REMOVAL EVALUATION WORK PLAN
CHURCH ROCK SITES 1 and 1E
PHASE II

Volume III: Standard Operating Procedure

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Phase II SOPs

Provided Under Separate Cover as Volume 3

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Environmental Particulate Air Sampling

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1.0 SCOPE

1.1 PURPOSE

Environmental air samples are collected to estimate airborne concentrations of radionuclide particulates to ensure protective measures are adequate.

1.2 APPLICABILITY

Air sampling is conducted to determine if airborne contamination is present. It provides a method for estimating the potential radiation dose to workers and members of the public. Sampling for airborne concentrations of radionuclide particulates is part of an overall program to ensure compliance with regulatory limits and to keep exposure to radiation as low as reasonably achievable (ALARA). High volume air samplers with an airflow across the filter of between 40 to 60 cubic feet per minute (cfm) are used because large quantities of air can be sampled in a relatively short period of time. This provides a conservative estimate of potential airborne concentrations of radionuclides which is then used to assist in decisions regarding protective actions.

2.0 EQUIPMENT AND MATERIALS

The following equipment will be used for environmental air sampling:

- High volume air samplers, 110-125 Volt, 50-60 Hertz, with 8" x 10" filter holders
- Tri-pods or aluminum outdoor shelters
- GPS
- Power for high volume air samplers, options include:
  - Generators and gas can with gas
  - Power from the grid
- Ludlum Model 4 ratemeter with Model 43-5 alpha scintillation probe (or equivalent)
- Glass fiber filter paper, 8" x 10", box of 100
- Gallon size plastic Ziploc® bags for filter paper storage
- Envelopes for filter paper storage/shipping
- Sandbags as needed to hold shelters and tripods in place
- Barometric pressure and temperature for area
- Weather resistant logbook
- Permanent ink pen or marker

3.0 AIR SAMPLER PLACEMENT

3.1 COMMUNITY

Two air samplers should be placed off site in the community area. Placement of these samplers will be done as required by the work plan. Samples in the community should be taken for several days prior to the beginning of work on site, if possible. These samplers will be in aluminum shelters for weather protection and general protection from the public.

3.2 OPERATIONAL AREA

One air sampler should be placed off site and upwind of the project. This sampler will function as background for the project. A second air sampler should be placed directly downwind of the areas where work is occurring. If the wind direction changes significantly, by 45 degrees or more, change the air filter per the instructions below and set up the air sampler to a more downwind location. This air sampler will monitor airborne radioactivity potentially liberated by the project and can be considered a conservative measure of breathing conditions for both workers and downwind members of the public.

4.0 SAMPLE COLLECTION

The following procedure applies to samples taken in the community prior to the beginning of work and during work activities and to samples taken upwind and downwind during onsite activities.

4.1 SETUP

- Set up the sampler in the aluminum outdoor shelter or on a tripod with sandbags as needed for windy conditions in the morning prior to beginning site work for the day (or at the same approximate time of day for samples taken in the days prior to work starting). Record the GPS location.
- Visually inspect a new 8" x 10" filter for physical damage prior to use. With the sampler off, place the filter paper in the filter holder on the sampler. Care should be taken to avoid touching the collection area of the filter.
- If using a generator, do pre-operational checks and ensure fuel level is at least half full, add fuel as needed.
- Turn on the air sampler. Record the time the sampler was turned on and the airflow rate. For EPA measurements, use a flow rate of 40 cfm.

4.2 CHECKS DURING THE DAY

- Depending on site conditions, airflow and fuel level of the generator should be checked every 2-3 hours. The airflow and time of observation should be recorded in the logbook. If a drop of 20% or more in airflow is observed, the filter should be changed.
- During the routine 2-3 hour checks, turn off the air sampler and obtain an estimate of the count rate of the filter in counts per minute (cpm) using the alpha scintillation detector. Place the detector face against the filter covering roughly the top half then the bottom half of the filter and average the two readings.
- If the airflow has dropped or when the work day has ended, record the flow rate and turn off the air sampler and follow the instructions in paragraph 4.3.
- If the weather is windy such that it becomes difficult to work or the samplers may blow over, then the samplers will be taken down.
- If rain precipitation above a very light mist occurs, the samplers will also be taken down.
- If the filter was not changed because it's the end of the day, insert a new filter and proceed as in paragraph 4.1.

4.3 END OF SAMPLING PERIOD

- Using the beginning and ending flow rates, calculate the approximate average flow rate for the sampling period. Using the barometric pressure and temperature for the area obtained from the nearest weather station, correct the flow rate.
- Carefully remove the filter and place a small "x" on the flow entry side of the filter and place the filter into a clean, dry plastic bag labeled with the following information:

    - Model and serial number of the air sampler
    - Model and serial number of the filter holder
    - GPS location of the sampler, including identification of field marking used to mark location
    - Beginning, end, average, and corrected flow rate
    - Date
    - Start and stop time of the sample
    - Radiation levels from the alpha scintillation detector
    - Wind direction and weather conditions
    - Type of filter
    - Laboratory to which the filter should be sent for processing

- Obtain an estimate of the count rate of the filter using the alpha scintillation detector. Place the detector face against the filter covering roughly the top half then the bottom half of the filter and average the two readings.
- Filters should be allowed to sit for at least 4-5 hours before final counting to allow for decay of short-lived radon daughter products. Thoron daughter products are gone after 3 days and should be considered to be present unless ruled out.
- The health physicist and/or Radiation Safety Officer for the project must assess sample results after each days analysis by comparing downwind sample results with upwind background results. Filters should be read intermittently to track decay of short-lived daughter products and to assess field results after their decay is complete.
- Additional protective actions must be considered if doses to the public or workers have the potential to exceed 10% of allowable limits.

5.0 DOCUMENTATION

The following information must be recorded in the log book for each sample location.

- Radiation levels and times of measurement using the alpha scintillation detector.
- Information recorded on each sample container (plastic bag) as outlined above.
- Health physicist/RSO assessment of potential dose to the public and workers.

SOP-2

Rio Algom Mining LLC

Gamma Ray Intensity to Ra-226 Soil Concentration Correlation

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1.0 SCOPE

1.1 PURPOSE

The purpose of this procedure is to develop a correlation between radium-226 (Ra-226) concentrations in surface soil and field gamma radiation level measurements. The correlation is developed by comparing gamma radiation levels measured in the field to Ra-226 concentrations in soil samples taken from the same location and analyzed in a laboratory. The correlation will be used to determine Ra-226 concentrations in surface soils for locations where only gamma radiation levels have been measured.

1.2 APPLICABILITY

Ra-226 is primarily an alpha emitting radionuclide with a gamma radiation emission of 186 keV for a low proportion (about 4%) of the Ra-226 decays. Bismuth-214 (Bi-214) and lead-214 (Pb-214) are also associated with Ra-226 decay and emit higher energy gamma radiation with a higher proportion of decays than for Ra-226. Therefore, Bi-214 and Pb-214 provide a strong signal of radioactivity in the field utilizing a sodium iodide (NaI) scintillation detector with high sensitivity.

Bi-214 and Pb-214 are decay products of Ra-226 through radon-222 (Rn-222). Rn-222 is a gas which emanates to some extent from the soil, resulting in disequilibrium of the activities of Ra-226 and Bi-214 and Pb-214 in the soil. Typically most of the Rn-222 remains in the soil which means the Bi-214 and Pb-214 are retained in the soil. Studies have shown that up to 80% of the Rn-222 decayed from Ra-226 in soil is retained within the soil matrix.

If soil geometry and other parameters such as moisture, radon emanation fraction, vertical contamination profile, gamma ray shine from nearby sources, and land topography are consistent, the ratio of Bi-214 and Pb-214 to Ra-226 would be consistent. This means there would be a direct correlation between Bi-214 and Pb-214 gamma radiation levels to Ra-226 concentrations in the soil. The gamma radiation from other naturally occurring isotopes in soil, such as thorium-232 (Th-232) decay products and potassium-40 (K-40), may contribute to gamma radiation levels. However, the gamma radiation level from such naturally occurring isotopes and sources usually remain fairly constant. A linear regression is used to identify this constant level to correct for and minimize interference with the correlation between gamma radiation levels and Ra-226 soil concentrations.

The correlation procedure is designed to calibrate a 2"x 2" NaI scintillation detector by determining a site-specific correlation between gamma radiation intensity and Ra-226 concentration in soil. The gross gamma radiation intensity (count rate) will be measured at each of the soil sampling locations. Soil samples will be collected from these locations for Ra-226 analysis by an off-site laboratory.

A linear regression will be performed between gamma radiation count rates and corresponding Ra-226 concentrations in soil to determine the correlation. This correlation may then be used to assess Ra-226 concentrations using only field measurements of gross gamma radiation levels.

2.0 EQUIPMENT AND MATERIALS

2.1 GENERAL

Equipment and material requirements for field gamma radiation level measurements and soil sampling are described in SOP-3, *Field Gamma Radiation Surveys*, and SOP-7, *Surface and Shallow Subsurface Soil Sampling*. Decontamination equipment and material is described in SOP-5, *Equipment Decontamination*.

2.2 DETECTOR COLLIMATION

Correlation surveys and later surveys that utilize the correlation will both be done using the same configuration of the detector, i.e., if the correlation was done using a 0.5-inch thick collimated lead shield then the correlation value can only be applied to field measurements taken using the same collimator. At locations with higher than typical levels, often referred to as "hot spots", and at locations with substantial variation in gamma radiation levels, the detector will be encased in a 0.5-inch thick collimated lead shield. However, if required, separate correlations between a lead collimated detector and an uncollimated detector could be developed by taking both gamma radiation measurements at each location.

3.0 SURVEY PROCEDURES

3.1 SURVEY LOCATIONS

The locations of the soil samples and gamma radiation level measurement will be designated by the site-specific program. For some surveys, this will be conducted for all locations where Ra-226 concentrations have been collected. In other cases, the soil sampling locations may be selected from a gamma radiation survey with the intent to include a range of key concentrations of interest for the study (i.e., background, at the criterion of interest and slightly above the criterion of interest).

