SITE SAFETY PLAN
FOR
PHASE 1
REMEDIAL INVESTIGATION
MONTEREY APARTMENTS

CONTRACT No. C0089007

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Toxics Cleanup Program

8.2.10 Selective Ion Meters

Calibration of selected ion meters is performed following manufacturer's instructions for the specific instrument. A series of standards is used that encompasses the expected range of the samples.

8.2.11 Nephelometer or Turbidimeter

Calibration is performed following manufacturers operating instructions for the specific instrument. A series of standards is used that encompasses the expected range of the samples.

The bailing of MW-6 will be performed using a 1.66-inch outside diameter (O.D.) by 3.0-foot bailer constructed of clear PVC, which will enable personnel conducting the test to monitor for product recovery thickness. Following removal of each bailer volume, product thickness will be measured and recorded in the logbook. The number of bailer volumes will be recorded, including an estimate of water/product recovered. The bailer has a volume of 725 cubic centimeters (0.0256 cubic feet or 0.19 gallons).

MW-6 is completed to a depth of 29.0 feet bgs. A standing fluid volume of 1.15 gallons (.154 cubic feet) was measured on September 17, 1990, and again on February 1, 1991, including an 8.0 inch floating layer of petroleum product. Bailing at a rate of 1 bailer volume per minute would achieve a rate of 11.4 gallons per hour (gph). An estimated screen transmitting capacity of as high as 190 gph was calculated for MW-6, assuming adequate recharge from the surrounding geologic materials. The bailing of MW-6 will initially be aimed at the removal of the floating layer only to assess yeild. The test will continue until a minimum of 50 gallons of product/water is recovered. The final amount of product recovered will be measured in the 55 gallon recovery drum containing the bail-down test liquids. All bail-down test liquids will be contained in clearly labeled unused 55-gallon drums (17-E) and stored in a secured, outdoor, fenced area. Arrangements will be made with Rollins/ChemPak, under contract with Ecology, for disposal of the test waters generated by the test (see Section 5.8).

By using the measured pumping rate, floating layer water level changes, and recovery volumes of petroleum product and water, estimated values for transmissivity (T) and hydraulic conductivity (K) will be calculated using the following:

$$K = \frac{r_c^{2} \ln(R_e/r_w)}{2d} \cdot \frac{1}{t} \cdot \ln\frac{h_o}{h_t} \qquad \text{(Bouwer-Rice 1976)}$$

K = hydraulic conductivity
r_c = well radius
r_w = horizontal distance from well center to undisturbed aquifer
R_e = radial distance over which the difference in head, h_o, is dissipated in the aquifer

d = length of the well screen
h_o = head in the well at time $t_o = 0$
h_t = head in the well at time $t > t_o$

and,

$$T = Kb$$

T = transmissivity
K = hydraulic conductivity
b = saturated thickness

The petroleum product recovery rate will be determined using the amount of product recovered, and the total product/water recovery ratio, at the specified bailing rate. This will give a semi-quantitive product recovery rate at MW-6. It is assumed that these characteristics will be representative of the aquifer surrounding MW-6 and that the aquifer is of a homogeneous nature to warrant the iteration and interpretation.

Petroleum product recovery rate values obtained from MW-6 will be used to determine if a Westinghouse FAP pump or comparable skimming system can be used for interim recovery. The FAP pump has an approximate floating product pumping rate of 20 gph from a 2-inch well, at an air pressure of 80 pounds per square inch (psi). The FAP pump is a peristaltic pump utilizing a compressed air energy source to lift floating product off the water surface in a well. If the product recovery rate of MW-6 is nonconstant, an automated switch can be installed to turn on the pump when product is available and then switch off to allow the well to recover. With this system, a maximum amount of petroleum product can be recovered without pumping unwanted water.

5.2 MONITORING WELL GROUNDWATER SAMPLING

Groundwater samples will be obtained from the 14 existing monitoring wells on the Unocal, Express, and Monterey Apartments properties. The sampling event will result in the first comprehensive sampling of all Monterey Apartments site wells. Samples will be analyzed for selected volatile organic compounds and inorganics, including benzene, toluene, ethyl benzene, and xylenes (BTEX), ethylene dibromide (EDB), total petroleum hydrocarbons (TPH), and total lead (see Table 2-1).

Additionally, samples will be collected at three of the wells for analyses of bacteriological indicators (due to concerns over possible sewage contamination) and nutrient parameters relevant to FS evaluation. Specifically, these biologic and nutrient parameters include Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), heterotrophic bacterial population densities, and NH_3-N, PO_4-P, NO_3-N nutrients. These wells also will be analyzed for several other selected ions to establish local groundwater geochemical conditions also in support of FS planning, and the assessment of water quality relative to EPA primary and secondary drinking water standards.

Sampling of the monitoring wells will consist of the following activities:

- Measuring depth to static water level, floating gasoline/ diesel, and total well depth;
- Evacuating (purging) calculated water volumes (3 to 5 volumes per well);
- Containing of purged waters for approved disposal;
- Measuring and recording groundwater temperature, pH, and conductivity during the purge cycles and while sampling; and
- Collecting the groundwater sample.

5.2.1 Measurement of Water Level and Well Volume

E & E will conduct a survey of static groundwater levels and total well depths, measured to the nearest 0.01 foot. All measurements will be performed as one event prior to commencement of the purging and sampling subtasks. Measurements will be made using an oil-water interface probe (Marine Moisture Control Co. Model D-2401-2UI) having an accuracy of 1/32-inch to 1/8-inch. Care will be taken to decontaminate equipment by washing with an Alconox solution and tap water, followed by a distilled water rinse, between each use to avoid cross-contamination of wells. The product interface probe tape generally is constructed of plastic or metal and the product/water level indicator is housed in plastic; therefore, solvents will not be used in the decontamination of this equipment.

If standing petroleum product is observed in the well, its thickness, as well as any subsequent volumes of recovered product during the purging process, will be measured and recorded in the logbook.

Based on the results of this survey, potentiometric contour maps will be prepared using the existing surveyor well elevation records to determine, or verify, the direction of groundwater flow and hydraulic gradient of the aquifer.

The number of linear feet of static water (standing water column) will be determined by calculating the difference between the static water level and the total depth of the well. The static volume will be calculated using the formula:

$$V = Tr\ (0.163)^2$$

where :

V = Static volume of well (in gallons);
T = Standing water column (in feet);
r = Inside radius of well casing (in inches); and
0.163 = A constant conversion factor which compensates for pi, for the conversion of the casing radius from inches to feet, and the conversion of cubic feet to gallons.

All information concerning the purging of static water will be recorded for each well.

5.2.2 Well Purging

Before a groundwater sample is collected, the static water must be purged to ensure that a representative groundwater sample is collected. A minimum of three volumes of the standing water column will be purged from each well prior to sample collection. Groundwater temperature, pH, and conductivity will be monitored following the removal of each well volume. If temperature, pH, and conductivity do not stabilize after the removal of 3 well volumes, purging will continue until 5 well volumes have been removed. If a well does not recover quickly enough to permit the removal of 3 static water volumes, the well will be pumped or bailed dry and sampled immediately following a sufficient recovery.

Purging will be performed using a WaTerra Inertial Pump (Model No. D-25) or Teflon hand bailers. The pump is equipped with a Teflon hose connected to a hand pump and one-way foot valve, making use of inertia to trap water above the valve on successive downward thrusts of the tubing. If standing petroleum product is observed in the well, its thickness will be measured and recorded in the logbook, and purging/ sampling will be performed using a hand bailer, only. Any subsequent volumes of product recovered during the purging process also will be recorded.

All purge waters will be contained in labeled unused 55-gallon drums (17-E), unless otherwise directed by the Ecology project officer. Arrangements will be made with Rollins/ChemPak, under contract with Ecology, to dispose of purge waters as necessary (see Section 5.8).

5.2.3 Sample Collection

Sampling personnel will take precautions to avoid cross-contamination when using the WaTerra Inertial pump for a series of samples. If possible, "clean" or "background" samples will be collected first. Before and after each sample is collected, the pump will be decontaminated as specified in Section 5.7. Sample collection procedures are as follows:

- A WaTerra Inertial pump equipped with decontaminated Teflon tubing will be used to collect groundwater samples from monitoring wells. The sampling port will be positioned no less than 1 foot above the base of the well. A Teflon hand bailer will be used instead of the WaTerra in wells containing floating petroleum.

- When transferring water from pump tubing to sample containers, care will be taken to avoid agitating the sample, which promotes the loss of volatile constituents. The WaTerra Inertial pump design does not promote agitation or aeration during pumping, ensuring good sample integrity.

- Sample volumes, containers, and preservation requirements will be followed as summarized previously in Table 2-1 of Section 2.4.

- Any observable physical characteristics of the groundwater (e.g., color, sheen, odor, turbidity) as it is being sampled will be recorded in the logbook.
- Sample temperature, pH, and specific conductance will be measured and recorded.
- Weather conditions at the time of sampling will be recorded (e.g., air temperature, wind conditions, recent heavy rainfall, and drought conditions).

5.3 SOIL-GAS SAMPLING AND GROUNDWATER SAMPLING

Collection of soil-gas will be accomplished by the use of a truck-mounted, Geoprobe Model 8-A, hydraulic percussion RAM system to drive collection rods into the subsurface vadose zone. The system also will be used, selectively, to drive collection rods past the water table to permit collection of groundwater samples.

5.3.1 Probe Installation

Each desired collection station will be marked and given utility clearance prior to probe installation. Preferred locations will be non-paved to permit rapid drilling. If a station location is paved, the operator will utilize a coring adapter to open an access hole to the underlying substrate. Paved surfaces having a thickness in excess of 3 to 4 inches may require that the operator abandon the station due to tool limitations.

Once a station has been cleared, the 1-inch O.D., 0.5-inch inside diameter (I.D.) threaded, 3-foot length drive rods will be fitted with an expendable hardened steel tip and then hydraulic/percussion-driven to the desired sampling depth. The rod string then will be pulled back 2 to 3 inches to expose the rod end to the soil, leaving the drive tip in place.

Due to dense urban development at the site, several stations will require temporary traffic diversion through the use of cones and/or barricades.

Installation depths will be dependent on several factors, including: the composition the substrata, the position and presence of high/low permeability intervals, and depth to groundwater. To eliminate concerns for near surface oxidation and microbial breakdown of contaminants, as well as other surface interference effects, samples will be collected at a depth of at least 4 feet bgs.

At selected locations, vertical contaminant profiling will be performed to establish the most appropriate sample depths for plume detection. At stations targeting potential man-created migration routes, such as buried sewer lines, the installations will be designed for those features specifically.

Groundwater Sampling Stations. Groundwater sampling stations will be selected using the existing permanent monitoring well network to predict the optimum penetration depth. The rods will be driven at least 2 feet below the water table to permit successful sample collection. A standard, or modified, electric water-level meter will be lowered into the annular space to confirm positioning prior to initiation of sample collection.

5.3.2 Sample Collection

The soil-gas collection system selected for this project is designed for collection of analytical samples using Tekmar adsorbant media fitted into Carbotrap 300 Multi-bed Thermal Desorption Tubes, distributed by Supelco. The sampling-train is constructed of stainless-steel and Teflon shutoff valves which control gas flow through separate Teflon purge and sample collection lines connected to a vacuum pump at the top of the probe rod.

An in-line rotometer, coupled with a volume-calibrated vacuum gauge will permit flow rate and volume regulation. Vacuum-induced pumping flow rates of 200 mL/min will be used to draw soil-gas through the desorption tubes for sample collection.

Actual flow volumes directed through the collection tubes will be dependent on preliminary soil-gas organic vapor concentrations, as screened in the field using a portable PID. Maximum collection volumes of 1.5 liters are anticipated. Sample volumes will be reduced as necessary, to prohibit over-saturation of the collection media, or increased to maximize absorption and achieve lower laboratory quantitation limits at stations near the boundaries of the vapor plume.

