ROCKY FLATS PLANT
GOLDEN, COLORADO

TECHNICAL REVIEW
AREA-WIDE STANDARD OPERATING PROCEDURES
VOLUMES 1.0 - 4.0

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
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ADMIN RECORD

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1.0 INTRODUCTION

PRC Environmental Management, Inc. (PRC) reviewed the area-wide standard operating procedures (SOPs) for the environmental restoration program at Rocky Flats Plant, Golden, Colorado. PRC has prepared this report for the U.S. Environmental Protection Agency (EPA) under Technical Enforcement Support (TES) 12 contract number 68-W9-0009, work assignment number C08061.

This review is divided into two sections: general comments (Section 2.0) concerning all the SOPs and specific comments (Section 3.0) relating to individual SOPs. The review is based on the assumption that the SOPs should contain all procedures, methods, and descriptions of equipment applicable to all site characterization activities throughout the Rocky Flats Plant area, and the SOP addenda (SOPAs) and project-specific field sampling plans (FSPs) should contain any site-specific procedures not appropriate for the area-side SOPs.

2.0 GENERAL COMMENTS

1. The purpose of the area-wide SOPs is to provide a single set of documents to describe standard procedures, methods, and equipment for site characterization activities at Rocky Flats. However, in their current form, the SOPs defer many general procedures to site-specific SOPAs and FSPs. The area-wide SOPs should serve as a reference base for the FSPs and SOPAs, which should in turn be limited to site-specific variables in the sampling and analysis procedures (for example, borehole locations and sampling depths). In general, any procedures that are not site-specific should be described in these SOPs and not deferred to the FSPs or SOPAs.

2. The SOPs, as written, provide an inconsistent level of detail in describing different procedures. Some SOPs are very instrument-specific, such as descriptions of spectrophotometric dissolved oxygen measurements, while other instrument descriptions are generic and nonspecific. The SOPs should be as specific as possible with a consistent level of detail. Procedures for using equipment (for example, pH and conductivity meters) or calculating parameters (for example, development volumes or hydraulic conductivity from packer tests) should be presented clearly and concisely. Equipment and procedures should be fully described and documented in the SOPs, and references to manufacturers instructions or standard textbooks should be avoided. Step-by-step instructions for each type of sampling are necessary to enable the field team to gather data that will meet the data quality objectives.

3. There are no procedures, methods, or equipment described for air monitoring or meteorology in the SOPs. The importance of air monitoring for contaminant dispersion and environmental air quality assessments should be emphasized. Similarly, procedures for meteorological monitoring should be included in the SOPs. This should include measurements of wind velocity, precipitation, air temperature, and evapotranspiration. Measurement of these parameters is important for water balance calculations during infiltration and runoff (flow) modeling, and contaminant fate and transport calculations.

4. There are numerous figures and tables missing from the SOPs which should be reviewed and included before the documents are finalized.

3.0 SPECIFIC COMMENTS

Comments specific for each SOP (or group of SOPs) are provided below. These include comments for field operations, ground water, geotechnical, and surface water SOPs. Some of the specific comments, although made once, are applicable to numerous SOPs.

3.1 FIELD OPERATIONS (VOLUME 1.0)

General Comments

Standard operating procedures 1.1 and 1.2 do not exist or are apparently missing from the document. If they are missing, they should be included and reviewed before the document is finalized. If these SOPs do not exist, the numbering system should be changed.

The potential for moderately and highly radioactive material to be present at any of the work areas is downplayed or ignored throughout this document. The concept of contaminant characterization to classify work areas according to the level and type of contamination expected to be encountered, based on previous investigations, is repeated throughout the document. The four contaminant characterizations identified in this document are (1) uncontaminated, (2) low radioactively contaminated (RAD) wastes, (3) nonradioactive RCRA-regulated hazardous wastes, and (4) mixed wastes (low RAD and RCRA-regulated hazardous wastes). These groupings do not acknowledge the potential for moderately and highly radioactive materials to be present in such places as the 903 Pad Area at the East Trenches. Furthermore, the characterizations "low RAD waste" and "mixed waste" have not been adequately discussed and should be defined quantitatively either as a range of values or a maximum contamination and radioactivity level.

No reference is made to specific SOPs which describe the operation of the radiological screening devices. The SOPs for these instruments should be reviewed in conjunction with this SOP to properly evaluate this SOP. The SOP(s) for operating the radiological screening should be referenced or attached.

Specific Comments

1. SOP no. 1.3, section 5.0. This section discusses procedures for decontaminating equipment, but does not specify that the equipment should be completely dry before being wrapped in plastic for storage. The cleaned and rinsed equipment and containers should be dry before being wrapped in plastic for storage.

