1992

Lower Willamette River Sediment Evaluation - Portland Harbor

Abstract

Sediment from the shoal between RM 8.0 and 10.2 on the southwest side of the river is acceptable for both in-water and upland disposal according to provisions of the Clean Water Act. The sediment is predominantly silt. Metals, pesticides, PCBs, PAHs and phenols are below concern levels. No unacceptable adverse environmental impacts are expected from disposal. Sediment from the shoal at RM 10.3 on the northeast side of the river should be further studied before deciding whether it can be disposed at an unconfined in-water, confined in-water or upland site.

Introduction

Past Studies

1. The Lower Willamette River deep-draft channel is maintained at an authorized depth of 40 feet from the mouth of the Willamette to the Broadway Bridge (1). The channel width is typically 300 feet. Between 1986 and 1990 about 800,000 cubic yards were dredged by clamshell from the channel. The sediment has historically been disposed in-water at the Morgan Bar dispersive site at River Mile (RM) 100 on the Columbia River. Some material has gone to a confined in-water site at Ross Island lagoon. In 1989 about 10,000 cubic yards went upland on Port of Portland property.

2. Sediment evaluations of shoals in the channel were conducted in 1988 and 1989 (2,3). The 1988 study was an extensive survey in which 22 samples were collected. Both chemical and biological tests were performed on the sediment. The chemical tests showed that lead, cadmium and PAHs were elevated at RM 11, just below the Broadway Bridge. The lead contamination may have resulted from sand blasting operations on the bridge. PCBs and zinc were elevated at RM 10.3 on the north side of the channel. DDT and/or DDD and PAHs were elevated at RMs 5.1, 7.1 and 7.3. Mercury, DDD and PAHs were elevated at RM 4.3. Between RMs 8.1 and 10.0 samples were relatively free of contaminants. Bioassays were conducted on four samples judged to be the most contaminated. These were samples from the southwest side of the channel at RMs 4.3, 5.1, 7.1 and 7.3 (left side of channel facing downstream). None showed mortality in the solid phase tests. Only the sample from RM 7.1 exhibited significant mortality in the dissolved phase. This sample contained no unusual elevations of metals or organics. Mortality was thought to be caused by elevated ammonia or depressed oxygen in the test containers. Eluriate tests for metals, conducted on four samples, revealed that all were below freshwater, chronic water quality criteria as published in the EPA Gold Book (4). Ammonia release exceeded the chronic but not the acute criterium. The highest ammonia release was from the sample at RM 7.1. The sediment from shoals between RM 7.0 - 7.5 and 10.3 - 11.7 was recommended for disposal at confined in-water or upland sites. Most of the rest of the sediment, including that between RM 8.0 and 10.1, was acceptable for unconfined in-water disposal.

3. The 1989 study was of material in a shoal at the Burlington Northern Railroad Bridge at RM 7.0. The results revealed that metals, TOC, and oil & grease were low and typical of uncontaminated river sediment. Organics such as pesticides, PCBs, PAHs, phthalates and phenols were below detection limits. According to Clean Water Act requirements, the sediment was considered acceptable for unconfined in-water disposal.

Current Study

4. The purpose of the current study was to evaluate shoal material in the Lower Willamette River to assure compliance with requirements of the Clean Water Act (CWA). The CWA requires an environmental evaluation of dredge material to determine acceptable disposal options. Recently dredged shoals were not analyzed for contaminants because there was no reason to believe they had become contaminated. Only large shoals that had developed since the 1988 dredging operations were sampled and analyzed for contaminants. A recent depth survey of the channel indicated that a long shoal had formed on the left side of the channel (facing downstream) between RM 8.0 and 10.4. A smaller shoal had developed between RM 9.8 and 11.0 on the right side of the channel. The material to be dredged from these shoals is the subject of this sediment evaluation. Historically, the shoals have been composed of sediment that is greater than 20 % silt and 5 % volatile solids. Silty and/or organic rich sediment can serve as a sink for contaminants. The lower Willamette River is subjected to various sources of contaminants and sediment from the river is routinely tested for contaminants of concern on a 5 year schedule.

