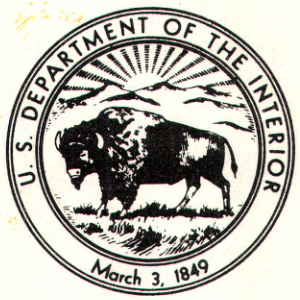
Elutriation Study of Willamette River Bottom Material and Willamette-Columbia River Water

U.S. GEOLOGICAL SURVEY
Open-File Report 78-28



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

ELUTRIATION STUDY OF WILLAMETTE RIVER BOTTOM MATERIAL AND WILLAMETTE-COLUMBIA RIVER WATER

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)
Miles (mi)	1.609	Kilometers (km)

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ABSTRACT

Bottom material from the Willamette River was collected and mixed with Willamette and Columbia River waters on May 17, 1977. The elutriate, as well as each sample, was analyzed for selected nutrients, metals, and pesticides. Results show that the average dissolved ammonia, manganese, and zinc concentrations would require dilution by receiving water to achieve aquatic-life criteria levels.

INTRODUCTION

On May 17, 1977, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers (Corps), made an elutriate test. The test provided data for evaluating possible environmental effects of a Corps-proposed pilot dredging study for the off-channel disposal of Portland Harbor bottom material into the Columbia River. In the pilot study, the Corps would dredge material from the bottom of the Willamette River near RM (river mile) 9.2, load it onto a hopper barge with water-sediment overflow, and transport and dump it into the Columbia River. The National Marine Fisheries Service feels that the disposal operation would be economically feasible and that the nutrient-enriched dredging material might stimulate biological productivity in the Columbia River system.

On February 1, 1977, a sample of Willamette River bottom material was collected at RM 9.2 and analyzed for chemicals that could adversely affect Columbia River aquatic life. On March 28, 1977, the preliminary chemical analyses were reviewed by personnel from the Corps of Engineers Navigational Division, National Marine Fisheries Service, and the U.S. Geological Survey. The U.S. Environmental Protection Agency later reviewed the data (McKenzie, 1977) and suggested that an elutriate study be made. The U.S. Environmental Protection Agency (1975, p. 41295) defines an elutriate as "the supernatant resulting from the vigorous 30-minute shaking of one part bottom sediment from the dredging site with four parts water (Vol/Vol) collected from the dredging site followed by one hour settling time and appropriate centrifugation and a 0.45-micron filtration." The elutriate test would indicate the chemicals in

the bottom material that would dissolve into water during the dredging operation and possibly be toxic to aquatic life.

During the proposed dredging operation, harbor bottom material would come in contact with Willamette River water through hopper overflow and with Columbia River water during the dumping operation. Sample analyses, therefore, included the following: One analysis of the bottom material, duplicate analyses of both Columbia and Willamette River water, and duplicate analyses of both bottom material-Willamette River water elutriate and bottom material-Columbia River water elutriate.

SAMPLE COLLECTION

The collection, preparation, and analysis of the river water, bottom material, and elutriate samples are described below.

River Water

A Willamette River water sample and a Columbia River water sample were collected from 1-meter depth at the proposed dredging site (Willamette River mile 9.2) and disposal site (Columbia River mile 101.8, near Kelley Point), respectively. The Willamette water sample was taken midchannel, and the Columbia water sample was taken about 300 feet from the south bank. After collection, the samples were stored in glass containers. Representative portions of each sample were independently filtered through prerinsed acid-soaked 0.45-micron membrane filters. The filtrate for a water sample was split into subsamples A and B and independently analyzed for pesticides, dissolved metals, cyanide, and ammonia using methods outlined by Goerlitz and Brown (1972) and Brown, Skougstad, and Fishman (1970). The remainder of each unfiltered water sample was used for the preparation of the respective elutriates.

Bottom Material

The Willamette River bottom material was collected at RM 9.2 using a Teflon-coated Ekman grab sampler. About 15 grab samples were collected from the bottom at midchannel and composited. The composite sample was mixed well and a portion was analyzed for chemical constituents using methods outlined by the U.S. Environmental Protection Agency (1974). Five representative portions (5 milliliters per portion) of the composited bed sample were each analyzed for percent moisture and residue, loss on ignition. The remainder of the bottom material was used in the elutriate test.

