March 2000

Willamette River

Sediment Sampling Evaluation

Abstract

The Clean Water Act (CWA) of 1977, as amended regulates dredging activities and requires sediment quality evaluation, including testing, prior to dredging. Guidelines to implement 40 CFR Part 230-Section 404(b)(1) regulations of the CWA, the national Inland Testing Manual (ITM) and the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF) have adopted a tiered testing approach for the evaluation of dredge material. Tier IIa (physical testing) and Tier IIb (chemical testing) have been completed for this evaluation, using screening levels (SL) adopted in the DMEF.

Prior to potential maintenance dredging, nine (9) vibra-core sediment samples were collected from the Willamette River, river mile (RM) 2+10 and RM 8+30 to 9+35, April 29, 1999 (see Figure 1 for locations). All samples were sent to Sound Analytical Services, Inc. laboratory of Tacoma, WA, for physical and chemical analyses, to include: metals, total organic carbon (TOC), pesticides/polychlorinated biphenyls (PCBs), herbicides, phenols, phthalates, miscellaneous extractables, polynuclear aromatic hydrocarbons (PAHs), and select samples for tributyltin (TBT) and dioxin/furan.

One or more contaminates were detected above the DMEF screening levels in potential dredge sites (see Figures 1-3). At RM 2+10, offshore from the Oregon Steel Mill dock, DDT was detected within the proposed dredging prism, within the federal navigation channel. A strong petroleum odor was detected in sample WR-VC-01C, approximately 5 feet below the 4’6” dredging prism. Tributyltin (TBT) was detected above the SL in the shoal at RM 9 to 9+35. Both DDT and TBT were detected above the SL at RM 8+40 (Texaco dock).

The sediment represented by the samples collected in the April, exceeded the SL of the DMEF and could not be determined to be suitable for open in-water disposal without further characterization at Tier III (biological testing) level. (The November sampling event is the Tier III follow-up to the April Tier II testing).

On November 29, 1999 seven (7) vibra core sediment samples for Tier III biological analyses, with simultaneous chemical analyses, were collected from the areas where DDT and TBT exceeded the SLs. Figures 1-3 show areas where individual samples were collected and composited. Freshwater bioassays were analyzed for 10-day survival (*Hyalella a.*), 10-day survival and growth (*Chironomus t.)* and 28-day tissue residue (*Limbriculus v.*).

The results of the biological tests did not give a clear indication which sediments are acceptable for in-water disposal, further characterization will be necessary to determine suitable disposal for proposed dredge material.

Introduction

The purpose of this report is to characterize the sediment of portions of the Willamette River navigation channel for the purpose of maintenance dredging based on the sampling event described. The sampling and analysis objectives are listed below. This report will outline the procedures used to accomplish these goals.

SAMPLING AND ANALYSIS OBJECTIVES

- Conduct physical and chemical characterization with follow-up Tier III Biological Assays to characterize and evaluate sediments in accordance with the regional dredge material testing manual, the Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF) for environmental impact during dredging and disposal.

- Collect, handle and analyze representative sediment, of the purposed dredging prism and newly exposed surface, in accordance with protocols and Quality Assurance/Quality Control (QA/QC) requirements.

History/Previous Studies

The Columbia and Lower Willamette (C&LW) Federal project is a deep-draft channel that is authorized to a depth of 40 feet, but the entire channel is not maintained to that depth. The project extends from the mouth of the Willamette to the Broadway Bridge located at approximate (RM 11.7). The project channel is between 600 and 1900 feet wide. Sediment below the SL has historically been placed inwater at the Morgan Bar dispersive site at RM 100 on the Columbia River. Some material has gone to a confined in-water site and about 10,000 cubic yards has been placed upland on Port of Portland property.

Sediment evaluations of shoals in the 40-foot channel were conducted in 1988, 1992 and 1996. The 1988 study was an extensive survey in which 22 samples were collected. Both Tier II chemical and Tier III biological tests were performed on the sediment. Most of the sediment, including that between RM 8.0 and 10.1, was found acceptable for unconfined in-water disposal.

In 1996 TBT was detected in all of the samples testing for total (bulk) TBT. The level of bulk TBT was below the level of concern and the material approved for in-water disposal.

In 1998 during permit dredging (around the water intake) at the Oregon Steel Mill dock (RM 2+10), an oil sheen was detected on the water surface during the dredging activity, the site was contained and all dredging was suspended. The dredging area is approximately 750 feet to the east of where the dredging area being evaluated in this report is located (see figure 2).

The 1997 sediment-sampling event for Columbia River Channel Deepening Feasibility Study collected 1 surface sample at RM 2.05 (WR-BC-09) mid-channel. A gravity core sample (WR-GC-30) was taken at RM 8.5 in the channel near Texaco Dock and an additional sample (WR-GC-31) was collected in the channel at RM 8.9. Low levels of some contaminants of

concern were detected, but none exceeded the DMEF screening levels for open in-water disposal. These were the only samples from the CRCD study near the areas associated with this evaluation.

Current Sampling Event

The Corps of Engineers, Portland District personnel and Marine Sampling Systems (MSS) collected 9-vibra core samples on April 29, 1999 using MSS boat and vibra core system. All cores were divided into three four foot lifts, lettered "A" – "C" by depth (lift "C" varied in length depending on the actual core recovery). The top two section ("A" and "B"), representing the dredge prism were composited at the lab and the lower section "C") was archived for possible future reference. Sample WR-VC-08C was an exception to the above protocol. Sample 08C was analyzed because it contained a petroleum odor.

The samples varied in color from brown to gray and were classified as " silt". The median grain size for all (April) sediment collected was 0.04mm, with 35.2% sand and 63.7% fines. Samples were sent to Sound Analytical Services laboratory in Tacoma, WA, for physical and chemical analyses, to include: metals, organotin (TBT) (samples 02,03,05 only), total organic carbon (TOC), pesticides/PCBs, dioxin/furan (samples 02 & 05 only), herbicides, phenols, phthalates, miscellaneous extractables and polynuclear aromatic hydrocarbons (PAHs).

The material sampled for potential dredging was divided into 3 dredge material management units (DMMUs). (A fourth DMMU was added in the November sampling event). The first two samples (WR-VC-01 & 02) were collected from a shoal on the east edge of the main channel at RM 2+10 to 2+20 (Oregon Steel Mill dock). This sampling area was designated DMMU 1 and represented approximately 50,000 cubic yards of dredge material. The cores penetrated 13 feet yielding 11'7" and 11'2" cores, respectively. DDT in sample 02 (composite of A & B) was detected at 11.3 ug/kg concentration (SL=6.9ug/kg). A strong petroleum odor was detected in WR-VC-01C, approximately 5 feet below the 4'6" dredging prism. As the 01C sample represented sediment below the dredging prism it was not analyzed, but archived.

Samples WR-VC-03 & 04, representing DMMU 2, approximately 80,000 to 100,000 cubic yards, were collected from a shoal on the west edge of the main navigational channel from RM 9 to 9+35. These cores were 10'6" and 11'7" in length. Analytical results for TBT (pore water method) in sample 03 was above the 0.15 ug/L SL, at a 0.315 ug/L concentration.

Samples WR-VC-05 through 09 were collected in front of the Texaco dock (RM 8+30 to 8+50) representing the up to 350,000 cubic yards designated as DMMU 3. The cores were 11'6", 12', 12', 11'10" and 12'1" in length. TBT was detected above the SL in sample 05 at a 0.60ug/kg concentration. Analysis for sample 08C exceeded the SL for DDT with a 7.1-ug/kg concentration.

On November 29, 1999 Tier III, biological samples were collected to further characterize the sediment represented by the samples that exceeded the DMEF screening levels. These samples were collected at the same coordinates as the April samples that contained

contaminate levels in excess of the SL (see Figures 1-3). Five (5) samples were submitted for bioassay and chemical analyses. Three (3) additional samples were collected from a shoal at RM 11 (see Figure 4) (DMMU 4). These samples were submitted for Tier II physical and chemical analyses only.

Sampling and analyses were performed using proper quality control measures, including proper procedures for chain of custody, preservation and cooler receipt. All laboratory QC is acceptable. All reported values in excess of the SL were checked for proper laboratory method calculation and in the case of DDT underwent a second column confirmation.

Results/Discussion, Tier IIb, April 29, 1999

Physical and Volatile Solids: Data for these analyses are presented in Table 1. All 9 samples submitted for analysis exceeded 20% fines with eight exceeding 5% volatile solids. All samples submitted were classified as "silt" (ML). Median grain size for all samples is 0.04 mm, with 35.2% sand and 63.7% fines. All samples were brown to gray in color with petroleum odor and sheen in samples WR-VC-01C & 08C (see PAHs below for more discussion).

Metals, Total Organic Carbon (TOC): Data for these analyses are presented in Table 2. Low levels of some metals were found in most of the samples collected, but levels do not approach the SL. The highest level detected was for mercury, which is 73% of the SL. As, Cu, Ni, and Zn were detected in all samples, but at levels less than 41% of the SL.

Organotin (TBT): Data for these analyses are presented in Table 2. Tributyltin (TBT) and its breakdown products (dibutyltin & monobutyltin) were detected, by pore water extraction method, above SL (0.15 ug/L) in samples WR-VC-03 (0.315ug/L) & WR-VC-05 (0.60 ug/L). Three samples were analyzed for TBT, one from each DMMU, RM 2+10 (WR-VC-02), RM 9 to 9+35 (WR-VC-03) and RM 8+40 (WR-VC-05).

