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RECEIVING WATER AND SEDIMENT SAMPLING: AMERICAN CROSSARM AND CONDUIT PENTACHLOROPHENOL SPILL

by

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ABSTRACT

Subsequent to the November 1986 flood which resulted in the spillage of wood-preserving chemicals at American Crossarm and Conduit (Chehalis, Washington), water and sediment samples were collected for analysis. Elevated concentrations of pentachlorophenol and polynuclear aromatic hydrocarbons were detected in water and sediment from a storm drain lagoon which discharges to Dillenbaugh Creek. Pentachlorophenol was detected in the creek at concentrations near and above the EPA chronic water quality criterion for protection of aquatic organisms. Several polychlorinated dioxins (not TCDD) and dibenzofurans were detected in bottom sediments from the storm drain lagoon and creek.

INTRODUCTION

On November 24 and 25, 1986, heavy flooding caused wood-preserving chemicals to leak from underground storage tanks and open sumps at the American Crossarm and Conduit (ACC) facility in Chehalis, Washington. A portion of this spill drained to the John's Street storm drain which routed the spill southwest to a lagoon which discharges to Dillenbaugh Creek, a tributary of the Chehalis River (Figure 1). Additional routes of contamination probably occurred at the height of the flood during which the lower Dillenbaugh Creek drainage, including much of the ACC property and nearby residential areas of Chehalis, was inundated.

Contamination of the John's Street storm drain and Dillenbaugh Creek by ACC operations had been previously documented by field inspectors from Ecology's Southwest Regional Office and investigators from the Water Quality Investigations Section (WQIS) (Crawford, 1987).

The Hazardous Waste Cleanup Program (HWCP), through Mike Blum, requested that WQIS design and conduct a survey to determine the extent of water and sediment contamination resulting from the spill. This document reports the results of that survey.

Study Area/Survey Design

Figure 1 shows the study area and sampling locations. Water samples were obtained at five locations: the storm drain lagoon (SDL-1); three locations in Dillenbaugh Creek (D-1, D-2, and D-3); and one location in the Chehalis River (C-1) downstream of its confluence with Dillenbaugh Creek. Sediment samples were obtained at four of these sites: the substrate at station D-1 was too rocky to obtain a sample. Sediment samples from the two sites (SDL-1 and D-2) judged most likely to be contaminated with product (spilled both during the flood and previously) were analyzed for chlorinated dioxins and dibenzofurans, in addition to parameters measured at other locations.

