

**Department of Environmental Protection
Bureau of Remediation & Waste Management
RCRA Program**

Standard Operating Procedure Change Record

Title: PROTOCOL FOR COLLECTING DATA USING A NITON FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETER FOR CERTAIN METALS IN SOLID MEDIA

Identification #: **RWM-DR 015**

SOP Originator: Brian Beneski

Author	Revision	Description of Change	Date
Erika Bonenfant	RCRA 01	Substitute MEDEP/RCRA in the place of MEDEP/DR, and Division of Oil and Hazardous Waste Facilities Regulation in the place of Division of Remediation. Section 2.0 Introduction: Change first sentence to "MEDEP/RCRA is responsible for the investigation and subsequent corrective actions for RCRA facilities throughout Maine."	8/1/2009

Approved by:

Scott Whittier, RCRA Program Director

Date:

**COVERSHEET
STANDARD OPERATING PROCEDURE**

Operation Title: **PROTOCOL FOR COLLECTING DATA USING A NITON FIELD
PORTABLE X-RAY FLUORESCENCE SPECTROMETER FOR
CERTAIN METALS IN SOLID MEDIA**

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Standard Operating Procedure: **RWM-DR-015**
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Date: **April 10, 2009**
Written/Revised by: **Jean Firth**
Reviewed by: **Brian Beneski**

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1.0 PURPOSE

The purpose of this document is to describe the Maine Department of Environmental Protection, Bureau of Remediation and Waste Management, Division of Remediation's (MEDEP/DR) procedure for collecting data using a portable x-ray fluorescence spectrometer (XRF) for certain metals in solid media.

2.0 APPLICABILITY

MEDEP/DR is responsible for the investigation and remediation of uncontrolled hazardous substance sites throughout Maine. In the course of the investigation and subsequent remediation, samples must be taken to determine the geographical extent, chemical characteristics, and relative levels of contaminants at each site and surrounding area. This standard operating procedure (SOP) is designed to be a guideline for data collection with a Niton XL-722S XRF for solid media (e.g. soil, sediment and sludge). This is a field screening method used for: profiling an area, locating sources of contamination, determining the horizontal or vertical extent of contamination or collecting preliminary data that will be used to design a sampling plan. Samples can be analyzed either in-situ methods or by intrusive sample preparation methods. This SOP will outline collecting data using both methods.

3.0 RESPONSIBILITIES

All MEDEP/DR Staff must follow this procedure when using the XRF. All managers and supervisors within MEDEP/DR are responsible for ensuring that their staff are familiar with and adhere to this procedure. *Additionally, before any person is allowed to use the XRF they **MUST:** have completed a radiation training course (proof of completion must be submitted to the DR Site Assessment and Support Services Unit (SASS)), wear a radiation dosimeter badge and have 2 days of supervised field use (within the last 6 months) by approved DR or Division of Technical Services staff.* The DR Radiation Safety Officer (RSO) is responsible for compiling and maintaining a current list of supervisors and users.

4.0 PREPARATION AND GENERAL INFORMATION

4.1 PREPARATION

Prior to conducting any sampling event, a sampling plan should be developed (see SOP DR#014 - Development of a Sampling and Analysis Plan). Clean containers must be used for each sampling event unless in-situ sampling is to be performed.

An evaluation of the site and the elements of concern should be made prior to using the XRF on a site. Determine if the XRF can analyze for the elements of concern and if the detection limits are acceptable to meet the Data Quality Objectives for the project.

Before sampling, a decision must be made whether to test the material:

- in-situ (in-place),
- as bagged samples (or for sludge, in cups) with a minimum of preparation, or

- in an XRF cup after preparation as described in Section 5.4.

If the primary objective of the sampling event is to determine whether an element is present (rather than in accurately measuring how much is present), in-situ or bagged samples are the quickest, simplest way to proceed. (Note: Preparing a sample by drying, milling and sieving will yield greater accuracy.) Even if the objective is to collect samples and prepare them prior to analysis, preliminary direct measurements can help to survey the site.

