COLUMBIA RIVER, MULTNOMAH CO., OR; OREGON SLOUGH SEDIMENT QUALITY EVALUATION

Abstract

Routine sediment sampling and testing results indicate the sediments to be dredged from a shoal located between RM 0.3 and 0.6 along the western margin of the Oregon Slough channel are acceptable for unconfined in-water disposal. These sediments, therefore, require no further testing according the provisions of the Clean Water Act. Mechanical analysis revealed the sediment sampled is silt with variable percentages of sand. Dredged materials sediment testing was conducted on the sediment for metals, pesticide, PCB, and organotins (TBT to MTB) according to EPA protocols and were all found to be below established concern levels. No unacceptable adverse environmental impacts are expected from disposal.

Introduction

Previous Studies

1. The authorized project provides for a channel 40 feet deep and 400 feet wide from the Columbia River to Oregon Slough RM 1.5, including a turning basin 3,000 feet long and 1,000 feet wide, which is also 40 feet deep. A 20 foot channel extends upstream from Oregon Slough RM 1.5 to 3.8. Access from the 40 foot channel to berthing areas at Terminal 6 extends from immediately below RM 0.0 upstream to RM 0.4 located on the western margin of Oregon Slough at its extreme downstream end.

2. Shoaling in this reach of Oregon Slough navigation channel began several years ago and has become a problem between RM 0.3, continuing upstream to RM 0.95. Hydrosurveys from February 1996 show the depths in this reach to be between 32 and 39 feet, whereas ships using the navigation channel to call at Terminal 6 are container vessels that have drafts of 39 or 40 feet. Consequently, the shoal on the western side of the channel restricts clear access to berthing for these vessels which must stand off until a berth with access to the unimpaired segment of the Federal channel is open. According to the Port of Portland, Terminal 6 is of "extreme" regional significance and continued operation with a shoal blocking a substantial portion of the Federal channel is causing them to endure great hardship.

3. Sediment quality evaluations of materials to be dredged from the Terminal 6 berths were conducted by the Port of Portland in 1988. More recently the Port of Portland conducted sediment quality evaluations of the berthing areas prior to dredging the berthing areas in 1993. The Port analyzed sedimints from that reach again in 1995. These evaluations showed the pollutant levels in the sediments to be below levels of concern and dredging operations were undertaken in the Federal channel during November 1995 using the Corps' hopper dredge Yaquina.

4. In attempting to dredge this reach of the Federal project in November 1995, the Yaquina encountered oil droplets which were seen rising to the surface and forming an oil sheen. The sheen developing from individual droplets formed a discontinuous sheen of discreet 13 to 18 cm circular patterns which moved in a downstream direction in response to current action. Two passes were made with the dredge, during which oil sheens were seen to develop. The appearance of a patterned oil sheen during both dredging passes caused dredging operations to be halted. The recurrence of the oil sheen on the second pass apparently led Corps personnel to the conclusion that the oil sheen may not be a transient condition and might persist throughout dredging of the prism. Based on the perceived potential for the condition to persist, the

dredging operation was suspended and the incident was reported to the Coast Guard and ODEQ.

5. The Corps was unable to readily identify the source of the oil droplets while the Yaquina was engaged in dredging the shoal. However, since dredging was halted without making a determination as to the cause of the oil sheen, and without knowing the source or nature of the contamination, the conjecture that a significant potential for a recurrence of a similar incident during future dredging operations is valid. A sediment quality testing plan, including physical and chemical analysis was developed based on this conjecture. This report addresses the physical and chemical aspects of sediment quality in the materials that will be removed when dredging of the Federal channel is resumed.

Current Study

6. The Oregon Slough study was undertaken to evaluate shoal materials in the reach between Oregon Slough RM 0.0 to 0.4 to assure compliance with requirements of the Clean Water Act (CWA) pertaining to disposal of dredged material. The CWA requires an environmental evaluation of dredge material to determine acceptable dredge material disposal options. Although CWA evaluations have previously been made on this shoal, recent high flows through the slough could have disturbed or redistributed the shoal, however, soundings of the area did not find any significant change in shoal configuration since the hopper dredge Yaquina attempted to remove it in November. No effort was made at that time to identify a possible source for the oily sheen which was noted during the dredging operation. Consequently, this study focuses on the physical and chemical evaluation of the sediments in the shoal itself as being a possible source of the oil that caused the surface sheen. Historically, the sediment in this shoal has been composed primarily of clean silt with subordinate amounts of medium to fine sands. Although clays and organics are present, they are found in small amounts, usually far less than 10 percent. Since organic materials and the clays provide attachment sites for physico-chemically active pollutants and contaminants, these fractions are of greatest concern in CWA evaluations of dredge materials to be placed in disposal sites.