Following probe installation, but prior to sample collection, an equivalent volume of at least three downhole rod casing volumes will be purged through the system using the vacuum pump. (A purge volume of 1 liter for every 3-foot stand of pipe will be used.) Upon completion of the purge cycle, the adsorbent tube will be connected and a sample collected. The sample line valves then will be closed and the tube will be disconnected, capped, and packaged for transport to the laboratory.

Field QA Sample Collection Monitoring Approach. At the initiation of the survey, a control base station will be installed at a location considered background to the impacted study area. At this location, a rod string will be driven into the vadose zone and left in-place for the duration of the survey. This station will be sampled at the beginning of operations, daily. The task will serve to assure proper equipment performance, to assess for potential diurnal fluxuations which may bias analytical results, serve to monitor laboratory performance, and ultimately, in part, demonstrate the representativeness of the survey results.

Special Groundwater Collection Considerations. Stations constructed for groundwater sampling purposes will be sampled in the following fashion:

- Following probe installation (as described for soil-gas sampling), static water level readings will be collected using a water level measurement meter to confirm appropriate rod positioning.
- Decontaminated Teflon tubing then will be lowered down the rod annular space below the water table. The tubing will be connected to a peristatic pump which will draw groundwater to the surface. The procedure may, or may not succeed in capturing floating petroleum samples, if present. At a minimum, it is anticipated that marked PID vapor readings will be observed if floating product conditions exist, as well as oil sheening in the sampled waters.
- At least three equivalent standing water well volumes will be purged prior to sampling.
- Samples will be collected for analysis as summarized previously in Table 2-1.

5.3.3 Station Abandonment

At the completion of sampling, each soil-gas collection station will be abandoned by pouring solid bentonite chips down the open hole remaining following removal of the rod string. Abandonment will then be completed by tapping additional chips into the hole at the surface and covering the site with original soil, or asphalt patch, if appropriate.

Special Groundwater Station Considerations. E & E has been given a drilling variance from WAC 173-160 and 162 to penetrate the perched water table to investigate the presence of floating product, and to sample groundwater for BTEX and TPH analyses during this investigation. The rods will be driven at least 2 feet into the water-bearing strata to permit withdrawal of samples using a peristaltic pumping system. Subsurface hydrologic data obtained from the existing 14 site wells show that Geoprobe installation will not be at risk of penetrating any natural barriers to groundwater movement.

Once the samples are collected, the wells will be abandoned immediately by pumping a bentonite slurry with a minimum mud weight of 9 pounds into the rod annular space and systematically withdrawing the rod string as the wells are plugged. The slurry volume required to fill the open hole will be calculated at each well station to assure proper abandonment. Upon removal of the rod string, a final surface seal will be made by filling and tapping dry bentonite chips over the location and topping the surface with native soil or asphalt to restore the site.

5.4 TERRAIN CONDUCTIVITY SURVEY

5.4.1 EM31-D Operation

The geophysical survey of the Express property will be conducted using a Geonics EM31-D conductivity meter. Terrain conductivity surveying is a non-destructive geophysical electromagnetic induction exploration technique used to identify variations in subsurface materials. These variations can be attributed to changes in soil texture, moisture content, groundwater quality, bedrock depth, buried objects, or waste materials. Conductivity is measured by using a transmitter coil to create a local electromagnetic field in the earth while simultaneously measuring changes in the field through a receiving antenna coil. The EM31-D emits an operating frequency of 9.3 KHz and is arranged with a fixed length (3.7 meter) transmitter and receiver boom. The arrangement results in a maximum effective exploration depth of approximately 6 meters. The basic principle of operation of the EM31-D is described below.

The transmitter coil located at one end of the instrument induces circular eddy current loops in the earth. The magnitude of any one of these current loops is proportional to the terrain conductivity in the vicinity of the loop. Each one of the current loops generates a magnetic field which is proportional to the value of the current flowing within the loop. A part of the magnetic field from each loop is intercepted by the receiver coil and results in an output voltage which is linearly related to the terrain conductivity. There is departure from linearity when true conductivity is greater than 100 millmhos/m.

The instrument is factory calibrated to read the correct conductivity when the earth is uniform. In the event that the earth is layered, with each layer of different conductivity, the instrument will read an intermediate value. This intermediate value will be an apparent conductivity which is a function of the cumulative relative contribution of the layered material. The percentage of the signal contribution by differing layers is a function of depth below ground surface. The unit of conductivity used is numerically equivalent to milliSiemen/meter.

5.4.2 Data Acquisition

The EM31-D survey of the Express property will be performed by operating the equipment in continuous read-out modes switched to both the vertical and horizontal coplanar configurations, as needed. Coverage will be made along predefined transects, where possible. Data readings will be recorded at 10-foot spacing intervals along transects, and will be recorded in the field logbook, along with distance reference measurements to tie-in the positions of the transects relative to surface land mark features for later reconstruction.

It is anticipated that locating buried features, such as cement tanks, will be accomplished through the observation of electromagnetic "edge-effects" (non-uniform lateral anomalies) created by the boundary contrasts existing between buried features and the surrounding subsoils. Lateral inhomogeneities will be identified by collecting both maximum and minimum quadrature-phase measurements at each station. This will be accomplished by rotating the transmitter/receiver boom 90° at each station to continuously observe response variations. Suspected features will be noted and located. Operator experience is an important facet of this investigative technique.

Background Reference Requirements. When performing terrain conductivity geophysical surveys, establishing a local reference background condition permits comparison of measurements in the study area to assumed expected conditions. Acquisition of background data is complicated in an urban setting such as the Queen Anne district. Locating an appropriate background reference area may not be possible. The EM31-D operator will use the Monterey Apartments asphalt-paved tenant parking lot, or a suitable alternate location, to perform instrument calibration checks and to perform background reading data acquisition.

5.5 SEWER LINE/STORM DRAIN LOCATING

5.5.1 Data Acquisition and Interpretation

E & E will subcontract Jim Dandy Sewer Service of Seattle, Washington, to assist in locating the sewer lines existing beneath the Express property. Background study and field observations of the Express property indicate the existence of at least two buried sewer/ storm lines beneath the service station complex. One line is a suspected lateral sewer line leading from the property toward the main sewer line running beneath Queen Anne Avenue North. The second line is a storm drain located near the property's northwest corner. Other previously abandoned sewer lines may exist on the property, but their location or existence is not known.

Line locating will be accomplished using a radio transmitter attached to a small diameter coiled cable which is lowered into the sewer line from the Express buildings via a "clean-out" opening, or if one is not available, through the toilet floor hole after removal of the toilet housing. For the storm drain, the cable will be lowered into the sewer line after removal of the grate, or between the grate openings. As the cable is uncoiled and fed into the sewer line the movement of the radio transmitter is tracked from the surface using a radio receiver which receives the radio waves and emits an audible sound when located near or above the radio transmitter. The operator will walk along the surface of the site until an audible tone is received from the receiver. The operator will then position the receiver at a point just above the transmitter location in the sewer line. The resulting product will be a location of the sewer line in terms of both lateral and vertical position, both of which can be determined fairly accurately with this method of detection. This technique requires non-metallic piping such as cement, tile, or plastic in order to be effective, as well as an area free of aboveground obstructions which would hinder the mobility of the radio receiver operator.

The sewer line lateral locations will be marked on a site map using existing building structures and a tape measure to determine distances and placement of the sewer lines on the Express property. The sewer line locations also may be spray-painted upon the concrete or asphalt surface of the Express property for later reference and determination of soil-gas sampling stations. The vertical depths of the sewer lines will be determined using the relative intensity received on the radio receiver and the experience of the operator, while the lateral distances of the sewer lines will be determined from the point of maximum receiver intensity.

5.6 TANK TIGHTNESS TESTING

5.6.1 Data Acquisition and Interpretation

Tank and pipe integrity testing will be performed using a patented non-volumetric acoustical signal and air ingress system, referred to as the VacuTect Precision Tank Testing System by Tankology. The system has been performance certified by the Midwest Research Institute (MRI) (see Appendix C), and complies with Washington State UST regulation requirements (WAC 173-360-345, and -350).

Performance of the tests will be achieved as per manufacturer requirements and specific conditions specified in the MRI performance report (MRI Project No. 9534-S, October 1990). The duration of each test is anticipated to last approximately 3 hours. At the start of the tests, each tank must be 70 to 95 percent full. During each test, the tank being evaluated will be closed temporarily to consumer use. Overall disruption to Express retailing is expected to be minimal.

Following the performance of each tank/line test, the results will be interpreted and recorded by a trained VacuTect operator and presented in a final analysis report. The entire procedure will be monitored and approved by an E & E employed, Washington State licensed tank test supervisor.

5.7 EQUIPMENT DECONTAMINATION

Sampling methods and equipment have been chosen to minimize decontamination requirements and the possibility of cross-contamination. Where possible, disposable sampling and personnel protective equipment will be used. Glass, Teflon, stainless steel, or other suitable inert containers will be utilized for the application of rinse solvents. Equipment which cannot be decontaminated effectively (i.e., rope or gloves) will be disposed of after sampling of each individual monitoring well. Investigation and sampling equipment will be cleaned at the site prior to use, between sampling locations, or as specified in the SAP, prior to transport back to the E & E warehouse. Unless otherwise specified or appropriate, the decontamination procedure of investigation and sampling equipment will be as follows:

- Wash in detergent (Alconox) solution using a pressure washer and/or a stiff brush and bucket of detergent solution;
- Rinse with clean water;
- Rinse with methanol (for organic sample collection only);
- Rinse with hexane (for organic sample collection only);
- Rinse with deionized, organic-free water; and
- Air dry.

Decontamination of the WaTerra Inertial pump will follow the steps above, with the exception that no solvents will be used to decontaminate the apparatus. The tubing will be washed in an Alconox solution, followed by a clean water rinse and a deionized, carbon-free water rinse. As noted previously, the WaTerra will not be used to collect samples suspected of containing floating petroleum.

Geoprobe equipment contacting soil during soil-gas borehole construction will be decontaminated by steam cleaning before each new drilling location. The Geoprobe drilling rods will be steam pressure washed and scrubbed using a stiff-bristled brush with a solution of clean water and Alconox. The rods then will be steam-clean rinsed until they are hot enough to self dry. After drying, the rods will be placed back in the truck rack and readied for transport to the next sampling station.

Pressurized ultrapure nitrogen gas will be used to purge and decontaminate the soil-gas sampling train system and tubing at each station in preparation for the next sampling station.

5.8 INVESTIGATION-DERIVED WASTE DISPOSAL

All investigation-derived wastes suspected as hazardous, including purge waters and decontamination solutions will be containerized in Department of Transportation (DOT)-approved containers, sealed, and labeled. The final disposition of the drums and their contents will be handled through Rollins Chempak, Inc., under a contract with Ecology for hazardous waste disposal (Contract No. 130-89).

5.8.1 Investigation Derived Purge Waters

It is anticipated that 50 to 100 gallons of purge water will be generated from the aquifer bail-down test at MW-6 (Field Task 1). Another 325 gallons of purge water is anticipated for the groundwater sampling event (Field Task 2). This estimate is based on 3 volumes of 15 feet standing water to be bailed, on average, from the twelve 2-inch and two 8-inch wells existing at the Monterey Apartments site. All purge waters will be containerized in labeled unused 55-gallon drums

(17-E). Each drum containing investigation-derived purge water will be labeled with the following information:

- Site name,
- Sequential Drum Number,
- Date of Collection,
- Source and type of waste, and
- Appropriate DOT placard (i.e., Flammable Liquid).

All such information will be recorded in field logbooks, and a final inventory of all investigation-derived wastes, including quantities, disposition, and dates will be compiled at the completion of the project.

The disposal of the investigation-derived purge waters will be arranged with Rollins Chempak Inc., a hazardous waste disposal firm under contract with Ecology (Contract No. 130-89), on a daily basis or as necessary by advance notice. The waste will be disposed of at one of three waste disposal sites operated by Rollins Chempak, Inc. E & E will provide Rollins Chempak, Inc. with sampling analytical data for manifesting and classifying of waste generated at the site during investigation activities at the time when arrangements are made for pickup and transport. An EPA site identification number has been obtained by Ecology for waste generation, in order to initiate disposal hauling of the generated purge water.