   Rationale: Allowing equipment to dry before storage assures the equipment will be dry during use. Wet equipment is more likely to be dropped and is more likely to attract airborne contaminants. Drying equipment prior to storage is a common, acceptable practice. Some equipment such as well sounders (page 15, section 5.6.1) has electrical alarms that may corrode and steel tapes must be dry before applying the marking chalk.

2. SOP no. 1.3, page 14, section 5.5.2. The second step states distilled water's acceptable limit of conductivity but does not mention how the conductivity of the distilled water is determined. If the rinse water's conductivity must be measured, the procedure should describe the method(s) used to measure this parameter, or refer to a SOP that describes the method(s).

   Rationale: All methods should be described in sufficient detail to allow trained personnel to perform the method effectively and consistently.

3. SOP no. 1.3, page 16, section 5.6.2. See comment number 2.

4. SOP no. 1.3, section 5.6. This section discusses miscellaneous cleaning procedures, but does not specify the need for final rinsing and drying of equipment. Water tight equipment should be rinsed with distilled water after being rinsed with tap water and allowed to dry before storage. Also, all equipment should be thoroughly dried before assembly.

   Rationale: All equipment which may come in contact with a sample should be cleaned in a manner that minimizes cross-contamination in subsequent use. Similarly, drying filter

equipment before wrapping and storage prevents the growth of any algae or bacteria remaining in the porous medium of the filter.

5. SOP no. 1.5, page 8, paragraph 2. It is stated that an organic vapor detector (OVD) will be used to monitor purge and development water for contaminants, and if no verified measurements above background are detected on the OVD, the purge and development water will be disposed of on the ground. However, radionuclides and inorganic compounds are additional contaminants of concern at most sites, and these contaminants cannot be detected with an OVD. Therefore, purge and development water should be drummed and sampled for organic compounds, inorganic compounds, and radionuclides. Only when analytical test results show that contaminants are not present should the purge and development water be disposed of on the ground.

   Rationale: Purge and development water should be analyzed for all contaminants of concern before a decision is made to dispose of it on the ground.

6. SOP no. 1.8, page 12, paragraph 1. It is unclear how a representative sample of drill cuttings will be obtained from the drummed cuttings if they are disposed of in the manner described in this paragraph. The surface soil, which is likely to have the highest level of contamination, will be drummed first and located at the bottom of the drum. The procedures to obtain a representative sample from drummed cuttings should be provided.

   Rationale: It will be difficult to obtain a representative sample of drill cuttings if the sample is obtained after the cuttings have been drummed.

7. SOP no. 1.8, form 1.8A. The third section of the form lists the classes of contaminants assumed to be present in drilling fluids and cuttings, and the fourth section of the form lists the classes of contaminants found but not anticipated at the site. Included in these classes are low-level isotopes and high-level isotopes. No values or ranges are assigned to these classifications. A range or absolute limit for each class of contaminants should be assigned and described in the SOP.

   Rationale: Unless numerical values are assigned to these characterizations, errors and inconsistencies in classifying drill cuttings or fluids may result in unsafe exposures to hazardous materials.

8. SOP no. 1.10, page 20, paragraph 3. The field log form (1.10A) and the contaminant characterization form (1.10C) are missing. Copies of these forms should be reviewed by EPA and included with the document before it is finalized.

Rationale: The forms must be included for documentation of field observations and data during implementation of this SOP.

9. SOP no. 1.12, page 6. The referenced figure is missing and should be reviewed by EPA and included in the document before it is finalized.

Rationale: The figure shows the locations of the east and west guard portals and is necessary to complete the SOP.

10. SOP no. 1.14, form 1.14G. One of the parameters to be calculated for stream conditions is "estimated volume." A definition (and calculations) for estimated volume should be provided in either the text or on the form. If the parameter to be calculated is discharge, it should be stated as such.

Rationale: The proper terminology should be used to avoid confusion and all parameters should be defined.

11. SOP no. 1.15, Appendix A, subsection A.3.3. The schedule frequency in the appendix states that primary calibration shall be performed monthly or if a secondary calibration is off by more than $\pm$ 10 percent, and the secondary calibration shall be performed prior to the start of each project. The text states the instrument(s) shall be calibrated each day prior to use and confirmed at the end of each day (page 9, section 9.0). The main text should define the terms "primary calibration" and "secondary calibration." The appendix should mention daily calibration in subsection A.3.3.

Rationale: The requirement of daily calibrations is stated only once in section 9.0 of the text. The schedule of calibration in A.3.3 could mislead one to believe the instrument must be calibrated monthly, rather than daily.

12. SOP no. 1.15, Appendix B, table B-1. Ethylene is listed twice and given two distinct values for photoionization sensitivity. The table should list only one value for ethylene.

Rationale: This is probably a typographic error. This compound has one ionization potential.

13. SOP no. 1.16, page 7, paragraph 2. The statement is made that "...a FIDLER (field instrument for detection of low energy radiation) reading of 250 counts per minute (cpm) or less indicates only background levels of radioactivity are present." The source of this background activity level should be explained or referenced.

