GW - 52

WORK PLANS

2002

CONCEPTUAL REMEDIAL DESIGN
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

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ENVIRONMENTAL BUREAU
OIL CONSERVATION DIVISION

August 30, 2002

Prepared for

Transwestern Pipeline Company
6381 North Main Street
Roswell, New Mexico 88201

Prepared by

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6121 Indian School Road, NE, Ste. 205
Albuquerque, New Mexico 87110

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

On behalf of Transwestern Pipeline Company, Tetra Tech EM Inc. (Tetra Tech) has prepared this conceptual remedial design to address soil and groundwater contamination at Transwestern Pipeline Company's Roswell Compressor Station Number 9 (Roswell Station). The Roswell Station is located approximately 9 miles north of the City of Roswell along U.S. Highway 285 (Drawing G-1). A site plan is also provided on Drawing G-1.

This discharge permit modification has been prepared to satisfy the requirements stated in the New Mexico Water Quality Control Commission (NMWQCC) Regulations, specifically New Mexico Administrative Code (NMAC), Title 20, Chapter 6, Part 2 (20 NMAC 6.2) Section 3000. This modification has been designed to address soil contamination, phase-separated hydrocarbon (PSH) contamination, and groundwater contamination. The proposed remedy includes both active and passive phases of remediation.

The active phase of remediation consists of multi-phase extraction (MPE), a combination of soil vapor extraction (SVE) and total fluids (groundwater and PSH) recovery. The goals of the MPE phase are (1) removal of PSH from the subsurface and (2) reduction of soil and groundwater constituents to levels more amenable to passive bioremediation.

The passive phase of remediation will consist of monitored natural attenuation (MNA) to address residual soil and groundwater contamination. The goal of the MNA phase will be to reduce soil contamination so that leachate in the vadose zone shall not be capable of contaminating groundwater or surface water (§4103.A) and groundwater constituent concentrations shall conform to §4103.B standards (or §4103.F. alternative abatement standards, if warranted).

The remedial design for the Roswell Station will consist of two volumes – a conceptual remedial design (RD) and a final RD. This document constitutes Volume 1, the Conceptual RD, and contains sufficient detail to allow review and comment on the proposed remedy. Upon concurrence with the Conceptual RD from Transwestern Pipeline Company and the New Mexico Oil Conservation Division (OCD), Volume 2, the Final RD will be prepared. The final RD will include supporting calculations and analysis, plans and specifications for implementation of the MPE system, as well as a plan for operation, maintenance, and performance assessment.

This Conceptual RD is divided into 5 Sections, of which this introduction is Section 1. A brief discussion of site hydrogeology is provided in Section 2. A discussion of the distribution of constituents of concern and cleanup goals is provided in Section 3. Section 4 provides a discussion of and justification for the recommended approach to remediation. Finally, Section 5 provides a detailed description of the technology proposed, the system layout, and the basis for design. Appendix A contains Drawings for the proposed system and Appendix B a copy of the SVE pilot test report (AcuVac 1996).

2. SITE HYDROGEOLOGY

The site lies within the northernmost portion of the Roswell hydrologic basin. The stratigraphic units of importance with regard to water resources are, in ascending order, the San Andres Formation (Permian age), the Artesia Group (Permian age), and the Quaternary-age alluvium. Groundwater is produced from both a shallow water-table aquifer (alluvium) and a deeper artesian aquifer (San Andres Limestone). In general, the Artesia Group is considered a confining bed that limits the exchange of water between alluvium and the San Andres Limestone.

Near the site, the Artesia Group is often thin or absent, and the clay beds within the valley fill act as the confining bed for the lower carbonate aquifer. The valley fill consists of poorly to moderately consolidated deposits of gravel, sand, and clay that 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. Silt and clay deposits frequently occur as lenses that were deposited in small ponds and lakes resulting from the dissolution and collapse of the underlying carbonate rocks.

A hydrogeologic cross section developed from lithologic descriptions is provided as Drawing G-2; the location of the cross section is shown on Drawing G-3. The alluvial sediments beneath the impoundments consist of discontinuous interbedded cobbles, gravel, sand, silt, and clay to depths of approximately 70 feet bgs, where at the base of the alluvium is marked by abundant gypsum beds.

The depth to water across the site ranges from approximately 50 to 65 feet bgs. An evaluation of groundwater flow under the surface impoundments is not straightforward; however, flow components can be discerned that support the contaminant distribution to the southeast and north, with a groundwater divide in the vicinity of Pit 2. Shallow groundwater is likely flowing primarily through discontinuous sand lenses within the predominantly clay matrix.

3. DISTRIBUTION OF CONTAMINANTS AND CLEANUP GOALS

The subsurface extent of impacted groundwater and PSH is depicted on Drawing G-3 in plan view and on Drawing G-2 in cross-sectional view. As shown on Drawing G-3, the impacted zone is long and narrow, roughly 1,200 feet long by 200 feet wide encompassing an area of about 240,000 square feet (approximately 6 acres). In a vertical sense, the impacted soil zone extends from near surface to below the water table near the former surface impounds. Away from these source areas, contamination occurs in a much thinner zone of relatively permeable sediments encountered near the water table – here, the thickness of impacted soil is only about 10 to 15 feet thick.

Based on recent monitoring data (Cypress Engineering 2001), the distribution of PSH is defined by MW-2 to the northwest and MW-27 to the southeast. The estimated area of PSH is about 100,000 to 120,000 square feet (approximately 3 acres), and lies entirely within the area of impacted groundwater. Where measured undisturbed, PSH is typically several feet thick. In wells where PSH recovery has been ongoing (e.g., MW-5, MW-10, and MW-11), PSH accumulations were not measurable.

Based on SVE performance testing conducted in 1996 (AcuVac 1996), soil vapor concentrations (total volatile organic compounds [VOCs]) ranged from a low of 826 parts per million by volume (ppm_v) at well SVE-2 to a high of 15,590 ppmv at well SVE-3. The high reading recorded at MW-1 was 7,510 ppm_v. Carbon dioxide (CO_2) averaged about 10 percent during the performance tests, indicating that in situ bioremediation is ongoing.

Groundwater cleanup goals for the site are based on NMWQCC human health based standards stated in 20 NMAC 6.2 §3103.A. For the organic constituents of concern being addressed by this plan, these standards are as follows:

• Benzene	10 µg/L
• 1,1-Dichloroethene (1,1-DCE)	5 µg/L

No other organic compounds exceed NMWQCC standards. In addition to restoring groundwater to the above referenced standards, a primary goal of the remedial action is to remove PSH from the water table and capillary fringe. PSH provides a continual threat to groundwater quality with respect to organic compounds.

It is not the intent to restore groundwater to either the benzene or the 1,1-DCE standard by active remediation (e.g., MPE system operation) alone. At such time as PSH is fully removed from the water table, active remediation may be suspended. The target concentrations for benzene and 1,1-DCE at suspension of active remediation will be in the range of 10 times standards (EPA 1995) as the MNA phase of remediation commences. For benzene and 1,1-DCE, these target concentrations are about 100 and 50 μg/L, respectively. Since the high benzene and 1,1-DCE concentrations in November 2000 sampling event were 1,430 and 95 μg/L, respectively, contaminant reduction factors (CRFs) of about 14 for benzene and 2 for 1,1-DCE will be required during the active remediation phase.

Inorganic constituents exceeding standards include total dissolved solids (TDS), chloride, sulfate, iron, and manganese. These constituents are widespread and fairly uniform in concentration, indicating that elevated inorganic concentrations may be representative of natural conditions. High concentrations of TDS and general anions and cations are not atypical of shallow groundwater within the region.

Soil impacts will be cleaned up to OCD guidelines for TPH, benzene, and total benzene, toluene, ethyl benzene, and xylenes (BTEX). These standards are 10 mg/kg for benzene, 50 mg/kg for total BTEX, and 100 mg/kg for TPH (OCD 1993). If soil contaminant concentrations remain above OCD cleanup guidelines, Transwestern will likely complete a risk assessment to determine whether final contaminant concentrations pose a threat to workers and underlying groundwater quality.

4. PROPOSED REMEDY

The proposed remedy for soil and groundwater contamination is MPE, a combination of SVE and total fluids (groundwater and PSH) pumping. Dedicated MPE wells will be used to extract contaminated vapors and fluids; the layout of the MPE well field is shown on Drawing C-1.

SVE is a proven technology for remedy of moderate to high permeability soils contaminated by high-vapor-pressure compounds such as those that comprise gasoline (EPA 1995). High vacuum MPE extends the effectiveness of SVE into the range of lower permeability soils (EPA 1999; EPA 1995). MPE has been demonstrated to remove large fractions of volatile PSH plumes by vapor means. In addition to the effective removal of PSH and volatile organic compound rich vapors, MPE stimulates and promotes in situ aerobic degradation of fuel hydrocarbons by indigenous bacteria as a result of increased subsurface oxygen levels.

With MPE, PSH can also be physically removed by total fluids recovery. Total fluids recovery results in dewatering in the zone of remediation, which in turn exposes the capillary fringe and upper portion of the contaminated aquifer matrix to the effects of SVE. Total fluids recovery also counters the rise in the water table that results from inducing high vacuum in the subsurface. Thus, MPE employs several remedial technologies in concert to effect cleanup in the most highly contaminated portion of PSH plumes – the smear zone, capillary fringe, and first few feet of aquifer matrix. Moreover, from a cost perspective, where conditions are amenable, MPE and the concomitant enhanced in situ bioremediation that occurs results in perhaps the most cost-effective cleanup technology available for remedy of volatile fuel hydrocarbons (USACE 1995, Hinchee 1994).

5. DESCRIPTION OF REMEDY

The remedy proposed at the Roswell Station consists of a two-phase approach: a period of aggressive, active remediation employing MPE followed by passive, MNA to restore residual groundwater contamination to standards. The following subsections discuss each phase in detail.

5.1 Multi-Phase Extraction Phase

The proposed MPE system layout is depicted on Drawings C-1 through C-3. Drawing C-1 shows the well locations and the effect of a 50-foot radius of influence (ROI) for each well. The ROI was obtained from the SVE performance test (AcuVac 1996). Drawing C-2 depicts the proposed trenching plan, and Drawing C-3 the equipment compound layout. A process flow diagram is provided as Drawing P-1.

The SVE pilot test (AcuVac 1996) indicated that soil vapor concentrations are moderately high, and emission control is required for extracted vapors. Extraction of soil vapors and emission control will be provided through the use of two thermal oxidizers. These oxidizers are owned and permitted (mobile permits) by Transwestern Pipeline Company.

Each of the 37 wells depicted on Drawing C-1 has a design flow rate of 20 cubic feet per minute (cfm). Shallow SVE wells will be co-located with MPE wells near the former pits to address residual soil contamination within the source area. The entire MPE and SVE well system will be designed to operate at maximum well output equal to 320 cfm (the maximum flow rate of the two oxidizers). Since well output will certainly vary as a result of subsurface heterogeneities in permeability and variable lengths of screens installed in each well, the exact system output will not be known until system startup testing. However, the system design accommodates variability by use of dedicated conveyance lines, valves, and manifolds to allow manipulation of SVE stresses.

Total fluids will pumped from the MPE wells with pneumatic pumps placed at the bottom of the MPE wells. The pneumatic pumps will be driven by a high pressure, high volume screw drive air compressor. The pumps will discharge upon filling, thereby keeping the well bore evacuated of water and PSH. The pumps will be driven by dedicated airlines and recovered fluids conveyed by dedicated discharge lines. The total fluids will be routed through an oil/water separator (O/WS) where PSH will be removed from the waste stream. PSH will be collected and recycled off site. Groundwater will be treated by liquid-phase granular activated carbon (GAC) or an air stripper and disposed by ground application over the zone of remediation.

The proposed system features include the following:

- Piping shall be high-density polyethylene (HDPE) in dedicated conveyance runs to allow complete system control. Piping will be covered with pea gravel and magnetic locating tape will be installed.
- All trenches within the existing plant boundary (e.g., within trafficked areas) will be compacted to 95% standard proctor to prevent trench failure. Trenches outside the plant in non-trafficked areas will be compacted by wheel rolling and will not require density testing.
- All well vaults will be traffic rated, 24-inch diameter, and set in minimum 8-inch thick 3,000 psi concrete.
- The compound will consist of a 50-foot by 50-foot open area and will include a 24-foot by 32-foot building to house remediation equipment and conveyance manifolds.
- A dedicated explosion-proof room will be constructed to house a total fluids retention tank and the O/W S.

- All conveyance lines will be valved and metered in the equipment building
- Two thermal oxidizers, specified as Baker Furnace 200-cfm units with high vacuum positive displacement pumps will provide SVE and emission control.
- Implementation includes a 5-day start-up phase to verify system mechanical performance.

The MPE system will be operated until PSH has been removed from the subsurface and groundwater concentrations of benzene and 1,1-DCE have been reduced to levels that are amenable to MNA. At that time, the MPE phase will be terminated and the MNA phase will commence.

5.2 Monitored Natural Attenuation Phase

Three lines of evidence (primary, secondary, and optional) are generally recommended to demonstrate the viability of MNA as an appropriate remedy (ASTM 1998). These lines of evidence include the following:

- Demonstration that the groundwater plume is stable or shrinking in areal extent (primary line of evidence)

- Groundwater monitoring data that indicate attenuation rates that will achieve remediation goals in a timely manner and geochemical indicators (secondary line of evidence)

- Demonstration or evidence that the microbiological mechanism exists in the subsurface to facilitate degradation of contaminants, estimation of the assimilative capacity of the aquifer to degrade COCs, and fate and transport modeling to evaluate natural attenuation rates (optional lines of evidence)

With regard to the primary line of evidence, data do not presently exist that indicate that the plume is stable or shrinking. It will not be until after the removal of PSH that hard evidence supporting the primary line of evidence can be established. The first year of monitoring following PSH removal will be critical in verifying the appropriateness of MNA as the remedy. Nonetheless, concentrations of benzene and 1,1-DCE in monitor wells that do not contain PSH and have been sampled sufficiently to establish trends indicate that concentrations are stable to declining in most wells.

The second line of evidence, attenuation rates, will be estimated from groundwater monitoring data obtained during the first year after PSH removal. Groundwater samples will be analyzed for dissolved oxygen (DO), oxidation-reduction potential (ORP), and alternative electron receptors in order to evaluate bioremediation mechanisms.

Finally, the third line of evidence will be substantiated during the MPE phase. Field evidence will be collected to verify if microbes are present and if biodegradation of constituents of concern is occurring. These include observation of biodegradation in soil samples collected during MPE well field installation and production of carbon dioxide (CO_2) in soil vapors indicating aerobic mineralization of organic compounds to water and CO_2 by microbes.

Groundwater Monitoring Regimen

The focus of groundwater monitoring will be supporting the MNA remedy. COCs to be monitored include BTEX, chlorinated ethenes and ethanes, and inorganic constituents. Geochemical indicators (second line of evidence) to be monitored include ferrous iron, nitrate, sulfate, manganese, DO, and ORP. A summary of MNA indicators is provided in Table 1. The final RD will contain a schedule for groundwater monitoring and performance assessment.

6. REFERENCES

AcuVac Remediation. 1996. Pilot Test: Roswell Compressor Station, Roswell, New Mexico. Letter Report to Mr. Bob Marley, Daniel B. Stephens & Associates. September 30.

American Society for Testing and Materials (ASTM). 1998. "Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites." ASTM E 1943-98. August.

Cypress Engineering. 2001. Annual Report of Groundwater Remediation Activities Compressor Station No. 9 – Roswell, New Mexico, Transwestern Pipeline Company. February 20.

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Hinchee,Robert E. 1994. Bioventing Petroleum Hydrocarbons *in* Handbook of Bioremediation, Robert D. Norris, Editor. Lewis Publishers. Pp. 39-59.

New Mexico Oil Conservation Division. 1993. Unlined surface impoundment closure guidelines (February 1993). Tab 7b. In Environmental Regulations, State of New Mexico Energy, Minerals, and March 13.

United States Army Corps of Engineers. 1995. Soil Vapor Extraction and Bioventing. Engineer Manual 1110-1-4001. November 30.

