

**Supplemental TBT Data
For the Coos Bay Channel Deepening Project**

Mark D. Siipola and James L. Britton

24 October 1994

Abstract

Tributyltin (TBT) in Coos Bay sediments were evaluated along two transects in the Isthmus Slough portion of Coos Bay. All samples analyzed contained detectable amounts of TBT. Nearshore areas contained TBT concentrations one to two orders of magnitude above sediments from the Federal channel.

Introduction

1. Sediment samples were collected along two transects in Isthmus Slough at Coos Bay to evaluate potential metal and TBT contamination. Previous evaluation of sediments from the Federal navigation channel by the USACE, Portland District determined that though TBT levels were detectable that the material to be dredged was suitable for unconfined in-water disposal. The evaluation of sediment samples from two locations outside of the Federal channel by the Oregon Department of Environmental Quality (DEQ) raised questions about contamination along the sides of the channel. Further, concerns were raised about the possibility of sloughing of contaminated sediments due to the proposed 2-foot channel deepening project.

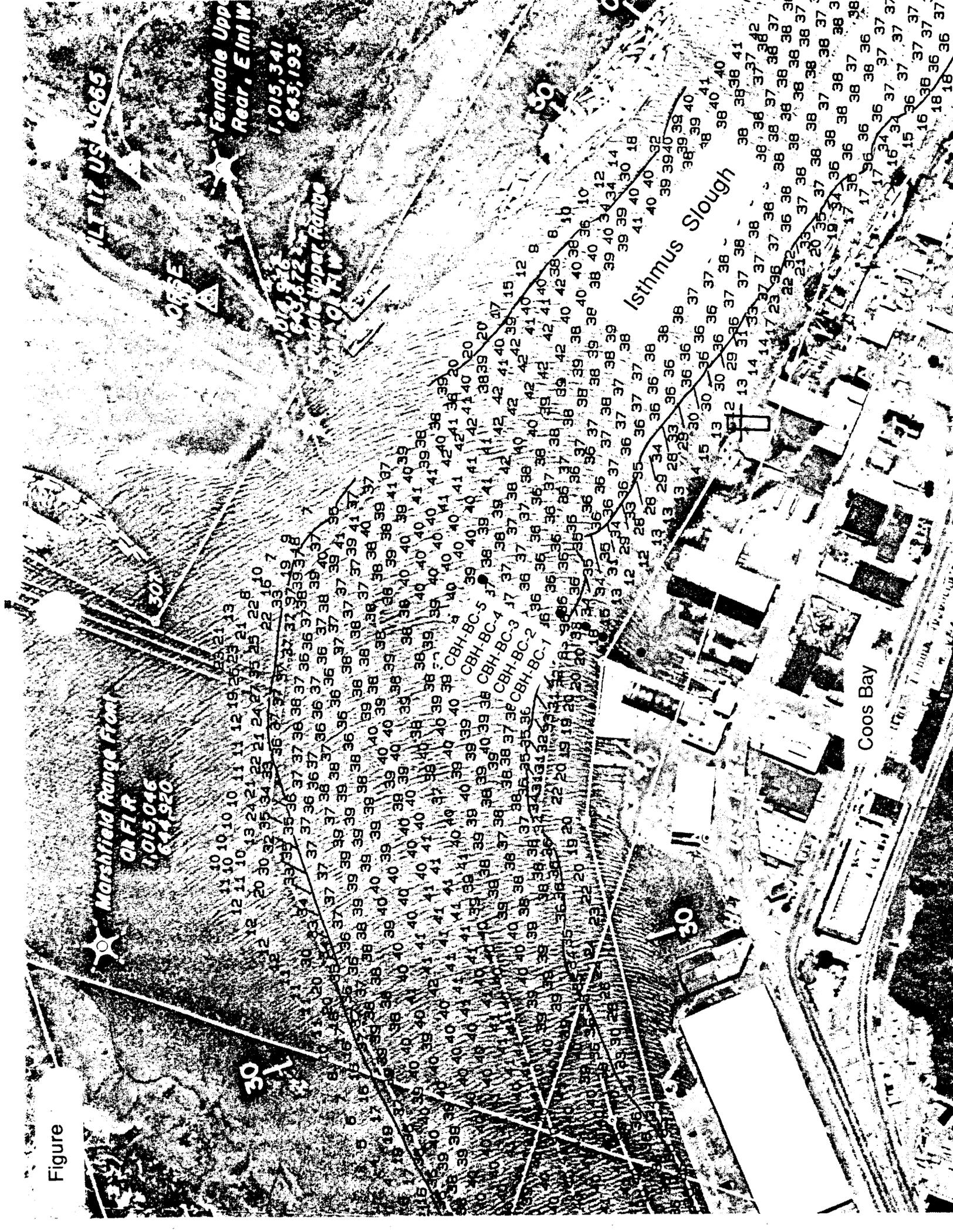
2. Hilstrom Marine (RM 13+40) and Mid Coast Marine (RM 15) have been sites of past boat repair, sandblasting, and painting activities. Sediments collected and analyzed by DEQ indicated high levels of metals and TBT at these two sites. The present sampling plan was designed to confirm previous analytical results and delineate sediment contamination at these two locations in relation to the Federal navigation channel.