5.8.2 Investigation-Derived Clothing and Expendable Sampling Equipment

It is anticipated that disposable personal protective clothing/equipment will be utilized during the course of this project. It is anticipated that three 4 by 4-foot double plastic bags of disposable clothing/equipment will be generated per week, and that this waste will be disposed of by E & E at a sanitary landfill.

6. SAMPLE CUSTODY

This section describes standard operating procedures (SOPs) for sample identification and chain-of-custody that will be used for the Monterey Apartments site field activities. The purpose of these procedures is to ensure that the quality of samples is maintained during collection, transportation, storage, and analysis. All chain-of-custody requirements comply with SOPs documented in E & E's sample handling protocol. All sample control and chain-of-custody procedures will follow the EPA CLP User's Guide (9240.0-1, December 1988).

6.1 SAMPLE IDENTIFICATION AND DOCUMENTATION

Sample identification documents must be prepared carefully so that sample identification and chain-of-custody can be maintained and sample disposition controlled. Sample documents accountable for custody purposes include:

- Sample identification numbers,
- Sample tags or labels,
- Custody seals,
- Chain-of-custody,
- Field logbooks,
- Sample collection forms,
- Analytical request forms, and
- Analytical records.

During the field effort, the project manager or delegate is responsible for maintaining an inventory of accountable sample documents. This inventory will take the form of a cross-referenced matrix of the following:

- Sample location,
- Sample identification number,
- Analyses requested,
- Chain-of-custody record number,
- Bottle lot numbers, and
- Airbill numbers.

A brief description of the major sample identification and documentation records and forms are provided below.

6.1.1 Sample Identification

All containers of samples collected from the project will be identified, prior to shipment, using the following format on a label or tag fixed to the sample container (labels are to be covered with clear plastic tape). An 11-digit alphanumeric code will be assigned to each sample as an identification number to track samples collected at the Monterey Apartments site. The sample code is broken down as follows:

Group	Digits	Time	Code Examples
(1)	1-2	Calendar Year	90,91,92
(2)	3-4	Week (1-52)	06,52
(3)	5-6	Identifying Code	MA (Monterey Apts)
(4)	7-9	Sample No.	010,110
(5)	10-11	Sample Type	GW (groundwater) SG (soil-gas)

Example: 90 28 MA 010 SG = 1990, Week 28, Monterey Apartments, Sample No. 10, Soil-gas

6.1.2 Sample Tags or Labels

Sample tags attached to or fixed around the sample container will be used to identify all samples collected in the field. The sample tags are to be placed on bottles so as not to obscure and QA/QC lot numbers on the bottles and sample information must be printed in a legible manner using waterproof ink. Field identification must be sufficient to enable cross-reference with the project logbook. For chain-of-custody purposes, all QC samples are subject to exactly the same custodial procedures and documentation as site samples.

To minimize handling of sample containers, labels may be filled out prior to sample collection. The sample label will be filled out using waterproof ink and will be attached firmly to the sample containers and protected with clear plastic tape. The sample label will give the following information:

- Site identifier,
- Initials of sampler,
- Date and time of collection,
- Sample identification,
- Analysis required,
- pH (when applicable), and
- Preservation.

6.1.3 Custody Seals

Custody seals are preprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. Sample shipping coolers are sealed in as many places as necessary to ensure security. Seals must be signed and dated before use. On receipt at the laboratory, the custodian must check (and certify, by completing the package receipt log) that seals on coolers and sampling containers are intact. Strapping tape should be placed over the seals to ensure that seals are not broken accidentally during shipment.

6.1.4 Chain-of-Custody Records

Ecology chain-of-custody records will be completed as appropriate. The chain-of-custody record will be completed fully, at least in duplicate, by the field technician who has been designated by the site manager as responsible for sample shipment to the appropriate laboratory for analysis. Information specified on the chain-of-custody record will contain the same level of detail found in the site logbook, with the exception that the on-site measurement data need not be recorded. The custody record will include, among other things, the following information:

- Name and company or organization of person collecting the samples;
- Date samples were collected;
- Type of sampling station (composite/grab);
- Location of sampling station (using sample code system);
- Number and type of containers shipped;
- Analysis requested; and
- Signature of the person relinquishing samples to the transporter, with the date and time of transfer noted, and of the sample custodian at the receiving facility.

In addition, if samples require rapid laboratory turnaround, the person completing the chain-of-custody record will note these constraints in the remarks section of the custody record. The relinquishing individual will record all shipping data (e.g., airbill number, organization, time, and date) on the original custody record, which will be transported with the samples to the laboratory and retained in the laboratory's file. Original and duplicate custody records, together with the airbill or delivery note, constitute a complete custody record. It is the project manager's responsibility to ensure that all records are consistent and that they are made part of the permanent job file.

6.1.5 Field Logbooks/Data Forms

Field logbooks (or daily logs) and data forms are necessary to document daily activities and observations. Documentation will be sufficient to enable participants to reconstruct events that occurred during the project accurately and objectively at a later time. All daily logs will be kept in a bound notebook containing numbered pages. All entries will be made in ink, dated, and signed. No pages will be removed for any reason. Minimum logbook content requirements are described in the E & E SOP for Preparation of Field Activities - Logbooks. If corrections are necessary, these must be made by drawing a single line through the original entry (so that the original is legible) and writing the corrected entry alongside. The correction must be initialed and dated. Corrected errors may require a footnote explaining the correction.

6.1.6 Photographs

Photographs will be taken as directed by the team leader. Documentation of a photograph is crucial to its validity as a representation of an existing situation. The following information will be noted in the project or task log concerning photographs:

- Date, time, location photograph was taken;
- Photographer;
- Weather conditions;
- Description of photograph taken;
- Reasons why photograph was taken;
- Sequential number of the photograph and the film roll number, if appropriate;
- Camera lens system used; and
- Direction, if appropriate.

After the photographs have been developed, the information recorded in the field notebook should be transferred to the back of the photographs.

6.2 CUSTODY PROCEDURES

The primary objective of chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is in custody if it is:

- In someone's physical possession;
- In someone's view;
- Locked up; or
- Kept in a secured area that is restricted to authorized personnel.

6.2.1 Field Custody Procedures

The following guidance will be used to ensure proper control of samples while in the field:

- As few persons as possible should handle samples;
- Sample bottles or absorbent sampling tubes must be obtained precleaned from an approved retail source such as I-Chem, or the contracted laboratory performing the analyses.
- Coolers or boxes containing cleaned bottles or sample media should be sealed with a custody tape seal during transport to the field or while in storage prior to use. Sample bottles that appear to have been tampered with will not be used;
- The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person or dispatched properly under chain-of-custody rules;
- The sample collector will record sample data in the field logbook; and
- The site team leader will determine whether proper custody procedures were followed during the fieldwork and decide if additional samples are required.

When transferring custody (i.e., releasing samples to a shipping agent), the following will apply:

- When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on the chain-of-custody record. This record documents sample custody transfer.
- Samples must be dispatched to the laboratory for analysis with separate chain-of-custody records accompanying each shipment. Shipping containers must be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information are entered in the chain-of-custody record.
- All shipments must be accompanied by chain-of-custody records identifying their contents. The original record accompanies the shipment. The other copies are distributed appropriately to the site team leader and project leader.
- If sent by mail, the package is registered with return receipt requested. If sent by common carrier, a bill of lading is used. Freight bills, postal service receipts, and bills of lading are retained as part of the permanent documentation.
- In the case of hand delivery of samples to the laboratory a chain-of-custody will be filled out prior to the exchange of samples as per chain-of-custody procedures.

6.2.2 Laboratory Custody Procedures

A designated sample custodian at the laboratory will accept custody of the shipped samples from the carrier and will record preliminary information about the package, including the status of the custody seals on the coolers (i.e., broken vs. unbroken). The custodian responsible for sample log-in will open the package, check the contents, and verify that the information on the chain-of-custody agrees with samples received. Pertinent information as to shipment, pickup, and courier must be entered into the chain-of-custody record. The custodian also will document the general condition of the sample containers and will note any discrepancy or improper preservation. The custodian then enters the project name and sample identification information into the laboratory's sample management system.

6.3 SAMPLE HANDLING, PACKAGING, AND TRANSPORT

The transportation and handling of samples must be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects to the courier due to the possible hazardous nature of samples. Regulations for packaging, marking, labeling, and shipping hazardous materials are promulgated by Washington Hazardous Materials Transportation Regulations (WAC 446-50-080) and the DOT in the Code of Federal Regulations (49 CFR 171 through 177).

6.3.1 Sample Packaging

Samples must be packaged carefully to avoid breakage or contamination and must be shipped to the laboratory at proper temperatures. The following sample package requirements will be followed:

- Sample bottle lids must never be mixed. All sample lids must stay with the original containers.
- The sample volume level of the groundwater samples can be marked by placing the edge of the label at the appropriate sample height, or by marking with a grease pencil. This procedure will help the laboratory to determine if any leakage occurred during shipment. The label should not cover any bottle preparation QA/QC lot numbers.
- All sample containers are placed in a plastic bag to minimize the potential for vermiculite contact.
- Shipping coolers must be filled partially with packing materials and ice (when required), to prevent the samples from moving during shipment.
- The environmental samples are to be cooled. The use of "blue ice" or some other artificial icing material is preferred. If necessary, ice may be used, provided that it is placed in plastic bags. Ice is not to be used as a substitute for packing materials.
- Any remaining space in the cooler should be filled with inert packing material, (vermiculite is recommended). Under no circumstances should material such as sawdust, sand, etc., be used.

- Two copies of the custody record must be placed in a plastic bag and taped to the inside of the cooler lid. Custody seals are affixed to the outside of the sample cooler.
- All sample containers generally will be segregated according to sample matrix and expected contaminant concentration. In addition, all containers from a given sample will be shipped in the same shipping container when possible.

6.3.2 Shipping Containers

Environmental samples will be properly packaged and labeled for transport and dispatched to the appropriate laboratories. Soil-gas samples will be sent to Columbia Analytical Services located in Bothell, Washington. Groundwater samples not scheduled for biological parameters analysis will be sent to the E & E ASC, located at 4285 Genesee Street, Buffalo, New York. Those samples to be analyzed for biological parameters will be sent to ARI located in Seattle, Washington. A separate chain-of-custody record must be prepared for each shipping container.

Shipping containers are to be custody-sealed for shipment as appropriate. Access to the container should be gained only by cutting the filament tape and breaking the seal. Field personnel will make arrangements for transportation of samples to the laboratory. When custody is relinquished to a shipper, field personnel will telephone the laboratory sample custodian, to inform him/her of the expected time of arrival of the sample shipment and to advise him/her of any time constraints on sample analysis.

6.3.3 Marking and Labeling

The following marking and labeling procedures will be performed.

- Use abbreviations only where specified.
- The words "This End Up" or "This End Down" will be clearly printed on the top of the outer package, if appropriate. Upward pointing arrows should be placed on the sides of the package. The words "Laboratory Samples" should also be printed on the top of the package.

- After a sample container has been sealed, two chain-of-custody seals are placed on the container, one on the front and one on the back. The seals are protected from accidental damage by placing strapping tape over them.

- If samples are designated as medium or high hazard, they must be sealed in metal paint cans, place in the cooler with vermiculite, and labeled and placarded in accordance with DOT regulations.

- In addition, the shipping containers must also be labeled and placarded in accordance with DOT regulations if shipping medium and high hazard samples.

7. ANALYTICAL PROCEDURES

7.1 FIELD ANALYTICAL PROCEDURES

Table 7-1 identifies the analytical methodologies to be used for collection of field measurement data (conductivity, temperature, and pH) at the Monterey Apartments site. Equipment for monitoring groundwater conditions during well purging prior to sample collection will meet the specifications identified in the methods specified.