TABLE

MONITORED NATURAL ATTENUATION GEOCHEMICAL PARAMETERS

TABLE 1
MONITORED NATURAL ATTENUATION GEOCHEMICAL PARAMETERS
ROSWELL COMPRESSOR STATION NUMBER 9, ROSWELL, NEW MEXICO

Geochemical Parameter	Method of Measurement	Field Procedure	Use of Data
pH	ASTM D 1293	Direct in-well measurement at 1.5 to 2.0 feet below water table with Horiba U-22 Water Quality Meter	Difference in pH between contaminated and uncontaminated groundwater may indicate ongoing biological activity.
Temperature	Down Hole Probe	Direct in-well measurement at 1.5 to 2.0 feet below water table with Horiba U-22 Water Quality Meter	Oxygen solubility is dependent on groundwater temperature. Biodegradation rates may depend on temperature. An increase in temperature may be observed within the solute plume.
Dissolved Oxygen (DO)	Down Hole Probe	Direct in-well measurement at 1.5 to 2.0 feet below water table with Horiba U-22 Water Quality Meter	An inverse correlation of DO to benzene, toluene, ethyl-benzene, and xylene concentrations indicates that aerobic degradation is occurring. This relationship may also be expressed as depressed or nondetectable DO throughout the plume.
Ferrous Iron	ASTM 3500 Fe	Field filtered 125-mL aliquot in polyethylene bottle; pH to <2.5 with hydrochloric acid.	Increased ferrous iron may indicate ferric iron is being used as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons.
Total Dissolved Iron	EPA 6010/6020 ICP/MS	Field filtered 125-mL aliquot in polyethylene bottle; pH to <2.5 with nitric acid.	Increased dissolved total iron may indicate that ferric iron is being used as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons.
Oxidation Reduction Potential (ORP)	ASTM D 1498	Direct in-well measurement at 1.5 to 2.0 feet below water table with Horiba U-22 Water Quality Meter	Data used to define regions of the plume under oxidizing and reducing conditions, and to evaluate potential for and type of biologically mediated reduction-oxidation reactions.
Nitrate	EPA 300.0	Field filtered unpreserved 125-mL aliquot in polyethylene bottle; backup 125-mL aliquot in polyethylene bottle with pH to <2.5 with sulfuric acid	Decreased nitrate in anaerobic portion of plume may indicate use of nitrate as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons.
Sulfate	EPA 300.0	Unfiltered 125-mL aliquot in polyethylene bottle; pH to <2.5 with sulfuric acid	Decreased sulfate in anaerobic portion of plume may indicate use of sulfate as an electron acceptor during anaerobic biodegradation of petroleum hydrocarbons
Manganese	EPA 6010/6020 ICP/MS	Field filtered 125-mL aliquot in polyethylene bottle; pH to <2.5 with nitric acid.	Increased manganese may indicate manganese IV is being used as a terminal electron acceptor during anaerobic biodegradation of petroleum hydrocarbons.

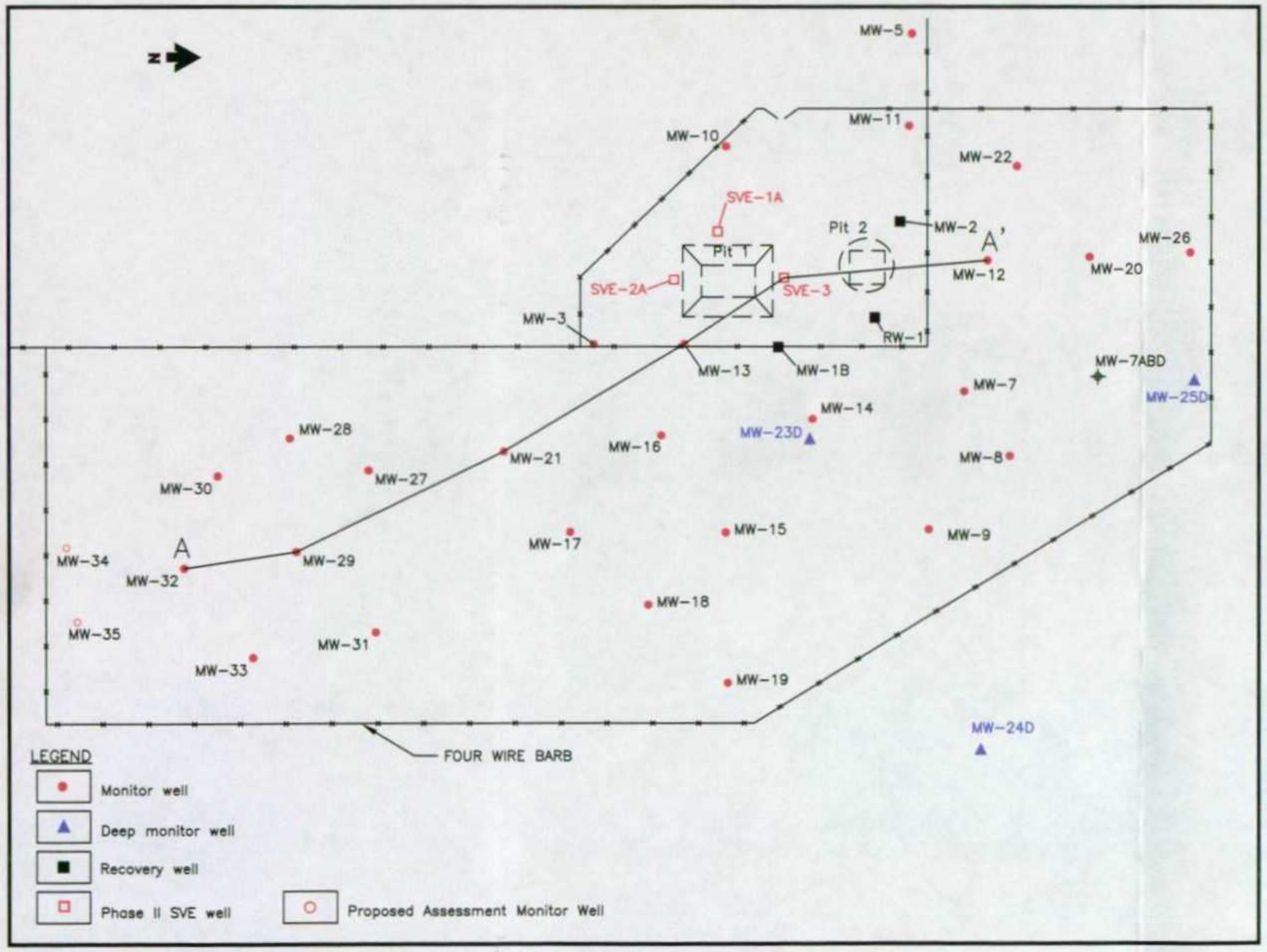
APPENDICES

APPENDIX A

DRAWINGS

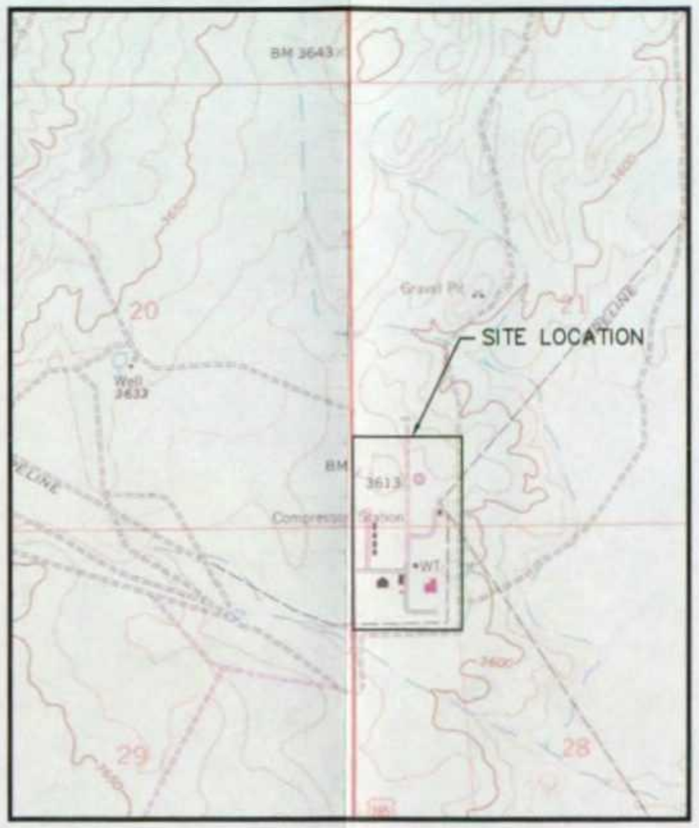
INDEX OF DRAWINGS

Dwg	Description
	Cover Sheet
G-1	Index of Drawings, Vicinity Map, Site Location Map, and Site Layout Map
G-2	Geologic Cross Section
G-3	Areal Extent of Impacted Groundwater
C-1	Multi-Phase Extraction Well Field Layout
C-2	Trenching/Conveyance Piping Plan
C-3	Equipment Compound Layout
C-4	Building Details
C-5	Manifold Details
P-1	Process Flow Diagram



SITE LAYOUT MAP

SCALE 1"=100'



SITE LOCATION MAP

SCALE 1"=2000'

VICINITY MAP

NOT TO SCALE

REVISIONS

Tetra Tech EM Inc.

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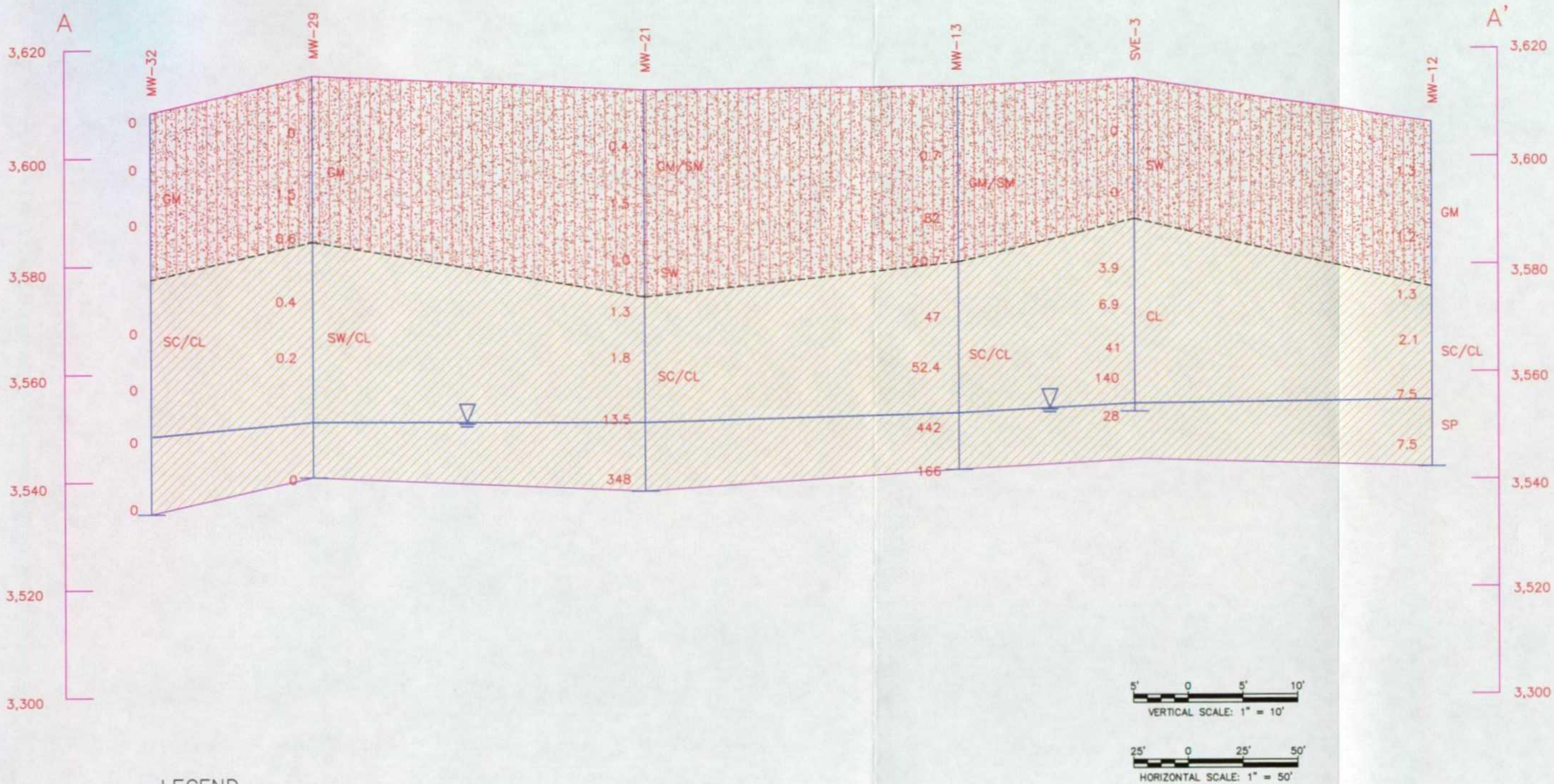
DRAWN BY: RM
CHECKED BY: BM
RE-CHECKED BY:
APPROVED BY:
DATE:

ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

Index of Drawings, Vicinity Map, Site Location Map, and Site Layout Map

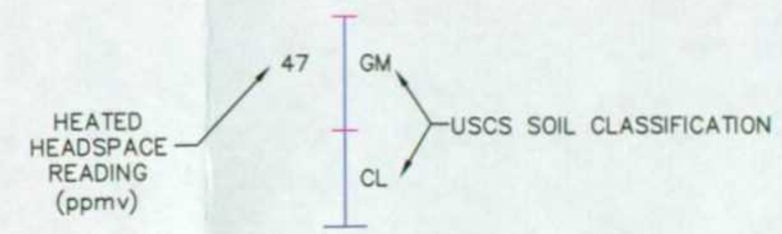
PROJECT NUMBER: P-202203

DRAWING NO.: G-1



LEGEND

GM	SILTY SAND
SW	WELL GRADED SAND
SM	SILTY SAND
SC	CLAYEY SAND
CL	CLAY
▽	POTENTIOMETRIC SURFACE ELEVATION
——	APPROXIMATE CONTACT BETWEEN SOIL TYPES



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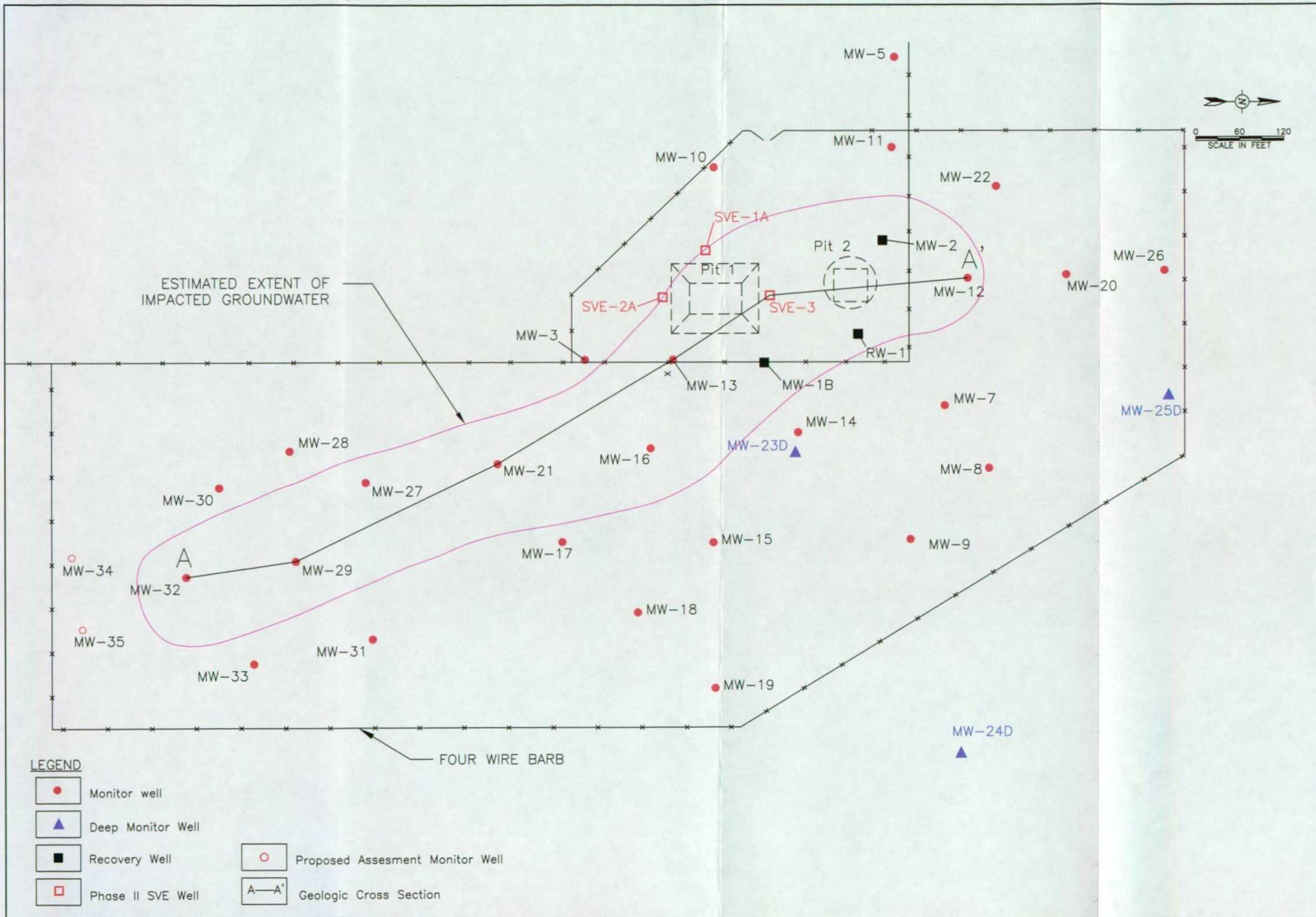
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

