Rocky Mountain
Remediation Services, L L C
protecting the environment

PROCEDURE

BOREHOLE CLEARING

Procedure No RMRS OPS PRO 102
Revision 0

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USE CATEGORY 2

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1 0 PURPOSE

This document describes procedures that will be used at the Rocky Flats Environmental Technology Site (RFETS) to clear drill sites and other intrusive work sites prior to commencing intrusive activities These procedures will be followed for all locations of proposed intrusive activities that are outside of buildings and other permanent enclosures regardless of the method of drilling or excavating

Locations of proposed intrusive activities must be cleared prior to beginning work to ensure that they are free of buried metal objects utility lines water lines domestic sewer lines and other above and below ground installations This document describes administrative requirements and geophysical data reduction and analyses that will be used for field data collection and documentation in the course of clearing activities

2 0 SCOPE

This document supersedes GT 10 and constitutes a standard operating procedure (SOP) that applies to all Rocky Mountain Remediation Services (RMRS) personnel and subcontractors conducting intrusive work at any outdoor location (that is outside of buildings and other permanent enclosures) at RFETS Locations that are within a temporary enclosure such as a tent will be cleared in accordance with this SOP unless the tent has been constructed as a permanent or semi permanent structure whose purpose is not related to the intrusive activities Intrusive activities conducted within buildings and other permanent enclosures are discussed in separate Kaiser-Hill procedures (MAN 072 OS&IH PM) This SOP has been written to comply with and complement these separate Kaiser-Hill procedures

The subsurface geophysical investigative techniques that are described by this procedure may be generally suitable for preliminary characterization of subsurface features at proposed excavation sites Refer to SOP RMRS/OPS-PRO 104 Surface Geophysical Surveys for additional instructions on such applications

The clearing procedures described in this procedure will be implemented by RFETS Excavation Specialists and verified by RMRS personnel working on the project of interest

Although most underground and aboveground utilities are located within the Industrial Area, intrusive activities must be cleared regardless of their location Only proven scientifically based geophysical methods are acceptable for use in clearing any location These methods are capable of ensuring that a location is free of buried utilities to depths based upon the limitations of the instruments Actual depth of penetration depends upon the instrument being used and the surficial geology and related conditions in the area of interest Geophysical tools that are employed at RFETS include electromagnetic (EM) techniques (including line locators), magnetic locators and ground penetrating radar (GPR) Magnetic and EM surveys can be used to identify areas where subsurface metal objects may be present GPR can be helpful in locating metallic and non-metallic objects as well as other subsurface features as it detects variations in the subsurface dielectric constant GPR is sensitive to interference caused by subsurface geologic materials Geophysical instruments are discussed under section 4 2 of this SOP

Except under certain circumstances additional instruments and/or techniques will not be allowed to replace or supplant any of the methods described in this SOP The purpose of using unaccepted methods is therefore limited to demonstrations and testing they cannot be used to clear or help clear sites proposed for intrusive activities As an example the activity known as dowsing may be performed but will not form the sole basis of any decisions regarding intrusive activities

If such a demonstration and/or testing of an unaccepted method is desired, it shall be scheduled as the last activity at a location of interest, after all clearing procedures have been completed (including locating and marking of utilities), so that the results it produces do not inadvertently affect other clearing procedures

Advances in technology may lead to the use of new scientifically based geophysical methods that replace or complement the methods described herein In such cases the new method must be approved by the RMRS project manager prior to its use If the RMRS project manager approves the use of such a new technology or instrument, he or

she will document the use and advantages of the new method and will write and submit a Document Modification Request (DMR) within 48 hours of the implementation of the new method in accordance with procedure 2 EO4-ER-ADM-05 07 This DMR will then be appended to this SOP

3 0 REQUIREMENTS

The following section identifies the personnel qualifications that are required in order to perform geophysical surveys and clear locations of proposed intrusive activities.

3 1 Personnel Qualifications

Personnel performing these procedures are required to have completed the initial 40-hour OSHA classroom training that meets Department of Labor Regulation 29 CFR 1910 120(e)(3)(i), and must maintain a current training status by completing the appropriate 8-hour OSHA refresher courses

Personnel must also complete and be current on any site-specific training that may be required to perform activities at RFETS Personnel are also required to have a complete understanding of the procedures described within all applicable SOPs

Qualifications will vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel. Clearing procedures will be implemented by RFETS Excavation Specialists. Excavation Specialists and project staff performing these surveys will either be trained geophysicists or trained personnel with a significant amount of geophysical field experience

The subcontractor's project manager will document personnel qualifications related to this procedure in the subcontractor's project QA files. Since RFETS Excavation Specialists typically perform the clearing activities, documentation will consist of a record of the Excavation Specialists involved and activities performed. The qualifications of these individuals are documented and maintained by their management.

3 2 Responsibilities

3 2 1 RMRS Project Manager

The RMRS project manager is responsible for obtaining the required clearances prior to initiating intrusive activities, coordinate these activities and consult with the Excavation Specialist who will perform the actual clearing procedures

The RMRS project manager will be responsible for completing all required excavation submittals and providing these materials in a timely manner to the Excavation Specialists. These submittals may include any or all of the following: Soil Disturbance Evaluation Forms, Land Use Request forms, Special Excavation Request Forms, and a written scope of all proposed intrusive activities (see Section 6 0, Records). If requested, these submittals will also include controlled engineering documents and/or drawings showing the area of the proposed intrusive activities and underground utilities. These documents should be submitted to the Excavation Specialists a minimum of 4 weeks (20 working days) before the start of work, except in emergency situations.

