



US Army Corps  
of Engineers  
Portland District



Region 10

# Characteristics of Chinook Marina Sediment in Baker Bay, Washington



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**Characteristics of Chinook Marina Sediment  
in Baker Bay, Washington**

**Prepared For:  
Sediment Management Program  
U. S. Environmental Protection Agency  
Region 10  
Seattle, Washington**

**Prepared By:  
U. S. Army Corps of Engineers  
Portland District  
Portland, Oregon**

**December 1992**

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## TABLE OF CONTENTS

ABSTRACT . . . . .	1
INTRODUCTION . . . . .	1
METHODS . . . . .	2
RESULTS/DISCUSSION . . . . .	3
PHYSICAL . . . . .	3
CHEMICAL . . . . .	3
CONCLUSIONS . . . . .	6
REFERENCES . . . . .	7
APPENDIX (RAW DATA AND QA/QC REPORTS) . . . . .	16

## LIST OF TABLES

Table		Page
1	Results of physical analyses of Chinook Marina sediment.	9
2	Concentrations of metals, AVS and TOC in Chinook Marina sediment.	10
3	Concentrations of organic contaminants in Chinook Marina sediment.	11
4	Concentrations of phenols in Chinook Marina sediment.	12
5	Concentrations of dioxins and furans in Chinook Marina sediment.	13

## LIST OF FIGURES

Figure		Page
1	Baker Bay Area Map	14
2	Locations of sediment samples taken in the Chinook Marina.	15

## Characteristics of Chinook Marina Sediment in Baker Bay, Washington

### Abstract

The sediment in Chinook Marina is relatively free of contaminants. Generally, the metals concentrations are typical for local marinas in the Columbia River estuary. Cadmium and zinc exceed EPA, Region 10 screening levels. TBT concentrations were well below the screening level. There are few local sources of metals other than stormwater runoff and activities associated with boat use. The AVS concentrations are typical of marina samples. PCBs were undetected. The pesticides DDD, DDE and endosulfan II were found in low amounts ( $\leq 8$  ppb). PAHs were below screening levels and typical of other small marinas. Phenol was detected in some samples, but its detection is suspect because the method blank was contaminated with phenol. Dioxins and furans were detected at low concentrations. The pattern of concentrations of the congener classes was similar to the pattern observed in other samples from the lower Columbia River, including offshore sites at the mouth and sites between Wauna and Bonneville. The pattern is also similar to that found in Yaquina Bay samples.

### Introduction

1. The purpose of the present study is to collect background information regarding sediment characteristics of the Chinook Marina. Many smaller boat basins are outside of Federally authorized dredging channels and are infrequently studied. In recent years the Corps of Engineers, Portland District, and EPA, Region 10, have been cooperatively and routinely evaluating selected locations and sediment quality parameters. This has allowed for efficient use of Federal monies while providing quality, scientific information useful to both agencies. Characteristics such as grain size distribution and levels of contaminants, if any, in small boat basin sediments are used to provide a basis for decision making regarding disposal of sediments from maintenance dredging. The information also provides a 'snap shot' of the environmental conditions in the boat basins. These conditions are important because of the importance of Baker Bay as a nursery and feeding area for aquatic life and because it is a depositional area for fine grained sediments. A similar sediment evaluation of Ilwaco Boat Basin is being prepared for the EPA by the Corps.

2. The Chinook Marina is located about 6 miles upstream from the mouth of the Columbia River on the Washington side along the eastern edge of Baker Bay. The boat basin is often called the Port of Chinook or Chinook Marina. In this report it will be referred to as the boat basin or Chinook Marina. The Chinook Marina is served by a Federally authorized side-channel that branches off the main Columbia River channel at RM 5.0. The Chinook Channel, as its called, passes the east end of Sand Island in a northeasterly direction. As this Channel extends 2 miles across Baker Bay to the Chinook Marina, the substrate changes progressively from sand near Sand Island to silt at the boat basin proper. The Chinook channel is 10 feet deep and 150 feet wide (1). At the Chinook Marina it widens into a turning and mooring basin that is 275 to 500 feet wide, 660 feet long and 10 feet deep. A quiet water moorage is provided by a stone breakwater. The turning and mooring basin is dredged by local interests. In the past, the material has been placed at a site adjacent to the southeastern edge of the Marina. The basin is run by the Port of Chinook and is adjacent to the city of Chinook, Washington.

3. Chinook Marina is subject to typical local sources of contaminants. Recreational, commercial and sports fishery water craft provide some input of pollutants. As many as 350 boats use the facility in the height of the fishing season in August and September. The marina has 300 boat slips and a fuel dock. A cannery is adjacent to the marina along its northwestern shoreline (2). Nearby outfalls deliver storm water from the city of Chinook and Highway 101 to Baker Bay, west and east of the Chinook Marina. One outfall drains directly into the northwest corner of the marina. Stormwater runoff from urban areas and highways may contain heavy metals and organics that could contaminate the sediment. The marina is a depositional area for fine grained material. Fine grained sedimentary and organic material adsorb metals and hydrophobic, organic compounds from the water column that, over time, can accumulate in concentrations harmful to the environment. The results of this study will provide information regarding the levels of contaminants in the marina sediment.

4. Baker Bay is "a shallow mudflat area that supports an important nursery and feeding area for many species of juvenile anadromous fish, adult and juvenile marine fishes, shellfish and birds" (3). Historically, Baker Bay was an exposed, sandy bottom habitat until the north, south and A jetties were constructed at the mouth of the Columbia River. Since then the bay has become a more protected and shallow area containing sand and mud sediments. Several studies of sediment from Baker Bay have been conducted by the Corps and U. S. G. S. over the years (4-8). Results of analyses for contaminants show that the Bay is relatively free of contaminants.

## **Methods**

5. On March 19, 1992 six samples were taken by U. S. Army Corps of Engineers (USACE) and National Marine Fisheries Service (NMFS) personnel, using a modified 0.96 m<sup>2</sup> Gray O'Hara box corer, at the locations shown on the enclosed map (Figure 1). Two of the samples were taken in the Federal channel leading up to the marina and 4 samples were taken from within the marina. The box corer obtains a sample that is roughly 2 feet in depth when used in soft, fine grained sediment typical of marina areas. At each of the 6 sampling stations sub-samples of sediment in the box corer were composited for physical and chemical analyses. Physical sub-samples were cold stored in plastic baggies and were analyzed for grain size distribution and volatile solids content. Physical tests were conducted by the U. S. Army Corps of Engineers Materials Lab, Troutdale, Oregon. Chemical sub-samples were cold stored in EPA approved, glass containers that were acid and hexane rinsed by the supplier according to EPA/USACE protocols and topped with teflon lined lids. The chemical samples were tested for total organic carbon (TOC), heavy metals, polynuclear aromatic hydrocarbons (PAHs), pesticides, polychlorobiphenyls (PCBs), acid volatile sulfides (AVS), phenols, tributyltin (TBT) and dioxin/furans. Chemical analyses were performed by Columbia Analytical Associates, Kelso, Washington, Battelle Laboratories, Squim, Washington and Keystone/NEA Environmental Resources, Portland, Oregon. All sampling procedures and analyses were performed according to EPA/USACE approved methods (9). A quality control (QC) and quality assurance (QA) report of the results was prepared by the USACE, Portland District Materials Lab in Troutdale, Oregon (see appendix).

## **Results/Discussion**

### **Physical**

6. The Chinook Marina samples (CB-BC-1, 2, 3, 4) are fine to medium silts with an average median grain size of 0.011 mm (Table 1). The samples averaged 2.7 % sand, 89.4 % silt and 7.9 % clay. The mean organic content as measured by volatile solids was 8.1 %. These physical values are typical of marina sediments in backwater areas. The 'U' shape of Chinook Marina tends to cause fine grained sediment to settle out from quiescent waters. Samples from the Federal channel leading up to the marina become more silty as they approach the marina. Sample CH-BC-1, taken from just outside the marina, was similar in its physical characteristics to the marina samples. Sample CH-BC-2, taken further away from the marina on the other side of the breakwater contained more sand, less silt and about the same amount of clay. These results confirm earlier studies, which have shown a progression from silty to predominantly sandy material in the Chinook Channel as it proceeds from Chinook Marina to the main Columbia River channel (4, 5, 6).

7. The amounts of fines and volatile solids in the sediment indicate a potential for enrichment of contaminants. Fine grained, organic rich sediment tends to adsorb and concentrate metals and hydrophobic, organic contaminants if any are present. Ninety percent of the sediment is in the 63  $\mu\text{m}$  grain size fraction. This fraction is readily carried in suspension and deposited in quiescent areas. The chemical results that follow, with few exceptions, show the sediment is relatively uncontaminated when compared to EPA, Region 10 screening levels for marine waters.

### **Chemical**

#### **Metals**

8. In general, the concentrations of metals found in the sediment are typical for fine grained sediment in marina locations in the lower Columbia river estuary. The concentrations of metals are presented in Table 2. Tests for eight heavy metals were conducted on the samples - arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Of these, only cadmium and zinc concentrations in the bulk sediment exceeded EPA Region 10 screening levels for marine waters. Cadmium exceeded the screening level (0.96 ppm) in three of the four samples (CB-BC-1, 3, 4; 1.6, 1.6, and 1.2 ppm respectively). The mean concentration of cadmium in the samples was 1.3 ppm. Samples taken in the channel leading to the boat basin show that cadmium concentrations decrease further away from the basin. To put these cadmium levels in perspective the U. S. Army Corps of Engineers, Portland District database was examined for cadmium concentrations in the lower Columbia River. The database contains detectable cadmium in 131 sediment samples taken between Rm 0.0 at the mouth and RM 144.0 just below Bonneville Dam. Cadmium exceeded the screening level in 7 locations all in backwater or marina areas, similar to Chinook Marina, containing fine grained sediment (Skipanon River, Astoria, Ilwaco, Tongue Point, Oregon Slough, Portland Harbor).

9. Zinc barely exceeded the screening level (160 ppm) in two of the samples; CB-BC-1 (164 ppm) and CB-BC-3 (165 ppm). But the mean concentration of zinc (140 ppm) in all 4

samples was below the screening level. Samples taken in the channel leading to the boat basin show that zinc concentrations decrease further away from the basin. The percent silt also decreases supporting the general rule that there is a positive correlation between the percent fines in a sample and the concentrations of extractable heavy metals. As in the case of cadmium, examination of the Portland District database for the lower Columbia River reveals that basically the same high cadmium areas contain elevated zinc concentrations. Zinc and cadmium are often associated with each other in soil and sediment because cadmium is a minor constituent of zinc bearing ores. Previous studies by the U. S. G. S. have shown a strong correlation between cadmium and zinc in sediment from Baker Bay (7,8).

10. There is a well known correlation between the amount of fine grained material in sediment and metals concentrations (14). The metals concentrations found in Chinook Marina sediment can be explained by this correlation. More than 90 % of the sediment sampled in the Chinook Marina was in the 63  $\mu\text{m}$  fraction that must have been carried in suspension and deposited in the marina. Most of the heavy metals in a sediment sample are contained in the 63  $\mu\text{m}$  fraction. While this study was not designed to identify potential contaminant sources, local sources of metals could be the storm drain outlets in the marina and activities associated with boating.

#### **AVS**

11. The AVS concentration ranged from 7-74  $\mu\text{m/g}$  and the mean for all samples was 43  $\mu\text{m/g}$  (Table 2). AVS is a measure of the fraction of sulfur available in the sediment that can form metal sulfides. These sulfides render metals less bioavailable to aquatic organisms thereby lowering toxic effects. The amounts in Chinook Marina are typical of boat basins with fine grained sediment. Sandy sediment often contains less than 1  $\mu\text{m/g}$  while in silty sediments as much as 300  $\mu\text{m/g}$  can be found.

#### **Pesticides/PCBs**

12. PCBs and most pesticides except DDE, DDD and endosulfan II were undetected in the sediment samples (Table 3). The DDT breakdown products, DDE and/or DDD were found in 3 of 6 samples at concentrations ranging from 4 to 8 ppb. The sum of each of the two breakdown products in the samples ranged from 4 to 12 ppb. Two samples, CB-BC-1 and 3 exceeded the EPA, Region 10 screening level (6.9 ppb) for total DDT and breakdown products. These breakdown products are highly persistent in the environment. They are hydrophobic and partition out of water to fine grained sediment particles and organic matter. They are also highly soluble in lipids and thus bioaccumulate and biomagnify by food chain transfer. Their most likely mode of acute toxicity is by interference with axonal transmission affecting nervous coordination. Sublethal, chronic toxicity occurs by more than one mechanism and depends on the organism and the stage of its development. One well known chronic, toxic effect is egg shell thinning and abnormal reproductive behavior in birds.

13. The levels found in Chinook Marina sediment are similar to those found in Skipanon River sediment samples. Other areas in the lower Columbia River where DDT or its breakdown products have been found, according to Portland District database records, are Astoria West-Side Boat Basin, Baker Bay West Channel near Ilwaco, Tongue Point, Elochoman Slough, Tansy

Point, Oregon Slough and the lower Willamette River. The highest amounts of total DDT and its products were found in the lower Willamette River (2-545 ppb). Below the mouth of the Willamette River concentrations varied between 0.1 and 26 ppb with the highest amounts found in Skipanon River sediments (6-26 ppb). Although use of DDT was banned in the 1970s it is likely DDT and its breakdown products will be found in the lower Columbia River for some time as sediments from various watersheds along the river are washed downstream.

### **PAHs**

14. Two to four PAHs were detected in the samples (Table 3). These were fluoranthene (150-270 ppb), pyrene (120-260 ppb), chrysene (87-160 ppb) and benzo (b+k) fluoranthene (220 ppb). PAHs are ubiquitous in the environment and are found in urban runoff and smoke from forest and range fires. The levels detected in Chinook Marina sediment are typical of other boat basins in the lower Columbia River. Three of the PAHs are noncarcinogenic - fluoranthene, pyrene and benzo (k) fluoranthene. Chrysene and benzo (b) fluoranthene are weakly carcinogenic, cocarcinogenic or tumorigenic (10). However, none of the PAHs detected exceeded EPA, Region 10 screening levels that trigger concern for aquatic biota in the marine environment.

### **TBT**

15. TBT concentrations ranged from 3.9-5.7 ppb and are 5 to 8 times lower than the screening level (30 ppb). TBT is used as an antifouling additive in marine paints. The concentrations in Chinook Marina sediment are average for boat basins in Oregon coastal areas which have ranged from less than 1.0 to 300 ppb.

### **Phenols**

16. Phenol was detected in 3 samples ranging from 130-150 ppb. However, the concentration is probably lower than reported because phenol was also observed in the method blank (72 ppb). The other types of phenols were not detected (Table 4). The detection limits were elevated in the procedure for 3 out of the 5 phenols tested because of matrix interferences. Thus, detection limits for 2-methylphenol, 2,4-dimethylphenol and pentachlorophenol were greater than the EPA, Region 10 screening level. Phenols are highly soluble in water. Even if concentrations were at the method reporting limits for these three phenols, it is likely that incoming water in the boat basin would dilute phenols released from sediment to acceptable concentrations.