4.2 EQUIPMENT

Equipment required for this SOP may include:

- **XRF** - Niton XL-722S X-Ray Fluorescence Spectrum Analyzer
 - a) XRF
 - b) Battery packs and charger
 - c) Test guard
 - d) Sample platform
 - e) Standards
 - f) Optical pen
 - g) Grinder
 - h) Mortar and pestle
 - i) various size sieves
- **Sampling implements** - This includes shovels, Geoprobe® soil boring system, dredges, etc, as outlined in the site specific sampling plan. Please refer to the following MEDEP/DR SOPs for using this equipment:
 - DR#004 - Sampling Surface Water and Sediment
 - DR#006 - Soil Sampling
- **Sample containers** – Whirl pack bags, zipper locking bags or sample cups.
- **Radiation dosimeter** – must be worn by anyone using the XRF.

4.3 GENERAL INFORMATION

4.3.1 Radiation Sources

The DR's XRF contains 2 radiation sources Cd_{109} and Am_{241} . The Cd source detects the following elements: Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Pb, Hg, Rb, Sr, Zr, and Mo. The Am source detects the following elements: Cd, Ag, Ba, Sn, and Sb. To analyze for all of the elements listed above two readings with the XRF must be performed, one with each source.

4.3.2 Radiation License and Training Requirements

The DR's XRF is licensed through the Department of Human Services Radiation Control Program. The DR's XRF is listed on the DHS's Lead Prevention Program's license. This license is located at the Division of Solid Waste's Asbestos and Lead Unit's Radiation Safety Coordinators desk. Further information regarding the radiation license and its requirements are also located with the license. Only staff who have completed radiation training and are issued a

radiation dosimeter badge may use the XRF. Additionally, staff using the XRF must have 2 days of supervised field use (within the last 6 months) by approved DR or Division of Technical Services staff. A current list of approved supervisors and users will be maintained by the RSO.

4.3.3 Detection Limits

An element will only be shown as detected by the XRF if the measured concentration of the sample is at least three times the standard deviation of the measurement. This detection limit will depend on the composition of the sample.

Detection limits depend on several factors, the analyte of interest, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. For more of an explanation of detection limits see Attachment A "EPA Method 6200". Detected elements are displayed as in the Measurement screen. Non-detected elements are shown as $< \mathbf{xx}$, where $\mathbf{xx}$ is the detection limit for that sample. The detection limit for each element is calculated from each sample.

4.3.4 Interferences

Physical matrix interferences result from variations in the physical character of the sample. These variations may include such parameters as particle size, uniformity, homogeneity, and surface condition.

Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by drying the samples in a convection or toaster oven.

Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

Chemical matrix effects result from differences in the concentrations of interfering elements. These effects occur as either spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena.

When present in a sample, certain x-ray lines from different elements can be very close in energy and, therefore, can cause interference by producing a severely overlapped spectrum.

Ambient temperature changes can affect the gain of the amplifiers producing instrument drift. Gain or drift is primarily a function of the electronics (amplifier or preamplifier) and not the detector as most instrument detectors are cooled to a constant temperature. Most XRF instruments have a built-in automatic gain control. If the automatic gain control is allowed to make periodic adjustments, the instrument will compensate for the influence of temperature changes on its energy scale. If the XRF instrument has an automatic gain control function, the

operator will not have to adjust the instrument's gain unless an error message appears. If an error message appears, the operator should follow the manufacturer's procedures for troubleshooting the problem. Often, this involves performing a new energy calibration.

4.3.5 Precision

The measurement precision for each element displayed appears to the right of the measured concentration, under the heading "+-". The **precision** of each measurement is two times the standard deviation (sigma). An element is classified **detected** if the measured concentration (in ppm) is at least 1.5 times the precision.

4.3.6 Maintenance

If there are any problems with how the XRF is working, stop using the instrument and report the problem to the DR's SASS. **Do not attempt to fix the XRF yourself.** Opening the instrument may expose the user to the radiation source and will void the warrantee.

4.4 PROCEDURE FOR OPERATING THE NITON XL-722S XRF

Refer to the attached Niton Users Guide for additional information and figures showing the features of the instrument (Attachment B).

4.4.1 To turn on the XRF depress and slide the *On/Off* switch on the bottom of the instrument to the on position. If the instrument does not turn on immediately, turn it off, wait a few seconds and turn it on again. The Main menu should appear.