Table 7-1

FIELD MEASUREMENT METHODOLOGIES
PHASE 1 REMEDIAL INVESTIGATION
MONTEREY APARTMENTS
SEATTLE, WASHINGTON

Parameter	Matrix	Method Reference	Method Number	Brief Description of Apparatus
Conductivity	Water	SW-846 (1)	9050	Self-contained conductivity meter
Temperature	Water	Standard Methods (2)	2550	Thermometer/Thermistor
pH	Water	SW-846 (1)	9040	Glass electrode pH meter

(1) "USEPA Test Method for Evaluating Solid Wastes," SW-846, Revision 0, September 1986.
(2) "Standard Methods for the Examination of Water and Wastewater", 17th Edition, 1989.

7.2 LABORATORY ANALYTICAL PROCEDURES

Table 7-2 provides the laboratory analytical methodologies to be used for completing Field Tasks 2 and 3 at the Monterey Apartments site. Analytes of interest for Field Task 2 are the VOCs listed in Appendix A (SW846 Method 8240), EDB, TPH, and total lead. The method modification for the EDB analysis is presented in Appendix B. Additional groundwater characterization parameters include the inorganic elements, as well as the nutrient and biological parameters, indicated in Table 7-2. The inorganic analytes are further detailed in Appendix A.

Analytes of interest for Field Task 3 include BTEX, which will be measured following SW846 Method 8020 (Appendix A), and volatile TPH. Analytical standard operating procedures to be followed by CAS for the soil-gas sample analyses are presented in Appendix D.

Task- and method-related QC requirements are presented in Table 4-3. Compound-specific QC requirements not indicated in Table 4-3, can be located in the referenced methodologies.

Table 7-2 (cont.)

Task	Parameter	Matrix	Method Reference	Method Number	Brief Description of Method
2	Nitrite-N	Groundwater (Monitoring wells)	EP1(4)	354.1	Spectrophotometric
2	Ammonia-N	Groundwater (Monitoring wells)	EP1(4)	350.2	Distillation - titrimetric, colorimetric, or potentiometric
2	Total Phosphorus/ organic phosphorus	Groundwater (Monitoring wells)	EP1(4)	365.2	Colorimetric
2	Sulfate	Groundwater (Monitoring wells)	EP1(4)	375.4	Turbidimetric
2	Turbidity	Groundwater (Monitoring wells)	EP1(4)	180.1	Nephelometric
2	Color	Groundwater (Monitoring wells)	SM	2120B	Colorimetric - platinum - cobalt
2	Total coliform	Groundwater (Monitoring wells)	SM	9222B	Membrane filtration
3	Benzene, toluene, xylenes, ethylbenzene, (BTEX)	Soil-gas	SW846(2)	8020	Gas chromatographic separation with photoionization detection (GC/PID) (screening data)
3	Benzene, toluene, xylenes, ethylbenzene, (BTEX)	Groundwater	SW846(2)	8020	Gas chromatographic separation with photoionization detection (GC/PID) (screening data)

Table 7-2 (cont.)

Task	Parameter	Matrix	Method Reference	Method Number	Brief Description of Method
3	Volatile total petroleum hydrocarbons (TPH)	Soil-gas	SW846(2) LUFT(3)	Modified 8015	Gas chromatographic separation with flame ionization detection (GC/FID) (screening data)
3	Volatile total petroleum hydrocarbons (TPH)	Groundwater	SW846(2) LUFT(3)	Modified 8015	Gas chromatographic separation with flame ionization detection (GC/FID) (screening data)

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(1) The specific parameters for each group are listed in Appendix A.

(2) Methods are contained in USEPA, "Test Methods for Evaluating Solid Wastes," SW-846, Revision 0, September 1986.

(3) Modification to the SW846 Method 8015 used for this analysis are contained in the State of California Leaking Underground Fuel Tank (LUFT) Task Force Field Manual, Appendix D (October 1989).

(4) Methods are contained in USEPA Methods for Chemical Analysis of Water and Wastes, Revised March 1983 (EPA-600/4-79-020).

(5) Method modification described in Appendix B.

(6) Methods are contained in "Standard Methods for the Examination of Water and Wastewater," 17th Ed, 1989.

8. CALIBRATION PROCEDURES AND FREQUENCY

All instruments and equipment used during sampling and analysis will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations, as well as criteria set forth in the applicable analytical methodology references. Operation, calibration, and maintenance will be performed by personnel properly trained in these procedures. Documentation of all routine and special maintenance and calibration information will be maintained in an appropriate logbook or reference list, and will be available on request. Brief descriptions of calibration procedures for applicable field and laboratory instruments follow.

8.1 FIELD INSTRUMENTATION

8.1.1 Water Conductivity Meter

Instrumentation will be self-contained, and capable of measuring conductivity with an error not exceeding 1 percent or 1 umho/cm, whichever is greater. The conductivity cell will be used in conjunction with a thermometer, capable of being read to the nearest 1.0°C. The conductivity meter is factory calibrated initially. The instrument conductivity measurement accuracy will be checked daily with a solution of known conductivity prior to field use, and recalibrated if necessary. Recalibration will be performed as per method and the specific instrument specifications.

8.1.2 Thermometer

Temperature measurements to the nearest 0.5°C will be made with a mercury-filled Celsius thermometer. The thermometer will be checked periodically against a precision thermometer certified by the National

Institute of Standards and Technology (NIST). The thermometer will be stored in a durable case for field use, to prevent breakage.

8.1.3 pH Meter

Measurements of pH will be performed using a battery-operated pH meter, consisting of a potentiometer, a glass electrode, a reference electrode, and a temperature compensating device. A meter with a range of 0 to 14 pH units, a minimum precision of ±0.05 pH units, and a minimum accuracy of ±0.1 pH units will be used. The meter will be calibrated over the working pH range in the field prior to use with buffer solutions of known pH (typically 4.0, 7.0 and 10.0). A calibration check will be performed using a standard buffer (typically pH 7.0) prior to each field pH measurement.

8.1.4 Water Level Indicator

The hand-held water level indicator is factory calibrated. A battery check will be done in the field, and prior to going out in the field to ensure operation ability.

8.1.5 Product Interface Probe

The product interface probe is factory calibrated. A battery check will be done in the field, and prior to going out in the field to ensure operation ability.

8.1.6 TIP II Photoionizer

A Photovac TIP II PID-based air survey monitor will be employed. The TIP II is calibrated to isobutylene, certifed to be at a concentration of 100 ppm. The TIP II will measure total gases and vapors with photoionization potentials less than or equal to 10.6eV, and will read total concentrations as isobutylene equivalents. The "true" concentrations of total vapors in the sample will depend on the individual concentrations and response factors relative to isobutylene.

The TIP II will be calibrated initially prior to field activity, and the calibration will be checked daily. Adjustments to the initial calibration will be performed as necessary.

8.1.7 Geonics EM31-D Terrain Conductivity Meter

The instrument is factory calibrated. The unit will undergo a series of equipment functional checks as recommended by the manufacturer prior to initiating the survey.

8.2 LABORATORY INSTRUMENTATION

8.2.1 Gas Chromatography/Photoionization Detector/Flame Ionization Detector (GC/PID/FID)

Each GC/PID/FID system used for BTEX and volatile TPH analysis is calibrated initially using either the internal or external standard technique for all packed or capillary columns used for quantitation, as outlined in the methodology (SW846 Method 8020 and modified Method 8015). Initial calibration standards are prepared at a minimum of three concentration levels for each parameter of interest; one standard is prepared at a concentration at or near, but above, the practical quantitation limit, and the others will correspond to the expected range of concentrations, or define the working range of the detectors. This is done for each column, each detector, and each instrument at the beginning of the sample analysis period, and each time a new column is installed. The results are used to establish retention time windows for the external standard technique, or relative retention time windows for the internal standard technique.

The calibration factors (external standard technique) or relative response factors (internal standard technique) calculated for each compound (BTEX) or for total response (volatile TPH) at the three or more levels must have a percent relative standard deviation of less than 30 percent. The calibration factors or relative response factors are verified after every 10 samples analyzed or every 12 hours, whichever is more frequent, and at the end of the analytical sequence. Each analyte must be within its (relative) retention time window, or corrective action is taken by the laboratory. The calibration factor or relative response factor must agree with the factor determined at the beginning of the analysis within ± 25 percent.

8.2.2 Gas Chromatography/Mass Spectrometer (GC/MS)

Prior to analysis, and on a 12-hour basis, the instrument is hardware-tuned using either bromofluorobenzene (BFB) for volatile analytes to ensure mass resolution, identification, and to some degree, sensitivity. Mass spectral peaks must conform both in mass numbers and relative intensity to method requirements before standard analysis can proceed.

All GC/MS instruments are calibrated initially at five concentration levels for analytes of interest, using the procedures outlined in the method, and standards traceable to EPA reference materials. One of the calibration standards is prepared at a concentration at or near, but above, the method quantitation limit, and the other four standards are at concentrations that define the linear range of the instrument. Compounds selected as System Performance Check Compounds (SPCCs) must show a minimum mean response factor (specified) for the initial calibration to be considered valid. Compounds selected as calibration check compounds (CCCs) must show a relative standard deviation (RSD) for response factors less than a specified amount for the calibration to be considered valid. This calibration can be used as long as it can be demonstrated to remain valid. Compounds of interest are quantitated using the internal standard technique. Internal standard areas must meet performance criteria of 50 percent to 200 percent of the internal standard area from the corresponding calibration to ensure that GC/MS sensitivity and response are stable during every run.

Every 12 hours, the initial five-point calibration is verified by a single mid-range standard (the continuing calibration). SPCCs and CCCs are used to check response factors for adequacy and consistency against required limits before analysis can proceed.

8.2.3 Gas Chromatography/Electron Capture Detector (GC/ECD)

Each GC/ECD system used for EDB analysis by EPA SW846 Method 8010 (modified for electron capture detection) is calibrated initially using either the internal or external standard technique for all packed or capillary columns used for quantitation or confirmation, as outlined in the method. Initial calibration standards are prepared at five concentration levels for each parameter of interest: one of the standards is prepared at a concentration near, but above, the practical quantitation limit, and the other four concentrations will correspond to the expected range of concentrations, or define the working range of the detector. This is done for each quantitation and confirmation column and each instrument at the beginning of the sample analysis period, and each time a new column is installed. The results are used to establish retention time windows for the external standard technique or relative retention time windows for the internal standard technique.

The calibration factors for the external standard technique or relative response factors for the internal standard technique calculated for each compound at the five levels must have a percent relative standard deviation of less than 20 percent. The calibration factors or relative response factors and (relative) retention times are verified after every five samples analyzed and at the end of the analytical sequence. Each analyte must be within its (relative) retention time window, or corrective action is taken by the laboratory. The calibration factor or relative response factor must agree with the factor determined at the beginning of the analysis within + 20 percent for quantitation and ± 25 percent for confirmation of analysis.

8.2.4 Inductively Coupled Plasma Emission Spectrometer (ICP)

The ICP is calibrated daily, using at least one standard and a blank. The standard is within the demonstrated linear range of the instrument. The linear range is verified quarterly.

The calibration is verified initially using an independent reference standard and a standard at two times the required quantitation limit. The calibration is verified every 10 samples or 2 hours (whichever is greater). The instrument is recalibrated if drift is indicated (if percent recovery of the standard is outside quality control limits).

8.2.5 Atomic Absorption Spectrometer (AAS)

AAS units are calibrated daily, using at least three standards and a blank to establish the analytical curve. For mercury analysis, a blank and at least four standards are used to establish the analytical curve. The correlation coefficient for all analytical curves must be greater than or equal to 0.995. The calibration is verified initially using an independent reference standard. The calibration is verified every 10 samples or 2 hours (whichever is greater). If drift is indicated (recovery percent of the standard is outside control limits), the instrument is recalibrated.

