QUALITY ASSURANCE PROJECT PLAN FOR THE FORMER SATRALLOY SITE JEFFERSON COUNTY, OHIO

PLAN

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1.0 PROJECT DESCRIPTION

This document is the Quality Assurance Project Plan (QAPP) for the Former Satralloy Site located in Cross Creek Township, Jefferson County, Ohio (the Site).

1.1 Background

The Site consists of approximately 333 acres of land and includes an abandoned ferrochromium alloy processing plant. The Site is located on County Road 74 in Cross Creek Township, Jefferson County, Ohio. Portions of the Site are bordered on the west, south, and east by Cross Creek, a perennial stream which discharges into the Ohio River.

Former processing facilities consisted primarily of two production mills (“Mill Buildings”), baghouses adjacent to the two Mill Buildings (for air pollution control during operation), ancillary support buildings, concrete bins used for unloading rail cars, an office building, a laboratory, a water supply plant, and a wastewater treatment plant. The alloys produced in the Mill Buildings were made from chromium ores by smelting and refining in electric-arc furnaces. Four furnaces and two converters were housed in the Mill Buildings. In addition to these structures in the “Plant Area,” piping used for disposing of by-products from the processing operations is present from the Mill Buildings to areas located in the upland areas north of the Mill Buildings. By-products were either pumped as slurry through this piping or were hauled in trucks to the “Ridge Top Area” and “Former Mine Area” of the uplands.

Byproducts of the ferroalloy plant operations included slag and baghouse dust from the electric arc furnaces. Baghouse dust from the electric arc furnaces is present beneath the baghouses and may be present in and around the Mill Buildings. An estimated 800,000 cubic yards of slag has been deposited across large tracts of both the upland and lowland areas of the Site. The upland area west of the Mill Buildings also includes a 5-acre area where chromite ore was stockpiled (Chromite Ore Storage Area) as part of the U.S. Government’s strategic mineral stockpile program.

Prior to the development of the Site in 1958, the predominant activities at the Site were agricultural in the lowlands adjacent to Cross Creek, and open cut and underground coal mining in the uplands. The remaining portions of the Site were heavily wooded and remain so to this day. In addition to the above activities, oil and gas drilling and exploration activities were also conducted at various locations across the Site and surrounding area. At least 23 oil and gas wells were bored on the Site, predominantly in the northern portion to the west of the town of Kolmont.

1.2 Scope and Objectives

This QAPP addresses activities associated with investigation and monitoring of soil, surface water, groundwater, sediment, biota, and other materials during the Remedial Investigation and Feasibility Study (RI/FS) and interim actions for the Site. The structure and contents of this QAPP are in compliance with the requirements of the Task 2, Section B of the Ohio Environmental Protection Agency (OEPA) *Generic Statement of Work – Remedial Investigation/ Feasibility Study – State Version* (OEPA 1998) and *EPA Requirements for Quality Assurance Project Plans,* EPA QA/R-5 (USEPA 2001). The QAPP is developed for use in conjunction with the *Remedial Investigation/Feasibility Study Workplan for the Former Satralloy Site* (Golder 2012).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Project Responsibilities and Assignments

Primary project responsibilities and assignments are as follows:

Ohio EPA Site Coordinator: Michael Sherron (740) 380-5251

The OEPA Site Coordinator will provide project oversight.

Cyprus Amax Project Manager: Ms. Barbara Nielsen, (602) 366-8270

The Cyprus Amax Project Manager has ultimate responsibility for project performance.

Golder Project Manager: Lee Holder, Golder Associates Inc., (425) 883-0777

The Golder Project Manager for the RI/FS coordinates the planning and implementation of the RI/FS Workplan action items, cost estimates, and scheduling. Golder's Project Manager is also responsible for executing decisions on field change requests.

Project QA Manager / Lead Analytical Chemist: Tom Stapp, Golder Associates Inc.

The Project QA Manager is responsible for preparation, update, and control of this QAPP and all supporting procedures. The Lead Analytical Chemist will be involved in project team activities for collection and handling of samples and coordination with analytical laboratories, data management and validation of data.

Biological Analysis QA Manager: Anne Thatcher, BBL / Arcadis

The Biological Analysis QA Manager is responsible for oversight and quality control of biological investigations and analyses. She will be involved in project team activities for collection and handling of biological samples and coordination with laboratories for biological analyses.

2.2 Field Personnel

Field personnel engaged in the collection of samples, the preparation of samples for field testing, and collection of field measurements will be required to have skills commensurate to standard procedures for acquisition of environmental quality samples. Field personnel will adhere to the requirements of Golder technical procedures, or other procedures authorized by the project manager or the Field Sampling Plan.

2.3 Laboratories

Chemical analyses will be performed by qualified commercial laboratories practiced in application of analytical methodologies from U.S. Environmental Protection Agency (USEPA) method manuals, Standard Methods for the Examination of Water and Wastewater, and other standard methods as applicable to the project needs (Methods anticipated are listed in Tables 1 through 12). The laboratory will have established procedures for applying these methods to soils, sediments, waste water, drinking water or other matrices as applicable to project needs. This will include standard operating procedures (SOPs), a Quality Assurance / Quality Control (QA/QC) Manual, participation in a national or regional accreditation program exhibiting compliance with performance evaluation standards, and established formats for data deliverables.

Although not a requirement for sites not in the Voluntary Action Program (VAP), a laboratory certified under the Ohio VAP will be used when practical. The laboratory often used to date for the Site has been the Test America laboratory in North Canton, Ohio. This laboratory is certified under Ohio VAP, and also under the National Environmental Laboratory Accreditation Program (NELAC).

3.0 SAMPLING PROCEDURES

Detailed, Site-specific sampling plans and procedures are specified in the RI/FS Workplan. Sampling for supplemental investigations may be added in other Site workplans. These workplans will specify sample locations, and analytical suites, sample handling procedures, and shipping methods. This section provides general QA/QC measures that will be used for sampling at the Site. Golder quality and technical procedures selected to support the RI/FS Workplan activities are listed in the Field Sampling Plan.

3.1 Chain of Custody

Formal chain of custody will be implemented as standard procedure to record sample sets, collection date/ times, and applicable analytical methodology. Chain-of-custody forms will be completed for each shipment of samples to a laboratory. The analyses requested for each sample will be identified by USEPA or Standard Methods method number citation on the chain-of-custody forms. Shipping documents and 'sample condition on receipt' forms will be maintained by the laboratory for each shipment of samples and included to the laboratory final report.

3.2 Surface Water Collection

Sample containers, container preparation services, preservatives, equipment trip blanks, temperature blank, and sample coolers will be provided by the analytical laboratory. Total and dissolved metal loss from aqueous samples due to adsorption on storage containers will be avoided by using polyethylene or similar containers and acidifying the solution to the proper pH. Sample container type, volume requirements, and preservation requirements are listed by analytical category in Table 15.

Each sample will be sealed and labeled with a unique location identification, along with analytical method, and date, and submitted to the analytical laboratory. Field quality control samples will be collected and analyzed as specified in Section 7.

3.3 Groundwater Collection

Groundwater collection will be performed as specified in the applicable workplan. Well water sampling procedures will be performed to ensure protection of reporting limit requirements listed in Tables 1, 2 and 4 through 6. All samples will be handled in conformance with the applicable procedures specified in this QAPP. Sample container type, volume requirements, and preservation requirements are also listed by analytical category in Table 15.

3.4 Hexavalent Chromium in Water

Hexavalent chromium (Cr^{+6}) may be reduced to trivalent chromium (Cr^{+3}) on some filtering media, particularly at low concentrations, and under acidic conditions. Teflon filters and alkaline solution are most suitable to prevent this reduction. Table 15 provides guidance on sample handling and preservation of water samples in the field for eventual Cr^{+6} testing.

3.5 Surface and Subsurface Soil Collection

Soil collection may include area wide characterizations of near surface and deeper soils, test pile soils, slag pile soils, bag-house accumulations, and over-bank soils and sediments in area water bodies. Soils and in-stream sediments will be collected as specified in the RI/FS Workplan. Analytical procedures will be performed to meet reporting limits as specified in Tables 7, 8, and 10 through 12. Samples that are to be analyzed in the field using x-ray fluorescence (XRF) will be handled and processed using standard procedures, and as cited in EPA Method 6200. Soil sampling procedures will be performed to ensure adherence to the required detection limits. Confirmation samples for the XRF field testing, if employed, will be selected at a frequency of at least 5% for chemical analysis by a qualified laboratory.

3.6 Biological Sampling

Any biological field sampling will be conducted under the supervision of an OEPA approved biologist. Biocriteria sampling may involve macroinvertebrate surveys, fish community surveys, and/or a qualitative habitat assessment. Sampling and analysis protocols are listed in *OEPA Biological Criteria for the Protection of Aquatic Life*, Volumes 1 and 2 (OEPA 1988) and Volume 3 (OEPA 1989), and *The Qualitative Habitat Evaluation Index* (OEPA 1989).

Macroinvertebrate survey samples will be collected using methods such as artificial substrates, sweep net, and grab samplers. The samples will be preserved in the field and sent to a qualified laboratory for sorting and taxonomic identification to the lowest practical taxonomic level (typically genus/species). Ten percent of the samples will be checked for representative invertebrate removal from the sediment/benthic matrix (must be >95% correct) and counting and identification (must be >95% Similarity Index correct). Fish community surveys will be conducted following OEPA protocols using electrofishing gear. Fish will be identified and counted in the field, and voucher specimens will be collected as necessary and/or photographs will be taken for later verification as needed. Aquatic habitat assessments will be conducted by visual observation following OEPA protocols.

3.7 Procedure Change Control

Variations from established technical procedure requirements may be necessary in response to unforeseen field conditions or other unique circumstances. All such variations will be documented on a Field Change Request (Appendix A), including a description of and justification for the change. The FCR will be approved by the Cyprus Amax and Golder Project Managers. All subcontractors will be subject to this directive when associated with sample locating, frequency of sample collection, sample handling and storage, or laboratory method. The Golder Project Manager may authorize field personnel to initiate changes immediately, provided the FCR is submitted for formal approval within one working day of its initiation.

4.0 CALIBRATION PROCEDURES

4.1 Field Calibration Requirements

Calibration of all measuring and test equipment used for the RI/FS will be controlled as required by manufacturers' instruction documentation. Rental equipment will require certifications or other documentation demonstrating acceptable calibration status for the period of use applicable to the project. Field calibration requirements will be in compliance with the manufacturer's instructions issued with the equipment and per the requirements listed in Table 17. Documentation of standard response for each instrument will be recorded on a daily basis in the field sample notebook. At a minimum, each field instrument will have a documented initial calibration record. Also, continuing calibration checks will be applied at least as often as once before the sampling and monitoring period and once after. Standards associated with all calibration procedures will be traceable to National Institute of Standards (NIST) quality, or other appropriate standard as provided by the rental supplier or instrument manufacturer.

4.2 Laboratory Calibration Requirements

Calibration of analytical laboratory equipment will be in accordance with the laboratory's internal procedures, which are subject to approval by Golder. The Quality Assurance document provided by the current contract laboratory will be made available to Golder before analyses will be performed, to assure proper QA/QC requirements are applied to analytical methods requested. These QA/QC specifications are at least as stringent as USEPA's *Contract Laboratory Program National Functional Guidelines for Superfund Inorganic Data Review*, (USEPA, 2010a) and USEPA's *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, (USEPA 2008). However, surrogate recovery, matrix spike/ matrix spike duplicate recovery, laboratory control sample recovery, and relative percent difference (RPD) specific control limits will be as applied by the contracted laboratory, as long as the laboratory can demonstrate that annual or more frequent studies are performed on the instruments involved in sample analysis for the purpose of establishing appropriate control limits for the measurement. Therefore, calibration checks will be monitored and held to the standard applied during the data validation task.

General chemistry parameters are not strictly subject to Data Validation Functional Guidelines, however acceptance criteria are subject to standard QA/QC specifications. These criteria and others are in substantial agreement with QC criteria applied to inorganic metal analysis, as found in the National Functional Guidelines, and the discretion of the data validator will be applied when reviewing general chemistry parameters and in recognizing qualified data.

5.0 ANALYTICAL PROCEDURES

The test methods employed by the laboratory are associated standard methods and are subject to interpretation by the laboratory through standard operating procedures (SOPs), or method recommendations. Substantial changes to analytical methods and extraction procedures will be identified by the laboratory before being applied to a new sample batch, and communicated in writing to the Golder QA manager. The change must be approved by the Golder Project Manager.

Laboratory standard operating procedures (SOP) are maintained by the commercial laboratories at their headquarter offices and are available for review upon request.

5.1 Analytical Methods

Parameters in soils and water will be analyzed using analytical methods as defined in Test Methods for Evaluating Solid Waste (USEPA 2007a), Methods for Chemical Analysis of Water and Waste (USEPA 1983), and Standard Methods for the Examination of Water and Wastewater, (SM 2007). Soil and sediment field monitoring actions may include use of X-Ray Fluorescence (XRF) using guidelines from USEPA Method 6200 (USEPA 2007b).

Screening levels are presented in Table 13 for water and Table 14 for soil. Laboratory detection limit capabilities for water are compared to USEPA Regional Screening Level (RSLs; USEPA 2012), Ohio VAP Rule #8 Generic Numeric Standards, and Ohio EPA Division of Surface Water Quality Standards. Laboratory detection limit capabilities for soil are compared to the RSLs, Ohio VAP residential soil direct contact, and the Ohio Division of Emergency & Remedial Response Sites (Non-VAP).

Asbestos testing of building components will employ USEPA Method 600/R-93/116 Polarized Light Microscopy (PLM) for bulk samples, possibly including the USEPA Point Count method. Periodic ambient air sampling will employ NIOSH Method 7402 which uses transmission electron microscopy (TEM) analysis for asbestos clearance testing of ambient air (see Table 9).

Biological testing will use sampling and testing methods from the OEPA Biological Criteria for the Protection of Aquatic Life, Volumes 1 and 2 (OEPA 1988) and Volume 3 (OEPA 1989), and The Qualitative Habitat Evaluation Index (OEPA 1989).

5.2 Field Testing

Water monitoring actions will include field analysis as necessary for field parameters pH, conductivity, oxidation-reduction, dissolved oxygen, turbidity and temperature. Quality control procedures for selected field testing parameters are provided in Table 17. RI/FS Workplan field testing for soil constituents will include the use, as necessary, of a portable X-Ray Fluorescent device to generate immediate screening data of selected metal elements. Other screening tools for targeted soil and water impacts, including colorimetric ‘kits’ may be employed as information is gained on the Site, however the selection of the screening tool will be determined at a later date.

5.3 Analytical Parameters

Potential analytes include those on the USEPA’s Target Compound List (TCL) for organics (SOM01.2; USEPA 2007c), and Target Analyte List (TAL) for metals (SOM01.2; USEPA 2010b), and general chemistry parameters. Summary lists of analytes associated with these references are provided in Tables 1 through 12. The actual analyses to be performed will be specified in the RI/FS Workplan (Golder 2012) and any subsequent workplans. Not all of the analytical methods or parameters listed in this QAPP will be used during the RI/FS.

5.4 Analytical Data Quality

An objective of the field sampling activities is to provide analytical data that is of known and defensible quality. Analytical data quality objectives are described as follows:

- Precision: Analytical precision will be reported as required by the governing analytical method cited in the tables in this QAPP.
- Accuracy (Bias): Accuracy will be reported as required by the governing analytical method cited in the tables in this QAPP.
- Representativeness: Goals for sample representativeness are addressed in the applicable workplans with collection of sample materials appropriate for the investigation. In addition, the use of standard procedures for sample acquisition (see Section 3) will facilitate the collection of representative data.
- Completeness: Completeness is defined as the percentage of valid analytical determinations with respect to the total number of requested determinations in a given sample delivery group. The completeness goal is 90%.
- Comparability: Approved analytical procedures will require the consistent use of the reporting techniques and units specified by the analytical methods cited in Tables 1 through 12 in order to facilitate the comparability of data sets from sequential sampling rounds in terms of their precision and accuracy. Sample split analyses performed at an alternate laboratory to exhibit confirmatory results will be performed on an ‘as needed’ basis.
- Detection Limits (Reporting Limits): Goals for detection limits will be those provided by normal commercial environmental laboratories.

Tables 1 through 12 list analytical parameters and associated analytical method(s), laboratory minimum reporting limits (RLs), and precision and accuracy requirements. The RLs in these tables are those provided by the Test America laboratory in North Canton, Ohio.

It is desirable that detection limits be below the established cleanup levels or remediation goals for a site. However, Site-specific remediation goals have not yet been established for the Site. For reference, the detection limits in this QAPP are compared to selected screening levels in Tables 13 and 14. Quality control criteria for each target compound list and target analyte list parameters are provided in Tables 18 through 21.

6.0 DATA REDUCTION AND VALIDATION

6.1 Minimum Requirements for Laboratory Analytical Data Packages

All analytical data packages submitted by the analytical laboratory will include the following:

- “Sample condition on receipt” forms, copies of completed chain of custody documentation noting dates of sample receipt and shipping documentation, including identification of field sampling personnel and shipping personnel (or organization).
- Hard copy completed laboratory reports with summary receipt information, per sample analytical data with consistent units and reporting limits, identified analytical methods, testing dates, associated quality control batch identifier with run dates, and case narrative of special analytical procedures and problems.
- Electronic format (Excel or Access) analytical results for each sample containing the reduced results and reporting limits for all analytes/constituents requested in the chain of custody, request for analysis or purchase order.
- Analytical quality control results and summary documents for laboratory method blanks, duplicates, laboratory control samples, blank spike/blank spike duplicates, matrix spike/matrix spike duplicates, per sample surrogate recoveries, and serial dilutions.
- Summary calibration data for initial and continuing calibration actions performed on the date(s) of analysis, including initial calibration verification (ICV) and continuing calibration verification (CCV) check recoveries bracketing the period of analysis of all samples (inorganic, organic analyses, and general chemistry), ICP interference check standards (metals), balance checks (gravimetric analyses), and secondary check standards.
- Sample extraction and preparation data and methodology including dates of sample extraction and analysis.

All data packages for all analytical parameters will be reviewed and approved by the analytical laboratory's QA Officer prior to submittal for validation.

Data packages will include, as appropriate, data qualification codes applied to each individual analytical result deemed to have a detection limit anomaly, or quality control deficiency. The laboratory will summarize qualification code definitions within the laboratory report for each type of qualification applied.

6.2 General Data Validation Requirements

Data will be validated by Golder personnel, based on the applicable elements of the U.S. EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA 2010a), USEPA Contract Laboratory Program, *National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA 2008), and other applicable reference method requirements as appropriate. Data validation work will be performed in order to ensure that the laboratory has met all contractual requirements, all applicable reference method requirements, and has met the data quality objectives for the project (see Section 5.4). A sample delivery group may be interpreted as a single hard copy deliverable provided by the laboratory or, all samples listed on a chain of custody and associated with a single hard copy deliverable.

Data validation will include the evaluation of holding times, method validity, laboratory blanks, field blanks, duplicates, matrix spikes/matrix spike duplicates, laboratory control samples, calibration data (as applicable for the specified method), and any re-qualification of analytical results required as a result of the validation exercise.