Pesticide/PCBs, Phenols, Phthalates, Herbicides, and Misc. Extractables: Data for these analyses are presented in Table 3. No herbicides or PCBs were found at the method detection limits. Three phenols were detected at levels < 45% of the SL. Four phthalates were detected at levels <5% of SL. Benzoic Acid, benzylalcohol and dibenzofuran were found at levels < 16% of SL. Total DDT and it's breakdown products, DDD and DDE were detected above the 6.9 ug/kg SL, in sample WR-VC-02 (RM2+10 Oregon Steel Mill dock) at 11.3 ug/kg and WR-VC-08C (RM 8+40 Texaco dock) at 7.1 ug/kg.

Polynuclear Aromatic Hydrocarbons (PAHs): Data for these analyses are presented in Tables 4 & 5. Low levels of some individual "low molecular weight" PAHs were found in all samples at levels <10.4% of SL. Low levels of most of the "high molecular weight" PAHs were found in all samples at levels <8.8% of the SL. Sample WR-VC-08C had a petroleum odor, but did not show PAHs above the SL when analyzed. Sample WR-VC-01C had a strong petroleum odor from 10'10" to 11'7". This depth was well below the dredging prism of 4'6" and was not analyzed, but was submitted as a sample to be archived for potential future reference.

Dioxin/Furan: Data for these analyses are presented in Table 6. This method (SW-846 8290) provides procedures for the detection and quantitative measurement of polychlorinated dibenzo-p-dioxins (tetra- through octachlorinated homologues; PCDDs), and polychlorinated dibenzofurans) (tetra- through octachlorinated homologues; PCDFs) in a variety of environmental matrices and at part-per-trillion (PPTr) concentrations. The PCDDs include 75 individual compounds, and the PCDFs include 135 individual compounds. These individual compounds are technically referred to as congeners. Only 7 of the 75 congeners of PCDDs are thought to have "dioxin-like" toxicity; these are ones with chlorine substitutions in, at least, the 2,3,7,8 positions. Only 10 of the 135 possible congeners of PCDFs are thought to have "dioxin-like" toxicity: these also are ones with substitutions in the 2,3,7,8 positions. For risk assessment purposes, a toxicity equivalency procedure was developed to describe the cumulative toxicity of these mixtures. This procedure involves assigning individual toxicity equivalency factors (TEFs) to the PCDD and PCDF congeners. These TEF values have been adopted by international convention (U.S. EPA, 1989: Ahlborg, et al., 1994). TEFs are estimates of the toxicity of dioxin-like compounds relative to the toxicity of 2,3,7,8-TCDD, which is assigned a TEF of 1.0. All other congeners have lower TEF values ranging from 0.5 to 0.001 for dioxin/furans. Calculating the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. For undetected congeners, detection limits will be divided by two and used in calculations. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

Samples WR-VC-02 and WR-VC-05 were the only samples analyzed for dioxin/furans. The TEQs for sample WR-VC-02; all dioxin/furan congeners = 7.083 pptr, for sample WR-VC-05; all dioxin/furan congeners = 8.495 pptr. These TEQ values are below the guidance of < 5 pptr allowed for the individual congeners and the total of <15 pptr TEQ allowed for the mixture concentration (See PSDDA and Ahlborg, et al references).

Results/Discussion, Tier III, November 29, 1999

Physical and Volatile Solids: Data for these analyses are presented in Table 7. Eight (8) of 10 samples submitted for physical analyses exceeded 20% fine-grained material (passing 230 sieve) with 7 containing > 5% volatile solids. Four (4) of 10 samples submitted were classified as "sandy silt", 2 as "silty sand", 2 as "silt with sand", 1 "silt" and 1 "poorly graded sand". Median grain size for all samples is 0.17 mm, with 49.2% sand and 49.4% fines. All samples were brown to gray in color.

Metals, Total Organic Carbon (TOC): Data for these analyses are presented in Table 8. Some metals were found in all of the samples collected, but levels do not exceed the SL. The highest level detected was for mercury, which is 85.4% of the SL. Zn was the next highest level at 56.1% of the SL. All other metals were detected at levels less than 22.1% of the SL.

Organotin (TBT): Data for these analyses are presented in Table 8. Tributyltin (TBT) and its breakdown products (dibutyltin & monobutyltin) were not detected, by pore water extraction method, above method detection limits (MDL) in any samples. Seven (7) of 10 samples submitted were analyzed for TBT, each DMMU was represented by 1 to 2 samples.

One (1) analysis from the reference site on the Columbia River, 1 at RM 2+10 (WR-VC-02), one (1) from the shoal at RM 9 to 9+35 (WR-VC-05), two (2) in front of the Texaco dock at RM 8+40 (WR-VC-03 & 04) and 2 from the RM 11 DMMU.

Pesticide/PCBs, Phenols, Phthalates, and Misc. Extractables (Sediment): Data for these analyses are presented in Table 9. No PCBs were detected at the method detection limits (MDL). Two (2) phenols were detected at levels <54% of the SL. Four (4) phthalates were detected at levels <2.5% of the SL. Benzoic Acid and dibenzofuran were found at levels < 8% of the SL. Total DDT or it's breakdown products, DDD and DDE, were detected in all samples. Only 1 sampling station at RM 11 indicated levels above the 6.9 ug/kg SL for DDT. Sample WR-VC-07ABC (representing the dredging prism) at 8.8 ug/kg & WR-VC-07D (representing the "newly exposed surface "after dredging) at 15.4 ug/kg. Endrinaldehyde (5.6 ug/kg) and 1,4-Dichlorbenzen (5.8 ug/kg), which have no established SL, were detected at the WR-VC-07 sampling station.

Polynuclear Aromatic Hydrocarbons (PAHs): Data for these analyses are presented in Tables 11 & 12. Low levels of some individual "low molecular weight" PAHs were found in all samples at levels <8.8% of SL. Low levels of most of the "high molecular weight" PAHs were found in all samples at levels <8.2% of the SL.

Bioassay/Bioaccumulation: Data for the November 29, 1999 samples analyses are presented in attached Appendix A (MEC laboratory reports and evaluations).

Survival for *Hyalella* in the control sample was 93.8% and in the reference sediment 92.5%.

Tissue DDT Analyses (Bioaccumulation): Data for these analyses are presented in Table10. Bioaccumulation, 28-day Tissue Residue Test (*Limbriculus variegatus*), were originally conducted due to the TBT present above SL (0.15 ug/L) in samples WR-VC-03 (0.315 ug/L) & WR-VC-05 (0.60 ug/L). However, after the chemical analyses were completed on the sediment collected on November 29, no TBT was detected at the method detection limit (MDL). The amount of tissue sample retrieved after the 28-day test was not sufficient to run more than one analysis for each replicate. The decision to run DDT on the Tissue was made rather than TBT as originally planned (ND in sediment). In the future, tissue composites will be made to increase sample volume to allow for more than 1 analysis at lower detection limits, if necessary.

Conclusion

Collection and evaluation of the sediment data was completed using guidelines from the Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF). The DMEF is a regional manual developed jointly with regional EPA, Corps, Oregon Dept. of Environmental Quality and Washington Depts. of Ecology and Natural Resources. This document is a guideline for implementing the Clean Water Act, 40 CFR 230 sec 404 (b)(1). The screening levels used are those adopted for use in the DMEF, final November 1998. The DMEF Tiered testing approach requires that material in excess of 20% fines and greater than 5% volatile solids, as well as any material with prior history or is suspected ("reason to believe") of being contaminated, be subjected to chemical as well as physical analyses. Under the Tiered approach, if the Tier IIb chemical analytical results do

not exceed the established screening levels (SL), the material is considered suitable for unconfined in-water disposal. When Tier IIb SLs are exceeded, the material must be further characterized at the Tier III level to determine if unconfined in-water disposal is possible.

The proposed dredging prism being evaluated in the 2 sampling events (April 29, 1999 and November 29, 1999) has been divided into 4 DMMU as described on page 3.

Analyses of the April 29, 1999 sampling of the shoal at RM 2+20 (DMMU 1), the Oregon Steel Mill dock, indicated DDT in the WR-VC-02 (11.3 ug/kg) sample to be above the SL (6.9 ug/kg). Possible PAH contamination was observed in the WR-VC-01(C) sample, at DMMU 1, which was not analyzed as it was at level 9' 6", five feet below the dredging prism.

DDT exceeded the SL in one other sample (WR-VC-08C) (7.1 ug/kg) collected in front of the Texaco dock at RM 8+40 (DMMU 3).

Only three samples were analyzed for TBT, one from each DMMU, RM 2+10 (WR-VC-02), RM 9 to 9+35 (WR-VC-03) and RM 8+40 (WR-VC-05). Two of the 3 samples (WR-VC-05 at 0.315 ug/L and WR-VC-05 at 0.60 ug/L) analyzed for TBT exceeded the 0.15 ug/L screening level.

The DMMU 4 at RM 11 was evaluated in the November event at a Tier IIb level only. DDT or its breakdown products exceeded the 6.9 ug/kg SL in sample WR-VC-07ABC, representing the dredging prism with 8.8 ug/kg of Total DDT. Analyses for sample WR-VC-07D, representing the "newly exposed surface" after dredging, indicated a 15.4-ug/kg Total DDT level present in the sample. DMMU 4 will require further characterization at the Tier III level to determine potential disposal methods.

DMMUs 1 through 3 have been evaluated at the Tier II and Tier III levels, but results are inconclusive for determination of suitability for unconfined, inwater disposal. Chemical tests conducted in conjunction with the November biological Tier III (due to exceedances of DMEF screening levels for DDT and TBT in the April sampling event) did not exceed any screening levels of the DMEF. Therefore, Tier III biological evaluation (conducted simultaneously with the chemical analyses) were actually conducted on "clean" material. This raises sufficient ambiguity such that a third analyses (sampling event) will be necessary to either confirm contamination found in the first sampling event or verify contamination is no longer present in the dredging prism.