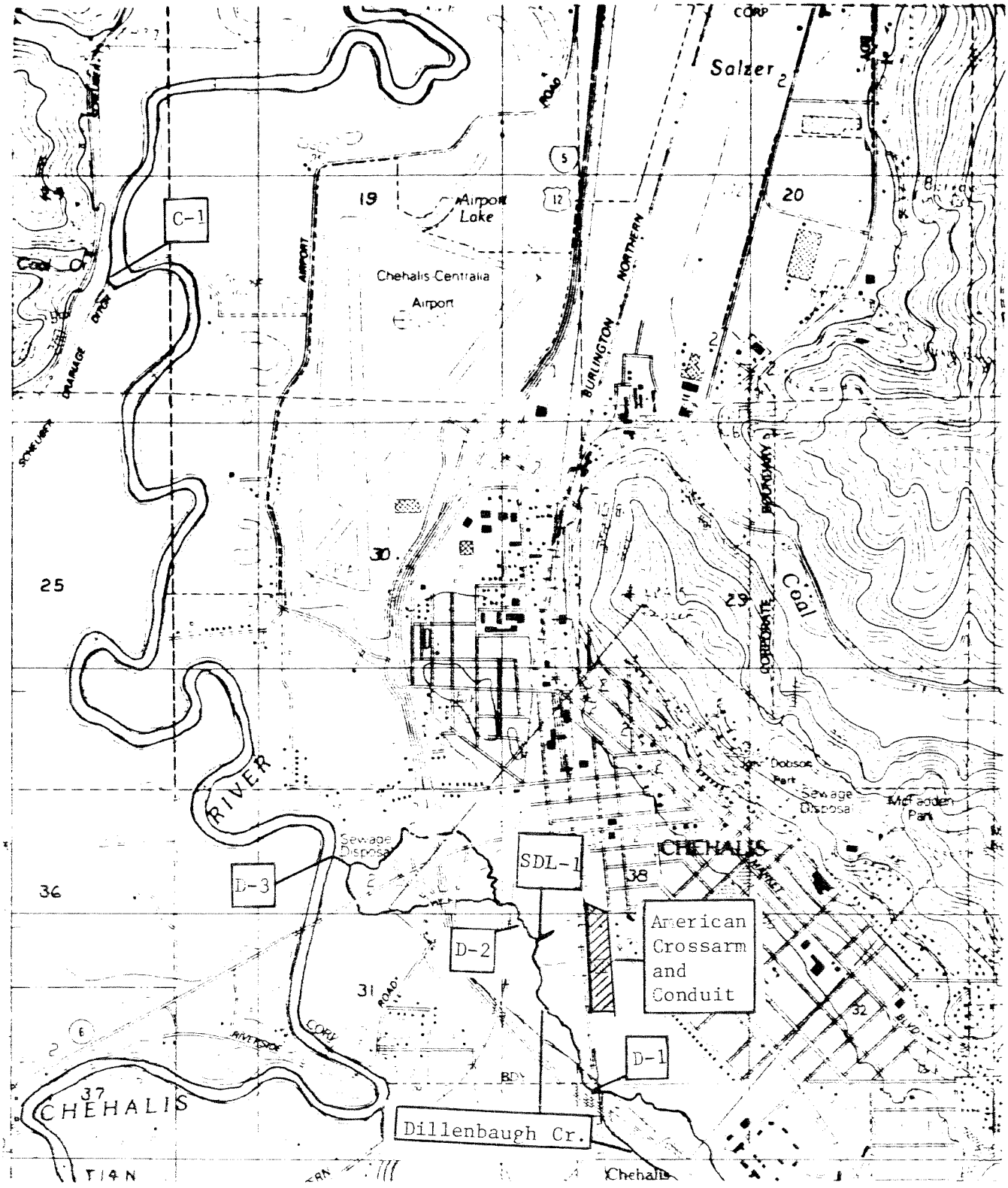

Figure 1. Study area.

Sampling Methods

Samples were collected on December 4 and 5, 1986. On December 4, field work was conducted by Dale Norton, Norm Glenn, and Bill Yake. Sample collection on December 5 was done by Art Johnson and Bill Yake.

Water

Water samples were obtained as grabs. Sample bottles were filled directly. Sample bottles for organics analyses were specially cleaned glass jars with teflon-lined lids provided by I-Chem (Hayward, California). Samples for volatiles analyses were collected in 40-mL glass vials with teflon-backed septa, also cleaned and provided by I-Chem. Bottles for conventionals analyses were provided by the Ecology/EPA laboratory in Manchester, Washington.

Sediment

Sediment samples at sites SDL-1 and D-1 were obtained with a stainless steel Emery pipe dredge, while samples from D-3 and C-1 were collected with a stainless steel Ponar grab (6" x 6"). All equipment used to collect and process sediment samples was cleaned in Liquinox detergent and rinsed sequentially in distilled water, nanograde methylene chloride, and nanograde acetone.

All sediment collected with the pipe dredge was composited in large stainless steel beakers and homogenized by stirring with stainless steel spoons. The top 2 cm of each sediment sample collected with the Ponar grab was likewise composited and homogenized. Aliquots for acid/base/neutral, organic carbon, grain size, and chlorinated dibenzo-p-dioxins/dibenzofurans were split from this homogenate. As with water samples, aliquots for organics analyses were placed in specially cleaned glass jars with teflon-lined lids provided by I-Chem.

