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September 10, 1993

Mr. Waddell Watters  
North Carolina Department of Environment,  
Health and Natural Resources  
8025 North Point Blvd., Suite 100  
Winston-Salem, NC 27106

*Red Horse Truck Stop*

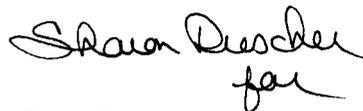
**Reference:**        **Corrective Action Plan**  
                         **Unocal Corporation**  
                         **Former Unocal Station #9787-214**  
                         **1342 Trollingwood Road**  
                         **Mebane, North Carolina**  
                         **S&ME, Inc. Project No. 1584-92-080**

Dear Mr. Watters:

On behalf of Unocal Corporation, S&ME, Inc. presents herein a Corrective Action Plan (CAP) for in-situ vapor extraction and air sparging of subsurface soils and groundwater containing gasoline constituents. This report conforms to the "Corrective Action Plan Guidelines", Section 15.4 presented by the North Carolina Department of Environment, Health and Natural Resource's (NCDEHNR) March 1993 "Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater", and to regulations specified in 15A NCAC 2N. 0707 and Federal Register 40 CFR 280.27. The purpose of this CAP is to satisfy the NCDEHNR requirements for a finalized CAP and implementation schedule.

If you have any questions or need additional information,  
please do not hesitate to contact us.

Sincerely,  
S&ME, Inc.



Joe Best  
Project Geologist



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SMH/DAH/ss  
Enclosures

cc: Wayne Holt, P.G. - Unocal Corporation  
Rick Holshouser, Jr. - S&ME, Inc.  
Myron Whitley - NCDEHNR, Air Quality Section  
Ray Jernigan - Property Owner

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**CORRECTIVE ACTION PLAN  
FORMER UNOCAL STATION #9787-214  
1342 TROLLINGWOOD ROAD  
MEBANE, NORTH CAROLINA  
S&ME PROJECT NO. 1584-92-080**

Prepared For:

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## 2 INTRODUCTION

The remedial approach outlined herein will utilize an integrated air sparging and soil vapor extraction system for remediation of hydrocarbons on-site and off-site. The proposed remediation system will consist of eight vertical air sparging wells surrounded by two horizontal soil vapor extraction wells. The air sparging system will utilize one 25-Hp (105 scfm @ 125 psi) air compressor integrated with an electronic timer and three 2-inch electric solenoids to cycle air sparging. The soil vacuum extraction (SVE) system will utilize one 25-Hp (600 scfm @ 14" Hg) vacuum blower and treatment of off-gas by two 500 lb., 500 scfm capacity, vapor phase carbon units in series.

### Site Name/Location

Figure 1 illustrates the former Unocal station #9787-214 (site) located in Mebane, Alamance County, North Carolina on the 1969, 7.5 series U.S.G.S. Mebane, NC Quadrangle topographic map. Figure 2 illustrates a scaled base map of the site.

Figures 3 and 4 illustrate the groundwater potentiometric map on March 25, 1993 and January 18, 1993, respectively. Table 1 provides the liquid level data from all wells on-site and off-site on these dates. Table 2 summarizes the free product recovery efforts to date and indicates that no measurable product has been present since March 8, 1993.

Figure 5 illustrates the horizontal extent of the soil TPH plume beneath the site. Table 3 provides a summary of the soil TPH analytical data collected for the site assessment. Figure 6 illustrates the horizontal extent of the groundwater BTEX plume. Figure 7 illustrates the horizontal extent of the groundwater MTBE. Table 4 provides a summary of the groundwater quality analytical data collected for the site assessment.

The responsible party, owner/operator of the former underground storage tanks on-site and property owner is Unocal Corporation. To our knowledge, no groundwater incident identification number has been assigned to this site.

### Purpose of CAP

The purpose of this Corrective Action Plan (CAP) is to satisfy federal and state requirements for site clean-up and provide an implementation schedule. Based on our experience and success with remediation of gasoline hydrocarbons at similar sites in the Piedmont area, we believe that the proposed remediation system will remediate hydrocarbon contaminated soil and groundwater beneath the site to NCDEHNR acceptable levels in a effective and economical manner.

Specific groundwater exceedances include groundwater quality standards per 15A NCAC 2L (including benzene @ 1 ug/L, toluene at 1000 ug/L, ethylbenzene @ 29 ug/L, total xylenes @ 400 ug/L, 1,2-Dichloroethane @ 0.38 ug/L, as well as soil quality standards per state guidance levels of 10 ppm TPH (volatiles). There are no numeric standards for phenol, dimethylphenol, naphthalene and 2-methylnaphthalene, thus the standard becomes the quantitation limit for that contaminant (i.e. 10 ug/L). The low concentrations (1.7 ug/L to 7 ug/L) of chloroform, methylene chloride and 1,1,2,2-tetrachloroethane are believed to be laboratory artifacts and not gasoline constituents or by-products. Phase separated hydrocarbons were also previously detected in monitor well MW-4 in February and March 1993 at 0.01 feet thickness.

Worst case groundwater concentrations noted to date include: Benzene - 26,800 ug/L in MW-4 on 1/18/93, Toluene - 42,000 ug/L in MW-4 on 1/18/93, Ethylbenzene - 17,000 ug/L in MW-2 on 1/7/93, Total xylenes - 95,000 ug/L in MW-2 on 1/7/93, MTBE - 12,000 ug/L in MW-4 on 1/18/93, 1,2 Dichloroethane - 8.4 ug/L in MW-3 on 1/26/93, phenol - 28 ug/L in MW-2 on 1/18/93, dimethylphenol - 22 ug/L in MW-3 on 1/26/93, naphthalene - 3300 ug/L in MW-4 on 1/18/93 and 2-methylnaphthalene - 3300 ug/L in MW-4 on 1/18/93. Table 4 is a summary of all groundwater quality data.

Worst case soil TPH concentrations detected in test boring soil samples on-site and off-site include the following: TPH (volatiles) - 1200 mg/Kg from MW-2 at 15 feet, and TPH (semivolatiles) - 13 mg/Kg from TMW-8 at 10 feet. BTEX concentrations in soils collected were highest in MW-2 (132.81 mg/Kg or ppm). Organic vapor concentrations exceeded 1000 ppm in soils collected at MW-2 (14 - 20.5 feet), MW-3 (14 - 20.5 feet) and MW-4 (9 - 20.5 feet). Table 3 provides soil TPH and organic vapor readings.

Worst case vapor concentrations in the vadose zone were measured during a soil vapor extraction pilot test, in which carbon tube samples were taken for TPH scan analysis. The highest soil gas TPH vapor concentration was 6575 mg/m<sup>3</sup> TPH from pilot test vapor extraction well PZ-1 (approximately 15 feet from MW-4). The highest benzene vapor concentration was 285 mg/m<sup>3</sup> from PZ-1. Table 6 indicates the vapor extraction pilot test air quality and emission data.

The state classification of the affected groundwater beneath the site is Class GA, per 15A NCAC 2L. 0201. The groundwater in the site vicinity is suitable for drinking purposes. Municipal water is supplied by Alamance-Orange Water Authority.

The closest active drinking water well to the hydrocarbon plume is located at 2715 Trollingwood Road located approximately 600 feet south-southeast from the site on the property of Mr. John Williams (adjacent to the subject site). The well is located approximately 500 feet outside the horizontal extent of the dissolved gasoline plume. There are no active drinking water wells within the plume boundary. A water well located on site (not currently being used) is located behind the restaurant building. This well was sampled and found to contain 1.4 ug/L 1,2-dichloroethane.

#### Summary of Initial Remedial Actions to Date

In 1992 James Contracting Company of Marietta, Georgia removed 11 USTs from the site. The USTs included: 4 - 4,000 gallon gasoline, 4 - 10,000 gallon diesel, 1 - 270 gallon kerosene, 1 - 560 gallon kerosene and 1 - 270 gallon used oil. Laboratory analyses

of soil samples collected at the time of removal detected petroleum hydrocarbon concentrations in excess of North Carolina standards.

In June of 1992, James Contracting Company excavated 3,314 tons of petroleum contaminated soil. The soil was transported to the Cherokee Sanford Group located in Sanford, North Carolina for thermal treatment. The soil sampling and closure report were performed by ENSCI of High Point, North Carolina (ENSCI UST Closure and Site Investigation Report, dated August 10, 1992).

A preliminary environmental evaluation was performed by Ecological Services, Inc. (ESI) of Charlotte, North Carolina. ESI performed 12 soil borings and 15 geoprobe (groundwater) samples. Based on the results of ESI's assessment, the installation of three groundwater monitoring wells was recommended.

S&ME, Inc. performed a Comprehensive Site Assessment (CSA) from January to April 1993. Seven permanent groundwater monitoring wells were installed and sampled at the site. One temporary monitoring well was installed on an adjacent property. Monitoring well MW-4 contained approximately 0.01-feet of phase separated hydrocarbons. Monitoring wells MW-2, MW-5 and MW-3 contained dissolved hydrocarbons. The results of all laboratory analyses are summarized in Table 4. The CSA concluded that petroleum hydrocarbons in groundwater were confined to the site with the exception of a small area under Trollingwood Road. Soil contamination is still present beneath and outside the excavations (Figure 5).

In June of 1993, S&ME conducted a one-day vapor extraction pilot test and one-day air sparging pilot test, as part of the Remedial Action Plan design.

## 2.1 QUANTITY OF HYDROCARBONS IN SUBSURFACE

A total of 3,314 tons of contaminated soil were excavated and treated off-site. Assuming an average concentration of 500 mg/kg of total petroleum hydrocarbons (TPH)

in the excavated contaminated soil areas (approximately 2550 cubic yards or 3,314 tons), an estimated 6000 lbs. of hydrocarbons were removed from the site via soil excavation.

Based on information from the Comprehensive Site Assessment Report of February 19, 1993 and CSA Addendum dated April 14, 1993, the following extent and amounts of hydrocarbons are present in the soil and groundwater beneath the site and off-site. For estimation purposes, phase-separated hydrocarbons are assumed to no longer be present, but rather adsorbed to the unsaturated soils, since product has not been measured in MW-4 since March 1993. The estimated area of dissolved hydrocarbons (BTEX plume) covers approximately 51,000 square feet, (Figure 6) and is estimated to be approximately 50 feet thick. The estimated soil plume covers approximately 16,000 square feet, (Figure 5) and is estimated to be 15 feet thick. One contaminated groundwater site volume (340' long x 150' wide x 50' deep (average over plume) x 0.3 effective porosity x 7.48 gallons/cubic foot) is estimated to be 5.7 million gallons of groundwater containing dissolved gasoline constituents above state standards. Assuming an average dissolved concentration of 5000 ug/L (ppb) of BTEX for the site volume, an estimated 250 lbs. of hydrocarbons are present in the dissolved phase (groundwater). Assuming an average concentration of 100 mg/kg of total petroleum hydrocarbons (TPH) in the contaminated soil area (approximately 9,000 cubic yards or 12,000 tons), an estimated 4000 lbs. of hydrocarbons are present in the adsorbed phase. Therefore, the total quantity of hydrocarbons present beneath the site is estimated to be less than 5,000 lbs. The quantity of hydrocarbons that have been naturally degraded or volatilized will be estimated during yearly remediation updates.

#### Previous Reports Submitted to the NCDEHNR

The following reports were submitted to the NCDEHNR on the associated dates in chronological order:

<u>Date</u>	<u>Report</u>	<u>Consultant</u>
6/29/92	Environmental Evaluation	ESI
8/10/92	UST Closure and Site Investigation	ENSCI
2/19/93	Comprehensive Site Assessment	S&ME
4/14/93	Addendum to Comprehensive Site Assessment	S&ME

### Previous Permits/Certificates

No permits (other than the state monitor well permit) or certificates have been issued for this site.

## **3 OBJECTIVES OF THE CAP**

### Statement of Goals

This CAP is designed to achieve the following objectives: (a) remove any remaining phase separated hydrocarbons from beneath the site by volatilization from the soil vapor extraction (SVE) and air sparging (AS) processes, (b) reduce or remove the adsorbed hydrocarbons in the vadose zone by SVE process to levels that will not cause contravention of North Carolina NCAC 15A 2L groundwater standards and to levels that are below state acceptable soil TPH levels, (c) reduce or remove the adsorbed and dissolved hydrocarbons in the phreatic zone to state acceptable levels in the areas defined in Figures 6 and 7, and (d) install an economical and effective remediation system using best available technology, which is considered reasonable and necessary.

Remediation of the entire hydrocarbon plume area, as shown in Figures 5 through 7 will be performed by operating two horizontal lines of air sparging and soil vapor extraction wells perpendicular to groundwater flow. Groundwater flow has remained unchanged towards the northwest since the first water levels were taken in January - 1993 (See Figures 3 and 4). Air sparging will be operated on a cyclic basis (i.e. 12 hours on and 12 hours off for different AS lines), whereas soil vapor extraction will be operated continuously. In this way, "dry" zones around the air sparging wells will be minimized so that the groundwater will be able to return to natural flow direction during off periods. As the groundwater plume moves across the three lines of air sparging and vapor extraction wells under natural hydraulic gradient, volatilization of dissolved and adsorbed hydrocarbons will occur, such that the entire groundwater plume on-site and the majority of the off-site plume underneath Trollingwood Road will be remediated. The estimated groundwater flow velocity is approximately 48 feet/year or 0.131 feet/day.

### Target Cleanup Concentrations for Soil and Groundwater

Tables 3 and 4 indicate existing soil TPH and groundwater analytical results. The CAP proposes to establish the target clean-up levels based on the worst case groundwater and soil concentrations mentioned in Section 2. The proposed soil TPH (volatiles) clean-up level would be 10 ppm, whereas, the soil TPH (semi-volatiles) clean-up level would be 40 ppm, per the latest NCDEHNR soil remediation guidelines. Petroleum contaminated groundwater will be remediated until "achievement of an asymptotic relationship between the clean-up goal and clean-up results". The clean-up goal would be the constituent concentration considered to be the asymptote on a concentration versus-time plot wherein continued remediation would not produce significant groundwater remediation. S&ME and Unocal understand that final soil and groundwater clean-up levels may be decided in negotiations with the NCDEHNR after the remedial action system effectiveness is demonstrated. Final clean-up levels could include application to the NCDEHNR for variances from established groundwater standards or a restricted (R5) designation for site groundwaters.

### Target Start-up and Completion Dates of Remedial Action Plan

Chart 7 indicates the estimated schedule for implementation of the CAP, installation of the remediation system, start-up of the remediation system and first year of operation and maintenance. The estimated time to achieve site closure is between 1 to 3 years from start-up of the remediation system. This time frame is estimated and should not be considered absolute, as air sparging is a new technology and to our knowledge, site closure by air sparging has not yet been achieved in North Carolina.

## **4 EXPOSURE ASSESSMENT**

### Historical Analytical Data

Historical soil and groundwater analytical data is included in Tables 3 and 4. Free product (0.01 ft.) was previously detected in monitor well MW-4 but is no longer evident. Worst case groundwater, soil and vapor concentrations measured for this CAP are mentioned in Section 2.

### Physical and Chemical Parameters of Contaminants

A Henry's constant value ( $K_h$ ) of  $> 10E-5$  at  $m^3/mole$  indicates a "strippable" volatile constituent. Henry's constants for BTEX range from  $5.6E-3$  to  $8.4E-3$  at  $m^3/mole$ . The  $K_{oc}$  indicates the ability of the compound to partition from the aqueous phase to the adsorbed phase.  $K_{oc}$  levels below 50 ml/g indicate contamination resides principally in the soil matrix.  $K_{oc}$  levels for soil BTEX range from 100 to 1100 ml/g, 2200 ml/g for MTBE and 7100 ml/g for TPH (C7-C22). The volatility of a compound is indicated by the vapor pressure of the material. Vapor pressures greater than 1 mm Hg at  $25^{\circ}C$  indicate that the contaminants volatilize readily and are, therefore, retrievable via soil vacuum extraction. Vapor pressures for BTEX range from 9.5 to 95 mm Hg at  $25^{\circ}C$ , 2 mm Hg for MTBE and 11 mm Hg for TPH (C7-C22). These contaminant properties thus indicate that volatilization based remedial technologies (i.e. soil vacuum extraction and air sparging) are feasible.

### Significant Pathways for Human Exposure

Potential pathways for human exposure of hydrocarbon vapors, contaminated soils or groundwater on-site and off-site are minimal. These pathways include utility line excavations (when present). No basements were identified in the plume area or immediate vicinity during the water well survey for the Comprehensive Site Assessment.

There are no surface water bodies within or immediately adjacent to the hydrocarbon plume. Soil gasoline contamination exists at approximately 15 feet or deeper below the ground surface. The water table lies approximately 12 to 17 feet below ground surface. Thus, there is minimal risk of human exposure to the subsurface gasoline contamination at present. Exposure routes would include (a) inhalation from open excavations within the plume (none present) or from open wells (none present), or ingestion of water from a contaminated well (not likely).

Current use of the land is residential, agricultural and commercial. Future use of the land is likely to become more commercial, as most of the property along Trollingwood Road and I-85 is zoned commercial.

### Potential Effects of Residual Contamination (Post Remedial)

Natural degradation of post remedial hydrocarbons will further reduce contaminant concentrations to levels which should not impact surface water or groundwater that is being used for human or animal consumption.

### Potential Receptors at Greatest Risk

The water well located on the adjacent Williams property represents the greatest potential pathway for human exposure. The location of this well was identified in the CSA. Groundwater pumping from the Williams well does not appear to alter the natural flow of groundwater towards the northwest. The Williams well is located hydraulically upgradient of the contamination plume.

## **5 EVALUATION OF REMEDIAL ALTERNATIVES**

A broad feasibility screening was performed to assist in the selection of remedial technologies and the final development of the preferred remedial alternative for the site. Each technology was evaluated according to effectiveness, implementability and cost. Treatment of soil by additional excavation was deemed too expensive and not feasible for contaminated soils extending 5 to 10 feet beneath the water table. Treatment of soils by vitrification is considered too expensive for the small quantity of contaminated soils remaining on-site. Treatment of groundwater by pump and treat technology was considered to expensive, slow in mass removal of contaminants due to low pumping rates, as well as, difficult to permit discharge, as the POTW would not accept the treated water. Pump and treat does not address the soil contamination above the water table and very little beneath the water table. In-situ bioremediation with addition of nutrients and oxygen releasing chemicals into the contaminated soils and groundwater is considered less cost effective than air sparging, which is an enhanced form of natural biodegradation. Permitting of in-situ bioremediation is also more expensive and time consuming, as compared to in-situ air sparging and soil vapor extraction.

Based upon screening of remedial alternatives, a combined air sparging and soil vapor extraction system was considered the most expeditious in terms of state and public

acceptance, most effective in terms of achieving site closure, and least costly technology for the treatment of all phases of hydrocarbons on-site. The most cost effective option for initial air emission treatment is believed to be vapor phase carbon units due to (a) the relatively low concentrations of vapor hydrocarbons measured during the pilot VE test (average TPH concentration = approx. 5000 mg/m<sup>3</sup>), (b) estimated design (maximum) inlet air flow rate (400 scfm), (c) high removal efficiency (99.999%), (d) relatively small quantity of hydrocarbons in the subsurface to be removed by volatilization (approx. < 5000 lbs.), (e) equipment cost, (f) relative cost for other air treatment devices (i.e. CATOX, THERMOX, etc.), and (g) high monthly cost to maintain these alternative air treatment systems (i.e. natural gas cost (approx. \$0.56/Therm) for CATOX vs. electrical cost (approx. \$0.62/Therm) for THERMOX.

Air sparging is considered much more effective than pump and treat due to the mass transfer limitations with groundwater recovery in a silty formation and the fact that the contaminants can be treated in place. Air sparging treats a much greater volume of contaminated groundwater per unit of time than conventional above ground air stripping give that in-place sparging is not limited by groundwater removal rates.

## **6 SOIL VAPOR EXTRACTION (SVE) AND AIR SPARGING (AS)**

### **PILOT TEST RESULTS**

S&ME conducted a 2-day air sparging (AS) and soil vapor extraction (SVE) pilot test on June 14 and 15, 1993, respectively (See Appendices 1 and 2). The SVE test was utilized by newly installed piezometers PZ-1 and PZ-2, whereas, the air sparging test was performed at deep "Type III" monitor well MW-5. Hydrocarbon vapors from the SVE test were not treated, since the total air emissions from the test were expected to be far below the NCDEHNR guidance limit of 40 lbs./day of total petroleum hydrocarbons (TPH). The actual air emissions from the 3-hour SVE pilot test were < 3 lbs. of TPH and < 0.15 lbs. of benzene. The emissions from the SVE test did not contravene any applicable ambient air quality emission control standard.

Equipment used for the AS pilot test consisted of a 3.5-Hp reciprocating air compressor powered by a single phase, 220-volt generator. The air compressor is capable of providing 2 scfm at 20 psi and 8 cfm at 50 psi. Equipment used for the SVE pilot test consisted of a 7.5-Hp mobile vacuum unit, which was connected to newly installed piezometers PZ-1 and PZ-2. The vacuum unit was powered by a 3-phase, 230-volt generator. The vacuum unit is capable of providing a vacuum range of between 50 to 100-inches of water and an air flow range of between 30 to 300 scfm.

Data from the pilot test was used to: (a) gather information for final SVE and AS remediation system design; (b) evaluate air compressor and vacuum operation settings including pressure, air flow and temperature; (c) assess the effectiveness of remediation by SVE and AS, in terms of radial influence (ROI) by recording negative pressures and upwelling of the water table in nearby monitor wells/piezometers for the SVE test and by recording upwelling of the water table, dissolved oxygen, organic vapor readings, positive pressures and ability to inflate balloons in nearby monitor wells and piezometers during the AS test; (d) aid in placement of proposed AS and SVE wells based on ROI measurements, (e) analyze air emission samples from the SVE test to evaluate the type and total quantity of hydrocarbons extracted during the pilot test and predict extraction and emission rates for the proposed SVE remediation system and; (f) assess if air emission treatment will be necessary to reduce emissions below the NCDEHNR guidance limit of 40 lbs./day of TPH.

The construction specifications for PZ-1 and PZ-2 consisted of a 2-inch diameter, schedule 40-PVC well screened with 0.020-inch slot screen from 5 feet to 20 feet below ground surface. A sand pack was used around the screen interval and was overlain with bentonite and grout to seal the well from air loss. The construction specifications for MW-5 are contained in the Site Assessment Report and consisted of an outer 4-inch diameter, schedule 40 PVC casing to 40 feet, and an inner 2-inch diameter, schedule 40-PVC well screened with 0.010-inch slot screen from 50 feet to 55 feet below ground surface. The outer annular space for the outer casing was grouted to ground surface. A sand pack was used around the inner well screen interval and was overlain with bentonite and grout to seal

the well from air loss. The well borehole was drilled with air rotary as part of the site assessment to evaluate the vertical extent of dissolved hydrocarbons. The SVE and AS pilot test wells were positioned in the area of greatest hydrocarbon concentration on-site (near MW-4, which at one time contained free product) and such that existing monitor wells were located at orthogonal radii.

## 6.1 METHODOLOGY

### Air Sparging

Control of the air flow and pressure into MW-5 during the AS pilot test was accomplished through regulators and gauges on the outlet air line. To assess the effectiveness of different air sparging rates during the pilot test, the air compressor was operated at varying flows and pressures.

The ROI was measured during the AS pilot test by measuring dissolved oxygen, upwelling of the water table, organic vapor readings, positive pressures (manometer), and inflating of balloons (to note very low positive pressures) at nearby monitor wells and piezometers. From this data, the air entry pressure, control settings for optimum sparging ROI, and effectiveness of AS were assessed.

### Soil Vapor Extraction

Control of the vacuum and air flow was accomplished through the dual inlet air valves. No ambient air was bled into the system during the SVE test. To assess the maximum ROI, and thus effectiveness of the SVE pilot test, the vacuum unit was operated at the maximum achievable vacuum from PZ-1 and PZ-2.

Off-gases from the vacuum unit discharge stack were sampled periodically and at varying sample volumes (i.e. 1 liter, 2 liter and 5 liters) for both test wells. The air samples revealed both extraction and emission rates, since no air treatment was used. Six carbon (charcoal) tubes were used to collect the hydrocarbon vapors. The carbon tubes were attached to SKC air sampling pumps, which were calibrated before use. One liter air

samples #1 and #4 were not analyzed, since greater detection limits are achieved with greater sample volumes, according to MDS laboratory, which analyzed the samples. The air samples were analyzed for total hydrocarbon scan (see Appendix 3). Total organic vapors were also measured at the time of each carbon tube sample with a Foxboro organic vapor analyzer (OVA) for comparison, as indicated in Appendix 3.

During the pilot test, negative pressures (vacuum) from PZ-1 and PZ-2 were recorded 10 and 29 feet away in the peripheral wells using a slack tube manometer, as illustrated in Charts 1 and 2, and indicated in Appendix 1. No significant rises in the water table were measured in nearby monitor wells or piezometers probably due to the short duration of the test. Upwelling of the water table did occur in the vacuum test wells (3.2 feet). This measurement is useful in evaluating the maximum vacuum level that can be utilized while maintaining the groundwater table below the top of well screen. Once the water table has risen over the top of a vacuum well screen, the vacuum unit can easily pull water up to the surface and into the moisture separator, thus deactivating the SVE and interlocked AS processes.

Vacuum unit readings were made during each carbon tube sample, vapor point pressure and water level reading and wellhead measurements to correlate air emissions and radial influence at corresponding vacuum levels. Vacuum unit readings consisted of: (1) inlet and outlet pitot tube (air flow) measurements (in inches of water), (2) inlet vacuum readings (in inches of water), and (3) inlet and outlet temperatures, which were used to calculate inlet (wellhead) and outlet (discharge) air flow rates in scfm. Equipment readings during the tests are provided in Appendices I and II.

## 6.2 EQUIPMENT OPERATIONAL SETTINGS

### Air Sparging

During the AS test, air pressures and air flow rates were 2 scfm @ 20 psi, 3 scfm @ 40 psi, and 8 scfm @ 50 psi. Higher air flow and volatilization rates are achievable using a larger air compressor. The air entry pressure is considered to be 15 psi. At this air

pressure, air flow (1 scfm) can be measured moving into MW-5, as water in the well is displaced through the bottom of the well screen. At lower pressures, no air flow occurs, as the back pressures from the water above the well screen exceeds the positive pressure from sparging.

### Soil Vapor Extraction

During the vapor extraction pilot test, the vacuum unit and wellheads (PZ-1 and PZ-2) were monitored to examine maximum vacuum and corresponding air flow rates attainable with the 7.5 Hp vacuum unit. Mechanical difficulties such as overheating the motor starter at low vacuums and high air flow rates prohibited varying pressure and air flow rates. The flow rate obtained at maximum vacuum (85 to 100-inches of water at PZ-1 and PZ-2) was 38 scfm (inlet and outlet), as indicated in Appendix I. Table 5 provides calculation of flow rates from the SVE pilot test. Total quantity of air discharged during the 3-hour test was approximately 7000 cubic feet.

The pilot test indicated the vacuum level rate at which the greatest radial influence and mass removal was attained without a rise in the groundwater table above the top of the well screen (i.e. 5 feet below ground surface). The test indicated that at vacuums of 85 and 100-inches of water, the water table rose 3.2 feet in PZ-1 and PZ-2. This indicates a water table rise of approximately 1-inch for every 2.4-inches of water (vacuum).

Seasonal water table rises ( $\pm 3$  feet) will reduce the available unsaturated screen interval and thus limit the vacuum levels that could be utilized. Depth to top of screen for the proposed two horizontal vapor extraction (HVE) wells (Section 7.4) would be -5 feet below ground surface. Depth to water in PZ-1 and PZ-2 before vacuum was approximately 16.5 feet (during mid-low seasonal water levels). Thus, the projected maximum vacuum is considered to be approximately 14-inches of Hg (190-inches of water) before water rises within 5 feet (10-feet below ground surface) of the top of the HVE well screen. Greater vacuums and air flow rates than obtained during the pilot test will be achievable by using a larger vacuum blower and by using horizontal VE wells, which are screened over much

longer distances and above the water table. Vertical VE wells screened into the water table (i.e. PZ-1 and PZ-2) allow groundwater to rise higher than would either vertical or horizontal VE wells completed above the seasonal high water table. The rising of groundwater in a VE well reduces air flow, volatilization of hydrocarbons and radius of influence, as less well screen is exposed to air flow.

### 6.3 RADIAL INFLUENCE

#### Air Sparging

The maximum ROI of air sparging from MW-5 was measured to be approximately 30 feet at 20 to 50 psi and an air flow rate of 8 scfm. Charts 3, 4, 5 and 6 illustrate the radius of sparging influence by increase in dissolved oxygen (DO), positive pressure, organic vapor concentrations and rise in the water table, respectively.

Dissolved oxygen levels, positive pressures, water levels and organic vapor concentrations increased slightly, as expected, during the increase in positive pressure and air flow from 20 psi to 50-psi. These readings also tapered off with distance, as expected. Water levels rose approximately 9 feet above static levels at 50 psi 10 feet away from the sparge well, which are considered too great to be effective with vacuum and could potentially cause hydrofracturing. Water levels rose approximately 4 feet at 40 psi at 10 feet away, which illustrates the maximum permissible water level rise. Water levels rose approximately 2 feet at 20 psi at 30 feet away, and approximately 4 feet at 50 psi at 50 feet away. DO levels increased by 1 to 2 mg/L out to 30 feet away from MW-5 at 20 to 50 psi. Slight positive pressures and organic vapor concentration increases were slightly detected at 30 feet away at 20 to 50 psi.

The optimum air sparge pressure is considered to be 20 to 40 psi. At these pressures, the greatest portion of the dissolved phase plume is influenced without excessive rise in the water table and without exceedance of the projected vacuum ROI of 40 feet. Volatilization of dissolved hydrocarbons by air sparging is enhanced with increase in air flow, as the air to water ratio is also increased. Air flow is also increased with increased air pressure,

however, too much pressure can produce adverse effects. A minimum air flow rate of 15 scfm will be provided to the proposed eight VAS wells (Section 7.5).

### Soil Vapor Extraction

Charts 1 and 2 illustrate the radial influence of vacuum applied at PZ-1 and PZ-2 for approximately 1.5 hours each at 100 and 85-inches of water (vacuum). The greatest ROI of negative pressure in the unsaturated soils surrounding PZ-1 was measured at 29 feet at a vacuum of 100-inches of water and an air flow rate of 34 scfm. A negative pressure of -0.2-inches of water was measured in PZ-3 located 29 feet from PZ-1. At a vacuum of 85-inches of water and an air flow rate of 34 scfm at PZ-2, a negative pressure of -0.3-inches of water was also measured at PZ-1 located 10 feet away from PZ-2. Based on the radius of influence data, we expect that at vacuums of 190-inches of water (14-inches of Hg) at HVE-1 and HVE-2, the projected maximum ROI would be approximately 40 feet.

Water levels in peripheral wells (PZ-3, MW-4, MW-5, and MW-7) remained relatively unchanged as compared to the rise of water in each vacuum test well (+3.2 feet), as indicated in Appendix I. This is probably due to the short duration of the pilot test.

Based on vacuum ROI measurements at a similar, active remediation site (i.e. Unocal-Derita, NC site) using one HVE well, we expect the following parameters will be obtainable from the proposed two HVE wells: 12 to 14-inches of Hg (vacuum) per HVE well, 150 to 200 scfm air flow per HVE well, a ROI characterized by at least 0.1-inch of water (negative pressure) at 40 feet outside each HVE well, less than 7 feet uplift of the water table beneath each HVE well, and less than 0.5 feet uplift of the water table at 40 feet away.

## 6.4 AIR EMISSIONS

Air emissions from the proposed soil vapor extraction system are expected to be highest during initial stages but then decrease after a few months of system operation. Analytical results of air emission (carbon tube) samples collected from the vacuum exhaust

stack during the 3-hour soil vapor extraction (SVE) pilot test at PZ-1 and PZ-2 are included in Appendix III. Table 5 indicates air flow data obtained during the SVE pilot test. Table 6 indicates air emission data from the four carbon tube samples analyzed by MDS labs. These results indicate a "worst case" scenario since vapor concentrations in the soil are typically greatest at the time of start-up.

Four carbon tube samples were collected from the vacuum exhaust stack and analyzed for total petroleum hydrocarbon scan. This analysis identifies and quantitates 18 specific organic analytes. Any remaining peaks on the GC-FID are quantitated as either A Hydrocarbons (low boiling organics) or B Hydrocarbons (higher boiling organics). Additional information on this analysis is included in Appendix 3. Greatest hydrocarbon concentrations detected in the VE exhaust stack were as follows: "A" Hydrocarbons (6445 mg/m<sup>3</sup>), "B" Hydrocarbons (130 mg/m<sup>3</sup>), benzene (285 mg/m<sup>3</sup>), toluene (550 mg/m<sup>3</sup>), ethyl benzene (70 mg/m<sup>3</sup>), total xylenes (230 mg/m<sup>3</sup>), hexane (4925 mg/m<sup>3</sup>), pentane (3210 mg/m<sup>3</sup>), and chloroform (95 mg/m<sup>3</sup>). MDS Lab analyses of the carbon tube samples are included in Appendix VII. The relatively low levels of chloroform measured are not believed to be components or by-products of petroleum fuels, but rather laboratory artifacts.

The maximum total hydrocarbon emission rates during the 3 hour SVE pilot test at a flow rate of 38 scfm were as follows: TPH-A&B (2.79 lbs./test period), benzene (1.21E-1 lbs./test period), toluene (2.3E-1 lbs./test period), ethylbenzene (2.9E-2 lbs./test period), total xylenes (9.8E-2 lbs./test period), hexane (2.1 lbs./test period), pentane (1.36 lbs./test period) and chloroform (4E-2 lbs./test period). Air emission calculations are included in Table 6.

Total petroleum hydrocarbons recovered from PZ-1 and PZ-2 during the 3 hour pilot test was approximately 3 lbs. Given the relatively low hydrocarbon concentrations measured at the vacuum stack and the state guidance discharge limit of < 40 lbs. of hydrocarbons/day, air emissions control by vapor carbon units in series is expected to be effective and economical to reduce air emissions to below state allowable levels. Carbon units are

expected to be required initially to reduce emissions below the state guidance level, as indicated in Appendix IV, but may not be required after emissions drop below the 40 lbs./day limit. The removal rate of hydrocarbons by vapor carbon under normal conditions, is 99.999%, as reported by the carbon manufacturer (U.S. Carbons).

## 7 PROPOSED REMEDIAL ACTION PLAN

### 7.1 OVERVIEW/GENERAL DESCRIPTION OF SYSTEM

#### Air Sparging

Conventional air sparging, which is the injection of air under pressure into saturated soils, has proven to be a method of bringing a similar degree of mass removal efficiency to saturated zone treatment as soil vapor extraction does to unsaturated (vadose) zone treatment. The air traverses the soil column vertically and horizontally creating a transient air-filled porosity. Volatile contaminants in the groundwater undergo a liquid-to-vapor phase change and enter the sparged air stream (due to the high air to contaminant ratio) and are thus effectively transported out of the saturated zone into the vadose zone where the contaminants are collected by a soil vapor extraction system. Additionally, the sparged air maintains high dissolved oxygen in the groundwater, which enhances natural biodegradation.

Air sparging/vacuum extraction offers several advantages over pump and treat approach:

- Increased volumetric flow of air compared to water due to the higher permeability of soil to air. Thus, more groundwater is treated more quickly in-situ than by bringing the groundwater to the ground surface for treatment and disposal.
- Simple, less expensive installation of air injection points compared to the cost of installation of groundwater recovery wells.
- Increased contaminant mass transfer characteristics for removal by air rather than water.
- Treated groundwater by in-situ air sparging does not have to be disposed of, therefore, much less permitting and associated costs.

Air sparging removes a significant mass of contaminants and reduces dissolved concentrations in the groundwater in a relatively short time. Effective use of air sparging, however, requires careful design and selective application to sites. Available literature indicates that silty soils such as exist in the Piedmont Physiographic Province are "marginally feasible" for air sparging. However, given that no confining clays are present on-site, and that the pilot test results indicate a radius of influence of up to 30 feet for air sparging and for vacuum, at moderate pressures, these technologies are expected to be viable for this site.

Theoretically, a large number of small sparge air bubbles, as compared to large bubbles, will provide the best mass transfer for the removal of VOCs from the aqueous/soil phase. To be effective the sand pack should have a grain size that will prevent coalescing of the small bubbles prior to entry into the formation. Entry of air into a saturated soil requires pressures greater than the resisting head pressure due to capillary forces. This is known as the "air entry pressure" required to displace water from a saturated soil. According to EPA literature (PB93-100154), approximately 1 psi pressure is needed per 2.3 ft. of hydraulic head. This pressure can vary with soil porosity and permeability. Injected air moves along paths of least resistance and maintains integrity as long as the air entry pressure is maintained within the channel. Excessive air injection pressure may create coalescing of bubbles and fractures in the sparging well annulus or along weak joints in the soil resulting in a loss of contaminant removal efficiency.

Site geology is considered an important design parameter. Air sparging is generally most effective in coarse grained soils. Lower air entry pressures are required in coarse grained soils, and provide a more even air distribution and larger ROI. This produces a better mass transfer efficiency, and therefore, more effective VOC removal. Air sparging has also proven to be successful at sites with finer grained soils according to EPA literature.

Generally, vapor extraction and air sparging should be performed concurrently and at a minimum withdrawal to injected air flow ratio of three to one. Therefore, air flow, pressure and vacuum controls should be provided at each wellhead. The radius of influence

of the vacuum should also exceed the radius of the air sparging to better capture the contaminated sparged air.

The groundwater air sparging system is typically implemented once the inlet air concentrations from the SVE system have stabilized at low concentrations. If the sparging wells are started too soon, a surge of contaminated air from the saturated zone could cause the vapor concentration in the vadose zone to exceed the equilibrium concentration. Resulting concentration gradients could cause further contaminant migration.

### Vapor Extraction

Extraction of hydrocarbon vapors from the unsaturated soils, capillary fringe and sparged groundwater beneath the site is based on transferring the contaminant from an existing phase (adsorbed and liquid) to a more mobile vapor phase which can be brought to the surface under controlled conditions. Contaminants having a vapor pressure greater than 1 mm of Hg at ambient temperatures are considered sufficiently volatile to effectively utilize vapor extraction. The vapor pressures (in mm Hg) for the contaminants identified on-site (predominantly gasoline constituents as BTEX) range from 9.5 to 95 mm Hg @ 25°C, which indicate a high extractability.

The actual rate of volatilization of a chemical in the subsurface environment is limited by the rate of desorption from mineral grains in the soil matrix. Under normal conditions, vapor movement in soil is from areas of high vapor concentration, to areas of low vapor concentration including the ground surface. Under vacuum conditions soil gas movement is from atmospheric pressure to low pressure at the vacuum extraction point. Since the horizontal permeability of soil is typically 3 to 10 times that of the vertical permeability, air flow to the well is generally horizontal. Maximum venting efficiency is obtained when soil gas flow is maintained through areas of contamination. If a soil vent system caused soil gas to flow through clean soil, then the rate of contaminant removal is controlled by the rate of diffusion of vapors into the zone being actively vented and not controlled by flow.

Volatilization of organics is more effective at higher air flow rates, than at high vacuums, since the air to contaminant ratio is greater. At higher vacuums, air turbulence is induced near the wellhead, which can cause vaporous hydrocarbons not to diffuse into the vapor stream. Desiccation of soils can also result from high vacuums, reducing the volatility of the adsorbed contaminant. Soil air velocity also increases with higher vacuum, which may not allow sufficient contact time between contaminant and air to reach equilibrium concentrations before the air is pulled away.

Vapor extraction will be used both to capture and recover the vaporous hydrocarbons in the unsaturated soils on-site, as well as, recover the sparged air from the in-situ air sparging process. A secondary benefit of vapor extraction is to provide oxygen to subsurface soil bacteria which helps to promote biodegradation of absorbed hydrocarbons.

## 7.2 CONCEPTUAL DESIGN/PROCESS FLOW DIAGRAM

Figure 8 illustrates a scaled site map showing the locations of the following: on-site and off-site property lines, station layout, on-site building, utility lines, monitor wells, proposed two horizontal vapor extraction (HVE) wells, proposed seven vertical air sparging (VAS) wells, subsurface remediation piping, remediation compound and equipment layout in compound. Figure 13 illustrates a process and instrumentation diagram of the soil vapor extraction and air sparging remediation systems, including conceptual wiring diagram.

S&ME proposes to install two horizontal vapor extraction wells at 5 feet below ground, which will allow for greater vacuum and air flow than measured during the VE pilot test, and thus a greater radius of influence (ROI) and greater volatilization rate. To ensure capture of the sparged air, the designed HVE well ROI (40 feet) will slightly exceed the designed vertical air sparging well ROI (30 feet). Figure 12 illustrates the estimated ROIs for the proposed 2 HVE wells and 8 VAS wells (including MW-5, which will be permanently converted into an air sparging well. We plan to achieve slightly larger vacuum ROI and greater volatilization rates than measured during the pilot test by using more powerful equipment, capable of higher pressures and air flow rates. This remediation equipment will

also be large enough to handle the greater pressures (negative and positive) and air flow rates as well as permit additional VE or AS wells, if needed.

According to the proposed S&ME plan, the dissolved hydrocarbon plume will pass through the lines of air sparging and vapor extraction wells under existing groundwater movement and be treated before moving off-site. Hydrocarbons desorbed from the soils and stripped from the groundwater by the sparging and VE processes will be collected by the two horizontal vacuum wells placed throughout the entire hydrocarbon plume, as illustrated in Figure 12.

Groundwater flow has been shown to flow towards the northwest in January and March 1993. Although there is uplift of the groundwater surface under sparging and vacuum conditions, the groundwater flow within most of the underlying sparged zone is expected to remain unchanged and continue to flow towards the northwest.

Air sparging will be cycled on/off at various intervals (i.e. 12 hours off and 12 hours on for different well lines) by three 2-inch electric solenoids located at each line of air sparging wells and one after the air compressor. These solenoids will be wired to an electronic timer with four circuits, which in turn is wired to the air compressor. Cycling off the air sparging will minimize "dry zones" which are believed to occur as air bubbles coalesce through saturated soil areas of least resistance and force water out of these pore spaces. Cycling off air sparging will also minimize groundwater turbulence and allow normal groundwater flow to continue to the northwest. Further the on/off cycles will also allow clean sparged groundwater to "re-contaminate" (i.e. allow contaminant desorption) as it comes in contact with contaminated soils in the phreatic zone, similar to cycling of vapor extraction.

During operation of a VE and AS system, S&ME has found that cycling on/off of vapor extraction wells aids in removing greater quantities of hydrocarbons, as the adsorbed

hydrocarbons in the soil pore spaces have greater time to equilibrate. Vapor extraction will always be operated during times of air sparging from adjacent AS wells. Each HVE well will be equipped with a ball valve to allow manual control of vacuum and air flow. The vacuum will also be interconnected with the electronic timer and air compressor, so that air sparging can not occur when the vacuum unit is off. If the vacuum unit shuts down, the solenoid valve located downstream of the air compressor (circuit #1) closes, preventing air to be sent to the eight AS wells.