ELUTRIATE TEST PROCEDURE

The bottom material and river-water samples were mixed together in a volumetric sediment-to-water ratio of 1:4. For the purpose of simulating a dredging and disposal process, a 1:4 ratio is used to approximate a dredged material slurry (U.S. Army Corps of Engineers Waterways Expt. Sta., 1976). The mixture was placed in a glass carboy and mechanically mixed with a Teflon-coated stirrer for 30 minutes. After mixing, the suspension was

allowed to settle for 1 hour. The supernatant was then decanted, centrifuged, and filtered through prerinsed 0.45-micron filters. Each filtrate (the standard elutriate) was then split into subsamples A and B, and each was analyzed for dissolved constituents using methods outlined by Goerlitz and Brown (1972) and Brown, Skougstad, and Fishman (1970). The elutriate test followed the general procedures outlined by the U.S. Army Corps of Engineers Waterways Experiment Station (1976).

MOISTURE AND RESIDUE, LOSS ON IGNITION

The percent moisture; density; and residue, loss on ignition, were analyzed on five subsamples of the bottom material collected for the elutriate test. The residue, loss on ignition, is the difference between the residue after evaporation and the residue after ignition. The densities were calculated from the determinations of moisture content of the bottom material. The analyses of percent moisture and residue, loss on ignition, were made as outlined by the American Public Health Association and others (1975).

RESULTS

The results of the chemical analyses of river water, elutriate, and bottom-sediment samples, which were analyzed at the U.S. Geological Survey laboratory in Arvada, Colo., are tabulated in table 1. The water and elutriate samples each were analyzed in duplicate and are listed under the sample identification columns labeled A and B. Table 2 lists the analyses of the bottom material for percent moisture; density; and residue, loss on ignition, which were done at the U.S. Geological Survey laboratory in Portland, Oreg.

Because the elutriate samples approximate the concentration of dissolved constituents in a dredged slurry, these concentrations should approximate the highest concentrations at any time in the dredging and dumping operation. As the slurry disperses in the river, the concentrations will quickly decrease. Table 3 lists the suggested maximum concentrations for some of the chemical constituents analyzed in the elutriate study. These concentration levels were selected from the "Quality criteria for water," by the U.S. Environmental Protection Agency (1976) as they apply to specific uses of the water.

The Columbia River-Willamette River bottom elutriate has an average dissolved ammonia concentration of 4,050 ug/L (micrograms per liter) as compared to the criterion level of 2,300 ug/L (tables 1, 3). This indicates that the elutriate or dredged material slurry will need to be further diluted by receiving water to achieve the criterion level.

An example of a chemical constituent of less concern would be dissolved arsenic. The Columbia River-Willamette River bottom elutriate had an average dissolved arsenic concentration of 2 ug/L compared with the criterion level for irrigation use of 100 ug/L. Because the elutriate should represent the maximum dissolved arsenic concentration during the dredging and disposal operation, the criterion standard should be met without difficulty.

SELECTED REFERENCES

American Public Health Association and others, 1975, Standard methods for the examination of water and waste water [14th ed.]: Washington, D.C., Am. Public Health Assoc., 1193 p.

Brown, Eugene, Skougstad, M. W., and Fishman, M. J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geol. Survey Techniques Water-Resources Inv., book 5, chap. A1, 160 p.

Demas, C. R., 1976, Analyses of native water, bed material and elutriate samples of major Louisiana waterways, 1975: U.S. Geol. Survey Open-File Rept. 76-853, 304 p.

Goerlitz, D. F., and Brown, Eugene, 1972, Methods for analysis of organic substances in water: U.S. Geol. Survey Techniques Water-Resources Inv., book 5, chap. A3, 40 p.

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U.S. Environmental Protection Agency, 1974, Methods for chemical analysis of water and wastes: Cincinnati, Ohio, Natl. Environmental Research Center, 298 p.

_____1975, Navigable waters: Discharge of dredged or fill material: Federal Register, September 5, 1975, v. 40, no. 173, pt. 230, p. 41292-41298.

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Table 1.--Chemical analyses of bottom material, river waters, and elutriate samples

[Analyses by the U.S. Geological Survey, Denver, Colo. ug/L, micrograms per liter; mg/kg, milligrams per kilogram; lb/yd^3, pounds per cubic yard]

