Appendix A – Standard Operating Procedures

Standard Operating Procedures (SOPs) to be followed by CH2M HILL and it's subcontractors during implementation of the SAPs for Group 5 are described in this appendix. The SOPs include:

- SOP 1 - Utility Clearance
- SOP 2 – Surveying of Soil and Soil Vapor Borings
- SOP 3 - Surface Geophysics
- SOP 4 - Soil Vapor Sampling
- SOP 5 - Split-spoon or Geoprobe Soil Sampling
- SOP 6 - Soil Boring Drilling and Abandonment
- SOP 7 - Surface/Hand-Auger Sampling
- SOP 8 – VOC Soil Sampling
- SOP 9 - Borehole and Trench Sampling and Logging
- SOP 10 - Surface Water Sampling
- SOP 11 - Quality Control Sampling
- SOP 12 - Decontamination of Personnel and Equipment
- SOP 13 - Investigation-derived Waste Management
- SOP 14 - Packaging and Shipping Procedures
- SOP 15 - Chain-of-Custody Procedures
- SOP 16 - Documentation and Records

STANDARD OPERATING PROCEDURE 1

Utility Clearance

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for determining the presence of subsurface utilities where planned site activities involve the physical disturbance of subsurface materials.

2.0 Equipment and Materials

- Field logbook
- As-built plans
- Metal detector and/or magnetometer
- Ground penetrating radar

3.0 Procedures and Guidelines

Field procedures and guidelines described in Odgen (1996) procedure number FP-B-7, Utility Clearance (Attachment A) will be followed.

4.0 Key Checks and Items

- Check as-built plans prior to work being completed.
- Conduct interviews with site personnel about any utilities.
- Procedures and guidelines described in Odgen (1996) procedure number FP-B-7, Utility Clearance (Attachment A) will be followed.

5.0 References

Odgen. 1996. *RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory, Ventura Count, California, Volume III*, September.

Attachment A
Ogden (1996), Procedure Number FP-B-7, Utility Clearance

UTILITY CLEARANCE

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process for determining the presence of subsurface utilities and/or other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials. This SOP is applicable to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities. The primary purpose of this SOP is to minimize the potential for damaging underground utilities or other subsurface features which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

2.0 SCOPE

These procedures should be utilized to locate and identify the positions and types of underground utilities at sites where subsurface work is to be directed by Ogden. This procedure has been developed to serve as management-approved professional guidance for subsurface investigation programs. As professional guidance for specific activities, these procedures are not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviances from these procedures in planning or in execution of planned activities must be approved by the Project Manager and fully documented.

3.0 DEFINITIONS

3.1 UTILITY

For this procedure a utility is defined as a man-made underground line or conduit, cable, pipe, vault or tank which is, or was at sometime in the past, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewer, product transfer lines, or underground storage tanks.

3.2 AS-BUILT PLANS

Plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 TONING

Toning refers to the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Following identification of underground utility locations, toning is typically conducted following careful examination of all available site utilities. Colored spray paint is typically used to mark locations with colors corresponding to the type of utility being identified. In addition areas cleared are typically flagged or staked to indicate that all identified utilities in a given area have been toned.

4.0 RESPONSIBILITIES

It is the responsibility of the Project Manager to verify that these utility locating procedures are performed prior to active subsurface exploration work begins.

The onsite Field Program Manager is responsible for planning, and performance of underground utility field location and marking following these procedures. All field personnel involved in subsurface investigations shall be familiar with these procedures.

5.0 PROCEDURES

The following steps shall be followed at all sites where subsurface exploration is to include excavations, drilling or any other subsurface investigative method that could damage existing utilities at a site. In addition to the steps outlined below, personnel must always exercise caution while conducting subsurface exploratory work.

5.1 PREPARE PRELIMINARY SITE PLAN

A preliminary, scaled site plan depicting the proposed exploratory locations shall be prepared as part of the work plan. This plan should include as many of the cultural and natural features as practical.

5.2 REVIEW BACKGROUND INFORMATION

A search of existing plan files to review the as-built plans is necessary to identify the known location of utilities at the site. The locations of utilities identified shall be plotted onto the preliminary, scaled site plan. If utilities are within close proximity to a proposed exploration activity, the Project Manager shall be informed. The Project Manager or Field Manager will determine if it is necessary to relocate the exploration activity.

Interviews with onsite and facility personnel familiar with the site will be conducted to obtain additional information regarding the known and suspected locations of underground utilities. Utilities other than those identified on the as-built plans will be penciled in on the preliminary plans, at their approximate location including identification of dimensions, orientation, and depth. A corresponding entry into the field log will be made describing the type of utility, the personnel who provided the information and the date the information was provided.

During the pre-fieldwork interviewing process, the interviewer will determine what personnel at the site would need to be notified of any incident involving the damage to existing utilities. This information will be recorded in the field log book with the corresponding telephone numbers and addresses.

5.3 SITE VISIT - LOCATE UTILITIES - TONING

Prior to the initiation of field activities, a site visit shall be made by the field task manager or similarly qualified staff personnel. Careful observations of existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression, should be noted. Comparisons between the preliminary site plan and the actual site configuration will be made. Any deviations should be noted in the field logbook and on the preliminary site plan. All areas where subsurface exploration is proposed shall be accurately located or surveyed, and clearly marked with stakes, pins, flags, paint, or other suitable devices. These areas shall correspond with the locations drawn on the preliminary site plan.

Following the initial site visit by the field program managers, a trained utility locator will locate, identify and tone all utilities depicted on the preliminary site plan. The locator should utilize appropriate sensing equipment to attempt to locate any utilities that may not have appeared on the as-built plans. This may involve the use of surface geophysical methods (Procedure FP-B-1). At a minimum a utility locator, metal detector and/or magnetometer should be utilized; however, it is important to consider the possibility that non-metallic utilities or tanks may be present at the site. If the potential for the presence of non-metallic cultural features at the site is believed to be significant, other appropriate surface geophysical methods, such as Ground Penetrating Radar, should be used. Proposed exploration areas shall be cleared of all utilities. All anomalous areas should be clearly toned. All toned areas shall be clearly identified on the preliminary site plan. Upon completion of toning and the plotting on the preliminary site plan of all known or suspected buried utilities, the utility locator shall provide the field program manager with a copy of the completed preliminary site plan.

Any anomalous areas detected and toned that are in close proximity to the exploration areas shall be reported to the Field Program Manager. The field program manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate proposed exploration areas. If this is required, the field program manager or a similarly qualified individual shall relocate these areas and clearly mark them using the methods described above. The markings at the prior location shall be completely removed. The new locations shall be plotted on the site plan and the prior locations shall be deleted from the areas plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to hand dig, hand auger, or excavate with a backhoe to determine the location of the utilities.

5.4 Prepare Site Plan

Prior to the initiation of field activities, a final site plan shall be drafted which indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Copies of this site plan shall be provided to the field task manager, the Project Manager and the subcontractor who is to conduct the subsurface exploration work. The site plan should be reviewed with the client representative to verify its accuracy prior to initiating subsurface sampling activities.

6.0 RECORDS

A bound field logbook detailing all activities conducted during the utility locating procedure shall be kept. The logbook will describe any changes and modifications made to the original exploration plan. A report prepared by the trained utility locator shall be prepared and kept in the project file. A copy of the final site plan shall also be kept on file.

7.0 REFERENCES

Procedure FP-B-1, Surface Geophysics.

8.0 ATTACHMENTS

None.

STANDARD OPERATING PROCEDURE 2

Surveying of Soil and Soil Vapor Borings

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for surveying of soil and soil vapor borings.

2.0 Equipment and Materials

- Field logbook
- GPS

3.0 Procedures and Guidelines

Horizontal X and Y coordinates for soil and soil vapor boring locations will be surveyed using a Field Global Positioning System (GPS) with sub-meter accuracy and will be referenced to North American Datum of 1983 (NAD83).

STANDARD OPERATING PROCEDURE 3

Surface Geophysics

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for surface geophysical data to facilitate the collection of geologic, hydrogeologic, and geotechnical data. For subsurface sampling investigations using direct-push, drilling, or hand-augering techniques, surface geophysical methods are applied to locate buried objects such as underground utilities so that they can be avoided during sampling activities.

2.0 Equipment and Materials

- Field logbook
- GPS, magnetometers, and other geophysical instruments

3.0 Procedures and Guidelines

Field procedures and guidelines described in Ogden (1996) procedure number FP-B-1, Surface Geophysics (Attachment A) will be followed.

4.0 Key Checks and Items

- Instrumentation must be calibrated.
- Procedures and guidelines described in Ogden (1996), procedure number FP-B-1, Surface Geophysics (Attachment A) will be followed.

5.0 References

Ogden. 1996. *RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory, Ventura Count, California, Volume III*, September.

Attachment A
Ogden (1996), Procedure Number FP-B-1, Surface Geophysics

SURFACE GEOPHYSICS

1.0 PURPOSE

This procedure describes the procedures needed to acquire surface geophysical data to facilitate the collection of geologic, hydrogeologic, and geotechnical data related to hazardous waste site characterization.

2.0 SCOPE

This procedure has been developed as an aid in determining whether surface geophysics should be used at a site, the most applicable methods for a particular objective and proper field procedures to be followed. As professional guidance for specific guidance activities, this procedure is not intended to obviate the need for professional judgment to accommodate unforeseen circumstances. Deviation from this procedure in planning or in the execution of planned activities must be approved by management personnel and documented.

3.0 DEFINITIONS

The following definitions apply to a number of terms contained herein. For a more complete set of terms and definitions, refer to R.E. Sheriff (1990).

3.1 COUPLING

Interaction between systems.

1. Device for fastening together, as the plugs for connecting electrical cables.

2. Aspects which affect energy transfer. Thus the "coupling of a geophone to the ground" involves the quality of the plant (how firmly the two are in contact) and also considerations of the geophone's weight and base area, because the

geophone-ground coupling system has natural resonances and introduces a filtering action.

3. The type of mutual electrical relationship between two closely related circuits. As coupling would exclude DC voltages by employing a series capacitive element. DC or direct coupling may exclude higher frequency signals by using a capacitive element across the inputs or may allow all components to pass.

4. Capacitive coupling may occur because of mutual capacitive impedance, as between the wires in IP circuits or between a wire and ground.

5. Inductive coupling occurs because of mutual inductive impedance, such as between grounded IP transmitter and receiver circuits, especially at higher frequencies, greater distances, or lower earth resistivity. This may give rise to false IP anomalies. Also called electromagnetic or EM coupling.

6. Resistive coupling in IP surveying is due to leakage between wires, between a wire and ground, or through the resistance of the ground itself between two grounded circuits.

3.2 Electrical Log

1. A generic term including all electrical borehole logs (SP, normal, lateral, induction, microresistivity logs).

2. Also used for records of surface resistivity surveying; compare electrical survey.

3. Electrolog, a borehole log which usually consists of SP and two or more resistivity logs, such as short and long normal and long lateral resistivity logs. Electrolog is a Dresser Atlas tradename.

3.3 Electrical Sounding

An IP, resistivity method, or electromagnetic method in which electrode or antenna spacing is increased to obtain information from successively greater depths at a given surface location. Electromagnetic sounding can also be done with a fixed spacing by varying the frequency (time-domain technique). Electrical sounding is intended to detect changes in resistivity of the earth with depth at this location (assuming horizontal layering).

Electrical Survey:

1. Measurements at or near the earth's surface of natural or induced electrical fields to map mineral concentrations or for geological or basement mapping. See electrical profiling, electrical sounding, electromagnetic method, resistivity method, self-potential method, induced-polarization method, telluric method, and magnetotelluric method.

2. Electrical logs run in a borehole.

3.4 Electromagnetic Methods

A method in which the magnetic or electrical fields associated with artificially generated subsurface currents are measured. In general, electromagnetic methods are those in which the electric and magnetic fields in the earth satisfy the diffusion equation (which ignores displacement currents) but not Laplace's equation (which ignores induction effects) nor the wave equation (which includes displacement currents). One normally excludes methods which use microwave or higher frequencies (and which consequently have little effective penetration) and methods which use DC or very low frequencies in which induction effects are not important (resistivity and IP methods). Some methods such as Afmag which employ natural energy as the source are usually classified as electromagnetic methods whereas other methods using natural energy such as the magnetotelluric method are not.

3.5 GEOPHYSICS

1. The study of the earth by quantitative physical methods, especially by seismic reflection and refraction, gravity, magnetic, electrical, and radiation methods.

2. The application of physical principles to studies of the earth. Includes the branches of (a) seismology (earthquakes and elastic waves), (b) geothermometry (heating of the earth, heat flow, and volcanology and hot springs), (c) hydrology (ground and surface water and sometimes including glaciology), (d) oceanography, (e) meteorology, (f) gravity and geodesy (the earth's gravitational field and the size and form of the earth), (g) atmospheric electricity and terrestrial magnetism (including ionosphere, Van Allen belts, telluric currents, etc.), (h) tectonophysics (geological processes in the earth), and (i) exploration and engineering geophysics. Geochronology (the dating of earth history) and geocosmogony (the origin of the earth) are sometimes added to the foregoing list. Enthusiasts in particular branches are inclined to appropriate the word "geophysics" to their own branch exclusively, whether that branch be ianospheric studies or exploration for oil.

3. Exploration geophysics is the use of seismic, gravity, magnetic, electrical, electromagnetic, etc., methods in the search for oil, gas, minerals, water, etc., for economic exploitation.

3.6 INDUCED POLARIZATION

1. Usually abbreviated IP. An exploration method involving measurement of the slow decay of voltage in the ground following the cessation of an excitation current pulse (time-domain method) or low frequency (below 100 hz) variations of earth impedance (frequency-domain method). Also known as the overvoltage method. Refers particularly to electrode polarization (overvoltage) and membrane polarization of the earth. Also called induced potential, overvoltage, or interfacial polarization. Various electrode configurations are used.

2. The production of a double layer of charge at mineral interfaces or of changes in such double layers as a result of applied electric or magnetic fluids.

3.7 Low-Velocity Layer

1. Weathering; a near-surface belt of very low-velocity material.

2. A layer of velocity lower than that of shallower refractors. See blind zone.

3. The B-layer in the upper mantle from 60 to 250 km deep, where velocities are about 6 percent lower than in the outermost mantle.

4. The region just inside the earth's core.

3.8 Resistance

Opposition to the flow of a direct current.

3.9 Resistivity

The property of a material which resists the flow of electrical current. Also called specific resistance. The ratio of electric-field intensity to current density. The reciprocal of resistivity is conductivity. In nonisotropic material the resistivity is a tensor.

3.10 Resistivity Logs

1. Well logs which depend on electrical resistivity, normal, lateral, laterolog, and induction log. Most resistivity logs derive their readings from 10 to 100 ft^3 of material about the sonde. Microresistivity logs on the other hand derive their readings from a few cubic inches of material near the borehole wall.

2. Records of surface resistivity methods.

3.11 RESISTIVITY METHOD

1 Observation of electric fields caused by current introduced into the ground as a means for studying earth resistivity in geophysical exploration. The term is normally restricted to include only those methods in which a very low frequency or direct current is used to measure the apparent resistivity. Includes electrical profiling and electrical sounding. Various array types are used.

2. Sometimes includes induced-polarization and electromagnetic-survey methods also.

3.12 SEISMIC SURVEY

A program for mapping geologic structure by creating seismic waves and observing the arrival time of the waves reflected from acoustic-impedance contrasts or refracted through high-velocity members. A reflection survey is usually implied unless refraction survey is specifically mentioned. The energy source for creating the waves is usually impulsive (i.e., energy is delivered to the earth for a very short period of time) although energy is introduced for considerable time with the Vibroseis method. The energy is detected by arrays of geophones or hydrophones connected to amplifiers, and the information is amplified and recorded for interpretation. The data often are processed to enhance the wanted information (signal) and displayed in record-section form. Signal is recognized as a coherent event, although noise often is coherent also. Events considered to be reflections from acoustic-impedance contrasts (reflectors) are used to locate the reflectors, it being assumed that their attitudes are that of the geologic structure. Events attributed to be head waves are used to locate the refractors of which they are characteristic, it being assumed that the attitudes of these refractors are those of the geologic structure. Velocity analysis is also done on reflection data where the offset varies.

3.13 SELF-POTENTIAL/SPONTANEOUS POTENTIAL (SP)

1. A well log of the difference between the potential of a movable electrode in the borehole and a fixed reference electrode at the surface. The SP results from electrochemical SP and electrokinetic potentials which are present at the interface between permeable beds adjacent to shale. In impermeable shales, the SP is fairly constant at the shale base-line value. In permeable formations the deflection depends on the contrast between the ion content of the formation water and the drilling fluid, the clay content, the bed thickness, invasion, and bed-boundary effects, etc. in thick, permeable, clean nonshale formations, the SP has the fairly constant sand line value, which will change if the salinity of the formation water changes. In sands containing disseminated clay (shale), the SP will not reach the sand line and a pseudostatic SP value will be recorded. The SP is positive with respect to the shale base-line in sands filled with fluids fresher than the borehole fluid (also SSP).

2. The DC or slowly varying natural ground voltage observed between nearby nonpolarizing electrodes in field surveying. In many mineralized areas this is caused by electrochemical reaction at an electrically conducting sulfide body.

3.14 TELLURIC

Of the earth. Often refers specifically to telluric currents.

3.15 TELLURIC CURRENT

A natural electrical earth current of very low frequency which extends over large regions and may vary cyclically in that direction. Telluric currents are widespread, originating in variations of the earth's magnetic field.

4.0 RESPONSIBILITIES

The Project Manager is responsible for determining whether surface geophysical methods should be used on a project and if so, which methods should be used. This information should be included in the site sampling plan.

The Field Program Manager (FPM) is responsible for ensuring that the appropriate selected procedures are conducted according to the instructions in this manual and the project specific sampling plan. In many cases, these procedures will be conducted by subcontractors. In these situations, the FPM is responsible for overseeing and directing the activities of the subcontractor. Of particular importance is the need to establish site-specific quality control procedures.

5.0 PROCEDURES

5.1 METHOD SUMMARY

A wide variety of surface-based geophysical methods exist that may apply to contamination delineation, geologic, hydrogeologic, or other site characterization/investigation requirements. In general, geophysical exploration methods provide for a non-invasive mapping of subsurface features through the measurement of the physical properties of a subsurface. Typically, an active signal (e.g., acoustic or electrical) propagates into the earth and the interaction of the signal with the subsurface materials is measured at the surface. Interpretation of the data provides for a map or image of the subsurface, for example, electrical conductivity of soils govern the propagation of an electrical signal through the subsurface. The geologic/hydrologic/waste characteristics are then inferred from an interpretation of the data or correlated with borehole data.

For a geophysical survey to be successful, the method of choice must be capable of resolving a particular physical characteristic that relates to the goals of the investigation. For example, if a zone of contaminated groundwater is being investigated by an electrical method, the electrical conductivity of the contaminated portion of the aquifer should be sufficiently different from the non-contaminated portion to allow for identification of the 'plume'. If the target (i.e., the high conductivity plume in this example) does not contrast sufficiently with the non-contaminated portion, then the geophysical survey will not be successful. Often, preliminary calculations or a trial survey can be performed to evaluate a particular method.

For purposes of this SOP, the geophysical methods discussed herein are classified as follows:

- Seismic methods. These include seismic refraction and reflection method and are typically applied to investigate depths to water or geologic structures (stratigraphic horizons or depth to bedrock).

- Electrical Methods. A wide variety of these exist. Included are Direct Current (DC) Resistivity, Complex Resistivity/Induced Polarization, Low-Frequency Electromagnetic (EM) Induction (i.e., loop-loop methods), VLF (Very Low Frequency EM), GPR (Ground Penetrating Radar), and metal detection equipment. These respond to variations in the electrical properties of a site, specifically the electrical conductivity and (for GPR) the dielectric/permitivity constant. Applications include general geologic/hydrologic mapping, identification of solute 'plumes,' and the detection of conductive metallic debris/objects.

- Potential Field Methods. Some methods do not require an active signal source and instead measure naturally occurring potential fields of the earth. These include measurements of the Earth's magnetic or gravitational fields. Magnetic methods are often used to detect the response of the Earth's magnetic field to metallic objects and can be very effective in locating buried metallic materials. Gravity methods respond to subtle density variations and are typically used to map the depth/thickness of alluvial basins or to detect cavities within consolidated sediments (e.g., Karst sinkholes).

While a number of geophysical methods may be applied at hazardous waste sites, the scope of this procedure is limited to the following commonly applied methods:

Seismic:	Refraction
Electrical:	DC Resistivity
	EM Induction (loop-loop)
	GPR
	Metal Detection
	Induced Polarization (IP)
Potential Field:	Magnetics

Often, geophysical contractors specialize in a particular survey method. The following references may be useful to provide additional information:

Journals: Geophysics (Society of Exploration Geophysics); Geophysical Exploration European Association of Exploration Geophysicists; occasionally - Groundwater, Groundwater Monitoring Review (National Water Well Association).

Telford, W.M., L.P. Geldart, R.E. Sheriff, D.A. Keys. 1978. Applied Geophysics, Cambridge University Press.

Dobrin, M.B. 1976. Introduction to Geophysical Prospecting, McGraw-Hill.

Sheriff, R.E. 1973, 1990. Encyclopedic Dictionary of Exploration Geophysics, Society of Exploration Geophysics.

5.2 METHOD LIMITATIONS/INTERFERENCES AND POTENTIAL PROBLEMS

Each of the geophysical methods discussed herein are typically designed and implemented on a site-specific basis. Care must be exercised to ensure that a particular method is applicable and that an identifiable target is likely to exist. A determination must be made that the exploration target can be resolved versus the background signal/site conditions and that cultural or other 'noise' problems will not interfere. 'Cultural Noise' is defined as near-surface or surficial features (e.g., power lines or traffic vibrations) that can potentially mask or overwhelm the signal produced by the subsurface target.

All of the survey methods require field instrumentation and electronics that may be impacted by extreme climactic variations. The equipment should be checked regularly (daily, at a minimum) to ensure internal calibration. The manufacturers' guidelines and specifications should be reviewed prior to any field application.

5.2.1 Seismic Method Limitations and Potential Problems

5.2.1.1 Refraction Surveys

Care should be exercised in avoiding the following potential problems:

- Poorly emplaced geophones, for example in loose soil;
- Poor couplings of induced signal (e.g., strike plate) with ground;
- Intermittent electrical shorts in geophone cable (never drag geophone cables);
- Wet geophone connections;
- Vibration due to wind and traffic-induced noise;
- Improper gain/filter settings;
- Insufficient signal strength; and
- Topographic irregularities. An accurate topographic survey is often required prior to field operations.

5.2.2 Electrical Method Limitations and Potential Problems

5.2.2.1 DC Resistivity

Measurement of electrical resistivity represents a bulk average of subsurface material resistivity. In some instances, the resistivity of the target material may not contrast sufficiently with 'background' material to be observed with this method, especially as the target material gets thinner and/or deeper. If highly conductive soils/rock are present at shallow depths, electrical current may not penetrate to depths beyond this layer. An electrical current always follows the path of least resistance.

The DC resistivity method has the following limitations or potential problems that may occur during a survey:

- Poorly coupled electrodes (insufficient grounding);

- Unshielded wires causing intermittent shorts;

- Background electrical noise such as natural currents (S.P. or telluric effects);

- Electromagnetic coupling with power lines, causing the introduction of induced electrical currents into the receiver wire;

- Grounded fence lines, power lines interfering with the survey;

- Inadequate signal power (increase current levels to produce sufficient signal to noise ratios);

- Very low resistivity layer at the surface preventing the electrical field from penetrating deeper layers; and

- Very high resistivity layer at the surface (e.g., dry sandy gravel) preventing the electrical field from penetrating the surface layer.

5.2.2.2 EM Method

A variety of EM methods may be applied; however, in practice the Geonics EM-31 and EM-34 Loop-Loop instruments are typically used in hazardous waste surveys. The EM methods are similar to DC methods in application and are sensitive to conductive materials except for the basic distinction that they are not electrically grounded. Complications may arise in the EM method in developed sites because above-ground, metallic objects or electrical fields may interfere. Power lines, automobiles, train tracks, water tanks, and other objects may completely dominate data results and render the method useless.

5.2.2.3 Ground Penetrating Radar (GPR) Methods

Ground penetrating radar (GPR) methods are often not useful where highly conductive conditions or clay is present at shallow depth. The high-frequency signal propagates as a function of both electrical conductivity and dielectric constant (permitivity). The selection of transmission frequency is important as high frequencies are rapidly attenuated and the signal may not penetrate. Often, a choice of frequencies is available and it is suggested that site-specific field tests be performed over known, observable targets to determine whether GPR is appropriate for use.

A number of potential problems may occur:

- Improperly adjusted/configured equipment (e.g., antenna gain, filter slopes or gain thresholds);
- Insufficient signal and/or poor transmission qualities of the materials found at a site (e.g., clay, saline water conditions); and
- The influence of reflected signals outside of the immediate zone of investigation upon the radar record (e.g., fences, power poles, buildings).

5.2.2.4 Metal Detection

Metal objects which are not targets of the survey, including those worn or carried by the operator, may interfere with measurements.

5.2.3 Potential Field Method Limitations and Problems

5.2.3.1 Magnetics

The signal measured by a magnetometer is time-varying and subject to solar storm induced variations. Specific problems that may occur include:

- Metal objects which are not survey targets, such as surficial metallic objects, may interfere with measurements;

- Metallic objects worn or carried by the operator;

- Lack of base station control to measure background field fluctuations; and

- Failure to maintain a constant sensor height with respect to ground elevation.

5.3 SURVEY DESIGN/PRE-FIELD PREPARATION

5.3.1 Survey Design

Prior to performing a field investigation, it is often possible to estimate the effectiveness of a surface geophysical survey using data interpretation software relevant to the survey or by other calculation methods. A sensitivity analysis is typically performed to determine if a geophysical target possesses sufficient contrast with background conditions to be detected using surface geophysics. In some instances, available site data or prior geophysical investigations may be available to obtain estimates of the geophysical characteristics of the site.

5.3.2 Field Preparation

A. Verify that the required geophysical equipment is pre-calibrated and operational.

B. Establish grid locations or set-up traverses for location of sampling stations. Survey the station locations and record on a scaled site plan.

C. Test and calibrate geophysical equipment.

5.4 FIELD PROCEDURES

The following procedures apply to geophysical surveys conducted at a hazardous waste site. Procedures may vary since equipment capabilities and methodologies are rapidly evolving. In general, make sure that field locations are surveyed, and recorded accurately and that the equipment is functional and calibrated. Typically, a control or base station location will be established to check the equipment response over the duration of the field investigation. In addition, make sure a high signal to noise (S/N) ratio can be maintained to obtain a geophysical response representative of the target/zone of interest.

5.4.1 Seismic Refraction Methods

Seismic refraction techniques are used to determine the structure of a site based upon the travel time or velocity of seismic waves within layers. Interpretation of the travel time variation along a traverse of geophones can yield information regarding the thickness and depth of buried strata. Seismic methods are often used to determine depths to specific horizons of contrasting seismic velocities such as bedrock, clay layers, or other lithologic contrasts, and the water table (under unconfined conditions).

Procedures

1. Check the seismic signal and noise conditions on the instrument to verify the proper functioning of geophones and cables and to check the instrument settings.

2. When hard copies of seismic records are not produced by the seismic field equipment, arrival time selected from the electronic display should be immediately plotted on a time/distance graph in the field. A hard copy of the data should generally be produced and kept in the record file. Problems with improper picks are often discovered by early inspection of these plots.

3. Background or offsite data may be required for correlation to site conditions. Correlation of the seismic data with electrical method results, if obtained, or

with borehole or outcrop data may be a useful means of assigning thickness or seismic velocities.

If possible, boring logs or other data should be analyzed to determine if low velocity (inverse layers) or thin beds may be present that might not be detected otherwise.

4. The seismic system should be run at a known standard base station for periodic check of instrument operation.

5. Properly store the data in digital form for subsequent processing and data evaluation.

5.4.2 Electrical Methods

5.4.2.1 DC Resistivity

The resistivity method provides a measurement of the bulk electrical resistivity of subsurface materials. Application of the method requires that a known electrical current be induced into the ground through a pair of surface electrodes. The resulting potential field (voltage) is measured between a second pair of surface electrodes. Evaluation of the subsurface electrical properties is performed based upon the current, voltage, and electrode position (array configuration).

Given the length of the wire cables, their connections to the electrodes and the coupling of the electrodes with the ground, there are a number of potential problems for obtaining reliable data (e.g., poor electrical contact, short and open circuits). These conditions can be minimized by careful observation of instrument readings and trends.

Procedures

Apparent resistivities should be calculated and plotted during field acquisition as a means of quality control. If VES sounding is performed, the data plots (curves) should be smooth, and discontinuous jumps in the data should not occur. Profiling data should also show a general trend in the data from one station to the next. However, abrupt changes may occur in both sounding and profiling data due to "noise" from near-surface inhomogeneities or electrode contact problems.

The resistivity instrument can be calibrated using standard resistors or by using the internal calibration circuits often contained within the equipment. Calibration is particularly important if the data are to be compared to resistivity measurements from other instruments or other parameters, such as specific conductance of water samples.

5.4.2.2 EM Methods

Electromagnetic methods (EM) provide a means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Electrical conductivity (the inverse of electrical resistivity) is a function of the type of soil, porosity, permeability, and the conductivity of fluids in the pore spaces. The EM method can be used to map natural subsurface conditions and conductive contaminant plumes. Additionally, trench boundaries, buried conductive wastes such as steel drums, metallic utility lines and steel underground storage tanks may potentially be located using EM techniques.

Following factory calibration, the instruments will generally retain their accuracy for long periods. However, a secondary standard area should be established at the field site by the user for periodic recalibration. This will provide a reference base station, to check "drift" in the instrument's performance and to permit correlation between instruments.

While precision can be easily checked simply by comparing subsequent measurements with the instrument at a standard site, accuracy is much more difficult to establish and maintain.

EM instruments are often used to obtain relative measurements. For these applications, maintenance of absolute accuracy is not critical; however, the precision of the instrument can be important. For example, in the initial mapping of the spatial extent of a contaminant plume, a moderate level of precision is necessary. If the same site is to be resurveyed annually to detect small changes in plume migration and movement, a very high level of precision is necessary.