3.2 GAMMA RADIATION MEASUREMENTS

Gamma radiation measurements for the correlation will be performed using static gamma radiation survey in SOP-3 at the soil sample locations. The selected sampling location areas will be relatively flat terrains, and large enough so that moving around several steps in each direction should not affect readings significantly. For the selected sample locations, three one-minute counts will be obtained at each location. The detector will be approximately l8 inches from the ground surface.

3.3 SOIL SAMPLING

Surface soil samples for the correlation will be collected using SOP-7 from the 0-6" soil horizon. The sampling locations will be marked with flags. Each sample bag will be marked and labeled with appropriate sample identification. Soil sampling equipment will be decontaminated between each sampling location using SOP-5.

4.0 STATISTICAL ANALYSIS

4.1 SITE-SPECIFIC VARIATIONS

Correlations should be developed for different surfaces such as wind-blown areas where the elevated Ra-226 may be present on the surface compared to locations where the elevated Ra-226 is more evenly distributed throughout the soil. For example, correlation values must be calculated separately for specific areas such as wind-blown areas and waste piles. Separate relationships should also be developed if there is a difference in background concentrations that is substantial relative to the criterion. The data used in the regression should be relevant to the objective. For example, when comparing against the criterion, use only samples from background up to no more than twice the criterion.

4.2 LINEAR REGRESSION ANALYSIS

To determine the correlation between gamma radiation level count rate and corresponding Ra-226 concentration in soil content a regression analysis will be performed on the sample Ra-226 concentration in picocuries per gram of soil (pCi/g), Y, and the associated gamma radiation count rate in counts per minute (cpm), X, from all the sample locations using a least-squares linear regression and plotting the results.

Linear regression data will be summarized by the generalized equation:

$$Y = mX + b$$

where,
Y = soil concentration in pCi/gm,
m = slope, pCi/gm/cpm
X = count rate (the mean) in cpm
b = constant, y intercept

This correlation will provide a site specific calibration factor (m) in pCi/gm/cpm for each of the 2"x2" NaI detector systems, with a constant (b) to correct for the presence of other gamma radiation emitting radionuclides (e.g. K-40, Th-232 series). The precision of the correlation and the associated confidence limits may be calculated and displayed using statistical methods.

Should the data demonstrate a non-linear relationship or higher variability with increasing gamma radiation level, a statistician should be consulted to apply more appropriate statistical methods for the relationship (e.g. transformation of data, non-linear weighted regression).

SOP-3

Rio Algom Mining LLC

Field Gamma Radiation Surveys

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1.0 SCOPE

1.1 PURPOSE

This procedure is used to assess gamma radiation levels for potential correlation with radium concentrations in surface soil for conducting site evaluations.

1.2 APPLICABILITY

RAML performs gamma radiation surveys in surface soil to assess the risk to the public and workers and determine the need to satisfy remedial action objectives.

2.0 EQUIPMENT AND MATERIALS

2.1 RADIATION DETECTION EQUIPMENT

The Ludlum 2221 Portable Scaler/Ratemeter coupled with a Ludlum 44-10 2"x2" sodium iodide (NaI) crystal scintillation detector is used for gamma radiation detection.

2.2 GPS AND MAPPING SOFTWARE

A Trimble® Pathfinder ProXRT global positioning system (GPS) with differential correction and a Ranger datalogger is used to provide radiation measurement locations. The GPS and datalogger is used with TerraSync™ GIS and Pathfinder Office software to download radiation measurements and corresponding locations.

2.3 COLLIMATING SHIELD

A collimating lead shield for the 2"x2" NaI detectors, is used as needed to reduce gamma shine interference from surrounding areas. The 0.5-inch thick collimating lead shield, which surrounds the NaI crystal, is contained within a protective marlex housing.

2.4 CHECK SOURCE

A cup-shaped soil gamma radiation source, Quivira Soil Standard #3, is used to perform functional checks on the detection equipment.

2.5 GAMMA RADIATION METER

The calibrated exposure meter ("µR" meter or tissue equivalent ion chamber) is used to measure real-time radiation levels to ensure regulatory limits are not exceeded.

2.6 VARIOUS MISCELLANEOUS ITEMS

Survey locations are found using a map of survey areas with marked grid nodes identified by northing and easting coordinates. An ink pen, appropriate Field Survey Forms and field notebooks are used to record readings, general weather conditions, and other notes. A measuring tape is used to measure the location for the surveyor to hold the meter such that it is approximately 18 inches from the ground. Safety gear requirements are found in the applicable Health and Safety Plans.

3.0 GAMMA RADIATION SURVEY PROTOCOL

Determinations of gamma radiation levels in soil can be conducted using measurements from static (stationary) surveys and/or scan (walkthrough) surveys.

3.1 STATIC SURVEYS

Static surveys will be performed at specified grid nodes within survey areas. Static survey measurements are often used to compare and/or correlate laboratory soil sampling results to gamma radiation surveys. The detector will be held at about 18 inches from the ground surface. The scaler/rate meter will be set in the integrating (scaler) mode. A one-minute count of gamma radiation level will be obtained at each location for static gamma radiation surveys.

Gamma radiation measurements may be required at depth prior to taking soil samples at various depths. After a hole has been dug to the highest depth of the soil sample and prior to taking the sample, a one-minute count is taken. The detector will be held 18 inches above the sampling surface. The approximate diameter of the sampling hole should be noted on the sample form as results can vary depending on the proximity of soil surrounding the sample location.

Static radiation surveys can be performed in arroyos using the same grid node method. Survey points may need to be adjusted for accessibility.

3.2 SCAN SURVEYS

Scan surveys will be performed by walking with the detector at about 18 inches from the ground surface with the scaler/ratemeter in count RATE MODE. Scan surveys will be performed within each survey area by walking in a serpentine pattern along transects to locate any hot spots and at and beyond survey area boundaries to delineate the lateral extent of radionuclide contamination. The scan rate will be approximately one to two feet per second based on an acceptable minimum detectable concentration (MDC).

Scan radiation surveys can be performed in arroyos to determine gamma radiation levels in the bed sediments by walking in a serpentine pattern along the bed of the arroyo and/or by transecting the arroyo along grid lines. Survey transects may need to be adjusted for accessibility.

4.0 INSTRUMENT CONFIGURATION AND OPERATIONS

Prior to any instrument function check or field work, the technician will review the Technical Manual for the instrument operations.

The field gamma radiation surveys will be performed using a Ludlum 2221 Ratemeter/Scaler. The Ratemeter/Scaler is connected to a 2"x2" NaI crystal scintillation detector (Ludlum 44-10) which detects gamma radiation emitted from Bi-214, a decay product of Ra-226. The detector will be held at approximately 18 inches from the ground surface. The Model 2221 Scaler/Ratemeter with external RS232 connector is coupled to a GPS receiver and data logger where the gamma radiation count rate in counts per minute (cpm) is logged with its corresponding coordinate in one or two second intervals. When used without the collimator the detector is sensitive to an area of approximately 5 to 6 foot in diameter.

For radiation surveys where significant shine interference is present from nearby areas, the 2"x2" NaI crystal scintillation detector will be installed in a collimating lead shield to reduce gamma shine interference. For radiation surveys in arroyos, the detector will be collimated to avoid radiation shine interference from the arroyo banks. The collimated detector will be most sensitive to the 3 to 4 foot diameter area under the detector.

4.1 INSTRUMENT FUNCTION CHECK

An operational function check will be performed on the Scaler/Ratemeter (Ludlum 2221) and the detector (Ludlum 44-10) each day prior to any field surveys. Verify calibration validity for the Scaler/Ratemeter and the detector. Calibration date for the instruments must be within one year. If not, the instrument must be calibrated with a certificate in file. The function check will be performed in a field office. The following function check procedures will be used and the pertinent information recorded on the Scaler/Ratemeter - 2"x2" NaI Detector Function Check Form (Attachment A). If checks do not meet requirements below, pull the instrument from service. The instrument will be repaired or re-calibrated prior to use.

4.1.1 Visual inspection

Perform a visual inspection of the instrument, cables, detector and the shield, checking for signs of any damage. Test for possible electrical shorts in the cable (with the instrument in the audio mode, move the cable and look for a sudden increase in counts).

4.1.2 Calibration

Verify calibration validity for the Scaler/Ratemeter and the detector. Calibration date for the instruments must be within one year.

4.1.3 Battery Charge

Ensure that the Scaler/Ratemeter battery is functional. For the Ludlum 2221, the battery voltage digital readout must be at least 4.4 volts. If it is below this, replace the batteries.

4.1.4 High Voltage

The detector high voltage must match that determined during high voltage calibration (the high voltage plateau) for that detector.

4.1.5 Threshold (input sensitivity) and Window

Check and make sure that the Ludlum 2221 Scaler/Ratemeter threshold is set at 100 in the instrument digital read out display. The WIN toggle switch must be in the OUT position.

4.1.6 Background Counts

The background count rate will be determined for the same time interval as the field survey count time, generally one minute. The background count rate measurement will be performed at a designated location in the field. Keep all beta/gamma radiation sources away from the detector while performing the background check. The background function check counts must be within 20% of the background counts obtained during the detector high voltage calibration.

4.1.7 Source Function Counts

Place the detector inside the cup-shaped soil source gamma radiation source against the surface at the bottom of the detector. Count the source for one minute and note the counts in cpm. The source function check counts must be within 20% of the source count after calibration. The initial detector and Scaler/Ratemeter check should be done when the instruments come back from calibration or prior to the first use after calibration. All future checks should be compared to the initial check after calibration.

4.1.8 Technician

After completing the function check, initial in the column marked TECH of the function check form.

4.2 INSTRUMENT MINIMUM DETECTABLE CONCENTRATION CALCULATIONS

If required, the minimum detectable concentrations (MDC) will be calculated for the instrumentation. Separate MDCs are calculated for static and scan radiation surveys. MDCs can be recorded on the Function Check Form (Attachment A).

5.0 FIELD GAMMA RADIATION SURVEY PROCEDURES

5.1 STATIC GAMMA RADIATION SURVEYS

Static surveys will be performed at specified grid nodes within survey areas or at other locations such as background points. The technician will perform the static gamma radiation survey as follows.

