concentration (mg/L)	Spike Added (mg/L)	Percent Recovery (%)	QC Limits
Phenol	0.126	ND	0.200	63%	5 - 112%
2 - Chlorophenol	0.133	ND	0.200	67%	23 - 134%
1,4 - Dichlorobenzene	0.060	ND	0.100	60%	20 - 124%
n-Nitroso-di-propylamine	0.079	ND	0.100	79%	D - 230%
1,2,4 - Trichlorobenzene	0.064	ND	0.100	64%	44 - 142%
4-Chloro-3-methylphenol	0.147	ND	0.200	74%	22 - 147%
Acenaphthene	0.080	ND	0.100	80%	47 - 145%
4 - Nitrophenol	0.111	ND	0.200	56%	D - 132%
2,4 - Dinitrotoluene	0.071	ND	0.100	71%	39 - 139%
Pentachlorophenol	0.157	ND	0.200	79%	14 - 176%
Pyrene	0.084	ND	0.100	84%	52 - 115%

ND - Analyte not detected at stated limit of detection

Spike Recovery: 0 of 11 recoveries outside acceptable limits.

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	45%	21 - 110%
Phenol - d6	51%	10 - 110%
Nitrobenzene - d5	65%	35 - 114%
2 - Fluorobiphenyl	84%	43 - 116%
2,4,6 - Tribromophenol	63%	10 - 123%
Terphenyl - d14	89%	33 - 141%

Reference:

Method 3510: Separatory Funnel Liquid-Liquid Extraction
Method 8270: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Quality Control Report
Duplicate Analysis

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 7A
Lab ID: 0495W05740/0695G00985
Matrix: Water
Condition: Intact

Report Date: 07/13/95
Receipt Date: 06/30/95
Sample Date: 06/28/95

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Method
pH (Lab)	7.2	7.2	0	0.1 s.u.	SW-846 9040
Conductivity (Lab)	12000	12000	0	1 µmhos/cm	SW-846 9050
Total Dissolved Solids (180° C)	8960	8960	0	10 mg/L	EPA 160.1
Total Alkalinity (as CaCO3)	287	287	0	1 mg/L	EPA 310.1
Total Hardness (as CaCO3)	2310	2320	0	1 mg/L	Calculation
Fluoride	1.5	1.6	3	0.1 mg/L	EPA 340.2
Calcium	383	383	0	1 mg/L	SW-846 6010A
Magnesium	330	331	0	1 mg/L	SW-846 6010A
Potassium	6	5	9	1 mg/L	SW-846 6010A
Sodium	2290	2280	0	1 mg/L	SW-846 6010A
carbonate	350	350	0	1 mg/L	EPA 310.1
rbonate	ND*	ND*	NC*	1 mg/L	EPA 310.1
Chloride	2500	2540	1	1 mg/L	SW-846 9251
Sulfate	3410	3400	0	5 mg/L	SW-846 9036
Major Cation Sum	146.03	145.74	0	meq/L	Calculation
Major Anion Sum	147.17	147.95	0	meq/L	Calculation
Cation/Anion Balance	-0.39	-0.75		% Diff	Calculation

*ND - Parameter not detected at stated Practical Quantitation Limit.
*NC - Non-Calculable RPD due to value(s) less than PQL

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Quality Control Report
Duplicate Analysis

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 7A
Lab ID: 0495W05740/0695G00985
Matrix: Water
Condition: Intact

Report Date: 07/13/95
Receipt Date: 06/30/95
Sample Date: 06/28/95

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Method
Total Metals					
Total Arsenic	0.022	0.021	2	0.005 mg/L	SW-846 7061A
Total Chromium	ND*	ND*	NC*	0.005 mg/L	SW-846 7191
Total Lead	ND*	ND*	NC*	0.01 mg/L	SW-846 7421
Total Nickel	ND*	ND*	NC*	0.05 mg/L	SW-846 7520

*ND - Parameter not detected at stated Practical Quantitation Limit.
*NC - Non-Calculable RPD due to value(s) less than PQL

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

[illegible]iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT
MATRIX SPIKE

Client: **Navajo Refining Co.**
Project: RFI Phase III / Artesia, NM
Sample ID: MW-4A
Lab ID: 0495W05736/0695G00981
Matrix: Water
Condition Intact

Report Date: 07/13/95
Receipt Date: 06/26/95
Sample Date: 06/21/95

Analyte	Unspiked Sample Concentration (mg/L)	Spiked Sample Concentration (mg/L)	Spike Amount (mg/L)	Percent Recovery
Total Arsenic	0.061	0.073	0.010	120
Total Chromium	0.005	0.06	0.05	110
Total Lead	ND	0.06	0.05	120
Total Nickel	ND	1.03	1.00	103

Reference: SW-846-"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", US EPA,Third Edition, Final Update 1,July 1992.

Reviewed by:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT
METHOD BLANK

CLIENT: **Navajo Refining Co.**
PROJECT: **RFI Phase III / Artesia, NM**

Sample ID: Blank W5736-41
Report Date: 07/13/95
Sample Matrix: Water

Analyte	Concentration	Units	POL	Method Reference
Total Arsenic	ND	mg/L	0.005	SW-846 7061A
Total Chromium	ND	mg/L	0.005	SW-846 7191
Total Lead	ND	mg/L	0.01	SW-846 7421
Total Nickel	ND	mg/L	0.05	SW-846 7520

ND - Parameter not detected at stated detection limit.

Reference: SW-846-"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", US EPA,Third Edition, Final Update 1,July 1992.

Reviewed by:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
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Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Mr. David Boyer
RE/SPEC
4775 Indian School Road
NE Ste. 300
Albuquerque, New Mexico 87110-3927

August 31, 1995

Dear Mr. Boyer,

On August 10, 1995, four water samples and one trip blank were received, cool and intact, by Inter-Mountain Laboratories - College Station. The one liter sample for semivolatile analysis of MW-5AR was broken in transit; therefore, no analysis was performed on it. The samples were identified by project location "Artesia, NM." Analyses for volatiles by Method 8240, semivolatiles by Method 8270, general water chemistry, and Metals were performed as requested on the accompanying chain of custody and verbal instruction on August 10, 1995.

It is the policy of this laboratory to employ, whenever possible, preparatory and analytical methods which have been approved by regulatory agencies. The methods used in the analysis of the sample reported here are found in "Test Methods for Evaluating Solid Waste", SW-846, USEPA, Final Update II, July 1994. All reports in this package reference the methods utilized.

Methods used for each analysis are listed on the reports. All detection limits are practical quantitation limits (PQLs). PQLs have been corrected for dilutions and sample volume analyzed.

Quality Control reports have been included for your information and use. These reports appear at the end of the analytical package and may be identified by title. If there are any questions regarding the information presented in this package, feel free to call at your convenience.

Sincerely,

Ramona R. Dennis

Ramona R. Dennis

Enclosures

NAV1405

Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name NAVAJO REFINING Company	**Project Location** ARTESIA NM	**ANALYSES / PARAMETERS**
Sampler: (Signature)	**Chain of Custody Tape No.**	

Sample No./ Identification	**Date**	**Time**	**Lab Number**	**Matrix**	**No. of Containers**	8240	8270	Metals	Water Chem	**Remarks**
* ~~Dog Canyon~~	~~7/31/95~~	~~1900~~	~~0695G01405~~	Water	1				✓	Full Suite 8240, 8270
MW-55	8/9/95	1010	1406		5	✓	✓	✓	✓	
MW-56	"	1040	1407		6	✓	✓	✓	✓	
* ~~MW-5AR~~	~~"~~	~~1350~~	~~1408~~		5	✓	✓	✓	✓	
TRIP Blank			1409		1	✓				
										Metals MW-55,
										56 - Same as
* NoT NCL	Analyses									NCL up
recd: cool Intact										Metals MW-5AR
MW-5AR: One 1-L bottle received broken										Same as MW-5A
										Will send FAX
										To confirm

Relinquished by: (Signature)	**Date** 8/9/95	**Time** 1605	**Received by: (Signature)**	**Date**	**Time**
Relinquished by: (Signature) FED EX (Courier)	**Date**	**Time**	**Received by: (Signature)**	**Date** 8/10/95	**Time** 0900
Relinquished by: (Signature)	**Date**	**Time**	**Received by laboratory: (Signature)**	**Date**	**Time**

Inter-Mountain Laboratories, Inc.

☐ 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

☐ 1714 Phillips Circle
Gillette, Wyoming 82716
Telephone (307) 682-8945

☐ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

☐ 1160 Research Dr.
Bozeman, Montana 59715
Telephone (406) 586-8450

☐ 11183 SH 30
College Station, TX 77845
Telephone (409) 776-8945

☒ 3304 Longmire Drive
College Station, TX 77845
Telephone (409) 774-4999

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iml Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project :	Artesia, NM	Report Date:	08/17/95
Sample ID:	MW-55	Date Sampled:	08/09/95
Laboratory ID:	0695G01406	Date Received:	08/10/95
Sample Matrix:	Water	Date Extracted:	08/16/95
Preservative:	Cool, HCl	Date Analyzed:	08/16/95
Condition:	Intact, pH<2	Time Analyzed:	4:01 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.010
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.010
Carbon disulfide	ND	0.010
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.005
Chloroform	ND	0.005
Chloromethane	ND	0.005
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.010
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.010
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project : Artesia, NM
Sample ID: MW-55
Laboratory ID: 0695G01406

Report Date: 08/17/95
Date Sampled: 08/09/95
Date Analyzed: 08/16/95
Time Analyzed: 4:01 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L)
None detected at reportable limits		

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	104%	86 - 118%
Toluene-d8	100%	88 - 110%
Bromofluorobenzene	95%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project:	Artesia, NM	Report Date:	08/23/95
Sample ID:	MW-55	Date Sampled:	08/09/95
Laboratory ID:	0695G01406	Date Received:	08/10/95
Sample Matrix:	Water	Date Extracted:	08/15/95
Condition:	Intact	Date Analyzed:	08/21/95
Preservative:	Cool	Time Analyzed:	12:35 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.010
Acenaphthylene	ND	0.010
Anthracene	ND	0.010
Benzo(a)anthracene	ND	0.010
Benzo(b)fluoranthene	ND	0.010
Benzo(k)fluoranthene	ND	0.010
Benzo(g,h,i)perylene	ND	0.010
Benzo(a)pyrene	ND	0.010
Benzoic acid	ND	0.010
Benzyl alcohol	ND	0.010
Bis(2-chloroethoxy)methane	ND	0.010
Bis(2-chloroethyl)ether	ND	0.010
Bis(2-chloroisopropyl)ether	ND	0.025
Bis(2-ethylhexyl)phthalate	ND	0.025
4-Bromophenyl phenyl ether	ND	0.010
Butyl benzyl phthalate	ND	0.010
p - Chloroaniline	ND	0.010
p - Chloro - m - cresol	ND	0.010
2 - Chloronaphthalene	ND	0.010
2 - Chlorophenol	ND	0.010
4-Chlorophenyl phenyl ether	ND	0.010
Chrysene	ND	0.010
o - Cresol	ND	0.010
m,p - Cresol	ND	0.010
Di - n - butylphthalate	ND	0.025
Dibenz(a,h)anthracene	ND	0.010
o - Dichlorobenzene	ND	0.010
m - Dichlorobenzene	ND	0.010
p - Dichlorobenzene	ND	0.010
3,3 - Dichlorobenzidine	ND	0.010
2,4 - Dichlorophenol	ND	0.010
Diethyl phthalate	ND	0.010
2,4 - Dimethylphenol	ND	0.010
Dimethyl phthalate	ND	0.010

ND - Analyte not detected at stated limit of detection

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project:	Artesia, NM	Report Date:	08/23/95
Sample ID:	MW-55	Date Sampled:	08/09/95
Laboratory ID:	0695G01406	Date Analyzed:	08/21/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.025
2,4 - Dinitrophenol	ND	0.025
2,4 - Dinitrotoluene	ND	0.010
2,6 - Dinitrotoluene	ND	0.010
Di-n-octyl phthalate	ND	0.025
Fluoranthene	ND	0.010
Fluorene	ND	0.010
Hexachlorobenzene	ND	0.010
Hexachlorocyclopentadiene	ND	0.025
Hexachloroethane	ND	0.010
Hexachlorobutadiene	ND	0.010
Ideno(1,2,3-cd)pyrene	ND	0.010
Isophorone	ND	0.010
2 - Methylnaphthalene	ND	0.010
Naphthalene	ND	0.010
o - Nitroaniline	ND	0.010
m - Nitroaniline	ND	0.010
p - Nitroaniline	ND	0.010
Nitrobenzene	ND	0.010
o - Nitrophenol	ND	0.010
p - Nitrophenol	ND	0.010
n - Nitrosodimethylamine	ND	0.010
n - Nitrosodiphenylamine	ND	0.010
n-Nitroso-di-n-propylamine	ND	0.010
Pentachlorophenol	ND	0.025
Phenanthrene	ND	0.010
Phenol	ND	0.010
Pyrene	ND	0.010
1,2,4 - Trichlorobenzene	ND	0.010
2,4,5 - Trichlorophenol	ND	0.010
2,4,6 - Trichlorophenol	ND	0.010

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE HYDROCARBONS
ADDITIONAL DETECTED COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: MW-55
Laboratory ID: 0695G01406

Report Date: 08/23/95
Date Sampled: 08/09/95
Date Analyzed: 08/21/95

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L)
None detected at reported limits of detection.		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	50%	21 - 110%
Phenol - d5	53%	10 - 110%
Nitrobenzene - d5	50%	35 - 114%
2 - Fluorobiphenyl	66%	43 - 116%
2,4,6 - Tribromophenol	80%	10 - 123%
Terphenyl - d14	87%	33 - 141%

References:

Method 3510: Separatory Funnel Liquid-Liquid Extraction.
Method 8270: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

Review

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 55
Lab ID: 0495W06799/0695G01406
Matrix: Water
Condition: Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Parameter	Concentration	PQL	Method
General Chemistry			
pH (Lab)	7.1 s.u.	0.1	SW-846 9040
Conductivity (Lab)	2940 µmhos/cm	1	SW-846 9050
Total Dissolved Solids (180° C)	2160 mg/L	10	EPA 160.1
Total Alkalinity (as CaCO3)	460 mg/L	1	EPA 310.1
Total Hardness (as CaCO3)	1270 mg/L	1	Calculation
Fluoride	1.4 mg/L	0.1	EPA 340.2

Major Ions				
Calcium	252 mg/L	12.57 meq/L	1 mg/L	SW-846 6010A
Magnesium	156 mg/L	12.84 meq/L	1 mg/L	SW-846 6010A
Potassium	1 mg/L	0.03 meq/L	1 mg/L	SW-846 6010A
Sodium	225 mg/L	9.79 meq/L	1 mg/L	SW-846 6010A
Bicarbonate	561 mg/L	9.20 meq/L	1 mg/L	EPA 310.1
[illegible]bonate	ND*	0.00	1 mg/L	EPA 310.1
Chloride	268 mg/L	7.56 meq/L	1 mg/L	SW-846 9056
Sulfate	901 mg/L	18.76 meq/L	1 mg/L	SW-846 9056
Major Cation Sum	35.23 meq/L		N/A	Calculation
Major Anion Sum	35.51 meq/L		N/A	Calculation
Cation/Anion Balance	-0.40 % Diff		N/A	Calculation

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

[illegible]iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 55
Lab ID: 0495W06799/0695G01406
Matrix: Water
Condition: Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Parameter	Concentration	PQL	Method
Total Metals			
Total Aluminum	6.8 mg/L	0.1	SW-846 6010A
Total Arsenic	0.005 mg/L	0.005	SW-846 7061A
Total Barium	0.19 mg/L	0.01	SW-846 6010A
Total Beryllium	ND*	0.005 mg/L	SW-846 6010A
Total Boron	0.48 mg/L	0.05	SW-846 6010A
Total Cadmium	ND*	0.001 mg/L	SW-846 7131A
Total Chromium	0.014 mg/L	0.005	SW-846 7191
Total Cobalt	ND*	0.02 mg/L	SW-846 6010A
Total Copper	0.02 mg/L	0.01	SW-846 6010A
Total Iron	4.24 mg/L	0.05	SW-846 6010A
Total Lead	ND*	0.01 mg/L	SW-846 7421
Total Manganese	0.22 mg/L	0.01	SW-846 6010A
otal Mercury	ND*	0.001 mg/L	SW-846 7471A
al Molybdenum	ND*	0.05 mg/L	SW-846 6010A
Total Nickel	ND*	0.05 mg/L	SW-846 7520
Total Selenium	ND*	0.005 mg/L	SW-846 7742
Total Silver	ND*	0.01 mg/L	SW-846 7761
Total Uranium	ND*	0.3 mg/L	SW-846 6010A
Total Vanadium	0.02 mg/L	0.02	SW-846 6010A
Total Zinc	0.03 mg/L	0.02	SW-846 6010A