7. Because the shoal was not materially affected during the February 1996 flooding and still constitutes a serious hazard to navigation in Oregon Slough, an attempt will be made to expedite the dredging effort and undertake clearing of the shoal from the Federal channel during August 1996.

8. In order to facilitate this effort, sampling and sediment quality testing was conducted during March 1996 in accordance with the Corps' Oregon Slough Sediment Sampling Plan. The objective of this recent sampling and testing was to evaluate current sediment quality in the portion of the shoal proposed for removal as well as to develop a dredged material management plan conforming to the requirements of the Clean Water Act (CWA). Materials from the same reach of the shoal in Oregon Slough where the Corps discovered an oil sheen in November of 1995 were analyzed to determine the options for dredged material placement. Leadline soundings at the time of sampling indicate the shoal configuration changed slightly since the February hydrosurvey, this was probably due to higher current velocities associated with the high water stage that prevailed in the slough after the February flood event.

Methods

Sediment Sampling

9. Sediment sampling was done in conformance with the Oregon Slough Sampling Plan, 1996. The plan was directed at sampling fine-grained sediments and calls for performing bulk chemical and physical analyses. Samples were taken with a gravity corer 2-meters long. The core is held by a butyrate innertube 6.3 cm in diameter as the corer is withdrawn from the sediment and is retained in the tube until extruded for examination and logging.

10. Four Sediment samples were taken using a Benthos Gravity Corer on 13 MAR 96. The sample locations are shown on the attached map (Figure 1). Each of the four cores were approximately 1 meter in length and therefore represent the full depth of sediments within the dredging prism. During the coring procedure no contaminants or pollutants of any nature were noted on the coring device, the water or any of the tackle. Cores were extruded and logged immediately upon completing the sampling operation. Each core was quartered longitudinally and composite samples were extracted along the full length of one longitudinal quarter of each core. Samples for chemical testing were placed in 500 ml commercially prepared "clean" jars and placed in a cold-packed cooler for shipment to NPD Laboratory. Physical samples were similarly obtained from quartered cores, placed in Zip-Loc PE bags and packed in a styrofoam cooler chest, but were not cold-packed for shipment. Chemical and physical samples were delivered to the North Pacific Division Materials Laboratory in Troutdale, OR on 14 MAR 96, and were maintained at a cold temperature until they were received at the contract analytical laboratory on 15 MAR 96.

Sediment Testing

11. Field testing of physical attributes of the sediment was performed on bulk and quartered cores immediately after they were extruded. Field analysis included determinations of fabric, stratification, texture, color, moisture content, plasticity, consistency or compactness, organic material content and remolded consistency.

12. Physical testing in the NPD laboratory was conducted for volatile solids content, particle sizes, resuspended density, void ratio, specific gravity, and particle roundness. Tests were performed according to ASTM standards.

13. Chemical analysis consisted of tests for total organic content (TOC), acid volatile sulfides (AVS), metals, organochlorine pesticides, polychlorinated biphenyls (PCB) and polynuclear aromatic hydrocarbons (PAH). A quality assurance report of contract laboratory performance is attached as Exhibit 1.

Results and Discussion

Physical Analysis

14. Results of physical analyses are presented in Table 1. The materials recovered were classified as ML, (non-plastic silt with sand) according to the Unified Soil Classification System (USCS) and ASTM D 2487. The particle sizes from all samples ranged from No. 10 sieve, 2.00 mm to 0.0048 mm, with mean particle diameter, (Diam. of 50% of sizes) between 0.041 and

0.049 mm. Silt and clay, or fines, range from 73 to 81 percent of the bulk samples and of this fraction, about 7 percent is clay. Subangular to subrounded sand comprises between 19 and 27 percent of the material that is to be dredged. Dredged materials analysis results show the mean of the resuspended density to be 2630 g/l, void ratio mean value is 2.354, the mean percentage of volatile solids is 3.7 percent and the mean specific gravity is 2.630. The physical values determined by this testing are within the range of values determined by the Port of Portland's analyses done in 1993. Neither of the physical analysis showed the presence of free oils or oily substances such as those that were seen during the dredging operation in November of 1995. Also, the fine fraction of the sediment contained relatively low clay percentages, which will partition contaminants or pollutants from the water column through the adsorption process.