Methods

3. Sediment samples were collected near Hilstrom Marine and Mid Coast Marine in the Isthmus Slough area of Coos Bay (Figure 1 & 2) with a modified 0.1 m Gray O'Hare box corer. A total of 5 physical and 5 chemical samples were collected along each transect. Exact sample locations were selected in the field based upon previous sample locations and bottom topography. Samples were collected at the toe, mid-slope, and crest of the side-slope of the Federal channels as well as midway to the center of the channel and at the Hilstrom Marine site itself. Since the Mid Coast Marine site was at grade with the Federal channel samples were collected across the channel starting at Mid Coast Marine and extending to the opposite dock.

4. All sampling, handling, shipment, storage, and analyses were conducted according to methods developed and approved jointly by the U. S. Environmental Protection Agency and the U. S. Army Corps of Engineers (1).

Figure



5. Physical analyses consisted of the standard dredge test as conducted by the USACE, Materials Testing Laboratory, Troutdale, Oregon. Physical parameters measured were resuspended density, void ratio, volatile solids, specific gravity, and sediment grain size distribution.
6. Chemical analyses were performed by Columbia Analytical Associates, Kelso, Washington. Samples were tested for the following parameters - percent solids (EPA method 160.3), 8 heavy metals (method 3050), acid volatile sulfide (EPA draft method, Aug. 1991), total organic carbon (ASTM method D4129-82) and tributyltin (including mono and dibutyltin) (Krone et al, 1988, NOAA).
7. A quality assurance report assessing the chemical data was prepared by the USACE, Materials Testing Laboratory, Troutdale. The report is included in the appendix with the raw data. The basic conclusions were that the data are acceptable except the acid volatile sulfide (AVS) and organotin data, which should be considered over estimates. In the case of AVS, matrix spike (MS) recoveries were above EPA QC limits. For organotins, both MS and surrogate recoveries were high. Based on these high recoveries the data may be considered over estimates.
8. Samples were taken along two additional transects at the request of representatives of the DEQ which were present during sediment sampling. One transect was on the downstream side of Hilstrom Marine, the other stretched across the channel at RM 14+40. These samples were processed along with the USACE's samples. The additional samples were split at the USACE's analytical laboratory with one split held in storage and the other sent to DEQ for analyses. DEQ also received a split of the samples analyzed by the USACE, Portland District.

Results/Discussion

Physical

9. Sediment from both sites contained roughly the same proportions of sand, silt, and clay (Table 1). With the exception of the samples closest to the shoreline at the two sites, the sediments were clayey, sandy silt with a median grain size of coarse silt. At each site the sample closest to the shore was sandy (Hilstrom Marine) or pebbly (Mid Coast Marine). The organic content was about 2 times greater in the samples from Mid Coast Marine than Hilstrom Marine. This is reflected in percent volatile solids and percent TOC content (Tables 1 and 3). Mid Coast Marine is further upstream in Isthmus Slough on a more quiescent portion of the channel. During sampling at Mid Coast Marine a high quantity of organic debris including wood chips and bark was noted in the box corer.
10. The sandy character of the samples closest to shore at each site can be explained by the nature of commercial activities at the sites. Sand blasting operations to remove paint is the probable reason for the "sandiness" of samples CBM-BC-1 and CBH-BC-1. Prop wash at Mid Coast Marine may also be a factor in the coarse grained nature of the bottom material next to the dock. Sample CBM-BC-1 contained rocks, nails, welding rod, and live native oysters. It was taken adjacent to the dock between two large fishing vessels. Physical analyses revealed it to be 46.1 percent sand and 47.7 percent gravel. Field notes commented on the possibility of sandblast "grit" in CBH-BC-1. This