References

1. U.S. army Corps of Engineers, Portland District, Seattle District; U.S. Environmental Protection Agency, Region 10; Oregon Department of Environmental Quality; Washington State Department of Natural Resources and Department of Ecology. 1998 Final. Dredge Material Evaluation Framework for the Lower Columbia River Management Area.

2. U. S. Environmental Protection Agency and U. S. Army Corps of Engineers. February 1998. Evaluation of Dredged Material Proposed for Discharge in Inland and Near Coastal Waters – Testing Manual, dated (referred to as the "Inland Testing Manual").

3. The Clean Water Act, 40 CFR 230 (b) (1).

4. U.S. Army Corps of Engineers, Portland District. 1988. Results of 1988 Lower Willamette River Sediment Quality Testing—USACE Portland Districting O&M Dredging.

5. U.S. Army Corps of Engineers, Portland District. 1992. Lower Willamette River Sediment Evaluation – Portland Harbor.

6. U.S. Army Corps of Engineers, Portland District. 1992. Columbia and Lower Willamette River Project, Lower Willamette River, Portland Harbor Sediment Evaluation, November 1996.

7. U.S. Army Corps of Engineers, Seattle District; U.S. Environmental Protection Agency, Region 10; Washington State Department of Natural Resources and Washington State Department of Ecology. Dredge Material Evaluation and Disposal Procedures (A Users Manual for the Puget Sound Dredge Disposal Analysis (PSDDA) Program, February 2000.

8. U.S. Environmental Protection Agency. 1989. Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-p-dioxins and –dibenzofurans (CDDs and CFDs and 1989 update. U.S. Environmental Protection Agency, Risk Assessment Form, Washington, DC; EPA/625/3-89/016.

Table 1, Willamette River, Tier IIa **Sampled April 29, 1999**

Physical Analysis

	Grain Size (mm)				%					
Sample I.D.	**Median**		**Mean**		**Gravel**	**Sand**	**Silt/Clay**	**Volatile solids**		
WR-VC-01	0.03		0.16		1.1	24.9	74.0		7.96	
WR-VC-02	0.03		0.21		1.0	31.4	67.5		7.79	
WR-VC-03	0.04		0.10		0.2	29.5	70.3		7.53	
WR-VC-04	0.05		0.20		2.0	41.7	56.4		6.69	
WR-VC-05	0.04		0.27		2.9	42.1	55.1		7.86	
WR-VC-06	0.06		0.19		1.3	43.7	55.1		7.66	
WR-VC-07	0.05		0.11		0.8	32.5	66.7		6.58	
WR-VC-08	0.05		0.22		2.0	31.9	66.1		4.79	
WR-VC-09	0.04		0.09		0.4	31.6	67.9		7.12	
WR-VC-09-Lab Dup.	0.05		0.09		0.0	42.2	57.8		6.89	
Mean	0.04		0.16		1.2	35.2	63.7		7.09	
Minimum	0.03		0.09		0.0	24.9	55.1		4.79	
Maximum	0.06		0.27		2.9	43.7	74.0		7.96	

Table 2, Willamette River, Tier IIb **Sampled April 29, 1999**

Inorganic Metals, TOC and TBT

Sample I.D.	As	Sb	Cd	Cu	Pb	Hg	Ni	Ag	Zn	TOC	TBT
	mg/kg (ppm)										ug/L
WR-VC-01	3.8	<85	<0.18	40	<14	<0.14	24	<0.053	170	24000	-
WR-VC-02	3.3	<91	<0.19	34	<18	<0.16	17	<0.058	87	19000	<0.017
WR-VC-03	4.1	<100	<0.21	39	<17	<0.13	21	<0.065	93	22000	**0.315**
WR-VC-04	3.1	<76	<0.16	30	<13	0.14	17	<0.048	88	19000	-
WR-VC-05	3.6	<72	<0.15	37	<12	0.11	20	0.068	93	12000	**0.60**
WR-A (DUP-05)	2.4	<87	<0.18	37	<14	0.19	24	<0.055	83	20000	-
WR-VC-06	3.7	<77	<0.16	34	<13	<0.11	23	<0.048	96	15000	-
WR-VC-07	3.3	<74	<0.15	33	<12	0.3	21	<0.047	93	24000	-
WR-VC-08	3.8	<80	<0.17	40	<13	<0.15	21	0.1	110	23000	-
WR-VC-08C	3.1	<69	<0.14	33	<12	0.12	21	<0.044	170	17000	-
WR-VC-09	3.8	<80	<0.17	41	<13	0.22	20	0.24	110	20000	-
Screening level (SL)	57	150	5.1	390	450	0.41	140	6.1	410		0.15
Mean	3.5	ND	ND	36.2	ND	0.098	20.8	0.04	108.5		**0.31**
Maximum	4.1	ND	ND	41	ND	0.3	24	0.24	170		**0.60**

Symbol (-) = Indicates analysis not run.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Pesticides/PCBs, Phenols, Phthalates, Herbicides and Extractables

Sample I.D.	Pesticides				Phenols			Phthalates				Extractables		
	ug/kg (ppb)													
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT	Pentachlorophenol	3-&4-Methylphenol	Phenol	bis(2-Ethylhexzylphthalate	Butylbenzylphthalate	Di-n-butylphthalate	Di-n-octylphthalate	Benzoic Acid	Benzyl Alcohol	Dibenzofuran
WR-VC-01	<0.27+	<0.57+	<2.1=	ND	21	28	<3.7	31	<1.8	<3.8	<2.4	<8.1	<6	9.7
WR-VC-02	**5.4+**	**5.9+**	<2.1=	**11.3**	19	24	<3.7	34	<1.8	<3.8	<2.4	<8.1	7.3	<3.7
WR-VC-03	<0.27+	<0.57+	<2.1=	ND	67	20	<3.7	50	<1.8	<3.8	13	<8.1	8.8	<3.7
WR-VC-04	<0.27+	<0.57+	<2.1=	ND	3.2	52	4.9	40	54	<3.8	<2.4	<8.1	<6	<3.7
WR-VC-05	<0.27+	<0.57+	<2.1=	ND	9.4	48	<3.7	47	<1.8	5	<2.4	<8.1	<6	<3.7
WR-A (DUP-05)	<0.27+	<0.57+	<2.1=	ND	13	4.8	<3.7	11	3.8	4.4	<2.4	<8.1	<6	<3.7
WR-VC-06	<0.27+	<0.57+	<2.1=	ND	16	15	<3.7	40	<1.8	4.6	<2.4	9.7	5.7	<3.7
WR-VC-07	<0.27+	<0.57+	<2.1=	ND	16	29	<3.7	39	3.8	5	<2.4	<8.1	7.3	<3.7
WR-VC-08	<0.27+	<0.57+	<2.1=	ND	15	33	5.1	33	19	6	<2.4	8.7	<6	<3.7
WR-VC-08C	**3.1+**	**4+**	<2.1=	**7.1**	22	16	<3.7	33	<1.8	7.6	<2.4	<8.1	<6	<3.7
WR-VC-09	<0.27+	5.9+	<1.8=	5.9	47	300	8.4	60	7.8	5.3	<2.4	<8.1	9	<3.7
Screen level (SL)	DDD + DDE + DDT =			6.9	400	670	420	8300	1200	5100	6200	650	57	540
Mean	0.77	1.44	ND	2.21	22.6	51.8	1.7	38	8.1	3.4	1.2	1.7	3.5	0.9
Maximum	5.4	5.9	ND	11.3	67	300	8.4	60	54	7.6	13	9.7	9	9.7

Values detected for DDT were confirmed with second column.

PCBs = Non-detect (ND) <18.0 ppb (SL = 130 ppb).

Chlorinated Herbicides (Method 8151) = Non-detect (ND) <19.0 ppb, (SL has not been set).

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Polynuclear Aromatic Hydrocarbons (PAHs)

Low Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Acenapththene	Acenaphthylene	Anthracene	Fluorene	2-Methyl napthalene	Naphthalene	Phenanthrene	Total Low PAHs
WR-VC-01	52	23	40	27	23	30	150	345
WR-VC-02	12	6.3	11	6.9	<2.9	4.1	45	85.3
WR-VC-03	<2.2	9.5	<3	<2.9	<2.9	<2.3	3.7	13.2
WR-VC-04	<2.2	3.6	4.3	<2.9	<2.9	15	17	39.9
WR-VC-05	<2.2	<2.2	3	<2.9	<2.9	5	13	21
WR-A (DUP-05)	<2.2	<2.2	<2.1	<2.9	<2.9	<2.3	<2.4	ND
WR-VC-06	<2.2	4.3	3.4	<2.9	<2.9	<2.3	12	19.7
WR-VC-07	<2.2	<2.2	<2.1	<2.9	<2.9	<2.3	7.3	7.3
WR-VC-08	<2.2	<2.2	3.6	<2.9	<2.9	6.3	9.6	19.5
WR-VC-08C	<2.2	6.7	3.5	<2.9	<2.9	3.7	10	23.9
WR-VC-09	3.1	5.9	7.8	3.9	<2.9	11	24	5.1
Screen level (SL)	500	560	960	540	670	2100	1500	5200
Mean	6.1	5.4	7.0	3.4	2.1	6.8	26.5	
Maximum	52	23	40	27	23	30	150	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Polynuclear Aromatic Hydrocarbons (PAHs)

High Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Benzo(a) anth racene	Benzo(b) fluro anthene	Benzo(k) fluro anthene	Benzo(g,h,i) perylene	Chrysene	Pyrene	Benzo(a) pyrene	Dibenz(a,h) anthracene	Indeno (1,2,3-cd) pyrene	Fluoran thene	Total High PAHs
WR-VC-01	56	76	23	50	65	160	96	<2.9	23	150	699.0
WR-VC-02	17	27	7.3	17	17	47	20	<3.2	17	40	209.3
WR-VC-03	3.7	8.1	<2.6	<2.1	<3.3	8.1	<2.1	<1.9	<2.4	6.7	26.6
WR-VC-04	9.7	<2.5	<2.2	13	11	24	<1.8	<1.6	6.9	21	85.6
WR-VC-05	4.7	13	<2.1	<1.7	8.5	18	4.7	<1.6	5.5	17	71.4
WR-A (DUP-05)	<2.9	<2.7	<2.5	<2.0	<3.1	5.1	<2.0	<1.8	<2.3	3.8	8.9
WR-VC-06	9.4	13	4.8	<1.8	13	23	<1.8	<1.6	<2.1	26	98.1
WR-VC-07	5.3	7.9	<2.3	<1.8	8.2	14	8.5	<1.7	<2.1	12	55.9
WR-VC-08	11	9	3.3	6.3	6.9	17	13	<1.7	7.2	19	92.7
WR-VC-08C	9	5.3	7.6	7.2	12	18	5.1	<1.3	<1.7	17	81.2
WR-VC-09	19	25	8.4	13	21	41	17	<1.6	14	37	195.4
Screen level (SL)	1300	3200		670	1400	2600	1600	230	600	1700	12000
Mean	13.2	21.7		9.7	14.8	34.1	14.9	ND	6.7	31.8	
Maximum	56	99		50	65	160	96	ND	23	150	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 6, Willamette River, Tier IIb **Sampled April 29, 1999**

Dioxins/Furans (ng/kg, pptr)

Sample I.D.	Dioxin/Furan	Result	½ MDL	TEF	TEQ	Guidance*
WR-VC-02 - Dioxin	2,3,7,8 - TCDD	<0.68	0.34	1.0	0.34	A bulk sediment 2,3,7,8-tetrachlorodibenzo-p-dioxin concentration of 5 ng/kg, or a total toxic equivalent concentration of 15 ng/kg, will trigger the requirement to perform bioaccumulation testing.
	Total TCDD	<1.3	0.65	0	0	
	1,2,3,7,8 – PeCDD	<0.89	0.45	0.5	0.23	
	Total PeCDD	<3.2	1.6	0	0	
	1,2,3,4,7,8 – HxCDD	<1.7	0.85	0.1	0.085	
	1,2,3,6,7,8 – HxCDD	11B		0.1	1.1	
		5.2J		0.1	0.52	
	Total (other)HxCDD	58		0	0	
	1,2,3,4,6,7,8-HpCDD	190B		0.01	1.9	
	Total (other) HpCDD	360		0	0	
	OCDD	1800B		0.001	1.8	
WR-VC-02 - Furan	2,3,7,8-TCDF	3.0CON,B		0.1	0.3	
	Total TCDF	16		0	0	
	1,2,3,7,8 – PeCDF	<1.9	0.95	0.05	0.048	
	1,3,4,7,8 – PeCDF	<1.3	0.65	0.05	0.033	
	Total (other) PeCDF	17		0	0	
	1,2,3,4,7,8 – HxCDF	<4.4	2.2	0.1	0.22	
	1,2,3,6,7,8 – HxCDF	<2.1	1.05	0.1	0.105	
	2,3,4,6,7,8 – HxCDF	<1.1	0.55	0.1	0.055	
	2,3,6,7,8,9 – HxCDF	<0.19	0.095	0.1	0.0095	
	Total (other) HxCDF	41		0	0	
	1,2,3,4,6,7,8 – HpCDF	25B		0.01	0.25	
	1,2,3,4,7,8,9 – HpCDF	<2.8	1.4	0.01	0.014	
	Total (other) HpCDF	94		0	0	
	OCDF	73		0.001	0.073	
Total Dioxins/Furans TEQ					**7.083**	**<15 ng/kg**

J = Estimated result. Result is < reporting limit.
CON = Confirmation analysis.
B = Method blank contamination. The associated method blank contains the target analyte at a reportable level.
MDL = Method Detection Limit
TEQ = Toxicity Equivalency Quotient
TEF = Toxicity Equivalency Factors
*Guidance = Puget Sound Dredged Disposal Analysis (PSDDA) Program (Feb 2000) and U.S. EPA Toxicity Equivalency Factors (U.S. EPA, 1989; Ahlborg, et al., 1994)

Table 6, Willamette River, Tier IIb **Sampled April 29, 1999**

Dioxins/Furans (ng/kg, pptr)

Sample I.D.	Dioxin/Furan	Result	½ MDL	TEF	TEQ	Guidance*
WR-VC-05 - Dioxin	2,3,7,8 - TCDD	<0.76	0.38	1.0	0.38	A bulk sediment 2,3,7,8-tetrachlorodibenzo-p-dioxin concentration of 5 ng/kg, or a total toxic equivalent concentration of 15 ng/kg, will trigger the requirement to perform bioaccumulation testing.
	Total TCDD	1.6		0	0	
	1,2,3,7,8 – PeCDD	<1.4	0.7	0.5	0.35	
	Total PeCDD	<4.9	2.45	0	0	
	1,2,3,4,7,8 – HxCDD	<2.0	1.0	0.1	0.1	
	1,2,3,6,7,8 – HxCDD	15B		0.1	1.5	
	1,2,3,7,8,9 – HxCDD	7.5J		0.1	0.75	
	Total (other)HxCDD	90		0	0	
	1,2,3,4,6,7,8-HpCDD	220B		0.01	2.2	
	Total (other) HpCDD	420		0	0	
	OCDD	2000B		0.001	2.0	
WR-VC-05 - Furan	2,3,7,8-TCDF	3.2CON,B		0.1	0.32	
	Total TCDF	25		0	0	
	1,2,3,7,8 – PeCDF	<1.2	0.6	0.05	0.03	
	1,3,4,7,8 – PeCDF	<1.8	0.9	0.05	0.045	
	Total (other) PeCDF	23		0	0	
	1,2,3,4,7,8 – HxCDF	<3.5	1.75	0.1	0.175	
	1,2,3,6,7,8 – HxCDF	<2.4	1.2	0.1	0.12	
	2,3,4,6,7,8 – HxCDF	<1.5	0.75	0.1	0.075	
	2,3,6,7,8,9 – HxCDF	<0.17	0.085	0.1	0.009	
	Total (other) HxCDF	49		0	0	
	1,2,3,4,6,7,8 – HpCDF	33B		0.01	0.33	
	1,2,3,4,7,8,9 – HpCDF	<3.4	1.7	0.01	0.017	
	Total (other) HpCDF	54		0	0	
	OCDF	94B		0.001	0.094	
Total Dioxins/Furans TEQ					**8.495**	**<15 ng/kg**

J = Estimated result. Result is < reporting limit.
CON = Confirmation analysis.
B = Method blank contamination. The associated method blank contains the target analyte at a reportable level.

MDL = Method Detection Limit
TEQ = Toxicity Equivalency Quotient
TEF = Toxicity Equivalency Factors
*Guidance = Puget Sound Dredged Disposal Analysis (PSDDA) Program (Feb 2000) and U.S. EPA Toxicity Equivalency Factors (U.S. EPA, 1989; Ahlborg, et al., 1994)

Physical Analysis

	Grain Size (mm)				%					
Sample I.D.	**Median**		**Mean**		**Gravel**	**Sand**	**Silt/Clay**	**Volatile solids**		
CB-VC-01R	0.14		0.33		0.00	82.07	17.93		2.03	
WR-VC-02	0.02		0.06		0.00	19.57	80.43		8.24	
WR-VC-03	0.03		0.04		0.00	19.40	80.60		7.89	
WR-VC-04	0.02		0.04		0.00	14.17	85.83		8.22	
WR-VC-05	0.03		0.06		0.00	35.95	64.05		6.96	
WR-VC-05 Lab Dup.	0.03		0.06		0.00	36.23	63.77		7.11	
WR-VC-06ABC	0.06		0.05		0.00	48.68	51.32		7.41	
WR-VC-06D	0.04		0.06		0.00	30.62	69.38		8.99	
WR-VC-07ABC	0.06		0.98		0.00	47.72	52.28		5.92	
WR-VC-07D	0.25		0.21		0.17	59.65	40.18		4.72	
WR-VC-08	0.90		1.41		11.89	89.05	0.94		1.22	
WR-VC-08 Lab Dup.	0.35		0.80		6.03	93.99	0.01		1.25	
Mean	0.17		0.36		1.64	49.17	49.36		5.72	
Minimum	0.02		0.04		0.00	14.17	0.01		1.22	
Maximum	0.35		1.41		11.89	93.99	85.83		8.99	

Metals, TOC and TBT

Sample I.D.	As	Sb	Cd	Cu	Pb	Hg	Ni	Ag	Zn	TOC	TBT
	mg/kg (ppm)										ug/L
WR-VC-01R	6.8	0.7	0.48	16	21	0.045	13	0.12	89	3700	<0.08
WR-VC-02	4.9	1.6	0.41	39	19	0.16	21	0.36	130	20000	<0.04
WR-VC-03	4.8	1.1	0.23	40	22	0.079	24	0.52	120	16000	<0.04
WR-VC-04	4.7	1.1	0.29	44	26	0.08	21	0.57	120	21000	<0.04
WR-VC-05	3.8	0.79	0.17	33	15	0.12	21	0.37	91	19000	<0.04
WR-VC-06ABC	4.2	<0.8	0.21	31	18	0.26	31	0.41	100	18000	<0.04
WR-VC-06D	5	1.1	0.36	42	42	0.35	28	1.1	110	24000	-
WR-VC-07ABC	3.6	<0.8	0.22	31	36	0.15	21	0.51	110	14000	<0.04
WR-VC-07D	3.1	<0.8	0.31	33	26	0.13	19	0.59	230	17000	-
Screening level (SL)	57	150	5.1	390	450	0.41	140	6.1	410		0.15
Mean	4.5	0.7	0.3	34.3	25.0	0.15	20.8	0.51	122		ND
Maximum	6.8	1.6	0.48	44	42	0.35	31	1.1	230		ND

TBT analysis is a pore water extraction.