Geologic Cross Section

PROJECT NUMBER: P-202203

DRAWING NO.: G-2



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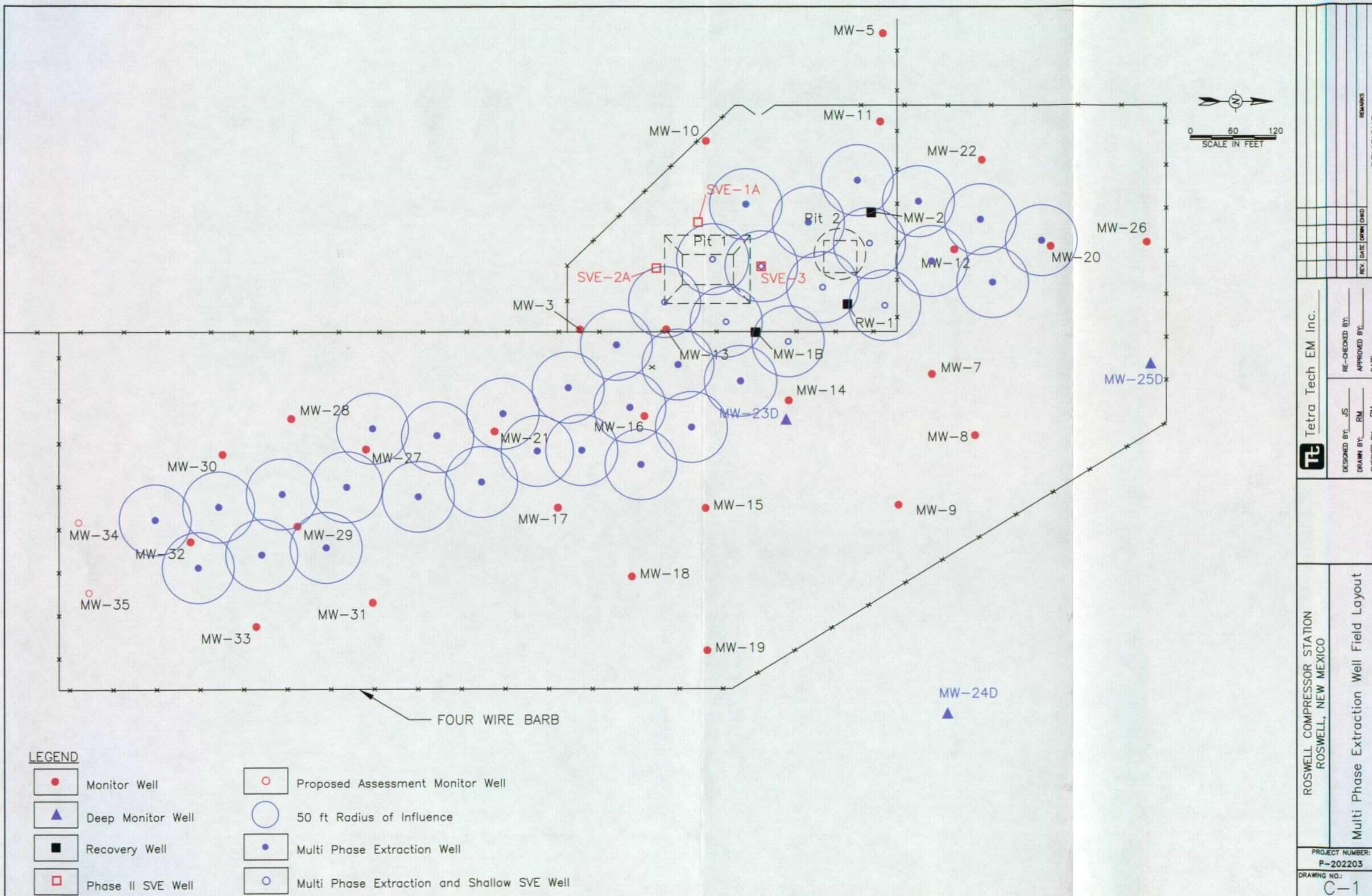
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO

Areal Extent of Impacted Groundwater

PROJECT NUMBER: P-202203

DRAWING NO.: G-3


MW-5
MW-11
MW-10
MW-22
SVE-1A
Pit 1
Pit 2
MW-2
SVE-2A
SVE-3
MW-12
MW-20
MW-26
MW-3
RW-1
MW-13
MW-1B
MW-7
MW-25D
MW-14
MW-28
MW-23D
MW-16
MW-21
MW-8
MW-27
MW-30
MW-15
MW-9
MW-17
MW-34
MW-29
MW-32
MW-18
MW-35
MW-31
MW-33
MW-19
MW-24D
FOUR WIRE BARB
0 60 120
SCALE IN FEET
LEGEND
Monitor Well
Deep Monitor Well
Recovery Well
Phase II SVE Well
Proposed Assessment Monitor Well
50 ft Radius of Influence
Multi Phase Extraction Well
Multi Phase Extraction and Shallow SVE Well
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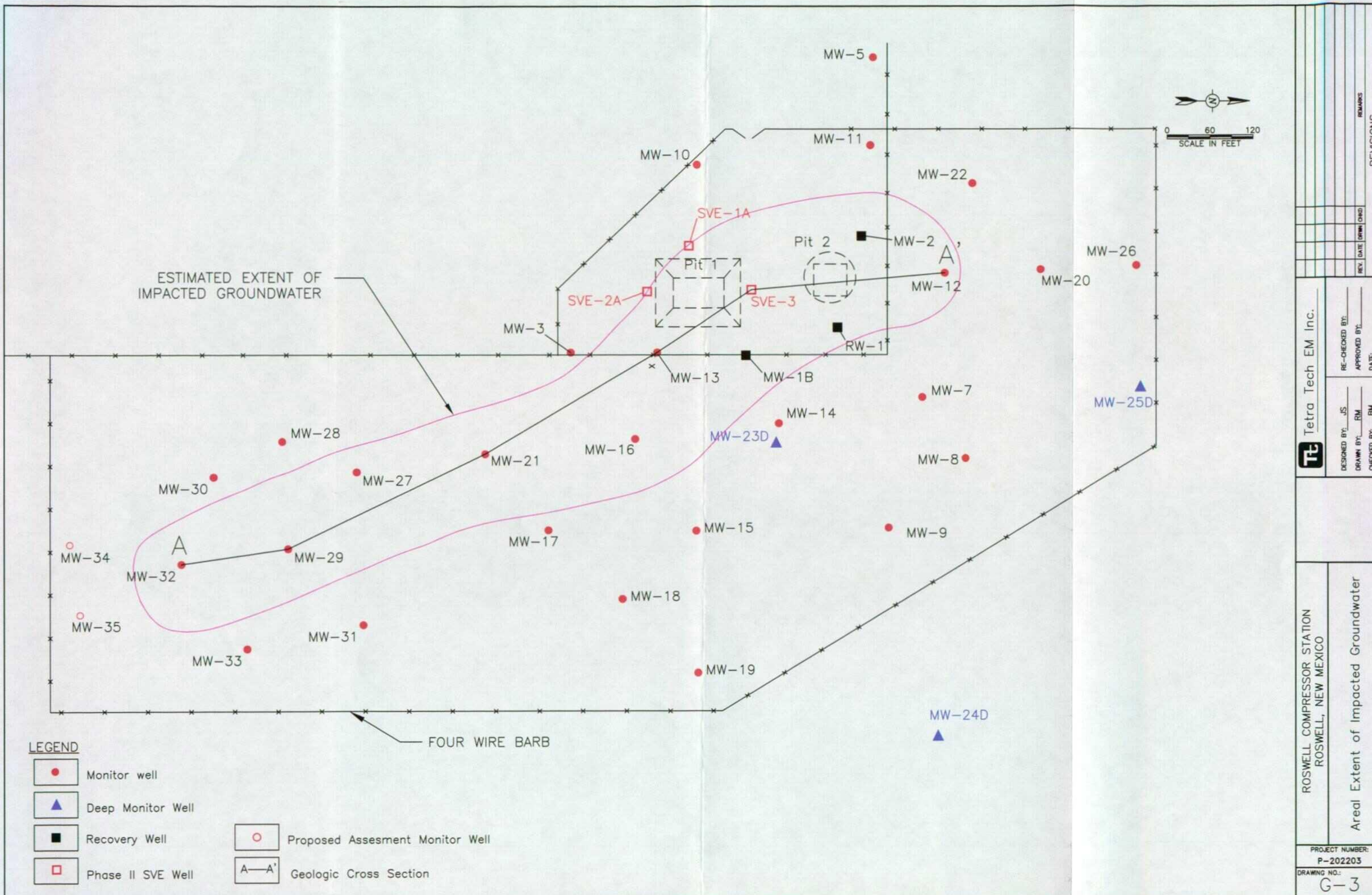
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO
Multi Phase Extraction Well Field Layout
PROJECT NUMBER:
P-202203
DRAWING NO.:
C-1


MW-5
MW-11
MW-10
MW-22
SVE-1A
Pit 2
MW-2
A'
MW-26
Pit 1
ESTIMATED EXTENT OF IMPACTED GROUNDWATER
SVE-2A
SVE-3
MW-12
MW-20
MW-3
RW-1
MW-13
MW-1B
MW-7
MW-25D
MW-14
MW-23D
MW-28
MW-16
MW-21
MW-8
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MW-33
MW-19
MW-24D
FOUR WIRE BARB
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SCALE IN FEET
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Monitor well
Deep Monitor Well
Recovery Well
Phase II SVE Well
Proposed Assesment Monitor Well
A—A' Geologic Cross Section
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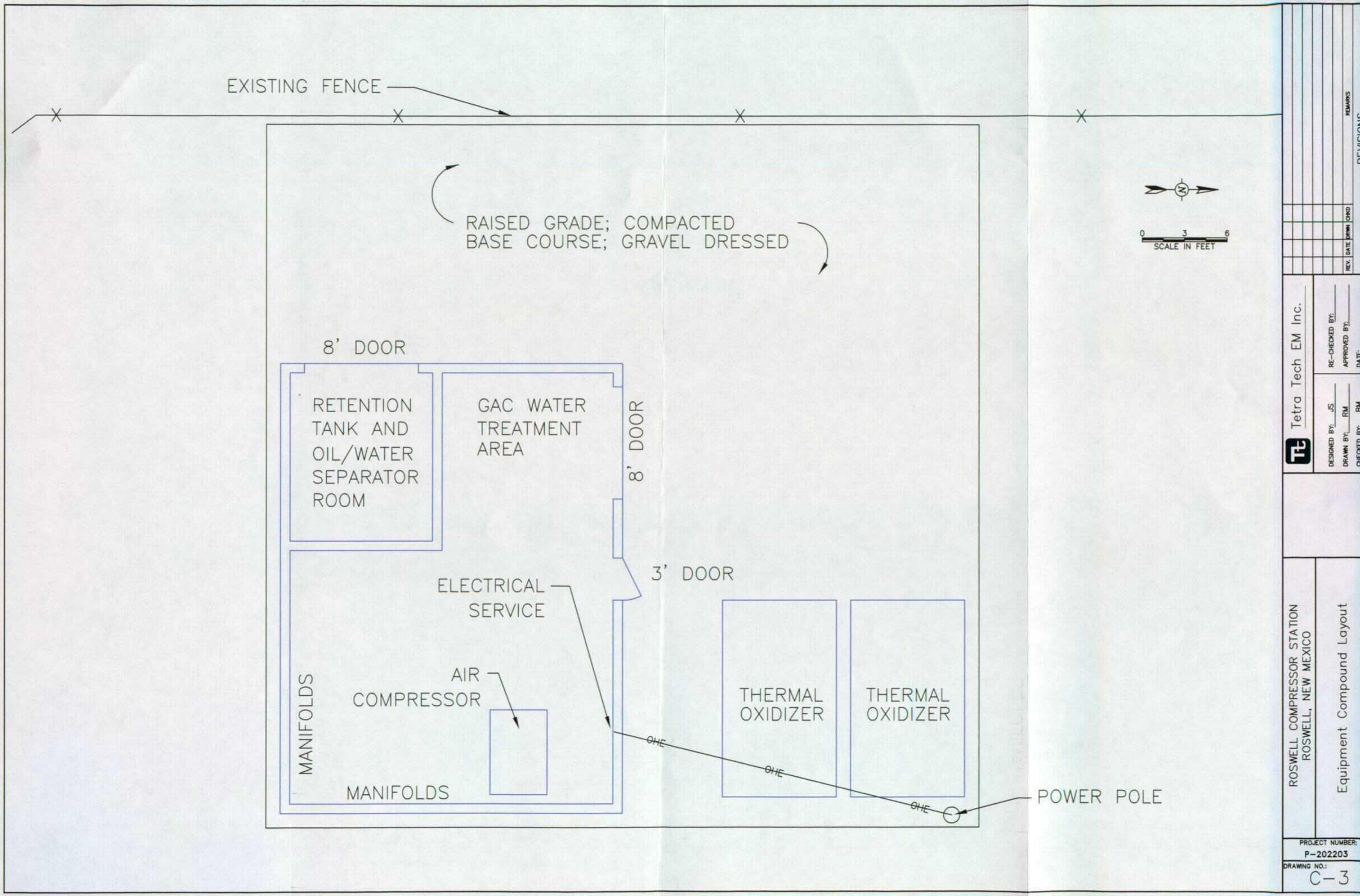
ROSWELL, NEW MEXICO
Areal Extent of Impacted Groundwater
PROJECT NUMBER: P-202203
DRAWING NO.: G-3


EXISTING FENCE
RAISED GRADE; COMPACTED BASE COURSE; GRAVEL DRESSED
8' DOOR
RETENTION TANK AND OIL/WATER SEPARATOR ROOM
GAC WATER TREATMENT AREA
8' DOOR
3' DOOR
ELECTRICAL SERVICE
AIR COMPRESSOR
MANIFOLDS
MANIFOLDS
THERMAL OXIDIZER
THERMAL OXIDIZER
OHE
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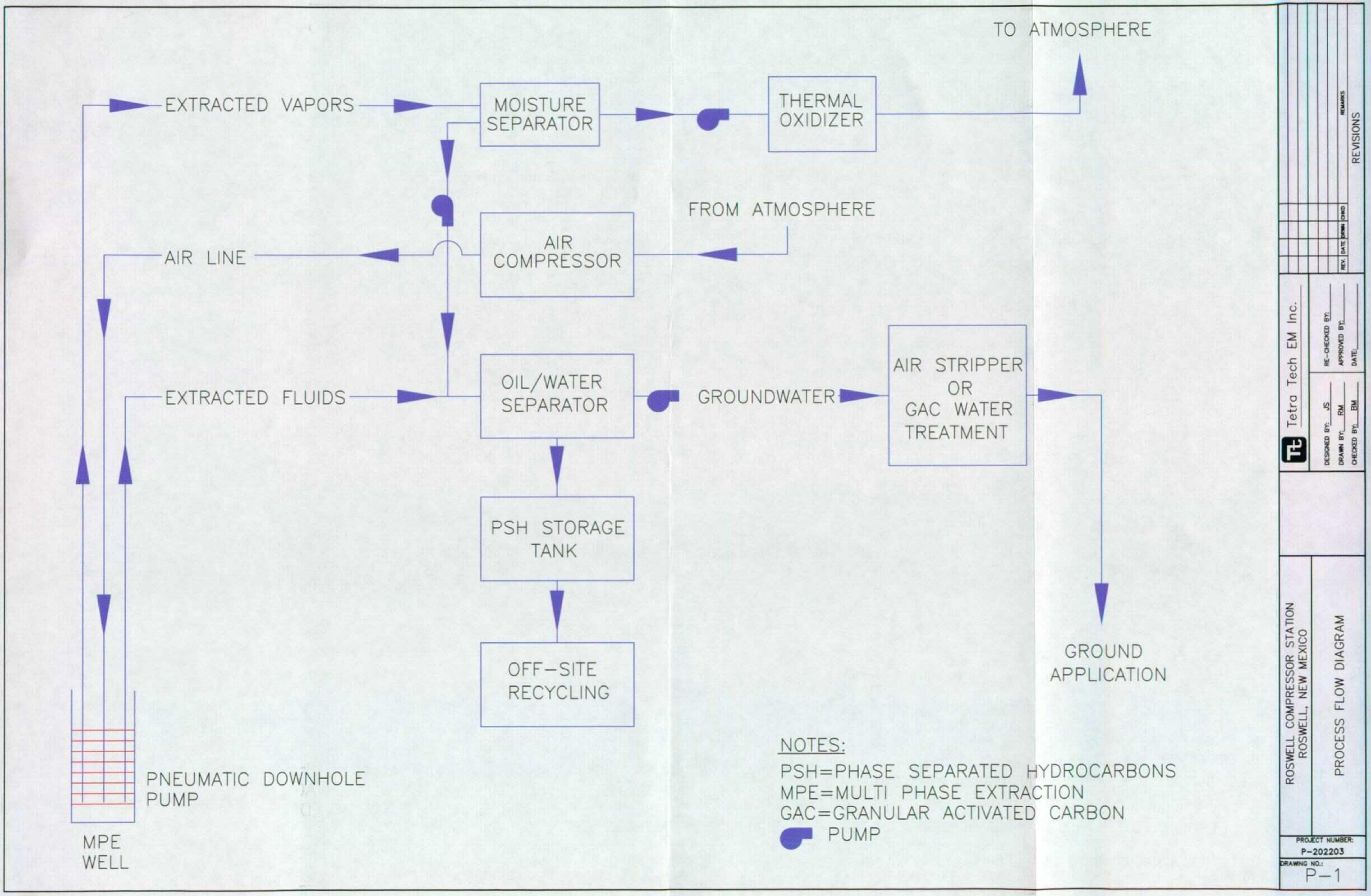
ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO
Equipment Compound Layout
PROJECT NUMBER: P-202203
DRAWING NO.: C-3


TO ATMOSPHERE
EXTRACTED VAPORS
MOISTURE SEPARATOR
THERMAL OXIDIZER
FROM ATMOSPHERE
AIR LINE
AIR COMPRESSOR
EXTRACTED FLUIDS
OIL/WATER SEPARATOR
GROUNDWATER
AIR STRIPPER OR GAC WATER TREATMENT
PSH STORAGE TANK
OFF-SITE RECYCLING
GROUND APPLICATION
PNEUMATIC DOWNHOLE PUMP
MPE WELL
NOTES:
PSH=PHASE SEPARATED HYDROCARBONS
MPE=MULTI PHASE EXTRACTION
GAC=GRANULAR ACTIVATED CARBON
PUMP
REVISIONS
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ROSWELL COMPRESSOR STATION
ROSWELL, NEW MEXICO
PROCESS FLOW DIAGRAM
PROJECT NUMBER: P-202203
DRAWING NO.: P-1

APPENDIX B

SVE PILOT TEST REPORT

AcuVac Remediation Inc.