If the optical pen is going to be used, this needs to be attached prior to turning the XRF on.

4.4.2 There are three buttons on the control panel that are used to navigate through all of the XRF screens and menus. To select a function press the Clear/Enter button for the function indicated on the screen with an arrow. When the instrument is turned on the arrow will point to *Calibrate & Test*. Leave the instrument on for at least 15 minutes prior to using to allow the XRF to warm up and equilibrate to the surrounding environment.

4.4.3 From the main menu select *Setup Menu* from here the sample mode can be selected. The DR's Niton XL-722S is only capable of analyzing in *Test Soil, Bulk Samples*. The XRF will automatically be set to the last mode used, so this should not have to be changed.

Other functions that are accessed from this menu include: setting the date and time, checking the strength of the sources, illuminating the screen and viewing the instrument specifications. For further information on using these functions, refer to Attachment B.

THE DATE AND TIME MUST BE CORRECT BEFORE USING THE XRF.

Select *Exit to Main Menu* to return to the *Main Menu*.

4.4.4 Select *Calibrate & Test* and press Clear/Enter to begin the self calibration. After the XRF beeps, the calibration is complete and the instrument is ready for use.

Check the XRF's calibration with testing standards before using the XRF to analyze samples, using standards that are closest to the levels of elements that are expected onsite. Recheck the standards at least once per hour during testing and after analysis has been completed for the day.

5.0 SAMPLING AND ANALYSIS PROCEDURE

EPA Method 6200 Field Portable X-Ray Fluorescence spectrometry for the determination of elemental concentrations in soil and sediment (Attachment A) provides additional information regarding acceptable testing procedures and may be used in place of the procedure described below.

5.1 IN-SITU ANALYSIS

5.1.1 Clear the area selected for analysis of any surface debris or vegetation. Level the area so the XRF will contact the area evenly. Keep in mind that a finer and more homogeneous material will yield more accurate the results. Increased accuracy can be obtained by loosening the soil and letting it dry in the sun before testing.

5.1.2 Place the test guard on ground being careful to keep the top of the test guard clean.

5.1.3 Hold the XRF in one hand keeping your hand behind the end plate. Make sure there are no people (including yourself) in the pathway of the radiation source.

Warning: Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring. Never point the NITON at yourself or anyone else when the shutter is open.

5.1.4 Push the safety slide out from under the shutter release. If the slide is still engaged the shutter release will not depress and the instrument will not fit on the test guard correctly.

5.1.5 Place the XRF on the test guard so that the rectangular opening on the test guard is under the window of the XRF, squeeze the shutter release, and firmly press the instrument flat against the surface of the test guard. If the shutter release is not completely pressed, the plunger will not depress. If the plunger is not fully depressed, the window is not fully open and the XRF cannot measure accurately. The back of the unit must be flush with the test guard. The shutter release does not need to be held continuously during the measurement. Hold the XRF tightly against the test guard to maintain the reading. Once the XRF is lifted the plunger will fall back and the shutter will close; this will end the reading. In the event that the plunger sticks in the open position simply push it down. If problems persist stop using the instrument and report any problems to the DR's SASS.

5.1.6 Watch the display screen results to decide when the test has reached the desired level of accuracy. A typical screening test will last 30-60 source seconds.

5.2 IN-SITU DEPTH PROFILING

An in-situ XRF soil test examines only the top millimeter or so of soil. To profile the depth of contamination, remove a vertical slice of soil and test several samples from different depths.

5.3 ANALYSIS OF BAGGED SOLID SAMPLES

Sometimes it is convenient for screening a site to collect samples in plastic bags and analyze them without preparation. Because samples are tested through a bag, test results will tend to be 5-10% lower than test results obtained from direct analysis.

5.3.1 Place 50-100 grams of sample in a clean whirl pack or zipper locking bag. Remove any large stones or debris. Keep in mind that finer and more homogeneous material will yield more accurate results. Increased accuracy can be obtained by letting the sample dry in the sun before testing. Mix the sample thoroughly by kneading the bag.

The accuracy of measurements will be limited by the thickness of the plastic in the bag used. 1 mil-thick polyethylene bags offer a reasonable compromise between accurate readings and bag durability.