### **Dioxins/Furans**

17. One sample CB-BC-2 was tested for dioxins/furans congeners. A summary of the results is shown in Table 5. Each dioxin or furan congener class is defined by the number of chlorine atoms attached to the molecule. For instance, the tetra class has 4 chlorine atoms in various positions on the molecule. The most toxic of all the dioxin or furan congeners is the tetra congener, 2,3,7,8-TCDD. It was not detected in the sediment. The total concentrations of each tetra, penta, hexa, hepta and octa congener class are shown. The concentration of each dioxin congener class increased as the number of chlorine atoms in the congeners increased. The

OCDD class, with 8 chlorine atoms, had the highest concentration (1,320 ppt). This is the least toxic congener class of dioxins. Generally, the concentrations of furan congener classes were more equal. OCDF, with 8 chlorine atoms, unlike OCDD, was not very high relative to the other furan congener classes. There was 30 times more OCDD (1,320 ppt) than OCDF (41.3 ppt). This distribution pattern between the congener classes of dioxins and furans is similar to that observed in other lower Columbia River samples, including samples offshore from the mouth, and samples from Yaquina Bay (7,8,9). By far the largest contributor to the dioxins are the OCDDs. They contribute 73 % of the total concentration of dioxins. By contrast the OCDFs contribute only 29 % of the total for furans. Dioxins and furans are ubiquitous in the environment. Besides point source inputs, especially from paper mills, they are produced naturally from forest and prairie grass fires. These molecules are hydrophobic and partition out in fine grained sediment.

## **Conclusions**

18. The sediment in Chinook Marina is relatively free of contaminants. Cadmium and zinc exceed EPA, Region 10 screening levels. The source of cadmium and zinc can not be determined from the data. There are few local sources of metals other than stormwater runoff and activities associated with boat use. Metals are known to be concentrated by fine grained sediment and it is likely that this is the cause of enrichment. Whether the levels of these metals exceed historical concentrations is unknown. The AVS concentrations are typical of marina samples. PCBs were undetected and are probably less than 10 ppb. The pesticides DDD, DDE and endosulfan II were found in low amounts. DDD and DDE, breakdown products of DDT, are persistent in the environment and so finding them in the sediment is not surprising and the amounts were typical for other areas in the lower estuary. PAHs were below screening levels and typical of other small marinas. TBT concentrations were well below the screening level. Phenol was detected in some samples, but its detection is suspect because the method blank was contaminated with phenol. In any case, the overall detection limits for phenols were not acceptable as they were above EPA screening levels. Dioxins and furans were detected at low concentrations. The pattern of concentrations of the congener classes was similar to the pattern observed in other samples taken from the Columbia River (between Wauna and Bonneville) and Yaquina Bay. More thorough chemical, and probably biological, analyses would be required prior to dredging and disposal of these materials.

## REFERENCES

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9. U. S. Environmental Protection Agency and U. S. Army Corps of Engineers. February 1991. Evaluation of Dredged Material Proposed for Ocean Disposal (Testing Manual).
10. Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service.
11. Britton J. U. S. Army Corps of Engineers, Portland District. December 1990. Results of Studies Correlating Total Organic Chlorine and Dioxin/furans in Selected Oregon Sediments. Prepared for U. S. Environmental Protection Agency, Region 10.
12. Britton J. U. S. Army Corps of Engineers, Portland District. October 1990. Characterization of Sediments at Yaquina Bay & Harbor. Prepared for U. S. Environmental Protection Agency, Region 10.
13. U. S. Army Corps of Engineers, Portland District. Dioxins and furans data, on file in the District Office, obtained from offshore sediment samples collected near the mouth of the Columbia River in 1992.

14. Horowitz, A. J. U. S. Geological Survey. 1984. A primer on trace metal-sediment chemistry. Open-file report 84-709.

**Table 1. Results of physical analyses of Chinook Marina sediment.**

sample	median grain size mm	sand silt clay			volatile solids
		%			
CB-BC-1	0.011	2.6	90.5	6.9	8.6
CB-BC-2	0.010	1.8	90.2	8.0	6.2
CB-BC-3	0.011	2.7	90.3	7.0	8.9
CB-BC-4	0.011	3.7	86.6	9.7	8.7
CH-BC-1	0.010	3.2	84.4	12.4	9.8
CH-BC-2	0.027	30.6	60.1	9.3	5.8

**Table 2. Metals, acid volatile sulfides (AVS) and total organic carbon (TOC) in Chinook Marina sediment.**

sample	metals								AVS um/g	TOC %
	As	Cd	Cr	Cu ppm	Pb	Hg	Ni	Zn		
CB-BC-1	9	1.6*	26	50	41	0.14	23	164*	45	2.65
CB-BC-2	6	0.9	16	52	15	0.09	16	108	38	1.92
CB-BC-3	8	1.6*	26	47	30	0.15	22	165*	74	2.75
CB-BC-4	8	1.2*	23	46	20	0.12	21	122	50	2.68
CH-BC-1	8	1.2	25	48	20	0.12	20	129	46	2.72
CH-BC-2	6	0.7	19	27	14	0.08	16	86	7.31	1.62
mean	8	1.2*	23	45	23	0.12	20	129	43	2.39

\* Exceeds EPA, Region 10 screening level

**Table 3. Concentrations PCBs, pesticides, PAHs and TBT in Chinook Marina sediment\*.**

sample	PCBs	DDE	DDD	Endosulfan II	Fluoranthene ppb	Pyrene	Chrysene	Benzo (b+k) Fluoranthenes	TBT
11 CB-BC-1	<10	8	4	<3	270	260	160	220	3.9
CB-BC-2	<10	4	<3	7	150	120	<78	<160	5.7
CB-BC-3	<10	7	<3	7	220	190	<90	<180	5.0
CB-BC-4	<10	<5	<5	<5	250	220	87	<170	5.0
CH-BC-1	<10	<2	<2	3	150	150	<88	<180	
CH-BC-2	<10	<2	<2	2	<60	<60	<60	<120	

< means less than the following method detection limit

\* 7 aroclors, 19 pesticides and 17 PAHs were sought in the sediment; see appendix for raw data

**Table 4. Concentration of phenols in Chinook Marina sediment.**

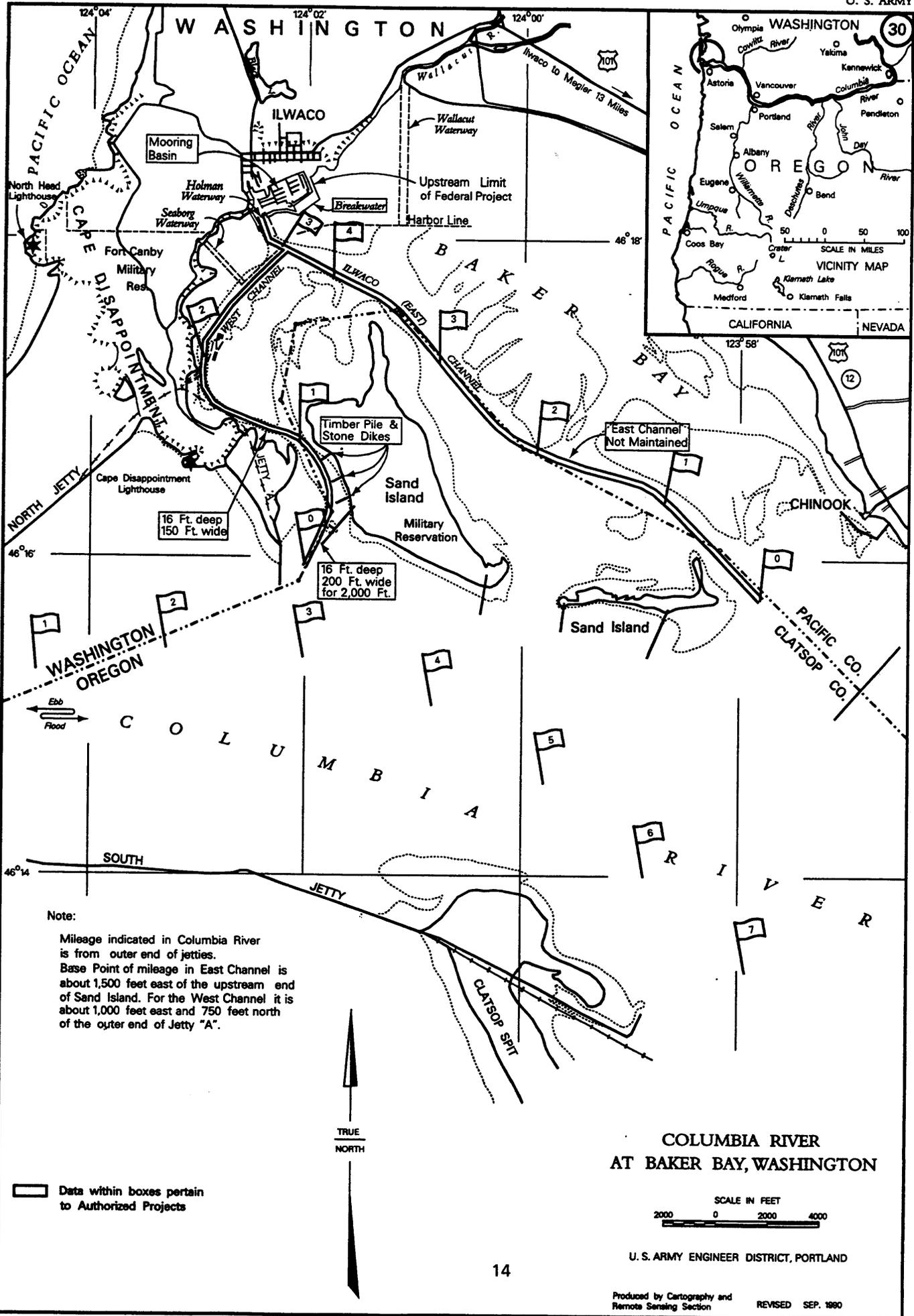
sample	phenol	2-methyl phenol	4-methyl phenol	2,4-dimethyl phenol	pentachloro phenol
ppb					
CB-BC-1	<95	<95	<95	<95	<240
CB-BC-2	130*	<78	<78	<78	<190
CB-BC-3	150*	<90	<90	<90	<230
CB-BC-4	130*	<86	<86	<86	<220
CH-BC-1	120*	<88	<88	<88	<220
	73*	<60	<60	<60	<150
method blank	72	<33	<33	<33	<67

< means less than the following method detection limit

\* estimate, because phenol was also found in method blank

Table 5. Concentrations of dioxins and furans in Chinook Marina sediment.

units	CB-BC-2	Method Blank
<hr/>		
ppt		
<hr/>		
2378 TCDD	<1.91	<0.78
total TCDD	1.06	<0.78
total PeCDD	9.13	<0.72
total HxCDD	95.9	<1.30
total HpCDD	388	<2.83
OCDD	1,320	<4.70
2378-TCDF	7.12	<1.08
total TCDF	20.1	<1.08
total PeCDF	12.5	<1.65
total HxCDF	16.2	<0.84
total HpCDF	54.7	<0.81
OCDF	41.3	<3.13



Note:

Mileage indicated in Columbia River is from outer end of jetties.  
 Base Point of mileage in East Channel is about 1,500 feet east of the upstream end of Sand Island. For the West Channel it is about 1,000 feet east and 750 feet north of the outer end of Jetty "A".

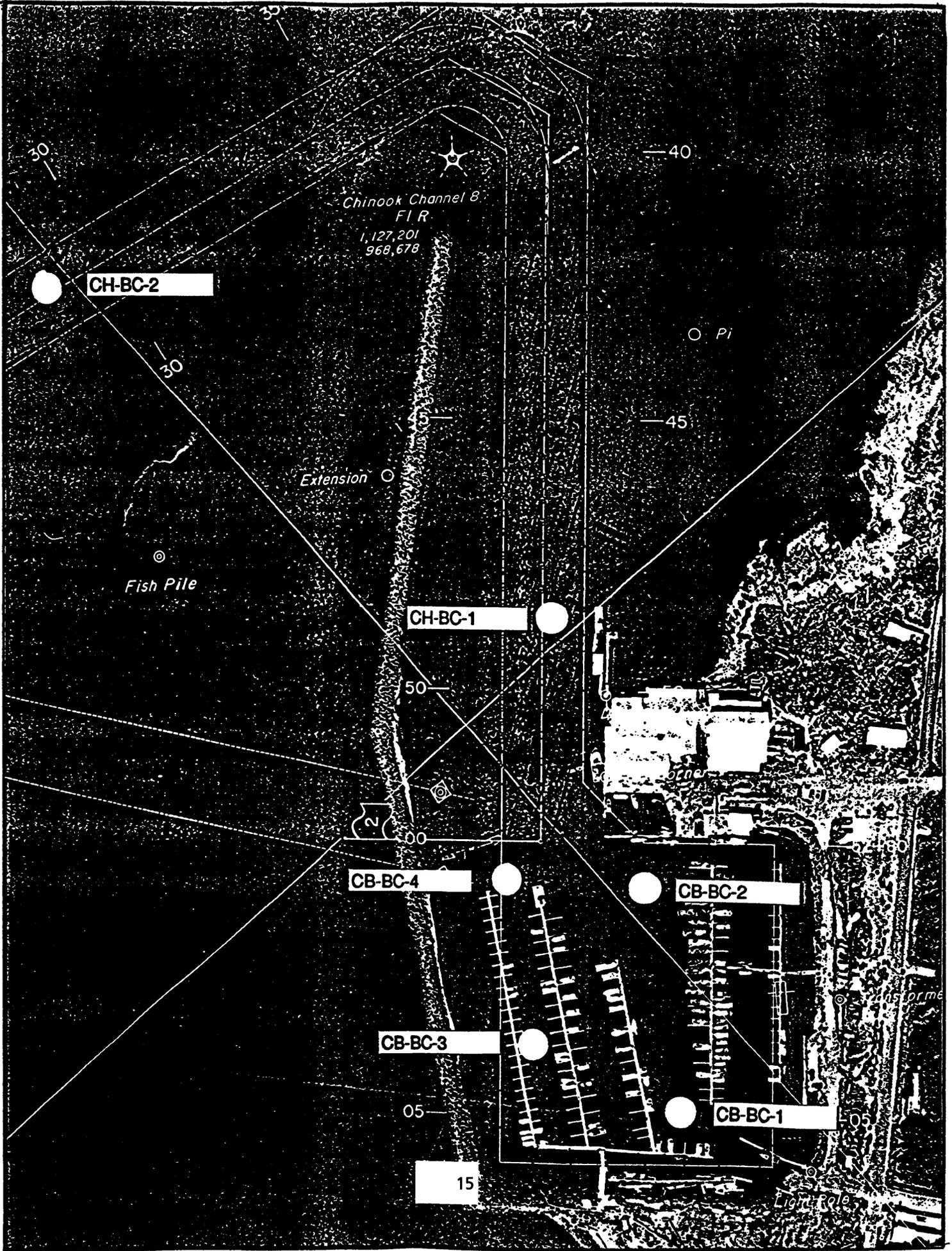
 Data within boxes pertain to Authorized Projects

**COLUMBIA RIVER  
 AT BAKER BAY, WASHINGTON**

SCALE IN FEET  
 2000 0 2000 4000

U. S. ARMY ENGINEER DISTRICT, PORTLAND

FIGURE 1





DEPARTMENT OF THE ARMY  
NORTH PACIFIC DIVISION LABORATORY  
CORPS OF ENGINEERS  
1491 N.W. GRAHAM AVENUE  
TROUTDALE, OREGON 97060-9503

CENPD-PE-GT-L (1110-1-8100c)

27 Aug 92

MEMORANDUM FOR Commander, Portland District, ATTN: CENPP-PE-HR (Britton)

SUBJECT: W.O. 92-SHM-183, Report of Soil Analysis

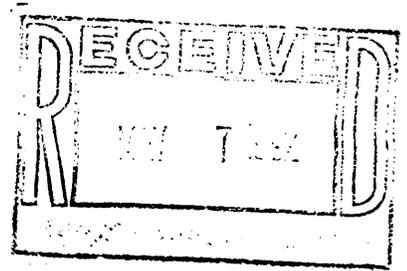
Project: PORTLAND DISTRICT DREDGING PROJECT  
Intended Use: Evaluate site  
Source of Material: Reference Chain of Custody Records  
Submitted by: CENPP-PE-HR (Britton)  
Date Sampled: 19 May 92 Date Received: 23 May 92  
Methods of Tests: Reference Enclosure 1  
Reference: a) DD Form 448, MIPR Nos. E86-92-0074, dated 12 Mar 92 and  
E86-92-0040, dated 31 Mar 92  
b) Our report, this subject, dated 29 Jul 92

1. Enclosed are results of total organic carbon (TOC) analysis for environmental samples collected from the above site. Included is report number K924822 from Columbia Analytical Services, Inc.
2. TOC levels ranged from 1.38 to 2.75-percent in all seventeen samples tested. The relative percent differences in the three laboratory duplicates ranged from <1 to 16-percent. Samples were analyzed for TOC after expiration of holding times, per request on 27 Jul 92 from Jim Britton.
3. Please contact Dr. Ajmal M. Ilias at (503) 665-4166 if you have any questions.
4. This completes all work requested to date.

