Monitoring Water Quality During Pilot Dredging in the Willamette and Columbia Rivers, Oregon

U.S. GEOLOGICAL SURVEY
Open-File Report 78-554

Prepared in cooperation with the
U.S. Army Corps of Engineers

MONITORING WATER QUALITY DURING PILOT DREDGING IN THE WILLAMETTE AND COLUMBIA RIVERS, OREGON

By Joseph F. Rinella and Stuart W. McKenzie

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CONVERSION FACTORS

The following factors may be used to convert the English units published herein to the International System of Units (SI). In the text, the metric equivalents are shown only to the number of significant figures consistent with the values for the English units.

Multiply	By	To obtain
Feet (ft)	0.3048	Meters (m)
Mile (mi)	1.609	Kilometers (km)
Cubic feet per second (ft^3/s)	.02832	Cubic meters per second (m^3/s)

MONITORING WATER-QUALITY DURING PILOT DREDGING IN THE WILLAMETTE AND COLUMBIA RIVERS, OREGON

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By Joseph F. Rinella and Stuart W. McKenzie

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ABSTRACT

Water quality was monitored in the Willamette and Columbia Rivers during a pilot dredging operation on December 16, 1977. Monitoring included in-situ measurements of pH, temperature, dissolved oxygen, and conductivity in the Willamette and Columbia Rivers; analyses of dissolved ammonia, dissolved manganese, suspended-sediment concentration and particle size, loss on ignition, and total organic carbon in river-water samples; and analyses of percent moisture, particle size, density, selected nutrients, total organic carbon, and loss on ignition in dredged material and barge-overflow samples.

INTRODUCTION

On December 16, 1977, the U.S. Geological Survey (USGS), in cooperation with the U.S. Army Corps of Engineers, Portland District (Corps), monitored water-quality conditions during a pilot dredging study. The purpose of the pilot study was to collect data for ascertaining the feasibility of using particular areas of the Columbia River as deposit sites for material dredged from the Willamette River. The Corps pilot dredging operation included three cycles each of (1) dredging the Portland Harbor bottom material, (2) placing dredged material in a hopper barge, (3) transporting the material in the barge to the Columbia River, and (4) dumping the dredged material into the Columbia River at a selected site in the stream outside the main navigation channel (fig. 1).

The Corps, National Marine Fisheries Service, and USGS met on January 13, 1977, to discuss data that would be needed to evaluate the possible environmental effects of dredging and disposal. The National Marine Fisheries Service indicated that the nutrient-enriched dredging material might stimulate biological productivity in the Columbia River system (oral commun., George Snyder, January 13, 1977). As a result of that meeting, duplicate samples of Willamette River bottom material were collected on February 1, 1977, at river