5.1.1 Radiation Detection Meter Preparation

Perform the function check as indicated in Section 4.1 of this procedure. Ensure that the Scaler/Ratemeter is set in scaler (integration) mode and the integration time is set for one minute. Turn the Scaler/Ratemeter audio speaker to the ON position.

5.1.2 Survey

Locate the survey point (grid node or a correlation sampling point) in the field using the GPS. Hold the detector at approximately 18 inches from the ground surface above the desired survey point. Obtain a one minute integrated count. Record the count rate in cpm and appropriate corresponding survey point information (location ID and/or coordinates etc) on the Static Gamma Radiation Survey Field Form (Attachment B).

5.2 SCAN GAMMA RADIATION SURVEYS

Scan radiation surveys will be performed by walking at a rate of about one to two feet per second with the detector at about 18 inches from the ground surface with the scaler/ratemeter in RATE

MODE. Scan surveys will be performed at coverage rate of up to 20% within survey areas to identify hot spots by walking in a serpentine pattern along transects. The scan percentage of an area will be determined based on the static survey of the grid nodes in that survey area as follows:

- If over 80% of the static survey results within a survey area exceed the screening level (equal to the action level or clean-up level plus background), there would be no scan survey in that area.
- If 60 to 80% of static survey results exceed the screening level, 5% of that area would be scanned.
- If 40 to 60% of static survey results exceed the screening level, 10% of that area would be scanned.
- If 20 to 40% of static survey results exceed the screening level, 15% of that area would be scanned.
- If less than 20 % of static survey results exceed the screening level, 20% of that area would be scanned.

If the scan radiation surveys report areas that exceed the screening level but those areas have not been delineated by the static and scan radiation surveys, then the percentage of area scanned will be re-evaluated and may be expanded in the field.

The scan radiation surveys will be performed at and may go beyond survey area boundaries to delineate the lateral extent of potential radionuclide contamination. These scan surveys will be performed by walking along the 80 foot spacing transects outside the perimeter of each survey area. These transects would run between the most outer 80 foot static grid node inside the initial boundary to the next 80 foot grid node outside the survey area boundary.

Scan surveys are performed in arroyos by walking in a serpentine pattern along the bed with the collimated detector at about 18 inches above the sediment bed.

5.2.1 GPS Backpack / Radiation Meter Preparation

For the scan surveys, the Ludlum 2221 with external RS232 output connector will be coupled to a GPS mapping system (Trimble Pathfinder ProXRT) with receiver/data logger to collect and store the survey data. The GPS receiver will store in the electronic data file the gamma radiation count rate to its corresponding location coordinates. This configuration can provide a gamma radiation intensity level in counts per minute (cpm) at approximately every one to two feet along the scan path based on a scan rate of one to two feet per second. The GPS receiver/antenna will be carried in a backpack. Set up the GPS system with data receiver/logger as described in Attachment C, GPS Setup, Operation and Data Management.

Perform the function check on the radiation meter as indicated in Section 4.1 of this procedure. Insure that the Scaler/Ratemeter (Ludlum 2221) is set in RATE mode. Turn the Ludlum 2221 audio speaker to the ON position. Set the RESP (response) toggle switch to F (fast) position. Connect the calibrated 2"x2" NaI detector.

5.2.2 Survey Location

Field locate transects within the survey areas. Create the appropriate file number and information for the data logger and record it in the Scan/Walkthrough Gamma Radiation Survey Field Form (Attachment D).

5.2.3 Survey Procedure

Walk in a serpentine pattern along the transect in that survey area with the detector at approximately 18 inches from the ground surface. The GPS receiver will collect and store gamma radiation count rate at every second with its corresponding coordinate while scanning through the walkthrough.

5.3 DATA RECOVERY

At the end of the day, download the survey data files for static and scan surveys into a laptop computer. The survey data will be processed as needed for presenting as the gamma radiation levels in counts per minute or converted into Ra-226 soil concentration using equations developed through correlation, if necessary, and plotting through the Arc View computer application.

5.4 SCAN SURVEYS FOR BOUNDARY DETERMINATION WITHOUT GPS

If the scan radiation survey is used for investigations, such as delineation of the survey area boundary, the scan survey can be performed with or without GPS configuration. To perform the surveys without using the GPS technician will use the meter as follows.

5.4.1 Radiation Detection Meter Preparation

Perform the function check as indicated in Section 4.1 of this procedure. Insure that the Scaler/Ratemeter (Ludlum 2221) is set in RATE mode. Turn the Scaler/Ratemeter audio speaker to the ON position. Set the RESP (response) toggle switch to F (fast) position.

5.4.2 Survey

Walk along a transect or within an area with the detector approximately 18 inches from the ground surface to investigate and determine locations that exceed the site specific gamma radiation count rate screening level provided by your supervisor.

5.4.3 Boundary Determination

Investigate any higher than radiation levels, as determined by audio response during the walkthrough survey, and by performing additional scan surveys to identify the elevated area. Use the static surveys to determine the gamma radiation levels of the elevated area. Mark the area with pin flags, obtain the location coordinate with the GPS system, and record the counts and other information in the Scan/Walkthrough Gamma Radiation Survey Field Form (Attachment D).

6.0 ATTACHMENTS

Attachment A	Scaler/Ratemeter - 2"x2" NaI Detector Function Check Form
Attachment B	Static Gamma Radiation Survey Field Form
Attachment C	GPS Setup, Operation and Data Management
Attachment D	Scan/Walkthrough Gamma Radiation Survey Field Form

Attachment A
Scaler/Ratemeter - 2" x 2" NaI Detector Function Check

Scaler/Ratemeter ID: ______________________________ Function Check Source: Soil Source Beaker

2" x 2" Detector ID: _______________________________ Acceptable Background Count Rate (cpm) Range (+/- 20%) ____________ to ________________
Acceptable Source Count Rate (cpm) Range (+/- 20%) ________________ to ________________

Date	Physical Check	Cal Due Date	Battery [1] (V)	High Voltage (V)	Threshhold [2]	Window IN or OUT [3]	Background Counts (cpm)	Source Counts (cpm)	Within Acceptable Range Y or N	MDC (pCi/g)

Note: (1) Battery Voltage for Ludlum 2221 must be >4.4 volts; (2) Threshold must be at 100 (= 10 mV); (3) Window Position must be OUT

Attachment B
Gamma Radiation Survey

Static Gamma Radiation Survey Field Form

Instrumentation: Scaler/Ratemeter ___________________, Detector _____________________________________

Instrument Calibration Date: ________________________, Instrument Daily Function Check Performed: ________

2"x2" NaI Detector Collimated ___________ Yes or ___________No

Survey Area/Unit Description ____

Survey Date/Time	Survey Point ID/Description	Survey Point Coordinate		Gamma Radiation Reading, CPM	Comments/Notes
		Northing	Easting		

Technician Signature: ______________________________ Reviewed by: ______________________________

Attachment C
Gamma Radiation Survey
GPS Setup, Operation, and Data Management

1. Purpose

The purpose of the procedure is to instruct the user on how to properly setup a Trimble Pathfinder ProXRT GPS unit to perform real time GPS gamma surveys using a Trimble Ranger datalogger and Ludlum 2221 ratemeter/scaler with RS-232 data output.

2. Discussion

This SOP discusses the integration of a Trimble Pathfinder ProXRT GPS unit, a Trimble Ranger datalogger, and a Ludlum 2221 ratemeter/scaler with RS-232 data output for use in conducting GPS radiological surveys. A data record is logged every time the Ludlum 2221 outputs a data value to the Ranger through its RS-232 output. The GPS calculates its location every one second. The coordinate associated with each data value is interpolated between the locations calculated in the second before and after each data value is received. The Ranger records each data value as a "Not-In-Feature" record and associates the interpolated coordinate with the record.

3. Setup Procedure

3.1 Equipment

3.1.1 Trimble ProXRT GPS receiver
3.1.2 Trimble Ranger datalogger with stylus
3.1.3 Charged batteries
3.1.4 Ludlum 2221 scaler/ratemeter with RS-232 output
3.1.5 Ludlum 44-10 probe
3.1.6 Necessary cables

3.2 Cabling Setup

3.2.1 Connect the GPS receiver data/power 'Y' cable to port B of the ProXRT receiver. Nothing connects to port A.
3.2.2 Connect the antenna cable to ANT port of the ProXRT receiver.
3.2.3 Connect the ProXRT receiver data output half of the data/power 'Y' cable to the Ranger COM 1 port.

3.2.4 On the Ludlum 2221 connect the RS-232 data output cable to the Ranger COM2 port. Use the DB9 to DB26 adaptor to connect to the Ranger COM2 port.

3.3 Ludlum 2221 Setup

3.3.1 Secure the RS-232 cable to the Ludlum 2221 handle.

3.3.2 Set the Ludlum 2221 switches to the following positions:

POWER: ON
RESP: F
WIN: OUT
SCALER/DIG.RATE: DIG.RATE

4. Operations Procedure

4.1 Opening a New File

4.1.1 From the opening window use the stylus and navigate to and tap the Data drop down box. Tap the Create button to create a new tile.

4.1.2 To open an existing file navigate to and tap the Existing File subsection list drop down box. Select the desired file and tap on the Open button in the upper right hand corner of the screen. Data collection will begin when a file is opened if the Ranger and Ludlum 2221 parameters are all set correctly and enough satellites are visible.

4.2 Pausing Data Collection

4.2.1 To pause data collection, navigate to the Map drop down box and tap on the pause button. To resume data collection, tap the play button.

4.3 Viewing Data Collection

4.3.1 It is advised to view data collection at the beginning of each survey to ensure all setup parameters have been set correctly and system is correctly collecting data. To view data collection, navigate to the Status drop down box and then the Sensor subsection drop down box. The Total Count line indicates the number of gamma counts collected. The Last String line indicates the last gamma count recorded.

4.4 Stopping Data Collection

4.4.1 There are two ways to stop and close a data file. You can close the TerraSync application completely or you can close the individual survey file and leave the TerraSync application running.

