

GW - 52

WORK PLANS

1995

RECEIVED

JUL 19 1996

Environmental Bureau
Oil Conservation Division

**PROPOSED CLOSURE PLAN FOR
THREE ROSWELL COMPRESSOR STATION
SURFACE IMPOUNDMENTS
TRANSWESTERN PIPELINE COMPANY**

Drafted by

**New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
2044 Galisteo Street
P.O. Box 26110
Santa Fe, New Mexico 87502**

July 13, 1995

TABLE OF CONTENTS

Section	Page
1. INTRODUCTION	1
1.1 Scope of Work	1
1.2 Closure Plan Objectives, Organization, and Amendments	1
1.3 Regulatory Requirements of 40 CFR Parts 265	2
2. SITE BACKGROUND	4
2.1 Facility Description	4
2.2 History and Operation of Former Surface Impoundments	5
2.3 Regulatory Background	9
2.4 Geographic Setting	11
2.5 Regional Hydrogeology	11
2.5.1 San Andres Formation	12
2.5.2 Artesia Group	13
2.5.3 Quaternary Valley Fill	14
2.6 Water Well Inventory	16
3. PREVIOUS ENVIRONMENTAL INVESTIGATIONS	19
3.1 Harding Lawson Associates Shallow Subsurface Investigation (1990)	19
3.2 Metric Corporation Shallow Subsurface Investigation (1991)	21
3.3 Halliburton NUS Corporation Monitor Well Installation (1992)	23
3.4 Brown & Root Environmental Ground-Water Assessment (1993)	23
3.5 Interim PSH Removal Program	25
3.6 Daniel B. Stephens & Associates, Inc. Subsurface Investigation (1994)	26
3.7 Extent of Soil and Ground-Water Contamination	28
3.7.1 Site Hydrogeology	29
3.7.2 Soil Impacts	30
3.7.3 Ground-Water Impacts	31
4. SOIL ASSESSMENT PLAN	32
4.1 Phase I Soil Sampling Strategy	32
4.2 Soil Sampling Procedures	37
4.3 Borehole Abandonment Procedures	38
4.4 Laboratory Analysis of Soil Samples	39
4.5 Decontamination Procedures	39
4.6 Management of Investigation-Derived Wastes	40
4.7 Phase II Soil Assessment	41
5. GROUND-WATER ASSESSMENT PLAN	45
5.1 Phase I Monitor Well Installation	46
5.2 Monitor Well Development Procedures	48
5.3 Ground-Water Sampling Procedures	49
5.4 Laboratory Analysis of Ground-Water Samples	52
5.5 Aquifer Testing	52
5.6 Decontamination Procedures	53

5.7	Management of Investigation-Derived Wastes	54
5.8	Phase II Ground-Water Assessment	55
6.	QUALITY ASSURANCE PROJECT PLAN	57
6.1	Analytical Parameters and Methods	57
6.2	Data Quality Objectives	58
6.3	Quality Assurance/Quality Control Samples	60
6.4	Sampling Procedures	61
6.5	Chain of Custody Procedures	61
6.6	Equipment Calibration Procedures and Frequency	62
6.7	Data Reduction and Reporting	64
6.8	Internal Quality Control Checks	65
6.9	Performance and System Audits	65
6.10	Corrective Actions	65
6.11	Routine Data Assessment Procedures	66
6.12	Quality Assurance Reports to Management	66
7.	PROJECT SCHEDULE AND CONDITIONS FOR CLOSURE CERTIFICATION	67
8.	REFERENCES	70
9.	APPENDIX C	

LIST OF FIGURES

Figure

- 1-1 Location Map
- 2-1 Site Plan
- 2-2 Generalized Stratigraphic Section Near Roswell Compressor Station
- 2-3 Approximate Thickness of Shallow Alluvial Aquifer
- 2-4 Water Levels in Shallow Alluvial Aquifer, January 1984
- 2-5 Water Supply Well Location Map
- 3-1 Harding Lawson Associates Soil Vapor Sample Locations
- 3-2 Concentrations of 1,1,1-TCA in Soil Vapor at 10-Foot Depth
- 3-3 Locations of Harding Lawson Associates Soil Borings
- 3-4 Locations of Metric Corporation Soil Borings
- 3-5 Locations of Halliburton and Brown & Root Soil Borings
- 3-6 Locations of Previous Soil Borings and Existing Monitor Wells and Recovery Wells
- 3-7 Hydrogeologic Cross Section
- 3-8 Estimated Areal Extent of Elevated TPH in Soils
- 3-9 Estimated Vertical Extent of Elevated TPH in Soils
- 4-1 Proposed Phase I Soil Boring Locations
- 5-1 Proposed Phase I Monitor Well Locations
- 5-2 Monitor Well Schematic
- 7-1 Proposed Schedule for Phase I Closure Activities

LIST OF TABLES

Table

- 2-1 Water Supply Wells Located Within 2 Miles of Roswell Compressor Station No. 9
- 3-1 Summary of Previous Soil Borings and Monitor Wells
- 3-2 Summary of Organic Compounds Detected in Soil Samples
- 3-3 Summary of TCLP Inorganic Constituents Detected in Soil Samples
- 3-4 Summary of Organic Compounds Detected in Ground-Water Samples
- 3-5 Summary of Inorganic Constituents Detected in Ground-Water Samples
- 3-6 Well Coordinates and Depth to Water for Existing Monitor Wells
- 6-1 Analytical Parameters, Methods, and Data Quality Objectives
- 6-2 Sample Collection Protocol

LIST OF ACRONYMS AND ABBREVIATIONS

ACL	Alternative concentration limit
B&C	Brown and Caldwell
B&R	Brown & Root Environmental
bgs	Below ground surface
BLM	Bureau of Land Management
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CES	Cypress Engineering Services
DBS&A	Daniel B. Stephens & Associates, Inc.
DO	Dissolved oxygen
DQOs	Data quality objectives
EDAC	Earth Data Analysis Center
EPA	Environmental Protection Agency
FID	Flame ionization detector
Halliburton	Halliburton NUS Environmental Corporation
HLA	Harding Lawson Associates
HRMB	Hazardous and Radioactive Materials Bureau (NMED)
HWMR	Hazardous Waste Management Regulations
mL	Milliliter
MS/MSD	Matrix spike/matrix spike duplicate
NMED	New Mexico Environment Department
NMSHTD	New Mexico State Highway and Transportation Department
OCD	Oil Conservation Division
O.D.	Outside diameter
OVA	Organic vapor analyzer
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PID	Photoionization detector
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
PPE	Personal protective equipment
PSH	Phase-separated hydrocarbons
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RPD	Relative percent difference
SCT	Salinity-conductivity-temperature meter
SEO	State Engineer Office
SVE	Soil vapor extraction
TCA	1,1,1-trichloroethane
TCLP	Toxicity characteristic leaching procedure
TDS	Total dissolved solids
TNRCC	Texas Natural Resources Conservation Commission
TPH	Total petroleum hydrocarbons

Transwestern	Transwestern Pipeline Company
USGS	United States Geological Survey
VOCs	Volatile organic compounds

1. INTRODUCTION

NOTE: Changes made in the draft Closure Plan are indicated as follows: shaded areas indicate added material, strikeouts indicate deleted material. This will assist the reader in rapid identification of the changes that were made.

At the request of Transwestern Pipeline Company (Transwestern), a wholly owned subsidiary of ENRON Operations Corporation, Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this Closure Plan for closure of former surface impoundments located at Transwestern's Compressor Station No. 9 (Roswell compressor station) near Roswell, New Mexico (Figure 1-1). The closure plan has been prepared for submission to the Hazardous and Radioactive Materials Bureau of the New Mexico Environment Department (NMED) in order to satisfy the requirements of the New Mexico Hazardous Waste Management Regulations (~~HWMR-7~~) (20 NMAC 4-1). Sections 1.1 through 1.3 provide information on the scope of work, objectives, and organization of the closure plan, along with a cross-reference to the relevant regulations.

1.1 Scope of Work

This closure plan addresses proposed activities for closure of several former surface impoundments located at the Roswell compressor station. The former surface impoundments were located in the northeastern corner of the compressor station. Initial operation began in approximately 1960 and may have continued until 1984, although the last impoundment was not backfilled until June 1986. Two impoundments are known to have existed at this location, and a third is suspected to have been present. No surface expression of the former impoundments is now visible at the site.

The impoundments served primarily to contain pipeline condensate, a hydrocarbon liquid that accumulates within natural gas pipelines. Pipeline condensate and other similar petroleum wastes are generally exempt from regulation under the Resource Conservation and Recovery Act (RCRA) by the petroleum exclusion. However, small quantities of RCRA-regulated spent halogenated solvents (F001 wastes) were also inadvertently released into the impoundments, along with miscellaneous non-hazardous solid wastes such as filters, engine parts, and office trash (Campbell, 1993). Therefore, NMED has requested that a RCRA closure plan be prepared to address the possible presence of RCRA hazardous wastes beneath the former impoundments.

The closure plan was prepared in accordance with the requirements of ~~(HWMP-7) Part VI of 20 NMAC 4.1~~, which incorporate by reference the federal requirements contained in 40 CFR Part 265. In addition, the closure plan is intended to address the list of required information requested by NMED in the Notice of Deficiency dated March 7, 1994, as well as that dated September 28, 1994.

1.2 Closure Plan Objectives, Organization, and Amendments

The overall objective of this closure plan is to provide the basis for performing final closure of the former surface impoundments. Closure will be considered complete upon receipt of a signed Closure Certificate from NMED. As described in 40 CFR Part 265, the three available options for closure of surface impoundments include (1) clean closure (2) landfill closure, and (3) Post Closure care Plan as per 20 NMAC 4.1, Subpart V, §264.117. Transwestern intends to attempt clean closure of the impoundments, whereby any hazardous wastes that may be present are removed to the extent that future threats to human health and the environment attributable to the facility no longer exist.

A phased approach will be used to achieve the clean closure objectives. This closure plan only addresses Phase I closure activities in detail. Scopes of work for subsequent phases will be prepared and submitted to NMED as amendments to this closure plan. In general, the objective of Phase I will be to characterize the nature of the subsurface wastes that remain immediately beneath and adjacent to the former impoundments. Thus the Phase I soil and ground-water assessments described here are confined to a relatively small area near the suspected contaminant sources. Following completion of Phase I, a second phase of investigation will be conducted to determine the lateral and vertical extent of impacted soil and ground water. Subsequent phases will address corrective actions that may be required to meet soil and ground-water cleanup criteria.

This closure plan is organized in the following manner. The site background and regulatory status of the former impoundments will be described first in Section 2 to provide a basis for the proposed closure activities. The results of all previous subsurface environmental investigations will then be summarized in Section 3. The proposed Phase I soil assessment and Phase I ground-water assessment plans are outlined in Sections 4 and 5, respectively. A quality assurance project plan is included in Section 6 to ensure that the data generated are of sufficient quality to support subsequent decisions. Finally, the proposed project schedule is included in Section 7.

1.3 Regulatory Requirements of 40 CFR Parts 265

The closure regulations in Subpart G of 40 CFR Part 265 include a specific list of requirements that must be fulfilled. An attempt has been made to address each of these requirements in this closure plan. ~~The facility shall meet the requirements of the applicable and relevant performance standards under, but not limited to 20 NMAC 4.1, Subpart VI, 40 CFR §265.111(b)(c), §265.112.~~

and §270.1(c)(5). This is because the closure activities will no longer be limited to cleanup work alone, but will also encompass the corrective action and reporting standards of §264. Reference to §264 standards found in this modified closure plan are intended to meet these requirements.

In addition to the closure requirements (Subpart G), the ground-water monitoring requirements stipulated in 40 CFR Part 265 Subpart F have been addressed in Section 5 of this document.

In accordance with the financial requirements of 40 CFR Part 265 Subpart H, documentation of financial assurance for closure must be provided with this closure plan. As owner of the Roswell compressor station, Transwestern can demonstrate that it passes the financial test specified in Part 265.143(e). A letter from the chief financial officer of Transwestern documenting the results of the financial test is provided in Appendix C, which is included at the end of this closure plan, along with several supporting documents. This information is the same as that previously submitted to NMED on July 1, 1993.

2. SITE BACKGROUND

The Roswell compressor station is located approximately 9 miles north of the city center of Roswell, New Mexico along the east side of U.S. Highway 285 (Figure 1-1). Sections 2.1 through 2.5 provide background information regarding the facility layout and operation, history of the former surface impoundments that are the subject of closure under this plan, as well as the regional geographic, geologic, and hydrologic setting.

2.1 Facility Description

The Roswell compressor station is situated on approximately 80 acres of land in Sections 21 and 28, Chaves County, New Mexico (Figure 1-1). The property is privately owned by Transwestern Pipeline Company, while the remainder of Sections 21 and Section 28 are State Trust Land (Glenn, 1993). Site access is via U.S. Highway 285, and the entire property is secured by a chain link fence. The following is a list of pertinent information regarding the facility:

<i>Facility name</i>	Transwestern Pipeline Company Compressor Station No. 9
<i>Facility address</i>	Transwestern Pipeline Company 6381 North Main Street P.O. Box 1717 Roswell, New Mexico 88202-1717
<i>Telephone number</i>	(505) 625-8022
<i>EPA I.D. number</i>	NMD 986676955
<i>County and state</i>	Chaves County, New Mexico
<i>Property legal description</i>	SW $\frac{1}{4}$ of the SW $\frac{1}{4}$ of Section 21, T. 9S. R. 24E. NW $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 28, T. 9S. R. 24E.
<i>Latitude/longitude of former impoundments</i>	Pit 1: N33°30'54" / W104°30'55" Pit 2: N33°30'55" / W104°30'55" Pit 3: N33°30'55" / W104°30'56"
<i>Site elevation</i>	Approximately 3610 feet above sea level

The Roswell compressor station is one of numerous similar facilities located along the Transwestern natural gas pipeline that extends from Texas to California. Natural gas is received from the east through two 24-inch pipelines, the West Texas Lateral and the Panhandle Lateral, and leaves to the northwest through two 30-inch pipelines. The primary function of the compressor station is to boost the pressure of the natural gas stream by means of piston

compressors powered by natural gas internal combustion engines. The facility also includes the district offices for Transwestern's New Mexico operations, along with other ancillary buildings including a warehouse and a repair shop (Figure 2-1). The compressor station has been in operation at this location since August 9, 1960.

The only environmental permit currently in force is Discharge Plan GW-52 with the New Mexico Oil Conservation Division (OCD). An RCRA Part A permit application was filed with NMED in January 1993 for closure of the former impoundments under interim status.

2.2 History and Operation of Former Surface Impoundments

Little information exists about the operational history of the surface impoundments. Much of what is known is based on the recollection of present or former Transwestern employees. The following discussion summarizes the available information regarding the locations, sizes, and periods of operation of the former surface impoundments.

As mentioned in Section 1, the primary function of the former impoundments was to contain pipeline condensate, a hydrocarbon liquid that accumulates during the periodic cleaning of the natural gas pipelines. Natural gas is composed mostly of alkane compounds, with methane being the most abundant (Eiceman, 1986). In addition, natural gas contains variable concentrations of heavier molecular weight hydrocarbons (C4+), which may condense due to changes in temperature and pressure within the pipelines. Besides the higher molecular weight hydrocarbons derived from the natural gas itself, pipeline condensate may also contain lube oil blow-by derived from upstream reciprocating engine gas compressors located at other compressor stations. The lube oil blow-by consists of crankcase lubricating oil that bypasses the compressor piston rings and enters the natural gas pipeline.

