

Statement of Qualifications for the



Analysis of Marine and Freshwater Sediment, Pore Water, and Tissue Samples



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TABLE OF CONTENTS

I. Introduction	1
II. Sample Preparation	
Pore Water Extraction	2
Tissue Homogenization	2
Total Solids	2
III. Analytical Protocol	
A. <i>Polyaromatic Hydrocarbons (PAH's)</i> <i>and Semi Volatile Organic Compounds</i>	
Seawater and Pore Water	3
Sediments	3
Tissue	4
B. <i>Pesticides/PCB Aroclors</i>	
Seawater and Pore Water	4
Sediments	4
Tissue	5
C. <i>PCB Congeners</i>	
Seawater and Pore Water	5
Sediments	5
Tissue	5
D. <i>Organotin</i>	
Seawater and Pore Water	6
Sediments	6
Tissue	6
E. <i>Metals</i>	
Seawater and Pore Water	7
Sediments	7
Tissue	8
F. <i>Dioxins/Furans</i>	
Seawater and Pore Water	8
Sediments	9
Tissue	9
Dioxin/Furan Screening	9
IV. Experience	10

I. Introduction

Since 1986, Columbia Analytical Services, Inc. (CAS) has been actively involved in the analysis of marine and freshwater sediment, water and tissue samples. Much of our analytical work is in support of dredging, remedial investigation, feasibility studies and risk assessment, which, in many cases, require extremely low-level detection limits. These types of samples present unique challenges to the laboratory due to analytical interferences caused by the matrices.

CAS has developed and implemented cleanup procedures and method modifications to specifically deal with these types of matrices. We have also developed the expertise necessary to perform complex ultra-trace analyses. These low-level analyses of sediment, tissue and water use advanced specialized instrumentation. This instrumentation includes Inductively Coupled Plasma Mass Spectroscopy (ICP/MS), purge and trap cold vapor atomic fluorescence spectrometry, High-Resolution Gas Chromatography/Mass Spectroscopy (HRGC/MS), and High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS).

CAS, headquartered in Kelso, Washington, is a certified, full-service chemical and biological analytical laboratory network. Our network is comprised of eight fixed laboratories and four service centers in Arizona, California, Florida, Hawaii, New York, Texas and Washington. In addition to supporting marine and freshwater aquatic sample analyses throughout the United States, our laboratories also possess the necessary permits to accept samples from foreign countries.

This Statement of Qualification provides a general description of CAS analytical protocols for determining trace analytes in marine and freshwater environmental samples. Detection limits for these analytes are also included. The analytes discussed in this SOQ are those typically requested for marine and freshwater projects. Also included in this SOQ, is a section discussing CAS' relevant experience that provides project references and a project experience matrix.

II. Sample Preparation

Pore Water Extraction

Pore water extractions are performed according to the latest Army Corps of Engineers (ACOE) interim protocol. CAS actively attends meetings and provides recommendations for the development of the procedures. Sample manipulations are performed in a glove box under anaerobic conditions. Double centrifuging is performed in a refrigerated centrifuge, maintaining anaerobic conditions within the sample containers. Filtration is optional, depending on project objectives. If required, filtration is performed using a silver membrane or polycarbonate filter media to prevent loss of butyltin compounds to adsorption. The analysis of pore water is performed using the procedures listed in the "Seawater" section of each constituent's analytical protocol.

Freeze-Drying

CAS incorporates the use of freeze-drying of sediment and tissue samples for environmental analysis. Freeze-drying of sediment and tissue samples is performed prior to extraction and analysis for Polynuclear Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), Pesticides, Dioxins, and Metals. The use of freeze-drying eliminates or reduces the undesirable effects of water. The most significant benefits are lower detection limits and more quantitative determinations. In addition to lower detection limits and better recoveries, freeze-drying of samples allows for complete homogenization of the sample matrices. Thus, improved precision is realized. This is particularly significant when analyzing heterogeneous samples (e.g. high organic sediments, whole-body tissues, etc.).

Tissue Homogenization

All tissue samples are subjected to homogenization techniques prior to analysis, which are designed to assure representative sub-sampling for each analytical parameter. The procedures used within CAS for homogenization vary significantly depending on the tissue type and the technical specifications for the project. Our laboratory is equipped to handle a wide variety of tissue preparations. These range from relatively simple whole body homogenization of juvenile fish, to more involved applications where small rodents require radiation treatment for destruction of biological hazards (e.g. Hantavirus, rabies, etc.) and subsequent dissection for analysis of individual organs.

Total Solids

Total solids values are derived from freeze-dried tissues. The determination is performed on a pre-homogenized wet sample. The dry solids from the freeze-drying determination are then further homogenized and used for the metals analysis (except mercury) as described in the metals section of this document. Freeze-drying is performed to avoid degradation and associated chemical changes that occur when the sample is dried at elevated temperatures.

III. Analytical Protocol

A brief description of the procedures CAS typically employs for the analysis of sediment, tissue, seawater and freshwater matrices in support of marine and freshwater studies is provided in the following sub-sections. Due to the complexity of analyzing these matrices for low-level constituents, specialized procedures beyond the scope of EPA SW 846, EPA-CLP and other routine methods are often required. Seawater presents no particular challenges when determining organic constituents. However, trace metals analysis in the presence of high dissolved solids requires relatively involved techniques to reach the levels of detection typically required to meet project objectives. CAS has been active in research and development of procedures for preparation and analyses of sediment, tissue and water samples. Our laboratory specializes in the analysis of tissue and sediment for low-level chemical constituents and has developed procedures for providing data of high technical quality that meets standard validation criteria. A summary of some of our experience over the last ten years may be found in Section IV.

A. *Polyaromatic Hydrocarbons (PAHs) and Base Neutral Acid Compounds (BNAs)*

Seawater and Pore Water

Sample preparations generally follow traditional solvent extraction techniques; continuous liquid/liquid or separatory funnel. These extracts rarely require cleanup procedures before instrumental analysis, and can be concentrated to smaller final volumes to gain sensitivity. For PAHs, instrumental analysis is performed using Gas Chromatograph /Mass Spectrometry (GC/MS) operated in the Selective Ion Monitoring (SIM) mode to maximize sensitivity. In addition to the standard list of PAHs typically analyzed, the associated alkylated homologs are also available. Detection limit information for the complete list of PAH compounds, including the alkylated homologs, is listed in the tables following page 13. For low-level semivolatile organic analysis conventional GC/MS techniques are used in conjunction with a Large Volume Injector (LVI) system. The LVI allows for a greater quantity of analyte to be introduced into the GC/MS. Detection limits for low-level semivolatile analytes are listed in the tables following page 13.

Sediments

Sample preparations are generally initiated using traditional solvent extraction techniques, usually soxhlet, and, occasionally, sonication. Prior to instrumental analysis, extracts are put through Gel Permeation Chromatography (GPC) cleanup and usually silica gel clean up. For PAHs, instrumental analysis is performed using Gas Chromatograph /Mass Spectrometry (GC/MS) operated in the Selective Ion Monitoring (SIM) mode to maximize sensitivity. In addition to the standard list of PAHs typically analyzed, the associated alkylated homologs are also available. Detection limit information for the complete list of PAH compounds, including the alkylated homologs, is listed in the tables following page 13. For low-level semi-volatile organic analysis conventional GC/MS techniques are used in conjunction with a Large Volume Injector (LVI) system. The LVI allows for a greater quantity of analyte to be introduced into the GC/MS than standard injection systems.

Detection limits for low-level semi-volatile analytes are listed in the tables following page 13.