### 7.3 RATIONAL FOR USING RECOMMENDED REMEDIATION

The rational for proposing an integrated air sparging and vapor extraction system is based on economy and effectiveness. The use of vertical air sparging wells and horizontal VE wells screened throughout the hydrocarbon plume on-site will affect a greater portion of the plume more quickly and thus remediate the site more cost effectively, than fewer remediation wells using pump and treat technology or conventional vertical vapor extraction wells. Vertical air sparging wells were proposed instead of horizontal air sparging wells due to thin layers of rock (0.5-foot thick) encountered at 25 to 25.5 feet and at 55 feet in MW-5. In addition, the penetration resistance for the soils encountered beneath 40 feet exceeded 30 blows/foot, which exceeds the < 20 blows/foot safe limit for horizontal drilling, according to UTILX Corporation, a horizontal drilling specialty contractor.

The S&ME approach will reduce short term installation and supervision costs, as less work will be required for system implementation, as compared to typical pump and treat systems, and overall operation and maintenance costs will be lower in that site closure will be achieved more quickly, and without discharge of treated water. Overall capital costs for air sparging and vapor extraction remediation equipment are typically less than pump and treat systems. Horizontal wells can now be installed for approximately the same cost as vertical screened wells. Also, fewer horizontal wells are needed, as they provide a much greater screened area over the hydrocarbon plume.

The following information is provided as requested in the NCDEHNR's March 1993 "Corrective Action Plan Guidelines, Section 15.4". Results of bench tests/pilot studies are included in Section 6. Figure 12 illustrates the design radius of influence for the 8 VAS and 2 HVE remediation wells superimposed over the groundwater BTEX, MTBE and soil TPH plume extent. Design pressure and air flow rates for the VAS and HVE wells are discussed in Sections 7.4 and 7.5. Anticipated air emissions from the vapor extraction/air treatment unit are included in Section 7.9 and Appendices 4.

#### 7.4 HORIZONTAL SOIL VAPOR EXTRACTION WELLS

The two horizontal vapor extraction (HVE) wells will be completed 5 feet below ground surface and consist of 2-inch diameter, schedule 40 PVC with 320 feet of 0.020-inch slotted screen for HVE-2 and 275 feet of 0.020-inch slotted screen for HVE-1. The two HVE wells are located approximately 55 feet apart, so as to capture the sparged contaminated air from the 8 VAS wells. The two HVE wells are placed at the leading edge of the hydrocarbon plume on-site to ensure treatment of hydrocarbons exhibiting greatest concentrations before the plume moves further off-site. Figure 11 illustrates the construction detail of the proposed HVE wells. Construction of horizontal wells underneath Trollingwood Road are likely not to be permitted by the NCDOT, as found during a recent denial for an NCDOT encroachment agreement at similar proposed remediation site.

Based on the VE pilot test results and projected ROI using a larger vacuum, we estimate that each HVE well will have a 40 foot radius of influence around the entire screened section at 14-inches of Hg and at flow rates of 200 scfm per HVE well. The estimated combined air flow rate from both HVE wells at 14-inches of Hg is approximately 400 scfm, which is within the proposed vacuum performance curve (Appendix V) of 600 scfm at 14-inches of Hg, 2000 rpm and a brake horsepower of 25. The uplift of the water table at a vacuum of 14-inches of Hg in each HVE well is estimated to be < 12 feet or approximately five feet below the HVE well screen. All HVE wells would be connected to a common 4-inch diameter, schedule 40 PVC manifold, which would traverse underneath the site to the proposed remediation compound, as illustrated in Figure 8.

The horizontal wells will be installed by UTILX Corporation and within the greatest magnitude of the hydrocarbon plume. Information on UTILX's horizontal drilling process is included in Appendix VII. UTILX has installed several horizontal vapor extraction wells in the Piedmont for Unocal and S&ME, which have proven to be more effective than vertical vapor extraction wells.

The advantage of using horizontal screened, vapor extraction wells is the greater effective area of the screened well section available for remediation which in turn produces a larger radius of vacuum influence than vertical screened wells. In addition, a greater air flow can be applied to the contaminant area, which is most important for volatilization of the hydrocarbons. Water table uplift beneath horizontal vapor extraction wells is less than vertical VE wells screened into the water table, as discussed in Section 6.3. Increased air flow also enhances oxygen content in the contaminated vadose zone. The increase in oxygen within the vadose zone promotes natural biodegradation. The fact that fewer horizontal wells are needed compared to vertical wells tends to minimize trenching, piping and backfill between VE wells.

#### 7.5 VERTICAL AIR SPARGING WELLS

The seven proposed vertical air sparging wells (VAS) would be installed adjacent to the two HVE wells, as shown in Figure 8. An eighth vertical air sparging well would be converted from deep "Type III" monitor well MW-5, which was formerly used for the air sparging pilot test. Figure 9 illustrates the construction of MW-5 and vault connections for air sparging. The proposed seven VAS wells would consist of 2-inch diameter, schedule 40 PVC, with 5 feet of 0.010-inch slotted screen from 60 to 65 feet below ground surface. The vertical extent of groundwater contamination was essentially defined at MW-5, which is screened from 49.5 to 54.5 feet below ground surface. Figure 10 illustrates the construction of the proposed seven vertical air sparging wells.

Based on the air sparging pilot test results, we estimate that each VAS well will have a radius of influence of 30 feet at between 20 to 40 psi positive pressure at a minimum air

flow of 15 scfm/well. Air flows may vary as VAS wells are cycled on and off. All sparge wells will be connected to a common 2-inch diameter "ChemAir" line, which is in turn connected to the air compressor.

Air sparging will occur at the base of the contaminated surficial aquifer, at 60 to 65 feet below grade at the proposed seven VAS wells, and at 49.5 to 54.5 at MW-5. In this way the air will traverse the most contaminated groundwater beneath the site as physically possible, and at a minimum bubble size.

Air will be injected periodically into the two rows of VAS wells at a design entry pressure of 20 to 40 psi and at flow rates of 15 scfm or greater per wellhead. Typically, 1 psi pressure is required per 2.3 foot of water (head) in the sparge well to force the water out of the well and blow air out into the formation. The optimum pressures and flow rates for the vertical sparge wells will be evaluated in the field. The air compressor has been sized to handle up to 105 scfm @ 20 to 100 psi, which will allow at least 15 scfm per eight wellheads if each were operating. Since, all sparge wells will not be operating at the same time, more air flow will be available for each operating sparge well or for additional sparge wells, if needed. The design air flow ratio for vapor extraction to air sparging is approximately 4/1 (400 scfm/105 scfm) for all wells operating simultaneously. This design will better aid in capturing of the sparged air.

## 7.6 VACUUM SPECIFICATIONS

The device to be utilized to create the vacuum will be a 25-Hp Roots U-RAI 68 pd blower. The Roots blower was selected over a regenerative blower due to (a) its capacity to maintain higher air flows over a range of vacuums, (b) its cooler operating temperatures, (c) gas-tight construction, (d) easy maintenance, and (f) affordability. A high air flow at moderate to high vacuum is considered necessary to achieve (a) maximum volatilization, (b) an effective capture zone, and (c) maintain the desired air flow from the proposed two HVE wells and possibly future additional wells, if necessary.

Prior to entering the blower unit, well vapors will pass through a 80-gallon water moisture separator to remove moisture from the vapor stream. The moisture separator will contain a liquid level float sensor that will shut down the vacuum unit should the tank become full. Shutdown of the vacuum will in turn close the main solenoid downstream of the air compressor, which will cease air sparging at all eight VAS wells. Inasmuch as industrial blowers are most effectively operated at a constant speed, the concentration of VOCs in the vapor stream will be controlled through operation of a bleed air valve wherein the influent vapors are diluted with clean ambient air. The inlet valve and variable frequency drive also allows fine tuning of the vacuum and air flow. Additional fine tuning of the vacuum and air flow will be provided at each HVE wellhead by use of 4-inch ball valves. During vacuum extraction, the highest extraction rates occur during initial operation and typically decrease exponentially over time.

The vacuum unit consists of (a) the blower with a 25-Hp TEFC motor, (b) an 80-gallon moisture separator with level sensor, automatic drain and visual level gauge, (c) two inlet bleed air valves (one adjustable pressure control valve and one factory set Kunkle valve), (d) inlet and discharge silencers, (e) in-line 5-micron particulate filter, (f) variable frequency driver in NEMA 4 enclosure for remote mounting and changing motor speed and thus operating parameters, (g) inlet and outlet averaging flow sensors and magnehelic gauges, (h) inlet and outlet temperature gauges, (i) adjustable discharge pressure relief valve, (j) vacuum gauge, and (k) high and low pressure shutdown switches. The unit will be installed on a level concrete surface inside the chain link fence compound, as illustrated in Figure 8. Figure 13 illustrates a process and instrumentation diagram for the soil vapor extraction and air sparging processes.

The vapor extraction system will have a blower capable of 580 scfm at 16 inches of Hg (vacuum) or 700 scfm at 6 inches Hg @ 2000 rpm, which will be able to handle the expected 400 scfm air flow from the two HVE wells. Brake horsepower (shown on the blower curve) is a function of the Hp needed to pull vacuum and discharge air at the same time. Based on similar operating systems, we expect the discharge pressure to be less than

1 psig or < 2 brake horsepower. This implies that approximately 23 Hp or greater will be available for vacuum. The 25-Hp blower will be operated by three-phase, 480-volt power. Vacuum equipment specifications are included in Appendix V.

The variable frequency driver (VFD) acts as a starter, and no other starter is required. The high and low pressure switches, level sensor in the moisture separator and thermal overload protection switch will be wired through the VFD to interrupt operation if any of the switches are activated. The particulate filter is necessary to remove fine particles which can contribute to excessive blower wear. Differential pressure across the filter should not exceed 10-inches of water, before change-out.

As indicated in Figure 13, adjustable pressure control valve (PCV-5) will be field set at 14-inches of Hg, so that air will bleed in at this set vacuum level, to prevent higher vacuums from occurring. Pressure sensor or "Kunkle" valve (PSV-6) will be factory set at 14.25-inches of Hg, which will also open to bleed in air and protect the blower from excessive vacuums and wear. Adjustable pressure switch low (PSL-4) will deactivate the VFD and shut down the blower if vacuums exceed 14.5-inches of Hg. On the discharge side, adjustable pressure sensor valve (PSV-11) will be field set at 1.5-psig. Adjustable pressure switch high (PSH-9) will be set at 1.6-psig. Additional pressure gauges will be installed before and after each vapor phase carbon unit to allow measurement of differential pressures.

## 7.7 AIR COMPRESSOR SPECIFICATIONS

The device to be utilized to create the positive pressure for air sparging at the eight VAS wells will be a 25-Hp reciprocating direct drive air compressor. The compressor was selected over a positive pressure blower due to (a) its capacity to maintain higher pressures necessary for air sparging at 20 to 40 psi, (b) its reduced voltage starting, (c) low noise, (d) easy maintenance, and (f) affordability. A unit which can deliver a high air flow at a relatively high pressure is considered necessary to achieve (a) maximum volatilization, (b)

an effective radial influence, and (c) supply enough air flow to the proposed sparging wells and possibly future additional wells as needed.

The air compressor will be equipped with a main oil coalescing filter, particulate filter, receiver air pressure gauge and switch, NEMA-4 low oil monitor, automatic tank drain, TEFC motor, air cooled after cooler, and magnetic starter. The unit will be installed on a level concrete surface inside the fenced compound. The compressor will be able to supply forced air of up to 106 acfm at 125 psi, which will be able to easily handle eight or more air sparging wells. The 25-Hp compressor will also operate on 3-phase, 480-volt power. Compressor equipment specifications are included in Appendix V.

#### 7.8 VAPOR CARBON AIR TREATMENT

Air emissions from the vacuum extraction unit will be treated by two, 500 lb., 500 cfm capacity vapor carbon units in series. Air emissions after carbon treatment will be below the state guidance limit of 40 lbs./day of total hydrocarbons and should not exceed any other current state air pollution control standard.

Each vapor carbon unit will consist of coal based, 4 X 10 activated carbon mesh with a minimum iodine number of 1000 and carbon tetrachloride minimum of 60%. Each unit will contain 500 lbs./steel drum (net weight is 900 lbs.). The maximum air flow capacity of the vapor carbon system is 500 scfm, to which the vacuum unit discharge will be limited. In practice we anticipate operating the vacuum unit at a maximum of 400 scfm. The carbon units have been tested by the manufacturer to handle up to 600 scfm and have a burst pressure of 20 psi. The inlet and outlet connections will be 4-inch diameter. Sample ports and vacuum pressure gauges will be connected on the 4-inch manifold piping before and after each drum. Vapor carbon unit specifications are provided in Appendix V.

#### 7.9 AIR EMISSIONS

According to the carbon supplier, Continental Environmental Services (CES), the "worst case" carbon usage rate is estimated at 34 to 52 lbs./day for benzene and 780 to 1180

lbs./day for total hydrocarbons, based on the greatest concentrations measured during the pilot test (i.e. 285 mg/m<sup>3</sup> benzene and 6575 mg/m<sup>3</sup> TPH) and a design maximum air flow rate of 400 scfm. These carbon usage rates represent the projected maximum and may be many times higher than actual usage rates during start-up. The carbon usage rate is expected to decrease quickly over time due to lower influent concentrations over time. The pilot test air quality results were measured in an area of the site near the former free product plume and are, therefore, not representative of lesser contaminated soils elsewhere on-site. The screened sections of the proposed horizontal wells (HVE-1 and HVE-2) predominantly lie over soils with TPH concentrations less than 100 ppm (average). The HVE wells will thus be predominantly used to capture air from the groundwater sparging system where the average groundwater hydrocarbon concentrations are less than 10 ppm.

CES states in a December 3, 1992 letter (Appendix V) that their vapor phase carbon will remove 99.999% of petroleum hydrocarbon constituents in an air stream.

Air emission calculations for the proposed soil vapor extraction and air sparging system (with carbon treatment) and (without carbon treatment) are included in Appendix IV. These emissions, based on the pilot test analytical results and the design maximum discharge rate of 400 scfm, and are estimated as follows:

<u>Air emissions (without carbon)</u>	<u>Air Emissions (with carbon)</u>
benzene-10.2 lbs./day	benzene-1.02E-2 lbs./day
toluene-19.78 lbs./day	toluene-1.97E-2 lbs./day
ethylbenzene-2.52 lbs./day	e-benzene-2.52E-3 lbs./day
xylenes-8.28 lbs./day	xylenes-8.28E-3 lbs./day
hexane-177.12 lbs./day	hexane-1.77E-1 lbs./day
pentane-115.44 lbs./day	pentane-1.15E-1 lbs./day
chloroform-3.408 lbs./day	chloroform-3.4E-3 lbs./day
TPH (A&B)-236 lbs./day	TPH (A&B)-2.36E-1 lbs./day

Actual vapor concentrations in the VE emissions will be measured in the field utilizing an organic vapor analyzer (OVA) or photoionization meter (HNU) and correlating these readings with the analytical results from carbon tubes analyzed for TPH and benzene. The air emissions can be readily controlled by reducing vacuum and/or increasing the flow of ambient air. Our experience indicates that maximum VOC yield occurs soon after the system becomes operative at a given vacuum level, at which time a technician would normally be on site to monitor vapor concentrations. Thus, the likelihood of excessive VOC discharge occurring while the system is unattended would be low. Air emission rates for benzene and TPH will be computed as the product of the hours of operation, vapor flow rate and the periodic carbon tube vapor concentrations. A schedule for the carbon tube sampling frequency and VE unit operation and maintenance is included in Section 8.

#### 7.10 SAFETY FEATURES

The vacuum extraction and air sparging systems are designed to operate unattended, seven days per week, 24 hours per day, 365 days per year. Automatic shut-down of the vacuum unit will occur in the event that any of the following conditions develop: (a) high temperature in the blower motor due to amperage or thermal overload, (b) high water level (approx. 60-gallons) in the moisture separator which will activate LSHH-6, (c) vacuums greater than 14.5-inches of Hg at PSL-4, (d) positive pressures greater than 1.6-psig at PSH-9, and (e) fault codes at the VFD, such as electrical outage, extreme temperatures, or electronic malfunctions. Automatic shut-down will require a manual re-start at the VFD once the cause of the shut-down has been evaluated and corrected. Adjustment of the blower motor speed at the VFD and adjustment of the ball valves at HVE-1 and HVE-2 will be necessary to maintain optimum vacuum and air flow rates. The vacuum will be interlocked with the air compressor and electronic timer so that the main electric solenoid closest to the air compressor will close, shutting off air to the eight VAS wells if the vacuum unit stops operating. The vacuum unit will be able to operate independently of the air compressor.

Safety controls for the air compressor include (a) thermal overload due to high voltage or current draw, (b) safety valve on the receiver line for releasing excess air pressure, and (c) high temperature switch for low oil or malfunction in the cooling system.

## 8 MONITORING AND MAINTENANCE

### Baseline Hydrocarbon Content in Phreatic and Vadose Zone

A baseline will be established for the dissolved gasoline plume in the phreatic zone so that the progress of the groundwater remediation can be measured. The baseline for the groundwater plume will involve sampling of all monitor wells, and the deep well for the dissolved hydrocarbons detected during the assessment phase {i.e. EPA Method 601, 602 (including MTBE) and 625 (B/N) constituents} prior to remediation. A baseline for iron, manganese, TDS and bacterial count in selected groundwater samples will be analyzed by the Unocal-Brea, California laboratory prior to remediation. A new permanent monitor well (MW-8) should be installed in the location of former TMW-8, so as to allow monitoring of water quality at the downgradient leading edge of the dissolved phase plume. Additional vapor points and piezometers will be installed around the HVE and innermost VAS wells to more accurately measure ROI (including DO, water levels, positive pressure, and organic vapors) for the air sparging and vapor extraction processes. Liquid levels will also be measured and the direction of groundwater flow re-evaluated prior to initiation of remediation.

Carbon tube air samples will be analyzed for TPH and benzene. Samples will be collected daily for the first three days of system start-up, bi-weekly for the first month, then monthly thereafter from the sample ports before and after the carbon units. These analyses will be used to measure air quality compliance, carbon treatment effectiveness, hydrocarbon removal rates and natural biodegradation from the vacuum and sparging processes. Sensidyne tubes will be used quarterly for analysis of CO<sub>2</sub> and O<sub>2</sub> in the air stream (before carbon).

## Schedule for Implementation and Operation and Maintenance of the Remedial Action System

The construction phase will begin when the following have occurred: (a) notification of approval of this CAP and estimated implementation schedule by the NCDEHNR (Groundwater and Air Quality Sections), (b) no objection to the 30-day public notice advertised by the NCDEHNR, and (c) Unocal approval of the budget to purchase, construct and operate the proposed remediation system. We will conduct a preconstruction meeting prior to commencement of site activities. An estimated schedule for implementation of the CAP, system installation, start-up and first year of operation and maintenance is included as Chart 7.

### Start-Up

Initial start-up/shakedown will consist of operating the systems for a 3-day test period to evaluate radius of influence for vacuum and air sparging, optimum vacuums, positive pressures, air flows, upwelling of water table, compliance with the state guidance emission rate of < 40 lbs./day of total hydrocarbons, and re-evaluating air treatment efficiency rates. The 3-day test will entail adjusting air injection pressures, vacuum pressures and air flow rates to realize maximum efficiency of the systems and maximize the radial influence of each of the eight VAS wells and two HVE wells. The hydrocarbon removal efficiency will be measured as the difference between concentrations of total volatile hydrocarbons in the untreated influent and treated effluent air stream. Carbon tube samples will be taken to evaluate air emissions from the vacuum process, as mentioned previously.

### Monitoring Parameters and Procedures

Selected groundwater monitoring wells will be analyzed semi-annually for petroleum hydrocarbons detected during the assessment phase, using EPA Methods 601, 602 (MTBE) and 625 (B/N) to assess the system effectiveness. Analysis of iron, manganese, TDS and bacterial count in selected groundwater samples will be performed on a semi-annual basis by the Unocal-Brea, California laboratory prior to remediation. Monthly ROI measurements of water levels, dissolved oxygen, negative and positive pressures, air flow and

organic vapor readings shall also be taken at all remediation wells and at selected monitoring wells, vapor points and piezometers to evaluate remediation system performance in terms of radial influence, and water and soil quality.

Parameters to be measured during purging and sampling of monitor wells include static water level, pH, conductivity, temperature, and dissolved oxygen. These parameters will be utilized in spreadsheet and graphical form to monitor changes in plume geometry and groundwater flow direction, in order to operate the remediation systems efficiently.

Site visits will be made on a weekly basis for the first six months of operation, then bi-weekly (if practical) for the remainder of system operation. During each site visit, a site check form for air sparging and vapor extraction system information (see Appendix VIII for example) will be completed and forwarded to the project manager. In addition, system performance will be monitored and adjustments made to equipment settings, and the operational readiness of all safety equipment verified. Groundwater and air sampling will also be performed on a periodic basis, as specified previously.

Selected analytical and system performance data will be entered on spreadsheets and graphed. These data formats will be evaluated monthly to maintain the systems at their optimum efficiency and to note when asymptotic levels are reached in order that closure of remediation can be achieved in a timely and cost effective manner.

#### Air Sparging System

Operation and maintenance of the air sparging system will include monitoring of the radius of influence around selected air sparging wells by measuring dissolved oxygen, water levels, positive pressures, as well as by taking OVA readings and analyzing groundwater quality in peripheral monitor wells, vapor points and piezometers. Adjustment of the positive pressure and air flow will be made to maintain approximately 30-foot radial influence without creating excessive upwelling of groundwater. Air pressures will be gradually increased from 20 to 40 psi until the optimum radius of influence is obtained

without negative effects.

The air compressor will be checked during each site visit for proper operation, gauge readings, oil level and filter use. Maintenance on the air compressor will include the following:

- Check for any unusual noise (M)
- Check hoses (M)
- Check linkages (M)
- Check separator element indicator (M)
- Check cooler cores and clean if necessary (M)
- Change oil filter (M)
- Check air filter (M)
- Check oil level, add oil if necessary (M)
- Change air filter (BM)
- Change oil (Q)
- Change separator element (Q)
- Lubricate drive motor as needed (Q)

Notes: M = Monthly, BM = Bimonthly, Q = Quarterly

#### Vapor Extraction System

Operation and maintenance of the vapor extraction system will include monitoring of selected hydrocarbon concentrations in the vapor stream, which have been detected in the groundwater (i.e. benzene and TPH), as well as, monitoring and adjustment of both the vacuum and air flow to produce a maximum radial influence limit uplifting the water table to 3 to 5 feet below the HVE well screen. Adjustment of the vacuum and air flow will be made periodically at the VFD to maintain approximately 40-foot radial influence without creating excessive upwelling of groundwater. Differential pressures will also be checked across the particulate filter and vapor carbon units.

Carbon tube air samples and organic vapor measurements in the field will be collected from the vacuum exhaust as previously mentioned to evaluate system performance, air emissions, and compliance with the state guidance limit.

The vacuum will be checked during each site visit for proper operation, gauge readings, oil level and water level in the moisture separator. Maintenance on the vacuum will include the following:

- Check for any unusual noise (M)
- Change oil in gearbox (M)
- Lubricate shaft bearings (M)
- Check belt deflection (M)
- Spray WD40 on PSV-11 (M)
- Check differential pressure across particulate filters (M)
- Check drain on silencers, drain as needed (M)
- Check water level in separator, drain as needed (M)

Notes: M = Monthly

### Closure

In accordance with Section 15.5 (Site Closure) of the NCDEHNR's March 1993 "Groundwater Section Guidelines For the Investigation and Remediation of Soils and Groundwater", S&ME will apply for "No further Action" at such time as either standard 2a and 2b or 2c have been achieved.

## **9 PERMITS**

According to the NCDEHNR, a well permit is not required for installing a horizontal vapor extraction well or vertical air sparging well. According to Table 8 (Permit Requirements for Groundwater Remediation) in the NCDEHNR's March 1993 "Groundwater Section Guidelines For the Investigation and Remediation of Soils and Groundwater", no state permits are known to be required for this proposed remediation system. No county or federal approval or permits are known to be required for this proposed remediation system. This report serves as registration of the proposed vacuum unit and air treatment device with the NCDEHNR Air Quality Section.

## **10 RECOMMENDATIONS**

S&ME recommends properly closing the inactive water well on-site, in accordance

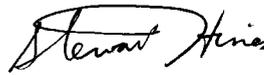
with NCAC Title 15, Subchapter 2C, Section .0100 of the Well Construction Standards. The well serves as a potential conduit for vertical migration of dissolved hydrocarbons.

If you have any questions, or if you need additional information, please do not hesitate to call.

Very Truly Yours,

S&ME, Inc.

  
Joe Best  
Project Geologist

  
Stewart M. Hines, P.G.  
Hydrogeologist

  
Dane A. Horna, P.E.  
Environmental Services Manager

smh/  
Enclosure

cc: Wayne Holt, P.G. - Unocal Corporation  
Waddell Watters - NCDEHNR, Groundwater Section  
Rick Holshouser, Jr. - S&ME, Inc.  
Myron Whitley - NCDEHNR, Air Quality Section  
Ray Jernigan - Property Owner

**TABLE 1  
GROUNDWATER ELEVATIONS  
FORMER UNOCAL STATION #9787-214  
MEBANE, NORTH CAROLINA  
S&ME JOB NO. 1584-92-080**

Date	Location	Reference Elevation (In Feet)	Depth to Groundwater (In Feet)	Groundwater Elevation (In Feet)
1/18/93 3/25/93	MW-1	98.56	11.63 9.72	86.93 88.84
1/18/93 3/25/93	MW-2	99.33	14.62 12.98	84.71 86.35
1/18/93 3/25/93	MW-3	99.51	15.42 13.91	84.09 85.60
11/18/93 3/25/93	MW-4	98.75	16.50 14.99	82.25 83.76
11/18/93 3/25/93	MW-6	100.98	N/A 12.62	N/A 88.36
11/18/93 3/25/93	MW-7	98.81	N/A 15.64	N/A 83.17

Notes: Free Product (0.01 Feet) measured in monitor well MW-4 on 2/1/93

N/A = Not Available

**TABLE 2**  
**FREE PRODUCT RECOVERY TO DATE**  
**FORMER UNOCAL STATION #9787-214**  
**MEBANE, NORTH CAROLINA**  
**S&ME JOB # 1584-92-080**

Date	Monitor Well	Product Thickness	Gallons Removed
1/18/93	MW-4	Sheen	NA
2/1/93	MW-4	0.01 Feet	0.5 Gallons
3/8/93	MW-4	0.01 Feet	0.5 Gallons
4/14/93	MW-4	Sheen	N/A
5/5/93	MW-4	Sheen	N/A
6/15/93	MW-4	N/A	<u>N/A</u>
		Total	1 Gallon

Hines/92-080.FRM

**TABLE 3**  
**RESULTS OF LABORATORY ANALYSES - TPH AND DETECTED**  
**8020 COMPOUNDS - SOIL SAMPLES**  
**FORMER UNOCAL STATION 9787-214**  
**MEBANE, NORTH CAROLINA**  
**S&ME JOB NO. 1584-92-080**

Sample Location	Depth of Sample (ft)	TPH Volatile (ppb)	TPH Semi-volatile (ppb)	Benzene (ppb)	Toluene (ppb)	Xylenes (ppb)	Ethyl-benzene (ppb)	Chloro-benzene (ppb)
MW-1	15	BQL	16	BQL	120	120	BQL	BQL
MW-2	15	1,200,000	510	810	20,000	95,000	17,000	BQL
MW-3	15	99,000	N/A	BQL	1,300	13,000	2,100	BQL
MW-4	15	95,000	N/A	BQL	1,700	31,000	4,900	BQL
MW-6	15	BQL	BQL	BQL	BQL	BQL	BQL	BQL
MW-7	15	BQL	BQL	BQL	BQL	BQL	BQL	BQL
TMW-8	10	BQL	13,000	BQL	BQL	BQL	BQL	BQL
SB-1	15	BQL	4,500	BQL	BQL	BQL	BQL	BQL
SB-2	15	BQL	BQL	BQL	BQL	BQL	BQL	BQL
SB-3	15	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Notes:

NCDEHNR "Action Level" for TPH (as gasoline) = 10ppm

ft = Feet

ppb = Parts per billion

N/A = Not analyzed

Organic Vapor readings (attached)

BQL = Below Quantitation Limits

**TABLE 3 (continued)**  
**OVA SCREENING RESULTS**  
**FORMER UNOCAL STATION 9787-214**  
**MEBANE, NORTH CAROLINA**  
**S&ME JOB NO. 1584-92-080**

Sample Location	Depth Interval	OVA Reading (ppm)
MW-1	4-5.5	1.5
	9-10.5	5
	14-15.5	1
	19-20.5	0.5
	24-25.5	0.5
MW-2	4-5.5	160
	9-10.5	525
	14-15.5	> 1000
	19-20.5	> 1000
	24-25.5	290
MW-3	4-5.5	15
	9-10.5	100
	14-15.5	> 1000
	19-20.5	> 1000
	24-25.5	400
MW-4	4-5.5	350
	9-10.5	> 1000
	14-15.5	> 1000
	19-20.5	> 1000
	24-25.5	500

ppm = Parts per million

**TABLE 3 (continued)**  
**OVA SCREENING RESULTS**

**FORMER UNOCAL STATION #9787-214**  
**MEBANE, NORTH CAROLINA**  
**S&ME JOB NO. 1584-92-080**

Sample Location	Depth Interval (ft)	OVA Reading (ppm)
MW-6	3.5-5	ND
	8.5-10	ND
	13.5-15	ND
	18.5-20	ND
	23.5-25	ND
MW-7	3.5-5	ND
	8.5-10	ND
	13.5-15	ND
	18.5-20	ND
	23.5-25	ND
SB-1	4.5-5	ND
	8.5-10	ND
	13.5-15	ND
SB-2	3.5-5	ND
	8.5-10	ND
	13.5-15	ND
SB-3	3.5-5	ND
	8.5-10	ND
	13.5-15	ND

pm = Parts per million  
ND = Not detected

TABLE 4  
 SUMMARY OF GROUNDWATER ANALYTICAL DATA  
 FORMER UNOCAL STATION #9787-214  
 MEBANE, NORTH CAROLINA  
 S&ME JOB # 1584-92-080

Date	Well Location	Benzene	Toluene	Ethyl/Benzene	Xylenes	MTBE	IPE	Total 601 Compounds	Total 625 (B/N/A) Compounds
1/7/93	MW-1	BQL	120	BQL	120	NA	NA	NA	NA
1/18/93	MW-1	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1/7/93	MW-2	810	20,000	17,000	95,000	NA	NA	NA	NA
1/18/93	MW-2	120	65	4.2	160	BQL	BQL	7.9	28
1/7.11/93	MW-3	BQL	1300	2100	13,000	NA	NA	NA	NA
1/26/93	MW-3	84	82	5.1	590	BQL	BQL	8.4	22
1/11/93	MW-4	BQL	1700	4900	31,000	NA	NA	NA	NA
1/18/93	MW-4	26,800	42,000	5,200	24,000	12,000	BQL	6.8	6600
3/24/93	MW-5	55	95	20	120	29	BQL	7	BQL
3/8.17/93	MW-6	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
3/8.17/93	MW-7	BQL	BQL	BQL	BQL	BQL	BQL	6.5	BQL
4/14/93	TMW-8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
15A NCAC 2L "Action Levels"		1	1000	29	400	200	1*	*	*

Notes:  
 . All results in ug/L or ppb  
 . BQL = Below Quantitative Limit  
 . ppb = parts per billion  
 . All other compounds analyzed for were BQL  
 . \*Action level not set, therefore it is the detection level reported for the analysis

601 Compounds detected for MW-1 (methylene chloride- 5 ug/L), (1,2 DCE - 2.9 ug/L) for MW-3 (1,2 DCE-8.4 ug/L)

601 Compounds detected for MW-4 (methylene chloride- 5.1 ug/L), (1,1,1,2,2-tetrachlorethane - 1.7 ug/L) MW-5 (Chloroform - 7.0 ug/L) MW-7 (chloroform - 6.5 ug/L)

625 Compounds detected for MW-2 (Pheno) - 28 ug/L)  
 625 Compounds detected for MW-3 (Demethylphenol - 22 ug/L)  
 625 Compounds detected for MW-4 (Naphthalene - 3300 ug/L) and (2-methylnaphthalene-3300 ug/L)

15A NCAC 2L "Action Levels" 601 and 625 Compounds detected are the method detection limits (see analytical results)

TABLE 5  
CALCULATION OF AIR FLOW RATES FROM VACUUM TEST

FORMER UNOCAL #9787-214  
1342 TROLLINGWOOD ROAD  
MEBANE, NORTH CAROLINA  
S&ME PROJECT 1584-92-080

VACUUM ("H2O) V	DURATION (HR) D	BACK PRESSURE ("HG) P	DIFFERENTIAL PRESSURE ("H2O) dP	DISCHARGE TEMPERATURE (F) T	DISCHARGE FLOW RATE (SCFM) QS	TOTAL DISCHARGE (CF) Q
100	1.20	0	0.05	115	38	2,723
85	1.80	0	0.05	120	38	4,067
	3.00					6,791

NOTES: FLOW RATE FROM STACK MEASURED USING PITOT TUBE  
 $\text{FLOW RATE (SCFM)} = 741.53 * \text{SQRT}(((29.92 + P) * dP)/(T + 460))$   
 $\text{TOTAL DISCHARGE (CF)} = \text{FLOW RATE (SCFM)} * \text{DURATION (HOUR)} * 60 \text{ MINUTES/HOUR}$   
 "H2O INCHES WATER  
 "HG INCHES MERCURY

TABLE 6  
VAPOR EXTRACTION PILOT TEST AIR EMISSION DATA

FORMER UNOCAL STATION #9787-214  
1342 TROLLINGWOOD ROAD  
MEBANE, NORTH CAROLINA  
S&ME PROJECT 1584-92-080

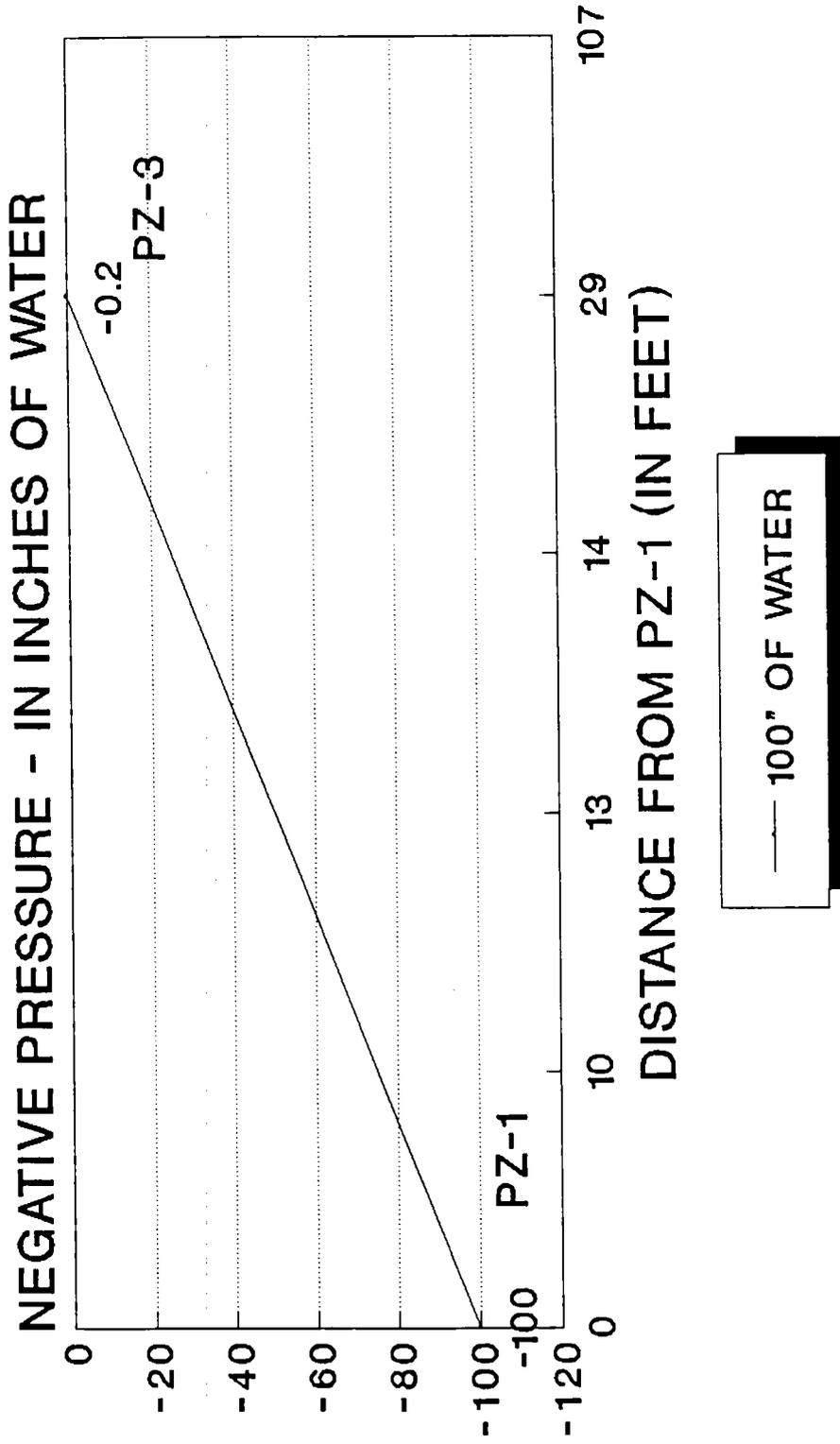
DISCHARGE FLOW RATE (SCFM)	DURATION (HR)	SAMPLE ID	CONCENTRATION (MG/M3)				MASS EMISSION RATE (lb/hr)				TOTAL				TOTAL HYDROCARBON EMISSIONS (lbs)	TOTAL BENZENE EMISSIONS (lbs)	TOTAL HYDROCARBON EMISSIONS (lbs)					
			B	E	T	X	B	E	T	X	A TOTAL HYDRO- CARBONS	B TOTAL HYDRO- CARBONS	COLORFORM	PENTANE				HEXANE	A TOTAL HYDRO- CARBONS	B TOTAL HYDRO- CARBONS		
38	3.00	2	230	60	315	200	4925	3210	80	5495	120	3.26E-02	6.50E-03	4.46E-02	2.83E-02	0.98E-01	4.53E-01	1.13E-02	7.79E-01	1.70E-02	9.78E-02	2.39E+00
38	3.00	3	182	40	304	168	1046	798	34	4082	66	2.30E-02	7.08E-03	4.31E-02	2.39E-02	1.48E-01	1.13E-01	5.10E-03	5.76E-01	1.22E-02	0.89E-02	1.76E+00
38	3.00	5	285	70	550	230	3775	2230	95	8445	130	4.04E-02	9.82E-03	7.79E-02	3.26E-02	5.33E-01	3.18E-01	1.35E-02	9.13E-01	1.84E-02	1.21E-01	2.79E+00
38	3.00	6	204	56	452	196	756	734	74	4028	116	2.69E-02	7.83E-03	6.40E-02	2.78E-02	1.07E-01	1.04E-01	1.05E-02	5.71E-01	1.64E-02	8.67E-02	1.76E+00
													AVERAGE EMISSION RATE (lb3)									

NOTES:  
SCFM = STANDARD CUBIC FEET PER MINUTE  
CONCENTRATIONS FROM MDS LABORATORY REPORTS  
MASS EMISSION RATE = (FLOW RATE (SCFM) \* CONCENTRATION (MG/M3) \* 3.748E-06 POUNDS/HOUR (CONVERSION FACTOR))  
TOTAL HYDROCARBON EMISSION RATE = TPH (A&B) MASS EMISSION RATE \* TEST DURATION (3 HOURS)  
INFLUENT SAMPLES #1 AND #4 WERE NOT ANALYZED SINCE DETECTION LEVELS WOULD BE TOO HIGH AT 1 LITER, AS COMPARED TO OTHER 2 AND 5 LITER SAMPLES FROM #2, 3, 5 AND 6  
ALL SAMPLES ARE INFLUENT AND REPRESENT EMISSIONS, SINCE NO AIR TREATMENT WAS REQUIRED DURING THE TEST  
ALL OTHER HYDROCARBONS SCANNED WERE BELOW OR APPROACHING QUANTIFICATION LIMITS  
B BENZENE  
E ETHYLBENZENE  
T TOLUENE  
X XYLENES

