Prepared for

New York State Department of Environmental Conservation

Division of Environmental Remediation, Region 8
6274 East Avon-Lima Road
Avon, New York 14414-9519

SOIL/DUST CONTROL AND MONITORING PLAN

INTERIM REMEDIAL MEASURES
Former Sperry Remington Site – North Portion
777 South Main Street,
City of Elmira, Chemung County, New York
NYSDEC Project C808022

Prepared by

Geosyntec consultants
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Project Number MN0832D

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1. INTRODUCTION

This Soil/Dust Control and Monitoring Plan (SDCMP) was prepared by Geosyntec Consultants, Inc. and its New York affiliate Beech and Bonaparte Engineering, P.C. (collectively Geosyntec) to address the issue of soil and dust control during planned Interim Remedial Measures (IRM) activities at the Former Sperry Remington Site – North Portion (Site #808022) (Site) in Elmira, New York. The Site is located at the Elmira High School (EHS) property (formerly known as Southside High School), 777 South Main Street in Elmira, Chemung County, New York and owned by Elmira City School District (ECSD).

The SDCMP was developed to be consistent with New York State Department of Health's (NYSDOH's) Generic Community Air Monitoring Plan (CAMP) provided in New York State Department of Environmental Conservation (NYSDEC) *Technical Guidance for Site Investigation and Remediation* (DER-10). A copy of the NYSDOH Generic CAMP is provided as Attachment 1. Geosyntec also reviewed dust control and monitoring plans presented in the 2009 Environmental Monitoring Plan (EMP) prepared for ECSD in preparation of the SDCMP.

2. PLAN ORGANIZATION

The remainder of the SDCMP is organized into the following Sections:

- Section 3, *Identification*, provides the required contact information for the project owner, contractor, and consultant;
- Section 4, *Scope of Work*, presents details on the specific work tasks for the remedial project;
- Sections 5.1 and 5.2, *Dust Mitigation and Dust Monitoring*, provide details of the dust mitigation, community air monitoring measures, and the numeric criteria that will be used in conjunction with dust monitoring activities to control emissions from the Site; and
- Section 6, *Quality Assurance*, presents the specific field and laboratory measures that will be conducted to maintain data quality.

3. IDENTIFICATION

3.1 Project Owner

Project Owner:	Unisys Corporation
Address:	3199 Pilot Knob Road, MS F1B05
	Eagan, MN 55121
Contact Person:	Kevin Krueger
Phone Number:	(651) 687-2210

3.2 IRM Contractor

IRM Contractor:	Remedial Construction Services, L.P. (RECON)
Address:	950 West Valley Road
	Wayne, PA 19087
Contact Person:	John Geary
Phone Number:	(857) 378-9225

3.3 Firm Preparing this Soil/Dust Control and Monitoring Plan

Firm Preparing SDCMP:	Geosyntec Consultants, Inc. and Its Affiliate
	Beech and Bonaparte Engineering, PC
Address:	10211 Wincopin Circle, 4th Floor
	Columbia, MD 21044
Project Manager:	Aron Krasnopoler, Ph.D., P.E.
Office Phone Number:	(410) 381-4333

3.4 Qualified Environmental Professional

A qualified environmental professional (QEP) as defined in DER-10 Section 1.3 (b) shall be designated at the start of each phase of work. The QEP will be responsible for the implementation of the dust monitoring, control and mitigation measures.

QEP: Aron Krasnopoler, Ph.D., P.E.
Mobile Phone Number: (202) 550-7724

On-site Representative: Ashwin Ranna
Mobile Phone Number: (412) 552-4758

4. SCOPE OF WORK

4.1 General

The general scope of the Site remediation work consists of the following:

- Clearing of vegetation and debris;
- In-situ Stabilization of Lead;
- Soil excavation;
- Direct loading of hazardous soils for off-Site transport;
- Stockpiling of non-hazardous soil for backfill or off-Site transport.
- Backfilling and compaction of fill to achieve design grade; and
- Off-Site Transport.

The potential for the development of dust from soil may exist at each of these steps.

4.2 Excavation and Backfilling

Soils will be excavated to achieve soil cleanup goals. Excavated soils that are characterized as hazardous waste will be direct loaded for off-Site transport and disposal. Non-hazardous soils will be stockpiled for either use as backfill on-Site or disposal off-Site. Backfilling and compaction of soils will occur on-Site as part of a re-grading restoration process. Imported fill and stockpiled soils will be used to achieve final grade for restoration. Soil will be moved and compacted on-Site during this process, therefore, continual dust monitoring will be required throughout the process.

4.3 Loading and Hauling

4.3.1 Movement of Material Between the Site and MSA

Trucks may be loaded directly from the excavation or stockpile areas. Loads will be wetted prior to relocation between the Site and the Material Staging Area (MSA). All soil transported within the Site will comply with the following:

- No material may extend above the sides or rear of the truck/trailer;
- Prior to leaving the excavation area, the surface of the loaded soils will be moistened;
- The exterior of the trucks/trailers shall be cleaned off prior to leaving the Site.

4.3.2 Transport of Material for Off-Site Disposal

Trucks may be loaded directly from the excavation or stockpile areas. Loads will be wetted and covered prior to leaving site. All soil transported within the Site will comply with the following:

- No material may extend above the sides or rear of the truck/trailer;
- Prior to covering, the surface of the loaded soils will be moistened;
- Beds of trucks/ trailers carrying impacted soils will be completely covered to prevent particulate emissions to the atmosphere.
- The exterior of the trucks/trailers shall be cleaned off prior to leaving the Site.

5. DUST MITIGATION PRACTICES

5.1 General

To mitigate the potential for fugitive dust from the Site, specific monitoring tasks as described in Section 5.2 will be conducted. Based on the results of monitoring actions, mitigation measures may be implemented.

5.1.1 Water Application Practices

Water application shall be used to suppress or mitigate the generation of fugitive dust or odors during excavation, backfilling, grading, and supplemental activities. Water will be applied by a water truck to carpet the targeted soil using fine atomized sprays. Water will be applied in the same manner to suppress dust on permanent and temporary haul roads, stockpiles, and areas undergoing the aforementioned activities. A direct spray may also be applied through the use of a fire hose and hydrant for more targeted dust mitigation at the Site.

5.1.2 Stockpile Management Practices

Additional practices shall be implemented for the control and mitigation of dust from the temporary stock piles created during soil excavation and grading:

- Stockpiles shall be maintained to avoid steep sides or faces;
- During periods of inactivity exceeding an hour, or as deemed necessary by the prevailing wind conditions, the soil stockpile shall be covered; and

Stockpiles shall not be placed within 25 yards of occupied buildings.

5.1.3 Grading Practices

The following grading practices shall be followed to minimize dust generation:

- Construction excavators will be emptied slowly;
- Direct water spraying shall be directed at the load buckets and excavation face; and
- Drop height from the loader bucket shall be minimized.

5.1.4 Vehicular Practices

The following vehicular practices shall be followed to minimize dust generation:

- Prior to loading or unloading at the Site, all trucks will be staged on-Site as much as possible to avoid potential impacts on the local streets;

- Trucks will not be allowed to sit idling more than 5 minutes to avoid unnecessary exhaust fumes;
- While on-Site, all vehicles are required to maintain slow speeds, e.g., less than ten miles per hour (10 mph), for safety purposes and for dust control measures;
- Vehicular traffic in non-designated travel areas shall be minimized;
- The size of the vehicle staging areas shall be limited;
- The trucks will remain on clean areas to the extent possible in an effort to minimize the need to decontaminate the truck tires; and
- All haul trucks shall be covered with tarps prior to transporting soil to or from the Site.