The RMRS project manager will evaluate any instruments and/or techniques proposed for use in clearing locations of proposed intrusive activities. If a new instrument and/or technique represents an improvement or favorable alternative to one that is described by this SOP, he or she may choose to accept the use of the new instrument and/or technique. If so accepted, the RMRS project manager will document the advantages of and instructions for the new instrument and/or technique and submit a DMR within 48 hours of its implementation.

The RMRS project manager or designee will be present during all borehole/excavation-clearing activities and will verify that these activities were conducted properly and using appropriate locating methods. This individual will also

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verify that the utilities located by the Excavation Specialists have been appropriately marked The RMRS project manager will be prepared to request the use of alternate methods provided for in this SOP if the procedures employed by the Excavation Specialists do not yield results of sufficient quality

If intrusive activities will result in road closure road blockage or restricted access to building entrances the project manager will contact the appropriate parties These may include RFETS Security RFETS Fire Department Occupational Safety Industrial Hygiene the RFETS Shift Supervisor and the building manager of affected buildings or work areas

If intrusive activities are to take place within 10 feet of a utility the project manager will ensure that this utility service is de energized and the proper lockout/tagout procedures implemented If this is not feasible the project manager will work with the Excavation Specialists and Safety Professionals to gain permission to proceed with the proposed activities This will require the project manager to complete a Special Excavation Request Form (see Section 6 0 Records)

Drill rigs paving breakers picks or earth moving equipment will not be used within a 3-foot radius of identified buried utilities unless determined otherwise by the Excavation Specialists If this is the case hand held shovels will be used to locate underground installations

The project manager will determine the steps required to clear a location of proposed intrusive activities as described in Section 4 0 Instructions

The RMRS project manager will ensure that field personnel are kept safe as per the project Health and Safety Plan and other appropriate RFETS health and safety practices

If unusual conditions are encountered during intrusive activities the project manager will be contacted by the field supervisor and will determine the appropriate response actions

If conditions warrant notification of third parties the project manager will be responsible for ensuring that the field supervisor has notified the appropriate third parties as defined in Subsection 3 2 2 This responsibility continues in situations that may constitute emergencies in that they present conditions that may be immediately threatening to life and/or health In such emergency situations however the project manager may be notified after the field supervisor has notified emergency responders and/or other appropriate parties rather than in advance of their notification The project manager will also be responsible for ensuring that activities have been adjusted as appropriate for the specific conditions encountered and that field personnel are kept safe

If there is a change in scope time frame or location of the proposed intrusive activities the project manager will notify the Excavation Specialists

The project manager is ultimately responsible for ensuring all clearing activities are performed in compliance with this SOP and other related procedures including applicable portions of procedure 1 B37 HSP 12 08

If the project manager concludes that the performance of geophysical clearing procedures is unwarranted, the project manager will be responsible for the consequences of this decision

3 2 2 *Field Supervisor*

The field supervisor will support the project manager by being present during all borehole/excavation clearing activities, and will assist the project manager in verifying that these activities were conducted properly and using appropriate locating methods The field supervisor will be prepared to request the use of alternate methods provided for in this SOP if the procedures employed by the Excavation Specialists do not yield results of sufficient quality This individual will also verify that the utilities located by the Excavation Specialists have been appropriately marked

The field supervisor will assist the project manager in ensuring that field personnel are kept safe

As the primary point of contact for field personnel, the field supervisor will coordinate response actions that may be necessary in the event of unforeseen occurrences. If unsafe conditions are detected or reported by field personnel the field supervisor will instruct personnel to pause work until the necessary precautions have been taken to ensure worker safety If intrusive activities encounter unexpected conditions, the field supervisor will notify the project manager and the appropriate parties Which parties must be notified depends on the nature of the conditions

If unidentified utilities are located or damage to utilities occurs during the intrusive activities, the Excavation Specialists, Occupational Safety, Industrial Hygiene, and Construction and Project Management Services will be notified immediately

If unusual substances or unidentified objects (such as odors, liquids, broken or leaking pipes, or discolored soils) are found during these activities, the Excavation Specialists, Occupational Safety, Industrial Hygiene, Radiological Operations, Environmental Restoration Management, and Construction and Project Management Services will be notified immediately However if the odors, liquids, or discolored soils are expected or appropriate due to the nature of the investigation and do not constitute an emergency situation, the project manager will be notified and will determine the subsequent notifications to be made

If water is accumulating or has accumulated in an excavation at an unusually rapid rate or where water is not anticipated, the Excavation Specialists, Occupational Safety, Industrial Hygiene, and Water Operations Management will be notified before activities resume

If fire, hazardous or suspected hazardous atmosphere, or medical emergency is experienced, the Fire Department will be notified. However, if the hazardous or suspected hazardous atmosphere is expected or appropriate due to the nature of the investigation and does not constitute an emergency situation, the project manager will be notified and will determine the subsequent notifications to be made.