CHART 1

# NEGATIVE PRESSURE VS. DISTANCE

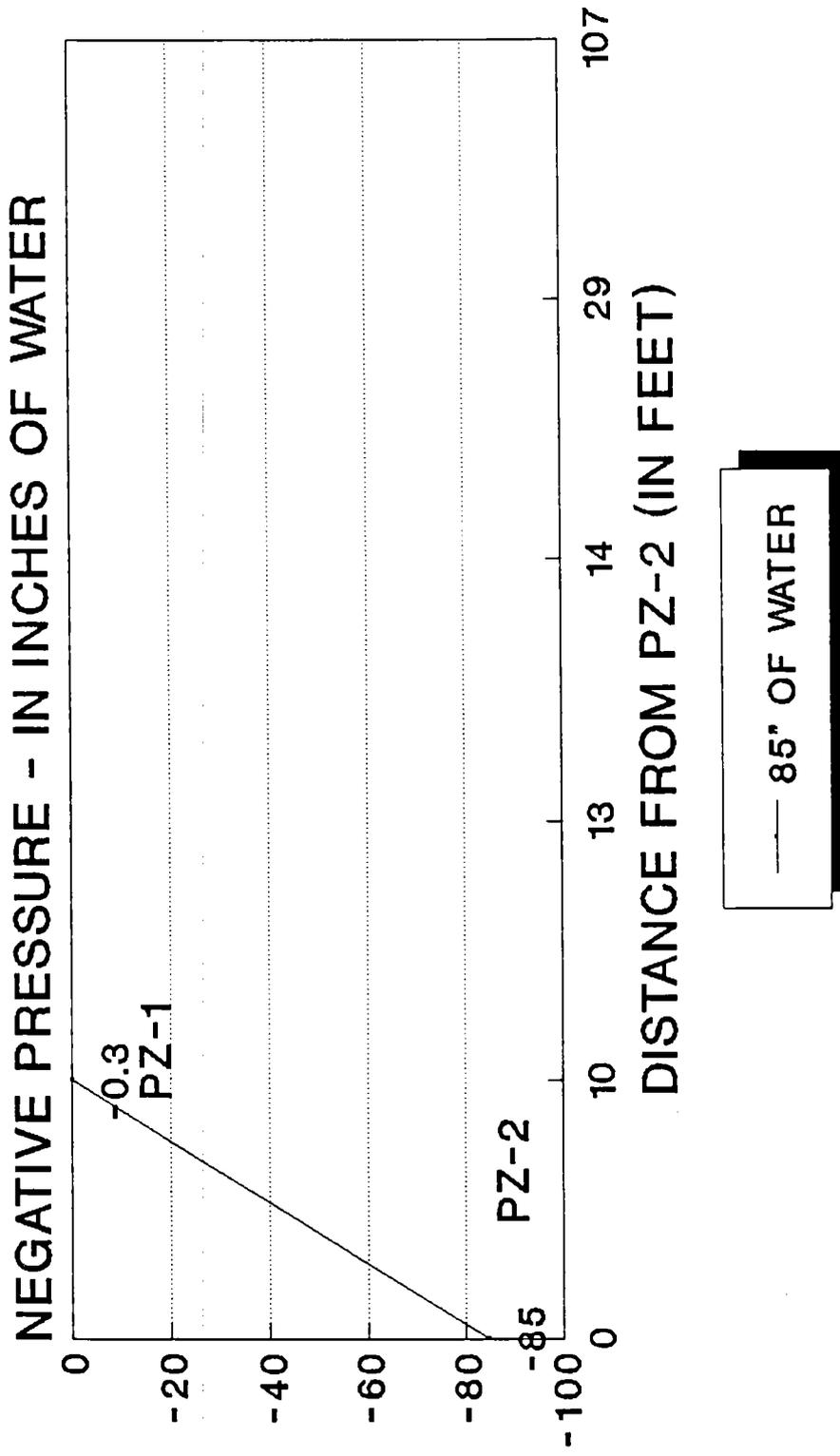
## VAPOR EXTRACTION PILOT TEST



VAPOR EXTRACTION PERFORMED AT PZ-1  
SEE FIGURE 2 FOR TEST WELL LOCATIONS  
NEG. PRESSURES MEASURED WITH MANOMETER

CHART 2

# NEGATIVE PRESSURE VS. DISTANCE VAPOR EXTRACTION PILOT TEST



VAPOR EXTRACTION PERFORMED AT PZ-2  
SEE FIGURE 2 FOR TEST WELL LOCATIONS  
NEG. PRESSURES MEASURED WITH MANOMETER

CHART 3

FORMER UNOCAL #9787-214

AIR SPARGE TEST RESULTS

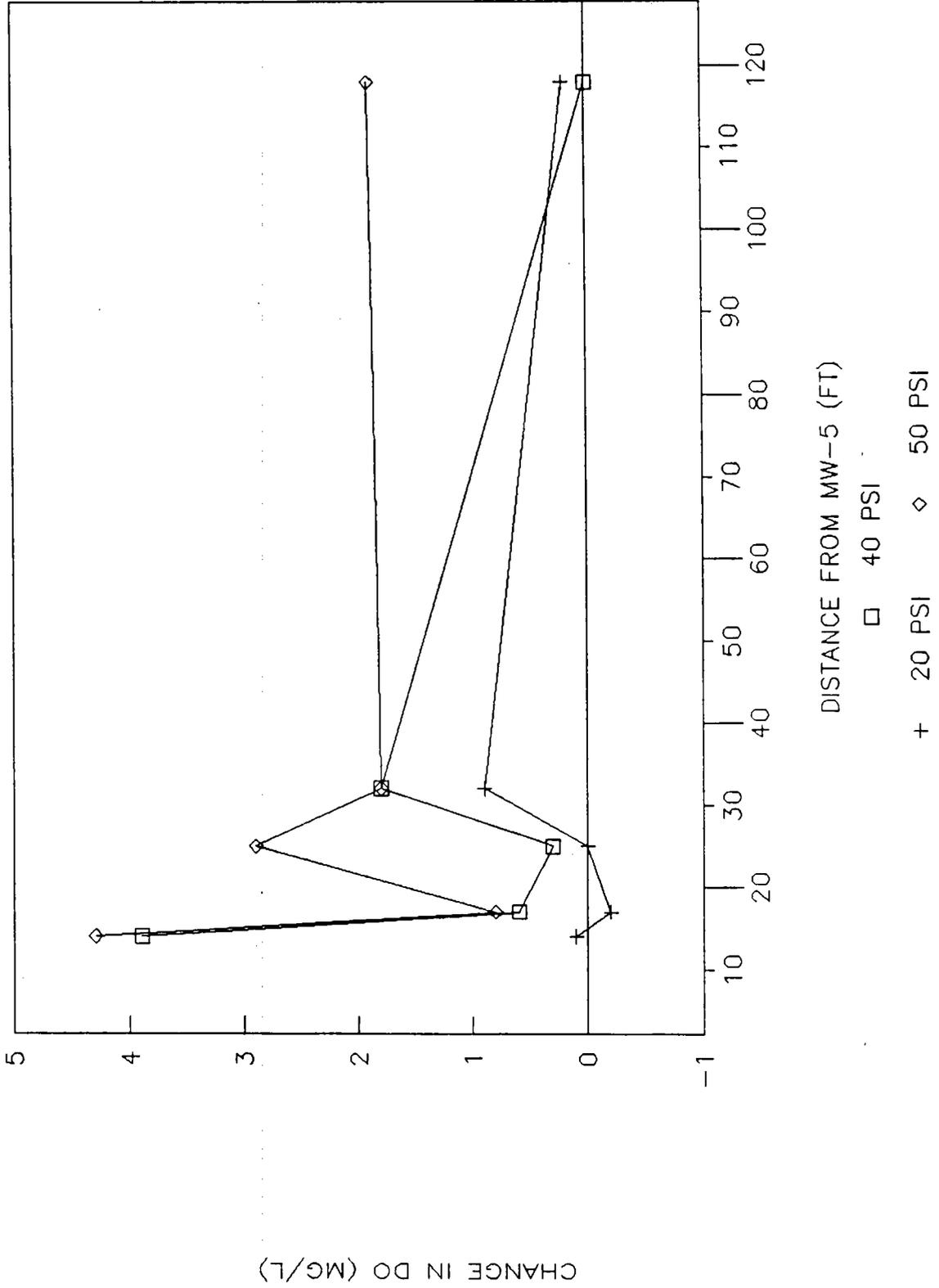


CHART 4

FORMER UNOCAL #9787-214

AIR SPARGE TEST RESULTS

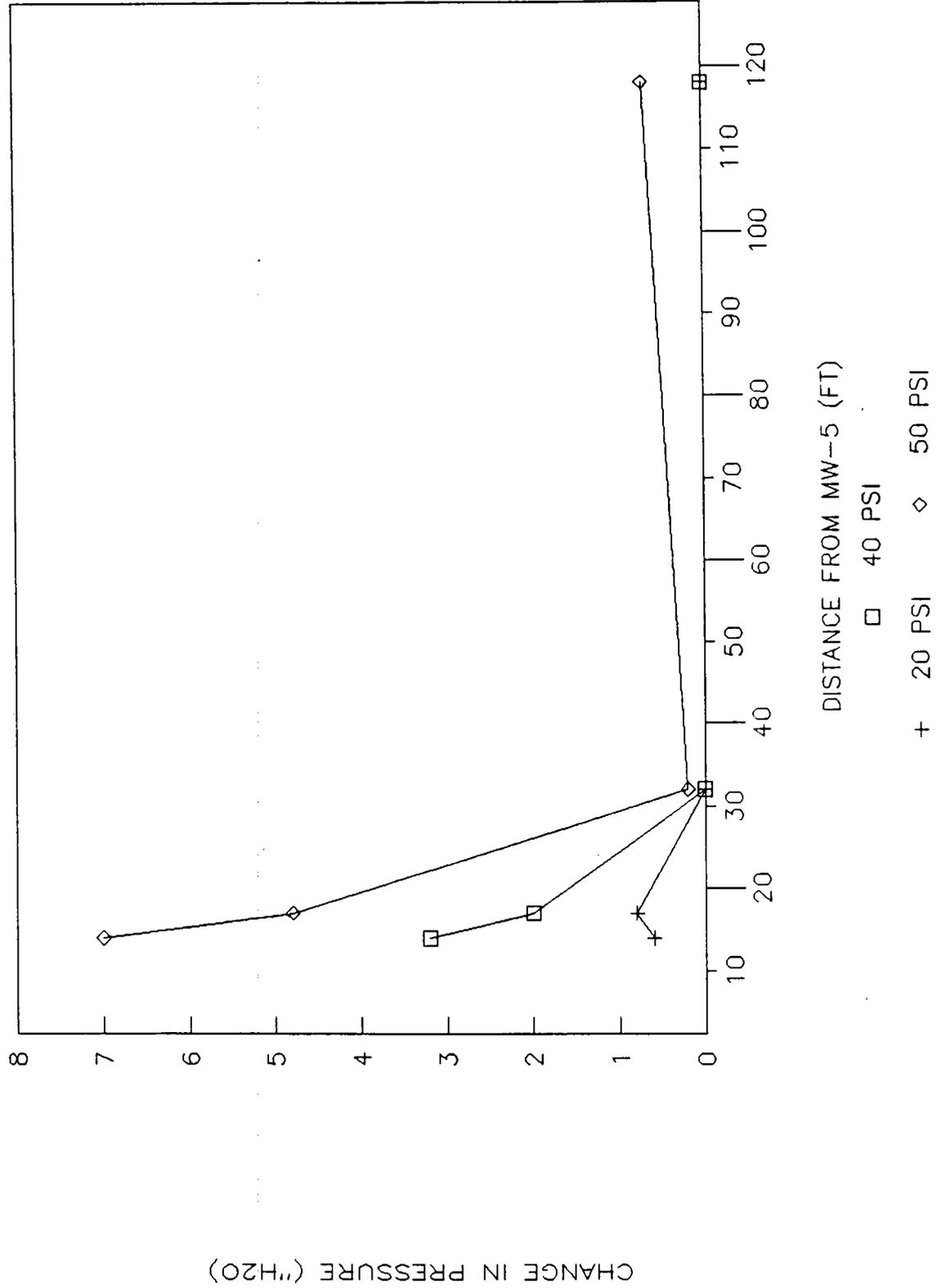


CHART 5

FORMER UNOCAL #9787-214

AIR SPARGE TEST RESULTS

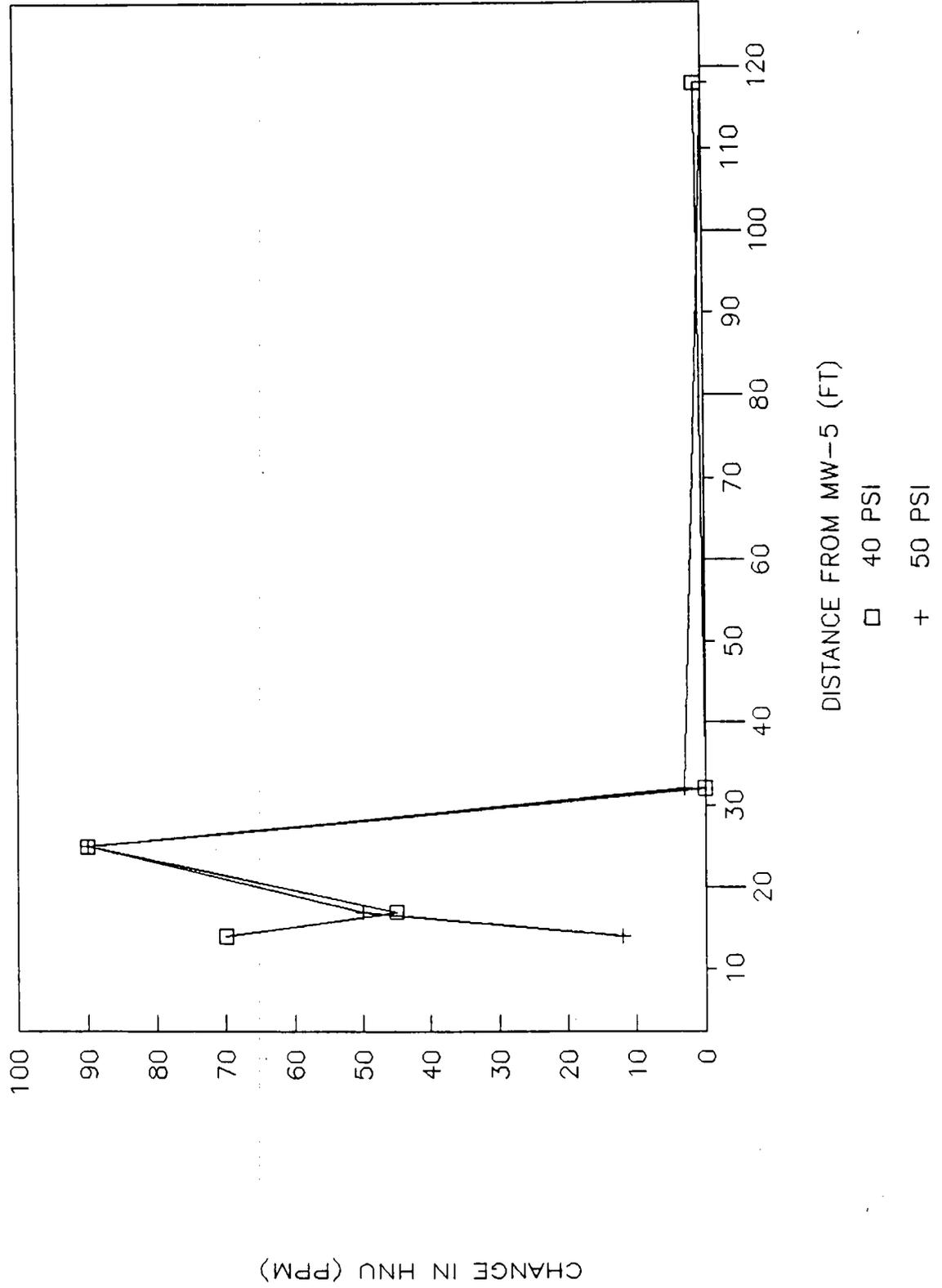
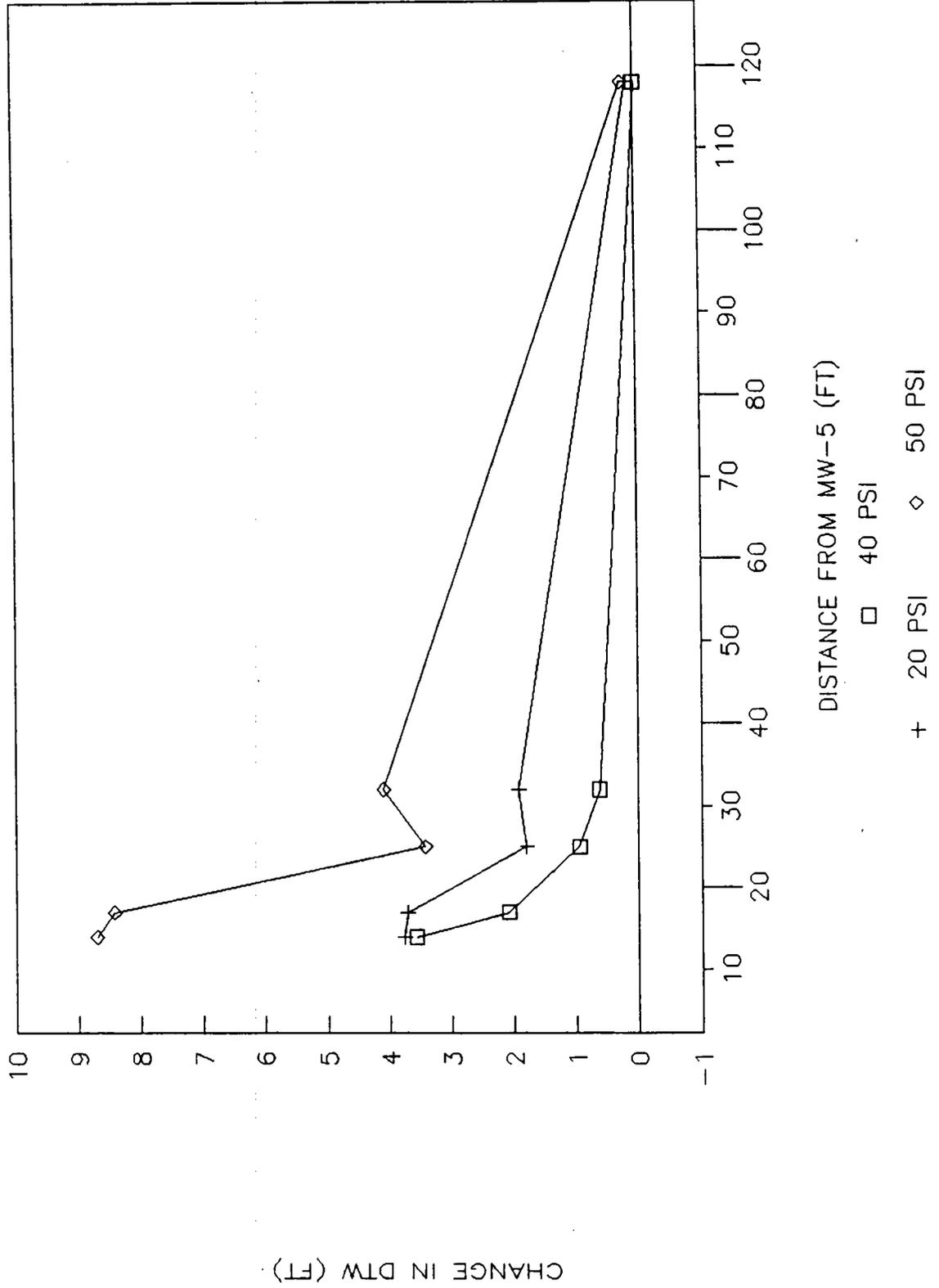


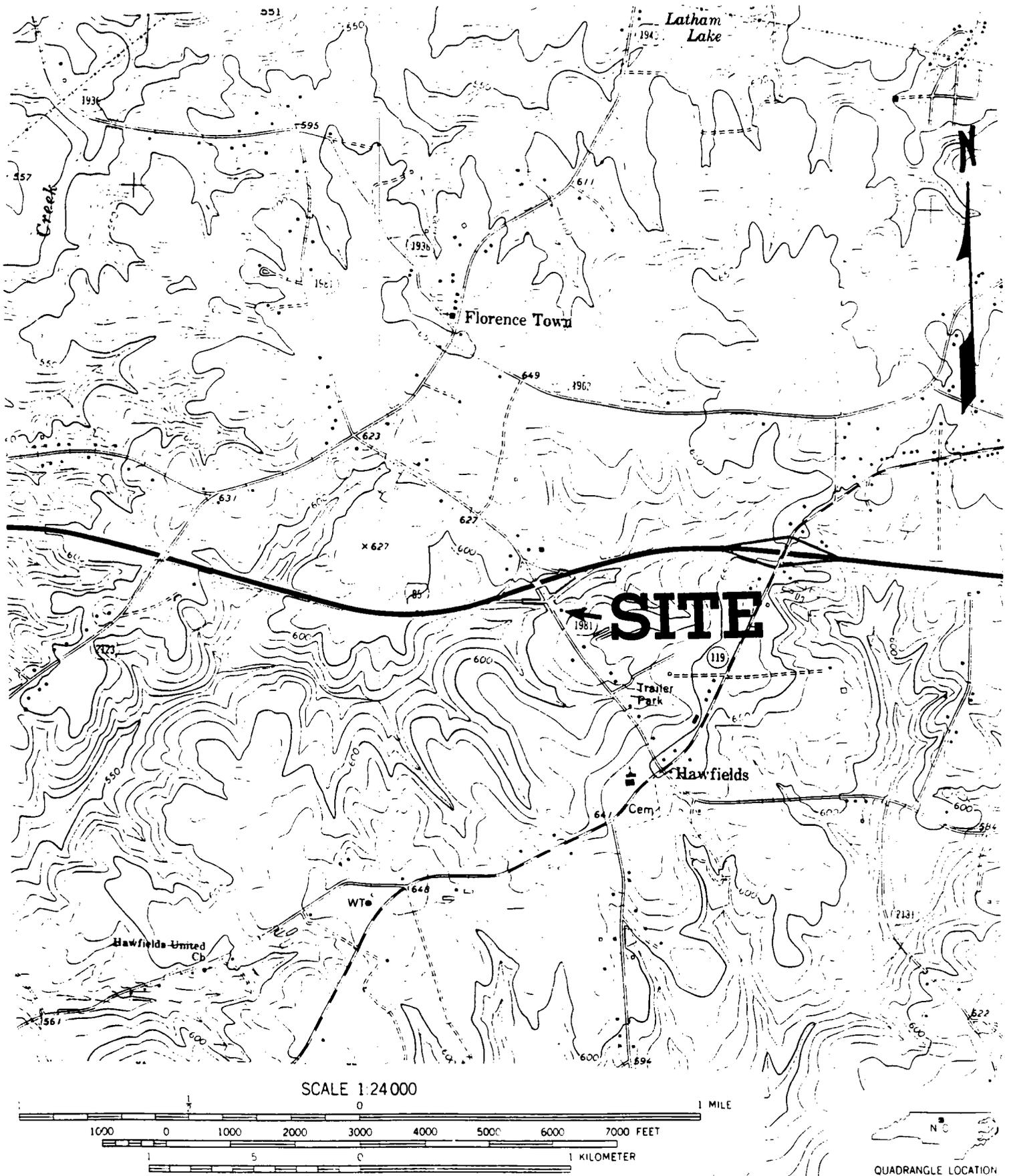
CHART 6

FORMER UNOCAL #9787-214

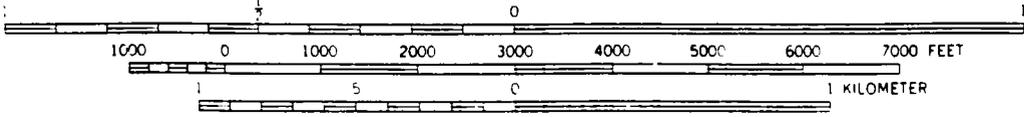
AIR SPARGE TEST RESULTS



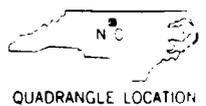




SCALE 1:24 000



CONTOUR INTERVAL 10 FEET  
DATUM IS MEAN SEA LEVEL



SCALE:	AS SHOWN
CHECKED BY:	JB
DRAWN BY:	VR
DATE:	09-08-93

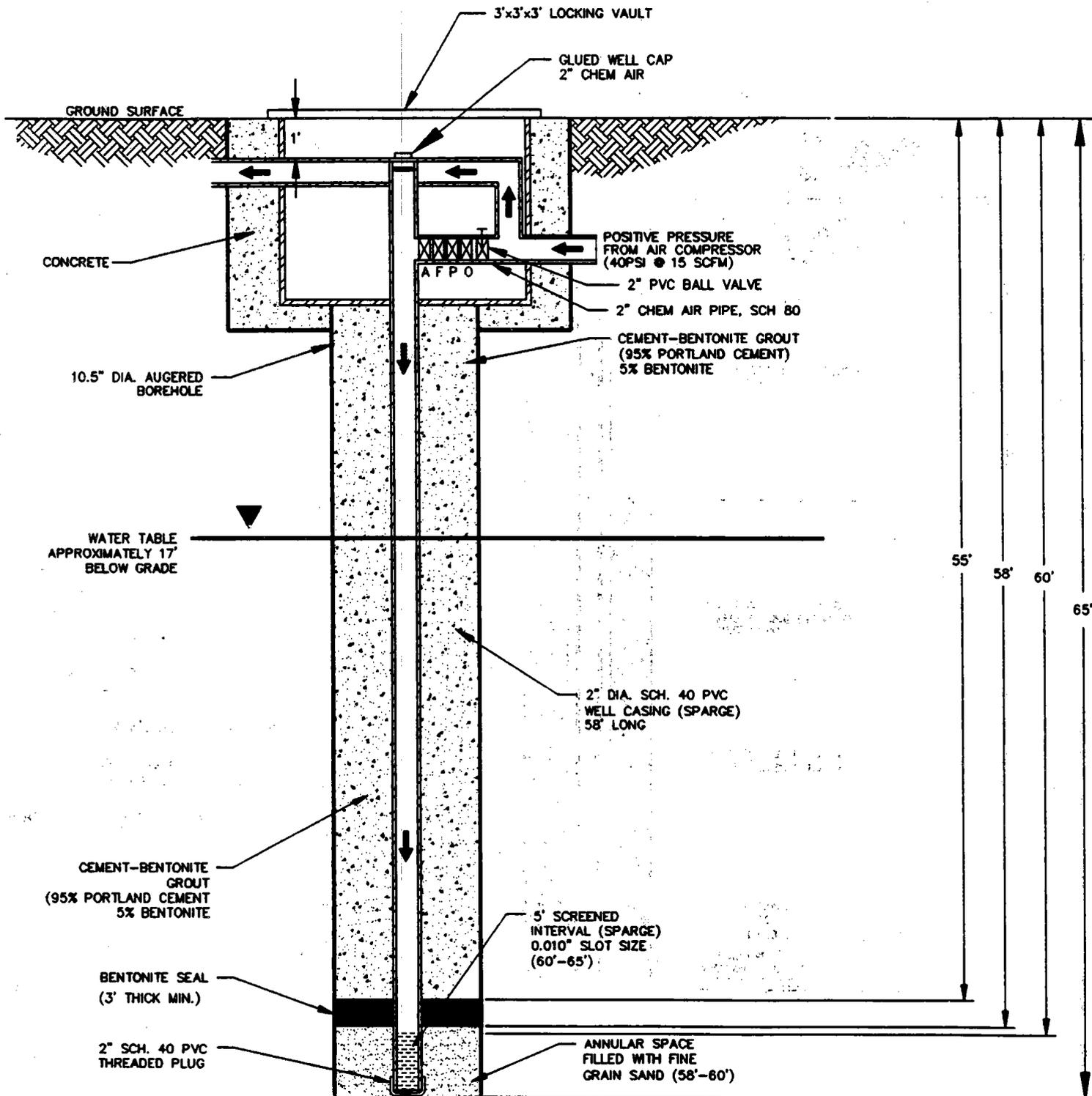


FORMER UNOCAL STATION 9787-214  
MEBANE, NORTH CAROLINA  
SITE LOCATION MAP  
JOB NO. 1584-93-080

FIGURE NO  
1



**PROPOSED 7 VAS WELLS**



- NOTES:
- O = OIL COALESCING FILTER (0.01 MICRON)
  - P = PRESSURE REGULATOR/GUAGE (0-150 psi)
  - F = FLOW REGULATOR
  - A = AIR FLOW GUAGE (0-60 scfm)
  - ➔ AIR FLOW PATH

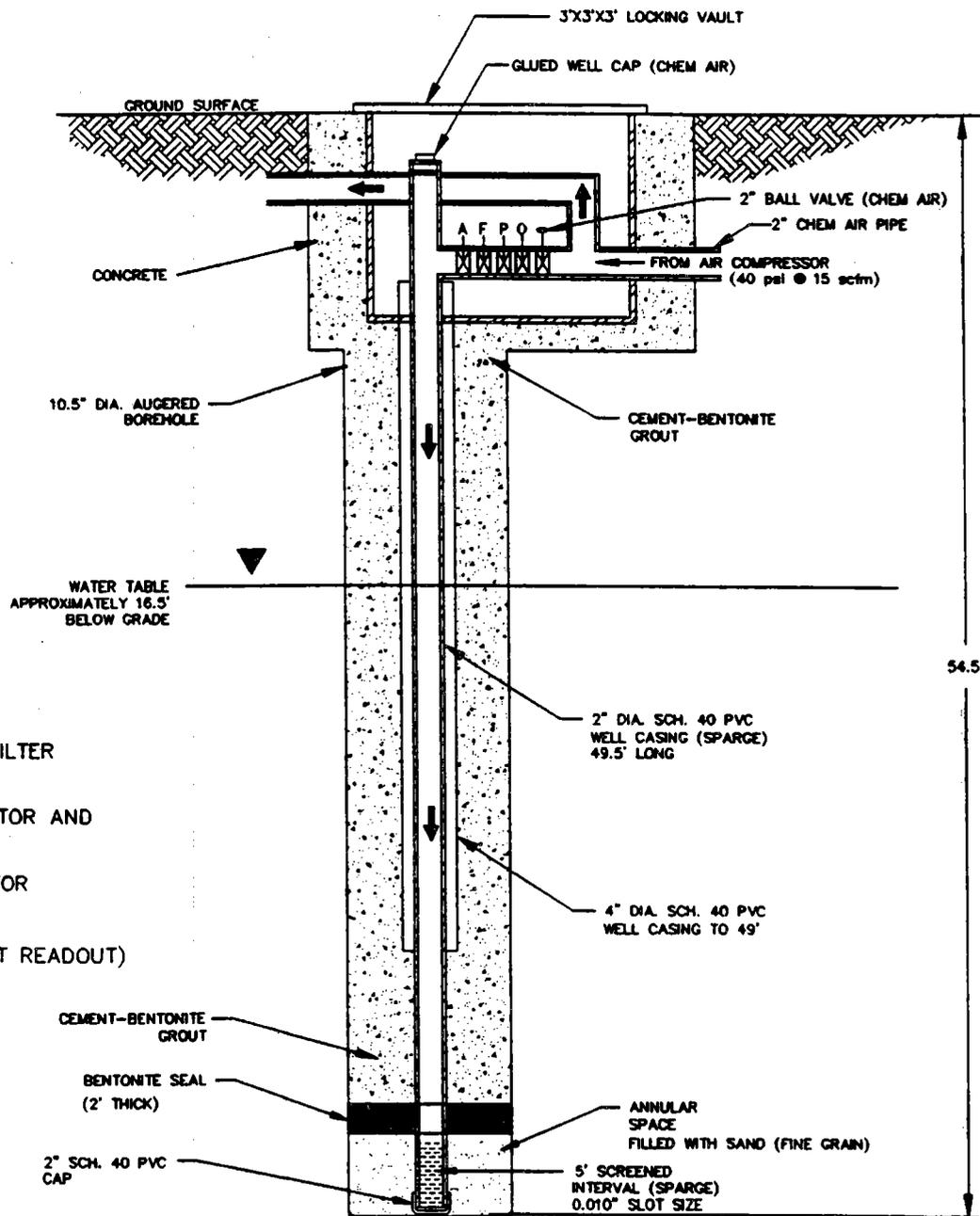
SCALE:	NTS
CHECKED BY:	
DRAWN BY:	HS
DATE:	9-1-93



<b>VERTICAL AIR SPARGE WELL CONSTRUCTION</b>
FORMER UNOCAL STATION #9737-214 MEBANE, NORTH CAROLINA
JOB NO: 1584-92-080

FIGURE NO.

**10**



**KEY**

- O = (OIL COALESCING FILTER 0.01 MICRON)
- P = PRESSURE REGULATOR AND GAUGE (0-150PSI)
- F = AIR FLOW REGULATOR
- A = AIR FLOW GAUGE (0-60 SCFM, DIRECT READOUT)

➔ AIR FLOW PATH

**MW-5  
(TYPE III DEEP WELL)**

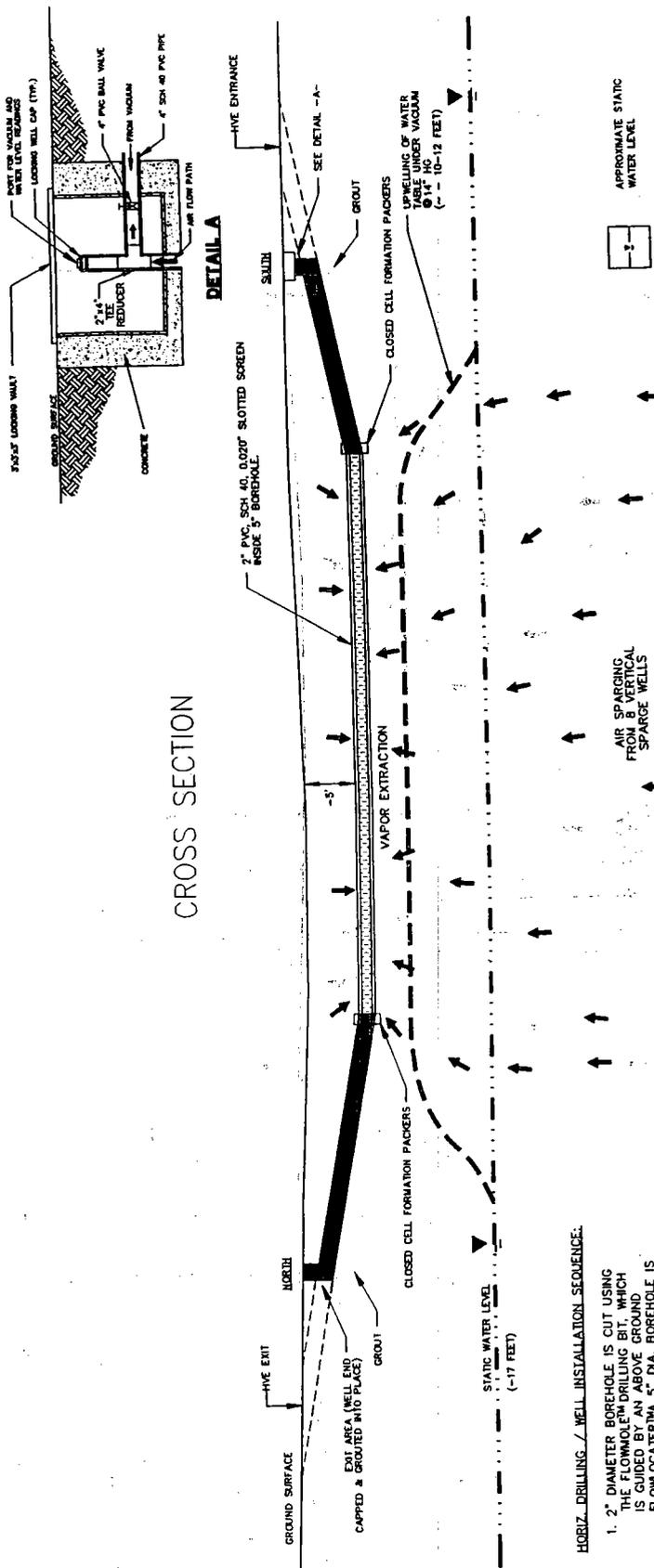


Charlotte Branch  
9751 Southern Pine Blvd.  
P.O. Box 7668  
Charlotte, N.C.  
28241  
(704) 523-4726

**AIR SPARGE WELL CONSTRUCTION  
FORMER UNOCAL STA. #9787-214**

1342 TROLLINGWOOD RD.  
MEBANE N.C.

SCALE: NTS	APPROVED BY:		
DRAWN BY: HS	REVISED:	DATE: 9-1-93	JOB NO: 1584-92-080
			FIGURE NO 9



**HORIZ. DRILLING / WELL INSTALLATION SEQUENCE:**

1. 2" DIAMETER BOREHOLE IS CUT USING THE FLOWMOTOR DRILLING BIT WHICH IS GUIDED BY AN ABOVE GROUND FLOWLOCATOR. 5" DIA. BOREHOLE IS REMOVED FROM THE INITIAL 2" DIA. BOREHOLE.
2. 2" DIAMETER, 0.020 INCH SLOTTED PVC WELL SCREEN IS ASSEMBLED AND PULLED INTO THE 5" DIAMETER CONDUIT, AS SHOWN ABOVE.
3. TREMIE GROUT UP BEHIND BOTH PACKERS TO BOTTOM OF 3'x3'x3' VAULT ON SITE. CAP EXIT END OF WELL AND GROUT INTO PLACE.

HVE-1 & HVE-2



**HORIZONTAL VAPOR EXTRACTION WELL DIAGRAM**  
 FORMER UNOCAL STA. #9787-214  
 1342 TROLLINGWOOD RD., MEBANE

SCALE: NTS	DRAWN BY: HS	CHECKED BY: N.C.
JOB NO. 1584-92-080	DATE 9-1-93	FIGURE NO. 11



**S&ME, INC.**  
**VAPOR EXTRACTION PILOT TEST**

PROJECT NAME: UNOCAL - MEBANE #9787-214  
 PROJECT NUMBER: 1584-92-80  
 PERSONNEL: H. KASEM  
 DATE: 6/15/93  
 PAGE: 2 OF: 3

**VACUUM UNIT READINGS**

VACUUM EXTRACTION WELL ID: PZ-1  
 INITIAL TIME (MILITARY): 11:25  
 ENDING TIME (MILITARY): 12:45      ELAPSED TIME (HOURS): 1.2

	INLET	OUTLET
PITOT TUBE READING ("H2O):	0.05	0.05
VACUUM ("H2O):	100	100
AIR TEMPERATURE (F):	88	115
BACKPRESSURE ("H2O):	0	0
AIR FLOW (SCFM):	38	38

**OBSERVATION WELL READINGS**

WELL ID	DISTANCE FROM TEST WELL (FT)	VACUUM READING ("H2O)	DEPTH TO WATER (FT)	DATE	TIME	OVA READINGS (ppm)
PZ-1	0	100	13.32	6/15/93	12:10P	3
PZ-2	10	0	16.7	6/15/93	12:25P	2
PZ-3	29	-0.2	16.74	6/15/93	12:30P	1
MW-4	13	0	15.8	6/15/93	12:40P	35
MW-5	14	0	17.17	6/15/93	12:20P	1
MW-7	107	0	15.94	6/15/93	12:35P	1

NOTES: NA\* = NOT AVAILABLE, DUE TO SCREEN SUBMERGED  
 "+" = INCREASE IN WATER LEVEL, "-" = DECREASE IN PRESSURE

**AIR QUALITY MONITORING**

SAMPLE #	PUMP RATE (CC/MIN)	SAMPLE DURATION (MIN)	SAMPLE VOLUME (L)	OVA/HNU READING (PPM)	DATE	TIME
1-INF	825	1.21	1	20	6/15/93	11:55
2-INF	825	2.42	2	20	6/15/93	11:57
3-INF	825	6.05	5	20	6/15/93	12:00

**S&ME, INC.**  
**VAPOR EXTRACTION PILOT TEST**

PROJECT NAME: UNOCAL - MEBANE #9787-214  
 PROJECT NUMBER: 1584-92-80  
 PERSONNEL: H. KASEM  
 DATE: 6/15/93  
 PAGE: 3 OF: 3

**VACUUM UNIT READINGS**

VACUUM EXTRACTION WELL ID: PZ-2  
 INITIAL TIME (MILITARY): 13:00  
 ENDING TIME (MILITARY): 15:00  
 ELAPSED TIME (HOURS): 3

	INLET	OUTLET
PITOT TUBE READING ("H2O):	0.05	0.05
VACUUM ("H2O):	85	85
AIR TEMPERATURE (F):	92	120
BACKPRESSURE ("H2O):	0	0
AIR FLOW (SCFM):	38	38

**OBSERVATION WELL READINGS**

WELL ID	DISTANCE FROM TEST WELL (FT)	VACUUM READING ("H2O)	DEPTH TO WATER (FT)	DATE	TIME	OVA READINGS (ppm)
PZ-1	10	-0.3	16.38	6/15/93	15:10	6
PZ-2	0	85	13.3	6/15/93	14:55	22
PZ-3	9	0	16.79	6/15/93	15:13	3
MW-4	20	0	15.79	6/15/93	15:05	20
MW-5	17	0	17.2	6/15/93	15:00	3
MW-7	103	0	15.93	6/15/93	15:15	2
NOTES: NA* = NOT AVAILABLE, DUE TO SCREEN SUBMERGED						
"+" = INCREASE IN WATER LEVEL, "--" = DECREASE IN PRESSURE						

**AIR QUALITY MONITORING**

SAMPLE #	PUMP RATE (CC/MIN)	SAMPLE DURATION (MIN)	SAMPLE VOLUME (L)	OVA/HNU READING (PPM)	DATE	TIME
4-INF	825	1.21	1	20	6/15/93	14:18
5-INF	825	2.42	2	20	6/15/93	14:21
6-INF	825	6.05	5	20	6/15/93	14:28

AIR SPARGING TEST RESULTS

FORMER UNOCAL #9787-214  
 1342 TROLLINGWOOD - HAWFIELD ROAD  
 MEBANE, NORTH CAROLINA  
 S&ME PROJECT 1584-92-080

WELL ID	DISTANCE FROM MW-5 (FT)	INITIAL READINGS					TEST I READINGS AT 40 PSI						
		DO	PRESS	HNU	DTW	DO	PRESS	HNU	DTW	d-DO	d-PRESS	d-HNU	d-DTW
		0.30	0.00		16.54	4.20	3.20	70.0	12.98	3.90	3.20	70.00	3.56
PZ-1	14	0.30	0.00		16.54	4.20	3.20	70.0	12.98	3.90	3.20	70.00	3.56
PZ-2	17	3.00	0.00		16.82	3.60	2.00	45.0	14.74	0.60	2.00	45.00	2.08
MW-4	25	0.40	0.00		16.37	0.70		90.0	15.42	0.30		90.00	0.95
PZ-3	32	2.60	0.00		16.87	4.40	0.00	0.0	16.25	1.80	0.00	0.00	0.62
MW-7	118	3.00	0.00		15.94	3.00	0.00	1.0	15.95	0.00	0.00	1.00	-0.01

WELL ID	DISTANCE FROM MW-5 (FT)	INITIAL READINGS					TEST II READINGS AT 20 PSI						
		DO	PRESS	HNU	DTW	DO	PRESS	HNU	DTW	d-DO	d-PRESS	d-HNU	d-DTW
		0.30	0.00		16.54	0.40	0.60	12.0	12.78	0.10	0.60	12.00	3.76
PZ-1	14	0.30	0.00		16.54	0.40	0.60	12.0	12.78	0.10	0.60	12.00	3.76
PZ-2	17	3.00	0.00		16.82	2.80	0.80	50.0	13.11	-0.20	0.80	50.00	3.71
MW-4	25	0.40	0.00		16.37	0.40		90.0	14.58	0.00		90.00	1.79
PZ-3	32	2.60	0.00		16.87	3.50	0.00	3.0	14.95	0.90	0.00	3.00	1.92
MW-7	118	3.00	0.00		15.94	3.20	0.00	0.0	15.82	0.20	0.00	0.00	0.12

WELL ID	DISTANCE FROM MW-5 (FT)	INITIAL READINGS					TEST II READINGS AT 50 PSI						
		DO	PRESS	HNU	DTW	DO	PRESS	HNU	DTW	d-DO	d-PRESS	d-HNU	d-DTW
		0.30	0.00		16.54	4.60	7.00	80.0	7.84	4.30	7.00	80.00	8.70
PZ-1	14	0.30	0.00		16.54	4.60	7.00	80.0	7.84	4.30	7.00	80.00	8.70
PZ-2	17	3.00	0.00		16.82	3.80	4.80	90.0	8.40	0.80	4.80	90.00	8.42
MW-4	25	0.40	0.00		16.37	3.30		100.0	12.95	2.90		100.00	3.42
PZ-3	32	2.60	0.00		16.87	4.40	0.20	8.0	12.78	1.80	0.20	8.00	4.09
MW-7	118	3.00	0.00		15.94	4.90	0.70	5.0	15.74	1.90	0.70	5.00	0.20

NOTES: PRESSURE READINGS IN "WATER  
 HNU - VOLATILE ORGANIC READINGS IN PPM  
 DTW - DEPTH TO WATER (FT)