Rationale: Background determinations should be made on the basis of an activity level that has been derived from a previous background study, such as a background geochemical characterization report.

14. SOP no. 1.16, page 8, figure 1. The array of FIDLER survey measurement points depicted in Figure 1 appears to be in error. The entire array is located east-northeast of the drilling location. The sampling array should be symmetrical around the drilling location. The array depicted in Figure 1 should be justified or corrected.

Rationale: A logical design for a prework survey would have measurement points distributed evenly around the designated drilling location. A less conventional approach might increase the density of measurement points southeast of the designated drilling location, in the prevailing downwind direction. The unusual design depicted in Figure 1 may be the result of a word processing error, as suggested by the lack of alignment between the measurement points and the distance interval arrows in the figure.

3.2 GROUND WATER (VOLUME 2.0)

General Comments

The SOP numbering system should account for SOP 2.4. SOP 2.4 does not exist or is missing in the document. If SOP 2.4 is missing, it should be included in the document for review. If SOP 2.4 does not exist, the numbering of subsequent SOPs should be changed.

The SOPs should emphasize the need for caution when approaching wells for ground water measurements or sampling. Wells should be approached from the upwind side. Once at the well, the lead person should systematically survey the immediate area around the well while wearing appropriate respiratory protection. In general, it should be assumed that all wells pose a health and safety risk until field measurements determine otherwise.

The importance of equipment decontamination between sampling measurements should be emphasized. Equipment decontamination is mentioned in some, but not all, of the SOPs. Strict decontamination procedures are necessary to avoid cross-contamination between wells and samples.

The level of detail in the SOPs should be consistent. Some SOPs are very instrument-specific, such as descriptions of spectrophotometric dissolved oxygen measurements (SOP no. 2.5, section 5.3). Other instrument descriptions are generic and nonspecific. SOPs should be as specific as possible with a consistent level of detail. Any procedures that are not site or project specific should be included in the SOP and not deferred to the FSP or the SOPA.

Specific Comments

1. SOP no. 2.1, page 11, paragraph 2. The second sentence states that observations of the tops and bottoms of water columns in wells have not shown the presence of phases. The sentence should be clarified to indicate immiscible or "dense or light non-aqueous liquid phases" have not been observed in the wells, because miscible phases have been detected.

   Rationale: As written, the sentence is confusing and does not define the immiscible phases of concern.

2. SOP no. 2.1, page 19, step 8. Water level measurement calculations should be checked in step 5, not step 4. Also, step 5 should specify the land surface datum (LSD) as the reference point for measuring elevation.

   Rationale: The calculations to be checked are not in step 4 but step 5. The measuring point elevation (above LSD) must be specified for consistency.

3. SOP no. 2.1, page 21, section 8.2. As part of quality assurance and quality control (QA/QC), the serial number(s) of measurement instruments (for example, electronic sounders or continuous water level recorders) should be recorded.

   Rationale: Serial numbers are useful in documenting instrument calibration procedures and for identifying the systematic errors in data measurement and collection which may result from inaccurate equipment.

4. SOP no. 2.1, page 22, section 8.3. While discussing calibration procedures, the text should indicate the importance of following the instructions (operator's manual) for electronic

sounder calibration. If a specific (brand name) sounder is to be used for area-wide water level measurements, this should also be indicated in the text, and calibration and operating instructions should be included in the SOP.

Rationale: Proper calibration of the instruments is necessary for accurate and precise data. SOPs should be as specific as possible when addressing instrument calibration and operation, and should include discussion of all procedures, equipment, and methods that are not site-specific.

5. SOP no. 2.2, general. Sections 1.0 through 4.0 of the SOP are missing.

6. SOP no. 2.2, page 6, section 5.2. The use of surge blocks for well development is not necessarily a high-energy method. The SOP should consider additional methods, such as surging, overpumping, backwashing, and low pressure well jetting (with water) for well development.

Rationale: The primary requirement of an effective development technique is to provide reversals or surges in flow to prevent bridging of formation particles, a common problem when flow is always in one direction. The well should be developed by drawing water through the screen and forcing it back through the screen repeatedly.

7. SOP no. 2.2, page 7. While discussing well development criteria, a formula for calculation of water removal volumes for development would be useful. Also, the method(s) for measuring actual volumes of water being removed during development should be presented.

Rationale: The calculation of three times the casing volume of standing water plus the saturated annular space must be standardized for consistency. Measuring volumes of water removed from the well is necessary to estimate duration of well development and to ensure complete development in accordance with this SOP.

8. SOP no. 2.2, page 10. The SOP states that estimated recharge rates should be documented as part of the development process. Methods for estimating recharge rate (well recovery) should be presented or the appropriate SOP should be referenced.

Rationale: A well recovery test should be performed immediately after and in conjunction with well development. The well recovery test not only provides an indication of well

performance but also provides data for determining the transmissivity of the screened hydrogeologic unit.