5.2 Community Air Monitoring Program

Ambient air monitoring will be conducted on-Site during IRM activities to monitor potential impacts to the downwind community (potential receptors include the school community, residences, businesses, and workers not directly involved with IRM activities). The air monitoring program will include two different types of ambient air quality measurements (1) real-time monitoring using direct reading instruments, and (2) periodic time-integrated sampling using fixed laboratory measurements for PCBs. The time-integrated sampling will be used to provide chemical-specific data for the assessment of potential impacts. Real-time air monitoring using direct reading instruments will be conducted during soil remediation activities whenever Site soils are disturbed or imported soils are handled on Site. The key elements of the program are described in detail in the following subsections.

5.2.1 Monitoring Locations

As a component of this approach, air monitoring will be conducted around the working areas and at designated upwind and downwind locations that will vary as a result of daily prevailing wind patterns. A minimum of one (1) upwind and four (4) downwind locations shall be used for real-time monitoring. The four (4) downwind locations shall be equally distributed along the perimeter of the work area. During work activities within twenty (20) feet of potentially exposed populations or occupied structures, continuous monitoring locations will be selected based on the nearest potentially exposed individual and the location of ventilation system intakes for nearby structures. In those cases, permanent air monitoring locations will be installed near ventilation system intakes. If action levels are exceeded at those locations, then the source of the exceedance will be evaluated, and the positioning of upwind and downwind monitoring stations will be reassessed. One (1) upwind and two (2) downwind real-time monitoring locations will be used for time-integrated sampling for PCBs during excavation of PCB-impacted soils.

5.3 Real-Time Monitoring

The real-time monitoring program will consist of real-time monitoring for particulate matter that are less than ten (10) micrometers in size (PM-10) using an aerosol monitor (Thermo Andersen DataRAM 4 or equivalent). The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration will be visually assessed during all work activities. Particulate concentrations will be monitored continuously at upwind and downwind perimeters of the work area at temporary particulate monitoring locations. Monitoring equipment will be capable of integrating over a period of fifteen (15) minutes (or less) for comparison to airborne particulate action levels. All readings must be recorded, and air monitoring records will be maintained electronically. Real-time monitoring data will be attached the Daily Construction Report to be sent the NYSDEC and the NYSDOH by noon the following day. Air monitoring records will be available for review by NYSDOH, NYSDEC and Chemung County Health Department, if requested.

5.3.1 Time-Integrated Sampling

Time-integrated sampling will include the collection of three (3), eight-hour (8-hr) time-integrated air samples along the perimeter of the Site for laboratory analysis of PCBs. These time-integrated samples will be used for assessing the potential for off-Site exposures. One (1) upwind and two (2) downwind monitoring locations will be used for time-integrated sampling. Time integrated samples will be collected during work hours (excluding lunch and break time) from each sampling location using high-volume air samplers for each day of the first week of PCB-impacted soil excavation activities. The samples will be analyzed under expedited three-day (3-day) laboratory turnaround times. After one week of PCB-impacted soil excavation, the need for daily time-integrated sampling for PCBs will be re-evaluated. If results from the first week of sampling indicate that PCB concentrations are consistent with background or are below comparison criteria, the PCB sampling frequency will be reduced to one day per week.

Samples for PCBs analyses will be collected using Tisch TE-1000 Series High Volume Samplers with PUF Poly-Urethane Foam, or equivalent. Five-point calibrations will also be performed on the PUF samplers following mobilization, using certified calibration devices. Samples will be collected on a PUF glass cartridges or equivalent prepared by the laboratory. Samples will be collected at flow rates of approximately eight standard cubic feet per minute (SCFM) and samplers will be battery and/or solar-powered or use on-Site utilities, if available. Gasoline powered generators may be needed for operation of the high-volume air samplers depending on field conditions. If gasoline powered generators are utilized, they will be placed approximately 50 to 100 feet away from sampling devices in a downwind direction in an attempt to mitigate potential biases for the samples. The inlet of the sampling device will be placed at a height of approximately six and a half feet (2 meters). Following sample collection, samples will be stored on ice and transported to the laboratory under chain-of-custody protocols for analysis of PCBs by USEPA Method TO-4A. The sample hold time for USEPA Method TO-4A is seven (7) days.

5.3.2 Action Levels

Downwind PM-10 particulate levels will be compared to the background (upwind perimeter) PM-10 particulate level. If the difference between any downwind level and the background level exceeds the one hundred (100) micrograms per cubic meter (µg/m^3) for the fifteen (15) minute averaging period or if airborne dust is observed leaving the work area, then dust control measures, including increasing water spraying, or stopping work, must be employed. If, after implementing dust suppression techniques, particulate levels above background (upwind) exceed one hundred fifty (150) µg/m^3, work will be suspended and controls will be re-evaluated. Work may resume provided that dust suppression measures and other controls are successful in reducing downwind particulate levels above background are below one hundred fifty (150) µg/m^3 and visible dust migration is not observed. Also, if extreme wind conditions make dust control ineffective, remedial actions will need to be suspended.

Downwind time-integrated PCB concentrations will be compared to background (upwind perimeter) time-integrated PCB concentrations and the difference will be compared to an action level for PCBs in ambient air. The proposed PCB action level is 15 µg/m^3 based on inhalation unit risk (IUR) of 1 x10 $^{-4}$ per µg/m^3 presented in the USEPA Integrated Risk Information System (IRIS)[1] and is calculated using the following formula:

$$Action\ Level = \frac{TR * AT}{IUR * ET * EF * ED}$$

Where:

TR = Target Risk = 1x10^6
AT = Averaging Time (70 year)
ET = Exposure Time (10 hours worked per day divided by 24 hours)
EF = Exposure Frequency (length of actual excavation [40 days]/365 days)
ED = Exposure Duration (1 year)

If any PCB concentration exceeds the PCB action level, NYSDEC and NYSDOH will be notified immediately and work practices will be re-evaluated and changes will be implemented, as appropriate.

[1] https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=294

6. QUALITY ASSURANCE

6.1 General

Data quality will be maintained for the project through implementation of specific evaluations or activities. The following sections describe the specific measures that will be conducted in the field and by the contracted laboratory.

6.2 Field

Field activities will be documented with daily air monitoring logs. Field activities and conditions will also be documented in daily field logs and with photographs. Sample integrity will be maintained by following the applicable sample collection and handling procedures, specified in this SDCMP. Samples collected for laboratory analysis will be shipped under chain-of-custody protocols. Field data quality will be maintained by calibrating field equipment in accordance with manufacturer's recommendations. Calibration records will be recorded in daily field logs. Field documentation including daily logs, air monitoring logs and laboratory chain-of-custody forms will be peer reviewed for quality and compliance with project objectives and protocols.

6.3 Laboratory

Laboratory data quality assessment criteria will be used to evaluate the quality of the reported laboratory data. The laboratory Standard Operating Procedure for USEPA Method TO-4A is provided as Attachment 2. The data quality assessment criteria are expressed in terms of precision, accuracy, representativeness, completeness, and comparability. Procedures used to assess data precision and accuracy will be in accordance with the respective analytical methods from the USEPA's Test Methods. These are discussed in more detail below.

6.4 Data Quality Assurance/Quality Control (QA/QC)

The data quality evaluation to be used on all elements of the data collected during the program includes:

- Precision;
- Accuracy;
- Representativeness;
- Completeness; and
- Comparability.

These elements are discussed in more detail below.

6.4.1 Precision

Precision is the measure of variability among individual sample measurements. Precision of the sample matrix will be demonstrated by the relative percent difference (RPD) between laboratory sample duplicates and between primary and field duplicate samples. Field duplicates will be collected once per week during the first two (2) weeks of daily sampling. When the laboratory control sample (LCS) results meet the accuracy criteria, results are also believed to be precise, and represent the precision of the laboratory independent from sample matrix. This is based on the LCS being within control limits in comparison to LCS results from previous analytical batches of similar methods and matrices. Precision is expressed in terms of RPD between the values resulting from duplicate sample analyses.