DO - DISSOLVED OXYGEN (MG/L)  
 d - CHANGE FROM INITIAL READINGS  
 PRESS - PRESSURE



MDS  
Laboratories

# LABORATORY REPORT

INDUSTRIAL HYGIENE

ENVIRONMENTAL TESTING

• EPA/NVLAP 1262  
• AIHA ACCREDITATION NO. 135

• NY DOH 10903  
• PA DER 06-353  
• NJ DEP 77678

S&ME, CHARLOTTE

P.O.# 9563

Work Order number: R062193-115

MDS Number            Client Number

Samples Received: 06/21/93  
Report Date: 06/24/93

	<u>Front</u>	<u>Back</u>	<u>Concentration</u>
3172129 #2			
1. ACETONE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
2. BENZENE	0.39 mg	0.07 mg	230.00 mg/m3
3. CHLOROFORM	0.16 mg	< 0.01 mg	80.00 mg/m3
4. CUMENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
5. 1,2-DICHLOROETHANE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
6. ETHYL BENZENE	0.12 mg	< 0.01 mg	60.00 mg/m3
7. HEXANE	5.36 mg	4.49 mg	4925.00 mg/m3
8. METHYL CHLOROFORM	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
9. METHYL ETHYL KETONE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
10. METHYLENE CHLORIDE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
11. PENTANE	3.71 mg	2.71 mg	3210.00 mg/m3
12. PERCHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
13. STYRENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
14. TOLUENE	0.63 mg	< 0.01 mg	315.00 mg/m3
15. TRICHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
16. M-XYLENE	0.06 mg	< 0.01 mg	30.00 mg/m3
17. O-XYLENE	0.09 mg	< 0.01 mg	45.00 mg/m3
18. P-XYLENE	0.25 mg	< 0.01 mg	125.00 mg/m3
19. TOTAL OTHER A HYDRO.	8.88 mg	2.11 mg	5495.00 mg/m3
20. TOTAL OTHER B HYDRO.	0.24 mg	< 0.01 mg	120.00 mg/m3

Air volume: 2.0 liters

Lower limit of quantitation: 0.01 mg each analyte per sample  
Analytical Method: NIOSH 1500, 1501

  
Fred Usbeck, CIH  
Laboratory Director



MDS  
Laboratories

# LABORATORY REPORT

INDUSTRIAL HYGIENE

ENVIRONMENTAL TESTING

• EPA/NVLAP 1262  
• AIHA ACCREDITATION NO. 135

• NY DOH 10903  
• PA DER 06-353  
• NJ DEP 77678

S&ME, CHARLOTTE

P.O.# 9563

Work Order number: R062193-115

MDS Client  
Number Number

Samples Received: 06/21/93  
Report Date: 06/24/93

	<u>Front</u>	<u>Back</u>	<u>Concentration</u>
3172130 #3			
1. ACETONE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
2. BENZENE	0.47 mg	0.34 mg	162.00 mg/m3
3. CHLOROFORM	0.18 mg	< 0.01 mg	36.00 mg/m3
4. CUMENE	0.01 mg	< 0.01 mg	2.00 mg/m3
5. 1,2-DICHLOROETHANE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
6. ETHYL BENZENE	0.25 mg	< 0.01 mg	50.00 mg/m3
7. HEXANE	5.15 mg	0.08 mg	1046.00 mg/m3
8. METHYL CHLOROFORM	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
9. METHYL ETHYL KETONE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
10. METHYLENE CHLORIDE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
11. PENTANE	2.33 mg	1.66 mg	798.00 mg/m3
12. PERCHLOROETHYLENE	0.06 mg	< 0.01 mg	12.00 mg/m3
13. STYRENE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
14. TOLUENE	1.46 mg	0.06 mg	304.00 mg/m3
15. TRICHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
16. M-XYLENE	0.14 mg	< 0.01 mg	30.00 mg/m3
17. O-XYLENE	0.18 mg	< 0.01 mg	36.00 mg/m3
18. P-XYLENE	0.51 mg	< 0.01 mg	102.00 mg/m3
19. TOTAL OTHER A HYDRO.	11.63 mg	8.68 mg	4062.00 mg/m3
20. TOTAL OTHER B HYDRO.	0.43 mg	< 0.01 mg	36.00 mg/m3

Air volume: 5.0 liters

Lower limit of quantitation: 0.01 mg each analyte per sample  
Analytical Method: NIOSH 1500, 1501

  
Fred Usbeck, CIH  
Laboratory Director



MDS  
Laboratories

# LABORATORY REPORT

INDUSTRIAL HYGIENE

ENVIRONMENTAL TESTING

EPA/NVLAP 1262  
AIHA ACCREDITATION NO. 135

NY DOH 10903  
PA DER 06-353  
NJ DEP 77678

S&ME, CHARLOTTE

P.O. # 9563

Work Order number: R062193-115

MDS Number      Client Number

Samples Received: 06/21/93  
Report Date: 06/24/93

	<u>Front</u>	<u>Back</u>	<u>Concentration</u>
3172131 #5			
1. ACETONE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
2. BENZENE	0.57 mg	< 0.01 mg	285.00 mg/m3
3. CHLOROFORM	0.19 mg	< 0.01 mg	95.00 mg/m3
4. CUMENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
5. 1,2-DICHLOROETHANE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
6. ETHYL BENZENE	0.14 mg	< 0.01 mg	70.00 mg/m3
7. HEXANE	5.21 mg	2.34 mg	3775.00 mg/m3
8. METHYL CHLOROFORM	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
9. METHYL ETHYL KETONE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
10. METHYLENE CHLORIDE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
11. PENTANE	2.76 mg	1.70 mg	2230.00 mg/m3
12. PERCHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
13. STYRENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
14. TOLUENE	1.10 mg	< 0.01 mg	550.00 mg/m3
15. TRICHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 5.00 mg/m3
16. M-XYLENE	0.08 mg	< 0.01 mg	40.00 mg/m3
17. O-XYLENE	0.10 mg	< 0.01 mg	50.00 mg/m3
18. P-XYLENE	0.28 mg	< 0.01 mg	140.00 mg/m3
19. TOTAL OTHER A HYDRO.	9.26 mg	3.63 mg	6445.00 mg/m3
20. TOTAL OTHER B HYDRO.	0.26 mg	< 0.01 mg	130.00 mg/m3

Air volume: 2.0 liters

Lower limit of quantitation: 0.01 mg each analyte per sample  
Analytical Method: NIOSH 1500, 1501

  
Fred Usbeck, CIH  
Laboratory Director



MDS  
Laboratories

# LABORATORY REPORT

INDUSTRIAL HYGIENE

ENVIRONMENTAL TESTING

• EPA/NVLAP 1262  
• AIHA ACCREDITATION NO. 135

• NY DOH 10903  
• PA DER 06-353  
• NJ DEP 77678

S&ME, CHARLOTTE

P.O.# 9563

Work Order number: R062193-115

MDS Client  
Number Number

Samples Received: 06/21/93  
Report Date: 06/24/93

	<u>Front</u>	<u>Back</u>	<u>Concentration</u>
3172132 #6			
1. ACETONE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
2. BENZENE	0.59 mg	0.43 mg	204.00 mg/m3
3. CHLOROFORM	0.37 mg	< 0.01 mg	74.00 mg/m3
4. CUMENE	0.02 mg	< 0.01 mg	4.00 mg/m3
5. 1,2-DICHLOROETHANE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
6. ETHYL BENZENE	0.28 mg	< 0.01 mg	56.00 mg/m3
7. HEXANE	2.93 mg	0.86 mg	758.00 mg/m3
8. METHYL CHLOROFORM	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
9. METHYL ETHYL KETONE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
10. METHYLENE CHLORIDE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
11. PENTANE	2.26 mg	1.41 mg	734.00 mg/m3
12. PERCHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
13. STYRENE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
14. TOLUENE	2.04 mg	0.22 mg	452.00 mg/m3
15. TRICHLOROETHYLENE	< 0.01 mg	< 0.01 mg	< 2.00 mg/m3
16. M-XYLENE	0.19 mg	< 0.01 mg	38.00 mg/m3
17. O-XYLENE	0.21 mg	< 0.01 mg	42.00 mg/m3
18. P-XYLENE	0.58 mg	< 0.01 mg	116.00 mg/m3
19. TOTAL OTHER A HYDRO.	12.20 mg	7.94 mg	4023.00 mg/m3
20. TOTAL OTHER B HYDRO.	0.57 mg	0.01 mg	116.00 mg/m3

Air volume: 5.0 liters

Lower limit of quantitation: 0.01 mg each analyte per sample  
Analytical Method: NIOSH 1500, 1501

  
Fred Usbeck, CIH  
Laboratory Director



MDS  
Laboratories

# LABORATORY REPORT

## INDUSTRIAL HYGIENE

\* EPA/NVLAP 1262  
\* AIHA ACCREDITATION NO. 135

## ENVIRONMENTAL TESTING

\* NY DOH 10903 \* NJ DEP 77678  
\* PA DER 06-353

S&ME, Charlotte

P. O. No. 9563

W. O. No.: R062193-115

<u>Sample Ident.</u>	<u>Volume</u>	<u>Analyte</u>	<u>Results</u>
3172129 #2	2.0 L	Benzene	230.0mg/M <sup>3</sup>
		A Hydro's	13,630.0
		B Hydro's	775.0
3172130 #3	5.0 L	Benzene	162.0mg/M <sup>3</sup>
		A Hydro's	5,906.0
		B Hydro's	644.0
3172131 #5	2.0 L	Benzene	285.0mg/M <sup>3</sup>
		A Hydro's	12,450.0
		B Hydro's	1,075.0
3172132 #6	5.0 L	Benzene	204.0mg/M <sup>3</sup>
		A Hydro's	5,520.0
		B Hydro's	898.0

Lower limit of quantitation = 0.01mg each analyte/category per sample.

Analytical Method: NIOSH 1500, 1501

Fred Usbeck, CIH  
Laboratory Director

Total Hydrocarbon Scan

MDS Laboratories performs a comprehensive scan for airborne organic vapors on both charcoal tubes and passive dosimeters. This Total Hydrocarbon Scan (THS) identifies and quantitates 18 specific analytes commonly found in IAQ and industrial settings, in addition to quantitating all other organics detected in two separate categories according to their molecular characteristics.

The THS may be your analysis of choice when: 1) you are not certain which hydrocarbons may be present in an industrial environment, 2) you need an indicator of indoor air quality, or 3) you want to establish a baseline level of hydrocarbon contamination in an environment with a complex mix of organics.

Analytically, the separation is performed with capillary or packed column GC using a wide-range time-temperature program and a flame ionization detector. Each hydrocarbon's retention time is determined by a combination of its molecular characteristics. After 18 specific analytes are identified and quantitated, any remaining peaks are quantitated as either A Hydrocarbons or B Hydrocarbons.

In most cases the A Hydrocarbons are non-polar (or low polarity) low boiling organics, including the alkanes, lower molecular weight ketones & alcohols, and some chlorinated organics. The B Hydrocarbons are typically polar organics with higher boiling points, including the more complex ketones & alcohols, aromatics, Cellosolves, esters, and some halogenated species. Results for the THS are calculated as concentrations when you supply air volumes to MDS. The THS:

acetone	benzene
chloroform	cumene
1,2-dichloroethane	ethyl benzene
hexane	methyl chloroform
methyl ethyl ketone	methylene chloride
pentane	perchloroethylene
styrene	toluene
trichloroethylene	m-xylene
o-xylene	p-xylene
total other A hydrocarbons	total other B hydrocarbons

The THS will also tentatively identify and quantitate mixed fraction hydrocarbons if applicable; these include:

Stoddard solvent	kerosene
gasoline	Diesel
mineral spirits	V M & P naphtha



AIR EMISSION CALCULATIONS FOR PROPOSED SOIL VAPOR EXTRACTION SYSTEM (WITHOUT CARBON)

FORMER UNOCAL STATION #9787 -214  
 1342 TROLLINGWOOD ROAD  
 MEBANE, NORTH CAROLINA  
 SAME PROJECT 1584 -92 -080

DISCHARGE FLOW RATE (SCFM)	DURATION (HR)	SAMPLE ID	CONCENTRATION (MG/M3)				MASS EMISSION RATE (lb/hr)				TOTAL X	A TOTAL CARBONS	B TOTAL HYDRO- CARBONS	A TOTAL CHOLORFORM	B TOTAL HYDRO- CARBONS	A TOTAL HYDRO- CARBONS	B TOTAL HYDRO- CARBONS	TOTAL HYDROCARBON EMISSIONS (LBS/DAY)					
			B	E	T	X	B	E	T	X									HEXANE	PENTANE	CHOLORFORM	HYDRO- CARBONS	HYDRO- CARBONS
400	24.00	2	230	60	315	200	4925	3210	80	5495	120	345E-01	8.99E-02	4.72E-01	3.00E-01	7.38E-00	4.81E+00	1.20E-01	8.23E+00	1.80E-01	9.27E+00	2.02E+02	
400	24.00	3	182	50	304	168	1046	786	36	4082	86	2.43E-01	7.49E-02	4.58E-01	2.92E-01	1.57E+00	1.20E+00	5.39E-02	6.09E+00	1.39E-01	5.83E+00	1.49E+02	
400	24.00	5	285	70	550	230	3775	2230	95	6445	130	4.27E-01	1.05E-01	8.24E-01	3.45E-01	5.86E+00	3.34E+00	1.42E-01	9.80E+00	1.85E-01	1.02E+01	2.38E+02	
400	24.00	6	204	56	452	196	738	734	74	4028	118	3.08E-01	8.39E-02	6.77E-01	2.94E-01	1.14E+00	1.10E+00	1.11E-01	6.04E+00	1.74E-01	7.34E+00	1.48E+02	
											AVERAGE EMISSION RATE (LBS/DAY)												
											5495	120	345E-01	8.99E-02	4.72E-01	3.00E-01	7.38E-00	4.81E+00	1.20E-01	8.23E+00	1.80E-01	9.27E+00	2.02E+02

NOTES: SCFM = STANDARD CUBIC FEET PER MINUTE  
 CONCENTRATIONS FROM MDS LABORATORY REPORTS  
 MASS EMISSION RATE = (FLOW RATE (SCFM) \* CONCENTRATION (MG/M3) \* 3.746E-06 POUNDS/HOUR (CONVERSION FACTOR))  
 TOTAL HYDROCARBON EMISSION RATE = TPH (A+B) MASS EMISSION RATE \* TEST DURATION (9 HOURS)  
 INFLUENT SAMPLES # 1 AND 4 WERE NOT ANALYZED SINCE DETECTION LEVELS WOULD BE TO HIGH AT 1 LITER, AS COMPARED TO OTHER 2 AND 3 LITER SAMPLES FROM #2, 3, 5 AND 6  
 ALL SAMPLES ARE INFLUENT AND REPRESENT EMISSIONS, SINCE NO AIR TREATMENT WAS REQUIRED DURING THE TEST  
 ALL OTHER HYDROCARBONS SCANNED WERE BELOW OR APPROACHING QUANTITATION LIMITS  
 B BENZENE  
 E ETHYLBENZENE  
 T TOLUENE  
 X XYLENES

AIR EMISSION CALCULATIONS FOR PROPOSED SOIL VAPOR EXTRACTION SYSTEM (WITH CARBON)

FORMER UNOCAL STATION #9787-214  
 1342 TROLLINGWOOD ROAD  
 MEBANE, NORTH CAROLINA  
 S&ME PROJECT 1584-92-080

DISCHARGE FLOW RATE (SCFM)	DURATION (HR)	SAMPLE ID	CONCENTRATION (MG/M3)				MASS EMISSION RATE (LB/HR)				TOTAL				TOTAL HYDROCARBON EMISSIONS (LBS/DAY) (LBS/DAY) @ 99.999% EFFIC.)																							
			B	E	T	X	B	E	T	X	A TOTAL HYDRO- CARBONS	B TOTAL HYDRO- CARBONS	CHOLORFORM	PENTANE		HEXANE	A TOTAL HYDRO- CARBONS	B TOTAL HYDRO- CARBONS	CHOLORFORM	PENTANE	HEXANE	A TOTAL HYDRO- CARBONS	B TOTAL HYDRO- CARBONS	CHOLORFORM	PENTANE	HEXANE	TOTAL EMISSIONS (LBS/DAY) (WITH CARBON @ 99.999% EFFIC.)											
400	24.00	2	230	60	315	200	4923	3210	60	5495	120	3.43E-01	8.99E-02	4.72E-01	3.00E-01	1.20E-01	6.23E+00	1.80E-01	1.20E-01	4.81E+00	7.38E+00	6.23E+00	1.80E-01	1.20E-01	4.81E+00	6.23E+00	1.80E-01	2.02E-01										
400	24.00	3	162	50	304	188	1046	798	36	4082	86	2.43E-01	7.49E-02	4.58E-01	2.32E-01	5.39E-02	6.09E+00	1.29E-01	5.39E-02	1.20E+00	1.57E+00	6.09E+00	1.29E-01	5.39E-02	1.20E+00	6.09E+00	1.29E-01	1.49E-01										
400	24.00	5	285	70	550	230	3775	2230	95	6445	130	4.27E-01	1.05E-01	8.24E-01	3.45E-01	1.42E-01	9.66E+00	1.95E-01	1.42E-01	3.34E+00	5.86E+00	9.66E+00	1.95E-01	1.42E-01	3.34E+00	9.66E+00	1.95E-01	2.38E-01										
400	24.00	6	204	58	432	186	758	734	74	4028	116	3.06E-01	8.39E-02	6.77E-01	2.94E-01	1.11E-01	8.04E+00	1.74E-01	1.11E-01	1.10E+00	1.14E+00	8.04E+00	1.74E-01	1.11E-01	1.10E+00	8.04E+00	1.74E-01	1.49E-01										
			TOTAL				TOTAL				TOTAL				TOTAL				TOTAL																			
			A				B				X				A				B				X				A				B				X			

NOTES: SCFM = STANDARD CUBIC FEET PER MINUTE  
 CONCENTRATIONS FROM MDS LABORATORY REPORTS  
 MASS EMISSION RATE = (FLOW RATE (SCFM) \* CONCENTRATION (MG/M3) \* 3.746E-06 POUNDS/HOUR (CONVERSION FACTOR))  
 TOTAL HYDROCARBON EMISSION RATE = TPH (A&B) MASS EMISSION RATE \* TEST DURATION (3 HOURS)  
 INFLUENT SAMPLES #1 AND 4 WERE NOT ANALYZED SINCE DETECTION LEVELS WOULD BE TOO HIGH AT 1 LITER AS COMPARED TO OTHER 2 AND 3 LITER SAMPLES FROM #2, 3, 5 AND 6  
 ALL SAMPLES ARE INFLUENT AND REPRESENT EMISSIONS SINCE NO AIR TREATMENT WAS REQUIRED DURING THE TEST  
 ALL OTHER HYDROCARBONS SCANNED WERE BELOW OR APPROACHING QUANTITATION LIMITS

- B BENZENE
- E ETHYLBENZENE
- T TOLUENE
- X XYLENES



JOB NO. \_\_\_\_\_

SHEET NO. \_\_\_\_\_

DATE 2-15-93JOB NAME Flow Calculation Under VacuumCOMPUTED BY DASSUBJECT (3" Dia. Inlet Pipe of Pitot Tube)CHECKED BY SMH $V_I = \text{inlet vacuum ("Hg)}$  $P_I = \text{inlet differential pressure ("H}_2\text{O)}$  $T_I = \text{inlet temperature (}^\circ\text{F)}$ 

Ref: Dwyor Calculations for Air Flow Under Vacuum Conditions Using Dwyor Pitot Tube

$$\text{vapor density, } d = 1.325 \left( \frac{P_B}{T} \right)$$

where barometric pressure,  $P_B = 29.92 - V_I$

and temperature,  $T (^{\circ}\text{Rankin}) = T_I + 460$

$$\therefore d = 1.325 \left( \frac{29.92 - V_I}{T_I + 460} \right) \frac{\text{lb}}{\text{ft}^3}$$

$$\text{Vapor Velocity, } V = (0.9)(1096.7) \sqrt{\frac{P_I}{d}}$$

0.9 = correction for centered pitot tube to provide "average" velocity.

$$V = (0.9)(1096.7) \sqrt{\frac{P_I}{1.325 \left( \frac{29.92 - V_I}{T_I + 460} \right)}} \frac{\text{ft}}{\text{min}}$$

$$Q_{ACFM} = A \times V = 0.049 \text{ ft}^2 \times V \left( \frac{\text{ft}}{\text{min}} \right)$$

$$Q_{ACFM} = 42.02 \sqrt{\frac{P_I (T_I + 460)}{29.92 - V_I}}$$

$$Q_{SCFM} = Q_{ACFM} \times \left[ \frac{29.92 - V_I}{29.92} \right] \times \left[ \frac{528}{T_I + 460} \right]$$

$$Q_{SCFM} = 741.53 \sqrt{\frac{(29.92 - V_I) P_I}{T_I + 460}}$$



JOB NO. \_\_\_\_\_

SHEET NO. \_\_\_\_\_

DATE 2-15-93JOB NAME Flow Calculation Under Pressure COMPUTED BY DHSUBJECT (3" Dia Discharge Stack w/Pitot Tube) CHECKED BY \_\_\_\_\_ $P = \text{Discharge Pressure ("Hg)}$  $P_D = \text{Differential Pressure @ Discharge ("H}_2\text{O)}$  $T_D = \text{Discharge Temperature (}^\circ\text{F)}$ 

$$Q_{ACFM} = 42.02 \sqrt{\frac{P_D (T_D + 460)}{29.92 + P}}$$

$$Q_{SCFM} = 741.53 \sqrt{\frac{(29.92 + P) P_D}{T_D + 460}}$$

Calculating Air Flow Under Vacuum Conditions  
Using Dwyer Pitot Tubes and Formulas

This information is compiled from use of the information from Dwyer instruments which is furnished with their model 167-6 Pitot Tubes.

The pitot tube is used to determine air flow in ducts or pipes. If installed in a small pipe the pitot should be centered in the pipe. Taking multiple differential pressure readings to establish an average differential pressure is impractical if not impossible. Dwyer instructs that a centered pitot tube's resulting velocity should be multiplied by .9 to obtain the "average" differential pressure for the pipe.

Dwyer's Formulas for calculating CFM in a pipe are:

1.  $V = 1096.7 * \text{square root}(h_w/d)$   
V = velocity in Ft/min  
h<sub>w</sub> = differential pressure in "H2O  
d = density of air at measured conditions
2.  $d = 1.325 * PB/T$   
d = density of air in Lbs/ft<sup>3</sup>  
P\* = Barometric (or absolute) pressure  
T = Temperature in Rankin (air temp at conditions + 460)
3.  $Q = AV$   
Q = Volume of air flow CFM at actual conditions  
A = Area of pipe or duct in ft<sup>2</sup>  
V = Velocity of air in Ft/min

To simplify and clarify the calculation of d this alternative formula can be use for vacuum conditions.

$$4. d = .075 \text{ Lbs/ft}^3 * \text{Pressure factor} * \text{Temp factor}$$
$$\text{Pressure factor} = \frac{(\text{Vacuum} - \text{"Hg} + \text{Baro Press})}{29.92 \text{ "Hg}}$$

$$\text{Temp factor} = \frac{(68 \text{ }^\circ\text{F} + 460)}{(\text{Flow's temp } ^\circ\text{F} + 460)}$$

This calculates the density of the air being measured using the vacuum and temperature in the air flow. It does not correct for the air humidity.

After calculating the air density calculate the air flow velocity using formula 1.

Correct this velocity for the average flow conditions by multiplying by 0.9

Calculate the Q value using formula 3. This value is in CFM for actual condition in the flow/pipe.

To convert this back to Standard conditions use the ideal gas formula.

$$\frac{V P}{T} = \frac{V' P'}{T'}$$

$$\text{Vol(SCFM)} = \text{Vol (ACFM)} * \frac{(- ?? \text{ "Hg} + 29.92)}{29.92} * \frac{528 \text{ }^\circ\text{F}}{(?? \text{ }^\circ\text{F} + 460)}$$

By following these procedures the flow calculated from the pitot tube should be approximately equal to the ICFM from the exhaustor's horsepower curve or the vacuum level curve.

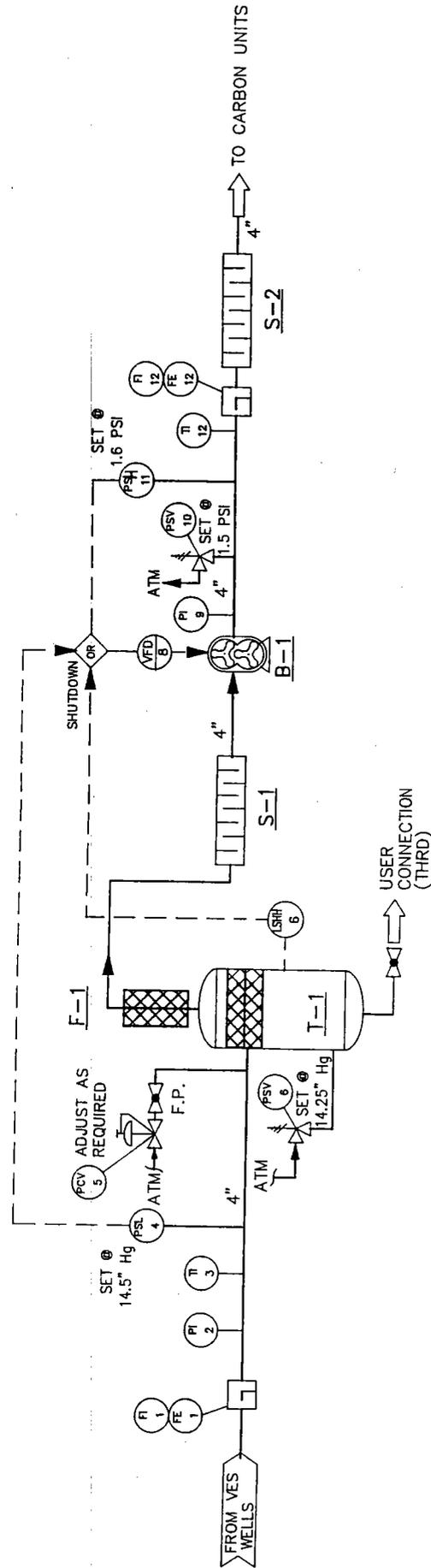
**I-1**  
 SEPARATOR  
 80 GALLONS  
 DESIGN PRESSURE 150 PSIG  
 POLYPROPYLENE PACKING

**S-1**  
 INLET SILENCER  
 4"  
 MATERIAL: C.S.

**F-1**  
 INLET FILTER  
 10 MICRONS

**B-1**  
 AIR BLOWER  
 500 ACFM  
 PRES = 1.5 PSI  
 VACUUM = 15" Hg.

**S-2**  
 DISCHARGE SILENCER  
 4"  
 MATERIAL: C.S.



**PROPRIETARY INFORMATION**  
 This document contains proprietary information which may not be used or disclosed without the written permission of Unocal Corporation.

<b>UNOCAL</b>	
DATE	08-09-83
BY	WJE
CHKD	WJE
APP'D	WJE
REVISION	
A	ISSUED FOR REVIEW & COMMENT
B	ADDED PSV TO R. PSR 11
C.E.R.T. - DENVER P.O. BOX 600 UNOCAL - WHEATRIE SITE	
PROJECT	DFP-022-D1
NO.	1 OF 1

**ROOTS****DRESSER**

\$2.00

# Universal BLOWER RAI

## INSTRUCTIONS ROTARY LOBE BLOWERS

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NUMBERS IN ( ) ARE METRIC EQUIVALENTS

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### DO THESE THINGS To Get The Most From Your Roots Blower

**1** Check shipment for damage. If found, file claim with carrier and notify Sales Office.

**2** Unpack shipment carefully, and check contents against Packing List. Notify Sales Office if a shortage appears.

**3** Store in a clean, dry location until ready for installation, if possible. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.

**4** Read LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.

**5** Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.

**6** Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.

**7** Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.

**8** Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.

**9** In event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify Sales Office or factory, giving all nameplate information plus an outline of operating conditions and a description of the trouble.

**10** Unauthorized attempts at equipment repair may void Manufacturer's warranty. Units out of warranty may be repaired or adjusted by the owner. It is recommended that such work be limited to the operation described in this manual, using Factory Parts. Good inspection and maintenance practices should reduce the need for repairs. See Distributor List on last page for parts and service after warranty period.

NOTE — Information in this manual is correct as of the date of publication. The Manufacturer reserves the right to make design or material changes without notice, and without obligation to make similar changes on equipment of prior manufacture.

## OPERATING CHARACTERISTICS

Roots UNIVERSAL RAI® blowers, as covered in this manual, are designated as air blowers, and may be used for handling air in either pressure or vacuum service. They are unsuitable for handling gases because shaft seals are not designed to prevent leakage to atmosphere.

The Roots rotary lobe blower is a positive displacement type unit, whose pumping capacity is determined by size, operating speed and pressure conditions. It employs two double-lobe impellers mounted on parallel shafts and rotating in opposite directions within a cylinder closed at the ends by headplates. As the impellers rotate, air is drawn into one side of the cylinder and forced out the opposite side against the existing pressures. The differential pressure developed, therefore, depends on the resistance of the connected systems.

Effective sealing of the blower inlet area from the discharge area is accomplished by use of very small operating clearances. Resulting absence of moving contacts eliminates the need for any internal lubrication. Clearances between the impellers during rotation are maintained by a pair of accurately machined timing gears, mounted on the two shafts extending outside the air chamber.

Operation of the familiar basic rotary lobe blower is illustrated in FIGURE 1, where air flow is right to left from inlet to discharge with the bottom impeller rotating clockwise. In Position 1 it is delivering a known volume (A) to the discharge, while space (B) between the upper impeller and cylinder wall is being filled. Counterclockwise rotation of this impeller then traps equal volume (B) in Position 2, and further rotation delivers it to the discharge in Position 3. At the same time, another similar volume is forming under the lower impeller, and will be discharged when rotation reaches Position 1 again.

One complete revolution of the driving shaft alternately traps four equal and known volumes of air (two by each impeller) and pushes them through to the discharge. The pumping capacity of a lobe blower operating at a constant speed therefore remains relatively independent of reasonable inlet or discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or vent some of the air.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This increases the power load on the driver, and may seriously damage the blower. Likewise, if a possibility exists that flow to the blower inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the blower. A pressure type relief valve in the discharge line near the blower is also strongly recommended for protection against cut-off or blocking in this line.

When a belt drive is employed, blower speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. See pages 18 and 20 for minimum sheave diameter. In a direct coupled arrangement, a variable speed motor or transmission is required, or air may be vented through a manually controlled unloading valve and silencer. If discharge air is returned to the blower inlet, it must be cooled to 100° F (38° C) through a cooling by-pass arrangement.

Before making any change in blower capacity or operating conditions, contact the nearest Distributor for specific information applying to your particular blower. In all cases, operating conditions must be maintained within the approved range of pressures, temperatures and speeds as stated under LIMITATIONS. Also, the blower must not be used to handle air containing liquids or solids, or serious damage to the rotating parts will result.

## OPERATING LIMITATIONS

To permit continued satisfactory performance, a Roots UNIVERSAL RAI® blower must be operated within certain approved limiting conditions. The Manufacturer's warranty is, of course, also contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1 for various sizes of UNIVERSAL RAI® blowers. These limits apply to all blowers of normal construction, having operating clearances as listed in Table 5 when operated under standard atmospheric conditions. Do not exceed any of these limits.

**Example:** The listed maximum allowable temperature rise (increase in air temperature between inlet and discharge) for any particular blower may occur well before its maximum pressure or vacuum rating is reached. This can easily occur at high altitude or at very low speed.

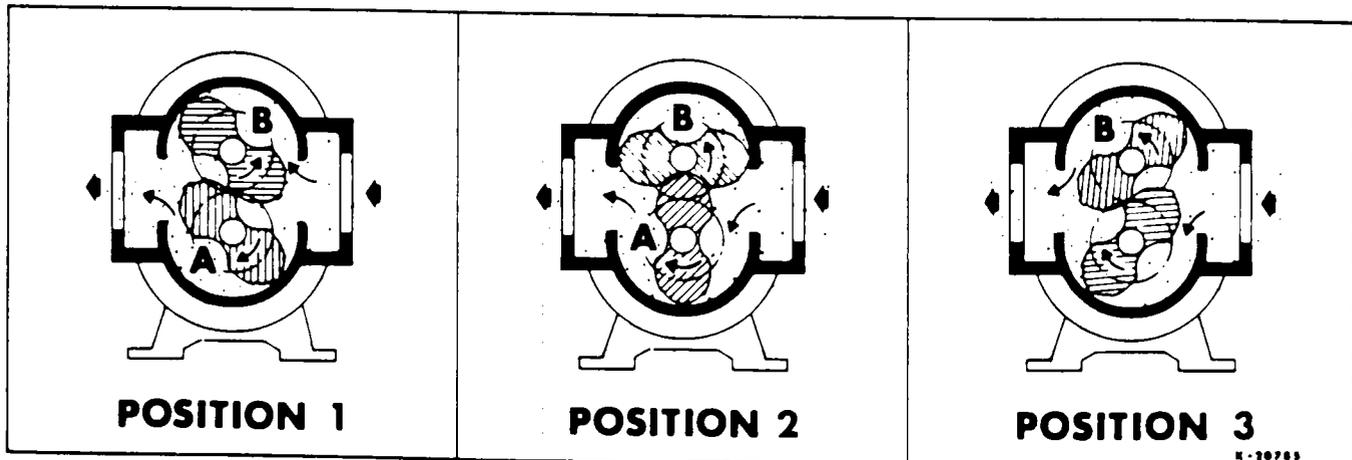


Figure 1 — Flow Through a Basic Type RAI Blower

Temperature rise then is the limiting condition. In other words, the operating limit is always determined by the maximum rating reached first. It can be any one of the three: pressure, temperature or speed.

Be sure to arrange connections or taps for thermometers and mercury type pressure or vacuum gauges at or near the inlet and discharge connections of the blowers. These, along with a good tachometer, will enable periodic checks of operating conditions to be made easily.

**PRESSURE** — On pressure service, the pressure rise in pounds per square inch (kPa) (between blower inlet and discharge) must not exceed the figure listed for the specific blower frame size concerned. Also, in any system where the blower inlet is at a positive pressure above atmosphere, the discharge pressure must never exceed 25 PSI (172 kPa) gauge regardless of blower size.

On vacuum service, with the discharge going to atmospheric pressure, the inlet suction or vacuum in inches of mercury (Hg.) (kPa) must not be greater than the values listed for the specific frame size.

**TEMPERATURE** — Various blower frame sizes are approved only for installations where the following temperature limitations can be maintained in service.

- A. Measured temperature rise in Fahrenheit degrees (C°) must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the blower. This is not outdoor temperature unless the blower is installed outdoors.
- B. If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- C. Average of inlet plus discharge temperature must not exceed 220°F (104°C)

**SPEED RANGE** — UNIVERSAL RAI® blowers may be operated at speeds up to the maximums listed for various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be the limiting factor as noted in the preceding example.

Table 1 — Maximum Allowable Operating Conditions

Frame Size	Speed RPM	Inlet Vac. Inches Hg. (kPa)	Temp. Rise Fahr. Deg. (C°)	Press. Rise PSI (kPa)
22	5275	14 (47)	225 (125)	12 ( 82)
24	5275	14 (47)	185 (102)	7 ( 47)
32	3600	14 (47)	225 (125)	15 (101)
33	3600	14 (47)	170 ( 94)	12 ( 82)
36	3600	14 (47)	115 ( 64)	7 ( 47)
42	3600	14 (47)	240 (133)	15 (101)
45	3600	14 (47)	170 ( 94)	10 ( 68)
47	3600	14 (40)	130 ( 72)	7 ( 47)
53	2850	14 (47)	195 (108)	15 (101)
56	2850	14 (47)	180 (100)	10 ( 68)
59	2850	14 (40)	115 ( 64)	7 ( 47)
65	2350	16 (53)	250 (139)	15 (101)
68	2350	16 (53)	240 (133)	12 ( 82)
615	2350	12 (40)	130 ( 72)	6 ( 40)
76	2050	16 (53)	250 (139)	15 (101)
711	2050	16 (53)	210 (117)	10 ( 68)
718	2050	12 (14)	130 ( 72)	6 ( 40)

## BLOWER ORIENTATION

The unique removable feet feature of Roots UNIVERSAL RAI® blowers permit field modification of blower mounting by repositioning blower feet and gear box breather as shown in Fig. 3.

Four blower mounting positions are possible:

1. Horizontal mounting, vertical air flow, drive shaft on left.
2. Same as (1) except drive shaft on right.
3. Vertical mounting, horizontal air flow, drive shaft on bottom.
4. Same as (3) except drive shaft on top.

To change blower mounting:

1. Place blower on its feet.
2. Loosen feet capscrews (32).
3. Place blower on a solid base resting on the gear box end with drive shaft on top.
4. Remove feet. (Note - Feet capscrews (32) are longer than cylinder capscrews (26), only capscrews (32) are to be used for feet.)
5. Remove cylinder capscrews (32) where feet are to be re-installed. Install capscrews (26) in the location previously occupied by feet capscrews (32).
6. Install feet using capscrews (32).
7. Place blower on its feet on flat surface.
8. Loosen feet capscrews (32) and square up blower and re-tighten capscrews (32).
9. Gear box has four threaded holes, one with breather and three with pipe plugs. Remove pipe plug (21) from the top most hole. Remove breather (25) and install it in the top most hole. Install pipe plug that was removed from the top hole into the hole previously occupied by the breather. The breather and the pipe plug should be sealed with a thread sealer.

For convenience, the position of the grease fitting (37) and the relief fitting (38) could be interchanged, however each bearing must have one grease fitting (37) and one relief fitting (38).

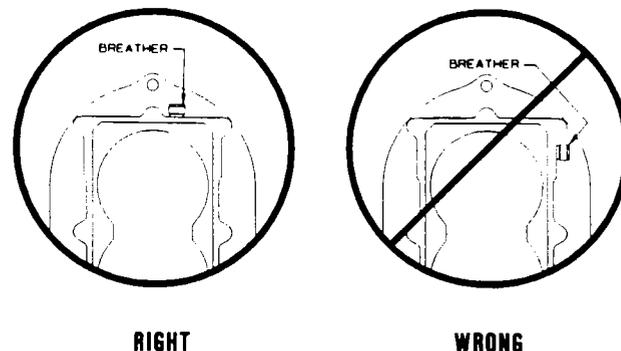
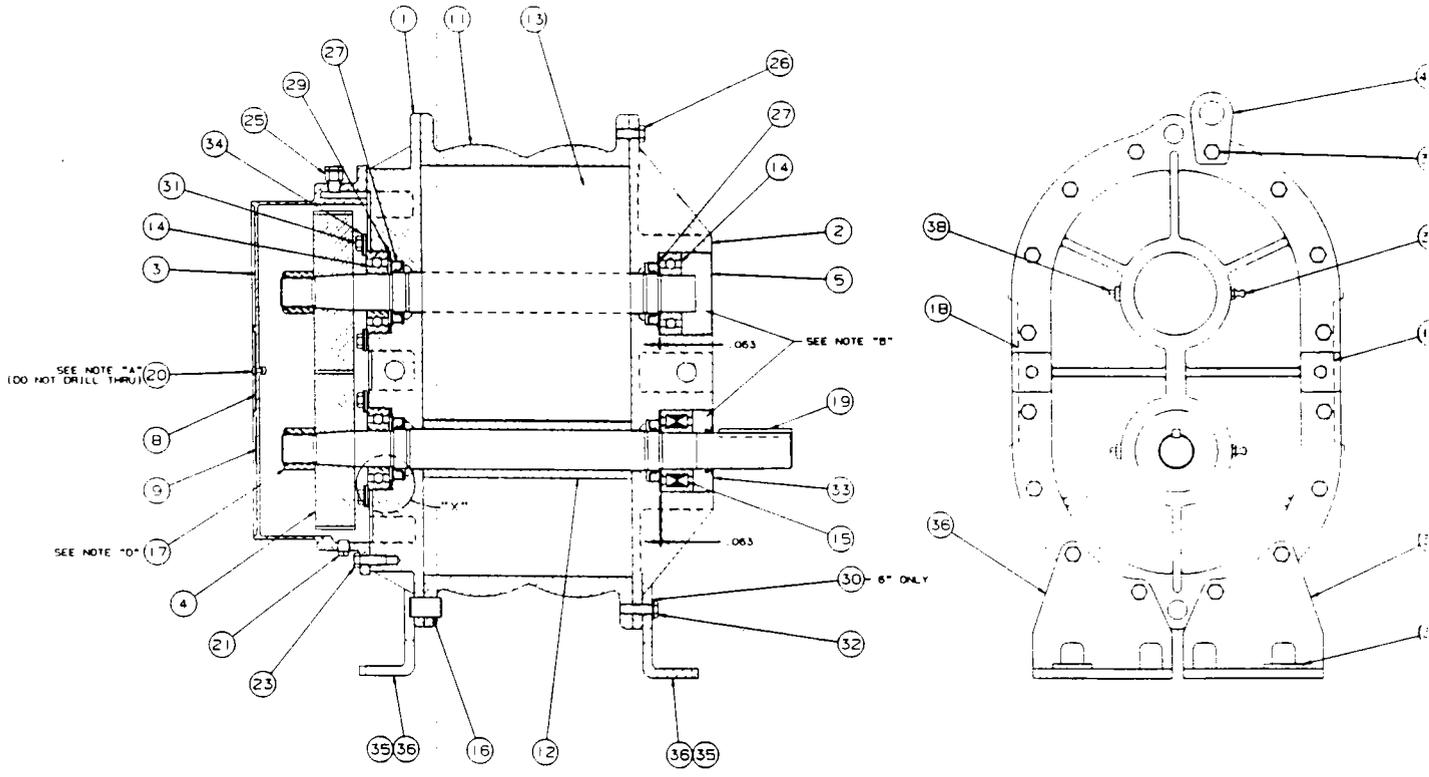


Figure 2 — Breather Installation

# REPAIR KIT INFORMATION

UNIVERSAL RAI®				
REF. NO.	QTY.	PART DESCRIPTION	REPAIR KIT PART NOS.	
			FRAME SIZE	REPAIR KIT NO.
4	1 Pr.	Timing Gear	2"	65-101-ORK
5	1	Plug — Opening	3"	65-104-ORK
7	1	Gasket	4"	65-107-ORK
14	1	Bearing, D.E. — DRVN	5"	65-111-ORK
14	2	Bearing, G.E.	*6"	65-115-ORK
15	1	Bearing, Dr. Shaft	*7"	65-119-ORK
17	1	Gear Nut		
27	2	Seals, D.E.		
27	2	Seals, G.E.		
31	4	Capscrew — Selflock		
33	1	Seal — Dr. Shaft		

\*Repair kits for the 6" and 7" UNIVERSAL RAI® do not contain gears.



SEE BACK COVER FOR NEAREST DISTRIBUTOR.

**ROOTS****DRESSER**

## INSTRUCTIONS FOR PRESSURE

### SPRING (PS) AND VACUUM SPRING (VS)

#### RELIEF VALVES

Since Roots rotary blowers are the positive displacement type, relief valves must be installed to prevent overloading the blower. This can be caused either by excessive discharge pressure or excessive inlet vacuum.