The data validator will document all contacts made with the laboratory to resolve questions related to the data package. Validated data will be documented on a validation checklist by the validator, with a summary list of qualifications applied to the sample delivery group or individual sample results as appropriate. In some cases, data validation will be reviewed from forms generated with Automated Data Review (ADR) software that has been used in place of hand generated checklists. The final review, by the Quality Assurance manager will be applied to either the hand generated checklists or the ADR forms, with the end result being the appropriate application of data qualifiers to the sample delivery group or individual sample results as required. The validation checklist, laboratory contact documentation, copies of the laboratory sample concentration reports, and the as-reviewed laboratory data package will be routed to the data management specialist for entry to the project specific database. The validation checklist will also be routed to the Quality Assurance manager and the Golder Project Manager as necessary.

7.0 QUALITY CONTROL PROCEDURES

7.1 Water

Aqueous analytical samples will be subject to quality control measures in both the field and laboratory. The following minimum field quality control requirements apply to all water analyses.

- Field duplicate samples. Depending on the availability of sufficient sample quantities, field duplicates will be collected at a minimum of one duplicate for each period of sampling activity or one duplicate sample for each twenty field samples collected, whichever is more frequent. A ‘sampling activity period’ will be identified as one or more field personnel engaged in a specific time of sample collection when one method of sampling is used. Duplicate samples will be retrieved from the same sampling location using the same equipment and sampling technique, and will be placed into identically prepared and preserved containers. All field duplicates will be analyzed independently as an indication of gross errors in sampling techniques.
- Equipment blanks. Equipment blanks will consist of deionized distilled water washed through decontaminated non-dedicated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of non-dedicated sampling equipment decontamination procedures, and will be collected and analyzed at the same frequency as field duplicate samples, if non-dedicated sampling equipment is used.
- Trip blanks. Trip blanks consist of deionized distilled water added to a like container as those provided for typical samples. Preservative will be added from the same preservative ‘lot number’ to the containers when the trip blank is created in the laboratory clean room and will accompany a batch of samples shipped during a sampling activity or period. Trip blanks will be returned unopened to the laboratory, and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or Site conditions.

Appropriate documentation of the field quality control sample will be maintained in the field log, and identified by the assigned sample identification. The laboratory will provide internal quality control checks that meet the following minimum requirements:

- Matrix spike and matrix spike duplicate samples. Matrix spike and matrix spike duplicate samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage. Sufficient sample will be collected for a select sample location to be available for each sample delivery group (as determined in the field). Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations will be described in the laboratories analytical procedures. One sample will be spiked per analytical batch, or once every 20 samples, whichever is greater and will be represented as a unique field sample to the analytical laboratory.
- Laboratory quality control standard reference material (SRM). A quality control reference standard will be prepared from an independently acquired standard material at a concentration other than that used for calibration, but within the calibration range. The quality control SRM is analyzed after the initial calibration and before any samples are analyzed, and will be run with every analytical batch, or every 20 samples, whichever is greater. SRM are required as an independent check on analytical technique and methodology.

7.2 Soil and Sediments

The following quality control elements apply to soils and sediments submitted for laboratory chemical analysis:

- Field duplicate samples. Field duplicates will be collected at a minimum of one duplicate for each homogeneous soil type for each period of sampling activity or one duplicate sample for each twenty field samples collected, whichever is more frequent. A homogeneous soil type may have distinct characteristics that make it different from other samples and therefore would present a unique analytical data response. A 'sampling activity period' will be identified as one or more field personnel engaged in a specific time of sample collection when one method of sampling is used. Duplicate samples will be retrieved from the same sampling location using the same equipment and sampling technique, and will be placed into identically prepared and preserved containers. All field duplicates will be analyzed independently as an indication of soil matrix in-homogeneity or gross errors in sampling techniques.
- Equipment blanks. Equipment blanks will consist of pure deionized distilled water washed through decontaminated non-dedicated sampling equipment used to collect soils, and placed into an appropriate container for water rinsate analysis. Equipment blanks are used to verify the adequacy of non-dedicated sampling equipment decontamination procedures, and will be collected and analyzed at the same frequency as field duplicate samples, if non-dedicated sampling equipment is used.

The laboratory will provide internal quality control checks that meet the following minimum requirements:

- Matrix spike and matrix spike duplicate samples. Matrix spike and matrix spike duplicate samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage. Sufficient sample will be collected for a select sample location to be available for each sample delivery group (as determined in the field). Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations will be described in the laboratories analytical procedures. One sample will be spiked per analytical batch, or once every 20 samples, whichever is greater and will be represented as a unique field sample to the analytical laboratory.
- Laboratory quality control standard reference material (SRM). A quality control reference standard will be prepared from an independently acquired standard material at a concentration other than that used for calibration, but within the calibration range. The quality control SRM is analyzed after the initial calibration and before any samples are analyzed, and will be run with every analytical batch, or every 20 samples, whichever is greater. SRM are required as an independent check on analytical technique and methodology.

7.3 XRF Analysis

Solids analyzed in the field by X-Ray Fluorescence (XRF) have specific quality control criteria for sample processing techniques as well as analytical technique. Prior to project sample collection and field testing, a number of soil matrices will be selected to represent typical Site soils to determine the range of matrix types that exhibit interference potential in the Site soils. These soils will be analyzed at a qualified laboratory to create Site-specific calibration samples (SSCS). The SSCS will be used throughout the testing period to maintain precision and accuracy data for the project. XRF soil and sediment field monitoring actions will be done using guidelines from USEPA Method 6200 (USEPA 2007b), and Golder Technical Procedure TP-2.2-13; *X-Ray Fluorescence Onsite Measurement* (Appendix B). A summary of guidelines for instrument QC procedures is provided in Table 22.

Specific sample handling requirements will be specified in the applicable Field Sampling Plan. At least 5 of XRF samples collected after the SCSS will be selected at random for chemical analysis at a qualified commercial laboratory at the end of the sampling event for analytical confirmation.

8.0 REFERENCES

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TABLES

TABLE 1

LABORATORY ANALYTICAL SPECIFICS / INORGANIC METAL ANALYTES / WATER

Parameter[a]	CAS Number	Method	Detection Reporting Limit	Method	Detection Reporting Limit	Precision	Accuracy
		Reference	(µg/L)	Reference	(µg/L)	RPD	% Recov.
Aluminum	7429-90-5	EPA 200.7	200	EPA 200.8	--	<20%	75-125%
Antimony	7440-36-0	EPA 200.7	60	EPA 200.8	2	<20%	75-125%
Arsenic	7440-38-2	EPA 200.7	10	EPA 200.8	1	<20%	75-125%
Barium	7440-39-3	EPA 200.7	200	EPA 200.8	10	<20%	75-125%
Beryllium	7440-41-7	EPA 200.7	5	EPA 200.8	1	<20%	75-125%
Cadmium	7440-43-9	EPA 200.7	5	EPA 200.8	1	<20%	75-125%
Calcium	7440-70-2	EPA 200.7	5000	--	--	<20%	75-125%
Chromium, Total	7440-47-3	EPA 200.7	10	EPA 200.8	2	<20%	75-125%
Chromium $^{6+}$	18540-29-9	EPA 7196A	20	--	--	<20%	80-120%
Cobalt	7440-48-4	EPA 200.7	50	EPA 200.8	1	<20%	75-125%
Copper	7440-50-8	EPA 200.7	25	EPA 200.8	2	<20%	75-125%
Iron	7439-89-6	EPA 200.7	100	--	--	<20%	75-125%
Lead	7439-92-1	EPA 200.7	10	EPA 200.8	1	<20%	75-125%
Magnesium	7439-95-4	EPA 200.7	5000	--	--	<20%	75-125%
Manganese	7439-96-5	EPA 200.7	15	EPA 200.8	1	<20%	75-125%
Mercury	7439-97-6	245.1	0.2	--	--	<20%	75-125%
Nickel	7440-02-0	EPA 200.7	40	EPA 200.8	1	<20%	75-125%
Potassium	9/7/7440	EPA 200.7	5000	--	--	<20%	75-125%
Selenium	7782-49-2	EPA 200.7	35	EPA 200.8	5	<20%	75-125%
Silver	7440-22-4	EPA 200.7	10	EPA 200.8	1	<20%	75-125%
Sodium	7440-23-5	EPA 200.7	5000	--	--	<20%	75-125%
Thallium	7440-28-0	EPA 200.7	25	EPA 200.8	1	<20%	75-125%
Vanadium	7440-62-2	EPA 200.7	50	EPA 200.8	1	<20%	75-125%
Zinc	7440-66-6	EPA 200.7	60	EPA 200.8	2	<20%	75-125%
Cyanide	57-12-5	SM 4500CN	10	--	--	<20%	75-125%

Note: a. Data from Table 8.2-10.2 of Laboratory Quality Manual for TestAmerica, North Canton, Ohio.

TABLE 2
LABORATORY ANALYTICAL SPECIFICS / GENERAL CHEMISTRY PARAMETERS / WATER

Parameter	Matrix	Method Reference	Detection Reporting Limit	Precision RPD	Accuracy % Recov.
Alkalinity	SW,GW	EPA 310.1	5 mg/l	<20%	90-127%
Ammonia	SW,GW	EPA 350.3	0.2 mg/l	<20%	85-114%
Bicarbonate	SW,GW	SM 2320	5 mg/l	<20%	80-120%
Carbonate	SW,GW	SM 2320	5 mg/l	<20%	80-120%
Hydroxide	SW,GW	SM 2320	5 mg/l	<20%	90-127%
Hardness	SW,GW	EPA 6010, by Calculation	33 mg/l as CaCO3	<20%	NA
Nitrate/Nitrite as N	SW,GW	EPA 353.2	0.1 mg/l	<20%	90-110%
Nitrate	SW,GW	EPA 300.0	0.1 mg/l	<20%	90-110%
Nitrite	SW,GW	EPA 300.0	0.1 mg/l	<20%	90-110%
Phosphate	SW,GW	SM 4500P	0.1 mg/l	<20%	89-115%
Fluoride	SW,GW	EPA 300.0	1 mg/l	<20%	90-110%
Chlorine	SW,GW	EPA 330.5	0.2 mg/l	<20%	75-125%
Chloride	SW,GW	EPA 300.0	1 mg/l	<20%	90-110%
Sulfate	SW,GW	EPA 300.0	1 mg/l	<20%	90-110%
COD	SW,GW	EPA 410.4	10 mg/l	<20%	90-110%
TOC	SW,GW	EPA 415.1	1 mg/l	<20%	88-115%
Sulfide	SW,GW	EPA 376.1	1 mg/l	<20%	79-104%
TDS	SW,GW	SM 2540 C	10 mg/l	<20%	88-110%
TSS	SW,GW	SM 2540 D	4 mg/l	<10%	73-113%

TABLE 3
LABORATORY ANALYTICAL SPECIFICS / FIELD DATA PARAMETERS / WATER

Parameter	Matrix	Method Reference	Detection Reporting Limit	Precision RPD	Accuracy % Recov.
pH	SW, GW	EPA 150.1	NA	<20%	± 0.1 pH
Temperature	SW, GW	EPA 170.1	NA	<20%	±0.5 deg C
Specific Conductance	SW, GW	EPA 120.1	NA	<20%	±10 mmhos/cm
Turbidity	SW, GW	EPA 180.1	NA	<20%	±1.0 NTU
Dissolved Oxygen	SW, GW	EPA 360.1	NA	<20%	±0.1 mg/l
Water Level	GW	--	--	--	--
Flow Rate	SW	USGS	NA	NA	±5%

TABLE 4
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Low Water (mg/L)	Precision RPD	Accuracy % Recov.
1,1,1-Trichloroethane	71-55-6	EPA 8260B	0.001	0% - 30%	74%-118
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B	0.001	0% - 30%	68%-118%
1,1,2-Trichloro,1,2,2-trifluoroethane	76-13-1	EPA 8260B	0.001	0% - 30%	74%-151%
1,1,2-Trichloroethane	79-00-5	EPA 8260B	0.001	0% - 30%	80%-112%
1,1,2-Trichloroethene (1,1,2-Trichloroethylene, Trichloroethene)	79-01-6	EPA 8260B	0.001	0% - 30%	76%-117%
1,1-Dichloroethane	75-34-3	EPA 8260B	0.001	0% - 30%	82%-115%
1,1-Dichloroethene	75-35-4	EPA 8260B	0.001	0% - 30%	78%-131%
1,2,3-Trichlorobenzene	87-61-6	EPA 8260B	0.001	0% - 30%	54%-126%
1,2,4-Trichlorobenzene	120-82-1	EPA 8260B	0.001	0% - 30%	48%-135%
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260B	0.002	0% - 30%	42%-136%
1,2-Dibromoethane, (EDB)	106-93-4	EPA 8260B	0.001	0% - 30%	79%-113%
1,2-Dichlorobenzene	95-50-1	EPA 8260B	0.001	0% - 30%	81%-110%
1,2-Dichloroethane, (EDC)	107-06-2	EPA 8260B	0.001	0% - 30%	71%-127%
1,2-Dichloropropane	78-87-5	EPA 8260B	0.001	0% - 30%	81%-115%
1,3-Dichlorobenzene	541-73-1	EPA 8260B	0.001	0% - 30%	80%-110%
1,4-Dichlorobenzene	106-46-7	EPA 8260B	0.001	0% - 30%	82%-110%
1,4-Dioxane[a]	123-91-1	EPA 8260B	0.2	0% - 50%	50%-150%
2-Hexanone	591-78-6	EPA 8260B	0.01	0% - 30%	55%-133%
4-Methyl-2-pentanone, (methyl isobutyl ketone)	108-10-1	EPA 8260B	0.01	0% - 30%	63%-128%
Acetone	67-64-1	EPA 8260B	0.01	0% - 30%	43%-136%
Benzene	71-43-2	EPA 8260B	0.001	0% - 30%	83%-112%
Bromochloromethane	74-97-5	EPA 8260B	0.001	0% - 30%	77%-120%
Bromodichloromethane	75-27-4	EPA 8260B	0.001	0% - 30%	72%-121%
Bromoform, (tribromomethane)	75-25-2	EPA 8260B	0.001	0% - 30%	40%-131%

TABLE 4 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method	Detection Reporting Limit Low Water (mg/L)	Precision RPD	Accuracy % Recov.
Bromomethane, (methylbromide)	74-83-9	EPA 8260B	0.001	0% - 30%	11%-185%
Carbon disulfide	75-15-0	EPA 8260B	0.001	0% - 30%	62%-142%
Carbon tetrachloride	56-23-5	EPA 8260B	0.001	0% - 30%	66%-128%
Chlorobenzene	108-90-7	EPA 8260B	0.001	0% - 30%	85%-110%
Chloroethane, (ethyl chloride)	75-00-3	EPA 8260B	0.001	0% - 30%	25%-153%
Chloroform	67-66-3	EPA 8260B	0.001	0% - 30%	79%-117%
Chloromethane, (methylchloride)	74-87-3	EPA 8260B	0.001	0% - 30%	44%-126%
cis-1,2-Dichloroethene	156-59-2	EPA 8260B	0.001	0% - 30%	80%-113%
cis-1,3-Dichloropropene	10061-01-5	EPA 8260B	0.001	0% - 30%	61%-115%
Cyclohexane	110-82-7	EPA 8260B	0.001	0% - 30%	54%-121%
Dibromochloromethane	124-48-1	EPA 8260B	0.001	0% - 30%	64%-119%
Dichlorodifluoromethane	75-71-8	EPA 8260B	0.001	0% - 30%	19%-129%
Ethylbenzene	100-41-4	EPA 8260B	0.001	0% - 30%	83%-112%
Isopropylbenzene	98-82-8	EPA 8260B	0.001	0% - 30%	75%-114%
Methyl acetate	79-20-9	EPA 8260B	0.01	0% - 30%	58%-131%
Methyl cyclohexane	108-87-2	EPA 8260B	0.001	0% - 30%	56%-127%
Methyl ethyl ketone, (2-butanone)	78-93-3	EPA 8260B	0.01	0% - 30%	60%-126%
Methyl tert butyl ether (MTBE)	1634-04-4	EPA 8260B	0.005	0% - 30%	52%-144%
Methylene chloride, (dichloromethane)	75-09-2	EPA 8260B	0.001	0% - 30%	66%-131%
Styrene	100-42-5	EPA 8260B	0.001	0% - 30%	79%-114%
Tetrachloroethylene, (tetrachloroethene), (PCE)	127-18-4	EPA 8260B	0.001	0% - 30%	79%-114%
Toluene	108-88-3	EPA 8260B	0.001	0% - 30%	84%-111%
trans-1,2-Dichloroethylene, (1,2-dichloroethene)	156-60-5	EPA 8260B	0.001	0% - 30%	83%-117%
trans-1,3-Dichloropropene	10061-02-6	EPA 8260B	0.001	0% - 30%	58%-117%
Trichlorofluoromethane	75-69-4	EPA 8260B	0.001	0% - 30%	49%-157%
Vinyl chloride	75-01-4	EPA 8260B	0.001	0% - 30%	53%-127%
Xylene(m-Xylene & p-Xylene)	1330-20-7	EPA 8260B	0.002	0% - 30%	83%-113%
Xylene(o-Xylene)	1330-20-7	EPA 8260B	0.001	0% - 30%	83%-113%

Note: a. Selected compound acceptance ranges are not provided by the laboratory, but are cited from National Functional Guideline (USEPA, 2008) validation criteria.