If the objective of the survey is to obtain quantitative results from the EM data, for correlation to other measurable parameters (e.g., specific conditions), proper steps should be taken to assure good instrument calibration. This is particularly important when performing surveys in areas of low conductivity, where measurement errors can be significant.

The dynamic range of EM instruments varies from 1 to 1000 millmhos/meter (mmho/m). At the lower conductivities, near 1 mmho/m and less, it is difficult to induce sufficient current in the ground to produce a detectable response, hence readings may become unreliable. At conductivity values greater than about 100 mm/m, the received signal is no longer linearly proportional to subsurface conductivities, and corrections must be applied to the data, if it is to be used for quantitative purposes.

Procedures

1. Maintain or verify calibration records from the equipment supplier or manufacturer. The EM system should be regularly calibrated.

2. Prior to conducting a survey, a temporary site shall be selected on location for daily calibration checks. Calibration checks shall be made twice daily, before and after conducting daily survey operations. Readings shall repeat to +/-5 percent. Originals of all calibration records shall remain on-site, copies shall be submitted to the records file.

   Note: Calibration checks should be made outside the influence of power lines, buried utilities, buried metal objects, fences, etc. on a relatively flat surface.

3. Instrument stability shall be checked by the field operating party when there is local or distant thunderstorm activity. Electromagnetic radiation from

thunderstorms can generate noise in the EM system. Operations may have to be postponed during rainstorms and resumed when these have ceased.

4. Technical judgment shall be exercised such that conductivity readings recorded in the field are reasonable with respect to existing site conditions.

5. Instrument sensitivity settings should be recorded in the field notebook as readings are taken. The notebook should be submitted to the records file.

5.4.2.3 Ground Penetrating Radar

Ground Penetrating Radar (GPR) uses high frequency radio waves to acquire subsurface information. Energy is radiated downward into the subsurface through a small antenna which is moved slowly across the surface of the ground. Energy is reflected back to the receiving antenna, where variations in the return signal are continuously recorded. This data produces a continuous cross sectional "picture" or profile of shallow subsurface conditions. These responses are caused by radar wave reflections from interfaces of materials having different electrical properties. Such reflections are often associated with natural hydrogeologic conditions such as bedding, cementation, moisture content, clay content, voids, fractures, and intrusions, as well as man-made objects. The radar method has been used at numerous hazardous waste sites to evaluate natural soil and rock conditions, as well as to detect buried wastes and buried metallic objects.

The radar system measures two-way travel time from the transmitter antenna to a reflecting surface and back to the receiver antenna. Calibration of the radar system and data requires a two-step process:

1. First, the total time window (range) set by the operator must be accurately determined.

2. Second, the electromagnetic velocity (travel time) of the local soil-rock condition must be determined.

After completing these two steps, the radar data may then be calibrated for depths of particular features.

The time window (range) which has been picked for the survey is calibrated by use of a pulse generator in the field. This generator is used to produce a series of time marks on the graphic display, measured in nanoseconds. These pulses are counted to determine the total time range of the radar. A calibration curve can be made up for each radar system.

In order to precisely relate travel time to actual depth units, the velocity (or two-way travel time per unit distance) must be determined for the particular soil or rock found at the site.

Various levels of accuracy in determining travel time can be used. These may range from first order estimates to precisely measured onsite values.

Using the depth of a known target (trenches, road cuts or buried pipes/road culverts can provide a radar target of known depth), a radar record taken over the known target, and a time scale provided by the pulse generator will provide basic calibration record. From these data a two-way travel time can be accurately determined at the given target location. Since this approach may give accurate calibration at the specific site, the assumption must be made that conditions in other areas to be surveyed are the same as in the calibration areas. If they are not, errors will occur in determining depths.

If significant changes in soil type or moisture content occur with depth, travel time will not be the same throughout the vertical radar profile, and the vertical radar depth scale may be non-linear. Such a condition is common, and occurs whenever an unsaturated zone exists over a saturated zone.

Procedures

1. The time scale of the GPR unit shall be checked regularly for accuracy. This can be done either on or off the site by placing the GPR unit at a known distance from the ground, a wall, etc., and measuring the two-way travel time to that reflecting surface in the air. The velocity of electromagnetic waves in air

is 1 foot per nanosecond ($3x10^8$ m/sec.). The following equation shall be used:

$$t = 2d/c$$

where:

t = two-way travel time from antenna to the surface, (nanoseconds)
d = distance of antenna to the surface, (feet)
c = velocity of light in air, (1 foot/nanosecond)

2. Prior to conducting a survey, a GPR traverse should be conducted over a buried object of known depth (if available). From the two-way travel time and the measured burial depth of the object, the average electromagnetic wave velocity in soil can be calculated from the following equation:

$$V = 2d/t$$

The average dielectric constant of the soil is then calculated using:

$$Er = c^2/v^2$$

where:

Er = average relative dielectric constant of soil (unitless)
c = velocity of light in air (1 foot/nanosecond)
v = average electromagnetic wave velocity of the soil (feet/nanosecond)

Note: The equation above assumes a soil with a relative magnetic permeability of 1. Technical judgment shall be exercised such that soil velocity and relative dielectric constant values are reasonable with respect to existing site conditions.

3. A short GPR traverse shall be repeated twice daily over a known feature prior to and after conducting daily operations. Technical judgment shall be exercised to

ensure that variations between repeat readings are due to changing soil conditions rather than the electronics.

5.4.2.4 Magnetometers

Magnetometers are designed to provide measurements of the earth's magnetic field. In hazardous waste site investigations, magnetometers are invaluable for detecting buried drums and for delineating the boundaries of areas containing ferrous metallic debris.

Procedures

1. Check the proposed date of the magnetic survey for solar flares to ensure that anticipated background conditions do not occlude data collection (Bureau of Standards, Boulder, CO, Goldendale, WA).

2. Obtain a daily background reading in the immediate vicinity of the site to be surveyed. This reading should be outside the influence of all sources of cultural magnetic fields (e.g., power lines, pipeline, etc.). Technical judgment should be exercised such that the background reading is reasonable with regard to published data for the total magnetic field intensity at the site latitude and longitude. This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field.

3. Sequential readings should be taken twice daily, before and after normal magnetic surveying operations. These readings (within 10 seconds of each other) shall be taken at any location onsite, distant from cultural magnetic fields, and recorded in the field notebook. Two or three sequential readings should be sufficient. In the absence of magnetic storms (sudden and violent variations in the earth's magnetic field), the readings should compare within 0.1 to a few tenths of a gamma. Variations during magnetic storms may approach 1 gamma.

4. Base station readings should be taken so that the efforts of diurnal variation in the earth's magnetic field may be removed from the data. Magnetic storms can

be detected if the base station sampling frequency is high enough. It may be prudent to suspend operations during a magnetic storm and resume them when the storm has passed. Identification of such periods of rapid synoptic variation may be documented at a permanent base stations set-up onsite where continuous readings are automatically recorded every ten to fifteen minutes. Alternatively, readings may be manually recorded at a base stations during the survey every 45 to 60 minutes.

5. Use of automatic recording magnetometers requires recording in a field notebook the magnetometer readings for the first and last station of each traverse. The data recorded in the field notebook should be compared at the end of the day with data from the automatic recording device. Data recorded in the field notebook should be within 1 gamma of the values derived from the recording device. It is recommended that the data be transferred onto hard copies from the recording device on a daily basis.

   Total field measurements may be corrected for these time variations by employing a reference base station magnetometer; changes in the earth's field are removed by subtracting fixed base station readings from the moving survey data. Gradiometers do not require the use of a base station, as they inherently eliminate time variation in the data.

5.4.3 Post-Operations

Standard hazardous waste site protocols should be followed by geophysical personnel working at a site. In many cases, the geophysical survey may precede services that may result in personnel contact with hazardous waste/materials. Standard hazardous waste site decontamination procedures should be followed by geophysical personnel at all sites.

5.5 DATA REDUCTION/DATA INTERPRETATION

Geophysical surveys typically require significant data reduction and processing. The exact methodology depends upon the purpose, scope, and type of survey.

Data interpretation and presentation reports should note the following:

- Data reduction technique;
- Data processing steps;
- Technical basis for data processing;
- Survey location data;
- Site base map showing survey location or transects;
- Dates and times of survey;
- Interpretation results;
- Theoretical assumptions for the interpretation;
- Equipment used; and
- Data format (digital format, ASCII, SEG B., etc.).

5.6 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance procedures apply to all of the geophysical instrumentation and their use during data acquisition.

- All data transmittals will be documented on standard Chain-of-Custody forms. Copies of the Chain-of-Custody forms will be maintained with the field files on site.

- All geophysical instrumentation shall be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.

- Battery voltage levels for all instruments shall be monitored each day throughout the survey. Battery packs should be charged or replaced when voltage levels fall below the recommended level specified by geophysical equipment manufacturers.

6.0 RECORDS

The Field Program Manager is responsible for documenting all field activities in the field notebook. The Field Program Manager should also oversee all subcontractor activities and make sure that their documentation is complete.

7.0 REFERENCES

Benson, Richard C., Glaccum, Robert A., and Noel, Michael R. 1983. Geophysical Techniques and Sensing Buried Wastes and Waste Migration, USEPA, Las Vegas, Nevada, 236 p.

Weston. 1983. Standard Operating Procedure (Draft), CGMP.

Dobrin, M.B. 1976. Introduction to Geophysical Prospecting, McGraw-Hill.

Telford, W.M., L.P. Geldart, R.E. Sheriff, D.A. Keys. 1978. Applied Geophysics, Cambridge University Press.

Sheriff, R.E. 1973, 1990. Encyclopedic Dictionary of Exploration Geophysics, Society of Exploration Geophysics.

U.S Army Corps of Engineers.

8.0 ATTACHMENTS

None.

STANDARD OPERATING PROCEDURE 4

Soil Vapor Sampling

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for soil vapor sampling.

2.0 Equipment and Materials

- Field logbook
- Gas-tight glass sampling bulb fitted with Teflon stopcocks and a rubber sampling port
- Leak detection compound, pentane or isopropyl alcohol
- Gloves

3.0 Procedures and Guidelines

Field procedures and guidelines described in DTSC (2003) Advisory – Active Soil Vapor Investigations (Attachment A) and previous Santa Susana Field Laboratory sampling methods will be followed. All probes will be temporary and will be installed using the direct push method.

In addition to following the DTSC Advisory, each sample collected will be documented in a bound field log book as outlined in SOP 16, Documentation and Records. Chain-of-custody (COC) procedures will be performed in accordance to SOP 15, Chain-of-custody procedures. Quality control samples will be collected as described in SOP 11, Quality Control Samples. Decontamination of equipment will be conducted as described in SOP 12, Decontamination of Personnel and Equipment.

3.1 Drilling and Probe Installation

Soil vapor probes will be installed using a direct-push rig. The direct-push rig will advance a 2-inch outside diameter steel tube fitted with a drop-off well point. When the target sampling depth (or refusal) is reached, the direct-push rods will be withdrawn several inches to drop the well point and expose the open pipe end. The soil vapor probe will then be inserted down the rods with the bottom of the ¼-inch outside diameter (OD) polyethylene tubing. The bottom 6 to 8 inches of the tubing will be slotted to allow vapor flow and the bottom of the tubing will be left open. The probe will be placed at the bottom of the boring or 6 to 12 inches off the bottom to allow adequate vapor flow for sample collection. Filter pack material (clean silica sand) will be placed around the screened portion of the probe by pouring the sand down the open direct-push rods as the rods are slowly retracted. Granular bentonite will be placed above the filter pack and hydrated to seal the probe.

For limited-access locations, soil vapor probes will be installed with a portable rotohammer or drilled by hand using a narrow metal "slam bar". Soil vapor probes installed by the roto-hammer or slam bar will be installed similar to those installed by the direct-push rig.

Several feet of polyethylene tubing will be allowed to extend above the ground surface to allow for easy sampling. Each probe will be labeled with a unique sample ID with a permanent marker. A small metal screw or a small rubber cap will be packed at the end of the polyethylene tubing to prevent insects, soil, rain, or any foreign object from entering the tubing prior to sampling.

3.2 Purging and Sampling

Following the installation of the soil vapor probes, field protocols specify that samples not be collected for at least one hour to allow equilibration with subsurface soil vapor conditions. For all previous RFI sampling, equilibration time was 24 to 48 hours. Therefore, the soil vapor probes will be allowed to equilibrate for at least 24 to 48 hours prior to sampling. Soil vapor samples will be collected using a gas-tight glass sampling bulb fitted with Teflon stopcocks and a rubber sampling port. The glass sampling bulb will be shielded from direct sunlight by wrapping the bulb in aluminum foil. The glass bulb will be connected to a flow meter and a portable sampling pump. A flow of approximately 100 to 150 millimeters per minute (mL/min) will be maintained to purge between 7 and 10 purge-volumes from the soil vapor probe.

During sampling, an open jar containing a pentane- or isopropyl alcohol-soaked cloth will be placed adjacent to the sampling train. This is to ensure that there is no leak in the bentonite surface seal or that the sampling equipment seals allow ambient air into the sample. After the probe is purged, the soil vapor sample will be collected by attaching the glass sampling bulb to the sampling train.

Sample bulbs will be decontaminated by opening the bulb to ambient air overnight and then purging the bulb for several minutes prior to reuse. Additional decontamination procedures will be employed on bulbs that were used to collect samples that contained greater than approximately 1000 micrograms per liter (ug/L) total VOCs. The additional decontamination procedure includes disassembling the bulb/stopcock setup, baking the glass bulb in a warm oven, and rinsing the equipment with methanol prior to reassembling and collection of another sample.

4.0 Key Checks and Items

- Probes will be allowed to equilibrate for at least 24 to 48 hours prior to sampling.
- Purge Volume will be 7 to 10 purge volumes.
- Leak detection test will be performed for all probes using pentane or isopropyl alcohol.
- Procedures and guidelines described in DTSC (2003), Advisory – Active Soil Vapor Investigations (Attachment A) will be followed.

5.0 References

DTSC. 2003. *Advisory – Active Soil Vapor Investigations*, January.

Attachment A

DTSC (2003), Advisory – Active Soil Gas Investigations

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January 28, 2003

To: Interested Parties

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

In a coordinated effort, the Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board – Los Angeles Region (LARWQCB) have jointly developed the "Advisory – Active Soil Gas Investigations" (see the attached). This document is to ensure that consistent methodologies are applied during active soil gas investigations to produce high quality data for regulatory decision-making. The document has been reviewed by other government organizations and by the soil gas consulting community. Their comments have been considered and, where appropriate, incorporated in the document. This is an on-going effort to streamline the characterization of gas phase contaminant sites. As additional knowledge and experience are obtained, this Advisory may be modified as appropriate.

This document is issued by DTSC and LARWQCB as an Advisory subject to review and revision as necessary. The information in this Advisory should not be considered as regulations. Mention of trade names or commercial products does not constitute the Agency's endorsement or recommendation.

If you have any questions regarding this document, please contact the joint-agency project coordinator Mr. Joe Hwong, of DTSC, at (714) 484-5406.

Sincerely,

Edwin F. Lowry
Director
Department of Toxic Substances Control

Dennis A. Dickerson
Executive Officer
California Regional Water Quality Control Board
Los Angeles Region

Enclosure

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Web-site at www.dtsc.ca.gov.

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ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

As a coordinated effort, this document is issued by the California Regional Water Quality Control Board– Los Angeles Region (LARWQCB) and Department of Toxic Substances Control (DTSC) as an Advisory subject to review and revision as necessary. Mention of trade names or commercial products does not constitute the Agency's endorsement or recommendation. The information in this Advisory should not be considered as regulations. In this Advisory, "Agency" should mean LARWQCB and/or DTSC.

1.0 INTRODUCTION

Active soil gas investigations are useful to obtain vapor phase data at sites potentially affected by volatile organic compounds (VOCs), including chlorinated and aromatic hydrocarbons. Active soil gas investigations may also be used to investigate sites potentially affected by methane and hydrogen sulfide, and to measure fixed and biogenic gasses (e.g., oxygen, carbon dioxide, or carbon monoxide). Among other things, the data can be used to identify the source and determine the spatial distribution of VOC contamination at a site, or to estimate indoor air concentrations for risk assessment purposes.

For site characterization, the Agency encourages both soil gas and soil matrix sampling. Typically, soil gas data are more representative of actual site conditions in coarse-grained soil formations while soil matrix data are more representative of actual site conditions in fine-grained soil formations. For evaluating the risk associated with vapor intrusion to indoor air, soil gas data are the preferred contaminant data set, where practicable. Flux chamber and passive sampling methods are not discussed in this Advisory. Any sites where such sampling methods are necessary will be addressed separately.

On February 25, 1997, LARWQCB re-issued the "Interim Guidance for Active Soil Gas Investigation" (ASGI) as guidance for investigating sites with potential VOC contamination. Unless otherwise noted in this Advisory, the active soil gas investigation should be performed in accordance with the most current ASGI.

2.0 SUPPLEMENTAL RECOMMENDATIONS

The following sections supplement the ASGI in an effort to ensure that consistent methodologies are applied during soil gas investigations to produce reliable and defensible data of high quality. All sampling probe installation, sampling, and analytical procedures, whether or not discussed below, are subject to Agency review and approval.

2.1 Project Management
2.2 Soil Gas Sampling Probe Installation
2.3 Purge Volume Test
2.4 Leak Test
2.5 Purge/Sample Flow Rate
2.6 Soil Gas Sampling
2.7 Analysis of Soil Gas Samples

2.1 Project Management

2.1.1 Workplan: An appropriate workplan should be prepared and submitted to the Agency for review and approval at least 30 days prior to its implementation. Any variations or deviations from this Advisory should be specified in the workplan. The soil gas workplan can either be incorporated as part of a comprehensive site investigation workplan or as a stand-alone document, depending on site-specific circumstances.

2.1.2 Field Activities

A. The Agency should be notified 10 working days prior to implementation of field activities. All necessary permits and utility clearance(s) should be obtained prior to conducting any investigations described in this Advisory.

B. All engineering or geologic work (e.g., logging continuous soil cores, soil description) should be performed or supervised by a California Registered Professional in accordance with the Business and Professions Code, Chapters 7 and 12.5, and the California Code of Regulations, Title 16, Chapters 5 and 29.

In addition, for proposed school sites, all work performed should be under the direction and supervision of a project coordinator experienced in soil gas investigations [e.g., an Environmental Assessor as defined in Education Code Section 17210(b)].

C. Evaluation of raw data by Agency staff may occur either in the field or in the office.

1. Hard copies of the complete raw laboratory data, including handwritten data and field notes, should be provided to the Agency staff upon request.
2. Adjustments or modifications to the sampling program may be required by Agency staff to accommodate changes mandated by evaluation of the data set or unforeseen site conditions.

D. Investigation derived wastes (IDWs) should be managed as hazardous waste until proven otherwise or until specifically approved by the Agency as being non-hazardous waste. IDWs should be handled and disposed in accordance with federal, state and local requirements.

E. Field Variations

1. To expedite the completion of field activities and avoid potential project delays, contingencies should be proposed and included in the project workplan (e.g., soil matrix samples will also be collected if clayey soils [as defined in the Unified Soil Classification System (USCS)] are encountered during the proposed soil gas investigation).

2. The Agency field staff should be informed of any problems, unforeseen site conditions, or deviations from the approved workplan. When it becomes necessary to implement modifications to the approved workplan, the Agency should be notified and a verbal approval should be obtained before implementing changes.

F. Soil Matrix Sampling Requirements: Companion soil matrix sampling may be conducted concurrently with a soil gas investigation (in accordance with the ASGI, Section 5.0), except where extremely coarse-grained soils (as defined in USCS) are encountered or when specifically excluded by the Agency.

2.1.3 Soil Gas Investigation Reports: A soil gas investigation report including a discussion of field operations, deviations from the approved workplan, data inconsistencies, and other significant operational details should be prepared. The report may either be a stand-alone document in a format recommended by the Agency or be included within a site-specific assessment report. At a minimum, the report should contain the following:

A. Site plan map and probe location map at an appropriate scale as specified in the workplan (e.g., scale: one inch = 40 feet);

B. Final soil gas iso-concentration maps for contaminants of concern at the same scale as the site plan map;

C. Summary tables for analytical data, in micrograms per liter (μg/L), in accordance with the ASGI;

D. Legible copies of field and laboratory notes or logs;

E. All analytical results and Quality Assurance/Quality Control (QA/QC) information including tables and explanations of procedures, results, corrective actions and effect on the data, in the format specified by the Agency; and

F. Upon request, all raw data including chromatograms and calibration data should be submitted to the Agency.

2.2 Soil Gas Sampling Probe Installation

2.2.1 Lithology: Site soil or lithologic information should be used to select appropriate locations and depths for soil gas probes. If on-site lithologic information is not available prior to conducting the soil gas investigation, at least one (1) continuously cored boring to the proposed greatest depth of the soil gas investigation should be installed at the first sampling location, unless specifically waived or deferred by Agency. Depending on site conditions, additional continuously cored borings may be necessary.

A. Lithologic logs should be prepared for all borings (e.g., continuously cored borings, soil matrix sampling, geotechnical sampling, etc.). Note: This does not apply to direct-push soil gas probe installations.

B. Information gathered from the continuously cored borings may include soil physical parameters, geotechnical data and contaminant data.

C. If low-flow or no-flow conditions (e.g., fine-grained soil, clay, soil with vacuum readings that exceed approximately 10 inches of mercury or 136 inches of water) are encountered, soil matrix sampling using EPA Method 5035A should be conducted in these specific areas. Also see Section 4 of LARWQCB's "General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites" on use of EPA Method 5035A.

D. If the bottom five (5) feet of a continuously cored boring is composed of clay or soil with a vacuum exceeding approximately 10 inches of mercury or 136 inches of water, the continuously cored boring should be extended an additional five (5) feet to identify permeable zones. If the extended boring is also composed entirely of clay, the boring may be terminated. Special consideration should always be given to advancing borings and ensuring that a contaminant pathway is not being created through a low permeability zone.

2.2.2 Sample Spacing: A scaled site plan depicting potential or known areas of concern (e.g., existing or former sumps, trenches, drains, sewer lines, clarifiers, septic systems, piping, underground storage tanks [USTs], chemical or waste management units) should be provided in the project workplan. Sample spacing should be in accordance with the most current ASGI and may be modified based on site-specific conditions with Agency approval. To optimize detecting and delineating VOCs, the grid spacing should be modified to include biased sampling locations.

2.2.3 Sample Depth: Sample depths should be chosen to minimize the effects of changes in barometric pressure, temperature, or breakthrough of ambient air from the surface; and to ensure that representative samples are collected. Consideration should be given to the types of chemicals of concern and the lithology encountered.

A. At each sample location, soil gas probes should be installed at a minimum of one sample depth, generally at five (5) feet below ground surface (bgs), in accordance with the most current ASGI.

B. Samples should be collected near lithologic interfaces or based on field instrument readings (e.g., Flame Ionization Detector [FID], Photo Ionization Detector [PID]) from soil cuttings and/or cores to determine the location of maximum analyte concentrations at the top or bottom of the interface depending upon the analyte.

C. Multi-depth sampling is appropriate for any of the following locations:

1. Sites identified with subsurface structures (e.g., USTs, sumps, clarifiers, waste or chemical management units), subsurface sources (e.g., oil fields, artificial fill, buried animal waste), changes in lithology, and/or contaminated groundwater. Soil gas probes should be emplaced below the base of any subsurface structures, sources or backfilled materials in the vadose zone. Collection of deeper samples should be done in consultation with Agency staff;

2. Areas with significantly elevated VOC concentrations detected during shallow or previous vapor sampling;

3. Areas where elevated field instrument readings are encountered from soil matrix cuttings, cores or samples; or

4. In the annular space of groundwater monitoring wells during construction, where an assessment of the vertical extent of soil gas contamination is necessary.

D. If no lithologic change or contamination is observed, default sampling depths may be selected for multi-depth sampling. For example, soil gas samples may be collected at 5, 15, 25, 40 feet bgs, etc., until either the groundwater is encountered or VOCs are not detected, whichever comes first.

1. Additional samples may be necessary based on site conditions.

2. For Preliminary Endangerment Assessments: When 40 feet bgs is reached, collection of deeper samples may be waived.

However, assessment and/or characterization of the deeper vadose zone may be required in the future to protect groundwater resources.

2.2.4 Sampling Tubes: Sampling tubes should be of a small diameter (1/8 to 1/4 inch) and made of material (e.g., nylon, polyethylene, copper or stainless steel) which will not react or interact with site contaminants. For example, metal tubes should not be used for collection of hydrogen sulfide samples.

A. Clean, dry tubing should be utilized at all times. If moisture, water, or an unknown material is present in the probe prior to insertion, the tubing should be decontaminated or replaced.

B. After use at each location:

1. Non-reusable (e.g., nylon or polyethylene) sampling tubes should be discarded; or

2. Reusable sampling tubes should be properly decontaminated as specified in Section 2.2.7.

C. A drawing of the proposed probe tip design and construction should be included in the project workplan.

2.2.5 Soil Gas Probe Emplacement Methods

A. Permanent or Semi-permanent Soil Gas Probe Methods: Permanent or semi-permanent soil gas probes may be installed, using a variety of drilling methods. Please note that the mud rotary drilling method is not acceptable for soil gas probe emplacement. Other drilling methods such as air rotary and rotosonic can adversely affect soil gas data during and after drilling and will require extensive equilibration times. Therefore, they are not recommended. Other soil gas probe designs and construction (e.g., soil gas wells or nested wells) may be appropriate and should be discussed with Agency staff prior to emplacement. When additional sampling is not anticipated per consultation with the Agency, such probes may be properly removed or decommissioned after completion of the soil gas investigation.

1. The probe tip should be emplaced midway within a minimum of one (1) foot of sand pack. The sand pack should be appropriately sized (e.g., no smaller than the adjacent formation) and installed to minimize disruption of airflow to the sampling tip. See Figure 1 for more information.

2. At least one (1) foot of dry granular bentonite should be emplaced on top of each sand pack to preclude the infiltration

of hydrated bentonite grout. The borehole should be grouted to the surface with hydrated bentonite. With respect to deep probe construction with multiple probe depths, the borehole should be grouted between probes. One (1) foot of dry granular bentonite should be emplaced between the filter pack and the grout at each probe location. See Figure 2 for more information.

3. The use of a downhole probe support may be required for deep probe construction (e.g., 40 feet bgs for direct push probes).

   a. Such probe support may be constructed from a one-inch diameter bentonite/cement grouted PVC pipe or other solid rod, or equivalent, allowing probes to be positioned at measured intervals.

   b. The support should be properly sealed or solid (internally or externally) to avoid possible cross-contamination or ambient air intrusion.

   c. The probes should be properly attached to the exterior of the support prior to placement downhole.

   d. Alternative probe support designs should be described in the project workplan. If probe support will not be used for deep probes, justification should be included in the project workplan.

4. Tubing should be properly marked at the surface to identify the probe location and depth.

5. As-built diagrams for probes or wells should be submitted with the soil gas investigation report detailing the well identification and corresponding probe depths. A typical probe construction diagram may be submitted for probes with common design and installation.

6. Unless soil gas probes are removed or decommissioned, probes should be properly secured, capped and completed to prevent infiltration of water or ambient air into the subsurface and to prevent accidental damage or vandalism. For surface completions, the following components may be installed:

   a. Gas-tight valve or fitting for capping the sampling tube;

   b. Utility vault or meter box with ventilation holes and lock;

   c. Surface seal; and

   d. Guard posts.

B. Temporary Soil Gas Probe Emplacement Method: In general, the drive rod is driven to a predetermined depth and then pulled back to expose the inlets of the soil gas probe. After sample collection, both the drive rod and tubing are removed.

1. During installation of the probe, hydrated bentonite should be used to seal around the drive rod at ground surface to prevent ambient air intrusion from occurring.

2. The inner soil gas pathway from probe tip to the surface should be continuously sealed (e.g., a sampling tube attached to a screw adapter fitted with an o-ring and connected to the probe tip) to prevent infiltration.

2.2.6 Equilibration Time: During probe emplacement, subsurface conditions are disturbed. To allow for subsurface conditions to equilibrate, the following equilibration times are recommended:

A. For probes installed with the direct push method where the drive rod remains in the ground, purge volume test, leak test, and soil gas sampling should not be conducted for at least 20 minutes following probe installation.

B. For probes installed with the direct push method where the drive rod does not remain in the ground, purge volume test, leak test, and soil gas sampling should not be conducted for at least 30 minutes following probe installation.

C. For probes installed with hollow stem drilling methods, purge volume test, leak test, and soil gas sampling should not be conducted for at least 48 hours (depending on site lithologic or drilling conditions) after the soil gas probe installation.

D. Probe installation time should be recorded in the field log book.

2.2.7 Decontamination: After each use, drive rods and other reusable components should be properly decontaminated to prevent cross contamination. These methods include:

A. 3-stage wash and rinse (e.g., wash equipment with a non-phosphate detergent, rinse with tap water, and finally rinse with distilled water); and/or

B. Steam cleaning process.

2.3 Purge Volume Test

To ensure stagnant or ambient air is removed from the sampling system and to assure samples collected are representative of subsurface conditions, a purge volume versus contaminant concentration test should be conducted as the first soil gas sampling activity at the selected purge test point. The purge volume test is conducted by collecting and analyzing a sample for target compounds after the removal of appropriate purge volumes.

2.3.1 Purge Test Locations: The purge test location should be selected as near as possible to the anticipated or confirmed contaminant source, and in an area where soil gas concentrations are expected to be greatest based on lithology (e.g., coarse-grained sediments). The first purge test location should be selected through the workplan approval process or as a field decision in conjunction with Agency staff.

2.3.2 Purge Volume: The purge volume or "dead space volume" can be estimated based on a summation of the volume of the sample container (e.g., glass bulbs), internal volume of tubing used, and annular space around the probe tip. Summa™ canisters, syringe, and Tedlar™ bags are not included in the dead space volume calculation. The Agency recommends step purge tests of one (1), three (3), and seven (7) purge volumes be conducted as a means to determine the purge volume to be applied at all sampling points.

A. The appropriate purge volume should be selected based on the highest concentration for the compound(s) of concern detected during the step purge tests. The purge volume should be optimized for the compound(s) of greatest concern in accordance with Section 2.2 of the ASGI.

B. If VOCs are not detected in any of the step purge tests, a default of three (3) purge volumes should be extracted prior to sampling.