The spring type relief valve is not intended to function as a pressure controller, its purpose is to provide a safety relief only. For the valve to pass full capacity of the blower, a pressure or vacuum increase up to 25% should be expected. (i.e. if the valve is set at 10 PSIG, an increase up to 25% (2.5 PSI) or a total pressure of 12.5 PSIG should be expected to pass the full capacity of the blower. NOTE: Relieving may be sign of overload on blower and cause must be corrected.)

The (PS) relief valve must be installed as close as feasible to blower discharge and the (VS) relief valve must be installed as close as feasible to blower inlet. In either case, the relief valve must be installed between the blower and the first line valve or restrictions. Relief valve can be installed either vertically up or horizontally.

When installing the relief valve, first wipe it clean and be sure that it works freely. Oil it with kerosene or light oil to prevent rust. Check periodically to make sure rust or dirt does not interfere with free operation.

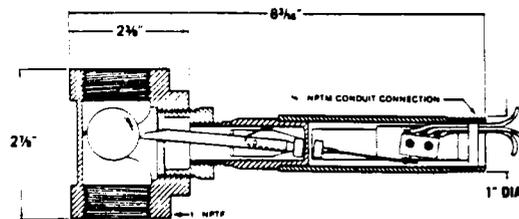
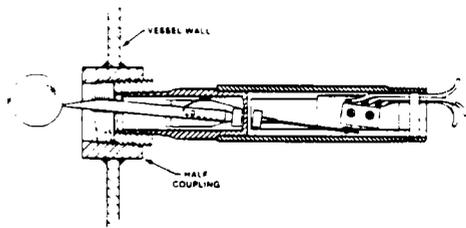
Relief valves are not set at the factory, **they must be adjusted after they are installed.** Various operating ranges of the valve are obtained by the selection of different springs. A spring is selected and built into the valve for conditions as specified on the order. Final adjustment must be made after the valve is installed. Tightening the spring will increase the pressure or vacuum setting. With the blower running at normal conditions, the valve should be adjusted so that it's barely closed. Any increase in pressure or vacuum should start opening the valve.



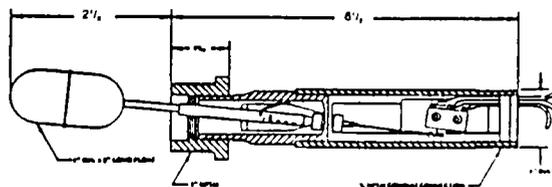
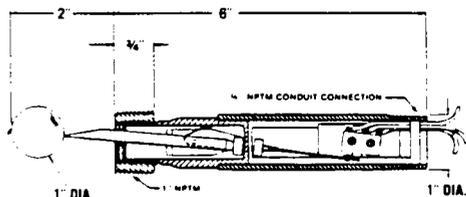


# FLOTECT® Model L6 Level Switch

## INSTALLATION AND OPERATING INSTRUCTIONS



L-6 WITH EXTERNAL FLOAT CHAMBER



L-6 FOR THRU—WALL INSTALLATION

### INSTALLATION

- Carefully unpack switch, making sure to remove any packing from inside float chamber and/or lower housing.
- Switch must be indexed during installation, so that the arrow on the side of the switch points down.
- If switch is installed "thru-wall", a 1" half-coupling must be welded in the vessel wall as shown above. Half-couplings must extend through the wall as shown above. Do not attempt to use thredolets, full couplings or other types of fittings.
- Pass the connecting wires through external conduit and connect. Switch is deactivated and contacts are in normal condition when level is below switch.

Black - Common  
 Blue - N. O.  
 Red - N. C.

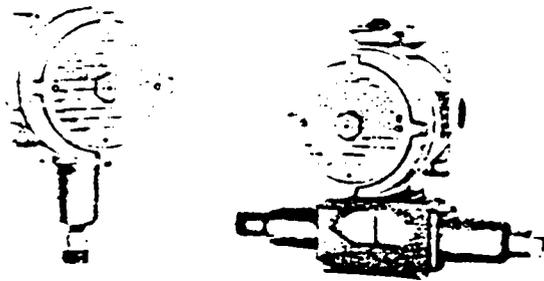
Note: Double pole, double throw switches have dual black, blue and red leads. These are connected in the same manner as single pole double throw switches as described above.

- Make sure conduit and wiring meet appropriate codes for hazardous areas. Make sure conduit is properly sealed. Care must be taken in hot/cold or outdoor installations to prevent condensation inside conduit. Electrical components must be kept free of moisture at all times. CAUTION: To prevent ignition of hazardous atmosphere, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in operation.
- Inspect and clean wetted parts at regular intervals.

**Limited Warranty:** The Seller warrants all Dwyer instruments and equipment to be free from defects in workmanship or material under normal use and service for a period of one year from date of shipment. Liability under this warranty is limited to repair or replacement F.O.B. factory of any parts which prove to be defective within that time or repayment of the purchase price at the Seller's option provided the instruments have been returned, transportation prepaid, within one year from the date of purchase. All technical advice, recommendations and services are based on technical data and information which the Seller believes to be reliable and are intended for use by persons having skill and knowledge of the business, at their own discretion. In no case is Seller liable beyond replacement of equipment F.O.B. factory or the full purchase price. This warranty does not apply if the maximum ratings label is removed or if the instrument or equipment is abused, altered, used at ratings above the maximum specified, or otherwise misused in any way.

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United Electric Controls Company  
INSTALLATION AND MAINTENANCE  
INSTRUCTIONS

## 120 SERIES

### Explosion Proof\* Pressure Controls

FM, UL & CSA listed: Meets Divisions I & 2;  
Class I, Groups B (UL only), C & D; Class II, Groups E, F & G; and Class III  
NOTE: CSA, Class I, Group B approval does not apply to controls with option  
code "L530" and/or "M540"; FM not approved with option M450.

IMP120-10

**WARNING:** Misuse of this product may cause explosion and personal injury. These instructions must be thoroughly read and understood before unit is installed.

## OPERATIONS

The 120 Series pressure switches are actuated when bellows, diaphragm or piston sensors respond to a pressure change. The response at a pre-determined setpoint(s) actuates a single, dual or a DPDT snap-acting switch(es). This converts the pressure signal into an electrical signal. Control setpoint(s) may be varied by turning the internal adjustment hex (J120 models) or the external knob and pointer(s) H121, H122 models) according to the procedures outlined below.

## PART I - INSTALLATION

**IMPORTANT:** Install units where shock, vibration and temperature fluctuations are minimal. Orient unit so moisture is prevented from entering the enclosure. It is imperative that properly rated explosion-proof sealing fittings be used for electrical wire entry. Do not mount unit in ambient temperatures exceeding published limits.

### MOUNTING

Standard pressure and differential pressure with or without manual reset option

120 Series pressure controls should be mounted vertically (pressure connections facing down) or horizontally (electrical conduit facing up). Either mounting position will properly orient the venting system. Controls may be surface mounted via the 4 - 1/4" screw holes on the enclosure or mounting bracket (see Mounting Dimensions on back page). They can also mount directly to a rigid pipe using the pressure connection.

Horizontal Differential Pressure Controls (Opposed Sensor) Types J120K, H121K, H122K

Horizontal differential pressure controls should be mounted with their pressure connection in the horizontal position. This will properly orient the vent holes on the pressure housing as well as the 1/4" NPT venting conduit at the bottom of the third compartment (standardly supplied with plastic plug).

**CAUTION:** Always hold a wrench on the pressure housing hex when mounting unit. Do not tighten by turning enclosure. This will damage sensor and weaken solder or welded joints

Controls with Breather Drain (Option M450)

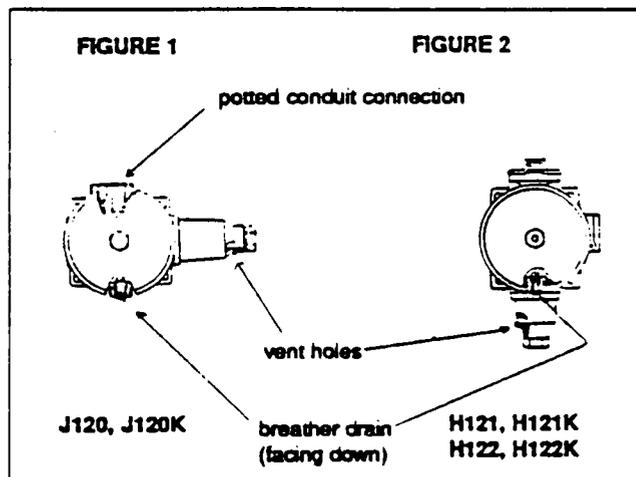
Types J120, J120K, Models 455-559

Mount with breather drain facing down and conduit connection facing up (see Figure 1). The conduit connection must

be properly sealed (potted) for this type of installation. Mount in vertical position (pressure connection facing down) or horizontally (electrical conduit facing up). Either mounting position will properly orient the venting system.

Types H121 & H122

Mount in vertical position with pressure assembly and breather drain facing down (see Figure 2).



## PART II - WIRING

**WARNING:** Disconnect all supply circuits before wiring unit.

**IMPORTANT:** Electrical ratings in literature and on nameplate must not be exceeded - overload on a switch may have an adverse effect on the control. Wire units according to national and local electrical codes. Maximum recommended wire size is 14 AWG.

Remove cover wire control according to appropriate diagram (see Figure 3). **NOTE:** Replacing cover hand tight (5 full threads engaged) is sufficient to maintain proper protection. Additional tightening may be required to fully engage cover O-ring and seal enclosure to rain-tight protection.

\*Enclosures are designed to withstand gas or vapor explosions without bursting or loosening of joints, and are capable of arresting the propagation of flame from the interior of the enclosure to the surroundings atmosphere.

# AIR COMPRESSORS

of the Carolinas, Inc.

FAX: 704/308 1660

Telephone: 704/393-3066

800/554-8111

August 9, 1993

Mr. Stewart Hines  
S&ME, Inc.  
Post Office Box 7668  
Charlotte, NC 28241-7668

SUBJECT: Remediation System  
Mebane, North Carolina

Dear Stewart:

We are pleased to offer this quotation for your consideration on the following equipment based on our understanding of your requirements.

CHAMPION RECIPROCATING AIR COMPRESSOR MODEL HRA25-25

Two stage, 25 HP, 250 gallon receiver, 208/230V, 3Ø. 105.7 CFM delivered at 125 PSI. Includes vibro-isolators, dual controls, NEMA-4 magnetic starter (mounted), NEMA-4 pressure switch, automatic tank drain, NEMA-4 low oil monitor, and TEFC motor.

QUOTED UNIT PRICE . . . . \$6,174.00 EACH

ARROW PARTICULATE FILTER #F309-04F5

1/2" NPT, 115 CFM flow capacity.

QUOTED UNIT PRICE . . . . \$ 53.50 EACH

ARROW COALESCING FILTER #F505-04F

1/2" NPT, 110 CFM flow capacity.

QUOTED UNIT PRICE . . . . \$ 153.35 EACH

- NOTES: 1. Freight will be prepaid to the first destination.  
2. Quoted prices do not include sales or use tax.  
3. Prices are subject to change without notice.

Stewart, we appreciate this opportunity to be of service. Should you have any questions or if we may offer additional information, please call us at your convenience. We look forward to hearing from you.

Best regards,

AIR COMPRESSORS OF THE CAROLINAS, INC.



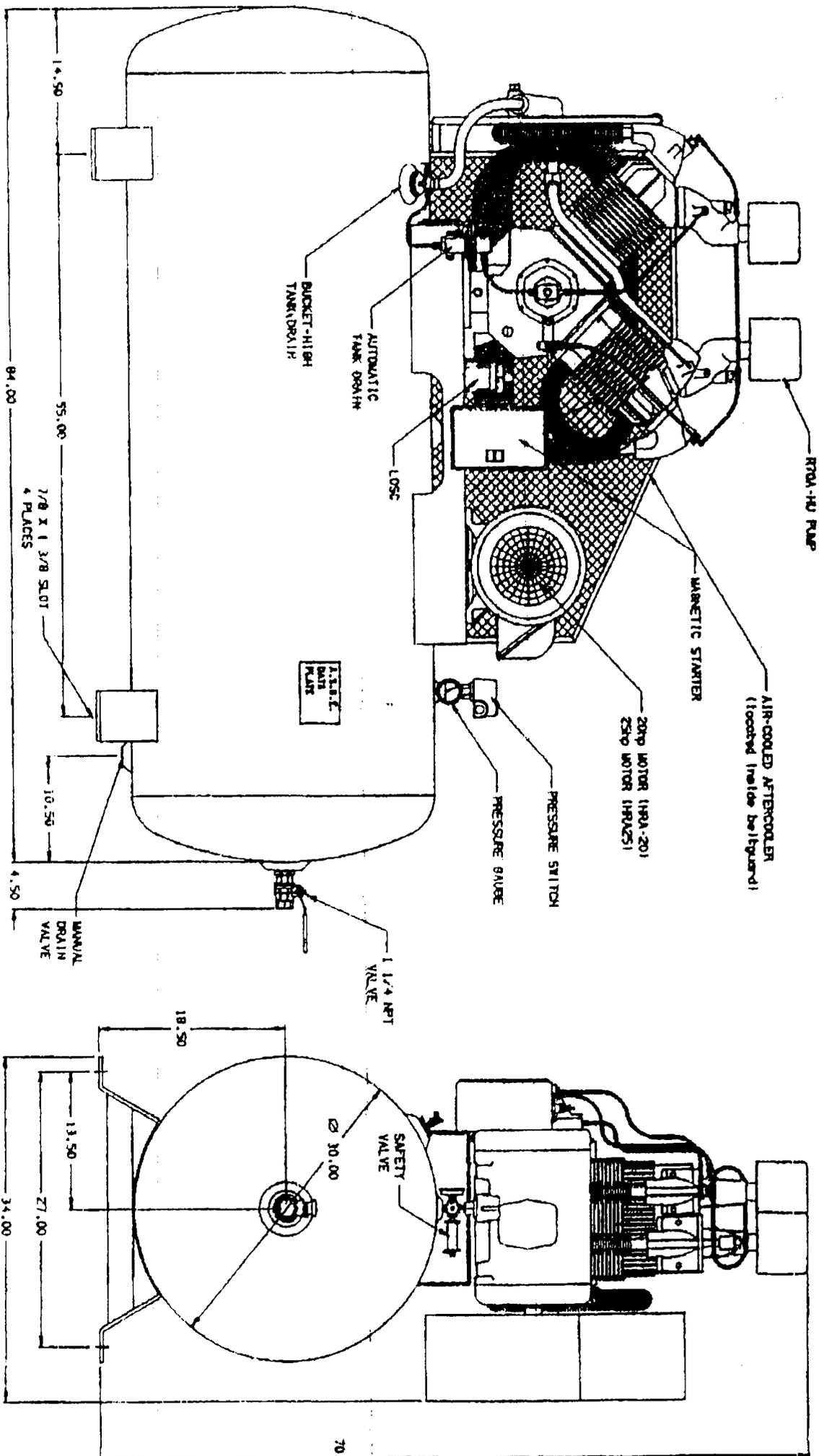
Doug Phillips  
Sales Representative



1122 Summerville Road • Charlotte, North Carolina 28214  
P.O. Box 949 • Paw Creek, North Carolina 28130



# EMPION PNEUMATIC MACHINERY CO., INC.



NOTE:  
 TYPICAL DIMENSIONS ONLY. NOT TO BE  
 USED FOR CONSTRUCTION WITHOUT  
 CONSULTING FACTORY.  
 ALL DIMENSIONS IN INCHES.

DO NOT SCALE PRINT

PRINT NO.: DD-B-451

PART NAME  
 HRA20-25 & HRY

DRAWN BY: HOBBERGER  
 DATE: ( )  
 CHK'D BY: DA  
 DATE: ( )

Fisher Controls

Instruction Manual

**289 Series Relief Valves****FISHER®**

August 1990

Form 1724

**Introduction****Scope of Manual**

This instruction manual provides installation, maintenance, and parts ordering information for the 289 Series relief valves. Instructions for other equipment used with these relief valves can be found in separate instruction manuals.

**Description**

The 289 Series pressure relief valves (see figure 1) are throttling relief valves used downstream of pressure regulators to protect the downstream system from overpressure. These relief valves can be used for natural gas, air, propane, or other noncorrosive, gas-flow service.

**Specifications**

Specifications for the 289 Series relief valves are given in table 1.

**Installation****WARNING**

Installing a 289 Series relief valve where its capabilities can be exceeded or where proper operation might be impaired may cause personal injury, property damage, or leakage due to bursting of pressure-containing parts or explosion of accumulated gas. To avoid such conditions, install a 289 Series relief valve where:

- Service conditions are within the unit capabilities specified in tables 1 and 2, and

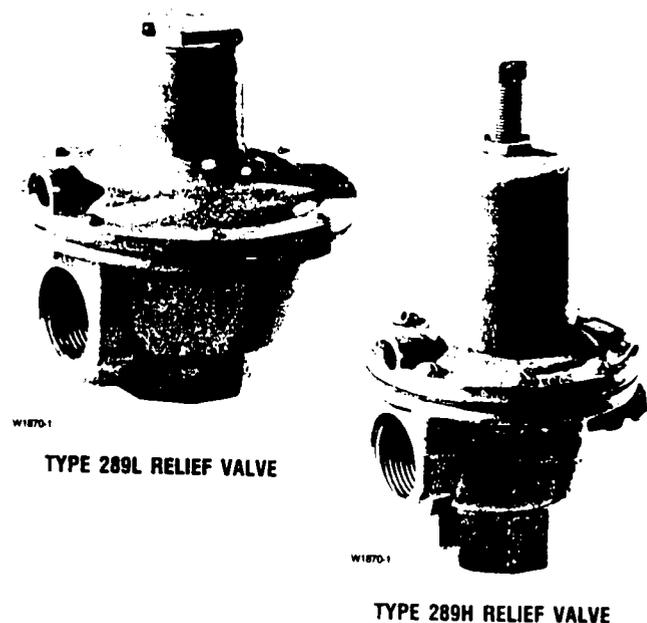


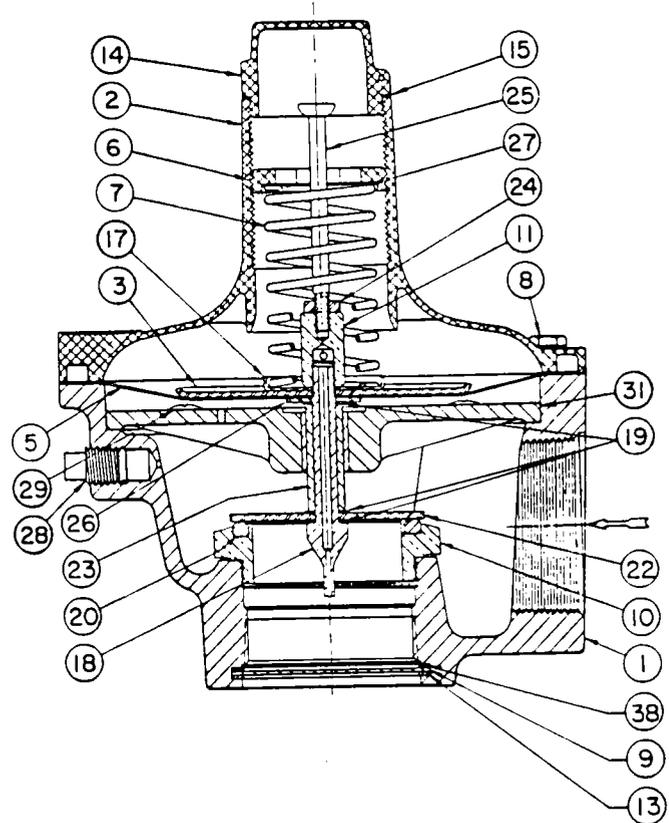
Figure 1. Typical 289 Series Relief Valves

- The relief valve is protected from exposure to physical damage and/or corrosive substances.

1. When installing a 289 Series relief valve, make sure that the installation of the system complies with applicable local, state, or federal codes or regulations.
2. Use qualified personnel when installing, operating, and maintaining a 289 Series relief valve. Before installation, make sure there is no damage to or foreign material in the relief valve and that all piping is clean and unobstructed.
3. For installation of Type 289H, 289HH, and 289L relief valves, the vent in the spring case must remain plugged or undrilled in order for the pitot tube to function properly.

**289 Series**

Key	Description	Part Number
17	Lower Spring Seat Types 289H and 289HH, 1-inch body Plated steel Type 289H, 2-inch body, zinc plated steel	1D6666 25072 1D7799 25062
18	Pitot Tube Types 289H and 289HH, 1-inch body Aluminum Type 289H, 2-inch body Brass Stainless steel	1F8262 09012 1E7019 14012 1E7019 35032
19*	Gasket, composition Type 289HH, 1-inch body (1 req'd) Type 289H, 2-inch body (3 req'd)	1F8268 04022 1D7798 04022
20*	O-Ring Type 289H, 1-inch body Nitrile Fluoroelastomer Type 289H, 2 in. body Nitrile Fluoroelastomer Type 289HH Nitrile Fluoroelastomer	1F8266 06992 1F2692 X0012 1P3361 06992 1V6646 06382 1F2692 06992 1F2692 X0012
21	O-Ring Holder, aluminum Types 289H and 289HH, 1-inch body	1F8264 09012
22	O-Ring Washer Types 289H and 289HH, 1-inch body Aluminum Types 289H, 2-inch body, stainless steel	1F8265 09012 1E7021 36072
23	Spacer Types 289H and 289HH, 1-inch body Stainless steel Type 289H, 2-inch body Brass Stainless steel	1F8263 35242 1E7022 14172 1E7022 35162
24	Hex Nut, plated steel Types 289H and 289HH, 1-inch body Type 289H, 2-inch body	1A4997 24122 1B2282 28982
25	Lifting Stem, plated steel Type 289H, 2-inch body	1D7802 24092
26	Lower Diaphragm Head, plated steel Type 289H, 2-inch body	1E7031 25072
27	Washer, aluminum Types 289H and 289HH, 1-inch body Type 289H, 2-inch body	1F8267 09012 1C6805 11032
28	Pipe Plug, plated steel Types 289H and 289HH	1D7548 28982
29	Machine Screw, plated steel (not shown) Types 289H and 289HH 1-inch body (2 req'd) Type 289H, 2-inch body (4 req'd)	1D3869 28982 1F3865 28992
30*	O-Ring (2 req'd) Types 289H and 289HH, 1 in. body Nitrile Fluoroelastomer	1D6875 06992 1N4304 06382



BE7030-J

Figure 8. 2-Inch Type 289H Relief Valves

Key	Description	Part Number
31	Stem Guide Assembly Type 289HH, 1-inch body Zinc/brass Zinc/303 stainless steel Type 289H, 2 in. body Cast iron/brass Cast iron/303 stainless steel	1F8272 000A2 1F8272 X0012 1E7028 000A2 1E7028 X00A2
32	Lifting Lever (not shown) Type 289H, 2-inch body	0R0617 25092
33	Wire Seal (not shown) Type 289L, 1-inch body	1D8847 99012
34	Diaphragm Protector (not shown) Types 289A and 289U	10A511 6X012
38*	Gasket, Type 289H, 2-inch body	11B1993 X012

\*Recommended spare part.

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## INSTALLATION INSTRUCTIONS

**INSPECTION** — Inspect the sensor upon receipt of shipment to be certain it is as ordered and not damaged. If damaged, contact carrier.

### INSTALLATION —

**General** — The sensing ports of the flow sensor must be correctly positioned for measurement accuracy. The instrument connections on the sensor indicate correct positioning. The side outlet is the static pressure connection and should be pointing downstream. With the side connection pointing downstream, the Top connection is Total or high pressure and the Side is Static or low pressure.

**Location** — The sensor should be installed in the flowing line with as much straight run of pipe upstream as possible. This will provide a flow profile as ideal as possible. A rule of thumb is to allow 10-15 pipe diameters upstream and 5 down. The table below lists recommended up and down piping:

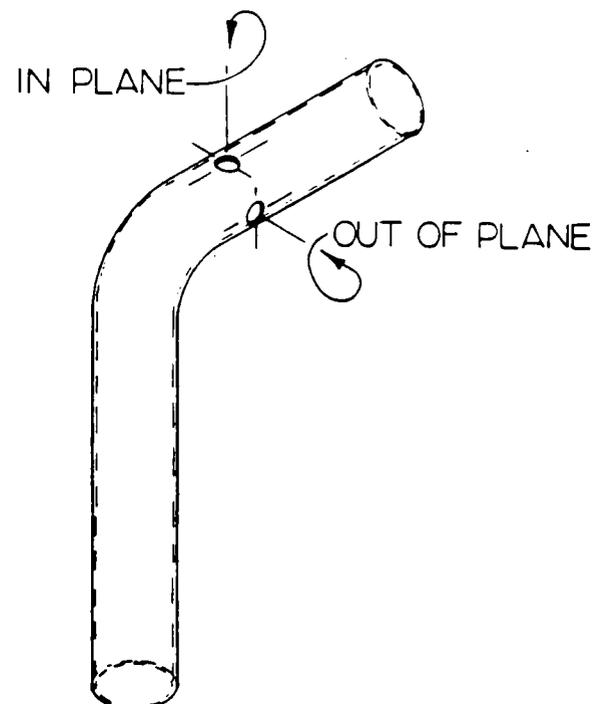
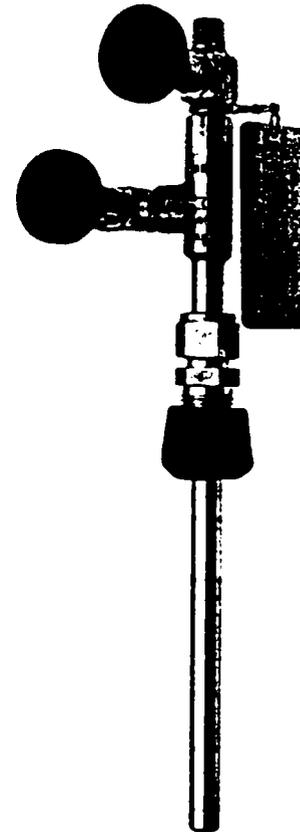
### Upstream And Downstream Dimensions In Terms Of Internal Diameter Of Pipe \*See Note #1

UPSTREAM CONDITION	MINIMUM DIAMETER OF STRAIGHT PIPE UPSTREAM		DOWNSTREAM
	IN-PLANE	OUT OF PLANE	
ONE ELBOW OR TEE	7	9	4
TWO 90° BENDS IN SAME PLANE	8	12	4
TWO 90° BENDS IN DIFFERENT PLANE	18	24	4
REDUCERS OR EXPANDERS	8		4
ALL VALVES *SEE NOTE 2	24		4

Note #1. Values shown are recommended spacing, in terms of internal diameter for normal industrial metering requirements. For laboratory or high accuracy work, add 25% to values.

Note #2. Includes gate, globe, plug and other throttling valves that are only partially opened. If valve is to be fully opened, use values for reducers or expanders.

**CONTROL VALVES SHOULD BE LOCATED AFTER FLOW SENSOR.**







# 1336-MOD-L1

## 5V DC TTL Logic Interface Board

**Description** The TTL Logic Interface Board provides a means of interfacing various signals and commands to the Bulletin 1336 Drive by using TTL logic signals or contact closures. The board is self-powered and does not require a separate user power source. The 1336-MOD-L1 is marked Part Number: 120666.



**WARNING:** Electric shock can cause injury or death. Remove all power before working on this product.

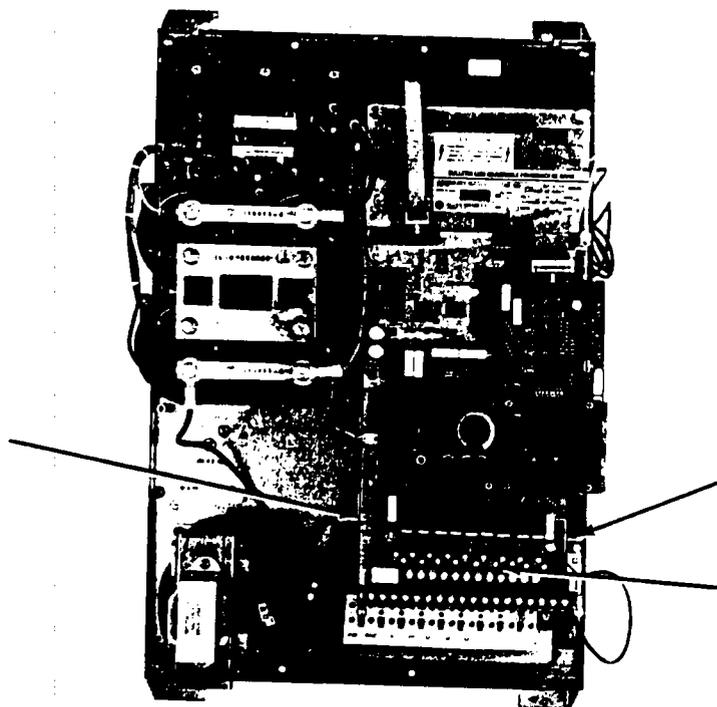
**Intallation** If no Interface Board (MOD-L1, MOD-L2 or MOD-L3) was previously installed, three jumpers will be present on J8 and J9 of the Main Control Board. These jumpers must be removed before installing the interface board. Special pins are provided on the left hand side of the main control board for storing these jumpers .

As shown in Figure 1, plug in connectors on the TTL Logic Interface Board allow it to be plugged directly into matching connectors on the Drive Control Board. Two captive thumb screws secure the board in place.



**CAUTION:** If the TTL Logic Interface Board will replace either the 1336-MOD-L2 or 1336-MOD-L3, external circuits must be reconfigured to operate at the +5V DC logic potentials required by the board. The application of either +24V DC or 115V AC to the TTL Logic Interface Board will damage both the TTL Logic Interface Board and the Drive Control Board.

Main Control  
Board, J8

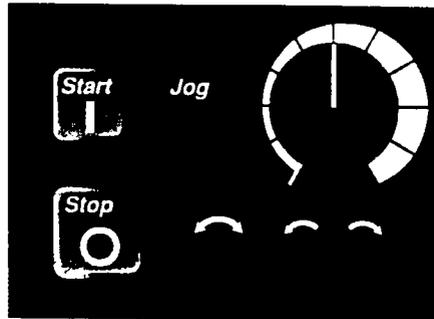


Main Control  
Board, J9

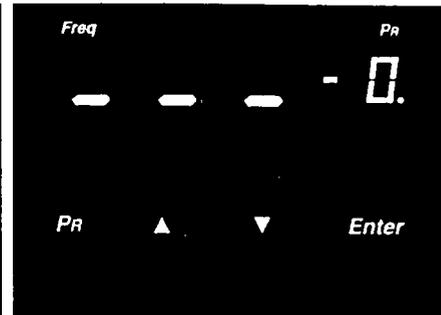
Interface  
Board

Figure 1. Bulletin 1336 Drive Interface Board Location (VFD)

## Operation



Control Panel



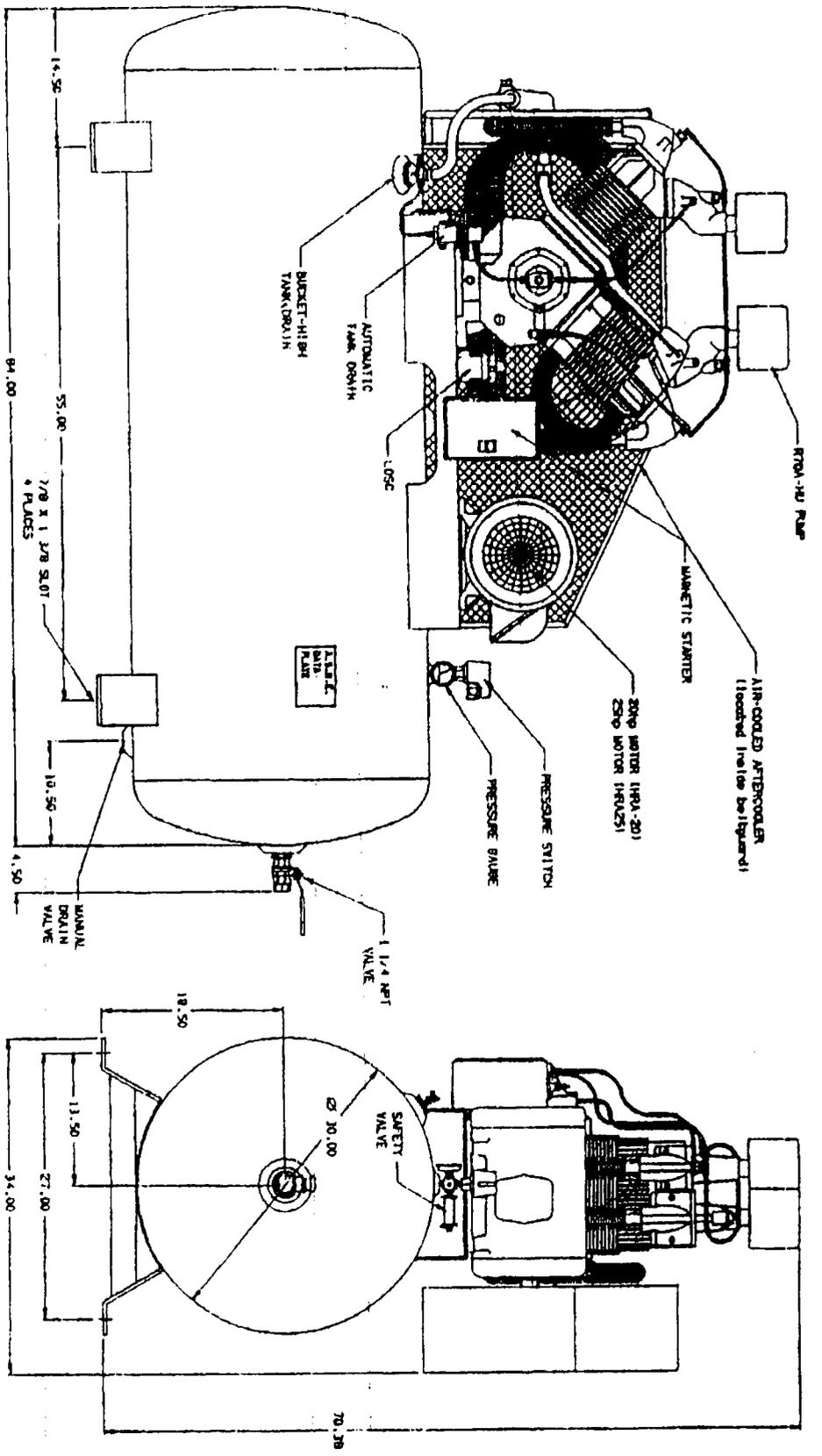
Programming and Display Panel

**Important:** 1336 Control Panels are not intended to replace or be considered a suitable alternative for an operator control station for all applications. If two-wire control is installed, option L1, L2 or L3 must also be installed. With two-wire control, the stop pushbutton on all Control Panels will allow the drive to restart once the button is released. Refer to codes and standards applicable to your particular system for specific requirements and additional information.

### Drive Restart

**Important:** The 1336 drive may be programmed to avoid responding to unintentional start commands. The stop input to the drive must first be false, then returned to true to restart the drive:

- When exiting programming at the Programming and Display Panel.
- After a power-on reset fault has occurred, if Parameter 14 is set to 0.
  - F01 power-on reset is displayed when power is first applied to the drive and when a fault is cleared.
  - If Parameter 14 is set to 1 and Option L1, L2 or L3 is installed to provide two-wire control, cycling a stop input is not required after reapplying power or clearing a fault.



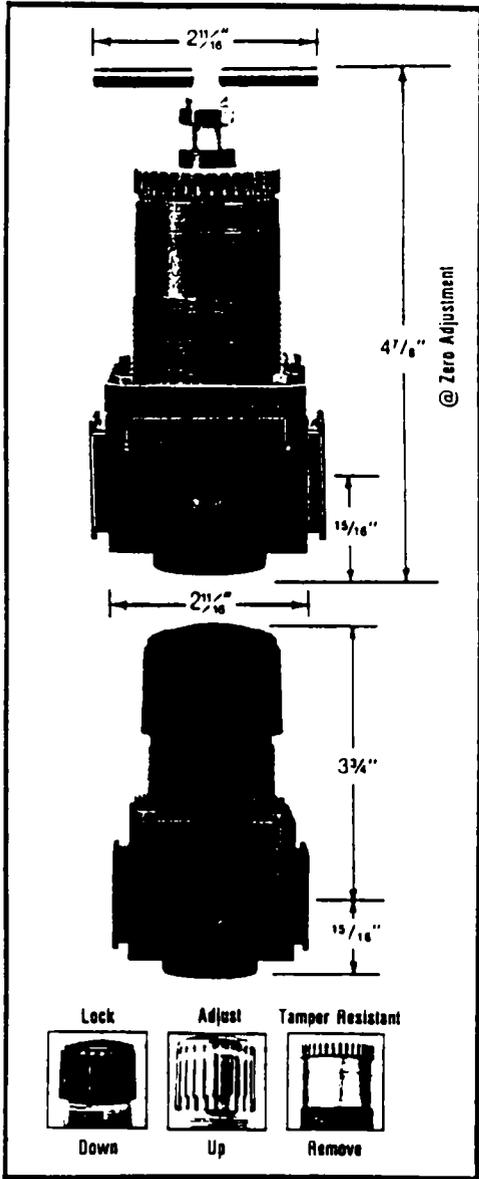
NOTE:  
 TYPICAL DIMENSIONS ONLY. NOT TO BE  
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 CONSULTING FACTORY.  
 ALL DIMENSIONS IN INCHES.

CHAMPION PNEUMATIC MACHINERY CO., INC.

DO NOT SCALE PRINT  
 PRINT NO.: DD-8-451

<b>PART NAME</b>	
HRA20-25 & HRA25-25	
DRAWN BY: HORNBERGER	DATE: 06-25-91
CHK'D BY: DA	DATE: 6-25-91

# ARROW TRI-STAR REGULATORS



Arrow's TRI-STAR regulators are available in  $\frac{1}{4}$ ,  $\frac{3}{8}$  and  $\frac{1}{2}$ -inch ports for air flows up to 100 SCFM. Engineered as high performance units with compact size, lightweight and cosmetic appeal, they exhibit added benefits for those critical machine tool requirements. Each is enhanced with the sensitivity of diaphragm operation for repeated accuracy, a highly balanced disc assembly to minimize the effect of supply pressure variations, an inserted machined brass seat and molded disc for zero creep and an efficient aspirator for minimal droop. TRI-STAR regulators are ideally suited for high flow industrial requirements as well as those requiring precise pressure control as in pneumatic cylinders and valves.

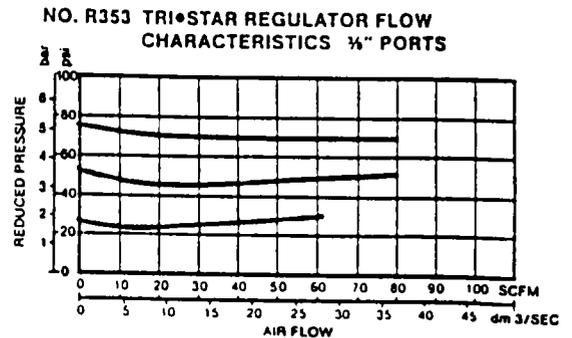
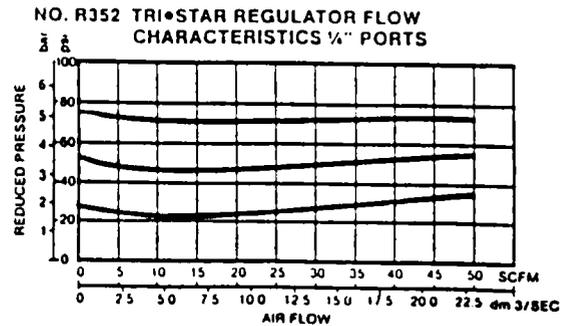
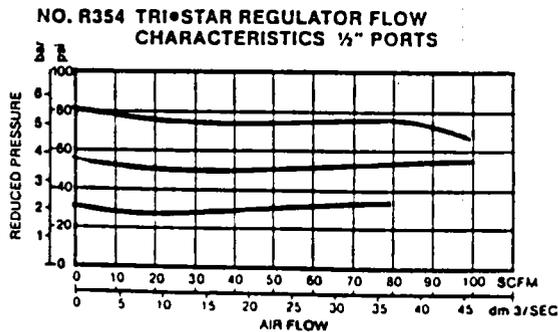
## Features

- $\frac{1}{4}$ ,  $\frac{3}{8}$  and  $\frac{1}{2}$  inch ports
- $\frac{1}{4}$ ,  $\frac{3}{8}$ ,  $\frac{1}{2}$  and  $\frac{3}{4}$  inch pipe inserts can be used with each unit
- Three position adjusting knob standard — Lock, adjust, and remove for tamper-resistance
- "T" handle optional
- Efficient aspiration
- 100 SCFM capacity
- Minimal droop
- Diaphragm operation
- Non-rising adjustment
- Machined brass valve seat
- Molded balanced disc
- Easily panel or wall mounted
- Three pressure ranges
- Die cast aluminum

Ordering Information			
Pipe Size	Model No.	Flow (SCFM)	Approx. Wt. Lbs.
$\frac{1}{4}$ "	R352	50	1.5
$\frac{3}{8}$ "	R353	80	1.5
$\frac{1}{2}$ "	R354	100	1.5

For options, performance specifications and gauges, See Pg. 22

## Flow Characteristics Inlet Pressure set at 100 PSIG



# ARROW COALESCING STYLE FILTERS

## SERIES F4 — Oil Removing

An extremely effective and economical oil removing filter, the Arrow Series F4 was developed to accommodate the variety of compressed air systems and their filtering needs. The white borosilicate style element removes liquid oil and oil aerosols up to a 90% efficiency rating, as well as sub-micron solid contaminants (such as dirt and scale) down to .9 microns in size. Effective filtration coupled with low pressure drop and servicing ease, make it ideally suited for dental equipment, sprayer painters, food processing, instrumentation and pharmaceuticals. It also acts as an excellent after filter for particle removal as required with a twin tower regenerative dryer.