Table 1. Results of physical analyses of Coos Bay sediment taken near Hilstrom Marine and Mid Coast Marine.

sample	median grain size mm	%			volatile solids
		sand	silt	clay	
Mid Coast Marine					
CBM-BC-1	4.240	46.1	4.2	2.0	1.0
CBM-BC-2	0.040	33.9	49.6	16.5	6.9
CBM-BC-3	0.044	33.8	49.8	16.4	9.4
CBM-BC-4	0.022	28.7	56.4	14.9	7.2
CBM-BC-5	0.021	25.2	58.5	16.3	6.1
mean*	0.032	33.5	43.7	13.2	6.1
Hilstrom Marine					
CBH-BC-1	0.370	75.8	20.2	4.0	1.3
CBH-BC-2	0.054	46.0	42.7	11.3	2.4
CBH-BC-3	0.023	21.3	59.5	19.2	4.0
CBH-BC-4	0.018	13.8	68.8	17.4	5.0
CBH-BC-5	0.029	26.0	55.3	18.7	4.0
mean	0.099	36.6	49.3	14.1	3.3

* mean for % sand does not include CBM-BC-1

Table 2. Metals concentrations in Coos Bay sediment samples taken near Hilstrom Marine and Mid Coast Marine.

sample	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	AVS	solids
	ppm									%
Mid Coast Marine										
CBM-BC-1	20	0.26	395	176	39	0.04	163	456	200	71
CBM-BC-2	10	0.29	73	33	15	0.06	40	109	830	37
CBM-BC-3	89	0.35	50	29	15	0.08	34	86	920	34
CBM-BC-4	9	0.35	56	28	17	0.08	38	90	590	33
CBM-BC-5	9	0.34	48	27	15	0.06	37	87	830	34
mean	27	0.32	124	59	20	0.06	62	165	674	42
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CBH-BC-3	9	0.31	53	282	22	0.06	37	89	370	35
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CBH-BC-5	8	0.26	44	21	11	0.06	32	76	290	40
mean	9	0.25	209	267	32	0.20	124	96	370	46
SL	57	0.96	180	81	66	0.21	140	160		

Table 3. Butyltins and organic carbon (TOC) in Coos Bay sediment taken from Hilstrom Marine and Mid Coast Marine.

sample	TBT	DBT	MBT	TOC
		ppb		%
Mid Coast Marine				
CBM-BC-1	240	95	39	0.84
CBM-BC-2	300	570	120	5.26
CBM-BC-3	87	6	14	6.82
CBM-BC-4	130	10	19	5.84
CBM-BC-5	67	<4	<4	5.57
mean	165	170	48	4.87
Hilstrom				
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CBH-BC-2	2700	470	140	3.27
CBH-BC-3	39	10	10	3.58
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mean	1122	256	120	2.85

EPA Region 10 screening level for TBT is 30 ppb.

sample was taken near the dock in 10 feet of water. Physical analyses showed it to be 75.8 percent sand.

Metals

11. Elevated levels of arsenic (13-20 ppm), chromium (395-600 ppm), copper (176-503 ppm), lead (39-65 ppm), nickel (163-363) and zinc (129-456 ppm) were found at both Hilstrom Marine and Mid Coast Marine (Table 2). Mercury (0.58 ppm) was elevated at the Hilstrom site. These metals exceeded the EPA, Region 10 and Portland District concern levels in one or more samples (Table 2). It's interesting to note that the two sites are more than a mile distant from each other and on opposite banks of Isthmus Slough, yet have a similar pattern of metals contamination. The Hilstrom Marine site was formerly occupied by Mid Coast Marine. At each site boats were repaired, sandblasted, and painted. These operations are the probable sources of these metals. TBT data presented later corroborates this interpretation of the data.