C. The step purge tests and purging should be conducted at the same rate soil gas is to be sampled (see Section 2.5).

D. The purge test data (e.g., calculated purge volume, rate and duration of each purge step) should be included in the report to support the purge volume selection.

2.3.3 Additional Purge Volume Test

A. Additional purge volume tests should be performed to ensure appropriate purge volumes are extracted if:

1. Widely variable or different site soils are encountered; or

2. The default purge volume is used and a VOC is newly detected.

B. If a new purge volume is selected after additional step purge tests are conducted, the soil gas investigation should be continued as follows:

1. In areas of the same or similar lithologic conditions:

   a. Re-sample 20 percent of the previously completed probes. This re-sampling requirement may be reduced or waived in consultation with Agency staff, depending on site conditions. If re-sampling indicates higher detections (e.g., more than 50 percent difference in samples detected at greater than or equal to 10 µg/L), all other previous probes should be re-sampled using the new purge volume.

   b. Continue the soil gas investigation with the newly selected purge volume in the remaining areas.

2. In areas of different lithologic conditions: Continue the soil gas investigation with the newly selected purge volume in the remaining areas.

2.4 Leak Test

Leakage during soil gas sampling may dilute samples with ambient air and produce results that underestimate actual site concentrations or contaminate the sample with external contaminants. Leak tests should be conducted to determine whether leakage is present (e.g., the leak check compound is detected and confirmed in the test sample after its application).

2.4.1 Leak tests should be conducted at every soil gas probe.

2.4.2 Leak Check Compounds: Tracer compounds, such as pentane, isopropanol, isobutene, propane, and butane, may be used as leak check compounds, if a detection limit (DL) of 10 µg/L or less can be achieved. These compounds may be contained in common products such as shaving cream.

2.4.3 A leak check compound should be placed at any location where ambient air could enter the sampling system or where cross contamination may occur, immediately before sampling. Locations of potential ambient air intrusion include:

A. Sample system connections;

B. Surface bentonite seals (e.g., around rods and tubing); or

C. Top of the Temporary Soil Gas Probe (see Section 2.2.5.B).

2.4.4 The leak test should include an analysis of the leak check compound. If a leak check compound is detected in the sample, the following actions should be followed:

A. The cause of the leak should be evaluated, determined and corrected through confirmation sampling;

B. If the leak check compound is suspected or detected as a site-specific contaminant, a new leak check compound should be used;

C. If leakage is confirmed and the problem can not be corrected, the soil gas probe should be properly decommissioned;

D. A replacement probe should be installed at least five (5) feet from the original probe decommissioned due to confirmed leakage, or consult with Agency staff; and

E. The leak check compound concentration detected in the soil gas sample should be included and discussed in the report.

2.5 Purge/Sample Flow Rate

Sampling and purging flow rates should not enhance compound partitioning during soil gas sampling. Samples should not be collected if field conditions as specified in Section 2.6.4 exist.

2.5.1 The purging or sampling flow rate should be attainable in the lithology adjacent to the soil gas probe.

A. To evaluate lithologic conditions adjacent to the soil gas probe (e.g., where no-flow or low-flow conditions), a vacuum gauge or similar device should be used between the soil gas sample tubing and the soil gas extraction devices (e.g., vacuum pump, Summa™ canister).

B. Gas tight syringes may also be used to qualitatively determine if a high vacuum soil condition (e.g., suction is felt while the plunger is being withdrawn) is present.

2.5.2 The Agency recommends purging or sampling at rates between 100 to 200 milliliters per minute (ml/min) to limit stripping, prevent ambient air from diluting the soil gas samples, and to reduce the variability of purging rates. The low flow purge rate increases the likelihood that representative samples may be collected. The purge/sample rate may be modified based on conditions encountered in individual soil gas probes. These modified rates should be documented in the soil gas report.

2.6 Soil Gas Sampling

After the soil gas probe is adequately purged, samples should be collected by appropriate methodologies.

2.6.1 Sample Container: Samples should be collected in gas-tight, opaque/dark containers (e.g., syringes, glass bulbs wrapped in aluminum foil, Summa™ canisters), so that light-sensitive or halogenated VOCs (e.g., vinyl chloride) will not degrade.

A. If a syringe is used, it should be leak-checked before each use by closing the exit valve and attempting to force ambient air through the needle.

B. If syringe samples are analyzed within five (5) minutes of collection, aluminum foil wrapping may not be necessary.

C. EPA Method TO-14A, TO-15, or an equivalent air analysis method, requires samples be collected in Summa™ canisters.

D. If a Summa™ canister is used, a flow regulator should be placed between the probe and the Summa™ canister to ensure the Summa™ canister is filled at the flow rate as specified in Section 2.5.2.

E. Tedlar™ bags should not be used to collect VOC samples.

F. Specific requirements for methane and hydrogen sulfide sample containers are specified in Section 2.7.9.

2.6.2 Sample Collection

A. Vacuum Pump: When a vacuum pump is used, samples should be collected on the intake side of the vacuum pump to prevent potential contamination from the pump. Vacuum readings or qualitative evidence of a vacuum should be recorded on field data sheets for each sample.

B. Shallow Samples: Care needs to be observed when collecting shallow soil gas samples to avoid sample breakthrough from the surface. Extensive purging or use of large volume sample containers (e.g., Summa™ canisters) should be avoided for collection of near-surface samples [e.g., shallower than five (5) feet bgs].

2.6.3 Sample Container Cleanliness and Decontamination

A. Prior to its first use at a site, each sample container should be assured clean by the analytical laboratory as follows:

1. New containers should be determined to be free of contaminants (e.g., lubricants) by either the supplier or the analytical laboratory; and

2. Reused/recycled containers: Method blank(s), as specified in Section 2.7.1.A, should be used to verify sample container cleanliness.

B. After each use, reusable sample containers should be properly decontaminated.

1. Glass syringes or bulbs should be disassembled and baked at 240° C for a minimum of 15 minutes or at 120° C for a minimum of 30 minutes, or be decontaminated by an equivalent method.

2. Summa™ canisters should be properly decontaminated as specified by appropriate EPA analytical methods.

3. During sampling activities using reused/recycled sampling containers (e.g., glass syringes, glass bulbs), at a minimum one (1) decontaminated sample container per 20 samples or per every 12 hours, whichever is more often, should be used as a method blank (as specified in Section 2.7.1.A) to verify and evaluate the effectiveness of decontamination procedures.

C. Plastic syringes should be used only once and then properly discarded.

2.6.4 Field Conditions: Field conditions, such as rainfall, irrigation, fine-grained sediments, or drilling conditions may affect the ability to collect soil gas samples.

A. Wet Conditions: If no-flow or low-flow conditions are caused by wet soils, the soil gas sampling should cease. In addition, the Agency recommends that the soil gas sampling should not be conducted during or immediately after a significant rain event (e.g., 1/2 inch or greater) or onsite watering.

B. If low flow conditions are determined to be from a specific lithology, a new probe should be installed at a greater depth or a new lateral location should be selected after evaluation of the site lithologic logs (See Section 2.2.1) or in consultation with Agency staff.

C. If moisture or unknown material is observed in the glass bulb or syringe, soil gas sampling should cease until the cause of the problem is determined and corrected.

D. If refusal occurs during drilling, soil gas samples should be collected as follows or in consultation with Agency staff.

1. For sample depths less than five feet, collect a soil gas sample following the precautions outlined in Section 2.6.2.B.

2. For sample depths greater than five feet, collect a soil gas sample at the depth of refusal.

3. A replacement probe should be installed within five (5) feet laterally from the original probe decommissioned due to refusal. If refusal still occurs after three tries, the sampling location may be abandoned.

2.6.5 Chain of Custody Records: A chain of custody form should be completed to maintain the custodial integrity of a sample. Probe installation times and sample collection times should be included in the soil gas report.

2.7 Analysis of Soil Gas Samples

2.7.1 Quality Assurance/Quality Control (QA/QC): The soil gas analytical laboratory should comply with the project Quality Assurance Project Plan (QAPP) and follow the QA/QC requirements of the most current ASGI and the employed EPA Method. If there is any inconsistency, the most restrictive and specific requirements should prevail. The analytical data should be consistent with the Data Quality Objectives (DQOs) established for the project. The Agency staff may inspect the field and/or laboratory QA/QC procedures. Copies of the QA/QC plan and laboratory calibration data should be presented to the Agency field staff upon request

Field QC samples should be collected, stored, transported and analyzed in a manner consistent with site samples. The following QC samples should be collected to support the sampling activity:

A. Sample Blanks

1. Method Blanks: Method blanks should be used to verify the effectiveness of decontamination procedures as specified in Section 2.6.3.B.3 and to detect any possible interference from ambient air.

2. Trip Blanks for Off-site Shipments: Whenever VOC samples are shipped offsite for analysis, a minimum of one (1) trip blank

per day should be collected and analyzed for the target compounds. Trip blanks, consisting of laboratory grade ultra pure air, are prepared to evaluate if the shipping and handling procedures are introducing contaminants into the samples, and if cross contamination in the form of VOC migration has occurred between the collected VOC samples. Trip blank containers and media should be the same as site samples.

B. Duplicate Samples: At least one (1) duplicate sample per laboratory per day should be field duplicate(s). Duplicate samples should be collected from areas of concern.

1. Duplicate samples should be collected in separate sample containers, at the same location and depth.

2. Duplicate samples should be collected immediately after the original sample.

C. Laboratory Control Samples and Dilution Procedure Duplicates: Laboratory Control Samples (LCS) and Dilution Procedure Duplicates (DPD) should be done in accordance with the most recent ASGI (Sections 3.5.0 and 3.12.4, respectively).

D. Split Samples: The Agency staff may request that split samples be collected and analyzed by a separate laboratory.

2.7.2 Laboratory Certification: Although the California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP) does not currently require certification for soil gas analytical laboratories, the Agency recommends laboratories utilizing EPA Methods 8260B, 8021B, and 8015B for analyses of soil gas samples obtain ELAP certifications for such EPA analytical methods accordingly. The Agency or DTSC's Hazardous Materials Laboratory (HML) staff may inspect the laboratory.

2.7.3 Detection Limits for Target Compounds: Analytical equipment calibration should be in accordance with the most current ASGI. Consideration and determination of appropriate DLs should be based on the DQOs of the investigation.

A. The DL for leak check compounds should be 10 μg/L or less (see Section 2.4.2). The DL for oxygen (O_2) and carbon dioxide (CO_2) should be one (1) percent or less. The DLs for methane and hydrogen sulfide are specified in Section 2.7.9.

B. If the investigation is being conducted to delineate the extent of contamination, a DL of 1 μg/L is appropriate for all targeted VOCs.

C. If the soil gas data are to be used to support risk assessment activities, a DL of 1 μg/L may be appropriate for the initial screening when evaluating all targeted VOCs. If the data are non-detect for all targeted VOCs, additional sampling with lower DLs is not required. If VOCs are detected, additional sampling, using a DL of 0.1 μg/L, may be required to confirm the non-detection of carcinogenic VOCs [see the Toxicity Criteria Database of the California Environmental Protection Agency, Office of Environmental Health Hazard (OEHHA), or the Integrated Risk Information System (IRIS) Database of the United States Environmental Protection Agency]. A DL of 0.1 μg/L may be proposed and used for all carcinogenic target VOCs from the beginning of the investigation.

D. Based on site-specific DQO needs, lower DLs may be required. Examples of sites requiring site-specifc DQO needs include, but are not limited to, chlorinated solvents sites, former industrial facilities and landfills. Several less common VOCs, not included on the ASGI-targeted compound list, may require lower detection limits [e.g., bis(chloromethyl)ether, DBCP (1,2-dibromo-3-chloropropane), or ethylene dibromide] when they are known or suspected to be present.

E. If the required DLs cannot be achieved by the proposed analytical method, additional sample analysis by a method achieving these DLs [e.g., EPA Method 8260B with selective ion method (SIM), TO-14A, TO-15] may be required. Use of these methods should comply with the QA/QC requirements as specified in Section 2.7.1.

F. For results with a high DL reported (e.g., due to matrix interference or dilution), the laboratory should provide a written explanation. Re-sampling and analyses may be required at the appropriate DL for a specific compound.

2.7.4 Sample Handling: Exposure to light, changes in temperature and pressure will accelerate sample degradation. To protect sample integrity:

A. Soil gas samples should not be chilled;

B. Soil gas samples should not be subjected to changes in ambient pressure. Shipping of sample containers by air should be avoided; and

C. If condensation is observed in the sample container, the sample should be discarded and a new sample should be collected.

2.7.5 Holding Time: All soil gas samples (e.g., samples of VOCs, methane, fixed gases, or biogenic gases), with the exception of hydrogen sulfide samples, should be analyzed within 30 minutes by an on-site mobile laboratory. Hydrogen sulfide samples should be analyzed as specified in Section 2.7.9.B.2. Under the following conditions, holding times may be extended and analyses performed off-site:

A. Soil gas samples collected in glass bulbs with surrogates added within 15 minutes of collection may be analyzed within 4 hours after collection;

B. Soil gas samples collected in Summa™ canisters may be analyzed within 72 hours after collection; and

C. Methane samples may be analyzed as specified in Section 2.7.9.A.2.

2.7.6 Analytical Methods

A. VOC Samples: All VOC samples should be analyzed using only a Gas Chromatograph/Mass Spectrometer (GC/MS) method (e.g., EPA Method 8260B, used for analysis of soil gas samples, EPA Method TO-14A or TO-15, or equivalent), except at well-characterized sites (e.g., VOCs are known to be present and confirmed based on previous GC/MS analyses). A non-GC/MS method (e.g., EPA Method 8021B, used for analysis of soil gas samples) may be used only for routine monitoring of VOC contamination at well-characterized sites.

If during routine monitoring, new VOC(s) were detected by a non-GC/MS method, then at least 10 percent of the samples with each newly identified VOC should be confirmed by a GC/MS method. Thereafter, routine monitoring can resume with the non-GC/MS method, including the new analyte(s).

B. Methane and Hydrogen Sulfide Samples: These gas samples should be analyzed using methods specified in Section 2.7.9.

2.7.7 Auto samplers may be used if:

A. One (1) sample is introduced at a time;

B. The sample vials are gas-tight and never opened after the sample is added;

C. Proper holding times are maintained (see Section 2.7.5); and

D. All samples are secured and under proper custody.

2.7.8 Target Compounds

A. VOCs

1. ASGI-Targeted Compounds: The ASGI (dated February 25, 1997) includes 23 primary and four (4) other target VOCs. All quantifiable results should be reported.

2. Others: The estimated results of all Tentatively Identified Compounds [TICs]) or non-AGSI-targeted compounds detected should be included in the report. If TICs or non-ASGI-targeted compounds are identified, contact the Agency to determine whether additional action is required (e.g., running additional standards to quantify TICs or non-ASGI compounds) and whether the use of these estimated data for risk evaluation is appropriate.

B. Leak Check Compounds: All quantifiable results should be reported as specified in Section 2.4.4.E.

C. Specific Compounds: Based on the site history and conditions, analyses for specific compounds may be required by the Agency staff. Examples include:

1. In areas where USTs or fuel pipelines are identified, soil gas samples should be analyzed for oxygenated compounds [e.g., methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE), di-isopropyl ether (DIPE), tertiary amyl methyl ether (TAME), tertiary butyl alcohol (TBA), and ethanol];

2. At oilfield sites where semi-VOCs or Total Petroleum Hydrocarbons (TPHs) are detected in the soil gas samples, fixed and biogenic gas (O_2, CO_2, and CH_4) data should be obtained using a Thermal-Conductivity Detector (TCD) or a hand-held instrument;

3. At petroleum contaminated sites (including oilfields), dairies, wetlands, landfills or other sites where the presence of methane and/or hydrogen sulfide is suspected, soil gas samples should be analyzed for methane and/or hydrogen sulfide;

4. At sites where use of chlorinated solvents with 1,4-dioxane is suspected or known to exist, soil gas samples may be analyzed for 1,4-dioxane with a detection limit of 1 $\mu g/L$; or

5. See Section 2.7.9.A.4 below.

2.7.9 Methane and Hydrogen Sulfide Sampling Programs: If the presence of methane and/or hydrogen sulfide is suspected, they should also be included in the analytical plan. After evaluating the initial soil gas data, the Agency may recommend that testing for methane or hydrogen sulfide cease.

A. Methane Sampling Program: Methane samples may be analyzed by a GC using modified EPA Method 8015B, EPA Method TO-3, or ASTM 3416M (EPA 3C), or by an appropriate hand-held instrument (e.g., Land Tech Gas Analyzer GA-90, Gas Emissions Monitor GEM-500, GEM-2000).

1. Detection Limit: The DL for methane analysis should not exceed 500 parts per million by volume (ppmv).

2. Methane Sample Containers: In addition to the gas-tight sample containers previously specified in Section 2.6.1, Tedlar™ bags may be used for collection of methane samples with a holding time of no more than 24 hours.

3. Methane Screening Level: When methane is detected at 1,000 ppmv or more, additional sampling and/or further investigation is recommended to identify the source(s).

4. At sites where methane is investigated and detected at a level of 5,000 ppmv or more, fixed and biogenic gas (O_2, CO_2, and CH_4) data should be obtained using a Thermal-Conductivity Detector (TCD) or a hand-held instrument.

5. To determine that the area is pressurized by migration of gases, pressure readings of each sampling tube system should be recorded in the field logs and reported along with the methane concentration.

6. Special GC Requirements: The GC method requires calibration curves for analytes such as methane since it is not a normal target analyte for such an analytical method.

7. Special Hand-Held Instruments Requirements: Hand-held instruments should be calibrated in accordance with the manufacture's instructions. When a hand-held instrument is used to analyze methane samples, the Agency recommends that at least 10 percent of all positive methane samples (e.g., more than 5,000 ppmv), rounded to the nearest whole number, be confirmed by another hand-held instrument (different unit or brand) or by a GC method.

B. Hydrogen Sulfide Sampling Program: Hydrogen sulfide may be analyzed by a GC using the South Coast Air Quality Management District (SCAQMD) Method 307-91 or EPA Method 16, or by an appropriate hand-held instrument (e.g., LTX-310 calibrated for hydrogen sulfide or Jerome 631-X).

1. Detection Limit: The DL should be equal to or less than 0.5 ppmv or be sensitive enough to allow for a modeled ambient air concentration (at least one microgram per cubic meter) at the soil surface.

2. Holding Time: Hydrogen sulfide samples should be extracted directly into a hand-held analyzer within 30 minutes of collection to minimize the risk of losing the hydrogen sulfide due to reaction with active surfaces. If a hand-held instrument is not used, hydrogen sulfide samples should be analyzed as below:

    a. Within 30 minutes of collection, using the GC procedures; or

    b. Within 24 hours of collection, if a surrogate is added to the samples, or 100 percent duplicate samples are collected.

3. Sample Containers: The following sample containers are recommended:

    a. Minimum one (1) liter black Tedlar™ bag fitted with polypropylene valves or the equivalent;

    b. 100-ml gas-tight syringe fitted with an inert valve and wrapped in aluminum foil;

    c. Gas-tight glass bulb wrapped in aluminum foil; or

    d. Glass-lined or silicon coated Summa™ canister.

4. Precautions

    a. Since hydrogen sulfide is extremely unstable in the presence of oxygen and moisture, contact of hydrogen sulfide samples with them should be avoided.

    b. Due to the high reactivity of hydrogen sulfide gas, contact of hydrogen sulfide samples with metallic or other non-passive surfaces should be avoided during sample collection, storage and analysis.

    c. Care must be taken so that GC components do not react with the sample. Typically glass-lined injection ports and Teflon™ tube packed columns are used to avoid loss of hydrogen sulfide due to reaction with active surfaces.

3.0 SOIL PARAMETERS

If the soil gas data will be used in a health risk assessment, an estimation of the indoor air concentration should be performed using soil gas data with an Agency approved or modified predictable indoor air model. Default values of input parameters may be used in accordance with the approved indoor air modeling guidance and in consultation with Agency staff. If default values are not used, site-specific soil parameters should be obtained as discussed below.

To assess health risk, indoor air quality, the threat of groundwater contamination from VOCs, or to evaluate the effectiveness of a proposed remedial technology, the following soil matrix parameters should be obtained from a minimum of three (3) sample locations (at depths* corresponding to or associated with the detected VOCs) for each soil type in association with the soil gas investigation:

3.1 Soil description performed and presented in accordance with the Unified Soil Classification System (USCS);

3.2 Density;

3.3 Organic carbon content of the soil** (by the Walkee Black Method);

3.4 Soil moisture;

3.5 Effective permeability***;

3.6 Porosity; and

3.7 Grain size distribution analysis (curve) and evaluation of fine-grained soil content (by wet sieve analysis and any supplementary methods as necessary) to determine the percent clay, silt and sand. (The grain size distribution analysis will be used to classify the soil in accordance with the U. S. Soil Conservation Service [SCS] soil type, which is the same as the U. S. Department of Agriculture soil type.)

* Samples may be collected from proposed depths at the continuously cored boring.
** This input parameter is required for soil matrix VOC samples only. This parameter sample should not be collected from an impacted area.
*** As an alternative, the measurements of saturated hydraulic conductivity may be used to estimate vapor permeability.

4.0 REFERENCES

Additional information may be found in the following documents:

American Society for Testing and Materials (ASTM), "Standard Guide for Soil Gas Monitoring in the Vadose Zone, ASTM Standard D 5314-92," January 1993; Reapproved 2001; website http://www.astm.org

California Regional Water Quality Control Board, Los Angeles Region, "Interim Guidance for Active Soil Gas Investigation," February 25, 1997

California Regional Water Quality Control Board, Los Angeles Region, "General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites," June 22, 2000

U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Publication SW-846, Third Edition," November 1986, as amended by Updates I (Jul. 1992), II (Sep. 1994), IIA (August 1993), IIB (Jan. 1995), III (Dec. 1996), IIIA (Apr. 1998), IVA (Jan. 1998) and IVB (Nov. 2000); website http://www.epa.gov/SW-846/main.html

U.S. Environmental Protection Agency, "U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA 540/R-94/012," February 1994; website http://www.epa.gov/region09/qa/superfundclp.html

U.S. Environmental Protection Agency, "Soil Gas Sampling, SOP#: 2042, Revision #: 0.0," June 1, 1996; website http://www.ert.org/respns_resrcs/sops.asp

U.S. Environmental Protection Agency, "Summa Canister Cleaning Procedures, SOP #1703, Rev. #: 0.0," 09/01/94; website http://www.ert.org/respns_resrcs/sops.asp

California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard (OEHHA), Toxicity Criteria Database; website http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

United States Environmental Protection Agency, Integrated Risk Information System (IRIS) Database; website http://www.epa.gov/iris/

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FOR MORE INFORMATION

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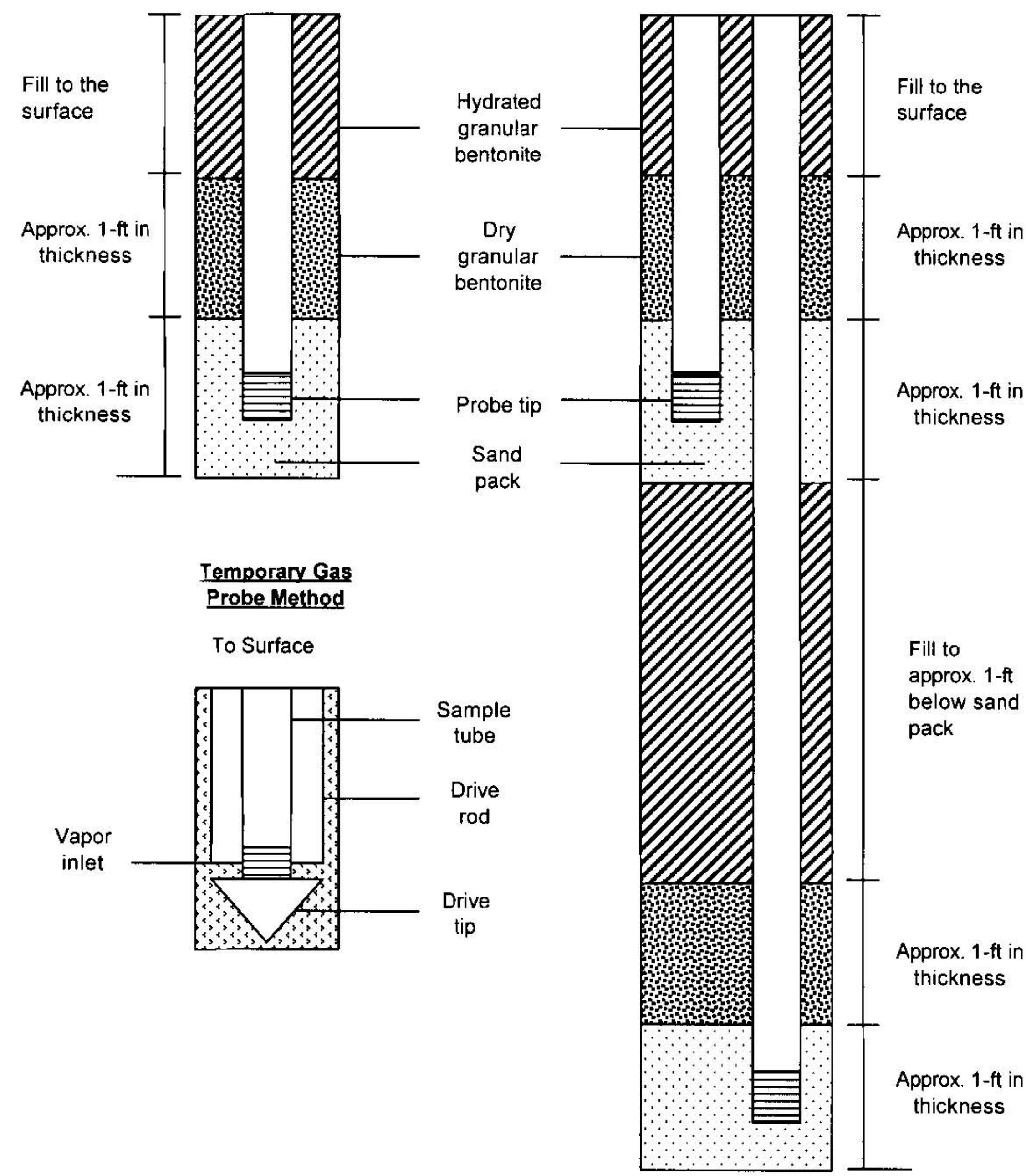
Figures – Soil Gas Probe Emplacement Methods

Figure 1 – Permanent/Semi-permanent Gas Probe Construction Diagram

Figure 2 – Multi-depth Gas Probe Construction Diagram



STANDARD OPERATING PROCEDURE 5

Split-Spoon or Geoprobe Soil Sampling

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for sampling subsurface soil produced from a split spoon or Geoprobe rig. This SOP covers the sample team's responsibility beginning with the opening of the MacroCore sampler.

2.0 Equipment and Materials

- Field logbook
- Latex or surgical gloves
- Stainless-steel tray or pan
- Stainless-steel spoon or spatula
- 6-inch long by 1.5 inch diameter thin-walled stainless steel sleeves and plastic end caps for sleeves
- Teflon liner sheets for end caps
- Decontamination solutions and equipment

3.0 Procedures and Guidelines

1. Field personnel will wear latex or surgical inner gloves and nitrile or neoprene outer gloves to protect from potential dermal contact with the soil.
2. A direct-push rig equipped with an open-tube MacroCore sampler consisting of a 48-inch-long, 2-inch-outer diameter (OD) core barrel capable of recovering a 45-inch-long, 1.5-inch diameter soil sample core will be used to obtain soil samples. The core barrel will be lined with pre-cleaned, thin-walled stainless steel sleeve measuring 6 inches long by 1.5 inches in diameter. The sampler will be fitted with sleeves, attached to the end of a 4-foot long steel probe and advanced a predetermined distance with the direct push rig. For limited-access sample locations, samples will be obtained as outlined in SOP 7, Surface Soil/Hand Auger Sampling SOP.
3. After the core barrel is removed from the borehole and opened by the driller, it will be turned over to the field personnel. For Geoprobe sampling, the stainless-steel sleeves will be removed from the drive tube and placed on the core table or on visqueen on the ground surface.
4. The sample description, depth, time, and date will be recorded on the borehole log form and in the field logbook.
5. Samples for laboratory analysis collected using the Geoprobe rig will be handled by submitting a stainless steel sleeve. Stainless steel sleeves will be capped at both ends.

VOCs will be collected using EnCore samplers as outlined in SOP 8, VOC Soil Sampling. A sample of the soil in the top liner typically is placed in a re-sealable plastic bag or 8-ounce clear glass jar and left in the sun for approximately 15 minutes to allow any volatile organic compounds (VOC) to volatilize. The soil vapor in the plastic bag is then measured for VOCs by taking a reading of the headspace with a field photo ionization detector. Background VOCs for the bag are determined by monitoring the air in an empty bag. Results of the organic vapor monitoring are recorded on the borehole log.

6. The core will be logged as described in SOP 9, Borehole and Trench Sampling and Logging.
7. Samples will be handled under chain-of-custody procedures, as outlined in SOP 15, Chain-of-Custody Procedures.
8. All samples will be documented as described in SOP 16, Documentation and Records. All samples will be packaged and shipped in accordance to SOP 14, Packaging and Shipping Procedures.
9. All equipment will be decontaminated as described in SOP 12, Decontamination of Personnel and Equipment before being used again.

4.0 Key Checks and Items

- Wear latex or surgical gloves.
- Decontaminate split spoon and transfer tools before next sample.
- Sample volatiles first, then semi-volatiles. Avoid mixing.
- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation-Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

STANDARD OPERATING PROCEDURE 6

Soil Boring Drilling and Abandonment

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) describes methods to obtain samples of subsurface soil using hollow-stem auger, rotary, sonic, or tripod-mounted rig drilling methods, and abandonment procedures for the borehole. The SOP briefly describes sampling methods. Other more detailed SOPs should be consulted regarding subsurface soil sampling, such as SOP 9, Borehole and Trench Sampling and Logging.

2.0 Equipment and Materials

- Truck-mounted drilling rig, skid rig, or barge-mounted tripod rig
- Hollow-stem augers and associated equipment
- Split-spoon or thin-walled tube samplers lined with 6-inch long and 1.5-inch diameter stainless steel sleeves
- Cement
- Bentonite
- Sand (for sand pack)
- Gloves
- Field Log Book

3.0 Procedures and Guidelines

3.1 Drilling

Use continuous-fight hollow-stem augers with an inside diameter of at least 3.25 inches. Do not use water or other fluid to assist in hollow-stem drilling. If water is needed to assist in drilling and for removal of cuttings, only the addition of distilled or potable water is permitted.