## SERIES F5 — Oilesceer

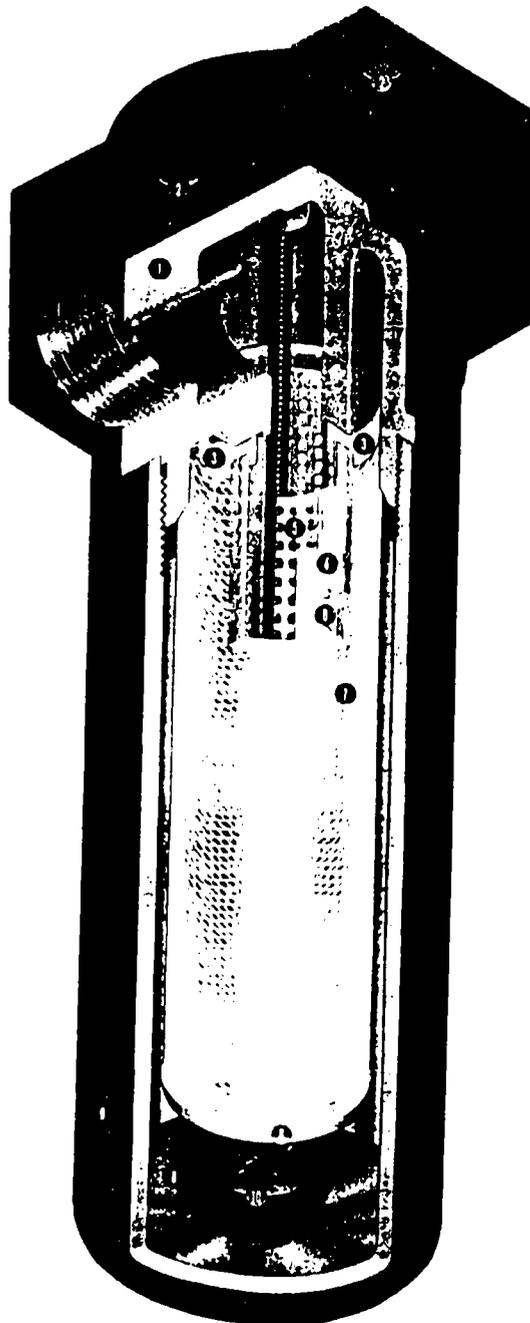
The Arrow Series F5 Oilesceer Filter Series, will remove oil aerosols and reduce the air quality index to .015 PPM remaining, by weight, based on an intake of 50 PPM. All sizes utilize a filter element constructed of the finest borosilicate micro glass fibers. These filters are vacuum formed to precisely control the physical parameters of the porous mass microfilament matrix. Graded as a .03 micron, they will eliminate oil aerosols to a D.O.P. efficiency rating of 99.97% and absolute particle retention to .3 microns. The filter element is completed with the addition of a rigid plastic support layer for durability and a non-wicking glass drain layer to insure against re-entrainment. High filtration efficiency and structural integrity make the F5 Oilesceer Filters a perfect choice for protecting sophisticated pneumatic systems.

## SERIES F6 — Adsorber

The Arrow Series F6 Adsorber filters were engineered for those critical applications that will not tolerate the presence of oil vapors, oil-associated odors and solid particle contaminants. Each unit exhibits the same fine qualities of a borosilicate filter element as its counterpart series F5 Oilesceer. However, it is further enhanced with the purification qualities of 40 micron powdered, activated charcoal particles. If the compressed air has been prepared by a suitable refrigerated dryer and F5 Oilesceer Filter, the F6 Adsorber will insure oil concentrates of .01 PPM by weight. In all cases, an F5 Oilesceer must precede an F6 Adsorber.

At maximum flow rates, 90% efficiency can be expected. At less than maximum flow, the efficiency approaches 95%. If applied at ambient temperatures, a 3 to 6 month service life is normal. The most effective way to determine when to replace the adsorber element is to sniff the effluent air.

Because it can emit virtually contamination-free air, the Arrow F6 Adsorber Filter is an excellent choice for the critical applications found in the food, dairy, pharmaceutical and brewery industries.



- 1 LIGHTWEIGHT CAST ALUMINUM HEAD
- 2 PRESSURE DIFFERENTIAL GAUGE PORTS
- 3 MOLDED, PERMANENTLY BONDED URETHANE RUBBER END SEALS ACT AS SEAL BETWEEN ELEMENT AND HOUSING. NO ADDITIONAL SEALS REQUIRED.
- 4 HIGH EFFICIENCY BOROSILICATE GLASS FIBER MEDIA COALESCES AND REMOVES FINEST OIL AEROSOLS. THE DEPTH PENETRATION EXTENDS FILTER LIFE. AN EXTRA LAYER OF POLYESTER PREVENTS MEDIA MIGRATION.
- 5 PLASTIC INNER SUPPORT CORE SUPPORTS ELEMENT AND PREVENTS DAMAGE UNDER REVERSE FLOW.
- 6 PLASTIC OUTER SUPPORT CORE PREVENTS DAMAGE TO ELEMENT UNDER HIGH PRESSURE DIFFERENTIAL CONDITIONS.
- 7 FIBERGLASS DRAIN LAYER PROVIDES DRAINAGE VEHICLE, PREVENTS RE-ENTRAINMENT OF DROPLETS, AND IS NOT AFFECTED BY SYNTHETIC OILS AND HIGH TEMPERATURES.
- 8 LARGE RESERVOIR FOR COLLECTED FLUIDS.
- 9 SPUN ALUMINUM BOWL IS RATED TO 250 PSI
- 10 FLOAT TYPE AUTOMATIC DRAIN (OPTIONAL) AUTOMATICALLY DRAINS COLLECTED FLUIDS, HAS MANUAL OVERRIDE.

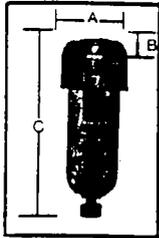
# ARROW F4, F5, F6 ORDERING INFORMATION

F4 Oil Removing (.9 micron)

F5 Oilescr (.03 micron)

F6 Adsorber (activated charcoal)

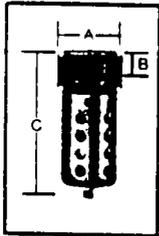
## F5 Miniature Series (.03 Micron)



Pipe Size	Model No. Plastic Bowl	Bowl Capacity	Nominal Air Flow (SCFM)	Dimensions			Approx. Wt. Lbs.
				A	B	C	
1/8"	F500-01	1 oz.	15	1 1/2"	1/2"	4 1/2"	.5
1/4"	F500-02	1 oz.	15	1 1/2"	1/2"	4 1/2"	.5

Options: (Specify as Suffix) "Z" — piston drain "M" — metal bowl "J" — overnight drain plastic bowl  
"K" — overnight drain metal bowl

## STANDARD SERIES



Pipe Size	F4 Metal Bowl	Nominal Air Flow (SCFM)	F5 Metal Bowl	Nominal Air Flow (SCFM)	F6 Metal Bowl	Nominal Air Flow (SCFM)	Dimensions				Approx. Wt. Lbs.
							A	B	C	D	
1/4"	F452	27	F552	24	F652	24	2 3/32"	1 3/16"	5 1/16"	—	1.0
3/8"	F453	45	F553	37	F653	37	2 3/32"	1 3/16"	5 1/16"	—	1.0
1/2"	F454	53	F554	37	F654	37	2 3/32"	1 3/16"	5 1/16"	—	1.0
1/4"	F402-02	30	F502-02	24	F602-02	24	3 5/16"	7/8"	6 3/8"	—	1.6
3/8"	F402-03	55	F502-03	40	F602-03	40	3 5/16"	7/8"	6 3/8"	—	1.6
1/2"	F402-04	72	F502-04	55	F602-04	55	3 5/16"	7/8"	6 3/8"	—	1.6
1/2"	F405-04	125	F505-04	110	F605-04	110	4 7/8"	1 3/16"	8 7/8"	—	3.7
3/4"	F405-06	185	F505-06	150	F605-06	150	4 7/8"	1 3/16"	8 7/8"	—	3.7
1"	F408-08	300	F508-08	200	F608-08	200	4 7/8"	1 3/16"	13 1/2"	—	6.0
1 1/2"	F410-12	475	F510-12	415	F610-12	415	6 1/2"	2"	18 1/2"	—	16.0
2"	F410-16	475	F510-16	515	F610-16	515	6 1/2"	2"	26 1/4"	—	19.0
2"	F418-16	590	F518-16	515	F618-16	515	6 1/2"	2"	17 3/4"	—	16.0
2"	F428-16	840	F528-16	765	F628-16	765	6 1/2"	2"	26 1/4"	—	19.0
3"	F411-24	620	F511-24	560	F611-24	560	7 5/8"	2 1/4"	36 1/2"	—	23.0
3"	F419-24	770	F519-24	800	F619-24	800	7 5/8"	2 1/4"	20 3/8"	—	21.0
3"	F429-24	1100	F529-24	1000	F629-24	1000	7 5/8"	2 1/4"	28 1/16"	—	24.0
							7 5/8"	2 1/4"	38 3/16"	—	28.0

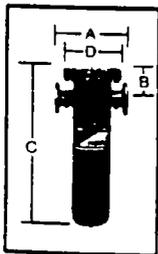
Options for Standard Series: (Specify as Suffix)

"F" — auto drain (5200) "W" — metal bowl w/Arrow Sight (except ASME)

"A" — .01 micron element (F5 series only) "K" — overnight drain metal bowl

"D" — heavy duty drain (N/A for F452, 3, 4; F552, 3, 4; F652, 3, 4)

## ASME



3"	F4N2-24	1300	F5N2-24	1100	F6N2-24	1100	17"	6 1/4"	42"	13 1/2"	200.0
4"FLG	F4X2-32	1300	F5X2-32	1100	F6X2-32	1100	17"	6 1/4"	42"	13 1/2"	212.0
4"FLG	F4X3-32	2000	F5X3-32	1750	F6X3-32	1750	20"	8 3/8"	46 1/2"	16"	300.0
6"FLG	F4X3-48	2000	F5X3-48	1750	F6X3-48	1750	20"	8 3/8"	46 1/2"	16"	315.0
6"FLG	F4X4-48	2750	F5X4-48	2400	F6X4-48	2400	23"	10 1/4"	50 3/4"	19"	450.0
6"FLG	F4X5-48	3500	F5X5-48	3000	F6X5-48	3000	25"	11"	52 3/8"	21"	540.0
6"FLG	F4X6-48	4300	F5X6-48	3750	F6X6-48	3750	27"	11"	53"	23 1/2"	650.0
6"FLG	F4X8-48	5000	F5X8-48	4500	F6X8-48	4500	30"	11 1/4"	54"	25"	875.0

Options for ASME Series: (Specify as Suffix) "F" — external auto drain (T53-04) "A" — .01 micron element (F5 series only)

Bowl	Max. Pressure	Temp. Rated
Plastic	150 psig	40°F to 120°F
Metal	250 psig	40°F to 200°F
w/sight glass (W)	250 psig	40°F to 160°F
w/auto drain (F)	30 to 175 psig	40°F to 120°F

**WARNING:** For compressed air service only. Not to be used on life support systems or breathing air systems. Never use polycarbonate plastic bowls on air supplied by a compressor lubricator with synthetic oils or oils containing phosphate esters or chlorinated hydrocarbons. They can carry over into the air distribution systems and chemically attack and possibly rupture the bowls. On these applications use a metal bowl. Also, do not expose these polycarbonate plastic bowls to materials such as trichloroethylene, acetone or paint thinner. Cleaning fluids or other harmful materials, will craze and/or rupture the bowl. If materials harmful to polycarbonate are present either outside or inside the bowl, use a metal bowl.

**CONTINENTAL ENVIRONMENTAL SERVICES***Innovators in contaminated groundwater cleanup***SPECIFICATIONS**

12/18/92

**Model:** 500DR02V, 500 cfm vapor phase adsorption system using two banks of drums in a series

**Inlet/Outlet:** 4"  
8"

**Activated Carbon:** 4 x 10 mesh, Iodine #1050  
500 pounds /vessel

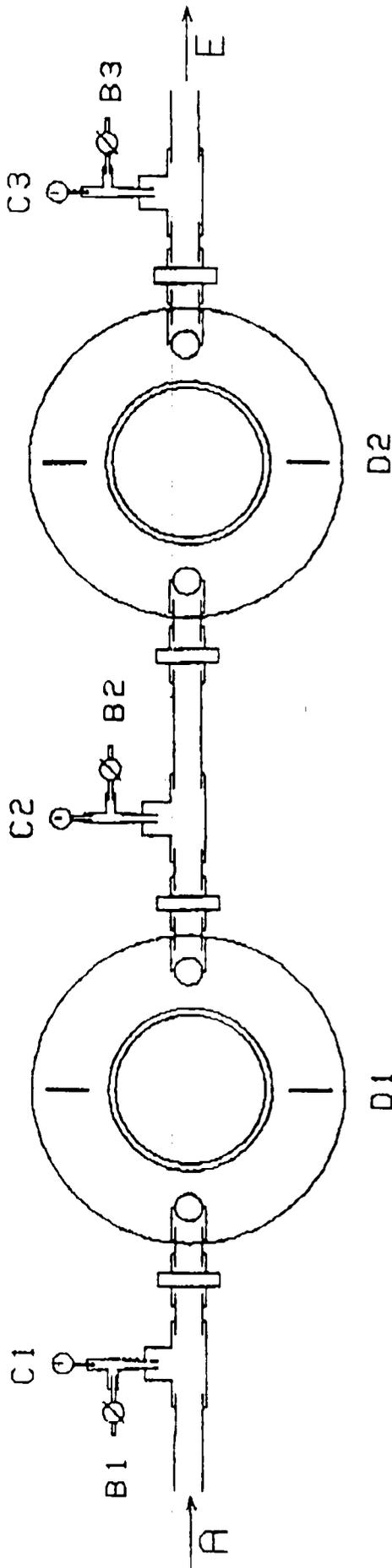
**Carbon Filters:** 2 - JDV500 Steel Drum Units

**Contact Time:** 4.32 seconds

**Installation Area:** 10' x 13'

*Specifications subject to change.*

# 500 CFM SOIL VENTING SYSTEM



**LEGEND**

- A: INLET AIR
- B: SAMPLE PORTS
- C: V/P GAUGES
- D: JUMBO GAC DRUMS
- E: TREATED AIR

**COPYRIGHT © 1989**  
 CONTINENTAL ENVIRONMENTAL SERVICES,  
 ALL RIGHTS RESERVED

DESIGNED (P&E)

PROJECT

CHECKED

DALE CANN  
 ENV. ENGR.

DATE

500J02 3

DATE

HOR

CES

CONTINENTAL  
 ENVIRONMENTAL SERVICES

# CONTINENTAL ENVIRONMENTAL SERVICES

Premium - grade GAC is Especially Suited for Pesticides & Petroleum HydroCarbons

Pesticides, petroleum products, and solvents require a higher grade of carbon for effective adsorption of VOC molecules. CES liquid phase GAC is graded with a minimum iodine number of 950.

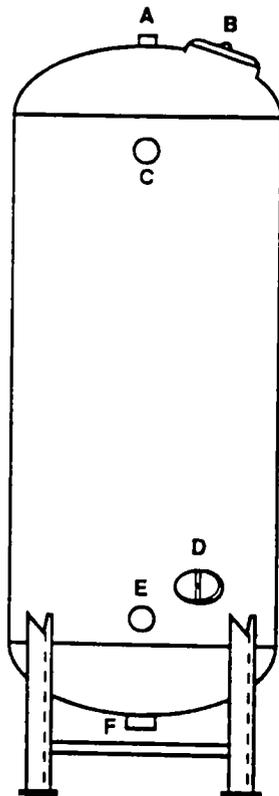
The iodine number represents the number of pores in the carbon granule that are available for adsorption. The greater the iodine number, the greater the carbon's capacity for adsorption.

Using carbon with more capacity improves the effectiveness and economics for the remediation and control of pesticides and petroleum hydrocarbons.

## Drums & Systems for Carbon Adsorption



Photo above, shows CES' 1,000- and 500-pound Jumbo drums behind CES' 200-pound drum and 50-pound mini drum. Drawing, left, is of CES' High Pressure steel tank.



A VENT  
B MANHOLE  
C INLET  
D HAND HOLE  
E DRAIN  
F OUTLET

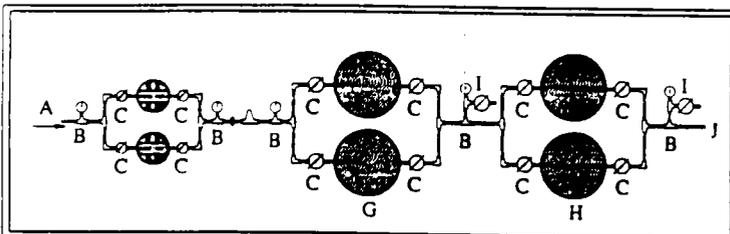
### Applications & Recommended System Types

GENERAL APPLICATIONS	MODEL NUMBERS							DESCRIPTION	
	MDC1L	DR02V	DRC1L	DRC2L	DRB2L	HPB2L	IDB2L		IDC2L
Filtration of water during sampling & well purging	*								of Model Numbers 1 2 3 4 1= Drum type MD=mini drum DR= 200-lb drum HP= High Pressure tank ID= Jumbo drum
Pump Testing				*	*		*		
Dewatering			*	*			*		
Tank Cleaning			*	*	*	*	*		
Pump & Treat					*	*	*	2= Prefiltration type O= No prefiltration B= Backwashing Assembly C= Disposable Cartridges	
Polishing effluent of Diffused Aerator			*	*	*	*	*		
Polishing liquid effluent of Air Stripper					*	*	*	3= # of carbon banks 4= Vapor or liquid phase	
Removal of vapors	*								

SPECIFICATIONS FOR VESSEL SIZE AND TYPE ON BACK.

# SPECIFICATIONS

MODEL NO.	LIQUID/VAPOR	AMOUNT OF CARBON (lbs.)	MAX FLOW/PRESSURE	DIA" x HT"	APPROX SHIP WT	INLET/ OUTLET"
CDL200	Liquid	200	10gpm/10psi	24 x 36	250	1/1
CDV200	Vapor	200	100 cfm	24 x 36	250	2/2
HP1000	Liquid	1000	50gpm/75psi	42 x 55	1800	3/3
HP1800	Liquid	1800	100gpm/75psi	54 x 92	3200	4/4
CDL500	Liquid	500	50gpm/10psi	45.5 x 42	900	2/2
→ CDV500	Vapor	500	500cfm	45.5 x 42	900	4/4
CDL800	Liquid	800	50gpm/10psi	45.5 x 42	1200	2/2
CDV800	Vapor	800	500cfm	45.5 x 42	1200	4/4
CDL1000	Liquid	1000	50gpm/10psi	45.5 x 56	1500	2/2
CDV1000	Vapor	1000	500cfm	45.5 x 56	1500	4/4
CDL1300	Liquid	1300	50gpm/10psi	45.5 x 62	1800	2/2
CDV1300	Vapor	1300	500cfm	45.5 x 62	1800	4/4
CDL1500	Liquid	1500	50gpm/10psi	45.5 x 70	2200	2/2
CDV1500	Vapor	1500	500cfm	45.5 x 70	2200	4/4
CDL1700	Liquid	1700	50gpm/10psi	45.5 x 78	2500	2/2
CDV1700	Vapor	1700	500cfm	45.5 x 78	2500	4/4
MDL50	Liquid	50	3gpm/10psi	15.25 x 19.875	60	.75/1
MDV50	Vapor	50	30cfm	15.25 x 19.875	60	1/1.75



**LEGEND:**

- |                                 |                             |
|---------------------------------|-----------------------------|
| A = Inlet Water                 | F = Pressure Reducing Valve |
| B = Pressure Guages             | G = GAC Drum (stage 1)      |
| C = Ball Valves                 | H = GAC Drum (stage 2)      |
| D = Cartridge Housing & Filters | I = Sample Ports            |
| E = Union                       | J = Treated Water           |

*Drawing of the Model 20DRC2L, a 20 gpm system with disposable cartridge filtration to protect the drum units. The 200-pound units are plumbed in series to provide a minimum 10 minute contact time at 20 gpm.*

**Standard 200-pound Drums**

- 16-gauge steel • epoxy-lined • channeling reduced with outlet distributor design •

**High Pressure Steel Tanks**

- Carbon-steel • skid mounted • epoxy-lined •

**Jumbo Drums**

- 10-gauge steel • Four-way Forklift entry • 2-inch Drain Valve •

**Mini Drums**

- High Density polyethylene • Compact design • Molded-in handle •

**P.O. Box 5039 • Gainesville, FL 32602  
TOLL-FREE 1-800-342-1103**

# U S Carbons

## ACTIVATED CARBON

### USC 41V

#### GRANULAR ACTIVATED CARBON

#### DESCRIPTION:

The USC 41V is a 4x10 mesh granular, vapor phase, activated carbon. Produced from select grades of coal and thermally activated under carefully controlled conditions to provide a strong, dust free product with a very high surface area. The USC 41V granular activated carbon, because of its production process, is not susceptible to fines or dust generation. This product will provide excellent adsorptive characteristics without increase in pressure drop, even under extended continuous service. The particle size distribution is carefully controlled to offer minimal pressure drop. The high hardness provides a strong filtration media. These features add up to longer service life, therefore fewer bed changes and more economical filtration performance.

#### SPECIFICATIONS:

- o
- o
- o
- o
- o
- o
- o

U.S. Sieve Series Mesh .....	4x10
Greater Than 4 Mesh (Maximum).....	5%
Less Than 8 Mesh (Maximum).....	3%
Iodine Number, mg/gm (Minimum).....	1000
Carbon Tetrachloride weight % (Minimum).....	60%
Hardness (Minimum).....	95
Moisture (As Packed) (Maximum).....	2%

#### PHYSICAL CHARACTERISTICS:

- o
- o
- o
- o

Total Surface Area, m <sup>2</sup> /gm (N <sub>2</sub> BET Method).....	1050-1150
Apparent Density, Bulk Dense Pack, lbs/ft <sup>3</sup> .....	28-30
gms/cc.....	0.48-0.50
Pore Volume, cc/gm.....	0.60

#### COMMERCIAL INFORMATION:

Packed in 200 net lbs drum or 1,000 net lbs bulk bag.  
National Motor Freight #40560, Class #70

Note: Steam activated carbons are excluded from provisions of IATA #395, IMCO Class 4.2 or UN #1362.

**CAUTION:** Wetted activated carbons preferentially remove oxygen from air. In closed or partially closed containers and/or vessels, oxygen reduction may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed. These include all applicable Federal and State requirements.

The data included herein are based on test information obtained by U S Carbons. These data are believed to be reliable but do not imply any warranty or performance guarantee. We recommend that the user determine performance by testing on his own processing equipment. We assume no liability or responsibility for patent infringement resulting from the use of this product.



# CONTINENTAL ENVIRONMENTAL SERVICES

*Innovators in Contaminant Remediation*

CORPORATE OFFICE

TEL: (800) 342-1103

FAX: (904) 373-7660

December 3, 1992

RECD DEC 09 1992

S & ME  
9751 Southern Pine Blvd.  
Charlotte, NC 28241

ATTN: Stewart Hines

Continental Environmental Services uses a coal based carbon, manufactured by US Carbons, in our vapor phase adsorption units. This carbon has a minimum iodine number of 1000, and a carbon tetrachloride minimum of 60%. This carbon will remove 99.999% of petroleum hydrocarbon constituents in an air stream.

Enclosed you will find a specification sheet for this carbon.

Sincerely,

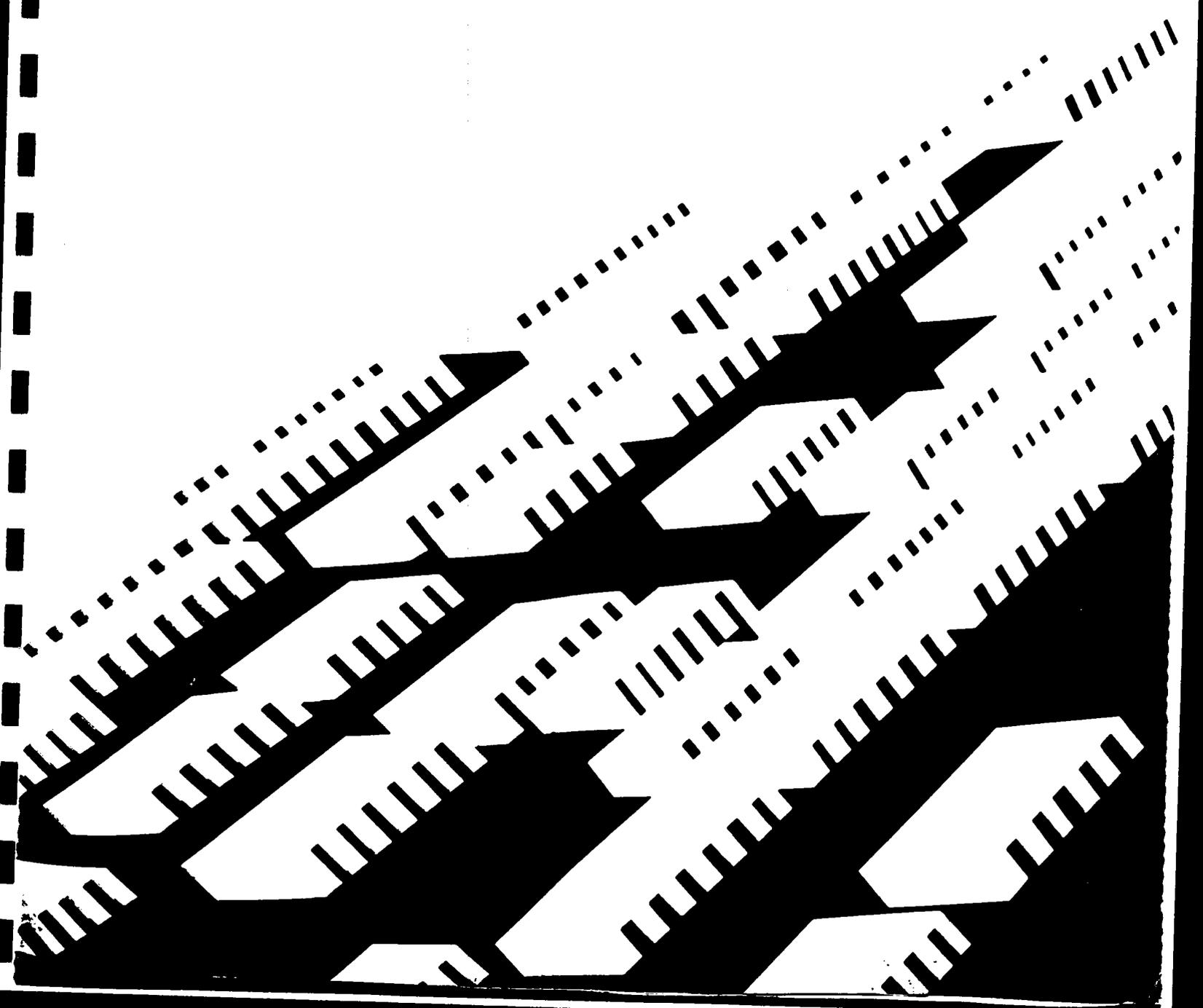
Dale Gann  
Environmental Engineer

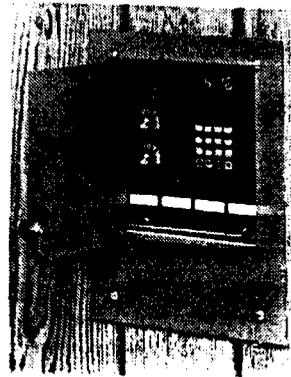
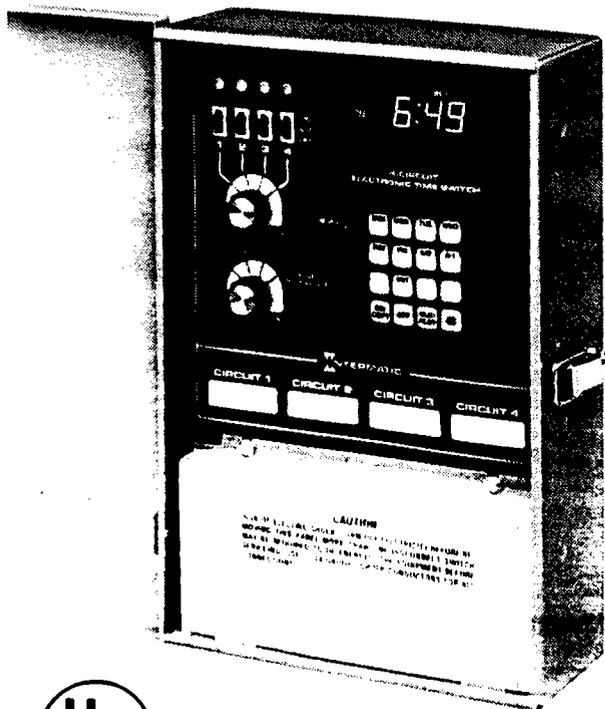
enclosure



# 4 CIRCUIT ELECTRONIC TIME SWITCH

OWNER/INSTALLER INSTRUCTION MANUAL





**CAUTION...Read this entire instruction manual carefully BEFORE attempting to install or operate this time switch. Failure to comply with instructions could result in personal injury and/or property damage.**

## INTRODUCTION

This time switch is designed to control lighting, HVAC, refrigeration and other energy consuming loads as well as security and convenience systems. It is capable of reducing energy consumption by providing accurate, independent scheduling, cycling and defrost control for up to four circuits. The time switch is ideal for small or medium size buildings such as schools, churches, restaurants, apartment complexes, fast food restaurants and other applications where accurate, full-year control of energy is desired.



### THE ET7415C FEATURES ARE:

- Independent to-the-minute scheduling, cycling and defrost control for four circuits.
- A total of 320 set points, assignable in ANY COMBINATION to ON times, OFF times, daylight saving time dates and holidays.
- Copy feature copies all programmed times, for all four circuits, from one day to any other day(s), effectively increasing number of scheduling times.
- Solid state memory protection circuit maintains all program data and time-of-day for 24 hours minimum without the need for batteries and associated battery maintenance.
- Optional battery backup for long term power loss of up to 125 days or 3,000 hours of accumulated power outages.
- Single pole double throw (SPDT) isolated contacts for each circuit.
- Full year control with automatic daylight saving time and leap year adjustment.
- Automatic day of week correction.
- Programming for an 8th day (A1) in addition to the normal 7 day week. (For holidays)
- Holidays programmable one year in advance, by month and date assignment. Can be assigned to the alternate day (A1) or any of the 7 week days.
- Automatic delay of 8 to 10 seconds between each circuit programmed for the same on time or upon power up after a power outage.
- Manual on/off override for each circuit independently, with load status indicator for each circuit.
- Easy to program - uses the same programming steps, for set points, as the Intermatic ET700 series time switches.
- Automatic review feature for easy review of data points and calendar information.
- Continual display of current day and time.
- Large .6" vacuum fluorescent display prevents washout and provides easy programming even in poorly lit areas.
- Large, well defined keypads with tactile feel.
- Permanent marking surface provides for load identification of each circuit.
- Rugged steel enclosure with lockable hasp. Optional flushmount cover available.

the microprocessor to reinitiate. This also resets the time to 10:00 A.M. RESET DOES NOT clear any of the programmed on/off times or any calendar data programmed.

Pressing the MEMORY CLEAR (MC) switch alone has no effect on the programmed data. If the CLEAR (C) keypad is pressed while MEMORY CLEAR (MC) is held depressed ALL PROGRAMMED ON/OFF TIMES AND CALENDAR DATA ARE ERASED from the memory. Display will be blank until this process has been completed.

**KEYBOARD:** The keyboard is used to select and enter all calendar and on/off program times. All keypads have tactile feel when pressed.

- The number keypads 1 thru 0 are used to enter all calendar dates and set point times.
- The number keypads 1 thru 7 are also used to select the days SUNDAY thru SATURDAY. The number 8 keypad is used to select the alternate day (A1) and the number 0 keypad is used for programming daylight saving time (DST) adjustment.
- The AM and PM keypads are used to select "day or night" based on a 12 hour repeating clock. Note that 12:00 PM is 12:00 noon.
- The ON/COPY and OFF keypads are used to program ON and OFF set times and to temporarily switch a circuit on or off. The ON/COPY and OFF keypads can also be used to initiate manual or automatic set point review. Both methods of review are accomplished in the REVIEW mode. After a day to be reviewed has been selected, by pushing appropriate day keypad, the ON/COPY or OFF keypads are pressed, one at a time, for manual review of set points. Pressing both keypads simultaneously initiates the automatic set point review whereby all set points, for the selected day, are displayed in chronological order beginning at 12:00 AM or midnight. Automatic or manual review may be terminated by exiting the review mode or by pressing any day keypad. The ON/COPY keypad is also used to copy all set

points for both circuits from one day to another day(s).

- The CLOCK keypad is used to set the time of day and to set or review all calendar data.
- The CLEAR (C) keypad is used to clear an error (EE:EE) indication, to clear the display if a mistake is made during data entry or to remove unwanted set point or calendar data during review. The CLEAR (C) keypad is also used in conjunction with the MEMORY CLEAR SWITCH (MC) to clear all set point and calendar data.

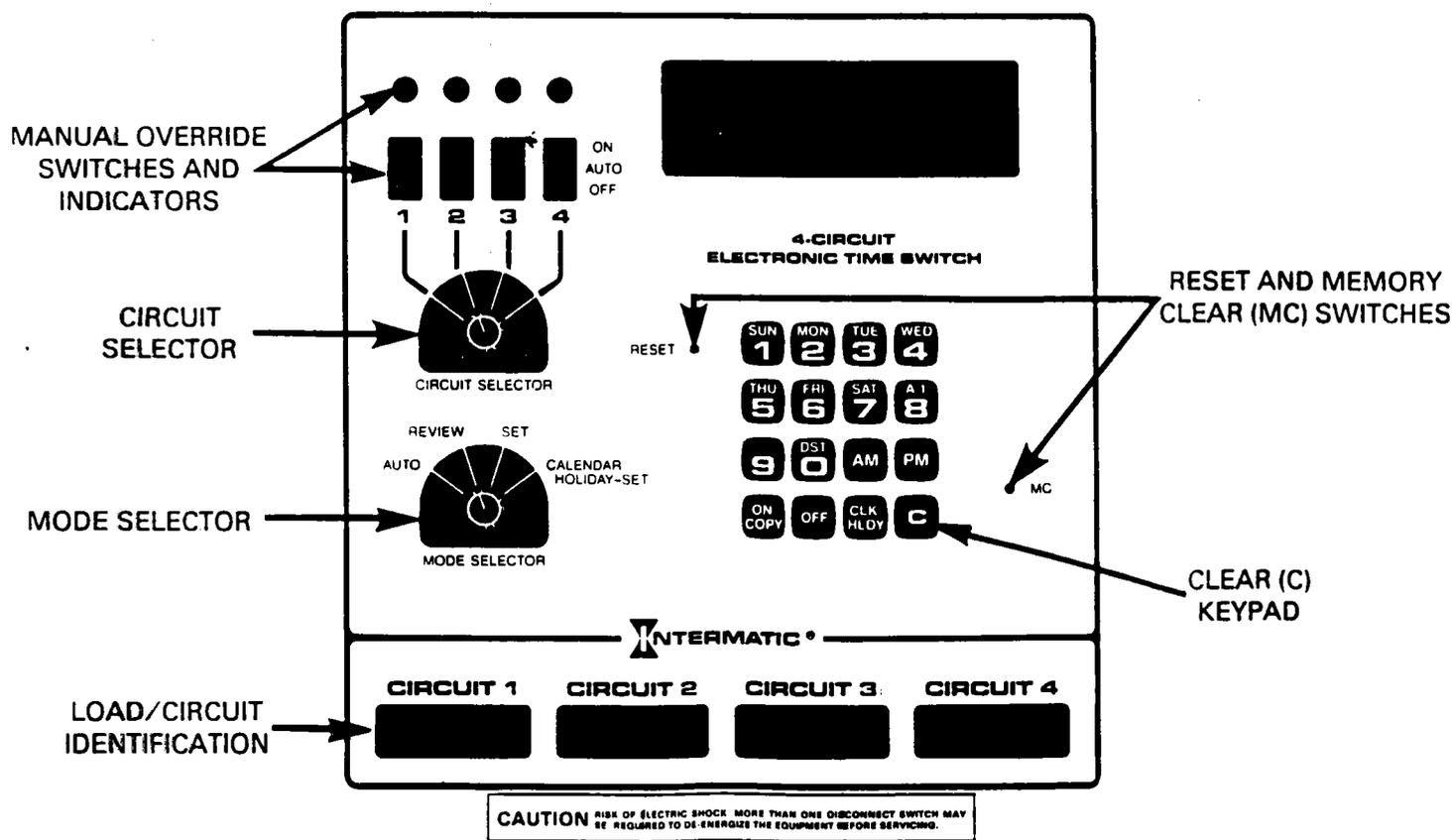
**SOLID STATE MEMORY BACKUP OPERATING CHARACTERISTICS:**

When using either the solid state memory backup or the optional battery backup the time switch has the same operating characteristics, as follows.

Immediately after restoration of power both output relays will be de-energized, except for circuits forced on by the respective manual override switch(es). Within one minute of restoration of line power, the time switch will "catch-up" with the existing programmed set point data. This means that the outputs will assume the state they would have been in, had there been no power failure. Any manual override, selected by use of the ON or OFF keypads, prior to the power outage will be overridden by the set points currently in effect. The only exception to this is if there are no set points programmed for that day for that circuit(s). If there are no set points programmed for that day, the circuit(s) output will return to the on or off state as selected by the ON or OFF keypad prior to the power outage.

It is recommended that override control for either circuit be accomplished by use of spring wound overrides. This will allow the time switch enclosure to be locked, to ensure that program control is made by authorized personnel only.

For long term override of any load, the MANUAL OVERRIDE switches should be used. This will ensure that the selected circuit output(s) remain in the desired on or off state regardless of the effects of a power outage.



(FIG. 2)



HERRY  
JONES

# Cap Cop II Monitoring Well Cover

EXHIBIT 2

Obviously, a monitoring well at your storage tank site must not be tampered with. Westinghouse Groundwater Recovery's Cap Cop II Monitoring Well Cover is the latest generation of a protective well cover to secure your well.

The Cap Cop II is an at grade well vault and cover constructed of durable steel throughout and excellent for use in heavily trafficked areas. For your added protection, the cover incorporates the latest American Petroleum Institute's (API) recommend-

ations on well identification and use.

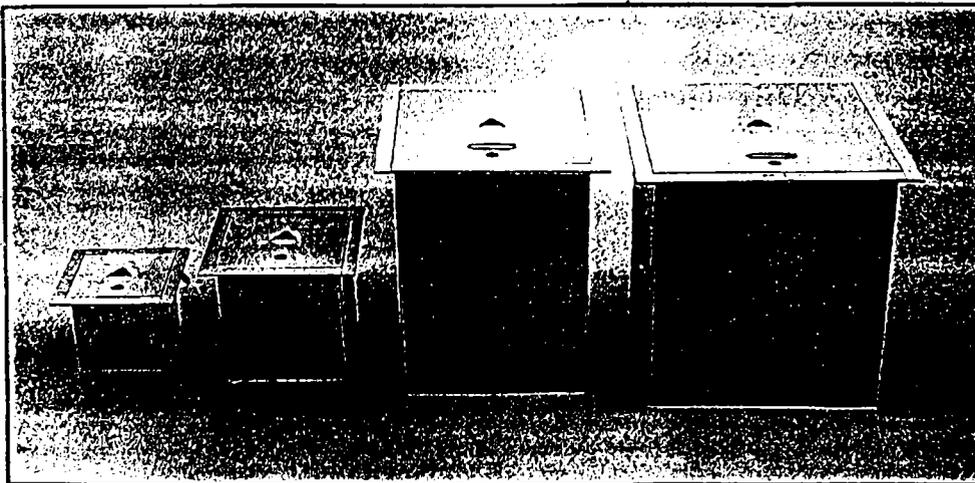
A molded plastic emblem—a black triangle on a white circle—is secured to the cover lid marking the installation as a monitoring well. Inside the vault a plastic label is attached to the locking device with the WARNING: "Do not place gasoline, petroleum products or other substances in this well. Violators may be subject to civil or criminal penalties."

(For owners of the earlier Cap Cop Cover, an identification retrofit kit is

available including cover emblem, warning tag, and retainer. Affixing the emblem requires only the drilling of a 3/8" hole.)

### The Cap Cop II features:

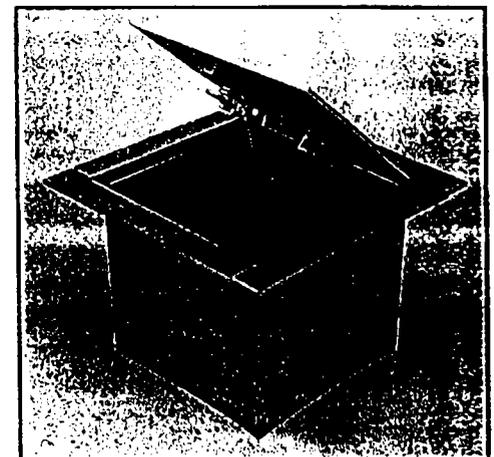
- Water resistant lid seal;
- Cam-lock security system is water and dust resistant, protected by compression O-ring seal and corrosion-protected dust cover;
- Lock key serves as convenient lift handle for smaller models (a recessed handle is included in larger models);
- Key cannot be removed from unlocked vault, helping to assure that you have secured the well;
- Lids and frames are designed for a 10,000 pound single axial wheel load providing adequate support for most industrial applications.



Cap Cop II vaults are available in four standard sizes.

	A	B	C	D	
Catalog Number	Box Size	Interior Opening	Skirt Length	Cover Steel	Appr. Shipping Weight
221	24"	21"	22"	3/8"	100 lb.
217	20"	17"	24"	3/8"	72 lb.
211	14"	11"	12"	1/4"	28 lb.
208	11"	8"	8"	3/16"	14 lb.

Rugged construction and easy installation are still other features that have made this WGR cover popular throughout the country. For information and immediate delivery of the Cap Cop II in sizes shown below, call or write Westinghouse Groundwater Recovery.



Cap Cop II vault and warning tag.

# UNOCAL

Corporate Environmental Remediation & Technology

August 31, 1993

Mr. Stewart Hines  
S&ME  
9751 Southern Pine Blvd.  
Charlotte, NC 28273

RE: Revised Proposal for VES, VFD Unit  
Unocal Site #9787-214  
DFF-022

Dear Stewart:

In accordance with your Request for Quotation revisions, Unocal's Denver Fabrication Facility (DFF) will provide the following VES system:

<u>QTY</u>	<u>DESCRIPTION</u>
1	Roots U-RAI 68 pd blower, directly coupled, with discharge silencer, inline filter, 25 HP TEFC motor (3 ph/ <del>250</del> <sup>440</sup> volt, 1.15 SF)
1	Variable Frequency Driver in NEMA 4 enclosure with heater. Skid mounted.
1	Adjustable vacuum breaker valve, set at 14" Hg
2	Averaging flow sensor w/gauge (inlet & outlet)
2	Sample port w/valve
1	80 gallon knock-out drum w/ LSHH, visual level gauge and drain valve
1	Vacuum relief valve
2	Temperature gauge (inlet & outlet)
1	Pressure gauge (PSI)
1	Vacuum gauge ("HG)
1	Low pressure shutdown switch (PSL)

Mr. Stewart Hines

August 31, 1993

Page 2

<u>QTY</u>	<u>DESCRIPTION</u>
1	High pressure shutdown switch (PSH)
1	Pressure relief valve
1	Set of drawings and manuals

All equipment is new and warranted by the manufacturers.

The VFD acts as a starter, and no other starter is required. The PSL, and LSHH will be wired through the VFD to inhibit operation if either of the switches are made.

The VES will be painted UNOCAL blue.

Fabrication will take approximately 4 weeks from the date the order is received.

Shipping will take 4-5 days via Consolidated Freightways and should not exceed \$500 in cost.

DFE will provide a one-day, on-site startup service for \$1,000 inclusive.

If you need more information, please call me at (303) 629-6667 or 6669.