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

viewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project :	Artesia, NM	Report Date:	08/17/95
Sample ID:	MW-56	Date Sampled:	08/09/95
Laboratory ID:	0695G01407	Date Received:	08/10/95
Sample Matrix:	Water	Date Extracted:	08/16/95
Preservative:	Cool, HCl	Date Analyzed:	08/16/95
Condition:	Intact, pH<2	Time Analyzed:	8:02 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.010
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.010
Carbon disulfide	ND	0.010
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.005
Chloroform	ND	0.005
Chloromethane	ND	0.005
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.010
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.010
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client:	NAVAJO REFINING COMPANY		
Project:	Artesia, NM	Report Date:	08/17/95
Sample ID:	MW-56	Date Sampled:	08/09/95
Laboratory ID:	0695G01407	Date Analyzed:	08/16/95
		Time Analyzed:	8:02 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L)
Hydrocarbon envelope	20 - 26	-

Quality Control:	Surrogate	Percent Recovery	Acceptance Limits
	Dibromofluoromethane	101%	86 - 118%
	Toluene-d8	99%	88 - 110%
	Bromofluorobenzene	94%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project:	Artesia, NM	Report Date:	08/23/95
Sample ID:	MW-56	Date Sampled:	08/09/95
Laboratory ID:	0695G01407	Date Received:	08/10/95
Sample Matrix:	Water	Date Extracted:	08/15/95
Condition:	Intact	Date Analyzed:	08/21/95
Preservative:	Cool	Time Analyzed:	1:21 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.010
Acenaphthylene	ND	0.010
Anthracene	ND	0.010
Benzo(a)anthracene	ND	0.010
Benzo(b)fluoranthene	ND	0.010
Benzo(k)fluoranthene	ND	0.010
Benzo(g,h,i)perylene	ND	0.010
Benzo(a)pyrene	ND	0.010
Benzoic acid	ND	0.010
Benzyl alcohol	ND	0.010
Bis(2-chloroethoxy)methane	ND	0.010
Bis(2-chloroethyl)ether	ND	0.010
Bis(2-chloroisopropyl)ether	ND	0.025
Bis(2-ethylhexyl)phthalate	ND	0.025
4-Bromophenyl phenyl ether	ND	0.010
Butyl benzyl phthalate	ND	0.010
p - Chloroaniline	ND	0.010
p - Chloro - m - cresol	ND	0.010
2 - Chloronaphthalene	ND	0.010
2 - Chlorophenol	ND	0.010
4-Chlorophenyl phenyl ether	ND	0.010
Chrysene	ND	0.010
o - Cresol	ND	0.010
m,p - Cresol	ND	0.010
Di - n - butylphthalate	ND	0.025
Dibenz(a,h)anthracene	ND	0.010
o - Dichlorobenzene	ND	0.010
m - Dichlorobenzene	ND	0.010
p - Dichlorobenzene	ND	0.010
3,3 - Dichlorobenzidine	ND	0.010
2,4 - Dichlorophenol	ND	0.010
Diethyl phthalate	ND	0.010
2,4 - Dimethylphenol	ND	0.010
Dimethyl phthalate	ND	0.010

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: MW-56
Laboratory ID: 0695G01407

Report Date: 08/23/95
Date Sampled: 08/09/95
Date Analyzed: 08/21/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.025
2,4 - Dinitrophenol	ND	0.025
2,4 - Dinitrotoluene	ND	0.010
2,6 - Dinitrotoluene	ND	0.010
Di-n-octyl phthalate	ND	0.025
Fluoranthene	ND	0.010
Fluorene	ND	0.010
Hexachlorobenzene	ND	0.010
Hexachlorocyclopentadiene	ND	0.025
Hexachloroethane	ND	0.010
Hexachlorobutadiene	ND	0.010
Ideno(1,2,3-cd)pyrene	ND	0.010
Isophorone	ND	0.010
2 - Methylnaphthalene	ND	0.010
Naphthalene	ND	0.010
o - Nitroaniline	ND	0.010
m - Nitroaniline	ND	0.010
p - Nitroaniline	ND	0.010
Nitrobenzene	ND	0.010
o - Nitrophenol	ND	0.010
p - Nitrophenol	ND	0.010
n - Nitrosodimethylamine	ND	0.010
n - Nitrosodiphenylamine	ND	0.010
n-Nitroso-di-n-propylamine	ND	0.010
Pentachlorophenol	ND	0.025
Phenanthrene	ND	0.010
Phenol	ND	0.010
Pyrene	ND	0.010
1,2,4 - Trichlorobenzene	ND	0.010
2,4,5 - Trichlorophenol	ND	0.010
2,4,6 - Trichlorophenol	ND	0.010

ND - Analyte not detected at stated limit of detection

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE HYDROCARBONS
ADDITIONAL DETECTED COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: MW-56
Laboratory ID: 0695G01407

Report Date: 08/23/95
Date Sampled: 08/09/95
Date Analyzed: 08/21/95

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
Unknown hydrocarbon	8.62	0.023
Unknown hydrocarbon	17.46	0.028

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	58%	21 - 110%
Phenol - d5	65%	10 - 110%
Nitrobenzene - d5	63%	35 - 114%
2 - Fluorobiphenyl	82%	43 - 116%
2,4,6 - Tribromophenol	84%	10 - 123%
Terphenyl - d14	81%	33 - 141%

References:

Method 3510: Separatory Funnel Liquid-Liquid Extraction.
Method 8270: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

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iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 56
Lab ID: 0495W06800/0695G01407
Matrix: Water
Condition: Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Parameter	Concentration		PQL	Method
General Chemistry				
pH (Lab)	6.9 s.u.		0.1	SW-846 9040
Conductivity (Lab)	5850 µmhos/cm		1	SW-846 9050
Total Dissolved Solids (180° C)	4900 mg/L		10	EPA 160.1
Total Alkalinity (as CaCO3)	427 mg/L		1	EPA 310.1
Total Hardness (as CaCO3)	2680 mg/L		1	Calculation
Fluoride	1.7 mg/L		0.1	EPA 340.2
Major Ions				
Calcium	596 mg/L	29.74 meq/L	1 mg/L	SW-846 6010A
Magnesium	289 mg/L	23.79 meq/L	1 mg/L	SW-846 6010A
Potassium	3 mg/L	0.08 meq/L	1 mg/L	SW-846 6010A
Sodium	537 mg/L	23.36 meq/L	1 mg/L	SW-846 6010A
Bicarbonate	521 mg/L	8.54 meq/L	1 mg/L	EPA 310.1
[illegible]rbonate	ND*	0.00	1 mg/L	EPA 310.1
Chloride	848 mg/L	23.92 meq/L	1 mg/L	SW-846 9056
Sulfate	2170 mg/L	45.20 meq/L	1 mg/L	SW-846 9056
Major Cation Sum	76.97 meq/L		N/A	Calculation
Major Anion Sum	77.66 meq/L		N/A	Calculation
Cation/Anion Balance	-0.45 % Diff		N/A	Calculation

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

[illegible]iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 56
Lab ID: 0495W06800/0695G01407
Matrix: Water
Condition: Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Parameter	Concentration	PQL	Method
Total Metals			
Total Aluminum	14.1 mg/L	0.1	SW-846 6010A
Total Arsenic	0.007 mg/L	0.005	SW-846 7061A
Total Barium	0.13 mg/L	0.01	SW-846 6010A
Total Beryllium	ND*	0.005 mg/L	SW-846 6010A
Total Boron	0.48 mg/L	0.05	SW-846 6010A
Total Cadmium	ND*	0.001 mg/L	SW-846 7131A
Total Chromium	0.013 mg/L	0.005	SW-846 7191
Total Cobalt	ND*	0.02 mg/L	SW-846 6010A
Total Copper	0.02 mg/L	0.01	SW-846 6010A
Total Iron	5.85 mg/L	0.05	SW-846 6010A
Total Lead	ND*	0.01 mg/L	SW-846 7421
Total Manganese	0.31 mg/L	0.01	SW-846 6010A
Total Mercury	ND*	0.001 mg/L	SW-846 7471A
al Molybdenum	ND*	0.05 mg/L	SW-846 6010A
Total Nickel	ND*	0.05 mg/L	SW-846 7520
Total Selenium	ND*	0.005 mg/L	SW-846 7742
Total Silver	ND*	0.01 mg/L	SW-846 7761
Total Uranium	ND*	0.3 mg/L	SW-846 6010A
Total Vanadium	0.03 mg/L	0.02	SW-846 6010A
Total Zinc	0.03 mg/L	0.02	SW-846 6010A

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project :	Artesia, NM	Report Date:	08/17/95
Sample ID:	Trip Blank	Date Sampled:	NA
Laboratory ID:	0695G01409	Date Received:	08/10/95
Sample Matrix:	Water	Date Extracted:	08/16/95
Preservative:	Cool, HCl	Date Analyzed:	08/16/95
Condition:	Intact, pH<2	Time Analyzed:	8:45 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.010
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.010
Carbon disulfide	ND	0.010
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.005
Chloroform	ND	0.005
Chloromethane	ND	0.005
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.010
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.010
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**
Project :	Artesia, NM
Sample ID:	Trip Blank
Laboratory ID:	0695G01409

Report Date:	08/17/95
Date Sampled:	NA
Date Analyzed:	08/16/95
Time Analyzed:	8:45 PM

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	100%	86 - 118%
Toluene-d8	99%	88 - 110%
Bromofluorobenzene	90%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0816
Sample Matrix: Water

Report Date: 08/17/95
Date Extracted: 08/16/95
Date Analyzed: 08/16/95
Time Analyzed: 3:01 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.025
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.020
Carbon disulfide	ND	0.005
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.010
Chloroform	ND	0.005
Chloromethane	ND	0.010
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.005
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.005
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

ADDITIONAL DETECTED COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0816
Sample Matrix: Water

Report Date: 08/17/95
Date Sampled: 08/16/95
Date Analyzed: 08/16/95
TimE Analyzed: 3:01 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L) *
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	100%	86 - 118%
Toluene - d8	102%	88 - 110%
Bromofluorobenzene	96%	86 - 115%

Reference: Method 8240B: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994

Comments:

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK
EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0816B
Sample Matrix: Water

Report Date: 08/17/95
Date Extracted: 08/16/95
Date Analyzed: 08/16/95
Time Analyzed: 5:47 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.025
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.020
Carbon disulfide	ND	0.005
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.010
Chloroform	ND	0.005
Chloromethane	ND	0.010
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.005
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.005
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

ADDITIONAL DETECTED COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0816B
Sample Matrix: Water

Report Date: 08/17/95
Date Sampled: 08/16/95
Date Analyzed: 08/16/95
TimE Analyzed: 5:47 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L) *
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	101%	86 - 118%
Toluene - d8	100%	88 - 110%
Bromofluorobenzene	91%	86 - 115%

Reference: Method 8240B: Gas Chromatography / Mass Spectrometry for Volatile Organics
Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States
Environmental Protection Agency, September 1994

Comments:

Analyst

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iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK
EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB0817
Sample Matrix: Water

Report Date: 08/17/95
Date Extracted: 08/17/95
Date Analyzed: 08/17/95
Time Analyzed: 10:57 AM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.025
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.020
Carbon disulfide	ND	0.005
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.010
Chloroform	ND	0.005
Chloromethane	ND	0.010
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.005
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.005
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.005
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

ADDITIONAL DETECTED COMPOUNDS

Sample ID:	Method Blank
Laboratory ID:	MB0817
Sample Matrix:	Water

Report Date:	08/17/95
Date Sampled:	08/17/95
Date Analyzed:	08/17/95
TimE Analyzed:	10:57 AM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L) *
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	103%	86 - 118%
Toluene - d8	101%	88 - 110%
Bromofluorobenzene	89%	86 - 115%

Reference: Method 8240B: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994

Comments:

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - MATRIX SPIKE / SPIKE DUPLICATE ANALYSIS

EPA Method 8240 - VOLATILE ORGANICS

Laboratory ID:	0695G01426 Spike and Spike Duplicate	Report Date:	08/17/95
Sample Matrix:	Water	Date Sampled:	08/09/95
Preservative:	Cool, HCl	Date Received:	08/11/95
Condition:	Intact, pH <2	Date Analyzed:	08/17/95
		Time Analyzed:	2:43 PM/3:30 PM

MATRIX SPIKE ANALYSIS

Analyte	Spiked Sample Result (mg/L)	Sample Result (mg/L)	Spike Added (mg/L)	Percent Recovery	QC Limits Recovery
1,1 - Dichloroethene	0.037	ND	0.050	74%	61 - 145
Trichloroethene	0.039	ND	0.050	78%	71 - 120
Benzene	0.041	ND	0.050	82%	76 - 127
Toluene	0.039	ND	0.050	78%	76 - 125
Chlorobenzene	0.038	ND	0.050	76%	75 - 130

MATRIX SPIKE DUPLICATE ANALYSIS

Analyte	Duplicate Result (mg/L)	Percent Recovery	Original Spike Result (mg/L)	RPD	QC Limits	
					RPD	Rec.
1,1 - Dichloroethene	0.037	74%	74%	0%	14%	61 - 145
Trichloroethene	0.041	82%	78%	5%	14%	71 - 120
Benzene	0.042	84%	82%	2%	11%	76 - 127
Toluene	0.042	84%	78%	7%	13%	76 - 125
Chlorobenzene	0.040	80%	76%	5%	13%	75 - 130

ND - Analyte not detected at stated limit of detection

Spike Recovery: 0 out of 10 outside QC Limits
RPD: 0 out of 5 outside QC Limits

Quality Control:

Surrogate	Spike Recovery	Duplicate Recovery	Recovery Limits
1,2-Dichloroethane-d4	103%	104%	86 - 118%
Toluene-d8	103%	105%	88 - 110%
Bromofluorobenzene	100%	99%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID:	Method Blank	Report Date:	08/23/95
Laboratory ID:	MB326	Date Extracted:	08/15/95
Sample Matrix:	Water	Date Analyzed:	08/21/95
		Time Analyzed:	10:18 AM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.010
Acenaphthylene	ND	0.010
Anthracene	ND	0.010
Benzo(a)anthracene	ND	0.010
Benzo(b)fluoranthene	ND	0.010
Benzo(k)fluoranthene	ND	0.010
Benzo(g,h,i)perylene	ND	0.010
Benzo(a)pyrene	ND	0.010
Benzoic acid	ND	0.010
Benzyl alcohol	ND	0.010
Bis(2-chloroethoxy)methane	ND	0.010
Bis(2-chloroethyl)ether	ND	0.010
Bis(2-chloroisopropyl)ether	ND	0.025
Bis(2-ethylhexyl)phthalate	ND	0.025
4-Bromophenyl phenyl ether	ND	0.010
Butyl benzyl phthalate	ND	0.010
p - Chloroaniline	ND	0.010
p - Chloro - m - cresol	ND	0.010
2 - Chloronaphthalene	ND	0.010
2 - Chlorophenol	ND	0.010
4-Chlorophenyl phenyl ether	ND	0.010
Chrysene	ND	0.010
o - Cresol	ND	0.010
m,p - Cresol	ND	0.010
Di - n - butylphthalate	ND	0.025
Dibenz(a,h)anthracene	ND	0.010
Dibenzofuran	ND	0.010
o - Dichlorobenzene	ND	0.010
m - Dichlorobenzene	ND	0.010
p - Dichlorobenzene	ND	0.010
3,3 - Dichlorobenzidine	ND	0.010
2,4 - Dichlorophenol	ND	0.010
Diethyl phthalate	ND	0.010
2,4 - Dimethylphenol	ND	0.010
Dimethyl phthalate	ND	0.010

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS (cont)