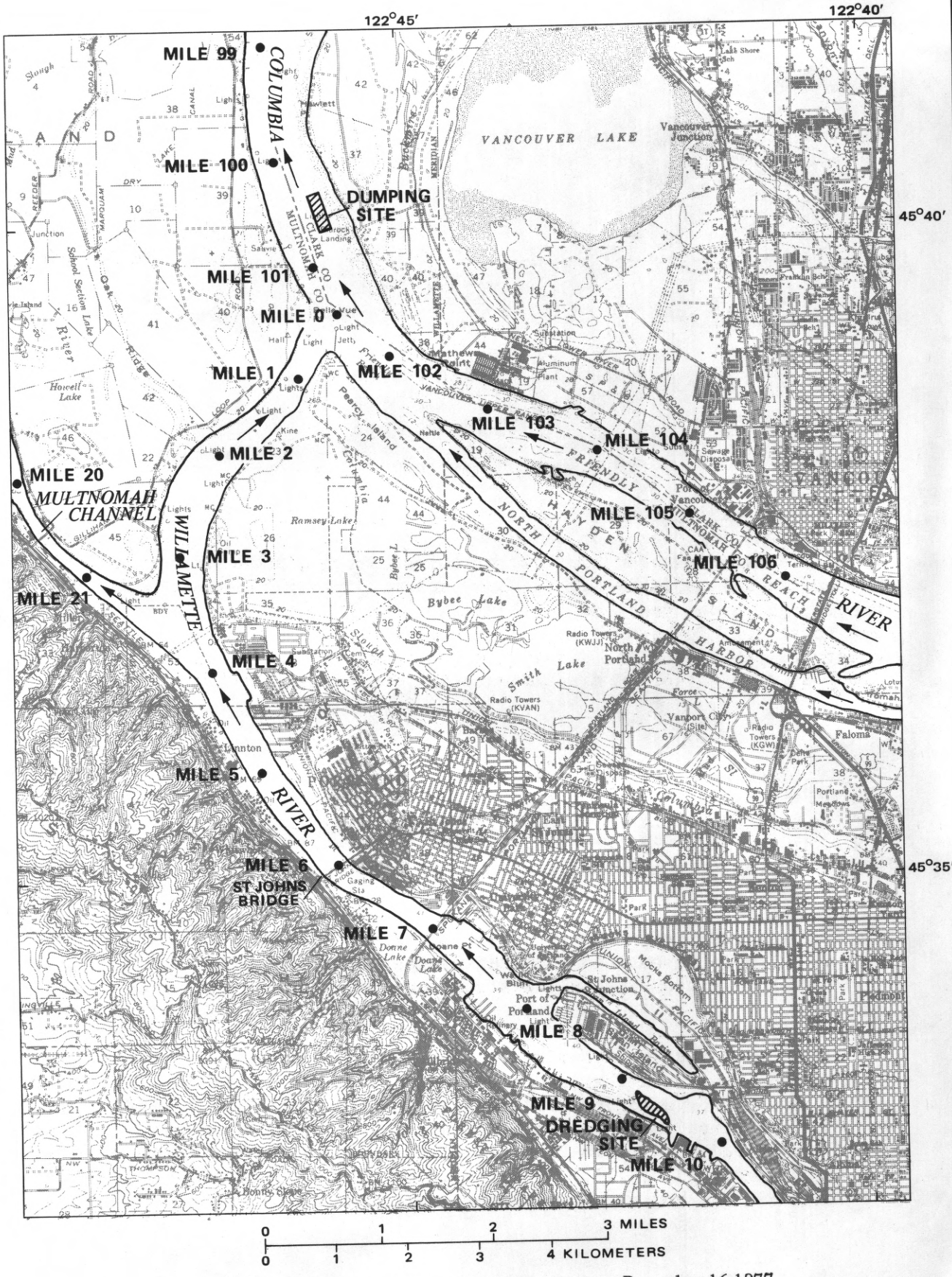

Figure 1.–Map showing dredging and dumping sites on December 16,1977.

mile (RM) 9.2 and analyzed for chemicals that could adversely affect Columbia and Willamette River aquatic life (McKenzie, 1977). Organic compounds in the sediments were determined by the National Marine Fisheries Service and particle size, oxygen demand, pesticides, and various inorganic constituents by the USGS. After a review of the analytical results, the Environmental Protection Agency (EPA) suggested that an elutriate study be made to indicate which chemicals in the bottom material might dissolve in water during a dredging operation and possibly be toxic to aquatic life. The elutriate data (Rinella and McKenzie, 1977) showed the average concentrations of dissolved ammonia and dissolved manganese to be above the aquatic-life criterion levels established by EPA (1976).

EPA recommended that the next phase for the ecological evaluation of the pilot study was a bioassay. The Corps authorized a short-term bioassay by the National Marine Fisheries Service to determine survival concentrations of bottom sediment for some indigenous fish species in the Columbia River system. After reviewing preliminary National Marine Fisheries Service bioassay results, the Corps decided to proceed with a small-scale pilot dredging study.

The objective of this USGS study was to monitor water-quality conditions during the small-scale dredging and dumping operation.