Enclosures

*Timothy J. Seeman*  
TIMOTHY J. SEEMAN  
Director

Copy Furnished: CENPD-PE-GT



May 5, 1992

Tim Seeman  
U.S. Army Corps of Engineers  
CENPD Materials Laboratory  
1491 N.W. Graham Avenue  
Troutdale, OR 97060-9503

Re: **Portland District Dredging/Project #92-SHM-183**

Dear Tim:

Enclosed are the results of the samples submitted to our lab on March 23, 1992. For your reference, these analyses have been assigned our work order number K921793.

Please note that the data for the dioxin/furan analyses is located in Appendix C.

Also note that the tributyltin analyses will follow under separate cover, as we have not received results from Battelle at this time.

All analyses were performed in accordance with our laboratory's quality assurance program.

Please call if you have any questions.

Respectfully submitted,

**Columbia Analytical Services, Inc.**

A handwritten signature in black ink that reads "Kevin DeWhitt". The signature is written in a cursive, somewhat stylized script.

Kevin DeWhitt  
Project Chemist

KD/krh

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging  
Sample Matrix: Soil

Date Received: 03/23/92  
Work Order No.: K924822

Inorganic Parameters  
Percent (%)  
Dry Weight Basis

Analyte: Total Organic Carbon (TOC) Total Solids  
Method: ASTM D 4129-28M EPA 160.3M  
Method Reporting Limit: 0.05 --  
Date Analyzed: 08/12/92 08/13/93

Sample Name	Lab Code			
BB-BC-3	K1793-1	1.38	1.38	60.8
CH-BC-1	K1793-2	2.72	2.72	37.7
CH-BC-2	K1793-3	1.62	1.62	60.3
IL-BC-4	K1793-4	1.92	1.92	49.1
IL-BC-5	K1793-5	1.68	1.68	43.9
IL-BC-6	K1793-6	1.60	1.60	47.3
IL-BC-8	K1793-7	1.73	1.73	43.6
IL-BC-9	K1793-8	1.88	1.88	40.0
IL-BC-10	K1793-9	2.04	2.04	39.3
IL-BC-11	K1793-10	2.16	2.16	34.0

M Modified

Approved by

*Kevin T. ...*

Date

8-26

900

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging  
Sample Matrix: Soil

Date Received: 03/23/92  
Work Order No.: K924822

Inorganic Parameters  
Percent (%)  
Dry Weight Basis

Analyte:	Total Organic Carbon (TOC)	Total Solids
Method:	ASTM D 4129-28M	EPA 160.3M
Method Reporting Limit:	0.05	--
Date Analyzed:	08/12/92	08/13/92

Sample Name	Lab Code		
CB-BC-1	K1793-11	2.65	36.9
CB-BC-2	K1793-12	1.92	44.5
CB-BC-3	K1793-13	2.75	34.7
CB-BC-4	K1793-14	2.68	40.3
IL-BC-1	K1793-15	2.22	43.0
IL-BC-2	K1793-16	1.96	46.1
IL-BC-3	K1793-17	2.23	46.9
Method Blank	K4822-MB	ND	--

M Modified  
ND None Detected at or above the method reporting limit

Approved by Kami DENHAM<sup>19</sup> Date 8-26

00002

**APPENDIX A**  
**LABORATORY QC RESULTS**



**COLUMBIA ANALYTICAL SERVICES, INC.**

**QA/QC Report**

**Client:** U. S. Army Corps of Engineers  
**Project:** Portland District Dredging  
**Sample Matrix:** Soil

**Date Received:** 03/23/92  
**Date Analyzed:** 08/12/92  
**Work Order No.:** K924822

**Duplicate Summary  
Total Organic Carbon (TOC)  
ASTM Method D 4129-28M  
Percent (%)  
Dry Weight Basis**

Sample Name	Lab Code	MRL	Sample Result	Duplicate Sample Result	Average	Relative Percent Difference
BB-BC-3	K1793-1	0.05	1.38	1.38	1.38	<1
CH-BC-1	K1793-2	0.05	2.72	2.92	2.82	4
CH-BC-2	K1793-3	0.05	1.62	1.91	1.76	16

**M** Modified  
**MRL** Method Reporting Limit

Approved by Kenn T. [Signature] Date 8-26 0004

**COLUMBIA ANALYTICAL SERVICES (CF #437)  
ORGANOTINS ANALYSIS OF SEDIMENT SAMPLES**

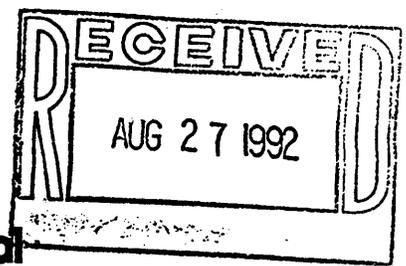
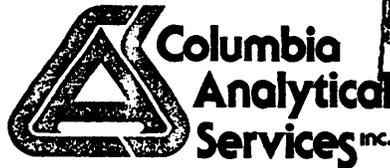
5/7/92

		(concentrations in ng/g)				
MSL Code	Sponsor Code	Tripentyl % Surrogate	Tetra Tin	Tributyl Tin	Dibutyl Tin	Monobutyl Tin
437CAS-1-R	CG-BC-1	53.36	2.3 U	2.4 U	2.3 U	5.0 U
437CAS-2-R	CG-BC-2	45.49	2.4 U	2.5 U	2.4 U	5.1 U
437CAS-3	IL-BC-4,5 (COMP)	48.33	2.4 U	2.6	3.8	2.3 J
437CAS-4-R	IL-BC-6	44.83	2.1 U	3.2	1.4 J	4.4 U
437CAS-5-R	IL-BC-8,9 (COMP)	42.38	2.0 U	2.4	4.3	4.2 U
437CAS-6-R	IL-BC-10,11 (COMP)	43.13	2.3 U	7.7	2.3 U	4.9 U
437CAS-7-R	CB-BC-1	24.11	2.0 U	3.9	2.0 U	1.8 J
437CAS-8	CB-BC-2	86.88	2.2 U	5.7	6.5	34.7
437CAS-9-R	CB-BC-3	43.75	2.2 U	5.0	2.2 U	4.6 U
437CAS-10-R	CB-BC-4	32.54	2.1 U	5.0	2.1 U	4.4 U
437CAS-Blank		42.18	2.3 U	2.4 U	2.3 U	4.9 U
437CAS-Blank-R		40.50	2.2 U	2.2 U	2.2 U	4.6 U

**MATRIX SPIKE RESULTS**

Amount Spiked			126.9	126.9	126.9	126.9
437CAS-2-R	CG-BC-2	45.49	2.4 U	2.5 U	2.4 U	5.1 U
437CAS-2-R + Spike		40.91	89.4	49.8	37.4	4.2 J
Amount Recovered			89.4	49.8	37.4	4.2 J
Percent Recovery			70%	39%	29%	3%

U = Indicates analyte not detected above detection limits.  
J = Indicates value detected below the detection limits.



August 26, 1992

Tim Seeman  
U.S. Army Corps of Engineers  
CENPD Materials Laboratory  
1491 N.W. Graham Avenue  
Troutdale, OR 97060-9503

Re: Portland District Dredging/Project #92-SHM-183

Dear Tim:

Enclosed are the results of the samples requested for analysis on July 27, 1992, from previous work order number K921793. For your reference, these analyses have been assigned our work order number K924822.

All analyses were performed in accordance with our laboratory's quality assurance program. Reproduction of reports is allowed only in whole, not in part. Results apply only to the samples analyzed.

Please call if you have any questions.

Respectfully submitted,

Columbia Analytical Services, Inc.

A handwritten signature in black ink, appearing to read "Kevin DeWhitt". The signature is written in a cursive, somewhat stylized script.

Kevin DeWhitt  
Project Chemist

KD/do



**COLUMBIA ANALYTICAL SERVICES, INC.**

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Analyzed:** 03/28/92  
**Work Order No.:** K921793

Acid Volatile Sulfides in Sediment  
EPA Draft Method for Acid Volatile Sulfides in Sediment August 1991  
 $\mu\text{moles/g}$   
Dry Weight Basis

Sample Name	Lab Code	MRL	Result
BB-BC-3	K1793-1	0.01	0.55
CH-BC-1	K1793-2	0.01	46
CH-BC-2	K1793-3	0.01	7.31
IL-BC-4,5 Comp	K1793-6	0.01	16
IL-BC-6	K1793-7	0.01	30
IL-BC-8,9 Comp	K1793-10	0.01	35
IL-BC-10,11 Comp	K1793-13	0.01	52
CB-BC-1	K1793-14	0.01	45
CB-BC-2	K1793-15	0.01	38
CB-BC-3	K1793-16	0.01	74

**MRL** Method Reporting Limit

Approved by Kevin T. Bennett <sup>24</sup> Date 5-5

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Analyzed: 03/28/92  
Work Order No.: K921793

Acid Volatile Sulfides in Sediment  
EPA Draft Method for Acid Volatile Sulfides in Sediment August 1991  
 $\mu\text{moles/g}$   
Dry Weight Basis

Sample Name	Lab Code	MRL	Result
CB-BC-4	K1793-17	0.01	50
Method Blank	K1793-MB	0.01	ND

MRL Method Reporting Limit  
ND None Detected at or above the method reporting limit

Approved by Kevin [Signature] 25 Date 55

00002



COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers
Project: Portland District Dredging/#92-SHM-183
Sample Matrix: Sediment

Date Received: 03/23/92
Work Order No.: K921793

Total Metals
mg/Kg (ppm)
Dry Weight Basis

Sample Name: BB-BC-3 CH-BC-1 CH-BC-2
Lab Code: K1793-1 K1793-2 K1793-3

Table with columns: Analyte, EPA Method, MRL, and three sample columns (BB-BC-3, CH-BC-1, CH-BC-2). Rows include Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc, and Solids, Total (%).

MRL Method Reporting Limit

Approved by [Signature] 26 Date 5-5

00003

**COLUMBIA ANALYTICAL SERVICES, INC.**

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Work Order No.:** K921793

Total Metals  
mg/Kg (ppm)  
Dry Weight Basis

Sample Name:	IL-BC-10,11	CB-BC-1	CB-BC-2
	Comp		
Lab Code:	K1793-13	K1793-14	K1793-15

Analyte	EPA Method	MRL	IL-BC-10,11 Comp	CB-BC-1	CB-BC-2
Arsenic	7060	1	10	9	6
Cadmium	7131	0.1	1.2	1.6	0.9
Chromium	6010	1	28	26	16
Copper	6010	1	48	50	52
Lead	7421	1	28	41	15
Mercury	7471	0.02	0.19	0.14	0.09
Nickel	249.2	1	20	23	16
Zinc	6010	1	142	164	108
Solids, Total (%)	160.3	--	36.1	34.6	40.7

**MRL** Method Reporting Limit

Approved by Kevin DeWitt 27 Date 5-5

00005

**COLUMBIA ANALYTICAL SERVICES, INC.**

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Work Order No.:** K921793

Total Metals  
mg/Kg (ppm)  
Dry Weight Basis

Sample Name:	CB-BC-3	CB-BC-4	Method Blank
Lab Code:	K1793-16	K1793-17	K1793-MB

Analyte	EPA Method	MRL	CB-BC-3	CB-BC-4	Method Blank
Arsenic	7060	1	8	8	ND
Cadmium	7131	0.1	1.6	1.2	ND
Chromium	6010	1	26	23	ND
Copper	6010	1	47	46	ND
Lead	7421	1	30	20	ND
Mercury	7471	0.02	0.15	0.12	ND
Nickel	249.2	1	22	21	ND
Zinc	6010	1	165	122	ND
Solids, Total (%)	160.3	--	33.8	38.0	--

**MRL** Method Reporting Limit  
**ND** None Detected at or above the method reporting limit

Approved by Kevin DeWitt 28 Date 5-5

**COLUMBIA ANALYTICAL SERVICES, INC.**

**Analytical Report**

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Work Order No.:** K921793

**Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)**  
**EPA Methods 3540/8080**  
**mg/Kg (ppm)**  
**Dry Weight Basis**

<b>Sample Name:</b>	<b>BB-BC-3</b>	<b>CH-BC-1</b>	<b>CH-BC-2</b>
<b>Lab Code:</b>	<b>K1793-1</b>	<b>K1793-2</b>	<b>K1793-3</b>
<b>Date Analyzed:</b>	<b>04/13/92</b>	<b>04/08/92</b>	<b>04/08/92</b>

<b>Analyte</b>	<b>MRL</b>			
Alpha-BHC	0.002	ND	ND	ND
Gamma-BHC (Lindane)	0.002	ND	ND	ND
Beta-BHC	0.006	ND	ND	ND
Heptachlor	0.002	ND	ND	ND
Delta-BHC	0.002	ND	ND	ND
Aldrin	0.002	ND	ND	ND
Heptachlor Epoxide	0.002	ND	ND	ND
Endosulfan I	0.002	ND	ND	ND
4,4'-DDE	0.002	ND	ND	ND
Dieldrin	0.002	ND	ND	ND
Endrin	0.002	ND	ND	ND
4,4'-DDD	0.002	ND	ND	ND
Endosulfan II	0.002	ND	0.003	0.002
4,4'-DDT	0.002	ND	ND	ND
Endrin Aldehyde	0.002	ND	ND	ND
Endosulfan Sulfate	0.002	ND	ND	ND
Methoxychlor	0.004	ND	ND	ND
Toxaphene	0.03	ND	ND	ND
Chlordane	0.01	ND	ND	ND
<b>PCBs:</b> Aroclor 1016	0.01	ND	ND	ND
Aroclor 1221	0.01	ND	ND	ND
Aroclor 1232	0.01	ND	ND	ND
Aroclor 1242	0.01	ND	ND	ND
Aroclor 1248	0.01	ND	ND	ND
Aroclor 1254	0.01	ND	ND	ND
Aroclor 1260	0.01	ND	ND	ND