If a situation arises that may constitute an emergency in that it presents conditions that may be immediately threatening to life and/or health, the field supervisor may need to notify the project manager after notifying other appropriate parties rather than in advance

The field supervisor will ensure that all appropriate traffic control devices (such as barricades, cones, stanchions, caution' tape signaling lights, etc) are erected where equipment and intrusive activities warrant the placement of these devices. If necessary, the field supervisor will secure a flagperson to direct the flow of traffic

3 2 3 *Excavation Specialists*

The title ' Excavation Specialist" will refer to the qualified individuals performing the actual clearing of the location of interest. The Excavation Specialists will ensure that the project manager has properly completed and delivered the required soil disturbance package This responsibility will remain with the Excavation Specialists regardless of whether it is they or other individuals who act to clear a location proposed for intrusive activities.

Using appropriate locating methods as defined in this SOP, an Excavation Specialist will locate all underground and above ground installations (utilities) in the proposed work area and within 10 feet of the proposed location of intrusive activities Underground installations will be properly marked and identified on the ground in fluorescent paint, as detailed in Kaiser-Hill procedure MAN-072-OS&IH PM. A second Excavation Specialist will verify all locations and identifications

The Excavation Specialist will provide as built drawings and site maps to confirm the locations of the utilities in the area being investigated.

Underground installations that are located but are unidentified will be marked accordingly If conditions vary from original drawings the Excavation Specialists will contact RFETS Engineering to document these findings If this variance is detected by qualified individuals performing clearances rather than by Excavation Specialists these individuals will contact the Excavation Specialists who will report to the location in question and investigate the area If this investigation confirms the conditions detected by the qualified individuals the Excavation Specialists will contact RFETS Engineering to document these findings

The Excavation Specialists will assist the project manager and field supervisor in moving the proposed location of intrusive activities if necessary to a new location that is both appropriate for the goals of the project and conforms with the requirements of the Excavation Specialists

If the project manager feels that moving the location is not appropriate given the goals of the project, the Excavation Specialists will consult with the project manager regarding completion of a Special Excavation Request Form and will work towards timely approval or denial of this request Responsibility for reviewing the Special Excavation Request Form will remain with the Excavation Specialists and will not be transferred to other individuals who may be acting to clear the proposed location of intrusive activities

Prior to commencement of intrusive activities, the Excavation Specialists will conduct a pre-evolution briefing for all project personnel and specific to the project site During this briefing the Excavation Specialists will identify utilities (above ground and underground) and hazardous conditions that may be encountered during the intrusive activities Excavation Specialists will also perform pre-entry and daily inspections of excavations as required and will direct excavation activities that have been interrupted due to safety concerns

4 0 INSTRUCTIONS

Locations of proposed intrusive activities will be cleared by Excavation Specialists and verified by the RMRS project manager and/or field supervisor Therefore, Excavation Specialists typically will perform most of the procedures described in this SOP and will complete most of the necessary records and documentation However the RMRS project manager will provide these individuals with the documents outlined in section 3 2 1 above and will document clearing activities in the project field logbook(s)

- All project field personnel including the field supervisor will be present during the field investigation

- All project field personnel including the field supervisor will also be present during performance of the geophysical clearing procedures to ensure that the area is cleared to their satisfaction and to sign the appropriate forms in the Soil Disturbance package and/or any other forms that may be required

Personnel may request the use of alternate methods provided for in this SOP if the procedures employed to clear a location of interest do not yield results of sufficient quality

- Before initiating intrusive activities locations proposed for these activities must be cleared to a minimum 10 foot radius

If buried utilities or other above ground or subsurface features of concern are located within this 10-foot radius the location of proposed intrusive activities will be moved to the nearest clearable area. If this is not feasible the RMRS project manager may request a waiver of this requirement in the form of a Special Excavation Request Form (see Section 6 0 Records) from the Excavation Specialists Pertinent information relevant to gaining clearance and/or a waiver will be recorded in the project field logbook(s)

- Intrusive activities must begin within three working days after a proposed location has been cleared If activities have not commenced by that time the location must be re-cleared.

4 1 General Procedures

Clearing sites for proposed borehole locations or other intrusive activities will generally follow the three steps shown below To conduct geophysical investigations for characterization studies, the procedures outlined in GT 18, Surface Geophysical Surveys, should be consulted.

1 A literature search shall be conducted, including site plans and utility maps, to determine if any features of concern (such as buried utilities) are or have been present in the area of proposed intrusive activities.

2 A site visit shall be conducted to confirm locations of features reported in the literature, look for unreported features, and investigate the general likelihood of utilities being present in the area of interest.

3 Geophysical clearing of the area of proposed intrusive activities will be performed. The Excavation Specialist will typically be responsible for performing the activities in conjunction with project personnel.

The RMRS project manager may decide the use of geophysical clearing methods is not warranted based on the results of the first two steps This decision should be made only after consulting with the Excavation Specialist.
However, geophysical methods will always be incorporated to clear locations within developed areas of RFETS.