SAMPLE COLLECTION

Willamette and Columbia River Flows

On December 16, 1977, both the Willamette and Columbia Rivers were near bankfull stage. The estimated mean daily discharge in the Willamette River at Portland Harbor was 240,000 ft^3/s (6,800 m^3/s); the 24-hour mean daily discharge in the Columbia River below Bonneville Dam was 240,000 ft^3/s (6,800 m^3/s).

River Water

Control data were collected upstream from the dredging and dumping sites, or downstream before an operation began. Sampling sites were also located downstream from the dredging and dumping sites because harbor bottom material would come in contact with Willamette River water through hopper overflow and with Columbia River water during the dumping operation. The dredging and dumping sites are shown in figure 1, and the time schedule for the pilot dredging operation is given in table 1.

At a river sampling site, depth-integrated and (or) point samples were collected. The depth-integrated samples were collected using a P-61 sediment sampler while maintaining a constant position in the river. The point samples were collected using a Scott-modified_/ Van Dorn bottle at 0.2, 0.6,

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_/ The use of brand names in this report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

Table 1.--Time schedule for dredging operation and USGS sample collection, December 16, 1977

Time (2400 hours)	River	Near river mile	Remarks
0755-0830	Willamette	10.0	USGS collected background data upstream from dredging site.
0840	do	9.2	Corps began dredging.
0841	do	9.2	USGS collected depth-integrated river sample downstream from dredging site.
0845-0900	do	9.2	Dredging was interrupted because of clogged pipe.
0900-0920	do	9.2	Dredging started and USGS resumed river sampling.
0915	do	9.2	Dredging ended--about 5-10 percent of hopper load by volume overflowed into the Willamette (estimated by the Corps).
0920	do	9.2	Corps began to transport dredged material to the Columbia River.
1000-1015	Columbia	100.25	USGS collected background data downstream from dumping site.
1024	do	100.5	Corps began dumping first load.
1024-1054	do	100.5	USGS collected samples downstream from first dump.
1032	do	100.5	Dump completed.
1200	Willamette	9.1	Corps began dredging of second load.
1206	do	9.1	Overflow from barge into the Willamette River began.
1200-1218	do	9.1	USGS collected samples downstream from dredge.
1222-1233	do	9.4	As dredge moved upstream, USGS moved upstream to monitor water quality.
1227	do	9.7	Dredging completed.

Table 1.--Time schedule for dredging operation and USGS sample collection, December 16, 1977--Continued

Time (2400 hours)	River	Near river mile	Remarks
1353	Columbia	100.5	Second dumping began.
1353-1414	do	100.5	USGS collected samples downstream from dumping site.
1358	do	100.5	Dump completed. USGS threw over marker buoy, designating end of dump.
1420-1425	do	99.2	USGS sampled downstream from marker buoy to monitor water quality over a 1-mile reach of the river downstream from dump site.
1442-1502	do	101.15	USGS collected background samples upstream from dump site.
1523	Willamette	9.1	Overflow from third barge load began.
1555-1605	do	9.5	USGS collected samples downstream from dredging site.
1605	do	9.5	Corps began to transport dredged material to the Columbia River.
1708	Columbia	--	Third dump began and was not monitored by USGS.

and 0.8 depth from the water surface, and about 1 meter above the river bottom (near-bottom sample). Each point sample was collected while the boat was drifting in the current of the river. Collection of a point sample generally began at a specified river mile; however, because of drift, actual collection may have been as much as 0.2 of a mile (0.3 km) downstream from the specified sampling location.

Dredged-Material and Hopper-Overflow Samples

The samples of dredged material and hopper overflow were collected by Corps personnel on board the dredge.

The dredged-material sample was a composite of several samplings throughout a hopper load. One composited dredged-material sample was collected from each of the three hopper loads. The sediment concentrations analyzed in the dredged-material samples do not necessarily represent the actual concentrations in a hopper load. The hopper-overflow sample consisted of bottom sediments, Willamette River water, and possibly Columbia River water, that overflowed from the hopper during a filling. An overflow sample was a composite of several samplings during overflow from a single loading. Two overflow samples were collected--one during the second hopper loading and one during the third hopper loading (table 9).