Parameter	Sample identification: Dissolved constituents (ug/L): Columbia River A	Columbia River B	Columbia River-Willamette bottom elutriate A	Columbia River-Willamette bottom elutriate B	Willamette River A	Willamette River B	Willamette River-Willamette bottom elutriate A	Willamette River-Willamette bottom elutriate B	Willamette River bottom sediment, dried (mg/kg[1])
Ammonia nitrogen-N	60	0	4,100	4,000	40	100	4,400	4,300	250
Arsenic	1	1	2	2	0	0	7	2	3
Chromium	40	40	40	40	40	40	40	40	18
Copper	3	2	5	4	1	1	5	9	35
Cyanide	0	0	0	0	0	0	0	0	0
Iron	20	20	40	60	70	110	60	100	23,000
Lead	6	4	4	5	5	3	6	5	20
Manganese	0	0	450	450	20	20	490	540	83
Mercury	.0	.0	.0	.0	.0	.0	.0	.0	.11
Zinc	10	20	20	20	8	8	10	20	120
Aldrin	.00	.00	.00	.00	.00	.00	.00	.00	.0
Chlordane	.0	.0	.0	.0	.0	.0	.0	.0	.015
DDD	.00	.00	.00	.00	.00	.00	.00	.00	.016
DDE	.00	.00	.00	.00	.00	.00	.00	.00	.009
DDT	.00	.00	.00	.00	.00	.00	.00	.00	.0011
Dieldrin	.00	.00	.00	.00	.00	.00	.00	.00	.0005

See footnote at end of table.

Table 1.--Chemical analyses of bottom material, river waters, and elutriate samples--Continued

Parameter	Sample identification: Dissolved constituents (ug/L): Columbia River A	Columbia River B	Columbia River-Willamette bottom elutriate A	Columbia River-Willamette bottom elutriate B	Willamette River A	Willamette River B	Willamette River-Willamette bottom elutriate A	Willamette River-Willamette bottom elutriate B	Willamette River bottom sediment, dried (mg/kg[1/])
Endosulfan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Endrin	.00	.00	.00	.00	.00	.00	.00	.00	.0
Heptachlor epoxide	.00	.00	.00	.00	.00	.00	.00	.00	.0
Heptachlor	.00	.00	.00	.00	.00	.00	.00	.00	.0
Lindane	.00	.00	.00	.00	.00	.00	.00	.00	.0
Methoxychlor	.00	.00	.00	.00	.00	.00	.00	.00	.0
Polychlorinated biphenyls (PCB)	.0	.0	.0	.0	.0	.0	.0	.0	.13
Polychlorinated napthalenes (PCN)	.0	.0	.0	.0	.0	.0	.0	.0	.0
Perthane	.00	.00	.00	.00	.00	.00	.00	.00	.0
Toxaphene	0	0	0	0	0	0	0	0	.0
Residue, loss on ignition									83,000
Chemical oxygen demand									79,000
Total organic carbon									19,000

1/ To convert mg/kg to lb/yd^3 (wet sediment), multiply by 1.16×10^{-3}.

Table 2.--Percent moisture and residue, loss on ignition, analyses of bottom material

[Analyses by the U.S. Geological Survey, Portland, Oreg.]

Sample identification	Wet sample volume (ml)	Moisture (percent)	Density		Residue, loss on ignition		
			g(dry) / ml(wet)	lb(dry) / yd^3(wet)	Percent of dry weight	g(dry) / kg(dry)	lb(dry) / yd^3(wet)
1	5	48	0.69	1,160	6.8	68	79
2	5	48	.67	1,130	7.0	70	79
3	5	54	.81	1,360	5.9	59	80
4	5	48	.72	1,220	6.9	69	84
5	5	48	.67	1,130	7.0	70	79
Median		48	.69	1,160	6.9	69	79

Table 3.--Suggested maximum concentrations for specific water uses

[According to Environmental Protection Agency (1976)]

Constituent	Concentration (ug/L)	Water use
Total ammonia	2,300 at 15°C, pH = 7.5	Freshwater aquatic life
Arsenic	50	Domestic
	100	Irrigation
Total chromium	50	Domestic
	100	Freshwater aquatic life
Copper	1,000	Domestic
	1.8	Chinook salmon
Cyanide	5	All aquatic life
Iron	300	Domestic
	1,000	Freshwater aquatic life
Lead	50	Domestic
	5.2	Coho salmon
Manganese	50	Domestic
	100	Marine mollusks
Mercury	2	Domestic
	.05	Freshwater aquatic life and wildlife
	.1	Marine aquatic life
Zinc	5,000	Domestic
	1	Chinook salmon
Aldrin	.003	All aquatic life
Chlordane	.01	Freshwater aquatic life
	.004	Marine aquatic life
DDT	.001	All aquatic life
Dieldrin	.003	All aquatic life
Lindane	4	Domestic
	.01	Freshwater life
	.004	Marine life
Methoxychlor	100	Domestic
	.03	All aquatic life
PCB	.001	All aquatic life