**MRL** Method Reporting Limit  
**ND** None Detected at or above the method reporting limit

Approved by Kevin Dewitt <sup>29</sup> Date 5-5 00007

**COLUMBIA ANALYTICAL SERVICES, INC.**

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Work Order No.:** K921793

Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
 EPA Methods 3540/8080  
 mg/Kg (ppm)  
 Dry Weight Basis

<b>Sample Name:</b>	<b>CB-BC-1</b>	<b>CB-BC-2</b>	<b>CB-BC-3</b>
<b>Lab Code:</b>	<b>K1793-14</b>	<b>K1793-15</b>	<b>K1793-16</b>
<b>Date Analyzed:</b>	<b>04/10/92</b>	<b>04/13/92</b>	<b>04/14/92</b>

Analyte	MRL			
Alpha-BHC	0.003	ND	ND	ND
Gamma-BHC (Lindane)	0.003	ND	ND	ND
Beta-BHC	0.006	ND	ND	ND
Heptachlor	0.003	ND	ND	ND
Delta-BHC	0.003	ND	ND	ND
Aldrin	0.003	ND	ND	ND
Heptachlor Epoxide	0.003	ND	ND	ND
Endosulfan I	0.003	ND	ND	ND
4,4'-DDE	0.003	0.008	0.004	0.007
Dieldrin	0.003	ND	ND	ND
Endrin	0.003	ND	ND	ND
4,4'-DDD	0.003	0.004	ND	ND
Endosulfan II	0.003	ND	0.007	0.007
4,4'-DDT	0.003	ND	ND	ND
Endrin Aldehyde	0.003	ND	ND	ND
Endosulfan Sulfate	0.003	ND	ND	ND
Methoxychlor	0.006	ND	ND	ND
Toxaphene	0.03	ND	ND	ND
Chlordane	0.01	ND	ND	ND
PCBs: Aroclor 1016	0.01	ND	ND	ND
Aroclor 1221	0.01	ND	ND	ND
Aroclor 1232	0.01	ND	ND	ND
Aroclor 1242	0.01	ND	ND	ND
Aroclor 1248	0.01	ND	ND	ND
Aroclor 1254	0.01	ND	ND	ND
Aroclor 1260	0.01	ND	ND	ND

**MRL** Method Reporting Limit  
**ND** None Detected at or above the method reporting limit

Approved by Kim DENAVIT 30 Date 5-5

00009

**COLUMBIA ANALYTICAL SERVICES, INC.**

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Work Order No.:** K921793

Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
 EPA Methods 3540/8080  
 mg/Kg (ppm)  
 Dry Weight Basis

Sample Name:	IL-BC-10,11	CB-BC-4
Lab Code:	Comp K1793-13	K1793-17
Date Analyzed:	04/10/92	04/14/92

Analyte	MRL		
Alpha-BHC	0.005	ND	ND
Gamma-BHC (Lindane)	0.005	ND	ND
Beta-BHC	0.010	ND	ND
Heptachlor	0.005	ND	ND
Delta-BHC	0.005	ND	ND
Aldrin	0.005	ND	ND
Heptachlor Epoxide	0.005	ND	ND
Endosulfan I	0.005	ND	ND
4,4'-DDE	0.005	ND	ND
Dieldrin	0.005	ND	ND
Endrin	0.005	ND	ND
4,4'-DDD	0.005	ND	ND
Endosulfan II	0.005	ND	ND
4,4'-DDT	0.005	ND	ND
Endrin Aldehyde	0.005	ND	ND
Endosulfan Sulfate	0.005	ND	ND
Methoxychlor	0.010	ND	ND
Toxaphene	0.03	ND	ND
Chlordane	0.01	ND	ND
PCBs: Aroclor 1016	0.01	ND	ND
Aroclor 1221	0.01	ND	ND
Aroclor 1232	0.01	ND	ND
Aroclor 1242	0.01	ND	ND
Aroclor 1248	0.01	ND	ND
Aroclor 1254	0.01	ND	ND
Aroclor 1260	0.01	ND	ND

**MRL** Method Reporting Limit  
**ND** None Detected at or above the method reporting limit

Approved by Kevin Dewitt 31 Date 5-5

00010

**COLUMBIA ANALYTICAL SERVICES, INC.**

**Analytical Report**

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Extracted:** 03/24,25/92  
**Work Order No.:** K921793

Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
 EPA Methods 3540/8080  
 mg/Kg (ppm)  
 Dry Weight Basis

<b>Sample Name:</b>	<b>Method Blank</b>	<b>Method Blank</b>
<b>Lab Code:</b>	<b>K1793-MB1</b>	<b>K1793-MB2</b>
<b>Date Analyzed:</b>	<b>04/07/92</b>	<b>04/07/92</b>

Analyte	MRL		
Alpha-BHC	0.001	ND	ND
Gamma-BHC (Lindane)	0.001	ND	ND
Beta-BHC	0.003	ND	ND
Heptachlor	0.001	ND	ND
Delta-BHC	0.001	ND	ND
Aldrin	0.001	ND	ND
Heptachlor Epoxide	0.001	ND	ND
Endosulfan I	0.001	ND	ND
4,4'-DDE	0.001	ND	ND
Dieldrin	0.001	ND	ND
Endrin	0.001	ND	ND
4,4'-DDD	0.001	ND	ND
Endosulfan II	0.001	ND	ND
4,4'-DDT	0.001	ND	ND
Endrin Aldehyde	0.001	ND	ND
Endosulfan Sulfate	0.001	ND	ND
Methoxychlor	0.002	ND	ND
Toxaphene	0.03	ND	ND
Chlordane	0.01	ND	ND
PCBs: Aroclor 1016	0.01	ND	ND
Aroclor 1221	0.01	ND	ND
Aroclor 1232	0.01	ND	ND
Aroclor 1242	0.01	ND	ND
Aroclor 1248	0.01	ND	ND
Aroclor 1254	0.01	ND	ND
Aroclor 1260	0.01	ND	ND

**MRL** Method Reporting Limit  
**ND** None Detected at or above the method reporting limit

Approved by *Kim DENNITT* 32 Date 5-5 00011

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/20/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CH-BC-1  
K1793-2

Analyte	MRL*	
Naphthalene	88	ND
2-Methylnaphthalene	88	ND
Acenaphthylene	88	ND
Dibenzofuran	88	ND
Acenaphthene	88	ND
Fluorene	88	ND
Phenanthrene	88	ND
Anthracene	88	ND
Fluoranthene	88	150
Pyrene	88	150
Benz(a)anthracene	88	ND
Chrysene	88	ND
Benzo(b+k)fluoranthene*	180	ND
Benzo(a)pyrene	88	ND
Indeno(1,2,3-cd)pyrene	88	ND
Dibenz(a,h)anthracene	88	ND
Benzo(g,h,i)perylene	88	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

◆ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by Kevin DENNITT

33

Date 5-5

00013

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/14/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CH-BC-2  
K1793-3

Analyte	MRL*	
Naphthalene	60	ND
2-Methylnaphthalene	60	ND
Acenaphthylene	60	ND
Dibenzofuran	60	ND
Acenaphthene	60	ND
Fluorene	60	ND
Phenanthrene	60	ND
Anthracene	60	ND
Fluoranthene	60	ND
Pyrene	60	ND
Benz(a)anthracene	60	ND
Chrysene	60	ND
Benzo(b+k)fluoranthene*	120	ND
Benzo(a)pyrene	60	ND
Indeno(1,2,3-cd)pyrene	60	ND
Dibenz(a,h)anthracene	60	ND
Benzo(g,h,i)perylene	60	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

♦ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by

*Kevin Dewitt* 34

Date 5-5

00014

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/14/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name: CB-BC-1  
Lab Code: K1793-14

Analyte	MRL*	
Naphthalene	95	ND
2-Methylnaphthalene	95	ND
Acenaphthylene	95	ND
Dibenzofuran	95	ND
Acenaphthene	95	ND
Fluorene	95	ND
Phenanthrene	95	ND
Anthracene	95	ND
Fluoranthene	95	270
Pyrene	95	260
Benz(a)anthracene	95	ND
Chrysene	95	160
Benzo(b+k)fluoranthene <sup>♦</sup>	190	220
Benzo(a)pyrene	95	ND
Indeno(1,2,3-cd)pyrene	95	ND
Dibenz(a,h)anthracene	95	ND
Benzo(g,h,i)perylene	95	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

♦ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by *Kevin Denhart*<sup>35</sup> Date 5-5

00019

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/14/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CB-BC-2  
K1793-15

Analyte	MRL*	
Naphthalene	78	ND
2-Methylnaphthalene	78	ND
Acenaphthylene	78	ND
Dibenzofuran	78	ND
Acenaphthene	78	ND
Fluorene	78	ND
Phenanthrene	78	ND
Anthracene	78	ND
Fluoranthene	78	150
Pyrene	78	120
Benz(a)anthracene	78	ND
Chrysene	78	ND
Benzo(b+k)fluoranthene <sup>♦</sup>	160	ND
Benzo(a)pyrene	78	ND
Indeno(1,2,3-cd)pyrene	78	ND
Dibenz(a,h)anthracene	78	ND
Benzo(g,h,i)perylene	78	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

♦ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by Kim Dewitt 36 Date 5-5

00020

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/14/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CB-BC-3  
K1793-16

Analyte	MRL*	
Naphthalene	90	ND
2-Methylnaphthalene	90	ND
Acenaphthylene	90	ND
Dibenzofuran	90	ND
Acenaphthene	90	ND
Fluorene	90	ND
Phenanthrene	90	ND
Anthracene	90	ND
Fluoranthene	90	220
Pyrene	90	190
Benz(a)anthracene	90	ND
Chrysene	90	ND
Benzo(b + k)fluoranthene <sup>♦</sup>	180	ND
Benzo(a)pyrene	90	ND
Indeno(1,2,3-cd)pyrene	90	ND
Dibenz(a,h)anthracene	90	ND
Benzo(g,h,i)perylene	90	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

♦ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by

*Kenny DENNITT*

37

Date

5-5

00021

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/14/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CB-BC-4  
K1793-17

Analyte	MRL*	
Naphthalene	86	ND
2-Methylnaphthalene	86	ND
Acenaphthylene	86	ND
Dibenzofuran	86	ND
Acenaphthene	86	ND
Fluorene	86	ND
Phenanthrene	86	ND
Anthracene	86	ND
Fluoranthene	86	250
Pyrene	86	220
Benz(a)anthracene	86	ND
Chrysene	86	87
Benzo(b + k)fluoranthene <sup>♦</sup>	170	ND
Benzo(a)pyrene	86	ND
Indeno(1,2,3-cd)pyrene	86	ND
Dibenz(a,h)anthracene	86	ND
Benzo(g,h,i)perylene	86	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

♦ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by

*Karin T. [Signature]*

38

Date

5-5

00022

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Extracted: 03/24/92  
Date Analyzed: 04/10/92  
Work Order No.: K921793

Polynuclear Aromatic Hydrocarbons  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

Method Blank  
K1793-MB

Analyte	MRL	
Naphthalene	33	ND
2-Methylnaphthalene	33	ND
Acenaphthylene	33	ND
Dibenzofuran	33	ND
Acenaphthene	33	ND
Fluorene	33	ND
Phenanthrene	33	ND
Anthracene	33	ND
Fluoranthene	33	ND
Pyrene	33	ND
Benz(a)anthracene	33	ND
Chrysene	33	ND
Benzo(b + k)fluoranthene ♦	67	ND
Benzo(a)pyrene	33	ND
Indeno(1,2,3-cd)pyrene	33	ND
Dibenz(a,h)anthracene	33	ND
Benzo(g,h,i)perylene	33	ND

SIM Selected Ion Monitoring

MRL Method Reporting Limit

ND None Detected at or above the method reporting limit

♦ These compounds coelute; therefore, the results are reported as the combined concentration.

Approved by

*Kain Bennett*

39

Date

5-5

00023

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/19/92  
Work Order No.: K921793

Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name: CH-BC-1  
Lab Code: K1793-2

Analyte	MRL*	
Phenol	88	**120
2-Methylphenol	88	ND
4-Methylphenol	88	ND
2,4-Dimethylphenol	88	ND
Pentachlorophenol	220	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

\*\* Analyte concentration is an estimate because this analyte was also found in the method blank.

**ND** None Detected at or above the method reporting limit

Approved by Kevin DeWitt 40 Date 5-5

00025

**COLUMBIA ANALYTICAL SERVICES, INC.**

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/19/92  
**Work Order No.:** K921793

Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CH-BC-25  
K1793-3

Analyte	MRL*	
Phenol	60	**73
2-Methylphenol	60	ND
4-Methylphenol	60	ND
2,4-Dimethylphenol	60	ND
Pentachlorophenol	150	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

\*\* Analyte concentration is an estimate because this analyte was also found in the method blank.

**ND** None Detected at or above the method reporting limit

Approved by Kevin DEWITT 41 Date 5-5

00026

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/19/92  
**Work Order No.:** K921793

Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CB-BC-1  
K1793-14

Analyte	MRL *	
Phenol	95	ND
2-Methylphenol	95	ND
4-Methylphenol	95	ND
2,4-Dimethylphenol	95	ND
Pentachlorophenol	240	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**ND** None Detected at or above the method reporting limit

Approved by

*Kevin DeWitt*

42

Date 5-5

00031



COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/23/92  
Work Order No.: K921793

Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

CB-BC-3  
K1793-16

Analyte	MRL*	
Phenol	90	**150
2-Methylphenol	90	ND
4-Methylphenol	90	ND
2,4-Dimethylphenol	90	ND
Pentachlorophenol	230	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

\* MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

\*\* Analyte concentration is an estimate because this analyte was also found in the method blank.

**ND** None Detected at or above the method reporting limit

Approved by KEVIN DENNITT 44 Date 55

00033



**COLUMBIA ANALYTICAL SERVICES, INC.**

**Analytical Report**

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/23/92  
**Work Order No.:** K921793

**Phenols**  
**EPA Method 3550 in Combination with GC/MS SIM Method**  
**µg/Kg (ppb)**  
**Dry Weight Basis**

**Sample Name:**  
**Lab Code:**

**CB-BC-4**  
**K1793-27**

Analyte	MRL*	
Phenol	86	**130
2-Methylphenol	86	ND
4-Methylphenol	86	ND
2,4-Dimethylphenol	86	ND
Pentachlorophenol	220	ND

**SIM** Selected Ion Monitoring

**MRL** Method Reporting Limit

**\*** MRLs are elevated because of matrix interferences, because the sample(s) required diluting, and because of the low percent solids in the sample as received.