4 2 Geophysical Surveys

Geophysical surveys will be performed to clear holes in all developed areas of RFETS. These surveys will also be performed in other areas known or suspected to contain either above ground or buried features of concern (such as overhead utilities, buried utilities, buildings, tunnels between buildings, etc)

The Excavation Specialists will perform the geophysical survey and the RMRS project manager and/or field supervisor will verify the results In most cases, when personnel other than Excavation Specialists are performing these procedures it will be to confirm the previous survey results

Instruments used for geophysical clearing will be recalibrated and recertified in accordance with the manufacturers recommended schedules and prescribed methods.The calibration of each instrument will be field checked both before and after field use following the procedures listed in the manufacturer's instructions

The date of the last calibration and certification will be documented on the Borehole Clearing Analysis form (Form PRO 102A). Note that this form will be completed for all intrusive activities, not just boreholes

Electromagnetic, magnetic and GPR instruments are influenced by the presence of metallic surface cultural features, such as fences, power lines, metal or metal-reinforced buildings, and metallic debris. The effects of these features can be mitigated by using a directional magnetic locator, which responds to a magnetic gradient. However, if a drill site or other excavation is being cleared within 40 to 50 feet of a metallic cultural feature, reliable geophysical clearing may be difficult to achieve In cases where the proposed location cannot be definitively cleared, the location will be moved to the nearest clearable site

The RMRS project manager must first approve the use of any type of instrument other than those listed below However using a different brand of the same type of instrument in place of one of the named units will not require this approval unless the unit has significantly different capabilities or produces results of lesser quality than the named version.

4.2 1 *Electromagnetic*

An EM survey can be used to detect ferrous and nonferrous metals as well as areas with high concentrations of inorganic substances This method involves the induction of electrical current into the ground. A low alternating current passing through a transmitter coil produces a primary magnetic field. Through inductive coupling, the primary

magnetic field produces small eddy currents in the subsurface which in turn create their own secondary magnetic field The receiver coil senses both the primary and secondary fields This results in an output voltage that is linearly related to the subsurface conductivity of the terrain The instrument then converts the voltage to a ground conductivity value that can be recorded by a strip recorder or digital logger
Electrical conductivity is a function of the soil or rock composition the porosity and permeability of the rock units and the conductivity of the fluids filling the pore spaces Plotting the conductivity values on a map allows their variation across a site to be analyzed

A Geonics EM 31 EM 38 or approved equivalent ground conductivity meter will be used for EM surveys Through the use of the horizontal dipole mode (HDM) the EM 31 can penetrate to a depth of 9 feet Where deeper penetration is required, the vertical dipole mode (VDM) will be used together with the HDM Use of both modes provides high resolution detection of objects to a depth of 9 feet, and will allow detection of larger metal objects to a depth of 18 feet

The size of a metal object that can be detected is proportional to the depth of burial For shallow investigations (less than 9 feet) the HDM provides the greatest resolution and can normally detect objects as small as a 1 foot length of rebar By monitoring the in phase component of the induced magnetic field, small amounts of subsurface metal can be detected For high resolution of depths less than 5 feet, the EM 38 can be used Table PRO 102-1 summarizes instrument modes and applications

Table PRO 102 1
EM INSTRUMENT MODE APPLICATION

Instrument	Dipole Mode	Depth of Penetration (ft)	Approximate Minimum Size of Detected Object
EM-31	Horizontal	9	1 foot piece of rebar
	Vertical	18	Steel drum
EM 38	Horizontal	2 5	
	Vertical	5	

4 2 1 1 Equipment

The following equipment is necessary to complete an EM survey

- Geonics EM-31 EM-38 or approved equivalent terrain conductivity meter
- Digital logger and/or analog strip recorder (when data collection is over a large grid area)
- Appropriate health and safety equipment
- Wood stakes or lath
- Flagging
- Fluorescent paint (to mark and identify buried utilities)
- Field logbook
- Black waterproof (permanent) pens
- Form PRO 102A Borehole Clearing Analysis (see Section 6 0 Records)

4 2 1 2 Field Procedures

A literature search and field inspection will be performed prior to initiating an EM survey In addition to the more routine forms of literature examined (utility plans, engineering drawings, etc.), the literature review will include the examination of existing magnetic data derived from the area of interest. Surface conditions of the site to be noted on Form GT 10A include the presence of metal objects on the ground surface, large variations in topography, and buildings within 50 feet.

If the purpose of the EM survey is other than to clear locations for proposed intrusive activities (for example to locate buried materials to be excavated), the Excavation Specialists will be contacted to confirm that the site is clear of utilities and other features of concern, and SOP RMRS/OPS-PRO 104, Surface Geophysical Surveys, will be followed.

Following the instructions provided by the instrument manufacturer, the EM survey will be initiated. The site will be investigated using traverses on an approximate 1-foot grid, clearing a minimum of 10 feet around the drilling or excavation location stake(s). Results to be documented on Form PRO 102A include whether anomalous values ere detected (which may indicate the presence of buried metal) or whether the area was free of anomalies. Locations at which anomalous values were detected will be marked and identified on the ground using fluorescent paint as described in Kaiser-Hill procedure MAN-072-OS&IH PM

If anomalous values are detected within 10 feet of a location of proposed intrusive activities, the location will be abandoned and moved to the nearest clearable area.

The same applies to proposed excavations that require larger cleared areas. However, if moving the location is not feasible, the project manager will consult with the Excavation Specialists to determine whether the location might be accepted as a Special Excavation, as described above in Subsection 3.2.3 If a location can be moved, an anomaly-free location within 50 feet of the originally proposed location will be cleared. The new location will be marked with one or more wood stakes or pin flags and documented on Form PRO 102A. The project manager will confirm the new location

To clear larger areas for excavation, a surveyed grid pattern will be followed when traversing with the EM instrument. If the grid was not surveyed before the EM traverse, a wood stake or pin flag will be placed at the end of each traverse The location of each stake will be documented on Form PRO 102A.