9111 Katy Freeway
Suite 303
Houston, TX 77024
(713) 468-6688: TEL
(713) 468-6689: FAX

September 30, 1996

Mr Bob Marley
Project Manager
Daniel B. Stephens & Associates, Inc.
6020 Academy NE, Ste 100
Albuquerque, NM 87109

Re: Pilot Test: Roswell Compressor Station, Roswell, NM

Dear Bob:

Enclosed is the report on Soil Vapor Extraction (SVE)/Air Injection (AI) Pilot Testing performed on September 24 - 25, 1996 at the above referenced location. The test was conducted using AcuVac's SVE I-6 System, with Roots RAI-33 and RAI-22 blowers, various instrumentation, including the HORIBA Analyzer, MMC Interface Probe, magnehelic gauges, flow gauges and other special equipment. The report is divided into three separate SVE tests (one with Air Injection) and three SVE Quick Tests.

Introduction

The Vacuum Extraction portion of the AcuVac SVE System consists of an internal combustion (IC) engine, driving a positive displacement, vacuum pump which is connected to the extraction well by a flexible hose. The vacuum created on the extraction well causes hydrocarbons in the soil to volatilize and flow through a moisture knockout tank to the vacuum pump and directed to the intake of the engine where they are burned as part of the normal combustion process. Propane is used as an auxiliary fuel to help power the engine if the well vapors do not provide the required BTU.

Emissions from the IC engine are passed through three catalytic converters to ensure maximum destruction of removed hydrocarbon vapors. The engine's air to fuel ratio can be adjusted to maintain efficient combustion. Because the engine is the only power source for all equipment, all systems stop when the engine shuts down. This eliminates any uncontrolled release of hydrocarbons. Since the System is held entirely under vacuum, any leaks in the seals or connections are leaked into the System and not emitted into the atmosphere. The engine is automatically shut down by intake vacuum loss, low oil pressure or overheating.

The air injection portion of the System consists of a positive displacement blower driven by the IC engine. The blower inlet is connected to an oversized fresh air filter. Air from the discharge side of the blower is directed through three aftercoolers and then through a metering system which can control the flow and pressure. Thereafter, the air is directed to the air injection well through a high pressure, flexible hose. An alternate, engine driven air compressor may be used if higher pressures are required. All the air from the compressor is passed through a moisture/oil dryer before it reaches the metering control system. Again, the engine is the power source for all equipment, thus providing complete protection if the engine stops.

Project Scope:

SOIL VAPOR EXTRACTION

- Install vacuum boot (or similar device) on the extraction well. Connect the blower via flexible hose to the vacuum boot.
- Open all monitoring points. Measure and record depth to PSH and depth to groundwater at monitoring points, then plug each monitoring point with vented plugs designed to accept magnehelic gauges.
- Record barometric pressure, ambient temperature, date and time.
- Start SVE blower and apply initial vacuum. Record applied vacuum and well flow, ambient and influent vapor temperature and barometric pressure. Note that all wellflow data is collected upstream of any dilution valve.
- Install magnehelic gauges on the outer monitoring points and calibrate to appropriate ranges.
- Apply vacuum at a minimum of three steps, with the highest vacuum at the selected capacity for the test conditions.
- For each step in applied vacuum, record all wellhead pressure, barometric pressure, ambient and influent vapor temperature and flowrate data, at 30 minute intervals until pressure stabilizes.
- Collect hydrocarbon sample from the extraction well near beginning of test (approximately 1 - 2 hours after blower startup).
- Record vapor concentration, using HORIBA Gas Analyzer, at selected times during each test.
- Periodically monitor and record offgas vapor emissions with HORIBA Gas Analyzer.
- Record monitoring point vacuum at 30 to 60 minute intervals for each vacuum step.
- Turn off System.

SOIL VAPOR EXTRACTION QUICK TESTS

- Install vacuum boot on extraction well. Connect blower via flexible hose to vacuum boot. Record DTPSH and DTGW.
- Start SVE blower and apply vacuum. Record well vacuum and flow, ambient air temperature and barometric pressure.
- Allow SVE to operate approximately 15 - 30 minutes.
- Record vapor concentrations using the HORIBA Analyzer.
- Record date and time.
- Turn off System.

COMBINED SOIL VAPOR EXTRACTION/AIR INJECTION

- Connect the air injection system to the SVE extraction well to provide air bubbling approximately 10 feet below the PSH/H_2O level. Connect the soil vapor extraction system to the extraction well with a vacuum boot or similar device.
- Record depth to groundwater and depth to PSH.
- Start the extraction system and stabilize the pressure. Record all operation data (pressure and flowrate). Operate at selected vacuums and flow rates.
- Introduce air injection and record initial pressure, flow and elapsed time to achieve breakthrough. Operate at two injection pressures.
- Record pressure or vacuum on the outer monitoring points, at System, and in the extraction well.
- Collect hydrocarbon sample from extraction well near start of test (approximately 1 - 2 hours after sparge blower startup).
- Periodically monitor and record vapor concentrations and offgas vapor emissions with HORIBA Analyzer.
- At the conclusion of the test, record depth to PSH and depth to groundwater.
- Turn off System.

ADDITIONAL PROCEDURES

- Record the distances from the selected extraction wells (EW) and AI to the outer wells.
- Operate the SVE/AI System in a manner that all well vapors are passed through the engine and catalytic converters, to destruct the contaminants and exhausted, to meet air emission standards. Comply with all safety regulations.
- Complete the tests by providing a report consisting of operating and analytical data and projection of vacuum radius of influence, and discussion regarding the air injection radius of influence.
- Comply, at all times, with the approved Health and Safety Plan.

Fuel Use Information - Tests #1-SVE, #3-SVE and #4-SVE/AI

The fuel requirement for the I-6 engine at 2,000 to 2,200 rpm at the h.p. requirement of under average test conditions is 2.86 gals/hr of propane. The measured (by volume) amount of propane used during the total test time of Tests #1, 3 & 4 was 25 gallons, or 1.79 gals/hr. Therefore, the influent well vapors provided fuel equivalent to 1.07 gals/hr of propane or 37.4%. This is equivalent to approximately 4.6 lb/hr of hydrocarbon contaminant based on a weight of 6.55 lbs/gal. For the three tests, this equates to 64.4 lbs or 9.83 gals. The well vapors should provide a higher percentage of fuel with an increased extraction well flow from additional extraction wells. Fuel consumption from Test #2-A, B, C was not included as these were "quick tests" and total fuel use was not recorded.

Summary of Data - 3 Tests (See Attached Schedule A)

Graphic Summary of Data - SVE & AI (See Attached Schedule B)

Well Data Information:

Test #1 & 3
TABLE #1

WELL NO.	SVE-3	SVE-2	SVE-1	MW-1B	MW-1	RW-1	MW-2
TD	61.8	30.0	30.0	65.5	68.0	42.5	65.0
SCREEN	32 - 61.8	20 - 30	20 - 30	55 - 65	28 - 68	36.8 - 41.7	55 - 65
WELL SIZE in	2.0	2.0	2.0	2.0	4.0	4.0	2.0
DTGW ft 0620	NA	NA	NA	-	-	-	-
DTGW ft 0730	NA	NA	NA	PSH 58.44 GW 61.05	-	-	-
DTGW ft 1330	NA	NA	NA	PSH 58.42 GW 61.02	-	-	-
DISTANCE FROM SVE-3 ft	-	146.5	107.5	93.0	128.0	128.5	-
DISTANCE FROM SVE-2 ft	146.5	-	86.5	147.0	222.0	223.0	-

Test #4-AI
TABLE #2

WELL NO.	Before AI MW-1	After AI MW-1	SVE-3	SVE-1	MW-2	RW-1	MW-1B
DTPSH ft 0615	36.96						
DTGW ft 0615	38.68						
DTPSH ft 1210		37.58					
DTGW ft 1210		37.26					
DISTANCE FROM MW-1 ft	-	-	128.1	222.0	120.5	7.0	126.0

NOTE: PSH in well MW-1 was checked with bailer at 1350 hours (2.3 hours after AI was discontinued) and 4.25 inches of oil/water emulsion was observed.

Discussion of Data:

Prior to starting this test, all the SVE systems are checked for normal operation. The depth to groundwater (DTGW) along with the amount of PSH levels are recorded. Each magnehelic gauge is checked and calibrated to "0". The outer monitoring wells are plugged with expandable well plugs designed to accept magnehelic gauges. Static well data, barometric pressure and ambient air temperature is recorded prior to engaging the SVE System. The propane tank fuel level is recorded so an accurate fuel consumption can be estimated for the total test period. The HORIBA Analyzer is set for the local altitude and calibrated with SPAN gas.

Test #1 was an 6.9 hour SVE test conducted from well SVE-3 as the extraction well (EW). Static well data indicated that the selected outer observation wells were recording slight vacuums ranging from 0.01 to 0.30" H_2O. The barometric pressure was steady at 30.21" Hg and the ambient air temperature was 64°F. At the start of the test, the initial EW vacuum was 30" H_2O, with a flow of 6 cfm, and only outer well MW-1B recorded an increased level of vacuum. During the first 1.5 hours of the test, the vacuum was held constant at 30.0" H_2O, with the flow steady at 6.0 cfm. During this period, outer well MW-1B continued to record a significant increasing vacuum trend while the other outer wells indicated minimum response to the EW vacuum and flow.

Starting a test with low variable rate vacuum and flow increases, allows the EW and outer wells sufficient time to adjust and stabilize, and minimizes the risk of channeling. This will also assist the development of newly installed extraction wells.

The EW vacuum was later increased to 50" H_2O, with a flow of 10 cfm. The outer wells indicated a slight, initial response to the increased vacuum and continued with a minimum but steady increase for 1.5 hours. MW-1B was not responding as a typical outer observation well. The increased vacuum levels were much too great for the distance. Most likely, other factors such as a decreasing groundwater level were influencing this well. The barometric pressure was on a slight increasing trend and the ambient air temperature increased to 67°F. The influent vapor temperature increased from 64 to 66°F. An increasing barometric pressure generally will have a positive effect on outer well vacuums. It is unlikely that the SVE from well SVE-3 will substantially effect outer wells SVE-2, MW-1 & RW-1 due to the length of the radials.

HORIBA analytical data indicated the influent vapors had a hydrocarbon concentration (HC) of 9,580 and 15,590 ppm, with CO_2 at 10.98 and 9.92%. The propane flow was recorded at 100 to 110 cfh, with a well flow of 6.0 and 10.0 cfm. The influent vapors were providing approximately 40% of the fuel value for the internal combustion engine.

During the next 1.4 hours of the SVE test period, the EW vacuum was increased to 80" H_2O, with a flow of 18 cfm. Outer observation wells SVE-1 & 2, MW-1 & RW-1 indicated a slight response to the EW increase. As previously mentioned, MW-1B continued on an abnormal vacuum increase, most likely not as the result of SVE. During the last 1.0 hour of the test, the EW vacuum was increased to 105" H_2O, with a flow of 26 and 28 cfm. Outer wells SVE-1 & 2, MW-1 & RW-1 indicated a marginal response to these increases while MW-1B indicated a decrease in well vacuum.

Additional HORIBA data indicated the influent vapors had HC levels of 12,780, 14,910 and 11,140 ppm, with CO_2 at 10.40, 10.10 and 9.92%. The CO_2 percent is abnormally high, indicating that natural bio-degradation is occurring. The O_2 is most likely very low, making it difficult for the engine to absorb these vapors as a fuel. Exhaust emissions were recorded at 96 and 26 ppm, with CO_2 at 8.22 and 9.94% and CO at 0.02%.

The static well data recorded 0.75 hours after the completion on the SVE, indicated the outer wells were recording well pressures ranging from 0.08 to 0.10" H_2O, with the exception of MW-1B , which was recording a vacuum of 1.30" H_2O. In conclusion, the test provided sufficient data for the calculation of a vacuum radius of influence.

Tests #2-A, B & C were SVE "quick tests" consisting of the SVE System connected to selected wells for 15 to 30 minutes. The following data was recorded during these tests:

Parameters		Date: 09/24/96	Date: 09/24/96	Date: 09/25/96
		Time: 1330	Time: 1730	Time: 1315
		Hr Meter: 862.0	Hr Meter: 866.0	Hr Meter: 873.0
Well #		SVE-1	MW-16	MW-15
HORIBA DATA		-	-	-
HC ppm		28	9,520	62
CO_2%		10.82	10.52	0.88
CO%		0	0	0
Gas Flow - Fuel/Propane	cfh	150	110	160
Air Flow	cfm	28	28	36
Well Flow	cfm	15	22	15
Recovery Well Vacuum	"H_2O	25	50	160
Air Temperature	°F	75	73	84
Barometric Pressure	"Hg	30.15	30.05	29.86

Test #3 was a 2.8 hour SVE test conducted from well SVE-2 as the extraction well (EW). Static well data indicated that the selected outer wells, SVE-1, MW-1 & RW-1, were recording well pressures ranging from 0.01 to 0.10" H_2O. The other outer well, SVE-3, was recording a residual vacuum of 0.70" H_2O from the previous test. The barometric pressure was decreasing from 30.12" Hg and the ambient air temperature was 76°F. Well SVE-2 has a TD of 30 ft and is screened from 20 to 30 ft. At the start of the test, the initial EW vacuum was 25" H_2O, with a flow of 30 cfm. The screened area was in a more permeable structure than SVE-3. Outer wells SVE-1, MW-1 & RW-1 indicated an immediate well vacuum. Due to the erratic data from well MW-1B, this well will not be considered as part of the test data.

HORIBA analytical data indicated the influent vapors had a hydrocarbon concentration (HC) of 848 and 826 ppm, with CO_2 at 12.28 and 11.04%.

During the last 0.6 hours of the test, the EW vacuum was increased to 40" H_2O, with a flow of 40 cfm. Outer well SVE-3 was still recording a residual vacuum. The other wells responded with a slight vacuum increase. The barometric pressure decreased from 30.12 to 30.05" Hg.

The static well data recorded 0.75 hours after the SVE was discontinued, indicated SVE-1, MW-1 & RW-1 were recording well pressures ranging from 0.03 to 0.05" H_2O, while SVE-3 recorded a decreased vacuum level. The test provided adequate data to use in the calculation of a vacuum radius of influence.

Test #4-AI was a 5.7 hour SVE/AI test, conducted through well MW-1 as the extraction and air injection (AI) well. Static well data indicated that the selected outer observation wells were recording a slight vacuum ranging from 0.02 to 0.10" H_2O. The barometric pressure was 29.95" Hg and the ambient air temperature was 66°F. At the start of the test, the initial EW vacuum was 15" H_2O, with a flow of 25 cfm. The outer wells recorded a slightly increased level of vacuum. During the first 1.6 hours of the test, the vacuum was held constant at 15" H_2O, with the flow remaining steady at 25 cfm. The outer wells continued to record an increasing vacuum trend during this period. Outer wells MW-1B & MW-2 continued to record erratic data which is not totally influenced by SVE.

SVE only was conducted for the first 2.0 hours until a stabilized condition was obtained. Although well RW-1 indicated a slight response to the EW vacuum, the response was minimal for a well located 7.0 ft from the extraction well. Therefore, outer wells SVE-1 & 3, which had radial distances of 128 and 222 ft, were the only two wells from which consistent SVE data was recorded.

The initial HORIBA data, prior to AI, indicated that the influent vapors HC levels were 7,510 and 6,800 ppm, with CO_2 at 12.14 and 11.82%. Exhaust emissions were 46 ppm, with CO_2 at 10.02% and CO at 0.02%.

The EW vacuum was increased to 18" H_2O, with flow of 30 cfm. The flow was allowed to stabilize for 0.5 hours. After 2.5 hours of testing, air injection in the form of air bubbling into the extraction well was started. The depth to PSH from TOC in well MW-1, was 36.96 ft, with depth to groundwater at 38.68 ft. The AI was being released at 51.0 ft below TOC. The initial pressure was 7.0 psi, with a flow of 5.5 cfm. The pressure and flow remained constant for 1.1 hours and then increased to 10 psi, with a flow of 7.0 cfm for the final 0.75 hours. The EW vacuum varied from 15 to 18" H_2O, while the flow varied from 25 to 30 cfm. The barometric pressure was mostly steady until the end of the test.