12. The most contaminated samples were nearest the shore (Table 2). These were also the samples that physical analyses revealed to be much different from the other samples. Concentrations of metals tapered off to below concern levels as the samples approached the upper edge of the Federal channel at both sites (Table 2). Along the edge of the Federal channel and within the channel metals concentrations were below concern levels. The physical nature of these samples was fairly uniform and more consistent (Table 1). The Federal channel is routinely dredged so, predictably, concentrations of heavy metals should be low. Over the years sediment studies have routinely shown this to be the case (2, 3). The fact that the concentrations taper off substantially as the samples approach the channel indicates that the source of metals is limited locally. These results show that Federal channel material even close to the edge of the channel is relatively free of contaminants. Slumping of this edge-of-channel sediment into the Federal channel, as a result of channel deepening, should not represent a serious contamination threat.

AVS

13. AVS is an important constituent of sediment that can ameliorate the toxicity of metals. AVS serves as a sulfur pool that reacts with soluble metals in sediment interstitial water forming insoluble metal sulfides. These sulfides precipitate out of water rendering the metals less toxic to aquatic organisms. Research shows that whether this happens or not depends on the ratio of metals to AVS in the sediment (4, 5). AVS is the fraction of sulfide extracted from sediment using cold hydrochloric acid (HCL). Metals extracted with the cold HCL are called simultaneously extracted metals, or SEM. When the ratio of SEM to AVS is greater than 1.0 toxicity to aquatic organisms may result from metals that are released into sediment interstitial water and possibly overlying water.

14. AVS was about twice as high in Mid Coast Marine versus Hilstrom Marine samples (Table 2). Both sites are in fairly quiescent areas of Isthmus Slough. They are similar in proportions of sand, silt, and clay. The major difference between sites is in the organic fraction. Mid Coast Marine samples contained more volatile solids and total organic carbon (TOC) than Hilstrom samples (Tables 1 and 3). Field observations indicated that Mid Coast Marine samples contained more organics such as bark, wood chips, twigs, and shell

fragments. Sulfur in organic matter from dead and living organisms is a major source of AVS in sediment.

15. The samples closest to shore at each site, CBM-BC-1 and CBH-BC-1, were 2 to 4 times lower in AVS than nearby samples. Again, this is probably reflective of the sandy nature of these samples and the greater organic content of the offshore samples. Besides organic matter, local in-sediment conditions can influence the level of AVS in sediment. Aerobic sediment is low in AVS because sulfur in the sediment is oxidized to sulfate which is soluble in water.

TBT

16. Coos Bay sediments have been found to contain elevated levels of TBT especially near boat repair areas like Hilstrom and Mid Coast Marine (3, 6). TBT in sediment in the form of paint chips can be slowly released into the sediment interstitial water and eventually makes its way into the water column. There is also evidence of toxic effects to oysters in some areas of the bay (7).

17. TBT was well above concern levels at both Hilstrom Marine and Mid Coast Marine (Table 3). For each site the two nearshore samples were higher than samples taken towards the edge of the Federal channel. At Hilstrom Marine TBT concentrations dropped two orders of magnitude between samples CBH-BC-2 and CBH-BC-3 from 2700 ppb to 39 ppb respectively. The concentrations of TBT found in the samples are probably overestimates because matrix spike and surrogate recoveries were high.

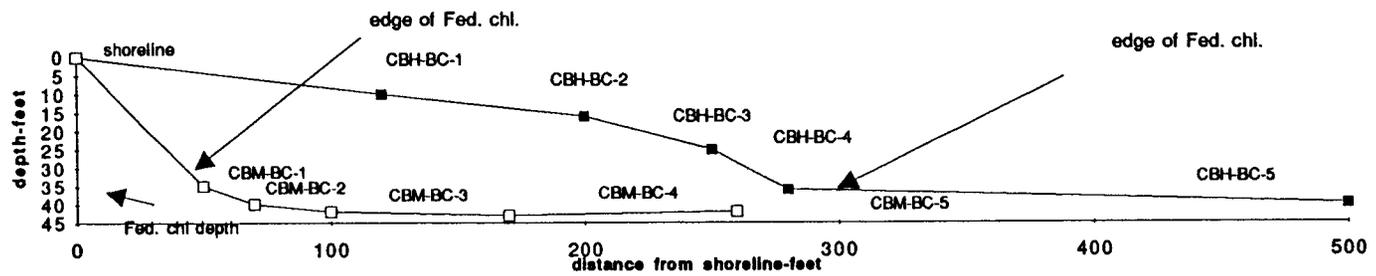
18. The fact that TBT levels drop off rapidly as the samples approach the edge of the Federal channel corroborates the conclusions of an earlier study that indicated Federal channel material is low in TBT (3). In marinas and boat works, paint chips from boats and from sandblasting operations settle quickly. This material is dredged infrequently. The Federal channel is regularly dredged so that TBT concentrations do not build up. In reaches of the channel adjacent to TBT hot spots, sediment samples do sometimes contain slightly elevated TBT concentrations - for example, the Federal channel near Mid Coast Marine (Table 3). Channel sediments near Hilstrom Marine slightly exceed the concern level of 30 ppb (Table 3). The probability that these values are overestimates indicates that actual values are likely below the concern level.