Pipeline condensate is periodically removed from the pipeline through "pigging" operations, which make use of a cylindrical piston-like device known as a "pig." The pig cleans the condensate

from the interior pipeline wall by scraping and brushing as it is carried through the pipeline by the pressurized gas stream. The pig and the accumulated liquid condensate are removed from the pipeline at the "pig receiver" (Figure 2-1). Currently, all condensate is collected and stored in aboveground tanks. The condensate is then sold for use as fuel. Formerly, the condensate was stored in one or more unlined surface impoundments that are the subject of this closure plan. The impoundments have been variously referred to as the "disposal pit" or the "burn pits." The latter term refers to the reported practice of periodically burning the hydrocarbon liquids in the impoundment to reduce their volume (Campbell, 1993).

The first reported use of a surface impoundment at this location was in August of 1960, shortly following construction of the compressor station in 1960 (Campbell, 1993). However, no records are currently available showing the exact location or size of this surface impoundment or others that may have been used subsequently until the last remaining surface impoundment was backfilled in 1986. Correspondence among Transwestern, NMED, and OCD has generally referred to a single impoundment as "the disposal pit" (Campbell, 1992) or "the burn pit." However, the General Plan map for the Roswell compressor station (Transwestern, 1959) showed two surface impoundments located in the northeast corner of the facility, in the NE $\frac{1}{4}$ of the SW $\frac{1}{4}$ of the SW $\frac{1}{4}$ of Section 21, T. 9S. R. 24E. The locations of the two former burn pits as previously shown on the General Plan were found to be incorrect, as discussed below.

Figure 3 of a report prepared by Metric Corporation (1991) indicated the possibility that three pits had existed in the northeast corner of the facility. This was reportedly based on discussions with a former compressor station supervisor who was able to recall the approximate locations of three former surface impoundments (Campbell, 1994). The three pits are designated in the Metric report (1991) as Pit 1 (southernmost), Pit 2 (northeast), and Pit 3 (northwest). The employee was said to have pointed out the approximate former locations of the pits to the Metric field staff. For the sake of consistency, these designations will be retained through this closure plan. However, it should be noted that the existence of Pit 3 is less certain than Pits 1 and 2, as described below.

Prior to the preparation of this closure plan, the location and number of former surface impoundments was not known precisely. In order to clarify the number and exact locations of the former impoundments, DBS&A obtained historical aerial photographs showing the compressor station. The following sources were contacted during this effort: the Earth Data Analysis Center (EDAC, Albuquerque), the Bureau of Land Management (BLM, Albuquerque), the New Mexico State Highway and Transportation Department (NMSHTD, Santa Fe), IntraSearch (Denver), and the United States Geological Survey (USGS) Earth Science Information Center (Denver). Several aerial photographs showing the compressor station were located, and contact prints were obtained for five different photographs taken on the following dates:

Date Flown	Approximate Scale	Source
07/28/61	1:23,000	EDAC-Albuquerque
10/10/72	1:25,000	NMSHTD-Santa Fe
06/21/73	1:32,000	BLM-Albuquerque
04/19/81	1:26,000	BLM-Albuquerque
08/05/82	1:19,000	NMSHTD-Santa Fe

The 1961 aerial photograph shows a single feature that appears to be a surface impoundment in the extreme northeast corner of the property. This impoundment corresponds to Pit 2 on Figure 2-1. This appears to be the first surface impoundment constructed at the compressor station.

The 1972 and 1973 photographs reveal two features that appear to be surface impoundments. In order to more clearly see these features, enlargements were made of the 1973 and 1981 BLM photographs to scales of 1:5340 and 1:4330, respectively. Examination of the 1973 photograph shows two surface impoundments (Pit 1 and Pit 2 on Figure 2-1), with a third feature that may represent a backfilled impoundment (Pit 3 on Figure 2-1). However, the existence of Pit 3 is by no means certain, and it is quite possible that no impoundment ever existed at this location.

In the 1981 and 1982 photographs, only Pit 1 remains visible (Figure 2-1). Pit 2 appears to have been backfilled prior to the April 19, 1981 flight, and the feature labeled as Pit 3 is no longer visible.

Pit 1 was reportedly taken out of service no later than 1984 and backfilled in June of 1986 (Campbell, 1993). No wastes of any type were received after that date. Based on the aerial photographs, the dimensions and approximate periods of operation of the three former surface impoundments were as follows:

Impoundment	Approximate Dimensions	Date Constructed	Date Backfilled
Pit 1	40' x 70' (rectangular)	After 7/61, before 10/72	6/86
Pit 2	70' diameter (circular)	Before 7/61	Before 4/81
Pit 3	50' diameter (circular)	After 7/61, before 10/72	Before 4/81

It is estimated that the impoundments were at most 10 feet deep. Therefore, the maximum volumes of Pits 1, 2, and 3 during their operational lifetimes were approximately a total of 3,061,487.00 gallons.

In addition to the pipeline condensate, trace quantities of chlorinated solvent wastes were inadvertently released into the impoundments. The solvents were primarily used as degreasers to remove oily deposits on engine parts during maintenance of the compressor engines. The quantity of solvents and the exact type of solvents used is unknown as no records that might indicate the quantity or type of solvent materials purchased are known to exist at the site or at any other Transwestern facility. In addition, most of the Transwestern employees who were employed during the period of operation of the surface impoundments have retired.

Discussions with the few remaining personnel who were employed during the period in question indicate that the most common solvent used was known by the trade name "VK-1." This solvent product contained 100% 1,1,1-TCA. The primary degradation product of 1,1,1-TCA is 1,1-DCA.

Therefore, the presence of these two compounds in soil and ground water are most likely the result of the use of the "VK-1" solvent product. The source of PCE and PCA compounds that were also detected in soil samples collected from the surface impoundment area is unknown.

Discussions with the same Transwestern personnel further indicate that the last surface impoundment in use (Pit 1) did not receive any waste materials after mid-1984. This information is supported by examination of facility drawings which indicate that considerable facility piping and AST upgrades and installations were made during the latter half of 1983.

2.3 Regulatory Background

This section provides a brief history of prior communications and regulatory actions related to the former surface impoundments being closed under this closure plan. This information is included to facilitate an understanding of events pertinent to regulation and closure of the impoundments.

As discussed in Section 1, operations involving wastes generated during the production and transmission of natural gas are generally exempt from regulation under RCRA as a result of the petroleum exclusion. Thus Transwestern's Compressor Station No. 9, along with other compressor stations in New Mexico, have historically been regulated by the New Mexico OCD.

As discussed in greater detail in Section 3, chlorinated solvents were first detected in soil gas near the former surface impoundments during a soil vapor survey by Harding Lawson Associates (HLA) in 1991. The survey was conducted at the request of legal counsel in order to provide legal advice to Transwestern concerning environmental matters. The compound detected most frequently was 1,1,1-trichloroethane (1,1,1-TCA). Because chlorinated volatile organic compounds (VOCs) are not natural components of natural gas or pipeline condensate, and because spent halogenated solvents are classified as F001 "Listed Wastes" under RCRA, the NMED Hazardous and Radioactive Materials Bureau became involved.

Following a subsequent soil investigation by Metric Corporation completed in December 1991, Transwestern attended a series of meetings with NMED and OCD to discuss the potential corrective action at the former surface impoundments. Because it appeared possible that RCRA-regulated wastes had been inadvertently released into the impoundments, NMED requested that Transwestern submit a RCRA Part A permit application.

On November 30, 1992, Transwestern submitted the RCRA Part A application to NMED and OCD. During a joint meeting of NMED and OCD with Transwestern on December 10, 1992, NMED requested that the Part A application be resubmitted using the proper EPA forms. This was done on January 5, 1993.

On February 17, 1993, NMED requested that Transwestern submit a RCRA closure plan for the former impoundments in accordance with the New Mexico Hazardous Waste Regulations, Part VI, Section 40 CFR 265.112(a). Although the impoundments had in fact been physically closed since June of 1986, Transwestern prepared a closure plan, which was delivered to NMED on July 1, 1993. NMED rejected this closure plan on March 7, 1994, however, on the grounds that it was incomplete and requested that another closure plan be submitted at a later date. On April 8, 1994, Transwestern met with NMED to discuss the Notice of Deficiency. The NMED requested that an administratively-complete closure plan be delivered by June 1, 1994.

Meanwhile, Transwestern had begun interim corrective measures to recover free hydrocarbon product from monitor well MW-1. Three additional wells, MW-1B, MW-2, and RW-1, were subsequently connected to the product recovery system. Transwestern has continued to keep NMED and OCD informed of the results of all subsurface investigations, as well as the performance of the product recovery system.

In addition to the above summary, Appendix D of this closure plan is a detailed chronology of events and relevant communications between Transwestern and the regulatory agencies regarding the former surface impoundments. The chronology is included to document the events

preceding the submission of this closure plan and is intended to aid the reviewer in understanding the context in which it was developed.

Transwestern continues to maintain that the hydrocarbon contaminants that originated from past disposal practices at the surface impoundments represent petroleum industry wastes, and nothing in this report is to be construed as an admission otherwise. Furthermore, Transwestern believes that the soil and ground water underlying the former impoundments are best addressed in a manner similar to other petroleum hydrocarbon spill sites, particularly since the concentration of halogenated hydrocarbon constituents is minute. However, in accordance with NMED's request, Transwestern has prepared this closure plan.

2.4 Geographic Setting

The Roswell compressor station is located approximately 6 miles west of the Pecos River within the Pecos Valley drainage basin. The entire area west of the Pecos River is generally referred to as the west Pecos slope (Kelley, 1971), which rises westward from elevations of about 3,300 feet at the Pecos River to over 10,000 feet in the Capitan Mountains some 50 miles to the west. Tributary surface streams drain west to east toward the Pecos River. Local topography is generally of low relief. The mean annual precipitation as measured at the Roswell Municipal Airport for a 23-year period was 9.82 inches. The majority of the precipitation occurs in July and August during frequent summer thunderstorms.

2.5 Regional Hydrogeology

The Roswell compressor station lies within the northernmost portion of the Roswell hydrologic basin. The basin is structurally controlled by eastward-dipping carbonate and evaporite sequences of Permian age which were uplifted during the Tertiary period during the development of the Sacramento and Guadalupe Mountains along the western margin of the basin (Kelley,

1971). Eastward flowing tributaries originating in the western highlands have deposited Quaternary alluvium over the Permian age rocks west of the Pecos River.

Because the average dip of the Permian rocks is greater than the slope of the land surface, progressively younger units are encountered eastward toward the Pecos River. Several prominent northeast trending ridges and hills interrupt the gently sloping plains near the site. These structures are narrow fault zones referred to as the Border Hills, Six-Mile Hill, and the Y-O faulted anticlines.

The stratigraphic units of importance with regard to water resources are, in ascending order, the San Andres Formation (Permian), the Artesia Group (Permian), and the undifferentiated Quaternary valley fill alluvium. Figure 2-2 shows the generalized stratigraphy in the vicinity of the site. Ground water is produced from both a shallow water-table aquifer (alluvium) and a deeper artesian aquifer that includes the two bedrock units (Welder, 1983). The deep bedrock aquifer is commonly known as the Roswell artesian aquifer. According to the State Engineer Office (SEO), approximately 400,000 acre-feet of water are pumped annually from the two aquifers of the Roswell hydrologic basin (DBS&A, 1992). The two aquifers are separated by a semi-confining layer, but are connected where the carbonate aquifer rises structurally to meet the shallow aquifer. Both aquifers are recharged along surface exposures on the slopes to the west and are believed to discharge to the Pecos River at the eastern margin of the basin.

The following subsections describe each of the hydrostratigraphic units in the Roswell basin in detail.

2.5.1 San Andres Formation

The San Andres Formation consists primarily of a thick sequence of limestones, dolomitic limestones, and dolomites, with increasing quantities of interbedded anhydrite and gypsum to the north (Kelley, 1971). The formation is divided into three members, in ascending order: the

Rio Bonito, the Bonney Canyon, and the Fourmile Draw members (Figure 2-2; Kelley, 1971). The average thickness of the formation is about 1,000 feet in the Roswell basin (Bean, 1949).

The Fourmile Draw member is the principal water-bearing unit within the San Andres Formation. High permeability has resulted from an irregular network of collapsed breccias, cavities, caves, and other interconnected open structures which were formed by dissolution of evaporite and carbonate beds. Gypsum beds become much more abundant in the Fourmile Draw member from Roswell northward (Kelley, 1971), and a well-developed karst surface is exposed where the unit is not covered by alluvium. In the northern portion of the basin the water-bearing zones of the San Andres Formation are approximately 400 to 600 feet thick and ground-water flow is primarily to the east-southeast toward the Pecos River.

In general, the lower boundary of the Roswell artesian aquifer, in general, is defined by low permeability zones that commonly occur within the Bonney Canyon member, which lies approximately 450 feet below the surface in the vicinity of the Roswell compressor station (Figure 2-2). SEO well records for wells near the site indicate that the upper boundary of the San Andres is approximately 92 feet below ground surface (bgs) in this area.

2.5.2 Artesia Group

The Artesia Group includes the following formations, in ascending order: the Grayburg, Queen, Seven Rivers, Yates, and Tansill Formations. In the vicinity of the Roswell compressor station, only the first three formations are present. The Artesia Group consists primarily of dolomite, sandstone, and gypsum units of Permian age. The sedimentary sequence represents a rapid lateral change in depositional environments from the southern massive reef complexes near Carlsbad to the northern clastic and evaporitic sequences representative of back reef and shelf environments (Kelley, 1971).

The Grayburg Formation unconformably overlies the San Andres Formation and ranges in thickness from 140 to 360 feet. The bottom of the Grayburg Formation provides a leaky confining bed that allows artesian ground water to move upward through the Artesia Group into the shallow alluvial aquifer. The thickness of this confining bed varies from 0 to 1,000 feet across the basin.

Drillers logs in the Roswell area indicate that discontinuous permeable units in the upper Artesia Group act as water-bearing zones (Welder, 1983). Fractures and cracks between fragments of collapsed breccia and solution-enlarged bedding planes and joints constitute the principal sources of permeability. These water-bearing zones generally occur in the upper quarter of the confining unit and may yield water to wells that tap both the upper Artesia Group and the shallow alluvium.

In most areas the Artesia Group is covered by a veneer of Quaternary alluvium west of the Pecos River. In the northwest portion of the basin, the bedrock confining unit is thin or absent, and the clay beds within the valley fill act as the confining bed for the lower confined carbonate aquifer. Historically, the lower carbonate aquifer discharged upward into the alluvium, but within the past 50 years, the vertical gradient across the confining bed has reversed because of ground-water pumping from the deep aquifer. This reversal has resulted in a downward gradient, causing ground water in the shallow aquifer to discharge to the deeper carbonate aquifer in some areas (DBS&A, 1992).

2.5.3 Quaternary Valley Fill

The Quaternary valley fill in the Roswell area was deposited by shifting streams flowing from the west toward the Pecos River. The valley fill consists of poorly to moderately consolidated deposits of gravel, sand, and clay which mantle the underlying Permian rocks. The thickness of alluvial sediments varies considerably from one locality to another because of the irregular bedrock erosional surface upon which the alluvium was deposited. In some areas the alluvial fill is moderately well cemented.