9. SOP no. 2.3, general. This SOP discusses methods for borehole packer testing. The distinction between packer tests in a completed borehole (with screen, riser pipe, and filter pack) and an uncompleted borehole should be made throughout the document.

Rationale: It is not clear whether packer tests must be conducted before monitoring well installation or can be conducted in any completed well. Theoretically, borehole storage resulting from annular space around the screen will affect the pressure of flow response and subsequent analytical techniques.

10. SOP no. 2.3, general. Equipment decontamination procedures should be discussed or referenced in this SOP.

Rationale: Decontamination of equipment is necessary to avoid cross-contamination between wells.

11. SOP no. 2.3, section 5.0. The general procedure for packer tests is injecting water (at constant pressure or flow) into an isolated interval. The SOP should specify that water introduced during constant pressure and constant flow tests must be tested for chemical properties.

Rationale: The chemistry of introduced water will be needed to evaluate potential impacts on in-situ water quality.

12. SOP no. 2.3, page 8, paragraph 4. While discussing maximum injection pressures for the constant head test, the logic of using a maximum testing pressure (reservoir head and pneumatic pressure) less than 0.07 pounds per square inch (psi) per foot of depth should be clarified or corrected in the text.

Rationale: The injection pressure should not exceed the sum of overburden and water column pressure [(0.5 psi/foot depth) + (0.43 psi/foot water column)]. The maximum injection pressure should not exceed 0.9 psi/foot water column, however, a selected testing pressure of 0.07 psi/foot of depth is too conservative.

13. SOP no. 2.3, section 5.2. The analytical techniques for the different packer tests should be discussed in the text. Currently, these techniques are not discussed in the text and the reader is referred to the appendices for analytical methods.

Rationale: The appendices discuss test methods for constant head and pressure pulse tests. The analytical technique for a constant rate flow test is not discussed. Consistency in data analysis and interpretation methods is necessary for comparison of results.

14. SOP no. 2.5, general. The terms "conductance" and "conductivity" should not be used interchangeably. A distinction should be made between these two terms and the text corrected for consistency.

Rationale: The resistance, R_x, of a cell is measured in ohms. The conductance, $1/R_x$(ohms), is directly proportional to the cross-sectional areas, A (cm^2), and inversely proportional to the length of the path, L (cm) [$1/R_x = K (A/L)$]. The conductance measured between opposite faces of a centimeter cube is called the conductivity, K. However, the value A/L is variable; so, conductance does not always equal conductivity. The value L/A (cm^{-1}) is known as the cell constant and is determined for each conductivity probe during calibration. (Also see SOP no. 4, comment 5.)

15. SOP no. 2.5, page 9, section 5.2. The section states that the amount of dissolved oxygen in water is dependent on both temperature and barometric pressure; therefore, these parameters must be recorded when dissolved oxygen is measured. The method for recording barometric pressure when measuring dissolved oxygen should be described.

Rationale: There are numerous ways for measuring barometric pressure (for example, sealed manometers or absolute transducers). A single method of measurement should be identified and described for consistency.

16. SOP no. 2.5, page 12, section 5.4 The calibration of pH meters, including general guidelines for calibration of any pH meter, should be discussed in greater detail.

Rationale: Because a variety of terms (balance, slope, standardized) are used to describe the pH meter calibration process, it is not practical to list a detailed set of instructions for each type of instrument. The user must be familiar with the manufacturer's instructions for a particular instrument; however, general guidelines can be provided (for example, use of two

buffer solutions traceable to the National Bureau of Standards). Calibration of a pH meter is not site-specific but rather program-wide.

17. SOP no. 2.5, page 13, section 5.4. The SOP should discuss potential problems such as temperature fluctuations, atmospheric contamination, and ionic strength errors associated with pH measurement. Currently, none of these problems are discussed in the text.

Rationale: The user should be aware of potential problems and solutions when performing field tests.

18. SOP no. 2.5, page 13, section 5.5. The SOP should discuss potential problems such as temperature effects, determination of the cell constant, and allowance for high ionic strength associated with conductivity measurements. Currently, none of these problems are discussed in the text.

Rationale: The user should be aware of potential problems and solutions when performing field tests. Note: It would be preferable to use a conductivity meter with readings corrected to 25°C (temperature compensated) to avoid errors in calculations.

19. SOP no. 2.6, page 9, section 6.0. The primary list of well sampling and associated equipment should include wastewater containers.

Rationale: Excess water and decontamination fluids should be collected (containerized) to avoid further contamination (or cross-contamination) of the sampling area.

20. SOP no. 2.6, page 15, section 9.0. This section describes procedures for collection of immiscible layer samples, but does not specify that water level, depth to bottom, and height of water column should be measured prior to immiscible phase sampling. This should be included in the collection procedures and is currently not discussed in the text.