Sincerely,



F. R. Rippey  
Manager, Denver Fabrication  
Facility

FRR:mlc

cc: W. Holt  
W. H. Bishop

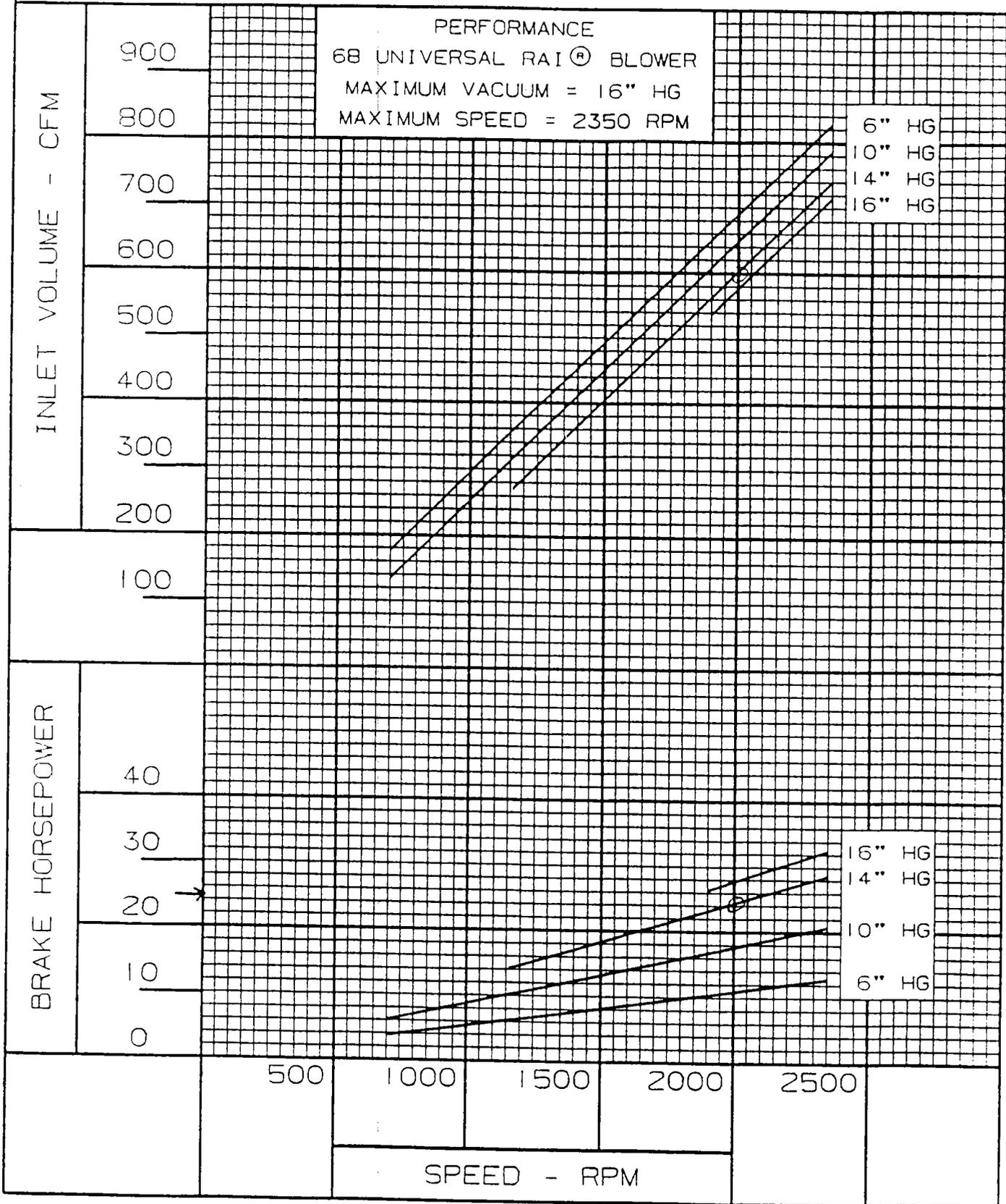
PROPOSAL ACCEPTED: \_\_\_\_\_ DATE: \_\_\_\_\_

A: DFF-030.BID

ROOTS DIVISION  
 DRESSER INDUSTRIES, INC.  
 CONNERSVILLE, IN. 47331  
 PRINTED IN U.S.A.

PERFORMANCE BASED ON 68°F  
 INLET AIR & DISCHARGE  
 PRESSURE - 30" HG ABS

JUNE 1990



## VAPOR PHASE CARBON USE RATE

S&ME  
STEWART HINES

AIR FLOW RATE IN CFM 400

CONTAMINANT	CONCENTRATION		CARBON USE RANGE		DISCHARGE
	PPM	LBS/DAY	LBS/DAY		LBS/DAY
BENZENE	236.9	10.23408	33.77247	51.17041	1.023408E-04
TOLUENE	457.2	19.75104	65.17843	98.75519	1.975104E-04
ETHYL BENZENE	58.2	2.51424	8.296993	12.5712	2.51424E-05
TOTAL XYLENES	191.2	8.25984	27.25747	41.2992	8.25984E-05
HEXANE	4093.9	176.8565	583.6263	884.2824	1.768565E-03
PENTANE	2668.3	115.2706	380.3929	576.3528	1.152706E-03
CHLOROFORM	78.9	3.40848	11.24798	17.0424	3.40848E-05

THESE RESULTS ARE ESTIMATES BASED ON LITERATURE AND FIELD DATA

## VAPOR PHASE CARBON USE RATE

S&ME  
STEWART HINES

AIR FLOW RATE IN CFM 400

CONTAMINANT	CONCENTRATION		CARBON USE RANGE		DISCHARGE
	PPM	LBS/DAY	LBS/DAY		
TOTAL HYDROCARBONS	5465.5	236.1096	779.1617	1180.548	2.361096E-03

THESE RESULTS ARE ESTIMATES BASED ON LITERATURE AND FIELD DATA

# Environmental Services



22404 66th Avenue South  
Kent, Washington, 98032-4801  
206-395-0200  
800-568-8459

# Gas Station Horizontal Vapor Extraction System

Orcutt, California  
May 1992

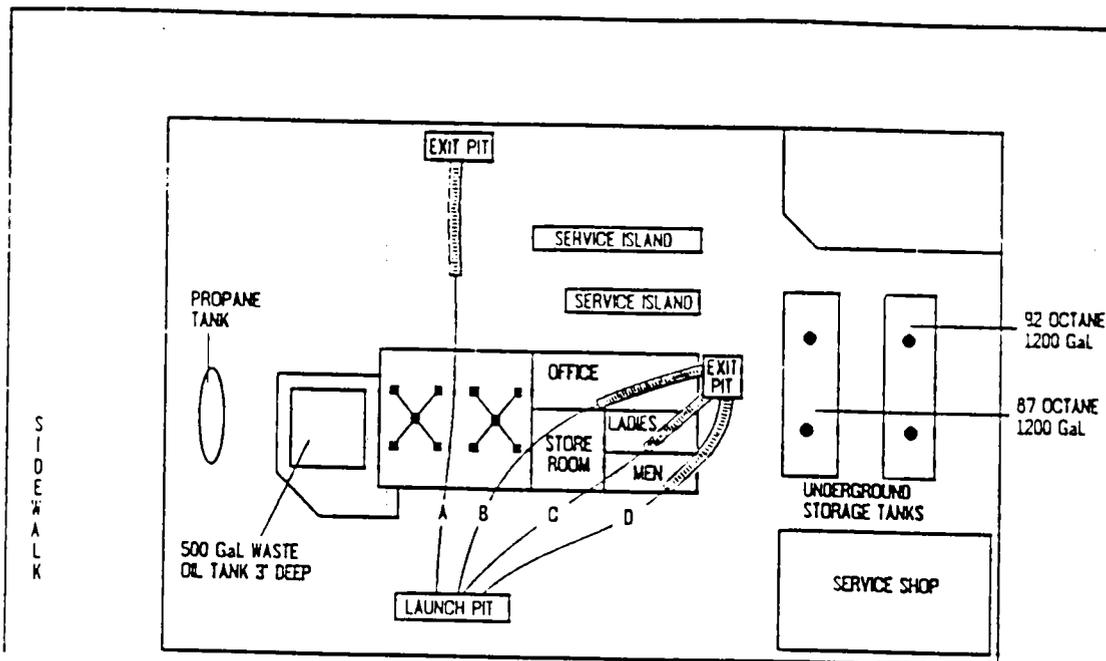
## Purpose

Place horizontal vapor extraction wells under gas station pump islands and building foundation using guided horizontal drilling.

## Observations

The leaking underground storage tanks were removed and replaced and the accessible contaminated soil was excavated and replaced with clean soil. Months later vapor traces began showing up in the monitoring wells. It was suspected this was a result of contaminated soil left under the station foundation. A horizontal vapor extraction system was designed to vacuum the gasoline vapors from the soil under the station foundation.

The well design is shown in Figure 1. Four (4) vacuum wells were designed and installed at a depth of 60 inches under the station foundation.

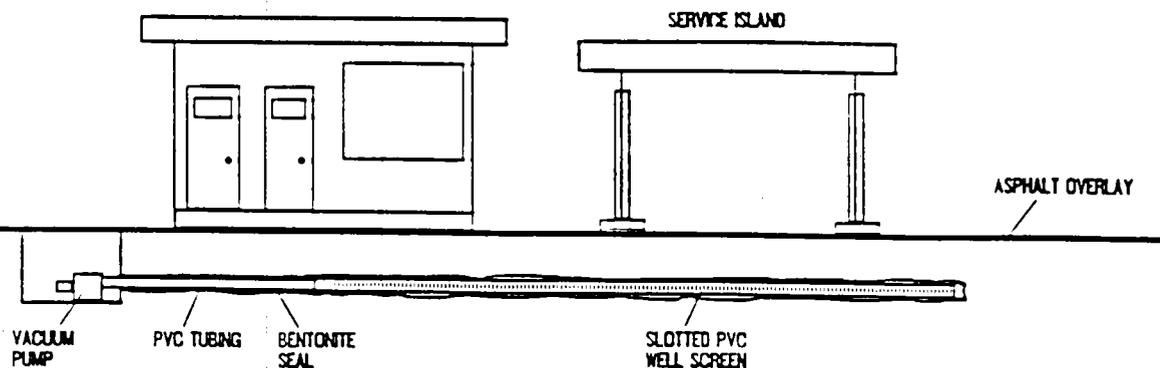


Well A is 120 ft. long, 35 ft. of which are slotted PVC.  
Well B is 70 ft. long, 50 ft. of which are slotted PVC.  
Well C is 70 ft. long, 30 ft. of which are slotted PVC.  
Well D is 70 ft. long, 30 ft. of which are slotted PVC.

The well construction used 2" slotted PVC wrapped with a filter foam material that was held in place with nylon tie wraps as shown in Figure 2.



An elevation view of the installation in Figure 3 shows the well depth of 60 inches and the profile of the slotted casing, foam cover and the solid casing leading back to the central collection point in an underground vault.



The sequence of the well installation is shown in Figures 4 - 7.

A two (2) inch diameter hole is drilled using the proprietary FlowMole guided drilling process as shown in Figure 4.

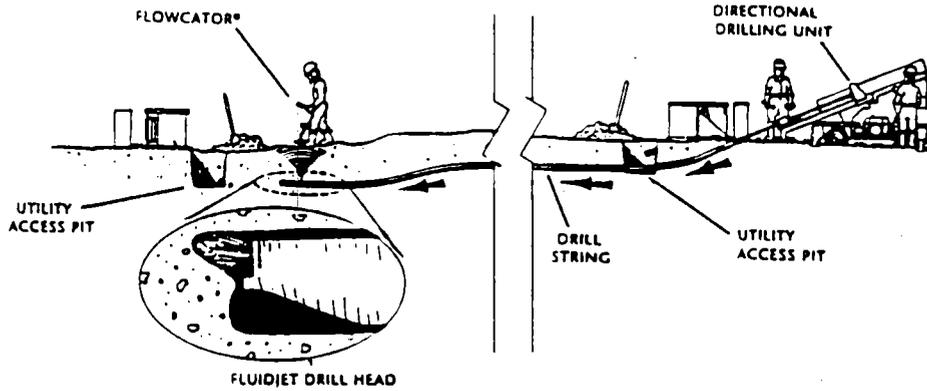
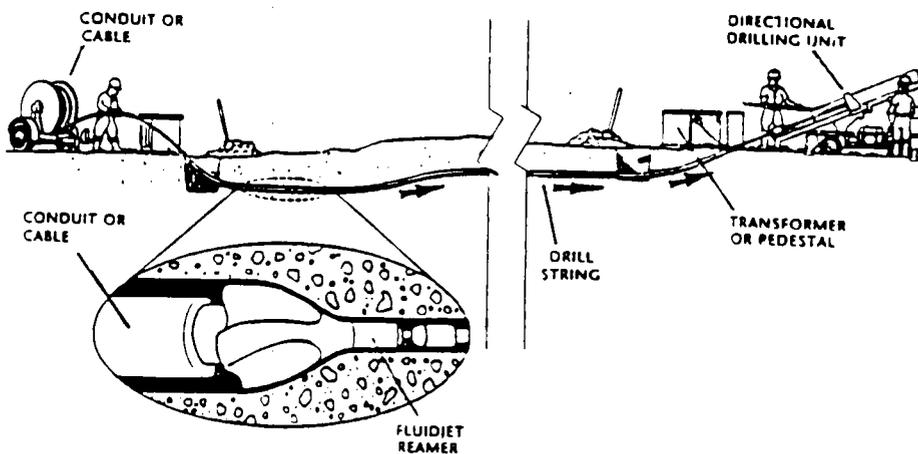


Figure 5 shows how the drilled hole is sized to six (6) inches with a backreaming cutter while the four (4) inch diameter high density polyethylene (HDPE) conduit is pulled into the hole.



Two (2) inch diameter filter-foam wrapped slotted PVC well screen is assembled and installed into the four (4) inch diameter conduit as shown in Figure 6.

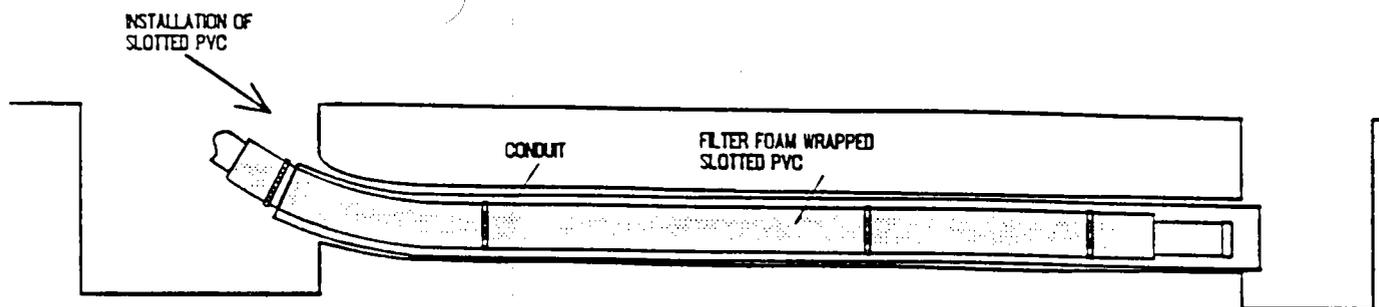
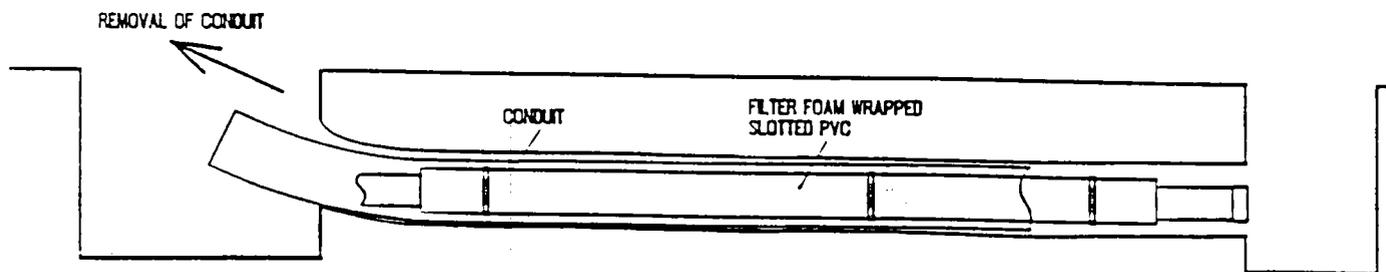


Figure 7 shows the four (4) inch diameter HDPE being pulled from the hole leaving the two (2) inch diameter well screen in place.



**Conclusion**

Gasoline vapors from the old leaking underground storage tanks had contaminated the soil and required cleaning. The old tanks were removed and disposed of and the contaminated soil was excavated and hauled to a site for treatment and cleaning. Clean soil was brought to the site for backfill. New concrete was poured and the station was placed back into service.



# CABLE, CONDUIT AND PIPE INSTALLATIONS FOR ELECTRIC, TELEPHONE, GAS, WATER AND SEWER UTILITIES.

**FlowMole**  
A Service of **UTLX**

- ▲ Full-service installation capabilities
- ▲ Long, trenchless installation runs with few pits and minimal surface disruption
- ▲ Small- to large-diameter drilling in a variety of soils
- ▲ Precise drilling for more accurate utility placement
- ▲ Greater routing flexibility
- ▲ Safe equipment and operating procedures for maximum operator and public safety
- ▲ High productivity rates
- ▲ Maximum customer satisfaction

**The FlowMole® service meets your most challenging utility placement needs.**

- Approved by the Department of Transportation (DOT) in various states for crossing highways and right-of-ways
- Approved by various regulatory agencies for crossing waterways, wetlands and environmentally sensitive areas
- Placement of underground services with minimum disruption to traffic flow under busy arterial streets, interstate highways, railroads and airport runways
- Drilling through a wide variety of soils:
 

caliche	sandstone
clay	frozen soils
sand	rocky soils
shale	glacial till

**Your single source for a full range of cost-effective services.**

- FlowMole trenchless excavation
- Conventional excavation (trenching)
- Installation of pedestals and enclosures
- Placement of transformers
- Termination work
- Plastic pipe fusion for gas mains
- Placement of cable in conduit
- Service drops to the home
- Engineering, furnishing and installation services (EF&I)

**Experience and technological innovation deliver more field-proven "trenchless" service capabilities.**

- Placement of a wide range of utilities: single-phase to multi-phase cables, small- to large-diameter conduits (up to 12 inches OD) and steel pipe installations (up to 8 inches OD)
- Longer utility runs (up to 600 feet) with fewer pits means fewer cable splices
- Turns within a 40-foot radius provide routing flexibility
- Accurate placement of utilities within a  $\pm$  6-inch window
- Precise monitoring of the drilling tool's position within 2 inches at depths to 12 feet and within  $\pm$  2 percent at depths to 40 feet
- Conformance to utility's maximum cable-pulling tension and sidewall bearing pressure (SWBP) requirements

**Use the FlowMole trenchless service for all types of residential and commercial applications.**

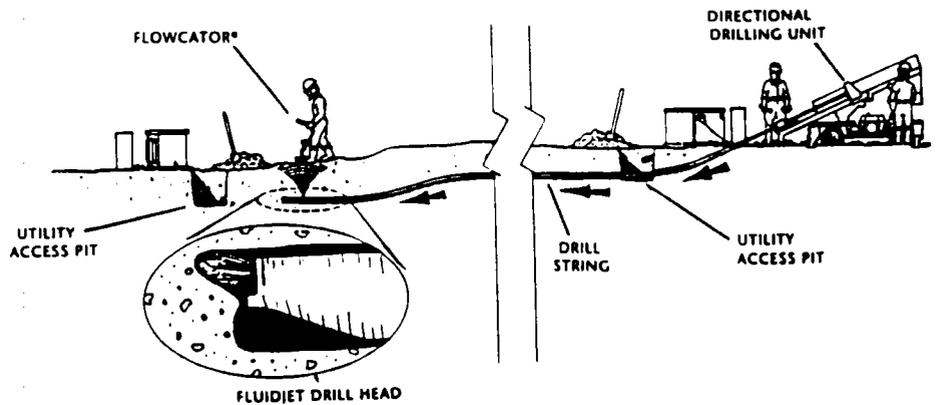
The FlowMole service is perfect for utility installations in congested areas with complex underground structures such as residential neighborhoods, industrial parks, commercial districts, mobile-home parks, military bases, university and corporate campuses, and historical landmarks. Other uses include installation of communication systems and environmental remediation.

**FlowMole is a technologically superior service that is environmentally safe.**

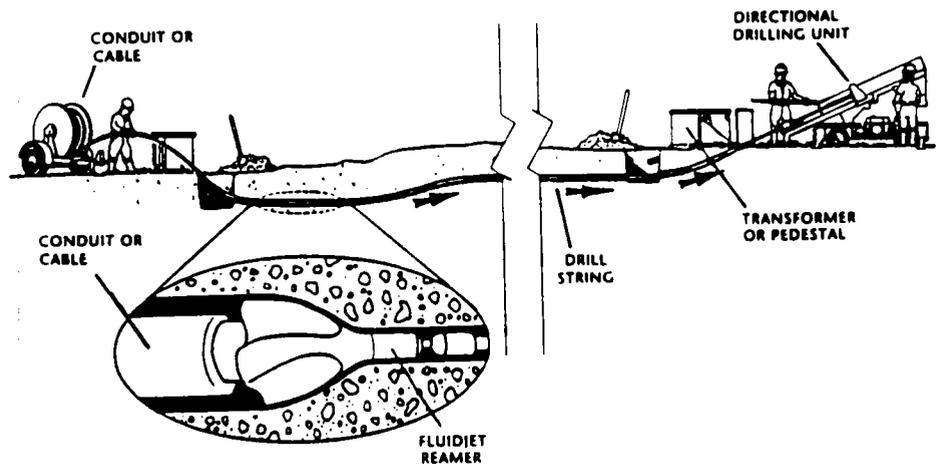
The FlowMole high-pressure fluidjet technology uses liquefied bentonite clay to cut through soils, maintain tunnel stability, and provide lubrication to reduce frictional drag on the utility being pulled. Bentonite is a natural, inert substance—not a polymer or chemical that could be detrimental to the underground utility or to the environment. Extensive testing and field experience have demonstrated that bentonite is the safest, most effective medium for high-pressure fluidjet cutting in a wide variety of soils.

## The FlowMole® Service

### Step 1: Guided Drilling Produces Microtunnel



### Step 2: Backreaming Tunnel and Utility Installation



**Place cable, conduit and pipe with minimal surface disruption and no costly restoration.**

1. A small access pit is dug.
2. A high-pressure fluidjet drill head is attached to the drill string and is surface launched into the pit.
3. Using a remotely controlled electromagnetic guidance system, the proprietary drill head is guided through the soil to create a tunnel.
4. Upon reaching the exit pit, a reamer with the utility attached is hooked to the drill pipe and is pulled back through the tunnel.
5. A vacuum system removes the spoils generated from the tunneling process.
6. Surface is restored to its original condition.

**Get more customer satisfaction for your installation dollar.**

To find out how our exclusive FlowMole® service can meet all of your utility placement needs, contact UTILX today. Call toll free, 1-800-568-8459 or write to:

UTILX Corporation  
22404 66th Avenue South  
Kent, WA 98032-4801 USA

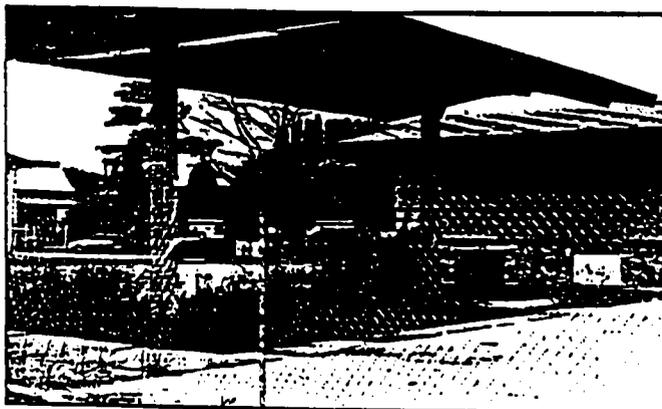
**UTILX**™

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Trademark of UTILX Corporation.

# FlowMole®

Guided Horizontal Drilling

**Solve  
Underground  
Remediation  
Problems  
With  
Guided  
Boring,**



**Don't  
Abandon  
Them.**

FlowMole is your low-cost solution to leaking tanks and pipes. Because we don't dig open trenches, there is minimal surface disruption. This means your customers will never know we were there. Call FlowMole for:

- Complete underground piping and collection systems
  - Well head connections
  - Street crossings

## **UTILX**

22404 66th Avenue South, Kent, WA 98032-4801  
Contact: Michael J. Kirby, 800-568-8459

- ANALYTICAL RESULTS -

## ANALYTICAL RESULTS

The method number provided on each data report sheet refers to a method or procedure from a publication originating from a regulatory or standard-setting organization. In general, the methods employed are those specified by the U.S. Environmental Protection Agency and other state and federal agencies. In cases where an approved regulatory method does not exist, a method developed by Enseco will be employed to meet the specific needs of the client. In all cases, Enseco's specific procedures are documented in proprietary Standard Operating Procedures (SOP). The methods commonly employed by Enseco are based on methods from the following references.

U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Cincinnati, OH, March.

U.S. Environmental Protection Agency. 1990. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846). Washington, D.C., November.

U.S. Environmental Protection Agency. 1988. Methods for Determination of Organic Compounds in Finished Drinking Water and Raw Source water. EPA-600/4-88/039. Cincinnati, OH, December.

"Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," 40 CFR, Part 136; Federal Register, Vol. 49, No. 209.

American Public Health Association, American Water Works Association, Water Pollution Control Federation. 1989. Standard Methods for the Examination of Water and Wastewater, 17th Edition. Washington, D.C., September.

Current EPA Contract Laboratory Program (CLP) protocols for the analysis of organic and inorganic hazardous substances including chlorinated dioxins and furans.

Volatile Organics  
 Halogenated Compounds  
 Method 8010



Client Name: Soil & Material Engineers  
 Client ID: MW-1  
 Lab ID: 013441-0001-SA  
 Matrix: AQUEOUS  
 Authorized: 20 JAN 93

Sampled: 18 JAN 93  
 Prepared: NA

Received: 20 JAN 93  
 Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (total)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	1.0
1,1,2-Trichloroethane	ND	ug/L	1.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	5.0
Surrogate	Recovery		
Bromochloromethane	110	%	--

ND = Not detected  
 NA = Not applicable

Reported By: Nancy Duggan

Approved By: Joyce Lombardo

Volatile Organics  
 Halogenated Compounds  
 Method 8010



Client Name: Soil & Material Engineers  
 Client ID: MW-2  
 Lab ID: 013441-0002-SA  
 Matrix: AQUEOUS  
 Authorized: 20 JAN 93

Sampled: 18 JAN 93  
 Prepared: NA

Received: 20 JAN 93  
 Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	5.0	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (total)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,2-Dichloroethane	2.9	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	1.0
1,1,2-Trichloroethane	ND	ug/L	1.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	5.0
Surrogate	Recovery		
Bromochloromethane	105	%	--

Note # : Analyte associated with sample processing and analysis in the lab environment. An acceptable blank must contain <5 times the reporting limit of this analyte for this method.

ND = Not detected  
 NA = Not applicable

Reported By: Nancy Duggan

Approved By: Joyce Lombardo

Volatile Organics  
 Halogenated Compounds  
 Method 8010



Client Name: Soil & Material Engineers

Client ID: MW-4

Lab ID: 013441-0003-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93  
 Prepared: NA

Received: 20 JAN 93  
 Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit	
Chloromethane	ND	ug/L	5.0	
Bromomethane	ND	ug/L	5.0	
Vinyl chloride	ND	ug/L	1.0	
Chloroethane	ND	ug/L	5.0	
Methylene chloride	5.1	ug/L	5.0	#
1,1-Dichloroethene	ND	ug/L	0.50	
1,1-Dichloroethane	ND	ug/L	0.50	
1,2-Dichloroethene (total)	ND	ug/L	0.50	
Chloroform	ND	ug/L	0.50	
1,2-Dichloroethane	ND	ug/L	1.0	
1,1,1-Trichloroethane	ND	ug/L	0.50	
Carbon tetrachloride	ND	ug/L	0.50	
Bromodichloromethane	ND	ug/L	1.0	
1,2-Dichloropropane	ND	ug/L	1.0	
trans-1,3-Dichloropropene	ND	ug/L	1.0	
Trichloroethene	ND	ug/L	0.50	
Dibromochloromethane	ND	ug/L	1.0	
cis-1,3-Dichloropropene	ND	ug/L	1.0	
1,1,2-Trichloroethane	ND	ug/L	1.0	
Bromoform	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	1.7	ug/L	1.0	
Tetrachloroethene	ND	ug/L	0.50	
Chlorobenzene	ND	ug/L	5.0	
Surrogate	Recovery			
Bromochloromethane	102	%	--	

Note # : Analyte associated with sample processing and analysis in the lab environment. An acceptable blank must contain <5 times the reporting limit of this analyte for this method.

ND = Not detected  
 NA = Not applicable

Reported By: Nancy Duggan

Approved By: Joyce Lombardo

Volatile Organics  
 Halogenated Compounds  
 Method 8010

 Client Name: Soil & Material Engineers  
 Client ID: FIELD BLANK  
 Lab ID: 013441-0004-SA  
 Matrix: AQUEOUS  
 Authorized: 20 JAN 93

 Sampled: 18 JAN 93  
 Prepared: NA

 Received: 20 JAN 93  
 Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (total)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	1.0
1,1,2-Trichloroethane	ND	ug/L	1.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	5.0
Surrogate	Recovery		
Bromochloromethane	95	%	--

 ND = Not detected  
 NA = Not applicable

Reported By: Nancy Duggan

Approved By: Joyce Lombardo

**Diesel Range Organics (DRO)**

Method Enseco DRO (Modified 3550/8015)

Client Name: Soil &amp; Material Engineers

Client ID: mw-1

Lab ID: 013410-0001-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 07 JAN 93

Prepared: 14 JAN 93

Received: 14 JAN 93

Analyzed: 14 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Diesel Range Organics	16	ug/g	4.4
Surrogate	Recovery		
o-Terphenyl	97	%	--

Percent Moisture is 25%. All results and limits are reported on a dry weight basis.

 ND = Not detected  
 NA = Not applicable

Reported By: Andrew Yaroshefski

Approved By: Alan Humason

Diesel Range Organics (DRO)

Method Enseco DRO (Modified 3550/8015)

Client Name: Soil & Material Engineers

Client ID: mw-2

Lab ID: 013410-0002-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 07 JAN 93

Prepared: 14 JAN 93

Received: 14 JAN 93

Analyzed: 14 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Diesel Range Organics	510	ug/g	19
Surrogate	Recovery		
o-Terphenyl	95	%	--

Percent Moisture is 32%. All results and limits are reported on a dry weight basis.

ND = Not detected  
NA = Not applicable

Reported By: Andrew Yaroshefski

Approved By: Alan Humason

Gasoline Range Organics (GRO)



Method Enseco GRO (Modified 5030/8015)

Client Name: Soil & Material Engineers

Client ID: mw-1

Lab ID: 013410-0001-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 07 JAN 93

Prepared: 15 JAN 93

Received: 14 JAN 93

Analyzed: 14 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Gasoline Range Organics	ND	ug/kg	7500
Surrogate	Recovery		
a,a,a-Trifluorotoluene	80	%	--

Percent Moisture is 25%. All results and limits are reported on a dry weight basis.

ND = Not detected  
NA = Not applicable

Reported By: Fred Morrison

Approved By: Joyce Lombardo

**Gasoline Range Organics (GRO)**

Method Enseco GRO (Modified 5030/8015)

Client Name: Soil &amp; Material Engineers

Client ID: mw-2

Lab ID: 013410-0002-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 07 JAN 93

Prepared: 15 JAN 93

Received: 14 JAN 93

Analyzed: 15 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit	
Gasoline Range Organics	1200000	ug/kg	36000	
Surrogate	Recovery			
a,a,a-Trifluorotoluene	357	%	--	I

Percent Moisture is 32%. All results and limits are reported on a dry weight basis.

Note I : Surrogate recovery outside of limits due to sample matrix interference.

ND = Not detected

NA = Not applicable

Reported By: Fred Morrison

Approved By: Joyce Lombardo

**Gasoline Range Organics (GRO)**

Method Enseco GRO (Modified 5030/8015)

Client Name: Soil &amp; Material Engineers

Client ID: mw-3

Lab ID: 013410-0003-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 11 JAN 93

Received: 14 JAN 93

Prepared: 15 JAN 93

Analyzed: 14 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Gasoline Range Organics	99000	ug/kg	8100
Surrogate	Recovery		
a,a,a-Trifluorotoluene	115	%	--

Percent Moisture is 30%. All results and limits are reported on a dry weight basis.

ND = Not detected

NA = Not applicable

Reported By: Fred Morrison

Approved By: Joyce Lombardo

Gasoline Range Organics (GRO)



Method Enseco GRO (Modified 5030/8015)

Client Name: Soil & Material Engineers

Client ID: mw-4

Lab ID: 013410-0004-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 11 JAN 93

Prepared: 15 JAN 93

Received: 14 JAN 93

Analyzed: 14 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Gasoline Range Organics	95000	ug/kg	5600
Surrogate	Recovery		
a,a,a-Trifluorotoluene	104	%	--

Percent Moisture is 22%. All results and limits are reported on a dry weight basis.

ND = Not detected  
NA = Not applicable

Reported By: Fred Morrison

Approved By: Joyce Lombardo

Volatile Organics  
 Aromatic Compounds  
 Method 8020

Client Name: Soil & Material Engineers  
 Client ID: mw-1  
 Lab ID: 013410-0001-SA  
 Matrix: SOIL  
 Authorized: 14 JAN 93

Sampled: 07 JAN 93      Received: 14 JAN 93  
 Prepared: 14 JAN 93     Analyzed: 18 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Benzene	ND	ug/kg	75
Toluene	120	ug/kg	75
Ethylbenzene	ND	ug/kg	75
Chlorobenzene	ND	ug/kg	75
Xylenes (total)	120	ug/kg	75
1,4-Dichlorobenzene	ND	ug/kg	75
1,3-Dichlorobenzene	ND	ug/kg	75
1,2-Dichlorobenzene	ND	ug/kg	75
Surrogate	Recovery		
a,a,a-Trifluorotoluene	63	%	--

Percent Moisture is 25%. All results and limits are reported on a dry weight basis.

ND = Not detected  
 NA = Not applicable

Reported By: Joyce Lombardo

Approved By: Peter Colonero

Volatile Organics  
Aromatic Compounds  
Method 8020



Client Name: Soil & Material Engineers

Client ID: mw-2

Lab ID: 013410-0002-SA

Matrix: SOIL

Authorized: 14 JAN 93

Sampled: 07 JAN 93

Prepared: 14 JAN 93

Received: 14 JAN 93

Analyzed: 19 JAN 93

Parameter	Result	Dry Weight Reporting	
		Units	Limit
Benzene	810	ug/kg	360
Toluene	20000	ug/kg	360
Ethylbenzene	17000	ug/kg	360
Chlorobenzene	ND	ug/kg	360
Xylenes (total)	95000	ug/kg	360
1,4-Dichlorobenzene	ND	ug/kg	360
1,3-Dichlorobenzene	ND	ug/kg	360
1,2-Dichlorobenzene	ND	ug/kg	360
Surrogate	Recovery		
a,a,a-Trifluorotoluene	112	%	--

Percent Moisture is 32%. All results and limits are reported on a dry weight basis.

ND = Not detected  
NA = Not applicable

Reported By: Joyce Lombardo

Approved By: Peter Colonero

Volatile Organics  
 Aromatic Compounds  
 Method 8020

Client Name: Soil & Material Engineers  
 Client ID: mw-3  
 Lab ID: 013410-0003-SA  
 Matrix: SOIL  
 Authorized: 14 JAN 93

Sampled: 11 JAN 93      Received: 14 JAN 93  
 Prepared: 14 JAN 93     Analyzed: 18 JAN 93

Parameter	Result	Dry Weight Units	Reporting Limit
Benzene	ND	ug/kg	81
Toluene	1300	ug/kg	81
Ethylbenzene	2100	ug/kg	81
Chlorobenzene	ND	ug/kg	81
Xylenes (total)	13000	ug/kg	81
1,4-Dichlorobenzene	ND	ug/kg	81
1,3-Dichlorobenzene	ND	ug/kg	81
1,2-Dichlorobenzene	ND	ug/kg	81
Surrogate	Recovery		
a,a,a-Trifluorotoluene	59	%	-- &

Percent Moisture is 30%. All results and limits are reported on a dry weight basis.

Note & : Surrogate recovery is outside of control limits.

ND = Not detected  
 NA = Not applicable

Reported By: Joyce Lombardo

Approved By: Peter Colonero

**Volatile Organics  
 Aromatic Compounds  
 Method 8020**

 Client Name: Soil & Material Engineers  
 Client ID: mw-4  
 Lab ID: 013410-0004-SA  
 Matrix: SOIL  
 Authorized: 14 JAN 93

 Sampled: 11 JAN 93      Received: 14 JAN 93  
 Prepared: 14 JAN 93     Analyzed: 18 JAN 93

Parameter	Result	Dry Weight Reporting	
		Units	Limit
Benzene	ND	ug/kg	56
Toluene	1700	ug/kg	56
Ethylbenzene	4900	ug/kg	56
Chlorobenzene	440	ug/kg	56
Xylenes (total)	31000	ug/kg	56
1,4-Dichlorobenzene	ND	ug/kg	56
1,3-Dichlorobenzene	ND	ug/kg	56
1,2-Dichlorobenzene	ND	ug/kg	56
Surrogate	Recovery		
a,a,a-Trifluorotoluene	64	%	--

Percent Moisture is 22%. All results and limits are reported on a dry weight basis.

ND = Not detected  
 NA = Not applicable

Reported By: Joyce Lombardo

Approved By: Peter Colonero

- QUALITY ASSURANCE/QUALITY CONTROL -

## QUALITY ASSURANCE/QUALITY CONTROL

The results of the internal quality control checks, used to monitor data quality, are included with this report. The following have been provided, where applicable. A comprehensive description of each of these elements can be found in the Enseco Quality Assurance Program Plan for Environmental Chemical Monitoring.

DUPLICATE CONTROL SAMPLES (DCS) are used to monitor the precision and accuracy of the analytical system on an on-going basis. Each DCS consists of a standard, control matrix that is spiked with a group of target compounds representative of the method analytes. A DCS pair is analyzed for every 20 samples processed by the method. DCS are analyzed with environmental samples to provide evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision.

SINGLE CONTROL SAMPLES (SCS) are analyzed with every batch of samples. An SCS consists of a control matrix that is spiked with surrogate compounds appropriate to the method being used. In cases where no surrogate is available (e.g., metals or wet chemistry), a single DCS serves as the control sample. Recovery data generated from the SCS are compared to control limits that have been established for each of the compounds being monitored.

METHOD BLANKS, also known as reagent, analytical, or preparation blanks, are analyzed to assess the level of contamination which exists in the analytical system. A method blank is analyzed with every batch of samples processed. A method blank consists of reagents specific to the method which are carried through every aspect of the procedure, including preparation, cleanup, and analysis. The results of the method blank analysis are evaluated, in conjunction with other QC information, to determine the acceptability of the data generated for that batch of samples.

MATRIX SPIKES, MATRIX DUPLICATES, AND MATRIX SPIKE DUPLICATES are types of Matrix Specific QC, which is used to assess the effects of a sample matrix or field conditions on the analytical data. A Matrix Spike (MS) is an environmental sample to which known concentrations of analytes have been added. A Matrix Duplicate (MD) is a sample that is divided into two separate aliquots which are analyzed separately. A Matrix Spike Duplicate (MSD) is a sample that is divided into two separate aliquots, each of which is spiked with known concentrations of analytes. This data is provided only where required or requested. The samples that are used are either project-specific or part of the analytical batch, depending on the requirements of the project.

QC LOT ASSIGNMENT REPORT  
Hydrocarbon

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
013410-0001-SA	SOIL	DRO-S	14 JAN 93-NA	14 JAN 93-N1
013410-0002-SA	SOIL	DRO-S	14 JAN 93-NA	14 JAN 93-N1

DUPLICATE CONTROL SAMPLE REPORT

Hydrocarbon  
Project: 013410

Category: DRO-S      Deisel Range Organics (DRO)  
Matrix: SOIL  
QC Lot: 14 JAN 93-NA  
Concentration Units: ug/g

Analyte	Spiked	Concentration			Accuracy		Precision
		DCS1	DCS2	AVG	DCS Limits	(RPD) DCS Limit	
Diesel Range Organics	40.9	36.8	35.0	35.9	88	60-120	5.02    30

Calculations are performed before rounding to avoid round-off errors in calculated results.