Symbol (-) = Indicates analysis not run.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Pesticides/PCBs, Phenols, Phthalates, Herbicides and Extractables

Sample I.D.	Pesticides						Phenol		Phthalate				Extractables		
	ug/kg (ppb)														
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT	Di el drin	Endri naldeh yde	Phen ol	3 & 4 Methylph enol	Dimeth ylphtha late	Di-n-butylpht halate	Butylben zylphthal ate	Bis (2 Ethyl)hex ylphthala te	1,4-Dichloro benzene	Benzoic Acid	Dibenzofu ran
WR-VC-01R	<0.21	<0.43	<1.5	ND	<0.12	<1.5	<3.9	13	<2.1	5.3	<1.7	9.2	<4.6	<8.3	<3.4
WR-VC-02	2.9	2.5	<2.1	5.4	<0.12	<1.5	<3.9	28	<2.1	4.6	<1.7	27	<4.6	11	12
WR-VC-03	2.2	3.5	<2.2	5.7	<0.12	<1.5	<3.9	180	<2.1	8.9	4.2	23	<4.6	<8.3	<3.4
WR-VC-04	1.2	1.8	<2.2	3.0	<0.12	<1.5	<3.9	110	3.1	7.3	3.4	32	<4.6	<8.3	<3.4
WR-VC-05	2.1	3.3	<2.0	5.4	<0.12	<1.5	<3.9	190	<2.1	5.4	3.0	22	<4.6	<8.3	<3.4
WR-VC-06ABC	<0.28	2.9	<2.0	2.9	<0.12	<1.5	20	130	<2.1	<3.8	<1.7	200	<4.6	<8.3	3.6
WR-VC-06D	<2.9	5.3	<2.9	5.3	<0.12	<1.5	<3.9	160	<2.1	<3.8	<1.7	68	<4.6	52	<3.4
WR-VC-07ABC	<2.9	5.4	3.4	**8.8**	3.4	<1.5	<3.9	360	<2.1	<3.8	<1.7	210	5.8	11	16
WR-VC-07D	<2.6	5.4	**10**	**15.4**	3.8	5.6	<3.9	44	<2.1	<3.8	<1.7	98	<4.6	<8.3	<3.4
Screen level(SL)	DDD + DDE + DDD = 6.9				10	*	420	670	1400	5100	970	8300	*	650	540
Mean	0.93	3.3	1.5	5.8	0.8	0.6	2.2	135	0.3	3.5	1.2	76.6	0.6	8.2	3.5
Maximum	2.9	5.4	10	15.4	3.8	5.6	20	360	3.1	8.9	4.2	210	5.8	52	16

Values detected for DDT were confirmed with second column.

Other pesticides, which do not have an established SL, were detected at levels < 1.0 ppb

PCBs = Non-detect (ND) <18.0 ppb (SL = 130 ppb).

* Screening level has not been established in the DMEF.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 10, Willamette River, Tier III, Tissue Analyses **Sampled November 29, 1999**

DDT Tissue (Bioaccumulation)

Sample I.D.	ug/kg (ppb)			
	4,4'-DDD	**4,4'-DDE**	**4,4'-DDT**	**Total DDT**
Control				
Rep - 1	<2.1	9.9	<5.2	9.9
Rep - 2	<2.1	11.0	<5.1	11.0
Rep - 3	<1.9	11.0	<4.7	11.0
Rep - 4	<2.0	10	<5.0	10.0
Rep - 5	<2.3	30.0	15.0	45.0
CR-VC-01R				
Rep - 1	<2.3	72.0	<5.7	72.0
Rep - 2	<1.7	78.0	<4.2	78.0
Rep - 3	<2.1	87.0	<5.2	87.0
Rep - 4	<2.3	75.0	<5.8	75.0
Rep - 5	<1.8	74.0	<4.5	74.0
WR-VC-02				
Rep - 1	7.1	30	<5.8	37.1
Rep - 2	9.1	47.0	<3.8	56.1
Rep - 3	9.3	47.0	<5.4	56.3
Rep - 4	7.2	37.0	<5.9	44.2
Rep - 5	11.0	44.0	<5.0	55.0
WR-VC-03				
Rep - 1	4.2	36.0	<4.1	40.2
Rep - 2	4.6	38.0	<5.0	42.6
Rep - 3	3.8	42.0	<5.1	45.8
Rep - 4	2.8	31.0	<4.2	33.8
Rep - 5	4.6	37.0	<4.5	41.6
WR-VC-04				
Rep - 1	2.8	26.0	<4.1	28.8
Rep - 2	3.2	28.0	<5.3	31.2
Rep - 3	4.2	33.0	<7.9	37.2
Rep - 4	<12.0	40	<29	40.0
Rep - 5	*	*	*	*
WR-VC-05				
Rep - 1	<17.0	32.0	<42	32.0
Rep - 2	*	*	*	*
Rep - 3	<4.9	31.0	<12.0	31.0
Rep - 4	11.0	30.0	<26.0	41.0
Rep - 5	*	*	*	*

Tissue samples not sent for chemical analysis.

Polynuclear Aromatic Hydrocarbons (PAHs)

Low Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Acenapththene	Acenaphthylene	Anthracene	Fluorene	2-Methyl napthalene	Naphthalene	Phenanthrene	Total Low PAHs
WR-VC-01R	<2.1	<2.8	<2.6	<2.7	<2.6	2.6	<2.3	2.6
WR-VC-02	44	12	17	26	45	9.3	73	226.3
WR-VC-03	<2.1	<2.8	<2.6	<2.7	<2.6	<2.1	7.5	7.5
WR-VC-04	<2.1	<2.8	7	<2.7	<2.6	<2.1	6.7	13.7
WR-VC-05	<2.1	3	3.5	<2.7	<2.6	2.7	15	24.2
WR-VC-06ABC	<2.1	18	4.5	6.9	5.3	41	27	85.7
WR-VC-06D	<2.1	5.1	11	6.5	12	28	40	102.6
WR-VC-07ABC	22	31	27	26	25	41	130	302
WR-VC-07D	4.8	10	11	5.6	16	9.4	52	108.8
Screen level (SL)	500	560	960	540	670	2100	1500	29000
Mean	7.9	8.8	9.0	7.9	11.5	14.9	39.0	
Maximum	44	31	27	26	45	41	130	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 12, Willamette River, Tier III, Bioassay **Sampled November 29, 1999**

Polynuclear Aromatic Hydrocarbons (PAHs)

High Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Benzo(a) anth racene	Benzo(b) fluro anthene	Benzo(k) fluro anthene	Benzo(g,h,i) perylene	Chrysene	Pyrene	Benzo(a) pyrene	Dibenz(a,h) anthracene	Indeno (1,2,3-cd) pyrene	Fluoran thene	Total High PAHs
WR-VC-01R	<2.6	<2.5	<2.3	<1.8	<2.9	<2.7	<1.8	<1.7	<2.1	<2.6	ND
WR-VC-02	30	39	17	39	29	86	47	<1.7	35	67	389
WR-VC-03	11	12	4.2	10	13	21	15	<1.7	<2.1	19	105.2
WR-VC-04	13	17	6.7	<1.8	16	22	13	<1.7	<2.1	21	108.7
WR-VC-05	9.2	9.2	4.3	7.3	7.5	25	<1.7	<1.7	<2.1	21	83.5
WR-VC-06ABC	16	<2.3	<2.1	14	21	39	16	<1.7	<2.1	32	138
WR-VC-06D	25	28	16	<1.8	34	68	25	<1.7	<2.1	95	291
WR-VC-07ABC	47	58	13	33	62	130	53	<1.7	23	140	559
WR-VC-07D	29	37	16	21	45	70	39	<1.7	11	87	355
Screen level (SL)	1300	3200		670	1400	2600	1600	230	600	1700	12000
Mean	20.0	30.8		13.8	25.3	51.2	23.1	ND	7.7	53.6	225.5
Maximum	47	71		39	62	130	47	ND	35	140	559

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Figure 1, General Sampling Site Map, Sampled April 29, 1999 & November 29, 1999