Place the bit of the auger or drill on the ground at the location to be drilled and then turn with the drilling or soilcoring rig. Advance the drilling to a depth just above the top of the interval to be sampled. While advancing the auger or drill to the full borehole depth, check the soils removed from the borehole for volatile organic compounds (VOCs) using a field photo ionization detector, or equivalent.

3.2 Sampling

Using a drilling rig, advance a hole to desired depth. For split-spoon sampling, collect the samples in accordance with American Society for Testing and Materials (ASTM) Standard D 1586. Lower the sampler into the borehole and drive to a depth equal to the total length of the sampler—typically 24 inches. Drive the sampler in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. Count and record the number of hammer blows (blow counts) for each 6-inch interval. Collect samples from the soil borings at the intervals specified in project specific work plan and sampling and analysis plan. Samples will be collected using 6-inch long and 1.5-inch diameter stainless steel sleeves. See SOP 9, Borehole and Trench Sampling and Logging, for more details on sampling and logging.

3.3 Borehole Destruction/Borehole Abandonment

The borehole shall be destroyed by placing non-stained, non-odorous soil cuttings and in the borehole and compacting the soil if groundwater has not been encountered. If the borehole is not filled to within 2 feet below ground surface (ft bgs) with the soil cuttings, then the remaining portion of the boring will be filled by thoroughly mixing a sand-cement or cement-bentonite grout and pumping the grout to the bottom of the borehole through a tremie pipe until the borehole is filled to ground surface. Dry holes less than 10 feet deep can be filled with grout poured from the surface. The grout mixture may be either cement and water or some combination of cement, bentonite, sand, and water. If groundwater is encountered, then the borehole will be abandoned by pumping grout down the boring. The grout should be completed to 2 feet below ground surface and completed to the surface with the same native surface material as the surrounding area. However, in areas with asphalt, concrete may be substituted since it is more durable than an asphalt patch.

The grout shall consist of clean water mixed with Type I or II Portland cement (or equivalent). It is also recommended that the grout include bentonite (3 to 5 percent by weight) to help reduce shrinkage. After the grout has set at least 12 hours, the grout shall be topped off if settlement has occurred.

Close attention should be paid to the mixture of the grout that is placed into the borehole. The recommended mixture consists of one sack (94 pounds) of dry cement mixed with 7.2 to 8.5 gallons of clean water and 3 to 5 percent of dry bentonite. The bentonite shall be pre-hydrated if possible. Less water is required for a neat cement grout. The optimum mix results in a volume of 1.5 to 1.6 cubic feet of slurry per sack of cement. The grout shall be mixed to a smooth, uniform consistency with no lumps or balls present.

3.4 Decontamination and Waste Disposal

Before sampling begins, decontaminate equipment according to the procedures identified in SOP 12, Decontamination of Personnel and Equipment. Clear the location to be sampled of debris and trash and note the location in the logbook.

Store and manage the soil cuttings as described in SOP 13, Investigation-Derived Waste.

4.0 Key Checks and Preventive Maintenance

- Check that the drill rig or soil-coring rig is in working order.
- Check that the borehole is backfilled with either soil cuttings or grout to the ground surface at the completion of drilling and sampling.

- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation- Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

STANDARD OPERATING PROCEDURE 7

Surface Soil/Hand-Auger Sampling

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides general guidelines for the collection and handling of surface soil samples for loosely-packed earth and is used to collect disturbed soil samples.

2.0 Equipment and Materials

- Gloves.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless-steel, Teflon, acetate, or glass materials should be used.
- A stainless-steel spatula should be used if the soil sample needs to be removed from the sampling device.
- Unpainted wooden stakes or pin flags.
- Fiberglass measuring tape (at least 200 feet long).
- Field Log book.

3.0 Procedures and Guidelines

1. Wear protective gear, as specified in the project health and safety plan.
2. To locate samples, identify the correct location using the pin flags, stakes, or painted markings on the ground surface. Proceed to collect a sample from the undisturbed soil adjacent to the marker following Steps 3 and 4 below. If markers are not present, the following procedures will be used.
    a. Use a measuring tape to position sampling point at the location described in the SAP by taking two measurements from fixed landmarks (e.g., corner of building, parking lot, or center of the intersection of two roads, etc.).
    b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.
    c. Proceed to sample as described in Step 3 below.
    d. Repeat a through c above until all samples are collected from the area.

3. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample as prescribed in the SAP. Do not locate samples in debris, tree roots, or standing water.

4. To collect samples:

   a. Use a decontaminated stainless-steel scoop/trowel to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

   b. If sampling:

      Surface soil: Obtain soil sample by using a hand auger to remove soil until prescribed depth in SAP is reached. Using a slide hammer with a stainless steel sleeve, obtain a sample.

      Subsurface soil: Obtain the subsurface soil sample using a hand auger to reach desired depth. To facilitate a hand-auger sample collection, measure the length of the auger bucket and place tape at 0.5-foot intervals on the hand-auger extensions. Collect the sample using a slide hammer with a stainless steel sleeve.

   c. If required in the SAP, based on known or suspected contaminants of concern, take an organic vapor meter reading of the sampled soil and record the response in the field notebook and soil boring log. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook and soil boring log.

   d. For volatile organic compounds (VOCs), collect samples using EnCore samplers as described in SOP 8, VOC Soil Sampling.

   e. For pesticides, polychlorinated biphenyls (PCBs), semi-volatile organic compounds, and target analyte list metals, cap the stainless steel sleeves on both ends with plastic end caps lined with Teflon liner sheets.

   f. To the extent possible, return appearance of sampling area to its pre-sampled condition.

4.0 Key Checks and Items

- Phthalate-free latex or surgical gloves and other personal protective equipment.
- Collect VOCs first using EnCore samplers.
- Decontaminate utensils before reuse, or use dedicated disposable utensils.
- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation-Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

STANDARD OPERATING PROCEDURE 8

VOC Soil Sampling

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for sampling soils for volatile organic compounds (VOCs).

2.0 Equipment and Materials

- Field logbook
- Latex or surgical gloves
- T-handle
- 5 gram Encore samplers
- Unpreserved 40-milliliter (mL) VOA vials
- 1 gram sodium bisulfate-preserved 40-mL VOA vials with 5 mL water
- gram methanol-preserved 40-mL VOA vials
- Decontamination solutions and equipment

3.0 Procedures and Guidelines

3.1 Soil Sampling with EnCore Sampler

The following procedure will be followed if a soil sample can be obtained using an EnCore sampler. If the soil sample is too coarse grained where an airtight sample can not be obtained or too saturated to push the EnCore sampler plunger, then another procedure will be followed as described in Section 3.2. Soil samples for laboratory analysis of VOCs will be collected from depths of at least 1 foot below ground surface.

1. Field personnel will wear latex or surgical inner gloves and nitrile or neoprene outer gloves to protect from potential dermal contact with the soil.

2. With clean gloves, remove the EnCore sampler from the resealable pouch and label the cap using the provided label on the pouch. Once the cap is labeled, place it back inside the pouch. If the Encore sampler or cap falls on the ground, dispose of the sampler and open a new EnCore sampler.

3. To insert the coring body into the T-handle, depress the locking lever located above the open end of the T-handle. The coring body is inserted, plunger end first, into the open end of the T-handle, aligning the two slots on the coring body with the two locking pins in the T-handle. Twist the coring body clockwise to lock the locking pins into the coring body slots.

4. Using the T-handle, push the EnCore sampler into the soil sample until the coring body is completely full. When full, the small O-ring will be centered in the T-handle viewing

hole. Once the coring body is full, remove the Encore sampler from the soil and wipe the excess soil from the coring body exterior with a paper towel.

5. Remove the cap from the sealable pouch, and cap the coring body while it is still on the T-handle. The cap will be placed over the open end of the coring body and aligned to allow the locking arms of the cap to pass through the flat areas of the coring body ridge. The cap will then be twisted to seat the locking arm grooves over the coring body ridge. The capped EnCore is then removed by depressing the locking lever on the T-handle. The coring body plunger will then be locked by rotating the extended plunger rod counter-clockwise until the wings rest firmly against the tabs.
6. Once capped, placed the EnCore sampler back into the resealable pouch. Label the outside of the pouch with the sample identification, time, and date. If only VOCs are being collected at the sampling location, some of the soil sample may be collected in a 40-mL unpreserved glass vial for moisture content analysis, if required. The vial will be labeled with the sample identification, time, and date and be sent to the lab for moisture content analysis so that a dry weight correction can be reported for the VOC analysis.
7. The sample description, depth, time, and date will be recorded on the borelog form and in the field logbook.
8. All equipment will be decontaminated before being used again.

3.2 Soil Sampling Using an Alternate Sample Technique

In the event that large gravel or cobbles or saturated soil are encountered, prohibiting sample collection in EnCore samplers, the project manager (PM) or field task manager (TM) shall be notified immediately so that the appropriate alternate sampling methodology, as described below, may be employed. The field task manager (TM) will directly supervise the implementation of any alternate sampling methodology or particle sample size reduction activities. Alternate sampling methodology will be based on the expected concentration range of the samples, as described below.

For low concentration soil samples, approximately 5 grams of sample will be collected into a 40-mL VOA vial with a screw cap and septum seal, supplied by the analytical laboratory and preserved with 1 gram of sodium bisulfate and 5 mL of water. Each VOA vial will be pre-weighed to the nearest 0.01 gram with the sodium bisulfate and recorded on the COC and field log book. The VOA vial will be sealed and weighed to the nearest 0.01 gram in the field with a portable balance. This final weight will be recorded on the chain-of-custody (COC) and the field log book. In the event that a sample larger than 5 gram must be collected, the amount of preservative must be adjusted to correspond to 0.2 gram of preservative to 1 gram of sample. A minimum of three-40-mL VOA vials per sample will be collected. If only VOC samples are collected, an additional 40-mL VOA vial without preservative will be collected for dry weight and screening purposes at the laboratory.

For high concentration soil samples, approximately 5 grams of sample will be collected into a 40-mL VOA vial prepared with 10 mL methanol. Each VOA will be pre-weighed to the nearest 0.01 gram with the methanol. One the sample is collected, the VOA vial will be re-weighed and recorded on the COC and field log book. A minimum of three 40-mL VOA vials per sample will be collected. If only VOC samples are collected, an additional VOA vial without preservative will be collected for dry weight and screening purposes at the laboratory.

In the event that the sample material will not fit intact into the VOA vial (i.e. larger gravel or cobbles), the sample will be broken up and immediately preserved as described above to minimize the loss of volatile components. The methods used to reduce the sample size of large cobbles and gravel will be determined on a case by case basis by the Project Manager or Field Manager and will be designed to minimize the disturbance to the sample. All methods used to reduce sample size will be documented in the field log book.

4.0 Key Checks and Items

- Wear latex or surgical gloves.
- Decontaminate T-handle before next sample.
- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation-Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

STANDARD OPERATING PROCEDURE 9

Borehole and Trench Logging

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil sampling activities. The characterization methods are based on visual examination and manual tests and not on laboratory examinations.

2.0 Equipment and Materials

- Field logbook
- Soil Boring log
- Waterproof or permanent ink pens
- Tape measure or other device graduated in tenths and hundredths of a foot
- Spatula or putty knife
- Munsell Soil Color chart
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index chart or table
- 10 percent hydrochloric acid solution or strong acetic acid solution
- EnCore and/or stainless steel sleeves
- Protective gloves
- Stainless steel sampling equipment
- Decontamination equipment (Alconox solution in spray bottle, brushes, buckets, rinse water spray bottle, distilled or portable water)

3.0 Procedures and Guidelines

The following covers aspects of soil characterization, including instructions for completing CH2M HILL soil boring log forms, and field classification of soil, and standard penetration test procedures for soils.

3.1 Instructions for Completing Soil Boring Logs

Soil boring logs will be completed on the soil boring log forms during the drilling activities at the time of the logging and soil descriptions. Information collected will be consistent with the standard CH2M HILL form (Attachment A). The information collected in the field to perform the soil characterization is described below.

The field team leader or lead geologist should review the completed forms for accuracy, clarity, and thoroughness of detail. A California Professional Geologist or Professional Engineer will oversee the field work. Sample information recorded on the soil boring log should be verified for consistency and accuracy with the field logbook, sample labels, and other field data sheets.

3.2 Soil Boring Log Heading Information

Boring/Well Number: Enter the boring or well number. The new number should be chosen to not conflict with information recorded from previous exploratory work at the site. Number the soil boring log sheets consecutively using subtotal and total page counts, such as Page 1 of 3, Page 2 of 3, and Page 3 of 3.

Location: If stationing, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as approximate or estimated. A detailed, accurate, and legible drawing should be included in the field logbook describing the boring location relative to local culture, such as distances to building corners, street intersections, or street signs.

Drilling Contractor: Enter the name of the drilling contractor.

Drilling Method and Equipment: Identify the drill rig type (hollow-stem, percussion hammer, air rotary, etc.) and model (CME75, Ingersoll Rand A60), drill bit size and type, drilling fluid, if used, and typical hole diameter based on the outside diameter of the drill bit (9-7/8 inches, 10 ¼ inches) or outside diameter of direct push rods.

Water Level and Date: Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment particularly if the water level is taken from an adjacent monitoring well or soil boring. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day of each water level measurement. Time of day will be recorded using 24-hour notation, such as 0910 for 9:10 AM.

Date / Time of Start and Finish: Enter the dates and times the boring was started and completed. Time of day should be added regardless if one or more borings are completed in a day since each soil boring log represents only one borehole. Time of day will be recorded using 24-hour notation, such as 0910 for 9:10 AM.

Geologist or Logger: Enter the first initial and full last name; middle initials are optional.

3.3 Borehole Sampling By Drilling

Split-spoon sampling procedures shall be executed in accordance with American Society for Testing and Materials (ASTM) D1586, Standard Method for Penetration Test and Split-barrel Sampling of Soils (ASTM, 1984). California (2-inch) or Modified California (2-1/2 inch) split-barrel samplers may also be used. The split-spoon or split-barrel sampler shall be advanced to the top of the sampling interval using a wire-line or sample rods such as A or AW. The larger-diameter samplers may be fitted with three 6-inch-long stainless-steel sleeves. The sampler shall be driven 18 inches, or to refusal, with a 140-pound hammer dropping repeatedly 30 inches. The number of blows required to drive the sampler each 6 inches shall be recorded on the soil boring log. Refusal shall be defined as requiring 50 blows with the hammer to advance the sampler less than 6 inches.

As the sample tubes are disassembled, an organic vapor monitor probe shall be inserted into the gap between the stainless steel sample liners, and the liner exhibiting the highest reading shall be selected for analysis. In general, the middle liner is collected for laboratory analysis, and 10 percent of the bottom liners are collected for quality assurance testing. A sample of the soil in the top liner typically is placed in a resealable plastic bag or 8-ounce clear glass jar and left in the sun for approximately 15 minutes to allow any volatile organic compounds (VOC) to volatilize. The soil vapor in the plastic bag is then measured for VOCs by taking a reading of the headspace. Background VOCs for the bag are determined by monitoring the air in an empty bag. Results of the organic vapor monitoring are recorded on the boring log. Small portions of soil at the ends of the sleeve are scraped off for classification.

Samples collected for laboratory analysis using split spoon sampling device will be submitted to the lab using stainless steel sleeves that have been capped with Teflon sheeting and plastic end caps on both ends. Samples for VOCs will be collected first using EnCore samples as described in SOP 8, VOC soil sampling.

Samples collected for laboratory analysis using a direct-push sampling drill rig will be handled by submitting stainless steel sleeves. The stainless steel sleeves will be capped with Teflon sheeting and plastic end caps at both ends, and taped with clear label or packing tape. Labels shall be affixed to the liners with job designation, time, boring number, sample depth interval, sample number, date sampled, and the initials of the sampler clearly marked. The samples shall then be enclosed in a plastic bag and stored in a cooler maintained at 4°C. Sample information shall be placed on the chain-of-custody, the borelog, and the field logbook. All samples shall be handled in accordance with SOP 15, Chain of Custody Procedures.

3.4 Technical Data Included on the Borehole Log

Soil encountered during drilling shall be classified by using ASTM Standard D2488 (ASTM 1993) (Attachment B to this SOP) unless otherwise specified in project sampling plans. Sampling activities shall be performed under the supervision of a California Professional Geologist or Professional Engineer experienced in environmental drilling and sampling. Sampling depths and total depths of holes shall be determined by temporary marking of drill equipment, by reference to standard equipment dimensions (for example, 5-foot hollow-stem auger flights), or by measurement using a fiberglass tape. Observations by the field geologist or engineer shall be recorded directly in the borehole log. The basic reporting requirements for subsurface lithologic logging shall be met by describing the encountered subsurface conditions on the borehole log, while documenting other information in a bound field logbook, as necessary.

The field borehole log is the standard form used to document subsurface geologic conditions. The borehole log is divided into two areas. One portion contains spaces for noting information on the drilling and sampling methods. The second portion contains space for noting lithologic descriptions. All sheets shall be filled out completely, legibly, and in ink. The borehole log will be filled out in the field at the time of the drilling and sampling. The original logs shall be permanent records, and information on the logs may not be erased. If corrections are needed, information shall be crossed out with a single line and the correction shall be initialed and dated.

Items documented on the borehole log include:

- **Depth Below Surface:** Depths recorded on the log shall be measured from ground surface. Use a scale that is appropriate for the sample logging and sample spacing and for the complexity of the subsurface conditions.
- **Sample Interval:** The top and bottom depth of each sample run should be recorded on the borelog. Sampling includes samples collected for analysis as well as core retrieved for logging purposes.
- **Sample Type and Number:** Enter the sample type and number consistent with the sampling and analysis plan at the correct depth intervals. An "x" should be placed across the vertical interval where the environmental soil, grab groundwater, or geotechnical sample was collected.
- **Sample Recovery:** Enter the length of retrieved core to the nearest 0.1 foot of sample recovered, and record the value in feet. Do not count slough or caved material as part of the total recovered length of core. Record total length and percent of sample recovered. If using a 5-foot sample barrel, multiply the total length by two and 100 to get a percentage number. Similarly, if using a 2-½-foot sampler, multiply by 4 and 100 to get the percent recovery.
- **Soil Lithologic Description:** The lithologic classification shall be entered at the depth of each soil change. Additional information such as the presence of roots, fossils, organic material, wood, and fill shall also be entered at the appropriate depth in the format as described in "Field Classification of Soil."
- **Comments During Drilling:** Include pertinent observations in the borehole log (where appropriate) and in the field log book. Blow counts (for Standard Penetration Test sampling), heaving sands, caving soil, gas pockets, odors, , penetration rates, damaged sampling tubes, rod chatter, and other salient details shall be noted. The driller should alert sampling personnel to any significant changes in drilling. Such information should be attributed to the driller and recorded in the soil boring log and field log book. Observations may include water-level measurements, sounding of borehole using a weighted tape, depth of rod chatter or difficult drilling, depth of hole caving or heaving sand, name and time of arrival and departure of visitors to the site, and health and safety monitoring data.
- **Sampling:** Sampling difficulties shall be noted. Disturbed samples shall be noted on the soil boring log as well as the sample recovery. The top of the sample shall be marked on the container.
- **Water Levels:** Water-level measurements, where groundwater is encountered, are required for each boring. Changes in soil moisture shall be noted and, if there is no water encountered, a note to that effect shall be included on the borehole log. The date and time of water-level measurements shall be documented.
- **Backfilling:** When a boring is completed and the water level measured, the boring shall be backfilled to ground surface according to applicable regulations. The destruction of

the hole shall be noted on the soil boring log. Borehole destruction should follow SOP 6, Soil Boring Drilling and Abandonment.

3.5 Soil Classification

This section presents the format for the field classification of soil. Soil descriptions should be precise, comprehensive, and succinct. The correct overall description of the soil should not be distorted by emphasis on minor details. Similarities rather than differences between consecutive samples should be identified. Soil descriptions must be recorded for every sample collected. The format and order for soil descriptions should be as follows:

Soil Name with Appropriate Modifiers: Soil name should be in all capitals and underlined in the log, for example "POORLY-GRADED SAND." (See detailed description below and ASTM D2488 for details.)

Group Symbol in Parenthesis: For example "(SP)." (See detailed description below and ASTM D2488 for details.)

Munsell Color Chart Designation: This should be used for all descriptions. (See detailed description below and Munsell Soil Color Chart book for details.)

Moisture Content: Moisture content is described only in three categories: dry, moist, or wet. (See detailed description below and ASTM D2488 for details.)

Relative Density or Consistency: This can relate to wet or dry strength, although it is generally used to describe samples with *in situ* moisture content. (See detailed description below and ASTM D2488 for details.)

Soil Qualities: Descriptions for modifying the soil name such as structure (blocky, fissle), mineralogy (micaceous, fossiliferous, quartz sand), or other descriptors. (See detailed description below and ASTM D2488 for details.)

Depending on the drilling method, soil descriptions are based on the drill cuttings, on soil samples collected by one of numerous methods, or on a combination of the two. ASTM D2488 shall be used in classifying soil by visual and manual examination. A copy of the procedure is provided in Attachment B. Although the remainder of this procedure summarizes the requirements of the ASTM procedure, all technical personnel who are responsible for soil logging and classification shall review and become familiar with the ASTM specification.

Color, consistency, or natural density, moisture, and structure shall be described in field logs. Typical soil descriptions are listed below, followed by a discussion of each part of the description.

Each stratum of soil shall be identified by the following items in the order given: soil type with textural and compositional modifiers, classification symbol, particle size, color and Munsell soil color chart number in parentheses, grading, plasticity, moisture content, consistency or relative density (for noncohesive and cohesive soils), structure and/or cementation, stratification, mineralogy, and stratigraphic contacts.

For example, a moist, sandy clay with 30 percent fine sand and minor quantities of pebble-sized gravel would read:

<u>SANDY CLAY</u> (CL) with some fine sand and trace pebble-sized gravel, yellowish brown (10 YR 5/4), poorly sorted, slightly plastic, moist, firm, laminated to lensed with fine sand, fissured and blocky fracture, fine sand 95 percent quartz, 5 percent feldspathic, subangular, clay mottled with rootlets, sharp contact with above silt, gradational with below.

Other examples and guidelines are as follows:

- <u>CLAYEY SAND</u> (SC) with little clay and few pebble-sized gravel, grayish brown (10 YR 5/2), poorly sorted, plastic, wet, moderately dense, stratified to cross-bedded, blocky fracture, 75 percent quartz sand, 10 percent biotite, 15 percent felsic and lithic fragments, angular to rounded.
- The modifiers of "well-graded" and "poorly-graded" for sands and gravels, "lean" (low plasticity) and "fat" (high plasticity) for clays, and "plastic" for silts should be given where appropriate. Estimates should be made of the approximate percentage of a secondary constituent, such as "approximately 20-percent fine sand." Borderline classifications (e.g., SP/SC) shall be used for soil with properties of both materials.
- The ASTM system uses a hyphen for borderline soil with 10-percent fines (e.g., SP-SC). Fifteen-percent fines shall be used as the dividing line between clean sand and gravel (e.g., SW, GP) and silty or clayey sand and gravel (e.g., SC, GM).
- For interbedded soil where two or more soil types are interbedded in approximately equal percentages, both soil types should be described along with interbed thickness. The particle distributions should be referred to as upward fining or upward coarsening for soils that exhibit gradational trends.

<u>Color</u>. Soil color is described by comparing the sample with the Munsell Soil Color Charts. The Munsell colors should be used unless directed otherwise by project sampling plans. Instructions for their proper use are in the color charts. The color name shall precede the Munsell color notation (e.g., "yellowish brown, 10 YR 5/4"), with color hue and chroma number parenthetically entered in the borelog description.

<u>Consistency</u>. An estimate of the consistency shall accompany descriptions of all fine-grained soil (silt and clay where more than 50 percent of the material would pass the No. 200 sieve). A pocket penetrometer is the most accurate method for estimating the consistency of fine-grained soils. Table 1 lists characteristics for soil consistency identification.

TABLE 1
Estimation of Soil Consistency

Consistency	Unconfined Compressive Strength (tons/ft)[a]	Blows/foot (SPT) [b]	Manual Procedure
Very soft	<0.25	0 – 4	Thumb will penetrate soil more than 1 inch (25 mm).
Soft	0.25 - 0.50	4 – 8	Thumb will penetrate soil about 1 inch (25 mm).
Firm (formerly stiff)	-1.50	8 – 15	Thumb will indent soil about 1/4 inch (6 mm).
Hard	-2.00	15 – 30	Thumb will not indent soil but readily indented with thumbnail.

TABLE 1
Estimation of Soil Consistency

Consistency	Unconfined Compressive Strength (tons/ft)[a]	Blows/foot (SPT) [b]	Manual Procedure
Very hard	>4.0	> 30	Thumbnail will not indent soil.

Notes:

[a] Pocket penetrometer

[b] Blows/foot is defined as the total number of blows required to drive the second and third 6 inches of penetration (blow counts for the first 6 inches are also noted) while driving an 18-inch SPT sampler with a 140-pound hammer falling a free height of 30 inches. Conversion factors may be applied when the field log information is transferred to the final log when using a sampler other than an SPT (Standard penetrometer) (e.g., S&H or Modified California), or when using different hammer weights and drop. The conversion factor is approximately 0.5 for an S&H sampler with a hammer weight of 140 pounds falling 30 inches.

Density. Descriptions of all coarse-grained soil (sand and gravel where less than 50 percent of the material would pass the No. 200 sieve and 100 percent would pass the 3-inch sieve) shall be accompanied by an estimate of the density based upon standard penetrometer (SPT) blow counts. The following terminology should be used:

Density	Blows/foot (SPT)
Very loose	< 4
Loose	4-10
Medium dense	10-30
Dense	30-50
Very dense	> 50

Moisture. Soil moisture content shall be estimated using only the terminology described below:

- Dry - Absence of moisture, dusty, dry to the touch
- Moist - Damp but no visible water
- Wet - Visibly free water, usually sampled from below the water table

Other Descriptions. The soil description may contain other descriptions as needed to best convey distinctive or important features of the soil. These may include grain size and percentage, structure, particle shape and angularity, cementation, odor, reaction with hydrochloric acid (HCl), physical properties of fine-grained soil (dry strength, dilatency, toughness, plasticity), mineralogic or geologic interpretation or local name, or other distinctive features. Criteria for the use of these other descriptions include:

- Grain Size and Percentages. Within the gravel sizes and the sand sizes, there are further divisions based on particle sizes. Gravel is divided into fine and coarse gravel. Fine gravel particles (pebbles) are those that would pass through 3/4-inch opening but not a 1/4-inch opening. The fine gravel ranges from pea to marble sized. Coarse gravel particles are those that would pass through a 3-inch opening but not a 3/4-in opening. Common objects of this size are grapes and tennis balls. Cobbles range from 3 inches to 12 inches in size; boulders are larger than 12 inches.

Sand is divided into three sizes: fine, medium, and coarse. Sand passes a No. 4 sieve (approximately 1/4 inch) and is retained in a No. 200 sieve (0.003 inch). Fine sand particles pass a No. 40 sieve (approximately 1/64 inch) and are retained in the No. 200 (0.003 inch) sieve. These particles are sugar or table salt sized. Medium sand passes the No. 10 sieve (approximately 1/2 inch) and retained on the No. 40 sieve. These particles are about the same size as the openings in window screening. Coarse sand particles would pass a No. 4 sieve (approximately 1/4 inch) and be retained on a No. 10 sieve. Rock salt granules fall in this size range. Sand and gravel particle sizes are illustrated in ASTM D2488 along with percentage estimating charts. The percentages of different grain size fractions are important in the soil type determination.

- Structure:
  - Stratified - Alternating layers of varying material or color with layers at least 1/4-inch thick; note thickness.
  - Laminated - Alternating layers of varying material or color with the layers less than 1/4-inch thick; note thickness.
  - Fissured - Breaks along definite planes of fracture with little resistance.
  - Slickensides - Fracture planes appear polished or glossy, often striated.
  - Blocky - Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
  - Lensed - Inclusion of small pockets of different soils, such as lenses of sand within clay; note thickness.
  - Homogeneous - Same color and appearance throughout.
  - Grading - Whether the particles increase or decrease in size toward the top of logged interval.
- Particle Shape :
  - Flat - Particles with width/thickness ratio > 3.
  - Elongated - Particles with length/width ratio > 3.
  - Elongated and flat - Particles meet criteria for both flat and elongated.
- Particle Angularity:
  - Angular - Particles have sharp edges and relatively planar sides with unpolished surfaces.
  - Subangular - Particles are similar to angular description but have rounded edges.

  - Subrounded - Particles have nearly planar sides but have well-rounded corners and edges.
  - Rounded - Particles have smoothly-curved sides and no edges.

- Cementation:
  - Weak - rumbles or breaks with handling or little finger pressure.
  - Moderate - Crumbles or breaks with considerable finger pressure.
  - Strong - Will not crumble or break with finger pressure.

- Reaction with HCl:
  - None - No visible reaction.
  - Weak - Some reaction, bubbles forming slowly.
  - Strong - Vigorous reaction, bubbles forming immediately.

3.6 Trench Excavation

Trenches will be excavated using a backhoe. The dimensions of individual trenches will vary depending on the strength and stability of the trench walls and the specific purpose of the trench.

1. Temporary shoring or sidewall sloping will be used as required to protect personnel, equipment, and structures that could be damaged by trench collapse.
2. Trenches will not be entered by any personnel.
3. When starting an excavation, the backhoe operator will first remove the topsoil or cover (if any) and place it in a discrete mound at least 5 feet from the edge of the trench.
4. The excavation will be continued in approximately 6-inch cuts with the backhoe using a horizontal scraping motion rather than a vertical scooping motion.
5. Each bucket will be placed in a separate mound adjacent to the mound from the cut preceding it so that the mounds will be placed in the order of removal. If a visibly-stained or otherwise chemically-affected soil interval is encountered, the affected excavated soils will be placed on the plastic sheeting or a paved surface.

Soils may be identified as potentially chemically affected if field organic vapor monitoring instruments, like the photo ionization detector (PID), detect concentrations in headspace analysis above background levels.

