



Rocky Mountain  
Remediation Services, L.L.C.  
... protecting the environment

# PROCEDURE

## PLUGGING AND ABANDONMENT OF BOREHOLES

RMRS/OPS-PRO.117

Revision 0

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APPROVED: *[Signature]*  
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### USE CATEGORY 2

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ADMIN RECORD

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## 1.0 PURPOSE

This document describes procedures that will be used at the Rocky Flats Environmental Technology Site (RFETS) to plug and abandon (P&A) boreholes completed by use of a drill rig, or small diameter holes completed by a Geoprobe® or similar type equipment (push method). Plugging refers to the physical process of filling the hole with grout while abandonment refers to the completion and documentation of the procedures used.

For the purpose of this document, a borehole is defined as a ground penetration that is drilled, or in the case of a Geoprobe® utilizes the push sample method, for the primary purpose of obtaining geologic and environmental information. Generally, a borehole will provide retrieval of cores, cuttings, and geophysical data. Boreholes may be uncased or partially or fully cased. This addresses the abandonment of boreholes immediately after completion of drilling; therefore, the depth, diameter, and other features of the borehole will be known. Unless the status of a borehole hole is changed, it will be plugged and abandoned immediately after the desired data are collected.

## 2.0 SCOPE

This document, which supersedes procedure No. GT.05, constitutes a Standard Operating Procedure (SOP) that applies to all Rocky Mountain Remediation Services (RMRS) personnel and subcontractors conducting borehole investigations and abandonments at the RFETS. The procedures described herein will be followed whenever borehole abandonments and/or associated activities are being performed.

The status of a borehole or Geoprobe® borehole may be changed to that of a well. For the purpose of this SOP, a well is defined as a surface penetration drilled for the purpose of installing a water well (i.e., for monitoring and/or production) or a cased penetration designed to obtain piezometric information. Abandonment of wells follows different procedures and is addressed in SOP RMRS/OPS-PRO.122, Plugging and Abandonment of Wells. Abandonment of previous ground penetrations of unknown status is also addressed in SOP RMRS/OPS-PRO.122.

## 3.0 REQUIREMENTS

A RMRS or subcontractor representative with experience or training related to borehole or Geoprobe® type investigations and abandonments will conduct oversight and supervision of any field operations that will provide for the retrieval of cores, cuttings, and geophysical data, and the immediate abandonment of the boreholes.

The following sections identify the personnel qualifications, the procedures, and the equipment required to carry out the

abandonment of boreholes.

### 3.1 PERSONNEL QUALIFICATIONS

Personnel overseeing the plugging and abandonment of boreholes will be geologists, geotechnical engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under the supervision of another qualified person.

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.

Prior to conducting borehole abandonment operations and other related work, personnel are required to have a complete understanding of the procedures described within this and certain related SOPs. Personnel will receive specific training regarding these procedures as necessary.

### 3.2 MATERIALS AND EQUIPMENT

The following materials and equipment will be required to abandon boreholes drilled by an auger or conventional rotary drill rig:

- Drill rig and associated equipment
- Reduced pH bentonite grout (American Colloid Pure Gold, or approved equivalent)
- Cement bentonite grout proportioned as 1 sack (94 pounds) of Portland cement, 5 pounds of powdered bentonite, and approximately 8 gallons of potable water
- Portable metal tanks for flushing and mixing
- High pressure steamer/sprayer
- Phosphate-free, lab-grade detergent (e.g., Liquinox)
- Drums for containment of borehole effluent and sediment
- Weighted tape measure
- Mirror and/or flashlight
- Health and safety monitoring equipment and personal protective equipment according to the Health and Safety Plan
- Well/Borehole Abandonment Form (PRO.117A, Rev. 0)

- Black waterproof (permanent) marking pens

For small diameter borehole abandonments (e.g. Geoprobe® type holes), the following materials and equipment will be required:

- Granular bentonite for upper hydrostratigraphic unit (UHSU) holes
- Bentonite grout and grout pump for lower hydrostratigraphic unit (LHSU) holes
- Daily Field Activity Report form ( See SOP RMRS/OPS-PRO.124)
- Deionized or distilled water