Sample ID:	Method Blank	Report Date:	08/23/95
Laboratory ID:	MB326	Date Analyzed:	08/21/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.025
2,4 - Dinitrophenol	ND	0.025
2,4 - Dinitrotoluene	ND	0.010
2,6 - Dinitrotoluene	ND	0.010
Di-n-octyl phthalate	ND	0.025
Fluoranthene	ND	0.010
Fluorene	ND	0.010
Hexachlorobenzene	ND	0.010
Hexachlorocyclopentadiene	ND	0.025
Hexachloroethane	ND	0.010
Hexachlorobutadiene	ND	0.010
Ideno(1,2,3-cd)pyrene	ND	0.010
Isophorone	ND	0.010
2 - Methylnaphthalene	ND	0.010
Naphthalene	ND	0.010
o - Nitroaniline	ND	0.010
m - Nitroaniline	ND	0.010
p - Nitroaniline	ND	0.010
Nitrobenzene	ND	0.010
o - Nitrophenol	ND	0.010
p - Nitrophenol	ND	0.010
n - Nitrosodimethylamine	ND	0.010
n - Nitrosodiphenylamine	ND	0.010
n-Nitroso-di-n-propylamine	ND	0.010
Pentachlorophenol	ND	0.025
Phenanthrene	ND	0.010
Phenol	ND	0.010
Pyrene	ND	0.010
1,2,4 - Trichlorobenzene	ND	0.010
2,4,5 - Trichlorophenol	ND	0.010
2,4,6 - Trichlorophenol	ND	0.010

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE HYDROCARBONS

ADDITIONAL DETECTED COMPOUNDS

Sample ID:	Method Blank	Report Date:	08/23/95
Laboratory ID:	MB326	Date Analyzed:	08/21/95

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
None detected at reported limits of detection.		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	36%	25 - 121%
Phenol - d5	39%	24 - 113%
Nitrobenzene - d5	42%	23 - 120%
2 - Fluorobiphenyl	55%	30 - 115%
2,4,6 - Tribromophenol	55%	19 - 122%
Terphenyl - d14	81%	18 - 137%

References:

Method 3510: Separatory Funnel Liquid-Liquid Extraction.
Method 8270B: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

Review

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METRIX SPIKE
EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID: Matrix Spike
Laboratory ID: 0694G01407
Sample Matrix: Water
Condition: Intact
Preservative: Cool

Report Date: 08/23/95
Date Sampled: 08/09/95
Date Received: 08/10/95
Date Extracted: 08/15/95
Date Analyzed: 08/21/95
Time Analyzed: 2:07 PM

Analyte	Spike Concentration (mg/L)	Sample Concentration (mg/L)	Spike Added (mg/L)	Percent Recovery (%)	QC Limits
Phenol	0.105	ND	0.200	53%	5 - 112%
2 - Chlorophenol	0.117	ND	0.200	59%	23 - 134%
1,4 - Dichlorobenzene	0.052	ND	0.100	52%	20 - 124%
n-Nitroso-di-propylamine	0.059	ND	0.100	59%	D - 230%
1,2,4 - Trichlorobenzene	0.054	ND	0.100	54%	44 - 142%
4-Chloro-3-methylphenol	0.130	ND	0.200	65%	22 - 147%
Acenaphthene	0.074	ND	0.100	74%	47 - 145%
4 - Nitrophenol	0.184	ND	0.200	92%	D - 132%
2,4 - Dinitrotoluene	0.081	ND	0.100	81%	39 - 139%
Pentachlorophenol	0.162	ND	0.200	81%	14 - 176%
Pyrene	0.081	ND	0.100	81%	52 - 115%

ND - Analyte not detected at stated limit of detection

Spike Recovery: 0 of 11 recoveries outside acceptable limits.

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	54%	21 - 110%
Phenol - d6	64%	10 - 110%
Nitrobenzene - d5	56%	35 - 114%
2 - Fluorobiphenyl	71%	43 - 116%
2,4,6 - Tribromophenol	83%	10 - 123%
Terphenyl - d14	84%	33 - 141%

Reference:
Method 3510: Separatory Funnel Liquid-Liquid Extraction
Method 8270: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

Review

iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Quality Control Report
Duplicate Analysis

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 5AR
Lab ID: 0495W06801/0695G01408
Matrix: Water
Condition: Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Method
General Chemistry					
pH (Lab)	7.9	7.9	0	0.1 s.u.	SW-846 9040
Conductivity (Lab)	29000	29000	0	1 µmhos/cm	SW-846 9050
Total Dissolved Solids (180° C)	26500	26700	0	10 mg/L	EPA 160.1
Total Alkalinity (as CaCO3)	460	465	1	1 mg/L	EPA 310.1
Total Hardness (as CaCO3)	5780	5780	0	1 mg/L	Calculation
Fluoride	4.6	4.6	0	0.1 mg/L	EPA 340.2

Major Ions					
Calcium	540	538	0	1 mg/L	SW-846 6010A
Magnesium	1078	1079	0	1 mg/L	SW-846 6010A
Potassium	10	9	5	1 mg/L	SW-846 6010A
Sodium	6080	6000	1	1 mg/L	SW-846 6010A
Bicarbonate	561	567	1	1 mg/L	EPA 310.1
[illegible]bonate	ND*	ND*	NC*	1 mg/L	EPA 310.1
Chloride	6510	6400	1	1 mg/L	SW-846 9056
Sulfate	9690	9730	0	1 mg/L	SW-846 9056
Major Cation Sum	380.17	376.67	0	meq/L	Calculation
Major Anion Sum	394.45	392.34	0	meq/L	Calculation
Cation/Anion Balance	-1.84	-2.04		% Diff	Calculation

*ND - Parameter not detected at stated Practical Quantitation Limit.
*NC - Non-Calculable RPD due to value(s) less than PQL

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

[illegible]iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Quality Control Report
Duplicate Analysis

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 5AR
Lab ID: 0495W06801/0695G01408
Matrix: Water
Condition: Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Method
Total Metals					
Total Arsenic	0.042	0.041	1	0.005 mg/L	SW-846 7061A
Total Chromium	ND*	ND*	NC*	0.005 mg/L	SW-846 7191
Total Lead	ND*	ND*	NC*	0.01 mg/L	SW-846 7421
Total Nickel	ND*	ND*	NC*	0.05 mg/L	SW-846 7520

*ND - Parameter not detected at stated Practical Quantitation Limit.
*NC - Non-Calculable RPD due to value(s) less than PQL

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

iewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

METHOD BLANK

CLIENT: **Navajo Refining Co.**
PROJECT: **RFI Phase III / Artesia, NM**

Sample ID: Blank W6798-6801 **Report Date:** 08/30/95
Sample Matrix: Water

Analyte	Concentration	Units	POL	Method Reference
Total Aluminum	ND	mg/L	0.1	SW-846 6010A
Total Barium	ND	mg/L	0.01	SW-846 6010A
Total Beryllium	ND	mg/L	0.005	SW-846 6010A
Total Boron	ND	mg/L	0.05	SW-846 6010A
Total Cadmium	ND	mg/L	0.001	SW-846 7131A
Total Cobalt	ND	mg/L	0.02	SW-846 6010A
Total Copper	ND	mg/L	0.01	SW-846 6010A
Total Iron	ND	mg/L	0.05	SW-846 6010A
Total Manganese	ND	mg/L	0.01	SW-846 6010A
Total Mercury	ND	mg/L	0.001	SW-846 7471A
Total Molybdenum	ND	mg/L	0.05	SW-846 6010A
Total Nickel	ND	mg/L	0.05	SW-846 6010A
Total Selenium	ND	mg/L	0.005	SW-846 7742
Total Silver	ND	mg/L	0.01	SW-846 7761
Total Uranium	ND	mg/L	0.3	SW-846 6010A
Total Vanadium	ND	mg/L	0.02	SW-846 6010A
Total Zinc	ND	mg/L	0.02	SW-846 6010A

Reference: SW-846-"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", US EPA,Third Edition, Final Update 1,July 1992.

Reviewed by:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT
MATRIX SPIKE

Client: **Navajo Refining Co.**
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 55
Lab ID: 0495W06799/0695G01406
Matrix: Water
Condition Intact

Report Date: 08/30/95
Receipt Date: 08/11/95
Sample Date: 08/09/95

Analyte	Unspiked Sample Concentration (mg/L)	Spiked Sample Concentration (mg/L)	Spike Amount (mg/L)	Percent Recovery
Total Alumimum	6.19	7.00	1.00	81
Total Arsenic	0.005	0.015	0.010	100
Total Barium	0.17	1.13	1.00	96
Total Beryllium	ND	0.97	1.00	97
Total Boron	0.48	1.38	1.00	90
Total Cadmium	ND	0.005	0.005	100
Total Cobalt	ND	0.96	1.00	96
Total Copper	0.018	0.97	1.00	95
Total Iron	3.85	4.68	1.00	83
Total Manganese	0.20	1.14	1.00	94
Total Mercury	ND	0.002	0.002	100
Total Molybdenum	ND	0.97	1.00	97
Total Selenium	ND	0.011	0.010	110
Total Silver	ND	0.020	0.025	80
Total Uranium	ND	2.01	2.00	101
Total Vanadium	0.02	0.98	1.00	96
Total Zinc	0.03	1.02	1.00	99

Reference: SW-846-"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", US EPA,Third Edition, Final Update 1,July 1992.

Reviewed by:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

Mr. David Boyer
Los Alamos Technical Asso., Inc.
2400 Louisiana Blvd NE
Building 1, Ste. 400
Albuquerque, New Mexico 87110

January 17, 1996

Dear Mr. Boyer,

On December 23, 1995, two water samples and one trip blank were received, cool and intact, by Inter-Mountain Laboratories - College Station. The samples were identified by project location "Artesia, NM." Analyses for Volatiles by Method 8240, Semivolatiles by Method 8270, general water chemistry, and Metals were performed as requested on the accompanying chain of custody.

It is the policy of this laboratory to employ, whenever possible, preparatory and analytical methods which have been approved by regulatory agencies. The methods used in the analysis of the sample reported here are found in "Test Methods for Evaluating Solid Waste", SW-846, USEPA, Final Update II, September 1994. All reports in this package reference the methods utilized.

Methods used for each analysis are listed on the reports. All detection limits are practical quantitation limits (PQLs). PQLs have been corrected for dilutions and sample volume analyzed.

Quality Control reports have been included for your information and use. These reports appear at the end of the analytical package and may be identified by title. If there are any questions regarding the information presented in this package, feel free to call at your convenience.

Sincerely,

Ulonda M Rogers

Ulonda M. Rogers

Enclosures

NAV2195

Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name NAVAjo Refining Co

Project Location ArTesiA

Sampler: (Signature) D G Boyer

Chain of Custody Tape No.

ANALYSES / PARAMETERS

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers	VOC (ALL) 8240	Semi's (ALL) 8270	Metals (will call)	Water Chem NO2, NO3, TKN	Remarks
MW-54B	12/22/95	1225	0695602195	Water	7	✓	✓	✓	✓	will call with metals list
MW-54A	"	1310	0695602196	"	7	✓	✓	✓	✓	
Trip Blank	—	—	0695602197	"	X 2					
										Intact.
										Cooler temp 3°C

Relinquished by: (Signature) David G Boyer	**Date** 12/22/95	**Time** 1615	**Received by: (Signature)** Federal Express	**Date**	**Time**
Relinquished by: (Signature)	**Date**	**Time**	**Received by: (Signature)**	**Date**	**Time**
Relinquished by: (Signature)	**Date**	**Time**	**Received by laboratory: (Signature)** David M Roberts	**Date** 12/23/95	**Time** 12 00

Inter-Mountain Laboratories, Inc.

☐ 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

☐ 1701 Phillips Circle
Gillette, Wyoming 82718
Telephone (307) 682-8945

☐ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

☐ 1160 Research Dr.
Bozeman, Montana 59715
Telephone (406) 586-8450

☐ 11183 SH 30
College Station, TX 77845
Telephone (409) 776-8945

☑ 3304 Longmire Drive
College Station, TX 77845
Telephone (409) 774-4999

31377

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client: NAVAJO REFINING COMPANY
Project : Artesia
Sample ID: MW-54B
Laboratory ID: 0695G02195
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH<2

Report Date: 12/28/95
Date Sampled: 12/22/95
Date Received: 12/23/95
Date Extracted: 12/27/95
Date Analyzed: 12/27/95
Time Analyzed: 4:49 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.03
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.04
Carbon disulfide	ND	0.01
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.01
Chloroform	ND	0.005
Chloromethane	ND	0.01
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.02
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.02
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.01
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client:	NAVAJO REFINING COMPANY
Project :	Artesia
Sample ID:	MW-54B
Laboratory ID:	0695G02195

Report Date:	12/28/95
Date Sampled:	12/22/95
Date Analyzed:	12/27/95
Time Analyzed:	4:49 PM

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
None detected at reported levels of detection		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	107%	86 - 118%
Toluene-d8	106%	88 - 110%
Bromofluorobenzene	106%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

Review

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**		
Project:	Artesia, NM	Report Date:	12/29/95
Sample ID:	MW-54B	Date Sampled:	12/22/95
Laboratory ID:	0695G02195	Date Received:	12/23/95
Sample Matrix:	Water	Date Extracted:	12/28/95
Condition:	Intact	Date Analyzed:	12/28/95
Preservative:	Cool	Time Analyzed:	7:22 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.01
Acenaphthylene	ND	0.01
Anthracene	ND	0.01
Benzo(a)anthracene	ND	0.01
Benzo(b)fluoranthene	ND	0.01
Benzo(k)fluoranthene	ND	0.01
Benzo(g,h,i)perylene	ND	0.01
Benzo(a)pyrene	ND	0.01
Benzoic acid	ND	0.01
Benzyl alcohol	ND	0.01
Bis(2-chloroethoxy)methane	ND	0.01
Bis(2-chloroethyl)ether	ND	0.01
Bis(2-chloroisopropyl)ether	ND	0.03
Bis(2-ethylhexyl)phthalate	ND	0.03
4-Bromophenyl phenyl ether	ND	0.01
Butyl benzyl phthalate	ND	0.01
p - Chloroaniline	ND	0.01
p - Chloro - m - cresol	ND	0.01
2 - Chloronaphthalene	ND	0.01
2 - Chlorophenol	ND	0.01
4-Chlorophenyl phenyl ether	ND	0.01
Chrysene	ND	0.01
o - Cresol	ND	0.01
m,p - Cresol	ND	0.01
Di - n - butylphthalate	ND	0.03
Dibenz(a,h)anthracene	ND	0.01
o - Dichlorobenzene	ND	0.01
m - Dichlorobenzene	ND	0.01
p - Dichlorobenzene	ND	0.01
3,3 - Dichlorobenzidine	ND	0.01
2,4 - Dichlorophenol	ND	0.01
Diethyl phthalate	ND	0.01
2,4 - Dimethylphenol	ND	0.01
Dimethyl phthalate	ND	0.01

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: MW-54B
Laboratory ID: 0695G02195

Report Date: 12/29/95
Date Sampled: 12/22/95
Date Analyzed: 12/28/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.03
2,4 - Dinitrophenol	ND	0.03
2,4 - Dinitrotoluene	ND	0.01
2,6 - Dinitrotoluene	ND	0.01
Di-n-octyl phthalate	ND	0.03
Fluoranthene	ND	0.01
Fluorene	ND	0.01
Hexachlorobenzene	ND	0.01
Hexachlorocyclopentadiene	ND	0.03
Hexachloroethane	ND	0.01
Hexachlorobutadiene	ND	0.01
Ideno(1,2,3-cd)pyrene	ND	0.01
Isophorone	ND	0.01
2 - Methylnaphthalene	ND	0.01
Naphthalene	ND	0.01
o - Nitroaniline	ND	0.01
m - Nitroaniline	ND	0.01
p - Nitroaniline	ND	0.01
Nitrobenzene	ND	0.01
o - Nitrophenol	ND	0.01
p - Nitrophenol	ND	0.01
n - Nitrosodimethylamine	ND	0.01
n - Nitrosodiphenylamine	ND	0.01
n-Nitroso-di-n-propylamine	ND	0.01
Pentachlorophenol	ND	0.03
Phenanthrene	ND	0.01
Phenol	ND	0.01
Pyrene	ND	0.01
1,2,4 - Trichlorobenzene	ND	0.01
2,4,5 - Trichlorophenol	ND	0.01
2,4,6 - Trichlorophenol	ND	0.01

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE HYDROCARBONS
ADDITIONAL DETECTED COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**	Report Date:	12/29/95
Project:	Artesia, NM	Date Sampled:	12/22/95
Sample ID:	MW-54B	Date Analyzed:	12/28/95
Laboratory ID:	0695G02195		

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
Unknown hydrocarbon	10.60	0.08B
Unknown hydrocarbon	11.47	0.05B

* - Concentration calculated using assumed Relative Response Factor = 1
B - Analyte detected in method blank

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	62%	21 - 110%
Phenol - d5	68%	10 - 110%
Nitrobenzene - d5	71%	35 - 114%
2 - Fluorobiphenyl	74%	43 - 116%
2,4,6 - Tribromophenol	97%	10 - 123%
Terphenyl - d14	85%	33 - 141%