Acceptable levels of precision will vary according to the sample matrix, the specific analytical method, and the analytical concentration relative to the method detection limit (MDL). Precision criteria for the laboratory QC samples must be defined by historical control limits developed through the use of control charts. An RPD within the control limit indicates satisfactory precision in a measurement system.

6.4.2 Accuracy

Accuracy is a measure of the closeness of a reported concentration to the true value. Accuracy is expressed as a bias (high or low) and is determined by calculating percent recovery from LCSs or surrogate spikes. Surrogate spike recoveries indicate accuracy relevant to a unique sample matrix. LCS recoveries indicate accuracy relevant to an analytical batch lot and are strictly a measure of analytical accuracy conditions independent of samples and matrices. The percent recovery of an analyte, and the resulting degree of accuracy expected for the analysis of QC spiked samples, are dependent upon the sample matrix, method of analysis, and the compound or element being measured. The concentration of the analyte relative to the detection limit of the method also is a major factor in determining the accuracy of the measurement.

The degree of accuracy and the recovery of the analyte to be expected for the analysis of QC samples and spiked samples are dependent upon the matrix, method of analysis, and the compound or element being measured. The concentration of the analyte relative to the detection limit is also a factor in determining the accuracy of the measurement. Laboratory control charts will be used to determine acceptance criteria.

6.4.3 Representativeness

Representativeness expresses the extent to which collected data characterizes the chemical concentrations from the Site. Sample collection, handling, and analytical procedures are designed to obtain the most representative sample possible. Representative samples will be achieved by the following:

- Use of appropriate sampling procedures, including proper equipment and equipment decontamination;

- Use of appropriate analytical methods for the required parameters and project reporting limits; and

- Analysis of samples within the required holding times.

6.4.4 Completeness

Completeness is defined as the percentage of laboratory measurements judged to be valid on a method-by-method basis. Valid data is defined as all data and/or qualified data considered to meet the DQOs for this project. Data completeness is expressed as percent complete (PC) and should be equal to 90 percent. The goal for meeting analytical holding times is 100 percent. At the end of each sampling event, the completeness of the data will be assessed. The laboratory results will be monitored as they become available to assess laboratory performance and its effect on data completeness requirements.

6.4.5 Comparability

Comparability expresses the confidence with which data from one sample, sampling round, Site, laboratory, or project can be compared to those from another. Comparability during sampling is dependent upon sampling program design and time periods. Comparability during analysis is dependent upon analytical methods, detection limits, laboratories, units of measure, and sample preparation procedures.

Comparability is determined on a qualitative rather than quantitative basis. For this project, comparability of data collected will be maintained by adherence to standard sample collection procedures, standard field measurement procedures, and standard reporting methods. In addition, to support the comparability of fixed-base laboratory analytical results with those obtained from previous or future testing, all samples will be analyzed by USEPA-approved methods, where available. The USEPA-recommended maximum permissible sample holding times for organic and inorganic parameters will not be exceeded. Analytical standards will be traceable to standard reference materials. Instrument calibrations will be performed in accordance with USEPA method specifications and will be checked at the frequency specified for the methods.

Attachment 1
NYSDOH Generic CAMP

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or

overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

December 2009

Attachment 2
Laboratory Standard Operating Procedure

Title: Polychlorinated Biphenyls (PCBs) by GC/ECD (SW846 8082A, USEPA TO4A/TO10A)

Approval Signatures:

Don Dawicki
Laboratory Director

Ben Kirchner
EHS Coordinator/ CLP-SVOA Dept. Manager

Luke Orchard
Quality Assurance Manager

Approval Date: January 24, 2018

Facility Distribution No. Electronic **Distributed To: Facility Intranet**

The controlled copy of this SOP is the PDF copy of the SOP that is posted to the laboratory's SOP Directory. Printed copies of this SOP or electronic copies of this SOP distributed outside the facility are considered uncontrolled.

1.0 Scope and Application

This SOP describes the laboratory procedure used to determine the concentration of polychlorinated biphenyls (PCBs) as Aroclors using dual column gas chromatography with electron capture detectors (GC/ECD).

This SOP is applicable to instrument analysis only. Extraction and extract cleanup procedures are provided in separate SOPs.

1.1 Analytes, Matrices, and Reporting Limits

This procedure may be used for a variety of matrices including: air, sediment, soil, tissue, and water.

The list of target compounds that can be determined from this method along with the associated reporting limits (RL) is provided in Table 1.

2.0 Summary of Method

2.0uL of extract is injected into a dual capillary column gas chromatograph equipped with electron capture detectors (GC/ECD). The chromatographic data is used to determine the list of analytes provided in Table 1. NOTE: Injection volumes used must be validated and all samples are to be analyzed with the same injection volume used for standard solutions within the initial calibration. Quantitation is accomplished by averaging the concentration of three to five peaks for each Aroclor against a calibration curve. Internal standards are used to compensate for instrument variation.

This SOP is based on the following reference methods:

- SW-846 Method 8082A Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 0, February 2007.
- Compendium Method TO-4A, Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using High Volume Polyurethane Foam (PUF) Sampling Followed By Gas Chromatographic/Multi-Detector Detection (GC/MD), January 1999 (EPA/625/R-96/010b)
- Compendium Method TO-10A, Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using Low Volume Polyurethane Foam (PUF) Sampling Followed By Gas Chromatographic/Multi-Detector Detection (GC/MD), January 1999 (EPA/625/R-96/010b)

If the laboratory procedure is modified from the above reference method, a list of modifications will be provided in Section 16.0 of this SOP.

3.0 Definitions

A list of terms and definitions are provided in Appendix A.

4.0 Interferences

- Method interference may be caused by contaminants in the extraction solvent. Solvents should be stored away from organochlorine compounds to minimize contamination.

- Non-target compounds co-extracted from the sample matrix can also cause interference, the extent of which will vary depending on the nature of the samples. Elemental sulfur is often found in sediment samples and its presence will result in broad peaks. Samples are screened prior to analysis, and those samples that contain high levels of sulfur are subject to sulfur cleanup (SW-846 3660B). Cleanup procedures that may be used for this method include: GPC (SW-846-3640A), silica gel (SW-846 3630C), Florisil (SW-846 3620B), and Sulfuric acid Cleanup (SW-846 3665A).

- Phthalate esters introduced during sample preparation can pose a problem in the determination of target analytes. Common flexible plastics contain varying amounts of phthalate esters. These phthalate esters can be easily extracted or leached during extraction. To minimize this interference, avoid contact with any plastic materials.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats, and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

The gas chromatograph contains zones that have elevated temperatures. The analyst must be aware of the locations of those zones and must cool them to room temperature prior to working on them.

There are areas of high voltage in the gas chromatograph. Depending on the type of work involved, either turn the power to the instrument off or disconnect it from its source of power.

5.2 Primary Materials Used

Table 2 lists materials used in this method which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

6.0 Equipment and Supplies

Catalog numbers listed in this SOP are subject to change at the discretion of the vendor. Analysts are cautioned to be sure equipment used meets the specification of this SOP.

6.1 Miscellaneous

- Autosampler Vials, National Scientific or equivalent.

- Hydrogen Generator: Parker Hannafin H2-1200 or equivalent.

- Volumetric Syringes, Class "A" (10µl, 25µl, 50µl, 100µl, 250µl and 500µl), Hamilton or equivalent.

6.2 Analytical System

- Computer Hardware/Software: GC Acquisition Platform – ChemStation. Data Processing – TestAmerica Chrom, current version.

- GC/ECD: with dual columns, dual ECDs, and auto-sampler capable of injecting a 0.2-2.0 µL aliquot split onto two columns: Agilent Technologies 6890N with 7683 Series injector, or equivalent.