TABLE 5
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Low Water (mg/L)	Precision RPD	Accuracy % Recovery
1,1'-biphenyl	92-52-4	EPA 8270C	0.01	0% - 30%	50%-130%
1,2,4,5-tetrachlorobenzene[a]	95-94-3	EPA 8270C	0.01	0% - 50%	75%-125%
2,2'-oxybis (1-chloropropane)	108-60-1	EPA 8270C	0.01	0% - 30%	25%-128%
2,3,4,6-tetrachlorophenol[a]	58-90-2	EPA 8270C	0.05	0% - 50%	75%-125%
2,4,5-Trichlorophenol	95-95-4	EPA 8270C	0.01	0% - 30%	39%-110%
2,4,6-Trichlorophenol	88-06-2	EPA 8270C	0.01	0% - 30%	35%-110%
2,4,Dinitrophenol	51-28-5	EPA 8270C	0.05	0% - 30%	17%-112%
2,4-Dichlorophenol	120-83-2	EPA 8270C	0.01	0% - 30%	33%-110%
2,4-Dimethylphenol	105-67-9	EPA 8270C	0.01	0% - 30%	12%-110%
2,4-Dinitrotoluene	121-14-2	EPA 8270C	0.01	0% - 30%	52%-123%
2,6-Dinitrotoluene	606-20-2	EPA 8270C	0.01	0% - 30%	52%-119%
2-Chloronaphthalene, (beta-chloronaphthalene)	91-58-7	EPA 8270C	0.01	0% - 30%	39%-110%
2-Chlorophenol	95-57-8	EPA 8270C	0.01	0% - 30%	27%-110%
2-Methylnaphthalene	91-57-6	EPA 8270C	0.01	0% - 30%	35%-110%
2-Methylphenol, (o-Cresol)	95-48-7	EPA 8270C	0.01	0% - 30%	30%-110%
2-Nitroaniline	88-74-4	EPA 8270C	0.05	0% - 30%	43%-130%
2-Nitrophenol	88-75-5	EPA 8270C	0.01	0% - 30%	29%-110%
3,3'-Dichlorobenzidine	91-94-1	EPA 8270C	0.05	0% - 30%	19%-110%
3-Nitroaniline	99-09-2	EPA 8270C	0.05	0% - 30%	45%-116%
4,6-Dinitro-o-cresol,(4,6-Dinitro-2-methylphenol)	534-52-1	EPA 8270C	0.05	0% - 30%	28%-112%
4-Bromophenyl phenyl ether	101-55-3	EPA 8270C	0.01	0% - 30%	51%-114%
4-Chloroaniline	106-47-8	EPA 8270C	0.01	0% - 30%	10%-110%
4-Chlorophenyl phenyl ether	7005-72-3	EPA 8270C	0.01	0% - 30%	50%-115%
4-Methylphenol, (p-Cresol)	106-44-5	EPA 8270C	0.01	0% - 30%	32%-110%
4-Nitroaniline	100-01-6	EPA 8270C	0.05	0% - 30%	45%-120%
4-Nitrophenol	100-02-7	EPA 8270C	0.05	0% - 30%	12%-130%
Acenaphthene	83-32-9	EPA 8270C	0.01	0% - 30%	40%-110%
Acenaphthylene	208-96-8	EPA 8270C	0.01	0% - 30%	43%-110%
Acetophenone	98-86-2	EPA 8270C	0.01	0% - 30%	50%-130%
Anthracene	120-12-7	EPA 8270C	0.01	0% - 30%	54%-114%
Atrazine	1912-24-9	EPA 8270C	0.01	0% - 30%	50%-130%
Benzaldehyde	100-52-7	EPA 8270C	0.01	0% - 30%	10%-130%
Benzo(a)anthracene	56-55-3	EPA 8270C	0.01	0% - 30%	55%-115%

TABLE 5 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Low Water	Precision RPD	Accuracy % Recovery
Benzo(a)pyrene	50-32-8	EPA 8270C	0.01	0% - 30%	43%-116%
Benzo(b)fluoranthene	205-99-2	EPA 8270C	0.01	0% - 30%	43%-122%
Benzo(g,h,i)perylene	191-24-2	EPA 8270C	0.01	0% - 30%	45%-120%
Benzo(k)fluoranthene	207-08-9	EPA 8270C	0.01	0% - 30%	43%-124%
bis(2-chloroethoxy)methane	111-91-1	EPA 8270C	0.01	0% - 30%	39%-110%
bis(2-chloroethyl)ether	111-44-4	EPA 8270C	0.01	0% - 30%	34%-113%
bis(2-ethylhexyl)phthalate, (DEHP)	117-81-7	EPA 8270C	0.01	0% - 30%	36%-163%
Butyl benzyl phthalate	85-68-7	EPA 8270C	0.01	0% - 30%	53%-126%
Caprolactam	105-60-2	EPA 8270C	0.01	0% - 30%	50%-130%
Carbazole	86-74-8	EPA 8270C	0.01	0% - 30%	53%-120%
Chrysene	218-01-9	EPA 8270C	0.01	0% - 30%	55%-115%
Dibenz[a,h]anthracene	53-70-3	EPA 8270C	0.01	0% - 30%	46%-122%
Dibenzofuran	132-64-9	EPA 8270C	0.01	0% - 30%	46%-111%
Diethyl phthalate	84-66-2	EPA 8270C	0.01	0% - 30%	33%-134%
Dimethyl phthalate	131-11-3	EPA 8270C	0.01	0% - 30%	15%-143%
Di-n-butyl phthalate	84-74-2	EPA 8270C	0.01	0% - 30%	55%-122%
Di-n-octylphthalate	117-84-0	EPA 8270C	0.01	0% - 30%	44%-128%
Fluoranthene	206-44-0	EPA 8270C	0.01	0% - 30%	54%-122%
Fluorene	86-73-7	EPA 8270C	0.01	0% - 30%	47%-112%
Hexachlorobenzene	118-74-1	EPA 8270C	0.01	0% - 30%	51%-112%
Hexachlorobutadiene	87-68-3	EPA 8270C	0.01	0% - 30%	13%-110%
Hexachlorocyclopentadiene	77-47-4	EPA 8270C	0.05	0% - 30%	10%-110%
Hexachloroethane	67-72-1	EPA 8270C	0.01	0% - 30%	12%-110%
Indeno[1,2,3-cd]pyrene	193-39-5	EPA 8270C	0.01	0% - 30%	46%-121%
Isophorone	78-59-1	EPA 8270C	0.01	0% - 30%	44%-128%
Naphthalene	91-20-3	EPA 8270C	0.01	0% - 30%	31%-110%
Nitrobenzene	98-95-3	EPA 8270C	0.01	0% - 30%	37%-115%
N-Nitrosodi-n-propylamine	621-64-7	EPA 8270C	0.01	0% - 30%	37%-121%
N-Nitrosodiphenylamine	86-30-6	EPA 8270C	0.01	0% - 30%	53%-113%
p-Chloro-m-cresol, (4-chloro-3-methyl phenol)	59-50-7	EPA 8270C	0.01	0% - 30%	39%-110%
Pentachlorophenol	87-86-5	EPA 8270C	0.01	0% - 30%	26%-110%
Phenanthrene	85-01-8	EPA 8270C	0.01	0% - 30%	52%-114%
Phenol	108-95-2	EPA 8270C	0.01	0% - 30%	14%-112%
Pyrene	129-00-0	EPA 8270C	0.01	0% - 30%	55%-120%

TABLE 6
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST PESTICIDE / PCBs / WATER

Parameter	CAS Number	Method Reference	Detection Reporting Limit Water (ug/L)	Precision RPD	Accuracy % Recov.
4,4'-DDD	72-54-8	EPA 8081A	0.05	0% - 30%	53%-168%
4,4'-DDE	72-55-9	EPA 8081A	0.05	0% - 30%	66%-136%
4,4'-DDT	50-29-3	EPA 8081A	0.05	0% - 30%	42%-140%
Aldrin	309-00-2	EPA 8081A	0.05	0% - 30%	61%-127%
Alpha chlordane	57-74-9	EPA 8081A	0.05	0% - 30%	60%-134%
Alpha-BHC	319-84-6	EPA 8081A	0.05	0% - 30%	65%-132%
beta-BHC	319-85-7	EPA 8081A	0.05	0% - 30%	59%-134%
Delta-BHC	319-86-8	EPA 8081A	0.05	0% - 30%	45%-143%
Dieldrin	60-57-1	EPA 8081A	0.05	0% - 30%	61%-142%
Endosulfan I	959-98-8	EPA 8081A	0.05	0% - 30%	35%-110%
Endosulfan II	33213-65-9	EPA 8081A	0.05	0% - 30%	39%-110%
Endosulfan sulfate	1031-07-8	EPA 8081A	0.05	0% - 30%	54%-143%
Endrin	72-20-8	EPA 8081A	0.05	0% - 30%	57%-148%
Endrin aldehyde	7421-93-4	EPA 8081A	0.05	0% - 30%	44%-116%
gamma chlordane	57-74-9	EPA 8081A	0.05	0% - 30%	59%-139%
gamma-BHC, (lindane)	58-89-9	EPA 8081A	0.05	0% - 30%	58%-140%
Heptachlor	76-44-8	EPA 8081A	0.05	0% - 30%	60%-132%
Heptachlor epoxide	1024-57-3	EPA 8081A	0.05	0% - 30%	60%-138%
Methoxychlor	72-43-5	EPA 8081A	0.1	0% - 30%	45%-139%
Toxaphene[a]	8001-35-2	EPA 8081A	2	0% - 50%	75% - 125%
Endrin ketone	7421-93-4	EPA 8081A	0.05	0% - 30%	52%-135%
Aroclor 1016	12674-11-2	EPA 8082	1	0% - 30%	44%-119%
Aroclor 1221[a]	11104-28-2	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1232[a]	11141-16-5	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1242[a]	53469-21-9	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1248[a]	12672-29-6	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1254[a]	11097-69-1	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1260	11096-82-5	EPA 8082	1	0% - 30%	41%-118%
Aroclor 1262[a]	--	EPA 8082	1	0% - 50%	75% - 125%
Aroclor 1268[a]	--	EPA 8082	1	0% - 50%	75% - 125%

TABLE 7
LABORATORY ANALYTICAL SPECIFICS / INORGANIC METAL ANALYTES / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit[b] / SOLIDS mg/kg	Precision RPD	Accuracy % Recov.
Aluminum	7429-90-5	EPA 6010 B	20	<20%	80-120%
Antimony	7440-36-0	EPA 6010 B	6	<20%	80-120%
Arsenic	7440-38-2	EPA 6010 B	1[a]	<20%	80-120%
Arsenic, by XRF	7440-38-2	EPA 6200	100	<35%	75-125%
Barium	7440-39-3	EPA 6010 B	20	<20%	80-120%
Beryllium	7440-41-7	EPA 6010 B	0.5	<20%	80-120%
Cadmium	7440-43-9	EPA 6010 B	0.5	<20%	80-120%
Calcium	7440-70-2	EPA 6010 B	500	<20%	80-120%
Chromium, Total	7440-47-3	EPA 6010 B	1	<20%	80-120%
Chromium, by XRF	7440-47-3	EPA 6200	100	<35%	75-125%
Chromium $^{6+}$	18540-29-9	EPA 3060 / SM3500[c]	--	<20%	80-120%
Chromium $^{6+}$	18540-29-9	EPA 7196A	0.8	<20%	80-120%
Cobalt	7440-48-4	EPA 6010 B	5	<20%	80-120%
Copper	7440-50-8	EPA 6010 B	2.5	<20%	73-137%
Iron	7439-89-6	EPA 6010 B	10	<20%	80-120%
Lead	7439-92-1	EPA 6010 B	1[a]	<20%	80-120%
Magnesium	7439-95-4	EPA 6010 B	500	<20%	80-120%
Manganese	7439-96-5	EPA 6010 B	1.5	<20%	73-121%
Mercury	7439-97-6	7471 B	0.1	<20%	80-120%
Nickel	7440-02-0	EPA 6010 B	4	<20%	80-120%
Potassium	9/7/7440	EPA 6010 B	500	<20%	80-120%
Selenium	7782-49-2	EPA 6010 B	0.5[a]	<20%	80-120%
Silver	7440-22-4	EPA 6010 B	1	<20%	80-120%
Sodium	7440-23-5	EPA 6010 B	500	<20%	80-120%
Thallium	7440-28-0	EPA 6010 B	1[a]	<20%	80-120%
Vanadium	7440-62-2	EPA 6010 B	5	<20%	80-120%
Zinc	7440-66-6	EPA 6010 B	2	<20%	68-123%
Cyanide	57-12-5	EPA 9012	0.5	<20%	80-120%

Notes: a - Trace analytical method.
b - Data from Table 8.2-10.2 of Laboratory Quality Manual for TestAmerica, North Canton, Ohio.
c –Methodology for Slag samples.

TABLE 8
LABORATORY ANALYTICAL SPECIFICS DETAIL FOR SLAG / GENERAL CHEMISTRY PARAMETERS / SOLIDS

Parameter	Matrix	Method Reference	Detection Reporting Limit SOLIDS mg/kg	Precision RPD	Accuracy % Recov.
Carbonate	Slag	SM 2320	100 mg/kg	<20%	80-120%
Phosphate	Slag	SM 4500P	10 mg/kg	<20%	75-125%
Sulfate	Slag	EPA 300.0	10 mg/kg	<20%	90-110%
Total Sulfur[b]	Slag	ASTM / LECO	10 mg/kg	<20%	75-125%
XRD Minerology[b]	Slag	ASTM	- -	NA	NA

Note - Detection limit assumes 1:1 digestion/ extraction of slag using appropriate method.

TABLE 9
LABORATORY ANALYTICAL SPECIFICS / SUPPLEMENTAL TARGET ANALYTES / SOLIDS

Parameter	CAS Number	Method Reference	Matrix	Reporting Limit & Units SOLIDS	Precision RPD	Accuracy % Recov.	Notes
Asbestos	1332-21-4	OSHA (NIOSH Method #7402)	Ambient Air	AIR – 8hr. TWA 0.2 fiber/cm^3	At least 100 fibers counted	NA	Polarized Light Microscopy followed by TEM
As by XRF	7440-38-2	EPA 6200	Soil	100 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Ba by XRF	18540-29-9	EPA 6200	Soil	200 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Cd by XRF	18540-29-9	EPA 6200	Soil	50 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Cr by XRF	18540-29-9	EPA 6200	Soil	200 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Pb by XRF	18540-29-9	EPA 6200	Soil	10 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Hg by XRF	18540-29-9	EPA 6200	Soil	20 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Se by XRF	18540-29-9	EPA 6200	Soil	20 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Ag by XRF	18540-29-9	EPA 6200	Soil	200 mg/kg	35%	75–125%	Field portable X-Ray Fluorescence
Chromium VI	18540-29-9	EPA 7198	Water	10 ug/L	10%	75–125%	Field portable Differential Pulse Polarography

Note: Selected methods may be applied as specified in the governing sampling plan.

TABLE 10
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit SOLIDS ug/kg[a]	Precision RPD	Accuracy % Recov.
1,1,1-Trichloroethane	71-55-6	EPA 8260B	5	0% - 30%	77%-126%
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260B	5	0% - 30%	77%-123%
1,1,2-Trichloro,1,2,2-trifluoroethane	76-13-1	EPA 8260B	5	0% - 30%	82%-138%
1,1,2-Trichloroethane	79-00-5	EPA 8260B	5	0% - 30%	83%-112%
1,1,2-Trichloroethene (1,1,2-Trichloroethylene, Trichloroethene)	79-01-6	EPA 8260B	5	0% - 30%	79%-113%
1,1-Dichloroethane	75-34-3	EPA 8260B	5	0% - 30%	76%-115%
1,1-Dichloroethene	75-35-4	EPA 8260B	5	0% - 30%	75%-135%
1,2,3-Trichlorobenzene	120-82-1	EPA 8260B	5	0% - 30%	61%-121%
1,2,4-Trichlorobenzene	120-82-1	EPA 8260B	5	0% - 30%	64%-124%
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260B	10	0% - 30%	61%-132%
1,2-Dibromoethane, (EDB)	106-93-4	EPA 8260B	5	0% - 30%	83%-117%
1,2-Dichlorobenzene	95-50-1	EPA 8260B	5	0% - 30%	76%-110%
1,2-Dichloroethane, (EDC)	107-06-2	EPA 8260B	5	0% - 30%	72%-120%
1,2-Dichloropropane	78-87-5	EPA 8260B	5	0% - 30%	87%-113%
1,3-Dichlorobenzene	541-73-1	EPA 8260B	5	0% - 30%	78%-111%
1,4-Dichlorobenzene	106-46-7	EPA 8260B	5	0% - 30%	75%-110%
1,4-Dioxane[b]	123-91-1	EPA 8260B	250	0% - 50%	50% - 150%
2-Hexanone	591-78-6	EPA 8260B	20	0% - 30%	64%-136%
4-Methyl-2-pentanone, (methyl isobutyl ketone)	108-10-1	EPA 8260B	20	0% - 30%	67%-135%
Acetone	67-64-1	EPA 8260B	20	0% - 30%	41%-137%
Benzene	71-43-2	EPA 8260B	5	0% - 30%	79%-112%
Bromochloromethane	74-97-5	EPA 8260B	5	0% - 30%	79%-111%
Bromodichloromethane	75-27-4	EPA 8260B	5	0% - 30%	84%-122%
Bromoform, (tribromomethane)	75-25-2	EPA 8260B	5	0% - 30%	62%-133%
Bromomethane, (methylbromide)	74-83-9	EPA 8260B	5	0% - 30%	42%-136%
Carbon disulfide	75-15-0	EPA 8260B	5	0% - 30%	62%-146%
Carbon tetrachloride	56-23-5	EPA 8260B	5	0% - 30%	71%-129%
Chlorobenzene	108-90-7	EPA 8260B	5	0% - 30%	78%-110%
Chloroethane, (ethyl chloride)	75-00-3	EPA 8260B	5	0% - 30%	58%-117%
Chloroform	67-66-3	EPA 8260B	5	0% - 30%	77%-114%
Chloromethane, (methylchloride)	74-87-3	EPA 8260B	5	0% - 30%	50%-110%
cis-1,2-Dichloroethene	156-59-2	EPA 8260B	5	0% - 30%	76%-113%

TABLE 10 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method	Detection Reporting Limit Solids ug/kg[a]	Precision	Accuracy
cis-1,3-Dichloropropene	10061-01-5	EPA 8260B	5	0% - 30%	74%-128%
Cyclohexane	110-82-7	EPA 8260B	10	0% - 30%	66%-110%
Dibromochloromethane	124-48-1	EPA 8260B	5	0% - 30%	72%-127%
Dichlorodifluoromethane	75-71-8	EPA 8260B	5	0% - 30%	26%-113%
Ethylbenzene	100-41-4	EPA 8260B	5	0% - 30%	79%-117%
Isopropylbenzene	98-82-8	EPA 8260B	5	0% - 30%	76%-122%
Methyl cyclohexane	108-87-2	EPA 8260B	10	0% - 30%	70%-126%
Methyl ethyl ketone, (2-butanone)	78-93-3	EPA 8260B	20	0% - 30%	52%-131%
Methyl tert butyl ether (MTBE)	1634-04-4	EPA 8260B	20	0% - 30%	49%-165%
Methyl acetate	79-20-9	EPA 8260B	10	0% - 30%	57%-130%
Methylene chloride, (dichloromethane)	75-09-2	EPA 8260B	5	0% - 30%	75$-118%
Styrene	100-42-5	EPA 8260B	5	0% - 30%	87%-117%
Tetrachloroethylene, (tetrachloroethene), (PCE)	127-18-4	EPA 8260B	5	0% - 30%	79%-114%
Toluene	108-88-3	EPA 8260B	5	0% - 30%	75%-111%
trans-1,2-Dichloroethylene, (1,2-dichloroethene)	156-60-5	EPA 8260B	5	0% - 30%	78%-117%
trans-1,3-Dichloropropene	10061-02-6	EPA 8260B	5	0% - 30%	73%-131%
Trichlorofluoromethane	75-69-4	EPA 8260B	5	0% - 30%	57%-146%
Vinyl chloride	75-01-4	EPA 8260B	5	0% - 30%	57%-114%
Xylene(m-Xylene & p-Xylene)	1330-20-7	EPA 8260B	10	0% - 30%	80%-117%
Xylene(o-Xylene)	1330-20-7	EPA 8260B	5	0% - 30%	80%-120%

Notes:

Low level extraction of soils requires ‘volatile organic analysis’ (VOA) vials, in triplicate.