8.2.6 Colorimeter

The colorimeter is calibrated every hour, using a minimum of one blank and three standard solutions. An independently prepared check standard is analyzed after every 15 samples to verify calibration. The instrument is recalibrated if drift is indicated (percent recovery of the standard is outside control limits).

8.2.7 Spectrophotometer

A linear calibration curve is established using a blank and a minimum of five standards. An independently prepared check standard is analyzed after every 15 samples to verify calibration. If drift is indicated (percent recovery of the standard is outside control limits), the instrument is recalibrated.

8.2.8 Electrometer

A linear calibration curve is established using a blank and a minimum of five standards. An independently prepared check standard is analyzed after every 15 samples to verify calibration. The instrument is recalibrated if drift is indicated (percent recovery is outside control limits).

8.2.9 Carbonaceous Analyzer

For the carbonaceous analyzer, one of several types of instrumentation may be incorporated; manufacturer's instructions should be followed for calibration. A series of standards will be used that encompass the expected concentration range of the samples.

9. DATA REDUCTION, VALIDATION, AND REPORTING

9.1 DATA REDUCTION

Data reduction includes all processes that change the numerical value of the raw data. All BTEX and volatile TPH screening data acquired during Field Task 3 will be reduced by the screening laboratory, and presented as sample results. Additional interpretation of the raw volatile TPH screening data will be performed by a qualified chemist, if required for further characterization of petroleum products present in the samples.

All other analytical data reduction for samples collected under Field Task 2 will be performed in accordance with the appropriate methodology and laboratory scope of work, and presented as sample results; no further data reduction will be performed.

9.2 DATA VALIDATION

Prior to the submission of the report to the client, all analytical data, will be evaluated for precision, accuracy, and completeness. Screening data also may be evaluated for characterization of petroleum products, if necessary. All analytical data (except for screening data) will be validated based on specific method requirements using guidelines presented in the following EPA documents:

- Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses (February 1, 1988); and
- Laboratory Data Functional Guidelines for Evaluating Inorganic Analyses (July 1, 1988).

QC parameters of interest for GC/MS methods will include:

- Holding time,

- Initial calibration,
- Continuing calibration,
- Tuning - BFB,
- Method blanks,
- Surrogate recoveries,
- Matrix spike/matrix spike duplicates analysis,
- Internal standard recoveries,
- Target Compound List compound identifier,
- Compound quantitation and reported detection limits
- Tentatively identified compounds, and
- System performance.

QC parameters of interest for GC/ECD analyses will include:

- Holding time,
- Instrument performance,
- Initial calibration,
- Analytical sequence,
- Continuing calibration,
- Blank analyses,
- Surrogate recovery,
- Matrix spike/matrix spike duplicate analyses,
- Compound identification, and
- Compound quantitation and reported detection limits.

QC parameters of interest for GFAA and ICP analyses will include:

- Holding time,
- Initial calibration,

- Calibration verification,
- Interference check sample (ICP),
- Laboratory control sample (ICP),
- Post digestion spike analysis (GFAA),
- Method blanks analysis,
- Matrix spike sample analysis,
- Duplicate sample analysis,
- Serial dilution (ICP), and
- Sample result verification.

Data validation procedures for other analyses will be equivalent to those for the analyses listed above and will be based on the QC criteria specific for the methodology, and the functional guidelines referenced above. A data deliverable package will be required at the completion of the data validation process. QC parameters of interest for gravimetric and titrimetric analyses, sulfate, turbidity, and total coliform will include:

- Holding time,
- Calibration curves and calibration verifications when applicable: frequency and QC limits,
- Spiked samples when applicable: frequency and QC limits,
- Method blanks: frequency and QC limits, and
- Laboratory duplicates: frequency and QC limits.

QC parameters of interest for colorimetric, spectrophotometric, filter photometric, and TOC methodologies include:

- Holding time,
- Initial calibration,
- Continuing calibration,

- Method blank analysis,
- Matrix spike sample analysis,
- Duplicate sample analysis, and
- Sample result verification.

No validation of field measurements or screening analysis is performed.

9.3 DATA REPORTING

All data generated by the screening laboratory will undergo internal evaluation, prior to submission of a deliverable to E & E. The data package will then be evaluated independently by a qualified E & E chemist. Additional interpretation of the raw screening data will be performed by a qualified chemist as required for characterization of petroleum products present in the samples. The chemist will prepare a report for the E & E project manager, including all analytical data and QC information, with any associated interpretations. After final approval by E & E's project manager, the screening data evaluation report will be submitted to the client as part of the Phase 1 RI Report.

Data generated by all other laboratories will undergo internal validation, with the addition of any qualifiers deemed necessary, prior to submission of a deliverable to E & E. The deliverable will then be independently validated by an E & E data validation specialist, using the process described in Section 9.2. The data validation specialist will prepare a report for the E & E project manager, including all analytical data with any associated qualifiers.

The information to be included in the analytical reports consists of a tabulation of analytical results and supporting QC information. Raw data will be available for inspection and maintained in the central job file. All records are maintained for a period of 5 years after the final report is issued.

Types of records to be maintained for this project include the following:

- Field notebooks containing documentation regarding sampling locations, station numbers, dates, times, sampler's name, designation of samples as grab or composite, notation of the type of sample, preservatives used, on-site measurement data, and other field observations and remarks.

- Chain-of-custody records including information regarding the sampler's name, date of sampling, type of sampling, location of sampling station, number and type of containers used, signature of E & E person relinquishing samples to a non-E & E person (e.g., Federal Express agent) with the date and time of transfer noted, signature of E & E sample custodian receiving samples with date and time noted.

- Any discrepancy/deficiency report forms completed regarding the samples due to problems encountered during sampling, transportation, or analysis.

- All laboratory notebooks including raw data readings, calibration details, QC results, etc.

- Hard copies of data system printouts (chromatograms, mass spectra, etc.).

- Tabulation of analytical results with supporting quality control information.

- Computer records on disk of analytical data and well location data in an Ecology compatable data management format.

10. INTERNAL QUALITY CONTROL CHECKS

QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences, and/or contamination of sampling equipment, glassware, and reagents, etc. Specified QC requirements for laboratory analysis are incorporated in the analytical methods listed in Table 7-2. These QC requirements will be followed for analytical work on the Monterey Apartments site Phase I RI. Field QC will include the following:

- o **Soil-gas adsorbent trap equipment blanks.** Blank samples designed to demonstrate that the soil-gas adsorbent trap has been cleaned properly by the laboratory, the soil-gas sampling train has been prepared and cleaned properly before field use, and that cleaning procedures between samples are sufficient to minimize cross contamination. Soil-gas blanks will be collected at a rate of approximately 1 per 20 soil-gas samples collected.

- o **Soil-gas background base station reference samples.** Designed to determine concentrations of background contaminants present in the vadose zone which are not attributable to any source contamination. These QC samples will serve as an indication of field variability for any background contaminants detected in the reference samples. Soil-gas background reference samples will be collected from a designated base station, at a rate of approximately one per each day of soil-gas sampling activity.

- o **Transport Blanks.** Blank samples prepared to assess transport conditions. They will be prepared by filling empty volatile organic analyte (VOA) sample containers with deionized/carbon-free water. They will be handled like a sample and shipped to the laboratory for VOC analysis. These will accompany the water samples at a rate of one per bottle lot for VOC analyses.

  Transport blanks also will be prepared for the soil-gas matrix. They will be prepared by shipping an unused soil gas tube (which has been taken to the site and handled like a sample) to the screening laboratory for BTEX and volatile TPH analysis. These will be prepared at a rate of 1 per 20 soil-gas samples collected.

- **Field Equipment Rinsate Blanks.** Blank samples designed to demonstrate that sampling equipment has been prepared and cleaned properly before field use, and that cleaning procedures between samples are sufficient to minimize cross contamination. Rinsate blanks will be collected at a rate of 1 blank per 20 samples for the Field Task 2 groundwater samples.

11. PERFORMANCE AND SYSTEMS AUDITS

No project-specific field office performance or systems audits are planned during the Monterey Apartments site Phase 1 RI.

E & E's ASC Laboratory is audited internally on a monthly basis, and external auditing occurs throughout the year at a frequency of once every 2 months. No project-specific laboratory audits are scheduled for the ASC, CAS, or ARI laboratories performing analytical services for the project.

12. PREVENTIVE MAINTENANCE

All field instruments and equipment used for analysis will be serviced and maintained only by qualified personnel. All instruments are maintained by senior staff and/or electronics technicians. All repairs, adjustments, and calibrations will be documented in an appropriate logbook or data sheet that will be kept on file. The instrument maintenance logbooks will document the date, the description of the problems, the corrective action taken, the result, and who performed the work.

All equipment used by E & E in the field is subject to standard preventive maintenance schedules established by corporate equipment protocols. When in use, equipment is inspected at least twice daily, once before start-up in the morning and again at the end of the work shift prior to overnight storage or return to the charging rack. Regular maintenance such as cleaning lenses, replacement of in-line filters, and removal of accumulated dust is to be conducted according to manufacturer's recommendations and in-field need, whichever is appropriate. All preventive maintenance performed will be entered in the individual equipment's logbook.

In addition to preventive maintenance procedures, daily calibration checks will be performed at least once a day prior to use, and recorded in the respective logbooks. Additional calibration checks will be performed as required. All logbooks will become part of either the permanent site file or the permanent equipment file.

13. DATA ASSESSMENT PROCEDURES

Data assessment procedures to be used on this project are detailed in Section 9, and will be evaluated in a manner consistent with the DQOs specified in Section 4.

14. CORRECTIVE ACTIONS

E & E's corrective action measure planning relative to the Phase 1 RI involves two primary areas: field collection procedures, and analytical requirements. Inconsistencies from planned actions will be addressed using the **CORRECTIVE ACTION CHECKLIST** presented in Appendix E. Sampling modifications will be initiated using the **SAMPLE MODIFICATION CHECKLIST**, also found in Appendix E. The E & E project manager will be responsible for initiating the corrective action and sampling modification processes. Corrective action evaluations by the project manager will be performed following the sampling events to determine if alteration recommendations are appropriate.

15. QUALITY ASSURANCE REPORT

Appropriate sections of the monthly Work Assignment Progress Report to the Ecology Project Officer will be devoted to QA reporting on the Monterey Apartments Phase 1 RI. Additional information, including report responsibility, is provided in Section 9 of the QAPP. Internal peer review will be conducted in accordance with criteria requirements set forth in Section 6 of the QAPjP.

16. REFERENCES

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Appendix A

GROUNDWATER AND SOIL-GAS ANALYTICAL PARAMETERS AND ASSOCIATED PRACTICAL QUANTITATION LIMITS FOR ORGANIC COMPOUNDS AND INORGANIC ELEMENTS

FIELD TASK 2
MONITORING WELL GROUNDWATER ANALYSIS
VOLATILE ORGANIC COMPOUND ANALYTE LIST
SW846 Method 8240

Compound	Practical Quantitation Limits[a] For Groundwater (ug/L)
Chloromethane	10
Bromomethane	10
Vinyl Chloride	10
Chloroethane	10
Methylene Chloride	5
Acetone	100
Carbon Disulfide	5
1,1-Dichloroethene	5
1,1-Dichloroethane	5
trans-1,2-Dichloroethene	5
Chloroform	5
1,2-Dichloroethane	5
2-Butanone	100
1,1,1-Trichloroethane	5
Carbon Tetrachloride	5
Vinyl Acetate	50
Bromodichloromethane	5
1,1,2,2-Tetrachloroethane	5
1,2-Dichloropropane	5
trans-1,3-Dichloropropene	5
Trichloroethene	5
Dibromochloromethane	5
1,1,2-Trichloroethane	5
Benzene	5
cis-1,3-Dichloropropene	5
2-Chloroethyl Vinyl Ether	10
Bromoform	5
2-Hexanone	50
4-Methyl-2-pentanone	50
Tetrachloroethene	5
Toluene	5
Chlorobenzene	5
Ethyl Benzene	5
Styrene	5
Total Xylenes	

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[a] Sample PQLs are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achieveable.