5.3.2 Flatten the bag of soil to form a continuous uniform layer of at least 1 cm. (0.4 inch) thickness. Place the NITON test guard flat against the bag. **Do not hold bagged samples in your hand during testing.**

5.3.3 Hold the XRF in one hand keeping your hand behind the end plate. Make sure there are no people (including yourself) in the pathway of the radiation source.

Warning: Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring. Never point the NITON at yourself or anyone else when the shutter is open.

5.3.4 Push the safety slide out from under the shutter release. If the slide is still engaged the shutter release will not depress and the instrument will not fit on the test guard correctly.

5.3.5 Place the XRF on the test guard so that the rectangular opening on the test guard is under the window of the XRF, squeeze the shutter release, and firmly press the instrument flat against the surface of the test guard. If the shutter release is not completely pressed, the plunger will not depress. If the plunger is not fully depressed, the window is not fully open and the XRF cannot measure accurately. The back of the unit must be flush with the test guard. The shutter release does not need to be held continuously during the measurement. Hold the XRF tightly against the test guard to maintain the reading. Once the XRF is lifted the plunger will fall back and the shutter will close this will end the reading. In the event that the plunger sticks in the open position simply push it down. If problems persist stop using the instrument and report any problems to the DR's SASS.

5.3.6 Watch the display screen results to decide when the test has reached the desired level of accuracy. A typical screening test will last 30-60 source seconds.

5.4 ANALYSIS OF PREPARED SAMPLES

Prepared sample analysis is the most accurate method for determining the concentration of elements in a solid media. Sample preparation minimizes the effects of moisture, large particle size and variations in particle size.

NITON recommends a specific sample protocol. Following this protocol for preparing and testing samples is vital for achieving a level of accuracy comparable with laboratory results. See Attachment B Figure 3.06 for a flow chart of the protocol. The following method is a slight modification of that method.

5.4.1 Collect 50-100 grams of sample to insure that there is enough sample to be representative and unbiased after mixing, grinding, and sieving it.

5.4.2 Place the sample in a clean bowl and mix the sample thoroughly by stirring and by rotating the bowl. Gently break up any dirt clods. Don't shake the sample because the sample may become stratified by weight.

5.4.3 If the sample is moist it should be dried. To best prepare a sample for analysis the material should be dry and well homogenized. Ideally, the entire sample should be dried to constant weight, sieved to remove gravel and debris, and ground or milled to a fine powder.

The sample can be dried in several ways:

- Oven dry the sample for approximately 2 hours at 150° C., until the sample reaches a constant weight;
- air dry the sample overnight at room temperature in a shallow pan;
- gently stir and warm the sample in a pan over a hot plate or burner.

Oven, hot plate or burner drying is inappropriate when volatile compounds may be present in the sample. For example, lead present as tetraethyl lead would be driven off by the heat of drying. Some forms of mercury and arsenic are volatile. If mercury is to be analyzed the sample must be air dried.

5.4.4 Sieve the dried sample with the #10 (2mm) mesh and separate out the larger pieces (stones, organic matter, metallic objects).

5.4.5 Grind the sample with a mortar and pestle or electric grinder the soil particles are finer and more homogenous.

5.4.6 Sieve at least 10 grams of the sample through #60 (250 um) and #120 (125 um) mesh. Re-grind the unpassed material until the required fraction is able to pass. Mix the resulting sample.

5.4.7 Place the sample in a sample cup. To assemble a sample cup: 1) place a circle of mylar film on top of an XRF sample cup. The window goes on the end of the cup with the indented ring. 2) Secure the film with the collar. The flange inside the collar faces down and snaps into

the indented ring of the cup. Inspect the installed film window for continuity and smooth, taut appearance. 3) Set the cup, window-side down, on a flat surface. Fill it with at least three grams of the prepared sample (no more than half-full). Take care that there are no voids or layering. 4) Placing the cup film-side down on a flat surface, tamp the sample into the cup. 5) Fill the cup with polyester fiber stuffing to prevent sample movement. Use aquarium filter or pillow filling as stuffing. A small supply of stuffing comes with the bulk sample kit. 6) Fasten the cap on the cup.