Volatile Organics  
Aromatic Compounds  
Method 8020



Client Name: Soil & Material Engineers  
Client ID: FIELD BLANK  
Lab ID: 013441-0004-SA  
Matrix: AQUEOUS  
Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: NA

Received: 20 JAN 93  
Analyzed: 21 JAN 93

Parameter	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50
Surrogate	Recovery		
a,a,a-Trifluorotoluene	100	%	--

ND = Not detected  
NA = Not applicable

Reported By: Peter Colonero

Approved By: Joyce Lombardo

Volatile Organics  
 Aromatic Compounds  
 Method 8020

Client Name: Soil & Material Engineers  
 Client ID: TRIP BLANK  
 Lab ID: 013441-0005-SA  
 Matrix: AQUEOUS  
 Authorized: 20 JAN 93

Sampled: 18 JAN 93  
 Prepared: NA

Received: 20 JAN 93  
 Analyzed: 21 JAN 93

Parameter	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50
Surrogate	Recovery		
a,a,a-Trifluorotoluene	100	%	--

ND = Not detected  
 NA = Not applicable

Reported By: Peter Colonero

Approved By: Joyce Lombardo

Volatile Organics  
Aromatic Compounds  
Method 8020



Client Name: Soil & Material Engineers  
Client ID: RINSATE BLANK  
Lab ID: 013441-0006-SA  
Matrix: AQUEOUS  
Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: NA

Received: 20 JAN 93  
Analyzed: 21 JAN 93

Parameter	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50
Surrogate	Recovery		
a,a,a-Trifluorotoluene	100	%	--

ND = Not detected  
NA = Not applicable

Reported By: Peter Colonero

Approved By: Joyce Lombardo

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers

Client ID: MW-1

Lab ID: 013441-0001-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: 22 JAN 93

Received: 20 JAN 93

Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
Phenol	ND	ug/L	10
bis(2-Chloroethyl) ether	ND	ug/L	10
2-Chlorophenol	ND	ug/L	10
1,3-Dichlorobenzene	ND	ug/L	10
1,4-Dichlorobenzene	ND	ug/L	10
Benzyl alcohol	ND	ug/L	10
1,2-Dichlorobenzene	ND	ug/L	10
2-Methylphenol	ND	ug/L	10
bis(2-Chloroisopropyl) ether	ND	ug/L	10
4-Methylphenol	ND	ug/L	10
N-Nitroso-di-n-propylamine	ND	ug/L	10
Hexachloroethane	ND	ug/L	10
Nitrobenzene	ND	ug/L	10
Isophorone	ND	ug/L	10
2-Nitrophenol	ND	ug/L	10
2,4-Dimethylphenol	ND	ug/L	10
Benzoic acid	ND	ug/L	50
bis(2-Chloroethoxy)-methane	ND	ug/L	10
2,4-Dichlorophenol	ND	ug/L	10
1,2,4-Trichlorobenzene	ND	ug/L	10
Naphthalene	ND	ug/L	10
4-Chloroaniline	ND	ug/L	10
Hexachlorobutadiene	ND	ug/L	10
4-Chloro-3-methylphenol	ND	ug/L	10
2-Methylnaphthalene	ND	ug/L	10
Hexachlorocyclopentadiene	ND	ug/L	10
2,4,6-Trichlorophenol	ND	ug/L	10
2,4,5-Trichlorophenol	ND	ug/L	50
2-Chloronaphthalene	ND	ug/L	10
2-Nitroaniline	ND	ug/L	50
Dimethyl phthalate	ND	ug/L	10
Acenaphthylene	ND	ug/L	10
3-Nitroaniline	ND	ug/L	50
Acenaphthene	ND	ug/L	10
2,4-Dinitrophenol	ND	ug/L	50
4-Nitrophenol	ND	ug/L	50
Dibenzofuran	ND	ug/L	10
2,4-Dinitrotoluene	ND	ug/L	10

(continued on following page)

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers  
Client ID: MW-1  
Lab ID: 013441-0001-SA  
Matrix: AQUEOUS  
Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: 22 JAN 93

Received: 20 JAN 93  
Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
2,6-Dinitrotoluene	ND	ug/L	10
Diethyl phthalate	ND	ug/L	10
4-Chlorophenyl phenyl ether	ND	ug/L	10
Fluorene	ND	ug/L	10
4-Nitroaniline	ND	ug/L	50
4,6-Dinitro-2-methylphenol	ND	ug/L	50
N-Nitrosodiphenylamine	ND	ug/L	10
4-Bromophenyl phenyl ether	ND	ug/L	10
Hexachlorobenzene	ND	ug/L	10
Pentachlorophenol	ND	ug/L	50
Phenanthrene	ND	ug/L	10
Anthracene	ND	ug/L	10
Di-n-butyl phthalate	ND	ug/L	10
Fluoranthene	ND	ug/L	10
Pyrene	ND	ug/L	10
Butyl benzyl phthalate	ND	ug/L	10
3,3'-Dichlorobenzidine	ND	ug/L	20
Benzo(a)anthracene bis(2-Ethylhexyl) phthalate	ND	ug/L	10
Chrysene	ND	ug/L	10
Di-n-octyl phthalate	ND	ug/L	10
Benzo(b)fluoranthene	ND	ug/L	10
Benzo(k)fluoranthene	ND	ug/L	10
Benzo(a)pyrene	ND	ug/L	10
Indeno(1,2,3-cd)pyrene	ND	ug/L	10
Dibenz(a,h)anthracene	ND	ug/L	10
Benzo(g,h,i)perylene	ND	ug/L	10
Surrogate	Recovery		
Nitrobenzene-d5	74	%	--
2-Fluorobiphenyl	76	%	--
Terphenyl-d14	50	%	--
Phenol-d5	55	%	--
2-Fluorophenol	55	%	--
2,4,6-Tribromophenol	92	%	--

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers

Client ID: MW-2

Lab ID: 013441-0002-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: 22 JAN 93

Received: 20 JAN 93

Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
Phenol	28	ug/L	10
bis(2-Chloroethyl) ether	ND	ug/L	10
2-Chlorophenol	ND	ug/L	10
1,3-Dichlorobenzene	ND	ug/L	10
1,4-Dichlorobenzene	ND	ug/L	10
Benzyl alcohol	ND	ug/L	10
1,2-Dichlorobenzene	ND	ug/L	10
2-Methylphenol	ND	ug/L	10
bis(2-Chloroisopropyl) ether	ND	ug/L	10
4-Methylphenol	ND	ug/L	10
N-Nitroso-di-n-propylamine	ND	ug/L	10
Hexachloroethane	ND	ug/L	10
Nitrobenzene	ND	ug/L	10
Isophorone	ND	ug/L	10
2-Nitrophenol	ND	ug/L	10
2,4-Dimethylphenol	ND	ug/L	10
Benzoic acid	ND	ug/L	10
bis(2-Chloroethoxy)-methane	ND	ug/L	50
2,4-Dichlorophenol	ND	ug/L	10
1,2,4-Trichlorobenzene	ND	ug/L	10
Naphthalene	ND	ug/L	10
4-Chloroaniline	ND	ug/L	10
Hexachlorobutadiene	ND	ug/L	10
4-Chloro-3-methylphenol	ND	ug/L	10
2-Methylnaphthalene	ND	ug/L	10
Hexachlorocyclopentadiene	ND	ug/L	10
2,4,6-Trichlorophenol	ND	ug/L	10
2,4,5-Trichlorophenol	ND	ug/L	10
2-Chloronaphthalene	ND	ug/L	50
2-Nitroaniline	ND	ug/L	10
Dimethyl phthalate	ND	ug/L	50
Acenaphthylene	ND	ug/L	10
3-Nitroaniline	ND	ug/L	10
Acenaphthene	ND	ug/L	50
2,4-Dinitrophenol	ND	ug/L	10
4-Nitrophenol	ND	ug/L	50
Dibenzofuran	ND	ug/L	50
2,4-Dinitrotoluene	ND	ug/L	10

(continued on following page)

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers  
Client ID: MW-2  
Lab ID: 013441-0002-SA  
Matrix: AQUEOUS  
Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: 22 JAN 93

Received: 20 JAN 93  
Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
2,6-Dinitrotoluene	ND	ug/L	10
Diethyl phthalate	ND	ug/L	10
4-Chlorophenyl phenyl ether	ND	ug/L	10
Fluorene	ND	ug/L	10
4-Nitroaniline	ND	ug/L	50
4,6-Dinitro- 2-methylphenol	ND	ug/L	50
N-Nitrosodiphenylamine	ND	ug/L	10
4-Bromophenyl phenyl ether	ND	ug/L	10
Hexachlorobenzene	ND	ug/L	10
Pentachlorophenol	ND	ug/L	50
Phenanthrene	ND	ug/L	10
Anthracene	ND	ug/L	10
Di-n-butyl phthalate	ND	ug/L	10
Fluoranthene	ND	ug/L	10
Pyrene	ND	ug/L	10
Butyl benzyl phthalate	ND	ug/L	10
3,3'-Dichlorobenzidine	ND	ug/L	20
Benzo(a)anthracene	ND	ug/L	10
bis(2-Ethylhexyl) phthalate	ND	ug/L	10
Chrysene	ND	ug/L	10
Di-n-octyl phthalate	ND	ug/L	10
Benzo(b)fluoranthene	ND	ug/L	10
Benzo(k)fluoranthene	ND	ug/L	10
Benzo(a)pyrene	ND	ug/L	10
Indeno(1,2,3-cd)pyrene	ND	ug/L	10
Dibenz(a,h)anthracene	ND	ug/L	10
Benzo(g,h,i)perylene	ND	ug/L	10
Surrogate	Recovery		
Nitrobenzene-d5	69	%	--
2-Fluorobiphenyl	68	%	--
Terphenyl-d14	27	%	--
Phenol-d5	49	%	--
2-Fluorophenol	47	%	--
2,4,6-Tribromophenol	74	%	--

&

(continued on following page)

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers

Client ID: MW-2

Lab ID: 013441-0002-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: 22 JAN 93

Received: 20 JAN 93

Analyzed: 25 JAN 93

Note & : Surrogate recovery is outside of control limits.

ND = Not detected

NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers

Client ID: MW-4

Lab ID: 013441-0003-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: 22 JAN 93

Received: 20 JAN 93

Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
Phenol	ND	ug/L	300
bis(2-Chloroethyl) ether	ND	ug/L	300
2-Chlorophenol	ND	ug/L	300
1,3-Dichlorobenzene	ND	ug/L	300
1,4-Dichlorobenzene	ND	ug/L	300
Benzyl alcohol	ND	ug/L	300
1,2-Dichlorobenzene	ND	ug/L	300
2-Methylphenol	ND	ug/L	300
bis(2-Chloroisopropyl) ether	ND	ug/L	300
4-Methylphenol	ND	ug/L	300
N-Nitroso-di-n-propylamine	ND	ug/L	300
Hexachloroethane	ND	ug/L	300
Nitrobenzene	ND	ug/L	300
Isophorone	ND	ug/L	300
2-Nitrophenol	ND	ug/L	300
2,4-Dimethylphenol	ND	ug/L	300
Benzoic acid	ND	ug/L	300
bis(2-Chloroethoxy)-methane	ND	ug/L	1500
2,4-Dichlorophenol	ND	ug/L	300
1,2,4-Trichlorobenzene	ND	ug/L	300
Naphthalene	3300	ug/L	300
4-Chloroaniline	ND	ug/L	300
Hexachlorobutadiene	ND	ug/L	300
4-Chloro-3-methylphenol	ND	ug/L	300
2-Methylnaphthalene	3300	ug/L	300
Hexachlorocyclopentadiene	ND	ug/L	300
2,4,6-Trichlorophenol	ND	ug/L	300
2,4,5-Trichlorophenol	ND	ug/L	300
2-Chloronaphthalene	ND	ug/L	1500
2-Nitroaniline	ND	ug/L	300
Dimethyl phthalate	ND	ug/L	1500
Acenaphthylene	ND	ug/L	300
3-Nitroaniline	ND	ug/L	1500
Acenaphthene	ND	ug/L	300
2,4-Dinitrophenol	ND	ug/L	1500
4-Nitrophenol	ND	ug/L	1500
Dibenzofuran	ND	ug/L	300
2,4-Dinitrotoluene	ND	ug/L	300

(continued on following page)

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers

Client ID: MW-4

Lab ID: 013441-0003-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: 22 JAN 93

Received: 20 JAN 93

Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit	
2,6-Dinitrotoluene	ND	ug/L	300	
Diethyl phthalate	ND	ug/L	300	
4-Chlorophenyl phenyl ether	ND	ug/L	300	
Fluorene	ND	ug/L	300	
4-Nitroaniline	ND	ug/L	1500	
4,6-Dinitro- 2-methylphenol	ND	ug/L	1500	
N-Nitrosodiphenylamine	ND	ug/L	300	
4-Bromophenyl phenyl ether	ND	ug/L	300	
Hexachlorobenzene	ND	ug/L	300	
Pentachlorophenol	ND	ug/L	1500	
Phenanthrene	ND	ug/L	300	
Anthracene	ND	ug/L	300	
Di-n-butyl phthalate	ND	ug/L	300	
Fluoranthene	ND	ug/L	300	
Pyrene	ND	ug/L	300	
Butyl benzyl phthalate	ND	ug/L	300	
3,3'-Dichlorobenzidine	ND	ug/L	600	
Benzo(a)anthracene bis(2-Ethylhexyl) phthalate	ND	ug/L	300	
Chrysene	ND	ug/L	300	
Di-n-octyl phthalate	ND	ug/L	300	
Benzo(b)fluoranthene	ND	ug/L	300	
Benzo(k)fluoranthene	ND	ug/L	300	
Benzo(a)pyrene	ND	ug/L	300	
Indeno(1,2,3-cd)pyrene	ND	ug/L	300	
Dibenz(a,h)anthracene	ND	ug/L	300	
Benzo(g,h,i)perylene	ND	ug/L	300	
Surrogate	Recovery			
Nitrobenzene-d5	ND	%	--	H
2-Fluorobiphenyl	ND	%	--	H
Terphenyl-d14	ND	%	--	H
Phenol-d5	ND	%	--	H
2-Fluorophenol	ND	%	--	H
2,4,6-Tribromophenol	ND	%	--	H

(continued on following page)

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers

Client ID: MW-4

Lab ID: 013441-0003-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: 22 JAN 93

Received: 20 JAN 93

Analyzed: 25 JAN 93

Note H : Surrogate not detected because of required sample dilution.

ND = Not detected

NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers  
Client ID: FIELD BLANK  
Lab ID: 013441-0004-SA  
Matrix: AQUEOUS  
Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: 22 JAN 93

Received: 20 JAN 93  
Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
Phenol	ND	ug/L	10
bis(2-Chloroethyl) ether	ND	ug/L	10
2-Chlorophenol	ND	ug/L	10
1,3-Dichlorobenzene	ND	ug/L	10
1,4-Dichlorobenzene	ND	ug/L	10
Benzyl alcohol	ND	ug/L	10
1,2-Dichlorobenzene	ND	ug/L	10
2-Methylphenol	ND	ug/L	10
bis(2-Chloroisopropyl) ether	ND	ug/L	10
4-Methylphenol	ND	ug/L	10
N-Nitroso-di-n-propylamine	ND	ug/L	10
Hexachloroethane	ND	ug/L	10
Nitrobenzene	ND	ug/L	10
Isophorone	ND	ug/L	10
2-Nitrophenol	ND	ug/L	10
2,4-Dimethylphenol	ND	ug/L	10
Benzoic acid	ND	ug/L	50
bis(2-Chloroethoxy)-methane	ND	ug/L	10
2,4-Dichlorophenol	ND	ug/L	10
1,2,4-Trichlorobenzene	ND	ug/L	10
Naphthalene	ND	ug/L	10
4-Chloroaniline	ND	ug/L	10
Hexachlorobutadiene	ND	ug/L	10
4-Chloro-3-methylphenol	ND	ug/L	10
2-Methylnaphthalene	ND	ug/L	10
Hexachlorocyclopentadiene	ND	ug/L	10
2,4,6-Trichlorophenol	ND	ug/L	10
2,4,5-Trichlorophenol	ND	ug/L	50
2-Chloronaphthalene	ND	ug/L	10
2-Nitroaniline	ND	ug/L	50
Dimethyl phthalate	ND	ug/L	10
Acenaphthylene	ND	ug/L	10
3-Nitroaniline	ND	ug/L	50
Acenaphthene	ND	ug/L	10
2,4-Dinitrophenol	ND	ug/L	50
4-Nitrophenol	ND	ug/L	50
Dibenzofuran	ND	ug/L	10
2,4-Dinitrotoluene	ND	ug/L	10

(continued on following page)

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

Semivolatile Organics  
Target Compound List (TCL)  
Method 625

Client Name: Soil & Material Engineers  
Client ID: FIELD BLANK  
Lab ID: 013441-0004-SA  
Matrix: AQUEOUS  
Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: 22 JAN 93

Received: 20 JAN 93  
Analyzed: 25 JAN 93

Parameter	Result	Units	Reporting Limit
2,6-Dinitrotoluene	ND	ug/L	10
Diethyl phthalate	ND	ug/L	10
4-Chlorophenyl phenyl ether	ND	ug/L	10
Fluorene	ND	ug/L	10
4-Nitroaniline	ND	ug/L	50
4,6-Dinitro-2-methylphenol	ND	ug/L	50
N-Nitrosodiphenylamine	ND	ug/L	10
4-Bromophenyl phenyl ether	ND	ug/L	10
Hexachlorobenzene	ND	ug/L	10
Pentachlorophenol	ND	ug/L	50
Phenanthrene	ND	ug/L	10
Anthracene	ND	ug/L	10
Di-n-butyl phthalate	ND	ug/L	10
Fluoranthene	ND	ug/L	10
Pyrene	ND	ug/L	10
Butyl benzyl phthalate	ND	ug/L	10
3,3'-Dichlorobenzidine	ND	ug/L	20
Benzo(a)anthracene	ND	ug/L	10
bis(2-Ethylhexyl) phthalate	ND	ug/L	10
Chrysene	ND	ug/L	10
Di-n-octyl phthalate	ND	ug/L	10
Benzo(b)fluoranthene	ND	ug/L	10
Benzo(k)fluoranthene	ND	ug/L	10
Benzo(a)pyrene	ND	ug/L	10
Indeno(1,2,3-cd)pyrene	ND	ug/L	10
Dibenz(a,h)anthracene	ND	ug/L	10
Benzo(g,h,i)perylene	ND	ug/L	10
Surrogate	Recovery		
Nitrobenzene-d5	64	%	--
2-Fluorobiphenyl	65	%	--
Terphenyl-d14	66	%	--
Phenol-d5	49	%	--
2-Fluorophenol	49	%	--
2,4,6-Tribromophenol	88	%	--

ND = Not detected  
NA = Not applicable

Reported By: Elizabeth Ellis

Approved By: Mark Porta

- QUALITY ASSURANCE/QUALITY CONTROL -

## QUALITY ASSURANCE/QUALITY CONTROL

The results of the internal quality control checks, used to monitor data quality, are included with this report. The following have been provided, where applicable. A comprehensive description of each of these elements can be found in the Enseco Quality Assurance Program Plan for Environmental Chemical Monitoring.

DUPLICATE CONTROL SAMPLES (DCS) are used to monitor the precision and accuracy of the analytical system on an on-going basis. Each DCS consists of a standard, control matrix that is spiked with a group of target compounds representative of the method analytes. A DCS pair is analyzed for every 20 samples processed by the method. DCS are analyzed with environmental samples to provide evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision.

SINGLE CONTROL SAMPLES (SCS) are analyzed with every batch of samples. An SCS consists of a control matrix that is spiked with surrogate compounds appropriate to the method being used. In cases where no surrogate is available (e.g., metals or wet chemistry), a single DCS serves as the control sample. Recovery data generated from the SCS are compared to control limits that have been established for each of the compounds being monitored.

METHOD BLANKS, also known as reagent, analytical, or preparation blanks, are analyzed to assess the level of contamination which exists in the analytical system. A method blank is analyzed with every batch of samples processed. A method blank consists of reagents specific to the method which are carried through every aspect of the procedure, including preparation, cleanup, and analysis. The results of the method blank analysis are evaluated, in conjunction with other QC information, to determine the acceptability of the data generated for that batch of samples.

MATRIX SPIKES, MATRIX DUPLICATES, AND MATRIX SPIKE DUPLICATES are types of Matrix Specific QC, which is used to assess the effects of a sample matrix or field conditions on the analytical data. A Matrix Spike (MS) is an environmental sample to which known concentrations of analytes have been added. A Matrix Duplicate (MD) is a sample that is divided into two separate aliquots which are analyzed separately. A Matrix Spike Duplicate (MSD) is a sample that is divided into two separate aliquots, each of which is spiked with known concentrations of analytes. This data is provided only where required or requested. The samples that are used are either project-specific or part of the analytical batch, depending on the requirements of the project.

QC LOT ASSIGNMENT REPORT  
Volatile Organics by GC

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
013441-0001-SA	AQUEOUS	602-A	21 JAN 93-G13	22 JAN 93-G13
013441-0001-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6
013441-0002-SA	AQUEOUS	602-A	21 JAN 93-G13	22 JAN 93-G13
013441-0002-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6
013441-0003-SA	AQUEOUS	602-A	22 JAN 93-G13	24 JAN 93-G13
013441-0003-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6
013441-0004-SA	AQUEOUS	602-A	21 JAN 93-G13	21 JAN 93-G13
013441-0004-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6
013441-0005-SA	AQUEOUS	602-A	21 JAN 93-G13	21 JAN 93-G13
013441-0005-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6
013441-0006-SA	AQUEOUS	602-A	21 JAN 93-G13	21 JAN 93-G13
013441-0006-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6

DUPLICATE CONTROL SAMPLE REPORT  
 Volatile Organics by GC  
 Project: 013441

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 21 JAN 93-G13  
 Concentration Units: ug/L

Analyte	Spiked	-----Concentration-----			Accuracy		Precision	
		-----Measured-----			Average(%)		(RPD)	
		DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Benzene	5.00	4.74	5.13	4.94	99	60-140	7.9	30
Toluene	5.00	4.47	4.86	4.66	93	60-140	8.4	30
Ethylbenzene	5.00	4.39	4.74	4.56	91	60-140	7.7	30
Xylenes (total)	5.00	4.75	5.10	4.92	99	60-140	7.1	30
1,3-Dichlorobenzene	5.00	3.52	3.74	3.63	73	60-140	6.1	30

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 22 JAN 93-G13  
 Concentration Units: ug/L

Analyte	Spiked	-----Concentration-----			Accuracy		Precision	
		-----Measured-----			Average(%)		(RPD)	
		DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Benzene	5.00	5.30	5.12	5.21	104	60-140	3.5	30
Toluene	5.00	4.99	4.82	4.90	98	60-140	3.5	30
Ethylbenzene	5.00	4.78	4.63	4.70	94	60-140	3.2	30
Xylenes (total)	5.00	5.11	4.97	5.04	101	60-140	2.8	30
1,3-Dichlorobenzene	5.00	3.76	3.64	3.70	74	60-140	3.2	30

Category: 601-A Halogenated Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 19 JAN 93-G6  
 Concentration Units: ug/L

Analyte	Spiked	-----Concentration-----			Accuracy		Precision	
		-----Measured-----			Average(%)		(RPD)	
		DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
1,1-Dichloroethane	5.00	4.39	4.90	4.64	93	60-140	11	30
Chloroform	5.00	3.21	2.96	3.08	62	60-140	8.1	30
Bromodichloromethane	10.0	10.7	9.44	10.1	101	60-140	13	30
Trichloroethene	5.00	6.45	5.41	5.93	119	60-140	18	30
Chlorobenzene	10.0	7.65	6.81	7.23	72	60-140	12	30

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT  
 Volatile Organics by GC  
 Project: 013441

Test: 8020-TCL-AP Volatile Organics Aromatic Compounds  
 Matrix: AQUEOUS  
 QC Lot: 21 JAN 93-G13 QC Run: 22 JAN 93-G13

Analyte	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

Test: 8020-TCL-AP Volatile Organics Aromatic Compounds  
 Matrix: AQUEOUS  
 QC Lot: 22 JAN 93-G13 QC Run: 24 JAN 93-G13

Analyte	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

Test: 8020-TCL-AP Volatile Organics Aromatic Compounds  
 Matrix: AQUEOUS  
 QC Lot: 21 JAN 93-G13 QC Run: 21 JAN 93-G13

Analyte	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50

ND = Not Detected

METHOD BLANK REPORT  
 Volatile Organics by GC  
 Project: 013441 (cont.)

Test: 8010-TCL-A Volatile Organics Halogenated Compounds  
 Matrix: AQUEOUS  
 QC Lot: 19 JAN 93-G6 QC Run: 22 JAN 93-G6

Analyte	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	9.8	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene (total)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	1.0
1,1,2-Trichloroethane	ND	ug/L	1.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	5.0

ND = Not Detected

SINGLE CONTROL SAMPLE REPORT  
 Volatile Organics by GC  
 Project: 013441

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 21 JAN 93-G13 QC Run: 22 JAN 93-G13  
 Concentration Units: ug/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	SCS	Limits
a,a,a-Trifluorotoluene	30.0	30.8	103	60-140

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 21 JAN 93-G13 QC Run: 21 JAN 93-G13  
 Concentration Units: ug/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	SCS	Limits
a,a,a-Trifluorotoluene	30.0	30.1	100	60-140

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 22 JAN 93-G13 QC Run: 24 JAN 93-G13  
 Concentration Units: ug/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	SCS	Limits
a,a,a-Trifluorotoluene	30.0	30.9	103	60-140

Category: 601-A Halogenated Volatile Organics  
 Matrix: AQUEOUS  
 QC Lot: 19 JAN 93-G6 QC Run: 22 JAN 93-G6  
 Concentration Units: ug/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	SCS	Limits
Bromochloromethane	30.0	29.2	97	60-140

Calculations are performed before rounding to avoid round-off errors in calculated results.

QC LOT ASSIGNMENT REPORT - MS QC  
 Volatile Organics by GC

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)	MS QC Run Number (SA,MS,SD,DU)
013441-0001-SA	AQUEOUS	602-A	21 JAN 93-G13	22 JAN 93-G13	21 JAN 93-G13
013441-0001-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6	19 JAN 93-G6
013441-0002-SA	AQUEOUS	602-A	21 JAN 93-G13	22 JAN 93-G13	21 JAN 93-G13
013441-0002-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6	19 JAN 93-G6
013441-0003-SA	AQUEOUS	602-A	22 JAN 93-G13	24 JAN 93-G13	22 JAN 93-G13
013441-0003-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6	19 JAN 93-G6
013441-0004-SA	AQUEOUS	602-A	21 JAN 93-G13	21 JAN 93-G13	21 JAN 93-G13
013441-0004-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6	19 JAN 93-G6
013441-0005-SA	AQUEOUS	602-A	21 JAN 93-G13	21 JAN 93-G13	21 JAN 93-G13
013441-0005-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6	19 JAN 93-G6
013441-0006-SA	AQUEOUS	602-A	21 JAN 93-G13	21 JAN 93-G13	21 JAN 93-G13
013441-0006-SA	AQUEOUS	601-A	19 JAN 93-G6	22 JAN 93-G6	19 JAN 93-G6

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT  
 Volatile Organics by GC  
 Project: 013441

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 Sample: 013446-0002  
 QC Lot: 21 JAN 93-G13 MS Run: 21 JAN 93-G13  
 Units: ug/L

Analyte	Sample Result	Concentration		Amount MS	Spiked MSD	%Recovery		%RPD MS-MSD
		MS Result	MSD Result			MS	MSD	
Benzene	ND	5.1	4.9	5.0	5.0	102	97	5.1
Toluene	ND	4.9	4.7	5.0	5.0	98	93	5.3
Ethylbenzene	ND	5.0	4.8	5.0	5.0	101	95	6.1
Xylenes (total)	ND	5.2	5.1	5.0	5.0	105	101	3.9
1,3-Dichlorobenzene	ND	5.2	4.9	5.0	5.0	104	98	5.9

Category: 602-A Aromatic Volatile Organics  
 Matrix: AQUEOUS  
 Sample: 013419-0003  
 QC Lot: 22 JAN 93-G13 MS Run: 22 JAN 93-G13  
 Units: ug/L

Analyte	Sample Result	Concentration		Amount MS	Spiked MSD	%Recovery		%RPD MS-MSD
		MS Result	MSD Result			MS	MSD	
Benzene	3.4	8.2	7.9	5.0	5.0	95	90	5.4
Toluene	2.2	6.8	6.6	5.0	5.0	92	87	5.6
Ethylbenzene	ND	4.8	4.7	5.0	5.0	97	94	3.2
Xylenes (total)	0.89	6.2	6.0	5.0	5.0	106	101	4.9
1,3-Dichlorobenzene	ND	3.8	3.8	5.0	5.0	75	76	1.3

Category: 601-A Halogenated Volatile Organics  
 Matrix: AQUEOUS  
 Sample: 013413-0001  
 QC Lot: 19 JAN 93-G6 MS Run: 19 JAN 93-G6  
 Units: ug/L

Analyte	Sample Result	Concentration		Amount MS	Spiked MSD	%Recovery		%RPD MS-MSD
		MS Result	MSD Result			MS	MSD	
1,1-Dichloroethane	ND	4.8	5.5	5.0	5.0	97	110	13
Chloroform	ND	2.7	3.5	5.0	5.0	55	70	24
Bromodichloromethane	ND	9.7	10.7	10.0	10.0	97	107	9.8
Trichloroethene	ND	5.4	5.0	5.0	5.0	108	99	8.7
Chlorobenzene	ND	6.6	7.1	10.0	10.0	67	71	5.8

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

QC LOT ASSIGNMENT REPORT  
Semivolatile Organics by GC/MS

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
013441-0001-SA	AQUEOUS	625-A	22 JAN 93-LA	22 JAN 93-L11
013441-0002-SA	AQUEOUS	625-A	22 JAN 93-LA	22 JAN 93-L11
013441-0003-SA	AQUEOUS	625-A	22 JAN 93-LA	22 JAN 93-L11
013441-0004-SA	AQUEOUS	625-A	22 JAN 93-LA	22 JAN 93-L11

DUPLICATE CONTROL SAMPLE REPORT  
 Semivolatile Organics by GC/MS  
 Project: 013441

Category: 625-A Semivolatile Organics - GC/MS  
 Matrix: AQUEOUS  
 QC Lot: 22 JAN 93-LA  
 Concentration Units: ug/L

Analyte	Spiked	Concentration			Accuracy		Precision	
		DCS1	DCS2	AVG	DCS	Limits	DCS	Limit
Pentachlorophenol	200	229	231	230	115	9-103	0.91	50
Phenol	200	107	106	106	53	12-89	1.1	42
2-Chlorophenol	200	107	108	108	54	27-123	0.65	40
4-Chloro-3-methylphenol	200	140	136	138	69	23-97	3.0	42
4-Nitrophenol	200	182	186	184	92	10-80	2.4	50
1,2,4-Trichlorobenzene	100	70.3	71.4	70.9	71	39-98	1.5	28
Acenaphthene	100	64.8	62.3	63.6	64	46-118	3.9	31
2,4-Dinitrotoluene	100	88.6	89.8	89.2	89	24-96	1.3	38
Pyrene	100	51.7	51.4	51.5	52	26-127	0.64	31
N-Nitroso-di- n-propylamine	100	69.0	67.4	68.2	68	41-116	2.4	38
1,4-Dichlorobenzene	100	57.9	58.9	58.4	58	36-97	1.7	28

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT  
Semivolatile Organics by GC/MS  
Project: 013441

Test: 625-TCL-A                      Semivolatile Organics Target Compound List (TCL)  
Matrix: AQUEOUS  
QC Lot: 22 JAN 93-LA      QC Run: 22 JAN 93-L11

Analyte	Result	Units	Reporting Limit
Phenol	ND	ug/L	10
bis(2-Chloroethyl) ether	ND	ug/L	10
2-Chlorophenol	ND	ug/L	10
1,3-Dichlorobenzene	ND	ug/L	10
1,4-Dichlorobenzene	ND	ug/L	10
Benzyl alcohol	ND	ug/L	10
1,2-Dichlorobenzene	ND	ug/L	10
2-Methylphenol	ND	ug/L	10
bis(2-Chloroisopropyl)ether	ND	ug/L	10
4-Methylphenol	ND	ug/L	10
N-Nitroso-di-n-propylamine	ND	ug/L	10
Hexachloroethane	ND	ug/L	10
Nitrobenzene	ND	ug/L	10
Isophorone	ND	ug/L	10
2-Nitrophenol	ND	ug/L	10
2,4-Dimethylphenol	ND	ug/L	10
Benzoic acid	ND	ug/L	50
bis(2-Chloroethoxy)-methane	ND	ug/L	10
2,4-Dichlorophenol	ND	ug/L	10
1,2,4-Trichlorobenzene	ND	ug/L	10
Naphthalene	ND	ug/L	10
4-Chloroaniline	ND	ug/L	10
Hexachlorobutadiene	ND	ug/L	10
4-Chloro-3-methylphenol	ND	ug/L	10
2-Methylnaphthalene	ND	ug/L	10
Hexachlorocyclopentadiene	ND	ug/L	10
2,4,6-Trichlorophenol	ND	ug/L	10
2,4,5-Trichlorophenol	ND	ug/L	50
2-Chloronaphthalene	ND	ug/L	10
2-Nitroaniline	ND	ug/L	50
Dimethyl phthalate	ND	ug/L	10
Acenaphthylene	ND	ug/L	10
3-Nitroaniline	ND	ug/L	50
Acenaphthene	ND	ug/L	10
2,4-Dinitrophenol	ND	ug/L	50
4-Nitrophenol	ND	ug/L	50
Dibenzofuran	ND	ug/L	10
2,4-Dinitrotoluene	ND	ug/L	10
2,6-Dinitrotoluene	ND	ug/L	10
Diethyl phthalate	ND	ug/L	10
4-Chlorophenyl phenyl ether	ND	ug/L	10
Fluorene	ND	ug/L	10
4-Nitroaniline	ND	ug/L	50
4,6-Dinitro-2-methylphenol	ND	ug/L	50
N-Nitrosodiphenylamine	ND	ug/L	10

ND = Not Detected

METHOD BLANK REPORT  
 Semivolatile Organics by GC/MS  
 Project: 013441 (cont.)

Test: 625-TCL-A                      Semivolatile Organics Target Compound List (TCL)  
 Matrix: AQUEOUS  
 QC Lot: 22 JAN 93-LA      QC Run: 22 JAN 93-L11 (cont.)

Analyte	Result	Units	Reporting Limit
4-Bromophenyl phenyl ether	ND	ug/L	10
Hexachlorobenzene	ND	ug/L	10
Pentachlorophenol	ND	ug/L	50
Phenanthrene	ND	ug/L	10
Anthracene	ND	ug/L	10
Di-n-butyl phthalate	ND	ug/L	10
Fluoranthene	ND	ug/L	10
Pyrene	ND	ug/L	10
Butyl benzyl phthalate	ND	ug/L	10
3,3'-Dichlorobenzidine	ND	ug/L	20
Benzo(a)anthracene	ND	ug/L	10
bis(2-Ethylhexyl) phthalate	ND	ug/L	10
Chrysene	ND	ug/L	10
Di-n-octyl phthalate	ND	ug/L	10
Benzo(b)fluoranthene	ND	ug/L	10
Benzo(k)fluoranthene	ND	ug/L	10
Benzo(a)pyrene	ND	ug/L	10
Indeno(1,2,3-cd)pyrene	ND	ug/L	10
Dibenz(a,h)anthracene	ND	ug/L	10
Benzo(g,h,i)perylene	ND	ug/L	10

ND = Not Detected

SINGLE CONTROL SAMPLE REPORT  
Semivolatile Organics by GC/MS  
Project: 013441

Category: 625-A      Semivolatile Organics - GC/MS  
Matrix:    AQUEOUS  
QC Lot:    22 JAN 93-LA      QC Run: 22 JAN 93-L11  
Concentration Units: ug/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	SCS	Limits
Phenol-d5	200	103	52	10-94
2-Fluorophenol	200	102	51	21-100
2,4,6-Tribromophenol	200	204	102	10-123
Nitrobenzene-d5	100	71.8	72	35-114
2-Fluorobiphenyl	100	63.6	64	43-116
Terphenyl-d14	100	66.0	66	33-141

Calculations are performed before rounding to avoid round-off errors in calculated results.



January 19, 1993

Mr. Joe Best  
Soil & Material Engineers  
135-C Montlieu Avenue  
Greensboro, NC 27419

Dear Mr. Best:

Enclosed are the results of the analyses for Red Horse Site Assessment (Project # 1584-92 080 Sampled 1/7/93). This project was received at Enseco - Erco Laboratory on January 14, 1993, and was processed for a 5 day turnaround time.

This report is presented in three sections. The first section consists of the Sample Description Information page, Analytical Test Requests summary, and a Project Narrative which lists any deviations or anomalies associated with sample analyses. The second section contains the analytical results and method references. The third section briefly describes the elements of Enseco's quality assurance/quality control (QA/QC) program and contains the QA/QC results. This letter authorizes the release of the analytical results and should be considered an integral part of this report.

Please refer to this project by the Enseco project number 013410 to expedite any further discussions. I will be happy to address any questions or concerns that you may have.

Sincerely,



Dan Wielandt  
Program Administrator

Encl.



SAMPLE DESCRIPTION INFORMATION  
for  
Soil & Material Engineers

Lab ID	Client ID	Matrix	Sampled		Received
			Date	Time	
013410-0001-SA	mw-1	SOIL	07 JAN 93	10:00	14 JAN 93
013410-0002-SA	mw-2	SOIL	07 JAN 93	15:00	14 JAN 93
013410-0003-SA	mw-3	SOIL	11 JAN 93	11:30	14 JAN 93
013410-0004-SA	mw-4	SOIL	11 JAN 93	13:00	14 JAN 93

ANALYTICAL TEST REQUESTS  
for  
Soil & Material Engineers

Lab ID: 013410	Group Code	Analysis Description	Custom Test?
0001 - 0002	A	TPH by GC (Gas and Diesel) - North Carolina	
		Gasoline Range Organics (GRO)	N
		Prep - Volatile Organics	N
		Methanol Extraction	
		Diesel Range Organics (DRO)	N
		Prep - Diesel Range Organics (DRO)	N
		Percent Water	N
		Volatile Organics	N
		Aromatic Compounds	N
		Prep - Volatile Organics	N
		Methanol Extraction	
0003 - 0004	B	Gasoline Range Organics (GRO)	N
		Prep - Volatile Organics	N
		Methanol Extraction	
		Percent Water	N
		Volatile Organics	N
		Aromatic Compounds	N
		Prep - Volatile Organics	N
Methanol Extraction			

January 19, 1993

Project Narrative

Client: Soil & Material Engineers  
Project Name: Project # 1584-92 080 Sampled 1/7/93  
Erco Project No.: 013410

1. This project consists of the results for samples received at Enseco - Erco Laboratory on January 14, 1993. Please see the sample description information sheet for a list of samples.
2. Samples were cold upon receipt.  
Bottles were not broken in transit.  
Samples agreed with chain of custody.

- ANALYTICAL RESULTS -



Volatile Organics  
Aromatic Compounds  
Method 8020



Client Name: Soil & Material Engineers

Client ID: MW-1

Lab ID: 013441-0001-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93  
Prepared: NA

Received: 20 JAN 93  
Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	ND	ug/L	0.50
Toluene	ND	ug/L	0.50
Ethylbenzene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	ND	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50
Surrogate	Recovery		
a,a,a-Trifluorotoluene	102	%	--

ND = Not detected  
NA = Not applicable

Reported By: Peter Colonero

Approved By: Joyce Lombardo

Volatile Organics  
Aromatic Compounds  
Method 8020



Client Name: Soil & Material Engineers

Client ID: MW-2

Lab ID: 013441-0002-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: NA

Received: 20 JAN 93

Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit
Methyl tert-butyl ether	ND	ug/L	5.0
Isopropyl ether	ND	ug/L	5.0
Benzene	120	ug/L	0.50
Toluene	65	ug/L	0.50
Ethylbenzene	4.2	ug/L	0.50
Chlorobenzene	ND	ug/L	0.50
Xylenes (total)	160	ug/L	0.50
1,4-Dichlorobenzene	ND	ug/L	0.50
1,3-Dichlorobenzene	ND	ug/L	0.50
1,2-Dichlorobenzene	ND	ug/L	0.50
Surrogate	Recovery		
a,a,a-Trifluorotoluene	104	%	--

ND = Not detected  
NA = Not applicable

Reported By: Peter Colonero

Approved By: Joyce Lombardo

Volatile Organics  
Aromatic Compounds  
Method 8020



Client Name: Soil & Material Engineers

Client ID: MW-4

Lab ID: 013441-0003-SA

Matrix: AQUEOUS

Authorized: 20 JAN 93

Sampled: 18 JAN 93

Prepared: NA

Received: 20 JAN 93

Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit	
Methyl tert-butyl ether	12000	ug/L	250	l
Isopropyl ether	ND	ug/L	250	
Benzene	26000	ug/L	100	ml
Toluene	42000	ug/L	100	ml
Ethylbenzene	5200	ug/L	25	
Chlorobenzene	ND	ug/L	25	
Xylenes (total)	24000	ug/L	25	
1,4-Dichlorobenzene	ND	ug/L	25	
1,3-Dichlorobenzene	ND	ug/L	25	
1,2-Dichlorobenzene	ND	ug/L	25	
Surrogate	Recovery			
a,a,a-Trifluorotoluene	131	%	--	

Note 1 : All results taken from a 1:50 dilution.

Note m : Compound exceeded standard calibration range in the original analysis and was rerun with a dilution.

Note l : Analyte present at a concentration above the calibration range, therefore a dilution of the sample was required and reporting limits were increased.

ND = Not detected  
NA = Not applicable

Reported By: Peter Colonero

Approved By: Joyce Lombardo

Volatile Organics  
 Halogenated Compounds  
 Method 8010



Client Name: Soil & Material Engineers  
 Client ID: TRIP BLANK  
 Lab ID: 013441-0005-SA  
 Matrix: AQUEOUS  
 Authorized: 20 JAN 93

Sampled: 18 JAN 93  
 Prepared: NA

Received: 20 JAN 93  
 Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit
Chloromethane	ND	ug/L	5.0
Bromomethane	ND	ug/L	5.0
Vinyl chloride	ND	ug/L	1.0
Chloroethane	ND	ug/L	5.0
Methylene chloride	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	0.50
1,1-Dichloroethane	ND	ug/L	0.50
1,2-Dichloroethene			
(total)	ND	ug/L	0.50
Chloroform	ND	ug/L	0.50
1,2-Dichloroethane	ND	ug/L	1.0
1,1,1-Trichloroethane	ND	ug/L	0.50
Carbon tetrachloride	ND	ug/L	0.50
Bromodichloromethane	ND	ug/L	1.0
1,2-Dichloropropane	ND	ug/L	1.0
trans-1,3-Dichloropropene	ND	ug/L	1.0
Trichloroethene	ND	ug/L	0.50
Dibromochloromethane	ND	ug/L	1.0
cis-1,3-Dichloropropene	ND	ug/L	1.0
1,1,2-Trichloroethane	ND	ug/L	1.0
Bromoform	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0
Tetrachloroethene	ND	ug/L	0.50
Chlorobenzene	ND	ug/L	5.0
Surrogate	Recovery		
Bromochloromethane	104	%	--

ND = Not detected  
 NA = Not applicable

Reported By: Nancy Duggan

Approved By: Joyce Lombardo

Volatile Organics  
Halogenated Compounds  
Method 8010



Client Name: Soil & Material Engineers  
 Client ID: RINSATE BLANK  
 Lab ID: 013441-0006-SA  
 Matrix: AQUEOUS  
 Authorized: 20 JAN 93

Sampled: 18 JAN 93  
 Prepared: NA

Received: 20 JAN 93  
 Analyzed: 22 JAN 93

Parameter	Result	Units	Reporting Limit	
Chloromethane	ND	ug/L	5.0	
Bromomethane	ND	ug/L	5.0	
Vinyl chloride	ND	ug/L	1.0	
Chloroethane	ND	ug/L	5.0	
Methylene chloride	5.1	ug/L	5.0	#
1,1-Dichloroethene	ND	ug/L	0.50	
1,1-Dichloroethane	ND	ug/L	0.50	
1,2-Dichloroethene (total)	ND	ug/L	0.50	
Chloroform	ND	ug/L	0.50	
1,2-Dichloroethane	ND	ug/L	1.0	
1,1,1-Trichloroethane	ND	ug/L	0.50	
Carbon tetrachloride	ND	ug/L	0.50	
Bromodichloromethane	ND	ug/L	1.0	
1,2-Dichloropropane	ND	ug/L	1.0	
trans-1,3-Dichloropropene	ND	ug/L	1.0	
Trichloroethene	ND	ug/L	0.50	
Dibromochloromethane	ND	ug/L	1.0	
cis-1,3-Dichloropropene	ND	ug/L	1.0	
1,1,2-Trichloroethane	ND	ug/L	1.0	
Bromoform	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	
Tetrachloroethene	ND	ug/L	0.50	
Chlorobenzene	ND	ug/L	5.0	
Surrogate	Recovery			
Bromochloromethane	122	%	--	

Note # : Analyte associated with sample processing and analysis in the lab environment. An acceptable blank must contain <5 times the reporting limit of this analyte for this method.

ND = Not detected  
 NA = Not applicable

Reported By: Nancy Duggan

Approved By: Joyce Lombardo