#### 4.0 PROCEDURES

##### 4.1 Auger or Rotary Drill Rig Abandonments

Equipment for plugging and abandoning boreholes will be used according to the requirements of SOP RMRS/OPS-PRO.114, Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques. These requirements include the use of contaminant-free lubricants only (i.e., pure vegetable oil) and visual monitoring of equipment for hydraulic and/or fuel or oil leaks. All procedures will be conducted according to the applicable Health and Safety Plan. If necessary, project-specific requirements will be addressed in a work plan.

A grouted surface casing may have been placed in some boreholes prior to completion of drilling (see SOP RMRS/OPS-PRO.114, Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques). Steel casing will be removed during borehole abandonment. PVC casing may be left in place except for the upper 1 to 3 feet where cement grout will be placed. Steel casing will be decontaminated after removal. Abandonment procedures must not allow cross-contamination from the alluvium into the bedrock or surface soils. This will require grouting the portion of borehole in bedrock prior to casing removal. If difficulties are encountered removing casing, further measures, such as overdrilling, may be required according to SOP RMRS/OPS-PRO.122, Plugging and Abandonment of Wells.

Plugging will involve placing bentonite grout by a tremie pipe positioned at the bottom of the hole. The grout will be mixed in a powered mechanical grout mixer according to the manufacturer's recommendations. The grout will contain at least 30 percent solids by weight and have a minimum density of 9.9 pounds per gallon after mixing. A mud balance will be used to check the grout density for each borehole prior to pumping. The grout will be tremied using a side-discharge tremie pipe. The tremie pipe can be raised during grouting, but it will be maintained several feet below the

upper level of the grout. The grout will be pumped until any other fluids have been displaced from the hole and undiluted grout is observed flowing from the hole. The tremie pipe will then be removed from the hole. After settlement of the bentonite grout, the hole will be cleaned out to a depth of approximately 1 to 3 feet and a cement bentonite grout cap will be placed from the ground surface to a minimum depth of 1 foot. This cement bentonite grout cap can be formed using a round concrete form of 6 to 8 inches in diameter and will be installed after 24 hours or more to allow for primary grout settlement. The top of the cap will be slightly domed, and will conform to ground surface. If the initial grout settlement is 3 feet or more, the upper grout surface will be rehydrated by adding water and waiting approximately 30 minutes prior to placing the cement bentonite grout cap. Alternatively, the dehydrated grout may be removed. A metal cap with the borehole ID and survey information will be embedded in the cement bentonite grout. The following information will be inscribed in the cap. See the Field Sampling Plan (FSP) for survey requirements.

- Borehole number
- Survey coordinates
- Date

All fluids displaced from the borehole during grouting will be collected and handled according to SOP RMRS/OPS-PRO.128, Handling of Purge and Development Water, and SOP RMRS/OPS-PRO.115, Monitoring and Containerizing Drilling Fluids and Cuttings. This will require provisions at the ground surface to collect fluid, such as surface casing discharging into a tank. In very deep boreholes when large quantities of fluids are anticipated, more elaborate measures such as grading the area and constructing lined pits, may be required to control displaced environmental materials. This will be addressed in a project-specific work plan.

Upon completion of plugging, the rig and associated equipment will be decontaminated according to SOP RMRS/OPS-PRO.127, Field Decontamination Operations, and SOP RMRS/OPS-PRO.070, Decontamination of Heavy Equipment at Decontamination Facilities. Remaining environmental materials will be handled according to SOP RMRS/OPS-PRO.115, Monitoring and Containerizing Drilling Fluids and Cuttings. The ground surface at the site will be restored to near original lines and grades. Landscaping and/or pavement will be replaced.