- GC Columns: A dual fused silica capillary column system that will provide simultaneous primary and confirmation analyses:
  - RTX-CLP, (30m x 0.32 mm ID x 0.5µm)
  - RTX-CLPII, (30m x 0.25 mm ID x 0.5µm)

Equivalent columns may be used provided the elution orders are documented and compound separations are maintained.

7.0 Reagents and Standards

7.1 Reagents

- Hexane, Ultra-Resi Analyzed, JT Baker or equivalent.

7.2 Standards

Purchase stock standard solutions from commercial vendors and from these prepare calibration and working standards by diluting a known volume of stock standard in an appropriate solvent to the final volume needed to achieve the desired concentration. The recommended formulation for each standard used in this procedure is provided in Appendix B along with the recommended source materials, expiration dates and storage conditions.

8.0 Sample Collection, Preservation, Shipment and Storage

The laboratory does not perform sample collection, so these procedures are not included in this SOP. Sampling requirements may be found in the published reference method. Listed below are minimum sample size, preservation, and holding time requirements needed for this test.

Matrix	Sample Container	Minimum Sample Size	Preservation	Extract Holding Time	Reference
Air	Polyurethane Foam Plug (PUF)	1 PUF	Chilled to 4℃	40 Days	TO-10A
Air	PUF	1 PUF	Chilled to 4℃	40 Days	TO-4A
Water	Glass	1 L	Chilled to 4℃	40 Days	SW-846 8082A

Solid	Glass	50 g	Chilled to 4℃	40 Days	SW-846 8082A

Analytical holding time is determined from date of initiation of extraction.

Unless otherwise specified by client or regulatory program, after analysis, samples and extracts are retained for a minimum of 30 days after provision of the project report and then disposed of in accordance with applicable regulations.

Note: EPA SW-846 Update IV Chapter 4 re-defined the holding times for PCBs as "NONE". The EPA Methods Update Rule re-defined holding times for PCBs as one year from collection to extraction and one year from extraction to analysis. The laboratory incorporates the extended preparation holding times for PCBs on a project-specific basis, as allowed by that particular state agency and client.

9.0 Quality Control

9.1 Sample QC

The laboratory prepares the following quality control samples with each batch of samples.

QC Item	Frequency	Acceptance Criteria
Method Blank (MB)	1 in 20 or fewer field samples	See Table 3
Laboratory Control Sample (LCS)	1 in 20 or fewer field samples	See Table 3
Laboratory Control Sample Duplicate (LCSD)	1 in 20 or fewer field samples, if volume is not present for MS/MSD	See Table 3
Matrix Spike(s) MS/MSD	1 in 20 or fewer field samples	See Table 3
Sample Duplicate (SD)	Client Request	See Table 3

9.2 Instrument QC

The following instrument QC is performed:

QC Item	Frequency	Acceptance Criteria
Initial Calibration (ICAL)	Initially; when ICV or CCV fail	See Table 3
Second Source Calibration Verification (ICV)	Once, after each ICAL	See Table 3
Continuing Calibration Verification (CCV)	Daily, every 20 field samples or 12 hours (whichever is sooner)	See Table 3
Retention Time Windows	Once every 24 hours for all Aroclors reported (8082A). Once every 24 hours for Aroclor 1016/1260 (TO4/TO10)	See Table 3

10.0 Procedure

10.1 Instrument Operating Conditions

Install a five meter deactivated guard column into the injection port and connect the guard column to the separate analytical columns using a glass "Y". The analytical columns are installed into independent ECD detectors.

The recommended instrument operating conditions are as follows:

Initial Temperature	130ºC
Temperature Program	30ºC per minute to 210ºC; 10ºC per minute to 250ºC, hold 0.37 minutes; 20.0ºC per minute to 300°C. 30ºC per minute to 320 ºC. Hold for 3 minutes.
Detector Temperature	300ºC
Injector Temperature	220ºC
Injection volume	2.0µL
Carrier Gas	Hydrogen

Optimize the flow rate of the carrier gas by injecting an un-retained substance onto the column at an isothermal oven state and adjusting the flow to obtain the recommended dead volume time.

10.2 Retention Time Window Establishment

Whenever a new GC column is installed, establish RT windows for each analyte by analyzing three standards over a 72-hour period. Calculate the mean RT and Standard Deviation (SD). The RT window is calculated as the mean RT ± 3SD. If the SD is <0.01 minutes, a default SD of 0.01 minutes may be used.

If this procedure results in RT windows that are too tight, favoring false negatives, the laboratory may opt to use an alternate method to determine the RT windows. An alternate method consists of using a RT window of ± 0.05 minutes. The center of the RT window is set at the midpoint calibration level in the initial calibration sequence. RT windows are then updated daily (minimum frequency), re-centering the windows on the retention times established in a CCV.

When determining retention time windows, analyze a standard of DDT to ensure that the aroclor peaks being used do not interfere with the major single-peak pesticides (DDT, DDE, DDD).

10.3 Instrument Calibration

10.3.1 Initial Calibration (ICAL)

Analyze a minimum of five calibration levels for each Aroclor. The following Aroclors may be combined in the standards: 1016/1260 (also known as 1660), 1221/1254, 1232/1262, 1242/1268. Aroclor 1248 may not be combined with other Aroclors.

Tetrachloro-m-xylene and Decachlorbiphenyl are calibrated from the Aroclor 1660 standards.

Note: If the calibration will be used only for 8082A analysis, a single point calibration may be used except for Aroclors 1016 and 1260. The full set of Aroclors do not need to be calibrated if used for projects with a limited requested list. Every initial calibration block requires at least one standard with Aroclor 1016 to be analyzed for pattern recognition purposes, however.

Prepare the calibration standards using the formulations provided in Appendix B then transfer 100 µg/L to an autosampler vial insert. Add 4uL of the internal standard (IS) solution, then crimp the vial tightly.

Place the vials in the autosampler, and initiate the analytical sequence.

A minimum of five quantitation peaks must be chosen for each Aroclor with the exception of Aroclor 1221 which requires a minimum of 3 peaks. The peaks must be characteristic of the Aroclor in question.

The peaks used for quantitation in each Aroclor standard must be at least 25% of the height of the largest Aroclor peak with the exception of Aroclor 1268 where the requirement is 10%.

Each set of 5 peaks should include at least one peak that is unique to that Aroclor.

Calculate the Calibration Factor (CF), mean CF, and Percent Relative Standard Deviation (%RSD) for each analyte on both columns using the peak height, adjusted for internal standard response.

The %RSD for each target analyte must be less than or equal to 20% in order to use the mean CF for quantification. This evaluation is performed for each quantitation peak chosen for each Aroclor. All peaks must individually pass the 20% evaluation.

Alternately, use linear regression with a correlation coefficient (r) ≥ 0.995. Linear regression requires a minimum of five calibration points.

The mid-level AR1660 ICAL standard must meet a resolution criteria of <75% for the triplet near the end of the AR1260 pattern on at least one column. The resolution may be calculated per the equation in Appendix C.

10.3.2 Second Source Calibration Verification (ICV)

Immediately after each calibration and prior to the analysis of any QC or field samples, verify the accuracy of the initial calibration by analyzing a standard prepared from a second source of Aroclor 1660.

Prepare the ICV using the formulation provided in Appendix B. Aliquot 100uL of the working standard into a vial, and add 4uL of the IS solution. Crimp tightly. Inject the ICV standard onto the instrument in the same manner as performed for the initial calibration standards.

The percent recovery of the must be within ± 20% of the expected value of the average concentration of each Aroclor.

If this criterion is not met, correct the problem and reanalyze the ICV. If reanalysis fails, remake the calibration standards and/or perform instrument maintenance and recalibrate. The acceptance criteria must be met on both columns.

10.3.3 Continuing Calibration Verification (CCV)

Analyze a CCV (AR1660) at or below the mid-calibration range each day before sample analysis. This CCV is used to update the retention times of AR1660.