TABLE 11
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit Solids ug/kg	Precision RPD	Accuracy % Recov.
1,1'-biphenyl	92-52-4	EPA 8270C	330	0% - 30%	50%-130%
1,2,4,5-tetrachlorobenzene[a]	95-94-3	EPA 8270C	330	0% - 50%	50%-150%
2,2'-oxybis (1-chloropropane)	108-60-1	EPA 8270C	330	0% - 30%	36%-116%
2,3,4,6-tetrachlorophenol[a]	58-90-2	EPA 8270C	330	0% - 50%	50%-150%
2,4,5-Trichlorophenol	95-95-4	EPA 8270C	330	0% - 30%	42%-110%
2,4,6-Trichlorophenol	88-06-2	EPA 8270C	330	0% - 30%	37%-110%
2,4,Dinitrophenol	51-28-5	EPA 8270C	330	0% - 30%	10%-110%
2,4-Dichlorophenol	120-83-2	EPA 8270C	330	0% - 30%	40%-110%
2,4-Dimethylphenol	105-67-9	EPA 8270C	330	0% - 30%	28%-110%
2,4-Dinitrotoluene	121-14-2	EPA 8270C	330	0% - 30%	56%-116%
2,6-Dinitrotoluene	606-20-2	EPA 8270C	330	0% - 30%	54%-115%
2-Chloronaphthalene, (beta-chloronaphthalene)	91-58-7	EPA 8270C	330	0% - 30%	46%-110%
2-Chlorophenol	95-57-8	EPA 8270C	330	0% - 30%	39%-110%
2-Methylnaphthalene	91-57-6	EPA 8270C	330	0% - 30%	46%-110%
2-Methylphenol, (o-Cresol)	95-48-7	EPA 8270C	330	0% - 30%	36%-110%
2-Nitroaniline	88-74-4	EPA 8270C	1600	0% - 30%	47%-124%
2-Nitrophenol	88-75-5	EPA 8270C	330	0% - 30%	35%-110%
3,3'-Dichlorobenzidine	91-94-1	EPA 8270C	1600	0% - 30%	31%-110%
3-Nitroaniline	99-09-2	EPA 8270C	1600	0% - 30%	44%-110%
4,6-Dinitro-o-cresol,(4,6-Dinitro-2-methylphenol)	534-52-1	EPA 8270C	1600	0% - 30%	21%-110%
4-Bromophenyl phenyl ether	101-55-3	EPA 8270C	330	0% - 30%	53%-112%
4-Chloroaniline	106-47-8	EPA 8270C	330	0% - 30%	25%-110%
4-Chlorophenyl phenyl ether	7005-72-3	EPA 8270C	330	0% - 30%	53%-110%
4-Methylphenol, (p-Cresol)	106-44-5	EPA 8270C	330	0% - 30%	40%-110%
4-Nitroaniline	100-01-6	EPA 8270C	1600	0% - 30%	50%-110%
4-Nitrophenol	100-02-7	EPA 8270C	1600	0% - 30%	24%-117%
Acenaphthene	83-32-9	EPA 8270C	330	0% - 30%	46%-110%
Acenaphthylene	208-96-8	EPA 8270C	330	0% - 30%	47%-110%
Acetophenone	98-86-2	EPA 8270C	330	0% - 30%	50%-130%
Anthracene	120-12-7	EPA 8270C	330	0% - 30%	56%-111%
Atrazine	1912-24-9	EPA 8270C	330	0% - 30%	50%-130%
Benzaldehyde	100-52-7	EPA 8270C	330	0% - 30%	10%-130%
Benzo(a)anthracene	56-55-3	EPA 8270C	330	0% - 30%	58%-111%
Benzo(a)pyrene	50-32-8	EPA 8270C	330	0% - 30%	44%-115%
Benzo(b)fluoranthene	205-99-2	EPA 8270C	330	0% - 30%	43%-124%
Benzo(g,h,i)perylene	191-24-2	EPA 8270C	330	0% - 30%	44%-120%

TABLE 11 (continued)
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
SEMI-VOLATILE ORGANICS / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit Solids ug/kg	Precision RPD	Accuracy % Recov.
Benzo(k)fluoranthene	207-08-9	EPA 8270C	330	0% - 30%	38%-122%
bis(2-chloroethoxy)methane	111-91-1	EPA 8270C	330	0% - 30%	42%-110%
bis(2-chloroethyl)ether	111-44-4	EPA 8270C	330	0% - 30%	41%-110%
bis(2-ethylhexyl)phthalate, (DEHP)	117-81-7	EPA 8270C	330	0% - 30%	56%-123%
Butyl benzyl phthalate	85-68-7	EPA 8270C	330	0% - 30%	57%-121%
Caprolactam	105-60-2	EPA 8270C	330	0% - 30%	50%-130%
Carbazole	86-74-8	EPA 8270C	330	0% - 30%	56%-115%
Chrysene	218-01-9	EPA 8270C	330	0% - 30%	56%-111%
Dibenz[a,h]anthracene	53-70-3	EPA 8270C	330	0% - 30%	45%-122%
Dibenzofuran	132-64-9	EPA 8270C	330	0% - 30%	50%-110%
Diethyl phthalate	84-66-2	EPA 8270C	330	0% - 30%	55%-114%
Dimethyl phthalate	131-11-3	EPA 8270C	330	0% - 30%	54%-112%
Di-n-butyl phthalate	84-74-2	EPA 8270C	330	0% - 30%	57%-119%
Di-n-octylphthalate	117-84-0	EPA 8270C	330	0% - 30%	45%-123%
Fluoranthene	206-44-0	EPA 8270C	330	0% - 30%	55%-118%
Fluorene	86-73-7	EPA 8270C	330	0% - 30%	51%-110%
Hexachlorobenzene	118-74-1	EPA 8270C	330	0% - 30%	51%-110%
Hexachlorobutadiene	87-68-3	EPA 8270C	330	0% - 30%	39%-110%
Hexachlorocyclopentadiene	77-47-4	EPA 8270C	1600	0% - 30%	10%-110%
Hexachloroethane	67-72-1	EPA 8270C	330	0% - 30%	38%-110%
Indeno[1,2,3-cd]pyrene	193-39-5	EPA 8270C	330	0% - 30%	45%-121%
Isophorone	78-59-1	EPA 8270C	330	0% - 30%	46%-117%
Naphthalene	91-20-3	EPA 8270C	330	0% - 30%	42%-110%
Nitrobenzene	98-95-3	EPA 8270C	330	0% - 30%	40%-110%
N-Nitrosodi-n-propylamine	621-64-7	EPA 8270C	330	0% - 30%	40%-114%
N-Nitrosodiphenylamine	86-30-6	EPA 8270C	330	0% - 30%	54%-112%
p-Chloro-m-cresol, (4-chloro-3-methyl phenol)	59-50-7	EPA 8270C	330	0% - 30%	42%-110%
Pentachlorophenol	87-86-5	EPA 8270C	330	0% - 30%	10%-110%
Phenanthrene	85-01-8	EPA 8270C	330	0% - 30%	54%-110%
Phenol	108-95-2	EPA 8270C	330	0% - 30%	39%-110%
Pyrene	129-00-0	EPA 8270C	330	0% - 30%	58%-113%

TABLE 12
LABORATORY ANALYTICAL SPECIFICS / TARGET COMPOUND LIST
PESTICIDE / PCBs / SOLIDS

Parameter	CAS Number	Method Reference	Detection Reporting Limit Solids ug/kg	Precision RPD	Accuracy % Recov.
4,4'-DDD	72-54-8	EPA 8081A	1.7	0%-30%	64%-141%
4,4'-DDE	72-55-9	EPA 8081A	1.7	0%-30%	49%-141%
4,4'-DDT	50-29-3	EPA 8081A	1.7	0%-30%	35%-143%
Aldrin	309-00-2	EPA 8081A	1.7	0%-30%	39%-144%
Alpha chlordane	57-74-9	EPA 8081A	1.7	0%-30%	42%-138%
Alpha-BHC	319-84-6	EPA 8081A	1.7	0%-30%	41%-147%
beta-BHC	319-85-7	EPA 8081A	1.7	0%-30%	44%-140%
Delta-BHC	319-86-8	EPA 8081A	1.7	0%-30%	48%-148%
Dieldrin	60-57-1	EPA 8081A	1.7	0%-30%	52%-141%
Endosulfan I	959-98-8	EPA 8081A	1.7	0%-30%	18%-110%
Endosulfan II	33213-65-9	EPA 8081A	1.7	0%-30%	22%-113%
Endosulfan sulfate	1031-07-8	EPA 8081A	1.7	0%-30%	61%-1325
Endrin	72-20-8	EPA 8081A	1.7	0%-30%	44%-143%
Endrin aldehyde	7421-93-4	EPA 8081A	1.7	0%-30%	34%-120%
gamma chlordane	57-74-9	EPA 8081A	1.7	0%-30%	48%-140%
gamma-BHC, (lindane)	58-89-9	EPA 8081A	1.7	0%-30%	44%-140%
Heptachlor	76-44-8	EPA 8081A	1.7	0%-30%	43%-132%
Heptachlor epoxide	1024-57-3	EPA 8081A	1.7	0%-30%	49%-140%
Methoxychlor	72-43-5	EPA 8081A	3.3	0%-30%	38%-143%
Toxaphene[a]	8001-35-2	EPA 8081A	67	0%-50%	50%-150%
Endrin ketone	7421-93-4	EPA 8081A	1.7	0%-30%	44%-135%
Aroclor 1016	12674-11-2	EPA 8082	33	0% - 30%	34%-127%
Aroclor 1221[a]	11104-28-2	EPA 8082	33	0%-50%	50%-150%
Aroclor 1232[a]	11141-16-5	EPA 8082	33	0%-50%	50%-150%
Aroclor 1242[a]	53469-21-9	EPA 8082	33	0%-50%	50%-150%
Aroclor 1248[a]	12672-29-6	EPA 8082	33	0%-50%	50%-150%
Aroclor 1254[a]	11097-69-1	EPA 8082	33	0%-50%	50%-150%
Aroclor 1260	11096-82-5	EPA 8082	33	0% - 30%	32%-141%
Aroclor 1262[a]	--	EPA 8082	33	0%-50%	50%-150%
Aroclor 1268[a]	--	EPA 8082	33	0%-50%	50%-150%

Note: a – Selected compound acceptance ranges are not provided by the laboratory, but are cited from National Functional Guideline (USEPA, 2008) validation criteria.

TABLE 13
SCREENING LEVELS - WATER
Former Satralloy Site

Chemical Type	CAS #	Parameters	Laboratory Reporting Limits[a]	USEPA Regional Screening Levels (RSL)[b]	2002 Ohio VAP[c] Unrestricted Potable Residential Use	Ohio Surface Water Quality Standards for protection of Human Health[d]
			ug/L	ug/L	ug/L	ug/L
PCBs		Individual PCBs	1	--	--	--
Pest	72-54-8	4,4-DDD	0.05	0.28	2.3	**0.0083**
Pest	72-55-9	4,4-DDE	0.05	0.2	0.7	**0.0059**
Pest	50-29-3	4,4-DDT	0.05	0.2	1.4	**0.0059**
Pest	309-00-2	ALDRIN	0.05	**0.00021**	--	**0.0013**
Pest	319-84-6	ALPHA-BHC	0.05	0.0062	--	**0.039**
Pest	57-74-9	ALPHA-CHLORDANE	0.05	--	--	**0.021**
Pest		ALPHA-ENDOSULFAN	0.05	--	--	110
Pest	319-85-7	BETA-BHC	0.05	**0.022**	--	0.14
Pest		BETA-CHLORDANE	0.05	--	--	--
Pest		BETA-ENDOSULFAN	0.05	--	--	110
Pest	319-86-8	DELTA-BHC	0.05	--	--	--
Pest	60-57-1	DIELDRIN	0.05	**0.0015**	--	**0.0014**
Pest	1031-07-8	ENDOSULFAN SULFATE	0.05	--	--	110
Pest	72-20-8	ENDRIN	0.05	1.7	--	0.76
Pest	7421-93-4	ENDRIN ALDEHYDE	0.05	--	--	0.76
Pest	7421-93-4	ENDRIN KETONE	0.05	--	--	--
Pest	58-89-9	GAMMA-BHC (Lindane)	0.05	**0.036**	--	0.19
Pest	76-44-8	HEPTACHLOR	0.05	**0.0018**	--	**0.0021**
Pest	1024-57-3	HEPTACHLOR EPOXIDE	0.05	**0.0033**	--	**0.0010**
Pest	72-43-5	METHOXYCHLOR	0.1	27	--	40
Pest	8001-35-2	TOXAPHENE	2	**0.013**	--	**0.0073**
SVOCs	95-94-3	1,2,4,5-TETRACHLOROBENZENE	10	**1.2**	--	**2.3**
SVOCs	58-90-2	2,3,4,6-TETRACHLOROPHENOL	50	170	--	--
SVOCs	95-95-4	2,4,5-TRICHLOROPHENOL	10	890	1400	2600
SVOCs	88-06-2	2,4,6-TRICHLOROPHENOL	10	**3.5**	120	21
SVOCs	120-83-2	2,4-DICHLOROPHENOL	10	35	--	93
SVOCs	105-67-9	2,4-DIMETHYLPHENOL	10	270	310	540
SVOCs	51-28-5	2,4-DINITROPHENOL	50	30	--	70
SVOCs	121-14-2	2,4-DINITROTOLUENE	10	**0.2**	32	**1.1**
SVOCs	606-20-2	2,6-DINITROTOLUENE	10	**15**	16	--
SVOCs	91-58-7	2-CHLORONAPHTHALENE	10	550	--	1700
SVOCs	95-57-8	2-CHLOROPHENOL	10	71	--	120
SVOCs	91-57-6	2-METHYLNAPHTHALENE	10	27	--	--
SVOCs	95-48-7	2-METHYLPHENOL (CRESOL)	10	720	78	--
SVOCs	88-74-4	2-NITROANILINE	50	150	--	--
SVOCs	88-75-5	2-NITROPHENOL	10	--	--	--
SVOCs	91-94-1	3,3'-DICHLOROBENZIDINE	50	**0.11**	--	**0.4**
SVOCs	99-09-2	3-NITROANILINE	50	--	--	--
SVOCs	534-52-1	4,6-DINITRO-2-METHYLPHENOL	50	**1.2**	--	**13**
SVOCs	101-55-3	4-BROMOPHENYL-PHENYLETHER	10	--	--	--
SVOCs	59-50-7	4-CHLORO-3-METHYLPHENOL	10	1100	--	--
SVOCs	106-47-8	4-CHLOROANILINE	10	**0.32**	--	--
SVOCs	7005-72-3	4-CHLOROPHENYL-PHENYLETHER	10	--	--	--
SVOCs	106-44-5	4-METHYLPHENOL	10	1400	78	--
SVOCs	100-01-6	4-NITROANILINE	50	**3.3**	--	--
SVOCs	100-02-7	4-NITROPHENOL	50	--	--	--
SVOCs	83-32-9	ACENAPHTHENE	10	400	680	1200
SVOCs	208-96-8	ACENAPHTHYLENE	10	--	--	--
SVOCs	98-86-2	ACETOPHENONE	10	1500	1600	--
SVOCs	120-12-7	ANTHRACENE	10	1300	2600	9600
SVOCs	1912-24-9	ATRAZINE	10	**0.26**	--	**3**
SVOCs	100-52-7	BENZALDEHYDE	10	1500	--	--
SVOCs	56-55-3	BENZO(A)ANTHRACENE	10	**0.029**	--	**0.044**
SVOCs	50-32-8	BENZO(A)PYRENE	10	**0.0029**	--	**0.044**
SVOCs	205-99-2	BENZO(B)FLUORANTHENE	10	**0.029**	--	**0.044**
SVOCs	191-24-2	BENZO(G,H,I)PERYLENE	10	--	--	--
SVOCs	207-08-9	BENZO(K)FLUORANTHENE	10	**0.29**	--	**0.044**
SVOCs	92-52-4	BIPHENYL	10	**0.83**	--	--
SVOCs	111-91-1	BIS(2-CHLOROETHOXY)METHANE	10	47	--	--
SVOCs	111-44-4	BIS(2-CHLOROETHYL) ETHER	10	**0.012**	--	**0.31**
SVOCs	39638-32-9	BIS(2-CHLOROISOPROPYL) ETHER	10	--	--	1400

TABLE 13
SCREENING LEVELS - WATER
Former Satralloy Site

Chemical Type	CAS #	Parameters	Laboratory Reporting Limits[a]	USEPA Regional Screening Levels (RSL)[b]	2002 Ohio VAP[c] Unrestricted Potable Residential Use	Ohio Surface Water Quality Standards for protection of Human Health[d]
			ug/L	ug/L	ug/L	ug/L
SVOCs	117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	10	**0.071**	19	**6**
SVOCs	85-68-7	BUTYLBENZYL PHTHALATE	10	14	2900	3000
SVOCs	105-60-2	CAPROLACTUM	10	7700	--	--
SVOCs	86-74-8	CARBAZOLE	10	--	64	--
SVOCs	218-01-9	CHRYSENE	10	**2.9**	47	**0.044**
SVOCs	53-70-3	DIBENZO(A,H)ANTHRACENE	10	**0.0029**	--	**0.044**
SVOCs	132-64-9	DIBENZOFURAN	10	**5.8**	--	--
SVOCs	84-66-2	DIETHYL PHTHALATE	10	11000	13000	23000
SVOCs	131-11-3	DIMETHYL PHTHALATE	10	--	--	310000
SVOCs	84-74-2	DI-N-BUTYL PHTHALATE	10	670	1400	2700
SVOCs	117-84-0	DI-N-OCTYL PHTHALATE	10	--	41	--
SVOCs	206-44-0	FLUORANTHENE	10	630	370	300
SVOCs	86-73-7	FLUORENE	10	220	500	1300
SVOCs	118-74-1	HEXACHLOROBENZENE	10	**0.042**	--	**0.0075**
SVOCs	87-68-3	HEXACHLOROBUTADIENE	10	**0.26**	--	**4.4**
SVOCs	77-47-4	HEXACHLOROCYCLOPENTADIENE	50	**22**	--	50
SVOCs	67-72-1	HEXACHLOROETHANE	10	**0.79**	15	19
SVOCs	193-39-5	INDENO(1,2,3-CD)PYRENE	10	**0.029**		**0.044**
SVOCs	78-59-1	ISOPHORONE	10	67	1700	360
SVOCs	91-20-3	NAPHTHALENE	10	**0.14**	140	--
SVOCs	98-95-3	NITROBENZENE	10	**0.12**	--	17
SVOCs	621-64-7	N-NITROSO-DI-N-PROPYLAMINE	10	**0.0093**	--	**0.05**
SVOCs	86-30-6	N-NITROSODIPHENYLAMINE	10	10	--	50
SVOCs	87-86-5	PENTACHLOROPHENOL	10	**0.17**	--	**1**
SVOCs	85-01-8	PHENANTHRENE	10	--	--	--
SVOCs	108-95-2	PHENOL	10	4500	9400	21000
SVOCs	129-00-0	PYRENE	10	87	280	960
VOCs	71-55-6	1,1,1-TRICHLOROETHANE	1	7500	--	200
VOCs	79-34-5	1,1,2,2-TETRACHLOROETHANE	1	**0.066**	5.9	1.7
VOCs	79-00-5	1,1,2-TRICHLOROETHANE	1	**0.24**	--	5
VOCs	75-34-3	1,1-DICHLOROETHANE	1	2.4	1400	--
VOCs	75-35-4	1,1-DICHLOROETHENE	1	260	--	**0.57**
VOCs	120-82-1	1,2,3-TRICHLOROBENZENE	1	**5.2**	--	70
VOCs	120-82-1	1,2,4-TRICHLOROBENZENE	1	**0.99**	--	70
VOCs	96-12-8	1,2-DIBROMO-3-CHLOROPROPANE	2	**0.00032**	--	**0.2**
VOCs	106-93-4	1,2-DIBROMOETHANE	1	**0.0065**	--	**0.05**
VOCs	95-50-1	1,2-DICHLOROBENZENE	1	280	--	600
VOCs	107-06-2	1,2-DICHLOROETHANE	1	**0.15**	--	3.8
VOCs	78-87-5	1,2-DICHLOROPROPANE	1	**0.38**	--	5
VOCs	541-73-1	1,3-DICHLOROBENZENE	1	--	13	400
VOCs	106-46-7	1,4-DICHLOROBENZENE	1	**0.42**	--	75
VOCs	123-91-1	1,4-DIOXANE	200	**0.67**	**140**	--
VOCs	78-93-3	2-BUTANONE	10	4900	6800	--
VOCs	591-78-6	2-HEXANONE	10	34	--	--
VOCs	108-10-1	4-METHYL-2-PENTANONE	10	1000	760	--
VOCs	67-64-1	ACETONE	10	12000	1600	--
VOCs	71-43-2	BENZENE	1	**0.39**	--	5
VOCs	74-97-5	BROMOCHLOROMETHANE	1	83	--	--
VOCs	75-27-4	BROMODICHLOROMETHANE	1	**0.12**	--	5.6
VOCs	75-25-2	BROMOFORM	1	7.9	--	43
VOCs	74-83-9	BROMOMETHANE	1	7	--	48
VOCs	75-15-0	CARBON DISULFIDE	1	720	1400	--
VOCs	56-23-5	CARBON TETRACHLORIDE	1	**0.39**	--	2.5
VOCs	108-90-7	CHLOROBENZENE	1	72	--	100
VOCs	75-00-3	CHLOROETHANE	1	21000	6100	--
VOCs	67-66-3	CHLOROFORM	1	**0.19**	50	57
VOCs	74-87-3	CHLOROMETHANE	1	190	--	--
VOCs	156-59-2	CIS-1,2-DICHLOROETHENE	1	28	--	70
VOCs	10061-01-5	CIS-1,3-DICHLOROPROPENE	1	--	--	--
VOCs	110-82-7	CYCLOHEXANE	1	13000	--	--
VOCs	124-48-1	DIBROMOCHLOROMETHANE	1	**0.15**	19	4.1
VOCs	75-71-8	DICHLORODIFLUOROMETHANE	1	190	1900	--