4.4.2 To close the TerraSync application, tap the ×| in the upper right hand corner.

4.4.3 To close only the survey file, tap the Data drop down box and then tap the Close button.

5. Creating a New Project or Opening an Existing Project

5.1 Create the Necessary Directories for a New Project

When creating a new project, it is necessary to also create a new project folder with subfolders to keep all of the files properly organized. As projects get larger they become very complicated. It is recommended that the filing structure stick to the default Pathfinder Office setup.

5.2 Create a New Pathfinder Office Project

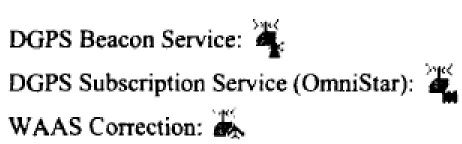
6. Download, Correction, and Exporting of Survey Data

6.1 Download of Survey Data

Data is collected in the Ranger datalogger. The Ranger must be connected to the computer and the data transferred for the data to be corrected, exported and managed. The Pathfinder Office Data Transfer Utility transfers data to and from the computer and Ranger.

6.2 Differentially Corrected Survey Data

Most survey data collected will be collected in "real time", meaning the data is differentially corrected as it is collected. It is still desirable to differentially correct the data "post process" to achieve highest accuracy for the data. The following figures are examples of images you will see on the Ranger screen indicating "real time" corrections are taking place:



6.3 Export Survey Data into ArcView Shapefile Format

Data is collected in a Trimble file format. This file must be converted, or exported, into an ESRI ArcView GIS format known as a shape file. This is done through the Pathfinder Office Export feature.

Attachment D
Gamma Radiation Survey

Scan/Walkthrough Gamma Radiation Survey Field Form

Instrumentation: Scaler/Ratemeter ____________________, Detector ____

Instrument Calibration Date: _________________________, Instrument Daily Function Check Performed: _________

2"x2" NaI Detector Collimated ___________ Yes or ___________No

Survey Area/Unit Description ____

Survey Date/Time	Survey Area-Transect ID/Description	Gamma Radiation Reading Range CPM	Comments/Notes

Technician Signature: ________________________________ Reviewed by: ________________________________

SOP-4

Rio Algom Mining LLC

Field Documentation for General and Soil Boring Activities

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Page No.

1.0 SCOPE

1.1 PURPOSE

This Standard Operating Procedure (SOP) is a guidance document for required general documentation to be completed by field personnel during any field activity. Specific instructions are also included to document soil boring activities.

1.2 APPLICABILITY

Documentation in the form of field logbooks, reports, and forms shall be completed for every activity in the field; in addition, specific documentation requirements are provided that apply to soil boring activities. Records shall be maintained on a daily basis as the work progresses. All field documentation should be considered as potentially a legal document. Forms for other specific activities such as gamma surveys and soil sampling are found in the SOPs for those activities.

2.0 EQUIPMENT AND MATERIALS

The following materials will be used in the process of field documentation for general and soil logging activities:

- Weather resistant logbook
- Boring Log Forms
- Black or blue permanent ink pens
- Camera
- Measuring tape

3.0 FIELD DOCUMENTATION PROCEDURES

Field documentation serves as the foundation for field data collected that will be used to evaluate the project site. All field documentation shall be accurate, legible and written in indelible black or blue ink. No pencils or erasures shall be used. Incorrect entries in field books, logs, or on forms that need to be deleted shall be crossed out with one line, initialed, and dated. Skipped pages or blank sections at the end of a page shall be crossed out with an "X" covering the page or blank section; "No Further Entries," initials, and date shall be written by the person crossing out the blank section or page. The responsible field team member shall sign with the date and time after each day's last entry.

To further assist in the organization of the field books, logs, or forms, the date shall be recorded on top of each page along with the significant activity description (e.g., surface sample or soil boring). The descriptions of field data documentation given below serve as an outline; individual activities may vary in documentation requirements.

3.1 FIELD LOGBOOKS

The field logbook shall be a bound, weatherproof book with numbered pages, and shall serve primarily as a daily log of activities carried out during the fieldwork. Entries shall be made in indelible black or blue ink. A field logbook shall be completed for each operation and include field team leader notes, activity descriptions, and a list of site visitors. The logbook shall serve as a diary of the events of the day.

Field activities vary from project to project; however, the concept and general information that shall be recorded are similar. A description of two basic example logbooks, suitable for documentation of field activities, is given below. These field logbooks include the Field Team Leader (FTL) logbook and, when applicable, the field geologist/sampling team logbook.

FTL Logbook: The FTL's responsibilities include the general supervision, support, assistance, and coordination of the various field activities. As a result, a large portion of the FTL's day is spent rotating between operations in a supervisory mode. Records of the FTL's activities, as well as a summary of the field team's activities, shall be maintained in a logbook. The FTL's logbook shall be used to fill out daily/weekly reports. Items to be documented include:

- Record of tailgate project task meetings
- Health and Safety Activities
    - Record of health and safety equipment (e.g., uR meter, associated readings, etc.)
    - Personnel contamination prevention and decontamination procedures
    - Site specific safety hazards
    - Record of daily tailgate safety meetings
- Personnel and subcontractors on job site and time spent at the site; a record of time by name
- Field operations and personnel assigned to these activities
- A site sign in log will be maintain by the project manager or his designate
- Problems encountered and related corrective actions
- Deviations from the sampling plan and reasons for the deviations
- Records of communications; discussions of job-related activities with subcontractors, field team members, and project manager
- Information on addresses and contacts

- Record of invoices and other billing information
- Field observations

Field Geologist/Sampling Team Logbook, when applicable: The field geologist or sampling team leader shall be responsible for recording the following information in a logbook:

- Weather
- Calibration of field equipment
- Equipment decontamination procedures
- Personnel and subcontractors on job site and time spent on the site
- Site name and well or soil boring number
- Drilling activities
  - Sample location (sketch)
  - Drilling method and equipment used
  - Borehole diameter
  - Drill cuttings disposal/containerization (e.g., number of drums, roll-off bins, etc.)
  - Type and amount of drilling fluids used (e.g., mud, water, etc.)
  - Depth and time at which first groundwater was encountered. The absence of water in the boring should also be noted.
  - Total drilling depth of well or soil boring
  - Type and amount of material used to abandon soil borings
  - Time and date of drilling, completion, and backfilling
  - Name of drilling company, driller, and helpers
- Sampling
  - Date and time of sample collection
  - Sample interval
  - Number of samples collected
  - Analyses to be performed on collected samples
- Disposal of contaminated wastes (e.g., PPE, paper towels, etc.)
- Field observations
- Problems encountered and corrective action taken
- Deviations from the sampling plan and reason for the deviations
- Site visitors

3.2 BORING LOGS

The preparation of boring logs shall be the responsibility of the field team members assigned to the drill rig. While a soil boring log will be completed for each soil boring drilled at the site some soil borings will not be continuously logged. After the geology and interface between native and fill material has been determined based on field observations. The specific format is dictated by project requirements; however, the following information shall be recorded on the soil boring log.

- Project name, project number, and site name
- Name of drilling company
- Soil boring ID and location (sketch)
- Drilling and backfilling dates and times
- Total depth of completed soil boring
- Name of the logger
- Description of unconsolidated materials
  - Lithologic description
  - Descriptive Unified Soil Classifications System (USCS) classification
  - USCS symbol
  - Descriptive observations including gradation, plasticity, moisture content, cementation, grain size, angularity of coarse particles, odor, fractures, visible contamination, specific mineralogy, bedding, etc.)
- Color (use and record appropriate soil color chart [e.g., Munsel Color Chart])
- Description of consolidated materials
  - Geologic rock description
  - Rock type
  - Descriptive observations including relative hardness, density, texture, weathering, bedding, structures (e.g., fractures, joints, bedding, etc.), odor, visible contamination, PID readings and stratigraphic/lithologic changes
- Depth intervals of sample and the amount of sample recovered
- Blow counts
- Depth intervals from which samples are retained
- Analyses to be performed on collected samples
- Depth at which first groundwater was encountered, depth to water at completion of drilling, and the stabilized depth to water. The absence of water in the boring should also be noted
- Use of drilling fluids
- Evidence of contamination

3.3 PHOTOLOGS

Photologs are often used in the field to document site conditions (e.g., trenches and excavations, significant lithologic changes during soil logging and classification). While photographs may not always be required, they shall be used wherever applicable to show existing site conditions at a particular time and stage of the investigation or related site activity. Photolog information shall include:

- Photographer's name
- Date and time of photo
- Direction of the photo
- Prevailing weather conditions at the time the photo was taken
- Description of what the photo is intended to show
- Borehole identification number
- Interval
- An engineer's scale or tape should be included in photographs taken of soil core

SOP-5

Rio Algom Mining LLC

Equipment Decontamination

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Page No.

1.0 SCOPE

1.1 PURPOSE

Decontamination of drilling, sampling equipment, monitoring equipment and support vehicles is an important aspect of environmental field investigations. Proper decontamination is a key element in reducing the potential for cross-contamination between samples from different locations, ensuring that samples are representative of the sampled materials, and to protect the public and workers.

1.2 APPLICABILITY

The procedures outlined in this standard operating procedure shall be followed during decontamination of field equipment used in the sampling process. Three major categories of field equipment, along with applicable decontamination methods for each, are discussed below.

2.0 EQUIPMENT AND MATERIALS

The following equipment will be used in the decontamination procedure:

- Potable water
- Dionized/distilled water
- Phosphate free detergent (e.g. Alconox)
- 55 gallon (non-leaking) drums
- Large (5 gallon) buckets with lids
- Steam cleaner/pressure washer (when necessary)
- Dilute nitric acid (when necessary for VOC/petroleum hydrocarbon sampling)
- Clean plastic bags
- Trowel/steel brush

3.0 DECONTAMINATION PROCEDURES

3.1 SOIL SAMPLING EQUIPMENT

The following procedure will be used to decontaminate sampling equipment such as split-spoon samplers; brass sleeves; continuous core barrels; scoops; hand augers; metal sampling pans; and other sampling equipment and tools that may come into contact with samples. Personnel involved in decontamination activities shall wear appropriate protective clothing as defined in the project-specific health and safety plan.