Additional HORIBA data, taken between 0915 and 1040 hours, indicated that the influent vapors had HC levels of 5,710, 5,460 and 4,550 ppm, with CO_2 at 9.90, 9.78 and 8.50%. Immediately after AI was discontinued and SVE was still operating, the HC level was 6,360 ppm, with CO_2 at 12.20%.

After the SVE was discontinued, another significant fact was determined. At the start of this test, 1.72 ft of PSH in the form of black oil was recorded. At the completion, 0.32 ft of oil/water emulsion was recorded.

Static well data recorded 0.5 hours after the completion of the test indicated the outer wells were recording a well pressure. SVE-1 & 3 may provide some data that can assist in the calculation of a vacuum radius of influence.

Additional Information (This should be read as a vital part of the report):

- Summary of Operating Data
- Graphic Summary of Data, SVE & AI Tests
- Figure 1 - Plot of Observed Vacuum versus Distance at the Facility
- Field Operating Data and Notes
- Site Map

Conclusion

Pilot Tests are conducted to provide information on short term tests that can be projected into a long term remedial plan. These feasibility tests indicated that soil vacuum extraction (SVE) would be an effective method of remediation for this facility. Although the observed vacuum on some of the outer observation wells was relatively low, the duration of the pilot tests was short compared to continuous operation. However, the results give positive indication that the observed and reported wells were in vacuum communication with the selected SVE extraction well. The radius of influence defines the region within which the vapor in the vadose or vented zone flows to the extraction well under the influence of a vacuum. The radius of influence depends on soil properties of the vented zone, properties of surrounding soil layers, the depth at which the well is screened, well installation and the presence of any impermeable boundaries such as the water table, clay layers, surface seal, building basements and the presence of such areas as tank pits with backfill and underground utilities.

Figure #1 indicated that the effective vacuum radius of influence, for a well screened in the 30 to 60 ft range, would be from approximately 80 to 90 ft with extraction well flow of 20 to 25 cfm and extraction well vacuum in the 90" H_2O range. The projection of the radius of influence from data collected during SVE Tests #1, #3 & 4-SVE/AI were determined by a proprietary computer program that calculates and plots the observed (as modified) radial pressure distribution data versus distance. An approximation of the radius of influence may be obtained by determining the point at which the measured vacuum is **0.30 to 0.35" H_2O**. It is assumed that beyond the lower point, the pressure gradient (driving force) is negligible to effectively transport vaporized contaminants to the extraction well. Under continuous operation, vacuum and radius of influence may continue to increase.

To calculate SVE and AI well placement, the equation we use is as follows:
$L = 2\ Ri \cos 30°$; L = distance between wells; Ri = radius of influence

All other data, including the groundwater depth, well placement, extraction well screened intervals, SVE recovery rate and AI pressure and flow must be considered in the final design for a remedial plan.

Once you have reviewed the report, please call me if you have any questions.

Sincerely,

James E. Sadler
Engineer/Environmental

60124.REP

9/24/96	Static Data Time 0625	First Data Time 0630	Second Data Time 0700	Third Data Time 0730	Fourth Data Time 0800	Fifth Data Time 0830
Horiba HC ppm	ND	ND	ND	9,580	ND	15,590
Horiba CO_2%	ND	ND	ND	10.98	ND	9.92
Influent Vapor Temp °F	-	64	65	66	66	65
Barometric Pressure "Hg	30.21	30.21	30.22	30.22	30.22	30.22
Extraction Well Flow CFM Well SVE-3	-	6	6	6	6	10
Extraction Well Vacuum CFM Well SVE-3	-	30	30	30	30	50
Well SVE-1 Vacuum "H_2O Dist. 107.5 ft	0.02	0.03	0.03	0.02	0.02	0.04
Well SVE-2 Vacuum "H_2O Dist. 146.5 ft	0.03	0.03	0.03	0.03	0.03	0.02
Well MW-1B Vacuum "H_2O Dist. 93.0 ft	0.30	0.40	1.40	1.80	1.50	2.00
Well MW-1 Vacuum "H_2O Dist. 128.0 ft	0.02	0.02	0.02	0.01	0.02	0.03
Well RW-1 Vacuum "H_2O Dist. 128.5 ft	0.01	0.02	0.01	0	0.02	0.04

9/24/96	Sixth Data Time 0900	Seventh Data Time 0930	Eighth Data Time 1000	Ninth Data Time 1030	Tenth Data Time 1100	Eleventh Data Time 1130
Horiba HC ppm	ND	ND	12,780	ND	ND	14,910
Horiba CO_2%	ND	ND	10.40	ND	ND	10.10
Influent Vapor Temp °F	66	66	66	66	66	66
Barometric Pressure "Hg	30.21	30.22	30.22	30.22	30.23	30.21
Extraction Well Flow CFM Well SVE-3	11	11	11	18	18	19
Extraction Well Vacuum CFM Well SVE-3	50	50	50	80	80	80
Well SVE-1 Vacuum "H_2O Dist. 107.5 ft	0.04	0.07	0.07	0.08	0.08	0.06
Well SVE-2 Vacuum "H_2O Dist. 146.5 ft	0.02	0.05	0.07	0.07	0.07	0.05
Well MW-1B Vacuum "H_2O Dist. 93.0 ft	2.15	2.05	2.10	2.10	2.05	1.85
Well MW-1 Vacuum "H_2O Dist. 128.0 ft	0.03	0.04	0.04	0.07	0.07	0.06
Well RW-1 Vacuum "H_2O Dist. 128.5 ft	0.03	0.03	0.03	0.08	0.07	0.05

9/24/96	Twelfth Data Time 1200	Thirteenth Data Time 1230	Static Data Time 1315	Average Data 6.0 Hrs	Maximum Effective Data
Horiba HC ppm	11,140	ND	-	12,800	15,590
Horiba CO_2%	9.92	ND	-	10.26	10.98
Influent Vapor Temp °F	66	66	-	65.69	66
Barometric Pressure "Hg	30.20	30.18	30.15	30.21	30.23
Extraction Well Flow CFM Well SVE-3	26	28	-	13.54	28
Extraction Well Vacuum CFM Well SVE-3	105	105	-	59.23	105
Well SVE-1 Vacuum "H_2O Dist. 107.5 ft	0.08	0.09	-(.10)	0.05	0.19
Well SVE-2 Vacuum "H_2O Dist. 146.5 ft	0.08	0.08	-(.10)	0.05	0.18
Well MW-1B Vacuum "H_2O Dist. 93.0 ft	1.70	1.60	1.30	1.75	-
Well MW-1 Vacuum "H_2O Dist. 128.0 ft	0.06	0.09	-(.08)	0.04	0.17
Well RW-1 Vacuum "H_2O Dist. 128.5 ft	0.07	0.09	-(.09)	0.04	0.18

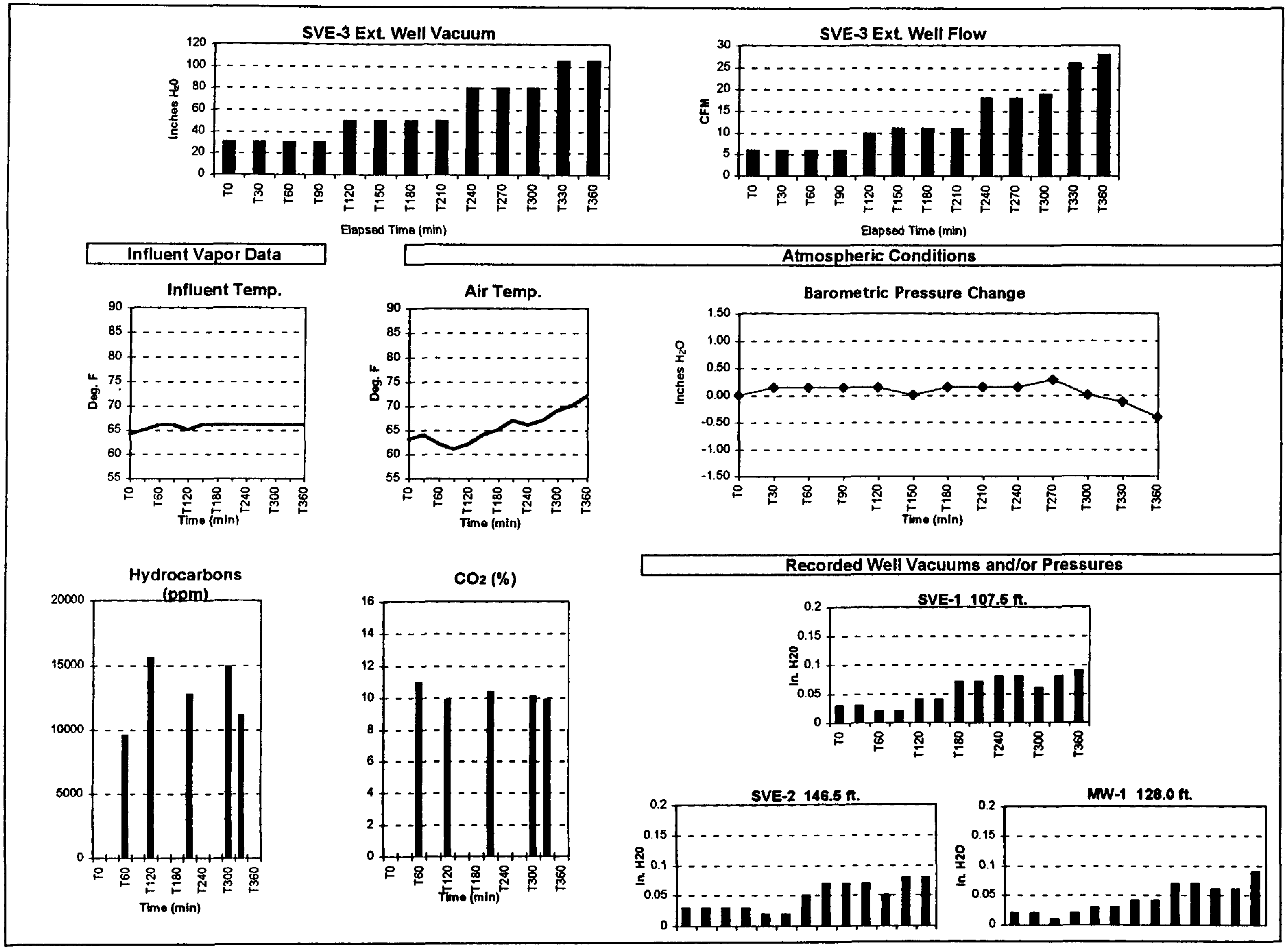
9/24/96	Static Data Time 1425	First Data Time 1430	Second Data Time 1500	Third Data Time 1530	Fourth Data Time 1600	Fifth Data Time 1630	Static Data Time 1715	Average Data 2.0 Hrs	Maximum Effective Data
Horiba HC ppm	-	ND	848	ND	826	ND	-	837	848
Horiba CO_2%	-	ND	12.28	ND	11.04	ND	-	11.66	12.28
Influent Vapor Temp °F	-	71	70	69	69	69	-	70	71
Barometric Pressure "Hg	30.12	30.12	30.11	30.07	30.07	30.06	30.05	30.09	30.12
Extraction Well Flow CFM Well SVE-2	-	30	30	30	30	40	-	32	40
Extraction Well Vacuum CFM Well SVE-2	-	25	26	26	26	40	-	29	40
Well SVE-1 Vacuum "H_2O Dist. 86.5 ft	0	0.08	0.10	0.11	0.10	0.11	-(.03)	0.10	0.14
Well SVE-3 Vacuum "H_2O Dist. 146.5 ft	0.70	0.60	0.56	0.45	0.36	0.32	0.22	0.46	0.12
Well MW-1B Vacuum "H_2O Dist. 147.0 ft	0.90	0.82	0.70	0.53	0.47	0.40	0.20	-	-
Well MW-1 Vacuum "H_2O Dist. 222.0 ft	-(.07)	0.03	0.05	0.04	0.06	0.06	-(.05)	0.05	0.10
Well RW-1 Vacuum "H_2O Dist. 223.0 ft	-(.10)	0.04	0.06	0.05	0.07	0.07	-(.04)	0.06	0.11

9/25/96	Static Data Time 0625	First Data Time 0630	Second Data Time 0700	Third Data Time 0730	Fourth Data Time 0800	Fifth Data Time 0830	Sixth Data Time 0900
Horiba HC ppm	ND	ND	ND	7,510	ND	6,800	5,710
Horiba CO_2%	ND	ND	ND	12.14	ND	11.82	9.90
Influent Vapor Temp °F	-	64	64	64	64	64	65
Barometric Pressure "Hg	29.95	29.95	29.95	29.96	29.96	29.96	29.96
Extraction Well Flow CFM Well MW-1	-	25	25	25	25	30	25
Extraction Well Vacuum CFM Well MW-1	-	15	15	15	15	18	18
Well RW-1 Vacuum "H_2O Dist. 7.0 ft	0.02	0.10	0.07	0.08	0.10	0.12	0.08
Well SVE-3 Vacuum "H_2O Dist. 128.1 ft	0.03	0.03	0.05	0.08	0.09	0.07	0.10
Well SVE-1 Vacuum "H_2O Dist. 222.0 ft	0.03	0.03	0.04	0.08	0.07	0.06	0.10
Well MW-1B Vacuum "H_2O Dist. 126.0 ft	-(.55)	-(.60)	-(.60)	-(.65)	-(.60)	-(.65)	-(.65)
Well MW-2 Vacuum "H_2O Dist. 120.5 ft	0.10	0.26	0.27	0.30	0.30	0.26	0.21

9/24/96	Seventh Data Time 0930	Eighth Data Time 1000	Ninth Data Time 1030	Tenth Data Time 1130	Static Data Time 1200	Average Data 5.0 Hrs	Maximum Effective Data
Horiba HC ppm	ND	5,460	4,550	6,360	-	6,065	7,510
Horiba CO_2%	ND	9.78	8.50	12.20	-	10.72	12.20
Influent Vapor Temp °F	65	65	66	66	-	65	66
Barometric Pressure "Hg	29.96	29.96	29.95	29.91	29.90	29.95	29.96
Extraction Well Flow CFM Well MW-1	25	25	30	30	-	27	30
Extraction Well Vacuum CFM Well MW-1	14	15	18	18	-	16	18
Well RW-1 Vacuum "H_2O Dist. 7.0 ft	0.07	0.07	0.08	0.08	-(.20)	0.09	0.28
Well SVE-3 Vacuum "H_2O Dist. 128.1 ft	0.09	0.06	0.07	0.07	-(.19)	0.07	0.26
Well SVE-1 Vacuum "H_2O Dist. 222.0 ft	0.10	0.06	0.09	0.08	-(.11)	0.07	0.19
Well MW-1B Vacuum "H_2O Dist. 126.0 ft	-(.75)	-(.80)	-(.90)	-(1.25)	-(1.40)	-	-
Well MW-2 Vacuum "H_2O Dist. 120.5 ft	0.14	0.07	-(.27)	-(.64)	-(.88)	-	-

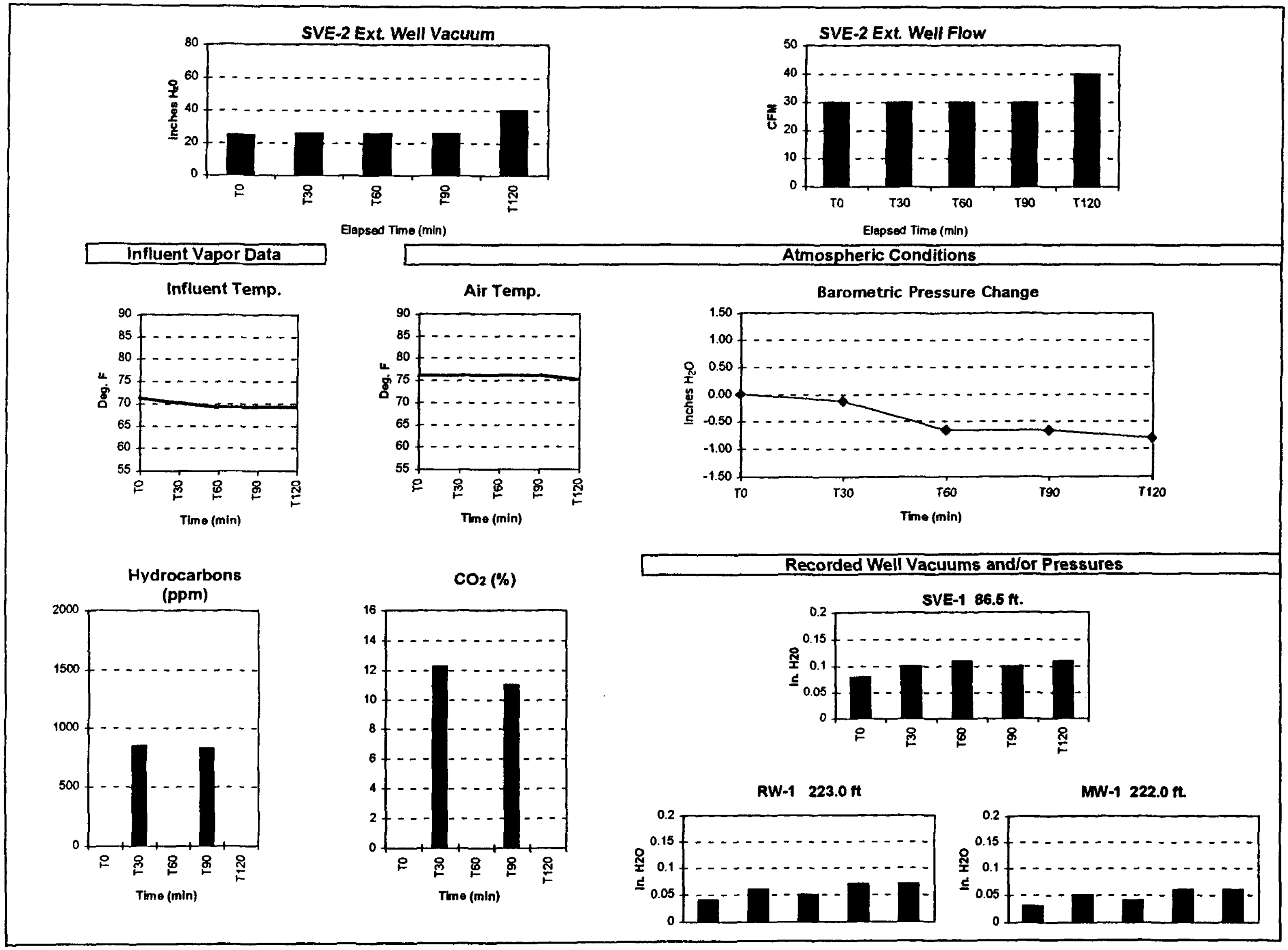
SCHEDULE B
Summary of ACUVAC SVE TEST #1