TABLE 13
SCREENING LEVELS - WATER
Former Satralloy Site

Chemical Type	CAS #	Parameters	Laboratory Reporting Limits[a]	USEPA Regional Screening Levels (RSL)[b]	2002 Ohio VAP[c] Unrestricted Potable Residential Use	Ohio Surface Water Quality Standards for protection of Human Health[d]
			ug/L	ug/L	ug/L	ug/L
VOCs	100-41-4	ETHYLBENZENE	1	1.3	--	700
VOCs	76-13-1	FREON 113	1	53000	--	--
VOCs	98-82-8	ISOPROPYLBENZENE	1	390	1300	--
VOCs	1330-20-7	M,P XYLENES	2	190	--	10000
VOCs	79-20-9	METHYL ACETATE	10	16000	--	--
VOCs	110-82-7	METHYL CYCLOHEXANE	1	13000	--	--
VOCs	1634-04-4	METHYL TERT-BUTYL ETHER	5	12	--	--
VOCs	75-09-2	METHYLENE CHLORIDE	1	9.9	--	5
VOCs	95-47-6	O-XYLENE	1	190	--	--
VOCs	100-42-5	STYRENE	1	1100	--	100
VOCs	127-18-4	TETRACHLOROETHENE	1	9.7	--	5
VOCs	108-88-3	TOLUENE	1	860	--	1000
VOCs	156-60-5	TRANS-1,2-DICHLOROETHENE	1	86	--	100
VOCs	542-75-6	TRANS-1,3-DICHLOROPROPENE	1	**0.41**	14	10
VOCs	79-01-6	TRICHLOROETHENE	1	**0.44**	--	5
VOCs	75-69-4	TRICHLOROFLUOROMETHANE	1	1100	3700	--
VOCs	75-01-4	VINYL CHLORIDE	1	**0.015**	--	2
Metals	7429-90-5	ALUMINUM	200	16000	16000	--
Metals	7440-36-0	ANTIMONY	50	**6**	--	**6**
Metals	7440-38-2	ARSENIC	10	**0.045**	--	10
Metals	7440-39-3	BARIUM	5	2900	--	2000
Metals	7440-41-7	BERYLLIUM	2	16	--	4
Metals	7440-43-9	CADMIUM	5	6.9	--	5
Metals	7440-70-2	CALCIUM	5000	--	--	--
Metals	16065-83-1	CHROMIUM	10	16000	--	100
Metals	18540-29-9	CHROMIUM $^{+6}$	1	**0.031**	--	--
Metals	7440-48-4	COBALT	5	**4.7**	317	--
Metals	7440-50-8	COPPER	10	620	--	--
Inorgan	18496-25-8	SULFIDE	100	--	--	--
Inorgan	57-12-5	CYANIDE, (TOTAL)	50	**9.3**	--	200
Metals	7439-89-6	IRON	100	11000	--	--
Metals	7439-92-1	LEAD	10	--	--	--
Metals	7439-95-4	MAGNESIUM	5000	--	--	--
Metals	7439-96-5	MANGANESE (Non-diet)	15	320	--	--
Metals	7439-97-6	MERCURY	0.2	0.63	--	**0.012**
Metals	7440-02-0	NICKEL	40	300	--	610
Metals	7440-09-7	POTASSIUM	5000	--	--	--
Metals	7782-49-2	SELENIUM	50	78	--	50
Metals	7440-22-4	SILVER	10	71	78	--
Metals	7440-23-5	SODIUM	5000	--	--	--
Metals	7440-28-0	THALLIUM	10	**0.16**	--	**1.7**
Metals	7440-31-5	TIN	50	9300	--	--
Metals	7440-62-2	VANADIUM	5	78	140	--
Metals	7440-66-6	ZINC	10	4700	4700	9100

Notes:

Bold values are parameters below the Reporting Limit of the Laboratory.

[--] Value not provided in referenced document.

a. Laboratory limits as stated in Laboratory Quality Manual for TestAmerica North Canton (formerly STL N.Canton), Rev.4, May 30, 2006.

b. Regional Screening Levels (Formerly PRGs), May 2012, http://www.epa.gov/region9/superfund/prg/

c. Ohio EPA VAP values from, Ohio Administrative Code rule 3745-300-08, Table VII, effective October, 2002.

d. Ohio EPA Division of Surface Water, from OAC rule 3745-1-34, Water Quality Criteria for the Ohio River Drainage Basin, Outside Mixing Zone Average (OMZA) for protection of human health in drinking water, December 30, 2002.

Golder Associates

TABLE 14
SCREEING LEVELS - SOIL
Former Satralloy Site

				USEPA Regional Screening Levels (RSL)[b]		Ohio EPA Voluntary Action Program (VAP)[d]		Ohio Division of Emergency Response & Remediation (DERR) Sites/ NON-VAP[e]	
Chemical Class	**CAS #**	**Parameters**	**Laboratory Reporting Limits [a]**	**Residential Soil / Direct Contact [b]**	**Soil Concentration Protective of Groundwater (DAF=1)**	**2002 Ohio VAP / Residential Soil Direct Contact [d]**	**Soil Concentration Protective of Groundwater (DAF=1) [c]**	**Residential Soil / Direct Contact [e]**	**Cancer (ca) and Non-Cancer (NC) Designation [e]**
		Units:	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
PCBs		Individual PCBs	0.033	--	--	1.1	--	--	ca
Pesticide	72-54-8	4,4-DDD	3.3	**2.00**	**0.066**	41	**0.066**	**2.437**	ca
Pesticide	72-55-9	4,4-DDE	3.3	**1.40**	**0.047**	29	**0.047**	**1.72**	ca
Pesticide	50-29-3	4,4-DDT	3.3	**1.70**	**0.067**	29	**0.067**	**1.72**	ca
Pesticide	309-00-2	Aldrin	1.7	**0.03**	**0.000034**	--	**0.00065**	**0.029**	ca
Pesticide	319-84-6	Alpha-BHC	1.7	**0.08**	**0.000036**	--	**0.000062**	--	ca
Pesticide	5103-71-9	Alpha-Chlordane	1.7	--	--	28	--	--	ca
Pesticide	959-98-8	Alpha-Endosulfan	1.7	--	--	--	--	--	ca
Pesticide	319-85-7	beta-BHC	1.7	**0.27**	**0.00013**	--	**0.00022**	--	ca
Pesticide	57-74-9	beta-Chlordane	1.7	--	--	--	--	--	ca
Pesticide	33213-65-9	beta-Endosulfan	3.3	--	--	--	--	--	ca
Pesticide	319-86-8	delta-BHC	1.7	--	--	--	--	--	ca
Pesticide	60-57-1	Dieldrin	3.3	**0.03**	**0.00061**	--	**0.00017**	**0.03**	ca
Pesticide	1031-07-8	Endosulfan Sulfate	3.3	--	--	--	--	--	ca
Pesticide	72-20-8	Endrin	3.3	18.0	**0.068**	23	**0.44**	**1.833**	NC
Pesticide	7421-93-4	Endrin Aldehyde	3.3	--	--	--	--	--	ca
Pesticide	7421-93-4	Endrin Ketone	3.3	--	--	--	--	--	ca
Pesticide	58-89-9	gamma-BHC	1.7	**0.52**	**0.00021**	7.6	**0.00036**	**0.437**	ca
Pesticide	76-44-8	Heptachlor	1.7	**0.11**	**0.00014**	2.5	**0.0012**	**0.108**	ca
Pesticide	1024-57-3	Heptachlor Epoxide	1.7	**0.05**	**0.000068**	**1**	**0.00015**	**0.053**	ca
Pesticide	72-43-5	Methoxychlor	17	310	**1.5**	390	**9.9**	30.552	NC
Pesticide	8001-35-2	Toxaphene	170	**0.44**	**0.0021**	**10**	**0.0094**	**0.442**	ca
SVOA	95-94-3	1,2,4,5-Tetrachlorobenzene	0.33	18.0	**0.0058**	--	**0.051**	1.833	NC
SVOA	58-90-2	2,3,4,6-Tetrachlorophenol	0.33	1800	1.1	--	6.7	183.309	NC
SVOA	95-95-4	2,4,5-Trichlorophenol	0.33	6100	3.3	7700	14	611.031	NC
SVOA	88-06-2	2,4,6-Trichlorophenol	0.33	44	**0.013**	1000	**0.023**	0.611	NC
SVOA	51-28-5	2,4-Dinitrophenol	1.6	122	**0.034**	--	**0.082**	122.206	ca
SVOA	120-83-2	2,4-Dichlorophenol	0.33	180	**0.041**	--	**0.13**	18.331	NC
SVOA	105-67-9	2,4-Dimethylphenol	0.33	1220	0.32	1500	0.86	1222.062	ca
SVOA	121-14-2	2,4-Dinitrotoluene	0.33	1.60	**0.00028**	150	**0.00029**	122.206	ca
SVOA	606-20-2	2,6-Dinitrotoluene	0.33	61.0	**0.02**	76	**0.05**	61.103	ca
SVOA	91-58-7	2-Chloronaphthalene	0.33	6300	2.9	--	15	493.664	NC
SVOA	95-57-8	2-Chlorophenol	0.33	390	**0.057**	--	**0.15**	63.398	ca
SVOA	91-57-6	2-Methylnaphthalene	0.33	230	0.14	--	0.75	--	ca
SVOA	95-48-7	2-Methylphenol (o-Cresol)	0.33	3100	0.58	390	1.5	305.516	NC
SVOA	88-74-4	2-Nitroaniline	1.6	610	**0.062**	--	**0.15**	182.772	ca
SVOA	88-75-5	2-Nitrophenol	0.33	--	--	--	--	--	ca
SVOA	91-94-1	3,3'-Dichlorobenzidine	1.6	**1.10**	**0.00071**	24	**0.00098**	**1.081**	ca
SVOA	99-09-2	3-Nitroaniline	1.6	--	--	--	--	1.833	NC
SVOA	534-52-1	4,6-Dinitro-2-Methylphenol	1.6	4.90	**0.002**	--	**0.005**	--	ca
SVOA	101-55-3	4-Bromophenyl-Phenylether	0.33	--	--	--	--	--	ca
SVOA	59-50-7	4-Chloro-3-Methylphenol	0.33	6100	1.3	--	4.3	--	ca
SVOA	106-47-8	4-Chloroaniline	0.33	2.40	**0.00013**	--	**0.00014**	244.412	ca
SVOA	7005-72-3	4-Chlorophenyl-Phenylether	0.33	--	--	--	--	--	ca
SVOA	106-44-5	4-Methylphenol (p-cresol)	0.33	6100	1.1	390	**0.15**	30.552	NC
SVOA	100-01-6	4-Nitroaniline	1.6	24	**0.0014**	--	**0.0014**	23.161	ca
SVOA	100-02-7	4-Nitrophenol	1.6	--	--	--	--	--	ca
SVOA	83-32-9	Acenaphthene	0.33	3400	4.1	4600	22	368.171	NC
SVOA	208-96-8	Acenaphthylene	0.33	--	--	--	--	--	ca
SVOA	98-86-2	Acetophenone	0.067	7800		7600	1.1	--	ca
SVOA	120-12-7	Anthracene	0.33	17000	42	23000	360	2189.612	NC
SVOA	1912-24-9	Atrazine	0.33	2.10		--	**0.00019**	2.191	ca
SVOA	100-52-7	Benzaldehyde	0.33	7800		--	0.81	611.031	NC
SVOA	56-55-3	Benzo(a)Anthracene	0.33	**0.15**	**0.01**	11	**0.01**	0.621	ca
SVOA	50-32-8	Benzo(a)Pyrene	0.33	**0.015**	**0.0035**	1.1	**0.0035**	**0.062**	ca
SVOA	205-99-2	Benzo(b)Fluoranthene	0.33	**0.15**	**0.035**	11	**0.035**	0.621	ca
SVOA	191-24-2	Benzo(g,h,i)Perylene	0.33	--	--	--	--	--	ca
SVOA	207-08-9	Benzo(k)Fluoranthene	0.33	1.5	0.35	110	**0.35**	6.215	ca
SVOA	92-52-4	Biphenyl	0.33	51	0.0087	--	19	--	ca
SVOA	111-91-1	Bis(2-Chloroethoxy)Methane	0.33	180	**0.011**	--	**0.025**	--	ca
SVOA	111-44-4	Bis(2-Chloroethyl) Ether	0.33	**0.21**	**0.0000031**	--	**0.0000031**	**0.218**	ca
SVOA	39638-32-9	Bis(2-Chloroisopropyl) Ether	0.33	--	--	--	--	--	ca
SVOA	117-81-7	Bis(2-Ethylhexyl) Phthalate	0.33	35	0.017	230	1.1	--	ca
SVOA	85-68-7	Butylbenzyl Phthalate	0.33	260	**0.2**	220	**0.51**	1222.062	NC
SVOA	105-60-2	Caprolactum	0.33	31000	1.9	--	4.5	3055.155	NC
SVOA	86-74-8	Carbazole	0.33	--	--	530	**0.03**	24.319	ca
SVOA	218-01-9	Chrysene	0.33	15	1.1	1100	1.1	62.146	ca
SVOA	53-70-3	Dibenzo(a,h)Anthracene	0.33	**0.015**	**0.011**	1.1	**0.011**	--	ca
SVOA	132-64-9	Dibenzofuran	0.33	78	**0.11**	--	**0.68**	14.526	NC
SVOA	84-66-2	Diethyl Phthalate	0.33	48900	4.7	640	12	4888.248	NC
SVOA	131-11-3	Dimethyl Phthalate	0.33	--	--	--	--	100000	ca
SVOA	84-74-2	Di-n-Butyl Phthalate	0.33	6100	1.7	100	9.2	--	ca
SVOA	117-84-0	Di-n-Octyl Phthalate	0.33	--		1500	10000	244.412	NC
SVOA	206-44-0	Fluoranthene	0.33	2300	70	2300	160	229.361	NC
SVOA	86-73-7	Fluorene	0.33	2300	4	3100	27	274.711	NC