RESULTS

In-Situ Water-Quality Measurements

At each sampling site, in-situ readings of dissolved oxygen, pH, conductivity, and temperature were measured at 0.2, 0.6, and 0.8 depth, and near the bottom. Measurements were made using a multiparameter Martek unit with a submersible probe. Generally, the in-situ measurements were made while the boat was set adrift, beginning from a specified river mile. The measurements may have been made as much as 0.2 mile (0.3 km) downstream from the specified monitoring location.

Tables 2 and 3 show the in-situ measurements made in the Willamette and Columbia Rivers, respectively.

River-Water Analyses

The results of the river-water analyses are tabulated in tables 4, 5, 6, and 7. Tables 4 and 6 show the analyses for Willamette River water, and tables 5 and 7 show the analyses for Columbia River water. Dissolved manganese, dissolved ammonia, and total organic carbon were analyzed by the USGS central laboratory in Arvada, Colo., using standard analytical methods (Brown and others, 1970; Goerlitz and Brown, 1972). Turbidity; suspended-sediment concentration; sand split, particle size; conductivity; and residue, loss on ignition (semiquantitative indicator of organic material), were analyzed at the USGS laboratory in Portland, Oreg., using standard analytical methods (Brown and others, 1970; Guy, 1969; Greeson and others, 1977).

Dredged-Material and Hopper-Overflow Analyses

Table 8 includes the percent moisture; turbidity; conductivity; residue, loss on ignition; and chemical analyses of dredged-material and hopper-overflow samples. The chemical analyses were made by the USGS central laboratory, using standard analytical methods (Brown and others, 1970; Goerlitz and Brown, 1972). The remainder of the analyses were analyzed at the USGS Portland laboratory, using standard analytical methods (Guy, 1969; Brown and others, 1970; Greeson and others, 1977).

Particle-Size and Density Analyses on Selected Samples

Table 9 shows the results of particle-size analyses for three loads of dredged material, two samples of hopper overflow, and selected river-water samples. The Willamette River water samples are composites of samples collected downstream from the second and third dredgings, and the Columbia River water samples are composites of samples collected downstream from the second dump. For each river, the 0.2-depth samples were composited and analyzed separately from the composited 0.8-depth and near-bottom samples. Standard USGS procedures were used for the analyses (Guy, 1969) at the USGS Portland laboratory. Sediment density was determined at the USGS Portland laboratory for the first and third dredge loads.

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Table 2.--In-situ water-quality measurements of the Willamette River, December 16, 1977

River mile	Location and (or) operation	Time (2400 hours)	Percentage of stream width from left bank	Depth to bottom (ft)	Temperature (degrees Celsius)				Specific conductance (umhos/cm at 25°C)				Dissolved oxygen (mg/L)				pH (units)			
					Sampling location in water column (fraction of depth from surface)															
					0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom
Background data																				
10.0	Upstream from dredging site	0800-0815	50	59	8.5	8.5	8.5	8.5	53	53	53	53	14.1	14.0	13.8	13.6	6.8	6.8	6.7	6.7
First loading: Dredging commenced at 0840; Corps estimated 5-10 percent volume of overflow																				
9.2	Downstream from dredge	0840-0855	50	55	8.5	8.5	8.5	8.5	53	53	53	53	14.0	14.3	13.8	13.3	6.8	6.8	6.8	6.7
Second loading: Dredging commenced at 1200; overflow commenced at 1206 and occurred for 21 minutes																				
9.1	Downstream from dredge	1200-1205	40	52	8.5	8.5	8.5	8.5	53	53	53	53	13.4	12.6	13.2	12.8	7.0	7.0	7.0	7.0
9.1	do.	1206-1214	40	52	8.5	8.5	8.5	--	53	56	53	--	13.0	13.0	12.9	--	6.9	6.9	6.9	
9.1	do.	1216-1222	40	52	8.5	8.5	8.5	8.5	54	53	54	56	12.9	12.6	12.8	12.6	6.9	6.9	6.9	6.8
9.4	do.	1222-1224	40	48	8.5	--	--	--	53	--	--	--	12.9	--	--	--	6.9	--	--	--
9.4	do.	1225-1229	40	48	8.5	8.5	8.5	8.5	53	54	54	54	13.2	12.8	13.0	12.5	6.9	6.8	6.8	6.8
9.4	do.	1230-1235	40	48	8.5	8.5	8.5	8.5	53	54	56	56	12.8	12.6	12.8	12.6	6.8	6.8	6.8	6.9
Third loading: Dredging commenced at 1523; overflow occurred for 42 minutes																				
9.5	Downstream from dredge	1555-1605	40	52	8.5	8.5	8.5	8.5	54	54	56	56	12.8	12.8	12.8	12.6	6.8	6.8	6.8	6.8