1. Headspace analyses will be performed by placing soil in a resealable plastic bag for approximately 10 to 15 minutes. Organic vapor concentrations are then determined using a PID. Soils may also be considered as potentially chemically-affected if they exhibit visual staining.
2. Subsequent samples of these suspected soils will be collected from the backhoe bucket using a slide hammer.

3.7 Trench Logging

1. After the excavation has been completed, baseline stakes will be installed at each end, the trench will be measured, and orientation of the trench will be determined using a compass. Field personnel will not enter the trench to perform this or any other activities under this SOP.
2. Soil encountered in the trenches will be lithologically logged as described in Section 3.5.
3. Soil samples/cores taken from the walls and/or floor of the trench will be visually observed and logged according to Section 3.5 and recorded on a trench log and in the field log book.
4. Waste materials encountered, if any, will also be described and recorded in the field log book and trench log.
5. A vertical profile of a trench wall will be sketched on gridded paper. Both trench walls will be sketched, described, and photographed if they have different chemical occurrence or lithologic characteristics. A scale will be selected that allows optimum display of the trench, and the horizontal scale will equal the vertical scale, if practical. The characteristics above will be noted on the trench profile, field log book and trench log with the following information:

- Logger's name
- Date
- Backhoe operator's name and affiliation
- Project name and number
- Trench identification
- Trench orientation, including compass direction
- Scale

3.8 Trench Sampling

Samples will be collected from selected locations within trenches fro the purpose of defining the nature and extent of potential chemical impact in the soils. In general, the sample(s) should be collected from the soils that are suspected of being chemically-affected and from the soil beneath these zones. Soils may be identified as potentially chemically-affected if field organic vapor monitoring instruments, like the PID, detect concentrations in headspace analysis above background levels, or if they exhibit visual staining.

Soil samples will be collected from the bucket of the backhoe. The surface of the soil in the backhoe will be scraped away with a trowel and a sample will be collected using a slide hammer.

3.9 Trench Backfilling and Surveying

1. The soils will be replaced in the trench at their original depths to the extent practicable so that the soil from the bottom of the trench will be placed on the bottom and the topsoil will be replaced on the top.
2. The backhoe bucket will be used to backfill and compact the soil back into the trench.

3. The original soil from the trench will not be used to backfill the trench if the soils appear to be chemically-affected based on visual observations or headspace analysis.
4. Chemically-affected soil excavated from the trench will be placed in soil bins or drums and disposed in accordance with SOP 13, Investigation-Derived Waste Management.
5. Soil that is not chemically-affected will be returned to the trench.
6. If necessary, plastic sheeting will be placed in the trench to separate affected and clean soils.
7. Then, as necessary, additional clean soil will be brought to the site to complete the trench backfill.
8. After the trench backfilling is complete, the baseline stakes will be labeled to designate the trench number and then surveyed in accordance with SOP 2.

4.0 Key Checks and Preventive Maintenance

- Check entries to the soil boring log and field logbook in the field during sampling activities because the samples will be disposed at the end of the fieldwork, confirmation and corrections cannot be made later.
- Check that the sample numbers and intervals are properly specified.
- Ensure that drilling equipment is decontaminated prior to the beginning of work and between each borehole.
- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

5.0 References

American Society for Testing and Materials (ASTM). 1984. "Standard Method for Penetration Test and Split-Barrel Sampling of Soils, D1586-84."

__________. 1993. "Standard Method for Description and Identification of Soils (Visual-Manual Method) D2488-93."

Munsell Soil Color Charts. 1992. Macbeth Division of Kollmorgen Instrument Corporation, Newburgh, N.Y.

Attachment A
Soil Boring Log Template

CH2MHILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT ______________________ LOCATION ______________________

ELEVATION ______________ DRILLING CONTRACTOR ______________________

DRILLING METHOD AND EQUIPMENT ______________________

WATER LEVELS ______________ START __________ FINISH __________ LOGGER __________

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

REV 9/96 FORM D1586

Attachment B
ASTM D-24

Designation: D 2488 – 93

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

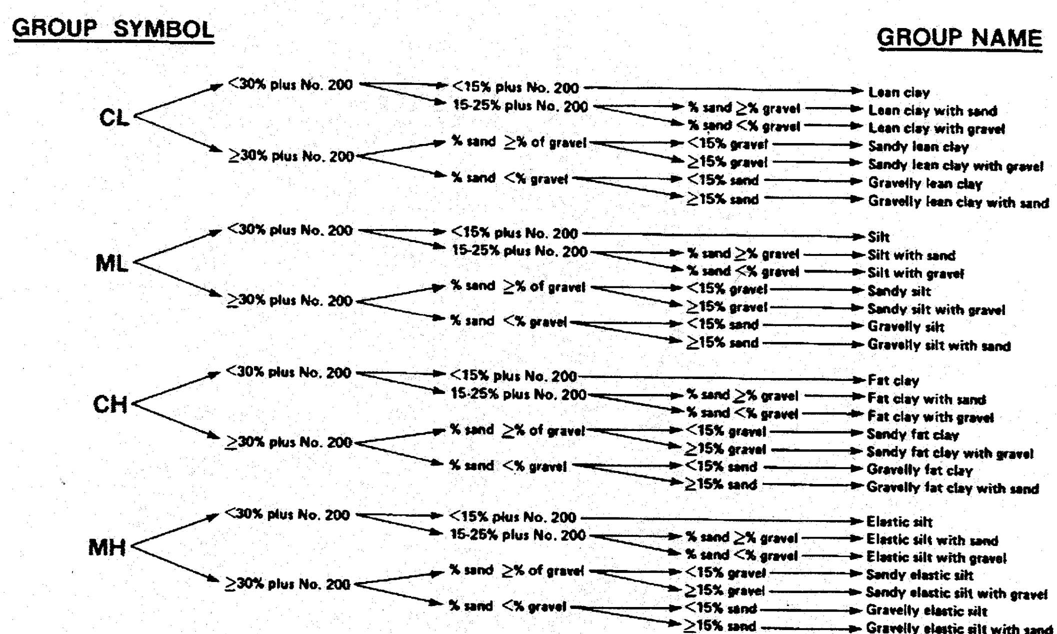
3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Sept. 15, 1993. Published November 1993. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 90.

[2] *Annual Book of ASTM Standards*, Vol 04.08.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:,

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

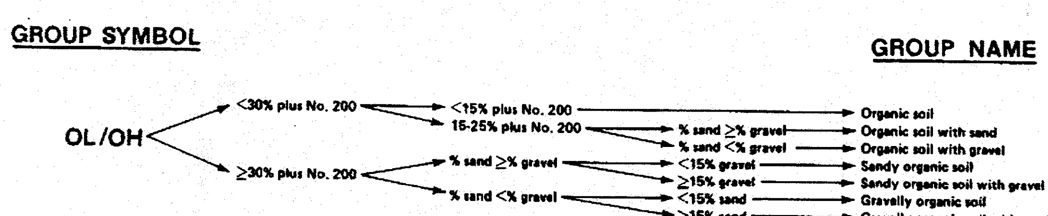
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

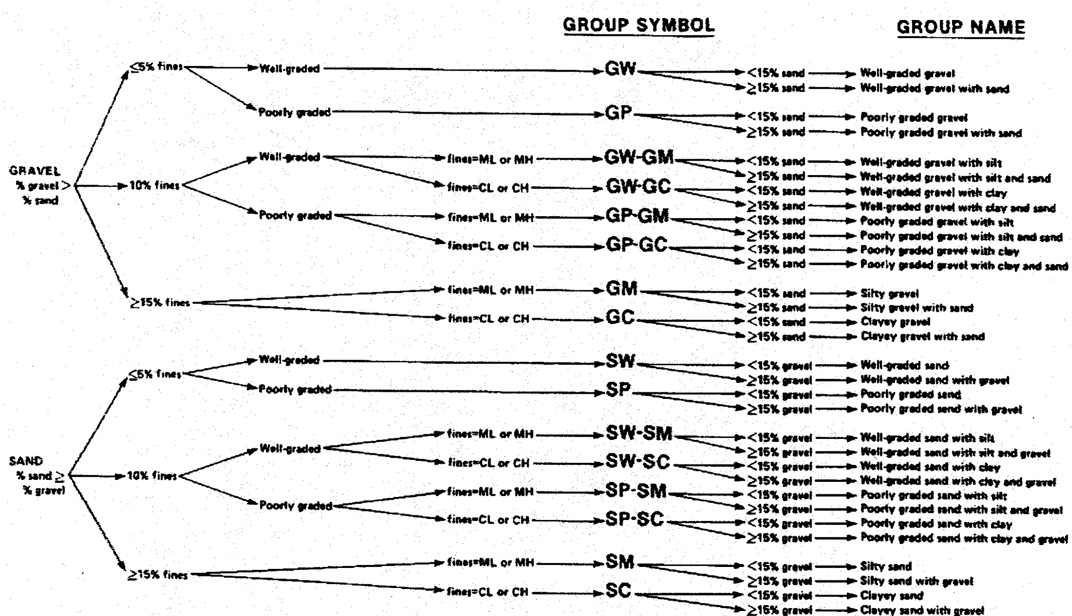
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

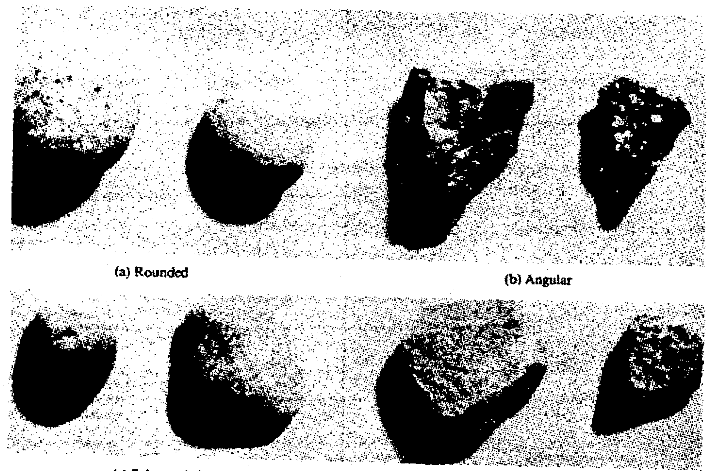
6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.



(a) Rounded (b) Angular

(c) Subrounded (d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the

X6. RATIONALE

Changes in this version from the previous version, D 2488 – 90, include the addition of X5 on Abbreviated Soil Classification Symbols.

STANDARD OPERATING PROCEDURE 10

Direct-push and Hydropunch Groundwater Sample Collection

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general guideline for the collection of groundwater samples using Hydropunch sampling methods. These methods are similar to those employed using direct-push approaches such as Geoprobe.

2.0 Equipment and Materials

- Truck-mounted, hollow-stem auger rig, Geoprobe, or percussion hammer.
- Drive rods and Hydropunch sampling device
- Peristaltic pump and environmental grade tubing
- Narrow diameter bladder pump and appropriately sized disposable tubing
- Pre-cleaned sample containers
- Clean latex or surgical gloves

3.0 Procedures and Guidelines

- Decontaminate sampling device and other downhole equipment in accordance with SOP 12 Decontamination of Personnel and Equipment.
- Advance the direct push or hollow stem auger method to approximately 5 feet above the desired sampling depth.
- Confirm the depth of the borehole using a water level meter or weighted cloth tape and measure to the closest 0.5 foot.
- Verify the presence of water by visual inspection of soil cutting, using site-specific geologic information, or by sounding the depth to water using a water level meter.
- Drive the sampling device into the formation beyond the end of the auger bit to the desired sampling interval. Alternatively, drive the sampling device to the desired sampling depth using the Geoprobe..
- Retract the outer cylinder, exposing the perforated entry barrel and filter material and allow the groundwater sample to enter the device.
- After about 15 minutes, remove the sampling device from the ground.
- Fill all sample containers, beginning with the containers for volatile organic compound analysis.
- Alternate methods of grab groundwater collection can be employed depending on the type of sampling method. These include using the following: 1) vacuum pump and

clean disposable tubing to pump water to the surface from the hydropunch sampling ports; 2) peristaltic pump (limited to about 25 feet deep) and clean disposable tubing to collect grab groundwater samples directly from the base of the drill string (or geoprobe tip); 3) narrow diameter stainless steel thief bailer or disposable polyethylene bailer to collect a sufficient volume of groundwater directly from the drill string, or; 4) narrow diameter bladder pump and clean disposable tubing to collect grab groundwater samples directly from the base of the drill string (or geoprobe tip).

- Abandon the borehole with neat cement grout or bentonite at each sampling location in accordance with SOP 6, Soil Boring Drilling and Abandonment.

4.0 Key Checks and Preventive Maintenance

- Evaluate site-specific information such as monitoring well logs or other borehole information prior to drilling and advancing in-situ groundwater sampling.
- Verify that the augers or the hydraulic percussion hammer are clean and in proper working order.
- Ensure that the operator thoroughly completes the decontamination process between sampling locations.
- Verify the depth of the hole and the presence of water prior to inserting additional sampling equipment.
- Ensure that the sampling device has been inserted to the proper sampling depth.
- Verify that the borehole made during sampling activities has been properly abandoned.
- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation-Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

STANDARD OPERATING PROCEDURE 11

Quality Control Sampling

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides a general procedure for quality control (QC) samples that will be collected during field work.

2.0 Equipment and Materials

- Field logbook
- Blank liquid (use ASTM Type II grade water) or distilled water purchased from a water vendor or grocery store.
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

3.0 Procedures and Guidelines

Field procedures and guidelines described in Odgen (1996) procedure number FP-F-2, Field QC Samples (Attachment A) will be followed.

In addition to following the Odgen (1996) procedure, each sample collected will be documented in a bound field log book as outlined in SOP 12, Documentation and Records. Chain-of-custody (COC) procedures will be performed in accordance to SOP 15, Chain-of-custody procedures.

4.0 Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare equipment rinsate samples or blanks.
- Procedures and guidelines described in Odgen (1996) procedure number FP-F-2, Field QC Samples (Attachment A) will be followed.

5.0 References

Odgen. 1996. RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory, Ventura Count, California, Volume III, September.

Attachment A

Ogden (1996), Procedure Number FP-F-2, Field QC Samples

Procedure Number: FP-F-2, Field QC Samples (Water, Soil)		Revision:	1
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FIELD QC SAMPLES (WATER, SOIL)

1.0 PURPOSE

This standard operating procedure (SOP) describes in general the number and types of field Quality Control (QC) samples that will be collected during project field work. Additional information regarding the number and types of field QC samples is provided in the site-specific Quality Assurance Project Plan (QAPP).

2.0 SCOPE

This procedure applies to all site sample collection activities conducted during the field program. As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgement to accommodate unforeseen circumstances. Deviance from this procedure in planning or in the execution of planned activities must be approved by the Project Manager.

3.0 DEFINITIONS

None.

3.1 TRIP BLANK

Trip blanks are samples which originate from ASTM Type III analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with samples to be analyzed for volatile organic compounds (NEESA 1988).

3.2 EQUIPMENT RINSATE SAMPLES

An equipment rinsate (i.e., "decontamination rinsate," or "equipment blank") sample consists of analyte-free water which has been poured over or through the sample collection equipment after its final decontamination rinse. Analytical results of equipment rinsate samples are used to access equipment cleanliness and the effectiveness of the decontamination process.

3.3 FIELD BLANKS

Field blanks are samples of the source water used as the final decontamination rinse water of sampling equipment, and should be from the same source water as used to generate the equipment rinsate sample.

3.4 FIELD DUPLICATE

A field duplicate is a second sample taken from the same source at the same time and analyzed under identical conditions to assist in evaluating sample variance. There are two types of duplicates: replicates and collocates. Replicates are identical samples that have typically been homogenized, while collocates are samples collected next to each other (e.g., laterally or vertically, in separate containers, and not homogenized).

4.0 RESPONSIBILITIES

The Field Program Manager and the Project Manager are responsible for ensuring that field QC samples are collected and analyzed according to this procedure. The Laboratory Manager is responsible for ensuring that field QC samples are analyzed according to the specifications of the project Statement of Work and the analytical methods used.

5.0 PROCEDURES

Field QC checks may include submission of trip blank, equipment rinsate, field blank, duplicate, and reference samples to the laboratory. Suggested frequency and types of QC check samples are discussed in the following guidance documents: *RCRA Technical Enforcement Guidance Document*, Section 4.6.1 (EPA 1986) and *Data Quality Objectives for Remedial Response Activities: Development Process*, Section C.6 (EPA 1987); the use and frequency of these field QC samples should be incorporated as appropriate. Types of field QC samples are discussed in general below. The frequency at which field QC samples should be collected for each QC level is provided in Table FP-F-2-1.

5.1 TRIP BLANKS

Trip blanks are samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with samples to be analyzed for volatile organic compounds. Trip blanks shall be placed in sample coolers prior to transport to the site so that they accompany the samples throughout the sample collection/handling/transport process. Once prepared, trip blanks should not be opened before they reach the laboratory. One set of two 40 milliliter vials will form a trip blank and will accompany each cooler containing samples to be analyzed for volatile organics (VOCs) by methods such as CLP VOCs, 8010/601, 8020/602, 8240/624, and modified 8015 (only if purge and trap analysis is performed, e.g., for gasoline, not for extraction and analysis for diesel fuel). Trip blanks will only be analyzed for VOCs (EPA 1987). Results of trip blank analyses are used to determine whether samples have been contaminated by VOCs during sample handling and transport to the laboratory containing samples to be analyzed for volatile organics (VOCs) by methods such as CLP VOCs, 8010/601, 8020/602, 8240/624, and modified 8015 (only if purge and trap analysis is performed, e.g., for gasoline, not for extraction and analysis for diesel fuel). Trip blanks will only be analyzed for VOCs (EPA 1987). Results of trip blank analyses are used to assess whether samples have been contaminated by VOCs during sample handling and transport to the laboratory.

Table FP-F-2-1

FIELD QC SAMPLES PER SAMPLING EVENT

Type of Sample	Level C		Level D		Level E	
	Metal	Organic	Metal	Organic	Metal	Organic
Trip blank (for volatiles only)	NA[1]	1/cooler	NA[1]	1/cooler	NA[1]	1/cooler
Equipment rinsate[2]	1/day	1/day	1/day	1/day	1/day	1/day
Field blank	1/decontamination water source/event/for all QC levels and all analytes					
Field duplicates[3]	10%	10%	10%	10%	5%	5%
Background samples at least 1/sample media/sample event[4]						

Notes:
1) NA means not applicable.
2) Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.
3) The duplicate must be taken from the same sample that will become the laboratory matrix/spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.
4) Sample event is defined from the time sampling personnel arrive at the site until they leave the site for more than a period of one week; the use of controlled-lot source water makes one sample per lot rather than per event an option.

Because trip banks are typically not analyzed for in tissue samples, they are not required for tissue sampling programs.

5.2 Equipment Rinsate Samples

An equipment rinsate (i.e., "decontamination rinsate," or "equipment blank") sample consists of analyte-free water which has been poured over or through the sample collection equipment after its final decontamination rinse. One equipment rinsate sample shall be collected per day per sampling technique utilized that day (EPA 1986). Initially, rinsate samples from every other day will be analyzed. The samples will be analyzed for the same parameters for which samples collected utilizing a particular sampling method were analyzed. If analytes pertinent to the project are found in the rinsates, the remaining rinsate samples will be analyzed unless holding times have been exceeded. If no analytes are found in any rinsate samples, the frequency of analysis may be decreased from every other day to weekly. Results of rinsate samples are used to determine whether equipment decontamination was effective.

When disposable or dedicated sampling equipment is utilized, only one equipment rinsate sample will be collected per equipment lot or project phase. Disposable and/or dedicated sampling equipment may include stainless steel bowls or trowels that will be used for collection of only one soil sample, disposable bailers for ground-water sampling, dedicated submersible pumps for ground-water sampling, or other such equipment. These disposable and/or dedicated sampling equipment are typically pre-cleaned and individually wrapped by the manufacturer prior to delivery to the site. In this case, the equipment rinsate sample is used to provide verification that contaminants are not being introduced to the samples via sampling equipment.

Sampling devices (e.g., gloved hands, dip nets, or traps) for collection of tissue samples are generally non-intrusive into the organisms collected, so equipment rinsate samples will not be collected as long as the devices have been properly cleaned following SOP FP-D-5, *Equipment Decontamination*, and the devices appear clean.

5.3 FIELD BLANKS

Field blanks, consisting of samples of the source water used as the final decontamination rinse water, (both potable and deionized or distilled water sources) will be analyzed to assess whether the wash or rinse water contained contaminants that may have been carried over into the site samples.
The final decontamination rinse water source, the field blank source water, and equipment rinsate source water should all be from the same purified water source. Tap water used for steam cleaning augers or used in the initial decontamination buckets need not be collected and analyzed as a field blank, because augers typically do not touch the actual samples and because the final decontamination rinse water should be from a purified source.

Field blanks are collected at a frequency of one per sampling event per each source of water for all levels of QC. A sampling event is considered to be from the time sampling personnel arrive at a site until they leave for more than a week. Field blanks will be analyzed for the same analyses as the samples collected during the period that the water sources are being used for decontamination. If the same lot of the water source is used, a field blank needs to be collected only once per lot.

5.4 FIELD DUPLICATES

Field duplicates consist of either collocated or replicate samples. Collocated samples (soil samples collected from adjacent locations or liners or water samples collected from the same well at the same time) provide information on the entire sample measurement system, including sampling, analysis, and non-homogeneities of the media sampled. Replicates, which are collected at the same point in time (e.g., homogenized or split samples), provide information for various points in the analytical process. Sampling error can be approximated by the inclusion of collocated and replicated versions of the same sample.

Field duplicates for ground-water and surface water samples will generally consist of replicates. Field duplicates for soil samples will consist primarily of collocates. Soil field duplicates that are to be analyzed for volatile constituents will only consist of collocates; no soil samples that are to be analyzed for volatiles will be replicated (i.e., homogenized or otherwise processed or split) in the field. A separate sample will be collected to provide duplicates for non-volatile analyses. The sample may be homogenized and split in the field to form an original and duplicate (replicate) sample, or an additional volume into a separate sample container may be collected to form a duplicate (collocate) sample. Alternatively, replicates may be formed by homogenization in the laboratory. Duplicates will be analyzed for the same analytical parameters as their associated original sample.

Field duplicates for biological tissue samples will consist of splits of the original sample. Twice the required volume of organisms for one sample will be collected and placed into one foodgrade self-sealing bag. The sample will later be homogenized in the laboratory and split, producing an original and a replicate sample. Replicates will be analyzed for the same analytical parameters as their associated original samples.

6.0 RECORDS

Records of the collection of field QC samples should be kept in the sample logbook by the methods discussed in SOP III-EFP-F-6 *Record Keeping, Sample Labeling, and Chain-of-Custody*.

7.0 HEALTH AND SAFETY

Not applicable.

8.0 REFERENCES

EPA. 1986. RCRA Technical Enforcement Guidance Document.

EPA. 1987. Data Quality Objectives for Remedial Response Activities: Development Process

9.0 ATTACHMENTS

None.

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STANDARD OPERATING PROCEDURE 12

Decontamination of Personnel and Equipment

1.0 Purpose and Scope

The purpose and scope of this SOP is to provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

2.0 Equipment and Materials

- Distilled water
- Potable water from a municipal water supply or bottled drinking water in 5-gallon containers, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5 percent (W/W) Alconox and water solution
- 5-gallon buckets for Alconox and water, scrub brushes, squirt bottles for Alconox solution, water, plastic bags, and sheets
- Phthalate-free gloves
- Decontamination pad and steam cleaner/high-pressure cleaner for large equipment

3.0 Guidelines

3.1 Drilling Rigs

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be steam cleaned in a designated area. The steam-cleaning area will be designed to contain decontamination waste and waste water.

3.2 Downhole Drilling Tools

Downhole tools will be decontaminated using a three-stage rinse before the onset of drillingand between boreholes. This will include, but will not be limited to, rods, split-spoons or similar samplers, coring equipment, and augers. Three stage rinse consist of rinsing equipment in 1) Alconox and water 2) potable water and 3) de-ionized (DI) water.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler will be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

3.3 Field Equipment

3.3.1 Water-level Indicators

Water-level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

- Washed with Alconox or Liquinox solution.
- Rinse with tap water.
- Rinse with distilled water.

3.3.2 Probes

Probes (e.g., pH or specific ion electrodes, micropurge flow-through cell, geophysical probes, or thermometers coming in direct contact with the sample) will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. Devices have been fouled by non-aqueous phase liquid, if encountered, should be cleaned using Alconox solution. For probes that make no direct contact (e.g., organic vapor monitoring equipment, such as a field photo ionization detector), the probe will be wiped with paper towels or cloth wetted with methanol.

3.3.3 Other Sampling Equipment

Other sampling equipment such as spatulas, spoons, or bowls should be decontaminated and cleaned in the manner prescribed in this SOP.

4.0 Procedures

4.1 Personnel Decontamination

To be performed after completion of tasks, whenever potential for contamination exists, and upon leaving the exclusion zone.

1. discard gloved into garbage bag.
2. Remove disposable coveralls (Tyvek) and discard into garbage bag.
3. Remove respirator (if worn).
4. Remove inner gloves and discard.
5. At the end of the work day, shower entire body, including hair, either at the work site or at home.
6. Sanitize respirator if worn.

4.2 Sampling Equipment Decontamination

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Rinse and scrub with potable water.
3. Wash all equipment surfaces that contacted the potentially-contaminated soil/water with Alconox solution.
4. Rinse with potable water.
5. Rinse with distilled water or triple rinse with potable water.
6. Air dry.
7. Completely air dry and wrap exposed areas with aluminum foil (shiny side out), plastic sheeting, or clean plastic garbage bag for transport and handling if equipment will not be used immediately.
8. Collect all rinsate 5-gallon buckets and dispose in Boeing provided containers.
9. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed in DOT-approved 55-gallon drums.

4.3 Sample Container Decontamination

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Alconox solution or immerse in the solution **after the containers have been sealed**. Repeat the above steps using potable water.
2. Dispose of all used paper towels appropriately.

4.4 Heavy Equipment and Tools

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated prior to arrival at the site and between locations as follows:

1. The subcontractor will set up a decontamination area designated by CH2M HILL.
2. Steam clean heavy equipment until no visible signs of dirt are observed.
3. Observe guidelines described in Section 3.0 of this SOP.

5.0 Key Checks and Items

- Clean with solutions of Alconox, and distilled water.
- If necessary, decontaminate the outside of filled sample containers before relinquishing them to anyone.

- All decontamination liquids generated during sampling will be placed in 5-gallon buckets during the field day and will be transferred to Boeing provided containers at the end of the field day, as outlined in SOP 13, Investigation-Derived Waste Management. Soil cuttings will be placed back down hole unless the soil is stained or odorous, in which case, the soil will be placed in a 5-gallon bucket and transferred to a Boeing provided container at the end of the field day.

The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis. Any time a sampling event occurs, at least one such quality control sample shall be collected. The total number of equipment blanks will be at least 5 percent of the number of samples collected during large-scale field sampling efforts.

At least one piece of field equipment shall be selected for this procedure each time equipment is washed. An attempt should be made to select different pieces of equipment for this procedure.

STANDARD OPERATING PROCEDURE 13

Investigation-Derived Waste Management

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) describes the procedures used to dispose of Investigation-Derived Waste (IDW) during site operations. This SOP does not provide guidance on the details of Department of Transportation (DOT) regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced.

2.0 Equipment and Materials

2.1 Fluids

- 5-gallon buckets with lids for storage during the field day and Boeing provided containers for storage after the field day
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Marking pens and paint pens for appropriate labels

2.2 Solids

- 5-gallon buckets with lids for storage during the field day and Boeing provided containers for storage after the field day
- Tools for securing drum lids
- Tools for securing drum lids
- Plastic sheets
- Labels
- Marking pen and paint pen for appropriate labels

3.0 Procedures and Guidelines

Field procedures and guidelines described in Odgen (1996) procedure number FP-B-8, IDW Management (Attachment A) will be followed. IDW generated at Boeing Sites will be transferred to Boeing provided containers at the end of the day at Building 3260 and IDW generated a DOE sites will be transferred to Boeing provided containers at the end of the day at Building 4011.

4.0 Key Checks and Preventive Maintenance

- Check that representative samples of the containerized materials are obtained.

- Check with Boeing personnel as to where IDW should be stored.
- Procedures and guidelines described in Odgen (1996) procedure number FP-B-7, Utility Clearance (Attachment A) will be followed.

5.0 References

Odgen. 1996. *RCRA Facility Investigation Work Plan Addendum, Santa Susana Field Laboratory, Ventura Count, California, Volume III*, September.

Attachment A
Ogden (1996), Procedure Number FP-B-8, IDW Management

Procedure Number: FP-B-8, IDW Management Date: August 1996	Revision: 1 Page: 1 of 20

IDW MANAGEMENT

1.0 PURPOSE

This procedure describes the activities and responsibilities of Ogden and Rocketdyne pertaining to management of investigation-derived waste. The purpose of this procedure is to provide guidance for the minimization, handling, labeling, temporary storage, and inventory of investigative-derived waste (IDW) generated during field activities. The information presented will be used to prepare and implement Work Plans (WP) and Field Sampling Plans (FSP) for IDW related field activities. Results from implementation of WPs and FSPs will then be used to develop and implement final IDW disposal by Rocketdyne.

2.0 SCOPE

This document applies to all Ogden personnel involved in the development and implementation of WPs and FSPs that include the generation of IDW.

This procedure was developed to serve as management-approved professional guidance for the management of IDW generated during the field program. This procedure is focused on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure. This procedure is not intended to obviate the need for professional judgement to accommodate non-specified or unforeseen circumstances. Specific guidance from local regulatory agencies must be obtained and acted upon. Deviance from this procedure in planning or in the execution of planned activities must be documented and approved by management personnel.

IDW management practices shall also conform to applicable requirements within the Rocketdyne System of Procedures for hazardous waste management at the SSFL (RSOP C-203). A complete copy of RSOP C-203 is included as Attachment 1. Applicable general requirements within RSOP C-203 include items 1, 4, 6, 7, and 10 through 14

(Attachment 1). In the event that discrepancies arise between the IDW management procedures given in this SOP and the Rocketdyne procedures listed in RSOP C-203, preference shall be given to RSOP C-203 requirements.

3.0 DEFINITIONS

The following definitions apply to a number of technical terms contained in the text of this procedure.