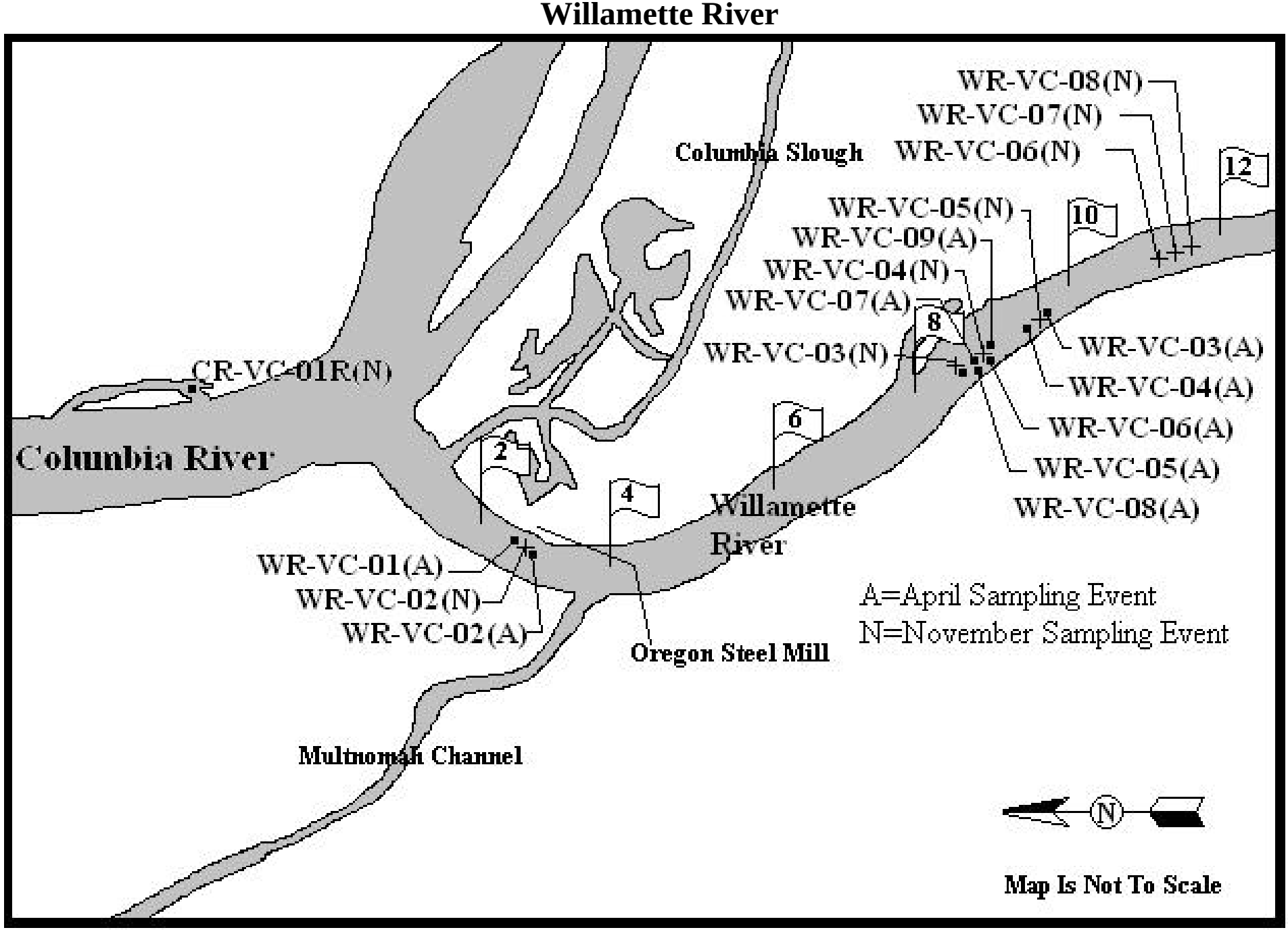


Figure 2, River Mile 2 Sampling Sites, April 29, 1999 & November 29, 1999

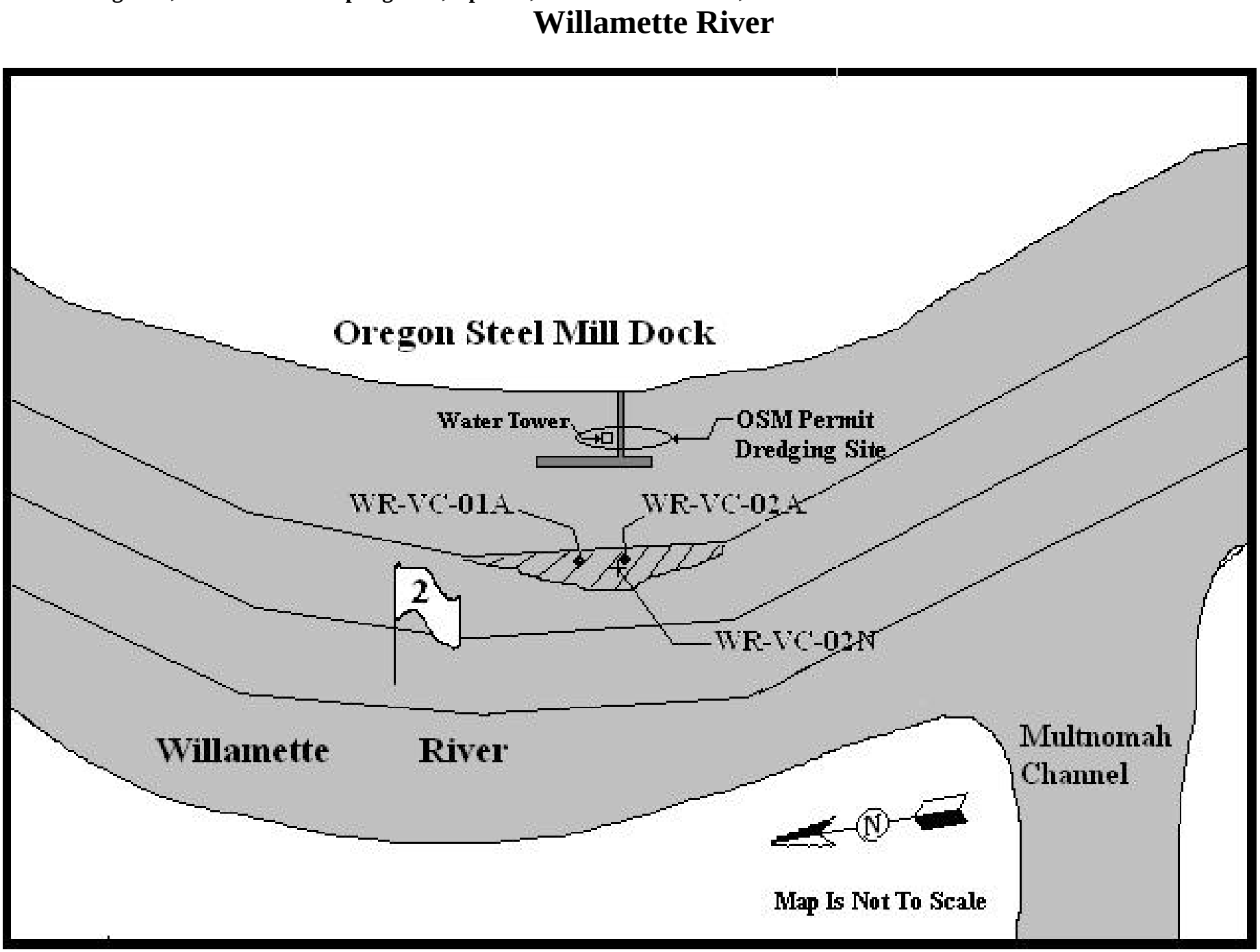


Figure 3, River Mile 8 to 10 Sampling Sites, April 29, 1999 & November 29, 1999

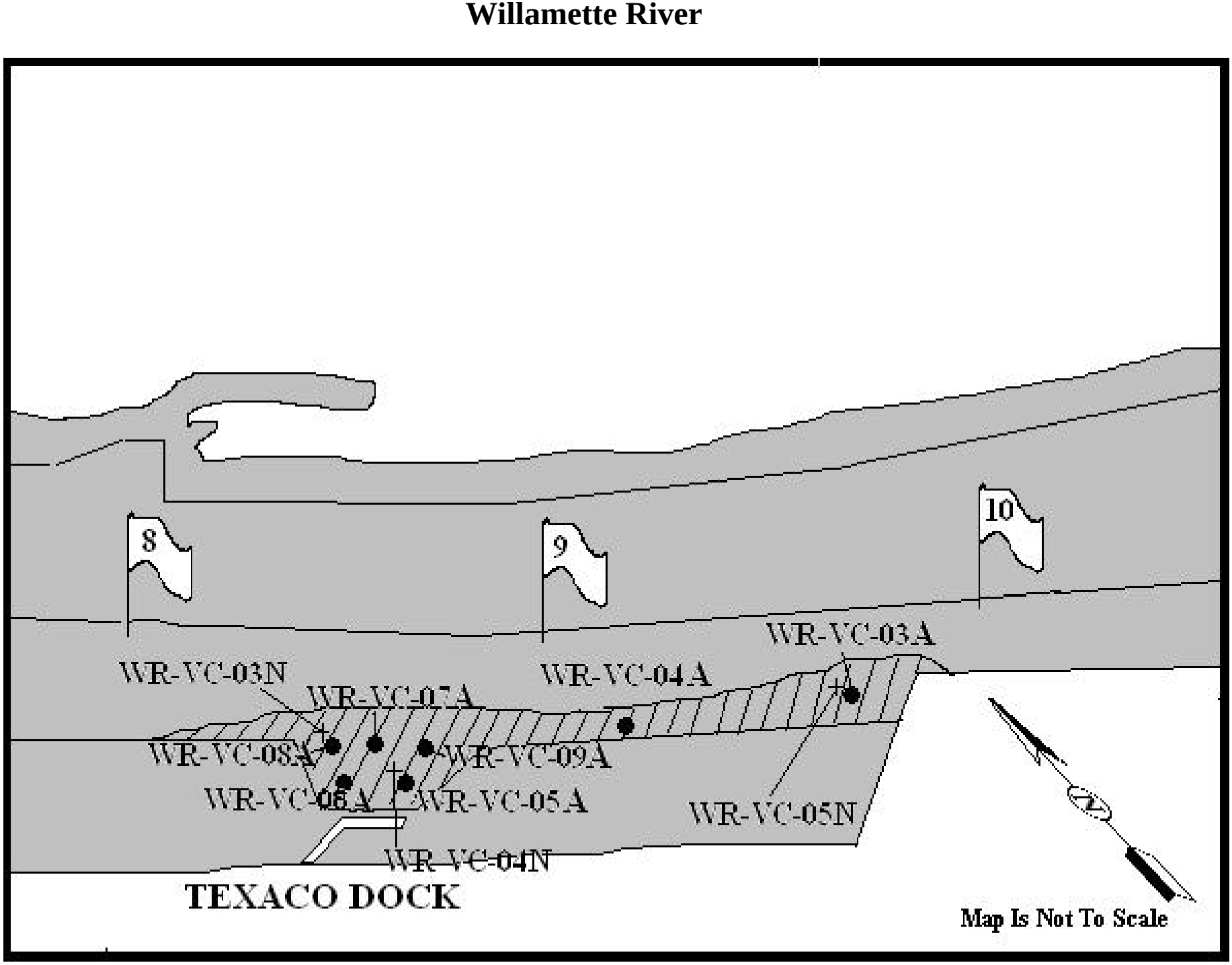
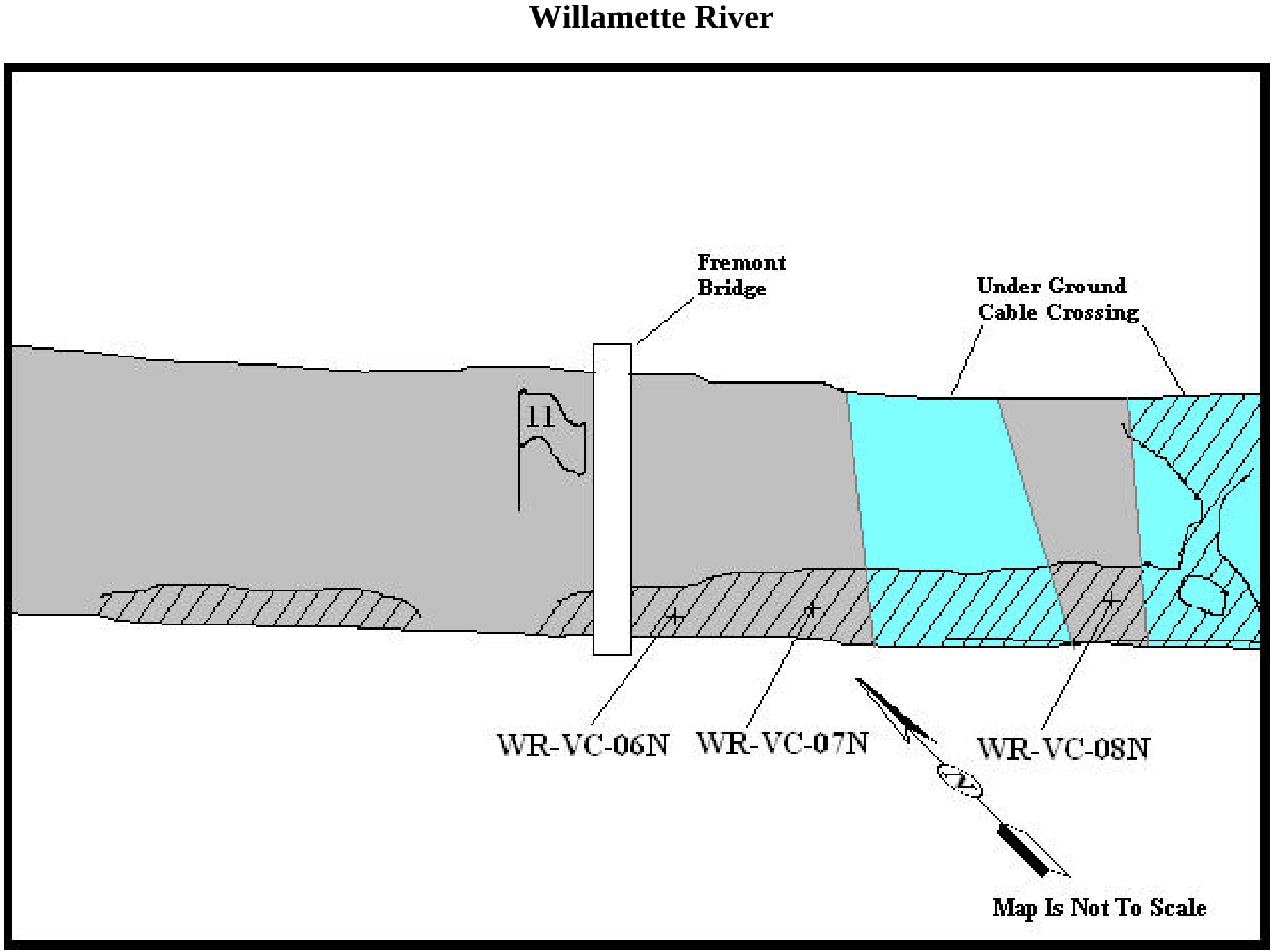


Figure 4, River Mile 11 Sampling Sites, November 29, 1999.



Appendix A
MEC Bioassay Report
Willamette River
Sampled November 29, 1999

25 February 2000

USACE (Attn. Tim Sherman)
333 SW First Avenue
Portland, OR 97204

Dear Mr. Sherman:

This document is the final letter report for the dredged material disposal sediment toxicity testing (*Chironomus tentans*, *Hyalella azteca*, and *Lumbriculus variegatus*) for Willamette River project sediments. Included in this letter report are copies of the Chain-of-Custody (COC) forms (Attach. 1), test organism receipt information (Attach. 2), laboratory bench sheets (Attach. 3), reference toxicant bench sheets (Attach. 4), sediment porewater ammonia and overlying ammonia data (Attach. 5), statistical analysis information (Attach. 6), and temperature plots (Attach. 7). Please see tables and text below for a summary of test results.

MEC laboratory personnel received five samples (WR-VC-05, WR-VC-04, WR-VC-03, WR-VC-02, and CR-VC-01R (reference sediment)) for sediment toxicity tests reported herein. All samples were received 01 December 1999, and were evaluated in 10-day sediment toxicity tests with the freshwater amphipod, *H. azteca* and the midge, *C. tentans*; and in a 28-day bioaccumulation test with the freshwater oligochaete, *Lumbriculus variegatus.*

Table 1: Sample Identification and Collection Summary

Sample Description	Client Sample I.D.	MEC Sample I.D.	Date Collected	Date Received	COC #
Reference Sediment	CR-HC-01R	C991201.01	11/29/99	12/01/99	4101
Test Sediment	WR-VC-02	C991201.02	11/29/99	12/01/99	4101
Test Sediment	WR-VC-03	C991201.03	11/29/99	12/01/99	4101
Test Sediment	WR-VC-04	C991201.04	11/29/99	12/01/99	4101
Test Sediment	WR-VC-05	C991201.05	11/29/99	12/01/99	4101
Control Sediment	N.A. [1]	Control	N.A. [1]	N.A. [1]	N.A. [1]

[1] Not applicable (laboratory control sediment is clean sediment obtained from Lake Skinner, CA).

All samples were logged-in upon receipt. Upon receipt, the condition of each sample was noted and the temperature recorded on the COC form. All samples arrived in good conditions, however temperatures were above the recommended shipping/storage

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temperature range of >0ºC and <4ºC (9.5 to 14.0°C). This deviation is not considered significant and is not expected to impact testing results. After being logged-in, samples were placed in a locked cold storage walk-in and held at 4ºC until test initiation.