The thickness of the shallow alluvial aquifer is shown on Figure 2-3 for the northern portion of the Roswell Basin. Lyford (1973) developed the thickness (isopach) map after examination of drill cuttings from 225 wells penetrating the valley fill. Lyford's map indicates that the alluvium near the site is generally less than 50 feet thick. In other areas, however, the thickness can exceed 250 feet thick where the alluvium fills depressions in the underlying bedrock surface. Recent SEO well records indicate that the alluvium near the site is approximately 70 feet thick (DBS&A, 1992).

Lyford (1973) described three distinct units in the valley fill of the Roswell Basin. These units were termed the quartzose, clay, and carbonate gravels. The quartzose unit consists of sandstone, quartzite, quartz, chert, and igneous and carbonate fragments with varying degrees of calcium carbonate cementation. The quartzose unit in the vicinity of the Pecos River consists primarily of medium to coarse, uncemented quartz grains (Welder, 1983). Silt and clay deposits occur as lenses overlying the quartzose unit. These lenses were deposited in small ponds and lakes that resulted from the dissolution and collapse of the underlying carbonate rocks. The carbonate-gravel unit overlies the other valley fill deposits and generally consists of coarse carbonate gravel with intermixed silts and caliche.

The alluvial sediments underlying the compressor station, as observed in borings drilled during several investigations (Section 3), consist predominantly of interbedded cobbles, gravel, sand, silt, and clay. The finer-grained zones form lenticular beds which appear to be discontinuous across the site. Some of the alluvial deposits are firmly cemented in some places. These lithologic descriptions are consistent with Lyford's descriptions of the valley fill.

The principal water-bearing zones of sands and gravels are separated by less permeable lenses of silt and clay. According to Welder (1983), one to five water-bearing zones exist within the valley fill, and in many areas the alluvium is hydraulically connected to the upper bedrock units of the Artesia Group. The perimeter of the shallow alluvial aquifer is generally bounded by a margin of less permeable alluvium.

Figure 2-4 shows the approximate elevation of the water table in the shallow alluvium, as determined from measurements of water levels in wells completed in the alluvium (DBS&A, 1992). The map indicates that the station lies slightly outside the mapped extent of the shallow alluvial aquifer and that ground-water flow is toward the Pecos River. Although a thin layer of saturated alluvium exists as far north as Arroyo del Macho, Welder (1983) did not include this area within the extent of the shallow alluvial aquifer as defined by him, primarily because the ground-water quality in this area is too poor to be used for water supply purposes (DBS&A, 1992). The poor water quality in the shallow alluvial aquifer from slightly south of the Roswell compressor station northward is due to the presence of gypsum beds of the Fourmile Draw member at the base of the alluvium.

Because of the poor water quality and the low yields, most wells completed in the shallow alluvium are used primarily as livestock water supplies. In general, the chloride content of water in the shallow aquifer increases from west to east and ranges from 20 mg/L to 3700 mg/L (Welder, 1983). The presence of gypsum beds results in objectionably high calcium and sulfate concentrations in the shallow alluvial aquifer in the vicinity of the Roswell compressor station and northward. Sulfate concentrations are typically in the range of 2,000 to 3,000 mg/L, which is approximately equal to the equilibrium saturation concentration for ground water in direct contact with gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Thus, background sulfate concentrations in this area are four to five times above the New Mexico Water Quality Control Commission ground-water standard for sulfate of 600 mg/L. The poor water quality in the alluvium is consistent with the high total dissolved solids concentrations reported for ground water from the on-site monitor wells, as discussed further in Section 3.

2.6 Water Well Inventory

A survey was conducted to locate water supply wells within 2 miles of the Roswell compressor station. This survey was accomplished by searching a water well database created by DBS&A that is based on the USGS Ground-Water Sites Inventory database. The database contains the

locations of all known water wells plus additional information regarding well construction, well use, and aquifer penetrated. The water well database was compiled by DBS&A for a ground-water modeling project conducted for the SEO.

A review of the database revealed that there are 18 wells within about 2 miles of the compressor station. Table 2-1 details the location, total depth, depth to water, use, and completion aquifer for each of these 18 wells, along with their distance from the compressor station, and Figure 2-5 shows the locations of the wells relative to the site.

On December 2 and 3, 1994 a field reconnaissance of the off-site wells was conducted, and the wells were accurately located using a Magellan GPS satellite navigator. In addition, the condition and current use of each well was noted. The results of the well inventory and field reconnaissance are described below.

The closest off-site well to the former surface impoundments is a shallow livestock well completed in alluvium to a depth of 58 feet (well 3 on Figure 2-5). This well, which is no longer in use, is located about a half mile due east of the impoundments in the direction that would presumably be downgradient. The well is completed with 8⁵/₈-inch casing, and the depth to water measured in 1937 reportedly was 15 feet. The well is presently plugged and abandoned, and may have gone dry because of declining water levels in the Roswell area.

The next nearest well is a 352-foot-deep well (TW-1) located in the southwestern portion of the compressor station property (well 2 on Figure 2-5). This well was reportedly drilled in 1969 for use as a water supply well for the compressor station (Campbell, 1994). Following connection of the facility to the City of Roswell water distribution system, however, use of the well was turned over to the Pecos Valley Artesian Conservancy District for monitoring water levels in the Roswell bedrock aquifer. Based on comparison of the drillers' log with the local stratigraphy, the well is completed in limestone of the San Andres Formation. The well is cased with 9⁵/₈-inch

steel casing from the surface to a depth of 240 feet, and is open from 240 feet to the total depth of 352 feet. The depth to water as measured in December 1994 was 65 feet.

Several active and inactive irrigation and livestock wells are located between 1 and 2 miles east of the site (Figure 2-5). All of these wells are completed in the San Andres limestone aquifer. Given the distance to the downgradient wells and the presence of the aquitard between the alluvium and the bedrock aquifer, it is very unlikely that ground water from the compressor station could impact any of the active water supply wells.

3. PREVIOUS ENVIRONMENTAL INVESTIGATIONS

Several hydrogeologic investigations have been completed at the Roswell compressor station to characterize the extent of subsurface impacts near the former surface impoundments. The investigations have included (1) a comprehensive soil vapor survey and soil coring program by HLA, (2) a drilling and soil sampling program by Metric Corporation, (3) installation of a monitor well by Halliburton NUS Environmental Corporation (Halliburton), (4) installation of a product recovery pump in monitor well MW-1 by Cypress Engineering Services (CES), (5) a drilling and soil sampling program by Brown & Root Environmental (B&R), and (6) system operation and optimization by Brown & Caldwell.

The above investigations and the interim corrective action program have been undertaken in phases beginning in the spring of 1990 and continuing to the present. During this period extensive data have been collected regarding subsurface soils and ground-water conditions at the site.

Sections 3.1 through 3.5 provide an accounting of each of the field investigations conducted to date, and Section 3.6 ~~3.7~~ summarizes the extent of subsurface impacts resulting from past surface impoundment operations. Table 3-1 provides a summary of the soil borings and monitor wells installed during each investigation. Analytical summaries of hydrocarbon compounds detected in soil and ground water are provided in Tables 3-2 through 3-6.

3.1 Harding Lawson Associates Shallow Subsurface Investigation (1990)

During the spring of 1990, a soil investigation was performed by HLA to investigate the presence of VOCs in the shallow subsurface in the vicinity of the former surface impoundments (HLA, 1991a). The HLA investigation included an extensive soil gas survey and a soil coring and sampling program.

During the soil gas survey, HLA collected a total of 812 soil vapor samples from the locations shown on Figure 3-1. Soil gas samples were collected from depths ranging from 2 feet to 36 feet by driving a soil vapor probe several feet ahead of the hollow-stem auger bit. Soil vapor samples were analyzed in a mobile laboratory by subcontractor Fahrenthold & Associates using a gas chromatograph equipped with an electron capture detector. Five target purgeable halocarbons were quantified, including 1,1,1-TCA, trichloroethene, perchloroethene, chloroform, and carbon tetrachloride. The laboratory results for the soil gas samples are provided in Appendix E of this document.

The highest VOC concentrations were measured near the surface impoundments located in the northeast portion of the facility. The most frequently detected compound was 1,1,1-TCA, which was also detected at the highest concentrations (up to 372 ppmv). The areal distribution of 1,1,1-TCA at the 10-foot depth, as determined by HLA, is illustrated in Figure 3-2. The mass of vapor phase 1,1,1-TCA within the plume is estimated to be approximately 18 kg, assuming that the concentrations at the 10 foot depth apply to all soils from the surface to the water table at a depth of about 60 feet. This is equivalent to a volume of liquid 1,1,1-TCA of only about 3.5 gallons.

Following completion of the soil gas survey, HLA undertook a program of continuous coring and soil sampling in order to validate the soil vapor survey results. A total of 11 borings were drilled to depths of up to 65 feet. Continuous 5-foot-long soil cores were collected using a hollow-stem auger drill rig. Figure 3-3 shows the location of each boring drilled by HLA. The soil samples were analyzed in the laboratory for a suite of selected VOCs, semivolatile organic compounds, total petroleum hydrocarbons (TPH), and toxicity characteristic leaching procedure (TCLP) metals. The results of these analyses are summarized in Tables 3-2 and 3-3, and the complete laboratory reports are provided in Appendix E.

Only a few of the HLA soil samples contained detectable concentrations of the target purgeable halocarbons. A soil sample collected from 35 to 37 feet deep in boring SB-9-07 near the surface

impoundments contained the highest concentration of 1,1,1-TCA (2 mg/kg). This boring also contained somewhat higher concentrations of Freon-113, ethylbenzene, xylenes, and TPH.

In 4 of the 11 borings, HLA encountered perched water on top of a clay lens at approximately 30 feet bgs. The boreholes that contained water were near the utility garage and engine room (Figure 2-1). HLA postulated that the clay formed an aquitard with an undulating surface, thus allowing the water to pond within depressions in the upper surface of the clay. Water samples collected from these borings contained concentrations of 1,1,1-TCA below EPA drinking water MCLs.

3.2 Metric Corporation Shallow Subsurface Investigation (1991)

During July and November 1991, Metric Corporation drilled 20 additional soil borings to delineate the areal and vertical extent of the VOCs identified by HLA near the surface impoundments (Metric, 1991). The locations of borings drilled by Metric are shown on Figure 3-4. Soil borings were generally advanced to approximately 30 to 40 feet bgs in order to characterize soil type and to determine if VOCs were present above the uppermost clay unit. Only four soil borings were drilled to depths greater than 50 feet bgs (Table 3-1).

Metric collected soil samples using a continuous tube sampler, and each core was screened for the presence of VOCs using an organic vapor analyzer (OVA). Within a given soil core, the material with the highest concentration of organic vapors was submitted to the laboratory for analysis of the following constituents: TPH, benzene, toluene, ethylbenzene, and xylenes (BTEX); and purgeable halocarbons by EPA Methods 418.1, 8010, and 8020, respectively. The results of these laboratory analyses are summarized in Tables 3-2 and 3-4. Several of the borings contained VOC concentrations above the soil cleanup standards enforced by NMED and OCD.

Based on the analytical results, Metric estimated that the areal and vertical extent of VOC impacts extended approximately 240 feet east and approximately 100 feet north of the northeast property corner. The investigation further established that purgeable halocarbons are present to depths of at least 30 feet bgs near surface impoundments 1 and 2 (soil borings "Pit 1" and "Pit 2") and along the eastern fence line (soil boring SG 86). In addition, some soil samples contained TPH concentrations of 100 mg/kg, or greater, to depths exceeding 27 feet in soil borings "Pit 1," "Pit 2," SG 86, and OS BH-9.

Most borings drilled previously by HLA and Metric had penetrated a clay layer at approximately 30 feet bgs. However, clay was not encountered in soil boring "Pit 2" above about 68 feet bgs. This prompted Metric to conclude that a natural clay basin existed beneath the surface impoundments, with the sides sloping from the 30 to 40 foot depth around the perimeter, to approximately 70 feet bgs near the basin bottom.

However, subsequent drilling programs verified that the upper clay is, in fact, present at the 35 to 40 foot depth near the "Pit 2" soil boring, but is thinner and contains coarser sediments. The upper clay unit appears to grade laterally into a coarser zone of sandy clays near soil boring "Pit 2." Further, the clay unit identified at 67.9 feet bgs by Metric is actually part of the lower clay unit that underlies the entire site. This lower clay may lie near the contact between the valley-fill alluvium and the underlying Artesia Group Permian bedrock units (see Figure 2-2, Section 2.5).

Ground water was encountered at depths ranging from 37 to 57 feet bgs in 6 of the 20 borings drilled by Metric. Soil borings "Pit 2" and SG 361 (Figure 3-4) contained thin perched water zones (1 to 6 feet thick) above fine-grained sandy clays which correspond to the upper clay unit. Approximately 1-foot of water was measured at the bottom of soil borings OS BH-8 and OS BH-9 (Figure 3-4) at approximately 49 feet bgs. The water measured at the 49-foot depth may have migrated down the boreholes from the top of the upper clay unit. Finally, the ground water encountered at depths of about 55 feet bgs likely represents the water table of the uppermost

aquifer, as these depths to water were generally reported in borings drilled to depths of approximately 70 feet bgs.

3.3 Halliburton NUS Corporation Monitor Well Installation (1992)

During July 1992, Halliburton installed one monitor well within the natural clay basin determined by Metric (Section 3.2) (Halliburton, 1992). The boring was drilled to a depth of 60 feet prior to sampling, at which point continuous samples were collected with a split-spoon sampler until a red clay layer containing very hard sulfate lenses was encountered at 68 feet bgs. Monitor well MW-1 was installed at the location depicted on Figure 3-5.

Following installation of MW-1, the well was developed by bailing and subsequently sampled for 8240 volatile and 8270 semivolatile organics, TPH, and total metals. The analytical results indicated that the ground water within monitor well MW-1 contained aromatic and halogenated hydrocarbons, as well as several semivolatile organic compounds. These results are summarized in Table 3-4.

3.4 Brown & Root Environmental Ground-Water Assessment (1993)

In April 1993, B&R, a division of Halliburton, completed a limited assessment of ground-water impacts resulting from disposal activities at the former surface impoundments (B&R, 1993). The investigation was undertaken to determine if two separate saturated zones existed within the alluvium and to establish ground-water quality beneath the former impoundments.

As part of their investigation, seven soil borings were drilled, and four of these were completed as monitor wells. Figure 3-5 shows the locations of soil borings and monitor wells installed by B&R. Soil samples were collected from each boring using a split-spoon sampler or continuous core barrel. The samples were screened for the presence of VOCs using an OVA. Unfortunately, the OVA was not functioning during the drilling of soil borings SB-4, SB-5, and SB-

1C. Soil samples were collected above the two saturated zones and analyzed for TPH using EPA Method 418.1; the results are summarized in Table 3-4.

Perched water was not encountered above the upper clay unit during drilling of soil borings SB-1B, SB-2, SB-3, and SB-5 (Figure 3-5). However, phase-separated hydrocarbons (PSH) and water were encountered in soil boring SB-1A immediately above the upper clay layer at approximately 40 feet bgs. This boring was subsequently plugged and abandoned by B&R. Soil boring SB-4 encountered a small saturated zone in fractured limestone at approximately 47 feet bgs. This boring is located approximately 250 feet east of the property boundary, and the limestone probably corresponds to the top of the Artesia Group (Section 2.5).