Methods

5. Five sediment samples were taken using a Benthos Gravity Corer on June 3, 1992. The sample locations are shown on the enclosed map (Figure 1). On the same day as collection the cores were extruded, the length of each core was measured and any obvious layers were described. The core lengths were considered to be representative of the project dredge prism. A lengthwise section of each core was subjected to physical and chemical analyses. One core, WR-GC-2, was divided into a top (TOP) and bottom (BOT) section because of the prescence of two very distinct layers. The physical samples taken from each core were cold stored in plastic ziplock bags. Physical analyses consisted of determining volatile solids content, grain size distribution, resuspended density, void ratio, specific gravity and particle roundness grading. Chemical samples taken from the cores were placed in acid washed and hexane rinsed glass jars topped with teflon lined lids. They were cold stored from time of collection until analysis at the contract analytical lab. Chemical analyses consisted of tests for total organic carbon (TOC), acid volatile sulfides (AVS), metals, organochlorine pesticides, polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs). All sampling proceedures and tests were conducted following EPA/Corps approved methods (5). A quality assurance report of contract lab performance was prepared by the U. S. Army Corps of Engineers Materials Lab, Troutdale, Oregon. It is encluded as an enclosure with this report.

Results/Discussion

Physical

6. Results of physical analyses are shown in Table 1. The mean grain sizes varied from medium silt to medium sand. As expected, the samples were greater than 20 % silt and 5 % volatile solids. The silt content averaged 58 % except for the bottom 19 inches of sample WR-GC-2, which was 93 % medium sand. The mean clay content was 8.8 % and mean volatile solids was 6.9 %. TOC was less than 3 % for all samples. The physical properties of samples from the current study are similar to those of samples taken in 1988. The physical values reported here indicate a potential for contaminant loading in the sediment. Sediments high in fines, volatile solids and organics can partition out contaminants from the water column. But the following

chemical results will show that the material is relatively free of contaminants except for the small shoal at RM 10.3 which is suspect pending further study.

Chemical

Metals

7. Results of chemical analyses for metals are shown in Table 2. None of the samples had metals concentrations above Portland District established levels of concern (6). However one sample, WR-GC-1, showed a zinc concentration (196 ppm) much higher than in the other samples (46-116 ppm), and this concentration was above the EPA, Region 10 concern level (for marine sediments). This station was located at RM 10.2 very near where a sample from the 1988 study also showed a high zinc concentration (244 ppm). In both studies the zinc concentration was about 1.5 times higher than that in the other samples. The 1988 station also showed a PCB concentration that nearly exceeded district concern levels, but PCBs were undetected in the current sample. For comparison the concentrations of metals in 5 samples, taken in 1988 from the same areas as in the current study, are also shown in Table 2. As can be seen, metals concentrations have changed little over the past 4 years.

8. The level of AVS found is on the low side for fine grained sediment. AVS is the sulphide fraction extracted from sediment using cold hydrochloric acid. There is experimental evidence that AVS is protective of aquatic organisms because the sulphur forms insoluble metal sulphides that affect bioavailability of metals in the interstitial water in the sediment. The AVS concentrations varied from 0.29 to 0.85 µm/g. In silty sediment from other locations in Oregon AVS has ranged from 0.04 to 140 µm/g. In sample WR-GC-2, which had 2 distinctly different layers, the AVS concentration ranged from undetectable in the lower sand layer (WR-GC-2 BOT) to 0.41 µm/g in the top silt layer (WR-GC-TOP). This is a good example showing that AVS is often associated with the fine grained fraction of sediment.

Organics

Pesticides/PCBs

9. Pesticides and PCBs concentrations are shown in table 3. Very low levels of the pesticides DDE and DDD were detected in the samples. The amounts detected were estimates and they were very near the method detection limits. All five samples were estimated to contain between 2 - 3 ppb of DDE and four samples between 3 - 4 ppb of DDD. Endosulfan II (2 ppb) and methoxychlor (6 ppb) were detected at in sample WR-GC-4. No pesticides were detected in the WR-GC-2 bottom sample. These concentrations are well below established concern levels. PCBs were undetected in the samples.