Sample handling, testing, and analysis was conducted in accordance with the Inland Testing Manual (ITM) (USEPA/USACE 1998) and the Dredged Material Evaluation Framework – Lower Columbia River Management Area (1998). Tests conducted by MEC included standard 10-day solid phase sediments toxicity tests with the freshwater amphipod, *Hyalella azteca* (USEPA 1994; as revised 1998, MEC SOP# BIO068.00) and the midge, *Chironomus tentans* (USEPA 1994; as revised 1998, MEC SOP# BIO069.00); and a 28-day bioaccumulation test with the freshwater oligochaete, *Lumbriculus variegatus* (USEPA 1994, as revised 1998, MEC SOP# BIO057.00). Initial interstitial ammonia was measured on Day 0 for 10-day solid phase testing. Total ammonia values ranged from 5.81 to 33.8 mg/L in CR-VC-01R and WR-VC-04, respectively. Prior to bioaccumulation testing, a small subsample was collected to evaluate porewater ammonia levels in the test sediments. Pre-test porewater ammonia levels ranged from 5.56 to 28.5 mg/L total ammonia in the CR-VC-01R sediment and WR-VC-03 sediment, respectively (Table 4). The ten-day solid phase sediment toxicity test with *H. azteca* was initiated on 28 January 2000; the ten-day solid phase sediment toxicity test with *C. tentans* was initiated on 07 December 2000; and the bioaccumulation test with *L. variegatus* was initiated on 20 January 2000. Tests with *C. tentans* and *L. variegatus* were initiated within the prescribed eight weeks, per ITM guidance. Initial tests with *H. azteca* were initiated on 7 December 1999, 8 days from sampling. However, due to failure of the control (74% survival), *H. azteca* tests were repeated. Subsequent testing occurred 58 days from sampling, falling outside the recommended limit (56 days). Test results are summarized in Table 2. Control survival (93.8%) and Reference (CR-VC-01R) survival (92.5%) in *H. azteca* met test acceptability criteria of 80% and 70% survival, respectively. Mean test mortality for *H. azteca* in the test sediment, WR-VC-02, was statistically different relative to reference, and was 15% different from the mean reference response. Control survival (92.5%) and Reference (CS-HC-01R) survival (96.3%) in *C. tentans* met test acceptability criteria of 70% and 65%, respectively. Control ash free dry weight (1.39 mg) in the test with *C. tentans* met the test acceptability criterion >0.6mg. There were no statistically significant effects, relative to reference, in the *C. tentans* tests.

The test species, *H. azteca* and *C. tentans*, were also evaluated in reference toxicant tests with copper sulfate. Toxicant tests with *H. azteca* were exposed to nominal concentrations of 125, 250, 500, 1000, and 2000 Cu^{2+}µg/L. Toxicant tests with *C. tentans* were exposed to nominal concentrations of 250, 500, 1000, 2000, and 4000 Cu^{2+}µg/L. The LC_{50} for *H. azteca* (327.26µg/L) and *C. tentans* (853.74µg/L) were within two standard deviations of laboratory mean for each species (i.e., 401.3 ± 575.4µg/L for *H. azteca* and 837.3± 1264.5µg/L for *C. tentans*) indicating that test organisms were within the expected range of sensitivity to the reference toxicant.