All samples were handled using chain-of-custody procedures and stored on ice between time of collection and delivery to the Manchester laboratory.

Analytical Methods

Samples collected during this survey were analyzed for a range of conventional and organic pollutants. Tables 1a (water samples) and 1b (sediment samples) summarize the analyses and the entities responsible for these analyses.

Table 1a. Analyses conducted on water samples.

Parameter	Analyses Conducted by	Location
Conventional		
Flow	WQIS	On-site, Chehalis
Spec. cond., pH, temp.	WQIS	On-site, Chehalis
Spec. cond., pH, susp. solids, turb.	Ecology laboratory	Manchester
Priority Pollutants		
Volatile organics	Analytical Res., Inc.	Seattle
Acid/base/neutrals	METRO laboratory	Seattle

Table 1b - Analyses conducted on sediment samples.

Parameter	Analyses Conducted by	Location
Conventional		
Total solids, total organic carbon	Laucks Testing Labs.	Seattle
Grain size	Parametrix	Bellevue
Organics		
Acid/base/neutrals	METRO laboratory	Seattle
Chlorinated dioxins/ dibenzofurans	Cal Analytical	Sacramento

Field Measurements - Measurements conducted in the field were:

- Flow in Dillenbaugh Creek was measured by determining cross-sectional velocities using a Marsh-McBirney magnetic flow meter and top-setting rod. Flow in the Chehalis River was estimated by reading the wire-weight gage at the Mellon Street bridge and converting the reading to flow using the USGS discharge rating curve.

- pH was measured using a temperature-compensated Orion Research Ionanalyzer/model 399A after two-point calibration with buffered standards.

- Specific conductivity was measured using a temperature-compensated Beckman Solubridge/model RB-5-327A.

- Temperature was measured with a 0 to 30°C ASTM thermometer.

Conventional Analyses

- pH was measured at the Manchester laboratory using a Corning pH/ionanalyzer model #155.

- Specific conductivity was measured at Manchester with a Beckman model RC-20 conductivity bridge.

- Suspended solids and percent solids analyses followed Method 160.2 - gravimetric, and Method 160.3 - gravimetric, respectively, in Methods for Chemical Analysis of Water and Wastes (EPA, 1979).

- Turbidity was determined using Method 214A in Standard Methods for the Examination of Water and Wastewater (APHA, 1985).

- Grain size was analyzed by Parametrix, Inc. using the method of sieves and pipettes described by Buchanin and Kain (1971).

- Total organic carbon was analyzed by Laucks Laboratories using a method in which a 1- to 1.5-gram sample is ignited in a combustion tube. Resulting CO_2 is absorbed to ascarite, and quantified gravimetrically. The method was developed by the Ecology Manchester laboratory, but has no current citation.

Organics Analyses

- Volatile organics were analyzed by Analytical Resources, Inc. using EPA Method 624 (40 CFR, part 136). This method uses gas chromatography (GC) with packed column, followed by mass spectrophotometry (MS) detection.

- Analyses of acid/base/neutral extractable organics were performed by the METRO laboratory using EPA Method 1625B (40 CFR, Part 136). This is a GC/MS method using capillary column and stable isotope dilution.

  The data package from METRO was reviewed for quality assurance (QA) by Ecology and Environment, Inc. (E&E). The major problem noted by E&E was that a "number of surrogate recoveries were unacceptably low." Both the original data package and E&E's QA review were incorporated into a final data report by Raleigh Farlow of Ecology's Manchester laboratory.

- Polychlorinated dibenzofuran (PCDF) and dibenzo-p-dioxin (PCDD) analyses were conducted by California Analytical Laboratories using a hybrid of EPA Method 613 (40 CFR, Part 136) for TCDD and EPA Method 8280 (a RCRA method). The resulting method includes extensive cleanup including acid/base digestion, separation on polyurethane foam and charcoal. It uses stable isotope dilution method to determine recovery efficiencies. The analytical method is GC/MS using capillary column and selected ion monitoring.