TABLE 14
SCREEING LEVELS - SOIL
Former Satralloy Site

				USEPA Regional Screening Levels (RSL)[b]		Ohio EPA Voluntary Action Program (VAP)[d]		Ohio Division of Emergency Response & Remediation (DERR) Sites/ NON-VAP[e]	
Chemical Class	CAS #	Parameters	Laboratory Reporting Limits [a]	Residential Soil / Direct Contact [b]	Soil Concentration Protective of Groundwater (DAF=1)	2002 Ohio VAP / Residential Soil Direct Contact [d]	Soil Concentration Protective of Groundwater (DAF=1) [c]	Residential Soil / Direct Contact [e]	Cancer (ca) and Non-Cancer (NC) Designation [e]
		Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SVOA	118-74-1	Hexachlorobenzene	0.33	**0.3**	**0.00053**	6.9	**0.00053**	**0.304**	ca
SVOA	87-68-3	Hexachlorobutadiene	0.33	6.2	**0.0005**	15	**0.0017**	6.236	ca
SVOA	77-47-4	Hexachlorocyclopentadiene	1.6	370	0.07	--	0.68	36.549	NC
SVOA	67-72-1	Hexachloroethane	0.33	12	**0.00048**	77	**0.0029**	34.741	ca
SVOA	193-39-5	Indeno(1,2,3-cd)Pyrene	0.33	**0.15**	**0.12**	11	**0.12**	0.621	ca
SVOA	78-59-1	Isophorone	0.33	510	**0.022**	4600	**0.023**	511.979	ca
SVOA	91-20-3	Naphthalene	0.33	3.6	**0.00047**	54	**0.00047**	5.592	NC
SVOA	98-95-3	Nitrobenzene	0.33	4.8	**0.000079**	23	**0.000079**	1.964	NC
SVOA	621-64-7	n-Nitroso-Di-n-Propylamine	0.33	0.069	**0.000007**	--	**0.0000072**	--	ca
SVOA	86-30-6	n-Nitrosodiphenylamine	0.33	99	**0.057**	--	**0.075**	99.261	ca
SVOA	87-86-5	Pentachlorophenol	0.33	0.89	**0.0017**	51	**0.0017**	2.979	ca
SVOA	85-01-8	Phenanthrene	0.33	--	--	--	--	--	ca
SVOA	108-95-2	Phenol	0.33	18300	2.6	46000	6.3	1833.093	NC
SVOA	129-00-0	Pyrene	0.33	1700	9.5	1700	120	231.595	NC
Volatiles	71-55-6	1,1,1-Trichloroethane	0.005	8700	2.6	990	3.2	1200	ca
Volatiles	79-34-5	1,1,2,2-Tetrachloroethane	0.005	0.56	**0.000026**	11	**0.000026**	0.408	ca
Volatiles	79-00-5	1,1,2-Trichloroethane	0.005	1.1	**0.000077**	24	**0.000078**	0.729	ca
Volatiles	75-34-3	1,1-Dichloroethane	0.005	3.3	**0.00068**	580	**0.00069**	50.640	NC
Volatiles	75-35-4	1,1-Dichloroethene	0.005	240	0.093	1.6	0.12	12.353	NC
Volatiles	87-61-6	1,2,3-Trichlorobenzene	0.005	49	**0.015**	--	**0.0068**	6.216	NC
Volatiles	120-82-1	1,2,4-Trichlorobenzene	0.005	22	**0.0029**	--	**0.0068**	6.216	NC
Volatiles	96-12-8	1,2-Dibromo-3-Chloropropane	0.005	0.0054	**0.00000014**	--	**0.00000014**	0.46	ca
Volatiles	106-93-4	1,2-Dibromoethane	0.005	0.034	**0.0000018**	--	**0.0000018**	0.032	ca
Volatiles	95-50-1	1,2-Dichlorobenzene	0.005	1900	0.27	150	0.36	600	ca
Volatiles	107-06-2	1,2-Dichloroethane	0.005	0.43	**0.000042**	10	**0.000042**	0.278	ca
Volatiles	78-87-5	1,2-Dichloropropane	0.005	0.94	**0.00013**	6.4	**0.00013**	0.342	ca
Volatiles	541-73-1	1,3-Dichlorobenzene	0.005	--	--	--	--	53.135	NC
Volatiles	542-75-6	1,3-Dichloropropene	0.005	1.7	**0.00015**	--	**0.00015**	0.777	ca
Volatiles	106-46-7	1,4-Dichlorobenzene	0.005	2.4	**0.0004**	95	**0.00041**	3.447	ca
Volatiles	123-91-1	1,4-Dioxane	0.1	4.9	**0.00014**	980	**0.00014**	--	ca
Volatiles	78-93-3	2-Butanone	0.01	28000	1	6700	1.5	2231.120	NC
Volatiles	591-78-6	2-Hexanone	0.01	210	0.0079	--	0.011	--	ca
Volatiles	108-10-1	4-Methyl-2-Pentanone	0.01	5300	0.23	700	0.45	528.089	NC
Volatiles	67-64-1	Acetone	0.01	61000	2.4	7300	4.5	1412.657	NC
Volatiles	71-43-2	Benzene	0.005	1.1	**0.0002**	9.8	**0.00021**	0.643	ca
Volatiles	74-97-5	Bromochloromethane	0.005	--	--	--	--	--	ca
Volatiles	75-27-4	Bromodichloromethane	0.005	0.27	**0.0021**	--	**0.000032**	0.824	ca
Volatiles	75-25-2	Bromoform	0.005	62	**0.0021**	--	**0.0023**	61.569	ca
Volatiles	74-83-9	Bromomethane	0.005	7.30	**0.0018**	--	**0.0022**	0.390	NC
Volatiles	75-15-0	Carbon Disulfide	0.005	820	0.21	350	0.31	35.534	NC
Volatiles	56-23-5	Carbon Tetrachloride	0.005	0.61	**0.00015**	1.7	**0.00017**	0.251	ca
Volatiles	108-90-7	Chlorobenzene	0.005	290	0.00088	150	0.062	15.066	NC
Volatiles	75-00-3	Chloroethane (ethyl chloride)	0.005	15000	5.9	8800	5.9	3.026	ca
Volatiles	67-66-3	Chloroform	0.005	0.29	**0.000053**	7.3	**0.000053**	0.221	ca
Volatiles	74-87-3	Chloromethane	0.005	120.0	0.049	--	0.049	4.685	NC
Volatiles	156-59-2	cis-1,2-Dichloroethene	0.005	160.0	0.0082	760	0.021	4.294	NC
Volatiles	110-82-7	Cyclohexane	0.005	7000	13	--	13	140	ca
Volatiles	124-48-1	Dibromochloromethane	0.005	0.68	**0.000039**	130	**0.000039**	1.109	ca
Volatiles	75-71-8	Dichlorodifluoromethane	0.005	94.0	0.3	120	0.61	9.388	NC
Volatiles	100-41-4	Ethylbenzene	0.005	5.4	**0.0015**	230	**0.0017**	395	ca
Volatiles	76-13-1	Freon 113	0.005	43000	130		150	5600	ca
Volatiles	98-82-8	Isopropylbenzene (cumene)	0.005	2100	0.64	860	1.1	57.213	NC
Volatiles	79-20-9	Methyl Acetate	0.005	78000	3.2	--	7.5	2208.674	NC
Volatiles	110-82-7	Cyclohexane	0.005	7000	13	--	13	140	ca
Volatiles	1634-04-4	Methyl Tert-Butyl Ether	0.005	43	0.028	5300	**0.0028**	32	ca
Volatiles	75-09-2	Methylene Chloride	0.005	56	0.025	250	**0.0012**	9.107	ca
Volatiles	100-42-5	Styrene	0.005	6300	1.2	1700	1.8	1700	ca
Volatiles	127-18-4	Tetrachloroethene	0.005	22	**0.0044**	130	**0.000049**	0.484	ca
Volatiles	108-88-3	Toluene	0.005	5000	0.59	520	1.6	520	ca
Volatiles	156-60-5	trans-1,2-Dichloroethene	0.005	150.0	0.025	1500	0.031	6.949	NC
Volatiles	542-75-6	trans-1,3-Dichloropropene	0.005	1.7	**0.00015**	13	**0.00015**	0.777	ca
Volatiles	79-01-6	Trichloroethene	0.005	0.91	**0.00016**	80	**0.00072**	0.053	ca
Volatiles	75-69-4	Trichlorofluoromethane	0.005	790	0.69	490	0.83	38.582	NC
Volatiles	75-01-4	Vinyl Chloride	0.005	0.06	**0.0000053**	3.7	**0.0000056**	0.079	ca
Volatiles	1330-20-7	Xylenes (total)	0.005	630	0.18	160	0.2	270.631	ca
Inorganic	57-12-5	Cyanide, (Total)	50	47	**0.094**	1600	**7.4**	122.210	NC
Inorganic	18496-25-8	Sulfide	100	--	--	--	--	--	ca

TABLE 14
SCREEING LEVELS - SOIL
Former Satralloy Site

				USEPA Regional Screening Levels (RSL)[b]		Ohio EPA Voluntary Action Program (VAP)[d]		Ohio Division of Emergency Response & Remediation (DERR) Sites/ NON-VAP[e]	
Chemical Class	CAS #	Parameters	Laboratory Reporting Limits [a]	Residential Soil / Direct Contact [b]	Soil Concentration Protective of Groundwater (DAF=1)	2002 Ohio VAP / Residential Soil Direct Contact [d]	Soil Concentration Protective of Groundwater (DAF=1) [c]	Residential Soil / Direct Contact [e]	Cancer (ca) and Non-Cancer (NC) Designation [e]
		Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Metals	7429-90-5	Aluminum	20	77000	23000	75000	55000	7614.195	NC
Metals	7440-36-0	Antimony	6	31.0	**0.27**	31	**0.66**	**3.129**	NC
Metals	7440-38-2	Arsenic	1	**0.39**	**0.0013**	6.8	**0.0013**	**0.39**	ca
Metals	7440-39-3	Barium	20	15000	120	5400	300	5375	ca
Metals	7440-41-7	Beryllium	0.5	160	13	150	58	15.437	NC
Metals	7440-43-9	Cadmium	0.5	70	--	35	--	3.703	NC
Metals	7440-70-2	Calcium	500	--	--	--	--	--	ca
Metals	16065-83-1	Chromium	1	120000	28000000	120000	99000000	100000	ca
Metals	18540-29-9	Chromium $^{+6}$	1	**0.29**	**0.00059**	230	**0.00083**	30.096	ca
Metals	7440-48-4	Cobalt	5	23	**0.21**	1400	**0.49**	902.893	ca
Metals	7440-50-8	Copper	2.5	3100	22	--	51	312.855	NC
Metals	7439-89-6	Iron	10	55000	270	--	640	--	ca
Metals	7439-92-1	Lead	0.3	400	--	400	--	400	ca
Metals	7439-95-4	Magnesium	500	--	--	--	--	--	ca
Metals	7439-96-5	Manganese	1.5	1800	21.00	--	--	176.235	NC
Metals	7439-97-6	Mercury	0.1	10.0	**0.033**	7.8	**0.03**	2.346	NC
Metals	7440-02-0	Nickel	4	1500	20	1500	48	1564	ca
Metals	7440-9-7	Potassium	500	--	--	--	--	--	ca
Metals	7782-49-2	Selenium	0.5	390	0.4	390	0.95	39.107	NC
Metals	7440-22-4	Silver	1	390	0.6	390	1.6	39.107	NC
Metals	7440-23-5	Sodium	500	--	--	--	--	--	ca
Metals	7440-28-0	Thallium	1	0.78	0.011	6.2	--	**0.516**	NC
Metals	7440-31-5	Tin	10	47000	2300	--	5500	4692.417	NC
Metals	7440-62-2	Vanadium	5	390.0	78	700	**2.6**	7.821	NC
Metals	7440-66-6	Zinc	2	23000	290	23000	680	2346.319	NC

Notes:

Bold values are parameters below the Reporting Limit of the Laboratory.

[--] Value not provided in referenced document.

a. Laboratory limits for ICP and CVAA as stated in Laboratory Quality Manual for TestAmerica North Canton (formerly STL N.Canton), Rev.4, May 30, 2006.

b. Regional Screening Levels (Formerly PRGs), May 2012, http://www.epa.gov/region9/superfund/prg/

c. Values are from Risk Based screening levels, and do not include MCL based screening levels, which are sometimes lower.

d. Ohio EPA VAP values from October, 2002, promulgated Rule #8, (Ohio Adminstrative Code 3745-300-08); Presents a list of 62 analytes, associated with the SOM01.2 EPA SOW document lists.

e. Applicable to the Ohio DERR Remedial Response Program for NON-VAP sites. Uses PRG values, but Residential Non-Cancer designated analytes are lowered by a factor of 10.

TABLE 15
WATER SAMPLE CONTAINER TYPES, VOLUMES, HANDLING, PRESERVATION, AND HOLDING TIMES

Analytes	Container Type	Special Handling	Preservation	Maximum Holding Time
Sulfate Chloride' Alkalinity	1, 500 ml narrow mouth polyethylene bottle.	Fill to neck, (Collect an additional 500 mL aliquot for MS/MSD analysis if required)	None, store at 4°C	14 days for Alkalinity analysis, 28 days for others.
pH, Temperature, Conductivity, Dissolved Oxygen, Turbidity	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected	Field Parameters; Sample is not collected
Dissolved Metals, Mercury	1, 1000 mL narrow mouth polyethylene bottle.	Filter through 0.45 um membrane filter into a preserved bottle, fill to neck	HNO_3, pH < 2, store at 4°C.	6 months 28 day for Hg
Total Metals, Mercury	1, 1000 mL narrow mouth polyethylene bottle.	Fill to neck	HNO_3 to ph <2, store at 4°C	28 day for Hg
Dissolved Cr^{+6}	1, 1000 mL narrow mouth polyethylene bottle.	Filter through 0.45 um Teflon membrane filter into a preserved bottle, Fill to neck	NaOH, pH >11, store at 4°C.	28 day for Cr^{+6}
Total Cr^{+6}	1, 1000 mL narrow mouth polyethylene bottle.	Fill to neck	NaOH, pH >11, store at 4°C.	28 day for Cr^{+6}
Volatiles	3, 40 ml glass vials, with Teflon lined septa.	Fill to eliminate all bubbles.	None, store at 4°C, or optionally preserve ph <2, and store at 4°C	7 days for non-preserved, 14 days for preserved.
Semi-volatile	1, 1000 ml amber glass bottle.	Fill to neck.	None, store at 4°C	Extract within 7 days of collection, analyze within 40 days of collection.

TABLE 16
SOIL SAMPLE CONTAINER TYPES, VOLUMES, HANDLING, PRESERVATION, AND HOLDING TIMES

Analytes	Container Type	Special Handling	Preservation	Maximum Holding Time
Total Metals	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	6 months
Total Metals by XRF	1, 8 oz. Plastic zip-lock bag	Ensure finely divided soil, and mix thoroughly	None, store in dark	6 months
Total Mercury	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Organic Carbon	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Soil pH	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	As soon as practical
Ammonia	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Nitrate / Nitrate as N	1, 4 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	28 days
Volatiles	1, 8 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	14 days
Semi-volatiles	1, 8 oz. Wide mouth soil jar	Fill completely	None, store in dark at 4°C.	Extract within 7 days of collection, analyze within 40 days of collection.

TABLE 17
QUALITY CONTROL SUMMARY – FIELD PARAMETERS

Parameter	Description
Method References	GAI Technical Procedure 1.2-20, Collection of Groundwater Quality Samples Low Flow (Minimal Drawdown) Groundwater Sampling Procedures (EPA, 1996)
Matrix	Groundwater (well sampling).
Analytes	pH, conductivity, dissolved oxygen, turbidity, and temperature.
Maximum Holding Time	Analyze all field parameters immediately upon collection.
Calibration	At least two reference buffers or standards at a high and low concentration are used to calibrate pH, conductivity. A blank and at least one calibration standard shall be used for turbidity, and dissolved oxygen. Verify calibration prior to sample analysis and at the conclusion of sample analysis. A NIST traceable thermometer shall be used for temperature measurements, no field calibration is required.
Method Blank	A method blank sample is analyzed when required to check calibration.
Equipment Blanks	Analyze equipment blanks as appropriate.
QC Check Standards	Reanalysis of standards following field sample analyses is required. Verification of standards values should be ±10%.
Surrogate	NA
Internal Standard	NA
Duplicate Sample	Duplicate sample analyses are not required, however, repeat analysis of a second sample aliquot is recommended for all parameters and required for groundwater sampling to verify stability of field measurements within 10% for all parameters (0.5 °C for temperature).
Spike Sample	Spike sample analyses are not required.
Sample Collection	Minimize both atmospheric contact and delay on analyses of all field parameters. A closed cell sampling configuration may be used.
Other QC Criteria	The working calibration must be verified before and after field sampling analyses. If the response for any analyte varies from the expected value by more than ±10% (0.5 °C for temperature), the test must be repeated using fresh calibration standards.

TABLE 18
QUALITY CONTROL SUMMARY – METAL ANALYSIS

Parameter	Description
Method Reference	EPA CLP SOW for Inorganic Analyses ILM03.0. EPA 6010 and 6000 series, Test Methods for Evaluating Solid Waste, SW-846. EPA Method 7000B series, Test Methods for Evaluating Solid Waste, SW-846. EPA 200.7 and EPA 200.8, U.S. EPA National Exposure Research Laboratory (NERL)
Matrix	Soils, sediments, groundwater.
Analytes	Metals lists as indicated in Tables 1 and 7, including mercury and Cr^{+6}.
Holding Time	6 Months, (28 days for mercury and Cr^{+6}).
Laboratory Instrument Calibration	ICP: A blank and at least one calibration standard. Hg: A blank and 5 level calibration standards. The low level standards must be analyzed at the method specified concentration at the required frequency.
Laboratory Method Blank	Blank sample is analyzed at each analyte parameter and no analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 times the concentration in the blank.
Laboratory Calibration	Laboratory calibration blanks analyzed at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
Field Blanks	SOIL & GROUNDWATER: The equipment blanks will be scheduled in the SAP.
Laboratory QC Check Standards	ICP and AA initial calibration verified with independent standard %R 90-110. Digest an independent LCS with each sample batch for ICP and AA if available %R 80-120.
Duplicate Sample	SOIL & GROUNDWATER: Field duplicates are scheduled for analysis as presented in Table A-2 of the SAP. Each is prepared as a blind field duplicate. Relative percent differences (RPD) between field duplicates are advisory only; ≤20% for water samples ≤35% for soil samples. (MS/MSD or BS/BSD also checked for RPD if included).
Laboratory Matrix Spike/ Matrix Spike Duplicate Sample	Analyze spiked field sample at frequency of one per twenty samples or each batch, whichever is more frequent for soil and groundwater. MS/MSD analyzed for Hg and AA analytes only. Percent recovery (%R) between 80-120%. Use method of standard additions for AA, and Hg if interference is indicated.
Sample Collection	WATER: 1,000 ml polyethylene bottle acidify with HN03 to pH <2. SOIL: sample in 8 oz. wide mouth polyetheylene or glass cool to 4°C.
Other Laboratory QC Criteria	ICP: Analyze ICS at beginning and at end of run or twice during 8 hour shift, whichever is more frequent. Results ±20% of true value. To verify linearity near the detection limit, analyze standard at 2X the limit and analyze at the beginning and end of the run or twice per 8 hours. Serial dilution analysis performed if concentration is 50X limit, must agree ±10% of the original value. Verify linear ranges quarterly. Results must be within ±5% of true value. All measurements minimum of 2 replicate exposures, report average. AA, Hg: Serial dilution analysis performed if concentration is 25X limit, must agree ±10% of the original value. Method of standard additions required if interference is indicated.

TABLE 19
QUALITY CONTROL SUMMARY – VOLATILES ANALYSIS

Parameter	Description
Method Reference	Chemical Methods for the Analysis of Water and Waste EPA CLP SOW for Organic Analyses OLM04.2. EPA 8260B, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, groundwater, and surface water (if necessary).
Analytes	Volatiles list as indicated in Organic SOW and in Tables 4 and 10.
Holding Time	14 days for volatiles in preserved water, 14 days for all volatiles in soil and sediment, from date of sampling.
Calibration	SOIL & GROUNDWATER GC/MS: A blank and at least five calibration standards. Instrument tuning criteria must meet SOW limits.
Method Blank	SOIL & GROUNDWATER: No analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 X the concentration (for common lab contaminants, 5X for others) in the blank.
Other Blanks	SOIL & GROUNDWATER: Equipment blank and trip blank recommended per each batch. Analyze calibration blank at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
QC Check Standards	SOIL & GROUNDWATER: Relative response factors and % difference from initial calibration meet SOW limits.
Surrogate	SOIL & GROUNDWATER: Three surrogates tested in samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Internal Standard	SOIL & GROUNDWATER: Three internal standards tested in samples, blanks, and other QC samples. Recoveries must meet -50% and +100% or Lab control limits.
Field Duplicate Sample	SOIL & GROUNDWATER: One per matrix specific and sampling method specific batch, blind field duplicate sample recommended. Relative percent differences (RPD) are advisory only. MS/MSD checked for RPD; ≤20% for water samples ≤35% for soil samples.
Spike Sample	SOIL & GROUNDWATER: Analyze matrix spike/ matrix spike duplicate (MS/MSD) sample at frequency of one per twenty samples or each analytical batch, whichever is more frequent for soil and groundwater. Percent recovery (%R) per established laboratory limits.
Sample Collection	Water 3x 40 mL glass vial, teflon-lined silicon septum cap; Soil sample 8 oz. Wide mouth polyetheylene or glass; Cool to 4°C.
Other QC Criteria	SOIL & GROUNDWATER: Laboratory control sample (LCS) required if MS/MSD recoveries exceed laboratory established limits.