All EM traverses will be documented on a field map during the survey For larger areas, a portable computer may be required to quickly analyze the data and facilitate the location of additional survey lines.

4 2 2 *Line Locator*

Instruments referred to as "line locators" are commonly used at RFETS. They operate on electromagnetic principles, but are somewhat different from the EM instruments described above. Line locator transmitters and receivers are typically two separate components. Line locators are available in a wide variety of models, and can operate in up to three modes. These are conductive, through physical contact with a conductive element; inductive, as described above for other EM instruments, or through inductive coupling, wherein a signal is inductively transmitted through a selected utility rather than widely broadcast. All three modes are described more fully below In all cases the conductive element conducts the signal generated by the transmitter, and is detected as the receiver nears the conductor The relative strength of the signal detected by the receiver (and in some models the direction from which the signal is being received) is displayed through audio or visual output, or both This relative strength increases as the receiver nears the conductive element, enabling the conductor's location to be identified.

- In all uses of line locators, the manufacturer's instructions will be followed.
- When using the conductive mode, the utility to which the transmitter is to be connected should be de-energized for safety reasons.

Special considerations relevant to the use of line locators include the potential for interference when the two components (transmitter and receiver) are too close together such that the receiver detects transmitted signals through the air as well as through the ground Depending on the model the two components should typically be operated at least 50 feet and sometimes at least 100 feet apart, following the manufacturer s recommendations Other considerations include the conductivity and depth of the conductor and which mode (direct conductive contact, inductive coupling or inductive) is being used These instruments are typically not as widely applicable as other types of EM instruments described in Subsection 4 2 1

Line locators are most useful when searching for linear conductive objects that are present at relatively shallow depths The preferred modes of operation in order of preference are as follows

- Direct (conductive) connection is the preferred mode of operation for line locators and requires that the transmitter be grounded in order to complete the circuit initiated by the transmitter

  With the transmitter connected directly to a metallic part of the conductor the signal that is conducted by the conductor is stronger than would be conducted through inductive coupling or inductive modes Therefore locating is most accurate in the conductive mode and the effects of interference are reduced

- The next preferred mode is inductive coupling

  The inductive coupling mode is typically used when a portion of the conductor is available for physical connection but direct metallic contact (electrical connection) is not feasible The conductor must be well grounded A clamp connected to the transmitter is attached to the conductor The transmitter sends a signal through the clamp which is then induced in the conductor and detected by the receiver

- The least preferred mode is the inductive mode

  If connection (for either conductive or inductive coupling modes) with the conductor of interest is not feasible the inductive mode must be used This is the least preferred method to use with line locators because the signal is broadcast through the air and soil and can be picked up by other conductors in the area In this mode an antenna within the transmitter generates the signal which radiates from the transmitter and couples to the conductor(s) by electromagnetic induction The receiver detects the induced signal

4 2 2 1 Equipment

The following equipment is necessary to complete a line locator survey

- Metrotech Model 810 line locator or approved equivalent
- Appropriate health and safety equipment
- Wood stakes or laths
- Flagging
- Fluorescent paint (to mark and identify buried utilities)
- Field logbook
- Black waterproof (permanent) pens
- Form PRO 102A Borehole Clearing Analysis (see Section 7 0, Documentation)

4 2 2.2 Field Procedures

Line locators used at RFETS are available with three different modes, as described above Selection of the proper mode for the application being considered shall proceed as follows (in each case the buried utility is conductive and its underground location is not known):

- The buried utility has an aboveground component. Electrical connection can be made between the line locator transmitter and the aboveground component, which is in electrical connection with the buried component. The conductive mode shall be selected.

- The buried utility has an above ground component (e.g. an electrical wire inside of a metallic or nonmetallic conduit). Electrical connection cannot be made directly between the line locator transmitter and the above ground portion of the electrical conductor (wire). The inductive coupling mode shall be selected and the clamp (see above) attached to the conduit.

- There is no above ground component, or the above ground component is not electrically connected to the buried component. The inductive mode shall be selected.

Once the appropriate mode has been selected, the field investigation can proceed. The field method depends on the mode, and will always be performed according to the manufacturer's instructions. The general procedure for each mode is outlined below
For the conductive mode a line locator can be used to map the subsurface location and orientation of the conductor To do so, attach the transmitter component to the above ground portion of the conductor and make sure that a good electrical connection has been made The receiver would be moved far enough from the transmitter to negate effects of interference Traverses with the receiver would then be made, typically circular and centered on the above ground portion of the conduit, to scan the ground surface for locations where the signal is strongest. The strongest signal will correspond to the subsurface locations of the conduit, which then shall be marked and identified on the ground using fluorescent paint as described in procedure MAN-072-OS&IH PM

If direct electrical connection cannot be made (i.e. an electrical conductor inside of a nonmetallic conduit), the inductive coupling clamp would be attached to the above ground portion of the conduit, and the same detection procedures as above would be followed (with the unit set to the inductive coupling mode).

If there is no above ground conduit, or the above ground component is not electrically connected to the buried component, the inductive mode would be used. Separate individuals would carry the transmitter and receiver along parallel traverses that had been laid out to cover the area of interest. (i.e. the initial traverses might be oriented north-south.) This would be performed without allowing the two components to be so near as to be subject to interference A signal should be detected by the receiver when it is situated over a conductor The ground shall be marked and the survey continued. After completing the traverses that cross the area along one orientation, the process would be repeated following traverses orientated perpendicularly to the first set of traverses (in this example, east-west). After completing the survey, the markings would be linked to show the layout of the conductors.