**\*\*** Analyte concentration is an estimate because this analyte was also found in the method blank.

**ND** None Detected at or above the method reporting limit

Approved by KIM DENNITT <sup>45</sup> Date 5-5

00034

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/18/92  
**Work Order No.:** K921793

Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name:  
Lab Code:

Method Blank  
K1793-MB

Analyte	MRL	
Phenol	33	72
2-Methylphenol	33	ND
4-Methylphenol	33	ND
2,4-Dimethylphenol	33	ND
Pentachlorophenol	67	ND

**SIM** Selected Ion Monitoring  
**MRL** Method Reporting Limit  
**ND** None Detected at or above the method reporting limit

Approved by Kevin Dewitt 46 Date 5-5

00035

**APPENDIX A**  
**LABORATORY QC RESULTS**

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Analyzed: 03/28/92  
Work Order No.: K921793

Matrix Spike Summary  
Acid Volatile Sulfides in Sediment  
EPA Draft Method for Acid Volatile Sulfides in Sediment August 1991  
 $\mu$ moles/g  
Dry Weight Basis

Sample Name	Lab Code	MRL	Spike Level	Sample Result	Spiked Sample Result	Percent Recovery
Batch QC	K1786-1MS	0.01	0.13	0.04	0.14	78
Batch QC	K1786-1DMS	0.01	0.13	0.04	0.11	54

MRL Method Reporting Limit

Approved by KIM DENAUA 48 Date 55

00037

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24,25/92  
Date Analyzed: 04/07-14/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
EPA Methods 3540/8080

Sample Name	Lab Code	Percent Recovery	
		Tetrachloro- <i>m</i> -xylene	Decachlorobiphenyl
CB-BC-4	K1793-17	55	77
CB-BC-1	K1793-14MS	64	94
CB-BC-1	K1793-14DMS	72	94
Laboratory Control Sample	K1793-LCS	62	92
Method Blank	K1793-MB1	64	96
Method Blank	K1793-MB2	66	110
	CAS Acceptance Criteria	45-112	53-120

Approved by Kevin DeMott 49 Date 5-5

00040

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/07-14/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
EPA Methods 3540/8080

Sample Name	Lab Code	Percent Recovery	
		Tetrachloro- <i>m</i> -xylene	Decachlorobiphenyl
BB-BC-3	K1793-1	54	82
CH-BC-1	K1793-2	69	81
CH-BC-2	K1793-3	61	76
IL-BC-4,5 Comp	K1793-6	52	70
IL-BC-6	K1793-7	70	*52
IL-BC-8,9 Comp	K1793-10	74	108
IL-BC-10,11 Comp	K1793-13	66	96
CB-BC-1	K1793-14	68	98
CB-BC-2	K1793-15	62	94
CB-BC-3	K1793-16	67	88
	CAS Acceptance Criteria	45-112	53-120

\* Outside of acceptance limits because of matrix interferences. The chromatogram showed nontarget components that interfered with the analysis.

Approved by Kevin Dennis 50 Date 5-5

00041

**COLUMBIA ANALYTICAL SERVICES, INC.**

QA/QC Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/10/92  
**Work Order No.:** K921793

Matrix Spike/Duplicate Matrix Spike Summary  
 Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
 EPA Methods 3540/8080  
 mg/Kg (ppm)  
 Dry Weight Basis

**Sample Name:** CB-BC-1  
**Lab Code:** K1793-14

**Percent Recovery**

Analyte	Spike Level		Sample Result	Spike Result		Percent Recovery		CAS Acceptance Criteria	Relative Percent Difference
	MS	DMS		MS	DMS	MS	DMS		
Gamma-BHC (Lindane)	0.08	0.06	ND	0.05	0.03	62	*50	52-125	21
Heptachlor	0.08	0.06	ND	0.06	0.04	75	67	38-147	11
Aldrin	0.08	0.06	ND	0.06	0.04	75	67	51-124	11
Dieldrin	0.08	0.06	ND	0.07	0.05	88	83	57-130	6
Endrin	0.08	0.06	ND	0.06	0.06	75	100	54-143	29
4,4'-DDT	0.08	0.06	ND	0.03	0.01	*38	*17	40-157	NC

**ND** None Detected at or above the method reporting limit

**\*** Outside of acceptance limits because of matrix interferences. The chromatogram showed nontarget components that interfered with the analysis.

**NC** Not Calculated

Approved by Kevin DeLuca 51 Date 5-5

00042

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
LCS Matrix: Sediment

Date Extracted: 03/24/92  
Date Analyzed: 04/07/92  
Work Order No.: K921793

Laboratory Control Sample Summary  
Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)  
EPA Methods 3540/8080  
mg/Kg (ppm)

Analyte	True Value	Result	Percent Recovery	CAS Percent Recovery Acceptance Criteria
Gamma-BHC (Lindane)	0.020	0.011	55	52-125
Heptachlor	0.020	0.014	70	38-147
Aldrin	0.020	0.014	70	51-124
Dieldrin	0.020	0.015	75	57-130
Endrin	0.020	0.016	80	54-143
4,4'-DDT	0.020	0.016	80	40-157

Approved by

Kevin DeWitt 52

Date 5-5

00043

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Extracted: 03/24/92  
Date Analyzed: 04/10/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method

Sample Name	Lab Code	Percent NAP	Recovery FLR	CRY
Method Blank	K1793-MB	*61	*86	*91

SIM Selected Ion Monitoring  
NAP Naphthalene-D<sub>8</sub>  
FLR Fluorene-D<sub>10</sub>  
CRY Chrysene-D<sub>12</sub>

\* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.

Approved by Karin DeWitt 53 Date 5-5

00044

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/18,19/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method

Sample Name	Lab Code	P e r c e n t R e c o v e r y		
		*2FP	*PHL	*TBP
BB-BC-3	K1793-1	76	91	143
CH-BC-1	K1793-2	66	85	139
CH-BC-2	K1793-3	56	65	121
IL-BC-4,5 Comp	K1793-6	54	67	133
IL-BC-6	K1793-7	28	54	122
IL-BC-8,9 Comp	K1793-10	36	50	123
IL-BC-10,11 Comp	K1793-13	27	36	124
CB-BC-1	K1793-14	32	26	114
Method Blank	K1793-MB	139	144	113
Laboratory Control Sample	K1793-LCS	131	147	86

SIM Selected Ion Monitoring  
2FP 2-Fluorophenol  
PHL Phenol-D<sub>6</sub>  
TBP 2,4,6-Tribromophenol

\* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.

Approved by Kevin Trevitt 54 Date 5-5

**COLUMBIA ANALYTICAL SERVICES, INC.**

**QA/QC Report**

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Received:** 03/23/92  
**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/14/92  
**Work Order No.:** K921793

**Surrogate Recovery Summary**  
**Polynuclear Aromatic Hydrocarbons and Phenols**  
**EPA Method 3550 in Combination with GC/MS SIM Method**

Sample Name	Lab Code	P e r c e n t R e c o v e r y		
		*NAP	*FLR	*CRY
CH-BC-2	K1793-3	64	96	99
IL-BC-4,5 Comp	K1793-6	48	94	108
IL-BC-6	K1793-7	32	93	95
IL-BC-8,9 Comp	K1793-10	56	99	87
IL-BC-10,11 Comp	K1793-13	53	95	48
CB-BC-1	K1793-14	43	91	82
CB-BC-2	K1793-15	44	87	55
CB-BC-3	K1793-16	50	66	88
CB-BC-4	K1793-17	58	101	95

**SIM** Selected Ion Monitoring  
**NAP** Naphthalene-D<sub>8</sub>  
**FLR** Fluorene-D<sub>10</sub>  
**CRY** Chrysene-D<sub>12</sub>

\* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.

Approved by Kevin DENNITT 55 Date 5-5

00046

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Extracted: 03/24/92  
Date Analyzed: 04/18,19/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method

Sample Name	Lab Code	P e r c e n t R e c o v e r y		
		*2FP	*PHL	*TBP
Batch QC**	K1786-2	143	156	164
Batch QC**	K1786-2MS	116	140	161
Batch QC**	K1786-2DMS	86	119	152

SIM Selected Ion Monitoring  
2FP 2-Fluorophenol  
PHL Phenol-D<sub>6</sub>  
TBP 2,4,6-Tribromophenol

- \* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.
- \*\* Batch QA/QC data from another ACOE project.

Approved by Kevin Dewhart 56 Date 5-5

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/19,20/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method

Sample Name	Lab Code	Percent Recovery		
		*NAP	*FLR	*CRY
BB-BC-3	K1793-1	62	97	82
CH-BC-1	K1793-2	54	99	87
Laboratory Control Sample	K1793-LCS	74	74	109

SIM Selected Ion Monitoring  
NAP Naphthalene-D<sub>8</sub>  
FLR Fluorene-D<sub>10</sub>  
CRY Chrysene-D<sub>12</sub>

\* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.

Approved by Kevin Dewitt 57 Date 5-5

U0048

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/20/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method

Sample Name	Lab Code	P e r c e n t R e c o v e r y		
		*NAP	*FLR	*CRY
Batch QC**	K1786-2	65	98	82
Batch QC**	K1786-2MS	61	102	78
Batch QC**	K1786-2DMS	72	108	85

SIM Selected Ion Monitoring  
NAP Naphthalene-D<sub>8</sub>  
FLR Fluorene-D<sub>10</sub>  
CRY Chrysene-D<sub>12</sub>

- \* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.
- \*\* Batch QA/QC data from another ACOE project.

Approved by Kevin DeWitt 58 Date 5-5

00049

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Received: 03/23/92  
Date Extracted: 03/24/92  
Date Analyzed: 04/23/92  
Work Order No.: K921793

Surrogate Recovery Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in Combination with GC/MS SIM Method

Sample Name	Lab Code	P e r c e n t R e c o v e r y		
		2FP	PHL	TBP
CB-BC-2	K1793-15	*84	*103	**354
CB-BC-3	K1793-16	*99	*123	**322
CB-BC-4	K1793-17	*81	*82	**307

SIM Selected Ion Monitoring  
2FP 2-Fluorophenol  
PHL Phenol-D<sub>6</sub>  
TBP 2,4,6-Tribromophenol

- \* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.
- \*\* Elevated percent recovery. This sample was analyzed in duplicate, with elevated recoveries noted for both analyses. Results from the second analysis are reported.

59

Approved by

*Kevin Dewitt*

Date

*5-5*

00050

**COLUMBIA ANALYTICAL SERVICES, INC.**

QA/QC Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/18,19/92  
**Work Order No.:** K921793

Matrix Spike/Duplicate Matrix Spike Summary  
 Polynuclear Aromatic Hydrocarbons and Phenols  
 EPA Method 3550 in Combination with GC/MS SIM Method  
 µg/Kg (ppb)  
 Dry Weight Basis

**Sample Name:** Batch QC\*  
**Lab Code:** K1786-2

Analyte	Spike Level		Sample Result	Spike Result		Percent Recovery		CAS Acceptance Criteria	Relative Percent Difference
	MS	DMS		MS	DMS	MS	DMS		
Pentachlorophenol	21	23	ND	**40	**39	‡190	‡170	10-120	11

- SIM** Selected Ion Monitoring
- \* Batch QA/QC data from another ACOE project.
- ND** None Detected at or above the method reporting limit
- \*\* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.
- ‡ Outside of acceptance limits. Accuracy of spike recovery value is reduced, since analysis of the sample required a dilution such that the target compound concentration was diluted below both the MRL and the quantitative calibration range of the instrument.

Approved by Kim DeWitt 60 Date 5-5

00051

**COLUMBIA ANALYTICAL SERVICES, INC.**

QA/QC Report

**Client:** U.S. Army Corps of Engineers  
**Project:** Portland District Dredging/#92-SHM-183  
**Sample Matrix:** Sediment

**Date Extracted:** 03/24/92  
**Date Analyzed:** 04/20/92  
**Work Order No.:** K921793

Matrix Spike/Duplicate Matrix Spike Summary  
 Polynuclear Aromatic Hydrocarbons and Phenols  
 EPA Method 3550 in Combination with GC/MS SIM Method  
 µg/Kg (ppb)  
 Dry Weight Basis

**Sample Name:** Batch QC\*  
**Lab Code:** K1786-2

Analyte	Spike Level		Sample Result	Spike Result		Percent Recovery		CAS Acceptance Criteria	Relative Percent Difference
	MS	DMS		MS	DMS	MS	DMS		
Acenaphthene	21	23	ND	**20	**20	95	87	40-130	9
Pyrene	21	23	**31	**60	56	‡138	109	40-130	23

- SIM** Selected Ion Monitoring
- \* Batch QA/QC data from another ACOE project.
- ND** None Detected at or above the method reporting limit
- \*\* Analyte concentration is an estimate because the result was below the instrument calibration range and below the sample MRL.
- ‡ Outside of acceptance limits. Accuracy of spike recovery value is reduced, since analysis of the sample required a dilution such that the target compound concentration was diluted below both the MRL and the quantitative calibration range of the instrument.

Approved by Kevin Dewitt Date 5-5

00052

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers Date Extracted: 03/24/92  
Project: Portland District Dredging/#92-SHM-183 Date Analyzed: 04/18/92  
Sample Matrix: Sediment Work Order No.: K921793

Laboratory Control Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name: Laboratory Control Sample  
Lab Code: K1793-LCS

Analyte	Spike Level	Blank Result	Spiked Sample Result	Percent Recovery	CAS Percent Recovery Acceptance Criteria
Pentachlorophenol	17	ND	*19	112	10-20

**SIM** Selected Ion Monitoring  
**ND** None Detected at or above the method reporting limit  
\* Analyte concentration is an estimate because extract dilutions resulted in values below the instrument calibration range.

Approved by Kevin Dewitt 62 Date 5-5

00053

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client: U.S. Army Corps of Engineers  
Project: Portland District Dredging/#92-SHM-183  
Sample Matrix: Sediment

Date Extracted: 03/24/92  
Date Analyzed: 04/19/92  
Work Order No.: K921793

Laboratory Control Summary  
Polynuclear Aromatic Hydrocarbons and Phenols  
EPA Method 3550 in combination with GC/MS SIM Method  
 $\mu\text{g/Kg}$  (ppb)  
Dry Weight Basis

Sample Name: Laboratory Control Sample  
Lab Code: K1793-LCS

Analyte	Spike Level	Blank Result	Spiked Sample Result	Percent Recovery	CAS Percent Recovery Acceptance Criteria
Acenaphthene	17	ND	*15	88	40-130
Pyrene	17	ND	*14	82	40-130

**SIM** Selected Ion Monitoring  
**ND** None Detected at or above the method reporting limit  
\* Analyte concentration is an estimate because the result was below the instrument calibration range.

Approved by Kevin DeWitt 63 Date 5-5

00054



DEPARTMENT OF THE ARMY  
NORTH PACIFIC DIVISION MATERIALS LABORATORY  
CORPS OF ENGINEERS  
1491 N.W. GRAHAM AVENUE  
TROUTDALE, OREGON 97060-9503

CENPD-PE-GT-L (1110-1-8100c)

29 Jul 92

MEMORANDUM FOR: Commander, Portland District, ATTN: CENPP-PE-HR (Britton)

SUBJECT: W.O. 92-SHM-183, Results of Chemical Analyses

Project: PORTLAND DISTRICT DREDGING PROJECT  
Intended Use: Evaluate site  
Source of Material: Reference Chain of Custody Records  
Submitted by: CENPP-PE-HR (Britton)  
Date Sampled: 19 May 92 Date Received: 23 Mar 92  
Methods of Test: Reference Enclosure 1  
Reference: DD Forms 448, MIPR Nos. E86-92-0074 dated 4 Mar 92 and  
E86-92-0040, dated 31 Mar 92

1. Enclosed are results of analyses and quality assurance data for environmental samples collected from the above site. Included are:
  - a. Enclosure 1, Chemical Quality Assurance Report.
  - b. Enclosure 2, Report number K921793 from Columbia Analytical Services, Inc.
  - c. Enclosure 3, Report dated 27 May 92 from Battelle.
  - d. Enclosure 4, Chain of Custody and Cooler Receipt forms.
2. If you have any questions or comments regarding the Chemical Quality Assurance Report, please contact Dr. Ajmal Ilias at (503) 665-4166.
3. This completes all work requested to date.