Chemical Testing Results

Metals

15. The results of analysis for specific metals are given in Table 2. Metals were found to be below levels of concern according to Portland District established levels. This result agrees with the result of 1993 testing conducted by the Port of Portland.

Organics

Pesticides and PCB

16. Results of pesticide analysis are shown in Table 3. Pesticides 4,4'-DDD and 4,4'-DDE were present in all four samples in amounts estimated to be between 2 and 4 parts per billion, which is higher than the method reporting limit, but well below the Tier II screening limits. No other pesticides were detected in the sample materials. There were no PCB's detected in any of the samples.

PAH

17. Polynuclear Aromatic Hydrocarbons, PAH's, were detected by gas chromatography in all four samples at very low levels (Table 4). Because these levels are below the reporting limits, but below or only slightly above the detection limit for the analysis method, the values reported here are estimates. The PAH's that were detected are Flouranthrene and Bis(2-Ethylhexyl) Phthalate. In addition, the presence of a number of tentatively identified, but unknown compounds were detected in each of the sediment samples. Based on the reporting limit being higher than required, the sediment samples were analyzed using the Selected Ion Monitoring (SIM) method, which enables detection of specific compounds to the parts per billion range. At this level of detection, the number of PAH's found to be present in the sediment increased from one compound in OS-GC-1 and 4, to 8 compounds in OS-GC-1, and 3 compounds in OS-GC-4. Detected compounds in OS-GC-2 increased from 2 to 4; in OS-GC-3 detected compounds increased from 3 to 6. Irrespective of detecting more PAH's at lowered detection levels, values were still well below the Portland District or EPA's level of concern for Tier II analysis.

Organotins

18. Organotins, also known as Butyltins or commonly by the more frequently found member of the compound class, Tetra-n-butyltin (TBT), were detected in all four of the samples. The TBT values were below Corps' established levels of concern, with three being present at or less than one-half the concern value and one value at about two-thirds of the concern level.

Quality Control

19. Quality assurance is accomplished by NPD Materials laboratory and is attached as Exhibit E. As noted on the testing reports from the contract laboratory, PAH and Organotin analysis results show some matrix interference, however, method blanks were free of targeted analytes and results of the contaminant analysis are within QC tolerances and is acceptable.

Discussion

Physical Analysis

20. The core evaluation performed in the field disclosed no trace of unusual odors, colorations or staining, or other indications of the presence of oily substances within the sampled portions of the dredging prism. A 100 ml vial with a few droplets of the oily substance was recovered from the dredge in November 1995. Visual comparison of the oily droplets taken from the slough water with the sediment cores and water associated with the core showed no similarities. Also the water surface, core barrel and liners showed no oil or iridescent film during the March sampling operation. Based on these findings, it is suggested that the source of the oil that caused the sheen was either not found during the sampling, or it was a transient condition that manifested coincident with the dredging operation. With regard to the conjecture that the February 1996 flood may have significantly altered the shoal, there were no indications to confirm such conjecture nor was it confirmed that alteration of the shoal by the flood would necessarily have affected the production of an iridescent sheen. In the absence of any physical evidence to support the supposition that the sediment in the dredging prism was the source of the sheen, there is no reason to believe that a recurrence of an oily sheen would be contingent on a dredging operation being conducted in Oregon Slough.

21. The bulk samples obtained were field-classified as fine-grained and were observed to have the physical characteristics of a reworked sediment typical of those usually found in relatively slow-moving portions of the lower Columbia River. These sediments are largely of glacio-fluvial origin and seldom contain significant amounts of clay. They have undergone several alluvial cycles; each of which removes a fraction of the clay deposited during the previous cycle. It is significant that clays make up a relatively small percentage (about 7%) of these sediments because it is the clay and organic content of the fine-grained fraction that is primarily responsible for partitioning the chemicals from the water column and concentrating them in the bottom sediments.