3.1 Investigative-Derived Waste

Investigative-derived waste (IDW) consists of all materials generated during site investigation activities that may be contaminated with chemicals of concern identified at the site. IDW consists of many different types of potentially contaminated materials, including but not limited to, personal protective equipment (PPE); disposable sampling and decontamination equipment; investigation-derived soil, sludge, and sediment; well development and purge water; and decontamination fluids.

3.2 Personal Protective Equipment (PPE)

PPE, as defined in this procedure, refers to all disposable materials used to protect personnel from contact with potentially contaminated site media, such as inner and outer gloves, Tyvek® suits and overboots, and disposable respirator cartridges. Non-consumable items such as steel-toe boots, respirators, and hard hats are not included in this procedure.

3.3 Disposable Sampling Equipment

Disposable sampling equipment consists of all single-use equipment that may have come in contact with potentially contaminated site media, including sample bailers, Draeger® air monitoring tubes, used soil sampling trowels and spatulas, plastic drop cloths, plastic bags and bucket liners, and sample containers from field analytical test kits.

3.4 Investigative-Derived Soil, Sludge, and Sediment

Investigative-derived soil consists of all potentially contaminated soil that is disturbed as part of site investigation activities. The most commonly encountered form of IDW soil is drill cuttings brought to the ground surface by hollow stem auger drilling methods. Other forms of disturbed soil, including trenching spoils and excess soil remaining from surface sampling, should not be stored as IDW. Excavated soil should be returned to its source, if site conditions permit.

Investigative-derived sludge consists of all potentially contaminated sludge materials generated or disturbed during site investigation activities. Generated sludge may consist of drilling mud used or created during intrusive activities. Other sludge may include solvents or petroleum-based materials encountered at the bottom of storage tanks and grease traps.

Investigative-derived sediment consists of all potentially contaminated sediments that are generated or disturbed during site investigation activities. Generated sediments may include solids that settle out of suspension from well development, purge, or decontamination water (see Definitions 3.5 and 3.6) while stored in 55-gallon drums or during sample filtration. Disturbed sediments may also consist of catch basin sediments or excess sediment from surface water activities.

3.5 Well Development and Purge Water

Development water consists of ground water withdrawn from newly installed monitoring wells in preparation for well purging or pump testing. Purge water consists of ground water that is removed from monitoring wells immediately prior to sampling.

3.6 Decontamination Fluids

Decontamination fluids consist of all fluids used in decontamination procedures conducted during site investigation activities. These fluids consist of wash water and rinse water for the decontamination of non-consumable PPE, sampling equipment, and drilling equipment. Decontamination procedures are discussed in SOP FP-D-5, *Equipment Decontamination.*

3.7 NON-IDW TRASH

Non-IDW trash is all waste materials such as waste paper, drink containers, food, and packaging generated in the support zone that have not come in contact with potentially contaminated site media.

3.8 NON-INDIGENOUS IDW

Non-indigenous IDW consists of all waste materials from offsite sources that are generated in the transition or contamination reduction zones that have generally not come in contact with potentially contaminated site media. Non-indigenous IDW includes materials such as PPE from "clean" field activities (e.g., field blank generation, water sampling events); and refuse from monitoring well installation (e.g., unused sections of well casing, used bentonite buckets, sand bags, and cement bags).

3.9 RCRA HAZARDOUS WASTE

Under the Resource Conservation and Recovery Act (RCRA), a solid waste that is not excluded from regulation is defined as hazardous if it is listed as a hazardous waste in Chapter 40, Code of Federal Regulations (CFR), Parts 261.31 through 261.33; it exhibits any of four hazardous characteristics: ignitibility, corrosivity, reactivity, or toxicity (as determined using the Toxicity Characteristic Leachate Procedure [TCLP]); or, it is subject to certain mixture rules (EPA 1992). If IDW is determined to be RCRA hazardous waste, then RCRA storage, transportation, and disposal requirements may become applicable.

3.10 LAND DISPOSAL RESTRICTIONS (LDR)

Land disposal, as defined in RCRA, is any placement of RCRA hazardous waste on the land in a waste pile, landfill, impoundment, well, land treatment area, etc. LDRs are regulatory restrictions placed on land disposal including pre-treatment standards, engineered containment, capacity constraints, and reporting and permitting requirements.

3.11 Area of Contamination (AOC)

The United States Environmental Protection Agency (EPA) considers the area of contamination (AOC) to be a single land-based disposal unit, usually a "landfill," and including non-discrete land areas in which there is generally dispersed contamination (EPA 1991). Note that storing IDW in a container (i.e., portable storage devices such as drums and tanks) within the AOC and returning it to its source, whether RCRA hazardous or not, does not trigger RCRA LDRs. In addition, sampling and direct replacement of wastes within an AOC do not constitute land disposal (EPA 1992).

3.12 Ogden Technical Information System

The Ogden Technical Information System (OTIS) is the centralized data management system that has been designed and equipped to manage large volumes of data generated during performance of field programs. OTIS incorporates not only chemical data, but also topographical, meteorological, lithological, geotechnical, hydrogeological, and other pertinent site investigation data that can ultimately be used for subsequent site analysis, such as site modeling and exposure assessments. The IDW drum inventory to be generated from the implementation of this procedure will be stored and updated in OTIS. OTIS provides the capability for customized reporting using selected data and report formats.

4.0 RESPONSIBILITIES

The Project Manager is responsible for preparing WPs and FSPs in compliance with this procedure, and is responsible for documenting instances of non-compliance.

The Field Program Managers are responsible for implementing this IDW procedure and for ensuring that all project field personnel utilize these procedures.

5.0 PROCEDURES

The procedures for IDW management in the field are described below in Sections 5.1 to 5.5. The implementation of these procedures requires Project Managers, Field Program Managers, and their designates to perform the following tasks:

- Minimize IDW as it is generated;
- Segregate IDW by matrix and source location;
- Apply suitable procedures for IDW drum handling and labeling;
- Apply protective methods for IDW drum storage;
- Prepare an IDW drum inventory; and
- Update and report changes to the IDW drum inventory.

5.1 IDW MINIMIZATION

Field Program Managers and their designates shall minimize the generation of onsite IDW to reduce the need for special storage or disposal requirements that may result in substantial additional costs and provide little or no reduction in site risks (EPA 1992). The volume of IDW shall be reduced by applying minimization practices throughout the course of site investigation activities. These minimization strategies include substitution of biodegradable raw materials; using low-volume IDW-generating drilling techniques; where possible, returning excess material to the source location; use of disposable sampling equipment versus generating more decontamination fluids from reusable sampling equipment; use of bucket and drum liners; and separating trash from IDW.

Material substitution consists of selecting materials that degrade readily or have reduced potential for chemical impacts to the site and the environment. An example of this practice is the use of biodegradable detergents (e.g., Alconox® or non-phosphate detergents) for decontamination of non-consumable PPE and sampling equipment. In addition, field equipment decontamination can be conducted using isopropyl alcohol rather than hexane or other solvents (for most analytes of concern), to reduce the potential onsite chemical impacts of the decontamination solvent. Decontamination solvents shall be selected carefully so that the solvents, and their known decomposition products, are not potentially RCRA hazardous waste.

Drilling methods that minimize potential IDW generation should be given priority. Hollow stem auger and air rotary methods should be selected, where feasible, over mud rotary methods. Mud rotary drilling produces significant quantities of waste drilling mud, while hollow stem and air rotary drilling methods produce relatively low volumes of soil waste. Small diameter borings and cores shall be used when soil is the only matrix to be sampled at the boring location; the installation of monitoring wells requires the use of larger diameter borings.

Soil, sludge, or sediment removed from borings, containment areas, and shallow test trenches shall be returned to the source immediately after sampling and/or geological logging of the soils (EPA 1991, 1992). Immediate replacement of solid waste in the source location during investigation activities avoids RCRA land disposal restrictions (LDRs), which permit movement of IDW within the same area of contamination (AOC) without considering land disposal to have occurred, even if the IDW is later determined to contain RCRA hazardous material (EPA 1991). Following excavation, the soil IDW shall be replaced into the boring or trench and compacted. Soil IDW from borings or trenches deeper than 10 feet or that penetrate into a saturated layer shall be contained in drums.

The quantity of decontamination rinse water generated can be reduced by using dedicated and disposable sampling equipment such as plastic bailers, trowels, and drum thiefs, that do not require decontaminating. In general, decontamination fluids, and well development and purge water, should not be minimized because the integrity of the associated analytical data may be affected.

The storage of visibly soiled PPE and disposable sampling equipment IDW shall be minimized by implementing decontamination procedures. If, according to the Field Program Manager's best professional judgement, the PPE and disposable sampling equipment can be rendered non-hazardous after decontamination, then the PPE and disposable sampling equipment shall be double-bagged and disposed offsite as municipal waste (EPA 1991, 1992).

Bucket liners can be used in the decontamination program to reduce the volume of solid IDW generated and reduce costs on larger projects. The plastic bucket liners can be crushed into a smaller volume than the buckets, and only a small number of plastic decontamination buckets are required for the entire project. The larger, heavy-duty, 55-gallon drum liners can be used for heavily contaminated IDW to provide secondary containment, and reduce the costs of disposal and drum recycling. Drum liners may extend the containment life of the drums in severe climates and will reduce the costs of cleaning out the drums prior to recycling.

All waste materials generated in the support zone are considered non-IDW trash. To minimize the total volume of IDW, all trash shall be separated from IDW, sealed in garbage bags, and properly disposed offsite as municipal waste.

Excess cement, sand, and bentonite grout prepared for monitoring well construction shall be kept to a minimum. Well construction shall be observed by Field Program Managers to ensure that a sufficient, but not excessive, volume of grout is prepared. Some excess grout may be produced. Unused grout (that should not come in contact with potentially contaminated soil or ground water) shall be considered non-hazardous trash and shall be disposed offsite by the drilling subcontractor. Surplus materials from monitoring well installation such as scrap PVC sections, used bentonite buckets, and cement/sand bags that do not come in contact with potentially contaminated soil, shall be considered non-IDW trash and shall be disposed offsite by the drilling subcontractor.

IDW generated from the use of field analytical test kits consists of those parts of the kit that have come into contact with potentially contaminated site media, and used or excess extracting solvents and other reagents. Potentially contaminated solid test kit IDW shall be contained in plastic bags and stored with PPE or disposable sampling equipment IDW from the same source area as soil material used for the analyses. The small volumes of waste solvents, reagents, and water samples used in field test kits should be segregated, and evaporated onsite or disposed to the sanitary sewer, as appropriate. Most other test kit materials should be considered non-IDW trash, and shall be disposed as municipal waste.

5.2 Segregation of IDW by Matrix and Location

To facilitate subsequent IDW screening, sampling, classification and/or disposal, IDW shall be segregated by matrix and source location at the time it is generated. Each drum of solid IDW shall be completely filled, when possible. For liquid IDW, drums should be left with headspace of approximately 5 percent by volume to allow for expansion of the liquid and potential volatile contaminants. IDW from only one matrix shall be stored in a single drum (e.g., soil, water or PPE shall not be mixed in one drum). If practical, IDW from separate sources should not be combined in a single drum.

It is possible that monitoring well development and purge water will contain suspended solids which will settle to the bottom of the storage drum as sediment. Significant observations on the turbidity or sediment load of the development or purge water shall be included in the field notebook and reported in attachments to the quarterly drum inventory report to the client (see SOP FP-F-5, *Logbooks* and Section 5.5). To avoid having mixed matrixes in a single drum (i.e., sediment and water), it may be necessary to decant the liquids into a separate drum, after the sediments have settled out. This segregation may be accomplished during subsequent IDW sampling activities or during consolidation in a holding tank prior to disposal to the sanitary sewer.

Potentially contaminated well construction materials shall be placed in a separate drum. No soil, sediment, sludge, or liquid IDW shall be placed in drums with potentially contaminated waste well construction materials, and potentially contaminated well construction materials from separate monitoring wells shall not be commingled.

Potentially hazardous PPE and disposable sampling equipment shall be stored in drums separate from other IDW. PPE from generally clean field activities such as water sampling shall be segregated from visibly soiled PPE, double-bagged and disposed offsite as municipal waste. Disposable sampling equipment from activities such as soil, sediment, and sludge sampling includes plastic sheeting used as liner material in containment areas around drilling rigs and waste storage areas; disposable sampling equipment; and soiled decontamination equipment. If, according to the Field Program Manager's best professional judgement, the visibly soiled PPE can be decontaminated and rendered nonhazardous, then the decontaminated PPE shall be double-bagged and disposed offsite as municipal waste (EPA 1991, 1992). PPE and disposable sampling equipment generated on separate days in the field may be combined in a single drum, provided clean and visibly soiled IDW are segregated as discussed above.

Decontamination fluids shall be stored in drums separate from other IDW. If practical, decontamination fluids generated from different sources should not be stored in the same drum. If decontamination fluids generated over several days or from different sources are stored in a single drum, information about the dates and IDW sources represented in the drum shall be recorded. This information shall be noted in the field notebook, on the drum label (see Section 5.3), and in the drum inventory (see Section 5.5).

Part of IDW segregation by the Field Program Manager and designated personnel should include separating the liquid and sediment portions of the equipment decontamination fluid present in the containment unit used by the drilling or excavation field crew. The contents of this unit normally consist of turbid decontamination fluid above a layer of predominantly coarse-grained sediment. When the contents of the containment unit are to be removed for storage in IDW drums, the field crew shall be instructed by the Field Program Manager to place as much of the liquid into drums as possible and transfer the remaining solids into separate drums. Observations of the turbidity and sediment load of the liquid IDW should be noted in the field notebook, on the drum label (see Section 5.3), and in attachments to the drum inventory (see Section 5.5). It is likely that decontamination fluids will contain minor amounts of suspended solids that will settle out of suspension to become sediment at the bottom of IDW storage drums. As noted above, it may be necessary to segregate the drummed water from sediment during subsequent IDW sampling or disposal activities.

5.3 Drum Handling and Labeling

Drum handling consists of those actions necessary to prepare an IDW drum for labeling. Drum labeling consists of those actions required to legibly and permanently identify the contents of an IDW drum.

5.3.1 Drum Handling

The drums used for containing IDW shall be approved by the United States Department of Transportation (DOT HM-181 1990). The drums shall be made of steel or plastic, generally of 55-gallon capacity, they shall be completely painted or opaque, and they should have removable lids (i.e., type 17-H or United Nations Code 1A2 or 1H2). New steel drums are preferred over recycled drums. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consideration must be given to the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.

For long-term IDW storage at other project locations, the DOT-approved drums with removable lids are recommended. The integrity of the foam or rubber sealing ring located on the underside of some drum lids shall be verified prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.

To prepare IDW drums for labeling, the outer wall surfaces and drum lids shall be wiped clean of all material that may prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, that material shall be wiped from the drum, and the paper towel or rag used to remove the material shall be segregated with visibly soiled PPE and disposable sampling equipment. All IDW drums shall be labeled and placed on pallets prior to storage (see Section 5.4).

5.3.2 Drum Labeling

Proper labeling of IDW drums is essential to the success and cost-effectiveness of subsequent waste screening and disposal activities. Labels shall be permanent and descriptive to facilitate correlation of field analytical data with the contents of individual IDW drums. All IDW drums must be labeled using the two distinct labeling methods described below to ensure durability of the information. These two recommended methods are completing and affixing preprinted labels and marking information on drum surfaces with paint. Use of the preprinted labels, and painted labeling is mandatory. These methods are described below.

Preprinted Labels

Two preprinted Rocketdyne drum labels shall be completed and sealed in separate heavy-duty, clear plastic bags to prevent moisture damage. One label shall be on the outside of the drum with the label data facing outward. The bag shall be affixed to the drum at the midpoint of the drum height using a sufficient quantity of adhesive tape (e.g., duct tape, packing/strapping tape) to enable the bag to remain on the drum as long as possible during storage. A second copy of the preprinted label shall be prepared, sealed in a plastic bag, affixed to the underside of the drum lid, and sealed inside the drum. If appropriate, a third label may be prepared and placed in the plastic bag, behind the outside label and facing the drum.

The drum labels to be used for the field investigation at the Santa Susana Field Laboratory are shown in Attachment 1 (see Attachments A and D within Attachment 1). A preprinted Rocketdyne *Hazardous Waste Pending Analysis* drum label shall be affixed to each drum as soon as IDW is added. If applicable analytical results indicate that the IDW is a hazardous waste, preprinted Rocketdyne *Hazardous Waste* drum labels shall be affixed to the drum as described above. If the analytical results indicate that the IDW is not a hazardous waste, a note shall be added to the *Hazardous Waste Pending Analysis* drum label identifying the waste as non-hazardous. Additional *Hazardous Waste Pending Analysis* drum labels shall also be affixed to the drum in the manner described above.

It is essential that all relevant information recorded on individual drum labels be repeated in the field notebook for later development of the OTIS drum inventory data base (see Section 5.5 and SOP FP-F-5, *Logbooks*).

Painted Labels

The second method for labeling drums is to paint label information directly on the outer surface of the drum. At a minimum, the information placed on the drum shall include the project number, the drum number (following the numbering convention given above), the source identification type and number, the type of IDW, the generation date(s), and the telephone number provided at the bottom of the preprinted label appropriate for the project location. The drum surface shall be dry and free of material that could prevent legible labeling. Label information shall be confined to the upper two-thirds of the total drum height. The top surface of the drum lid may be used as an additional labeling area, but this area should only be used in addition to the upper two-thirds of the sides of the drum. The printing on the drum shall be large enough to be easily legible. Yellow, white, or red paint markers (oil-based enamel paint) that are non-photodegradable are recommended to provide maximum durability and contrast with the drum surface.

5.4 DRUM STORAGE

Drum storage procedures shall be implemented to minimize potential human contact with the stored IDW and prevent extreme weathering of the stored drums. All IDW drums shall be placed upright on pallets before the drums are stored. RCRA storage requirements include the following: containers shall be in good condition and closed during storage; wastes shall be compatible with containers; storage areas shall have a containment system; and spills or leaks shall be removed as necessary. However, until the IDW is conclusively determined to be a RCRA hazardous waste, the Project Manager shall manage the IDW in a protective manner, and not necessarily in accordance with these listed RCRA storage requirements (EPA 1992). In general, drums of IDW shall be stored within the area of contamination (AOC) so that RCRA land disposal restrictions (LDRs) will not apply in future, if onsite disposal is an option. If the IDW is determined to be RCRA hazardous waste, then RCRA storage, transportation, and disposal requirements may become applicable, including a limited 90-day storage permit exemption period prior to required disposal. The AOC concept does not affect the approach for managing IDW that did not come from the AOC, such as PPE, decontamination equipment and fluids, and ground water. If RCRA hazardous, these wastes must be drummed and disposed offsite (EPA 1991).

Drums shall be stored onsite within the AOC prior to disposal, except as directed by RCRA requirements for removal when professional judgement suggests the IDW may pose an immediate or permanent public endangerment (EPA 1991). All IDW drums generated during field activities at a single AOC shall be placed together in a secure, fenced area onsite to prevent access to the drums by unauthorized personnel. When a secure area is not available, drums shall be placed in an area of the site with the least volume of human traffic; at a minimum, plastic sheeting (or individual drum covers) and yellow caution tape shall be placed around the stored drums. Drums from projects involving multiple AOCs shall remain at the respective source areas where the IDW was generated. IDW should not be transferred offsite for storage elsewhere, except under rare circumstances such as the lack of a secure storage area onsite.

Proper drum storage practices shall be implemented to minimize damage to the drums from weathering. When possible, drums shall be stored in dry, shaded areas and covered with impervious plastic sheeting or tarpaulin material. Every effort shall be made to protect the preprinted drum labels from direct exposure to sunlight, which causes ink on the labels to fade. In addition, drums shall be stored in areas that are not prone to flooding. The impervious drum covers shall be appropriately secured to prevent dislodging by the wind. It may be possible to obtain impervious plastic covers designed to fit over individual drums; however, the labeling information shall be repeated on the outside of these opaque covers.

Drums in storage shall be placed with sufficient space between rows of drum pallets and shall not be stacked, such that authorized personnel may access all drums for inspection. Proper placement will also render subsequent IDW screening, sampling, and disposal more efficient. It is recommended that IDW drums be segregated in separate rows/areas by matrix (i.e., soil, liquid or PPE/other).

If repeated visits are made to the project site, the IDW drums shall be inspected to clear encroaching vegetation, check the condition and integrity of each drum, check and replace aluminum tags as necessary, and replace or restore the tarpaulin covers.

5.5 OTIS DRUM INVENTORY

Accurate preparation of an IDW drum inventory is essential to all subsequent activities associated with IDW drum tracking and disposal. An inventory shall be prepared for each project in which IDW is generated, stored, and disposed. The inventory data from each project will be entered into OTIS to become part of the field program data base.

An updated inventory of all IDW drums associated with the field program shall be generated from OTIS, to be compiled and transmitted by Ogden to Rocketdyne personnel at the completion of field work or on a quarterly basis. The drum inventory information in OTIS shall include 12 elements that identify drum contents and indicate their fate (see Attachment 2, Table A4-1).

Attachment 3 to this procedure indicates the type and format of the IDW information that will be provided by the Field Program Manager to the Data Base Administrator or designate for input to OTIS, on a monthly basis. Uploading drum inventory information and site characterization data into the OTIS data base will provide users an efficient means for conducting the initial screening of IDW by automating the comparison of site analytical data with relevant regulatory criteria. The inventory information required includes the drum identification number; the storage location of the drum prior to disposal; the origin or source(s) of the drum contents; the type of drum contents; the amount of waste; the starting waste generation date; the expected disposal date; and the actual date of disposal (see Attachment 3, Table A5-1).

In addition, the recommended analytical methods to adequately characterize the IDW contained in each drum and the recommended or actual disposition of the IDW drum contents (see Attachment 4), will be provided by the Field Program Manager to the Project Manager on an as-needed basis for attachment to the quarterly IDW drum inventory report.

5.5.1 Generator/Site Name

Inventory data shall include the field activity and the site name where the IDW was generated.

5.5.2 Project Number

Inventory data shall include the four-digit project number associated with each drum.

5.5.3 Drum Number

The drum number assigned to each drum shall be included in the inventory data base.

5.5.4 Storage Location Prior to Disposal

The storage location of each drum prior to disposal shall be included in the inventory (e.g., west of Building 304, north of well SH-8, etc.).

5.5.5 Origin of Contents

The source identification of the contents of each IDW drum shall be specified in the inventory (e.g., soil boring number, monitoring well number, sediment sampling location, or the multiple sources for PPE- or rinse water-generating activities).

5.5.6 IDW Type

Inventory data shall include the type of IDW in each drum (e.g., soil, PPE, disposable sampling equipment, sludge, sediment, development water, steam cleaning water, decontamination rinse water).

5.5.7 Waste Volume

The amount of waste in each drum shall be specified in the inventory as a percentage of the total drum volume or an estimated percentage-filled level (e.g., 95 percent maximum for liquid IDW).

5.5.8 Recommended Analytical Methods and Test Results Compared with Applicable Regulatory Standards

The EPA analytical methods recommended to adequately characterize IDW contained in each drum will be summarized in a tabular format (e.g., TCLP Metals, TCLP Benzene, 8080 Pesticides, 8015 Mod. BTEX, Total Cadmium, etc.) and attached to the quarterly IDW drum inventory report (see Attachment 4).

5.5.9 Recommended or Actual Disposition of IDW Drum Contents

The recommended means of IDW disposal for each drum shall be summarized in a tabular format (e.g., Offsite, Encapsulated Onsite, Treatment/Sewer, Offsite Incinerator) and attached to the quarterly IDW drum inventory report (see Attachment 4). Additional narrative discussion of the rationale for the recommended disposal option shall be attached to the quarterly IDW drum inventory report as data become available.

5.5.10 Generation Date

Inventory data shall include the date IDW was placed in each drum. If a drum contains IDW generated over more than one day, the start date for the period shall be specified in dd-Mon-yy format. This date is <u>not</u> to be confused with a RCRA hazardous waste accumulation date (40 CFR 262).

5.5.11 Expected Disposal Date

The date each drum is expected to be disposed shall be specified as part of the inventory in Mon-yy format. This date is for informational purposes only to Rocketdyne, and shall not be considered contractually binding.

5.5.12 Actual Disposal Date

The actual drum disposal date occurs at the time of onsite disposal, or acceptance by the offsite treatment or disposal facility. It shall only be entered in the drum inventory data base when such a date is available in dd-Mon-yy format.

In order to provide information for all 12 of the inventory elements for the quarterly inventory report described above, and summarized in Attachment 2, the main source of information will be provided to OTIS by Project Managers in the format presented in Attachment 3. The information that does not appear in Attachment 3 will be available from other sources.

The recommended analytical test methods along with actual test results compared with applicable regulatory standards will be provided by Project Manager to Rocketdyne personnel in the format presented in Attachment 4, when such data are available. Recommended disposal options or actual disposition of the IDW drum contents will also be provided by Project Manager in the format presented in Attachment 4 as data becomes available. This information constitutes the results of preparing and implementing an IDW screening, sampling, classification, and disposal program for each site.

6.0 RECORDS

The Project Manager is responsible for completing and updating the site-specific IDW drum inventory spreadsheet (see Attachment 3), and submitting it as needed to the Database Manager for updating in OTIS. The original information for uploading into OTIS shall be available in the detailed notes recorded in the site-specific field notebook. In addition, actual site or drum sampling results shall be forwarded to the Rocketdyne personnel, along with a comparison to the applicable regulatory standards. As necessary, the backup documentation to the quarterly IDW drum inventory report shall also include the recommended means for IDW disposal for each drum (see Section 5.5.9 and Attachment 4). After disposal, the actual means and/or location of disposal shall be indicated in tabular format with supporting narrative per Attachment 4.

Field Project Managers and designates are responsible for documenting all IDW-related field activities in the field notebook, including most elements of the IDW drum inventory spreadsheet. The correct methods for developing and maintaining a field notebook are presented in SOP FP-F-5, *Logbooks*.

The Data Base Administrator or designate is responsible for providing an updated copy of the OTIS IDW drum inventory to the Ogden Project Manager, on a quarterly basis. The Ogden Project Manager is responsible for compiling the IDW drum inventories and associated documentation from active projects, and submitting it to the Rocketdyne Project Manager on a quarterly basis at the completion of field work.

7.0 IDW Disposal Plan

Upon receipt of analytical data from the investigation, an IDW Disposal Plan shall be prepared that will include the following:

- identify criteria for selecting disposal options;
- identify possible disposal options;
- provide a comparison between analytical data for each drum of IDW and the comparative criteria; and
- identify the disposal option selected for each drum of IDW.

The IDW Disposal Plan must be approved by Rocketdyne and, in some cases, pertinent regulatory agencies. It must also be amended following each phase of field work.

8.0 REFERENCES

Department of Transportation (DOT). 1990. Transporting Hazardous Materials (HM-181). December 21.

EPA. 1991. Management of Investigation-Derived Wastes During Site Inspections. U.S. Environmental Protection Agency/540/G-91/009. May.

EPA. 1992. Guide to Management of Investigation-Derived Wastes. Quick Reference Guide. U.S. Environmental Protection Agency: 9345.3-03FS. January.

Ogden. 1992. Quality Assurance Management Plan. CLEAN Program. June 26.

9.0 ATTACHMENTS

1. Rocketdyne System of Procedures C-203
2. Example Format _ Quarterly IDW Drum Inventory Updates
3. Example Format _ IDW Drum Inventory Updates to OTIS
4. Example Format _ Attached Documentation for the Analytical Methods, Test Results, and Disposition of Drums, for the Quarterly or Final IDW Drum Inventory

Procedure Number: FP-B-8, IDW Management   Revision: 1
Date: August 1996

ATTACHMENT 1
Rocketdyne System of Procedures C-203

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Attachment 1

Rocketdyne System of Procedures

Rockwell

RSOP C-203
Page 1 of 7
May 1, 1996

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RSOP C-203, HAZARDOUS WASTE MANAGEMENT PROGRAM, MAY 1, 1996, F. SWANSON, EH&S

PROCEDURE CHANGE SUMMARY - This procedure replaces Environmental Control Procedures EC 4.00 dated November 15, 1990, EC 4.10 dated January 7, 1994, and EC 7.20 dated April 25, 1994, and Manufacturing Procedure L03-12, dated November 5, 1993.

PURPOSE

This procedure provides requirements for the management of hazardous wastes to ensure compliance with relevant regulations. On-site permitted treatment, storage, and disposal facilities may have additional existing procedures which are applicable to the management of hazardous waste.

DEFINITIONS

Date of Accumulation - The date waste is first added to the container or tank.

Date of Storage - (applies only to satellite accumulation areas and on-site permitted TSDF's) The date when one or more of the listed criteria are met in a Satellite accumulation area: (1) the container is filled; (2) an excess of 55 gallons of hazardous waste or one quart of extremely hazardous waste or per recyclable or compatible wastestream(See Section 6.c.) has been accumulated in a satellite accumulation area; and/or (3) 180 days have passed since the first addition of waste.

Hazardous Waste - a waste that, because of it's quantity, concentration, physical, or chemical characteristics, poses a significant present or potential hazard to human health and safety or the environment if released into the workplace or environment.

Incompatible Wastes - Any hazardous waste unsuitable for commingling with another waste material, where the commingling might produce heat, fire or explosion, violent reaction, toxic or flammable dusts, mists, fumes, vapors or gases which might endanger public health, safety or the environment.

GENERAL REQUIREMENTS (see Figure 1)

1. The Hazardous Waste Generator (generator) determines if there is potential hazardous waste generation. If waste is corrosive, reactive, ignitable or toxic, it is hazardous. Generator will contact Environmental Protection (EP). EP will assist generators in waste characterization.

   If the generator is not sure the waste is hazardous, the waste will be managed as hazardous. The generator will label the waste using the Hazardous Waste Pending Analysis label, Form 653-T-003 (Attachment A). EP will then characterize the waste.

2. Generators must attend Hazardous Waste Handling, Course 4004, and must attend refresher training annually.

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3. Generators will accumulate or store their waste in "red cans", satellite accumulation points, generator container storage, or generator tank storage. Generators must follow storage requirements. EP will assist generators in setting up these hazardous waste management areas.

4. Generators must label the hazardous waste container or tank with a Hazardous Waste Label, Form 642-J. Generators may choose instead to stencil tanks with "Hazardous Waste" and a generic waste name. Specific examples of labels are in Attachments B-D.