- Remove visible dirt as much as possible
- Rinse with potable water, collecting excess water in a plastic drum/bucket when not performed on a decontamination pad
- When necessary, wash and scrub equipment with phosphate-free, laboratory-grade detergent (e.g., Alconox™ or equivalent); steam cleaning may also be performed if possible.
- Rinse with dilute nitric acid (only when applicable, i.e. sampling for VOC and petroleum hydrocarbons) collecting excess nitric acid in a container.
- Rinse twice with deionized or distilled water collecting excess water in a plastic drum/bucket when not performed on a decontamination pad
- Air dry.
- Store in clean plastic bag or designated casing.

3.2 DRILLING AND LARGE EQUIPMENT

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment and support vehicles. This may include percussion hammer drill pipe, hollow-stem auger flights, drill rods for sampling, the drill rig, support vehicles and other equipment and tools that may come in contact with sampling equipment or that may have possible contamination.

- Remove visible dirt as much as possible.
- Rinse with minimal potable water, collecting water in a large plastic drum/bucket.
- Steam clean the external surfaces and internal surfaces, when necessary, on equipment using high-pressure hot water from an approved water source. If necessary, scrub using a phosphate-free detergent (e.g., Alconox™), or equivalent laboratory-grade detergent until all visible dirt, grime, grease, oil, loose paint, rust, etc., have been removed.
- A decontamination pad, when needed, will be designed to collect rinsate and associated soil or chemicals. The decontamination pad will be constructed in an area designated by RAML. The decontamination pad will be large enough to accommodate vehicles present at the site. The rinsate collected from the decontamination pad and from other onsite decontamination activities will be stored in labeled containers until the proper disposal protocol is established pending characterization.
- Soil boring, drilling and soil sampling procedures require that decontaminated tools be employed in order to prevent cross-contamination. The decontamination procedures described below shall be followed to ensure that only uncontaminated equipment and tools will be introduced to the subsurface during drilling and sampling. The equipment decontamination process shall be undertaken before and after each use of the equipment and include either steam cleaning or washing when necessary. Steam cleaning of

equipment shall be performed at a dedicated decontamination pad. The flooring of the decontamination pad shall be impermeable to water and have a sump or low area to collect the rinsate to be transferred into the storage containers.
- The precise location of the decontamination pad shall be determined based on such factors as ease of access for personnel and proximity to work site and rinsate storage or staging areas.

4.0 PROCEDURE FOR OTHER WASTE DISPOSAL

Decontamination fluids (typically washwater) will be contained as generated. The washwater produced on a decontamination pad will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad). Washwater will then be containerized to await waste determination. Solids will also be containerized in a separate container to await waste determination.

In the absence of a decontamination pad, wash water will be collected directly into large plastic drums/buckets. Solids will be allowed to settle out of the collected water and may be transferred to their own container. Both solid and liquid containers will await waste determination.

SOP-6

Rio Algom Mining LLC

Sample Handling and Shipping

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Page No.

1.0 SCOPE

1.1 PURPOSE

The purpose of this SOP is to define sample management activities as performed from the time of sample collection to the time they are received by the laboratory.

1.2 APPLICABILITY

This standard operating procedure (SOP) describes the requirements on all samples for sample identification, chain-of-custody (COC) documentation, and sample handling, storage and shipping.

2.0 EQUIPMENT AND MATERIALS

The following materials will be used in the process of handling and shipping samples:

- RAML General or Site-specific Sample Register
- Chain of Custody Forms
- FedEx, UPS or other commercial carrier forms as required by shipping method
- Ice chests, typically provided by the analytical laboratory
- Packing material to prevent shifting of samples during shipping
- Custody seals, typically provided by the analytical laboratory
- Black or blue permanent ink pens
- Sampling containers as required by the analytical laboratory
- Preservatives as required by the analytical laboratory technique

3.0 PROCEDURES

3.1 SAMPLE MANAGEMENT

Sample Containers: The sample containers to be used are dependent upon the sample matrix and analyses desired. Once opened, the containers shall be used immediately. If the container is used for any reason in the field (e.g., screening) and not sent to the laboratory for analysis, it shall be discarded. Prior to discarding the contents of the used container and the container, disposal requirements shall be evaluated. During storage, the containers shall remain separate from solvents and other volatile organic materials. Sample containers with preservatives added by the laboratory shall not be used if held for an extended period on the job site or exposed to extreme heat conditions. Containers shall be kept in a cool, dry place.

Sample Labels. A sample label shall be affixed to all sample containers. Labels provided by the laboratory or another supplier may be used, and at a minimum shall include the following information:

- Company name, project title, and project location;
- Sample location;
- Sample identification number;
- Date and time of sample collection;
- Type of sample (grab or composite);
- Initials of sampler;
- Preservative used (when applicable);
- Analyte(s) of interest.

After labeling, each sample shall be kept in an ice chest in as cool a location as practical. Samples will be kept on ice when required by the laboratory.

Custody Seals. Custody seals will be used to preserve the integrity of each sample ice chest that is shipped to the laboratory from the time it is filled until the time it is opened at the lab. A custody seal will be signed, dated, and placed on the closing point of the sample ice chest prior to transport such that is must be broken to open the ice chest. Custody seals may be placed on each sample container after collection such that it must be broken to open the container.

Chain-of-Custody: Chain-of-custody (COC) procedures require a written record of the possession of individual samples from the time of collection through laboratory analyses. A sample is considered to be in custody if it is:

- In a person's possession;
- In view after being in physical possession;
- In a secured condition after having been in physical custody;
- In a designated secure area, restricted to authorized personnel.

The COC record shall be used to document the samples taken and the analyses requested. Information recorded by field personnel on the COC record shall include the following:

- Company name;
- Project name;
- Project location;
- Sampling location;
- Signature of sampler(s);

- Sample identification number;
- Date and time of collection;
- Sample matrix;
- Signatures of individuals involved in custody transfer (including date and time of transfer);
- Type of analysis and laboratory method number;
- Any comments regarding individual samples (e.g., organic vapor meter readings, special instructions).

COC records shall be placed in a waterproof plastic bag (e.g., Ziploc®) taped to the inside lid of the ice chest or taped to the top of the ice chest and transported with the samples. When the sample(s) are transferred, both the receiving and relinquishing individuals shall sign the record. Official carriers (e.g., FedEx) hand carry shall serve as custody transfer between the field sampler and courier, as well as courier and laboratory. If a carrier service is used to ship the samples (e.g., FedEx), custody records shall remain with the samples until it is relinquished to the laboratory. The company representative shall retain copies of the COC record and bill of lading if a carrier service is used.

Sample Register/Sample Tracking: The sample register is a logbook, field form or electronic database used to document which samples were collected on a particular day. The sample register is also used as the key to correlate field samples with duplicate samples. Information recorded in the sample register shall include the following:

- Client name;
- Project name and location;
- Job number;
- Date and time of collection;
- Sample identification number;
- Type of sample (e.g., grab or composite, etc.);
- Sample matrix (e.g., soil, groundwater, etc.);
- Number and type of bottles;
- Type of analysis;
- Sample destination;
- Sampler's initials.

A sample tracking database, which includes the above information, may be substituted for a handwritten sample register. However, a hard copy of each day's sampling activities shall be maintained in the field files or field logbook.

Sample Preservation/Storage: The requirements for sample preservation are dependent on the desired analyses and the sample matrix. Unless otherwise specified by the project plan, sample preservation requirements shall be observed.

3.2 SAMPLE SHIPPING

3.2.1 General Procedures

Procedures for packaging and transporting samples to the laboratory are based on the actual chemical, physical, and hazard properties of the material. The procedures may also be based on an estimation of contaminant concentrations/properties in the samples to be shipped. Samples shall be identified as environmental samples, excepted quantities samples, limited quantities samples, or standard hazardous materials. Environmental samples are defined as solid or liquid samples collected for chemical or geotechnical analysis. These samples are used to support remedial investigation, feasibility studies, treatability studies, remediation design and performance assessment, waste characterization, etc. Excepted quantities involve the shipment of a few milliliters of either an acid or base preservative in an otherwise empty sample container. Limited quantities are restricted amounts of hazardous materials that may be shipped in generic, sturdy containers. Standard hazardous material shipments require the use of stamped/certified containers. All samples shall be packaged and shipped or hand delivered to the laboratories as required by laboratory analysis hold times and as specified in project-specific work plans.

The following paragraphs describe standard shipping procedures. Any exceptions to these procedures shall be defined in the project-specific work plan. It is the responsibility of the sampler to understand U.S. Department of Transportation (DOT) requirements and limitations associated with the shipment of samples.

3.2.2 Sample Shipping via Commercial Carrier:

Samples shall be packaged and shipped to the laboratories as specified in the project work plans and depending on holding time requirements for individual samples. For aqueous or solid samples that are shipped to the laboratory via a commercial carrier the following procedures apply:

- Sample labels shall be completed and attached to sample.
- The samples shall be placed upright in a waterproof metal or equivalent strength plastic ice chest.
- When necessary, ice in double Ziploc bags (to prevent leakage) shall be placed around, among, and on top of the sample bottles. When required, enough ice shall be used so that the samples shall be chilled and maintained at 4°C ± 2°C during transport to the

laboratory. Dry ice shall not be used. In addition, experience has shown that blue ice is inadequate.

- To prevent the sample containers from shifting inside the ice chest, the remaining space in the ice chest shall be filled with inert cushioning material, such as shipping peanuts, additional bubble pack, or cardboard dividers.
- The original copy of the completed COC form shall be placed in a waterproof plastic bag and taped to the inside of the ice chest lid or taped to the top of the ice chest.
- The lid shall be secured by wrapping strapping tape completely around the ice chest in two locations.
- Custody seals shall be used at the closure points of each shipping container to ensure custody. Custody seals shall consist of security tape with the date and initials of the sampler.
- A copy of the COC record and the bill of lading shall be retained for the project files.

3.3 HOLDING TIMES

The holding times for samples will depend on the analysis and the sample matrix.

3.4 TRAINING

The U.S. DOT requires that all employees involved in any aspect of hazardous materials transport (e.g. shipping, transport, receipt, preparing documents, and etc.) receive training every three years.

SOP-7

Rio Algom Mining LLC

Surface and Shallow Subsurface Soil Sampling

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Page No.