Further details on using the line locators and its various modes will be found in the manufacturer's instructions

4 2 3 *Magnetic Locator*

A magnetic locator detects magnetic fields associated with certain objects The depth to which a magnetic locator can accurately investigate depends on the size of the object. The Schonstedt magnetic locator, for example, can detect well casings up to 15 feet deep; however, a 1 1/4-inch nail can be detected only to a depth of approximately 8 inches

A magnetic locator responds to the magnetic gradient between two magnetic field sensors (A and B). If no anomalies exist, the magnetic field between sensors A and B is balanced, and a 40 Hz frequency signal is produced at the magnetic locator's audio output. This frequency output (40 Hz) is the ambient magnetic field of the earth. However,

when the magnetic field becomes stronger at sensor A (at the bottom of the locator) than at sensor B the output signal increases in frequency When the tip of the locator is directly over a ferrous object, the audio signal increases to its highest frequency Note that a magnetic locator is not appropriate for locating buried objects that are non magnetic

4 2 3 1 Equipment

The following equipment is necessary to complete a magnetic locator survey

- Schonstedt Model GA 52B magnetic locator or approved equivalent
- Appropriate health and safety equipment
- Wood stakes or laths
- Flagging
- Fluorescent paint (to mark and identify buried utilities)
- Field logbook
- Black waterproof (permanent) pens
- Form PRO 102A Borehole Clearing Analysis (see Section 7 0 Documentation)

4 2 3 2 Field Procedures

Operation of the magnetic locator instrument will be performed in accordance with the manufacturer s instructions Otherwise the field procedures for a magnetic survey are the same as the procedures described for an EM survey (Subsection 4 2 1 2)

4 2 4 *Ground Penetrating Radar*

GPR may be used to locate or map a variety of natural and man-made features For example, it has been used in such applications as mapping or locating shallow geologic interfaces voids in concrete or limestone buried utilities (pipes and cables) reinforcement bars and storage tanks GPR has also been used with some success in mapping hazardous wastes

GPR employs a system that transmits electromagnetic pulses into the ground from an antenna near the surface These pulses are reflected from a variety of subsurface interfaces back to a receiver As the antenna is towed along a survey line the GPR signals are processed and displayed on a graphic recorder The data are displayed as a two-dimensional continuous time-versus-distance profile along the surveyed line The display is very similar to a geologic section except that it shows a time section rather than a depth section

GPR has excellent resolution of subsurface features when favorable conditions exist However the actual depth of penetration is highly site-specific and depends on the conductivity of near-surface soils Highly conductive soils such as clays can reduce penetration to less than 3 feet. Similarly increased conductivity resulting from near-surface groundwater or saturated surficial materials will limit penetration Less conductive materials such as dry limestone can allow penetration to depths in excess of 30 feet

4 2 4 1 Equipment

The following equipment is necessary to complete a GPR survey

- GSSI SIR System-2 or approved equivalent radar system
- Flagging
- Wooden stakes or laths
- Fluorescent paint (to mark and identify buried utilities)
- Field logbook
- Black waterproof (permanent) pens
- Tape measure (200 feet minimum) (Note for relatively smooth surfaces a measuring wheel can be substituted)

- Extra paper for profile recorder
- Extra stylus for profile recorder
- Form PRO 102A, Borehole Clearing Analysis (See Section 7 0 Documentation)

4 2 4 2 Field Procedures

A standard field procedure for collecting GPR data is described below Before collecting GPR data, complete these two preliminary procedures

1 Select field parameters (orientation of lines or grid, grid spacing, frequency of antenna, antenna shielding, etc.) that are appropriate for the purpose of the survey, as described below

2 Locate endpoints a ong each line in addition to any other points of interest, and denote these locations in the field with laths or other wood stakes

To select appropriate field parameters, the following must be considered.

1 The appropriate antenna and associated transmitter frequency must be selected to optimize the penetration depth and required resolution, given the purpose of the survey Typical frequencies are 80 MHz, 100 MHz, 120 MHz, 300 MHz, 500 MHz, and 1000 MHz. Higher-frequency antennas allow greater subsurface resolution, but penetration is reduced compared to lower frequencies. To optimize results, surveys should have at least two antenna frequencies available For clearing applications at RFETS, a 300 MHz or 120 MHz antenna should be appropriate For other applications, other antenna frequencies may be more appropriate depending on the project objectives

2 Spacing of grid lines affects resolution. A spacing of 2 to 20 feet is commonly used for clearing applications. The actual spacing chosen must be appropriate for the overall project objectives

3 The method of antenna towing must be evaluated with respect to the site conditions For even, smooth terrain, the antenna can be towed directly across the ground surface For areas with significant vegetation or a rocky ground surface, the antenna may need to be suspended 6 to 18 inches above the ground or carried in a plastic non-conducting wagon to prevent antenna damage and collection of potentially dubious GPR data.

4 Antenna shielding must be considered and selected based on site conditions. Metallic surface features such as fences and power lines can cause interfering reflections on the radar record.

A standard field procedure for conducting a GPR survey is described below Portions of the survey typically will be completed during the literature review and field inspection steps described above in Subsections 4.2 and 4.3 Geophysical surveys conducted for purposes other than to clear a location proposed for intrusive activities must follow SOP OPS-PRO 104, Surface Geophysical Surveys.