FIELD TASK 2
MONITORING WELL GROUNDWATER ANALYSIS
INORGANIC ANALYTE LIST
SW846 Method 6010

Element	Practical Quantitation Limits for Groundwater (µg/L)
Barium	200
Cadmium	5
Calcium	5000
Chromium	10
Copper	25
Iron	100
Magnesium	5000
Manganese	15
Potassium	5000
Silicon	100
Silver	10
Sodium	5000
Zinc	20

FIELD TASK 3
GROUNDWATER AND SOIL-GAS SCREENING
VOLATILE AROMATIC ORGANIC ANALYTE LIST
SW846 Method 8020

Compound	Practical Quantitation Limits For Soil Gas[a]	Practical Quantitation Limits For Groundwater[b]
Benzene	20 ng	2.0 µg/L
Ethyl Benzene	20 ng	2.0 µg/L
Toluene	20 ng	2.0 µg/L
Total Xylenes	40 ng	4.0 µg/L

[a] Reported quantitation limits are dependent on sample collection volume (e.g., a 1-liter sample would have a resulting concentration of 20 ng/L benzene).

[b] Using purge-and-trap method (Method 5030).

Appendix B

METHOD 8010 MODIFICATION FOR EDB ANALYSIS

GC.20
Revision No.0
Date: February 27, 1991
Page 1 of 2

Title: EDB by Purge and Trap
Prepared by: R. Samson
Review date: (3 / 1 / 92)

Cross Reference: ____________
Approved by: Harry Hah (2 /28/91)
____________(/ /)

OBJECTIVE

Procedure for the analysis of EDB (ethylene dibromide, 1,2-dibromoethane) by purge and trap-GC/ECD
Limitation: This is not an approved method for the analysis of potable water

REFERENCES

Modifications to SW 846 Method 8010 and
EPA Method 601

EQUIPMENT AND REAGENTS

Tekmar ALS/ASC
Varian 6000/3700 GC
Detector: ECD
Columns:
  1% SP-1000 on Cabopack B or
  N-Octane on Porisil C
  or DB-5 megabore (0.53 mm i.d. capillary)
  Any of the above columns may be used as the primary or confirmation column as long as calibration criteria are met

PROCEDURE

Calibration and Analysis

1. The primary column gas chromatograph is calibrated initially at three concentrations (o.022 ug/l, 0.109 ug/l abd 0.218 ug/l)

2. Linearity is considered acceptable when the %RSD of the calibration factor is less than 20%.

3. Linearity is verified daily with the 0.022 ug/l standard and must be within + 15% difference of the initial calibration for analysis to proceed. This standard, if acceptable is used as the daily calibration factor.

4. A blank is analyzed and is considered acceptable when the analyte is below quantitation limits.

5. Five milliliters of sample are analyzed by purge and trap.

6. Samples are diluted if necessary to bring responses within the calibration curve.

DATA

Documentation: The logbook contains initial and contuinuing calibration check, method blank and sample information. Calibration curves are filed.

Review - Data is reveiwed by supervisor or analyst designated by supervisor 48 hrs. if possible. Data are checked against established QC criteria. If analyses are out of control, the supervisor will ensure corrective action is taken. If out of control analyses cannot be reanalyzed, discrepancy forms will be issued to the QA coordinator, lab manager, and job file. Logbooks are checked in a daily basis.

Quantitation limit: 0.01 ug/l

Quality Control

Operation	Preparation	Frequency	Control Limits
Matrix Spike (MS)	5 ul of 0.192 ng/ul standard to 5ml sample	1 per 20 samples	Under development
Matrix Spike Duplicate (MSD)	same as MS	1 per 20 samples	Under development
Method Blank	5 ml of analyte-free water	1 per 20 samples	Less than quantitation limit
Spiked Blank (reference)	5 ul of 0.192 ng/ul standard to 5 ml analyte-free water	1 per batch	

Appendix C

UST PERFORMANCE REPORT

MRI REPORT

Performance Estimates of the VacuTect Tank Test System

For Tanknology Corporation International

MRI Project No. 9534-S

October 12, 1990

MIDWEST RESEARCH INSTITUTE 425 Volker Boulevard, Kansas City, MO 64110-2299 • (816) 753-7600

Results of U.S. EPA Standard Evaluation

Nonvolumetric Tank Tightness Testing Method

This form tells whether the tank tightness testing method described below complies with the performance requirements of the federal underground storage tank regulation. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Nonvolumetric Tank Tightness Testing Methods." The full evaluation report also includes a form describing the method and a form summarizing the test data.

Tank owners using this leak detection system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

Method Description

Name Vacutect

Version

Vendor Tanknology Corporation International

5225 Hollister Street
(street address)

Houston (city) Texas (state) 77040 (zip) (713) 690-8265 (phone)

Evaluation Results

This method, which declares a tank to be leaking when air ingress is detected within the product in the tank

has an estimated probability of false alarms [P(FA)] of 0.0 % based on the test results of 0 false alarms out of 23 tests. A 95% confidence interval for P(FA) is from 0.0 to 12.2 %.

The corresponding probability of detection [P(D)] of a 0.10 gallon per hour leak is 100.0 % based on the test results of 23 detections out of 23 simulated leak tests. A 95% confidence interval for P(D) is from 87.8 to 100.0 %.

Does this method use additional modes of leak detection? ☒ Yes ☐ No. If Yes, complete additional evaluation results on page 3 of this form.

Based on the results above, and on page 3 if applicable, this method ☒ does ☐ does not meet the federal performance standards established by the U.S. Environmental Protection Agency (0.10 gallon per hour at P(D) of 95% and P(FA) of 5%).

Test Conditions During Evaluation

The evaluation testing was conducted in a 10,000 -gallon ☒ steel ☐ fiberglass tank that was 96 inches in diameter and 324 inches long, installed in clean sand backfill.

The ground-water level was 0.0 inches above the bottom of the tank.

Nonvolumetric TTT Method VACUTECT
Version

Test Conditions During Evaluation (continued)

The tests were conducted with the tank 70-95 percent full.

The temperature difference between product added to fill the tank and product already in the tank ranged from N/A °F to N/A °F, with a standard deviation of N/A °F.

The product used in the evaluation was Diesel.

This method may be affected by other sources of interference. List these interferences below and give the ranges of conditions under which the evaluation was done. (Check None if not applicable.)

☒ None

Interferences	Range of Test Conditions

Limitations on the Results

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for using the method are followed.
- The tank contains a product identified on the method description form.
- The tank capacity is 15,000 gallons or smaller.
- The difference between added and in-tank product temperatures is no greater than + or - N/A degrees Fahrenheit.

  ☒ Check if applicable:
  Temperature is not a factor because system is independent of temperature.

- The waiting time between the end of filling the test tank and the start of the test data collection is at least N/A hours.
- The waiting time between the end of "topping off" to final testing level and the start of the test data collection is at least N/A hours.
- The total data collection time for the test is at least 2 * hours.
- The product volume in the tank during testing is 70-95 % full.
- This method ☒ can ☐ cannot be used if the ground-water level is above the bottom of the tank.

* unless water is detected, when the test is extended to 3 h

Other limitations specified by the vendor or determined during testing:

The tank is sealed and a vacuum pump is used to reduce the pressure at the bottom of the tank to 2 PSI below atmospheric pressure.

Nonvolumetric TTT Method VACUTECT
Version

> **Safety disclaimer: This test procedure only addresses the issue of the method's ability to detect leaks. It does not test the equipment for safety hazards.**

Additional Evaluation Results (if applicable)

This method, which declares a tank to be leaking when air ingress is detected in ullage space.

has an estimated probability of false alarms [P(FA)] of 0.0 % based on the test results of 0 false alarms out of 23 tests. **Note:** A perfect score during testing does not mean that the method is perfect. Based on the observed results, a 95% confidence interval for P(FA) is from 0 to 12.2 %.

The corresponding probability of detection [P(D)] of a 0.10 gallon per hour leak is 100 % based on the test results of 20 detections out of 20 simulated leak tests. **Note:** A perfect score during testing does not mean that the method is perfect. Based on the observed results, a 95% confidence interval for P(D) is from 86.1- 100%.

> **Water detection mode (if applicable)**

Using a false alarm rate of 5%, the *minimum water level* that the water sensor can detect with a 95% probability of detection is 0.245 inches.

Using a false alarm rate of 5%, the *minimum change in water level* that the water sensor can detect with a 95% probability of detection is 0.018 inches.

Based on the minimum water level and change in water level that the water sensor can detect with a false alarm rate of 5% and a 95% probability of detection, the *minimum time* for the system to detect an increase in water level at an incursion rate of 0.10 gallon per hour is 286 minutes in a 10,000 -gallon tank. with an 8" square striker plate that is ¼" thic

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Certification of Results

I certify that the nonvolumetric tank tightness testing method was installed and operated according to the vendor's instructions. I also certify that the evaluation was performed according to the standard EPA test procedure for nonvolumetric tank tightness testing methods and that the results presented above are those obtained during the evaluation.

Jairus D. Flora
(printed name)

Jairus D. Flora, Jr.
(signature)

October 12, 1990
(date)

Midwest Research Institute
(organization performing evaluation)

425 Volker Boulevard K.C., MO 64110
(city, state, zip)

(816) 753-7600
(phone number)

Description

Nonvolumetric Tank Tightness Testing Method

This section describes briefly the important aspects of the nonvolumetric tank tightness testing method. It is not intended to provide a thorough description of the principles behind the method or how the equipment works.

Method Name and Version

VACUTECT

Product

> Product type

For what products can this method be used? (check all applicable)

- ☒ gasoline
- ☒ diesel
- ☒ aviation fuel
- ☒ fuel oil #4
- ☒ fuel oil #6
- ☒ solvents
- ☒ waste oil
- ☒ other (list) WATER: ANY LIQUID THAT DOESN'T ATTACK THE PROBE.

> Product level

What product level is required to conduct a test?

- ☐ above grade
- ☐ within the fill pipe
- ☐ greater than 90% full
- ☐ greater than 50% full
- ☐ empty
- ☒ other (specify) 70 - 95% FULL

Principle of Operation

What principle or principles are used to identify a leak?

☒ acoustical signal characteristic of a leak
☐ identification of a tracer chemical outside the tank system
☐ changes in product level or volume
☒ detection of water inflow
☒ other (describe briefly) Vacuum pump cycle

Temperature Measurement

If product temperature is measured during a test, how many temperature sensors are used?

☒ single sensor, without circulation
☐ single sensor, with circulation
☐ 2-4 sensors
☐ 5 or more sensors
☐ temperature-averaging probe

If product temperature is measured during a test, what type of temperature sensor is used?

☐ resistance temperature detector (RTD)
☐ bimetallic strip
☐ quartz crystal
☐ thermistor
☒ other (describe briefly) Semiconductor device

If product temperature is not measured during a test, why not?

☐ the factor measured for change in level or volume is independent of temperature (e.g., mass)
☐ the factor measured for change in level or volume self-compensates for changes in temperature
☒ other (explain briefly) Temperature is measured, but system is independent of temperature.

Data Acquisition

How are the test data acquired and recorded?

☐ manually
☐ by strip chart
☒ by computer

Procedure Information

> Waiting times

What is the minimum waiting period between adding a large volume of product to bring the level to test requirements and the beginning of the test (e.g., from 50% to 95% capacity)?

- ☐ not applicable
- ☒ no waiting period
- ☐ less than 3 hours
- ☐ 3-6 hours
- ☐ 7-12 hours
- ☐ more than 12 hours
- ☐ variable, depending on tank size, amount added, operator discretion, etc.

> Test duration

What is the minimum time for collecting data?

- ☐ less than 1 hour
- ☐ 1 hour
- ☒ 2 hours
- ☐ 3 hours
- ☐ 4 hours
- ☐ 5-10 hours
- ☐ more than 10 hours
- ☐ variable

> Total time

What is the total time needed to test with this method?