References:

Method 3510B: Separatory Funnel Liquid-Liquid Extraction.
Method 8270B: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

Wenda M Rog
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iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 54B
Lab ID: 0495W11812/0695G02195
Matrix: Water
Condition: Intact

Report Date: 01/16/96
Receipt Date: 12/26/95
Sample Date: 12/22/95

Parameter	Concentration	PQL	Method
pH (Lab)	8.1 s.u.	0.1	SW-846 9040A
Conductivity (Lab)	2380 µmhos/cm	1	SW-846 9050
Total Dissolved Solids (180° C)	2100 mg/L	10	EPA 160.1
Total Alkalinity (as CaCO3)	314 mg/L	1	EPA 310.1
Total Hardness (as CaCO3)	1350 mg/L	1	Calculation
Fluoride	0.7 mg/L	0.1	EPA 340.2
Nitrite	ND*	0.1 mg/L	EPA 353.2
Nitrogen TKN	ND*	0.1 mg/L	EPA 351.3

Calcium	319 mg/L	15.92 meq/L	1 mg/L	SW-846 6010A
Magnesium	135 mg/L	11.11 meq/L	1 mg/L	SW-846 6010A
Potassium	2 mg/L	0.05 meq/L	1 mg/L	SW-846 6010A
[illegible]dium	55 mg/L	2.39 meq/L	1 mg/L	SW-846 6010A
Bicarbonate	383 mg/L	6.28 meq/L	1 mg/L	EPA 310.1
Carbonate	ND*	0.00	1 mg/L	EPA 310.1
Chloride	111 mg/L	3.13 meq/L	1 mg/L	SW-846 9056
Nitrate	0.2 mg/L	0.02 meq/L	0.1 mg/L	EPA 353.2
Sulfate	1000 mg/L	20.82 meq/L	1 mg/L	SW-846 9056
Major Cation Sum	29.47 meq/L		N/A	Calculation
Major Anion Sum	30.23 meq/L		N/A	Calculation
Cation/Anion Balance	-1.27 % Diff		N/A	Calculation

**ND - Parameter not detected at stated Practical Quantitation Limit.*

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

[illegible]viewed By:

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: **Navajo Refining Co.**
Project: **RFI Phase III / Artesia, NM**
Sample ID: MW - 54B
Lab ID: 0495W11812/0695G02195
Matrix: *Water*
Condition: Intact

Report Date: 01/16/96
Receipt Date: *12/26/95*
Sample Date: 12/22/95

Parameter	Concentration	PQL	Method
Total Aluminum	ND*	0.1 mg/L	SW-846 6010A
Total Arsenic	ND*	0.005 mg/L	SW-846 7061A
Total Barium	0.02 mg/L	0.01	SW-846 6010A
Total Beryllium	ND*	0.005 mg/L	SW-846 6010A
Total Boron	0.16 mg/L	0.05	SW-846 6010A
Total Cadmium	ND*	0.001 mg/L	SW-846 7131A
Total Chromium	ND*	0.005 mg/L	SW-846 7191
Total Cobalt	ND*	0.02 mg/L	SW-846 6010A
Total Copper	ND*	0.01 mg/L	SW-846 6010A
Total Iron	0.09 mg/L	0.05	SW-846 6010A
Total Lead	ND*	0.01 mg/L	SW-846 7421
Total Manganese	0.14 mg/L	0.01	SW-846 6010A
tal Mercury	0.003 mg/L	0.001	SW-846 7471A
tal Molybdenum	ND*	0.05 mg/L	SW-846 6010A
Total Nickel	ND*	0.05 mg/L	SW-846 7520
Total Selenium	ND*	0.005 mg/L	SW-846 7742
Total Silver	ND*	0.01 mg/L	SW-846 7761
Total Vanadium	ND*	0.02 mg/L	SW-846 6010A
Total Zinc	ND*	0.02 mg/L	SW-846 6010A

ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

viewed By:

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client: NAVAJO REFINING COMPANY
Project : Artesia
Sample ID: MW-54A
Laboratory ID: 0695G02196
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH<2

Report Date: 12/28/95
Date Sampled: 12/22/95
Date Received: 12/23/95
Date Extracted: 12/27/95
Date Analyzed: 12/27/95
Time Analyzed: 4:08 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.03
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.04
Carbon disulfide	ND	0.01
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.01
Chloroform	ND	0.005
Chloromethane	ND	0.01
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	0.006	0.005
2-Hexanone	ND	0.02
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.02
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.01
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client:	NAVAJO REFINING COMPANY		
Project :	Artesia	Report Date:	12/28/95
Sample ID:	MW-54A	Date Sampled:	12/22/95
Laboratory ID:	0695G02196	Date Analyzed:	12/27/95
		Time Analyzed:	4:08 PM

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
Isopropyl Benzene	23.64	0.006
1,2,4-Trimethylbenzene	24.56	0.006
Hydrocarbon Envelope	14 - 30	

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	106%	86 - 118%
Toluene-d8	108%	88 - 110%
Bromofluorobenzene	109%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

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iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project: Artesia, NM
Sample ID: MW-54A
Laboratory ID: 0695G02196
Sample Matrix: Water
Condition: Intact
Preservative: Cool

Report Date: 12/29/95
Date Sampled: 12/22/95
Date Received: 12/23/95
Date Extracted: 12/28/95
Date Analyzed: 12/28/95
Time Analyzed: 8:07 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.05
Acenaphthylene	ND	0.05
Anthracene	ND	0.05
Benzo(a)anthracene	ND	0.05
Benzo(b)fluoranthene	ND	0.05
Benzo(k)fluoranthene	ND	0.05
Benzo(g,h,i)perylene	ND	0.05
Benzo(a)pyrene	ND	0.05
Benzoic acid	ND	0.05
Benzyl alcohol	ND	0.05
Bis(2-chloroethoxy)methane	ND	0.05
Bis(2-chloroethyl)ether	ND	0.05
Bis(2-chloroisopropyl)ether	ND	0.63
Bis(2-ethylhexyl)phthalate	ND	0.63
4-Bromophenyl phenyl ether	ND	0.05
Butyl benzyl phthalate	ND	0.05
p - Chloroaniline	ND	0.05
p - Chloro - m - cresol	ND	0.05
2 - Chloronaphthalene	ND	0.05
2 - Chlorophenol	ND	0.05
4-Chlorophenyl phenyl ether	ND	0.05
Chrysene	ND	0.05
o - Cresol	ND	0.05
m,p - Cresol	ND	0.05
Di - n - butylphthalate	ND	0.63
Dibenz(a,h)anthracene	ND	0.05
o - Dichlorobenzene	ND	0.05
m - Dichlorobenzene	ND	0.05
p - Dichlorobenzene	ND	0.05
3,3 - Dichlorobenzidine	ND	0.05
2,4 - Dichlorophenol	ND	0.05
Diethyl phthalate	ND	0.05
2,4 - Dimethylphenol	ND	0.05
Dimethyl phthalate	ND	0.05

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE ORGANIC COMPOUNDS

Client:	NAVAJO REFINING COMPANY		
Project:	Artesia, NM	Report Date:	12/29/95
Sample ID:	MW-54A	Date Sampled:	12/22/95
Laboratory ID:	0695G02196	Date Analyzed:	12/28/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.63
2,4 - Dinitrophenol	ND	0.63
2,4 - Dinitrotoluene	ND	0.05
2,6 - Dinitrotoluene	ND	0.05
Di-n-octyl phthalate	ND	0.63
Fluoranthene	ND	0.05
Fluorene	ND	0.05
Hexachlorobenzene	ND	0.05
Hexachlorocyclopentadiene	ND	0.63
Hexachloroethane	ND	0.05
Hexachlorobutadiene	ND	0.05
Ideno(1,2,3-cd)pyrene	ND	0.05
Isophorone	ND	0.05
2 - Methylnaphthalene	ND	0.05
Naphthalene	ND	0.05
o - Nitroaniline	ND	0.05
m - Nitroaniline	ND	0.05
p - Nitroaniline	ND	0.05
Nitrobenzene	ND	0.05
o - Nitrophenol	ND	0.05
p - Nitrophenol	ND	0.05
n - Nitrosodimethylamine	ND	0.05
n - Nitrosodiphenylamine	ND	0.05
n-Nitroso-di-n-propylamine	ND	0.05
Pentachlorophenol	ND	0.63
Phenanthrene	ND	0.05
Phenol	ND	0.05
Pyrene	ND	0.05
1,2,4 - Trichlorobenzene	ND	0.05
2,4,5 - Trichlorophenol	ND	0.05
2,4,6 - Trichlorophenol	ND	0.05

ND - Analyte not detected at stated limit of detection

EPA Method 8270
SEMIVOLATILE HYDROCARBONS
ADDITIONAL DETECTED COMPOUNDS

Client:	**NAVAJO REFINING COMPANY**
Project:	Artesia, NM
Sample ID:	MW-54A
Laboratory ID:	0695G02196

Report Date:	12/29/95
Date Sampled:	12/22/95
Date Analyzed:	12/28/95

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
Unknown hydrocarbon	10.60	0.09B
Unknown hydrocarbon	11.46	0.06B

* - Concentration calculated using assumed Relative Response Factor = 1
B - Analyte detected in method blank

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	75%	21 - 110%
Phenol - d5	52%	10 - 110%
Nitrobenzene - d5	65%	35 - 114%
2 - Fluorobiphenyl	73%	43 - 116%
2,4,6 - Tribromophenol	107%	10 - 123%
Terphenyl - d14	103%	33 - 141%

References:

Method 3510B: Separatory Funnel Liquid-Liquid Extraction.
Method 8270B: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

Analyst

Review

iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 54A
Lab ID: 0495W11813/0695G02196
Matrix: Water
Condition: Intact

Report Date: 01/16/96
Receipt Date: 12/26/95
Sample Date: 12/22/95

Parameter	Concentration	PQL	Method
pH (Lab)	7.7 s.u.	0.1	SW-846 9040A
Conductivity (Lab)	2430 µmhos/cm	1	SW-846 9050
Total Dissolved Solids (180° C)	1970 mg/L	10	EPA 160.1
Total Alkalinity (as CaCO3)	488 mg/L	1	EPA 310.1
Total Hardness (as CaCO3)	1360 mg/L	1	Calculation
Fluoride	1.0 mg/L	0.1	EPA 340.2
Nitrite	ND*	0.1 mg/L	EPA 353.2
Nitrogen TKN	ND*	0.1 mg/L	EPA 351.3

Calcium	357 mg/L	17.81 meq/L	1 mg/L	SW-846 6010A
Magnesium	113 mg/L	9.30 meq/L	1 mg/L	SW-846 6010A
[illegible]tassium	1 mg/L	0.03 meq/L	1 mg/L	SW-846 6010A
[illegible]dium	53 mg/L	2.31 meq/L	1 mg/L	SW-846 6010A
Bicarbonate	595 mg/L	9.75 meq/L	1 mg/L	EPA 310.1
Carbonate	ND*	0.00	1 mg/L	EPA 310.1
Chloride	183 mg/L	5.16 meq/L	1 mg/L	SW-846 9056
Nitrate	ND*	0.00	0.1 mg/L	EPA 353.2
Sulfate	745 mg/L	15.51 meq/L	1 mg/L	SW-846 9056
Major Cation Sum	29.45 meq/L		N/A	Calculation
Major Anion Sum	30.42 meq/L		N/A	Calculation
Cation/Anion Balance	-1.62 % Diff		N/A	Calculation

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

[illegible]viewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml

Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

WATER QUALITY REPORT

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Sample ID: MW - 54A
Lab ID: 0495W11813/0695G02196
Matrix: Water
Condition: Intact

Report Date: 01/16/96
Receipt Date: 12/26/95
Sample Date: 12/22/95

Parameter	Concentration	PQL	Method
Total Aluminum	0.4 mg/L	0.1	SW-846 6010A
Total Arsenic	0.008 mg/L	0.005	SW-846 7061A
Total Barium	0.03 mg/L	0.01	SW-846 6010A
Total Beryllium	ND*	0.005 mg/L	SW-846 6010A
Total Boron	0.28 mg/L	0.05	SW-846 6010A
Total Cadmium	ND*	0.001 mg/L	SW-846 7131A
Total Chromium	ND*	0.005 mg/L	SW-846 7191
Total Cobalt	ND*	0.02 mg/L	SW-846 6010A
Total Copper	ND*	0.01 mg/L	SW-846 6010A
Total Iron	0.40 mg/L	0.05	SW-846 6010A
Total Lead	ND*	0.01 mg/L	SW-846 7421
Total Manganese	0.35 mg/L	0.01	SW-846 6010A
[illegible]tal Mercury	ND*	0.001 mg/L	SW-846 7471A
[illegible]tal Molybdenum	ND*	0.05 mg/L	SW-846 6010A
Total Nickel	ND*	0.05 mg/L	SW-846 7520
Total Selenium	ND*	0.005 mg/L	SW-846 7742
Total Silver	ND*	0.01 mg/L	SW-846 7761
Total Vanadium	ND*	0.02 mg/L	SW-846 6010A
Total Zinc	ND*	0.02 mg/L	SW-846 6010A

*ND - Parameter not detected at stated Practical Quantitation Limit.

Reference: SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Enviromental Protection Agency, Final Update 2, September 1994.

SW-846 - "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", United States Environmental Protection Agency, Final Update 1, July 1992.

EPA - "Methods for Chemical Analysis of Water and Wastes", United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

[illegible]eviewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

iml **Inter-Mountain Laboratories, Inc.**

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240
VOLATILE ORGANIC COMPOUNDS

Client: **NAVAJO REFINING COMPANY**
Project : Artesia
Sample ID: *Trip Blank*
Laboratory ID: 0695G02197
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH<2

Report Date: 12/28/95
Date Sampled: NA
Date Received: 12/23/95
Date Extracted: 12/27/95
Date Analyzed: 12/27/95
Time Analyzed: 3:27 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.03
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	*ND*	*0.04*
Carbon disulfide	ND	0.01
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.01
Chloroform	ND	0.005
Chloromethane	ND	0.01
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.02
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.02
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.01
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

EPA Method 8240

VOLATILE ORGANIC COMPOUNDS
ADDITIONAL DETECTED COMPOUNDS

Client:	NAVAJO REFINING COMPANY
Project :	Artesia
Sample ID:	Trip Blank
Laboratory ID:	0695G02197

Report Date:	12/28/95
Date Sampled:	NA
Date Analyzed:	12/27/95
Time Analyzed:	3:27 PM

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
None detected at reported levels of detection		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
Dibromofluoromethane	106%	86 - 118%
Toluene-d8	106%	88 - 110%
Bromofluorobenzene	105%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB1227
Sample Matrix: Water

Report Date: 12/28/95
Date Extracted: 12/27/95
Date Analyzed: 12/27/95
Time Analyzed: 1:08 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acetone	ND	0.03
Benzene	ND	0.005
Bromodichloromethane	ND	0.005
Bromoform	ND	0.005
Bromomethane	ND	0.005
2-Butanone (MEK)	ND	0.04
Carbon disulfide	ND	0.01
Carbon tetrachloride	ND	0.005
Chlorobenzene	ND	0.005
Chloroethane	ND	0.01
Chloroform	ND	0.005
Chloromethane	ND	0.01
Dibromochloromethane	ND	0.005
1,1-Dichloroethane	ND	0.005
1,1-Dichloroethene	ND	0.005
trans-1,2-Dichloroethene	ND	0.005
1,2-Dichloroethane	ND	0.005
1,2-Dichloropropane	ND	0.005
cis-1,3-Dichloropropene	ND	0.005
trans-1,3-Dichloropropene	ND	0.005
Ethylbenzene	ND	0.005
2-Hexanone	ND	0.02
Methylene chloride	ND	0.005
4-Methyl-2-pentanone	ND	0.02
Styrene	ND	0.005
1,1,2,2-Tetrachloroethane	ND	0.005
Tetrachloroethene	ND	0.005
Toluene	ND	0.005
1,1,1-Trichloroethane	ND	0.005
1,1,2-Trichloroethane	ND	0.005
Trichloroethene	ND	0.005
Vinyl acetate	ND	0.01
Vinyl chloride	ND	0.005
Xylenes (total)	ND	0.005

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA METHOD 8240 VOLATILE ORGANIC COMPOUND

ADDITIONAL DETECTED COMPOUNDS

Sample ID: Method Blank
Laboratory ID: MB1227
Sample Matrix: Water

Report Date: 12/28/95
Date Extracted: 12/27/95
Date Analyzed: 12/27/95
Time Analyzed: 1:08 PM