1.0 SCOPE

1.1 PURPOSE

This standard operating procedure (SOP) describes methods and equipment used for collecting environmental surface and shallow subsurface soil samples for chemical, radiological, and geotechnical analyses. For the purposes of this SOP, shallow subsurface samples shall be those that are collected using sampling equipment other than a drill rig, such as a hand auger or backhoe.

1.2 APPLICABILITY

This SOP defines sample collection procedures using hand augers, shovels/trowels, soil core samplers, and split spoon samplers. Procedures for collecting deep subsurface soil samples using a drill rig are provided in a separate SOP. This document is not intended to provide an all-inclusive discussion of sample collection methods. Specific sampling problems may require the adaptation of existing equipment or design of new equipment. Such innovations shall be described in the project-specific sampling plan.

2.0 EQUIPMENT AND MATERIALS

2.1 SAMPLING EQUIPMENT AND MATERIALS

The following equipment may be employed in the collection of surface and shallow subsurface soil sampling. Decontamination equipment, field documentation requirements, sampling forms, and sampling equipment are discussed in detail in the following SOPs: SOP-4, *Field Documentation*; SOP-5, *Equipment Decontamination*; and SOP-6, *Sample Handling and Shipping*.

- Trimble GPS and datalogger
- Terra Sync GIS
- Hand auger or power auger, trowel, shovel, soil core sampler, or split spoon sampler
- Backhoe with either bucket or power auger attachment
- Large (1 gallon or larger) sealable plastic bags or bottles, as needed for analysis
- Sample labels
- Cooler for shipping samples
- Ice, if necessary
- Stainless steel bowl and utensils, if necessary

2.2 GPS AND MAPPING SOFTWARE

A Trimble® Pathfinder ProXRT global positioning system (GPS) with differential correction and a Ranger datalogger is used to provide radiation measurement locations. The GPS and datalogger is used with TerraSync™ GIS and Pathfinder Office software to download radiation measurements and corresponding locations.

2.3 GAMMA RADIATION METER

The calibrated exposure meter ("µR" meter or tissue equivalent ion chamber) is used to measure real-time radiation levels to ensure regulatory limits are not exceeded.

2.4 VARIOUS MISCELLANEOUS ITEMS

Survey locations are found using a map of survey areas with marked grid nodes identified by northing and easting coordinates. An ink pen and field notebooks are used to record readings, general weather conditions, and other notes. The chain of custody form from the laboratory serves as the field sampling form. Safety gear requirements are found in the project Health and Safety Plan. Minimum personal protection equipment (PPE) will include hart hat, steel toed shoes, safety vest, gloves and safety glasses.

3.0 SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING PROTOCOL

3.1 BACKGROUND

Soil samples are collected at the surface and at various depth intervals as specified in the work plan. Soil samples shall be taken at 0-2 inches and 2-6 inches to determine the potential effect from windblown contaminants. Soil samples may be collected as grab samples or as composite samples. The sample method is determined based on the characteristics of the site, the matrix, and/or regulatory requirements.

- Grab sample: A sample taken from one location. Grab samples are useful in determining discrete concentrations, but also provide spatial variability when multiple samples are collected.

- Composite sample: A number of samples that are individually collected then combined (homogenized) into a single sample for subsequent analysis. Composite samples are useful when averaged or normalized concentration estimates of a waste stream or an area are desired.

3.2 SAMPLING PROGRAM OBJECTIVES

The objective of surface and shallow subsurface soil sampling is to identify the extent of any potential radioactive contaminants. Sampling objectives are typically diverse and dependent on the nature of the project objectives.

Details pertaining to sample locations, number of samples, and type of analyses required, shall be presented in project-specific work plans. An approved contracted laboratory shall be contacted prior to sampling to provide minimum sample sizes required to meet detection limit requirements for the requested analysis.

4.0 SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING PROCEDURES

All soil sample locations shall be recorded with coordinates from a GPS device. The logbook should also include the location, date, and time of each sample taken, sampling personnel present, and any unusual conditions.

A soil sample may consist of a single scoop or core, or the sample may be a composite of several individual samples. Soil samples shall be obtained using hand augers, shovels/trowels, soil core samplers, or split spoon samplers. Core samples are obtained using soil core samplers or split spoon samplers. Continuous samples to a specific depth can only be taken using an auger, core sampler, or split spoon sampler since each incremental depth of soil removed must be included in the sample.

4.1 HAND AUGER

A hand auger consists of a stainless steel tube with two sharpened spiral wings at the tip. The auger typically cuts a 2-inch to 3-inch diameter boring. Because the auger is hand-driven, penetration in dense or gravelly soil may be difficult. If penetration is difficult then a power auger or backhoe will be employed. For soil sample collection, the procedures are outlined below.

- For surface samples 0-6 inches, advance the auger by hand into the soil, to the depth of 6 inches, by turning in a clockwise direction with downward force applied. For surface samples at different depths, for instance 0-2 inches, use the same procedure if possible or use a trowel to sample to that depth.
- Retrieve the auger to the surface, preferably without rotation. Empty the soil into a stainless steel bowl if necessary depending on the soil matrix.

- Fill sample containers using the stainless steel spoon, as necessary. Do not include twigs, rocks, leaves and other undesirable debris if they are not considered part of the sample. The outside of sampling containers shall be kept free from dust and other materials to the extent possible to prevent cross contamination when opened at the laboratory.
- If continuous sampling is required to a specific depth, material will be removed incrementally and all soil will be combined in a large stainless steel bowl and composited. Care must be taken to remove roughly equal amounts of soil from each depth. The required amount will be placed into the sample container from the composite material.
- If a composite sample is needed, place samples into the stainless steel bowl for homogenization. Prior to homogenization, remove twigs, rocks, leaves and other undesirable debris if they are not considered part of the sample.
- For shallow subsurface sampling, continue in a similar method. For example, for a sample required at a depth at 18-24 inches, the following procedures would be used:
  - The soil from 6-18 inches should be removed and set aside for back fill.
  - Obtain a soil sample from 18-24 inches.
  - Follow the same procedure to fill the container as in the surface sample.
  - When sampling is complete, backfill the unused soil into the hole using a shovel, trowel or other appropriate method.
- The hand auger and other tools must be wiped clean of visible dirt and decontaminated between sample intervals.

4.2 SHOVEL/TROWEL

Various shovel/trowel designs and sizes are commercially available for a variety of sampling applications. These devices are hand-driven and are typically used for sampling relatively soft, unconsolidated soil deposits. Some designs can be driven into hard, rocky soil by opening a deep, narrow hole. A shovel/trowel cannot be used for continuous sampling to a specific depth since each increment must be included in the sample.

Shovels or trowels used for soil sampling shall be made of an impervious material, ideally stainless steel. The procedures outlined below shall be followed while collecting samples with shovels or trowels.

- Drive the shovel/trowel into the soil. If the soil is dense, use your own weight to drive the shovel by stepping on the rear edge of the shovel.
- Retrieve the shovel/trowel to the surface.
- Fill sample bags using decontaminated stainless steel spatulas or spoons. Do not use twigs, rocks, leaves and other undesirable debris if they are not considered part of the

sample. The outside of sampling containers shall be kept free from dust and other materials to the extent possible to prevent cross contamination when opened at the laboratory.

- If a composite sample is needed, place samples into a stainless steel bowl for homogenization. Prior to homogenization, remove twigs, rocks, leaves and other undesirable debris if they are not considered part of the sample.
- Shovel/trowel and other tools must be wiped clean of visible dirt and decontaminated between sample intervals

4.3 Soil Core Sampler and Split-Spoon Sampler

Soil core samplers consist of variable diameter (commonly 1-2 inches), stainless-steel tubes that can be attached to a hammer using a cap to allow for driving into surface and shallow soil. The steel tubes can also be fitted with aluminum or stainless steel liners for the collection of undisturbed samples. Polyethylene liner caps are used to seal the ends of the tube after sample collection. Split-spoon samplers consist of a hollow tube consisting of two halves split lengthwise that are held together by a circular connector head at the top and a drive shoe at the bottom. This procedure is used for samples taken at the surface of soil. The procedures outlined below shall be followed when collecting soil samples using this method.

- Attach a stainless steel cap to the sampler.
- Attach the sampler and cap assembly to a hammer.
- For the collection of undisturbed soil samples, install stainless-steel liners in the sampler.
- Push the hammer and sampler into the surface soil. For dense soil, turn hammer slightly clockwise to enhance penetration.
- Once the desired sample depth is reached, retrieve sampler to the surface and detach the sampler from the hammer.
- Fill sample bags using decontaminated a stainless steel bowl and spoon, as necessary. Do not use twigs, rocks, leaves and other undesirable debris if they are not considered part of the sample. The outside of sampling containers shall be kept free from dust and other materials to the extent possible to prevent cross contamination when opened at the laboratory.
- If continuous sampling is required to a specific depth, material will be removed incrementally and all soil will be combined in a large stainless steel bowl and composited. Care must be taken to remove roughly equal amounts of soil from each depth. The required amount will be placed into the sample container from the composite material.

- If a composite sample is needed, place samples into a stainless steel bowl for homogenization. Prior to homogenization, remove twigs, rocks, leaves and other undesirable debris if they are not considered part of the sample.
- Shovel/trowel and other tools must be wiped clean of visible dirt and decontaminated between sample intervals.

4.4 BACKHOE

The rocky terrain at the site may prevent the use of auger/ shovel methods for obtaining soils at depth. In this event a backhoe or backhoe with power auger may be used; use of a backhoe with power auger is covered in the next section. A backhoe cannot be used for continuous sampling to a specific depth since each increment must be included in the sample. Procedures for sampling with a backhoe are as follows:

- Use any of the above methods to remove a sample for the 0-6 inch interval and fill a sample container as described above.
- For shallow subsurface sampling, continue in a similar method as used for the hand auger. For example, for a sample required at a depth at 18-24 inches, the following procedures would be used:
    - The soil from 6-18 inches should be removed and set aside for back fill.
    - Obtain a soil sample using a shovel, trowel or hand auger from 18-24 inches.
    - Follow the same procedure to fill the container as in the surface sample.
    - When sampling is complete, backfill the unused soil into the hole using a shovel, trowel or other appropriate method.
- If continuous sampling is required to a specific depth, material will be removed incrementally and all soil will be combined in a large stainless steel bowl and composited. Care must be taken to remove roughly equal amounts of soil from each depth. The required amount will be placed into the sample container from the composite material.
- The backhoe, auger attachment and other tools must be wiped clean of visible dirt and decontaminated between sample intervals.