Channel Edge Considerations - Hilstrom vs Mid Coast Marine

19. A major purpose of this study was to determine the extent and pattern of TBT contamination and potential for contamination of the Federal channel from slumping of side-slope material due to dredging activities associated with channel deepening. The side slope at Hilstrom Marine is much less steep than at Mid Coast Marine (Figure 3).

20. At Hilstrom Marine samples CBH-BC-1 and 2 are on a gently sloping shelf. Sample CBH-BC-3 was collected half way down the slope while CBH-BC-4 was collected at the toe of the Federal channel roughly 280 feet from the shoreline. Between samples CBH-BC-2 and 4 the slope steepens gradually from a 15 foot depth to project depth of 35 feet in the space of 80 feet.

Figure 3. Location of samples in relation to the approximate cross section of channel at Hilstrom Marine and Mid Coast Marine



Horizontal is about 0.7 the vertical scale. This graph was developed from survey data taken in June 1994.

Sandblasting sand, metals, and TBT contamination is confined to CBH-CB-1 and CBH-CB-2. The data shows that contamination does not extent into the Federal channel since CBH-BC-3 and 4 are not contaminated with either metals or TBT (Tables 2 and 3, Figure 3). Dredging to deepen the Federal channel 2 feet should not result in contamination of sediment in the Federal channel nor release of contamination during dredging.

21. Bathymetry at Mid Coast Marine is quite different. It reveals that the bottom drops off rapidly from the shoreline to project depth (Figure 3). The Federal channel here is approximately 50 feet from the shoreline. Sample CBM-BC-1, taken alongside the dock, was 40 feet out from the shoreline and in water 35 feet deep, while CBM-BC-2 was at a depth of 40 feet. In contrast to Hilstrom Marine, it is evident that the slope to the bottom is very steep at Mid Coast Marine and there is no gentle slope to project depth. This may explain why higher concentrations of TBT are found in samples along the transect at Mid Coast Marine. Metals are higher in concentration near the dock (CBM-BC-1).

22. Side-slope slumping or sloughing along the edge of the Federal channel, because of deepening the channel 2 feet, should not cause a large increase in sediment resuspension. The area adjacent to the channel is near final grade, the cut-slope would be minimum. The part of the slope near the undercut should achieve dynamic equilibrium slowly over time. This process should not be rapid nor should it lead to vigorous churning of sediment. The natural process of bedload adjustment is ongoing.

Conclusions

23. Sediment samples from both sites were clayey, sandy silt except the two nearshore samples which were sandy. There was evidence of sandblasting sand and/or other man-made artifacts in the nearshore samples based on field observations.

24. Elevated levels of arsenic (13-20 ppm), chromium (395-600 ppm), copper (176-503 ppm), lead (39-65 ppm), nickel (163-363), and zinc (129-456 ppm) were found in one or more samples at both Hilstrom Marine and Mid Coast Marine. Mercury (0.58 ppm) was elevated at the Hilstrom site. The most contaminated samples were nearest the shoreline. There was a dramatic drop-off in metals concentrations along the transect towards the Federal channel.

25. AVS was about twice as high in Mid Coast Marine versus Hilstrom Marine samples. There was visibly more organic debris in Mid Coast Marine samples which could account for the difference. The samples closest to shore at each site were 2 to 4 times lower in AVS than samples further from shore. AVS may be overestimated in the samples because of high matrix spike recoveries.