Tissue

All Tissue samples are subjected to homogenization before analysis. This preparation insures representative sub-sampling for each analytical parameter. Conventional solvent extraction techniques such as soxhelt and sonication are usually employed for extracting the samples. Prior to instrumental analysis, extracts are put through Gel Permeation Chromatography (GPC) cleanup and silica gel cleanup. Removal of lipids is of particular concern during the cleanup process. The instrumental analysis is performed using GC/MS operated in SIM mode to maximize sensitivity. In addition to the standard list of PAHs typically analyzed, the associated alkylated homologs are also available. Detection limit information for the complete list of PAH compounds, including the alkylated homologs, is listed in the tables following page 13.

B. Pesticides/PCB Aroclors

Seawater and Pore Water

The pesticide and PCB Aroclor analyses are performed by following EPA Methods 8081 and 8082. Prior to instrumental analysis for pesticides, extracts are generally not put through any cleanup process. The PCB Aroclor fraction receives an acid cleanup prior to Gas Chromatograph/Electron Capture Detector (GC/ECD) analysis. Detection limit information is listed in the tables following page 13. For ultra low-level Aroclor analysis a Large Volume Injector (LVI) system is used in conjunction with GC/ECD.

Sediments

To obtain the low level detection limits required when analyzing marine sediments, the pesticide and PCB Aroclor analyses are performed by following EPA Methods 8081 and 8082 with slight modifications to the sample mass, final extract volume, and cleanup procedures. To accommodate the relatively large sample mass required to reach the low level detection limits, the samples are extracted using a sonication technique. The extracts are put through Gel Permeation Chromatography (GPC) cleanup and mercury cleanup procedures prior to splitting for Aroclor and pesticide analyses. The pesticide fraction generally goes directly to the Gas Chromatograph/Electron Capture Detector (GC/ECD) for analysis. The PCB Aroclor fraction receives an acid cleanup prior to GC/ECD analysis. Detection limit information is listed in the tables following page 13.

Tissue

To obtain the low level detection limits required when analyzing biological tissues, the pesticide and PCB Aroclor analyses are performed by following EPA Methods 8081 and 8082 with slight modifications to the sample mass, final extract volume, and cleanup procedures. In order to assure representative sub-sampling for each analytical parameter, all tissue samples are subject to homogenization prior to analysis. To accommodate the relatively large sample mass required to reach the low level detection limits, the samples are extracted using a sonication technique. The extracts are put through GPC and Florisil® cleanups prior to splitting for PCB Aroclor and pesticide analyses. The pesticide fraction generally goes directly to the GC/ECD for analysis. The PCB Aroclor fraction receives an acid cleanup prior to GC/ECD analysis. Detection limit information is listed in the tables following page 13. For ultra low-level Aroclor analysis a Large Volume Injector (LVI) system is used in conjunction with GC/ECD.

C. PCB Congeners

Seawater and Pore Water

The PCB congener analysis is performed by following EPA Method 8082 with slight modifications. The extracts are subjected to acid and permanganate cleanups prior to GC/ECD analysis. Detection limit information is listed in the tables following page 13.

Sediments

To obtain the low level detection limits required when analyzing marine sediments, the PCB congener analysis is performed by following EPA Method 8082 with slight modifications to the sample mass, final extract volume, and cleanup procedures. To accommodate the relatively large sample mass required to reach the low level detection limits, the samples are extracted using a sonication technique. The extracts are subjected to GPC, mercury, silica gel, acid, and permanganate cleanups prior to GC/ECD analysis. Detection limit information is listed in the tables following page 13.

Tissue

To obtain the low level detection limits required when analyzing biological tissues, the PCB congener analysis is performed by following EPA Method 8082 with slight modifications to the sample mass, final extract volume, and cleanup procedures. In order to assure representative sub-sampling for each analytical parameter, all tissue samples are subject to homogenization prior to analysis. To accommodate the relatively large sample mass required to reach the low level detection limits, the samples are extracted using a sonication technique. The extracts are subjected to GPC, silica gel, acid, and permanganate cleanups prior to GC/ECD analysis. Detection limit information is listed in the tables following page 13.

D. Organotin

Seawater and Pore Water

Aqueous samples are analyzed using solvent extraction, derivatization, and a Gas Chromatography Flame Photometric Detector (GC/FPD). Following the addition of surrogate compounds (tripropyltin chloride and tripropyltin chloride), aqueous samples are extracted with hexane that contains 0.2% (wt./vol.) tropolone. Extracts are derivatized with hexylmagnesium bromide in ether via a Grignard reaction. The Grignard reagent is synthesized by CAS (commercially available reagent is not used due to unacceptable purity). Extracts are cleaned by elution through alumina and silica gel columns. The extracts are analyzed by GC/FPD with a 610 nm filter. A minimum (10%) of analyte hits are confirmed by secondary column GC/FPD or GC/MS analysis. All detectable values are confirmed if the samples originated from an uncharacterized site (i.e. no historical data to suggest the likelihood of the presence of organotin). Detection limit information is listed in the tables following page 13.

Sediments

Bulk sediment samples are analyzed using solvent extraction, derivatization, and a GC/FPD. Samples are dried with muffled, anhydrous sodium sulfate. Following the addition of surrogate compounds (tripropyltin chloride and tripropyltin chloride), sediments are extracted with methylene chloride that contains 0.1% (wt./vol.) tropolone. After solvent exchange into hexane, extracts are derivatized with hexylmagnesium bromide in ether via a Grignard reaction. The Grignard reagent is synthesized by CAS (commercially available reagent is not used due to unacceptable purity). Sediment extracts are cleaned by elution through alumina and silica gel columns. The extracts are analyzed by GC/FPD with a 610 nm filter. A minimum (10%) of analyte hits are confirmed by secondary column GC/FPD or GC/MS analysis. All detectable values are confirmed if the samples originated from an uncharacterized site (i.e. no historical data to suggest the likelihood of the presence of organotin). Detection limit information is listed in the tables following page 13.

Tissue

Tissue samples are analyzed using solvent extraction, derivatization, and GC/FPD. Samples are dried with muffled, anhydrous sodium sulfate. Following the addition of surrogate compounds (tripropyltin chloride and tripropyltin chloride), tissues are extracted with methylene chloride that contains 0.1% (wt./vol.) tropolone. After solvent exchange into hexane, extracts are derivatized with hexylmagnesium bromide in ether via a Grignard reaction. The Grignard reagent is synthesized by CAS (commercially available reagent is not used due to unacceptable purity). Tissue extracts are cleaned by elution through Florisil® columns. The extracts are analyzed by GC/FPD with a 610 nm filter. A minimum (10%) of analyte hits are confirmed by a secondary column GC/FPD or GC/MS analysis. All detectable values are confirmed if the samples originated from an uncharacterized site (i.e. no historical data to suggest the likelihood of the presence of organotin). Detection limit information is listed in the tables following page 13.

E. Metals

Seawater and Pore Water

Several procedures have been used at CAS for the analysis of seawater, but the most universal technique with the best overall performance for a relatively wide range of elements is the reductive precipitation technique. The procedure incorporates a chemical separation to remove interfering matrix components so final analysis can be performed using inductively coupled plasma-mass spectroscopy (ICP-MS). The separation utilizes reduction of certain target analytes to the elemental state and precipitation of others as the boride depending on reduction potentials and/or boride solubility. The precipitation is facilitated using elemental palladium and iron boride as carriers. Once separated from the seawater matrix via centrifugation, the precipitate is re-dissolved and analyzed using ICP-MS. Typically, this procedure is performed with the intention of including arsenic and chromium in the analyses. When these elements are not of concern, some improvement of sensitivity can be achieved by altering the dissolution acid used in the procedure. Detection limit information is listed in the tables following page 13. Mercury determinations are generally performed using EPA Method 1631, purge and trap atomic fluorescence. Detection limit information is listed in the tables following page 13.