Rationale: This information is necessary to determine sampling intervals, purging volumes, and potentiometric surface calculations (mapping).

21. SOP no. 2.6, page 17, section 10.0. In the discussion of well purging, the text should indicate the need to containerize purged water. The text should describe measurements of the actual volume of purged water and an optimum purging rate.

Rationale: Purged water should be containerized to avoid discharge of contaminated water to the surrounding area. Measuring the volume of purged water is necessary to estimate duration of purging and ensure complete purging of the well in accordance with the SOP. Optimum purging rates should be established. The evacuation rate should not be high enough to cause ground water to cascade back into the well, thus causing excessive aeration and potential stripping of volatile constituents.

22. SOP no. 2.6, page 18, paragraph 2. The text states that casing volumes will be calculated during well purging by multiplying the entire saturated thickness with the appropriate storage capacity factor. The term "storage capacity" should be defined and associated equations or references for calculating the storage capacity should be presented.

Rationale: The storage capacity factor is necessary for calculating purging volumes. Storage capacity should be defined for consistency and the benefit of the SOP user.

23. SOP no. 2.6, page 28, paragraph 3. The text indicates that volatile organic compound (VOC) samples will be collected using a bailer. The text should also indicate that VOC samples can be collected with bladder pumps (after purging air from the discharge tubing).

Rationale: Collecting VOC samples with a bailer is limiting. Bladder pumps are commonly used in large diameter wells for purging and sampling.

3.3 GEOTECHNICAL (VOLUME 3.0)

Specific Comments

1. SOP no. 3.1, general. Eight figures are referenced throughout this SOP but are not included for review. The figures should be reviewed by EPA and included before the SOP is finalized.

2. SOP no. 3.1, section 5.1. Soil sample descriptions will include color, grain size, angularity (or roundness/sphericity), composition, bedding, and moisture content. Brief discussions of these parameters should be included in the text.

Rationale: An understanding of the descriptive parameters will facilitate proper and consistent classification of soils. The unified soil classification system (USCS) (Appendix A) does not discuss all the parameters in detail.

3. SOP no. 3.1, section 5.2. The "Manual of Field Geology" (Compton, 1962)[1] is referenced repeatedly throughout the SOP and should be required as an appendix to this SOP for mandatory logging equipment in the field.

   Rationale: All bedrock material will be classified and described by using the procedures and techniques described by Compton (1962). These procedures and techniques are not described in the SOP; therefore, the Manual of Field Geology should be required as part of the SOP or pertinent information from the book should be summarized in the SOP.

4. SOP no. 3.1, page 22, section 5.2.4. The USCS (Appendix A) suggests use of the Munsell color chart and plates for precise soil descriptions. The Munsell color chart should also be used for accurate descriptions of sediment or rock.

   Rationale: Using the Munsell color chart for soil, sediment, and rock will provide standardized descriptions of all samples.

5. SOP no. 3.1, page 36, section 8.0. The borehole log form referenced in the SOP is missing. The borehole log form should be reviewed by EPA and included before the SOP is finalized.

   Rationale: The borehole log form is necessary to document logging activities and implement this SOP.

6. SOP no. 3.3, page 7, section 5.1.2. The SOP states that the grout will contain at least 30 percent solids by weight and have a minimum density of 9.9 pounds per gallon. The methods used to verify grout requirements should be discussed in the text.

   Rationale: The SOP specifies density and solids requirements for grout mixtures, but does not indicate how the suitability of the mixtures will be tested.

7. SOP no. 3.4, page 9, section 5.3.2. In the discussion of rotary drilling techniques, it should be noted that rotary drilling (with air or water) will affect the moisture content of subsequent core, cuttings, and hydrogeologic measurements (for example, wet bulk density and air

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[1] Compton, Robert R., 1962, Manual of Field Geology, John Wiley and Sons, Inc.

permeability). Volatilization of contaminants can occur because of air turbulence, and water injection can change in-situ water quality.

Rationale: The field team (using the SOP) should be aware of the limitations of the drilling methods in order to minimize adverse effects and collect representative samples.

8. SOP no. 3.6, general. The distinction between monitoring well and piezometer installation should be made throughout the SOP.

Rationale: Installation of a piezometer or a piezometer nest will vary from monitoring well installation. The SOP only discusses monitoring well installation procedures.

9. SOP no. 3.6, page 8, section 5.3.1.2. The text states that preselected well screens and filter pack material will be used during well installations unless the FSPs or SOPAs indicate otherwise. It is not appropriate to select slot sizes or filter pack material without sieve analysis information from the specific borehole. The text should be corrected to indicate methods used for well screen selection.

Rationale: Slot size, screen length, well diameter, and filter pack selection will depend on site-specific considerations, including grain size distributions, contaminants of concern, and hydrogeology.