Analyze a CCV (AR1660) at least every 20 field samples for 8082A. If Aroclors other than 1660 are identified in a sample, a CCV of the identified Aroclor must be analyzed within 12 hours of the sample. Bracketing CCVs are not required.

Analyze a CCV (AR1660) at least every 20 field samples for TO4A/TO10A. The laboratory does not perform a CCV for the remaining Aroclors unless requested for the project or by regulatory requirement.

A CCV (AR1660) must be analyzed at least every 12 hours of operation.

Aliquot 100uL of the needed standard into a vial. Add 4uL of the IS solution, and crimp tightly. . Inject the CCV standard onto the instrument in the same manner as performed for the initial calibration standards.

The data system calculates an average calibration factor (CF) for each set of 5 quantitation peaks. The percent difference from the average calibration factor in the initial calibration is then calculated.

For 8082A, the percent difference or drift must be within ±20% for the average of the quantitation peaks and the retention time (RT) must be within the established RT window. Acceptance criteria must be met on both columns.

For TO4A/TO10A, the percent difference or drift must be within ±15% for the average of the quantitation peaks and the retention time (RT) must be within the established RT window. Acceptance criteria must be met on both columns.

The AR1660 CCV standard must meet a resolution criteria of <75% for the triplet near the end of the AR1260 pattern on at least one column. The resolution may be calculated per the equation in Appendix C.

If the CCV fails, it may be repeated once. If repeat analysis fails, corrective action must be taken. If the two CCVs do not meet the criteria, recalibration is required prior to running samples.

10.3.4 Retention Time Updates

For 8082A analysis, all target analytes must have at least one CCV per 24 hours to update the retention time. If the samples have been screened and the Aroclors present in the samples are known, only those Aroclors must have the retention times updated daily.

For TO4A and TO10A analysis, only Aroclor 1660 is required to be analyzed every 24 hours. Update retention times of the other Aroclors as necessary.

10.4 Troubleshooting

Check the following items in case of calibration failures:

- ICAL Failure – Perform injection port maintenance, install new guard column, check detector ends to see if detector jet has slipped. In extreme cases, install new columns, particularly if the chromatography has degraded as evidenced by peak shapes.
- CCV Failure – Perform Injection port maintenance; if injection port maintenance does not result in acceptable performance install a new guard column and remove one or more loops from each analytical column.
- Needle crushed during injection - Replace the needle and check the injection port for obstructions and check the autosampler for misalignment. Remove and clean the needle guide if necessary.
- Auto-sampler failure - Reset the auto-sampler and GC system. Replace the z-axis belt or clean the needle guide as necessary.
- Power failure - Reset run in ChemStation and re-acquire or re-initiate run sequence.

10.5 Sample Analysis

It is recommended that samples are screened to determine dilutions, Aroclor identifications, and the potential need for further sample cleanup prior to analysis.

Samples are typically screened at a 10x dilution against a single-point calibration curve. Screen data is not uploaded to TALS and is not reported.

10.6 Sample Analysis

Remove the extract from refrigerated storage and warm to room temperature.

Transfer 100 µL of extract to an autosampler vial. Add 4uL of IS solution, and crimp the vial tightly.

Place the vials in the autosampler in a sequence that begins with the calibration standards followed by the analysis of an ICV, QC samples, field samples and continuing calibration verification standards (CCVs).

Enter the sample ID's into the data acquisition program in the order that the samples were placed in the autosampler tray and initiate the analytical sequence.

Example analytical sequences follow:

Full Calibration Sequence	
Injection Number	**Lab Description**
1-2	Conditioning Blank
3-7	AR1221/1254 Calibration Block
8-12	AR1232/1262 Calibration Block
13-17	AR1242/1268 Calibration Block
18-22	AR1248 Calibration Block

23-27	AR1660 and Surrogate Calibration Block
28	Initial Calibration Verification

Example Sample Analysis Sequence	
Injection Number	**Lab Description**
1-2	Conditioning Blank
3	Retention Time Update Standard(s)
4	AR1660 CCV
	CCVs for other Aroclors, as needed
5-24	Sample injections
	Repeat sample/CCV blocks as necessary

Cleaning blanks (PIBLK) consisting of hexane may be analyzed after high-level samples at the discretion of the analyst for samples which contain large concentrations of late-eluting compounds.

11.0 Calculations / Data Reduction

11.1 Qualitative Identification

The data processing system identifies the target analytes by comparing the retention time of the peaks to the established retention time windows.

Review and accept or reject the qualitative identifications made by the data processing system using the following guidelines:

Compare the retention time of the peak to the established RT window, taking into account the shift of the surrogate peaks. If the surrogate peaks have shifted, open the retention time window in the direction of the shift. The processing system identifies the peak in the retention time window that is closest to the expected retention time set in the Chrom method, so the peak may need to be re-identified if a shift has occurred. The data system does not recognize Aroclor patterns. The analyst manually identifies Aroclors by comparing the pattern in the samples to the patterns in the initial calibration standards. Weathering of PCB's in the environment may alter the PCB's to the point that the pattern no longer matches the pattern established for that Aroclor in the initial calibration. The laboratory takes the best pattern match approach to the identification and quantification of weathered PCB's.

Look for shoulders on the side of large peaks that may be peaks of interest. The processing system does not always automatically integrate shoulders from larger peaks, so manual integration (split) of the shoulder may be necessary.

Each target analyte must be detected on both columns for qualitative identification to be made.

11.2 Quantitative Identification

Using an average of the chosen quantification peaks per Aroclor the data system calculates the corrected concentration for each target analyte using the equations given in Appendix C. If sample interference is suspected, the laboratory may remove quantification peaks per column, keeping a minimum of 3 quantitation peaks per Aroclor on each column. The lower value between the two columns is reported as the primary result, unless the project specifies otherwise and the TALS formatter uses another formatting rule.

11.3 Calculations

See Appendix C.

11.4 Data Review

See laboratory SOP BR-QA-019 for detailed data review requirements.

11.4.1 Primary Review

Review project documents to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Confirm qualitative and quantitative identification criteria using the criteria provided in Sections 11.1 and 11.2. If the data system does not properly integrate the peaks, perform manual integration in accordance with corporate SOP CA-Q-S-002.

Upload the data files from the data processing system (Chrom) to the laboratory information management system (TALS). Complete the batch information for standards and reagents and verify ICAL and QC sample associations. Review the results and set results to primary, secondary, acceptable or rejected as appropriate. Dilute and reanalyze samples whose results exceed the calibration range. The dilution analysis should result in a determination within the calibration range, preferably in the upper half of the calibration range. A more concentrated analysis is not necessary unless the project requires it. Dilution analyses may be performed to minimize matrix interference.

If a sample was analyzed immediately following a high concentration sample, review the results of the sample for any sign of carryover. If carryover is suspected, reanalyze the sample.

Create a non-conformance memo (NCM) for any calibration, QC and sample data that is reported outside established acceptance criteria and/or schedule necessary corrective action. Set batch to 1st level review and complete the data review checklist.

11.4.2 Secondary Data Review

Verify quantitative and qualitative identification in the initial calibration standards and spot check such for ~15% of the remaining data in the batch.

If manual integrations were performed, review each integration to verify that the integration meets the requirements for manual integration as specified in corporate SOP CA-Q-S-002. If an error is suspected or found consult with the analyst that performed the integration and request correction or notify the Department Supervisor, Operations Manager, or QA Manager. Do not “fix” the

integration. Reintegration by a secondary data reviewer must not be performed except in limited circumstances as approved by the department supervisor or other laboratory management. In those instances where the secondary reviewer performs the integration, this person is now considered the primary analyst and each integration performed by the secondary reviewer must be subsequently reviewed by a peer analyst or the department supervisor to verify the integration is consistent and compliant with the requirements specified CA-Q-S-002.