Sediments

Sediment samples are prepared for analysis using one of two approaches. One procedure incorporates the use of hydrofluoric acid to assure dissolution of refractory compounds and/or refractory compounds containing heavy metals (i.e. contained within the crystalline structure). In recent years, this approach has almost been eliminated for marine studies conducted for environmental applications. Currently, the digestion procedure most commonly required consists of a more traditional nitric/peroxide dissolution essentially equivalent to the EPA soil procedures. CAS performs both procedures. The analysis of the digestate for trace constituents is typically performed using ICP-MS. Major components are analyzed using ICP-Optical Emission Spectrometry (OES). Sediment samples generally present no analytical difficulties with regard to uncorrectable interferences. Occasionally, Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS) is needed for confirmation of some elements. Detection limit information is listed in the tables following page 13.

For mercury, a larger aliquot of the wet sample is digested than is usually done for routine analyses of solid and semi-solid materials. This allows representative sub-sampling of sediments and provides the additional sensitivity typically required. The digestion procedure incorporates similar ratios of digesting/oxidizing reagents as standard EPA procedures. Additional concentrated nitric is added to facilitate the digestion of the high organic content. Standard Cold Vapor Atomic Absorption Spectrophotometry (CVAAS) technique is used for the analysis of the digestate. Detection limit information is listed in the tables following page 13.

Tissue

The digestion procedure for all elements except mercury consists of an acid digestion-oxidation under elevated temperature and pressure in a closed system. The procedure is generally preferred over modifications to conventional EPA soil digestions for several reasons. By freeze-drying the sample and grinding it to a homogenous meal, a representative sample is easily obtained. This is especially significant when analyzing whole-body samples where bone, gristle, and skin are difficult to disperse uniformly throughout the sample. This is also true for portions of bivalve samples that are very difficult to homogenize when wet. Besides helping homogeneity, the absence of water in freeze-drying facilitates the digestion/oxidation of organic material by the oxidants added. Performing the digestion in a closed Teflon vessel under elevated temperature and pressure also increases the completeness of digestion and minimizes loss of target analytes during the procedure (i.e. superior matrix spike recoveries are attained).

For mercury, our laboratory digests a larger aliquot of the wet sample than is typically done for routine analyses of solid and semi-solid materials. This allows representative sub-sampling of tissues. The digestion procedure incorporates similar ratios of digesting/oxidizing reagents as standard EPA procedures. Additional concentrated nitric is added to facilitate the digestion of the high organic content.

The digestates are analyzed using a combination of ICP-MS, ICP-OES, GFAAS, and CVAAS. Selenium is typically analyzed using GFAAS because of uncorrectable isobaric interferences when using ICP-MS. Mercury is analyzed in tissue using standard cold vapor techniques. Our laboratory does perform ultra trace mercury determinations using purge and trap cold vapor atomic fluorescence techniques, but generally does not need the added sensitivity to obtain the required detection limits to meet most project objectives. All other elements are analyzed using ICP-MS or ICP-OES, depending on the required sensitivity. Detection limit information is listed in the tables following page 13.

F. Dioxins/Furans

Seawater and Pore Water

The polychlorinated dioxins/furans analyses are performed by EPA Methods 8290 and 1613 to meet part per quadrillion detection limits usually specified for this work. The typical reporting limits are listed in the tables following page 13. In order to reach these ultra-low detection limits, extensive procedures were developed to minimize contamination. These procedures minimize sample transfer and use disposable glassware where feasible.

Sediments

CAS follows EPA Methods 8280, 8290, and 1613 to perform dioxin/furan analyses. EPA Methods 8290 and 1613 require high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) techniques to meet the parts per trillion (sediment) detection limits typically requested. The reporting limits are listed in the tables following page 13. In order to reach these ultra-low detection limits, extensive procedures were developed to minimize contamination. These procedures minimize sample transfer and use disposable glassware where feasible. Special clean-up techniques have been specifically developed for sediment to minimize matrix interferences.

Tissue

Analysis is performed by EPA Methods 8280, 8290, and 1613 on biological tissue samples. Special clean-up techniques were developed for dealing with tissue samples verses sediment samples to remove biologically active components that could interfere with the analysis. Instrumental analysis is performed by HRGC/HRMS techniques to meet the one part-per-trillion detection limit often requested for tissue samples. Typical reporting limits are listed in the tables following page 13.

Dioxin/Furan Screening

CAS provides full service dioxin testing. In our Houston laboratory both high and low resolution GCMS methodologies are performed on a variety of sample matrices: XAD resins/filters, sediments, tissues, paper, ash, soil, water, and waste. Methodologies employed by CAS/Houston include: EPA 8290, EPA 8280, EPA 613, EPA 1613, and NCASI 551.

IV. Experience

Since 1986, Columbia Analytical Services, Inc. (CAS) has been actively involved in the analysis of water, sediment and tissue in support investigations of sediments and dredge spoils as administered by the Army Corps of Engineers, the US EPA, Port Authorities and various other government agencies throughout the US and other countries. CAS has performed chemical analyses in support of the Puget Sound Estuary Program (PSEP), Puget Sound Dredged Disposal Analyses (PSDDA), and the Puget Sound Water Quality Authority. These studies have included numerous analyses of sediment, tissue and water samples for a variety of trace metals, organics, and conventional chemical constituents. Specific project experience is discussed in the following paragraphs and listed in the following experience matrix.

Sediment Testing: Our project work involves the development and validation of specialized analytical techniques to meet the low-level detection limits and difficult matrix requirements of sediment samples. All data generated under sediment programs must meet specific quality control and stringent data deliverable requirements for complete data validation.

Tissue: CAS performs trace level analyses of a variety of marine tissues. Typical matrices are marine and freshwater fish, as well as crustaceans, mollusks and other invertebrates. Project work involves developing and validating specialized analytical techniques to meet difficult matrix and low-level detection limit requirements. This includes the development of dissection and other sample preparation techniques as well as sample digestion procedures.

Ultra-Trace Metals: CAS performs ultra-trace level metals analyses of pore water samples associated with harbor dredging projects. The analyses can be extremely challenging due to the sample matrix and the limited volume of sample available. Detection limits in the sub-part per billion (ppb) range are commonly requested and the analyses are supported by strict QA/QC protocols.

CAS EXPERIENCE MATRIX

Most of these projects have typically required validatable data packages, including project-specific data deliverables.