PAHs

10. PAHs were detected at low concentrations in five of six samples (Table 3). WR-GC-1 showed the most "hits" with 8 detectable PAHs observed. One of these PAHs, 2-methylnaphthalene, exceeded the EPA, Region 10 screening level set for marine waters of Puget Sound (7). However the total concentrations of low and high molecular weight PAHs were well below EPA, Region 10 and USACE, Portland District screening levels. This was also true of the other four samples. The PAH of highest concentration in all the samples was pyrene (78-190

ppb). The other samples showed hits on 2 to 4 PAHs. No PAHs were detected in the WR-GC-2 Bot sample, which was a sandy layer in the WR-GC-2 core.

Phenols

11. 3- and 4- methylphenol, otherwise known as m- and p-cresols, were detected in three samples. The analysis was unable to distinguish between the two phenols. The concentrations (70 - 110 ppb) were below concern levels.

Total Organic Carbon (TOC)

12. TOC averaged around 2.59 % in the samples. In core number 2 the top silty layer (WR-GC-TOP) had a TOC of 2.34 % while the bottom sandy portion of core 2 (WR-GC-2 -BOT) was the lowest of all the samples (0.10 %). The mean TOC for all samples was 2.25 %.

Quality Control

13. The quality assurance report prepared by the Materials Lab, Troutdale, Oregon is enclosed. All holding times met requirements. There were some matrix interferences, but generally, detection limits, surrogate recoveries, matrix spike and matrix spike duplicates were acceptable. Method blanks were free of targeted analytes. The results of contaminant analyses were considered acceptable based on quality control data.

Recommendations

14. Federal project sediment from the shoal on the southwest side (left side facing downstream) of the river between RM 8.0 and 10.2 is acceptable for both unconfined in-water or upland disposal according to provisions of the Clean Water Act (Section 404 (b) (1) Guidelines). The same conclusioin was reached in the 1988 study. The concentrations of contaminants in the sediment are below established concern levels. Elutriate tests, performed in 1988 on sediment from the same area and with similar levels of contaminants, found levels of metals in the water column that were below EPA freshwater, acute water quality criteria. Receiving water concentrations for metals were below acute water quality criteria also. These facts support the conclusion that the current shoal material is acceptable for unconfined in-water disposal. During in-water disposal operations a temporary turbidity plume would appear but then disperse rapidly. Since the material is silty most of it would disperse downstream and some minor burial of benthic organisms may occur. There is no reason to believe unacceptable adverse environmental impacts would result from unconfined in-water disposal in the Columbia River at the Morgan Bar disposal site. This is where material from the same shoal area was disposed in 1988.

15. The sample of sediment (WR-GC-1) from the shoal at RM 10.3 on the northeast side (right side facing downstream) of the river contained the most contaminants of all the samples. It had a higher level of zinc compared to the other samples - about twice as high. The zinc concentration (196 ppm) exceeded the EPA, Region 10 screening level (160 ppm for marine waters) but not the USACE, Portland District established level of concern (250 ppm). Lead and cadmium were about twice as high as in the other samples but did not exceed concern levels.

AVS was highest of all samples and this may help ameliorate the toxicity, if any, of metals in the sediment. The sample also contanined DDD (3.0 ppb) and DDE (3.0 ppb) as well as the most hits for PAHs, including the PAH 2-methylnaphthalene at a concentration (170 ppb) that exceeded the EPA, Region 10 screening level (67 ppb). The remaining PAHs and total PAHs were below concern levels. In the 1988 study this shoal was recommended for confined in-water or upland disposal. The sediment was not dredged in 1988 and is not anticipated to be dredged at this time. Until further evaluations are conducted to establish the suitability of this shoal material for unconfined in-water disposal, the recommendations of the 1988 study seem appropriate.

16. The information regarding contaminants gathered in this sediment evaluation indicates that no significant degradation of sediment quality has occurred in the two shoals studied. The results are similar to those obtained in the 1988 sediment evaluation.

17. This sediment evaluation was prepared by Jim Britton, CENPP-PE-HR. If you have any questions regarding the report please contact him at (503)326-6471.

REFERENCES

1. Navigation Branch, Operations Division, U. S. Army Corps of Engineers, Portland District. September 1991. Federal Navigation Projects: Columbia River Maintenance Disposal Plan. (Prepared by Mandaville Associates, 600 S. W. Tenth #418, Portland, Oregon 92205)

2. Fletcher, B., Turner, R., and Babcock, S. U. S. Army Corps of Engineers, Portland District. December 1988. Results of 1988 Lower Willamette River sediment quality testing - USACE Portland District O&M dredging.