1 Review site utility plans and other pertinent literature Perform a visual survey along the proposed lines. Check for overhead wires and any other above ground utilities, as well as manhole covers, evidence of buried cables, markers of buried gas lines and any other buried utilities, and cased monitoring wells If any of these features other than monitoring wells are present, have Excavation Specialists clear the location of proposed intrusive activities. If the GPR survey is being performed for other reasons than clearing a location, have Excavation Specialists confirm the presence of utility features. Note any such features in the field logbook.

2 In the field logbook note the presence of large pieces of metal on the ground surface, whether any other metallic debris is present, any large variations in topography that may occur nearby, and any buildings within 50 feet of the proposed location

3 To the extent that it is possible note the approximate moisture content and relative clay content of surveyed media, as these will affect GPR penetration depths However note that the relative clay content of surface media at RFETS can vary erratically and significantly over short horizontal and vertical distances

4 Conduct a test line following the manufacturer's recommendations Instrument settings must be optimized to obtain appropriate data given project goals and site conditions Specific recording parameters that must be optimized include but are not limited to the following

- Radar scan speed
- Signal range gain
- High pass and low pass filter settings
- Time range for recording
- Transmitter pulse rate
- Recording printer speed
- Antenna towing speed

Instrument settings should be varied during the test line to determine the optimum recording parameters When possible the test line should be conducted over a known buried feature in the survey area to help optimize instrument settings and help calibrate penetration depths

Once it has been determined that the field parameters and instrument settings have been selected to provide high-quality data appropriate for the goals of the survey and the site conditions follow the final steps in the GPR procedure as listed below

6 Initiate site survey traverse Beginning at the GPR line endpoint, tow the antenna along the line, using optimum instrument settings and towing speed (as determined from the test line) Continue for the entire line and subsequent grid lines

7 If hard copies of each line of data from the printer are made, label all notations on the record to correspond to notes made in the field logbook including recording parameters

8 Permanent copies of this GPR data must be retained digitally on tape or disk, or on hard copy plots

4 3 Data Analysis

When the anticipated hazards to the proposed intrusive activities are buried utility lines or isolated pieces of metal proposed locations will be cleared to a minimum of 10 feet around the location stake In these cases data will not be retained for later analysis, but the results will be documented on Form PRO 102A

If an anomalous area is identified within 10 feet of the proposed location stake the location will be moved to an anomaly free area at least 10 feet away from the original location to minimize the possibility of contact with any anomalous material below the surface As indicated above (Subsection 3 2 3) there are provisions available for locations that cannot be moved

When the anticipated hazards are larger such as buried trenches or pits a larger area will need to be cleared In these cases EM data will be collected with a digital data logger The data will be transferred to a personal computer for analysis Adjustments to the location of intrusive activities (if required) will be made after the data are analyzed and interpreted

In both of the above cases Form PRO 102A will be used to document the procedures employed and the rationale supporting relocation or approval of a borehole or intrusive activity location However if Excavation Specialists clear the location(s) of interest, documentation of the results will be completed by those individuals and field personnel will record in the field logbook(s) the activities performed by the Excavation Specialists

At all times, geophysical data will be collected and interpreted in a conservative and prudent manner Additionally appropriate levels of caution will be exercised by all field crews involved in intrusive activities, even on properly cleared locations

5 0 ADMINISTRATIVE CLEARANCE

Administrative clearance will be required for all drilling and other intrusive activities at RFETS and will consist of excavation authorization The required forms are described below and in Section 6 0, Records

5 1 Radiological Work Permit

A Radiological Work Permit (RWPs) will be required for intrusive activities in any Radiological Controlled Area (RCA) or Underground Radiation Material Area (URMA). These permits will be issued by and returned to the Radiological Engineering Department daily The RWP will be kept at the site of intrusive activities in the contamination reduction or support zone when work is being performed. RWPs remain valid until completion of the work for which the permit was issued.

Daily work permits will be required for intrusive operations within the Protected Area.

5.2 Soil Disturbance Assessment Authorization

Operations involving drilling or excavating will require approval from the Soil Disturbance Assessment Committee before work can begin Initiation of this process begins by contacting the RMRS Operations Service Division and completing the Soil Disturbance Evaluation Form (see Section 6.0, Records) with the appropriate project-specific information

Approval by the Soil Disturbance Assessment Committee is required for each project in which intrusive activities are a component, and will be valid for a period of 60 days. A copy of the approval form will be kept at the work site in the contamination reduction or support zone

A Land Use Request Form (see Section 6 0 Records) will be required for excavation or drilling work in the RFETS buffer zone

6.0 RECORDS

A permanent record of the implementation of this SOP will be kept by the personnel performing the clearing procedures This record will consist of all documented field observations and data, as described in this SOP The date of the manufacturer's most recent calibration and certification will be documented. Field calibration checks, geophysical observations, and data will be documented on the Borehole Clearing Analysis form (Form PRO 102A) Note that completion of this form is required for all intrusive activities, not just boreholes. Administrative clearances will be documented on the Environmental Management excavation authorization. Sample copies of the Soil Disturbance Evaluation Form, Land Use Request Form, and Special Excavation Request Form (see Kaiser-Hill procedure MAN-072-OS&IH PM) are attached.