Enclosures

*Timothy J. Seeman*

TIMOTHY J. SEEMAN  
Director

Copy Furnished: CENPD-PE-GT

29 Jul 92

**CHEMICAL QUALITY ASSURANCE REPORT**  
**PORTLAND DISTRICT DREDGING PROJECT**

**1. SUMMARY:**

a. Up to 74 u moles/g of acid volatile sulfides (AVS), 0.08 through 165 ppm of metals, 8 ppb of pesticides, 370 ppb of polynuclear aromatics (PNA), 34.7 ppb of organotin compounds, and 782/150 ppt of dioxin/furans were detected in this tier of analysis.

b. The project and quality assurance (QA) data comparisons are shown in Table I. All data agree.

**2. BACKGROUND:** The samples were collected on March 19, 1992 and were received by the analytical laboratories on March 23, 1992.

**3. OBJECTIVES:**

a. Seventeen sediment samples were collected to determine the extent of chemical contamination on the site.

b. One QA sample was submitted to evaluate the project laboratory's data.

**4. PROJECT ORGANIZATION:**

a. The samples were collected by North Pacific Division/Portland District staff.

b. The project samples were analyzed by Columbia Analytical Services, Inc. (CAS), Kelso, Washington, Keystone/NEA, Environmental Resources, Tigard, Oregon, and Battelle, Sequim, Washington.

c. The QA samples were analyzed by Battelle, Sequim, Washington and Analytical Resources, Inc., Seattle, Washington.

**5. ANALYTICAL REFERENCES:**

<u>Number</u>	<u>Title</u>	<u>Date</u>
a. SW-846, Third Edition	Test Methods for Evaluating Solid Waste	11/86
b. Battelle	In-house Modified Methods	91/92

6. **PROJECT LABORATORIES' DATA:** Up to 74 u moles/g of acid volatile sulfides (AVS), 0.08 through 165 ppm of metals, 8 ppb of pesticides, 370 ppb of polynuclear aromatics (PNA), 34.7 ppb of organotin compounds, and 782/150 ppt of dioxin/furans were detected in this tier of analysis.

7. **EVALUATION OF THE PROJECT LABORATORIES' DATA:** All method blanks were free from targeted analytes except for phenol blanks, which were contaminated with 72 ppb of phenol. Phenol data reported in CAS report K921793 is due to laboratory contamination. The detection limits and holding times met method requirements and are acceptable. Surrogate recoveries of all methods were within quality control (QC) limits and are acceptable. The matrix spike (MS) and matrix spike duplicates (MSD) of all organics were within QC limits except for the following: MSD of gamma-BHC was marginally below QC limits and MS and MSD of 4,4'-DDT were below lower QC limits, data were accepted based on acceptable surrogate and laboratory control (LC) recoveries. MS and MSD of PNA were within QC limits except for MS of pyrene, which was above advisory limits. Data of PNA were accepted based on surrogate and other acceptable MS and MSD recoveries. The MS and MSD of pentachlorophenols were above upper QC advisory limits. Phenol data were not affected as no targeted analytes except for laboratory contaminated phenols were found. MS and MSD of dioxin/furans and AVS were within QC limits and are acceptable. The recoveries of monobutyl through tributyl tins were 3 through 39-percent, which are considered poor since no EPA guidelines are available, and data should be considered acceptable as low estimates. The MS recoveries of metals were within QC limits and are acceptable. The relative percent differences (RPDs) of all methods were within QC limits except for the following: The RPD of 123478HXCD, 1234678XPCDD and OCDD were above QC limits, probably due to non-homogeneous samples. The data of these analytes should be considered estimates. Overall, data are acceptable except for phenol, which is due to laboratory contamination.

8. **EVALUATION OF THE QA LABORATORIES' DATA:** All surrogate, MS and MSD recoveries were within QC limits. All method blanks were free of targeted analytes except for the metals blank, where cadmium and mercury were detected. All holding times and detection limits met method requirements. Overall, all QA data are acceptable.

9. **QA/QC COMPARISONS:** The project and QA data comparisons are shown in Table I. All data agree.

10. **PROBLEMS ENCOUNTERED/LESSONS LEARNED:** The project laboratory (CAS), subcontracted tributyl-tin analysis to Battelle Laboratories. Battelle was also the QA laboratory for this analysis and inadvertently conducted both the project and QA analyses for tributyl tin.

## COMPARISON OF PROJECT AND QA RESULTS

TABLE I

Project: PORTLAND DISTRICT DREDGING PROJECT Matrix: sediment  
 Project Laboratory: CAS QA Laboratory: Battelle

1. Method: Pesticides/PCBs (EPA 8080) Units: ug/Kg (ppb)

<u>Analytes Detected</u>	<u>Project Lab CB-BC-4</u>	<u>Detection Limits</u>	<u>QA Lab CB-BC-4-QA</u>	<u>Detection Limits</u>
4,4'-DDE	ND	5	2.1	2.0
Endrin	ND	5	0.96J	2.0
Percent Solids	38.0		--	

ND = None detected

-- = Not reported

J = Estimated value found at less than instrument detection limits

SUMMARY: The project and QA data agree within a factor of three to each other or their detection limits and are acceptable.

2. Method: Acid Volatile Sulfides in Sediment Units: u moles/q (ppt)

<u>Analytes Detected</u>	<u>Project Lab CB-BC-4</u>	<u>Detection Limits</u>	<u>QA Lab CB-BC-4-QA</u>	<u>Detection Limits</u>
	50	0.01	58.84	--

SUMMARY: The project and QA data agree and are acceptable.

3. Method: Polynuclear Aromatics (GC/MS SIM) Units: ug/Kg (ppb)

<u>Analytes Detected</u>	<u>Project Lab CB-BC-4</u>	<u>Detection Limits</u>	<u>QA Lab CB-BC-4-QA</u>	<u>Detection Limits</u>
Fluoranthene	250	86	178.8	--
Pyrene	220	86	158.8	--
Chrysene	87	86	55	--
Naphthalene	ND	86	48.1	--
Phenanthrene	ND	86	63.6	--
Anthracene	ND	86	24.2	--
Benzo(a)anthracene	ND	86	56.3	--
Benzo(b)fluoranthene	ND	170	143.4	--
Indeno(1,2,3-c,d)pyrene	ND	86	40.2	--
Di-benzo(a,h)anthracene	ND	86	18.8	--
Benzo(g,h,i)perylene	ND	86	50.8	--

SUMMARY: The project and QA data agree within a factor of three to each other or their detection limits and are acceptable.

CENPD-PE-GT-L (92-SHM-183)  
Table I

4. Method: Phenols (EPA 3550 GC/MS) Units: ug/Kg (ppb)

<u>Analytes Detected</u>	<u>Project Lab CB-BC-4</u>	<u>Detection Limits</u>	<u>QA Lab CB-BC-4-QA</u>	<u>Detection Limits</u>
Phenol	130B	86	ND	100
2-Methylphenol	ND	86	ND	66
4-Methylphenol	ND	86	ND	71
2,4-Dimethylphenol	ND	86	ND	75
Pentachlorophenol	ND	220	ND	5.8

B = Found in laboratory blank as well as sample

SUMMARY: The project and QA data agree and are acceptable. The phenol reported by the project laboratory is due to laboratory contamination.

5. Method: Butyl tins Units: ng/g

<u>Analytes Detected</u>	<u>Project Lab CB-BC-4</u>	<u>Detection Limits</u>	<u>QA Lab CB-BC-4-QA</u>	<u>Detection Limits</u>
Monobutyl tin	ND	4.4	ND	6.2
Dibutyl tin	ND	2.1	ND	2.9
Tributyl tin	5.0	2.1	13.0	--

SUMMARY: The project and QA data agree and are acceptable.

6. Method: Total Metals (EPA 6000/7000) Units: ug/Kg (ppb)

<u>Analytes Detected</u>	<u>Project Lab CB-BC-4</u>	<u>Detection Limits</u>	<u>QA Lab CB-BC-4-QA</u>	<u>Detection Limits</u>
Arsenic	8000	1000	10500	--
Cadmium	1200	100	940	--
Chromium	23000	1000	58300	--
Copper	46000	1000	58400	--
Lead	20000	1000	23900	--
Mercury	120	20	119	--
Nickel	21000	1000	30600	--
Zinc	122000	1000	174000	--

SUMMARY: The project and QA data agree within a factor of three and are acceptable.

**APPENDIX B**  
**CHAIN OF CUSTODY INFORMATION**

CHAIN OF CUSTODY RECORD

PROJECT Baker Bay Channels, Ilwaco & Chinook Boat Basins					NO. CONTAINERS	* Metals (see list) Pesticides / PCBs PAHs (5µg) Phenols (5µg) TBT AVS Dioxins										PRESERVATION	
SAMPLERS: (Signature) Jim Britton						REMARKS OR SAMPLE LOCATION	ICED	SPECIFY CHEMICALS ADDED AND FINAL pH IF KNOWN									
SAMPLE NUMBER	DATE	TIME	COMP.	GRAB													
BB-BC-3.	3/19				1	X	X	X	X	X							
CH-BC-1.	"				1	X	X	X	X	X							
CH-BC-2.	"				1	X	X	X	X	X							
IL-BC-4.	"				1	X	X	X	X	X							Composite
IL-BC-5.	"				1	X	X	X	X	X							Composite
IL-BC-6.	"				1	X	X	X	X	X							Composite
IL-BC-8.	"				1	X	X	X	X	X							Composite
IL-BC-9.	"				1	X	X	X	X	X							Composite
IL-BC-10.	"				1	X	X	X	X	X							Composite
IL-BC-11.	"				1	X	X	X	X	X							Composite
CB-BC-1.	"				1	X	X	X	X	X							
CB-BC-2.	"				1	X	X	X	X	X	X						
CB-BC-3.	"				1	X	X	X	X	X							
CB-BC-4.	"				1	X	X	X	X	X							
IL-BC-1,2 & 3.	"				3												Hold
Relinquished by: (Signature) ① Jim Britton		Date / Time 3/20/92 1:57		Received by: (Signature) Pamela Dwan		Relinquished by: (Signature) ④		Date / Time		Shipped via:							
Relinquished by: (Signature) ② Pamela Dwan		Date / Time 3/20/92 1700		Received by: (Signature)		Received for Laboratory by: (Signature) Liam Quirk		Date / Time 3-23-92, 0800		Shipping Ticket No.							
Relinquished by: (Signature) ③		Date / Time		Received by: (Signature)		Remarks * metals - As, Cd, Cr, Cu, Hg, Ni, Pb, Zn											

92-SHM-183

92-SHM-181

70

00056

TBT = Tributyl Tin  
AVS = acid volatile sulfide

COOLER RECEIPT FORM

Project: Portland District Dredging

Cooler received on 3 21 192 and opened on 3 21 192 by R. Auerson

- 1) Were custody seals on outside of cooler -----  YES NO  
If yes, how many and where? 2 - Front  
Were signature and date correct? -----  YES NO
- 2) Were custody papers taped to lid inside cooler? -----  YES NO
- 3) Were custody papers properly filled out (ink, signed, etc.)? -----  YES NO
- 4) Did you sign custody papers in the appropriate place? -----  YES NO
- 5) Did you attach shipper's packing slip to this form? -----  YES NO
- 6) What kind of packing material was used? vermiculite
- 7) Was sufficient ice used (if appropriate)? -----  YES NO
- 8) Were all bottles sealed in separate plastic bags? -----  YES NO
- 9) Did all bottles arrive in good condition (unbroken)? -----  YES NO
- 10) Were all bottle labels complete (No., date, signed, anal. pres, etc.)  YES NO
- 11) Did all bottle labels and tags agree with custody papers? -----  YES NO
- 12) Were correct bottles used for the tests indicated? -----  YES NO
- 13) Were VOA vials checked for absence of air bubbles, & noted if so? YES NO
- 14) Was sufficient amount of sample sent in each bottle? -----  YES NO

Explain any discrepancies ----->

cc: Central File  
Login File

PROJECT: COLUMBIA ANALYTICAL - TBT 04/01/92

**SAMPLE LOGIN**

<u>SPONSOR CODE</u>	<u>BATTELLE CODE</u>	<u>SAMPLE TYPE</u>	<u>UNIT</u>	<u>SHELF/FR#</u>	<u>TRAY/RM#</u>	<u>PARAMETERS REQUESTED</u>	<u>DATE</u>	<u>INITIALS</u>
CG-BC-1	437CAS*1	SED	C	4	2	TBT	04/01/92	MPG
CG-BC-2	437CAS*2	SED	C	4	2	TBT	04/01/92	MPG
IL-BC-4, 5 (COMP)	437CAS*3	SED	C	4	2	TBT	04/01/92	MPG
IL-BC-6	437CAS*4	SED	C	4	2	TBT	04/01/92	MPG
IL-BC-8, 9-COMP	437CAS*5	SED	C	4	2	TBT	04/01/92	MPG
IL-BC-10, 11COMP	437CAS*6	SED	C	4	2	TBT	04/01/92	MPG
CB-BC-1	437CAS*7	SED	C	4	2	TBT	04/01/92	MPG
CB-BC-2	437CAS*8	SED	C	4	2	TBT	04/01/92	MPG
CB-BC-3	437CAS*9	SED	C	4	2	TBT	04/01/92	MPG
CB-BC-4	437CAS*10	SED	C	4	2	TBT	04/01/92	MPG

0003

72

COMMENTS:

**ANALYSIS OF SOILS**  
**For The Presence of**  
**PCDD's AND PCDF's**  
**By**  
**HIGH RESOLUTION GAS CHROMATOGRAPHY**  
**HIGH RESOLUTION MASS SPECTROMETRY**



## CASE NARRATIVE

## CASE NARRATIVE

### I. SAMPLE DESCRIPTION

Two soil samples were received under Chain-of-Custody on March 31, 1992. The samples were in good condition upon receipt, and were stored in a refrigerator maintained at 4°C until extraction.

One laboratory method blank, and one Matrix Spike and Matrix Spike Duplicate were also analyzed with this sample set.

### II. ANALYSIS REQUEST

The analytical test requested for this sample set was as follows:

<u>LAB ID NUMBER</u>	<u>ANALYSIS</u>	<u>LMCL</u>
92CA31MR01	EPA Method 8290+	2 ppt (tetras) 10.0 (pentas ,hexas ,heptas) 20.0 (octas)

### III. SAMPLE ANALYSIS SUMMARY

#### A. Background

Keystone/NEA's Center for Analytical Mass Spectrometry has analyzed this set of samples by High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS) according to EPA Method 8290+. Deviations from the proposed Method 8290 are described under "Analytical Methodology", below.