3. Siipola, M. U. S. Army Corps of Engineers, Portland District. 1989. Results of 1989 Willamette River - Burlington/Northern R. R. bridge sediment quality evaluation.

4. U. S. Environmental Protection Agency. May 1986. Quality Criteria for Water ("The Gold Book"). Office of Water Regulations and Standards. Washington, DC.

5. Ecological Analysts, Inc. Concord, California. A Technical Evaluation of Potential Environmental Impacts of Proposed Ocean Disposal of Dredged material at Winchester Bay, Oregon. Prepared for USACE, Portland District. September, 1981.

6. U. S. Army Corps of Engineers, Portland District. November 1991. Levels of Concern Tier II Analysis. (A list of chemicals and associated concern levels in bulk sediment, established as a temporary guideline useful in evaluating toxicity of sediment. These levels of concern are subject to change as new information warrants.)

7. U. S. Environmental Protection Agency, Region 10, Seattle, WA. Screening levels on file in the office of the Ocean Dumping Coordinator.

Figure 1. Sediment quality sampling locations, June 1992.

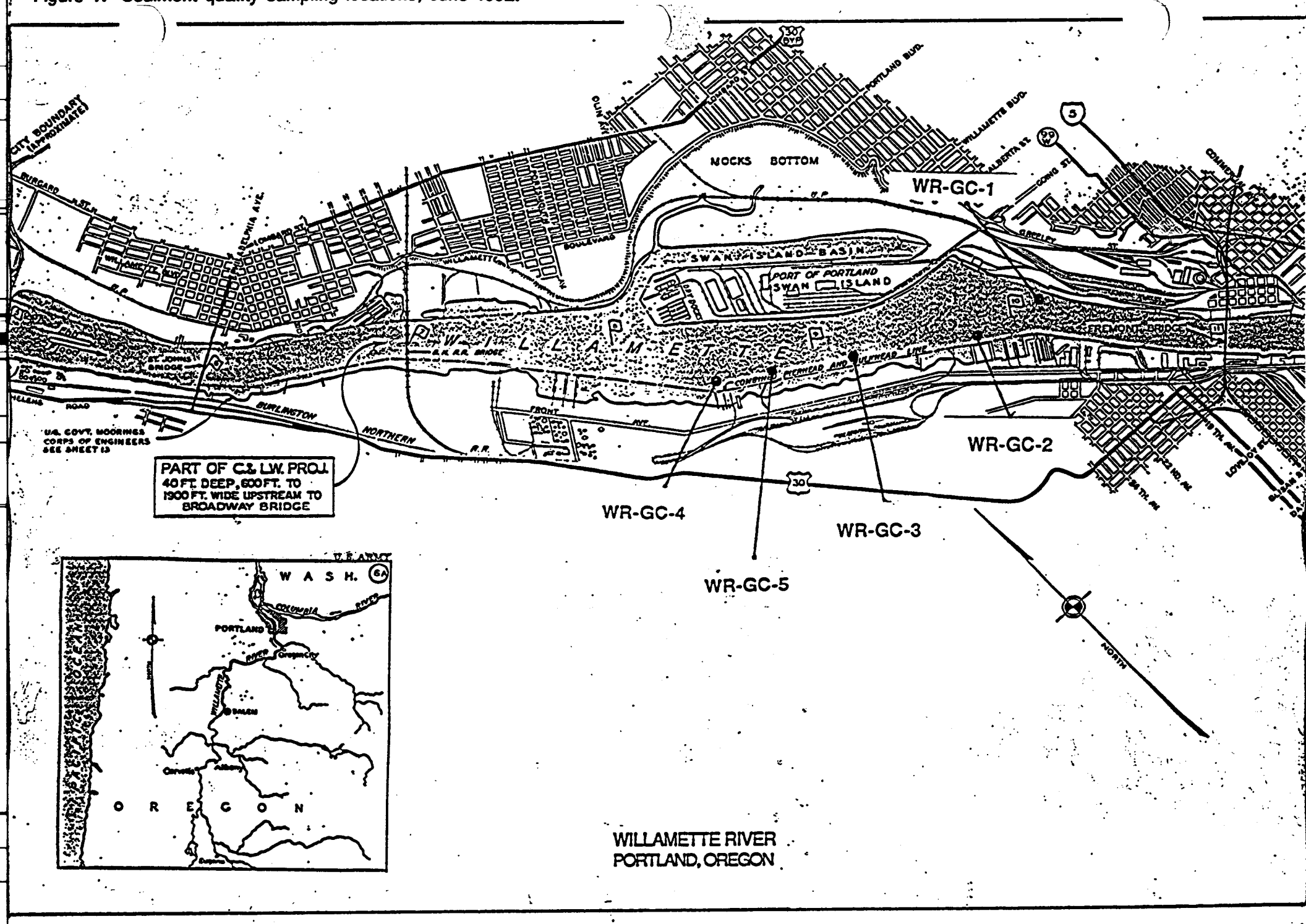

Table 1. Results of physical analyses of Portland Harbor sediment samples, 1992.

sample	core length inches	mean gr. size mm	sand	silt	clay	volatile solids	TOC
			%				
WR-GC-1	25	0.061	33.4	58.3	8.3	7.2	2.23
WR-GC-2 TOP	6	0.034	16.7	73.7	9.6	8.8	2.34
WR-GC-2 BOT	19	0.320	93.2	5.9	0.9	1.4	0.10
WR-GC-3	53	0.050	32.1	59.5	8.4	7.0	2.78
WR-GC-4	42	0.030	14.3	74.6	11.1	8.1	2.71
WR-GC-5	53	0.028	11.5	75.5	13.0	8.8	2.88
mean*	-	0.084	33.2	58.0	8.8	6.9	2.25