B&R installed four monitor wells in the uppermost aquifer within soil borings SB-1B, SB-2, SB-3, and SB-5. The monitor wells, identified as MW-1B, MW-2, MW-3, and MW-5, were set at total depths ranging from 65 to 70 feet bgs (Table 3-1). The newly installed wells were then checked for the presence of PSH, developed, and sampled.

Approximately 4 feet of PSH was present on top of the water table in monitor wells MW-1B and MW-2. Ground-water samples were collected from the two monitor wells without PSH (MW-3 and MW-5) and analyzed for TPH (EPA Method 418.1), volatile organics (EPA Method 624 and 8240), and total dissolved solids (EPA Method 160.1). The results of these analyses are summarized in Tables 3-4 and 3-5.

B&R concluded that two water bearing zones were present in the alluvium and that both were impacted by VOCs. The two zones included (1) the upper thin zone of perched water on the upper clay unit (approximately 40 feet bgs) and (2) a deeper zone of saturated silty sand and sand at depths ranging from 55 to 65 feet bgs. During the drilling of soil borings SB-1B and SB-2, B&R identified zones of residual saturation and PSH above the upper clay unit. Following construction of monitor wells MW-1B and MW-2 in the uppermost aquifer, approximately 4 feet of PSH was measured in each well.

In June 1993 B&R returned to the site to install PSH recovery wells in the upper water-bearing zone above the upper clay unit. An additional seven borings were drilled near the surface impoundments, designated RB-1 through RB-7 (Figure 3-5). Only one of the seven additional borings contained perched liquids. The one boring which contained liquid (RB-7) was completed as recovery well RW-1 near monitor well MW-1 (Figure 3-5). Approximately 1.4 feet of PSH was measured in recovery well RW-1 following its construction.

On March 23, 1994, CES removed an inoperative recovery pump from MW-1 and collected ground-water samples from monitor wells MW-3 and MW-5. On April 15, 1994, B&R installed a pneumatic product recovery pump and skimmer in monitor well MW-1. At that time B&R measured the following depths to PSH and to ground water in the four wells containing free hydrocarbon product:

Well	Date	Total Depth of Well (feet)	Depth to PSH ¹ (feet)	Depth to Water ¹ (feet)	PSH Thickness (feet)
MW-1	04-15-94	68.0	53.30	61.54	8.24
MW-1B	04-15-94	65.5	58.42	61.30	2.88
MW-2	04-15-94	65.0	58.68	61.50	2.82
RW-1 ²	04-15-94	42.5	38.70	39.00	0.30

¹ Depth in feet below top of casing.

² Recovery well RW-1 is completed in the perched water zone.

3.5 Interim PSH Removal Program

On May 21, 1993, a recovery pump was installed in MW-1 by CES. During July 1993, B&R installed PSH recovery pumps in monitor wells MW-1B, MW-2, and RW-1. Since that time, PSH and water have been pumped from these wells and routed to an aboveground storage tank. Rollins Environmental Services then periodically transports the waste hydrocarbon liquid to Deer Park, Texas for incineration.

During the fall of 1993, Brown and Caldwell (B&C) installed skimmers on each recovery pump to reduce the volume of water recovered. Prior to the installation of the skimmers, B&C

measured PSH levels and ground-water levels of approximately 58.5 and 62 feet bgs in monitor wells MW-1B and MW-2, respectively. The depth to water was approximately 38.6 feet bgs in recovery well RW-1, which contained approximately 0.06 feet of PSH at the time of measurement. The interim PSH recovery system has successfully removed approximately 7300 gallons of PSH and 5800 gallons of ground water to date and is maintained by a local contractor.

3.6 Daniel B. Stephens & Associates, Inc. Subsurface Investigation (1994)

Following correspondence and discussions between NMED and Transwestern, DBS&A performed a limited field investigation during November and December 1994. Upgradient monitor well MW-6 was installed approximately 500 feet southwest of the location of the former surface impoundments (Figure 2-1). The MW-6 boring was drilled using a hollow-stem auger to a depth of 80 feet, and the well is screened from 60 to 75 feet bgs. Soil samples were collected at 5-foot intervals during drilling, and field headspace measurements using a PID did not detect the presence of VOCs in any of the soil samples.

The alluvial sediments penetrated during drilling of MW-6 were generally consistent with those observed in previous borings; that is, they consisted predominantly of sandy gravel and sand from the surface to a depth of 60 feet and silty clay and clayey sand from 60 to 75 feet. A gravelly sand of unknown thickness was penetrated at the 79-foot depth in this boring; however, the red plastic clay reported in previous borings was not encountered.

A ground-water sample from MW-6 and a soil sample from the same boring collected from a depth corresponding to the water table were submitted for laboratory analysis of VOCs and TPH. Both the soil and the ground-water sample exhibited no detectable concentrations of 8010/8020 VOCs or TPH determined by method 418.1. The results of these analyses are included in Appendix E.

In order to allow a better estimate of the ground-water flow direction and gradient within the shallow alluvium, the elevations and coordinates of all on-site monitor wells were resurveyed on

December 1, 1994. The well locations and elevations based on this survey are provided in Table 3-6.

Depths to water were measured in on-site monitor wells MW-3, MW-5, and MW-6 on December 4, 1994 and again on December 22. These data are also shown in Table 3-6. Ground-water flow directions calculated for the two dates of measurement are ~~N74E and N72E~~ are approximately N34E and N32E, respectively, indicating that ground water in the shallow alluvium flows to the east north-northeast in the vicinity of the former impoundments. The flow direction is shown graphically on Figure 2-1. The dimensionless ground-water gradient calculated using the December 22 data is 0.009, which is typical of relatively permeable alluvial sediments of the type encountered during drilling.

In addition to the sampling and analysis of MW-6, ground-water samples were also collected from on-site deep well TW-1 (Figure 2-1) and off-site deep well #5 (Figure 2-5). Well #5 was selected as representative of background upgradient water quality within the San Andres bedrock aquifer. The ground-water samples from these two wells were analyzed for a modified Appendix IX suite of constituents, and the laboratory results for these analyses are included in Appendix E of this document.

These results indicate that both deep wells yield very hard ground water of relatively high salinity. Well #5 contains high concentrations of sulfate (768 mg/L), chloride (750 mg/L), and TDS (2420 mg/L). These values significantly exceed the New Mexico ground-water standards for sulfate (600 mg/L), chloride (250 mg/L), and TDS (1000 mg/L). The ground-water sample collected from Transwestern well TW-1, although of somewhat lower salinity, still exceeds the New Mexico standards for chloride and TDS, with reported concentrations of 631 mg/L and 1290 mg/L, respectively. In addition, deep well TW-1 also contained elevated concentrations of iron (4.22 mg/L) and manganese (0.39 mg/L), which exceed the New Mexico ground-water standards for these elements of 1.0 mg/L and 0.2 mg/L, respectively.

The high salinity of the ground water from TW-1 and Well #5 is almost certainly natural and probably results from dissolution of soluble evaporite minerals within the upper Fourmile Draw Member of the San Andres Formation, as discussed in Section 2.5. The high salinity of the ground water in the bedrock aquifer in this vicinity may also account for the fact that many of the production wells are no longer in use.

Appendix IX VOC analyses of the ground-water samples collected from the two deep wells revealed no detectable concentrations of any of these compounds. In addition, the sample from TW-1 was analyzed for Appendix IX SVOCs, and the only compound detected was bis(2-ethylhexyl)phthalate (18 $\mu\text{g/L}$). The phthalate esters are well-known laboratory contaminants used as plasticizers in most flexible plastic products, such as the plastic beakers and tubing used in many laboratory applications. EPA has acknowledged this compound as a common laboratory contaminant (EPA 1988, 1991). Therefore, we conclude that the reported detection of this compound is probably the result of laboratory handling of the sample; it is almost certainly not present in the ground water, as no other organic compounds were detected in the sample.

3.7 Extent of Soil and Ground-Water Contamination

The investigations completed to date and described in Sections 3.1 through 3.5 have been conducted to characterize the subsurface hydrogeology and the distribution of VOCs in the soils and ground water beneath the former surface impoundments. Figure 3-6 shows the locations of all borings and monitor wells installed to date. The contaminants detected consist primarily of petroleum hydrocarbons that are typical components of pipeline condensate, which was formerly held in the surface impoundments. Tables 3-2 through 3-5 provide summaries of the organic and inorganic constituents detected in soils and ground water during each of the previous investigations.

Sections 3.7.1 through 3.7.3 summarize the findings of the investigations discussed above ~~and provide an accounting of the subsurface distribution of constituents exceeding regulatory guidelines set by NMED and EPA.~~

3.7.1 Site Hydrogeology

The Quaternary sediments beneath the impoundments consist of interbedded cobbles, gravel, sand, silt, and clay to depths of approximately 70 feet bgs. The lithology of the alluvium is consistent with the descriptions provided by Lyford (1973). A generalized hydrogeologic cross section of the sediments underlying the impoundments constructed along a north-south line (Figure 3-6) is provided in Figure 3-7. Soil types in Figure 3-7 are defined using the Unified Soil Classification System. The hydrogeology underlying the site is as follows:

- From the ground surface to depths of approximately 30 to 35 feet bgs, brown gravelly sands and clays are present. Perched water is often encountered within the bottom few feet of this interval.
- At depths of approximately 35 to 60 feet, light brown to reddish-colored interbedded silts, sands, and clays are encountered. The fine-grained clay lenses serve as perching layers for the downward moving fluids and likely represent interfingering deposits of limited lateral extent.
- At depths of approximately 60 to 70 feet, saturated silty sands and sands are present. This zone is referred to as the uppermost aquifer.
- At approximately 70 feet, a red plastic clay of unknown thickness is present. This unit probably represents the transition from the Quaternary alluvium to the Permian-age bedrock of the Artesia Group.
- As discussed in Section 2.5, the background water quality in the shallow alluvial aquifer is very poor in the vicinity of the site due to the presence of gypsum beds beneath the

alluvium. TDS concentrations exceed 3000 mg/L in on-site monitor wells MW-3 and MW-5 (Table 3-5). These two wells do not appear to be impacted by site activities; rather, the elevated TDS concentrations in these wells simply reflect the poor background quality of ground water in the region.

- The ground-water flow direction in the alluvium underlying the former impoundments is **east north**-northeast, and the dimensionless head gradient is approximately 0.009.

3.7.2 Soil Impacts

Based on field OVA measurements and analytical chemistry results, elevated VOC concentrations in soil appear to encompass an area of approximately 600 feet by 400 feet centered between the three former surface impoundments. Figure 3-8 shows the estimated areal extent of impacted soil, in excess of 100 mg/kg TPH.

Near the former surface impoundments, the vertical extent of impacted soils extends from approximately land surface to the uppermost aquifer at approximately 60 feet. The vertical extent of impacted soil decreases as one moves laterally away from the surface impoundments. Due to local soil heterogeneities, it appears that VOCs have spread out along preferential pathways on top of the clay lenses at the 30- to 40-foot depth, prior to continued downward migration to the uppermost aquifer.

A generalized cross-sectional profile of impacted soils is shown in Figure 3-9; Figure 3-6 shows the location of the cross section. The estimated distribution of impacted soils is based both on field organic vapor analyzer readings and soil TPH concentrations as determined in the laboratory.

The extent of 1,1,1,-TCA detected in soil samples is limited to the area immediately below the former surface impoundments. However, elevated 1,1,1-TCA soil vapor concentrations are present throughout the estimated area of actionable soils (Figure 3-8).

3.7.3 Ground-Water Impacts

The estimated extent of actionable VOCs in ground water is difficult to ascertain due to the limited number of existing monitor wells. However, the lateral extent of VOCs ~~is~~ appears to be bounded on-site by monitor wells MW-3, MW-5, and MW-6. The ground-water plume most likely extends downgradient beyond the estimated extent of actionable soil contamination. The direction of ground-water flow is east north-northeast in this area. As noted in section 3.0, previous investigations lacked analysis for Appendix IX parameters and RCRA required QA/QC. A summary of the analytical results from previous water sampling events can be found in Tables 3-4 & 3-5. A complete listing of the hazardous constituents analyzed per well can be found in Appendix E.

The following VOCs have been detected in MW-2: benzene (6500 ppb), toluene (15000 ppb), ethyl-benzene (2100 ppb), and total xylene (13000 ppb). SVOC, PCB/organochlorine pesticides, and inorganic compounds have not been analyzed for in MW-2. Ground-water analysis results from MW-1 detected the following organic constituents: benzene (370 ppb), toluene (61 ppb), ethyl-benzene (110 ppb), o-xylene (120 ppb), p-m xylene (820 ppb), 1,1,1, TCA (180 ppb), 1,1, DCA (560 ppb), 2-butanone (MEK) (220 ppb), naphthalene (34 ppb), 2-methyl-naphthalene (51 ppb), 4-methyl-phenol (250 ppb).

PSH is present in on-site monitor wells MW-1, MW-2, and MW-1B completed in the uppermost aquifer at 55 to 70 feet bgs, and in recovery well RW-1, completed in the limited perched zone from 35 to 42 feet bgs. The extent of PSH off-site, if any, remains to be defined.

4. SOIL ASSESSMENT PLAN WASTE AND UNIT CHARACTERIZATION

A phased approach will be used to assess the nature and extent of soil impacts ~~contamination~~ resulting from past usage of the former surface impoundments. ~~Phase I Waste and unit characterization~~ will consist of precisely locating the former impoundments and characterizing residual wastes through laboratory analyses. ~~Hazardous constituents identified from the contaminant source characterization~~ will be used to develop a hazardous constituent monitoring list for sampling of soil and ground water during assessment phases. ~~A hazardous constituent monitoring list will be proposed in the Waste and Unit Characterization Report.~~ ~~Phase II will attempt to define the lateral and vertical extents of impacts to soils underlying and adjacent to the former surface impoundments.~~ Sections 4.1 through 4.6 describe Phase I soil sampling strategy and procedures, while Section 4.7 provides a brief description of Phase II objectives.

4.1 Phase I Soil Sampling ~~Waste and Unit Characterization~~ Strategy

The sampling strategy described herein is based on information collected from previous investigations at the facility (Section 3) and examination of historical aerial photographs (Section 2.2). The goal of the ~~Phase I soil assessment~~ ~~waste and unit characterization~~ is to characterize any wastes that may remain within the former impoundments with respect to RCRA Appendix IX ~~hazardous~~ constituents. In accordance with NMED's request, waste characterization will include collection of soil samples from ~~two locations~~ directly beneath each of the known and suspected surface impoundments. ~~Four potential source areas (Pit 1, Pit 2, Pit 3, and SG 86) have been identified at this site (Figure 3-4).~~ ~~Six to eight soil samples from the four potential source areas (Pit 1, Pit 2, Pit 3, SG 86) will be analyzed in the laboratory for Appendix IX VOCs, SVOCs, PCBs, metals, cyanide, and sulfide.~~

As described in Section 2.2, hydrocarbon liquids, primarily pipeline condensate, were placed in the impoundments during their operational lifetimes. Later, the impoundments were backfilled with clean soil, and the surface was restored to approximately original grade. At each

impoundment location, this history has resulted in clean backfill overlying subsoils that are potentially impacted by seepage of liquids from the former impoundments. ~~The Phase I soil assessment waste and unit characterization~~ is intended to permit collection of subsoil samples from the most highly impacted horizon immediately beneath the clean backfill. Based on prior experience, the clean soil backfill is generally visually quite distinct from the underlying impacted subsoil, due to staining of the latter by hydrocarbon liquids. The soil sampling rationale for each suspected source area is described in the following paragraphs, and detailed soil sampling procedures are provided in Section 4.2.