The samples were extracted in one set on April 1, 1992. The extracts were analyzed on a DB-5.625 column on April 7, 1992. Confirmation analysis was done on a DB-225 column on April 7, 1992.

## B. Results

**General** Soil results are based on the initial weight of the sample (approximately 5 grams). All of the reported results are rounded to three significant figures. Laboratory Method Blank results are also based on a theoretical sample size of 5 grams. Reported results for the 2378-TCDF are from a DB-225 column, and are highlighted with an asterisk (\*). All other results are from a DB-5 column.

**Sample Results** The only significant differences between the two samples were in the concentrations of the two highest chlorinated dioxin isomers. The 1234678-HpCDD isomer was present in samples K1793-10 and K1793-15 at 358 ppt and 140 ppt, and OCDD was present at 2,700 ppt and 1,320 ppt, respectively. Otherwise the two soil samples contained similar concentrations of the seventeen target analytes. (See Table 1.)

Six of the seventeen 2378-substituted isomers were present in both samples at levels above the Lower Method Calibration Limit (LMCL). Sample K1793-10 contained 123678-HxCDD (18.0 ppt), 123789-HxCDD (10.5 ppt), 1234678-HpCDD (358 ppt), OCDD (2,700 ppt), 1234678-HpCDF (49.1 ppt), and OCDF (144 ppt).

Sample K1793-15 contained five of those isomers at concentrations above the LMCL: 123678-HxCDD (13.6 ppt), 1234678-HpCDD (140 ppt), OCDD (1,320 ppt), 1234678-HpCDF (20.1 ppt), and OCDF (41.3 ppt).

The remaining eleven isomers were detected in both samples at levels calculated to be below or near the individual LMCLs. Concentrations reported below the LMCL should be considered ESTIMATES ONLY.

## C. Analytical Methodology

Modifications have been made to EPA Method 8290 to improve quantitation of the seventeen 2378-substituted isomers. Most of the modifications have been approved for other EPA methods (primarily EPA Method 1613). The significant modifications to EPA Method 8290 for PCDD and PCDF are outlined below.

**Sample Preparation** The extraction, sample clean-up, and instrumental analyses were done by EPA Method 8290. Solid samples are extracted with toluene in a soxhlet-Dean Stark apparatus. This procedure azeotropically removes the water from the sample, thus eliminating the time-consuming step of pre-drying the sample, or mixing with a drying agent. This adaptation has been approved for Method 1613 and Method 8290.

Calibration Standards

This laboratory uses independently prepared and certified calibration standards, at concentrations specified in EPA Method 1613. The standards are traceable to EPA standards.

Internal Standard

EPA Method 8290 calls for an Internal Standard solution containing nine of the seventeen 2378-substituted isomers for quantitation (section 2.3). The Internal Standard used for these analyses contains labeled analogues of sixteen of the 2378-substituted isomers. One compound,  $^{13}\text{C}$ -123789-HxCDD, is used as a Recovery Standard; its native analyte is quantified against  $^{13}\text{C}$ -123678-HxCDD.

Standard Preparation and Spiking

To prevent changes in concentration due to solvent losses, the standards for these analyses have been prepared in tetradecane. Internal Standards and PAR solutions are dissolved in acetone immediately prior to spiking aqueous matrices.

Clean-Up Recovery Standard Spiking Levels

EPA Method 8290 calls for spiking the sample extracts with 2,000 pg of  $^{37}\text{Cl}$ -2378-TCDD immediately prior to the clean-up procedure. That level has been reduced to 200 pg, as suggested by NCASI. The purpose of this change is to reduce the occurrence of false positives due to native contamination in the 322 channel.

D. Calculations and Reporting

Positive Identification

Where a peak has been positively identified as one of the 2378-substituted PCDD/PCDF isomers by passing all the QA criteria (retention times, analyte isotope ratios, and signal-to-noise), a concentration has been calculated in the usual manner and reported in the attached tables. In cases where the reported concentration falls below the LMCL, it should be considered an estimate only.

Estimated Maximum Possible Concentration

Where a peak has passed all the QA criteria except for the analyte isotope ratios, there may be co-eluting contaminants or other chemical interferences. In such cases, a concentration has been calculated in the usual manner, but reported as an Estimated Maximum Possible Concentration (EMPC).

Analyte Not Detected

Where the Chromatogram is characterized by the absence of peaks in both native channels (at the appropriate retention times), or where a peak is present in one or both channels, but does not pass the signal-to-noise criteria of 2.5:1, the analyte cannot be positively

identified and may be reported as Not Detected at or above the sample specific Estimated Detection Limit (ND/EDL). A data-review specialist has inspected each one individually and calculated an EDL based on the reporting requirements specified in EPA method 8290. Hard copies of the calculations are included in the sample data packet.

**Calibration Limits** A series of three Lower Method Calibration Limits (LMCLs) and three Upper Method Calibration Limits (UMCLs) can be calculated based on a sample size of 5 grams. The equations used are as follows:

$$(1) \quad LMCL = \frac{\text{Lowest Instrument Calibration Pt} \times \text{Final Volume}}{\text{Sample Size}}$$

$$(2) \quad UMCL = \frac{\text{Highest Instrument Calibration Pt} \times \text{Final Volume}}{\text{Sample Size}}$$

Note: pg/g = ppt

The Lowest and Highest Instrument Calibration Points (LICPs and HICPs) vary with each homologue group. For a sample size of 5 grams:

<u>Homologue Group</u>	<u>LICP/HICP</u>	<u>LMCL</u>	<u>UMCL</u>
Tetra	0.5/200 pg/μL	2.0 pg/g	800 pg/g
Penta, Hexa, Hepta	2.5/1,000 pg/μL	10.0 pg/g	4,000 pg/g
Octa	5.0/2,000 pg/μL	20.0 pg/g	8,000 pg/g

#### IV. QUALITY CONTROL

##### A. Project Quality Control

No special quality control measures were required or requested for this set of samples.

##### B. Instrument Quality Control

Conventional instrument quality control measures were applied for the analysis of these samples. The HRGC and HRMS systems' initial calibrations were verified immediately prior to and following analysis by injection of appropriate standards. One instrument blank was run prior to the laboratory Method Blank. All relevant instrument performance criteria were met. Documentation of initial and continuing calibrations, and GC and MS resolution checks can be found in the "QUALITY CONTROL DOCUMENTS" section of this report.

Continuing Calibration Because the samples were analyzed on a DB-5.625 column immediately following an initial calibration, only the continuing calibration following the sample analyses is included here.

### C. Laboratory Quality Control

Laboratory Method Blank One laboratory Method Blank was analyzed with this set of samples to test for laboratory contamination. Its treatment in the laboratory was identical in all respects to that of the actual samples. The data are included in the "QUALITY CONTROL DOCUMENTS" section of this report.

The laboratory method blank was Non-Detect for all PCDD/PCDF isomers at the LMCL of 2.0 ppt (tetras), 10.0 ppt (pentas, hexas, heptas), and 20.0 ppt (octa). Many of these analytes, however, had sample specific EDL's significantly lower than the LMCL, ranging from 0.72 ppt to 3.17 ppt.

Matrix Spike and Matrix Spike Duplicate Fourteen of the seventeen 2378-substituted isomers in the Matrix Spike and Matrix Spike Duplicate samples had a Relative Percent Difference (RPD) below the method specified criteria of  $\pm 20\%$ . The three remaining isomers had RPDs of 31%, 37% and 78%. The percent analyte recovery was lower in the MSd sample for each of the three isomers. One possible explanation may be inhomogeneity of the sample.

D. Quality Control Review

All of the data have been reviewed by the scientist performing the analysis, by the Director of the Center for Analytical Mass Spectrometry, and the Quality Assurance Officer. All of the quality control and sample-specific information in the package is complete and meets or exceeds the minimum requirements for acceptability.

Laura Chambers 4/10/92  
Date  
Laura Chambers  
Senior Scientist  
Center for Analytical Mass Spectrometry

Peggy L. Meek 4/10/92  
Date  
Peggy L. Meek  
Wet Lab Supervisor  
Center for Analytical Mass Spectrometry

William H. Chambers 4.10.92.  
Date  
William H. Chambers  
Director  
Center for Analytical Mass Spectrometry

Jeff Sprenger 4/10/92  
Date  
Jeff Sprenger  
QA Officer  
Keystone/NEA



## SAMPLE ANALYSIS SUMMARY

# SUMMARY OF ANALYTICAL RESULTS

## 2378-Substituted Isomers

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

MS File Number:	07APR92LCB2071	07APR92LCB2091	07APR92LCB2101
Keystone/NEA Number:	92CA31MR01-MB	92CA31MR01-01	92CA31MR01-02
Customer Number:		K1793-10	K1793-15
Sample Description:	Method Blank	Soil <i>1L-BC-8A conc.</i>	Soil <i>CB-BC-2</i>

Units	pg/g (ppt)	pg/g (ppt)	pg/g (ppt)
-------	------------	------------	------------

Dioxins

2378-TCDD	ND/EDL=0.78	EMPC=1.68	1.06 <i>1.91</i>
12378-PeCDD	ND/EDL=0.72	EMPC=3.63	EMPC=1.67
123478-HxCDD	ND/EDL=2.30	7.85	2.54 <i>1</i>
123678-HxCDD	ND/EDL=1.30	18.0	13.6 <i>2</i>
123789-HxCDD	ND/EDL=1.28	10.5	6.43
1234678-HpCDD	ND/EDL=2.83	358	140
OCDD	EMPC=4.70	2,700	1,320

Furans

2378-TCDF	ND/EDL=1.08	10.9*	7.12*
12378-PeCDF	ND/EDL=1.84	EMPC=3.36	2.03
23478-PeCDF	ND/EDL=1.65	4.37	2.25
123478-HxCDF	ND/EDL=0.90	7.25	EMPC=6.07
123678-HxCDF	ND/EDL=0.84	2.95	EMPC=2.22
234678-HxCDF	ND/EDL=1.26	6.99	EMPC=3.67
123789-HxCDF	ND/EDL=1.11	EMPC=2.54	EMPC=2.29
1234678-HpCDF	ND/EDL=0.81	49.1	20.1
1234789-HpCDF	ND/EDL=1.00	3.49	2.57
OCDF	ND/EDL=3.17	144	41.3

Notes:

1. ND/EDL = Analyte Not Detected at or above the sample specific Estimated Detection Limit.
2. EMPC = Estimated Maximum Possible Concentration.
3. Concentrations highlighted with an asterisk (\*) are from a DB-225 column.
4. Concentrations below the LMCL or above the UMCL are ESTIMATES ONLY.

LMCL  
UMCL

*Lower method calibration limit*  
*upper*

Table 1

**SUMMARY OF ANALYTICAL RESULTS**

**Homologue Group Totals**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

MS File Number:	07APR92LCB2071	07APR92LCB2091	07APR92LCB2101
Keystone/NEA Number:	92CA31MR01-MB	92CA31MR01-01	92CA31MR01-02
Customer Number:		K1793-10	K1793-15
Sample Description:	Method Blank	Soil	Soil

*IL-BR-8/9 comp. CB-B (-2)*

Units	pg/g (ppt)	pg/g (ppt)	pg/g (ppt)
-------	------------	------------	------------

Dioxins

Total TCDD	ND/EDL=0.78	5.37	1.06 <sup>2</sup>
Total PeCDD	ND/EDL=0.72	9.34	9.13
Total HxCDD	ND/EDL=1.30	126	95.9
Total HpCDD	ND/EDL=2.83	782	388

Furans

Total TCDF	ND/EDL=1.08	21.9	20.1
Total PeCDF	ND/EDL=1.65	32.0	12.5
Total HxCDF	ND/EDL=0.84	73.0	16.2
Total HpCDF	ND/EDL=0.81	150	54.7

Notes:

1. ND/EDL = Analyte Not Detected at or above the sample specific Estimated Detection Limit.
2. Concentrations below the LMCL or above the UMCL are ESTIMATES ONLY.

**SUMMARY OF ANALYTICAL RESULTS**

**Internal Standard Recoveries**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

MS File Number: 07APR92LCB2071 07APR92LCB2091 07APR92LCB2101  
 Keystone/NEA Number: 92CA31MR01-MB 92CA31MR01-01 92CA31MR01-02  
 Customer Number: K1793-10 K1793-15  
 Sample Description: Method Blank Soil Soil

*IL-BC-8/9 composite CB-BC-2*

Units	%	%	%
<u>Dioxins</u>			
13C-2378-TCDD	51	50	50
13C-12378-PeCDD	66	62	63
13C-123478-HxCDD	68	65	70
13C-123678-HxCDD	91	77	81
13C-1234678-HpCDD	71	75	78
13C-OCDD	61	65	72
<u>Furans</u>			
13C-2378-TCDF	58	47*	56*
13C-12378-PeCDF	45	44	45
13C-23478-PeCDF	48	46	47
13C-123478-HxCDF	75	67	72
13C-123678-HxCDF	71	57	63
13C-234678-HxCDF	50	45	57
13C-123789-HxCDF	68	72	78
13C-1234678-HpCDF	67	58	65
13C-1234789-HpCDF	69	75	79
<u>Clean-Up Recovery Standard</u>			
37C14-2378-TCDD	80	73	75

**Notes:**

1. Recoveries highlighted with an asterisk (\*) are from a DB-225 column.

**SUMMARY OF ANALYTICAL RESULTS**

**Internal Standard Recoveries**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

MS File Number:	07APR92LCB2111	07APR92LCB2121
Keystone/NEA Number:	92CA31MR01-02MS	92CA31MR01-02MSd
Customer Number:	K1793-15	K1793-15
Sample Description:	Soil	Soil

Units	%	%
<u>Dioxins</u>		
13C-2378-TCDD	46	48
13C-12378-PeCDD	58	56
13C-123478-HxCDD	64	75
13C-123678-HxCDD	71	62
13C-1234789-HpCDD	74	78
13C-OCDD	70	72
<u>Furans</u>		
13C-2378-TCDF	56*	58*
13C-12378-PeCDF	43	44
13C-23478-PeCDF	46	43
13C-123478-HxCDF	62	64
13C-123678-HxCDF	58	59
13C-234678-HxCDF	55	54
13C-123789-HxCDF	70	66
13C-1234678-HpCDF	61	59
13C-1234789-HpCDF	72	77
<u>Clean-Up Recovery Standard</u>		
37Cl4-2378-TCDD	72	72

**Notes:**

1. Recoveries highlighted with an asterisk (\*) are from a DB-225 column.

**SUMMARY OF ANALYTICAL RESULTS**

**Matrix Spike Samples**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

Sample Description:	07APR92LCB2101		07APR92LCB2111			
	92CA31MR01-02		92CA31MR01-02MS			
	Measured Levels	Spiked Levels*	Spiked Levels**	Theoretical Levels	Measured Levels	% Recy.
Units	pg/g (ppt)	pg	pg/g (ppt)	pg/g (ppt)	pg/g (ppt)	%
<u>Dioxins</u>						
2378-TCDD	1.06	200	44.13	45.19	55.5	123
12378-PeCDD	1.67	1079	238.08	239.75	225	94
123478-HxCDD	2.54	904	199.47	202.01	313	155
123678-HxCDD	13.6	888	195.94	209.54	227	108
123789-HxCDD	6.43	783	172.77	179.20	240	134
1234678-HpCDD	140	1012	223.30	363.30	415	114
OCDD	1,320	1909	421.23	1741.23	2,080	119
<u>Furans</u>						
2378-TCDF	7.12	188	41.48	48.60	72.5	149
12378-PeCDF	2.03	931	205.43	207.46	289	139
23478-PeCDF	2.25	880	194.17	196.42	297	151
123478-HxCDF	6.07	950	209.62	215.69	288	134
123678-HxCDF	2.22	934	206.09	208.31	289	139
234678-HxCDF	3.67	904	199.47	203.14	286	141
123789-HxCDF	2.29	960	211.83	214.12	285	133
1234678-HpCDF	20.1	897	197.93	218.03	266	122
1234789-HpCDF	2.57	948	209.18	211.75	262	124
OCDF	41.3	1842	406.44	447.74	487	109

Notes:

1. Concentrations marked with an asterisk (\*) are the absolute amount of each native analyte spiked into the sample -02MS.
2. Concentrations marked with a double asterisk (\*\*) are the spike levels expressed as pg/g (ppt) for a sample weight of 4.532 grams.