10. SOP no. 3.6, page 9, section 5.3.2. The FSP or SOPA will contain site-specific well construction details. However, general considerations for well installation should be presented in this SOP. Some of these considerations are listed below:

- Water table wells should have screens of sufficient length and thickness to monitor the water table and provide sufficient sample volume during high and low water table conditions.
- Wells with low recharge should have screens of sufficient length and width to allow for adequate sample volume collection.
- Wells should be screened over short distances to allow discrete intervals of contamination to be monitored.
- Where immiscible floaters or contamination in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water bearing zone is below the top of the screen.
- Where dense immiscible fractions are being monitored, the screen should be set within the lower portion of the water bearing zone, just above a relatively impermeable lithologic unit.

- The screened interval should not extend across more than one hydraulically distinct saturated zone.
- If contamination is known to be present and concentrated within a discrete interval of the saturated zone, the screen should be placed in a manner that minimizes the potential for cross contamination with other intervals.

Rationale: The SOP should provide enough detail and understanding to establish acceptable design and construction methods for monitoring well emplacement. Any procedures that are not site- or project-specific should be included in the SOP, not deferred to the FSPs or SOPAs.

11. SOP no. 3.7, page 9, section 5.2.4. The SOP specifies density requirements for trench backfill materials, but does not indicate how the density is to be measured. Methods for verification of pit compaction and density should be discussed in the text.

Rationale: The SOP specifies requirements for trench backfilling but does not present methods to evaluate the suitability of the backfill material.

12. SOP no. 3.8, page 12, section 6.0. The SOP discusses soil sampling with stainless steel scoops and spades. The SOP should also consider surface sampling with core samplers, hand augers, or triers.

Rationale: The selection of the optimum sampling technique depends on the texture, structure, and moisture content of the targeted soils. The availability of several techniques will improve the flexibility and effectiveness of the sampling program.

13. SOP no. 3.8, page 18, section 9.1. Form number 3.8B is currently missing from the SOP. This form should be reviewed by EPA and included before the SOP is finalized.

Rationale: The form must be included for documenting surface soil sampling activities and is currently missing from the SOP. The form is necessary to implement this SOP.

14. SOP no. 3.9, page 11, paragraph 1. The procedure for sampling wells includes a 5-foot hollow steel sampling probe as part of the required supplies but does not describe the use of this probe. The method should describe the intended use of all required instruments, tools, and equipment.

Rationale: Vagueness in operational procedures may lead to variations in performance between personnel, which may result in variations in data values. The data collected from soil gas surveys, specifically wells, may be used to determine locations of new boreholes and wells. Therefore, the sample collection methods should be implemented in a consistent manner.

15. SOP no. 3.9, page 14, paragraph 1. The procedure for obtaining a gas sample from a probe using a syringe indicates the probe and extraction line should be isolated and allowed to return to ambient pressure before the sample is collected. The procedure should be corrected to indicate the importance of collecting a sample before the probe and extraction line return to ambient pressure.

Rationale: The objective of sampling should be to minimize dilution. If the system is under a partial vacuum, the sample within the syringe will be below ambient pressure. When the needle is removed from the extraction tubing, the pressure within the syringe will equilibrate with the ambient pressure, thus "diluting" the sample with ambient air. The amount of dilution will be directly proportional to the differential between the ambient and the probe and extraction line pressures. If the probe and extraction line are allowed to return to ambient pressure before the sample is collected, the dilution factor will be even greater because of increased air volumes.

16. SOP no. 3.9, page 14, paragraph 2. The procedure for soil gas analysis includes analyzing multiple samples at some locations to assess the variability of the measurements. This paragraph describes the corrective actions to be taken if a "large concentration variation" is noted. The procedure should define the phrase "large concentration variation" and quantify the maximum acceptable variation for the compounds being analyzed.

Rationale: The phrase "large concentration variation" is subject to multiple interpretations. Quantifying variations or accuracy is necessary for consistency in field operations and data interpretation.

17. SOP no. 3.9, page 14, paragraph 4. The soil gas collection procedures describe collecting a sample in a Tedlar bag by attaching the Tedlar bag to the extraction tube. The Tedlar bag should be attached to a low flow pump that is attached to the extraction tubing, and only after the drive pipe has been purged.

Rationale: A pump is required to fill the Tedlar bag. A low volume pump minimizes the phase changes of VOCs caused by the pressure drop induced by pumping.

18. SOP no. 3.9, page 18, section 6.1.2. The soil gas collection procedures describe collecting replicates to check instrument precision. If "large discrepancies" are noted, the procedure provides details of the corrective actions to be taken. This procedure should define the phrase "large discrepancies" and quantify the maximum acceptable discrepancies for the compounds being analyzed.

Rationale: The phrase "large discrepancies" is subject to multiple interpretations. Quantifying acceptable discrepancy limits is necessary for consistency in evaluating precision and data interpretation.