Review project documents to ensure those project requirements were met. If project requirements were not met, immediately notify the project manager (PM) to determine an appropriate course of action.

Verify that the acceptance criteria for the calibration and QC items listed in Table 1 were met. If the results do not fall within the established limits verify the recommended corrective actions were performed. If not, initiate corrective actions and/or verify an NCM was created to document the criteria exception. Verify analytical results are qualified accordingly. Set batch to 2nd level review and complete the data review checklists.

Run the QC checker and fix any problems found. Run and review the deliverable. Fix any problems found. When complete set the method chain to lab complete and forward any paperwork to report/project management.

12.0 Method Performance

12.1 Method Detection Limit (MDL), Limit of Detection (LOD), and Limit of Quantitation (LOQ)

Establish a LOD and LOQ at initial method set up following the procedures specified in laboratory SOP BR-QA-005. Verify the LOD and LOQ at the frequency established for the method using the procedures specified in same SOP. The frequency of LOD and LOQ verification depends on the strictest frequency of the regulatory program for which the method supports. The frequency requirement is documented in a spreadsheet maintained by the QA Department.

12.2 Demonstration of Capabilities (DOC)

Perform a method demonstration of capability at initial set-up and when there is a significant change in instrumentation or procedure.

Each analyst that performs the analytical procedure must complete an initial demonstration of capability (IDOC) prior to independent analysis of client samples. Each analyst must demonstrate on-going proficiency (ODOC) annually thereafter. DOC procedures are further described in the laboratory's quality system manual (QAM) and in the laboratory SOP for employee training.

12.3 Training Requirements

Any employee that performs any portion of the procedure described in this SOP must have documentation in their employee training file that they have read this version of the SOP.

Instrument analysts, prior to independent analysis of client samples, must also have documentation of demonstration of initial proficiency (IDOC) and annual on-going proficiency (ODOC) in their employee training files.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to BR-EH-001. The following waste streams are produced when this method is carried out.

- Vials containing sample extracts: Satellite container: 15 gallon bucket connected to a fume hood.
- Solvent Waste: Satellite container: 1 L glass bottle located in fume hood.

15.0 References / Cross-References

- SW-846 Method 8082A Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 0, February 2007.
- Compendium Method TO-4A, Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using High Volume Polyurethane Foam (PUF) Sampling Followed By Gas Chromatographic/Multi-Detector Detection (GC/MD), January 1999 (EPA/625/R-96/010b)
- · Compendium Method TO-10A, Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using Low Volume Polyurethane Foam (PUF) Sampling Followed By Gas Chromatographic/Multi-Detector Detection (GC/MD), January 1999 (EPA/625/R-96/010b)
- Corporate Environmental Health and Safety Manual (CW-E-M-001)
- Laboratory SOP BR-QA-002, Traceability, Handling, & Storage of Standards & Reagents
- Laboratory SOP BR-QA-011, Employee Training and Analyst Demonstration of Proficiency
- Laboratory SOP BR-EH-001, Tracking and Collection of Hazardous Waste
- Laboratory SOP BR-QA-014, Laboratory Records
- Laboratory SOP BR-QA-005, Procedures for Detection Limits, Limits of Detection, Limits of Quantitation
- Corporate SOP CA-Q-S-002, Manual Integrations
- Corporate SOP CA-Q-P-003, Calibration Curves and the Selection of Calibration Points
- Laboratory SOP BR-QA-005

16.0 Method Modifications

Method Reference	Modification
TO4A 13.1/TO10A 12.1	The laboratory uses five-point calibration curves for all Aroclors instead of the three-point curves required in the reference method
	The laboratory calibrates with all Aroclors, not only 1242 and 1254 or 1260
	The use of internal standards has been incorporated with this method based on guidance from method 8082A section 11.6.8. Per that guidance, bracketing CCVs are not required.

17.0 Attachments

- Table 1: Target Compound List and Reporting Limit
- Table 1A: Accuracy and Precision Limits
- Table 2: Primary Materials Used
- Table 3: QC Summary & Recommended Corrective Action (8082A)
- Table 3: QC Summary & Recommended Corrective Action (TO4A & TO10A)
- Appendix A: Terms and Definitions
- Appendix B: Standard Preparation Tables
- Appendix C: Equations

18.0 Revision History

BR-GC-005, Rev 13
This SOP is a complete rewrite of the procedure.

Previous Revisions are retained by the QA department.

Table 1: Routine Target Analyte List & Reporting Limits (RL)

ANALYTE	Routine Reporting Limit (RL)[1,2]				
	Water (ug/L)	Solid (ug/Kg)	Air (ug/m^3 TO10A)[3]	Air (ug/m^3 TO4A)[4]	Air (ug/PUF)
AR1016	0.50	17	0.10	0.00033	0.10
AR1221	0.50	17	0.10	0.00033	0.10
AR1232	0.50	17	0.10	0.00033	0.10
AR1242	0.50	17	0.10	0.00033	0.10
AR1248	0.50	17	0.10	0.00033	0.10
AR1254	0.50	17	0.10	0.00033	0.10
AR1260	0.50	17	0.10	0.00033	0.10
AR1262	0.50	17	0.10	0.00033	0.10
AR1268	0.50	17	0.10	0.00033	0.10

[1]The routine RL is the unadjusted value that can be achieved in a blank matrix.
[2]The RL for tissue matrix is project defined.
[3]RL based on a collection volume of 1m^3 or 1,000L
[4]RL based on a collection volume of 300m^3 or 300,000L

Table 1A: Routine Accuracy and Precision Limits[1]

Analyte	In-House Limits (%R)			Precision (RPD) (≤)
	Water	Solid	Air	
AR1016	55-120	55-120	65-125	30
AR1260	60-125	55-125	65-125	30
Surrogate: Decachlorobiphenyl (DCB)	30-150	45-125	60-120	NA
Surrogate:TCX (Advisory)[2]	55-120	30-130	60-120	NA

[1] The limits in this table are those used as of the effective date of this SOP. Current limits are stored in the LIMS database.
[2] The control limits for TCX (Tetrachloro-m-xylene) are advisory. Corrective action is not performed when recovery is outside limits.

Table 2: Primary Materials Used

Material[1]	Hazards	Exposure Limit[2]	Signs and symptoms of exposure
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.

[1] Always add acid to water to prevent violent reactions.
[2] Exposure limit refers to the OSHA regulatory exposure limit.

Table 3: QC Summary, Frequency, Acceptance Criteria and Recommended Corrective Action (8082A)

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action[1]
ICAL	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	RSD for each analyte ≤ 20% -OR- Linear Regression: r ≥ 0.995	Correct problem, reanalyze, and repeat calibration.
ICV	After each initial calibration	(% R) ± 20% from expected value	Correct problem and verify second source standard. If that fails, repeat initial calibration.
CCV	Daily before sample analysis, every 20 field samples or 12 hours (whichever is sooner).	% Difference or Drift ≥20%	See Section 10.3. Perform maintenance such as Injection Port maintenance, check for leaks, and change the lines / septa.
MB	One per extraction batch of 20 or fewer field samples	Target Analyte < RL	Examine project DQO's and take appropriate corrective action, which may include re-analysis of MB, re-extraction of batch, and/or non-conformance memo (NCM). If there are no detects in samples, or if all detects are > 10 X MB level, re-prep and reanalysis may not be required.
LCS	One per extraction batch of 20 or fewer field samples	See Table 1A	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance memo (NCM). Flag all reported values outside of control limits
LCSD	One per extraction batch of 20 or field fewer samples, when MS/MSD is not present	See Table 1A	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance memo (NCM). Flag all reported values outside of control limits.
MS/MSD	One per extraction batch of 20 or fewer field samples	See Table 1A	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze and/or re-extract. Flag all reported values outside of control limits.
SD	Per client request	See Table 1A	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze and/or re-extract. Flag all reported values outside of control limits.
Internal Standard	All field and QC samples	Area between 50-200% of area of daily calibration internal standard area	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze and/or re-extract. Flag all reported values outside of control limits.
Surrogate	All field and QC samples	See Table 1A	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze or re-extract. If matrix effect, review project DQOs to determine if a matrix effect must be confirmed by re-analysis. Flag all reported values outside of control limits.