AcuVac Remediation Inc.
ROSWELL COMPRESSOR STATION
September 24,1996



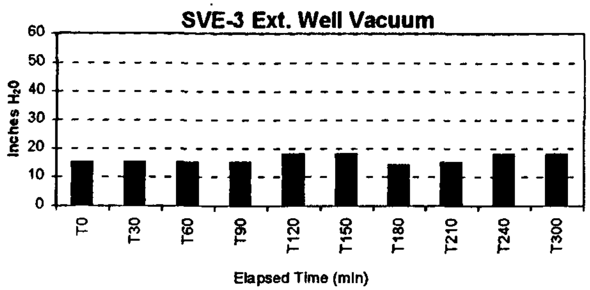
SCHEDULE B
Summary of ACUVAC SVE TEST #3

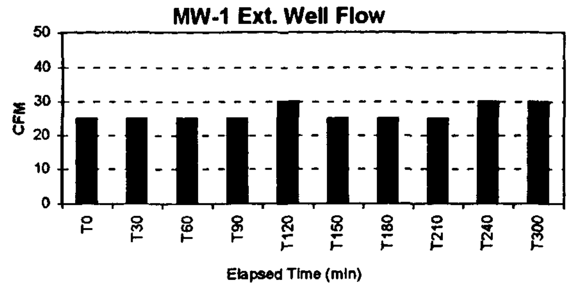
AcuVac Remediation Inc.
ROSWELL COMPRESSOR STATION
September 24,1996



SCHEDULE B
Summary of ACUVAC SVE TEST #4-AI

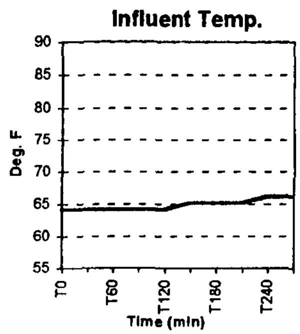
AcuVac Remediation Inc.
ROSWELL COMPRESSOR STATION
September 25,1996

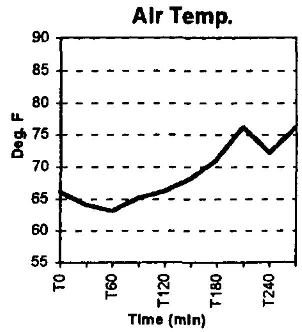


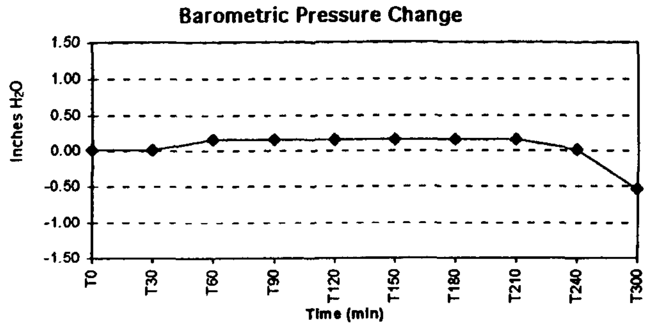


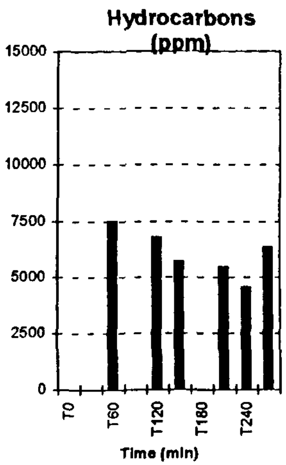
Influent Vapor Data

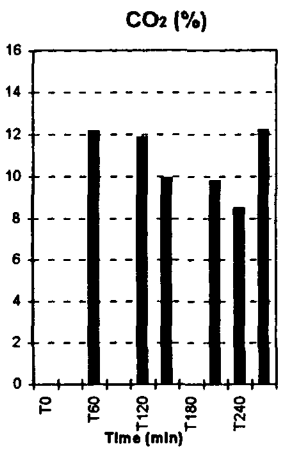
Atmospheric Conditions



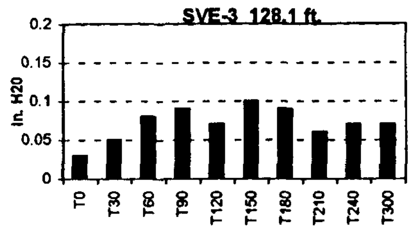








Recorded Well Vacuums and/or Pressures



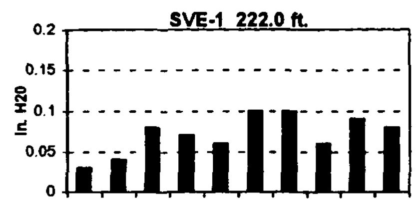
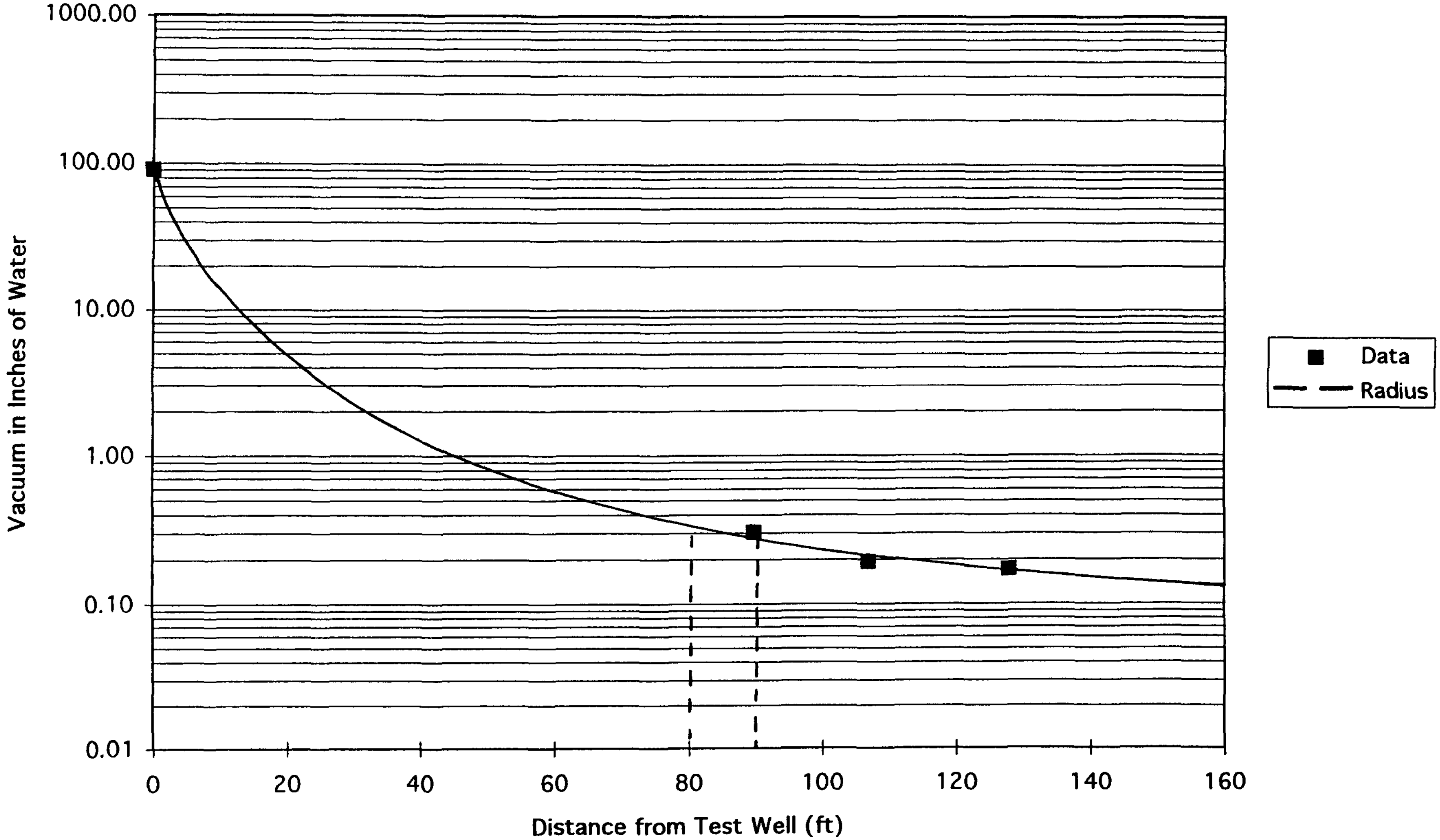


Figure #1

AcuVac Remediation Inc
ROSWELL COMPRESSOR STATION
September 25, 1996

Radius of Influence



AcuVac Remediation Inc.

OPERATING DATA - TEST # 1 PAGE # 1

ACUVAC SVE SYSTEM

Location: ROSWELL COMPRESSOR STATION - ROSWELL, NM Project Engr: SADLER / LUNDGREN

	Date:		9/24/96	–	–	–	–	–
	Parameters	Time	0625	0630	0700	0730	0800	0830
		Hr Meter	854.9	855.0	855.5	856.0	856.5	857.0
ENGINE/BLOWER	R.P.M.		1200	1900	2000	2000	2000	2000
	Oil Pressure	psi	60	50	50	50	50	50
	Water Temp	°F	140	160	160	160	160	160
	Volts		14	14	14	14	13.5	13.5
	Intake Vac	"Hg	14	11	11	11	11	13
	Gas Flow Fuel/Propane	cfh	90	120	110	110	110	100
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow	cfm	26	34	34	34	34	32
	Extraction Well Flow SVE-3	cfm	–	6.0	6.0	6.0	6.0	100
	Extraction Well Vac SVE-3	"H_2O	–	30	30	30	30	50
	Influent Vapor Temp	°F	–	64	65	66	66	65
	Air Temp	°F	64	63	64	62	61	62
	Barometric Pressure 3600'	"Hg	30.21	30.21	30.22	30.22	30.22	30.22
MONITOR WELL VACUUM	SVE-1	"H_2O	.02	.03	.03	.02	.02	.04
	SVE-2	"H_2O	.03	.03	.03	.03	.03	.02
	MW-1B	"H_2O	.30	.40	1.40	1.80	1.50	2.00
	MW-1	"H_2O	.02	.02	.02	.01	.02	.03
	RW-1	"H_2O	.01	.02	.01	0	.02	.04
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
MANIFOLD	SVE	On/Off	OFF	ON	ON	ON	ON	ON
	Air Injection Pressure	psi	OFF	–	–	–	–	–
	Air Injection Flow	cfm	OFF	–	–	–	–	–
	Samples				Influent Vapor		Influent Vapor	

( ) Indicates Well Pressure

TEST	Instrument	HORIBA	HORIBA				
	Time	0725	0820				
VAPOR/INFLUENT	HC ppm	9580	15,590				
	CO_2 %	10.98	9.92				
	CO %	0	0				
EMISSIONS	HC ppm						
	CO_2 %						
	CO %						
	Air/Fuel Ratio %						

OPERATING DATA AND NOTES

DATE: 9/24/96 TEST NO: 1 Page No: 1

1700	9/23/96 Positioned SUE System near well SUE-3 as extraction well
	(EW) - Opened and plugged selected outer wells - Checked System - OK
0605	9/24/96 - Arrived at location - Connected SUE System to SUE-3
0620	No DTGW recorded in SUE-3 - TD = 61.8' - Calibrated instruments
0625	Recorded static well data - All outer wells recording slight VOC X MW-1
0630	START TEST #1 - Initial EW vacuum @ 30" H_2O, flow @ 6 CFM
	Outer wells mostly steady - MW-1B recording increased vac - May not be SUE effect
0700	Recorded data - No change in outer wells except MW-1B which continues
	on increasing vacuum trend. Undetermined if SUE or H_2O level adjustment
	Barometric pressure steady, Influent vapors near steady at 64°F
0725	HORIBA DATA - Influent vapors - HC @ 9580 ppm, CO_2 @ 10.98% Propane 110
0730	Recorded data - MW-1B continues on increasing vacuum trend - Others
	off slightly - All Systems steady - Atmospheric steady MW-1B PSH = 58.94 H_2O 61.05
0800	Recorded data - Outer wells apparently not affected by SUE
0805	Increased EW vacuum to 50" H_2O, flow @ 11 CFB - Propane @ 100
0820	HORIBA DATA - Influent vapors - HC @ 15,590 ppm, CO_2 @ 9.92 - Propane @ 100
0830	Recorded data - EW @ 50" H_2O, flow @ 10 CFM - Outer wells mostly steady
	SUE-1 may be indicating a slight ↑ VOC trend - Also RW-1 - MW-1

AcuVac Remediation Inc.

OPERATING DATA - TEST # 1 PAGE # 2

ACUVAC SVE SYSTEM

Location: ROSWELL COMPRESSOR STATION - ROSWELL, NM Project Engr: SADLER | LUNDGREEN

		Date:	9/24/96	-	-	-	-	-
	Parameters		Time 0900 / Hr Meter 857.5	Time 0930 / Hr Meter 858.0	Time 1000 / Hr Meter 858.5	Time 1030 / Hr Meter 859.0	Time 1100 / Hr Meter 859.5	Time 1130 / Hr Meter 860.0
ENGINE/BLOWER	R.P.M.		2000	2000	2000	2000	2000	2000
	Oil Pressure	psi	50	50	50	50	50	50
	Water Temp	°F	160	160	160	160	160	160
	Volts		13.5	13.5	13.5	13.5	13.5	13.5
	Intake Vac	"Hg	13	13	13	12	12	12
	Gas Flow Fuel/Propane	cfh	100	100	100	90	90	90
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow	cfm	32	32	32	28	28	28
	Extraction Well Flow SVE-3	cfm	11.0	11.0	11.0	18	18	19
	Extraction Well Vac SVE-3	"H_2O	50	50	50	80	80	80
	Influent Vapor Temp	°F	66	66	66	66	66	66
	Air Temp	°F	64	65	67	66	67	69
	Barometric Pressure	"Hg	30.21	30.22	30.22	30.22	30.23	30.21
MONITOR WELL VACUUM	SVE-1	"H_2O	.04	.07	.07	.08	.08	.06
	SVE-2	"H_2O	.02	.05	.07	.07	.07	.05
	MW-1B	"H_2O	2.15	2.05	2.10	2.10	2.05	1.85
	MW-1	"H_2O	.03	.04	.04	.07	.07	.06
	RW-1	"H_2O	.03	.03	.03	.08	.07	.05
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
MANIFOLD	SVE	On/Off	ON	ON	ON	ON	ON	
	Air Injection Pressure	psi	OFF	-	-	-	-	-
	Air Injection Flow	cfm	OFF	-	-	-	-	-
	Samples				Influent AND Emissions			Influent Vapors

( ) Indicates Well Pressure

TEST	Instrument	HORIBA	HORIBA	HORIBA			
	Time	0955	0957	1125			
VAPOR/INFLUENT	HC ppm	12,780		14,910			
	CO_2 %	10.40		10.10			
	CO %	0		0			
EMISSIONS	HC ppm		96				
	CO_2 %		8.22				
	CO %		.02				
	Air/Fuel Ratio %		2811				

OPERATING DATA AND NOTES

DATE: 9/24/96 TEST NO: 1 Page No: 2

0900	Recorded data - Outer wells mostly steady - Temp and barometric
	pressure steady - SVE System normal
0930	Recorded data - Outer wells SVE-1 & 2 indicating slight
	increased vacuum - Others steady
0955	HORIBA DATA - Influent vapors - HC @ 12,780 ppm, CO_2 @ 10.40%
	Exhaust emissions - HC @ 96 ppm, CO_2 @ 8.22% CO @ .02%
1000	Recorded data - Outer wells steady - SVE-2 up slightly
1010	Increased EW vacuum to 80" H_2O, flow @ 18 cfm - Propane @ 90 c[fh]
1030	Recorded data - SVE #1 & 2 and MW-1 and RW-1 indicating
	an increasing vacuum trend in response to the EW increase
1100	Recorded data - Outer wells steady to off slightly - All
	SVE Systems and EW vacuum and flow steady
1125	HORIBA DATA - Influent vapors - HC @ 14,910 ppm, CO_2 @ 10.10%
1130	Recorded data - All outer wells indicating a decreasing vacuum
	trend - Slight decrease in barometric pressure - EW vac & flow steady
1135	Increased EW vacuum to 105 " H_2O, flow @ 26 cfm
	RPM @ 2300 - Propane @ 110 cfh

AcuVac Remediation Inc.