#### 4.2 Push-Method Borehole Abandonments

Small diameter boreholes used to collect geologic or environmental samples will be installed using the equipment and procedures covered in SOP-RMRS/OPS-PRO.124, Push Subsurface Soil Sampling. Unless a small diameter borehole is converted to a piezometer or small diameter monitor well by installing small diameter well casing, the hole will be abandoned immediately after completion. If converted to a well or piezometer it will eventually be abandoned using

one of the methods covered under SOP RMRS/OPS-PRO.122, Plugging and Abandonment of Wells.

Boreholes used for the collection of samples only will be abandoned immediately after completion of the hole. If the borehole penetrates the alluvium, weathered bedrock, or unweathered bedrock claystone (UHSU), it will be backfilled with granular bentonite and hydrated with deionized or distilled water, or formation water if the hole contains water. If the hole is collared in concrete, the bentonite should be backfilled to the base of the concrete, and the upper portion of the hole filled with concrete patch cement. The same procedure applies to hole collared in asphalt, except the upper portion of the hole will be filled with asphalt patch material.

If a sample collection borehole penetrates both the UHSU and a confined bedrock aquifer (LHSU), it will be backfilled with bentonite grout using a grout pump, hose and open ended tremie pipe. The hole will be filled from the bottom up as the tremie pipe is withdrawn from the hole. If the hole is collared in concrete or asphalt, the same procedure as above will be followed.

Because of the small diameter of the push-method sampling holes, the minimal surface disturbance, and the lack of downhole waste materials, the boreholes will not be marked with a permanent marker. The locations will be surveyed using the site GPS specialist and equipment, and the coordinates and elevations transmitted to the RMRS GIS division to update the RFETS borehole map.

## 5.0 DOCUMENTATION

Information required by this SOP will be documented on the Borehole Log Form PRO.101A (see SOP RMRS/OPS-PRO.101), and the Well/Borehole Abandonment Form (Form PRO.117A), and the Daily Field Activity Report form required for Geoprobe® type operations (see SOP RMRS/OPS-PRO.124). In situations where more than one boring is abandoned per day per drill rig, at least one form will be completed per boring. The boring log will include information on subsurface material classification, stratigraphy, and lithology. Environmental materials handling will be documented according to SOP RMRS/OPS-PRO.115, Monitoring and Containerizing Drilling Fluids and Cuttings. Both the Well/Borehole Abandonment Form Report and the Daily Field Activity Report will include, but are not limited to, the following information and have space for comments and documentation of general observations:

- Project name and location code
- Date
- Weather conditions
- Drilling company and driller

- Geologist and other crew members (with subcontractors)
- Equipment descriptions (rig, tremie, pump, etc.)
- Borehole depth and diameter
- Water level in borehole prior to abandonment (if any)
- Volume of grout placed
- Type, length, and diameter of casing removed (if applicable)
- Type, depth, and diameter of casing left in place (if applicable)
- Surface seal information (date set and depth)
- Chronological record of activities

Copies of Form PRO.117A should be transmitted to the GIS division of RMRS for the update of maps.

## 6.0 REFERENCES

### 6.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. December 1987.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final.  
EPA/540/G-89/004. October 1988.

RCRA Facility Investigation Guidance. Interim Final. May 1989.

RCRA Groundwater Monitoring Technical Enforcement Guidance Document. EPA. OSWER-9950.1. Washington  
D.C. September 1986.

### 6.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows:

- SOP RMRS/OPS-PRO.070 Decontamination of Heavy Equipment as Decontamination Facilities
- SOP FO.9, Handling of Residual Samples

- SOP RMRS/OPS-PRO.101, Logging Alluvial and Bedrock Materials
- SOP RMRS/OPS-PRO.102, Borehole Clearing
- SOP RMRS/OPS-PRO.114, Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques
- SOP RMRS/OPS-PRO.115, Monitoring and Containerizing Drilling Fluids and Cuttings
- SOP RMRS/OPS-PRO.122, Plugging and Abandonment of Wells
- SOP RMRS/OPS-PRO.124, Push Subsurface Soil Sampling
- SOP RMRS/OPS-PRO.127, Field Decontamination Operations
- SOP RMRS/OPS-PRO.128, Handling of Purge and Development Water