4.5 BACKHOE WITH POWER AUGER

The rocky terrain at the site may prevent the use of auger/ shovel methods for obtaining soils at depth. If available, a backhoe with power auger may be used. A backhoe with power auger can be used for continuous sampling if each increment is saved in one or more large stainless steel bowls to be composited as described below. Procedures for sampling with a backhoe are as follows:

- Use any of the above methods to remove a sample for the 0-6 inch interval and fill a sample container as described above.
- For shallow subsurface sampling, continue in a similar method as used for the hand auger. For example, for a sample required at a depth at 18-24 inches, the following procedures would be used:
  - The soil from 6-18 inches should be removed and set aside for back fill.
  - Obtain a soil sample using a shovel, trowel or hand auger from 18-24 inches.
  - Follow the same procedure to fill the container as in the surface sample. The outside of sampling containers shall be kept free from dust and other materials to the extent possible to prevent cross contamination when opened at the laboratory.
  - When sampling is complete, backfill the unused soil into the hole using a shovel, trowel or other appropriate method.
- If continuous sampling is required to a specific depth, material will be removed incrementally and all soil will be combined in several large stainless steel bowls and composited. Care must be taken to remove roughly equal amounts of soil from each depth. The required amount will be placed into the sample container from the composite material.
- The auger attachment and other tools must be wiped clean of visible dirt and decontaminated between sample intervals.

5.0 DECONTAMINATION

Equipment used in the sampling process shall be decontaminated prior to and after field use and between sample locations/depth intervals. Decontamination procedures are presented in SOP 5, *Equipment Decontamination.* Personnel shall don appropriate personal protective equipment as specified in the SOP and in the project-specific work plan. Any investigation-derived waste generated during the sampling process shall be managed in accordance with procedures outlined in the work plan.

Rio Algom

SOP-8

Rio Algom Mining LLC

Soil Sampling for Semi-Volatile and Volatile Organic Compound Analysis

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1.0 SCOPE

1.1 PURPOSE

This standard operating procedure (SOP) describes methods and equipment that shall be used for collecting environmental surface soil, subsurface soil, and sediment samples for volatile organic compound (VOC) analysis. This SOP, prepared in accordance with EPA Publication SW-846, *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods* (EPA, 1996), defines sample collection procedures for screening and definitive sampling levels, using a soil sampler, methanol, and sodium bisulfate preservation methods according to SW-846 Method 5035A (EPA, 1996).

1.2 APPLICABILITY

This document focuses on methods and equipment that are specific to sampling surface soil and subsurface soil for VOC analysis. It is not intended to provide an all-inclusive discussion of soil sample collection methods. The standard procedures for collecting soil samples are described in SOP 7, *Surface and Shallow Subsurface Soil Sampling*, and SOP 9, *Deep Subsurface Soil Sampling.*

2.0 EQUIPMENT AND MATERIALS

The following equipment is used employed in the process of sampling for VOCs in soil samples. Decontamination equipment, field documentation requirements, sampling forms, and sampling equipment are discussed in detail in the following SOPs: SOP-4, *Field Documentation*; SOP-5, *Equipment Decontamination*; and SOP-6, *Sample Handling and Shipping*.

- Field Balance
- EPA-approved VOC sampling kit (e.g., cut plastic syringe, EnCore sample, Purge-and-Trap sampler, Terra Core™)
- 40 mL Teflon cap glass vials
- Bagged ice for sample cooling (do not use dry ice)

3.0 SURFACE AND SUBSURFACE SOIL AND SEDIMENT SAMPLING PROCEDURES

3.1 BACKGROUND

Soil and sediment samples will be collected at the surface and subsurface. Techniques in SOP-7 and SOP-9 apply to sampling by hand and by using a drill rig, respectively, and should be followed prior to techniques provided in this SOP.

3.2 SAMPLE PRESERVATION

Methanol or Sodium Bisulfate Preservation is used with VOC sampling. Refer to SW-846 Method 5035A (EPA, 1996) for full details on sample preservation. A sodium bisulfate preservative solution is used for the collection of soil samples in which the suspected VOC concentration is in the range of 0.5 to 200 micrograms per kilogram (µg/kg). For soil samples in which the VOC concentration is suspected to be greater than 200 µg/kg, either a bulk sample may be collected and the laboratory will add a water miscible solvent or the sample is collected in a vial that contains a water-miscible organic solvent (methanol).

3.3 SAMPLING TECHNIQUES

All soil samples for VOC should be collected using the following techniques:

1. Obtain a tared 40 ml glass VOC vial containing the appropriate preservative and a magnetic stirring rod. With the plunger seated in the handle, push the VOC sampler into freshly exposed soil until the sample chamber is filled. A filled chamber will deliver approximately 5 grams of soil.
2. Wipe all soil or debris from the outside of the sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.
3. Rotate the plunger that was seated in the handle top 90° until it is aligned with the slots in the body. Place the mouth of the sampler into the tared 40 ml VOC vial containing the appropriate preservative, and extrude the sample by pushing the plunger down. Quickly place the lid back on the tared 40ml VOC vial. Note: When capping the 40 mL VOC vial, be sure to remove any soil or debris from the threads of the vial.
4. Because the soil vial cannot be opened without compromising the integrity of the sample, at least one additional vial of sample may be collected for dry weight determination. This additional replicate must not contain preservative, since an aliquot will be used for dry weight determination.
5. All samples for VOC analysis shall be cooled to approximately 4°C, packed in appropriate containers, and shipped to the laboratory on ice. For further details on shipping and handling refer to SOP-12.

4.0 DECONTAMINATION

All non-disposable equipment used in the sampling process shall be decontaminated prior to field use and between sample locations. Decontamination procedures are presented in SOP-5. Personnel shall don appropriate personal protective equipment as specified in the project-specific health and safety plan. Note that when handling the vials that contain methanol, methanol resistant gloves shall be worn. Investigation-derived waste generated in the sampling process shall be managed in accordance with the Work Plan.

5.0 REFERENCES

U.S. Environmental Protection Agency. 1996. SW-846 Method 5035A Revision 0, Closed System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

SOP-9

Rio Algom Mining LLC

Deep Subsurface Soil Sampling

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1.0 SCOPE

1.1 PURPOSE

This standard operating procedure (SOP) describes methods and equipment used for collecting environmental subsurface soil samples for chemical, radiological, and geotechnical analyses. For the purposes of this SOP, deep subsurface samples shall be those that are collected using a standard drill rig outfitted with hollow-stem augers.

1.2 APPLICABILITY

This SOP defines sample collection procedures for collecting deep subsurface soil samples using a drill rig. This document is not intended to provide an all-inclusive discussion of sample collection methods. Specific sampling problems may require the adaptation of existing equipment or design of new equipment. Such innovations shall be described in the project-specific sampling plan.

2.0 EQUIPMENT AND MATERIALS

2.1 SAMPLING EQUIPMENT AND MATERIALS

The following equipment may be employed in the collection of deep subsurface soil samples. Decontamination equipment, field documentation requirements, sampling forms, and sampling equipment are discussed in detail in the following SOPs: SOP-4, *Field Documentation*; SOP-5, *Equipment Decontamination*; and SOP-6, *Sample Handling and Shipping*.

Drilling and sampling operations are typically conducted with the use of a mobile power auger drill equipped to advance holes through overburden using hollow-stem and continuous flight augers. Soil samples are generally recovered on a continuous or discontinuous basis, with the use of a 2 inch (51 mm) diameter, 6 inch (150 mm), 2 ft (600 mm) or 2.5 ft (750 mm) long, split-spoon sampler, over the full depth of the boreholes. The split spoon sampling is carried out in conjunction with the Standard Penetration Test used to provide ‘N’ values for the determination of relative density in cohesionless soils and consistency in cohesive soils.

Individual soil samples are examined upon recovery by the field geologist for purposes of describing and recording texture, colour, odour and moisture content. Borehole logs are prepared on the basis of sample and drilling process observations in the field describing the encountered strata and visual or olfactory evidence of subsurface contamination, if present.

Following field logging, samples are placed into labelled, sterile, plastic bags for shipment to the laboratory for analysis. Additional samples may be retained for detailed inspection off-site as necessary.

2.2 GPS AND MAPPING SOFTWARE

A Trimble® Pathfinder ProXRT global positioning system (GPS) with differential correction and a Ranger datalogger is used to log the borehole locations.

2.3 GAMMA RADIATION METER

The calibrated exposure meter ("µR" meter or tissue equivalent ion chamber) is used to measure real-time radiation levels to ensure regulatory limits are not exceeded.

2.4 VARIOUS MISCELLANEOUS ITEMS

Survey locations are found using a map of survey areas with marked grid nodes identified by northing and easting coordinates. An ink pen and field notebooks are used to record readings, general weather conditions, and other notes. The chain of custody form from the laboratory serves as the field sampling form. Safety gear requirements are found in the project Health and Safety Plan. Minimum personal protection equipment (PPE) will include hard hat, steel toed shoes, safety vest, gloves and safety glasses.

3.0 DEEP SOIL SAMPLING PROTOCOL

3.1 BACKGROUND

Subsurface soil samples are to be collected starting at five-feet below surface and extending down to the native soil surface. This can be accomplished by continuous sampling or by augering down to the required depth, collecting a sample using a standard split spoon tube and then augering to the next five foot interval. If native soil is discovered at an interval less than 5 foot below surface or below the previous sample, a sample will be collected at approximately halfway between the native soil and the last sample. A sample of native soil will also be collected. The sample method is determined based on the characteristics of the site, the soil matrix, and/or regulatory requirements.

3.2 SAMPLING PROGRAM OBJECTIVES

The objective of the deep subsurface soil sampling is to identify the extent of potential radioactive contaminants extending from the surface to the native soil surface at five-foot intervals. Sampling objectives are typically diverse and dependent on the nature of the project objectives.