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Table 2: Summary of solid phase bioassay test results for Willamette River sediments.

Sample Name	H. azteca			C. tentans		
	% Survival (S.E.)			% Survival (S.E)	Mean Est. Indiv. Ash Free Dry wt. in mg (S.E)	
Control	93.8 (0.032)			92.5 (0.049)	1.39 (0.083)	
CR-VC-01R	92.5 (0.016)			96.3 (0.018)	1.27 (0.143)	
WR-VC-02	77.5 (0.049)[1]			95.0 (0.027)	1.42 (0.093)	
WR-VC –03	80.0 (0.042)			97.5 (0.025)	1.30 (0.114)	
WR-VC –04	80.0 (0.046)			92.5 (0.049)	1.21 (0.219)	
WR-VC –05	90.0 (0.046)			87.5 (0.070)	1.58 (0.087)	
Reference Toxicant	Copper Conc. (µg/L)	% Survival	LC_{50}	Copper Conc. (µg/L)	% Survival	LC_{50}
	Control	90.0	327.3 µg/L	Control	100.0	853.7 µg/L
	125	76.7		250	80.0	
	250	60.0		500	70.0	
	500	23.3		1000	50.0	
	1000	0.0		2000	20.0	
	2000	0.0		4000	0.0	

[1] = *t* – test significantly different ($p \leq 0.05$) relative to reference sediment.

Following the 28-day bioaccumulation test, *L. variegatus* were retrieved from the test sediment and weighed. Test results are summarized in Table 3. Mean biomass of retrieved organisms ranged from 0.60 to 4.08 grams in WR-VC-05 and Control sediments, respectively. Samples WR-VC-04 and WR-VC-05 had particularly low recovery (biomass of individual replicates ranged from 0.00 to 4.00 grams for treatment WR-VC-04 and 0.00 to 1.50 grams for WR-VC-05 [See Attachment 3 for details]) suggesting possible effects on survival. Tissue samples were then frozen, and sent to Sound Analytical Systems for subsequent residue analysis.

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Table 3: Summary of biomass (wet weight) results for 28-day bioaccumulation test of Willamette River sediments.

Sample Name	L. variegatus	
	Initial Wet Weights Grams	Mean Final Wet Weights Grams (S.E.)
Control	7.00	4.08 (0.136)
CR-VC-01R	7.00	3.24 (0.062)
WR-VC-02	7.00	2.96 (0.060)
WR-VC-03	7.00	3.72 (0.039)
WR-VC-04	7.00	1.89 (0.228)
WR-VC-05	7.00	0.60 (0.080)

Test conditions were within recommended limits for the *H. azteca* test species with the exception of dissolved oxygen. Dissolved oxygen was outside the recommended range of >3.4 mg/L (0.7 to 8.5 mg/L). Aeration was begun on 29 January 2000 in order to rectify low dissolved oxygen concentrations. Aeration was increased in test chambers when dissolved oxygen concentrations fell below the recommended range. Low dissolved oxygen levels were of short duration (i.e. a few hours on 29 January 2000) and not expected to have altered test results. Test conditions were within recommended limits for the *C. tentans* test species with the exception of dissolved oxygen and pH. Dissolved oxygen and pH were slightly outside the recommended ranges of >3.5 mg/L (3.3 to 8.4 mg/L); and 7.0±1.0 (6.2 to 8.2), respectively. Aeration was begun on 14 December 1999 in order to rectify low dissolved oxygen concentrations. Excursions in pH were not significant (small and of short duration) and did not affect test results. A summary of water quality during the 10-day solid phase tests with *H. azteca* and *C. tentans* is provided in Table 4. Test conditions were within recommended limits for the *L. variegatus* test species with the exception of temperature. Instantaneous temperature was outside the recommended range of 23±3°C (20.4 to 26.6°C). However, mean test temperature, as recorded by a continuous temperature recording computer, was within the daily recommended mean temperature range of 23±1°C (22.5°C [See Attachment 7 for details]). These excursions in temperature were not significant (small and of short duration) and did not affect test results. Due to low initial dissolved oxygen readings, aeration was begun on 20 January 2000. A summary of water quality during the bioaccumulation test is provided in Table 5.

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Table 4: Summary of Water Quality Data, Porewater Ammonia, and Overlying Ammonia for solid phase bioassay tests of Willamette River sediments.

H. azteca								
Sample Name	**Water Quality Measurements**				**Total Ammonia – Porewater [1]**		**Total Ammonia – Overlying**	
	D.O mg/L (S.E.)	**Temp. °C (S.E.)**	**Cond. MS/cm (S.E.)**	**pH Units (S.E.)**	**Initial NH_3-N mg/L**	**Final NH_3-N mg/L**	**Initial NH_3-N mg/L**	**Final NH_3-N mg/L**
Control	6.6 (0.392)	23.4 (0.889)	0.43 (0.005)	7.6 (0.076)	3.76	5.06	0.608	0.441
CR-VC-01R	7.2 (0.174)	23.4 (0.109)	0.31 (0.002)	7.3 (0.043)	5.81	4.80	2.22	0.474
WR-VC-02	6.9 (0.160)	23.8 (0.139)	0.32 (0.004)	7.1 (0.041)	26.1	14.4	8.42	0.313
WR-VC –03	6.7 (0.204)	23.7 (0.102)	0.33 (0.002)	7.0 (0.037)	23.3	14.0	9.50	1.02
WR-VC –04	6.9 (0.167)	23.5 (0.131)	0.32 (0.003)	7.1 (0.039)	19.6	14.3	8.42	0.638
WR-VC –05	6.8 (0.222)	23.5 (0.109)	0.32 (0.005)	7.1 (0.047)	15.9	10.2	6.92	0.245
Reference Toxicant	8.0 (0.082)	23.7 (0.124)	0.32 (0.003)	8.0 (0.043)				
C. tentans								
Sample Name	**Water Quality Measurements**				**Total Ammonia – Porewater [1]**		**Total Ammonia – Overlying**	
	D.O mg/L (S.E.)	**Temp. °C (S.E.)**	**Cond. mS/cm (S.E.)**	**pH Units (S.E.)**	**Initial NH_3-N mg/L**	**Final NH_3-N mg/L**	**Initial NH_3-N mg/L**	**Final NH_3-N mg/L**
Control	7.3 (0.212)	22.5 (0.094)	0.29 (0.002)	7.6 (0.093)	0.175	0.221	0.675	0.258
CR-VC-01R	6.7 (0.207)	23.0 (0.079)	0.28 (0.001)	7.2 (0.051)	6.27	5.01	2.93	0.380
WR-VC-02	6.1 (0.272)	22.5 (0.126)	0.32 (0.006)	7.1 (0.051)	27.6	16.8	8.59	1.36
WR-VC –03	6.0 (0.268)	22.8 (0.185)	0.31 (0.004)	7.1 (0.048)	31.3	14.3	9.38	2.53
WR-VC –04	6.0 (0.260)	22.7 (0.109)	0.32 (0.005)	7.1 (0.050)	33.8	13.5	8.91	2.15
WR-VC –05	5.8 (0.227)	22.8 (0.154)	0.32 (0.005)	7.1 (0.044)	25.8	11.6	6.30	1.53
Reference Toxicant	8.4 (0.089)	24.3 (0.166)	0.32 (0.005)	7.7 (0.080)				

[1] Measurements taken from surrogate testing chambers.

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Table 5: Summary of Water Quality Data, Pore Water Ammonia, and Overlying Ammonia for bioaccumulation tests of Willamette River sediments.

L. variegatus							
Sample Name	**Water Quality Measurements**				**Total Ammonia – Porewater [1]**	**Total Ammonia – Overlying**	
	D.O. mg/L (S.E.)	**Temp. °C (S.E.)**	**Cond. mS/cm (S.E.)**	**pH Units (S.E.)**	**Pretest NH_3-N mg/L**	**Initial NH_3-N mg/L**	**Final NH_3-N mg/L**
Control	6.5 (0.068)	22.8 (0.050)	0.45 (0.003)	7.6 (0.015)	0.959	0.37	0.291
CR-VC-01R	7.3 (0.041)	23.2 (0.051)	0.30 (0.001)	7.3 (0.014)	5.56	2.80	0.000
WR-VC-02	6.4 (0.054)	22.9 (0.031)	0.32 (0.001)	7.0 (0.013)	27.2	11.1	0.377
WR-VC –03	6.3 (0.056)	23.2 (0.026)	0.32 (0.001)	6.9 (0.016)	28.5	12.0	0.344
WR-VC –04	7.2 (0.028)	22.8 (0.022)	0.31 (0.001)	6.9 (0.015)	19.8	9.62	0.113
WR-VC –05	6.6 (0.063)	22.6 (0.061)	0.31 (0.001)	6.9 (0.017)	17.3	9.22	0.338

[1] Measurements taken from surrogate testing chambers.

In summary, test results for solid phase tests with *H. azteca* and *C. tentans* did not indicate significant effects for survival (*H. azteca* and *C. tentans*) or growth (*C. tentans* only) in the test sediments. Tissue residues of *L. variegatus* were sent to Sound Analytical Systems for subsequent analysis. On the basis of the toxicity test results, reported herein, it appears that all of the test sediments evaluated as part of this project are suitable for open water disposal in accordance with the DMEF for the Lower Columbia River.

Thank you for the opportunity to conduct these tests on the Willamette River sediments. Should you have any questions regarding these test results or require additional information please contact me at 760-931-8081.

Sincerely,

David W. Moore, Ph.D.
Director of Toxicology and Chemistry
MEC Analytical Systems, Inc.