26. TBT was above concern levels at both Hilstrom Marine and Mid Coast Marine. For each site the two nearshore samples were higher than samples taken from the Federal channel. TBT may be slightly overestimated in the samples because of high matrix spike and surrogate recoveries.

27. A major conclusion of this study is that Federal channel sediment is not likely to be contaminated by metals or TBT as a result of channel deepening. While it is true that nearshore samples at Hilstrom Marine are contaminated

with metals and TBT, potential slump material on the slope adjacent to the Federal channel is not contaminated at this site. Further, the slope to the Federal channel is gentle at this site.

28. At Mid Coast Marine metals contamination is confined to a narrow region close to the dock. TBT contamination is higher in the area of the dock (240-300 ppb) and less in the Federal channel (67 ppb to 130 ppb). These values are above the EPA, Region 10 screening level of 30 ppb. While sediments containing 300-600 ppb of TBT were not found toxic to the copepod Acartia tonsa or the mysid Acanthomysis sculpta (10) additional evaluation of the potential adverse effect prior to deepening the upper reaches of the Federal project are warranted. Alternatively the dredging needs for this area could be reassessed and dredging deferred until needed. However, because the dock area is at grade, slumping of slope material into the Federal channel should not further contaminate the channel with metals and TBT.

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Metals

11. Elevated levels of arsenic (13-20 ppm), chromium (395-600 ppm), copper (176-503 ppm), lead (39-65 ppm), nickel (163-363) and zinc (129-456 ppm) were found at both Hilstrom Marine and Mid Coast Marine (Table 2). Mercury (0.58 ppm) was elevated at the Hilstrom site. These metals exceeded the EPA, Region 10 and Portland District concern levels in one or more samples (Table 2). It's interesting to note that the two sites are more than a mile distant from each other and on opposite banks of Isthmus Slough, yet have a similar pattern of metals contamination. The Hilstrom Marine site was formerly occupied by Mid Coast Marine. At each site boats were repaired, sandblasted, and painted. These operations are the probable sources of these metals. TBT data presented later corroborates this interpretation of the data.

12. The most contaminated samples were nearest the shore (Table 2). These were also the samples that physical analyses revealed to be much different from the other samples. Concentrations of metals tapered off to below concern levels as the samples approached the upper edge of the Federal channel at both sites (Table 2). Along the edge of the Federal channel and within the channel metals concentrations were below concern levels. The physical nature of these samples was fairly uniform and more consistent (Table 1). The Federal channel is routinely dredged so, predictably, concentrations of heavy metals should be low. Over the years sediment studies have routinely shown this to be the case (2, 3). The fact that the concentrations taper off substantially as the samples approach the channel indicates that the source of metals is limited locally. These results show that Federal channel material even close to the edge of the channel is relatively free of contaminants. Slumping of this edge-of-channel sediment into the Federal channel, as a result of channel deepening, should not represent a serious contamination threat.

AVS

13. AVS is an important constituent of sediment that can ameliorate the toxicity of metals. AVS serves as a sulfur pool that reacts with soluble metals in sediment interstitial water forming insoluble metal sulfides. These sulfides precipitate out of water rendering the metals less toxic to aquatic organisms. Research shows that whether this happens or not depends on the ratio of metals to AVS in the sediment (4, 5). AVS is the fraction of sulfide extracted from sediment using cold hydrochloric acid (HCL). Metals extracted with the cold HCL are called simultaneously extracted metals, or SEM. When the ratio of SEM to AVS is greater than 1.0 toxicity to aquatic organisms may result from metals that are released into sediment interstitial water and possibly overlying water.

14. AVS was about twice as high in Mid Coast Marine versus Hilstrom Marine samples (Table 2). Both sites are in fairly quiescent areas of Isthmus Slough. They are similar in proportions of sand, silt, and clay. The major difference between sites is in the organic fraction. Mid Coast Marine samples contained more volatile solids and total organic carbon (TOC) than Hilstrom samples (Tables 1 and 3). Field observations indicated that Mid Coast Marine samples contained more organics such as bark, wood chips, twigs, and shell

fragments. Sulfur in organic matter from dead and living organisms is a major source of AVS in sediment.