Tentative Identification	Retention Time (Minutes)	Concentration (mg/L)*
None detected at reportable levels		

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:	Surrogate	Percent Recovery	Acceptance Limits
	Dibromofluoromethane	107%	86 - 118%
	Toluene-d8	107%	88 - 110%
	Bromofluorobenzene	106%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

Analyst

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11183 SH 30 College Station, Texas 77845
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Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - MATRIX SPIKE / SPIKE DUPLICATE ANALYSIS
EPA Method 8240 - VOLATILE ORGANICS

Laboratory ID: 0695G02195
Sample Matrix: Water
Preservative: Cool, HCl
Condition: Intact, pH<2

Report Date: 12/28/95
Date Sampled: 12/22/95
Date Received: 12/23/95
Date Analyzed: 12/27/95
Time Analyzed: 5:31 PM / 6:12 PM

MATRIX SPIKE ANALYSIS

Analyte	Spiked Sample Result (mg/L)	Sample Result (mg/L)	Spike Added (mg/L)	Percent Recovery	QC Limits Recovery
1,1 - Dichloroethene	0.045	ND	0.050	90%	61 - 145
Trichloroethene	0.053	ND	0.050	106%	71 - 120
Benzene	0.054	ND	0.050	108%	76 - 127
Toluene	0.055	ND	0.050	110%	76 - 125
Chlorobenzene	0.055	ND	0.050	110%	75 - 130

MATRIX SPIKE DUPLICATE ANALYSIS

Analyte	Duplicate Result (mg/L)	Percent Recovery	Original Spike Result (mg/L)	RPD	QC Limits	
					RPD	Rec.
1,1 - Dichloroethene	0.044	88%	90%	2%	14%	61 - 145
Trichloroethene	0.052	104%	106%	2%	14%	71 - 120
Benzene	0.053	106%	108%	2%	11%	76 - 127
Toluene	0.054	108%	110%	2%	13%	76 - 125
Chlorobenzene	0.054	108%	110%	2%	13%	75 - 130

ND - Analyte not detected at stated limit of detection

Spike Recovery: 0 out of 10 outside QC Limits
RPD: 0 out of 5 outside QC Limits

Quality Control:

Surrogate	Spike Recovery	Duplicate Recovery	Recovery Limits
Dibromofluoromethane	106%	106%	86 - 118%
Toluene-d8	107%	107%	88 - 110%
Bromofluorobenzene	105%	105%	86 - 115%

Reference: Method 8240A: Gas Chromatography / Mass Spectrometry for Volatile Organics Test Methods for Evaluating Solid Waste, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments: A capillary column is used instead of a packed column as in the reference above.

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11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID:	Method Blank	Report Date:	12/29/95
Laboratory ID:	MB506	Date Extracted:	12/28/95
Sample Matrix:	Water	Date Analyzed:	12/28/95
		Time Analyzed:	4:23 PM

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
Acenaphthene	ND	0.01
Acenaphthylene	ND	0.01
Anthracene	ND	0.01
Benzo(a)anthracene	ND	0.01
Benzo(b)fluoranthene	ND	0.01
Benzo(k)fluoranthene	ND	0.01
Benzo(g,h,i)perylene	ND	0.01
Benzo(a)pyrene	ND	0.01
Benzoic acid	ND	0.01
Benzyl alcohol	ND	0.01
Bis(2-chloroethoxy)methane	ND	0.01
Bis(2-chloroethyl)ether	ND	0.01
Bis(2-chloroisopropyl)ether	ND	0.03
Bis(2-ethylhexyl)phthalate	ND	0.03
4-Bromophenyl phenyl ether	ND	0.01
Butyl benzyl phthalate	ND	0.01
p - Chloroaniline	ND	0.01
p - Chloro - m - cresol	ND	0.01
2 - Chloronaphthalene	ND	0.01
2 - Chlorophenol	ND	0.01
4-Chlorophenyl phenyl ether	ND	0.01
Chrysene	ND	0.01
o - Cresol	ND	0.01
m,p - Cresol	ND	0.01
Di - n - butylphthalate	ND	0.03
Dibenz(a,h)anthracene	ND	0.01
Dibenzofuran	ND	0.01
o - Dichlorobenzene	ND	0.01
m - Dichlorobenzene	ND	0.01
p - Dichlorobenzene	ND	0.01
3,3 - Dichlorobenzidine	ND	0.01
2,4 - Dichlorophenol	ND	0.01
Diethyl phthalate	ND	0.01
2,4 - Dimethylphenol	ND	0.01
Dimethyl phthalate	ND	0.01

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS (cont)

Sample ID: Method Blank
Laboratory ID: MB506
Report Date: 12/29/95
Date Analyzed: 12/28/95

Analyte	Concentration (mg/L)	Detection Limit (mg/L)
4,6 - Dinitro -2- methylphenol	ND	0.03
2,4 - Dinitrophenol	ND	0.03
2,4 - Dinitrotoluene	ND	0.01
2,6 - Dinitrotoluene	ND	0.01
Di-n-octyl phthalate	ND	0.03
Fluoranthene	ND	0.01
Fluorene	ND	0.01
Hexachlorobenzene	ND	0.01
Hexachlorocyclopentadiene	ND	0.03
Hexachloroethane	ND	0.01
Hexachlorobutadiene	ND	0.01
Indeno(1,2,3-cd)pyrene	ND	0.01
Isophorone	ND	0.01
2 - Methylnaphthalene	ND	0.01
Naphthalene	ND	0.01
o - Nitroaniline	ND	0.01
m - Nitroaniline	ND	0.01
p - Nitroaniline	ND	0.01
Nitrobenzene	ND	0.01
o - Nitrophenol	ND	0.01
p - Nitrophenol	ND	0.01
n - Nitrosodimethylamine	ND	0.01
n - Nitrosodiphenylamine	ND	0.01
n-Nitroso-di-n-propylamine	ND	0.01
Pentachlorophenol	ND	0.03
Phenanthrene	ND	0.01
Phenol	ND	0.01
Pyrene	ND	0.01
1,2,4 - Trichlorobenzene	ND	0.01
2,4,5 - Trichlorophenol	ND	0.01
2,4,6 - Trichlorophenol	ND	0.01

ND - Analyte not detected at stated limit of detection

QUALITY CONTROL REPORT - METHOD BLANK

EPA Method 8270

SEMIVOLATILE HYDROCARBONS

ADDITIONAL DETECTED COMPOUNDS

Sample ID:	Method Blank	Report Date:	12/29/95
Laboratory ID:	MB506	Date Analyzed:	12/28/95

Tentative Identification	Retention Time (Minutes)	Concentration* (mg/L)
Unknown hydrocarbon	10.60	0.09
Unknown hydrocarbon	11.47	0.06

* - Concentration calculated using assumed Relative Response Factor = 1

Quality Control:

Surrogate	Percent Recovery	Acceptance Limits
2 - Fluorophenol	71%	21 - 100%
Phenol - d5	77%	10 - 110%
Nitrobenzene - d5	86%	35 - 114%
2 - Fluorobiphenyl	94%	43 - 116%
2,4,6 - Tribromophenol	109%	10 - 123%
Terphenyl - d14	101%	33 - 141%

References:

Method 3510B: Separatory Funnel Liquid-Liquid Extraction.
Method 8270B: Gas Chromatography / Mass Spectrometry for Semivolatile Organics Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

Comments:

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
Phone (409) 776-8945 FAX (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0692

QUALITY CONTROL REPORT - BLANK SPIKE AND BLANK SPIKE DUPLICATE

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID: Blank Spike and Blank Spike Duplicate
Laboratory ID: DI504, DI505
Sample Matrix: Water

Report Date: 12/29/95
Date Extracted: 12/28/95
Date Analyzed: 12/28/95
Time Analyzed: 5:08 PM
5:53 PM

Analyte	Spike Conc. (mg/L)	Sample Conc. (mg/L)	Spike Added (mg/L)	Percent Recovery	QC Limits
Phenol	0.105	ND	0.200	53%	5 - 112%
2 - Chlorophenol	0.098	ND	0.200	49%	23 - 134%
1,4 - Dichlorobenzene	0.062	ND	0.100	62%	20 - 124%
n-Nitroso-di-propylamine	0.083	ND	0.100	83%	D - 230%
1,2,4 - Trichlorobenzene	0.077	ND	0.100	77%	44 - 142%
4-Chloro-3-methylphenol	0.157	ND	0.200	79%	22 - 147%
Acenaphthene	0.080	ND	0.100	80%	47 - 145%
4 - Nitrophenol	0.127	ND	0.200	64%	D - 132%
2,4 - Dinitrotoluene	0.083	ND	0.100	83%	39 - 139%
Pentachlorophenol	0.155	ND	0.200	78%	14 - 176%
Pyrene	0.076	ND	0.100	76%	52 - 115%

Analyte	Spike Dup Conc. (mg/L)	Sample Conc. (mg/L)	Spike Dup Added (mg/L)	Percent Recovery	%RPD	RPD Limits
Phenol	0.107	ND	0.200	54%	2	42
2 - Chlorophenol	0.099	ND	0.200	50%	1	40
1,4 - Dichlorobenzene	0.063	ND	0.100	63%	2	28
n-Nitroso-di-propylamine	0.083	ND	0.100	83%	0	38
1,2,4 - Trichlorobenzene	0.077	ND	0.100	77%	0	28
4-Chloro-3-methylphenol	0.162	ND	0.200	81%	3	42
Acenaphthene	0.078	ND	0.100	78%	3	31
4 - Nitrophenol	0.136	ND	0.200	68%	7	50
2,4 - Dinitrotoluene	0.082	ND	0.100	82%	1	38
Pentachlorophenol	0.157	ND	0.200	79%	1	50
Pyrene	0.076	ND	0.100	76%	0	31

ND - Analyte not detected at stated limit of detection.

Spike Recovery: 0 out of 22 outside QC Limits
RPD: 0 out of 11 outside QC Limits

QUALITY CONTROL REPORT - MATRIX SPIKE AND MATRIX SPIKE DUPLICATE

EPA Method 8270

SEMIVOLATILE ORGANIC COMPOUNDS

Sample ID: Blank Spike and Blank Spike Duplicate
Laboratory ID: DI504, DI505
Report Date: 12/29/95
Date Analyzed: 12/28/95

Quality Control:

Surrogate	Spike Recovery	Duplicate Recovery	Recovery Limits
2 - Fluorophenol	62%	61%	21 - 110%
Phenol - d6	73%	70%	10 - 110%
Nitrobenzene - d	76%	75%	35 - 114%
2 - Fluorobipheny	81%	77%	43 - 116%
2,4,6 - Tribromop	100%	96%	10 - 123%
Terphenyl - d14	86%	84%	33 - 141%

Reference: Method 3510: Separatory Funnel Liquid-Liquid Extraction.
Method 8270B: Gas Chromatography / Mass Spectrometry for Semivolatile Organics
Test Methods for Evaluating Solid Wastes, SW - 846, Final Update II, United States Environmental Protection Agency, September 1994.

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Inter-Mountain Laboratories, Inc.

Inorganics Laboratory
11183 SH 30 College Station, Texas 77845
[illegible]e (409) 776-8945 Fax (409) 774-4705

Organics Laboratory
3304 Longmire Drive College Station, Texas 77845
Phone (409) 774-4999 Fax (409) 696-0962

Quality Control Report
Laboratory Control Sample Analysis

Client: Navajo Refining Co.
Project: RFI Phase III / Artesia, NM
Lab ID: 0495W11812 / 0695G02195
Matrix: Water

Report Date: 01/16/96
Receipt Date: 12/26/95
Sample Date: 12/22/95

Parameter	QC ID	Concentration			
		Found Value		Known Value	
Aluminum	ICP 7	1.02	mg/L	1.00	mg/L
Arsenic	SPEX	0.010	mg/L	0.010	mg/L
Barium	ICP 7	0.97	mg/L	1.00	mg/L
Beryllium	ICP 19	0.98	mg/L	1.00	mg/L
Boron	ICP 7	0.98	mg/L	1.00	mg/L
Cadmium	SPEX	0.004	mg/L	0.004	mg/L
Chromium	ICP 19	0.050	mg/L	0.050	mg/L
Cobalt	ICP 19	1.02	mg/L	1.00	mg/L
Copper	ICP 19	1.02	mg/L	1.00	mg/L
Iron	ICP 19	1.07	mg/L	1.00	mg/L
Lead	SPEX	0.040	mg/L	0.040	mg/L
Manganese	ICP 19	1.00	mg/L	1.00	mg/L
Mercury	SPEX	0.004	mg/L	0.004	mg/L
Molybdenum	ICP 19	0.99	mg/L	1.00	mg/L
Nickel	ICP 19	1.02	mg/L	1.00	mg/L
Selenium	SPEX	0.011	mg/L	0.010	mg/L
Silver	QC 7	0.024	mg/L	0.025	mg/L
Vanadium	ICP 19	0.98	mg/L	1.00	mg/L
Zinc	ICP 19	1.01	mg/L	1.00	mg/L

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes"' United States Environmental Protection Agency, EPA 600/4-79-020, Revised March, 1983.

Reviewed By:

Robert Alford

Robert Alford
Supervisor, Water Laboratory

Appendix C

Appendix C

APPENDIX C

AQUIFER TEST DATA AND GRAPHS

APPENDIX C

1. Slug Test Data Set Configuration for Hydraulic Conductivity Determination

NRC Monitor Well	MW-54A Slug In	MW-54A Slug Out	MW-54A Slug In	MW-54B Slug In	MW-54B Slug Out
Test Date:	12/22/95	12/22/95	12/22/95	12/22/95	12/22/95
Test Identification	Test-2	Test-3	Test-4	Test-0	Test-1
Initial rise/drawdown in well, s_o (ft.)	1.76	2.32	2.26	2.49	2.66
Radius of well casing, r_c (ft.)	0.08333	0.08333	0.08333	0.08333	0.08333
Radius of well borehole, r_w (ft.)	0.3438	0.3438	0.3438	0.3438	0.3438
Saturated aquifer thickness, **b** (ft.)	13.53	13.53	13.53	28.6	28.6
Screen length, L (ft.)	9.5	9.5	9.5	9.5	9.5
Height of water in well, H (ft.)	13.53	13.53	13.53	28.6	28.6
Hydraulic Conductivity, K (ft/min)	0.00078	0.001094	0.000782	0.008135	0.008136
Transmissivity, T (ft^2/min)	N/A	N/A	N/A	0.15	0.13

2. Hydraulic Conductivity Determined using the Bouwer and Rice Method

The method uses a graphical approach to calculation of hydraulic conductivity whereby the straight line portion of the time-drawdown graph is fitted and the line extended to the logarithmic y-axis. For any value of time, a displacement (drawdown) can be determined and used, together with the "shape factor," to calculate the hydraulic conductivity.

$$\ln s_o - \ln s_t = (2\,K\,L\,t) / (r_c^2 \ln(r_e/r_w))$$

where:

s_o = initial drawdown in well due to instantaneous removal of water from well (ft.)
s_t = drawdown in well at time **t** (ft.)
K = hydraulic conductivity (ft/min)
L = length of well screen (ft.)
r_c = radius of well casing (ft.)
$\ln(r_e/r_w)$ = empirical "shape factor" determined from tables provided by Bouwer and Rice
r_e = equivalent radius over which head loss occurs (ft.)
r_w = radius of well, including sand pack (ft.)
b = saturated thickness of aquifer (ft.)

3. Transmissivity Determined using Cooper, et al., Method

This method utilizes a curve-matching technique to determine transmissivity. Time is plotted logarithmically on the x-axis, and the ratio of displacement (drawdown) at time t to displacement at time **t** = 0 is plotted on the Y-axis. The plotted curve is overlain and compared against a series of type-curves and the best match selected. For the best match, coordinate points are selected and entered into standard equations to determine transmissivity. The equations are generated using complex Bessel functions and are not shown here.