OPERATING DATA - TEST # 1 PAGE # 3

ACUVAC SVE SYSTEM

Location: ROSWELL COMPRESSOR STATION - ROSWELL, NM Project Engr: SADLER / LUNDGREN

	Parameters						
	Date:	9/24/96	–	–			
	Time	1200	1230	1315			
	Hr Meter	860.5	861.0	861.8			
ENGINE/BLOWER	R.P.M.	2300	2300	1700			
	Oil Pressure psi	50	50	50			
	Water Temp °F	170	170	160			
	Volts	13.5	13.5	13.5			
	Intake Vac "Hg	9.0	9.0	17.0			
	Gas Flow Fuel/Propane cfh	110	110	80			
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow cfm	26	26	24			
	Extraction Well Flow SVE-3 cfm	26	28	—			
	Extraction Well Vac SVE-3 "H_2O	105	105	—			
	Influent Vapor Temp °F	66	66	—			
	Air Temp °F	70	72				
	Barometric Pressure "Hg	30.20	30.18	30.15			
MONITOR WELL VACUUM	SVE-1 "H_2O	.08	.09	(.10)			
	SVE-2 "H_2O	.08	.08	(.10)			
	MW-1B "H_2O	1.70	1.60	1.30			
	MW-1 "H_2O	.06	.09	(.08)			
	RW-1 "H_2O	.07	.09	(.09)			
	"H_2O			STATIC WELL DATA - NO SVE			
	"H_2O						
	"H_2O						
	"H_2O						
	"H_2O						
	"H_2O						
MANIFOLD	SVE On/Off	ON	ON	OFF			
	Air Injection Pressure psi	OFF	–	–			
	Air Injection Flow cfm	OFF	–	–			
	Samples						

( ) Indicates Well Pressure

TEST	Instrument	HORIBA						
	Time	1210	1215					
VAPOR/INFLUENT	HC ppm	11,140						
	CO_2 %	9.92						
	CO %	0						
EMISSIONS	HC ppm		26					
	CO_2 %		9.94					
	CO %		.02					
	Air/Fuel Ratio %							

OPERATING DATA AND NOTES

DATE: 9/24/96 TEST NO: 1 Page No: 3

1200	Recorded data - Outer wells indicated slight increased
	vacuum to EW increase - SVE Systems normal for
	+ 10% CO_2 EW vac & flow steady
1210	HORIBA Data - Influent vapors HC@ 11,140 ppm, CO_2 9.92%
1215	Exhaust emissions - HC@ 26 ppm, CO_2 @ 9.94 % CO @ 0.02 %
1218	Exhaust emission sample - Tedlar bag
1220	Influent vapor sample - TW-101 - SS tube container - CORE LAB 1315
1230	Recorded data - Outer wells steady to slight vacuum
	increase - EW vac & flow steady
1245	Discontinued SVE
1315	Recorded static well data - SVE - 1 & 2, MW-1 & DW-1
	recording well pressure - MW-1B, reduced vacuum

Form/19952

AcuVac Remediation

OPERATING DATA - TEST NO 2 A-B-C

ACUVAC SVE SYSTEM

Page 1 Location ROSWELL COMPRESSOR STATION - ROSWELL, NM Project Engr. SADLER/LUNDGREN

		A	B				
	Date	9/24/96	—	9/25/96	—		
	Parameter	Time 1330	Time 1730	Time 1300	Time 1335	Time	Time
		Hr. Meter 862.0	Hr. Meter 866.0	Hr. Meter 872.8	Hr. Meter 873.4	Hr. Meter	Hr. Meter
IDENTIFICATION/ VAPOR DATA	Well No.	SVE-1	MW-3	MW-15	MW-15		
	HORIBA	—	—	—	—	—	—
	HC PPM	28	9520	68	56		
	CO_2%	10.82	10.52	0.88	0.88		
	CO%	0	0	0	0		
FUEL/AIR	Gas Flow Fuel/Propane cfh	150	110	160	160		
	Air Flow cfm	28	28	36	36		
	Well Flow cfm	15	22	16	14		
	Recovery Well Vac "H_2O	25	50	150	170		
	Air Temp °F	75	73	84	85		
	Barometric Pressure "Hg	30.15	30.05	29.87	29.85		

OPERATING DATA AND NOTES

1315	CONNECTED SVE to well SVE-1 as EW - Started test @ 1330 - Vac @ 15" H2O, Flow 25
1345	HORIBA DATA - SVE-1 Influent vapors - HC @ 28 ppm, CO2 @ 10.82, CO @ 0
	Oater well SVE-1 = .07 V
1700	Recorded DTPSH = 61.73' DTGW = 66.66' MW-16
1730	Recorded data on well MW-16 - Start SVE @ 1715
	HORIBA DATA - HC @ 9520 ppm, CO2 @ 10.52, CO = 0
9/25/96	
1300	CONNECTED System to MW-15 - Initial vacuum 150, flow @ 16 cfm
	TD = 68.5 Screen 38.5-68.5 - HORIBA Data @ 1315 hrs
1335	Additional HORIBA Data - Influent vapors - MW-15

AcuVac Remediation Inc.

OPERATING DATA - TEST # 3 PAGE # 1

ACUVAC SVE SYSTEM

Location: ROSWELL COMPRESSOR STATION - ROSWELL, NM Project Engr:

	Date:	9/24/96	–	–	–	–	–
	Parameters	Time 1425 / Hr Meter 862.9	Time 1430 / Hr Meter 863.0	Time 1500 / Hr Meter 863.5	Time 1530 / Hr Meter 864.0	Time 1600 / Hr Meter 864.5	Time 1630 / Hr Meter 865.0
ENGINE/BLOWER	R.P.M.	1200	2200	2200	2200	2200	2200
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	160	170	175	175	175	175
	Volts	13.5	13.5	13.5	13.5	13.5	13.5
	Intake Vac "Hg	17	16	16	16	16	16
	Gas Flow Fuel/Propane cfh	90	160	160	160	160	160
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow cfm	26	24	24	24	24	18
	Extraction Well Flow SVE-2 cfm	–	30	30	30	30	40
	Extraction Well Vac SVE-2 "H2O	–	25	25	26	26	40
	Influent Vapor Temp °F	–	71	70	69	69	69
	Air Temp °F	76	76	76	76	76	75
	Barometric Pressure "Hg	30.12	30.12	30.11	30.07	30.07	30.06
MONITOR WELL VACUUM	SVE-1 "H2O	(.01)	.08	.10	.11	.10	.11
	SVE-3 "H2O	0.70	.60	.56	.45	.36	.32
	MW-18 "H2O	0.90	.82	.70	.53	.47	.40
	MW-1 "H2O	(.07)	.03	.05	.04	.06	.06
	RW-1 "H2O	(.10)	.04	.06	.05	.07	.07
	"H2O	STATIC WELL DATA - NO SVE					
	"H2O						
	"H2O						
	"H2O						
	"H2O						
	"H2O						
MANIFOLD	SVE On/Off	OFF	ON				
	Air Injection Pressure psi	OFF	–	–	–	–	–
	Air Injection Flow cfm	OFF	–	–	–	–	–
	Samples						

( ) Indicates Well Pressure

TEST	Instrument	HORIBA	HORIBA				
	Time	1455	1615				
VAPOR/INFLUENT	HC ppm	848	826				
	CO_2 %	12.28	11.04				
	CO %	0	0				
EMISSIONS	HC ppm						
	CO_2 %						
	CO %						
	Air/Fuel Ratio %						

OPERATING DATA AND NOTES

DATE: 9/24/96 TEST NO: 3 Page No: 1

1410	Positioned SVE System near well SVE-2 - Connected system for extraction well EW - 1420 checked SVE System - Calibrate
1425	Recorded static well data - SVE-3 still has residual vacuum from Test #1, SVE-2 has slight residual vacuum from Test 2
1430	START TEST # 3 - Initial vacuum @ 25" H_2O, flow @ 30 cfm SVE-2 Screen 20-30 - TD = 30 - Sand gravel area
1455	HORIBA Data - Influent vapors - HC @ 848 ppm, CO_2 @ 12.28%
1500	Recorded data - Outer wells SVE-1, MW-1 & RW-1 continue to record slight increasing vacuum trend - SVE-3 and MW-1B still influenced by prior vacuums or liquid level changes
1530	Recorded data - Outer wells mostly steady - SVE steady Barometric pressure continues to decrease
1600	Recorded data - Outer wells steady to up slightly
1610	Increase EW vacuum to 40" H_2O, flow @ 38 cfm
1615	HORIBA DATA Influent vapors: HC @ 826 ppm, CO_2 @ 11.04%
1630	Recorded data - Outer wells steady to slight inc. on SVE-1 Barometric pressure still on decreasing trend - EW @ 40" H_2O, 40 cfm
1635	Discontinued SVE - Wells remain plugged - 1700 Recorded static well data -

Form/19952

AcuVac Remediation Inc.

OPERATING DATA - TEST # 3 PAGE # 2

ACUVAC SVE SYSTEM

Location: Roswell Compressor Station, Roswell, NM Project Engr: Sadler / Lundquen

	Date:	9/24/96					
	Parameters	Time 1715 / Hr Meter 8657	Time / Hr Meter	Time / Hr Meter	Time / Hr Meter	Time / Hr Meter	Time / Hr Meter
ENGINE/BLOWER	R.P.M.	1200					
	Oil Pressure psi	50					
	Water Temp °F	160					
	Volts	13.5					
	Intake Vac "Hg	17					
	Gas Flow Fuel/Propane cfh	90					
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow cfm	26					
	Extraction Well Flow SVE-2 cfm	—					
	Extraction Well Vac SVE-2 "H_2O	—					
	Influent Vapor Temp °F	—					
	Air Temp °F	73					
	Barometric Pressure "Hg	30.05					
MONITOR WELL VACUUM	SVE-1 "H_2O	(.03)					
	SVE-3 "H_2O	.22					
	MW-1B "H_2O	.20					
	MW-1 "H_2O	(.05)					
	RW-1 "H_2O	(.04)					
	"H_2O						
	"H_2O	STATIC WELL ON TO - NO SVE!					
	"H_2O						
	"H_2O						
	"H_2O						
	"H_2O						
MANIFOLD	SVE On/Off	OFF					
	Air Injection Pressure psi	OFF					
	Air Injection Flow cfm	OFF					
	Samples						

( ) Indicates Well Pressure

AcuVac Remediation Inc.

OPERATING DATA - TEST # 4-A I PAGE # 1

ACUVAC SVE SYSTEM

Location: ROSWELL COMPRESSOR STATION — ROSWELL, NM Project Engr: SADLER / LUNDGREN

		Date:	9/25/96	—	—	-	—	-
	Parameters		Time 0625 / Hr Meter 866.1	Time 0630 / Hr Meter 866.3	Time 0700 / Hr Meter 866.8	Time 0730 / Hr Meter 867.3	Time 0800 / Hr Meter 867.8	Time 0830 / Hr Meter 868.3
ENGINE/BLOWER	R.P.M.		1200	2200	2200	2200	2200	2300
	Oil Pressure	psi	60	50	50	50	50	50
	Water Temp	°F	150	160	160	160	160	165
	Volts		14	13.5	13.5	13.5	13.5	13.5
	Intake Vac	"Hg	14	14	14	14	14	13
	Gas Flow Fuel/Propane	cfh	80	130	130	130	130	140
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow	cfm	24	30	30	30	30	28
	Extraction Well Flow MW-1	cfm	—	25	25	25	25	30
	Extraction Well Vac MW-1	"H_2O	—	15	15	15	15	18
	Influent Vapor Temp	°F	—	64	64	64	64	64
	Air Temp	°F	66	66	64	63	65	66
	Barometric Pressure 3600'	"Hg	29.95	29.95	29.95	29.96	29.96	29.96
MONITOR WELL VACUUM	RW-1	"H_2O	.02	.10	.07	.08	.10	.12
	SVE-3	"H_2O	.03	.03	.05	.08	.09	.07
	SVE-1	"H_2O	.03	.03	.04	.08	.07	.06
	MW-1B	"H_2O	(.55)	(.60)	(.60)	(.65)	(.60)	(.65)
	MW-2	"H_2O	.10	.26	.27	.30	.30	.26
		"H_2O	STATIC WELL DATA - NO SVE					
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
		"H_2O						
MANIFOLD	SVE	On/Off	OFF	ON	ON	ON	ON	ON
	Air Injection Pressure	psi	OFF	—	—	—	—	—
	Air Injection Flow	cfm	OFF	—	—	—	—	—
	Samples					Influent Vapor		

( ) Indicates Well Pressure

TEST	Instrument	HORIBA	HORIBA	HORIBA			
	Time	0720	0825	0835			
VAPOR/INFLUENT	HC ppm	7510	6800				
	CO_2 %	12.14	11.82				
	CO %	0	0				
EMISSIONS	HC ppm			46			
	CO_2 %			10.02			
	CO %			.02			
	Air/Fuel Ratio %			26:1			

OPERATING DATA AND NOTES

DATE: 9/25/96 TEST NO: 4-AI Page No: 1

0605	Arrived at location - Connected SVE System to well MW
	as the extraction well (EW) - Checked System - All OK
0615	Recorded DTPSH = 36.96' DTGW 38.68' - Installed
	well boot with AI hose @ 51' - Calibrated instruments
0620	Recorded static well data - All wells indicating vac X MW-1B
0630	START TEST 4-AI - Initial EW vacuum @ 15" H₂O, Flow
	at 20 cfm - Engine very rough due to low O₂, high CO₂
	Outer well MW-2 indicated slight response - Also, RW-1
0700	Recorded data - RW-1 and MW-1B may be problem wells - Other
	wells indicated slight increasing vacuum trend
0720	HORIBA DATA - Influent vapors - HC @ 7510 ppm, CO₂ @ 12.14%
	Contaminate is mostly black motor oil over water, some diesel gas
0730	Recorded data - All outer wells indicating slight vacuum increase
	RW-1 and MW-1B will not be referred to as outer wells
0800	Recorded data - Outer wells indicating slight increase in vacuum
0805	Increased EW vacuum to 18" H₂O, flow @ 30 cfm
0825	HORIBA DATA Influent vapors HC @ 6800 ppm, CO₂ @ 11.82%
0830	Recorded data - Outer wells on decline - No response to EW increase.

AcuVac Remediation Inc.