	Regulatory Programs							Technical Elements																
	CERCLA	Washington SMS	Washington PSDDA/PSSEP	EPA Green/Gold Book	Clean Water Act (TMDL, 404)	Regional Board Protocols	NOAA Status and Trends	Regional Regulatory Program	Methods Development	Physical Sediment Properties	Metals Analysis	Semivolatiles Analysis (A/B/N)	PCB Aroclors	PCB Congeners	Ultra-Low Level Analysis	Volatiles Analysis	Organotins Analysis	Organochlorine Pesticides	Lipids	Petroleum Hydrocarbons	AVS	SEM	Screen PAHs, PCBs, Dioxins, or Dioxin/Furans	TOC
Alaska Mine Discharge and Investigations <i>(analysis of sediment, soil, freshwater, & other samples)</i>				•		•				•	•	•	•		•	•		•		•				•
Alaska Pulp Corp. RI/FS <i>(analysis of sediment, marine, & wood samples)</i>	•									•	•	•	•			•		•		•	•	•		•
Alaska River Bioaccumulation Study <i>(analysis of tissue, sediment & freshwater samples)</i>					•		•	•	•	•	•	•	•	•			•	•						•
Columbia River Estuary Study Task Force Studies <i>(analysis of tissue, sediment, soil, freshwater, porewater)</i>					•		•		•	•	•	•	•		•	•	•	•	•					•
Coos Bay Investigations <i>(analysis of tissue, sediment, marine water, porewater, & wood-related materials)</i>	•						•	•	•	•	•	•	•		•	•	•	•	•					•
Duwamish River Sediment Characterization <i>(analysis of sediment samples)</i>		•					•	•	•	•					•	•		•						
Duwamish River Water Quality Assessment <i>(analysis of marine water & freshwater samples)</i>							•					•	•		•									
East Waterway Bioaccumulation Testing <i>(analysis of tissue, sediment & freshwater samples)</i>				•			•								•		•		•					
Forest Service Abandoned Mine Investigations <i>(analysis of sediment, soil, freshwater samples)</i>	•						•		•	•	•	•	•		•		•		•					•
Freshwater Stream Biota Toxics Inventory <i>(analysis of tissue, sediment, soil, & freshwater sample)</i>							•	•		•	•	•	•		•	•	•	•	•					•
Grand Calumet PRP Analytical Support <i>(analysis of sediment & freshwater samples)</i>	•						•	•	•			•			•		•		•					•
Hugo Neu-Proler Sediment Investigation <i>(analysis of sediment & marine water samples)</i>						•			•	•	•	•			•		•		•					•
Hylebos Waterway Cleanup Committee Investigations <i>(analysis of sediment & wood-related materials)</i>		•					•				•											•		•
Hylebos Waterway Wood Debris Group Cleanup <i>(analysis of sediment & wood-related materials)</i>		•									•	•												•
Hylebos Waterway Wood Debris Group Cleanup <i>(analysis of sediment & marine water samples)</i>	•						•				•													•
Jackson Park Housing Complex RI/FS <i>(analysis of sediment & soil samples)</i>	•								•	•	•	•			•		•		•		•			•
Ketchikan Pulp Superfund Investigation <i>(analysis of sediment, marine water & wood-related materials)</i>	•			•					•	•	•	•			•		•		•					•
Marina Sediment Characterization <i>(analysis of sediment & freshwater samples)</i>		•	•				•		•	•	•	•			•	•	•	•	•	•				•
McCormick and Baxter Creosoting Company RI/FS <i>(analysis of sediment, soil, freshwater and wood-related samples)</i>							•		•	•	•	•			•		•		•					•
Midway California Sediment Investigation <i>(analysis of sediment, marine water & freshwater samples)</i>						•	•		•	•	•	•			•		•		•	•				•
NCASI Freshwater and Marine Studies <i>(analysis of tissue, sediment, soil, marine water, freshwater and wood-related samples)</i>							•		•	•	•	•			•	•	•	•	•					•
NOAA-NMFS Overflow Analytical Support <i>(analysis of tissue samples)</i>							•			•	•	•	•		•		•	•	•					
Port Arthur Sediment RI <i>(analysis of sediment, marine water & freshwater samples)</i>	•								•						•		•		•		•	•		•
Port of Kalama Investigations <i>(analysis of sediment, freshwater & porewater samples)</i>		•					•		•	•	•	•			•		•		•					•
Port of LA Operable Unit 2&3 <i>(analysis of sediment & marine water samples)</i>					•				•	•	•	•			•	•	•	•	•					•
Port of Newport Dredge Characterization <i>(analysis of sediment & marine water samples)</i>							•		•	•	•	•			•	•	•	•	•					•
Port of Portland General Environmental Services <i>(analysis of tissue, sediment, soil, porewater, freshwater and other samples)</i>	•			•			•		•	•	•	•			•	•	•	•	•					•
Port of San Diego- Analytical Services <i>(analysis of sediment, marine water & freshwater samples)</i>						•			•	•	•	•			•	•	•	•	•					•

CAS EXPERIENCE MATRIX

Most of these projects have typically required validatable data packages, including project-specific data deliverables.

	Regulatory Programs								Technical Elements															
	CERCLA	Washington SMS	Washington PSDDA/PSEP	EPA Green/Gold Book	Clean Water Act (TMDL, 404)	Regional Board Protocols	NOAA Status and Trends	Regional Regulatory Program	Methods Development	Physical Sediment Properties	Metals Analysis	Semivolatiles Analysis (A/B/N)	PCB Aroclors	PCB Congeners	Ultra-Low Level Analysis	Volatiles Analysis	Organotins Analysis	Organochlorine Pesticides	Lipids	Petroleum Hydrocarbons	AVS	SEM	Screen PAHs, PCBs, Dioxins, or Dioxin/Furans	TOC
Port of San Diego- Chula Vista Dredge <i>(analysis of sediment samples)</i>							•			•	•	•	•				•	•						•
Port of Seattle T-3 <i>(analysis of tissue, sediment, soil, marine water, porewater)</i>		•	•					•		•	•	•	•	•		•	•	•	•	•	•	•		•
Portland Shipyard RI/FS <i>(analysis of sediment, soil, marine water & freshwater samples)</i>				•				•	•	•	•	•	•			•	•	•		•	•			•
Potlatch Sediment and Effluent Studies <i>(analysis of sediment, soil, freshwater, wood-related and other samples)</i>					•			•		•	•	•	•			•	•	•		•	•			•
Puget Sound Confined Disposal Site Study <i>(analysis of tissue, sediment & marine water samples)</i>		•	•					•		•	•	•	•			•	•	•	•	•	•	•		•
Rayonier Mill and Landfill Analytical Services <i>(analysis of sediment, soil, freshwater, wood-related and other samples)</i>		•						•		•	•	•	•			•	•	•		•	•			•
Ross Island Initial and RI <i>(analysis of tissue, sediment, soil, porewater, freshwater and wood-related samples)</i>								•	•	•	•	•	•			•	•	•	•	•	•	•		•
San Francisco Corps Sediment Monitoring <i>(analysis of sediment, marine water & freshwater samples)</i>				•				•		•	•	•	•			•	•	•						•
South Carolina Superfund Investigation <i>(analysis of tissue, sediment, marine water & freshwater samples)</i>	•									•	•	•	•			•	•	•	•		•			•
Spokane River Investigation <i>(analysis of tissue, sediment, soil, porewater, freshwater and wood-related samples)</i>					•			•	•	•	•	•	•	•	•	•	•	•	•					•
Tongue Point Finger Piers and Landfill RI <i>(analysis of sediment & marine water samples)</i>	•									•	•	•	•				•	•		•	•			•
Totem Marine Sediment Investigation <i>(analysis of sediment samples)</i>		•								•	•	•	•			•	•	•						•
Tributyl Tin Method Porewater Development Study <i>(analysis of marine water & freshwater samples)</i>	•		•					•	•	•					•		•							
U.S. EPA SAS Program- Tissue Studies <i>(analysis of tissue, sediment, soil, marine water, freshwater, porewater, air & other samples)</i>	•			•						•	•	•	•	•		•	•	•	•	•	•	•		•
U.S. Oil & Refining PSDDA Characterization <i>(analysis of sediment samples)</i>		•	•							•	•	•	•			•	•	•		•	•			•
U.S. Navy Pearl Harbor/West Loch Dredge <i>(analysis of sediment, porewater, and tissue samples)</i>											•	•				•	•			•	•		•	•
U.S. Navy Puget Sound Long Term Monitoring <i>(analysis of tissue, sediment & marine water samples)</i>		•	•	•						•	•	•	•			•	•	•	•	•	•	•		•
U.S. Navy San Diego Bay Sediment and Toxicity Analysis <i>(analysis of tissue, sediment & marine water samples)</i>						•		•		•	•	•	•	•	•	•	•	•						•
NOAA BioEffects and Status and Trends Programs Sediment samples from the areas below were tested by P450HRGS (EPA4425) Southern Calif. Bays Galveston Bay, Biscayne Bay and Sabine Lake, Texas St. Lucie Bay, Florida Northern, Central and Southern Puget Sound Charleston Harbor and Winyah Bay, South Carolina Delaware River and Bay Chesapeake Bay 1998, 1999 and 2001 San Francisco Bay 2000 and 2001 San Diego Bay																							•	
U. S. ACE - Columbia and Willamette Rivers Sediment samples from the areas below were tested by P450HRGS (EPA4425)																								•
U. S. ACE - Miami Harbor Expansion & Maintenance Dredging <i>(Analysis of sediment and tissue samples)</i>											•				•			•	•	•				
Southern CA Coastal Water Res. Project - So. CA Bight 1998 Sediment samples from the area below were tested by P450HRGS (EPA4425)																								•