The soil sampling rationale for Pits 1 and 2 differs from that for Pit 3 and SG 86. Because the former locations of Pit 1 and Pit 2 (Figure 2-1) are known with relative certainty from examination of aerial photographs, two soil borings will be drilled at each of these two areas at the approximate locations shown on Figure 4-1. ~~Samples will be analyzed in the laboratory for petroleum refining hazardous constituents found in list 4 (Industry Specific Monitoring Constituents) of U.S. EPA, May 1989, RCRA Facility Investigation (RFI) Guidance. Analytical methods shall be in accordance with EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, Update II. For each analytical method, appropriate preparation techniques shall be employed for the various hazardous constituents in accordance with SW-846. Analytical methods for the above hazardous constituent list include the following EPA methods: full 8270, full 8080, full 8240, full 6010, 7470 for mercury, and 9010 for cyanide.~~

In order to chemically characterize the wastes, ~~a single samples~~ of the most highly impacted soil will be selected from each boring at Pits 1 and 2 for laboratory analysis of ~~Appendix IX RCRA hazardous~~ constituents. The most highly impacted sample from each boring will be selected based on visual examination and field headspace screening with the PID. ~~If no readings are obtained from the PID and no visual staining is evident then a single soil sample will be taken from each soil boring to be sent for laboratory analysis. The soil~~

samples will be taken within undisturbed sediments at no deeper than 2 feet below the base of the fill material of the former surface impoundments.

The location of Pit 3, if indeed it ever existed, is not known with any degree of certainty (Figure 2-1). Likewise, the location of a possible hydrocarbon source area in the vicinity of Metric Corporation boring SG 86 is poorly known (Figure 3-4). Therefore, in order to determine whether subsurface wastes exist at these two suspect areas, an exploratory soil sampling program will be undertaken at these locations. The approach will be to begin by collecting a continuous soil core at the center of each suspected location (Figure 4-1). If hydrocarbon-impacted soils are not found **by screening methods**, up to four additional soil borings will then be drilled at 50-foot centers on a grid centered **at about the initial soil sampling boring** location, as shown in Figure 4-1. **However, if sampling results detect hydrocarbon-impacted soil within a soil boring, only one additional soil boring will be required. The location of this additional boring will be at 15 feet from the impacted boring, and a direction to be determined in the field.** One of the Pit 3 borings will be drilled to the top of the bedrock, at approximately 75 feet, in order to allow stratigraphic correlation between the monitor wells. Each boring will then be plugged as described in Section 4.3, to prevent downward migration of fluids. **The waste characterization procedures and methodology at Pit 3 and SG 86 will follow the same procedures and methodology used at Pits 1 and 2.**

The presence of any hydrocarbon wastes at these sites is expected to be obvious, based upon visual examination of soil cores and field headspace screening of soil samples using a PID. If wastes are found at the locations of Pit 3 and SG 86, a single soil sample from the two most highly impacted borings at each of the two locations (Pit 3 and SG 86) will be selected for laboratory analysis of ~~Appendix IX~~ **RCRA hazardous** constituents. If no evidence of hydrocarbon impacts are noted in any of the five borings at Pit 3 or SG-86, as determined by field screening with the PID **or visual examination**, then a single soil sample ~~from the center boring~~ **shall be collected from the center boring and one additional boring within the undisturbed sediments at a depth of 15 feet below ground surface. Therefore two**

samples will be submitted from each potential source area for laboratory analysis, as discussed above. in Section 6.

The overall purpose of the Phase I soil assessment waste and unit characterization is to characterize residual subsurface wastes with respect to RCRA constituents such that a list of "target analytes" may be developed and the extent of subsurface impacts can be further defined during Phase II. The soil assessment will define the lateral and vertical extent of contamination to soils underlying and adjacent to the former impoundments. Laboratory analysis of the soil samples collected during Phase I for selected Appendix IX analytes the waste and unit characterization will enable permit identification of those constituents that represent contaminants of concern at this site RCRA regulated unit. As agreed upon in a meeting on November 1, 1994, NMED Hazardous and Radioactive Materials Bureau HRMB will approve the list of target analytes (hazardous constituents) for the Phase II investigation soil and groundwater assessment based on the laboratory analytical results of the Phase I soil and ground-water analyses waste and unit characterization .

A Waste and Unit Characterization Report will be submitted to HRMB following completion of the source contamination characterization. This report will contain at a minimum:

- a descriptive summary of work conducted and general conclusions
- soil boring logs. Logs will include:
 - 1) boring number and location
 - 2) dates drilling began and finished
 - 3) driller's name and company
 - 4) drill rig type
 - 5) bit/auger size
 - 6) borehole diameter
 - 7) total depth drilled
 - 8) depth (s) sampled

9) lithologic logs

■ **field screening results**

- 1) boring number and location
- 2) sample depth - interval
- 3) sample date - time
- 4) instrument type - detection limit
- 4) calibration notes
- 5) field notes
- 6) sample results

■ **soil sampling information**

- 1) boring number and location
- 2) sample depth - interval
- 3) sample date - time
- 4) sample collection method
- 4) field observations
- 5) sample parameters/methods
- 6) sample container types
- 7) sample handling procedures
- 8) copy of chain of custody
- 9) sampling results
- 10) detection limits
- 11) quality assurance / quality control information

■ **comparison of constituents detected with action levels, background levels, and any QA/QC concerns**

- 1) summary of constituents detected:
 - . descriptive
 - . tabular
- 2) statistical comparison of soil results to:
 - . action levels
 - . background levels

3) quality assurance / quality control summary

- proposed hazardous constituent monitoring list to be utilized during the phased investigation for soil and ground water assessment. The ground water list may be different than the soil assessment list depending on whether certain constituents have media specific analytical methods as advised in List 3 (Monitoring Constituents Potentially Applicable to Specific Media) of U.S. EPA, May 1989, RCRA Facility Investigation (RFI) Guidance. Analytical methods shall be in accordance with EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update II.

4.2 Soil Sampling Procedures

Phase I soil Waste and unit characterization sampling will be performed by continuous drive sampling through the clean soil backfill and into the underlying **potentially hydrocarbon-**impacted subsoil below. By retrieving successive continuous soil samples, the maximum stratigraphic information will be obtained from each boring, with a minimum of soil cuttings that require disposal being generated. Based on reasonable assumptions regarding the depths of the former impoundments, it is estimated that the contact between the clean soil backfill and the underlying impacted subsoils will be encountered between 10 and 20 feet below grade.

Drive samples will be obtained using a 24-inch-long split-barrel sampler in accordance with DBS&A SOP 13.3.2 (Appendix F). The split-barrel sampler will be driven into the soil using the rig-mounted drive hammer with uniform drive-pressure/drop-height. Blow counts will be recorded for all split-barrel drives. Following retrieval from the borehole, the split-barrel sampler will be placed on a table covered with a clean plastic sheet. The split-barrel sampler will then be opened and the soil material described according to DBS&A SOP 13.3.2. A subsample of the material will be placed in a ziplock plastic bag for field headspace screening for VOCs using a PID.

When the base of the clean backfill is encountered, a clean split-barrel sampler equipped with 6-inch-long brass liner rings will be used to collect a sample of the hydrocarbon-impacted subsoil below. The split-barrel sampler will be driven in the same manner as described above. Upon opening the split-barrel, however, the center two liner rings to be submitted for laboratory analysis will immediately be sealed with Teflon[®] membranes, plastic end caps, and solvent-free tape to minimize loss of VOCs from the soil samples due to volatilization.

All sample containers will be labeled using waterproof ink. Label information will include the sampling location, depth interval, sampling date and time, type of analysis requested, project number, and the initials of the sampler. The containers will be sealed and placed in clear plastic bags. The sealed containers will be put into coolers on bags of ice or frozen ice packs. Plastic bubble pack or other suitable packing material will be used to protect the samples during shipping. Chain-of-custody forms will be completed in triplicate for each sample shipment as described in Section 6.5.

Field personnel will ship the sample coolers to the laboratory using an overnight courier service. The fastest possible shipping method will be used, and all sample shipments will be carefully tracked to ensure that samples arrive intact and that all holding times are met.

4.3 Borehole Abandonment Procedures

The approximately 15 foot-deep, 3-inch-diameter boreholes created by continuous drive sampling of the soil will be abandoned by ~~plugging them with a bentonite slurry poured slowly down the borehole using a funnel. The approximate volume of each borehole will be determined to estimate the volume of bentonite slurry required, and the quantity of slurry actually emplaced will be recorded. Borings drilled using a hollow stem auger will be plugged in a similar manner, except that a cement bentonite grout will be emplaced using a tremie pipe.~~ **in accordance with DBS & A SOP 13.4.4, Well and Boring Abandonment (Appendix F).**

4.4 Laboratory Analysis of Soil Samples

Six to eight soil samples will be submitted to the laboratory for analysis of Appendix IX VOCs, SVOCs, PCBs, metals, cyanide, and sulfide. These samples will include one collected from the uppermost portion of the impacted soil horizon in each of two borings drilled at Pit 1 and Pit 2, plus one or two soil samples from Pit 3 and SG 86. At a minimum, two samples will be submitted to the laboratory from each potential source area. As discussed in Section 4.1, soil samples will be analyzed in the laboratory for hazardous constituents found in List 4 (Industry Specific Monitoring Constituents) of U.S. EPA, May 1989, RCRA Facility Investigation (RFI) Guidance. Chemical analysis of the soil samples will be performed using standard RCRA protocols in Test Methods for Evaluating Solid Waste, SW-846, Third Edition, Update II (U.S. EPA). The analytical methods and data quality objectives are discussed in greater detail in Section 6 of this closure plan.

4.5 Decontamination Procedures

All non-disposable field equipment that may potentially come in contact with any soil sample will be decontaminated in accordance with DBS&A SOP 13.5.2, Decontamination of Field Equipment (Appendix F), in order to minimize the potential for cross-contamination between sampling locations. Clean latex or plastic gloves will be worn during all decontamination operations. The following sequence of decontamination procedures will be followed prior to each sampling event:

1. Wash all down-hole equipment in a solution of non-phosphate detergent (Liquinox[®]) and distilled/deionized water. All surfaces that may come into direct contact with the soil sample will be washed. Use a clean Nalgene[®] tub to contain the wash solution and a scrub brush to mechanically remove loose particles.
2. Rinse the equipment twice with distilled/deionized water.
3. Allow the equipment to air dry prior to the next use.

The drill rig and all down-hole equipment will be steam-cleaned and allowed to air dry between borings. A decontamination area lined with plastic sheeting will be set up to contain all wash water associated with the steam-cleaning operation. Liquid wastes produced during equipment decontamination will be contained in 55-gallon drums at a designated on-site drum storage area. Pending the results of laboratory analyses, all liquids will be handled as potentially hazardous wastes, as described in Section 4.6.

4.6 Management of Investigation-Derived Wastes

All soil cuttings, decontamination fluids, and used personal protective equipment (PPE) will be stored in 55-gallon drums and labeled to identify contents, date of generation, and amount of material generated. All wastes, ~~with the exception of PPE~~, will be handled as potentially hazardous wastes, pending results of laboratory analyses for associated samples.

Liquid wastes generated during decontamination of drilling and sampling equipment will be stored pending results of associated soil sample **and equipment blank** laboratory results. For example, the disposition of wash water associated with a particular boring will be determined from the analytical results of soil samples collected from that particular boring. If the water is determined to be hazardous, it will be filtered through an activated carbon filtration system as described in Section 5.7. **A verification sample of each potential waste stream that has been filtered will be analyzed by the appropriate analytical method to test for the constituents by which the water was determined to be hazardous. If the water after verification sampling shows concentrations of constituents above any applicable federal, state, and or local regulations then the remaining waste will be disposed of according to applicable regulations.**

Soil cuttings generated during the soil assessment will be stored in 55-gallon drums pending analytical results for soil samples collected from associated soil borings. Hydrocarbon-contaminated soils, as determined by field headspace screening, will be segregated from **clean soils** ~~soils determined by field screening not to be contaminated~~. **Soils segregated by field**

~~screening techniques will await analytical results before a hazardous waste determination is made.~~ Clean soils will be disposed of on-site by spreading soil cuttings on the ground surface, and contaminated soils will be shipped for off-site disposal at a permitted RCRA disposal facility. PPE and dry waste associated with these materials will be disposed of ~~accordingly~~ in a sanitary landfill ~~pending analytical results~~.

4.7 ~~Phase II~~ Soil Assessment

~~The detailed scope of work for the Phase II hazardous constituent monitoring list for soil assessment cannot will be determined until the Phase I investigation based upon results of the waste and unit characterization is completed. The specific constituent list for sampling will be submitted to HRMB as a part of the Waste and Unit Characterization Report for HRMB approval. Once TW receives HRMB approval of the Waste and Unit Characterization Report and the hazardous constituent monitoring list for soil assessment, TW will then begin work on Phase I soil assessment. The Phase II soil assessment scope of work, along with that for the Phase II ground water assessment, will therefore be submitted later as an amendment to this closure plan. Nevertheless, the overall objectives for the Phase II assessment may be defined at this time.~~

Following its completion, the results of the Phase I soil assessment will be summarized in a report submitted to NMED, along with copies of the laboratory results for the soil samples analyzed during Phase I. The report will include a proposed list of target analytes to direct subsequent Phase II investigations. For RCRA metals, the selection of target analytes will be based on ~~statistical~~ comparison of the observed concentrations of each element with its expected background concentration in soils, as reported in existing literature. ~~Expected background concentrations and the pertinent reference(s) are listed in Appendix H.~~ Statistical techniques for determining whether a particular constituent is present above background levels will follow EPA guidance (EPA, 1989a, 1989b). ~~Following review of the Phase I report and proposed list of target analytes by NMED, a meeting will be scheduled between~~

~~Transwestern and NMED to discuss any issues remaining to be resolved prior to approval of the target analyte list and preparation of a closure plan amendment detailing Phase II activities.~~

Briefly, the Phase II soil assessment will consist of delineating delineation of the lateral and vertical extent of impacted contaminated soils beneath and adjacent to the former impoundments. The soil borings drilled to investigate the extent of contamination will also determine the concentration distribution throughout the vadose zone. This delineation will necessitate an iterative approach to soil sampling. Following NMED's review and approval of the Phase II scope of work, additional soil borings will be drilled outward along a grid centered on the location of each source area identified during Phase I.

For the purposes of soil assessment, the multiple source areas of the RCRA-regulated units, will be considered as one source area. Within this source area, individual areas with the highest laboratory results of TPH, as determined from waste characterization, will be considered as the focal point for grid spacing purposes. Initially, four soil borings will be drilled at a distance of 300 feet from the focal point along a N-S, E-W grid. If soil borings already exist in the gridded locations from previous phases of investigation approved within this closure plan, data from the previous soil boring (s) may be substituted for the gridded soil boring (s).