15. The samples closest to shore at each site, CBM-BC-1 and CBH-BC-1, were 2 to 4 times lower in AVS than nearby samples. Again, this is probably reflective of the sandy nature of these samples and the greater organic content of the offshore samples. Besides organic matter, local in-sediment conditions can influence the level of AVS in sediment. Aerobic sediment is low in AVS because sulfur in the sediment is oxidized to sulfate which is soluble in water.

TBT

16. Coos Bay sediments have been found to contain elevated levels of TBT especially near boat repair areas like Hilstrom and Mid Coast Marine (3, 6). TBT in sediment in the form of paint chips can be slowly released into the sediment interstitial water and eventually makes its way into the water column. There is also evidence of toxic effects to oysters in some areas of the bay (7).

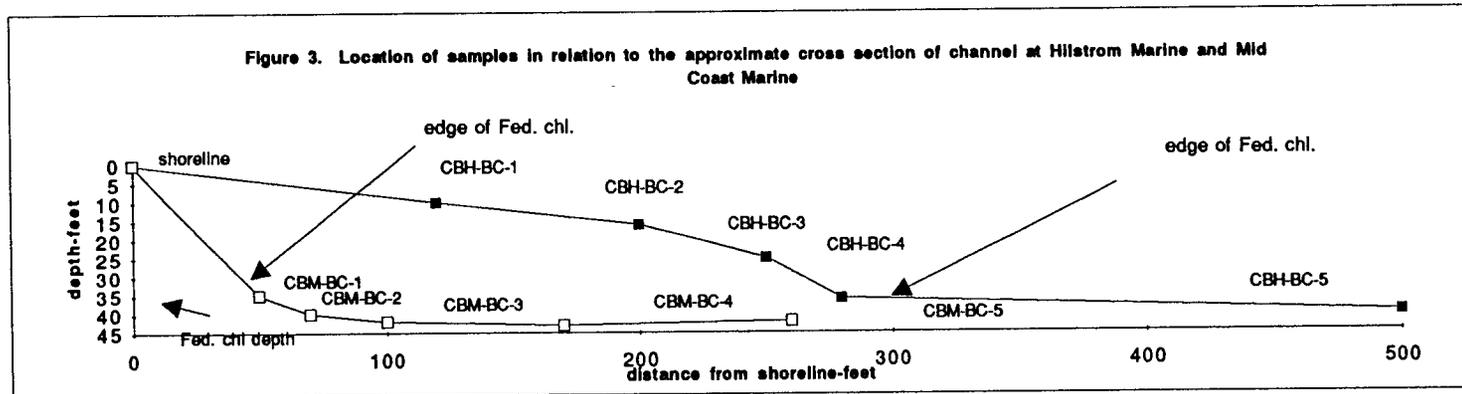
17. TBT was well above concern levels at both Hilstrom Marine and Mid Coast Marine (Table 3). For each site the two nearshore samples were higher than samples taken towards the edge of the Federal channel. At Hilstrom Marine TBT concentrations dropped two orders of magnitude between samples CBH-BC-2 and CBH-BC-3 from 2700 ppb to 39 ppb respectively. The concentrations of TBT found in the samples are probably overestimates because matrix spike and surrogate recoveries were high.

18. The fact that TBT levels drop off rapidly as the samples approach the edge of the Federal channel corroborates the conclusions of an earlier study that indicated Federal channel material is low in TBT (3). In marinas and boat works, paint chips from boats and from sandblasting operations settle quickly. This material is dredged infrequently. The Federal channel is regularly dredged so that TBT concentrations do not build up. In reaches of the channel adjacent to TBT hot spots, sediment samples do sometimes contain slightly elevated TBT concentrations - for example, the Federal channel near Mid Coast Marine (Table 3). Channel sediments near Hilstrom Marine slightly exceed the concern level of 30 ppb (Table 3). The probability that these values are overestimates indicates that actual values are likely below the concern level.

Channel Edge Considerations - Hilstrom vs Mid Coast Marine

19. A major purpose of this study was to determine the extent and pattern of TBT contamination and potential for contamination of the Federal channel from slumping of side-slope material due to dredging activities associated with channel deepening. The side slope at Hilstrom Marine is much less steep than at Mid Coast Marine (Figure 3).