Table 4a

**SUMMARY OF ANALYTICAL RESULTS**

**Matrix Spike Samples**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

Sample Description:	07APR92LCB2101 92CA31MR01-02			07APR92LCB2121 92CA31MR01-02MSd		
	Measured Levels	Spiked Levels*	Spiked Levels**	Theoretical Levels	Measured Levels	% Recy.
Units	pg/g (ppt)	pg	pg/g (ppt)	pg/g (ppt)	pg/g (ppt)	%
<u>Dioxins</u>						
2378-TCDD	1.06	200	44.55	45.61	49.6	109
12378-PeCDD	1.67	1079	240.37	242.04	215	89
123478-HxCDD	2.54	904	201.38	203.92	228	112
123678-HxCDD	13.6	888	197.82	211.42	274	130
123789-HxCDD	6.43	783	174.43	180.86	253	140
1234678-HpCDD	140	1012	225.44	365.44	284	78
OCDD	1,320	1909	425.26	1745.26	915	52
<u>Furans</u>						
2378-TCDF	7.12	188	41.88	49.00	60.9	124
12378-PeCDF	2.03	931	207.40	209.43	274	131
23478-PeCDF	2.25	880	196.03	198.28	286	144
123478-HxCDF	6.07	950	211.63	217.70	274	126
123678-HxCDF	2.22	934	208.06	210.28	281	134
234678-HxCDF	3.67	904	201.38	205.05	257	125
123789-HxCDF	2.29	960	213.86	216.15	278	129
1234678-HpCDF	20.1	897	199.82	219.92	249	113
1234789-HpCDF	2.57	948	211.18	213.75	240	112
OCDF	41.3	1842	410.34	451.64	433	96

Notes:

1. Concentrations marked with an asterisk (\*) are the absolute amount of each native analyte spiked into the sample -02MSd.
2. Concentrations marked with a double asterisk (\*\*) are the spike levels expressed as pg/g (ppt) for a sample weight of 4.489 grams.

Table 4b

**SUMMARY OF ANALYTICAL RESULTS**

**Matrix Spike Samples**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

MS File Number:	07APR92LCB2111	07APR92LCB2121	Relative
Keystone/NEA Number:	92CA31MR01-02MS	92CA31MR01-02MSd	Percent
Sample Description:	Soil	Soil	Difference
Units	pg/g (ppt)	pg/g (ppt)	%
<b>Dioxins</b>			
2378-TCDD	55.5	49.6	-11
12378-PeCDD	225	215	-5
123478-HxCDD	313	228	-31
123678-HxCDD	227	274	19
123789-HxCDD	240	253	5
1234678-HpCDD	415	284	-37
OCDD	2,080	915	-78
<b>Furans</b>			
2378-TCDF	72.5	60.9	-17
12378-PeCDF	289	274	-5
23478-PeCDF	297	286	-4
123478-HxCDF	288	274	-5
123678-HxCDF	289	281	-3
234678-HxCDF	286	257	-11
123789-HxCDF	285	278	-2
1234678-HpCDF	266	249	-7
1234789-HpCDF	262	240	-9
OCDF	487	433	-12

Table 4c

# CHESTER LabNet - Portland

Center for Analytical Mass Spectrometry

## TELEPHONE CONTACT LOG

Person: Jim Button  
Company: Army Corp of Engineers  
Address: Portland  
Date: 1/26/93 Time: 3pm  
Incoming Call: \_\_\_\_\_  
Outgoing Call: ✓  
Telephone No.: 326-6471

Subject: 92CA31MR01

Discussion: Our client was Columbia Analytical.

- 2 sediment samples from W. River
- Sample # 92CA31MR01-02 (K1793-15) reported as:

2378-TCDD 1.06 pg/g  
Total-TCDD 1.06 pg/g

- He asked for clarification
- I reviewed the Chrom and found that there was one peak in the tetradibin window which passed all QC, and had a concentration of 1.06 ppt. (Estimated)

Action Items: • However the 2378-TCDD should have been reported as ND/EDL.

- I manually calculated a sample-specific EDL of 1.91 pg/g for that isomer.

• Sample size = 5g. LMCL = 2.0 pg/g

Circulation: file  
QJHC  
JS.

Signature: J. Chambers

Houston  
Monroeville  
Pittsburgh  
Portland

12242 S.W. Garden Place  
Building One  
Tigard, OR 97223  
503-624-2773  
FAX 503-624-2653

## **CHESTER LabNet**

January 27, 1993

Army Corps of Engineers  
Attn: CENPP-PE-HR, Jim Britton  
P.O. Box 2946  
Portland, Oregon 97208-2946

RE: Sediment Sample # K1793-15  
Laboratory Sample # 92CA31MR01-02

Dear Mr. Britton:

Following up on our phone conversation yesterday, I have made the necessary changes to our data package.

To summarize, the concentration of 2378-TCDD in sample "K1793-15" should have been reported as Not Detected at a sample-specific Estimated Detection Limit of 1.91 ppt (ND/EDL = 1.91). The concentration of Total-TCDD was reported correctly at 1.06 ppt.

If you have further questions, please don't hesitate to call me at 624-2183.

Sincerely,



Laura Chambers  
Senior Scientist

LC/ms  
Enclosures

cc: file  
Hank Chambers  
Jeff Sprenger

**SUMMARY OF ANALYTICAL RESULTS**

**2378-Substituted Isomers**

Date received: March 31, 1992  
 Client name: Columbia Analytical  
 Laboratory Project Number: 92CA31MR01  
 Customer Project Number: Portland Dist. Dredging 92-HM-183 & 181

MS File Number:	07APR92LCB2071	07APR92LCB2091	07APR92LCB2101
Keystone/NEA Number:	92CA31MR01-MB	92CA31MR01-01	92CA31MR01-02
Customer Number:		K1793-10	K1793-15
Sample Description:	Method Blank	Soil	Soil

Units	pg/g (ppt)	pg/g (ppt)	pg/g (ppt)
-------	------------	------------	------------

Dioxins

2378-TCDD	ND/EDL=0.78	EMPC=1.68	1.06
12378-PeCDD	ND/EDL=0.72	EMPC=3.63	EMPC=1.67
123478-HxCDD	ND/EDL=2.30	7.85	2.54
123678-HxCDD	ND/EDL=1.30	18.0	13.6
123789-HxCDD	ND/EDL=1.28	10.5	6.43
1234678-HpCDD	ND/EDL=2.83	358	140
OCDD	EMPC=4.70	2,700	1,320

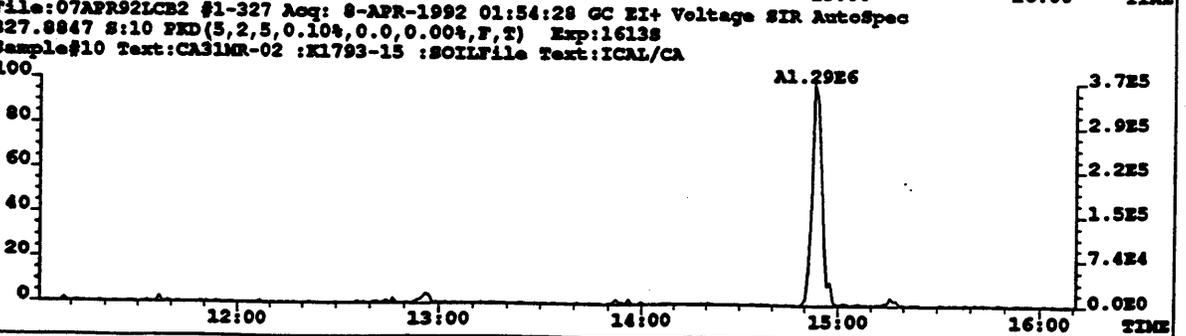
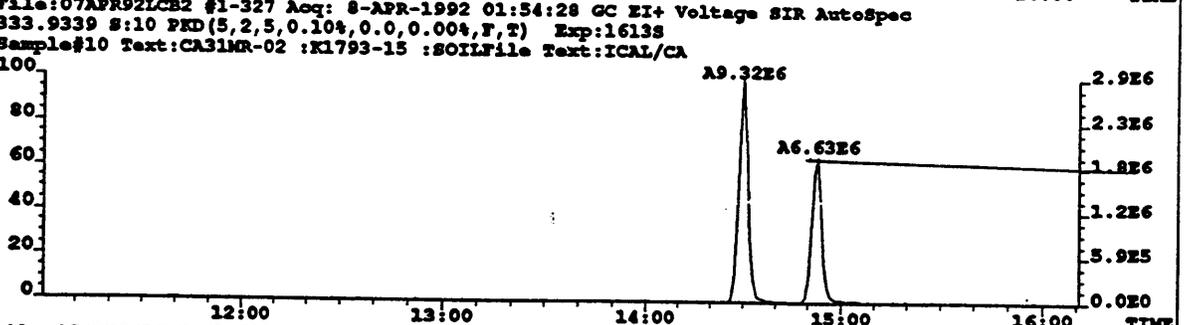
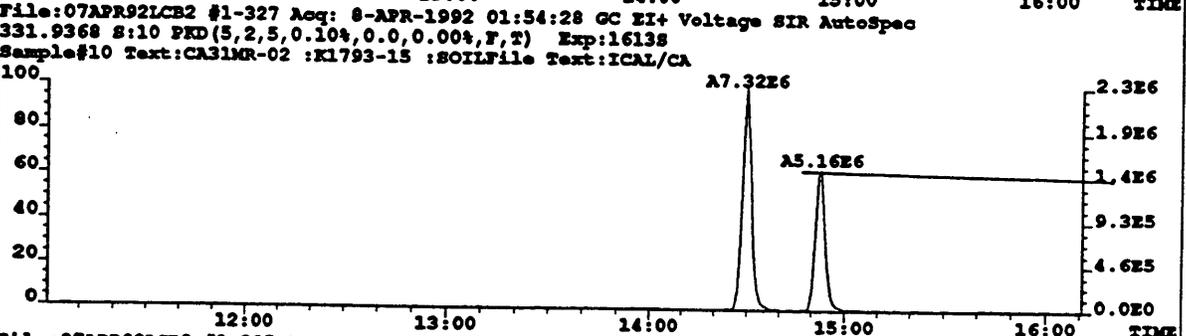
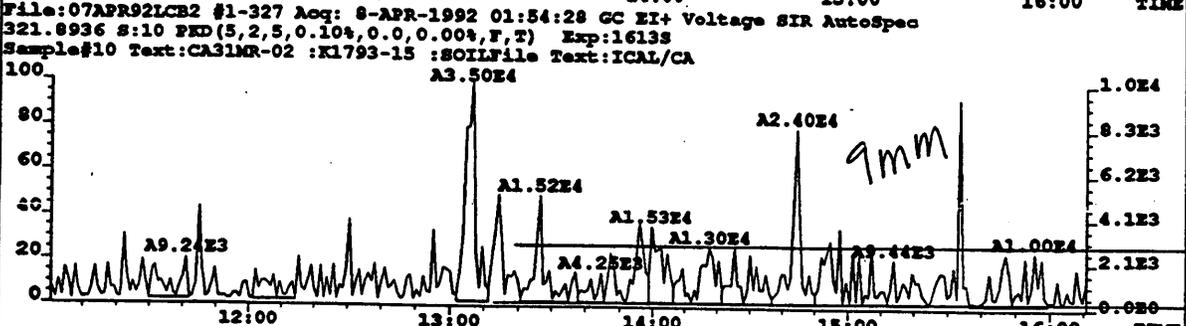
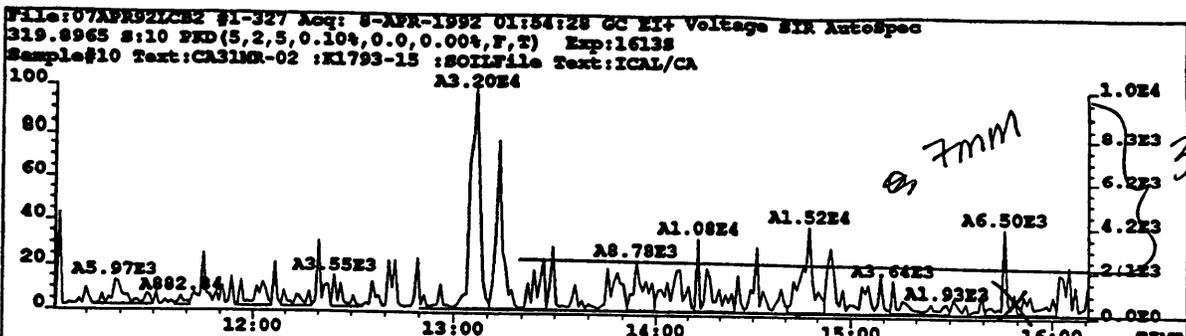
*ND/EDL = 1.91*  
*1/26/93*

Furans

2378-TCDF	ND/EDL=1.08	10.9*	7.12*
12378-PeCDF	ND/EDL=1.84	EMPC=3.36	2.03
23478-PeCDF	ND/EDL=1.65	4.37	2.25
123478-HxCDF	ND/EDL=0.90	7.25	EMPC=6.07
123678-HxCDF	ND/EDL=0.84	2.95	EMPC=2.22
234678-HxCDF	ND/EDL=1.26	6.99	EMPC=3.67
123789-HxCDF	ND/EDL=1.11	EMPC=2.54	EMPC=2.29
1234678-HpCDF	ND/EDL=0.81	49.1	20.1
1234789-HpCDF	ND/EDL=1.00	3.49	2.57
OCDF	ND/EDL=3.17	144	41.3

Notes:

1. ND/EDL = Analyte Not Detected at or above the sample specific Estimated Detection Limit.
2. EMPC = Estimated Maximum Possible Concentration.
3. Concentrations highlighted with an asterisk (\*) are from a DB-225 column.
4. Concentrations below the LMCL or above the UMCL are ESTIMATES ONLY.



Handwritten notes:  $\frac{1}{33} \times 9$ ,  $\frac{1}{33} \times 7$ , and  $= 1.91$  per cent.

$$EDL = 2.5 \left[ \left( \frac{7}{33} \right) (1E4) + \left( \frac{9}{33} \right) (1E4) \right] 2270 \text{ ps}$$

$$(1.4 + 1.8) E_0 (4.424g) (1.02)$$