Because the vertical extent of contamination within the vadose zone is expected to intercept the uppermost aquifer, as indicated by ground water contamination, the maximum soil boring depth will be approximately 55 - 60 feet.

Approximately five samples will be taken per soil boring. Samples will be collected within every 10 foot interval based on field screening techniques as described in Section 4.1. If no readings are obtained from the PID and no visual staining is evident then discrete samples will be taken every 10 feet. The soil samples will be taken within undisturbed sediments at no deeper than 15 feet below ground surface. Geologic descriptions will be recorded at least every 5 feet.

The soil boring samples will be analyzed for TPH in the field by mobile lab, as described in Appendix F, SOP for mobile lab. TPH will be used as an indicator parameter for gross estimation of extent of contamination. This approach expedites the soil assessment by allowing for continuous drilling without waiting for analytical lab results on soil samples to determine the need for further drilling. If no TPH is detected within a soil sample then that sample will be sent off for lab analysis of the media-specific hazardous constituent monitoring list for determination of subsequent drilling needs for delineation of extent of contamination.

This iterative process will continue until horizontal and vertical extent is determined. The horizontal extent of contamination shall be defined as that boundary at which hazardous constituents do not exceed action levels within the soil boring (laboratory confirmed analysis). The vertical extent of contamination shall be defined as that boundary at which hazardous constituents do not exceed action levels within a 10 foot section of soil boring (two samples of laboratory confirmed analysis). Media-specific action levels, per Subpart S guidance or some other acceptable methodology (e.g., EPA Region 3 guidance), for TPH and all hazardous constituents detected during the waste and unit characterization and phase I Ground Water assessment activities will be submitted to HRMB for approval and included as an amendment to the Closure Plan for Roswell Compressor Station Surface Impoundments.

For each soil boring in which TPH is detected or in which hazardous constituents are found at or above action-levels, additional soil borings will be drilled along an orthogonal N-S, E-W grid, outward from the known extent of contamination. A grid spacing of 100 feet between previous and subsequent soil borings will continue until the horizontal and vertical extent of contamination has been delineated. If no samples within a soil boring are found by laboratory analyses to contain hazardous constituents at or above action levels, then additional soil borings will not be drilled outwardly in that grid direction. This methodology will assure delineation of soil contamination at a scale acceptable to the regulators and also serve to minimize the need to remediate excess soil.

Following completion of the soil assessment, as determined by the delineation of the vertical and horizontal extent of soil contamination, TW will submit a Soil Assessment Summary Report. The Soil Assessment Summary Report will include at a minimum:

- all requirements contained within the Waste and Unit Characterization Report
- cross-sections shall be constructed throughout source areas from both N-S and E-W directions using definable stratigraphic units which can be correlated according to:
 - 1) particle size
 - 2) mineral composition
 - 3) and overall texture

Cross-sections should indicate intervals of contamination as observed by field screening and laboratory analyses with the two methods noted. Also dry color descriptions based on Rock-Color Chart as specified by U.S. Geological Society of America and notation of zones of moisture or saturation where drilling method allows should be included.

- Plan contour map(s) showing the concentrations and horizontal extent of contamination for each hazardous constituent of concern identified from laboratory analysis.
- a summary of the nature, rate, and extent of soil contamination at the site

5. GROUND-WATER ASSESSMENT PLAN

~~In parallel~~ Concurrent with the soil assessment plan, a phased approach will be used to assess ground-water ~~impacts~~ contamination resulting from ~~releases from the RCRA-regulated unit,~~ the former impoundments. ~~Phase I will consist of characterization of the target analytes present in ground water both on and off site, and Phase II will define the downgradient extent of a potential off-site ground water contaminant plume. In addition, a deep monitor well will be installed to define the vertical extent of impacts. As described in the soil assessment plan, the detailed scope of work for Phase II activities will be submitted at a later date as an amendment to this closure plan.~~ The objectives of the ground-water assessment plan are as follows:

- Determine if interim stabilization measures (ISM) are required.
- Establish the vertical and lateral extent of contamination within the uppermost aquifer and deeper aquifers which are in hydraulic connection with the uppermost aquifer beneath and around the former surface impoundments.
- Determine the ground-water flow direction, vertical and horizontal hydraulic gradient, and velocity (ies).
- Collect additional ground-water quality data from the uppermost aquifer to determine background (upgradient) conditions not affected by the facility.
- Collect ground-water quality data from the deep bedrock aquifer to establish background conditions and to determine if contamination from the former surface impoundments has occurred.
- Establish aquifer hydraulic parameters for ground-water flow and specific contaminant transport calculations.

The Phase I ground-water assessment will include the following tasks: (1) installation and development of three ~~additional monitor wells and ground water assessment monitoring wells~~ downgradient of the former impoundments, (2) redevelopment of existing monitor wells MW-3, MW-5, and MW-6, (3) sampling of all new and existing monitor wells, and (4) additional water level measurements in the new and existing monitor wells to allow refinement of the ground-water flow direction and gradient. The procedures for the Phase I ground-water assessment are described in Sections 5.1 through 5.7.

~~The current ground-water monitoring network consists of six wells completed within the uppermost aquifer and one well completed within the perched ground water (Figure 3-6). Information collected from the new monitor wells will help to establish ground-water flow direction, background ground-water quality, and to determine the nature, rate, and extent of ground-water contamination in the uppermost aquifer. Deeper monitor wells may be needed to determine the vertical extent of contamination. The installation of deeper monitor wells will follow the same investigative approach as the shallower monitor well installation. Eventually, point of compliance monitoring (POC) wells will be installed to monitor the effectiveness of the ground-water remediation program and to allow the permittee to demonstrate compliance with the specific media cleanup standards to be determined by a risk-assessment following the soil and ground-water assessment.~~

5.1 Phase I Monitor Well Installation

~~Initially, three groundwater assessment~~ monitoring wells will be installed within the uppermost aquifer downgradient of the former impoundments using hollow-stem auger drilling techniques. The proposed locations for the downgradient monitor wells are shown in Figure 5-1.

~~One monitoring well will be located halfway between the facility boundary and the previous soil boring SG-360. Another monitoring well will be located halfway between the facility boundary and boring OS BH-4. The third initial ground-water assessment~~

monitor well shall be located halfway between the facility boundary and boring OS BH-5 (see Figure 5-1).

Prior to well installation, pilot soil borings will be drilled to the total depth at each location with minimum 6-inch-O.D. augers. Soil samples will be collected at 10-foot intervals during the drilling of the pilot hole using the procedures described in Section 4, and field headspace screening will be performed using a PID meter, as described in Section 4. Soil grab samples will also be collected periodically during drilling to better define the geologic conditions at the site. All soil samples will be collected in accordance with DBS&A SOP 13.3.2, Soils Logging, Sampling, Handling, and Shipping for Geotechnical and Chemical Analyses (Appendix F).

The shallow monitor wells will be installed within the hollow-stem augers following the completion of the pilot soil boring. Immediately prior to well construction, the total depth of the borehole will be determined using a clean, weighted steel tape or tag line.

The **initial assessment** monitor wells will be constructed of **2 1/4**-inch-diameter schedule 40 PVC pipe and will include, in ascending order, a 6-inch flush-threaded silt trap (sump) at the bottom, 10 to 25 feet of flush-threaded 0.01-inch machine-slotted PVC screen, and blank casing from the top of the screen to approximately 2 feet above the ground surface. **Additional monitoring wells** ~~If high VOC concentrations are detected, however, up to 10 feet of screen may extend above the water table in the vadose zone, to allow subsequent use of the well for soil vapor extraction.~~

Once the well casing has been lowered to the bottom of the borehole, a sandpack consisting of #20-40 mesh silica sand will be poured down the annulus of the auger in 3-foot lifts. After each 3-foot interval is filled, the augers will be pulled up approximately the same distance. This procedure will be repeated until the sand pack level is approximately 2 feet above the top of the screened section. The annular space above the sand pack will then be filled with a minimum 2-foot-thick pelletized bentonite seal, which will be hydrated with distilled water. The remaining annular space will be filled with a cement/bentonite slurry grout consisting of approximately 3

percent bentonite by weight. The top of the well casing will be protected by a PVC cap, and the exposed casing will be protected by a locking steel shroud. A 6-inch-thick concrete pad will then be constructed around the shroud. Generalized monitor well construction details are shown in Figure 5-2.

Immediately following their well installation, the ~~three new~~ downgradient monitor wells will be checked for the presence of PSH. ~~If any of the groundwater assessment monitoring wells are found to contain PSH, TW may propose to HRMB that the wells be fitted as a product recovery well. This proposal would allow expansion of the interim stabilization measures ongoing at this facility.~~ If any of the ~~three wells~~ are found to contain PSH, ~~one additional monitor well will be installed approximately 100 feet downgradient from that well. This procedure will permit the subsequent conversion of the well with free product to a soil vapor extraction well, while still satisfying the RCRA recommendation for three downgradient monitor wells.~~

5.2 Monitor Well Development Procedures

The newly installed downgradient monitor wells and existing wells MW-3, MW-5, and MW-6 will be developed by a sequence of surging and pumping and/or bailing in accordance with DBS&A SOP 13.4.3, Well Development (Appendix F). Initially, the wells will be surged with a surge block to dislodge any smeared material on the borehole wall that would otherwise inhibit ground-water flow and to remove fine particles from the formation. The suspended sediments will be removed by bailing, pumping, or air lifting. During well development, pH, temperature, specific conductance, and turbidity will be monitored periodically to determine when the wells have been sufficiently developed. Development will be considered complete when the water becomes relatively clear and water quality parameters have stabilized to within ± 5 percent over three consecutive measurements.

5.3 Ground-Water Sampling Procedures

Ground-water samples will be collected on a quarterly basis for the first year and on an annual basis thereafter. This monitoring schedule will be maintained until closure certification has been achieved. Ground-water samples will be collected from existing monitor wells MW-3, MW-5, and MW-6 and from all of the new downgradient monitor wells (Figure 5-1). ~~except those found to contain PSH. Initially, the three assessment monitoring wells and background monitoring wells (MW-3, MW-5, and MW-6) will be sampled for full 40 CFR 264 Appendix IX constituents (excluding pesticides, herbicides, dioxins and furans) plus any additional constituents identified from the waste and unit characterization. The assessment and background monitoring well MW-6 will then be sampled quarterly and analyzed for constituents identified within the hazardous constituent monitoring list developed from the waste and unit characterization. The results of four quarters will be compared for statistical significance by an EPA approved statistical method and compiled into an annual ground-water monitoring report submitted no later than March 1 following each calendar year. Additionally, once a year, a source well, to be specified in the Ground Water Assessment Summary Report, and a background well, MW-6, will be sampled and analyzed for all 40 CFR 264 Appendix IX constituents. Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained (see DBS&A SOP 13.6.1). This will meet intent of the requirements for assessment monitoring under 40 CFR 265 Subpart F.~~

All additional monitor wells installed for the purpose of determining the extent of contamination and the background monitor wells (MW-3, MW-5 and MW-6) will be sampled annually for the ground-water hazardous constituent monitoring list. Initial analysis for all assessment monitoring wells will be determined by the media-specific hazardous constituent monitoring list. The annual sampling results of the additional assessment monitoring wells will be included in the annual ground-water monitoring report. Elevation of the ground-water surface for all monitoring wells will be taken quarterly and the results provided in the annual ground-water monitoring report. The sampling requirements

~~specified above will continue as long as necessary to demonstrate that corrective measures taken comply with the ground-water protection standard, or the NMED Water and Waste Management Director (WWMD) determines that an alternate program shall be conducted. As with the soil assessment plan, the Phase II ground-water assessment cannot be fully scoped until the Phase I results are available. However, the objective of the Phase II ground-water investigation is to define the downgradient extent of impacted groundwater. Thus an iterative approach will be required.~~ All ground-water samples will be collected in accordance with DBS&A SOP 13.5, Water Sampling (Appendix F). Dedicated bladder pumps will be installed in all new and existing monitor wells that do not contain PSH, to allow purging and collection of representative ground-water samples using low flow rates.

Prior to ground-water sample collection, the following preparations will be made:

1. The area around the wellhead will be inspected for integrity, cleanliness, and signs of possible contamination.
2. A clean plastic sheet will be spread over the ground around the wellhead.
3. The cap on the wellhead will be removed and a flame ionization detector (FID) or photoionization detector (PID) will be used to determine if VOC vapors are present. Any obvious odors will be noted in the field logbook.
4. The static water level will be measured to the nearest 0.01 foot using an electrical water level sounder. The presence of any obvious contamination on the water level sounder will be noted in the field logbook. The sounder will be decontaminated between wells, as described in Section 5.6, in order to prevent cross contamination.
5. Prior to purging the wells, a clear bailer or interface probe will be used to check for the presence of PSH. The presence or absence of PSH will be recorded in the field logbook, as well as the thickness of PSH, if any.

6. The well will then be purged to remove standing/stagnant water in order to ensure the collection of representative ground-water samples. Purging will be accomplished using the dedicated bladder pump at a rate equal to or greater than the anticipated sample collection flow rate. The field parameters pH, electric conductivity, dissolved oxygen, and temperature will be measured throughout the purging process at a frequency of at least once per casing volume. These parameters will be measured at the pump outlet within a clean container or a closed flow-through cell. Purging will continue for a minimum of three casing volumes and until the field parameters remain stable to within ± 5 percent over at least one casing volume, except if the well is a very poor producer. In this case, the well will be purged dry once prior to sample collection. All fluids produced during purging will be contained for later disposal as described in Section 5.7.

Following purging, unfiltered ground-water samples will be collected as soon as possible using the dedicated bladder pump. Under no circumstances will the well be allowed to stand for more than three hours after well purging before collecting samples. The only exception is for very low-yield wells that are pumped dry under normal purging and sampling rates. In this case, the well will be pumped dry and allowed to recover until sufficient water is present in the well to allow a sample to be collected.

The samples will be collected in order of decreasing volatility, with samples for VOC analysis being collected first. The pumping rate during sample collection of VOC samples will be maintained at 100 milliliters (mL) per minute or less to minimize volatilization. All samples will be collected in precooled, acidified, certified-clean 40-mL glass vials with septum caps supplied by the laboratory. Following collection of the VOC samples, the SVOC, metals, and other samples will be collected in appropriate containers, as described in greater detail in Section 6.

Sample labeling, packaging, and chain-of custody procedures will be performed as described in Section 6.5. The sample coolers with the associated chain-of-custody forms will be shipped to the laboratory using an overnight commercial carrier. The fastest possible shipping method will

be used, and all sample shipments will be carefully tracked to ensure that samples arrive intact and that all holding times are met.

5.4 Laboratory Analysis of Ground-Water Samples

~~During the first sampling event, ground water samples from each well will be analyzed for RCRA Appendix IX VOCs, SVOCs, PCBs, metals, cyanide, and sulfide.~~ In addition, the major cations and anions (Ca, Mg, Mn, Na, K, Cl, Fe, bicarbonate, nitrate, and sulfate) will be determined, along with total dissolved solids (TDS) and TPH by EPA Method 8015. Chemical analyses will be performed in accordance with procedures set forth in *Test Methods for Evaluating Solid Waste* (U.S. EPA, 1986). Section 6 describes data quality objectives and quality assurance procedures applicable to the ground-water assessment.