Table 3.--In-situ water-quality measurements of the Columbia River, December 16, 1977

River mile	Location and (or) operation	Time (2400 hours)	Percentage of stream width from left bank	Depth to bottom (ft)	Temperature (degrees Celsius)				Specific conductance (umhos/cm at 25°C)				Dissolved oxygen (mg/L)				pH (units)			
					Sampling location in water column (fraction of depth from surface)															
					0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom
Background data collected before first dump																				
100.25	Downstream from dumping site	1000-1015	40	56	7.5	7.5	7.3	7.0	106	120	122	128	12.2	12.9	12.8	12.5	7.6	7.6	7.6	7.6
First dump commenced at 1024 and completed at 1032																				
100.5	Downstream from dump	1025-1030	60	52	7.0	7.0	7.0	--	139	152	157	--	12.6	13.0	12.8	--	7.6	7.7	7.7	--
100.5	do.	1030-1035	60	52	7.5	7.2	7.0	7.0	114	138	137	139	13.1	12.8	12.0	12.1	7.5	7.6	7.5	7.5
100.5	do.	1035-1040	60	52	7.0	--	7.0	--	123	--	154	--	12.4	--	12.9	--	7.7	--	7.6	--
100.5	do.	1043-1045	60	52	7.0	7.0	7.0	--	146	157	154	--	12.0	12.8	12.7	--	7.8	7.8	7.7	--
100.5	do.	1046	60	52	--	--	7.0	--	--	--	157	--	--	--	12.4	--	--	--	7.8	--
100.5	do.	1050-1055	60	52	--	7.0	7.0	--	--	159	154	--	--	12.7	12.6	--	--	7.8	7.8	--
Second dump commenced at 1353; dredge doors closed at 1358																				
100.5	Downstream from dump	1353	60	52	7.0	--	--	--	162	--	--	--	12.9	--	--	--	7.6	--	--	--
100.5	do.	1354-1400	60	52	7.0	7.0	7.0	7.0	162	162	162	162	12.6	12.6	12.7	12.7	7.6	7.6	7.6	7.6
100.5	do.	1400-1406	60	52	7.0	7.0	7.0	7.0	154	162	162	162	12.2	12.4	12.4	12.4	7.8	7.7	7.8	7.8
100.5	do.	1407-1412	60	52	7.0	7.0	7.0	--	154	162	162	--	11.3	12.2	12.8	--	7.8	7.8	7.8	--
100.5	do.	1415	60	52	7.0	--	--	--	131	--	--	--	12.8	--	--	--	7.8	--	--	--
100.5	do.	1416	60	52	7.0	--	--	--	162	--	--	--	11.8	--	--	--	7.8	--	--	--

Table 3.--In-situ water-quality measurements of the Columbia River, December 16, 1977--Continued