7 0 REFERENCES

7 1 Source References

The following references were reviewed before this procedure was written.

Environmental Protection Agency (EPA), December 1987 *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001

Environmental Protection Agency (EPA) October 1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* Interim Final EPA/540/G 89/004

Environmental Protection Agency (EPA) May 1989 *RCRA Facility Investigation Guidance* Interim Final

7 2 Internal References

Related SOPs and other procedures cross-referenced by this SOP are the following

- SOP RMRS/OPS PRO 104, Surface Geophysical Surveys
- MAN-072-OS&IH PM Excavations and Trenching

U S Department of Energy
Rocky Flats Environmental Technology Site

Form PRO 102A(Rev 0)

BOREHOLE CLEARING ANALYSIS

Project Name and Number _____

Date _____ Operator(s) _____

Survey Type _____ Instrumentation _____

Date of Last Calibration and Instrument Certification. _____

Field Calibration Dates _____

Location (Borehole/Excavation ID and Coordinates, if Available)	Surface Conditions	Maximum Depth of Interest (Ft)	Anomaly Present (Y/N)	Comments or Action

Completed By _____
Print Name Signature Date

Checked By _____

Company _____

SOIL DISTURBANCE EVALUATION FORM

The purpose of this information is to assist the committee in identifying the potential hazards associated with this soil disturbance Return the completed form to the Excavation Specialist Building 130

REQUESTER Name _____

Group _____ Phone/Pager _____

PROJECT TITLE _____ **CHARGE #** _____

Will the disturbance occur in or near an Individual Hazardous Substance Site (IHSS formerly SWMU)?

Yes [ ] No [ ]

Explain _____

Will the disturbance interfere with any radiological or other hazard boundary or postings?

Yes [ ] No [ ]

Explain _____

Are overhead utilities present? Yes [ ] No
Are Underground utilities present? Yes [ ] No
Will a utility outage be required? Yes [ ] No

IS THE EXCAVATION FOR

Construction [ ] Trenching [ ] Sampling [ ] Driven rods/Posts [ ]
Grounding [ ] Post Holes [ ] Other Types [ ]

IF SAMPLING Soil removal by hand Yes [ ] No [ ]
Drilling? Yes [ ] No [ ]

Depth of drilling _____ Diameter _____

IF CONSTRUCTION

Hand digging only? Yes [ ] No [ ]

Will mechanical equipment be required? Yes [ ] No [ ]

Desribe type? _____

Depth of excavation _____ Length of excavation _____

Width of excavation _____ Will shoring be required _____

ADDITIONAL COMMENTS _____

_____

_____

Requester shall fill out this form and submit it along with information required in SOIL DISTURBANCE GUIDELINE to EXCAVATION SPECIALIST

U S DEPARTMENT OF ENERGY ROCKY FLATS PLANT

LAND USE REQUEST

SOW or CA Title	Authorization No
	WC No

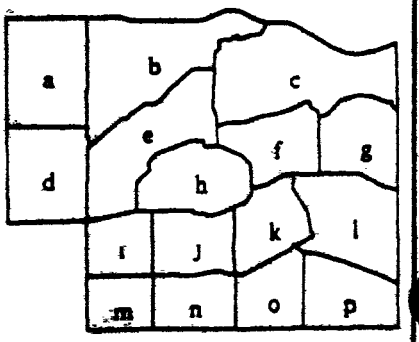
ork Manager | Group | Phone No

Check the Boxes That Apply

- ☐ IAG Driven
- ☐ Regulatory Driven
  - ☐ RCRA
  - ☐ CERCLA
- ☐ Routine Program
- ☐ Site Investigation
- ☐ Othe
  Describe _____

Job Description/Objectives

Location Description (Describe Below and Indicate on Locator Map to Right – Also Attach Detailed Plan and Location Map)



Emergency Contacts (Name and Number)
&G Project Manager
ubcontractor Manager

Plant Support Required? If Yes, List/Describe (If No, List Contractor Support To Be Provided) ☐ Yes ☐ No

Duration of Project (Include Start/End Dates)

Is This Follow-Up To Existing Work? ☐ Yes ☐ No

Contract No _____ Title _____ Manager _____

Describe

Note Upon Contract Award Submit List of Subcontract Personnel Needing Access to Buffer Zone

AUTHORIZATION

	RECOMMEND REFERRAL TO RFP LONG RANGE PLANNING COMMITTEE			
	PERMISSION DENIED			
	REQUEST MORE INFORMATION AS SPECIFIED			
	PERMISSION GRANTED	LMC Signature	Date	Control No

SPECIAL EXCAVATION REQUEST FORM

Requestor _____ Title _____ Ext _____ Date _____

Job Charge No _____ WP No _____ _____

Excavation Request Scope of Work to Be Performed

_____

_____

_____

Justification For Excavating For Near Hazardous Electrical or Mechanical Energized Systems

_____

_____

_____

_____

Clearly Identify The System Or Equipment To Be Worked In The Energized State And Why It Must Be Worked Energized

_____

_____

_____

_____

Provide A Brief Comparison Of The Risks Involved For Working The System Energized Versus De Energizing The System Risk Comparison

_____

_____

_____

_____

Rejected For Reasons

_____

_____

_____

_____

_____

_____

Approval

Competent Safety Professional _____ Ext _____ Date _____

Excavation Specialist _____ Ext _____ Date _____