5.4.8 Place the sample cup in the receptacle of the sample test platform. Included in the kit are some foam disks that can be put in the receptacle under the cup for firmer contact between the XRF and the sample cup window. Attach the XRF to the test stand. Make sure there are no people (including yourself) in the pathway of the radiation source.

Warning: Always treat radiation with respect. Do not put your hand on the end plate of the NITON while measuring. Never point the NITON at yourself or anyone else when the shutter is open.

5.4.9 Push the safety slide out from under the shutter release. If the slide is still engaged you cannot press in the shutter release and the instrument will not fit on the test platform correctly.

5.4.10 Place the XRF on the test platform so that the window of the XRF is over the sample cup, squeeze the shutter release, and firmly press the instrument flat against the surface of the test guard. If the shutter release is not completely pressed, the plunger will not depress. If the plunger is not fully depressed, the window is not fully open and the XRF cannot measure accurately. The back of the unit must be flush with the test guard. The shutter release does not need to be held continuously during the measurement. Hold the XRF tightly against the test guard to maintain the reading. Once the XRF is lifted the plunger will fall back and the shutter will close; this will end the reading. In the event that the plunger sticks in the open position simply push it down. If problems persist stop using the instrument and report any problems to the DR's SASS.

5.4.11 Watch the display screen results to decide when the test has reached the desired level of accuracy. A typical screening test will last 30-60 source seconds.

5.5 DOWNLOADING DATA FROM THE XRF

5.5.1 Downloading Data

The DR's XRF stores up to 1,000 measurements plus their spectra. This can be downloaded to a computer for reporting or insertion in a database.

Note: Downloading data does not erase readings. To make room for the next set of data, erase readings after verifying that the data was downloaded successfully (see next section).

See Attachment B for directions on downloading data.

5.5.2 Erasing readings

If you do not erase your data, the NITON will continue to record data until the memory is completely full. Then the NITON will start to overwrite older data. Any data that is overwritten in this way will be lost. Download your data before the memory is completely full. Clear the memory after downloading.

6.0 DECONTAMINATION

Decontamination of equipment will follow the MEDEP RWM-DR-017 - "Decontamination Procedures Protocol". Additionally the following methods may be used in the field:

The mortar, pestle, and grinding mill may be cleaned with dry paper towels. Water will also clean the mortar, pestle, and the mill's container, but be sure each is absolutely dry before they are used for another sample. The mortar and pestle may be cleansed by grinding clean dry sand in the mortar. Use the short bristle brushes (included in the Bulk Testing Kit) to clean the sieves.

7.0 CHAIN OF CUSTODY

For confirmatory samples that are submitted to a fixed laboratory, procedures for chain of custody outlined in MEDEP/DR SOP RWM-DR-012 - "Chain of Custody" must be followed.

8.0 DOCUMENTATION

All sampling activities must be documented as outlined in MEDEP/DR SOP RWM-DR-013 – "Documentation of Field Activities and Development of a Trip Report". Each sample location will be given a unique sample number. This number will be entered into the XRF with the optical pen and or recorded in the field notes. If no number is entered into the XRF, the default number shown on the XRF screen for that sample will be recorded in the field notes.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 QUALITY ASSURANCE SAMPLES

Depending on the DQO's for a project the following QA samples may be collected. Any QA sample analyzed will be documented in field notes or in a written report. Calculations for QA samples will also be documented and if QA samples are re analyzed the results of will be documented.

9.1.1 Energy Calibration Check

To determine whether the XRF is operating within resolution and stability tolerances, an energy calibration check should be run. The energy calibration check determines whether the characteristic x-ray lines are shifting, which would indicate drift within the instrument. This check also serves as a gain check in the event that ambient temperatures are fluctuating greatly (> 10 to 20deg.F). Generally, this is run at the beginning of each working day, after the batteries are changed or the instrument is shut off, at the end of each working day, and at any other time when the instrument operator believes that drift is occurring during analysis.

9.1.2 Blank Samples:

Two types of blank samples should be analyzed for XRF analysis: instrument blanks and method blanks. An instrument blank is used to verify that no contamination exists in the spectrometer or on the probe window.