5. Red Can Storage Requirements

   a. Generators will use red cans for storing flammable or combustible hazardous waste.

   b. Generator will enter "Daily" as the Date of First Accumulation and N/A as the Date of Storage on the red can Hazardous Waste Label (Attachment B).

   c. Generator will empty red can daily. EP may perform this task if generator does not have an authorized generator storage area.

6. Hazardous Waste Satellite Accumulation Point Requirements (see Figure 2)

   a. Generator will accumulate hazardous waste at the initial point of generation in the same or adjacent work area.

   b. Generator will maintain control of the Satellite Accumulation Area. The generator will keep the container in the operator's line of sight. The generator may also keep the waste in a locked compartment to which the generator controls access.

   c. Generator will have less than 55 gallons of hazardous waste or one quart of extremely hazardous waste stored at a satellite accumulation point. There are two exceptions: (1) if wastes are incompatible, the volume limits apply to each waste, and/or (2) if a single container prevents recycling, is unsafe to the generator or to the environment, then the volume limits apply to each compatible wastestream.

   d. Generator will enter Date of First Accumulation when waste is first added to container (Attachment C).

   e. Generator will store hazardous waste at the satellite accumulation point up to 180 days.

   f. When the stored waste reaches the volume or time limits for satellite storage, or when container is full, the generator will store the container by entering the Date of Storage on the hazardous waste label.

   g. Generator must ship the "stored" hazardous waste container to the HWSA or the applicable TSDF within 72 hours. Container must remain in satellite area until picked up by Internal Trucking.

7. Hazardous Waste Generator Area Storage Requirements (see Figure 3)

   a. Generator may store any amount of containerized hazardous waste in an approved generator storage area.

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b. Generator storage area must have communication equipment, fire extinguisher, emergency spill equipment, safety shower, hazardous waste warning sign, and secondary containment.

c. Generator may store hazardous waste for up to 60 days.

d. Generator must inspect the generator area weekly. The generator will complete the Hazardous Waste Container Weekly Container Checklist, Form 624-T-1.

e. Generator must maintain checklists in area for one year.

f. Generator must maintain emergency spill cabinets.

g. Generator must maintain aisle space to allow for drum movement, emergency equipment, and inspection.

8. Hazardous Waste Tank Storage Requirements (see Figure 4)

a. Tank must meet specific design requirements which EP will assist in determining.

b. Tank storage area must have communication equipment, fire extinguisher, emergency spill equipment, safety shower, hazardous waste warning sign and secondary containment.

c. Generator must only store hazardous waste which is compatible with the tank.

d. Generators may only store 5000 gallons or less of hazardous waste in tanks.

e. Generators may store hazardous waste for up to 90 days.

f. Generators must perform tank inspections each operating day. The generator must complete Hazardous Waste Tank Inspection Checklist, Form 653-T-4 (Attachment F).

g. Generators must maintain completed Checklists near the tank for on e year.

h. Generators must maintain Emergency Spill Cabinet Supplies.

9. Generators will obtain hazardous waste containers from the Hazardous Waste Storage Area(HWSA) located at each facility.

10. Generators must use containers or tanks which are compatible with the hazardous waste.

11. Generators must segregate incompatible wastes.

12. Generators must keep containers closed when not adding or removing hazardous waste from the container. The generator must keep bungs wrench tight, drum rings tightened, or latches locked.

13. Generators will ensure hazardous wastes are accumulated in a manner which minimizes the potential for storm water pollution.

14. Generators will minimize the generation of hazardous waste to the extent it is economically feasible.

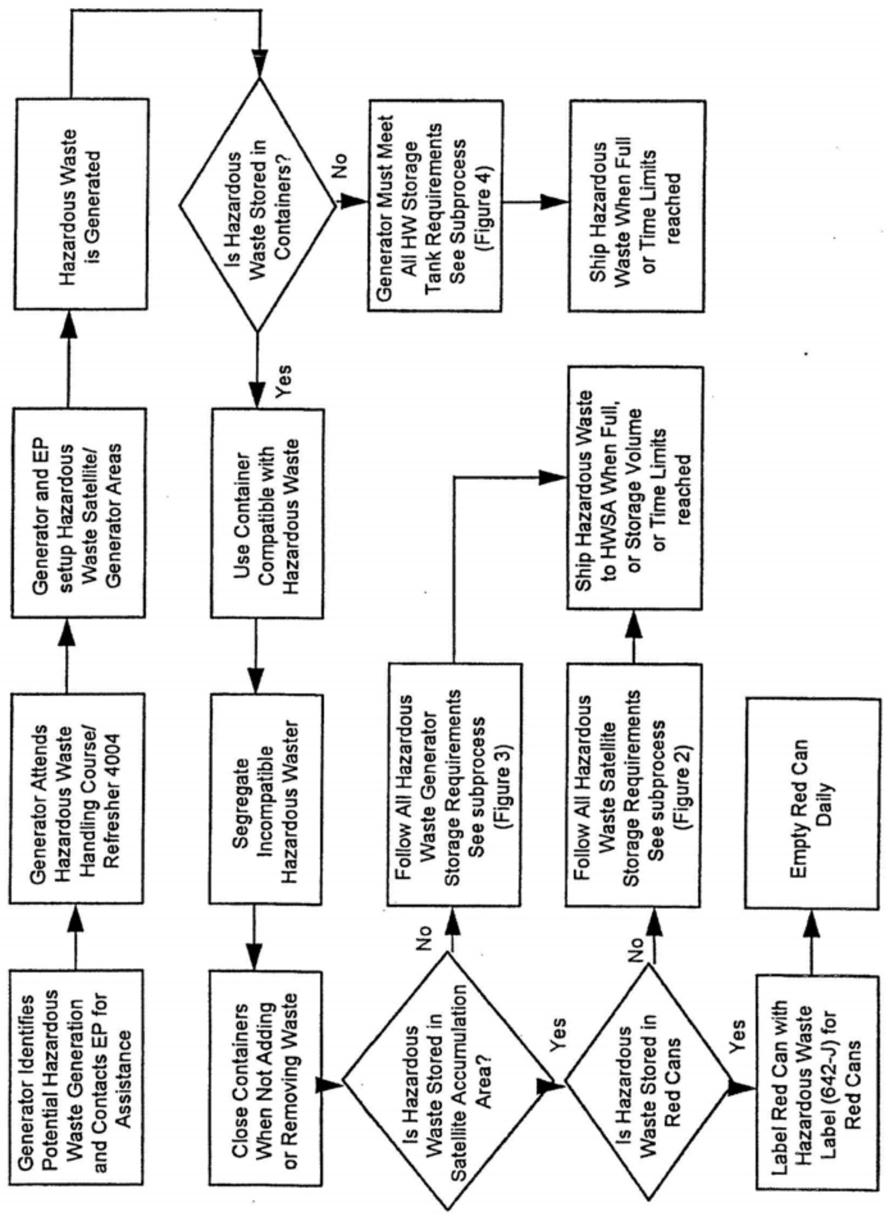

Figure 1 - Hazardous W[illegible]te Management Program

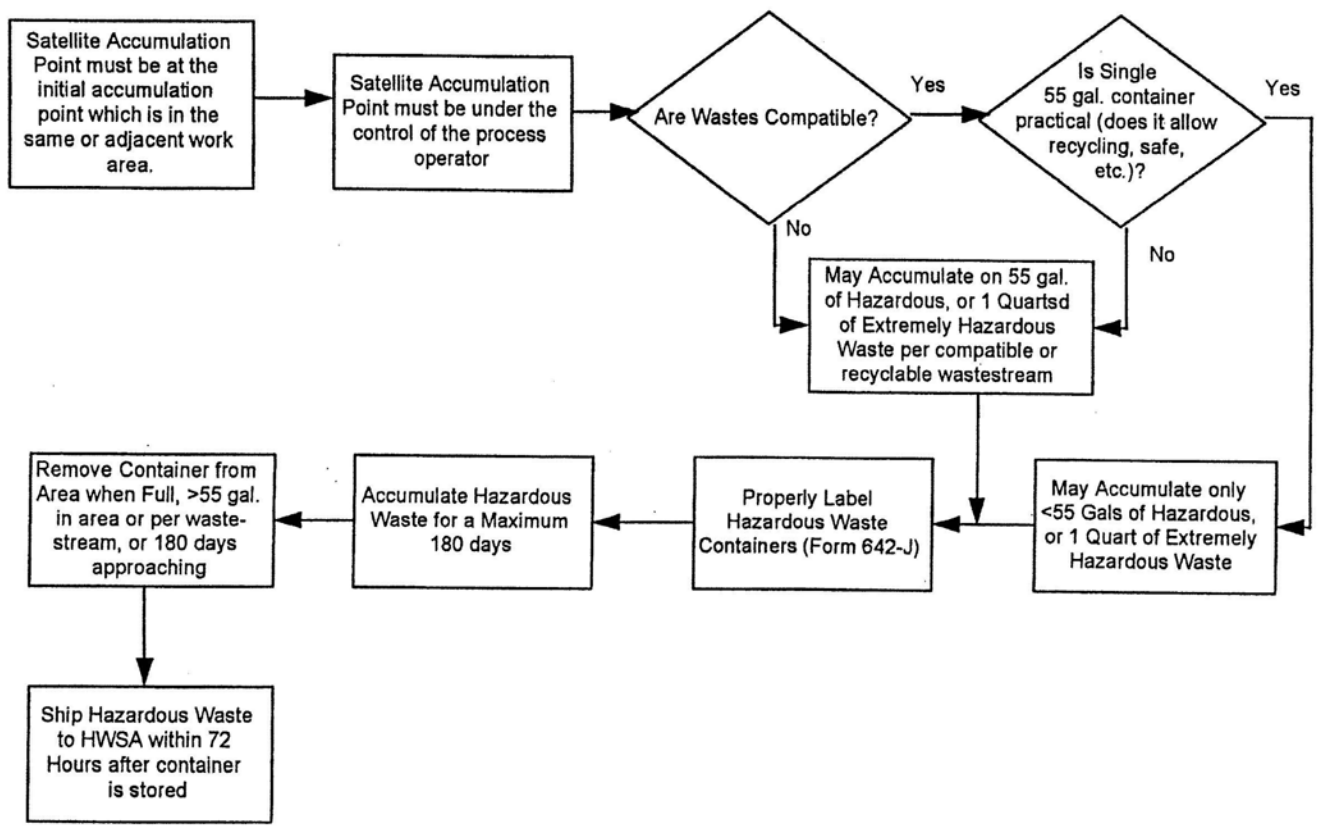

Figure 2 - Hazardous Waste Satellite Accumulation Point Requirements

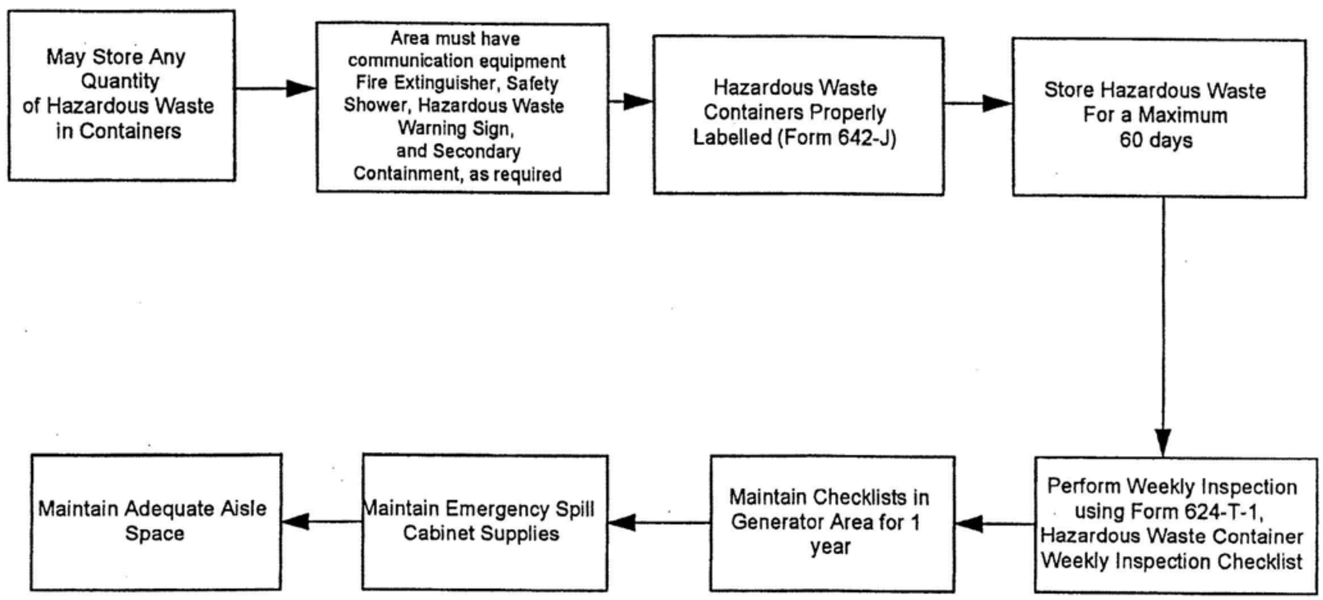

Figure 3 - Hazardous Waste Generator Storage Requirements

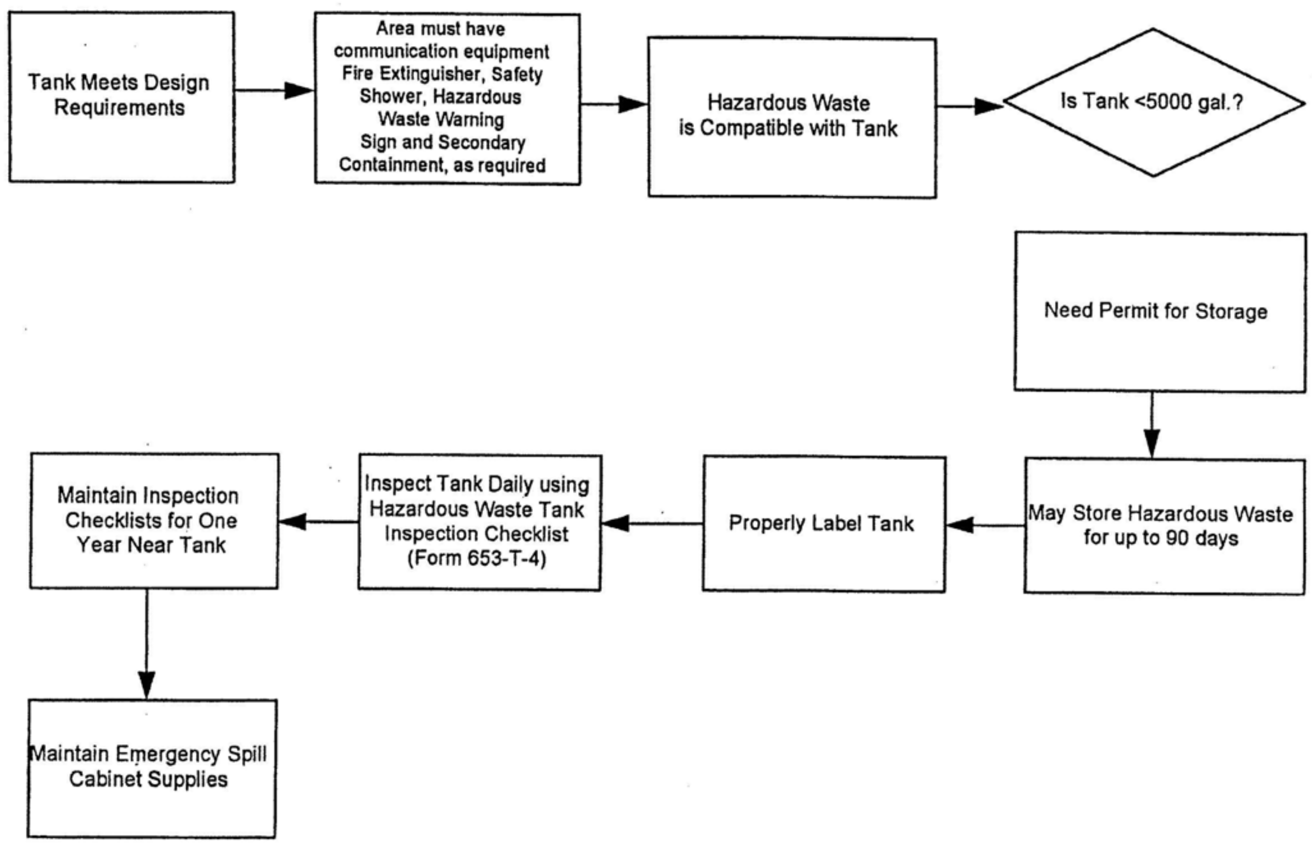

Figure 4 - Hazardous Waste Tank Storage Requirements

Attachment A to RSOP C-203
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May 1, 1996

HAZARDOUS WASTE
PENDING ANALYSIS

☐ Canoga
6633 Canoga Avenue
Canoga Park, CA 91303

☐ DeSoto
8900 DeSoto Avenue
Canoga Park, CA 91304

☐ SSFL
End of Woolsey Canyon Road
Simi Hills, CA 91311

☐ Westlake
2625 Townsgate Rd.
Westlake, CA 91361

☐ Plummer
21415 Plummer Ave
Chatsworth, CA 91311

☐ Other

Date of Storage ____________________

Date of 1st Accum./Date Deemed to be a Waste ____________________

Department Number / Name ______________ Area/Site ______________ Bldg. No. ______ Area Contact / Phone ______________

____________________ ______**% Known** ☐ **Ignitability** (F.P.< 140 °) ☐ **Corrosivity** (PH <2 or> 12.5) ☐ **Toxicity**
____________________ ______**% Properties:**
____________________ ______**%** ☐ **Reactivity** ☐ **Other** ____________
____________________ ______**% Known**
____________________ ______**% Physical State:** ☐ **Solid** ☐ **Liquid** ☐ **Sludge** ☐ Gas ☐ Other ____________
____________________ ______**%**
____________________ ______**%** Quantity in Container: ____________ ☐ gal. ☐ lbs. ☐ cu. yds
____________________ ______**%** Process Generating Waste ____________________
____________________ ______**%** ____________________

Analysis Log No. ____________________ **Date Sampled** ____________________

Rockwell International Corporation/Rocketdyne Division, 6633 Canoga Avenue, Canoga Park, CA 91303 818/710-5163

FORM 653-T-003 REV. 3-88

Form 653-T-003 - Hazardous Waste Pending Analysis

Attachment B to RSOP C-203
Page 1 of 1
May 1, 1996

N/A

Daily

HAZARDOUS WASTE

☐ Canoga
6633 Canoga Avenue
Canoga Park, CA 91303

☐ DeSoto
8900 DeSoto Avenue
Canoga Park, CA 91304

☐ SSFL
End of Woolsey Canyon Road
Simi Hills, CA 91311

☐ Westlake
2625 Townsgate Rd.
Westlake, CA 91361

☐ Plummer
21415 Plummer Ave
Chatsworth, CA 91311

☐ Other

Date of Storage ____________ Process ____________

Date of 1st Accum. ____________ Container No. ________ Profile No. ________

Department Number / Name ____________ Area/Site ________ Bldg. No. ________ Area Contact / Phone ________

____________ ______ % Properties: ☐ Ignitability (F.P.< 140 °) ☐ Corrosivity (PH <2 or> 12.5)
____________ ______ %
____________ ______ % ☐ Toxicity ☐ Reactivity ☐ Other
____________ ______ %
____________ ______ % Physical State: ☐ Solid ☐ Liquid ☐ Sludge ☐ Gas ☐ Other
____________ ______ %
____________ ______ %
____________ ______ % Quantity in Container: ____________ ☐ gal. ☐ lbs. ☐ cu. yds
____________ ______ %

Generator's Certification

The above named wastes are properly identified, classified and labeled according to environmental regulations and Environmental Control Procedure 04.10. Failure to comply with these requirements can result in the issuance of extensive fines or imprisonment.

Printed Name ____________ Signature ____________ Date ________

Rockwell International Corporation/Rocketdyne Division, 6633 Canoga Avenue, Canoga Park, CA 91303 818/710-5163

FORM 642-J REV. 11-88

Form 642-J, Red Can

Attachment C to RSOP C-203
Page 1 of 1
May 1, 1996

Enter date on "Date of Storage" line when any one of these criteria is met:

1. Container is full
2. 55 gallons of hazardous waste or one quart of acutely or extremely hazardous waster is accumulated in area
3. 180 days have passed since the first addition of waste

Immediately arrange for shipment of container to hazardous waste storage area

In "Date of 1st Accumulation" enter date when waste is first added to container

HAZARDOUS WASTE

☐ Canoga 6633 Canoga Avenue Canoga Park, CA 91303
☐ DeSoto 8900 DeSoto Avenue Canoga Park, CA 91304
☐ SSFL End of Woolsey Canyon Road Simi Hills, CA 91311
☐ Westlake 2625 Townsgate Rd. Westlake, CA 91361
☐ Plummer 21415 Plummer Ave Chatsworth, CA 91311
☐ Other

Date of Storage ____________ Process ____________

Date of 1st Accum. ____________ Container No. ____________ Profile No. ____________

Department Number / Name ____________ Area/Site ____________ Bldg. No. ________ Area Contact / Phone ____________

____________ ______ % Properties: ☐ Ignitability (F.P.< 140 °) ☐ Corrosivity (PH <2 or> 12.5)
____________ ______ %
____________ ______ % ☐ Toxicity ☐ Reactivity ☐ Other
____________ ______ %
____________ ______ % Physical State: ☐ Solid ☐ Liquid ☐ Sludge ☐ Gas ☐ Other
____________ ______ %
____________ ______ %
____________ ______ % Quantity in Container: ____________ ☐ gal. ☐ lbs. ☐ cu. yds
____________ ______ %

Generator's Certification

The above named wastes are properly identified, classified and labeled according to environmental regulations and Environmental Control Procedure 04.10. Failure to comply with these requirements can result in the issuance of extensive fines or imprisonment.

Printed Name ____________ Signature ____________ Date ____________

Rockwell International Corporation/Rocketdyne Division, 6633 Canoga Avenue, Canoga Park, CA 91303 818/710-5163

FORM 642-J REV. 11-88

Form 642-J, Authorize˙ Satellite Accumulation Area

N/A

Enter the date when waste is first added to container

HAZARDOUS WASTE

☐ Canoga
6633 Canoga Avenue
Canoga Park, CA 91303

☐ DeSoto
8900 DeSoto Avenue
Canoga Park, CA 91304

☐ SSFL
End of Woolsey Canyon Road
Simi Hills, CA 91311

☐ Westlake
2625 Townsgate Rd.
Westlake, CA 91361

☐ Plummer
21415 Plummer Ave
Chatsworth, CA 91311

☐ Other

Date of Storage ____________ Process ____________

Date of 1st Accum. ____________ Container No. ____________ Profile No. ____________

Department Number / Name ____________ Area/Site ____________ Bldg. No. ____________ Area Contact / Phone ____________

____________ ______ % Properties: ☐ Ignitability (F.P.< 140 °) ☐ Corrosivity (PH <2 or> 12.5)
____________ ______ %
____________ ______ % ☐ Toxicity ☐ Reactivity ☐ Other
____________ ______ %
____________ ______ % Physical State: ☐ Solid ☐ Liquid ☐ Sludge ☐ Gas ☐ Other
____________ ______ %
____________ ______ %
____________ ______ % Quantity In Container: ____________ ☐ gal. ☐ lbs. ☐ cu. yds
____________ ______ %

Generator's Certification

The above named wastes are properly identified, classified and labeled according to environmental regulations and Environmental Control Procedure 04.10. Failure to comply with these requirements can result in the issuance of extensive fines or imprisonment.

Printed Name ____________ Signature ____________ Date ____________

Rockwell International Corporation/Rocketdyne Division, 6633 Canoga Avenue, Canoga Park, CA 91303 818/710-5163

FORM 642-J REV. 11-95

Form 642-J, Authorized Generator Storage Area

Rockwell International
Rocketdyne Division

HAZARDOUS WASTE CONTAINER WEEKLY INSPECTION CHECKLIST

NOTE: All Rocketdyne authorized generator storage areas which accumulate hazardous waste are required to conduct inspections of their containers on a weel Completed weekly container inspection checklists are to be kept at or near the location where the hazardous waste containers are stored. Copies of insp discrepancies shall be mailed to the Environmental Protection Department 543, 055-T486.

INSPECTION DATE	INSPECTION TIME AM | PM	FACILITY (e.g. Canoga, DeSoto, SSFL)	DEPT. NAME & NO.
HAZARDOUS WASTE CONTAINERS LOCATION BLDG./AREA		COLUMN	NUMBER OF CONTAINERS INSPECTED

Evaluation and Action

All "Yes" answers mean no discrepancies exist. A "No" answer to any question means a discrepancy exists that require immediate corrective action. Notify the area manager of the discrepancy and indicate the action taken in the Method o Correction area. The area manager must co-sign the inspection checklist when a discrepancy exists. When discrepancy has been corrected, area management must fill in date of correction and sign at bottom of form.

	YES	NO
Are hazardous waste containers in good condition?	______	______
Are hazardous waste containers free from leaks and residues on the outside of the container?	______	______
Is the area surrounding the containers free from leaks and residues?	______	______
Are hazardous waste container lids securely closed and latched?	______	______
Is the hazardous waste being stored compatible with the container?	______	______
Are incompatible hazardous wastes segregated?	______	______
Is the **Hazardous Waste Identification Tag** (Form 642-J) completely filled out and attached to the container?	______	______
Are containers stored less than 60 days?	______	______
Is hose and safety shower/eye wash unobstructed and operational?	______	______
Is emergency communication system (phone, audible alarm) in working condition?	______	______
Are hazardous waste warning signs in place?	______	______
Is fire extinguisher in area?	______	______
Is spill control cabinet properly stocked per inventory sheet?	______	______

Inspector's Name ______________________ Inspector's Signature ______________________

Date: ______________________

COPIES OF INSPECTIONS WITH DISCREPANCIES SHALL BE MAILED TO ENVIRONMENTAL PROTECTION, D/543, 055-T486

DISCREPANCY INDICATION AND CORRECTION AREA

Area Manager Co-Sign ______________________ **Date:** ______________

Describe Method of Correction (Use additional sheet if necessary): ______________________

____

____

____

____

____

____

Date Discrepancy Corrected ______________________

Area Manager Name ______________ **Signature** ______________ **Date:** ________

FORM 624-T-1 NEW 9-92

Rockwell International
Rocketdyne Division

HAZARDOUS WASTE TANK INSPECTION CHECKLIST

NOTE: All Rocketdyne departments which accumulate hazardous wastes in tanks are required to conduct daily inspections of the tanks each operating day. In addition, a weekly checklist (below) must be completed once per week. Completed checklists are to be maintained at or near the tank location and made available for inspection. Copies of inspections with discrepancies shall be mailed to Environmental Protection Department 543, 055-T486.

INSTRUCTIONS FOR COMPLETING TANK INSPECTION FORM 653-T-4

Evaluation and Action

All "Yes" answers mean no discrepancies exist. A "No" answer to any question means a discrepancy exists that requires immediate corrective action. An "N/A" answer means the question does not apply to your tank system. This inspection is required to be performed each operating day. Check the "Not In Operation" box below on non-operational days, i.e., Saturday, Sunday and Holidays. All questions must be answered. If a discrepancy is found, corrective action must be taken immediately. Notify the area manager of the discrepancy and indicate the action taken in the Method of Correction area. The area manager must co-sign the inspection checklist when a discrepancy exists. When discrepancy has been corrected, area management must fill in date of correction and sign at bottom of form.

FACILITY | LOCATION OF TANK

DEPARTMENT NAME/NUMBER

DESCRIPTION OF WASTE IN TANK

	NOT IN OPERATION ☐	NOT IN OPERATION ☐	NOT IN OPERATION ☐	NOT IN OPERATION ☐	NOT IN OPERATION ☐	NOT IN OPERATION ☐	NOT IN OPERATION ☐
	MONDAY	**TUESDAY**	**WED.**	**THURS.**	**FRIDAY**	**SAT.**	**SUNDAY**
DATE AND TIME							
INSPECTOR'S NAME							
INSPECTOR'S SIGNATURE							
§66265.195. Inspections. (a) The owner or operator shall inspect, where present at least once each operating day:	YES NO N/A	YES NO N/A	YES NO N/A	YES NO N/A	YES NO N/A	YES NO N/A	YES NO N/A
(1) Is overfill/spill control equipment (e.g., waste-feed cutoff systems, bypass systems, and drainage systems) in good working order?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
(2) Are the aboveground portions of the tank system free from leakage and corrosion?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
(3) Is data gathered from monitoring equipment and leak-detection equipment, (e.g., pressure and temperature gauges, monitoring wells) ensuring that the tank system is being operated according to its design?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
(4) Are the construction materials and the area immediately surrounding the externally accessible portion of the tank system including secondary containment structures (e.g., dikes) free from erosion or releases of hazardous waste (e.g., wet spots, dead vegetation)?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
(5) For uncovered tanks, are at least 2 feet of freeboard maintained?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
(6) Is the tank properly labeled with a Form 642-J, and date of accumulation is less than 90 days from the first addition of waste to the tank?	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐

WEEKLY CHECKLIST - To be Completed Once Per Week

Date: ____________________

Time: ____________________

Sign: ____________________

	YES	NO
Is hose and safety shower/eye wash unobstructed and operational?	☐	☐
Is emergency communication system (phone, audible alarm) in working condition?	☐	☐
Are hazardous waste warning signs in place?	☐	☐
Is fire extinguisher in area?	☐	☐
Is spill control cabinet properly stocked per inventory sheet?	☐	☐

COPIES OF INSPECTIONS WITH DISCREPANCIES SHALL BE MAILED TO ENVIRONMENTAL PROTECTION, D/543, 055-T486

DISCREPANCY INDICATION AND CORRECTION AREA

Area Manager Co-Sign ____________________ **Date:** ____________________

Describe Method of Correction (use additional sheet if necessary): ____________________

Date Discrepancy Corrected ____________________

Area Manager Name ____________________ **Signature** ____________________ **Date** ____________________

FORM 653-T-4 REV. 8-92

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Procedure Number: FP-B-8, IDW Management Revision: 1
Date: August 1996

ATTACHMENT 2
Quarterly IDW Drum Inventtory Updates
Table A4-1

Navy Activity/Site Name (generator/site)	CTO Number 0bbb	Drum Number (xxxx-AA-Dzzz)	Drum Storage Location	Origin of Contents (source ID #)	IDW Type	Waste Volume (fill level %)	Waste Generation Date (dd-Mon-yy)	Expected Disposal Date (Mon-yy)	Actual Disposal Date (dd-Mon-yy)
NSC Pearl Harbor/Landfill	0068	0068-LF-D001	NSC, Near Bldg. 7	SB-1	Soil Cuttings	100	16-Dec-92	Dec-93	NA
		0068-LF-D002	NA	MW-1 MW-2 MW-3	Purge Water	75	20-Dec-92	Jul-93	26-Jul-93
		0068-LF-D003	NA	MW-1 MW-2 MW-3	Decon Water	95	20-Dec-92	Jul-93	26-Jul-93
		0068-LF-D004	In NSC Bldg.16	SB-1 SB-2 SB-3 SB-4 MW-1 MW-2 MW-3	PPE	50	16-Dec-92	Oct-93	NA
NAVSTA Guam/Drum Storage	0047	0047-DS-001	HazMat Storage Area	SB-1 SB-2	Soil Cuttings	100	18-Feb-93	Sep-93	NA

Notes:
NA = Not Applicable

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Procedure Number: FP-B-8, IDW Management | Revision: 1
Date: August 1996

ATTACHMENT 3
IDW Drum Inventory Updates to OTIS

The IDW Drum Inventory updates to OTIS from active field projects shall be generated as needed by using MicroSoft Excel® version 3.0 or higher. One copy of all IDW Drum Inventory updates shall be submitted on 3.5- or 5.25-inch disks, formatted under MS/DOS. All MS/DOS Excel® file names shall be unique. Each disk shall be given an identification label as follows:

IDW Drum Inventory Update to OTIS

Project Number:____________

Site Name:______________________

____

Date:____________

Table A3-1 is an Excel® spreadsheet template that contains the headings and columns that shall be followed when submitting the IDW inventory updates to the Data Base Administrator or designate assigned to perform data management tasks. A hardcopy printout of the IDW Drum Inventory Excel® spreadsheet shall be submitted as necessary, along with an electronic copy.