TABLE 20
QUALITY CONTROL SUMMARY – SEMI-VOLATILES ANALYSiS

Parameter	Description
Method Reference	Chemical Methods for the Analysis of Water and Waste EPA CLP SOW for Organic Analyses OLM04.2. EPA 8270C, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, groundwater, and surface water (if necessary).
Analytes	Semi-Volatiles list as indicated in Organic SOW and in Tables 5 and 11.
Holding Time	7 days to extraction, 40 days after extraction from date of sampling.
Calibration	SOIL & GROUNDWATER GC/MS: A blank and at least five calibration standards. Instrument tuning criteria must meet SOW limits.
Method Blank	SOIL & GROUNDWATER: No analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 X the concentration (for common lab contaminants, 5X for others) in the blank.
Other Blanks	SOIL & GROUNDWATER: Equipment blank and trip blank recommended per each batch. Analyze calibration blank at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
QC Check Standards	SOIL & GROUNDWATER: Relative response factors and % difference from initial calibration meet SOW limits.
Surrogate	SOIL & GROUNDWATER: Six surrogates tested in samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Internal Standard	SOIL & GROUNDWATER: Up to six internal standards tested in samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Field Duplicate Sample	SOIL & GROUNDWATER: One per matrix specific and sampling method specific batch, blind field duplicate sample recommended. Relative percent differences (RPD) are advisory only. MS/MSD checked for RPD; ≤20% for water samples ≤35% for soil samples.
Spike Sample	SOIL & GROUNDWATER: Analyze matrix spike/ matrix spike duplicate (MS/MSD) sample at frequency of one per twenty samples or each analytical batch, whichever is more frequent for soil and groundwater. Percent recovery (%R) per established laboratory limits.
Sample Collection	Water 1,000 ml amber glass bottle; Soil sample 8 oz. Wide mouth polyetheylene or glass; Cool to 4°C.
Other QC Criteria	SOIL & GROUNDWATER: Laboratory control sample (LCS) required if MS/MSD recoveries exceed laboratory established limits.

TABLE 21
QUALITY CONTROL SUMMARY – PESTICIDE/ PCB ANALYSIS

Parameter	Description
Method Reference	Chemical Methods for the Analysis of Water and Waste EPA CLP SOW for Multi-Media, Multi-Concentration Organic Analyses SOM01.2. EPA 8081B/ 8082A, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, groundwater, and surface water (if necessary).
Analytes	Pesticide/ PCBs list as indicated in Organic SOW and in Tables 6 and 12.
Holding Time	7 days to extraction, 40 days after extraction from date of sampling.
Calibration	SOIL & GROUNDWATER GC/MS: Calibration check standard relative response factor must be within 20% of the initial calibration. Calibration standards used with internal or external procedures depending on single column or dual column confirmation.
Method Blank	SOIL & GROUNDWATER: No analytes should be found in the blank. At least one preparation blank must be prepared for each matrix per 20 field samples or each batch whichever is more frequent. If any analyte concentration in the preparation blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 X the concentration (for common lab contaminants, 5X for others) in the blank.
Other Blanks	SOIL & GROUNDWATER: Equipment blank and trip blank recommended per each batch. Analyze calibration blank at beginning and end of analytical batch and after initial and continuing calibration or every 10 samples or two hours, whichever is more frequent.
QC Check Standards	SOIL & GROUNDWATER: Relative response factors and % difference from initial calibration meet SOW limits.
Surrogate	SOIL & GROUNDWATER: Surrogates monitoring is suggested. Add to samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Internal Standard	SOIL & GROUNDWATER: Internal standards are optional. Add to samples, blanks, and other QC samples. Recoveries must meet Lab control or SOW limits.
Field Duplicate Sample	SOIL & GROUNDWATER: One per matrix specific and sampling method specific batch, blind field duplicate sample recommended. Relative percent differences (RPD) are advisory only. MS/MSD checked for RPD; ≤20% for water samples ≤35% for soil samples.
Spike Sample	SOIL & GROUNDWATER: Analyze matrix spike/ matrix spike duplicate (MS/MSD) sample at frequency of one per twenty samples or each analytical batch, whichever is more frequent for soil and groundwater. Percent recovery (%R) per established laboratory limits.
Sample Collection	WATER 1,000 ml amber glass bottle; SOIL sample 8 oz. Wide mouth polyetheylene or glass; Cool to 4°C.
Other QC Criteria	SOIL & GROUNDWATER: DDT and Endrin breakdown testing must be performed before each analytical run. Laboratory control sample (LCS) required if MS/MSD recoveries exceed laboratory established limits.

TABLE 22
QUALITY CONTROL SUMMARY – FIELD XRF ANALYSIS

Parameter	Description
Method Reference	EPA 6200, Test Methods for Evaluating Solid Waste, SW-846.
Matrix	Soils, sediments, elemental solids.
Analytes	Metals lists as indicated in Table 7 and 9, (excludes Cr^{+6}).
Holding Time	6 Months, (28 days for mercury).
Field Instrument Calibration	An SiO2 blank matrix and at least one Site Specific Calibration Soil (SSCS), and at least one National Institute of Standards Testing (NIST) certified reference material tested to confirm empirical calibration, or fundamental parameter calibration at beginning of day. Empirical calibration requires replicate testing and averaging of at least 3 standards for each targeted analyte.
Continuing Calibration Verification	Monitoring SSCS throughout testing procedures ensures instrument consistency and sample handling procedures. Verification of results with SSCS standard %R 80-120.
Field XRF QC Check Standards	NIST certified reference materials will be identified for testing at the beginning and end of each days tests. Verification of results with NIST standard %R 80-120.
Field Instrument Blank	Blank sample is analyzed for each analyte parameter and no analytes should be found in the blank. Blank materials include SiO2 'sand', Teflon disc, or quartz disc. Analyze blank matrix at beginning of each days tests, every 20 samples, and at the end of day testing. If any analyte concentration in the blank is above the reporting limit, the lowest concentration of that analyte in the associated sample must be 10 times the concentration in the blank.
Continuing Calibration Blanks	Monitoring blanks throughout testing procedures ensures contaminants are not adhering to exposure window. Continual detection of analytes at or near the criteria noted above, may require replacement of the exposure window. See manufacturers procedures for completing this step.
Equipment Blanks	Equipment blanks will not be performed. Standard decontamination procedures are recommended on collection equipment, and dedicated storage containers (bags) will be used for sample storage.
XRF Field Duplicates	Select field duplicates from a source container, at a frequency of 1 per 20 field samples. Relative percent differences (RPD) between field duplicates are advisory only (≤35% for soil samples).
Laboratory Split Samples	Select field sample splits from a single source container, when sending samples for laboratory analysis by digestion methods. Split samples are prepared as with the originating source. Relative percent differences (RPD) between field and split sample comparisons will target ≤35% for soil samples.
Matrix Spike/ Matrix Spike Duplicate Sample	MS /MSD analyses will not be performed
Sample Collection	At least 8 oz. sample in plastic zip-lock bag; Finely divided and homogenized. Microwave or air drying is recommended for better homogenizing and representativeness.
Other Field QC Criteria	Analyze manufacturers Fe/Mn elemental check standard at beginning and at end of day to ensure resolution of peak detection. Replicate measurements for each of a high, medium, and low concentration sample are recommended to track matrix variability, and instrument drift.

APPENDIX A
FIELD CHANGE REQUEST

FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: ______

Other Affected Documents: ______

Requested Change: ______

Reason for Change: ______

Change Requested by: ______ Date ______

Reviewed by: ______ Date ______
GAI Project Manager

Comments: ______

Reviewed by: ______ Date ______
GAI QA Manager

Comments: ______

IP3 1024/FCR 1.2-5

Golder Associates Inc.

EXHIBIT **F**
FIELD CHANGE REQUEST FORM
TP-1.2-5

APPENDIX B
GOLDER XRF TECHNICAL PROCEDURE

Golder Associates

Technical Procedure

Number: TP-2.2-13
Title: X-Ray Fluorescence On-Site Measurement

Prepared by	Approved by	Approved by	Effective Date	Rev. Level
950425	4-25-95	4/26/95	4-27-95	-0-
960326	3-27-96	3/27/96	4-5-96	-1-

1. PURPOSE

The purpose of this Technical Procedure is to serve as a guide to the start-up, check-out operation, calibration, and routine use of X-Ray Fluorescence (XRF) instruments for on-site measurement (OM) or fixed facility analysis of hazardous or potentially hazardous metals. It is not intended to replace or diminish the use of the specific manufacturer's operating instructions which contain additional information for optimizing instrument performance and for utilizing it for different applications.

2. APPLICABILITY

This technical procedure is applicable to all Golder personnel engaged in measurements or analysis using X-Ray Fluorescence instruments.

3. DEFINITIONS

3.1 X-Ray Fluorescence

XRF is a non-destructive simultaneous method providing qualitative and quantitative elemental analysis for a variety of sample types with little or no sample preparation. The basis for the method is detection of fluoresced X-rays characteristic of the elements present in a sample following excitation by a radiation source. Primary X-rays from a sealed radioisotope source contained in the XRF instrument are impinged on the sample resulting in emission of fluorescence secondary X-rays characteristic of the elements present in the sample. A microprocessor-based detector provides the spectral resolution and sensitivity to quantitate metals in soil samples in the 10 - 500 mg/kg range depending on the matrix makeup and the analytes of interest.

4. REFERENCES

4.1 Spectrace 9000 Portable XRF Analyzer Operating Instructions, Rev. 0.3, January 1992, Mountain View, CA.

4.2 Bernick, Mark, et. al. "A High Resolution Portable XRF HgI_2 Spectrometer for Field Screening of Hazardous Metal Wastes". Pacific-International Congress on X-ray Analytical Methods, August 1991.

4.3 "X-ray Fluorescence Spectrometry: Uses and Applications at Hazardous Waste Sites." HMCRI Research and Development Conference, San Francisco, California, February 1992.

4.4 "XRF Determination of Lead in Paint, Soil and Sampled Particulates with Field Portable Instrumentation." P. Berry, S. Little, G. Voots, M. Bernick, G. Prince. American Chemical Society-Division of Environmental Chemistry, August 1992.

4.5 Bernick, Mark, D. Idler, L. Kaelin, D. Miller, J. Patel, G. Prince. "An Evaluation of Field Portable XRF Soil Preparation Methods." Second International Symposium on Filed Screening Methods for Hazardous and Toxic Chemicals, February 1991.

4.6 Dzubay, T. Ed. "X-ray Fluorescence Analysis of Environmental Samples." Ann Arbor Science, 1977, p. 310.

4.7 Pasmore, Jim, Piorek, S. and McLaughlin, J. "Advancements in Portable XRF Technologies for On-Site Hazardous Waste Screening."

4.8 Chappell, R., Davis, A., Olsen, R. "Portable X-ray Fluorescence as a Screening Tool for Analysis of Heavy Metals in Soils and Mine Wastes." Proceedings Conference Management of Uncontrolled Hazardous Waste Sites, Washington, D.C., 1986, p. 115.

4.9 Piorek, Stan, Rhodes, J. "A New Calibration Technique for X-ray Analyzers Used in Hazardous Waste Screening." Proceedings 5th national RCRA/Superfund Conference, April 1988, Las Vegas, NV.

4.10 Rhodes, J., Stout, J., Schlinder, J. and Piorek, S. "Portable X-ray Survey Meters for In-Situ Trace Element Monitoring of Air Particulates." American Society for Testing and Materials, Special Technical Publication 786, 1982, pp. 70-82.

4.11 Piorek S., Rhodes, J. "In-Situ Analysis of Waste Water Using Portable Pre-concentration Techniques and a Portable XRF Analyzer." Presented at the Electron Microscopy and X-ray Applications to Environmental and Occupational Health Analysis Symposium. Penn State University, October 14-17, 1980.

4.12 Piorek, S., Rhodes, J. "Hazardous Waste Screening Using a Portable X-ray Analyzer." Presented at the Symposium on Waste Minimization and Environmental Programs within D.O.D., American Defense Preparedness Assoc., Long Beach, CA, April 1987.

4.13 SPECTRACE 9000 "Field-Portable X-Ray Fluorescence." U.S EPA/ERT Standard Operating Procedures (SOP) Number 1713, Rev. 0.0, August 31, 1992.

5. DISCUSSION

The XRF analyzer employs radioactive isotopes for the production of primary X-rays. Each source emits a specific energy range of primary X-rays that cause a corresponding range of elements in a sample to emit fluorescent X-rays. When more than one source can excite the element of interest, the appropriate source(s) is selected according to its excitation efficiency for the element of interest based upon the application in use.

The sample is positioned in front of the source-detector window, and sample measurement is initiated which exposes the sample to primary radiation from the source. Fluorescent and backscattered X-rays from the sample enter through the detector window and are counted in the detector.

Solid and liquid samples can be analyzed for the elements sulfur (S) through uranium (U) with proper X-ray source selection and instrument calibration. Typical environmental applications are:

- Heavy metals in soil (in-situ or samples collected from the surface or from bore hole drillings, etc.), sludges and liquids (e.g., lead (Pb) in gasoline).
- Light elements in liquids (e.g., sulfur (S), and chlorine (Cl) in organic solutions.
- Heavy metals in industrial waste stream effluents.
- PCB in transformer oil by analysis for chlorine atoms.
- Heavy metal air particulates collected on membrane filters, either from personnel samplers or from high volume samplers.
- Lead in paint

6. RESPONSIBILITIES

6.1 Project Manager/Project Chemist

The Project Manager or Project Chemist is responsible for ensuring that all Golder personnel engaged in the analysis of soil samples have been thoroughly trained in the use of this procedure and the equipment required.

6.2 Project Field Personnel

The project field personnel are responsible for sample management and analysis in accordance with governing project-specific plans or as directed by the Project Manager/ Project Chemist, and for complying with the requirements of this procedure.

7. EQUIPMENT AND MATERIALS

7.1 Transportable X-ray fluorescence (XRF) Spectrace 9000 and all the required accessories for operating on-site.

7.2 Pure element standards for initial instrument startup checks.

7.3 Sample preparation equipment including sample cups, Mylar® film, and sample cup ring for each sample analysis.

7.4 Small sledge, cotton rags, and suitable surface for impact crushing of rocks and other material requiring particle size reduction.

7.5 Sample sieves between 0.075 and 2 mm depending on application and sample homogeneity. A number 10 sieve (2mm) is the recommended maximum particle size for routine soils application.

7.6 Optional sample drying equipment: aluminum foil, heat gun, microwave or conventional oven for drying soils to a uniform moisture content of less than 25 percent.

7.7 NIST traceable standards or site-specific references.

8. PROCEDURE

8.1 General Considerations

8.1.1 Interferences and Potential Problems

The total method error for XRF analysis is defined as the square root of the sum of squares of both instrument precision and user or application related error. Generally, the instrument precision is the least significant source of error in XRF analysis. User or application related error is generally more significant and will vary with each site and method used. The components of the user or application related error are the following.

8.1.2 Sample Placement

This is a potential source of error because the X-ray signal decreases as the distance from the radioactive source is increased. However, this error is minimized by maintaining the same distance for each sample, therefore operation in stationary laboratory mode is recommended.

8.1.3 Sample Representivity

This can be a major source of error if the sample does not represent the site. Representivity is affected by the soil macro- and micro-heterogeneity. For example, a site contaminated with pieces of slag dumped by a smelting operation will be more heterogenous than a site contaminated by liquid plating waste. This error can be minimized by either mixing a large volume of sample prior to analyzing an aliquot or by analyzing several locations as discrete samples or in-situ and averaging the results.

8.1.4 Reference Analysis

Soil chemical and physical matrix effects may be corrected by using Inductively-Coupled Plasma (ICP) or Atomic Absorption (AA) spectroscopy analyzed site-specific soil samples as calibration or calibration check samples. A major source of error can result if the samples analyzed are not representative of the site and/or if the analytical error is large. Additionally, when comparing XRF results with reference analyses results, the efficiency of the sample digestion reference analysis should be considered. Some digestion methods may breakdown different sample matrices more efficiently than others. Total hydrofluoric (HF) digestion is recommended when fixed laboratory methods are used to compare to XRF results.

8.1.5 Chemical Matrix Effects

Chemical matrix effects (due to the chemical composition of the sample) result from differences in concentrations of interfering elements. These effects appear as either spectral interferences (peak overlaps) or as X-ray absorption/enhancement phenomena. Both effects are common in soils contaminated with heavy metals. For example, iron (Fe) tends to absorb copper (Cu) X-rays, reducing the intensity of Cu measured by the detector, however this effect can be corrected mathematically. Laboratory analysis using ICP or AA is essential if background contaminant levels are unknown. Soils application software accounts for high iron in soil samples, but the user should consult with the manufacture applications chemist or project chemist about possible effects due to background levels of major constituents.

8.1.6 Physical Matrix Effects

Physical matrix effects (due to sample morphology) are the result of variations in the physical character of the sample. They may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, consider a sample in which the analyte exists in the form of very fine particles within a matrix composed of much coarser material. If two separate aliquots of the sample are prepared in such a way that the matrix particles in one are much larger than in the other, then the relative volume of analyte occupied by the analyte-containing particles will be different in each. When measured, a larger amount of the analyte will be exposed to the source X-rays in the sample containing finer matrix particles; this results in a higher intensity reading for that sample, and consequently, an apparently higher measured concentration for that element. Sample preparation (Section 8.3) can be designed to minimize error introduced by sample morphology.

8.1.7 Application Error

XRF instruments have the ability to operate in different modes or applications. Generally, the error in the application calibration is insignificant (relative to the other sources of error) if the instrument's application operating instructions are followed correctly. However, if the sample matrix varies significantly from the design of the application (e.g., using the soils application to analyze a 50% iron mine tailing sample) the application error may become significant.

8.1.8 Moisture Content

Sample moisture content will affect the analytical accuracy of soils or sludges. The overall error may be a minimal when the moisture range is small (5-20%), or it may be a major source of error when measuring the surface of soils that are saturated with water. Drying samples to a uniform moisture content before analysis is recommended.

8.1.9 Cases of Severe X-ray Spectrum Overlaps

When present in the sample, certain X-ray lines from different elements can be very close in energy and, therefore, interfere by producing a severely overlapped spectrum. Typical spectral overlaps are caused by the Kb line of element Z-1 (or as with heavier elements Z-2 or Z-3) overlapping with the Ka line of element Z (where Z is the atomic weight). This is the so-called Ka, Kb interference. Since the Ka, Kb intensity ratio for the given element usually varies from 5:1 to 7:1;, the interfering element Z-1 must be present in concentrations greater than Z in order to disturb the measurement, which can often be the case in environmental analyses. The presence of large concentrations of vanadium (Z-1) could disturb the measurement of chromium (Z). The vanadium Kb energy is 5.427 Kev and the chromium Ka energy is 5.41 Kev. The resolution of the detector is not sufficient to separate these energies. Therefore, large amounts of V in a sample will result in spectral overlap with the chromium giving erroneous results.