19. SOP no. 3.10, section 5.0. The SOP describes geophysical equipment and procedures to be used during borehole clearing, but does not discuss the limitations of the methods. The limitations or disadvantages of electromagnetic and magnetic geophysical methods should be discussed in the text.

Rationale: The limitations will affect the applicability of geophysical techniques at certain sites. The user should be aware of these limitations when selecting and implementing geophysical methods. For example, magnetic methods are sensitive to "cultural clutter" such as metal fences, power lines, motors, and surface metallic debris.

20. SOP no. 3.10, page 9, paragraph 1. The third sentence states "... the size of a metal object that can be detected is inversely proportional to the depth of burial." This can be interpreted to mean smaller objects can be detected at greater depths. The sentence should be corrected or clarified to indicate only larger objects can be detected at greater depths.

Rationale: The sentence is confusing.

21. SOP no. 3.10, page 9, table 1. Table 1 summarizes instrument modes and applications for electromagnetic (EM) surveys, but only includes the EM-31. Table 1 should also include information on the Geonics EM-34-3.

Rationale: Information on the EM-34-3 (including depth of penetration and resolution) would be useful when selecting geophysical equipment for a site assessment.

3.4 SURFACE WATER (VOLUME 4.0)

Specific Comments

1. SOP no. 4.1, page 7, section 5.1. The first paragraph of this section refers to the field equipment check list. The reference should be section 5.1.1, not section 6.1.1.

   Rationale: The reference to section 6.1.1 is incorrect.

2. SOP no. 4.1, page 15, section 6.0. The field activity daily log form (4.1A) should be included in section 8.0 and reviewed by EPA before the SOP is finalized.

   Rationale: The form must be included for the field team to document sampling activities, and is currently missing from the SOP. The form is necessary to implement this SOP.

3. SOP no. 4.2, page 7. While discussing the measurement of dissolved oxygen, the text should indicate that temperature and barometric pressure should be recorded when dissolved oxygen is measured. Procedures for measuring temperature and barometric pressure should be included in the text or as an appendix.

   Rationale: The amount of dissolved oxygen in water is dependent on both the temperature of the water and barometric pressure.

4. SOP no. 4.2, page 7, section 5.3. The SOP should describe potential problems such as temperature fluctuations, atmospheric contamination, and ionic strength errors associated with pH measurement. Currently, none of these problems are discussed in the text.

   Rationale: The user should be aware of potential problems and solutions when performing the field tests.

5. SOP no. 4.2, page 9, section 5.5. The terms "conductance" and "conductivity" should not be used interchangeably. A distinction should be made between these two terms and the text corrected for consistency.

   Rationale: Specific electrical conductance is the conductance of a body of unit length and unit cross section at a specified temperature. This term is synonymous with volume conductivity. Electrical conductivity is defined by the American Society for Testing and

Materials[2] as the reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of an aqueous solution at a specified temperature. The units for reporting conductance are microsiemens (μs) or microhmos (μmhos). Conductance multiplied by the cell constant [length/area (cm^{-1})] of the probe is reported as conductivity in μmhos per centimeter at t °C. (Also see SOP no. 2.5, comment 14).

6. SOP no. 4.2, page 9, section 5.5. The SOP should discuss potential problems such as temperature effects, determination of the cell constant, and allowance for high ionic strength associated with conductivity measurements. Currently, none of these problems are discussed in the text.

Rationale: The user should be aware of potential problems and solutions when performing field tests for conductivity. Note: It would be preferable to use a conductivity meter with readings corrected to 25°C (temperature compensated) to avoid error in calculations.

7. SOP no. 4.3, page 9, paragraph 2. The SOP states that for large detention ponds, samples may only be obtained at a "channelized influent or effluent stream." This could result in samples not representative of the pond. The samples should be collected sequentially along the shore; or the body of water should be cross sectioned, and samples should be collected at various depths across the water in accordance with a specified sampling plan.

Rationale: Collecting a representative sample from a larger body of surface water is difficult, but not impossible. Sampling techniques should account for lateral and vertical distributions of contaminants in the pond (for example, light or dense nonaqueous phase liquids).

8. SOP no. 4.4, page 6, section 5.0. While discussing surface water discharge measurements, practical methods associated with the measurement of overland flow (sheet flow or emergent subsurface flow) and problems related to the quantification of such flows should be discussed in the SOP.

Rationale: Overland flow can have a significant role on fate and transport of contaminants. Other reasons for measuring overland flow rates include assessing impacts on receiving

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[2] Standard Test Methods for Electrical Conductivity and Resistivity of Water, American Society for Testing and Materials, D1125-82.

streams, acquiring data to design and operate wastewater treatment facilities, and determining compliance with load limitations placed on selected pollutants.

9. SOP no. 4.4, page 33, section 5.1.3.1.1. This section presents an equation ($Q = CLH^{3/2}$) for measuring discharge over broadcrested weirs. The coefficients L and H in the equation should be defined.