22. Although fine-grained material constitutes the major percentage of the sediment, it is mostly silt having a relatively "gritty" feel, indicating that coarse-grained silt is the major constituent. Therefore, its ability to partition chemicals of concern in significant amounts within the sediment column would be relatively small. The clay minerals, by contrast, carry an electrical charge on the crystal lattice and, depending on the clay mineral involved, have more or less affinity for molecules of elements or compounds which carry an electrical charge. These

electrically charged molecules, including most priority pollutants and chemicals of concern tend to attach to the crystal lattices of compatibly charged clay crystals. In general, non-plastic silts exhibit a lack of plasticity because they do not contain enough clay and, or organics to enable them to demonstrate plastic behavior. Lacking a substantial amount of clay, the low plasticity silts which are normally found in Lower Columbia sediment columns, tend to adsorb chemicals only when the organic fraction of the sediment is in excess of about 12 percent. If the clay and, or organic content is less than about 15 to 20 percent of the total sediment, regardless of the percentage of "fines," there are few adsorption sites available for electro-chemical bonding. Therefore, the pollutant content tends to be very low in silty or sandy sediment with low plasticity.

23. It should be pointed out that mechanisms for retention of pollutants other than electro-chemical bonding are active in fine-grained sediments. Chief among these other pollutant retention mechanisms is entrapment within pore spaces, in which case the pollutant remains within the water column. This often occurs when the material of interest is insoluble or nearly so, in water or is in a solid phase. Entrapment may well have been the means of retention for the oily substance which caused the sheen that developed during the dredging in November of 1995. The nature of the oily droplets recovered from the dredge suggest that the substance could have originated from some material trapped within the pores of the sediment column since nothing was noted on the water surface around the dredge before the shoal was disturbed. It would be hard to postulate this type of event stemming from mechanical disturbance of something held in suspension within the water column. The Dredge itself could introduce something into the water that would cause the observed phenomenon, but no malfunction of the equipment was apparent either before or after the incident.

Chemical Analysis

24. The pollutant content of the sediment was in all cases below levels of concern. Values reported in the laboratory analysis were too low to have produced enough volume to be seen as droplets, discolorations or to have produced detectable odors. Consequently the results of the chemical analysis provides no information about the nature or source of the oily sheen that was noted during the November 1995 dredging.

25. In comparing the values obtained from the Port's 1993 sediment quality analysis and the analysis reported here, this analysis detected fewer compounds overall, but those common to both analyses were present at roughly the same concentrations and both analyses found concentrations to be below Portland District's and EPA's established levels of concern. A trend in concentrations of specific substances or groups of compounds upward or downward is not apparent in the data sets, nor is there any indication that targeted substances are concentrated in any specific portion of either the shoal or sediment column outside the shoal.

Recommendation

26. Based on the results of this analysis, sediments from this shoal can be placed in unconfined in-water disposal site. No unacceptable adverse effects on the aquatic environment will result from such disposal and State water quality standards should not be violated as a result of unconfined in-water disposal of the materials dredged from the shoal lying immediately downstream of Oregon Slough RM 0.0 and 0.4.