Other interferences can occur in the overlap of K, L, and M lines of various elements. While these are less common, examples of a severe overlap include arsenic and lead. Unwanted interference can be corrected, however due to the limits of mathematical corrections, measurement sensitivity is reduced. Generally, as concentrations in samples with Pb:As ratios of 10:1 or more can not be efficiently calculated. This may result in zero As being reported regardless of the actual As concentration.

Identification of the elements present in typical field samples using ICP or similar techniques is essential prior to initiating a field sampling program utilizing XRF.

8.2 Instrumentation

8.2.1 Limits and Precautions

The probe containing the X-ray source should be handled in accordance with the following radiological control practices:

1. The probe shall always be in contact with the surface of the material being analyzed and the analyzed material shall completely cover the probe opening (aperture) when the sources are exposed. Do not remove a sample or move the probe while the source is in operating mode.

2. When the sources are exposed, under no circumstances shall the probe be pointed at the operator or surrounding personnel.

3. Do not place any part of the operator's or co-worker's body in line of exposure when the sources are exposed or partially covered.

4. The probe must be covered with the safety cover or laboratory safety shield when not in use.

5. The appropriate state agency or the Nuclear Regulatory Commission (NRC) office must be notified (see factory supplied data on radiological safety) immediately of any damage to the radioactive source or any loss or theft of the device.

6. Labels or instructions on the probe(s) must not be altered or removed.

7. The user must not attempt to open the probe.

8. The source(s) in the probe must be leak-tested every six months. The leak test certificates must be kept on file and a copy must accompany the instrument at all times.

9. The probe laboratory safety shield assembly must be used when the probe is inverted for measuring samples contained in cups.

10. During operation the probe must be kept at least 10 feet from computer monitors and any other source of radio frequency (RF). Some monitors have very poor RF shielding and will affect measurement results.

11. The instrument shall not be dropped or exposed to conditions of excessive shock or vibration.

Additional precautions include:

1. The probe cable must never be pulled while unplugging the probe. The probe plug shall be grasped at the ribbed metal connector and squeezed and pulled gently while unplugging the connector. The connector must never be forced when plugging in the connector.

2. The handle of the electronic unit must not be rotated unless the release buttons on each side of the handle are depressed.

3. The instrument shall not be stored at an ambient temperature below -4°F or above 110°F.

4. The battery charging unit shall only be used indoors in dry conditions.

5. Battery packs shall be changed only in dry conditions.

8.3 Reagents

Generally, calibration standards (NIST traceable) are not necessary for site screening and extent of contamination analyses. Optionally, an application can be optimized or verified to be 1:1 proportional to another analytical (reference) method. This can be done by analyzing a set of Site-Specific Calibration Standards (SSCS) and performing a regression analysis on the reference and the XRF results for each element of concern. In an application any element's calibration bias can be adjusted by entering the desired slope and offset.

8.3.1 Site-Specific Calibration Standards (SSCS)

SSCS shall be representative of the matrix to be analyzed by XRF to the greatest extent possible. The concentration of the target elements in the SSCS shall be determined by independent reference described in analysis Section 8.1.4 using approved analytical procedures that meet acceptable quality levels for referee data.

8.3.1.1 SSCS Sampling

See Section 8.1.3 on sample representivity. The SSCS samples shall be representative of the matrix to be analyzed by XRF. It does not make sense to collect SSCS samples in the site containment area if you are interested in investigating off-site contaminant migration. The matrices may be different and could affect the accuracy of the XRF results. If there are two different matrices on site, collect two sets of SSCS samples.

A full range of target element concentrations is needed to provide a representative calibration check. Mixing high and low concentration soils to provide a full range of target element concentrations is not recommended due to heterogeneity problems. Unlike liquid samples, solid samples cannot be diluted and re-analyzed.

Additionally, collect several SSCS samples in the concentration range of interest. If the action level of the site is 500 mg/kg, providing several SSCS samples bracketing the action level will tend to improve the XRF analytical accuracy in this concentration range.

Generally a minimum of three appropriate SSCS samples shall be taken. Collect a minimum sample size of 4 oz. A larger size sample shall be taken to compensate for sites with greater content of non-representative material such as rocks and/or organic debris or if these samples will be used for QA purposes throughout the project (i.e., blind reference samples). Standard glass or high-density polymeric sampling jars or bags shall be used.

8.3.1.2 SSCS Preparation

The SSCS samples shall be dried to a uniform dryness. Aluminum drying pans or large plastic weighing boats for air drying may be used. After drying, remove all large organic debris and non-representative material (twigs, leaves, roots, insects, asphalt, rocks, etc.).

The sample shall be sieved through a 10-mesh sieve. Clumps of soil and sludge shall be broken up prior to sieving. Pebbles and organic matter remaining in the sieve shall be discarded unless otherwise specified. The under-sieve fraction of the material constitutes the sample.

A maximum final particle size of 10-mesh is normally recommended, however, a smaller particle size may be desired. The sample shall be mixed by dividing the sieved soil into quarters and physically mixing opposite quarters with a clean stainless steel spoon. Re-combine and repeat the quartering and mixing procedure three times. Place the sieved sample in a clean sample jar and label it with both the site name and sample identification information.

The sieve shall be cleaned between reference sample preparation by brushing, blowing, or rinsing using soap and water.

One or more plastic XRF sample cups shall be filled with the sieved soil for each SSCS sample. Film shall be cut and stretched until it is wrinkle-free over the top of the X-ray sample cup and then sealed using the plastic securing ring. The cup shall be labeled using unique identification information.

Confirmation analyses can be performed on either the XRF sample cup or the balance of the prepared sample. Analysis of the requested element(s) by AA or ICP on the total hydrofluoric (HF) digest is recommended.

8.4 Operational Checks

8.4.1 Pre-Operational Checks

Each of the three sources is used to excite different elements of interest. Source/element X-ray response checks are performed and recorded each day. A sample of pure iron for Cd-109 elements, pure titanium for Fe-55 elements and pure tin for Am-241 elements are evaluated per the manufacturer's instructions. To verify response of the source(s) used the appropriate spectra is examined after excitation of a the pure element for 50 seconds. A relative response greater than 0.95 for each element is required. Examination of iron's Cd-109 spectra demonstrate acceptable resolution. Verify spectral resolution by examining cobalt and manganese (Z±1) values are less than 0.006 relative to iron.

Energy calibration is verified by examining iron's Cd-109 spectrum. The K alpha line is verified at 6.4 ± 0.02 keV and recorded before proceeding with sample analysis. If the keV value was out of range an energy recalibration is performed using the instrument energy calibration routine described in the Spectrace 9000 operations manual. After verifying the energy calibration, spectrum resolution was confirmed by verifying that the number of counts at the centroid of the iron's K alpha line (6.4 keV) is more than twice the number of counts at ± 0.3 keV (resolution at half height). These results are recorded each analytical day. Energy calibration during operation is maintained automatically by examining X-ray back-scatter in-between each analysis.

8.4.2 Analytical Background Check

The blank (Zero) sample check is performed to monitor the instrument's zero drift. This shall be done once at the beginning of the day after an energy calibration, after loading an application, and whenever the instrument exhibits a persistent drift on a blank or low level sample.

Mount the probe in the laboratory stand and select the appropriate application. Measure the TeflonÔ blank provided with the unit using a minimum acquisition time of 60 seconds for each source. Review the results table. Most (95%) of the elemental results shall be 0± (2 x STD) (their respective standard deviation), and all of them (99%) shall be 0± (3 x STD) (their respective standard deviation). Repeat the measurement if the unit fails to meet these specifications. If several elements continue to be significantly out of these specifications, check the probe window and the blank sample for contamination.

8.4.3 Target Element Response Check

The purpose of the target element response check is to ensure that the instrument and the selected application are working properly prior to performing sample analysis. This check shall be performed at the beginning of the day. Use a low, mid, or high level sample or a standard with a known concentrations for some or all of the target elements to be checked. Select a low sample near the quantitation limit of the target elements, a mid sample near the site action level and a high sample near the maximum concentration of the target elements expected on site when available or as outlined in project-specific plans.

These samples shall be measured using the same source acquisition times that will be used for sample analysis. Record the sample check results and spectra (if disk storage is available) for documentation.

8.5 Sample Handling and Preparation

Sample handling and preparation is dependent upon the data use and goals of the investigation. Sample preparation can range from direct in-situ measurements, in which the soil or other surface measurements are made with minimal sample preparation, to sample grinding and/or analysis of sieve fractions without grinding. A maximum particle size of -10 mesh is recommended for prepared samples to achieve uniform particle size between samples, but smaller particles may be desirable in order to characterize transport mechanism (such as wind-borne or surface water transport). Sample preparation techniques shall be described in site specific plan documents.

When making XRF measurements, be sure to maintain constant measurement geometry in order to minimize variations in analysis results. Document any anomalies in measurement geometry, sample surface morphology, moisture content, sample grain size, and matrix.

8.5.1 Soil Samples

Soil samples may be analyzed either in-situ or in prepared X-ray sample cups. Operating the XRF in a soils application assumes the sample to be infinitely thick. For in-situ measurements this is almost always the case but for sample cup measurements it is advisable to fill the cup nearly full and tap it on the bench to compact the soil. This ensures that the sample is as uniformly thick as possible from sample to sample. A safety shield shall be used when analyzing sample cups.

Sample analyses performed in-situ shall first be prepared by removing large rocks and debris from the area in contact with the probe. The soil surface shall be rendered flat and compact prior to analysis. The XRF probe shall be held firmly on the ground to maximize instrument contact with the ground. The probe shall not be moved during analysis. Analysis of water saturated soils shall be avoided whenever possible. A thin layer of 0.2-mil polypropylene XRF film may be mounted on the surface probe to minimize contamination. Use of varying thicknesses of plastic (bags) have been shown to interfere with light element measurements and may affect the calibration of other elements. Additionally, plastic may contain significant levels of target element contamination.

Course-grained soils conditions, nuggets of contaminated material, or rock may not permit a truly representative sample and may adversely bias the analytical result. Such samples shall be prepared before analysis. Preparation consistency is important to minimize variation in analytical results. Crushing the sample which has been folded into a cotton rag with a small sledge hammer has proven to be effective field sample preparation method.

8.6 Routine Field Procedures

8.6.1 Calibration

The instrument's analytical computations are based on a fundamental parameter (FP) calibration algorithm. The highest order of accuracy is obtained if the entire sample composition is known. Since many of the elements in the sample can not be measured directly with the instrument, it is necessary to make assumptions about the unmeasureable elemental composition of the sample. Certain sample types exhibit minor variations of bias (deviation from a known reference value) due to variations of the unmeasureable balance in the sample. For soil samples, the routine soils application assumes SiO_2 (silica) accounts for the majority of the unmeasureable balance. This assumption provides sufficiently accurate analyses without adjustment for most samples. The accuracy of the measurement can be fined tuned within the application by adjusting the slope and off-set values for a given target analyte when reference samples have been characterized for the project. Calibration adjustments are not considered trivial, but are performed based on knowledge of the site material being analyzed during on-site analysis. Adjustments to slope and offset are performed only when: 1) appropriate references samples are available and have been fully evaluated, and 2) when the samples collected for analysis are appropriate relative to the reference material. Under most conditions when XRF data are generated, 10% of all samples are confirmed using ICP or AA methods. This is the basis of evaluation of reported XRF results and provides quality assurance that the accuracy of the measurement are appropriate.

When the sample matrix can not be characterized as soil, special applications must be created if the desired accuracy is not obtained using the routine soil application. The user shall consult with the project manager/chemist or the manufacturer's technical support department for support in the development of non-routine applications.

Factory Set

The spectrace 9000 comes equipped with fundamental parameters capabilities which enables the user to make measurements without site specific or site typical calibration standards. Factory installed calibration for specific applications are based on the averages for a particular application. For example, the soils application calibration is based on the average abundance of elements in natural soil and accounts for inter-element matrix effects based on the average values of major elements present in a typical soil sample. Similar fundamental parameters are established for other matrices such as lead in paint, chlorine in oil etc. The use of standard reference materials derived from typical background matrix types, such as NIST or EPA standard reference materials, shall be used to verify factory set calibration when operating in the factory set calibration mode.

Site Typical

A site typical calibration curve is based on samples similar in composition, but not necessarily matrix matched. Extreme caution shall be exercised when using a site-typical calibration check. Situations have been encountered where increased iron levels in mine tailings relative to the calibration standards resulted in anomalously high chromium results (in excess of several wt% Cr!). Corroboratory analyses found chromium in the zero to 40 mg/kg range.

Site Specific

To minimize enhancement/absorption and spectral interference errors, calibration standards are collected from the specific site in question. These Site Specific Calibration standards (SSCS) shall closely emulate the physical and chemical matrix of the routine samples. The SSCS are prepared identically to field samples in order to minimize particle size bias.

Characterization of the SSCS using a total digestion procedure rather than a partial extraction is recommended because XRF is a total analyte method independent of phase or specification.

9. QUALITY ASSURANCE/QUALITY CONTROL

9.1 Precision

The precision of the method is monitored by reading the low or mid SSCS at the start and end of sample analysis and after approximately every tenth sample (a daily total of seven measurements is recommended). Determining the precision around the site action level can be extremely important if the XRF results are to be used in an enforcement action. Therefore, selection of an SSCS at or near the site action level or level of concern is recommended. The sample is analyzed by the instrument for the normal field analysis time and the results are recorded. The standard deviation for each dependent element is calculated. The relative standard deviation (RSD) of the sample mean can be used to calculate precision. The RSD should be within ±40% for the data to be considered adequately precise. Alternatively, field or laboratory duplicates may be analyzed to monitor precision. Relative percent difference (RPD) between duplicates shall be $\leq$35% for the data to be considered adequately precise without qualification.

9.1.1 Preliminary Detection Limit (DL) and Quantitation Limit (QL)

A preliminary DL and QL is needed to give the operator an indication of the instrument's capability out in the field. A low or blank SSCS sample is selected as described in Section 8.3.1. More than one standard may be needed to obtain low or blank concentration values for each element. Alternatively, the Teflon blank may be used if a blank soil or sediment sample is unavailable.

The sample is measured ten times without moving it using the anticipated field analysis measuring time. The standard deviation of the mean for each target element is calculated (using the N-1 formula).

If the standard deviation has a fractional component round up to the next whole number prior to calculating the DL and QL.

The definition of the DL is three times the calculated standard deviation value.

The definition of the QL is 10 times the calculated standard deviation value.

9.1.2 The Method Minimum Detection Limit (MMDL) and Method Quantitation Limit (MQL)

The MMDL and MQL are calculated from the measurement of a low SSCS selected as described in Section 8.3.1 at the start and end of sample analysis and after approximately every tenth sample (a daily total of seven measurements is recommended).

Disable the display thresholds. This will permit results less than one standard deviation (STD) to be displayed (even negatives). Measure the SSCS using the same analysis, measuring time used for the samples. Enable the display thresholds prior to analyzing the next sample.

The standard deviation of the mean for each target element is calculated. If the standard deviation has a fractional component round up to the next whole number prior to calculating the MMDL and MQL.

The definition of the MMDL is three times the calculated standard deviation value.

The definition of the MQL is 10 times the calculated standard deviation value.

9.2 Reporting Results

All raw XRF data shall be reported including the individual results of multiple analyses of samples and sampling points. The average and concentration range of each multiple analysis shall also be reported.

A "reported" value for each analysis or average of multiple analyses shall be processed in the following manner.

1. Round the value to the same degree of significance contained in the SSCS sample assay values (usually two) if the element's calibration has been adjusted (see Section 6.0).
2. Report all values less than or equal to the MMDL as not detected (ND).
3. Flag and note all values greater than the MMDL and less than or equal to the MQL as estimated (usually with a "J" next to the reported value).
4. Report all values above the MQL and within the linear calibration range (if the element's calibration has been adjusted (see Section 6.0).
5. Flag and note all values above the linear calibration range (greater than the highest SSCS used in the calibration adjustment procedure) with a "*" next to the reported value.

9.3 Accuracy

Accuracy, relative to a specific digestion method and elemental analysis procedure is determined by confirmation of the XRF sample result (prepared sample cups may be submitted) with AA or ICP analysis.

To do a total accuracy check, confirmation samples shall consist of field samples collected throughout the entire sampling effort. A minimum of 10% of the number of field samples are selected at random, but a number of samples at or near the action level is recommended. The results of the metal analysis (dependent) and the XRF analysis (independent) are evaluated with a regression analysis. The correlation coefficient (r^2) should be 0.7 or greater. All XRF results should be presented along with an estimate of the error based on confirmation analyses.

Another very important source of potential difference between XRF and AA or ICP results is incomplete digestion employed prior to ICP or AA analyses. Since XRF is a total elemental technique, any comparison with referee results must account for the possibility of variable extraction depending upon the extraction method used and its ability to dissolve the mineral form in question.

9.3.1 Matrix Considerations

Other types of QA/QC verification shall include verification that the instrument calibration is appropriate for the specific site to be assessed. This includes verification of potential multiple soil matrix types that may exist at a site. Matrix variations that affect the XRF measurement include large variations in calcium content such as may be encountered when going from siliceous to calcareous soils as well as variations in iron content.

10. DATA VALIDATION

10.1 Confirmation Samples

Confirmation samples are recommended at a minimum rate of 10%. Ideally, the sample cup analyzed by XRF shall be the same sample that is submitted for AA or ICP analysis. When confirming an in-situ analysis, collect a sample from a 6 inch by 6 inch area for both an XRF measurement and confirmation analysis. The correlation coefficient between XRF and AA/ICP data should be 0.7 or greater.

10.2 Recording Results

Record all results and monitoring activities including calibration and instrument checks in a laboratory or field notebook. Alternatively, record results electronically on a hard drive or floppy disk.

11. HEALTH AND SAFETY

When working with potentially hazardous materials follow USEPA, OSHA, GAI and/or any other applicable health and safety practices.

12. FIELD CHANGE REQUEST

Variation from established procedure requirements may be necessary due to unique circumstances encountered on individual projects. All variations from established procedures shall be documented on Field Change Request (Exhibit A) and reviewed by the Project Manager and the QA Manager.

The Project Manager may authorize the Task Leader to initiate variations as necessary. If practical, the request for variation shall be reviewed by the Project Manager and the QA

Manager prior to implementation. If prior review is not possible, the variation may be implemented immediately at the direction of the Task Leader, provided that the Project Manager is notified of the variation within 24 hours of implementation, and the Field Change Request is forwarded to the Project Manager and QA Manager for review within 2 working days of implementation. If the variation is unacceptable to either reviewer, the activity shall be reperformed or action shall be taken as indicated in the Comments section of the Field Change Request form.

All completed Field Change Request forms shall be maintained in project records.

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FIELD CHANGE REQUEST

Golder Associates

Job/Task Number: ____________________

Other Affected Documents: ____________________

Requested Change: ____________________

Reason for Change: ____________________

Change Requested by: ____________________ Date __________

Reviewed by: ____________________ Date __________
GAI Project Manager

Comments: ____________________

Reviewed by: ____________________ Date __________
GAI QA Manager

Comments: ____________________

EXHIBIT **A**
**FIELD CHANGE
REQUEST FORM**
TP-2.2-13

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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