TABLE 1

**Polynuclear Aromatic Hydrocarbons (PAHs) by
Gas Chromatography/Mass Spectrometry (GC/MS) Selected Ion Monitoring (SIM)
Method Detection Limits (MDLs) and Method Reporting Limits (MRLs)**

Analyte	Water (ug/L)		Soil/Sediment (ug/Kg) (Dry Wt. Basis)		Tissue (ug/Kg) (Wet Wt. Basis)	
	MDL	MRL	MDL	MRL	MDL	MRL
Naphthalene	0.004	0.02	0.3	5	0.3	5
2-Methylnaphthalene	0.004	0.02	0.3	5	0.2	5
1-Methylnaphthalene	0.004	0.02	0.2	5	0.2	5
C2-Naphthalenes*	0.02	0.02	5	5	5	5
C3-Naphthalenes*	0.02	0.02	5	5	5	5
C4-Naphthalenes*	0.02	0.02	5	5	5	5
Acenaphthylene	0.002	0.02	0.2	5	0.05	5
Acenaphthene	0.003	0.02	0.3	5	0.08	5
Dibenzofuran	0.003	0.02	0.2	5	0.06	5
Fluorene	0.003	0.02	0.2	5	0.06	5
C1-Fluorenes*	0.02	0.02	5	5	5	5
C2-Fluorenes*	0.02	0.02	5	5	5	5
C3-Fluorenes*	0.02	0.02	5	5	5	5
Dibenzothiophene	0.003	0.02	0.2	5	0.2	5
C1-Dibenzothiophenes*	0.02	0.02	5	5	5	5
C2-Dibenzothiophenes*	0.02	0.02	5	5	5	5
C3-Dibenzothiophenes*	0.02	0.02	5	5	5	5
Phenanthrene	0.003	0.02	0.2	5	0.07	5
Anthracene	0.003	0.02	0.2	5	0.06	5
C1-Phenanthrenes/Anthracenes*	0.02	0.02	5	5	5	5
C2-Phenanthrenes/Anthracenes*	0.02	0.02	5	5	5	5
C3-Phenanthrenes/Anthracenes*	0.02	0.02	5	5	5	5
C4-Phenanthrenes/Anthracenes*	0.02	0.02	5	5	5	5
Fluoranthene	0.003	0.02	0.2	5	0.06	5
Pyrene	0.003	0.02	0.2	5	0.07	5
C1-Fluoranthenes/Pyrenes*	0.02	0.02	5	5	5	5
Benz(a)anthracene	0.003	0.02	0.2	5	0.06	5
Chrysene	0.003	0.02	0.2	5	0.08	5
C1-Chrysenes*	0.02	0.02	5	5	5	5
C2-Chrysenes*	0.02	0.02	5	5	5	5
C3-Chrysenes*	0.02	0.02	5	5	5	5
C4-Chrysenes*	0.02	0.02	5	5	5	5
Benzo(b)fluoranthene	0.002	0.02	0.2	5	0.05	5
Benzo(k)fluoranthene	0.004	0.02	0.2	5	0.09	5
Benzo(a)pyrene	0.002	0.02	0.2	5	0.08	5
Indeno(1,2,3-cd)pyrene	0.002	0.02	0.2	5	0.08	5
Dibenz(a,h)anthracene	0.003	0.02	0.2	5	0.08	5
Benzo(g,h,i)perylene	0.004	0.02	0.1	5	0.1	5

* Method Detection Limits have not been experimentally determined for these analytes. The MDL listed is used for reporting purposes and is equal to the MRL.

Note: Lower detection limits in water are available. Please call laboratory for specifics.

6/16/04

TABLE 2**Polynuclear Aromatic Hydrocarbons (PAHs) by
Gas Chromatography/Mass Spectrometry (GC/MS) Selected Ion Monitoring (SIM)****ULTRA LOW LEVEL****Method Detection Limits (MDLs) and Method Reporting Limits (MRLs)**

Analyte	<u>Sediment (µg/Kg)</u> (Dry Wt. Basis)		<u>Tissue (µg/Kg)</u> (Wet Wt. Basis)	
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>
Naphthalene	0.2	1	0.3	1
2-Methylnaphthalene	0.2	1	0.2	1
1-Methylnaphthalene	0.2	1	0.2	1
Acenaphthylene	0.2	0.5	0.05	0.5
Acenaphthene	0.3	0.5	0.08	0.5
Dibenzofuran	0.2	0.5	0.06	0.5
Fluorene	0.2	0.5	0.06	0.5
Dibenzothiophene	0.2	0.5	0.2	0.5
Phenanthrene	0.2	0.5	0.07	0.5
Anthracene	0.2	0.5	0.06	0.5
Fluoranthene	0.2	0.5	0.06	0.5
Pyrene	0.2	0.5	0.07	0.5
Benz(a)anthracene	0.2	0.5	0.06	0.5
Chrysene	0.2	0.5	0.08	0.5
Benzo(b)fluoranthene	0.2	0.5	0.05	0.5
Benzo(k)fluoranthene	0.2	0.5	0.09	0.5
Benzo(a)pyrene	0.2	0.5	0.08	0.5
Indeno(1,2,3-cd)pyrene	0.2	0.5	0.08	0.5
Dibenz(a,h)anthracene	0.2	0.5	0.08	0.5
Benzo(g,h,i)perylene	0.1	0.5	0.1	0.5

Note: Lower detection limits in water are available. Please call laboratory for specifics.

TABLE 3**Low Level Semivolatile Organic Compounds****Gas Chromatography/Mass Spectrometry using Large Volume Injector (LVI)
Method Detection Limits (MDLs) and Method Reporting Limits (MRLs)**