OPERATING DATA - TEST # 4-AI PAGE # 2

ACUVAC SVE SYSTEM

Location: ROSWELL COMPRESSOR STATION - Roswell, NM Project Engr: SADLER / LUNDGREEN

	Date:	9/25/96	-	-	-	-	-
	Parameters	Time 0900	Time 0930	Time 1000	Time 1030	Time 1130	Time 1200
		Hr Meter 868.8	Hr Meter 869.3	Hr Meter 869.8	Hr Meter 870.3	Hr Meter 871.3	Hr Meter 871.8
ENGINE/BLOWER	R.P.M.	2300	2300	2300	2300	2300	1200
	Oil Pressure psi	50	50	50	50	50	50
	Water Temp °F	170	170	170	170	170	160
	Volts	13.5	13.5	13.5	13.5	13.5	13.5
	Intake Vac "Hg	13	13	13	13	13	16
	Gas Flow Fuel/Propane cfh	140	140	140	140	145	90
ATMOSPHERE/VAPORS/AIR	Fresh Air Flow cfm	30	30	30	28	28	24
	Extraction Well Flow cfm	25	25	25	30	30	—
	Extraction Well Vac MW-1 "H_2O	18	14	15	18	18	—
	Influent Vapor Temp MW-1 °F	65	65	65	66	66	—
	Air Temp °F	68	71	76	72	76	80
	Barometric Pressure "Hg	29.96	29.96	29.96	29.95	29.91	29.90
MONITOR WELL VACUUM	RW-1 "H_2O	.08	.07	.07	.08	.08	(.20)
	SVE-3 "H_2O	.10	.09	.06	.07	.07	(.19)
	SVE-1 "H_2O	.10	.10	.06	.09	.08	(.11)
	MW-1B "H_2O	(.65)	(.75)	(.80)	(.90)	(1.25)	(1.40)
	MW-2 "H_2O	.21	.14	.07	(.27)	(.64)	(.88)
	"H_2O						
	"H_2O						STATIC WELL DATA - NO SVE OR AI
	"H_2O						
	"H_2O						
	"H_2O						
	"H_2O						
MANIFOLD	SVE On/Off	ON	ON	ON	ON	ON	OFF
	Air Injection Pressure psi	7.0	7.0	7.0	10	OFF	OFF
	Air Injection Flow cfm	5.5	5.5	5.5	7.0	OFF	OFF
	Samples	Influent Vapor			Influent Vapor		

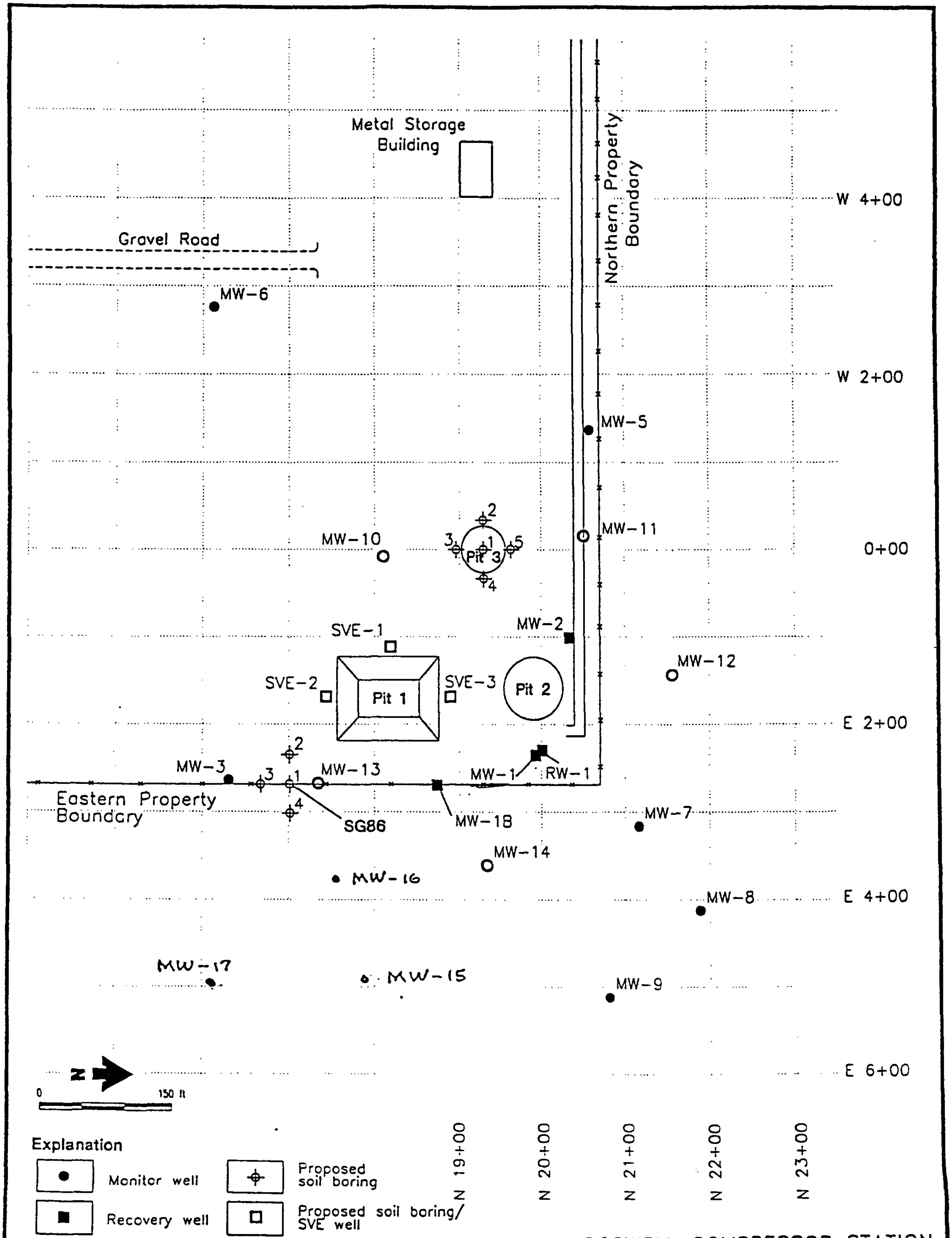
( ) Indicates Well Pressure

TEST	Instrument	HORIBA	HORIBA	HORIBA	HORIBA		
	Time	0915	1010	1040	1125		
VAPOR/INFLUENT	HC ppm	5710	5460	4550	6360		
	CO_2 %	9.90	9.78	8.50	12.20		
	CO %	0	0	0	0		
EMISSIONS	HC ppm						
	CO_2 %						
	CO %						
	Air/Fuel Ratio %						

OPERATING DATA AND NOTES

DATE: 9/25/96 TEST NO: 4-AI Page No: 2

0845	STARTED AI - Flow @ 5CFM, pressure @ 7.5PSI
	EW vacuum @ 18"H_2O, flow @ 25CFM
0900	Recorded data - Outer wells indicating slight vacuum
	decrease to steady - AI pressure & flow steady
0915	HORIBA DATA - Influent vapors - HC = 5710 ppm, CO_2 @ 9.90%
0930	Recorded data - Outer wells mostly steady - EW vacuum
	decreased to 14"H_2O
1000	Recorded data - Outer wells on decreasing vacuum trend
	AI press and flow steady at 7.0 psi, 5.5 cfm
1010	HORIBA Data - Influent vapors. HC @ 5460 ppm, CO_2 @ 9.78% Lab sample
1015	Increased EW vacuum to 20"H_2O, flow @ 30cfm - AI
	flow to 7.0cfm, press to 10PSI
1030	Recorded data - Outer SUE wells steady - MW-2 recording press
1040	HORIBA DATA HC = 4550 ppm CO_2 = 8.50% Lab sample SS canister #1388 - S# TW-103
1050	Discontinued AI
1125	HORIBA Data HC = 6360 ppm CO_2 = 12.20% - SUE ONLY NO AI
1130	Recorded data - Outer wells continue on decreasing trend - MW-2 big pressure
1200	Static well data - All wells indicating inc pressure - TEST 4-AI complete



ROSWELL COMPRESSOR STATION

Proposed Phase II Soil Boring and Monitor Well Locations

DANIEL B. STEPHENS & ASSOCIATES, INC.
12-19-95
JN 4115

Figure 3

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A N A L Y T I C A L   R E P O R T

Job Number: 964627
Prepared For:

DANIEL B. STEPHENS & ASSOCIATES
BOB MARLEY
6020 ACADEMY NE
ALBUQUERQUE, NM 87109

Date: 10/03/96

Signature: [signature]
Date: 10/3/96

Name: M. Jean Waits

Title: Supervising Chemist

CORE LABORATORIES
P O BOX 34766
HOUSTON, TX 77234-4282

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CORE LABORATORIES

LABORATORY TESTS RESULTS
10/03/96

JOB NUMBER: 964627 CUSTOMER: DANIEL B. STEPHENS & ASSOCIATES ATTN: BOB MARLEY

CLIENT I.D.........: 6033.2 Enron Roswell
DATE SAMPLED.......: 09/24/96
TIME SAMPLED.......: 12:20
WORK DESCRIPTION...: SVE-3

LABORATORY I.D...: 964627-0001
DATE RECEIVED....: 09/26/96
TIME RECEIVED....: 13:04
REMARKS..........:

TEST DESCRIPTION	FINAL RESULT	LIMITS/*DILUTION	UNITS OF MEASURE	TEST METHOD	DATE	TECHN
Extended Refinery Gas Analysis		*1		UOP 539, GPA 2286	10/03/96	AH
Hydrogen	<0.10	0.10	Mol %			
Oxygen	3.15	0.01	Mol %			
Nitrogen	80.21	0.01	Mol %			
Carbon Monoxide	<0.01	0.01	Mol %			
Carbon Dioxide	14.60	0.01	Mol %			
Hydrogen Sulfide	<0.01	0.01	Mol %			
Methane	0.76	0.01	Mol %			
Ethylene	<0.01	0.01	Mol %			
Ethane	<0.01	0.01	Mol %			
Propylene	<0.01	0.01	Mol %			
Propane	0.09	0.01	Mol %			
Isobutane	0.06	0.01	Mol %			
C4 Olefins	<0.01	0.01	Mol %			
n-Butane	0.22	0.01	Mol %			
Isopentane	0.16	0.01	Mol %			
n-Pentane	0.22	0.01	Mol %			
Hexanes Plus	0.53	0.01	Mol %			
Total	100.00	0.01	Mol %			
Relative Density	1.07145	0				
Gross Heating Value (Dry/Real)	62.4	0	BTU/CF 14.696			
---Analysis of Hexanes Plus	---------	0.001	Mol %			
Pentenes	<0.001	0.001	Mol %			
2,2-Dimethylbutane	0.006	0.001	Mol %			
2-Methyl Pentane	0.081	0.001	Mol %			
3-Methyl Pentane	0.053	0.001	Mol %			
n-Hexane	0.106	0.001	Mol %			
Hexenes	<0.001	0.001	Mol %			
Methylcyclopentane	0.043	0.001	Mol %			
Benzene	0.001	0.001	Mol %			
Cyclohexane	0.036	0.001	Mol %			
2-Methyl Hexane	0.017	0.001	Mol %			
3-Methylhexane	0.016	0.001	Mol %			
Dimethylcyclopentanes	0.016	0.001	Mol %			
n-Heptane	0.023	0.001	Mol %			
C7 Olefins	<0.001	0.001	Mol %			
Methylcyclohexane	0.027	0.001	Mol %			
Trimethylcyclopentanes	0.004	0.001	Mol %			
Toluene	0.002	0.001	Mol %			
2-Methylheptane	0.004	0.001	Mol %			
3-Methylheptane	0.004	0.001	Mol %			
Dimethylcyclohexanes	0.003	0.001	Mol %			
2,2,4 Trimethylpentane	<0.001	0.001	Mol %			
n-Octane	0.004	0.001	Mol %			

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10/03/96

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TIME SAMPLED.......: 12:20
WORK DESCRIPTION...: SVE-3

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DATE RECEIVED....: 09/26/96
TIME RECEIVED....: 13:04
REMARKS..........:

TEST DESCRIPTION	FINAL RESULT	LIMITS/*DILUTION	UNITS OF MEASURE	TEST METHOD	DATE	TECHN
Ethyl Benzene	<0.001	0.001	Mol %			
Xylenes	0.002	0.001	Mol %			
C9 Paraffins	0.006	0.001	Mol %			
n-Nonane	0.002	0.001	Mol %			
Decanes Plus	0.074	0.001	Mol %			
Total	0.531	0.001	Mol %			

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LABORATORY TESTS RESULTS
10/03/96

JOB NUMBER: 964627 CUSTOMER: DANIEL B. STEPHENS & ASSOCIATES ATTN: BOB MARLEY

CLIENT I.D.........: 6033.2 Enron Roswell
DATE SAMPLED.......: 09/25/96
TIME SAMPLED.......: 10:40
WORK DESCRIPTION...: MW-1 SVE/AI

LABORATORY I.D...: 964627-0002
DATE RECEIVED....: 09/26/96
TIME RECEIVED....: 13:04
REMARKS..........:

TEST DESCRIPTION	FINAL RESULT	LIMITS/*DILUTION	UNITS OF MEASURE	TEST METHOD	DATE	TECHN
Extended Refinery Gas Analysis		*1		UOP 539, GPA 2286	10/03/96	AH
Hydrogen	<0.10	0.10	Mol %			
Oxygen	1.46	0.01	Mol %			
Nitrogen	85.01	0.01	Mol %			
Carbon Monoxide	<0.01	0.01	Mol %			
Carbon Dioxide	12.02	0.01	Mol %			
Hydrogen Sulfide	<0.01	0.01	Mol %			
Methane	0.08	0.01	Mol %			
Ethylene	<0.01	0.01	Mol %			
Ethane	<0.01	0.01	Mol %			
Propylene	<0.01	0.01	Mol %			
Propane	0.03	0.01	Mol %			
Isobutane	0.02	0.01	Mol %			
C4 Olefins	<0.01	0.01	Mol %			
n-Butane	0.08	0.01	Mol %			
Isopentane	0.08	0.01	Mol %			
n-Pentane	0.15	0.01	Mol %			
Hexanes Plus	1.07	0.01	Mol %			
Total	100.00	0.01	Mol %			
Relative Density	1.06690	0				
Gross Heating Value (Dry/Real)	71.9	0	BTU/CF 14.696			
---Analysis of Hexanes Plus	---------	0.001	Mol %			
Pentenes	<0.001	0.001	Mol %			
2,2-Dimethylbutane	0.003	0.001	Mol %			
2-Methyl Pentane	0.077	0.001	Mol %			
3-Methyl Pentane	0.051	0.001	Mol %			
n-Hexane	0.160	0.001	Mol %			
Hexenes	<0.001	0.001	Mol %			
Methylcyclopentane	0.052	0.001	Mol %			
Benzene	0.013	0.001	Mol %			
Cyclohexane	0.056	0.001	Mol %			
2-Methyl Hexane	0.047	0.001	Mol %			
3-Methylhexane	0.040	0.001	Mol %			
Dimethylcyclopentanes	0.034	0.001	Mol %			
n-Heptane	0.113	0.001	Mol %			
C7 Olefins	<0.001	0.001	Mol %			
Methylcyclohexane	0.096	0.001	Mol %			
Trimethylcyclopentanes	0.021	0.001	Mol %			
Toluene	0.029	0.001	Mol %			
2-Methylheptane	0.035	0.001	Mol %			
3-Methylheptane	0.030	0.001	Mol %			
Dimethylcyclohexanes	0.037	0.001	Mol %			
2,2,4 Trimethylpentane	<0.001	0.001	Mol %			
n-Octane	0.055	0.001	Mol %			

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10/03/96

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DATE SAMPLED.......: 09/25/96
TIME SAMPLED.......: 10:40
WORK DESCRIPTION...: MW-1 SVE/AI

LABORATORY I.D...: 964627-0002
DATE RECEIVED....: 09/26/96
TIME RECEIVED....: 13:04
REMARKS..........:

TEST DESCRIPTION	FINAL RESULT	LIMITS/*DILUTION	UNITS OF MEASURE	TEST METHOD	DATE	TECHN
Ethyl Benzene	0.003	0.001	Mol %			
Xylenes	0.014	0.001	Mol %			
C9 Paraffins	0.034	0.001	Mol %			
n-Nonane	0.023	0.001	Mol %			
Decanes Plus	0.048	0.001	Mol %			
Total	1.073	0.001	Mol %			

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Ana[redacted]echnologies, Inc., Albuquerque, NM

San Dieg[redacted]Phoenix • Seattle • Pensacola • Ft. Collins • Portland • Albuquerque

[redacted] OF [redacted]USTODY

DATE: 9/25/96 PAGE 1 OF 1

ATI LAB I.D. [redacted]

PLEASE FILL THIS FORM IN COMPLETELY. SHADED AREAS ARE FOR LAB USE ONLY.

PROJECT MANAGER: Bob Marley

COMPANY: Daniel B. Stephens & Assoc.
ADDRESS: 6020 Academy NE Suite 100
Albuq. NM 87109
PHONE: (505) 822 9400
FAX: (505) 822 8877

BILL TO: George Robinson
COMPANY: c/o ENRON Enviro Affairs
ADDRESS: 1400 Smith St
Houston, TX 77002

ANALYSIS REQUEST

SAMPLE ID	DATE	TIME	MATRIX	LAB ID	Petroleum Hydrocarbons (418.1)	(MOD 8015) Gas/Diesel	Diesel/Gasoline/BTXE/MTBE (MOD 8015/8020)	BTXE/MTBE (8020)	Fixed & Extended Refinery Gas	BTEX	Chlorinated Hydrocarbons (601/8010)	Aromatic Hydrocarbons (602/8020)	SDWA Volatiles (502.1/503.1), 502.2 Reg. & Unreg.		Pesticides/PCB (608/8080)	Herbicides (615/8150)	Base/Neutral/Acid Compounds GC/MS (625/8270)	Volatile Organics GC/MS (624/8240)	Polynuclear Aromatics (610/8310)		SDWA Primary Standards - Arizona	SDWA Secondary Standards - Arizona	SDWA Primary Standards - Federal	SDWA Secondary Standards - Federal		The 13 Priority Pollutant Metals	RCRA Metals by Total Digestion	RCRA Metals by TCLP (1311)		NUMBER OF CONTAINERS
SVE-3	9/24/96	1220	Air						X	X																				
MW-1 SVE/AI	9/25/96	1040	Air																											

PROJECT INFORMATION		SAMPLE RECEIPT	
PROJ. NO.:	6033.2	NO. CONTAINERS	
PROJ. NAME:	ENRON - Roswell	CUSTODY SEALS	Y / N / NA
P.O. NO.:		RECEIVED INTACT	
SHIPPED VIA:	Fed X	RECEIVED COLD	

PRIOR AUTHORIZATION IS REQUIRED FOR RUSH PROJECTS

(RUSH) ☐24hr ☐48hr ☐72hr ☐1 WEEK (NORMAL) ☐2 WEEK

Comments:

SAMPLED & RELINQUISHED BY: 1.	RELINQUISHED BY: 2.	RELINQUISHED BY: 3.
Signature: Bob Marley Time: 1700	Signature: Time:	Signature: Time:
Printed Name: Bob Marley Date: 9/25/96	Printed Name: Date:	Printed Name: Date:
Company: DBS&A Phone: 505 822 9400	Company:	Company:

RECEIVED BY: 1.	RECEIVED BY: 2.	RECEIVED BY: (LAB) 3.
Signature: Time:	Signature: Time:	Signature: Roy Baldwin Time: 1050
Printed Name: Date:	Printed Name: Date:	Printed Name: Roy Baldwin Date: 9-26-96
Company:	Company:	Analytical Technologies, Inc.