4. References

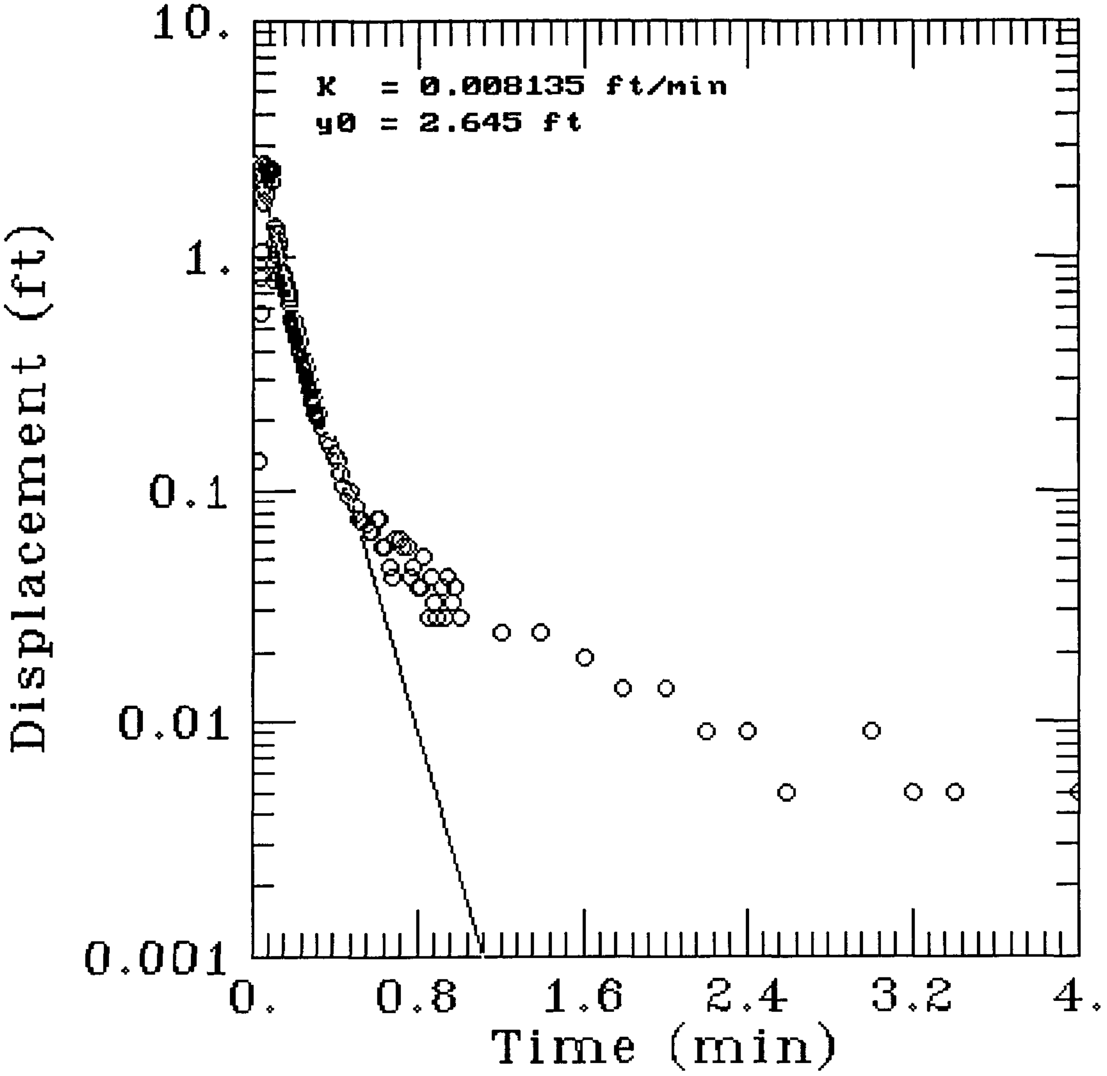
Computer programs utilizing both the Bouwer and Rice method, and the Cooper method to determine solutions to slug-test data are available from a number of public domain or commercial sources, together with extensive documentation of the applicability and limitations of the methods. The basic references which first described the test methods are listed below:

Bouwer, H., 1989. "The Bouwer and Rice Slug Test -- an Update." *Ground Water*, vol. 27, no. 3, pp. 304-309.

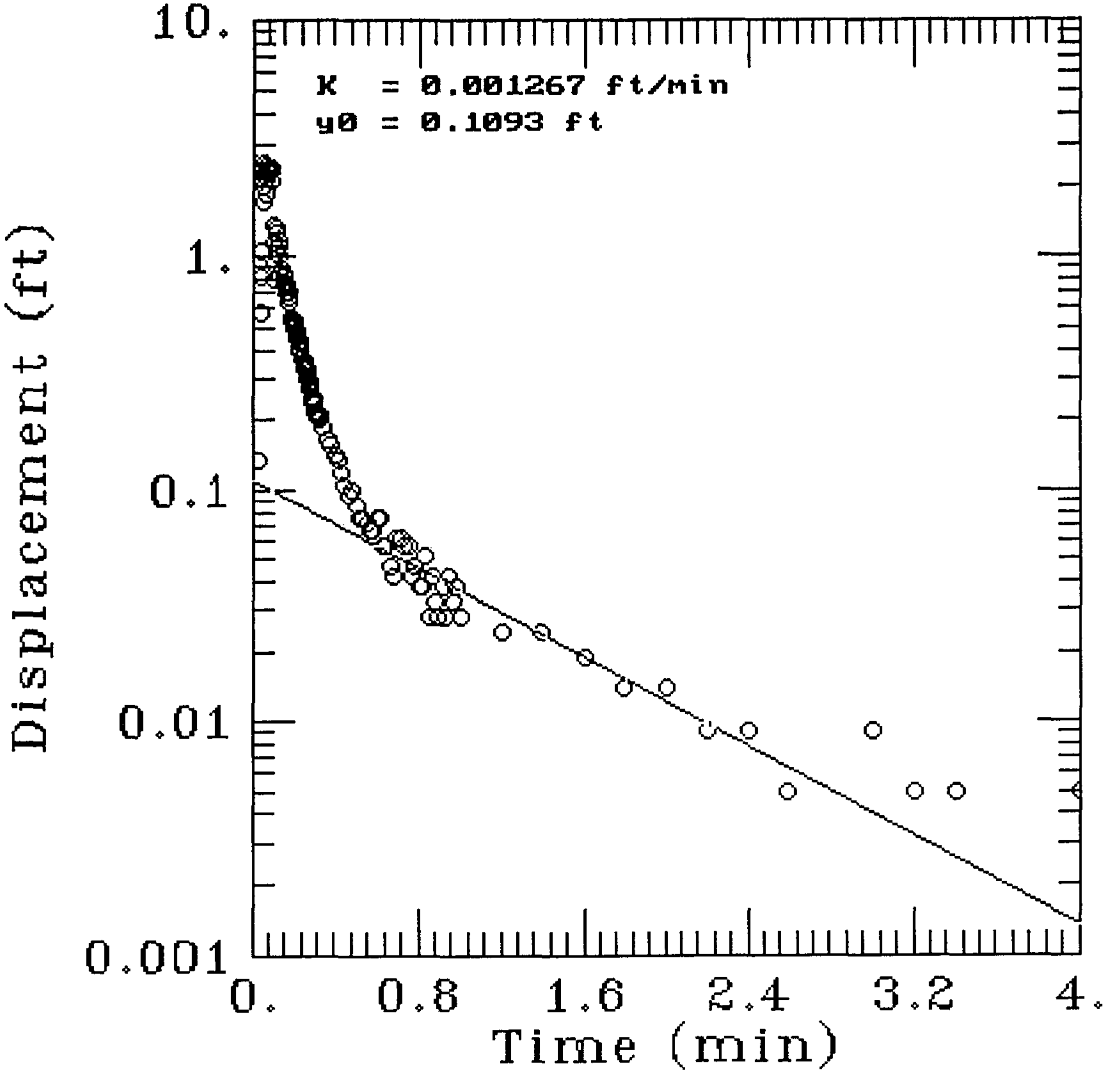
Bouwer, H. and R.C. Rice, 1976. "A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." *Water Resources Research*, vol. 12, no. 3, pp. 423-428.

Cooper, H.H., Jr., J.D. Bredehoeft, and I.S. Papadopulos, 1967. "Response of a Finite Diameter Well to an Instantaneous Charge of Water." *Water Resources Research*, vol. 3, pp. 263-269.