20. At Hilstrom Marine samples CBH-BC-1 and 2 are on a gently sloping shelf. Sample CBH-BC-3 was collected half way down the slope while CBH-BC-4 was collected at the toe of the Federal channel roughly 280 feet from the shoreline. Between samples CBH-BC-2 and 4 the slope steepens gradually from a 15 foot depth to project depth of 35 feet in the space of 80 feet.



Horizontal is about 0.7 the vertical scale. This graph was developed from survey data taken in June 1994.

Sandblasting sand, metals, and TBT contamination is confined to CBH-CB-1 and CBH-CB-2. The data shows that contamination does not extent into the Federal channel since CBH-BC-3 and 4 are not contaminated with either metals or TBT (Tables 2 and 3, Figure 3). Dredging to deepen the Federal channel 2 feet should not result in contamination of sediment in the Federal channel nor release of contamination during dredging.

21. Bathymetry at Mid Coast Marine is quite different. It reveals that the bottom drops off rapidly from the shoreline to project depth (Figure 3). The Federal channel here is approximately 50 feet from the shoreline. Sample CBM-BC-1, taken alongside the dock, was 40 feet out from the shoreline and in water 35 feet deep, while CBM-BC-2 was at a depth of 40 feet. In contrast to Hilstrom Marine, it is evident that the slope to the bottom is very steep at Mid Coast Marine and there is no gentle slope to project depth. This may explain why higher concentrations of TBT are found in samples along the transect at Mid Coast Marine. Metals are higher in concentration near the dock (CBM-BC-1).

22. Side-slope slumping or sloughing along the edge of the Federal channel, because of deepening the channel 2 feet, should not cause a large increase in sediment resuspension. The area adjacent to the channel is near final grade, the cut-slope would be minimum. The part of the slope near the undercut should achieve dynamic equilibrium slowly over time. This process should not be rapid nor should it lead to vigorous churning of sediment. The natural process of bedload adjustment is ongoing.

Conclusions

23. Sediment samples from both sites were clayey, sandy silt except the two nearshore samples which were sandy. There was evidence of sandblasting sand and/or other man-made artifacts in the nearshore samples based on field observations.

24. Elevated levels of arsenic (13-20 ppm), chromium (395-600 ppm), copper (176-503 ppm), lead (39-65 ppm), nickel (163-363), and zinc (129-456 ppm) were found in one or more samples at both Hilstrom Marine and Mid Coast Marine. Mercury (0.58 ppm) was elevated at the Hilstrom site. The most contaminated samples were nearest the shoreline. There was a dramatic drop-off in metals concentrations along the transect towards the Federal channel.

25. AVS was about twice as high in Mid Coast Marine versus Hilstrom Marine samples. There was visibly more organic debris in Mid Coast Marine samples which could account for the difference. The samples closest to shore at each site were 2 to 4 times lower in AVS than samples further from shore. AVS may be overestimated in the samples because of high matrix spike recoveries.

26. TBT was above concern levels at both Hilstrom Marine and Mid Coast Marine. For each site the two nearshore samples were higher than samples taken from the Federal channel. TBT may be slightly overestimated in the samples because of high matrix spike and surrogate recoveries.

27. A major conclusion of this study is that Federal channel sediment is not likely to be contaminated by metals or TBT as a result of channel deepening. While it is true that nearshore samples at Hilstrom Marine are contaminated

with metals and TBT, potential slump material on the slope adjacent to the Federal channel is not contaminated at this site. Further, the slope to the Federal channel is gentle at this site.

28. At Mid Coast Marine metals contamination is confined to a narrow region close to the dock. TBT contamination is higher in the area of the dock (240-300 ppb) and less in the Federal channel (67 ppb to 130 ppb). These values are above the EPA, Region 10 screening level of 30 ppb. While sediments containing 300-600 ppb of TBT were not found toxic to the copepod Acartia tonsa or the mysid Acanthomysis sculpta (10) additional evaluation of the potential adverse effect prior to deepening the upper reaches of the Federal project are warranted. Alternatively the dredging needs for this area could be reassessed and dredging deferred until needed. However, because the dock area is at grade, slumping of slope material into the Federal channel should not further contaminate the channel with metals and TBT.

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REMARKS

I have included the whole report.

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