(setup time plus waiting time plus testing time plus time to return tank to service)

2 hours 30 minutes

> Other important elements of the procedure or method

List here any other elements that could affect the performance of the procedure or method (e.g., positive or negative ullage pressure, tracer concentration, distance between tank and sampling ports, etc.)

The tank is sealed and a vacuum pump is used to reduce the pressure at the bottom of the tank to 2 PSI below atmospheric pressure. Test time is two (2) hours unless water is detected in the tank. If water is detected, then the test time is extended to 3 hours.

> Identifying and correcting for interfering factors

How does the method determine the presence and level of the ground water above the bottom of the tank?

- ☐ observation well near tank
- ☐ information from USGS, etc.
- ☐ information from personnel on-site
- ☐ presence of water in the tank
- ☒ other (describe briefly) NOT APPLICABLE
- ☐ level of ground water above bottom of the tank not determined

How does the method correct for the interference due to the presence of ground water above the bottom of the tank?

- ☐ head pressure increased by raising the level of the product
- ☐ different head pressures tested and leak rates compared
- ☐ tests for changes in water level in tank
- ☒ other (describe briefly) WATER IS DRAWN IN THROUGH A HOLE IN THE TANK. WATER INCREASE IS DETECTED, MEASURED, AND RECORDED.
- ☐ no action

Does the method measure inflow of water as well as loss of product (gallon per hour)?

- ☐ yes
- ☐ no

SYSTEM MEASURES INFLOW OF WATER BUT DOES NOT DIRECTLY QUANTIFY LOSS OF PRODUCT. WHEN PARTIAL VACUUM IS ESTABLISHED IN THE TANK, NO PRODUCT IS LOST TO THE ENVIRONMENT.

Does the method detect the presence of water in the bottom of the tank?

- ☒ yes
- ☐ no

How does the method identify the presence of vapor pockets?

- ☐ erratic temperature, level, or temperature-compensated volume readings
- ☐ sudden large changes in readings
- ☐ statistical analysis of variability of readings
- ☐ other (describe briefly) ____
- ☐ not identified
- ☒ not applicable; underfilled test method used

How does the method correct for the presence of vapor pockets?

☐ bleed off vapor and start test over
☐ identify periods of pocket movement and discount data from analysis
☐ other (describe briefly) ______________________________
☐ not corrected
☒ not applicable; underfilled test method used

How does the test method determine when tank deformation has stopped following delivery of product?

☐ wait a specified period of time before beginning test
☐ watch the data trends and begin test when decrease in product level has stopped
☐ other (describe briefly) ______________________________
☐ no procedure
☒ not applicable, does not affect principle of operation

Are the method's sensors calibrated before each test?

☐ yes
☒ no

If not, how often are the sensors calibrated?

☐ weekly
☐ monthly
☐ yearly or less frequently
☒ never Sensors are calibrated at the factory before delivery to the field. Computer continuously monitors calibration. Any recalibration is performed at Tanknology Q.C. Department - Houston.

> Interpreting test results

What effect is used to declare the tank to be leaking? (List all modes used by the method.)

1. Sonic emission of air ingress through leak in ullage area above fluid level.
2. Sonic emission of bubbles formed by air ingress through leaks in fluid bearing portion of tank.
3. Accumulation of water in bottom of tank from ingress through leak in any area of ta
4. Analysis of vacuum pump cycle.

If a change in volume is used to detect leaks, what threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

☐ 0.05 gallon per hour
☐ 0.10 gallon per hour
☐ 0.20 gallon per hour
☒ other Sonic emission of ingress of air bubbles in liquid; sonic emission of air ingress in ullage; ingress of water in tank; detected by increase in water; and vacuum pump cycle.

Under what conditions are test results considered inconclusive?

- ☐ ground-water level above bottom of tank
- ☐ presence of vapor pockets
- ☐ too much variability in the data (standard deviation beyond a given value)
- ☐ unexplained product volume increase
- ☒ other (describe briefly) NONE

Exceptions

Are there any conditions under which a test should not be conducted?

- ☐ ground-water level above bottom of tank
- ☐ presence of vapor pockets
- ☐ large difference between ground temperature and delivered product temperature
- ☐ extremely high or low ambient temperature
- ☐ invalid for some products (specify) ______
- ☐ soil not sufficiently porous
- ☒ other (describe briefly) PRODUCT LESS THAN 70% OR GREATER THAN 95%.

What are acceptable deviations from the standard testing protocol?

- ☐ none
- ☒ lengthen the duration of test (IF WATER IS FOUND IN THE TANK AT START OR END OF TEST, THEN LENGTHEN TEST PERIOD TO 3 HOURS OR LON
- ☐ other (describe briefly) ______

What elements of the test procedure are left to the discretion of the testing personnel on-site?

- ☐ waiting period between filling tank and beginning test
- ☒ length of test
- ☐ determination of presence of vapor pockets
- ☐ determination that tank deformation has subsided
- ☐ determination of "outlier" data that may be discarded
- ☐ other (describe briefly) ______
- ☐ none

Reporting Form for Leak Test Results
Nonvolumetric Tank Tightness Testing Method

Method Name: VacuTect

Name of Operators: Bender, Hennon, Jones, Nel.

Evaluation Period: from June 12, 1989 to January 30, 1990

Test No.	If applicable Date at Completion of Last Fill (m/d/y)	If applicable Time at Completion of Last Fill (military)	Date Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	If applicable Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Tank Tight? (Yes, No, or Test Invalid)	Test Conducted In Product or Ullage
Trial Run 1	N/A	N/A	22-Jan-90	1153	1351	N/A	0.00	0.00	Yes	Product
1	N/A	N/A	12-Jun-89	1120	1401	N/A	0.00	0.00	Yes	Product
2	N/A	N/A	12-Jun-89	1406	1434	N/A	0.20	0.20	No	Product
3	N/A	N/A	12-Jun-89	1445	1454	N/A	0.05	0.05	No	Product
4	N/A	N/A	12-Jun-89	1502	1511	N/A	0.20	0.20	No	Product
5	[illegible]	N/A	12-Jun-89	1516	1526	N/A	0.05	0.05	No	Product
6	N/A	N/A	12-Jun-89	1530	1730	N/A	0.00	0.00	Yes	Product
7	N/A	N/A	12-Jun-89	1735	1743	N/A	0.05	0.05	No	Product
8	N/A	N/A	12-Jun-89	1747	1756	N/A	0.20	0.20	No	Product
9	N/A	N/A	12-Jun-89	1801	1810	N/A	0.10	0.10	No	Product
10	N/A	N/A	13-Jun-89	711	719	N/A	0.05	0.05	No	Product
11	N/A	N/A	13-Jun-89	724	732	N/A	0.20	0.20	No	Product
12	N/A	N/A	13-Jun-89	741	750	N/A	0.10	0.10	No	Product
13	N/A	N/A	13-Jun-89	756	956	N/A	0.00	0.00	Yes	Product
14	N/A	N/A	13-Jun-89	1018	1026	N/A	0.10	0.10	No	Product
15	N/A	N/A	13-Jun-89	1030	1044	N/A	0.05	0.05	No	Product
16	N/A	N/A	13-Jun-89	1050	1250	N/A	0.00	0.00	Yes	Product
17	N/A	N/A	13-Jun-89	1256	1304	N/A	0.20	0.20	No	Product
18	N/A	N/A	13-Jun-89	1309	1318	N/A	0.10	0.10	No	Product
19	N/A	N/A	13-Jun-89	1324	1331	N/A	0.20	0.20	No	Product
20	N/A	N/A	13-Jun-89	1336	1351	N/A	0.05	0.05	No	Product
21	N/A	N/A	13-Jun-89	1407	1607	N/A	0.00	0.00	Yes	Product
22	N/A	N/A	13-Jun-89	1614	1814	N/A	0.00	0.00	Yes	Product

Reporting Form for Leak Test Results
Nonvolumetric Tank Tightness Testing Method

Method Name: VacuTect

Name of Operators: Bender, Hennon, Jones, Nelson

Evaluation Period: from June 12, 1989 to January 30, 1990

Test No.	If applicable Date at Completion of Last Fill (m/d/y)	If applicable Time at Completion of Last Fill (military)	Date Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	If applicable Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Tank Tight? (Yes, No, or Test Invalid)	Test Conducted In Product or Ullage
23	N/A	N/A	13-Jun-89	1820	1828	N/A	0.05	0.05	No	Product
24	N/A	N/A	13-Jun-89	1833	1841	N/A	0.20	0.20	No	Product
25	N/A	N/A	14-Jun-89	1413	1422	N/A	0.10	0.10	No	Product
26	N/A	N/A	14-Jun-89	1425	1440	N/A		0.022	No	Product
27	N/A	N/A	14-Jun-89	1442	1457	N/A		0.010	No	Product
28	N/A	N/A	14-Jun-89	1500	1515	N/A		0.857	No	Product
29	N/A	N/A	14-Jun-89	1517	1532	N/A		0.045	No	Product
30	N/A	N/A	14-Jun-89	1535	1550	N/A		0.507	No	Product
31	N/A	N/A	14-Jun-89	1553	1608	N/A		0.542	No	Product
32	N/A	N/A	14-Jun-89	1610	1625	N/A		0.102	No	Product
33	N/A	N/A	14-Jun-89	1628	1643	N/A		0.007	No	Product
34	N/A	N/A	14-Jun-89	1645	1700	N/A		0.140	No	Product
35	N/A	N/A	14-Jun-89	1704	1719	N/A		0.507	No	Product
36	N/A	N/A	14-Jun-89	1721	1736	N/A		0.175	No	Product
37	N/A	N/A	14-Jun-89	1739	1754	N/A		0.022	No	Product
38	N/A	N/A	23-Jan-90	742	802	N/A	0.05	0.05	No	Product
39	N/A	N/A	23-Jan-90	810	1010	N/A	0.00	0.00	Yes	Product
40	N/A	N/A	23-Jan-90	1016	1045	N/A	0.05	0.05	No	Product
41	N/A	N/A	23-Jan-90	1048	1249	N/A	0.00	0.00	Yes	Product
42	N/A	N/A	23-Jan-90	1300	1315	N/A	0.05	0.05	No	Product
43	N/A	N/A	23-Jan-90	1323	1338	N/A	0.05	0.05	No	Product
44	N/A	N/A	24-Jan-90	727	927	N/A	0.00	0.00	Yes	Product
45	N/A	N/A	24-Jan-90	928	940	N/A	0.05	0.05	No	Product
46	N/A	N/A	24-Jan-90	952	1008	N/A	0.05	0.05	No	Product