Analyte	Water (µg/L)		Soil/Sediment (µg/Kg) (Dry Wt. Basis)	
	MDL	MRL	MDL	MRL
1,2,4-Trichlorobenzene	0.02	0.2	2	10
1,2-Dichlorobenzene	0.02	0.2	2	10
1,3-Dichlorobenzene	0.02	0.2	2	10
1,4-Dichlorobenzene	0.02	0.2	2	10
2,4,6-Trichlorophenol	0.04	0.5	2	10
2,4-Dichlorophenol	0.03	0.5	2	10
2,4-Dimethylphenol	0.4	2	6	50
2,4-Dinitrophenol	0.6	4	40	200
2,4-Dinitrotoluene	0.02	0.2	3	10
2,6-Dinitrotoluene	0.009	0.2	3	10
2-Chloronaphthalene	0.02	0.2	4	10
2-Chlorophenol	0.02	0.5	2	10
2-Methyl-4,6-dinitrophenol	0.02	2	2	100
2-Methylnaphthalene	0.02	0.2	2	10
2-Methylphenol	0.06	0.5	4	10
2-Nitroaniline	0.02	0.2	3	20
2-Nitrophenol	0.02	0.5	3	10
3- and 4-Methylphenol Coelution	0.06	0.5	3	10
3,3'-Dichlorobenzidine	0.5	2	4	100
3-Nitroaniline	0.3	1	3	20
4-Bromophenyl Phenyl Ether	0.020	0.2	2	10
4-Chloro-3-methylphenol	0.03	0.5	3	10
4-Chloroaniline	0.02	0.2	3	10
4-Chlorophenyl Phenyl Ether	0.009	0.2	2	10
4-Methylphenol	0.06	0.5	3	10
4-Nitroaniline	0.2	1	4	20
4-Nitrophenol	0.6	2	30	100
Acenaphthene	0.009	0.2	1	10
Acenaphthylene	0.02	0.2	2	10
Anthracene	0.02	0.2	2	10
Azobenzene	0.02	0.2	3	10
Benz(a)anthracene	0.02	0.2	2	10
Benzo(a)pyrene	0.02	0.2	2	10
Benzo(b)fluoranthene	0.02	0.2	3	10
Benzo(g,h,i)perylene	0.02	0.2	3	10
Benzo(k)fluoranthene	0.02	0.2	3	10
Benzoic Acid	2	5	96	200
Benzyl Alcohol	1	5	4	10

TABLE 3 - CONTINUED

Low Level Semivolatile Organic Compounds
Gas Chromatography/Mass Spectrometry using Large Volume Injector (LVI)
Method Detection Limits (MDLs) and Method Reporting Limits (MRLs)

Analyte	Water (µg/L)		Soil/Sediment (µg/Kg) (Dry Wt. Basis)	
	MDL	MRL	MDL	MRL
Bis(2-chloroethoxy)methane	0.02	0.2	2	10
Bis(2-chloroethyl) Ether	0.02	0.2	3	10
Bis(2-chloroisopropyl) Ether	0.02	0.2	2	10
Bis(2-ethylhexyl) Phthalate	0.3	2	2	200
Butyl Benzyl Phthalate	0.03	0.2	2	10
Carbazole	0.02	0.2	2	10
Chrysene	0.02	0.2	2	10
Dibenz(a,h)anthracene	0.04	0.2	3	10
Dibenzofuran	0.02	0.2	2	10
Diethyl Phthalate	0.03	0.2	4	10
Dimethyl Phthalate	0.02	0.2	2	10
Di-n-butyl Phthalate	0.03	0.2	3	10
Di-n-octyl Phthalate	0.04	0.2	2	10
Fluoranthene	0.02	0.2	3	10
Fluorene	0.02	0.2	2	10
Hexachlorobenzene	0.02	0.2	3	10
Hexachlorobutadiene	0.02	0.2	2	10
Hexachlorocyclopentadiene	0.05	1	15	50
Hexachloroethane	0.02	0.2	3	10
Indeno(1,2,3-cd)pyrene	0.03	0.2	2	10
Isophorone	0.009	0.2	2	10
Naphthalene	0.02	0.2	2	10
Nitrobenzene	0.008	0.2	2	10
N-Nitrosodi-n-propylamine	0.04	0.2	4	10
N-Nitrosodiphenylamine	0.03	0.2	3	10
Pentachlorophenol (PCP)	0.03	1	9	50
Phenanthrene	0.02	0.2	2	10
Phenol	0.02	0.5	2	30
Pyrene	0.02	0.2	2	10

TABLE 4

Organochlorine Pesticides
Gas Chromatography (GC), EPA Method 8081
Method Detection Limits (MDLs) & Method Reporting Limits (MRLs)

Analyte	Water (µg/L)		Soil/Sediment (µg/Kg) (Dry Wt. Basis)		Tissue (µg/Kg) (Wet Wt. Basis)	
	MDL	MRL	MDL	MRL	MDL	MRL
alpha-BHC	0.001	0.01	0.1	1	0.2	1
beta-BHC	0.003	0.01	0.2	1	0.2	1
gamma-BHC (Lindane)	0.001	0.01	0.1	1	0.3	1
delta-BHC	0.002	0.01	0.1	1	0.3	1
Heptachlor	0.001	0.01	0.1	1	0.5	1
Aldrin	0.001	0.01	0.3	1	0.2	1
Heptachlor Epoxide	0.001	0.01	0.1	1	0.2	1
gamma-Chlordane	0.001	0.01	0.04	1	0.1	1
Endosulfan I	0.001	0.01	0.1	1	0.1	1
alpha-Chlordane	0.003	0.01	0.1	1	0.4	1
Dieldrin	0.001	0.01	0.1	1	0.1	1
4,4'-DDE	0.001	0.01	0.1	1	0.1	1
Endrin	0.001	0.01	0.2	1	0.1	1
Endosulfan II	0.001	0.01	0.1	1	0.4	1
4-4'-DDD	0.002	0.01	0.09	1	0.1	1
Endrin Aldehyde	0.002	0.01	0.2	1	0.2	1
Endosulfan Sulfate	0.003	0.01	0.2	1	0.3	1
4,4'-DDT	0.001	0.01	0.2	1	0.4	1
Endrin Ketone	0.001	0.01	0.06	1	0.3	1
Methoxychlor	0.001	0.01	0.2	1	0.3	1
Toxaphene	0.04	0.5	7	50	6	50
NOAA List						
Hexachlorobenzene	0.0006	0.01	0.2	1	0.3	1
Chlorpyrifos	0.002	0.01	0.06	1	0.2	1
Oxychlordane	0.0009	0.01	0.1	1	0.1	1
2,4'-DDE	0.0009	0.01	0.07	1	0.1	1
trans-Nonachlor	0.002	0.01	0.03	1	0.05	1
2,4'-DDD	0.0008	0.01	0.16	1	0.2	1
cis-Nonachlor	0.003	0.01	0.04	1	0.1	1
2,4'-DDT	0.001	0.01	0.08	1	0.2	1
Mirex	0.0009	0.01	0.06	1	0.3	1

TABLE 4 - CONTINUED

**Organochlorine Pesticides (Ultra Low Level)
Gas Chromatography (GC), EPA Method 8081
Method Detection Limits (MDLs) & Method Reporting Limits (MRLs)**

<u>Analyte</u>	<u>Water (ng/L)</u>	
	<u>MDL</u>	<u>MRL</u>
alpha-BHC	0.3	0.5
beta-BHC	*	0.5
gamma-BHC (Lindane)	0.2	0.5
delta-BHC	0.06	0.5
Heptachlor	0.07	0.5
Aldrin	0.1	0.5
Heptachlor Epoxide	0.2	0.5
gamma-Chlordane	0.07	0.5
Endosulfan I	0.1	0.5
alpha-Chlordane	0.04	0.5
Dieldrin	0.06	0.5
4,4'-DDE	0.1	0.5
Endrin	0.05	0.5
Endosulfan II	0.06	0.5
4-4'-DDD	0.05	0.5
Endrin Aldehyde	0.04	0.5
Endosulfan Sulfate	0.13	0.5
4,4'-DDT	0.047	0.5
Endrin Ketone	0.03	0.5
Methoxychlor	0.17	0.5

NOAA List

Hexachlorobenzene	0.1	0.5
Chlorpyrifos	*	0.5
Oxychlordane	*	0.5
2,4'-DDE	0.05	0.5
trans-Nonachlor	*	0.5
2,4'-DDD	0.06	0.5
cis-Nonachlor	*	0.5
2,4'-DDT	0.1	0.5
Mirex	*	0.5

* Analyte typically not requested in water matrix. Call laboratory for further information.