5.5 Aquifer Testing

Aquifer slug tests will be performed on existing monitor wells MW-3, MW-5, and MW-6, and on each of the newly installed shallow wells (Figure 5-1). Data collected from the individual slug tests will be used to estimate the hydraulic conductivity of both the uppermost aquifer and deep bedrock aquifer. All slug tests will be performed in accordance with the procedures described in DBS&A SOP 13.6.2, Slug Testing (Appendix F).

Slug tests are performed by causing a sudden change in the water level in the well and then measuring the water level recovery rate. Slug tests will be accomplished by either rapidly removing water from the water column or immersing a solid cylinder (slug) into the water column and measuring the resulting water level recovery. If the slug removal method is used (rising head), water will be removed from the well using a bailer. If the slug immersion method is used (falling head), water will be displaced in the well using a clean, solid PVC cylinder. Whichever method is used, the slug will be of sufficient size to achieve an instantaneous water level change of at least 2 feet.

Water levels will be measured immediately prior to the aquifer test and throughout the recovery period until water levels have recovered to within approximately 95 percent of the static water level. Water levels will be recorded using a downhole pressure transducer and electronic data logger. The transducer will be calibrated prior to the test using standard procedures required by the manufacturer. In addition, periodic manual water level measurements will be made using an electric water level indicator for comparison with the data recorded by the data logger.

Standard aquifer testing equations will be used to estimate the hydraulic conductivity of both the uppermost aquifer and deep bedrock aquifer. Appropriate analytical procedures are presented in *Groundwater and Wells* (Driscoll, 1986) and *Analysis and Evaluation of Pumping Test Data* (Kruseman and de Ridder, 1992).

5.6 Decontamination Procedures

All non-disposable field equipment that may potentially come in contact with contaminated ground water or soils will be decontaminated in accordance with DBS&A SOP 13.5.2, Decontamination of Field Equipment (Appendix F), in order to minimize the potential for cross-contamination between sampling locations. Clean latex or plastic gloves will be worn during all decontamination operations. The following sequence of decontamination procedures will be followed prior to each sampling and/or testing event:

1. Wash the equipment in a solution of non-phosphate detergent (Liquinox[®]) and distilled/deionized water. Use a clean Nalgene[®] tub to contain the wash solution and a scrub brush to mechanically remove loose particles.
2. Rinse the equipment twice with distilled/deionized water.
3. Allow the equipment to air dry before the next use.

All wash water generated during equipment decontamination will be contained in 55-gallon drums for proper disposal. All liquids will be assumed to be contaminated and properly labeled as

described in Section 5.7. Decontamination water will remain on-site pending the results of laboratory analysis of the associated ground-water samples. The laboratory results for the ground-water samples will be used to determine the method of disposal for the drummed wash water, as described in Section 5.7. All drilling equipment will be decontaminated as described in Section 4.5.

5.7 Management of Investigation-Derived Wastes

A variety of wastes will be generated during the implementation of the ground-water assessment plan. These wastes include soil cuttings, decontamination fluids, used PPE, and ground water produced during well development and purging. All wastes, ~~with the exception of PPE, pending analytical determination,~~ will be handled as potentially hazardous wastes.

All waste materials will be drummed and labeled to identify the contents, date of generation, and amount of material generated. Waste material will be stored in 55-gallon drums. All waste containers generated during the ground-water assessment will be stored in a designated drum storage area within the facility.

For those wastes that are associated with a particular sample collected during the ground-water assessment (e.g., soil cuttings collected during the drilling of a well with soil samples collected for chemical analyses at 10-foot intervals, or purged ground water from a well that was subsequently sampled and analyzed), the analytical results will be used to determine if the drummed materials constitute hazardous waste. All contaminated water and water that is potentially contaminated but cannot be associated with a particular sample or set of samples will be passed through an activated carbon filtration system to remove all organic constituents. A sample of the clean filtered water will then be collected for laboratory analysis ~~of VOCs.~~ ~~A verification sample of each potential waste stream that has been filtered will be analyzed by the appropriate analytical method to test for the constituents by which the water was determined to be hazardous. If the water after verification sampling shows concentrations of constituents above any applicable federal, state, and or local~~

~~regulations then the remaining waste will be disposed of according to applicable regulations.~~

Upon verification that the water is clean, it will be released to the ground surface on-site. The carbon filter will be disposed of at a licensed hazardous waste disposal facility such as the Rollins facility in Deer Park, Texas that is currently receiving PSH product from the recovery well system. PPE and dry refuse associated with these materials will be disposed of ~~in a sanitary landfill~~ properly pending analytical results..

5.8 Phase II Ground-Water Assessment

~~As with the soil assessment plan, the Phase II ground-water assessment cannot be fully scoped until the Phase I results are available. However, the objective of the Phase II ground-water investigation is to define the downgradient extent of impacted ground water. Thus an iterative approach will be required.~~ In general, additional downgradient monitor wells will be installed in the alluvium ~~uppermost aquifer to determine the nature, rate, and extent of contamination of the dissolved-phase plume that may exist to the northeast of the former impoundments.~~ Drilling, well installation, and well development procedures will be similar to those described in Section 5.1. The number of monitor wells that will be required to define the downgradient plume remains unknown at this time.

~~If action levels are equalled or exceeded from any new monitor well drilled to assess the horizontal extent of the plume then a subsequent monitor well will be drilled 200 feet further downgradient from the monitor well which exceeded the action-levels. In addition, two monitor wells will be installed 200 feet side-gradient of any well drilled which exceeds set action-levels unless a monitor well already exists in the area to be assessed. This placement of assessment monitor wells will assure adequate delineation of the ground-water plume from a horizontal perspective.~~

If the analytical results from any new ground water assessment monitor well are such that it is suspected that 200 feet will not provide an adequate downgradient distance to determine the extent of the plume horizontally, then TW may propose to increase the distance. This proposal can be verbal and communicated directly to the NMED facility manager to allow flexibility in the ground-water assessment as needed.

In addition to the installation of additional monitor wells in the shallow alluvium uppermost aquifer, initially, one downgradient deep monitor well will be installed into the deeper San Andres bedrock aquifer. The purpose of the deep well is to determine whether the bedrock aquifer has been impacted by the former impoundments. The location of the deep bedrock monitor well will be determined based on the results of the Phase I ground-water assessment. Drilling and well installation procedures will be provided in the closure plan amendment that details the scope of work for Phase II activities Phase I Groundwater Assessment Report (See Figure 7-1).

6. QUALITY ASSURANCE PROJECT PLAN

This section describes the procedures that will be followed to ensure that the data obtained during this investigation will be adequate for the project objectives. The Quality Assurance Project Plan (QAPP) presented herein describes the laboratory analyses to be performed, data quality objectives, and quality assurance/quality control (QA/QC) procedures to be used to ensure that project objectives are met. Sections 6.1 through 6.12 have been prepared in accordance with the *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (U.S. EPA, 1983), and are those elements required for consideration in any QAPP, according to EPA.

6.1 Analytical Parameters and Methods

Based on previous investigations, petroleum hydrocarbons, **polyaromatic hydrocarbons (PAHs)**, and the chlorinated solvent 1,1,1-TCA are recognized as the principal threats to ground water in the study area. However, in order to ensure that other **hazardous** constituents are not present, **initial waste - unit characterization will include hazardous constituents for petroleum refining found in list 4 (Industry Specific Monitoring Constituents) of U.S. EPA, May 1989. RCRA Facility Investigation (RFI) Guidance (Table 6-3).** **For each analytical method, appropriate preparation techniques shall be employed for the various constituents of concern in accordance with SW-846. Analytical methods which encompass the above hazardous constituent list include the following EPA methods: full 8270, full 8080, full 8240, full 6010, 7470 for mercury, and 9010 for cyanide.** ~~Appendix IX analyses~~ A hazardous constituents monitoring list will be specified for soil and ground-water samples collected during ~~Phase I Assessment~~. Accordingly, soil and ground-water samples collected as described in Sections 4.1 and 5.1 of this closure plan will be analyzed for the suite of target analytes listed in Table 6-1.

~~The suite of analytes specified in Table 6-1 includes all of the RCRA Appendix IX constituents except pesticides/herbicides and dioxins/furans, as there is no evidence that these compounds were ever present at this facility.~~ In addition, ground-water samples will be analyzed for major cations and anions and total dissolved solids in order to characterize the overall water quality. Total petroleum hydrocarbons (TPH) will also be determined on both soil and ground-water samples. Analytical methods for all parameters will follow standard RCRA procedures specified in *Test Methods for Evaluating Solid Waste (SW-846)* (EPA, 1986 **Third Edition, Update II**).

6.2 Data Quality Objectives

Data quality objectives (DQOs) are the qualitative and quantitative objectives established to ensure that the data generated meet the needs of the project. Therefore DQOs are project-specific and depend largely on the ultimate use for which the data are intended. DQOs have been established for this project in accordance with EPA guidance documents, particularly *Data Quality Objectives for Remedial Response Activities* (U.S. EPA, 1987a), and *RCRA Ground-Water Monitoring: Draft Technical Guidance* (U.S. EPA, 1992). The parameters used to quantify data quality include precision, accuracy, representativeness, completeness, and comparability (PARCC).

Objectives or goals for the so-called PARCC parameters (U.S. EPA, 1987a) constitute the project-specific DQOs for a particular investigation. Each PARCC parameter is described below, along with the proposed DQO for this closure plan, where applicable. The proposed DQOs for this investigation are summarized in Table 6-1.

- **Precision** is a quantitative measure of the reproducibility (or variability) of the analytical results. Precision will be calculated by determining the relative percent difference (RPD) between the concentrations reported for field duplicate samples collected from the same

location. Methods for collecting duplicate field samples are discussed in Section 5.3. The proposed RPD precision objective is 20 or less.

- **Accuracy** is defined as the degree to which the reported analytical result approaches the "true" value. Accuracy will be estimated through the analysis of matrix spikes (MS). The percent recovery (%R) of the "true" spike concentration will be calculated for each MS. The accuracy objective is within the range of 80 to 120 percent recovery of the matrix spike.
- **Representativeness** refers to how well the analytical data reflect subsurface contaminant concentrations. Due to numerous site-specific factors, such as the degree of heterogeneity in the subsurface, representativeness is difficult to define and even more difficult to quantify. For this project, representative data will be attained through the use of consistent and approved sampling and analytical procedures and through a well defined sampling plan that specifies adequate investigation of all areas of concern.
- **Completeness** is the percentage of samples collected that meet or exceed the DQOs for precision, accuracy, and representativeness, as estimated from the analysis of QA/QC samples described above. The completeness objective for this project is 90%.
- **Comparability** is an assessment of the relative consistency of the data. No quantitative method exists for evaluating comparability; hence, professional judgment must be relied upon. Internal comparability of the soil and ground-water data set will be achieved by the use of consistent sampling and analysis procedures throughout the project. Likewise, by using identical analytical methods to those employed during previous investigations, the data generated during this investigation will be comparable with existing data.

6.3 Quality Assurance/Quality Control Samples

QA/QC samples include matrix spikes/matrix spike duplicates (MS/MSD), field duplicates, trip blanks, and equipment blanks. EPA guidance recommends that QA/QC samples be collected at a minimum 5-percent frequency (U.S. EPA, 1987). For this project, both soil and ground-water QA/QC samples will be analyzed at this frequency.

Equipment blank samples are collected in order to determine if any of the analytes detected in environmental samples may be attributable to improper and/or incomplete decontamination of field sampling equipment. Equipment blanks will be collected in the following manner. After the sampling device has been decontaminated in accordance with DBS&A SOP 13.5.2, Decontamination of Field Equipment (Appendix F), it will be rinsed with deionized water. The rinsate will be collected and sent to the laboratory as an equipment blank.

Field duplicate samples will be collected to provide a measure of precision for the analytical results. VOC soil duplicates will be collected by submitting two adjacent brass liner rings from the same split-barrel sample. The ground-water duplicate samples will be collected by filling sample containers in an alternating manner following the sampling protocol described in Section 5.3 of this closure plan.

One VOC trip blank will accompany each shipment to the laboratory. VOC trip blanks are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or other site-specific conditions. VOC trip blanks will consist of deionized, organic-free water added to a clean 40-mL glass septum vial.

In addition to the above QA/QC samples, MS/MSD analyses will be performed in the laboratory by spiking the soil or water samples with a known quantity of the analyte of interest. MS/MSD analyses are performed to determine laboratory accuracy and precision and to determine if any

matrix interferences exist. MS/MSD analysis will be specified on the chain-of custody form for at least 5 percent of the samples collected.

6.4 Sampling Procedures

The soil and ground-water sampling procedures described in Sections 4 and 5 will be performed in accordance with DBS&A SOPs 13.3.2 and 13.5, respectively (Appendix F). A summary of the analytical methods, required sample volumes, containers, and sample preservation is provided in Table 6-2. All sample containers will be acquired from the laboratory and will be certified clean.

Adhesive labels will be applied to the sample containers, and a waterproof marking pen will be used to complete the labels. Information will include the date and time of sample collection, type of analysis to be performed, preservative used (if any), depth of sample (for soils), and the initials of sampling personnel. The containers will be sealed and placed in clear plastic bags. The sealed containers will be put in coolers on bags of ice or frozen ice packs. Plastic bubble pack or other suitable packing material will be used to prevent breakage.

The field personnel will ship the sample coolers to the laboratory using an overnight courier service. The fastest possible shipping method will be used, and all sample shipments will be carefully tracked to ensure that samples arrive intact and that all holding times are met.

6.5 Chain of Custody Procedures

For analytical data to be valid, samples must be traceable from the time of collection through chemical analysis and final disposition. Chain-of-custody forms have been developed for this purpose. The necessary blank documents will be obtained from the laboratory, including chain-of-custody forms and seals.

Chain-of-custody forms will be completed in triplicate. The original form and one copy will be placed inside each cooler, and one copy will be retained by field personnel. The chain-of-custody forms accompanying each cooler will be sealed in a plastic bag and taped to the inside of the cooler lid. Each cooler will have a clearly visible return address. The cooler lids will be secured with shipping tape that encircles the cooler ends. A chain-of-custody seal will be placed at the front left and rear right sides of the cooler so that opening the lid will break the chain-of-custody seals.

Field activities and sample collection will be documented in a bound logbook dedicated to the project. For each sample, the location, time, monitor well/boring number, sample depth, sample volumes and preservation, and other pertinent field observations will be recorded. Each page of the logbook will be dated, numbered, and signed by those individuals making entries.

6.6 Equipment Calibration Procedures and Frequency

Numerous instruments will be used in the field and the laboratory during this investigation. In order for reliable data to be generated, it is important that these instruments be routinely calibrated. Calibration of analytical instruments within the laboratory will be the responsibility of the contracted laboratory. Although the details of the laboratory calibration procedures are beyond the scope of this QAPP, the frequency of initial and continuing calibrations will adhere to established EPA protocols, as described in the analytical method (U.S. EPA, 1986). In addition, the laboratory's QA manual will be available for review upon request.

During this investigation, DBS&A anticipates using the following field equipment:

- PID (Thermo Environmental 580B or equivalent)
- FID type OVA (Foxboro 108 or equivalent)
- Salinity-conductivity-temperature (SCT) meter (YSI Model 33 or equivalent)
- pH meter (Orion Model 250A or equivalent)
- Dissolved oxygen (DO) meter (YSI Model 57 or equivalent)
- Water level indicator (Solinst or equivalent)
- PSH interface meter (Solinst or equivalent)

Calibration and maintenance procedures for each of these instruments are described in the following paragraphs. Documentation of daily calibration for each of these instruments will be recorded in the field logbook, along with any required maintenance procedures performed.