9.1.2.1 Instrument Blank

An instrument blank can be silicon dioxide, a Teflon block, a quartz block, "clean" sand, or lithium carbonate. This instrument blank should be analyzed on each working day before and after analyses are conducted and once per every twenty samples. An instrument blank should also be analyzed whenever contamination is suspected by the analyst. The frequency of analysis will vary with the data quality objectives of the project.

9.1.2.2 method blank

A method blank is used to monitor for laboratory-induced contaminants or interferences. The method blank can be "clean" silica sand or lithium carbonate that undergoes the same preparation procedure as the samples. A method blank must be analyzed at least daily. The frequency of analysis will depend on the data quality objectives of the project. To be acceptable, a method blank must not contain any analyte at a concentration above its method detection limit. If an analyte's concentration exceeds its method detection limit, the cause of the problem must be identified, and all samples analyzed with the method blank must be reanalyzed.

9.1.3 Calibration Verification Checks

A calibration verification check sample is used to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest. A check sample should be analyzed at the beginning of each working day, during active sample analyses, and at the end of each working day. The frequency of calibration checks during active analysis will depend on the data quality objectives of the project. The check samples used by the DR will be NIST or other SRM that contains the analytes of interest. These will verify the accuracy of the instrument. The measured value for each target analyte should be within ± 20 percent (%D) of the true value for the calibration verification check to be acceptable. If a measured value falls outside this range, then the check sample should be reanalyzed. If the value continues to fall outside the acceptance range, the instrument should be re-calibrated, and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

9.1.4 Precision Measurements

The precision of the method is monitored by analyzing a sample with low, moderate, or high concentrations of target analytes. The frequency of precision measurements will depend on the data quality objectives for the data. A minimum of one precision sample should be run per day. Each precision sample should be analyzed 7 times in replicate. It is recommended that precision measurements be obtained for samples with varying concentration ranges to assess the effect of concentration on method precision. A precision sample is analyzed by the instrument for the same field analysis time as used for other project samples. The relative

standard deviation (RSD) of the sample mean is used to assess method precision. For FPXRF data to be considered adequately precise, the RSD should not be greater than 20 percent with the exception of chromium. RSD values for chromium should not be greater than 30 percent.

The equation for calculating RSD is as follows: $RSD = (SD/Mean\ Concentration) \times 100$
where: RSD = Relative standard deviation for the precision measurement for the analyte
SD = Standard deviation of the concentration for the analyte, Mean Concentration = Mean concentration for the analyte.

9.1.5 Confirmatory Samples:

The comparability of the XRF analysis is determined by submitting XRF-analyzed samples for analysis at a laboratory. The method of confirmatory analysis must meet the project and XRF measurement data quality objectives. The confirmatory samples must be splits of the well homogenized sample material. In some cases the prepared sample cups can be submitted. A minimum of 1 sample for each 20 XRF-analyzed samples should be submitted for confirmatory analysis. This frequency will depend on data quality objectives. The confirmatory analyses can also be used to verify the quality of the XRF data. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the XRF. They should also include samples with analyte concentrations at or near the site action levels. Acceptance criteria for comparison of field and lab samples will be 20% difference of sample results or stated in the site specific QAPP or sampling plan. If the acceptance criteria is exceeded the project manager will evaluate the results to determine if they meet the data quality objectives for the project. If the data quality objectives are not met samples will be re-run or collected again for analysis.

9.2 DEVIATIONS FROM SOPS

All deviations from the procedures outlined in this or in any other SOPs followed for XRF sampling must be documented in field notes.

10. REFERENCES

NTION Corporation XL-309 & 700 Series Users Guide Version 5.0 (HTML). 1993, 1994, 1995, 1996, 1997, 1998.

EPA Method 6200 Field Portable X-Ray Fluorescence Spectrometry For the Determination of Elemental Concentrations in Soil and Sediment.

Attachment A

EPA Method 6200 Field Portable X-Ray Fluorescence Spectrometry For the Determination of Elemental Concentrations in Soil and Sediment.

ATTACHMENT B

NITON Corporation XL-309 & 700 Series Users Guide Version 5.0 (HTML). 1993, 1994, 1995, 1996, 1997, 1998.

THE USER'S MANUAL CAN BE FOUND IN WITH THE INSTRUMENT IN ITS STORAGE CASE, OR AT NITON.COM