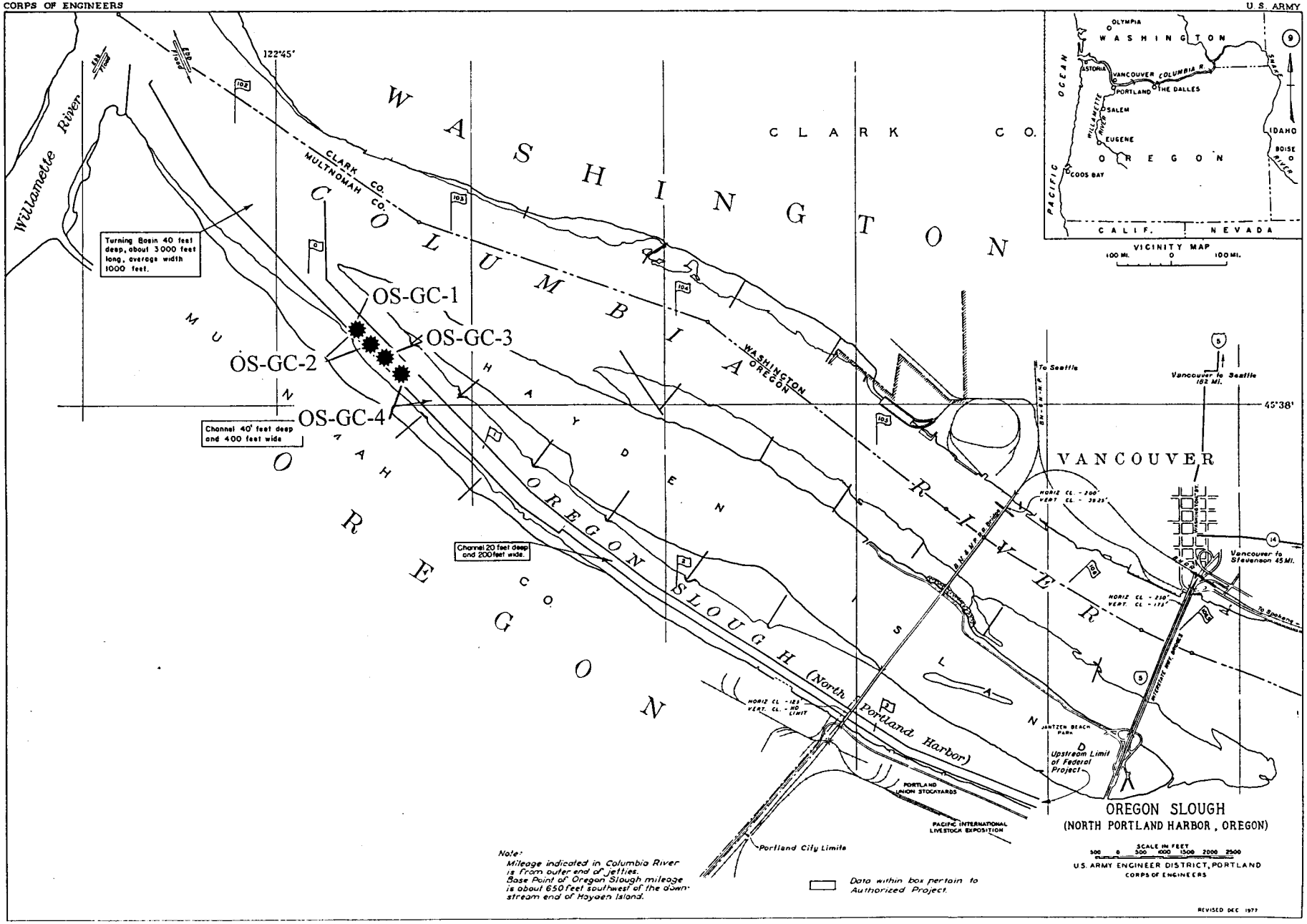

Figure 1. Sediment quality sampling locations, 1996

Table 1. Results of physical analyses of Portland Harbor sediment samples, 1996

sample	core length inches	mean gr. size mm	sand	silt	clay	volatile solids
			%			
OS-GC-1	46	0.05	33.2	59.6	7.2	4.0
OS-GC-2	43	0.04	35.8	57.0	7.2	3.5
OS-GC-3	31	0.04	32.4	59.5	8.1	3.4
OS-GC-4	43	0.04	27.2	65.1	7.7	4.0
mean		0.04	32.2	60.3	7.6	3.7

Table 3. Concentrations of pesticides and PCBs in Oregon Slough sediment samples, 1996

sample	Delta-BHC	4,4'DDE	4,4' DDD	endosulfan II	PCBs
			ppb		
OS-GC-1	< 2	4	4	< 1	ND
OS-GC-2	< 2	3	3	< 1	ND
OS-GC-3	< 2	4	2	< 1	ND
OS-GC-4	< 2	4	3	< 1	ND
mean	< 2	3.8	3.0	< 1	ND

Table 4. Concentrations of PAHs and phenols in Oregon Slough sediment samples, 1996

sample	fluoranthene	pyrene	benzo (a) anthracene	chrysene	benzo (b) fluoranthene	benzo (k) fluoranthene	benzo (a) pyrene	indeno (1,2,3-c,d) pyrene	dibenzo (a,h) anthracene	benzo (g,h,i) perylene	total
	ppb										
OS-GC-1	49	50	--	32	33	25	27	27	--	29	272
OS-GC-2	42	43	--	--	28	26	--	--	--	--	139
OS-GC-3	54	51	--	30	35	--	25	--	--	25	220
OS-GC-4	42	43	--	--	29	--	--	--	--	--	114
mean	47	47	--	31	31	26	26	27	--	27	261