A PID and/or FID will be used to screen soil samples for volatile organic compounds using the headspace method. The PID or FID will also serve for health and safety monitoring of the work area for organic vapors. Background VOC concentrations will be recorded daily in the logbook. The PID and/or FID will be calibrated daily with standard isobutylene (PID) or standard methane (FID). Recalibration of the PID and/or FID can occur during the work day at the discretion of the site health and safety officer in the event of suspect readings. Care will be taken to ensure that the PID and/or FID remains free of sand and dirt. The battery will be charged on a daily basis.

The SCT meter calibration will be checked initially with a standard potassium chloride solution and mercury thermometer, and a battery check will be performed daily prior to beginning field work. In the event of erratic measurements, the instrument calibration will be checked in the field. When not in use, the electrode will be kept immersed in deionized water to keep the platinum black surfaces fully hydrated, in accordance with manufacturers' instructions.

Prior to use each day, the pH meter will be calibrated using two pH buffers. The buffer solutions will be chosen to bracket the expected ground-water pH range. Calibration of the instrument will be periodically checked throughout the day using the pH buffers to ensure accurate readings.

In the event of instrument drift, the pH meter will be recalibrated. The electrode will be rinsed with deionized water following each measurement and placed in the appropriate potassium chloride storage solution.

The DO meter will be calibrated in air by adjusting the calibration control until the oxygen concentration reads the correct value for the elevation and temperature at the site. The DO meter calibration will be checked periodically during the day and recalibrated if necessary.

The water level indicator will be initially calibrated against a steel tape, prior to commencement of field activities. The battery and electrical connections will be periodically checked to ensure proper functioning of the instrument. The indicator probe and tape will be rinsed clean following each measurement. The PSH interface meter will be calibrated in a similar manner following manufacturer's instructions.

6.7 Data Reduction and Reporting

Data reduction will be performed by the laboratory in accordance with EPA protocols for the respective analytical method. Data from the analytical laboratory will be reviewed following the laboratory's internal QA/QC plan. All EPA required elements will be provided with the data package. If the analytical data do not meet the minimum data quality objectives, the laboratory will implement the corrective actions described in Section 6.10. All data falling outside the quality control limits defined in this QAPP will be flagged by the laboratory, as required by EPA protocol. Any discrepancies noted in the laboratory QA review will be noted in the case summaries included with the data packages.

Following the field investigation phase of the project, the degree to which the data quality objectives have been met will be examined by comparing the actual results for the QA/QC samples with the objectives listed in Table 6-1. The results of this comparison will be tabulated

in the final report, along with detailed descriptions of any deviations from the protocols proposed in this closure plan.

6.8 Internal Quality Control Checks

The specific quality control checks to be used are included with the individual analytical methods specified for each parameter. The quality control criteria for VOCs and TPH (gasoline) are described in *Test Methods for Evaluating Solid Wastes - SW-846*, (U.S. EPA, 1986).

6.9 Performance and System Audits

Performance and system audits are the practices followed by analytical laboratories to evaluate quality control procedures and laboratory performance (U.S. EPA, 1983). System audits are performed in order to assess whether a new analytical system is functioning properly. Performance audits rate the ongoing performance of the laboratory in terms of the accuracy and precision of the analytical data generated. Examples of performance audits include the analysis of performance evaluation samples, such as standard reference materials obtained from the National Institute of Standards and Technology or EPA, or participation in interlaboratory performance evaluation studies using "round-robin" samples. Each participating laboratory is graded and ranked based on the results. The performance and system audits of the laboratory contracted for this closure plan will be provided and available for review.

6.10 Corrective Actions

If QA activities reveal apparent problems or deficiencies with the analytical data, corrective actions must be applied. The type of corrective action depends on the specific problem that occurs, but a general sequence of corrective actions will be followed. If the data do not fall within the prescribed data quality objectives, the affected samples will be re-analyzed by the

laboratory until the objectives are met. Any data falling outside QC limits will be flagged and qualified to explain the nature of the data quality problem.

6.11 Routine Data Assessment Procedures

Routine procedures to assess the precision, accuracy, and completeness of the analyses include RPD for field duplicates and MS/MSD samples, as well as percent recovery (%R) for MS samples. The specific statistical techniques to be used are described with the appropriate analytical method (U.S. EPA, 1986). Any problems or deficiencies will be reported to the NMED in the quarterly progress reports, or by telephone, if warranted by the nature and urgency of the problem.

6.12 Quality Assurance Reports to Management

Periodic assessment of data accuracy, precision, and completeness will be performed by the QA manager of the contracted laboratory. The results of these assessments, as well as the results of laboratory performance and system audits, will be available upon request. The laboratory QA manager will also review the case narratives and accompanying analytical data package to ensure that all data quality objectives are met. In the event that objectives are not met, the QA manager will consult with the laboratory manager to correct the problem.

7. PROJECT SCHEDULE AND CONDITIONS FOR CLOSURE CERTIFICATION

~~The proposed Phase I project schedule will require about 4 months to complete (Figure 7-1). Quarterly progress reports will be prepared for submittal to NMED from the time field work begins until closure certification is achieved. The progress reports will provide a means of tracking the schedule for investigative and corrective action activities and explain the need for any modifications to the proposed project schedule. At the completion of each drilling phase, an assessment Phase Report will be drafted. The Phase Assessment Reports will provide results from the current phase of assessment drilling and include additional sampling and analysis plans for the subsequent assessment phase. These Phase Reports must be approved by HRMB before work on the next phase is to proceed as outlined in Figure 7-1.~~

~~The soil assessment plan (Section 4) and ground water assessment plan (Section 5) will be initiated approximately six weeks following approval of this closure plan. The drilling and monitor well installation program is expected to require approximately two weeks to complete. Monitor well development, ground water sampling, and aquifer testing will require an additional week.~~

~~(Preparation of a report summarizing Phase I activities will require 6 weeks following receipt of the laboratory data. A meeting between Transwestern and NMED is proposed to discuss the results of Phase I and to determine the scope of work for the upcoming Phase II activities to be submitted as a closure plan amendment. All remaining closure activities will be addressed in subsequent phases following completion of the Phase I report. These include establishing cleanup criteria, developing soil and ground water corrective action plans, and establishing the schedule for corrective action activities and closure certification. Each of these tasks will be included in subsequent closure plan amendments submitted for NMED approval.~~

A Soil and Ground Water Assessment Summary Report will be submitted to HRMB pending final determination of the nature, rate, and extent of contamination. The assessment of extent of contamination will be determined by HRMB as presented in the Assessment Phase Reports.

Following approval of both the Soil and Ground-Water Assessment Summary Reports a corrective measures proposal (CMP) to address a corrective measures study (CMS) listing all approaches to remediation which will be considered for the site should be submitted to HRMB for approval. A framework of a risk-assessment to be conducted to determine media cleanup standards should be included within the CMP. This proposal should be written in conjunction with the results from the Soil and Ground Water Assessment Reports. The CMP should include at a minimum:

1) What the residual concentration of each constituent after treatment will be using this technology?

2) At what rate can the cited level of cleanup be attained?

Either 1) cite two case studies using this technology where the proposed level of cleanup was achieved or 2) in lieu of case citations for cleanup, TW, may propose bench-scale tests of the proposed technologies as a basis for determining what cleanup levels and rates of cleanup will be achievable.

3) The framework for risk-assessment should contain sections on: 1) Data Evaluation, 2) Contaminants of Concern, 3) Exposure assessment, Toxicity Assessment, 4) Development of Target Remediation Goals, and 5) Risk Characterization. The approach should be based on EPA guidance following the methodology outlined in the Risk-assessment Guidance for Superfund (RAGS) manuals (EPA, 1991).

FIGURE 7-1

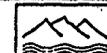
ROSWELL COMPRESSOR STATION

Proposed Schedule for Closure Activities

TASK	Weeks Following NMED approval of closure plan																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Waste Characterization Soil Sampling	[Gantt bar from week 1 to 10]																							
Laboratory Analysis of Soil Samples	[Gantt bar from week 1 to 10]																							
Waste Characterization Report Preparation	[Gantt bar from week 1 to 10]																							
Develop Hazardous Constituent Monitoring List	[Gantt bar from week 1 to 10]																							
Waste Characterization Report Submitted to NMED	[Gantt bar from week 1 to 10]																							
PSH Product Recovery	[Gantt bar from week 1 to 10]																							
Implement Soil Assessment Phases	[Gantt bar from week 1 to 10]																							
Implement Ground Water Assessment Phases	[Gantt bar from week 1 to 10]																							
Laboratory Analysis of Soil and Ground Water Samples	[Gantt bar from week 1 to 10]																							
Phase Assessment Reports Submitted to NMED	[Gantt bar from week 1 to 10]																							
Soil and Ground Water Assessment Summary Report Preparation	[Gantt bar from week 1 to 10]																							
Soil Assessment Summary & Post-Closure Plan Submitted to NMED	[Gantt bar from week 1 to 10]																							
Ground Water Assessment Summary Report Submitted to NMED	[Gantt bar from week 1 to 10]																							
Risk Assessment Preparation	[Gantt bar from week 1 to 10]																							
Corrective Measures Proposal Preparation	[Gantt bar from week 1 to 10]																							
Risk Assessment and Corrective Measures Proposal Submitted to NMED	[Gantt bar from week 1 to 10]																							
Implement Phase I Corrective Action (bench study)	[Gantt bar from week 1 to 10]																							
Phase I Corrective Action Report Preparation	[Gantt bar from week 1 to 10]																							
Phase I Corrective Action Report Submitted to NMED	[Gantt bar from week 1 to 10]																							
Implement Phase II Corrective Action	[Gantt bar from week 1 to 10]																							
Semi-annual Summaries Submitted to NMED	[Gantt bar from week 1 to 10]																							
Perform Confirmation Sampling	[Gantt bar from week 1 to 10]																							
Laboratory Analysis of Confirmation Samples	[Gantt bar from week 1 to 10]																							
Corrective Action Summary Report Preparation	[Gantt bar from week 1 to 10]																							
Corrective Action Summary Report Submitted to NMED	[Gantt bar from week 1 to 10]																							

Figure 7-1

Notes: Project 4115



Closure Performance Standard

Transwestern Pipeline Company must close the surface impoundments in accordance with this plan and in a manner that controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste and hazardous constituents from the already impacted uppermost aquifer to the regional aquifer. [20 NMAC 4.1, Subpart VI, 40 CFR §265.111(b)].

Post-Closure Care

In the event that clean-closure of the surface impoundments is not achieved, in addition to the requirements of 40 CFR §§265.111-115, Transwestern Pipeline Company must maintain and monitor the groundwater monitoring system and comply with all applicable groundwater monitoring and reporting requirements of 20 NMAC 4.1, Subpart VI, §265, Subpart F. Transwestern Pipeline Company must also submit a Post-Closure Plan (PCP) along with the Soil summary report at the beginning of the fifth week following phase Assessment Completion (See Figure 7-1). The PCP shall be submitted when it has been established that Transwestern Pipeline Company cannot demonstrate clean closure. Once HRMB has approved the Corrective Action Summary Report and the PCP, Transwestern Pipeline Company shall continue post-closure care of the former surface impoundments for 30 years after closure. At any time during the post-closure period, the Secretary of the New Mexico Environment Department may shorten the post-closure care period, if he/she finds that the reduced period is sufficient to protect human health and the environment (e.g., groundwater monitoring results indicate that the former surface impoundments are secure). The Secretary of NMED may also extend the post-closure care period, if he/she finds that the extended period is necessary to protect human health and the environment (e.g., groundwater monitoring results indicate a potential for migration of hazardous constituents at levels which may be harmful to human health and the environment. [20 NMAC 4.1, Subpart VI, 40 CFR §265.117(a)(2)].

9. REFERENCES

- Bean, Robert T. 1949. Geology of the Roswell artesian basin, New Mexico, and its relation to the Hondo Reservoir. New Mexico State Engineer Technical Report No. 9, 31 p.
- Brown & Root Environmental. 1993. Draft report: Groundwater assessment at Roswell Compressor Station No. 9, Transwestern Pipeline Company, Roswell, New Mexico, Project No. 5T72. Prepared for Enron Corporation, Houston, Texas, June 1993.
- Campbell, Larry. 1992. Letter from Mr. Campbell (Transwestern) to Mr. Ed Horst (NMED) regarding remediation investigation and closure of the disposal pit, dated November 30, 1992.
- Campbell, Larry, 1993. Letter from Mr. Campbell (Transwestern) to Ms. Barbara Hoditschek (NMED) regarding history of operation of 20 x 20 foot surface impoundment, dated February 7, 1993.
- Campbell, Larry, 1994. Personal communication between Larry Campbell (Transwestern) and Jeffrey Forbes (DBS&A) regarding locations of former surface impoundments, May 13, 1994.
- Cypress Engineering Services (CES). 1994. Letter report from George Robinson (CES) to Bill Kendrick (ENRON).
- Daniel B. Stephens & Associates, Inc. 1992. Task 1 summary report, data acquisition and review, Roswell Basin. Prepared for New Mexico State Engineer Office, December 1, 1992.
- Driscoll, F.G. 1986. Groundwater and Wells, Second Edition. Johnson Filtration Systems, Inc., St. Paul, MN. 1089 p.
- Eiceman, G.A. 1986. Hazardous organic wastes from natural gas production, processing, and distribution: Environmental fates. New Mexico Water Resources Research Institute Report No. 227.

- State of New Mexico Environmental Improvement Board. 1989. Underground Storage Tank Regulations, Part XII - Corrective Actions For Petroleum UST Systems, Appendix D - Monitoring Well Construction and Abandonment Policy, EIB/USTR-12.
- Transwestern Pipeline Company. 1959. General plan, Station No. 9, Roswell, Scale 1"=100' 1:1200. Drawing No. 9-85-000, May 19, 1959.
- U.S. Environmental Protection Agency (U.S. EPA). 1983. Interim guidelines and specifications for preparing quality assurance project plans. QAMS-005/80, December 1983.
- U.S. EPA. 1986. Test methods for evaluating solid waste, physical and chemical properties, 3rd ed. EPA-SW-846, November 1986.
- U.S. EPA. 1987a. Data quality objectives for remedial response activities. EPA/540/G-87/003 (OSWER Directive 9355.0-7B), March 1987.
- U.S. EPA. 1987b. Alternate concentrations limit guidance, Part 1, ACL Policy and Info Requirements. Interim Final, July 1987. EPA/530-SW-87-017, OSWER Directive 9481.
- U.S. EPA. 1988. Contract laboratory program statement of work for organics analysis. February 1988 SOW.
- U.S. EPA. 1992. RCRA ground-water monitoring: Draft technical guidance. EPA/530-R-93-001, November 1992.
- U.S. EPA. 1991. National functional guidelines for organic data review (draft), Contract Laboratory Program, December 1990, revised June 1991.
- Welder, G.E. 1983. Geohydrologic framework of the Roswell ground-water basin, Chaves and Eddy Counties, New Mexico. New Mexico State Engineer Technical Report 42.