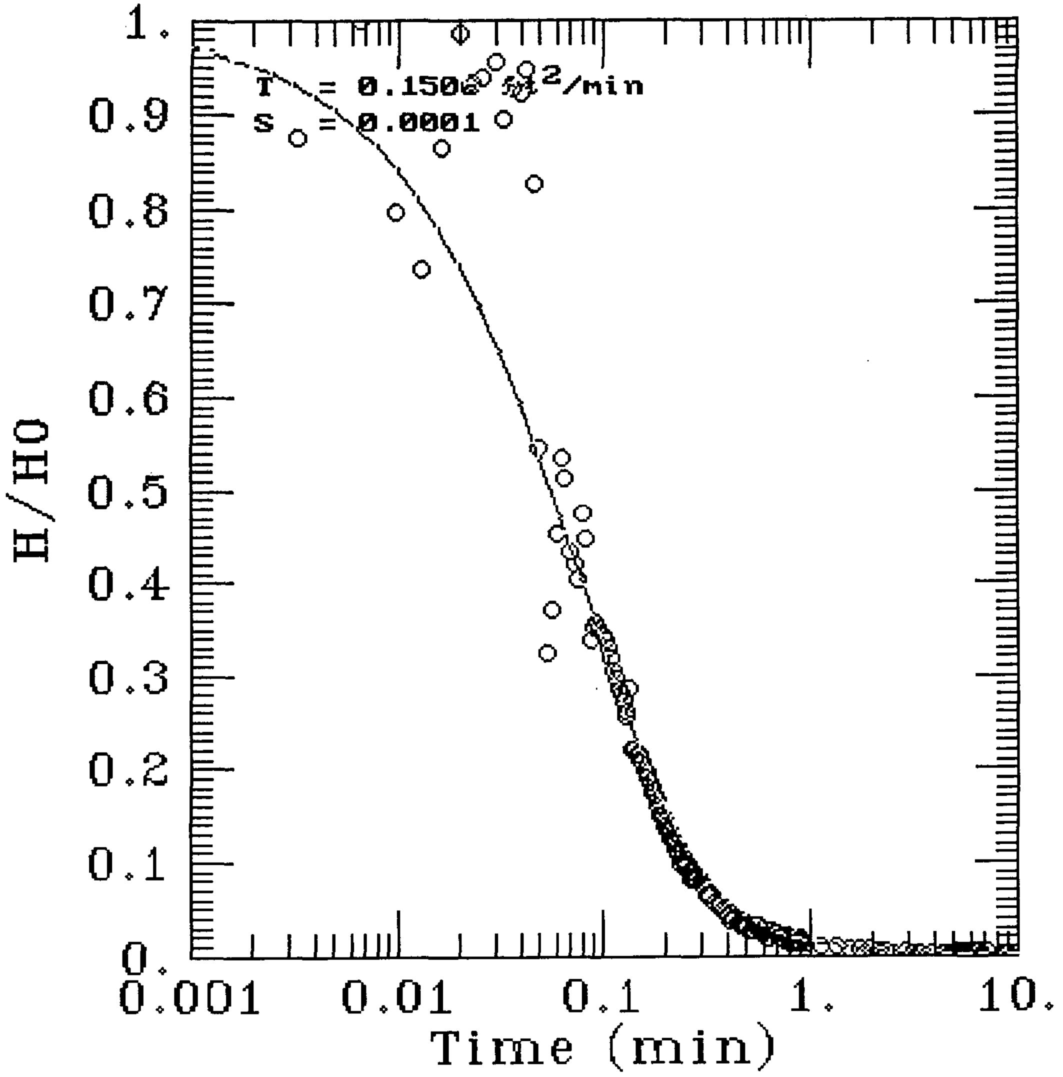
MW-54B, TEST-0, SLUG-IN



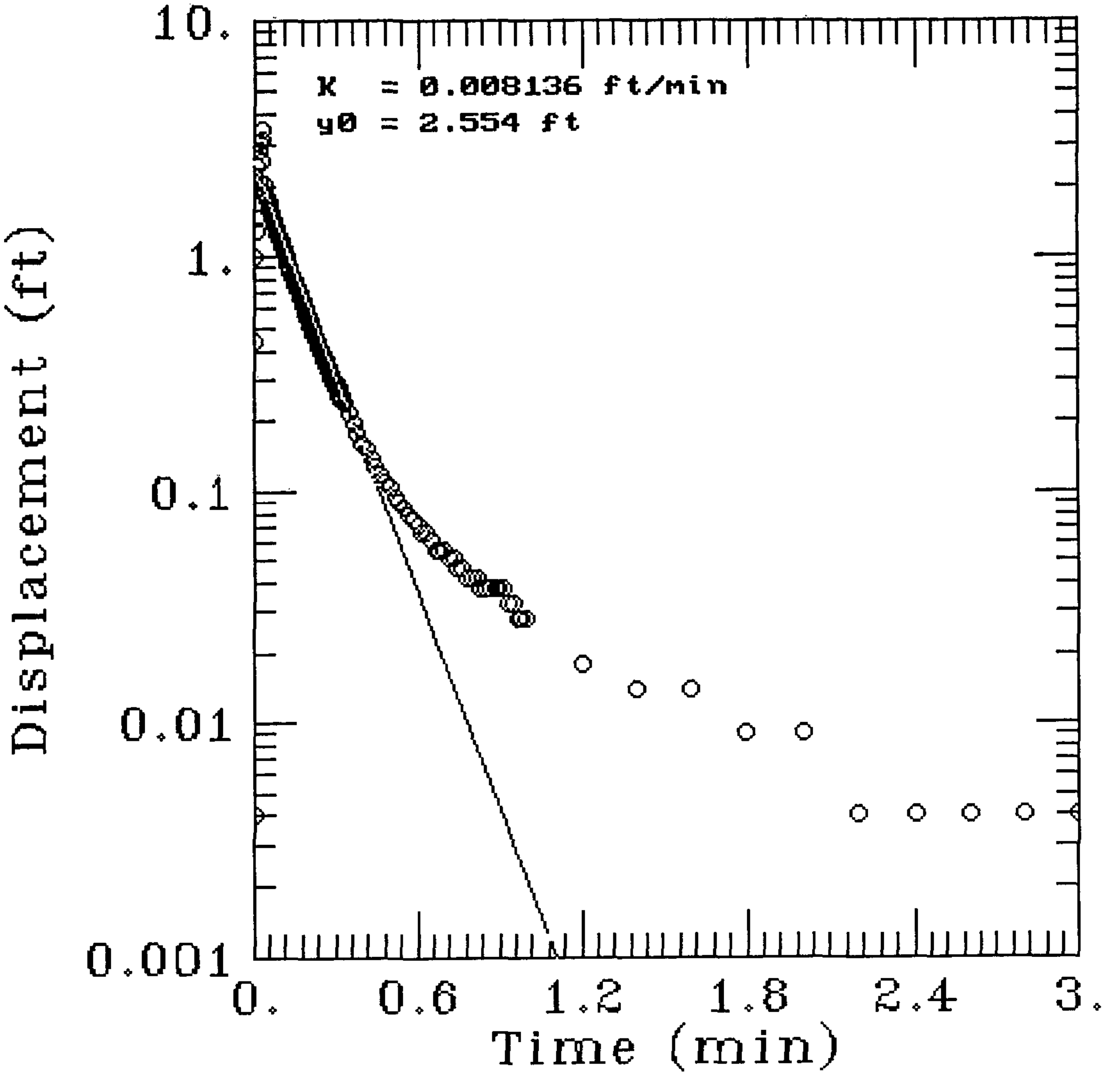
MW-54B, TEST-0, SLUG-IN



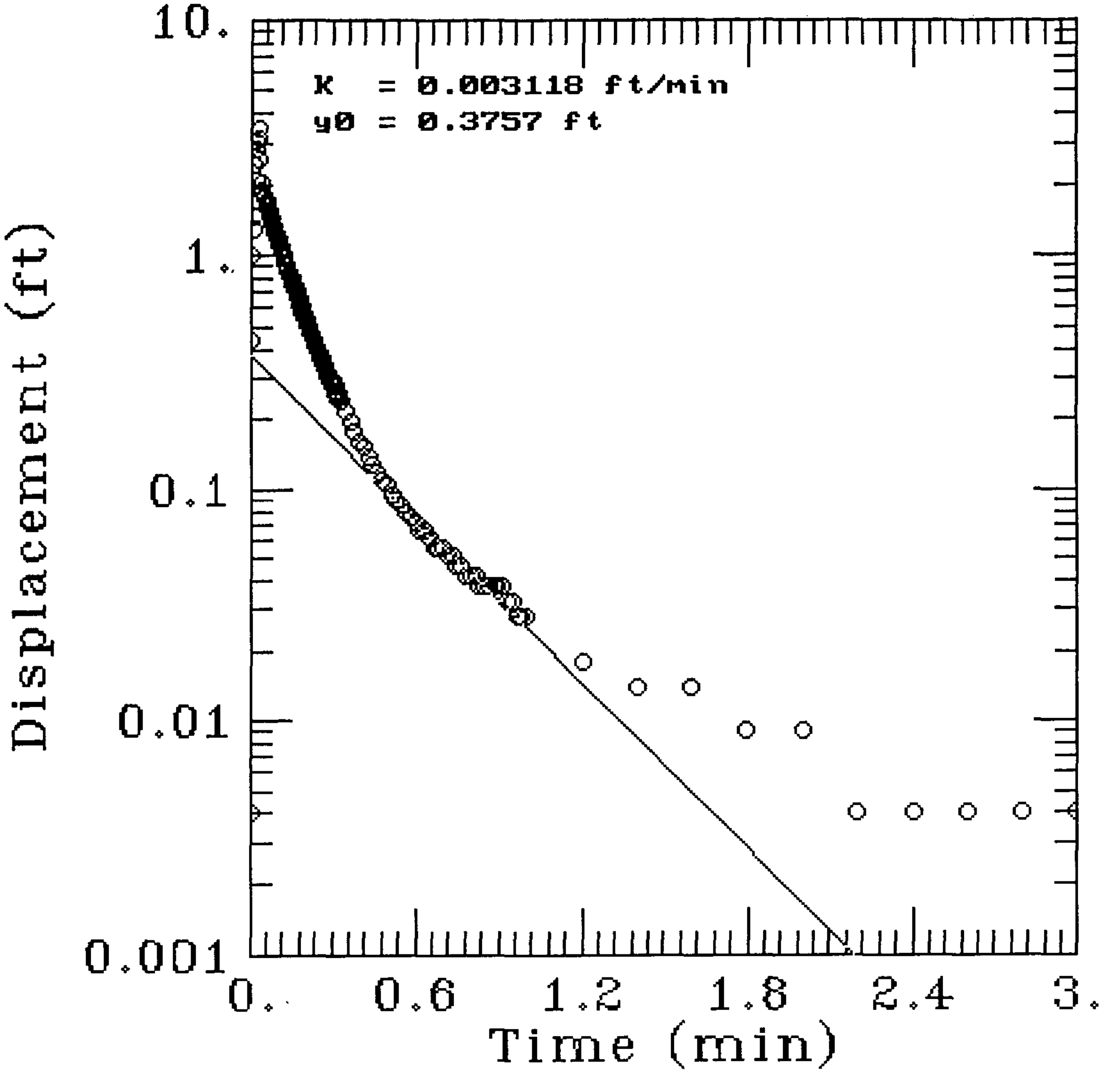
MW-54B, TEST-0, SLUG-IN



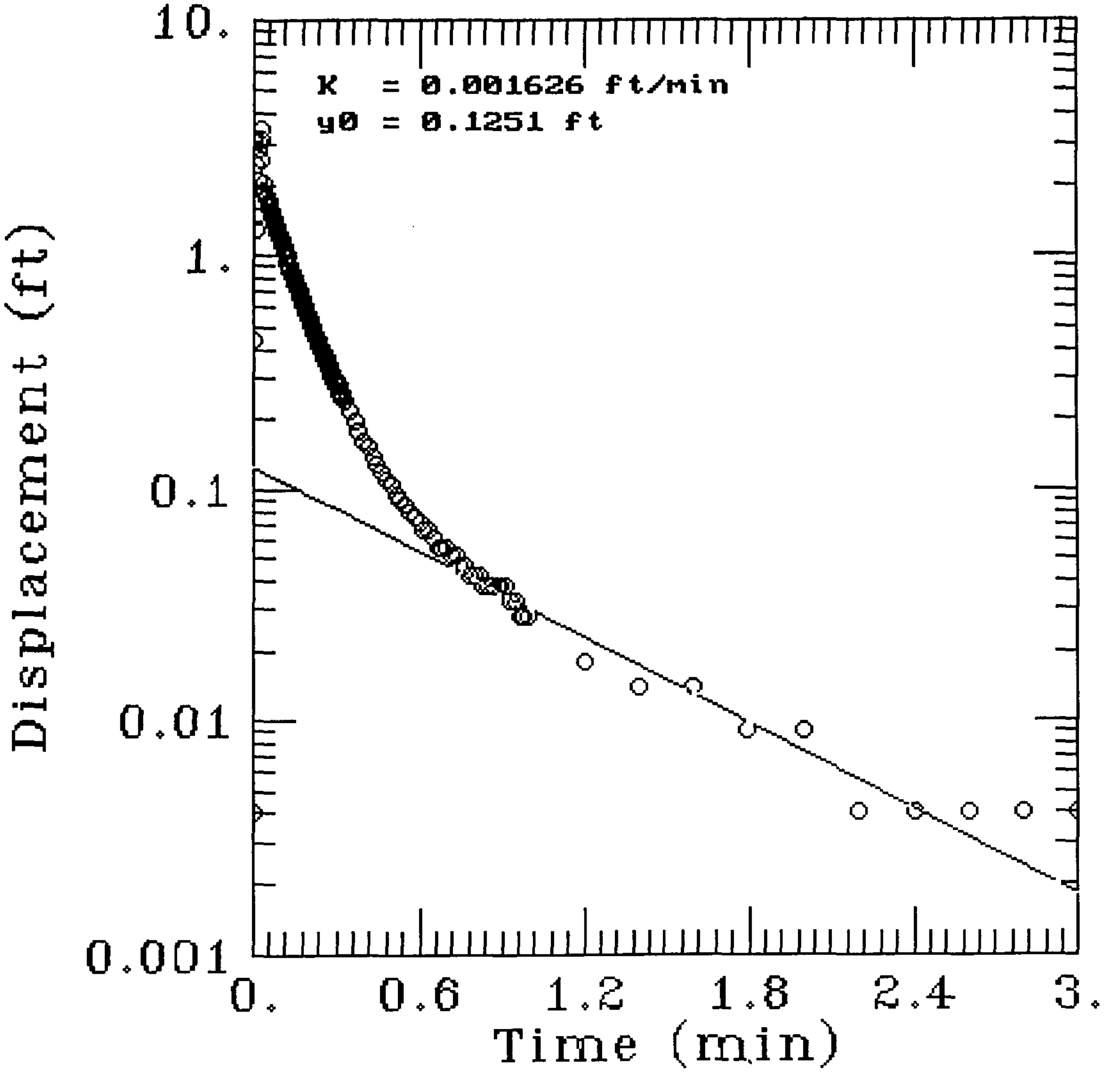
MW-54B TEST-1, SLUG-OUT



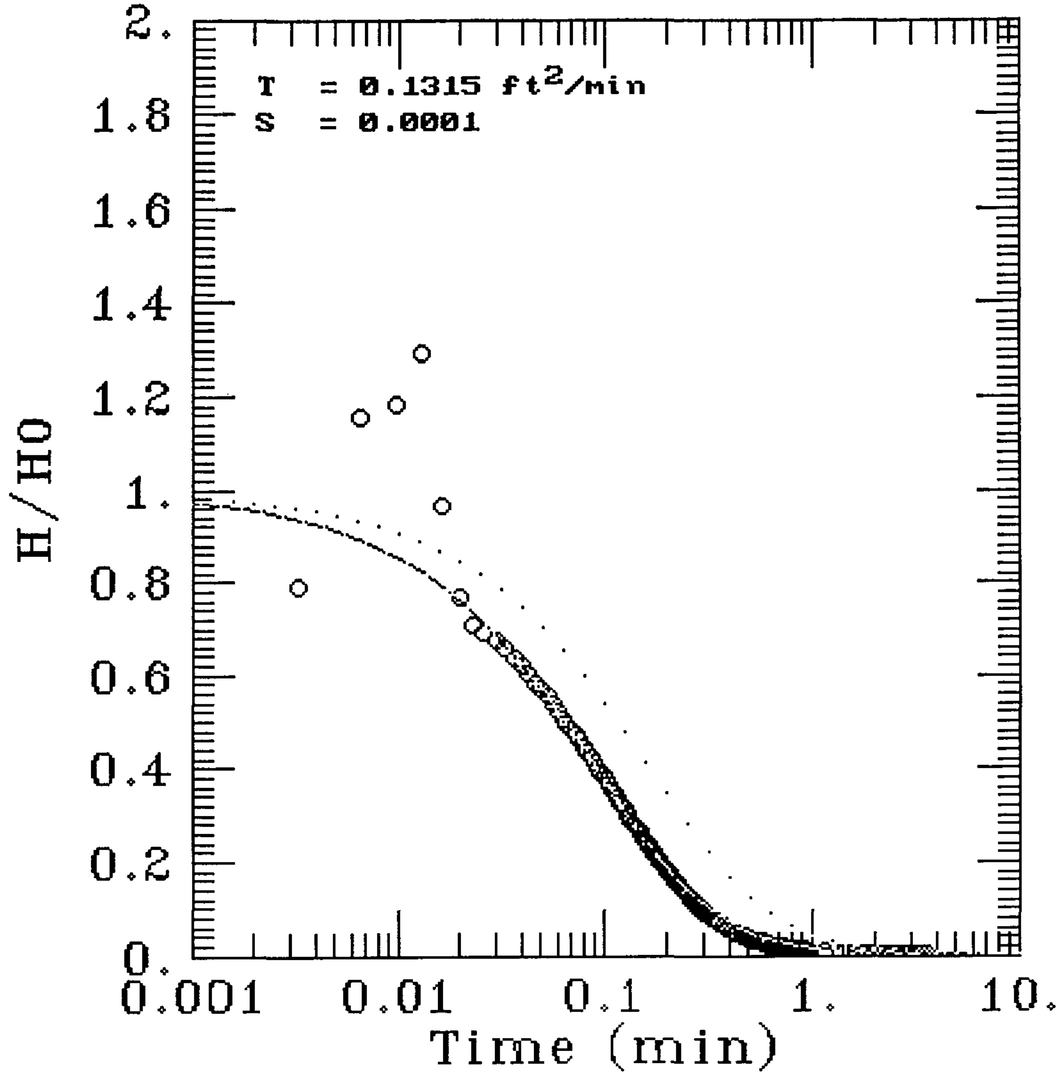
MW-54B TEST-1, SLUG-OUT



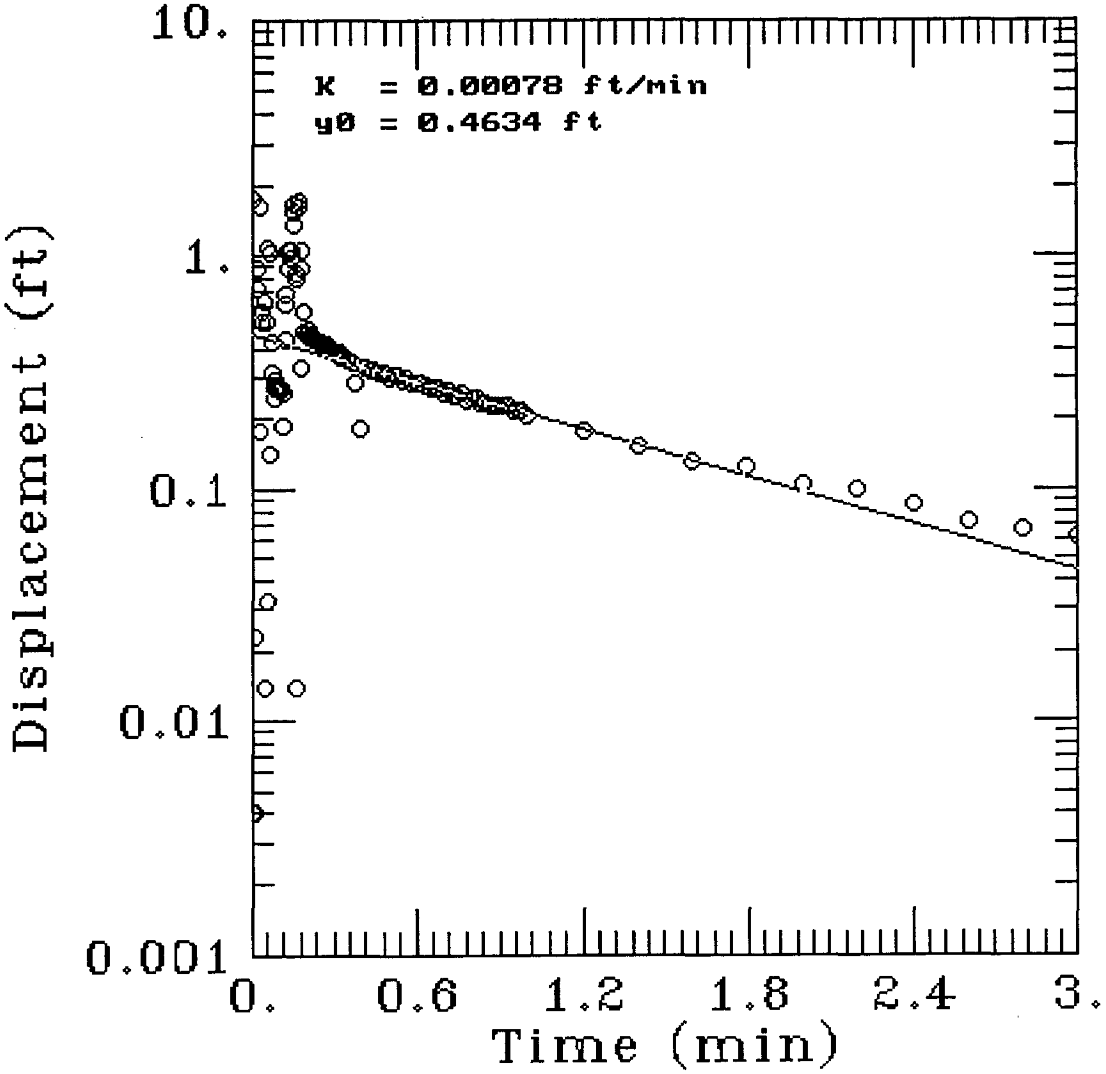
MW-54B, TEST-1, SLUG-OUT



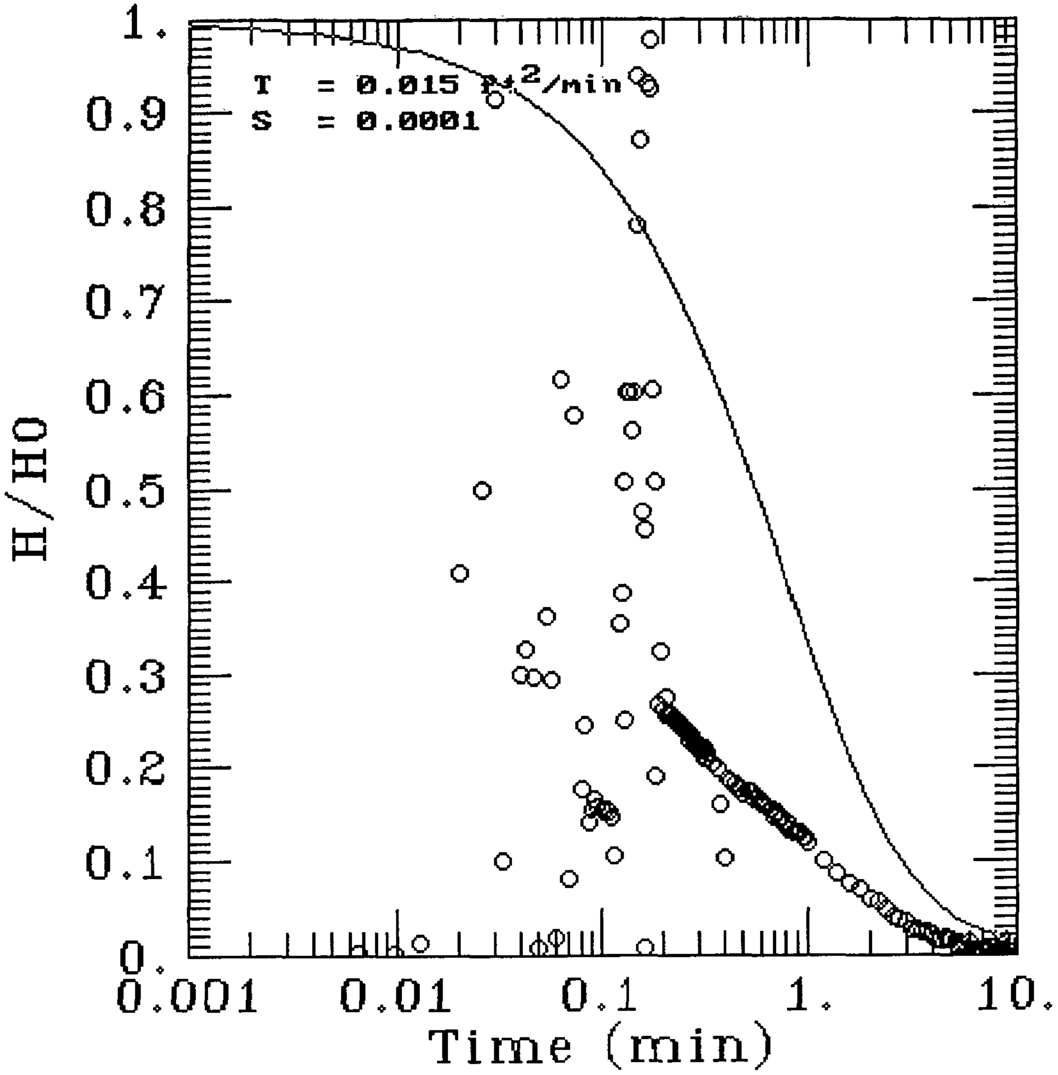
MW-54B, TEST-1, SLUG-OUT