TABLE 5

**PCB Aroclors
Gas Chromatography (GC), EPA Method 8082**

Method Detection Limits (MDLs) & Method Reporting Limits (MRLs)

<u>Analyte</u>	(SPE extraction)		<u>Soil/Sediment (µg/Kg)</u>		<u>Tissue (µg/Kg)</u>	
	<u>Water (µg/L)</u>		<u>(Dry Wt. Basis)</u>		<u>(Wet Wt. Basis)</u>	
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>
Aroclor 1016	0.02	0.2	10	100	2	10
Aroclor 1221	0.04	0.4	6	200	3	20
Aroclor 1232	0.06	0.2	10	100	2	10
Aroclor 1242	0.08	0.2	9	100	4	10
Aroclor 1248	0.02	0.2	4	100	1	10
Aroclor 1254	0.03	0.2	4	100	2	10
Aroclor 1260	0.01	0.2	12	100	5	10
Aroclor 1262	0.07	0.2	5	100	4	10
Aroclor 1268	0.09	0.2	3	100	2	10
<u>Ultra Low-Level</u>	(Requires 2-L aliquot for aqueous samples)					
Aroclor 1016	0.003	0.005			2	2
Aroclor 1221	0.003	0.01			2	4
Aroclor 1232	0.003	0.005			2	2
Aroclor 1242	0.003	0.005			2	2
Aroclor 1248	0.003	0.005			2	2
Aroclor 1254	0.003	0.005			2	2
Aroclor 1260	0.003	0.005			2	2
Aroclor 1262	0.003	0.005			2	2
Aroclor 1268	0.003	0.005			2	2
<u>Low-Level</u>	(Requires 1-L aliquot for aqueous samples)					
Aroclor 1016	0.007	0.02	2	10		
Aroclor 1221	0.007	0.04	2	20		
Aroclor 1232	0.007	0.02	2	10		
Aroclor 1242	0.007	0.02	2	10		
Aroclor 1248	0.007	0.02	2	10		
Aroclor 1254	0.007	0.02	2	10		
Aroclor 1260	0.007	0.02	2	10		
Aroclor 1262	0.007	0.02	2	10		
Aroclor 1268	0.007	0.02	2	10		

TABLE 6

**PCB Congeners - Gas Chromatography (GC), EPA Method 8082
Method Detection Limits (MDLs) & Method Reporting Limits (MRLs)**

<u>Analyte</u>	<u>Water (ng/L)</u>		<u>Soil/Sediment (µg/Kg) (Dry Wt. Basis)</u>		<u>Tissue (µg/Kg) (Wet Wt. Basis)</u>		
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>	
PCB 1	2	5	0.3	0.5	0.5	1	
PCB 5	2,3-Dichlorobiphenyl	0.8	5	0.06	0.5	0.2	0.5
PCB 8	2,4'-Dichlorobiphenyl	1	5	0.09	0.5	0.1	2
PCB 18	2,2',5-Trichlorobiphenyl	2	5	0.03	0.5	0.1	0.5
PCB 28	2,4,4'-Trichlorobiphenyl	1	5	0.3	0.5	0.3	0.5
PCB 31	2,4',5-Trichlorobiphenyl	2	5	0.07	0.5	0.1	0.5
PCB 33	2',3,4-Trichlorobiphenyl	2	5	0.1	0.5	0.2	0.5
PCB 37	3,4,4'-Trichlorobiphenyl	0.5	5	0.06	0.5	0.1	0.5
PCB 44	2,2',3,5'-Tetrachlorobiphenyl	2	5	0.2	0.5	0.1	0.5
PCB 49	2,2',4,5'-Trichlorobiphenyl	0.5	5	0.05	0.5	0.1	0.5
PCB 52	2,2',5,5'-Tetrachlorobiphenyl	2	5	0.05	0.5	0.08	1
PCB 56	2,3,3',4'-Trichlorobiphenyl	2	5	0.09	0.5	0.08	0.5
PCB 60	2,3,4,4'-Tetrachlorobiphenyl	0.9	5	0.04	0.5	0.2	0.5
PCB 66	2,3',4,4'-Tetrachlorobiphenyl	1	5	0.04	0.5	0.07	0.5
PCB 70	2,3',4',5-Trichlorobiphenyl	1	5	0.04	0.5	0.1	0.5
PCB 74	2,4,4',5-Trichlorobiphenyl	2	5	0.05	0.5	0.3	0.5
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	0.4	5	0.07	0.5	0.09	0.5
PCB 81	3,4,4',5-Tetrachlorobiphenyl	1	5	0.03	0.5	0.08	0.5
PCB 87	2,2',3,4,5'-Pentachlorobiphenyl	1	5	0.03	0.5	0.2	0.5
PCB 90	2,2',3,4',5-Pentachlorobiphenyl	1	5	0.03	0.5	0.1	0.5
PCB 95	2,2',3,5',6-Pentachlorobiphenyl	0.6	5	0.05	0.5	0.3	0.5
PCB 97	2,2',3',4,5-Pentachlorobiphenyl	1	5	0.03	0.5	0.1	0.5
PCB 99	2,2',4,4',5-Pentachlorobiphenyl	2	5	0.03	0.5	0.06	0.5
PCB 101	2,2',4,5,5'-Pentachlorobiphenyl	2	5	0.03	0.5	0.07	0.5
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	0.3	5	0.04	0.5	0.2	0.5
PCB 110	2,3,3',4',6-Pentachlorobiphenyl	2	5	0.03	0.5	0.1	0.5
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	1	5	0.08	0.5	0.3	0.5
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	1	5	0.04	0.5	0.1	0.5
PCB 119	2,3',4,4',6-Pentachlorobiphenyl	0.7	5	0.06	0.5	0.1	0.5
PCB 123	2',3,4,4',5-Pentachlorobiphenyl	1	5	0.03	0.5	0.1	0.5
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	0.3	5	0.04	0.5	0.1	0.5
PCB 128	2,2',3,3',4,4'-Hexachlorobiphenyl	0.4	5	0.3	0.5	0.09	0.5
PCB 132	2,2',3,3',4,6'-Hexachlorobiphenyl	2	5	0.03	0.5	0.3	0.5
PCB 138	2,2',3,4,4',5'-Hexachlorobiphenyl	1	5	0.03	0.5	0.2	0.5
PCB 141	2,2',3,4,5,5'-Hexachlorobiphenyl	1	5	0.03	0.5	0.1	0.5
PCB 149	2,2',3,4',5,6-Hexachlorobiphenyl	0.5	5	*	0.5	*	0.5
PCB 151	2,2',3,5,5',6-Hexachlorobiphenyl	1	5	0.06	0.5	0.07	0.5
PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl	0.9	5	0.04	0.5	0.2	0.5
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl	1	5	0.04	0.5	0.1	0.5
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	2	5	0.04	0.5	0.08	0.5
PCB 158	2,3,3',4,4',6-Hexachlorobiphenyl	0.3	5	0.04	0.5	0.08	0.5
PCB 166	2,3,4,4',5,6-Hexachlorobiphenyl	0.5	5	0.04	0.5	0.1	0.5
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	2	5	0.03	0.5	0.2	0.5
PCB 168	2,3',4,4',5,6-Hexachlorobiphenyl	0.6	5	0.04	0.5	0.08	0.5
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	0.3	5	0.03	0.5	0.09	0.5
PCB 170	2,2',3,3',4,4',5-Heptachlorobiphenyl	0.4	5	0.03	0.5	0.08	0.5
PCB 174	2,2',3,3',4,5,6'-Heptachlorobiphenyl	0.4	5	0.2	0.5	0.06	0.5
PCB 177	2,2',3,3',4',5,6-Heptachlorobiphenyl	1	5	0.09	0.5	0.3	0.5
PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl	1	5	0.03	0.5	0.1	0.5
PCB 183	2,2',3,4,4',5',6-Heptachlorobiphenyl	1	5	0.03	0.5	0.2	0.5
PCB 184	2,2',3,4,4',6,6'-Heptachlorobiphenyl	2	5	0.05	0.5	0.08	0.5
PCB 187	2,2',3,4',5,5',6-Heptachlorobiphenyl	2	5	0.04	0.5	0.2	0.5
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	1	5	0.03	0.5	0.09	0.5
PCB 194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl	1	5	0.03	0.5	0.3	0.5
PCB 195	2,2',3,3',4,4',5,6-Octachlorobiphenyl	1	5	0.04	0.5	0.1	0.5
PCB 201	2,2',3,3',4,5',6'-Octachlorobiphenyl	2	5	0.03	0.5	0.3	0.5
PCB 203	2,2',3,4,4',5,5',6-Octachlorobiphenyl	1	5	0.03	0.5	0.2	0.5
PCB 206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	2	5	0.06	0.5	0.08	0.5
PCB 209	2,2',3,3',4,4',5,5',6,6-Decachlorobiphenyl	2	5	0.05	0.5	0.1	0.5