River mile	Location and (or) operation	Time (2400 hours)	Percentage of stream width from left bank	Depth to bottom (ft)	Temperature (degrees Celsius)				Specific conductance (umhos/cm at 25°C)				Dissolved oxygen (mg/L)				pH (units)			
					Sampling location in water column (fraction of depth from surface)															
					0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom
Downstream from second dump																				
99.2	Downstream from buoy designating end of second dump	1420-1424	60	45	7.0	7.0	7.0	7.0	157	154	154	154	12.3	12.6	12.8	12.6	7.8	7.8	7.8	7.8
99.2	do.	1425-1428	60	45	7.0	7.0	7.0	--	157	157	154	--	12.2	12.0	12.6	--	7.8	7.8	7.8	--
Background data																				
101.15	Upstream from dumping site	1442-1445	75	25	7.0	7.0	7.0	7.0	154	154	154	154	12.6	12.1	12.7	12.5	7.4	7.5	7.6	7.8
101.15	do.	1447-1452	50	48	7.0	7.0	7.0	7.0	142	168	166	166	13.0	12.5	12.7	12.8	7.8	7.8	7.8	7.8
101.15	do.	1455-1500	25	62	7.5	7.5	7.0	7.0	79	97	136	139	12.8	12.2	12.8	12.6	7.6	7.6	7.7	7.7

Table 4.--Selected water-quality analyses of Willamette River water, December 16, 1977

River mile	Location and (or) operation	Time (2400 hour)	Percentage of stream width from left bank	Depth to bottom (ft)	Turbidity (JTU)		Suspended sediment concentration (mg/L)					Percentage suspended sediment less than 0.062-mm sieve diam					Specific conductance at 25°C (micromhos/cm) 1/				Dissolved manganese (ug/L)					Dissolved ammonia (mg/L)				
					Sampling location in water column (fraction of depth from surface)																									
					0.2	Near bottom	Depth integrated	0.2	0.6	0.8	Near bottom	Depth integrated	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	Depth integrated	0.2	0.6	0.8	Near bottom	Depth integrated	0.2	0.6	0.8	Near bottom
Background data																													
10.0	Upstream from dredging site	0755	25	55	--	--	2/ 188	--	--	--	--	--	--	--	--	--	--	--	--	--	20	--	--	--	--	0.00	--	--	--	--
10.0	do.	0800-0825	50	59	100	3/ 100	207	130	133	163	148	82	95	97	90	92	56	55	57	55	20	20	40	0	20	.03	0.00	0.04	0.01	0.01
10.0	do.	0830	75	59	--	--	141	--	--	--	--	94	--	--	--	--	--	--	--	--	20	--	--	--	--	.09	--	--	--	--
First loading: Dredging commenced at 0840; Corps estimated 5-10 percent volume overflow																													
9.2	Downstream from dredge	0841-0920	50	55	100	130	171	210	187	268	280	90	80	88	78	79	55	55	55	57	20	20	40	40	40	.00	.00	.00	.00	.00
Second loading: Dredging commenced at 1200; overflow occurred for 21 minutes																													
9.1	Downstream from dredge	1200	40	52	100	--	--	162	--	--	--	--	92	--	--	--	55	--	--	--	--	30	--	--	--	--	.00	--	--	--
9.1	do.	1202-1206	40	52	--	--	--	176	--	245	--	--	86	--	80	--	63	--	57	--	--	40	--	20	--	--	.01	--	.01	--
9.1	do.	1208-1216	40	52	100	200	--	129	400	1,300	751	--	96	78	58	75	--	57	--	53	--	20	20	80	100	--	.00	.07	.09	.00
9.1	do.	1218	40	52	100	--	--	156	--	--	--	--	93	--	--	--	--	--	--	--	--	10	--	--	--	--	.00	--	--	--
9.4	do.	1222-1233	40	48	100	270	--	206	331	918	718	--	84	84	92	83	--	55	--	--	--	10	60	120	80	--	.00	.02	.22	.09
Third loading: Dredging commenced at 1523; overflow occurred for 42 minutes																													
9.5	Downstream from dredge	1555-1605	40	52	90	200	--	147	273	693	668	--	92	79	82	90	--	59	--	--	--	0	40	60	80	--	.00	.04	.11	.06

1/ Laboratory measurements on samples split for chemical analyses.

2/ Concentration of dissolved solids plus suspended sediment.

3/ Sample collected at 0.6 depth from surface.