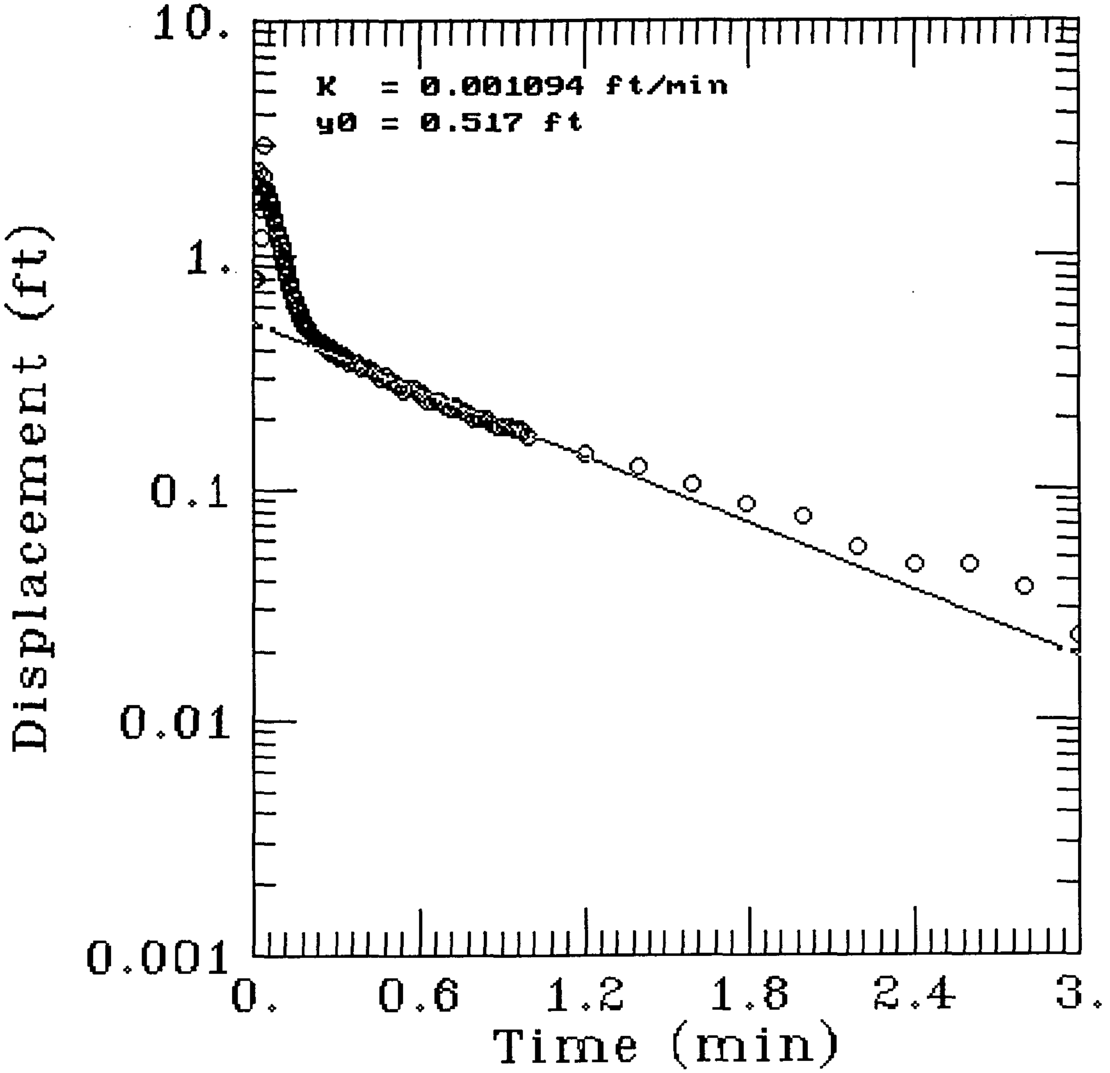
MW-54A, TEST-2, SLUG-IN



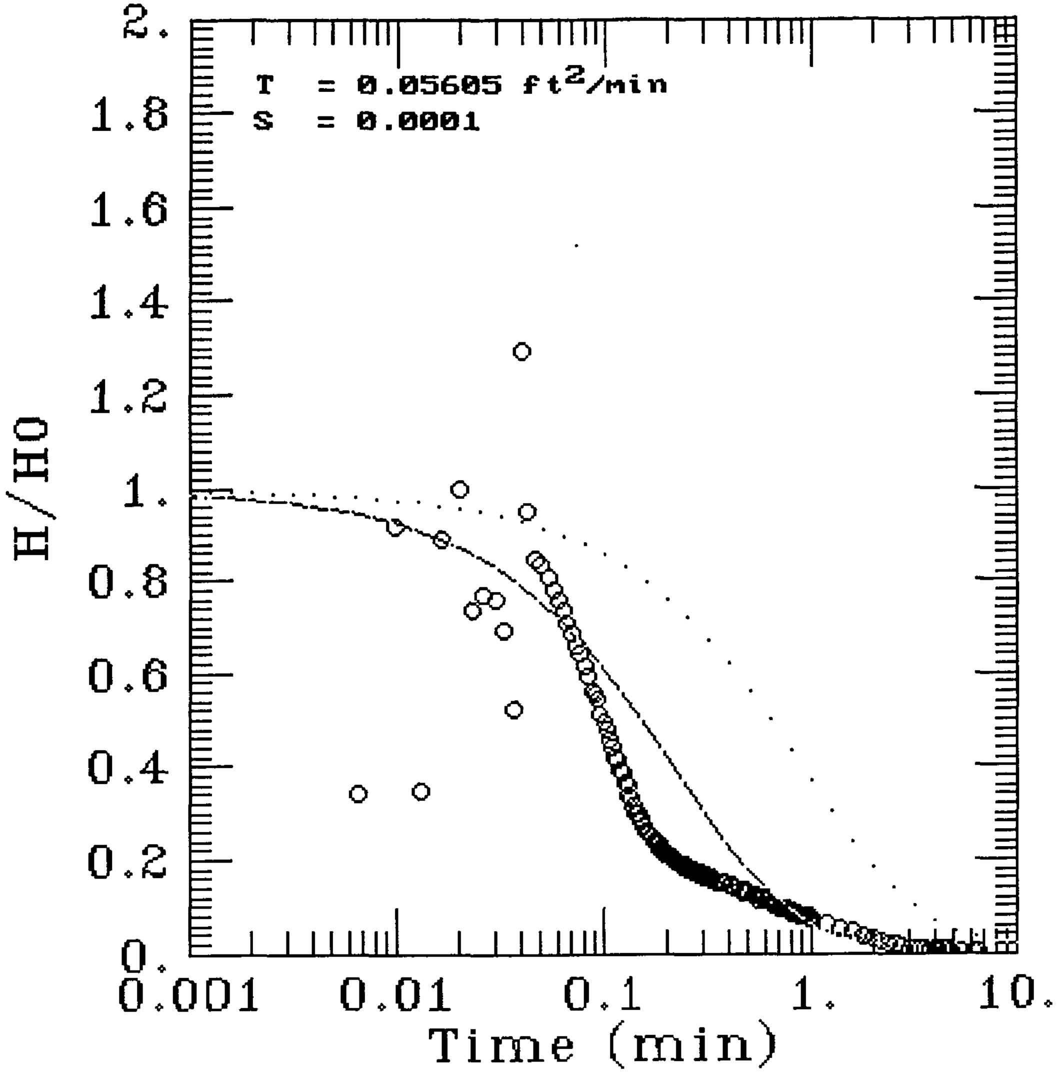
MW-54A, TEST-2, SLUG-IN



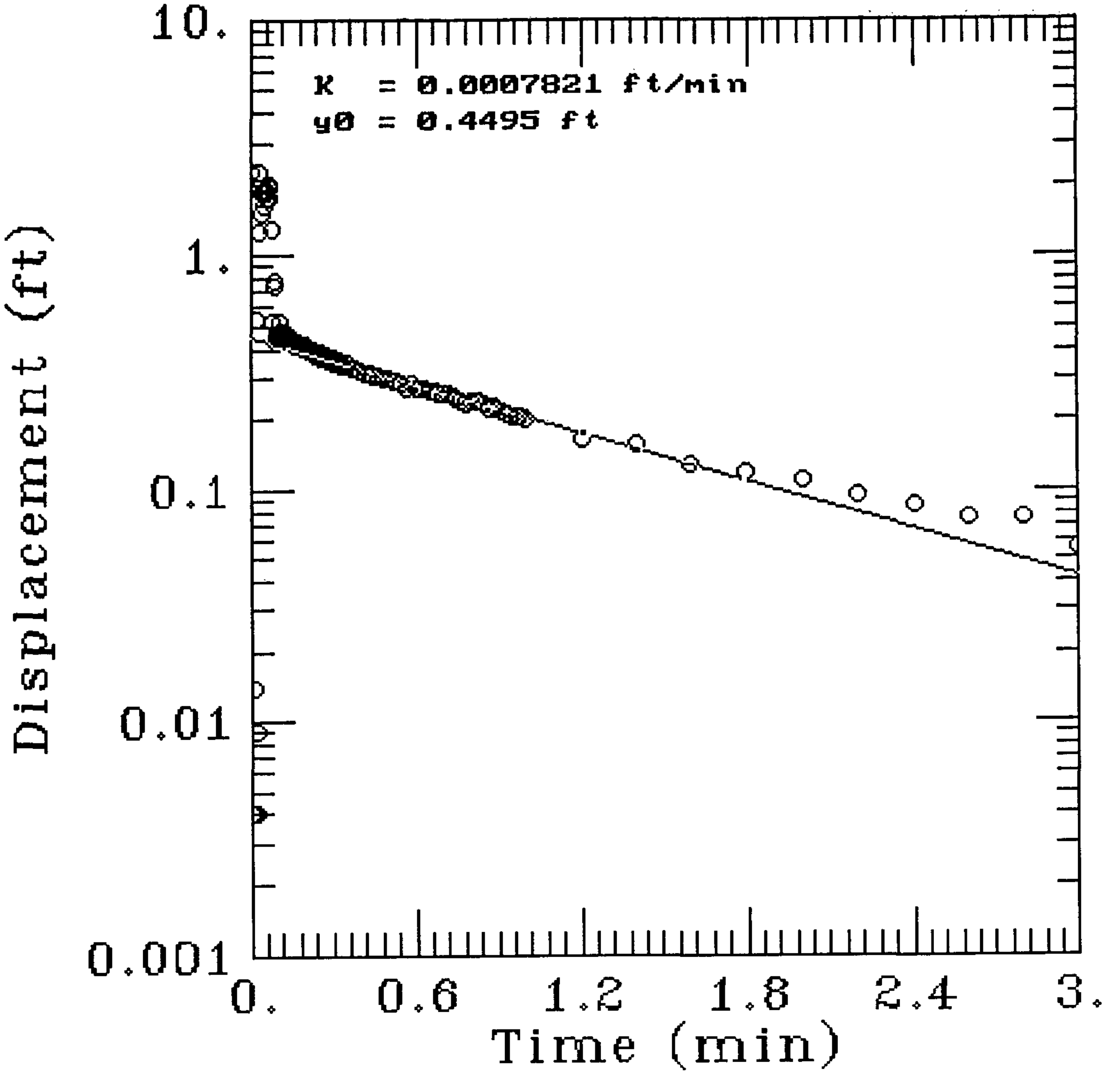
MW-54A, TEST-3, SLUG-OUT

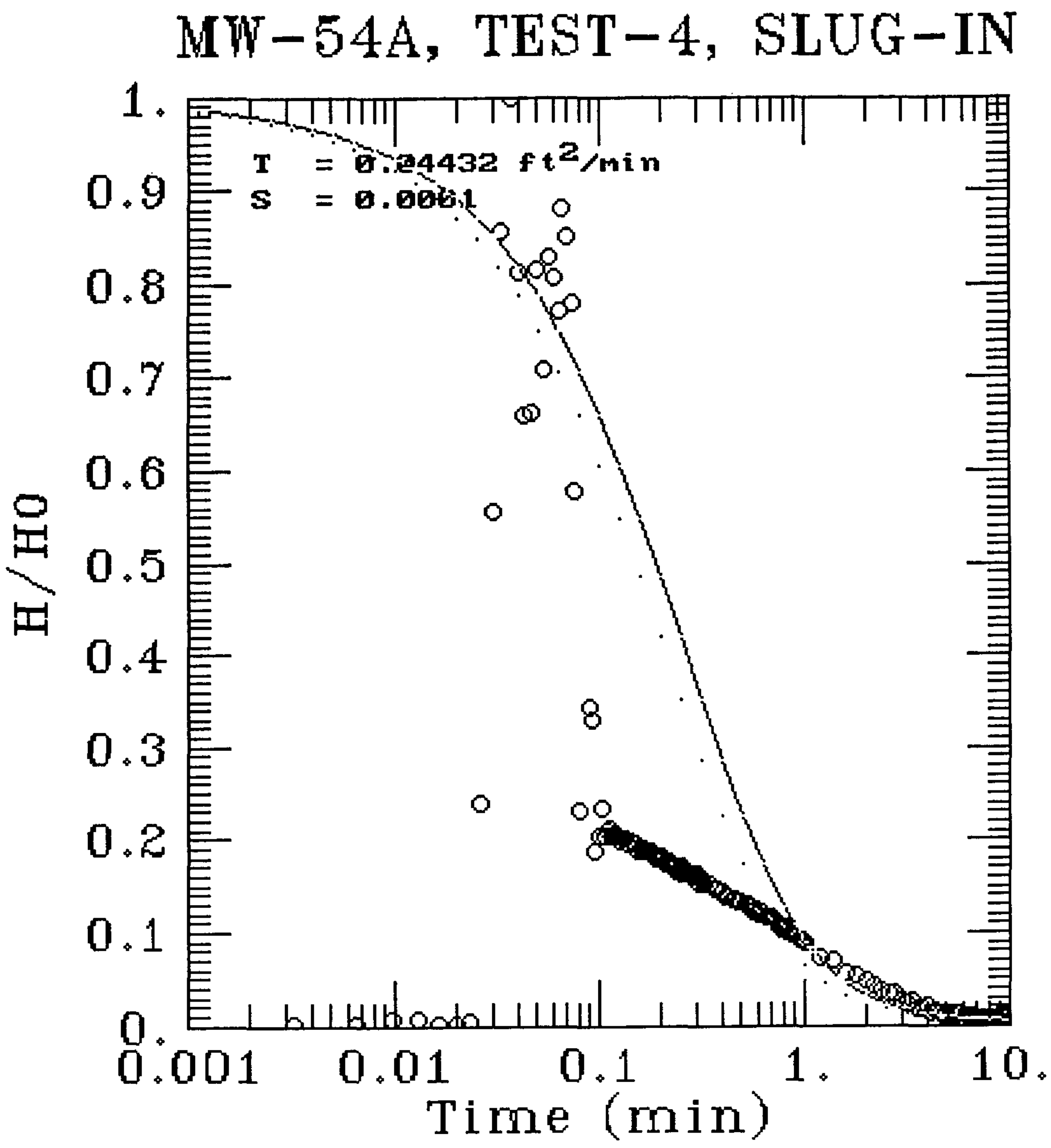


MW-54A, TEST-3, SLUG-OUT



MW-54A, TEST-4, SLUG-IN




MW-54A, TEST-4, SLUG-IN
T = 0.24432 ft²/min
S = 0.0061
H/H0
1.
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.
0.001
0.01
0.1
1.
10.
Time (min)