Details pertaining to sample locations, number of samples, and type of analyses required, shall be presented in project-specific work plans. An approved, contracted laboratory shall be contacted prior to sampling to provide minimum sample sizes required to meet detection limit requirements for the requested analysis.

4.0 DEEP SOIL SAMPLING PROCEDURES

All soil sample locations shall be recorded with coordinates using a Trimble® Pathfinder ProXRT GPS system. The logbook should also include the location, date, and time of each sample taken, sampling personnel present, and any unusual conditions.

Soil samples shall be obtained using split spoon samplers. Core samples can be collected using continuous core sampling or by augering to the required depth (5-foot intervals) and then using the split spoon sampler. Continuous samples to a specific depth can be taken using an auger, core sampler, or split spoon sampler since each incremental depth of soil removed must be included in the sample.

Split-spoon samplers consist of a hollow tube consisting of two halves split lengthwise that are held together by a circular connector head at the top and a drive shoe at the bottom. This procedure is used for samples taken at each new sub-surface soil layer – i.e. after the new depth is reached using an auger. The procedures outlined below shall be followed when collecting soil samples using this method.

- Attach a stainless steel cap to the sampler.
- Attach the sampler and cap assembly to a hammer.
- For the collection of relatively undisturbed soil samples, install a liner in the sampler.
- Once the desired sample depth is reached, retrieve sampler to the surface and detach the sampler from the hammer.
- Fill sample bags using a decontaminated stainless steel bowl and spoon or spatula, as necessary. Twigs, rocks, leaves and other undesirable debris should not be included if they are not considered part of the sample. The outside of sampling containers shall be kept free from dust and other materials to the extent possible to prevent cross contamination when opened at the laboratory.
- If continuous sampling is required to a specific depth, material will be removed incrementally and soil from specific intervals will be placed in a large stainless steel bowl and then into sample bags. Care must be taken to remove roughly equal amounts of soil from each depth.

- If a composite sample is needed, place samples into a stainless steel bowl for homogenization. Prior to homogenization, remove twigs, rocks, leaves and other undesirable debris if they are not considered part of the sample.
- Split spoons, augers and other tools must be wiped clean of visible dirt and decontaminated between sample intervals.

5.0 DECONTAMINATION

Equipment used in the sampling process shall be decontaminated prior to and after field use and between sample locations/depth intervals. Decontamination procedures are presented in SOP 5, *Equipment Decontamination.* Personnel shall don appropriate personal protective equipment as specified in the SOP and in the project-specific work plan. Any investigation-derived waste generated during the sampling process shall be managed in accordance with procedures outlined in the work plan.

SOP-10

Rio Algom Mining LLC

Daily Operational Health Physics

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Page No.

1.0 SCOPE

1.1 PURPOSE

This standard operating procedure (SOP) describes methods and equipment for operational health physics tasks during field work. It is a guidance document that outlines health physics tasks for characterization, construction and related activities.

1.2 APPLICABILITY

This SOP applies to general health physics and radiation safety tasks necessary during field work to protect personnel, the general public, and the environment. This document is not intended to provide an all-inclusive discussion of health physics tasks; specific characterization or construction work may require adaptation of existing methodology. Such innovations shall be described in the project-specific sampling plan and/or the final work product.

2.0 EQUIPMENT AND MATERIALS

2.1 SAMPLING EQUIPMENT AND MATERIALS

The following equipment may be employed in routine health physics tasks. Environmental air sampling equipment, decontamination equipment, field documentation requirements, sampling forms, and sampling equipment are discussed in detail in the following SOPs: SOP-1, *Environmental Particulate Air Sampling*, SOP-4, *Field Documentation*; SOP-5, *Equipment Decontamination*; and SOP-6, *Sample Handling and Shipping*.

- Alpha Probe (Ludlum Model 4 with Model 43-5 probe or equivalent) and Check Source
- Alpha Counter or Scaler (Ludlum Model 2000 Scaler with Model 43-1 probe or equivalent) and Check Source(s)
- Scaler Ratemeter (Ludlum Model 2221 with Model 44-10 probe or equivalent) and Check Source
- MicroR Meter or Tissue Equivalent Exposure Meter (Ludlum Model 19 or equivalent)
- Optically Stimulated Luminescent (OSL) Whole Body Dose Badges
- Environmental Air Sampling Pumps (Staplex Model TFIA-F)
- Lapel Breathing Zone Air Sampling Pumps

The following materials may be employed in routine health physics tasks. Environmental air sampling materials are discussed in detail in SOP-1, *Environmental Particulate Air Sampling*,

- Wipe Filter Papers (Biodex Rad-Wipe Smears 006-350 or equivalent)
- Environmental Air Filters (Staplex model TFA-GF 810 or equivalent)
- Lapel Breathing Zone Filter Cassettes

2.2 VARIOUS MISCELLANEOUS ITEMS

An ink pen and field notebooks are used to record readings, general weather conditions, and other notes. The sign-in sheet and chain of custody form from the laboratory serves as field sampling forms. Safety gear requirements are found in the project Health and Safety Plan. Minimum personal protection equipment (PPE) will include hard hat, steel toed shoes, safety vest, and safety glasses.

3.0 DAILY OPERATIONAL HEALTH PHYSICS PROCEDURES

The daily operational health physics tasks include monitoring of personnel, conducting surveys of equipment, and environmental monitoring. These tasks are followed to ensure that personnel and public doses are maintained as low as reasonably achievable (ALARA) and to monitor environmental levels for mitigation as needed.

3.1 DAILY INSTRUMENT CHECKS

Instruments should be checked at least daily using provided radioactive check sources and logged in the Rio Algom Mining, LLC (RAML) binder. Any instrument not performing within specifications of its current calibration shall be removed from service.

3.2 PERSONNEL MONITORING

Personnel working on site regularly should be issued an OSL badge for personal dose monitoring; issuance is determined by a health physicist or as required in the applicable work plan. OSL badges are issued each morning and collected each evening by the site safety and health representative. Badges are not to be taken home and should be stored in the bag provided with the badges. OSL badge issuance is documented in the RAML binder.

During dust producing activities two breathing zone air samples should be taken on separate days each week and on different personnel as determined by a health physicist or as required by the applicable work plan. Lapel sampling is documented in the logbook per SOP-4, *Field Documentation*, and in the RAML binder.

All personnel and visitors shall scan their hands, boot bottoms and other potentially contaminated areas at the end of the day or prior to leaving the site using an alpha probe and/or smears counted using the scintillating alpha counter. Monitoring using smear samples shall be based on the type of work being done and as determined by the safety and health representative. All personnel and visitors shall also have their hands surveyed prior to lunch, water breaks, or restroom breaks using an alpha probe. Personnel who are coming on site from a separate radiation site should be surveyed upon arrival on site. Contamination above allowable release limits must be removed prior to release of personnel from the site. Measurable contamination below release limits should also be removed in accordance with ALARA concepts. Results shall be documented on the sign-in sheet for scan surveys and in the field logbook for smear samples. Decontamination procedures are found in SOP-5, *Equipment Decontamination,* and may be supplemented as needed by the safety and health representative.

3.3 EQUIPMENT SURVEYS

Equipment should be surveyed prior to release off site as determined by the health physicist or applicable work plan. This will be performed using the alpha probe and smears counted on the alpha counter. Monitoring using smear samples is required for equipment and the number of samples will be based on the type of work being done and as determined by the safety and health representative. Equipment coming on site from another area that may have radiation levels above background should also be surveyed using smears prior to use on site. Results shall be documented in the field logbook. Contamination above allowable release limits must be removed prior to release of equipment from the site. Measurable contamination below release limits should also be removed in accordance with ALARA concepts. Decontamination procedures are found in SOP-5, *Equipment Decontamination,* and may be supplemented as needed by the safety and health representative.

3.4 ENVIRONMENTAL MONITORING

During dust producing activities, environmental air monitoring should be highly considered. The safety and health representative or applicable work plan shall determine the need for environmental air sampling. If needed, at least two air samplers should be set up with one upwind and one downwind of dust producing work and up to two air samplers set up within the community (near houses in the area) during dust producing work. These air samples should be placed in the same location each time unless otherwise determined by the safety and health representative or work plan. Air sampling procedures are outlined in SOP-1, *Environmental Particulate Air Sampling.* Sample filter details are included in the logbook per SOP-4, *Field Documentation*.

3.5 SAMPLE SHIPMENT

Lapel samples should be shipped to Energy Laboratories in Casper, WY. Soil samples, water samples, environmental air samples and smear samples (as determined by the health physicist) should be shipped to ALS Laboratory Group in Fort Collins, CO. The proper Chain-of-Custody (CoC) shall be filled out completely, signed, and shipped with the samples.

4.0 CONTAMINANTS OF CONCERN

4.1 URANIUM

Uranium is an actinide that occurs naturally in low concentrations of a few parts per million in soil, rock, and water. Natural uranium consists of approximately 99.27% uranium-238 (U-238), 0.71% uranium-235 (U-235), and 0.01% uranium-234 (U-234). U-238 has a half life of 4.47 billion years, while U-235 has a half life of 704 million years. Uranium decays slowly by emitting an alpha particle. U-238 decays via alpha particles of 4.20 MeV 77% of the time and 4.15 MeV 23% of the time. U-235 decays via alpha particles of 4.40 MeV 55% if the time, 4.45 MeV 26% of the time, and 4.37 MeV 17% of the time. These energies of alpha radiation make it possible to detect uranium contamination at low levels in the field. Uranium is a heavy metal and the potential health effects are similar to other heavy metals.

4.2 RADIUM-226

Radium 226 (Ra-226) is an alkaline earth metal found in trace amounts in the environment. Ra-226 has a half life of 1,600 years and decays into radon gas (radon--222). Ra-226 decays via alpha giving off a 4.78 MeV alpha particle 94.5% of the time and a 4.60 MeV alpha particle 5.5% of the time. Ra-226 also produces a gamma of 0.186 MeV 3.3% of the time. These energies of alpha and gamma radiation make it possible to detect uranium contamination at low levels in the field. Radium acts similarly to calcium in the body and is a bone seeker.