Reporting Form for Leak Test Results
Nonvolumetric Tank Tightness Testing Method

Method Name: VacuTect

Name of Operators: Bender, Hennon, Jones, Nelson

Evaluation Period: from June 12, 1989 to January 30, 1990

	If applicable	If applicable				If applicable				
Test No.	Date at Completion of Last Fill (m/d/y)	Time at Completion of Last Fill (military)	Date Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Tank Tight? (Yes, No, or Test Invalid)	Test Conducted In Product or Ullage
47	N/A	N/A	24-Jan-90	1013	1213	N/A	0.00	0.00	Yes	Product
48	N/A	N/A	24-Jan-90	1223	1423	N/A	0.00	0.00	Yes	Product
49	N/A	N/A	22-Jan-90	1408	1608	N/A	0.05	0.05	No	Ullage
50	N/A	N/A	23-Jan-90	1343	1543	N/A	0.00	0.00	Yes	Ullage
51	N/A	N/A	23-Jan-90	1550	1750	N/A	0.05	0.05	No	Ullage
52	N/A	N/A	23-Jan-90	1751	1951	N/A	0.10	0.10	No	Ullage,
53	N/A	N/A	24-Jan-90	1427	1627	N/A	0.00	0.00	Yes	Ullage
54	N/A	N/A	24-Jan-90	1630	1802	N/A	0.10	0.10	No	Ullage
55	N/A	N/A	25-Jan-90	726	840	N/A	0.10	0.10	No	Ullage
56	N/A	N/A	25-Jan-90	844	1044	N/A	0.00	0.00	Yes	Ullage
57	N/A	N/A	25-Jan-90	1049	1149	N/A	0.05	0.05	No	Ullage
58	N/A	N/A	25-Jan-90	1152	1239	N/A	0.10	0.10	No	Ullage
59	N/A	N/A	25-Jan-90	1243	1416	N/A	0.10	0.10	No	Ullage
60	N/A	N/A	25-Jan-90	1420	1547	N/A	0.05	0.05	No	Ullage
61	N/A	N/A	25-Jan-90	1550	1720	N/A	0.00	0.00	Yes	Ullage
62	N/A	N/A	25-Jan-90	1722	1816	N/A	0.10	0.10	No	Ullage
63	N/A	N/A	25-Jan-90	1820	1921	N/A	0.05	0.05	No	Ullage
64	N/A	N/A	26-Jan-90	800	1000	N/A	0.00	0.00	Yes	Ullage
65	N/A	N/A	26-Jan-90	1037	1237	N/A	0.05	0.05	No	Ullage
66	N/A	N/A	26-Jan-90	1243	1443	N/A	0.10	0.10	No	Ullage
67	N/A	N/A	26-Jan-90	1452	1652	N/A	0.00	0.00	Yes	Ullage
68	N/A	N/A	26-Jan-90	1655	1855	N/A	0.10	0.10	No	Ullage
69	N/A	N/A	29-Jan-90	756	957	N/A	0.00	0.00	Yes	Ullage
70	N/A	N/A	29-Jan-90	1010	206	N/A	0.05	0.05	No	Ullage

Reporting Form for Leak Test Results
Nonvolumetric Tank Tightness Testing Method

Method Name: VacuTect

Name of Operators: Bender, Hennon, Jones, Nelson

Evaluation Period: from June 12, 1989 to January 30, 1990

	If applicable	If applicable				If applicable				
Test No.	Date at Completion of Last Fill (m/d/y)	Time at Completion of Last Fill (military)	Date Test Began (m/d/y)	Time Test Began (military)	Time Test Ended (military)	Product Temperature Differential (deg F)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Tank Tight? (Yes, No, or Test Invalid)	Test Conducted In Product or Ullage
71	N/A	N/A	29-Jan-90	1211	1411	N/A	0.00	0.00	Yes	Ullage
72	N/A	N/A	29-Jan-90	1417	1617	N/A	0.10	0.10	No	Ullage
73	N/A	N/A	29-Jan-90	1621	1821	N/A	0.00	0.00	Yes	Ullage
74	N/A	N/A	29-Jan-90	1828	2014	N/A	0.05	0.05	No	Ullage
75	N/A	N/A	29-Jan-90	2019	2219	N/A	0.00	0.00	Yes	Ullage
76	N/A	N/A	30-Jan-90	719	919	N/A	0.10	0.10	No	Ullage
77	N/A	N/A	30-Jan-90	922	1124	N/A	0.05	0.05	No	Ullage
78	N/A	N/A	30-Jan-90	1138	1338	N/A	0.00	0.00	Yes	Ullage
79	N/A	N/A	30-Jan-90	1342	1542	N/A	0.10	0.10	No	Ullage
80	N/A	N/A	30-Jan-90	1545	1745	N/A	0.00	0.00	Yes	Ullage

Appendix D

SOIL-GAS ANALYSIS STANDARD OPERATING PROCEDURE

Columbia
Analytical
Services inc.

STANDARD OPERATING PROCEDURE
FOR
BTEX AND TPH ANALYSIS USING ADSORBENT TRAPS

I. SAMPLE PREPARATION
   A. ADD SURROGATE/INTERNAL STANDARD - 10 uL. OF THE 250 ppm 4-BROMOFLUOROBENZENE a,a,a-TRIFLUOROTOLUENE MIX TO TRAP.
   B. SLIDE TRAP INTO DESORBER ASSEMBLY AND CONNECT ASSEMBLY TO PURGE AND TRAP WITH PURGING SYSTEM DISABLED.
   C. DESORB TRAP ONTO COLUMN, CHECKING FOR LEAKS.

II. METHOD BLANK PREPARATION, ONE PER MATRIX, PER BATCH. ANALYZE A BLANK TRAP AS A SAMPLE.

III. MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) PREPARATION, a MS/MSD IS NOT ANALYZED DUE TO THE NATURE OF THE SAMPLING SCHEME.

IV. STANDARD PREPARATION (CONTINUING)
   A. ADD 10 uL. OF THE 250 ppm 4-BROMOFLUOROBENZENE a,a,a-TRIFLUOROTOLUENE MIX TO TRAP.
   B. ADD 5 uL. OF BTX-100 (100 ppm) TO TRAP.
   C. SLIDE TRAP INTO DESORBER ASSEMBLE AND CONNECT ASSEMBLY TO PURGE AND TRAP WITH PURGING SYSTEM DISABLED.
   D. DESORB TRAP ONTO COLUMN, CHECKING FOR LEAKS.

V. GASOLINE STANDARD PREPARATION (CONTINUING)
   A. ADD 10 uL. OF THE 250 ppm 4-BROMOFLUOROBENZENE a,a,a-TRIFLUOROTOLUENE MIX TO TRAP.
   B. ADD 2.5 uL. OF 10,040 ppm GASOLINE STANDARD TO TRAP.
   C. SLIDE TRAP INTO DESORBER ASSEMBLE AND CONNECT ASSEMBLY TO PURGE AND TRAP WITH PURGING SYSTEM DISABLED.
   D. DESORB TRAP ONTO COLUMN, CHECKING FOR LEAKS.

VI. SETTING UP A RUN
   A. TURN ON PID LAMP.
   B. IF INSTRUMENT HAS BEEN IDLE FOR OVER 12 HOURS.
      1. INJECT A STANDARD TO CONDITION TRAP.
      2. INJECT A BLANK TO CLEAN SYSTEM.
   C. CHECK GASSES, REPLACE IF LESS THAN 500 PSI IN TANK.
   D. LET STANDARDS WARM UP TO ROOM TEMPERATURE FOR 1 HOUR.
   E. LOAD TEMPLATE METHOD ON MAXIMA.

- F. DEVELOP METHOD CHANGING ONLY.
  - 1. METHOD TITLE.
    - a. TITLE = ANALYSIS DATE (ie. BTEX 043090)
    - b. FILENAME = DATE (ie. 043090).
  - 2. SAMPLE QUEUE.
    - a. NAMING STANDARDS.
      - 1. DATE STANDARD CODE NUMBER.
        - a. DATE = MONTH YEAR.
        - b. STANDARD CODE.
          - 1. STD = METHOD STANDARD.
          - 2. GST = GASOLINE STANDARD.
        - c. NUMBER = 1,2,3,4...
      - 2. ie. 0430STD1.
    - b. NAMING METHOD BLANKS.
      - 1. DATE B NUMBER.
      - 2. ie. 0430B1.
    - c. NAMING MATRIX SPIKES (NOT ANALYZING).
    - d. NAMING SAMPLES.
      - 1. WORK ORDER - NUMBER.
      - 2. ie. 1364-1.
    - e. INITIAL CALIBRATION RUN.
      - 1. BLANK.
      - 2. 5 STANDARDS (ACQUIRE AS STANDARDS).
        - a. LOW CONCENTRATION = 0.1 ug.
        - b. HIGH CONCENTRATION = 5 ug.
      - 3. BLANK.
      - 4. 3 GASOLINE STANDARDS (ACQUIRE AS UNKNOWNS).
        - a. LOW CONCENTRATION = 0.5 mg.
        - b. HIGH CONCENTRATION = 10 mg.
      - 5. BLANK.
      - 6. TOTAL INJECTIONS = 11.
    - g. CONTINUING CALIBRATION RUN.
      - 1. BLANK.
      - 2. CONTINUING STANDARD (ACQUIRE AS A STANDARD).
      - 3. CONTINUING GASOLINE STANDARD (ACQUIRE AS AN UNKNOWN).
      - 4. BLANK.
      - 5. 10 SAMPLES (OR METHOD BLANK + 9 SAMPLES).
      - 6. CONTINUING STANDARD (ACQUIRE AS AN UNKNOWN).
      - 7. CONTINUING GASOLINE STANDARD (ACQUIRE AS AN UNKNOWN).
      - 16. TOTAL INJECTIONS = 16.
- G. SAVE RUN TO DISK.
- H. GO TO RUN MENU AND START.

VII. REVIEW DATA.
- A. PEAK INTEGRATION.
- B. PEAK VERIFICATION.

VIII.PROCESS STANDARD(S) TO DATABASE.

IX. WRITE STANDARD PEAK RESPONSES TO DIF FILE.

X. PRINT
   A. METHOD.
   B. CHROMATOGRAMS.
   C. CUSTOM RESULTS.

XI. CONCENTRATION CALCULATIONS.
CONCENTRATION IN AIR (ng/L) = UNKNOWN PEAK AREA (STANDARD CONCENTRATION IN ng) / STANDARD PEAK AREA (VOLUME OF AIR DRAWN THROUGH TRAP IN L).

XII. DOWN LOAD RUN TO FLOPPY DISK AND DELETE FROM HARD DRIVE.

XIII. IN LOTUS
   A. TRANSLATE DIF FILE TO WORKSHEET FILE.
   B. ENTER 123.
   C. LOAD WORKSHEET AND ANSWER ALL PROMPTS.

XIV. PRINT DIRECTORY OF DATA DISK.
   A. DIR A: >PRN (OR "A" ON BTEX COMPUTER).
   B. LABEL DATA DISK
      1. RUN/INSTRUMENT/ANALYST
      2. ie. 043090/BTEX/JLZ.

XV. QC BOOK
   A. PUT ONE COPY OF EACH LOTUS PRINTOUT INTO APPROPRIATE SECTION.
   B. REPORT BLANKS.

XVI. REPORTING SAMPLES.
   A. REPORT SAMPLES.
   B. REPORT SURROGATES.
   C. ONE LOTUS COPY OF SURROGATES IS ATTACHED TO DATA PACKAGE.
   D. SIGN OFF LOG IN SHEET.
   E. TURN IN DATA PACKAGE TO CAS/CORPORATE.
      1. WORK ORDER.
      2. SAMPLE RESULTS.
      3. REQUESTED QC RESULTS.
      4. WHITE COPY OF THE CHAIN OF CUSTODY.
      5. BILLING SHEET.

XVII. ARCHIVING DATA
   A. STAPLE ALL DATA ASSOCIATED WITH RUN TO CHROMATOGRAMS.
   B. ON A POST-IT NOTE WRITE THE FOLLOWING INFORMATION AND ATTACH TO DATA PACKAGE.
      1. RUN NAME.
      2. WORK ORDERS ON RUN.
   C. ARCHIVE DATA PACKAGE IN DATA BINDER.

Appendix E

CORRECTIVE ACTION AND SAMPLE ALTERNATION CHECKLIST

CORRECTIVE ACTION CHECKLIST

Project Name and Number:

Sample Dates Involved:

Measurement Parameters:

Acceptable Data Range:

Problem Area Requiring Corrective Action:

Measures Required to Correct Problem:

Means of Detecting Problems and Verifying Correction:

Initiator's Name: ______________________ Date: __________
Project Approval: ______________________ Date: __________
Laboratory Approval: ______________________ Date: __________
QA Officer/Reviewer: ______________________ Date: __________
Sample Control Center: ______________________ Date: __________

SAMPLE ALTERATION CHECKLIST

Project Name and Number:

Material to be Sampled:

Measurement Parameters:

Standard Procedure for Field Collection and Laboratory Analysis:
(cite references)

Reason for Change in Field Procedure or Analytical Variation:

Special Equipment, Material, or Personnel Required:

Initiator's Name: ______________________ Date: __________
Project Approval: ______________________ Date: __________
Laboratory Approval: ____________________ Date: __________
QA Officer/Reviewer: ____________________ Date: __________
Sample Control Center: __________________ Date: __________