The **MAXIMUM** character width of each column in the IDW inventory spreadsheet will be as follows:

Drum Number	12 Characters
Drum Storage Location	40 Characters
IDW Source(s)	30 Characters
IDW Type	40 Characters
Waste Volume (percent)	3 Characters
Start Generation Date	9 Characters
Expected Disposal Date	6 Characters
Actual Disposal Date	9 Characters

Total Characters per row	**149**

Some guidelines for completing the IDW drum inventory spreadsheet are as follows:

All columns and rows are required fields except for Drum Storage Location and Actual Disposal Date. You shall specify the Drums Storage Location or the Actual Disposal Date. Fields that do not apply shall be recorded as "NA".

For drums with more than one source of IDW, each source shall be listed **SEPARATELY** on a different row in the spreadsheet. Note the examples in Table A5-1 for drums 0068-LF-D002, D003, and D004.

The Start Waste Generation Date and Actual Disposal Date shall be single dates completed in the dd-Mon-yy format. The Expected Disposal Date shall be estimated in a Mon-yy format.

Procedure Number: FP-B-8, IDW Management
Date: August 1996

Revision: 1

Table A3-1

Attached Documentation for the Analytical Methods, Test Results, and Disposition of Drums for the Quarterly IDW Drum Inventory Update

Navy Activity/Site Name (generator/site)	Drum Number (xxxx-AA-Dzzz)	IDW Type	Recommended EPA Analytical Methods	IDW Sampling Results (ppm)	Relevant Regulatory Criteria (e.g. TCLP, Guam EPA, HI DOH) (ppm)	Drum Storage Location	Recommended/Actual IDW Disposition	Expected Disposal Date (Mon-yy)	Actual Disposal Date (dd-Mon-yy)
NSC Pearl Harbor/Landfill	0068-LF-D001	Soil Cuttings	TCLP Metals TCLP Benzene Total Lead 8015 Mod. BTEX			NSC, Near Bldg. 7	Offsite	Dec-93	NA
	0068-LF-D002	Purge Water	Total Lead Total Chromium			NA	Carbon Filtration Prior to PWC Sewer Discharge	Jul-93	26-Jul-93
	0068-LF-D003	Decon Water	PWC Water Quality Parameters			NA	Carbon Filtration Prior to PWC Sewer Discharge	Jul-93	26-Jul-93
	0068-LF-D004	PPE	None			In NSC Bldg.16	Offsite Incinerator	Oct-93	NA
NAVSTA Guam/Drum Storage	0047-DS-001	Soil Cuttings	8080 PCBs only			HazMat Storage Area	Offsite Incinerator	Sep-93	NA

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ATTACHMENT 4

Table A4-1 is an Excel® spreadsheet template that contains an example of the format and headings that shall be followed when submitting the following updated information to the quarterly IDW drum inventory report to the Ogden Project Manager: the recommended analytical methods to characterize the waste, or a summary of actual test results compared with relevant regulatory criteria; and the disposal option selected, or the actual disposition of the contents of each drum of IDW. A hardcopy printout of the example Excel® Table A4-1 shall be submitted along with a narrative description of the rationale for recommending each analytical method or for selecting each disposal option; a detailed comparison of actual IDW analytical results versus relevant regulatory criteria; or a description of the actual disposition of the contents of each drum of IDW. If applicable, the narrative shall be summarized by matrix, analytical method, or disposal location.

The Recommended EPA Analytical Methods are those analytical methods required to characterize the IDW in a drum Sampling Plan, based on the analytes of concern at the site. The analytes of concern shall be determined from implementation of an IDW drum Screening Plan, by comparing available analytical site data and estimated IDW analyte concentrations, against applicable regulatory criteria.

The Recommended Disposition selected shall initially be a generic determination of where the IDW should be disposed. The table entry and supporting rationale shall be as specific as the data allows. The disposal option selected shall be based on the Program Manager's professional judgement; the results from the screening, sampling, and classification of the IDW against relevant regulatory criteria; regulatory agency approval of the screening, sampling, and classification methodologies; written acceptance criteria from applicable treatment/disposal facilities; and practical considerations for the treatment, transportation, and/or disposal of the waste.

Procedure Number: FP-B-8, IDW Management
Date: August 1996

Revision: 1

Table A4-1

IDW DRUM INVENTORY UPDATE to OTIS
EXAMPLE FORMAT

Drum Number (xxxx-AA-Dzzz)	Drum Storage Location (be specific)	IDW Source(s) (source ID #)	IDW Type (one type per drum)	Waste Volume (fill level %)	Start Waste Generation Date (dd-Mon-yy)	Expected Disposal Date (Mon-yy)	Actual Disposal Date (dd-Mon-yy)
0068-LF-D001	NSC, Near Bldg. 7	SB-1	Soil Cuttings	100	16-Dec-92	Dec-93	NA
0068-LF-D002	NSC, Near Bldg. 7	MW-1	Purge Water	75	20-Dec-92	Jul-93	26-Jul-93
0068-LF-D002	NSC, Near Bldg. 7	MW-2	Purge Water	75	20-Dec-92	Jul-93	26-Jul-93
0068-LF-D002	NSC, Near Bldg. 7	MW-3	Purge Water	75	20-Dec-92	Jul-93	26-Jul-93
0068-LF-D003	NSC, Near Bldg. 7	MW-1	Decon Water	95	20-Dec-92	Jul-93	26-Jul-93
0068-LF-D003	NSC, Near Bldg. 7	MW-2	Decon Water	95	20-Dec-92	Jul-93	26-Jul-93
0068-LF-D003	NSC, Near Bldg. 7	MW-3	Decon Water	95	20-Dec-92	Jul-93	26-Jul-93
0068-LF-D004	In NSC Bldg.16	SB-1	PPE	50	16-Dec-92	Oct-93	NA
0068-LF-D004	In NSC Bldg.16	SB-2	PPE	50	16-Dec-92	Oct-93	NA
0068-LF-D004	In NSC Bldg.16	SB-3	PPE	50	16-Dec-92	Oct-93	NA
0068-LF-D004	In NSC Bldg.16	SB-4	PPE	50	16-Dec-92	Oct-93	NA
0068-LF-D004	In NSC Bldg.16	MW-1	PPE	50	16-Dec-92	Oct-93	NA
0068-LF-D004	In NSC Bldg.16	MW-2	PPE	50	16-Dec-92	Oct-93	NA
0068-LF-D004	In NSC Bldg.16	MW-3	PPE	50	16-Dec-92	Oct-93	NA
0047-DS-D001	HazMat Storage Area	SB-1	Soil Cuttings	100	18-Feb-93	Sep-93	NA
0047-DS-D001	HazMat Storage Area	SB-2	Soil Cuttings	100	18-Feb-93	Sep-93	NA

Notes:
NA = Not Applicable

STANDARD OPERATING PROCEDURE 14

Packaging and Shipping Procedures

1.0 Purpose and Scope

This Standard Operating Procedure provides guidelines for packaging and shipping the samples collected for the project.

2.0 Equipment and Materials

- Coolers
- Ice
- Tape: fiberglass packing tape and 3M clear, wide, heavy-duty packing tape
- Mailing/shipping labels
- Zip-lock plastic bags, large plastic trash bags, bubble wrap, laboratory-provided foam inserts, laboratory-provided bubble wrap bags
- Chain-of-custody (COC) seal

3.0 Procedures and Guidelines

The procedures below include shipment by both the laboratory courier and third party shipper such as Federal Express or Airborne Express. Packaging and shipping procedures are described below.

3.1 Sample Packaging and Transport

3.1.1 Sample Container Preparation

- Secure the labels to each container with at least two revolutions of clear tape.
- Check container lids for tightness.
- Cover glass containers with at least two full layers of bubble wrap; tape containers closed tightly with clear packing tape to prevent breakage.

3.1.2 Shipping Cooler Preparation

- Remove all previous labels used on the sample shipping cooler.
- Seal the drain plugs with clear, wide packing or duct tape (outside and inside) to prevent melting ice from leaking.

- Place a cushioning layer of styrofoam popcorn or bubble wrap at the bottom of the cooler (about 1 inch thick) to prevent breaking during shipment.
- Line the cooler with a large plastic bag.
- Double-bag all ice in zip-lock plastic bags.

3.1.3 Placing Samples in the Cooler

- Place the original COC form in a zip-lock bag; tape COC form to the inner side of the cooler lid.
- Place samples in an upright position in the cooler.
- Fill void space between samples with styrofoam popcorn, bubble wrap, or foam.
- Place ice on top of samples and between samples.

3.1.4 Closing the Cooler

- Tape the cooler lid with strapping tape, encircling the cooler several times.
- Place custody seals on one side of the cooler lid (two seals in front).
- Cover strapping tape by three revolutions of 3M clear, heavy packing tape.

3.1.5 Transport

Transport sample coolers to the closest Federal Express facility immediately upon completion of sample collection. Intermediate stops should be avoided, with the exception of emergencies only, in which case the situation should be noted in the field notebooks

STANDARD OPERATING PROCEDURE 15

Chain-of-Custody Procedures

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) provides information on chain-of-custody (COC) procedures.

2.0 Definitions

A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on- or off-site analysis (chemical or geotechnical) during sampling program activities. Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This SOP identifies the necessary custody records and describes their completion. This procedure does not take precedence over region-specific or site-specific requirements for chain of custody.

Chain-of-Custody Record Form: A Chain-of-Custody Record Form is a two- to four-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file. A copy of this form is provided as Attachment A to this SOP.

Custodian: The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession, and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample: A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

3.0 Responsibilities

Field Team Leader: The field team leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory.

Sample Personnel: It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

4.0 Procedures

Chain-of-custody procedures, record-keeping, and documentation are an important part of the management control of samples. This includes from the time the sample is collected until it is shipped. The procedures followed facilitate correct sample labeling, tracking, and identification on the COC forms, as well as tracking, sample preparation, and sample analysis by the laboratory.

4.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in-situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information. Information that shall be recorded in the field logbook and soil boring log, when *in-situ* measurements or samples for laboratory analysis are collected, includes:

- Field sampler(s) initials or full name(s).
- Project number.
- Project sample number.
- Sample location or sampling station number.
- Date and time of sample collection and/or measurement.
- Field observations.
- Equipment used to collect samples and measurements.
- Calibration data for equipment used.
- Measurements and observations shall be recorded using waterproof ink.

4.1.1 Sample Label

Samples other than *in-situ* measurements are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the sampling and analysis plan. Each sample container is identified by a sample label (see Attachment B). Blank sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Sample Identification: the unique sample number identifying this sample.
- Date: a six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time: in 24-hour nomenclature, 9:10 am as 0910 or 5:22 pm as 1722.
- Medium: water, soil, sediment, sludge, waste, etc.
- Sample type: grab or composite.
- Preservation: type and quantity of preservation added.
- Analysis: VOC/8260; SVOC/8270; PCB/8082; TPM/8015M; etc.

- Sampled by: printed initials of the sampler.
- Project number and client or PO number and client.
- Remarks: any pertinent additional information.

4.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under COC procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

4.2.1 Field Custody Procedures

- Samples are collected as described in the site sampling and analysis plan. Precisely record the sample location and ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, compass direction in which the view is looking, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographs will be stored in the project files. It is good practice to identify sample locations in photographs by including an easily read sign (white board and erasable markers) with the appropriate sample/location number.
- Sample labels shall be completed for each sample, using waterproof ink.

4.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form, which will be generated using CH2M HILL's SMART Tool. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is completed as detailed below.

- Enter header information (date, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).
- Line out any unused portion of the COC and sign and date that portion of the form.
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zip-locked bag or other appropriate sample-shipping package. Retain the copy with field records.
- Complete other carrier-required shipping papers. The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted. Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zip-locked bag). As long as custody forms are sealed inside the shipping container, commercial carriers are not required to sign the custody form. The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

5.0 Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

STANDARD OPERATING PROCEDURE 16

Documentation and Records

1.0 Purpose and Scope

The purpose of this guideline is to provide methods for the documentation of records taken in the field.

2.0 Field Documentation

2.1 Field Logbooks

Field notes commonly are kept in bound logbooks used by surveyors and produced, for example, by Peninsular Publishing Company or Forestry Suppliers, Inc. (J.L. Darling write in the Rain No. 550, Sesco, Inc.). Pages should be water-resistant, lined, and numbered, and notes should be taken only with water-proof ink, such as that provided in Sanford Sharpie permanent markers.

All lines of all pages should be used to prevent later additions of text, which may be questioned in legal terms. Any pages not used should be marked through with a line, the author's initials, and the note "Intentionally Left Blank."

All pertinent information should be entered into the logbook, including times of starting and stopping work, activities, personnel on the work site, and equipment-calibration results and any equipment problems. The weather at the start of the day should be noted at the top of the first page for the day, and any major changes in weather should be noted at the appropriate time. Summary descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. It is helpful to include a hand-drawn diagram of well construction details and sampling locations in relation to permanent site features.

No irrelevant material, including comical statements, should be entered into the logbook.

An example of a set of logbook entries is provided as Attachment A.

2.2 Field Notebooks

Field equipment and forms notebooks may be used in lieu of bound field logbooks but are strongly discouraged. Although they do not have the advantage of containing all pertinent information in one volume, they do allow the use of pre-printed forms, which can make note taking easier. The notebooks are maintained to document field equipment maintenance and contain calibration logs and field forms, as described below. These provide information which is not recorded in sequentially-numbered, bound site or field logbooks. As an alternate method to using the field equipment and forms notebooks, the information maintained in these notebooks may be documented in the field logbooks. General site information should be documented into the field notebook that includes:

- Site name, personnel onsite and time and date of arrival
- Ambient weather conditions
- Documentation of field activities including decontamination, sampling, and preparation.
- Lot number and brand name for solvent and acid decontamination solutions and analyte-free water used for equipment and field blanks.

An example of well-completed field notebook entries is provided as Attachment B.

Calibration Logs

Calibration logs may be included in the field equipment notebooks and are used to document the proper maintenance and calibration of field testing equipment. All equipment will be inspected and approved by the Field Team Leader before being used, and a calibration log sheet shall be maintained for each instrument used on-site and shall be kept in the notebook. The calibration log will document:

- Name and identifying number of the instrument
- Date calibrated
- Calibration points
- Identification of the calibrator
- Manufacturer, lot number, and expiration date of calibration standards
- Results of the calibration.

Field Forms

Field forms may also be kept in the field notebook if using a three-ring binder form. Field forms include:

- Soil boring log
- Sample collection forms

An example of each of these forms is provided as attachments.

3.0 Attachments

- A - Example of field logbook entries
- B - Standardized field logbook entry formats.

Attachment A
Examples of Field Logbook Entries

3/21/96

Rite in the Rain®

ALL-WEATHER

LINE RULE

Spiral Notebook

Project Field logbook

Storage Tank Site

GW Sampling, Ft. Wain

727500.20.20

10/11/95

- Screening Well Sampling
- Soil Borings
- MW Installation

No. 393

32 Sheets

4 5/8 x 7

TABLE OF CONTENTS

MONDAY OCTOBER 16, 1995

0900 - Arrive Fairbanks on
AK Air flt 89 from Anc

Pick up rental vehicles,
equipt & materials, check into
hotel (Regency)

Team members: Tony Wagner
Bob Trebble, Kathy Kruschke

Weather: partly cldy ≈ 20°F

1200 - lunch

1300 - Meet w/ Joe Malen/DPW
discuss location for staging,
DCon, storage, etc.

Joe said to check w/ENSR
for room @ bldg 1595
share w/ HLA

A.R. Wagner 10/16/95

?

1330 - At bldg 1595.
Talked w/ Tim Gould / HLA.
OK to occupy bldg 1595
They will operate from
trailer.

1400 - Air Force MSgt. Boussard
arrive @ bldg 1595. OK
for us to use open bay
for whatever we need.

Inventory equipt. & materials

1600 - met w/ Driller Calvin Fray
and helper Jeff. They are
collecting their equipt &
materials. Health & Safety briefing

1730 - bldg 3425, w/ Calvin & Jeff
looked at site. Calvin
indicated that brush clearing
may take up to 1 day to
complete. Also, not sure
a pickup truck can
maneuver over the rough
terrain. May be able to

A. R. Wagner 10/16/95

use a bobcat to pull
screening well rig to location.

Agreed to meet driller early
on tomorrow ready to
drill @ bldg. 348P.

1800 - end day.

A. R. Wagner 10/16/95

A. R. Wagner 10/16/95

TUESDAY OCTOBER 17, 1995

0730 - Arrive @ bldg 1595. Prepare sample kits, calibrate instruments

Weather: mostly sunny, cold ≈ 15°F

Team: Tony Wagner screening well sampling

Kathy Kruschke, Bob Trebble MW sampling

0815 - Drillers arrive @ bldg 1595 Readying equipt.

Calvin ok's SOW and performance specifications for Discovery drilling. This will be faxed to ANC for inclusion in the contract.

0830 - Daily MTG. including brief safety discussion, work for day.

A.R. Wagner 10/17/95

Agree to meet Calvin at bldg. 3481 @ about 0930 to install screening wells.

Calibrate OVM and LEL/O_2 meter. Calibration info in calibration log book.

Equipt/materials loaded into van.

0900 - Arrive @ Regency Hotel fax SOW/performance specification to Jacques Gusmano/ANC

0930 - Arrive @ bldg 3481.

0940 - Driller arrive at bldg 3481 indicate that screening well rig is frozen due to cold. Will take it to 1595 to thaw.

A.R. Wagner 10/17/95

1045 - Drillers determine that rig is not frozen; actually a bad starter. Will go to Fairbanks to find one.

1145 - Drillers return to bldg 1555. not able to locate new starter. May have to get one from ANC. Will keep checking w/ local supplier.

In meantime, drillers will prepare lg drill rig for use. and clear brush @ bldg 3425.

1300 - Drillers had to order a new starter from Portland, OR. Will arrive tomorrow AM.

1500 - Drillers report that they have cleared access to screening location at bldg 3425

1730 - end day

A. R. Wagner 10/17/95

WEDNESDAY OCTOBER 18, 1995

0800 - Arrive @ bldg 1555. Prep for sampling

Team: Tony Wagner: screening well sampling, Kathy Kruschke and Bob Trebble: existing well sampling

Weather: partly cloudy
Temp = 14°F

Calibration of instruments by Bob Trebble recorded in calibration logbook OVM and LEL meter.

1215 - Screening well drill rig repaired. Move to bldg 3481. Health & safety briefing w/ drillers

1300 - begin drilling @ 3481. Screening well #01.

A. R. Wagner 10/18/95

Photo
Roll #1
1) screening well rig @ 3481 SC01

1330 - sampling @ 3481 SC01:
depth to water 11.85' bgs

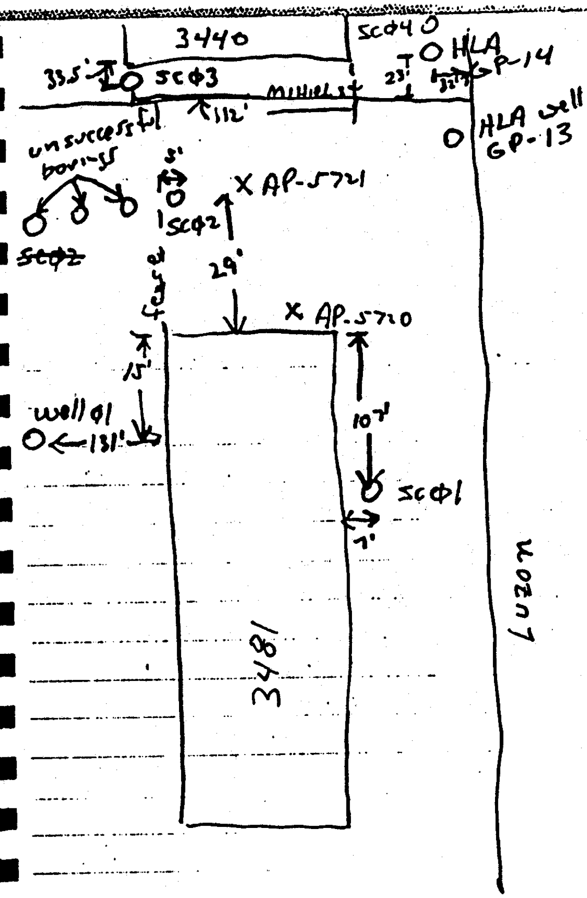
5.35' of water x .046 gal/ft
= .246 gal (well vol.)

1340 - ~~sample~~ purge ≈ 3.5 gal
from SC01

begin sampling:
collect BTEX, GRO, DRO samples
Sample # 95EN0100SC
No GW Monitoring
1400 - complete sampling of SC01
remove drill string

move to west side of fence
to next screening well

A.R. Wagner 10/18/95



Building 3481
Screening well locations

Attachment B
Standardized Field Logbook Entry Formats

14.0 Documentation Reports

14.1 Logbook Protocol

14.1.1 Summary of Method

Logbooks are used for recording pertinent field activity information including, but not limited to, the following:

- Fieldwork documentation
- Field instrumentation readings
- Photograph references
- Sample tag and label numbers
- Field descriptions, equipment used, and field activities accomplished to reconstruct field operations
- Meeting information
- Important times and dates of telephone conversations, correspondence, or deliverables

Field calculations and calibration records will also be recorded in logbooks. The methods of calculation and the format for recording the calculations will meet the applicable procedures for that instrument or actuator.

14.1.2 Required Equipment and Apparatus

Required equipment and apparatus are as follows:

- Logbook with appropriate data forms will be used. The logbook will be bound and have serialized pages. Data forms may be printed in the logbooks. The logbook will have water-repellent pages.
- Indelible black pens will be used.

14.1.3 Contamination Control

To the extent possible, the logbook should be protected from contamination by carrying it in a plastic bag or in an engineer's metal clipboard that closes over the logbook. Entries should be made by persons wearing clean gloves; persons wearing contaminated gloves or protective clothing should not handle the logbook. Should the logbook become contaminated, it will be decontaminated (dried, blotted) or placed in a clear plastic bag so that entries may still be read. If the logbook is contaminated to the extent that it cannot be removed from the sampling area, it will be hand copied onto the appropriate data forms at the site. The circumstances warranting this action must be noted on the rewritten form.

14.1.4 Definitions

Logbook

The person to whom a new logbook is first issued will check that the cover has been clearly marked (using indelible black marker) with the following information:

- The words "FORT WAINWRIGHT GROUNDWATER SAMPLING, STORAGE TANK SITES PROJECT LOGBOOK" and "DELIVERY ORDER 4."
- Logbook activity title–A short title that describes the contents of the logbook shall be used. The activity titles are designed to facilitate data retrieval. All data recorded in a logbook shall be appropriate to the logbook activity title. Following is a list of potential logbook activity titles for this project. Additional titles may be added to this list. To maintain standardization, this procedure shall be revised when other titles are created.

Activity Title	**Abbrev.**	**Description**
Screening	SC	Soil and groundwater screening activities including Hydropunch, MicroWell, drive point, or auger sampling methods
Soil borings	SB	Borehole, hand auger, and surface soil sampling; geologic description; and in situ testing data such as cone penetrometer and geophysical logging
Groundwater sampling	GW	Data from groundwater sampling events
Well installation	WI	Well installation records including materials used, methods employed, and construction details
Hydrologic data	H	Data from aquifer testing (pump, slug, and packer testing), head measurements (when not part of sampling), and surface water hydrology (weir studies)
Decontamination	DC	Logs of drilling and sampling equipment decontaminated at the decontamination facility, including records of equipment blanks. Field decontamination notes and records of equipment blanks at drilling

Activity Title	Abbrev.	Description
		locations will be included in the sample team leader's logbook.
Plugging and abandonment	PA	Records of grouting of soil borings and abandonment of wells

- Date of first entry in this logbook–The person turning in a completely filled logbook will ensure that the date of last entry in the logbook is also shown on the cover.

- Logbook number–The logbook number shall be in the following format:

  Logbook activity abbreviation title–unique sequential number.

  For example, the first logbook for soil borings would be numbered SB-001. Another example for the third logbook for groundwater well installation would be numbered WI-003. If possible, the logbook number should also be lettered on the spine of the logbook to facilitate retrieval from a bookcase.

Information Form

Produced data entry or information forms that list the data needs are used for a particular task or event. Information forms serve two purposes:

- They act as reminders of specific data needs.

- They aid in data entry in the Fort Wainwright Groundwater Sampling, Storage Tank Sites, database.

Information forms include soils classification charts and other basic data entry forms.

14.1.5 Procedures

The field logbook serves as the primary record of field activities. Entries are made chronologically in sufficient detail to allow the writer to reconstruct the events without relying on memory.

The logbook coordinator issues the appropriate logbook to the field logbook user at the beginning of each day. Each logbook shall contain a table of contents and a chronological record showing to whom the logbook was issued by date. Each logbook shall also contain a page or pages of the abbreviations used in the logbook, along with their meaning.

All field descriptions and observations are recorded in the logbook. Observations are noted in indelible black ink; any entry errors are corrected by drawing one solid line through the incorrect entry, which is then initialed and dated by the logbook user, who also provides a written explanation of the correction, if necessary. At the end of each day, the logbook entry is photocopied. One copy remains with the author and one copy is given to the logbook coordinator.

The field notes may be transcribed by the users onto clean information forms at the completion of each activity. The clean copy is used for database entry. Both the logbook and the clean copy will be submitted to the project manager or designee, who will check them for consistency. To prevent the release of unverified data, all requests for information or data received before data are entered into a database must be routed to the project manager.

The logbook user is responsible for completing necessary reports that detail sampling errors or omissions.

For each activity, the logbook entries will be completed to contain the following information, if appropriate:

- Name of activity–Such as subsurface soil sampling and groundwater monitoring well installation
- Task team members and equipment–Name all members on the field team involved in the specified field activity. List equipment used by serial number or other identifier; include information on calibration.
- Activity location–Indicate location of sampling area, as marked on the field stake placed by the civil survey, if appropriate.
- Weather–Indicate general weather, temperature, and precipitation conditions.
- Methods–Indicate method and/or procedure employed for activity.
- Sample number–Indicate the unique number associated with each physical sample, along with the sample collected, if applicable. Identify QC samples.
- Sample type and volume–Indicate the media, container type, preservative, and volume for each sample.
- Sample depth or interval–Indicate the depth interval from which each sample is collected (for example, 1 foot to 1.5 feet).
- Time and date–Record the time and date (TIME/DD/MMM/YY) on which the activity was performed (for example, 0830/27/JUN/87). Time is expressed in 24-hour (military) notation, in which the hours of 1:00 p.m. to 11:00 p.m. are represented by 1300 to 2300 hours, noon is 1200, and midnight is 0000. In recording the date, the day and year must be recorded with two numeric digits each. For the first 9 days of the month, the numbers 01 through 09 should be used. This procedure should be followed whenever a date is recorded.
- Analyses–Indicate the appropriate code for analyses to be performed on each sample.

- Field measurements–Indicate measurements and field instrument readings taken during each activity.

- Chain of custody and distribution–Indicate the chain-of-custody control number for each sample collected and indicate to whom samples are distributed and who the user is.

- References–If appropriate, indicate references used, such as maps or photographs.

- Narrative (including time and location)–Create a factual, chronological record of the team's activities throughout the day, including the time and location of each activity. Include descriptions of any general problems encountered and solutions. Provide the names of nonfield team personnel, including the client, who visit the sampling area, request changes in activity, affect the work schedule, request information, or observe team activities. Record any visual or otherwise sensed observations relevant to the activity or the sample itself.

  It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must also include observations and descriptive notations. He or she must take care, however, to be objective and record no opinions or subjective comments.

- Recorded by (signature)–The individual responsible for the entries contained on the form or in the logbooks will be recorded for the activities of each work shift, along with the date, at the bottom of each logbook page.

- QC check by (signature)–The logbook is signed by the task leader who performs the QC check on the completed entries.

In addition, there are individual data needs tailored to separate tasks (for example, soil logging, and water sampling). These data needs are listed on database information forms. All items listed on these forms must be addressed.

Boring logs and well installation information will be recorded on CH2M HILL forms. Two copies will be made daily. One copy will be given to the project manager, and one will be retained by the field supervisor.

14.2 Field Forms

Field forms are contained in Appendix E to this work plan. Field forms will consist of the following:

- Soil Boring Log
- Monitoring Well Construction Details
- Well Development Data
- Groundwater Sampling Form
- Sample Label