* Please contact Laboratory for latest limits

TABLE 7

**PCB Coplanar Congeners - HRGC/HRMS, EPA Method 1668A
PCB Congener World Health Organization (WHO) List
Method Reporting Limits (MRLs)***

<u>Analyte</u>		<u>TEF**</u>	<u>Water</u> (pg/L) <u>MRL</u>	<u>Soil/Sediment</u> (ng/Kg) (Dry Wt. Basis) <u>MRL</u>	<u>Tissue</u> (ng/Kg) (Wet Wt.) <u>MRL</u>
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	0.0001	500	50	50
PCB 81	3,4,4',5-Tetrachlorobiphenyl	0.0001	500	50	50
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	0.0001	200	20	50
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	0.0005	500	50	50
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	0.0001	500	50	50
PCB 123	2',3,4,4',5-Pentachlorobiphenyl	0.0001	500	50	50
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	0.1	500	50	50
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl	0.0005	500	50	50
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	0.0005	500	50	50
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	0.00001	500	50	50
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	0.01	500	50	50
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	0.0001	500	50	50

* Please contact Laboratory for latest limits, RLs can be adjusted to meet project requirements.

** Toxicity Equivalency Factor

TABLE 8**Organotins****Method Detection Limits (MDLs) & Method Reporting Limits (MRLs)**

<u>Analyte</u>	<u>Water/Porewater ($\mu\text{g/L}$)</u> M. A. Unger, et al. (GC/FPD)		<u>Soil/Sediment ($\mu\text{g/Kg}$)</u> (Dry Wt. Basis) C. A. Krone, et al. (GC/FPD)		<u>Tissue ($\mu\text{g/Kg}$)</u> (Wet Wt. Basis) M. O. Stallard, et al. (GC/FPD)	
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>
Tetra-n-butyltin	0.003	0.05	0.1	1	0.4	1
Tri-n-butyltin	0.007	0.02	0.2	1	0.3	1
Di-n-butyltin	0.005	0.05	0.04	1	0.4	1
n-butyltin	0.005	0.05	0.07	1	0.4	1

TABLE 9

**EPA Method 200.8/6020
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)
Method Detection Limits (MDLs) & Method Reporting Limits (MRLs)**

<u>Analyte</u>	<u>Water (µg/L)</u>		<u>Soil/Sediment (mg/Kg)</u> (Dry Wt. Basis)		<u>Tissue (mg/Kg)</u> (Wet Wt. Basis)	
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>
Aluminum	2	2	2	2	0.06	0.4
Antimony	0.02	0.05	0.02	0.05	0.002	0.01
Arsenic	0.2	0.5	0.07	0.5	0.006	0.1
Barium	0.03	0.05	0.03	0.05	0.004	0.01
Beryllium	0.007	0.02	0.006	0.02	0.002	0.004
Cadmium	0.02	0.02	0.07	0.05	0.002	0.004
Chromium	0.06	0.2	0.04	0.2	0.01	0.1
Cobalt	0.01	0.02	0.01	0.02	0.0006	0.004
Copper	0.03	0.1	0.02	0.1	0.02	0.02
Lead	0.009	0.02	0.02	0.05	0.002	0.004
Manganese	0.02	0.05	0.04	0.05	0.001	0.01
Molybdenum	0.02	0.05	0.008	0.05	0.001	0.01
Nickel	0.2	0.2	0.04	0.2	0.006	0.04
Selenium	0.6	1	0.2	1	0.08	0.2
Silver	0.009	0.02	0.003	0.02	0.0008	0.004
Thallium	0.004	0.02	0.002	0.02	0.0004	0.004
Uranium	0.006	0.02	0.004	0.02	0.0004	0.004
Vanadium	0.03	0.2	0.03	0.2	0.1	0.2
Zinc	0.3	0.5	0.2	0.5	0.02	0.1

*Chromium and Vanadium in tissue are analyzed by ICP-OES, Selenium is analyzed by GFAAS.

Lower limits are available for Selenium when using Hydride AAS.

EPA Method 1631M - Mercury by Atomic Fluorescence MDLs and MRLs

	<u>Water (µg/L)</u>		<u>Sediment (mg/Kg)</u>	
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>
Mercury	0.00006	0.001	0.0002	0.002

EPA Method 7471A - Mercury by CVAAS MDLs and MRLs *

	<u>Sediment (mg/Kg)</u> (Dry Wt. Basis)		<u>Tissue (mg/Kg)</u> (Wet Basis)	
	<u>MDL</u>	<u>MRL</u>	<u>MDL</u>	<u>MRL</u>
Mercury	0.008	0.02	0.002	0.004

*Lower detection limit for Hg in tissue is available. Call for specifications.

TABLE 10

**Reductive Precipitation
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)
Method Reporting Levels (MRLs)**

<u>Analyte</u>	<u>Seawater µg/L</u>	
	<u>MDL</u>	<u>MRL</u>
Arsenic	0.02	0.5
Beryllium	0.0008	0.02
Cadmium	0.003	0.02
Chromium	0.02	0.2
Cobalt	0.002	0.02
Copper	0.008	0.1
Lead	0.009	0.02
Nickel	0.02	0.2
Silver	0.005	0.02
Thallium	0.0006	0.02
Zinc	0.02	0.5

TABLE 11**Regulated Dioxin and Furan Isomers****HRGC/HRMS****SW 846 Method 8290**

<u>Dioxins</u>	<u>Reporting Limits*</u>	<u>Reporting Limits*</u>
	Water (pg/L)	Solids (ng/Kg)
2,3,7,8-TCDD	10	1
1,2,3,7,8-PeCDD	25	2.5
1,2,3,4,7,8-HxCDD	25	2.5
1,2,3,6,7,8-HxCDD	25	2.5
1,2,3,7,8,9-HxCDD	25	2.5
1,2,3,4,6,7,8-HpCDD	25	2.5
OCDD	50	5

<u>Furans</u>	<u>Reporting Limits*</u>	<u>Reporting Limits*</u>
	Water (pg/L)	Solids (ng/Kg)
2,3,7,8-TCDF	10	1
1,2,3,7,8-PeCDF	25	2.5
2,3,4,7,8-PeCDF	25	2.5
1,2,3,4,7,8-HxCDF	25	2.5
1,2,3,6,7,8-HxCDF	25	2.5
2,3,4,6,7,8-HxCDF	25	2.5
1,2,3,7,8,9-HxCDF	25	2.5
1,2,3,4,6,7,8-HpCDF	25	2.5
1,2,3,4,7,8,9-HpCDF	25	2.5
OCDF	50	5

* Actual reporting limits vary from sample to sample.



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