Table 5.--Selected water-quality analyses of Columbia River water, December 16, 1977

River mile	Location and (or) operation	Time (2400 hours)	Percentage of stream width from left bank	Depth to bottom (ft)	Turbidity (JTU)		Suspended sediment concentration (mg/L)				Percentage suspended sediment less than 0.062-mm sieve diameter				Specific conductance at 25°C (micromhos/cm)1/				Dissolved manganese (ug/L)				Dissolved ammonia (mg/L)			
					Sampling location in water column (fraction of depth from surface)																					
					0.2	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom	0.2	0.6	0.8	Near bottom
Background data collected																										
100.25	Downstream from dumping site	1000-1015	40	56	85	85	158	150	148	149	97	97	98	98	121	125	129	131	20	0	0	10	0.00	0.00	0.01	0.00
First dump commenced at 1024 and completed at 1032																										
100.5	Downstream from dredge dump	1024	60	52	--	--	155	--	--	--	99	--	--	--	--	--	--	--	10	--	--	--	.00	--	--	--
100.5	do.	1025-1031	60	52	80	80	131	145	209	169	98	99	93	95	126	--	145	145	0	10	20	10	.00	.00	.00	.00
100.5	do.	1033-1040	60	52	80	90	145	169	179	170	97	99	98	99	--	147	--	--	20	10	0	0	.00	.00	.00	.01
100.5	do.	1042-1054	60	52	100	100	186	185	191	212	99	100	99	95	--	158	--	--	10	10	10	0	.00	.01	.00	.00
Second dump commenced at 1353																										
100.5	Downstream from dredge dump	1353-1402	60	52	85	80	204	202	478	178	96	99	86	99	--	162	--	--	10	20	80	10	.01	.00	.06	.00
100.5	do.	1406-1414	60	52	75	100	125	202	229	221	99	97	90	97	--	163	--	--	10	10	0	20	.10	.00	.04	.00
99.2	Downstream from buoy--end of second dump	1420-1425	60	45	90	100	194	198	196	195	99	98	98	100	160	--	155	157	0	0	10	10	.03	.03	.02	.00
Background data																										
101.15	Upstream from dumping site	1442-1445	75	25	85	--	174	188	180	--	100	98	99	--	155	--	153	--	10	10	0	--	.03	.03	.04	--
101.15	do.	1447-1452	50	48	75	90	126	169	208	208	100	100	99	99	146	157	--	166	0	0	0	20	.03	.04	.03	.00
101.15	do.	1455-1502	25	62	85	2/85	127	153	160	--	98	100	99	--	76	127	138	--	20	10	10	--	.03	.02	.00	--

1/ Laboratory measurements on samples split for chemical analyses.

2/ Sample collected at 0.8 depth from surface.

Table 6.--Analyses of residue, loss on ignition; and total organic carbon in Willamette River water, December 16, 1977

River mile	Time (2400 hours)	Percentage of stream width from left bank	Residue, loss on ignition						Total organic carbon (mg/L)
			Percentage of dry sediment			Milligrams per liter			
			Sampling location in water column						
			Depth integrated samples	0.2 of depth from surface	Near bottom	Depth integrated samples	0.2 of depth from surface	Near bottom	Near bottom
Background data collected upstream from dredging site									
10.0	0755	25	12	--	--	22	--	--	7.3*
10.0	0800-0825	50	--	16	13	--	37	28	7.8
10.0	0830	75	--	--	--	--	--	--	5.9*
First loading: Dredging commenced at 0840									
9.2	0841-0920	50	--	10	10	--	24	29	6.8*/9.3
Second loading: Dredging commenced at 1200									
9.1	1202	40	--	12	--	--	31	--	--
9.1	1208-1216	40	--	13	9	--	28	54	21
9.4	1222-1233	40	--	13	7	--	38	71	24
Third loading: Dredging commenced at 1523									
9.5	1555-1605	40	--	15	9	--	35	80	27

* Depth-integrated sample.