   Rationale: Although the discussion is generic, understanding the equation is fundamental in understanding flow measurements through weirs. The user of the SOP should also be aware that the exponent (3/2) and the coefficient, C, are dependent on the geometry of the weir.

10. SOP no. 4.4, page 3, section 5.1.3.1.2. The discussion of flumes is limited and should be expanded if flumes are to be considered in any capacity as flow measurement and control structures at Rocky Flats.

    Rationale: The most widely used flume type is the Parshall flume. However, portable flumes (Palmer-Bowlus type) and low flow-rate flumes (H-type) exist and have potential applicability at the site.

11. SOP no. 4.4, page 33, section 5.1.3.2. Section 5.1.3.2.1 on required measurement conditions for weirs is missing from the SOP. Section 5.1.3.2.1 should be included in the text and reviewed by EPA before the document is finalized.

    Rationale: The section is missing, but is subsequently referred to.

12. SOP no. 4.5, page 5, section 5.1. This section discusses pre-field activities for surface water sampling. In addition to the listed provisions, the sample manager or field crew should also ensure that trip blanks are placed in appropriate coolers.

    Rationale: As part of the quality assurance program, trip blanks are required with the samples to check for potential contamination resulting from transportation procedures. The trip blanks should originate in the base lab with sampling containers and thereafter remain with the samples until laboratory analysis.

13. SOP no. 4.6, section 5.0, general. This section describes equipment and procedures for sediment sampling. The criteria for selecting different sampling methods and equipment should be discussed in the SOP.

Rationale: Although equipment and procedures may be different for each site, the criteria for selection are not site-specific. For example, sediments may be watery, with relatively little difference in density from water, or they may be compacted semi-solids where water is a minor fraction of the mass. Criteria for selecting sampling techniques are important for consistent and effective sampling.

14. SOP no. 4.6, page 9, paragraph 5. Table 1 is missing from the SOP and should be reviewed by EPA and included before the document is finalized.

15. SOP no. 4.6, page 12, section 5.3. Reference is made to "SOP SW.14, Logbook Protocol." The text should be corrected or identify the location of this SOP. If this SOP is missing, it should be included with other SOPs.

Rationale: The referenced SOP does not appear to exist in the site-wide SOP documents.

16. SOP no. 4.6, page 17, section 5.3.3.1. The reference to subsection 6.3.1 is incorrect and should be changed to 5.3.1.

17. SOP no. 4.7, section 5.0, general. Pertinent and supporting SOPs should be referenced within the text where appropriate. Also, before collection of samples at a sampling site, the presence of residual chlorine must be determined. This should be indicated in the text. If measurements for alkalinity, dissolved oxygen, and dissolved silica are to be measured on tap water samples, this should also be indicated.

Rationale: Field personnel should be referred to appropriate SOPs in the context of the discussion for more detailed procedures (for example, pH, temperature, and conductivity measurements). Samples for volatile organic analysis and cyanide analyses are susceptible to changes in chemical composition in the presence of residual chlorine. Residual chlorine should be measured to evaluate the need for sample preservation.

18. SOP no. 4.7, page 12, section 7.0. The field forms (log sheets) for tap water sampling should be referenced throughout the SOP. The forms, although included in section 9.0, are not identified in the discussion of procedures or documentation.

Rationale: The forms are necessary for proper and consistent documentation and should be included as an integral component of the sampling procedures and discussion.

19. SOP no. 4.8, general. The distinction between this SOP and SOP no. 4.3, which also discusses pond sampling, is not clear. SOP no. 4.8 contains more detail, but never references procedures in SOP no. 4.3. Pond sampling is discussed in SOP no. 4.3, but SOP no. 4.8 is never referenced. Combining SOPs 4.3 and 4.8 would facilitate an understanding of surface water sampling (in general) and pond sampling (in particular).

Rationale: Repetitive SOPs are cumbersome and often inconsistent. If pond sampling procedures merits an entirely separate SOP, then pond sampling should not be discussed in SOP 4.3.

20. SOP no. 4.8, page 12, section 5.4. This section discusses sampling equipment to be used during pond sampling. More detail should be provided on sampling equipment, specifically discrete zone sampling devices and depth measuring instruments.

Rationale: Descriptions and instructions for different equipment are necessary for the field sampling team. General considerations for selection and calibration of the equipment should also be presented. In general, all pertinent information for sampling which is not site-specific should be included in the SOP.

21. SOP no. 4.8, section 5.5, general. The pond sampling procedures should discuss provisions for sampling light or dense nonaqueous phase liquids (LNAPL or DNAPL) which may be present in surface water. Currently, the SOPs do not consider the possibility of LNAPLs or DNAPLs.

Rationale: The potential for LNAPLs or DNAPLs in ponds at Rocky Flats should not be ignored.