[1]*The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that results will be valid. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers.*

Table 3A: QC Summary, Frequency, Acceptance Criteria and Recommended Corrective Action (EPA TO4 & TO10)

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action[1]
ICAL	Before sample analysis, when CCVs indicate calibration is no longer valid; after major instrument maintenance	Option 1: RSD for each analyte ≤ 20%	Correct problem, reanalyze, repeat calibration.
ICV	After each initial calibration	(% R) ± 15 % from expected value	Correct problem and verify second source standard. If that fails, repeat initial calibration.
CCV	Daily before sample analysis, every 20 field samples or 12 hours (whichever is sooner).	% Difference or Drift ±15%	Re-analyze once, if still outside criteria perform corrective action, sequence can be re-started if two successive CCVs pass, otherwise repeat ICAL and all associated samples since last successful CCV, unless CCV is high and bracketed samples are non-detects.
Method Blank	One per extraction batch of 20 or fewer field samples	Target Analyte < RL	Examine project DQO's and take appropriate corrective action, which may include re-analysis of MB, re-extraction of batch, and/or NCM. Corrective action must be documented in an NCM. If there are no detects in samples, or if all detects are > 10 X MB level, re-prep and reanalysis may not be required.
Field Blank	One per sampling event	Target Analyte < RL	Notify client.
LCS	One per extraction batch of 20 or fewer field samples	See Table 1A	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance memo (NCM). Flag all reported values outside of control limits
LCSD	One per extraction batch of 20 or fewer field samples, when MS/MSD is not present	See Table 1A	Examine project DQO's and take appropriate corrective action, which may include re-analysis of LCS, re-extraction of batch, and/or non-conformance memo (NCM). Flag all reported values outside of control limits.
Field Spike	One per sampling event	%R (65-125)	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze and/or re-extract.
Internal Standard	All field and QC samples	Area between 50-200% of area of daily calibration internal standard area	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze and/or re-extract. Flag all reported values outside of control limits.
Surrogate	All field and QC samples	%R (60-120)	Evaluate data and determine if a matrix effect or analytical error is indicated. If analytical error, re-analyze or re-extract. If matrix effect, review project DQOs to determine if a matrix effect must be confirmed by re-analysis. Flag all reported values outside of control limits.

[1]*The recommended corrective action may include some or all of the items listed in this column. The corrective action taken may be dependent on project data quality objectives and/or analyst judgment but must be sufficient to ensure that results will be valid. If corrective action is not taken or is not successful, data must be flagged with appropriate qualifiers.*

Appendix A: Terms and Definitions

Acceptance Criteria: specified limits placed on characteristics of an item, process or service defined in requirement documents.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Analyte: The specific chemicals or components for which a sample is analyzed. (EPA Risk Assessment Guide for Superfund, OSHA Glossary).

Batch: environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria. An analytical batch is composed of prepared environmental samples (extracts, digestates and concentrates), which are analyzed together as a group.

Calibration: a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values realized by the standards.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard: A substance or reference used to calibrate an instrument.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Corrective Action: the action taken to eliminate the cause of an existing nonconformity, defect or other undesirable occurrence in order to prevent recurrence.

Data Qualifier: a letter designation or symbol appended to an analytical result used to convey information to the data user. (Laboratory)

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): a second replicate matrix spike

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs. Quantitative results are only produced in this range and qualified with the proper data reporting flag when a project requires this type of data reporting.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Quality Control Sample (QC): a sample used to assess the performance of all or a portion of the measurement system.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate: a substance with properties that mimic the analyte of interest but that are unlikely to be found in environmental samples.

Appendix B: Standard Preparation Tables

The standard formulations contained in this Appendix are recommended and are subject to change. If the concentration of the stock standard is different than those noted in this table, adjust the standard preparation formulation accordingly. Unless otherwise specified, prepare the standard solutions in hexane using Class A volumetric glassware and Hamilton syringes. Unless otherwise specified for a standard solution, assign an expiration date of 1 year from date of preparation unless the parent standard expires sooner in which case use the earliest expiration date. Store the prepared solutions under refrigeration at a temperature of 4ºC (±2) and protect from light. See laboratory SOP BR-QA-002 *Traceability, Handling, & Storage of Standards & Reagents* for further guidance.

Intermediate Calibration Standards (10 mg/L)

Parent Standard	Vendor	Component	Stock Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (mg/L)
AR1660[1]	Restek #32039	Aroclor 1016 Aroclor 1260	1000	0.40	40	10
AR1254	Restek #32011	Aroclor 1254	1000	0.40	40	10
AR1248	Restek #32010	Aroclor 1248	1000	0.40	40	10
AR1242	Restek #32009	Aroclor 1242	1000	0.40	40	10
AR1232	Restek #32008	Aroclor 1232	1000	0.40	40	10
AR1221	Restek #32007	Aroclor 1221	1000	0.40	40	10
AR1262	Restek #32409	Aroclor 1262	1000	0.40	40	10
AR1268	Restek #32410	Aroclor 1268	1000	0.40	40	10

[1] *Standard is a mix of AR1016/AR1260. Concentration shown is the concentration of each Aroclor in the mixed standard.*

Intermediate ICV Standard (10 mg/L)

Parent Standard	Vendor	Component	Stock Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (mg/L)
AR1660	Restek	Aroclor 1016 Aroclor 1260	1000	0.40	40	10

Surrogate Solution (10 mg/L)

Parent Standard	Vendor	Component	Stock Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (mg/L)
Pesticide Surrogate	Restek #3200	TCX DCB	1000	0.40	40	10

Working ICV Standard (200 ug/L)

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
Intermediate ICV	Laboratory Prepared	Aroclor 1016 Aroclor 1260	10	0.80	40	200
Surrogate	Laboratory Prepared	TCX DCB	10	0.080		20

AR1660 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1660 Intermediate	Laboratory Prepared	Aroclor 1016 Aroclor 1260	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1660 calibration standards*

AR1660 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1660 Level 5	AR1660 CAL Level 4	800	20	40	400
AR1660 Level 5	AR1660 CAL Level 3	800	10	40	200
AR1660 Level 5	AR1660 CAL Level 2	800	5.0	40	100
AR1660 Level 5	AR1660 CAL Level 1	800	2.5	40	50

AR1221 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1221 Intermediate	Laboratory Prepared	Aroclor 1221	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1221 calibration standards*

AR1221 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1221 Level 5	AR1221 CAL Level 4	800	20	40	400
AR1221 Level 5	AR1221 CAL Level 3	800	10	40	200
AR1221 Level 5	AR1221 CAL Level 2	800	5.0	40	100
AR1221 Level 5	AR1221 CAL Level 1	800	2.5	40	50

AR1232 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1232 Intermediate	Laboratory Prepared	Aroclor 1232	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1232 calibration standards*

AR1232 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1232 Level 5	AR1232 CAL Level 4	800	20	40	400
AR1232 Level 5	AR1232 CAL Level 3	800	10	40	200
AR1232 Level 5	AR1232 CAL Level 2	800	5.0	40	100
AR1232 Level 5	AR1232 CAL Level 1	800	2.5	40	50

AR1242 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1242 Intermediate	Laboratory Prepared	Aroclor 1242	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1242 calibration standards*