Table 7.--Analyses of residue, loss on ignition; and total organic carbon in Columbia River water, December 16, 1977

River mile	Time (2400 hours)	Percentage of stream width from left bank	Residue, loss on ignition				Total organic carbon (mg/L)
			Percentage of dry sediment		Milligrams per liter		
			Sampling location in water column				
			0.2 of depth from surface	Near bottom	0.2 of depth from surface	Near bottom	Near bottom
Background data collected downstream from dumping site before first dump							
100.25	1000-1015	40	13	11	31	25	5.3
First dump commenced at 1024							
100.5	1025-1031	60	15	8	33	21	4.8
100.5	1033-1040	60	15	8	39	23	5.5
100.5	1042-1054	60	12	8	37	24	6.1
Second dump commenced at 1353							
100.5	1353-1402	60	13	11	40	31	5.6
100.5	1406-1414	60	15	10	35	36	6.8
99.2	1420-1425	60	12	10	38	34	6.1
Background data collected upstream from dump							
101.15	1447-1452	50	15	9	35	31	6.5
101.15	1455-1502	25	16	14*	34	39*	

* 0.8 of depth from surface.

Table 8.--Water-quality analyses of Willamette River dredged-material and hopper-overflow samples, December 16, 1977

Sample identification	Remark	Time (2400 hours)	Moisture (percent)	Turbidity (NTU)	Specific conductance (micromhos/cm at 25°C)	Total constituents, in milligrams per kilogram of dried sediment									Dissolved constituents (mg/L)	
						Total nitrogen as N	Kjeldahl nitrogen as N	Ammonia as N	Nitrite plus nitrate as N	Phosphorus as P	Iron	Manganese	Total organic carbon	Residue, loss on ignition	Ammonia as N	Manganese
First dredge load	5-10 percent of load was overflowed	0840	1/ 75	44,000	589	70	--	52	--	240	15,000	540	14,000	1/ 56,000	--	--
Second dredge load	Overflowed for 21 minutes	1205	1/ 76	32,000	554	80	--	32	--	350	14,000	400	5,700	1/ 44,000	--	--
Third dredge load	Overflowed for 42 minutes	1530	1/ 55	64,000	735	57	--	13	--	220	14,000	470	7,500	1/ 36,000	--	--
Hopper overflow no. 1	From second dredge load	1215	2/ 94	9,800	107	1,000	1,000	58	0.5	280	18,000	730	16,000	3/ 65,000	3.5	1.1
Hopper overflow no. 2	From third dredge load	1545	2/ 92	11,800	167	990	990	55	.25	210	12,000	740	21,000	3/ 64,000	3.9	1.8

1/ Average of two analyses.

2/ Average of four analyses.

3/ Average of three analyses.

Table 9.--Particle-size analyses and density of selected samples

Sample identification	Remarks	Density (grams of dried sediment per cubic centimeter)	Particle size, in millimeters, percent finer than										
			Sand					Silt				Clay	
			0.350	0.250	0.175	0.125	0.088	0.062	0.031	0.016	0.008	0.004	0.002
First dredge load	5-10 percent of load was overflowed	2.7	--	100	98	92	78	67	39	26	18	12	8
Second dredge load	Overflowed for 21 minutes	--	100	99	89	65	48	39	25	17	11	8	6
Third dredge load	Overflowed for 42 minutes	2.7	--	100	97	76	50	39	22	15	11	8	6
Hopper overflow no. 1	From second dredge load	--	--	100	96	88	75	63	43	28	19	13	10
Hopper overflow no. 2	From third dredge load	--	--	100	99	95	83	71	47	31	22	15	10
Willamette R. water at 0.2 depth	Composite of samples taken downstream from dredging site for second and third loadings	--	--	--	--	--	--	--	--	72	--	60	52
Willamette R. water at 0.8 depth and near bottom	do	--	100	98	98	95	79	60	37	25	20	13	13
Columbia R. water at 0.2 depth	Composite of samples taken downstream from dumping site during second dump	--	--	--	--	--	--	--	--	92	--	58	49
Columbia R. water at 0.8 depth and near bottom	do	--	--	100	99	98	93	90	88	87	63	39	28