* WR-GC-TOP/BOT were combined into one weighted number for use in the mean calculation.

Table 2. Metals concentrations in Portland Harbor sediment samples, 1992.

sample	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	AVS
					ppm				um/g
WR-GC-1	3.0	0.40	35.0	43.0	29.0	0.13	25.0	*196.0	0.85
WR-GC-2 TOP	3.0	0.20	34.0	46.0	14.0	0.12	26.0	116.0	0.41
WR-GC-2 BOT	2.0	<0.10	15.0	16.0	3.0	<0.02	17.0	46.0	<.05
WR-GC-3	3.0	0.20	35.0	41.0	14.0	0.12	24.0	101.0	0.44
WR-GC-4	3.0	0.20	33.0	47.0	17.0	0.09	24.0	116.0	0.47
WR-GC-5	4.0	0.20	34.0	46.0	14.0	0.10	26.0	113.0	0.29
mean	3.0	0.24	31.0	39.8	15.2	0.11	23.7	114.7	0.49
mean 1988	3.9	0.31	23.2	45.0	21.9	0.10	36.8	157.0	-

* exceeds EPA, Region 10 screening level but is below Portland District's concern level

Table 3. Concentrations of pesticides and PCBs in Portland Harbor sediment samples, 1992.

sample	Delta-BHC	4,4' DDE	4,4' DDD	endosulfan II	PCBs
			ppb		
WR-GC-1	6	3	3	<2	<10
WR-GC-2 TOP	<2	3	4	<2	<10
WR-GC-2 BOT	<2	<2	<2	<2	<10
WR-GC-3	3	2	<2	<2	<10
WR-GC-4	6	3	<2	2	<10
WR-GC-5	<2	<2	4	<2	<10

Table 4. Concentrations of PAHs and phenols in Portland Harbor sediment samples, 1992.

sample	PAHs									total
	3-&4-methyl phenol	2-methyl naphthalene	phenanthene	fluoranthrene	pyrene	benzo (a) anthracene	chrysene	benzo(b+k) fluoranthene	benzo (a) pyrene	
	ppb									
WR-GC-1	110	*170	150	130	190	73	90	120	77	1,000
WR-GC-2 TOP	-	-	-	120	120	-	-	-	-	240
WR-GC-2 BOT	-	-	-	-	-	-	-	-	-	-
WR-GC-3	70	-	-	78	78	-	-	-	-	156
WR-GC-4	-	-	90	120	130	-	-	-	-	340
WR-GC-5	90	-	82	170	190	-	70	-	-	512

* exceeds EPA, Region 10 screening level