AR1242 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1242 Level 5	AR1242 CAL Level 4	800	20	40	400
AR1242 Level 5	AR1242 CAL Level 3	800	10	40	200
AR1242 Level 5	AR1242 CAL Level 2	800	5.0	40	100
AR1242 Level 5	AR1242 CAL Level 1	800	2.5	40	50

AR1248 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1248 Intermediate	Laboratory Prepared	Aroclor 1248	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1248 calibration standards*

AR1248 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1248 Level 5	AR1248 CAL Level 4	800	20	40	400
AR1248 Level 5	AR1248 CAL Level 3	800	10	40	200
AR1248 Level 5	AR1248 CAL Level 2	800	5.0	40	100
AR1248 Level 5	AR1248 CAL Level 1	800	2.5	40	50

AR1254 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1254 Intermediate	Laboratory Prepared	Aroclor 1254	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1254 calibration standards*

AR1254 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1254 Level 5	AR1254 CAL Level 4	800	20	40	400
AR1254 Level 5	AR1254 CAL Level 3	800	10	40	200
AR1254 Level 5	AR1254 CAL Level 2	800	5.0	40	100
AR1254 Level 5	AR1254 CAL Level 1	800	2.5	40	50

AR1262 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1262 Intermediate	Laboratory Prepared	Aroclor 1262	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard for each level of the AR1262 calibration standards*

AR1262 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1262 Level 5	AR1262 CAL Level 4	800	20	40	400
AR1262 Level 5	AR1262 CAL Level 3	800	10	40	200
AR1262 Level 5	AR1262 CAL Level 2	800	5.0	40	100
AR1262 Level 5	AR1262 CAL Level 1	800	2.5	40	50

AR1268 Calibration Standard: CAL Level 5 (800 ug/L)[1]

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1268 Intermediate	Laboratory Prepared	Aroclor 1268	10	8.0	100	800
Surrogate	Laboratory Prepared	TCX DCB	10	0.80		80

[1] *This standard is the parent standard fo each level of the AR1268 calibration standards*

AR1268 Calibration Standard(s): CAL Levels 1- 4

Parent Standard	Calibration Standard	Parent Standard Concentration (ug/L)	Volume Added (mL)	Final Volume (mL)	Final Concentration (ug/L)
AR1268 Level 5	AR1268 CAL Level 4	800	20	40	400
AR1268 Level 5	AR1268 CAL Level 3	800	10	40	200
AR1268 Level 5	AR1268 CAL Level 2	800	5.0	40	100
AR1268 Level 5	AR1268 CAL Level 1	800	2.5	40	50

Internal Standard Solution (500 ug/L)

Parent Standard	Vendor	Component	Parent Standard Concentration (mg/L)	Volume Added (uL)	Final Volume (mL)	Final Concentration (ug/L)
1-Bromo-2-nitrobenzene Stock	Restek p/n 32279	1-Bromo-2-nitrobenzene	1000	20	40	500

Appendix C: Equations

Relative Response Factor Calculation

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x}$$

Where:
AX =Peak height for the Aroclor peak to be measured.
Ais = Peak height for specified internal standard.
Cis = Amount of the internal standard injected (ng).
Cx = Amount of the target compound or DMC injected (ng).

Mean Relative Response Factor Calculation

$$\overline{RRF} = \frac{\sum_{i=1}^{n} RRF_i}{n}$$

Where:
n = The number of calibration standards

Percent Relative Standard Deviation Calculation

$$\%RSD = \frac{Standard\ Deviation}{Mean} \times 100$$

$$Standard\ Deviation = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2}{n-1}}$$

Where:
xi = Each individual value used to calculate the mean
$\overline{x}$ = The mean of n values
n = The total number of values

Relative Response Factor Percent Difference Calculation

$$\%Difference_{RRF} = \frac{RRF_C - \overline{RRF_i}}{\overline{RRFi}} x100$$

Where:

$\overline{RRF_i}$ = Mean Relative Response Factor from the most recent initial calibration meeting
technical acceptance criteria
RRFc = Relative Response Factor from CCV standard.

Percent Drift = Calculated Concentration – Theoretical Concentration X 100%
Theoretical Concentration

Percent Recovery

$$\%R = \frac{C_s}{C_n} \times 100\%$$

Cs = Concentration of the Spiked Field or QC Sample
Cn = Nominal Concentration of Spike Added

Percent Recovery (%R) for MS/MSD

$$\%R = \frac{C_s - C_u}{C_n} \times 100\%$$

Cs = Concentration of the Spiked Sample
Cu = Concentration of the Unspiked Sample
Cn = Nominal Concentration of Spike Added

Relative Percent Difference

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100\%$$

C1 = Measured Concentration of First Sample
C2 = Measured Concentration of Second Sample

Sample Concentration
Note: The concentrations of the 3-5 peaks chosen for quantification, determined by peak height, are calculated and the average is then taken for final calculation.

Concentration of Water Samples

$$Concentration\ ug/L = \frac{(A_x)(I_s)(V_t)(DF)(GPC)}{(A_{is})(\overline{RRF})(V_o)(V_i)}$$

Where:
Ax = Peak height for the peak to be measured.
Ais = Peak height for the internal standard.
Is = Amount of internal standard injected in nanograms (ng).
Vo = Volume of water extracted in milliliters (mL).
Vi = Volume of extract injected in microliters (µL).
Vt = Volume of the concentrated extract in microliters (µL)
$\overline{RRF}$ = Mean Relative response factor determined from the initial calibration standard.
DF = Dilution Factor (If no dilution is performed, DF = 1.0)
GPC = GPC Factor (If no GPC cleanup is performed, GPC = 1.0)

Concentration of Soil and Sediment Samples

$$Concentration\ ug/Kg\ (Dry\ Weight\ Basis) = \frac{(A_x)(I_s)(V_t)(DF)(GPC)}{(A_{is})(\overline{RRF})(V_i)(W_s)(D)}$$

Where:
Ax = Peak height for the peak to be measured.
Ais = Peak height for the internal standard.
Is = Amount of internal standard injected in nanograms (ng).
Ws = Weight of sample extracted in grams (g)
Vi = Volume of extract injected in microliters (µL).
Vt = Volume of the concentrated extract in microliters (µL)
$\overline{RRF}$ = Mean Relative response factor determined from the initial calibration standard.
DF = Dilution Factor (If no dilution is performed, DF = 1.0)
$D = \frac{100 - \%Moisture}{100}$
GPC = GPC Factor (If no GPC cleanup is performed, GPC = 1.0)

Concentration of Air Samples (ug/PUF)

$$\text{Concentration ug/PUF} = \frac{(A_x)(I_s)(1PUF)(DF)}{(A_{is})(\overline{RRF})(V_o)(V_i)}$$

Where:
Ax = Peak height for the peak to be measured.
Ais = Peak height for the internal standard.
Is = Amount of internal standard injected in nanograms (ng).
Vo = Volume of water extracted in milliliters (mL).
Vi = Volume of extract injected in microliters (µL).
Vt = Volume of the concentrated extract in microliters (µL)
$\overline{RRF}$ = Mean Relative response factor determined from the initial calibration standard.
DF = Dilution Factor (If no dilution is performed, DF = 1.0)

Concentration of Air Samples (ug/m3)

$$\text{Concentration ug/m3} = \frac{(A_x)(I_s)(V_t)(DF)}{(A_{is})(\overline{RRF})(V_o)(V_i)}$$

Where:
Ax = Peak height for the peak to be measured.
Ais = Peak height for the internal standard.
Is = Amount of internal standard injected in nanograms (ng).
Vo = Volume of air sampled via PUF apparatus (m3).
Vi = Volume of extract injected in microliters (µL).
Vt = Volume of the concentrated extract in microliters (µL)
$\overline{RRF}$ = Mean Relative response factor determined from the initial calibration standard.
DF = Dilution Factor (If no dilution is performed, DF = 1.0)

Resolution

(Height of Valley / Average of the Two Peak Heights)*100%