The PCDF/PCDD data package was reviewed by Ecology and Environment, Inc. to assess the QA aspects of the analyses. QA was acceptable, and the results accepted as submitted.

RESULTS

The results of the analyses of water samples are given in Table 2. The results of the sediment samples are summarized in Table 3.

Water Samples - The most notable water column results include:

- High pentachlorophenol concentration in the storm drain lagoon (590 ug/L), and detectable concentrations (9.3 and less than 3.6 ug/L) in Dillenbaugh Creek. These results compare to freshwater acute criterion of 55 ug/L and chronic criterion of 3.2 ug/L (Federal Register, 1980).

- Discolored (yellow) storm drain lagoon waters and downstream sheen in Dillenbaugh Creek. Lyn Fass of the METRO laboratory noted in her transmittal letter, "The other compounds present in the [storm drain lagoon water] sample were fuel components. From the retention times of the hydrocarbons, the fuel appears to be similar to diesel #2 with perhaps some weathering." E&E, in their QA review, added, "The sample appears to be a weathered mixture of higher boiling range gasoline compounds, diesel fuel, and light cycle oil."

- Presence of selected 3- and 4-ring polynuclear aromatic hydrocarbons (PNA's) in the storm drain lagoon. It is unusual to detect PNA's in these concentrations in water column or discharge samples. In conjunction with sediment results, these compounds suggest the presence of coal tar/creosote mixtures in the materials spilled to the storm drain.

Sediment Samples - Major findings include substantial PNA concentrations in the storm drain lagoon sediments and the identification of polychlorinated dioxin and dibenzofuran isomers in sediments from the storm drain lagoon and in Dillenbaugh Creek immediately downstream of the lagoon.

Several individual 3- and 4-ring PNA's were identified in the sediment samples from the storm drain lagoon. Based on an average of the replicate sample results, the total PNA concentration in this sediment was about 27 mg/kg (ppm) dry weight. PNA concentrations this high have rarely been identified in (freshwater) aquatic systems in Washington State. Sediment samples from Lake Washington near Quendall Terminals, and Lake Union near Gas Works Park are two examples of sites

Table 2. American Crossarm and Conduit spill; water quality data.

Station Number	D-1	SDL-1	D-2		D-3	C-1
Date	12/4	12/4	12/4		12/5	12/5
Time	1530	1240	1210		1115	1010
Sample Number	498275	498276	498278	498278R	498280	498282
			Lab Replicates			
Flow (cfs)	30		22			2250 (est)
Specific Conductance (umhos/cm, field)	78	150	82		85	74
Specific Conductance (umohs/cm, lab)	77	149	78		82	74
pH (S.U., field)	6.0	5.7	5.5		5.4	5.8
pH (S.U., lab)	6.6	5.8	6.2		6.3	6.7
Temperature (^{o}C)	4.6	9.4	4.5		4.9	5.3
Total Suspended Solids (mg/L)	1	19	3		6	10
Turbidity (NTU)	7	5	6		7	5
Volatile Organics (ug/L)						
Tetrachloroethene	1u	2	1u		1u	1u
1,2,3-Trimethylbenzene	ND	9 (est)	ND		ND	ND
Total Xylenes	2u	27	3		2u	2u
Acids (ug/L)						
Tetrachlorophenol	ND	7 (est)	ND		ND	ND
Pentachlorophenol	1.4u	590	3.6J	R	9.3	R
Methylphenol	ND	4 (est)	ND		ND	ND
Neutrals (ug/L)						
Acenapthene	0.6u	1.4J	1.2u	1.3u	0.7u	0.7u
Fluorene	0.7u	23	1.2u	1.4u	0.7u	0.7u
Phenanthrene	0.6u	23	1.1u	1.1u	0.7u	0.7u
Pyrene	0.8u	2.2	1.1u	1.3u	0.8u	0.6u
Chrysene	0.6u	2.8	1.4u	1.1u	0.5u	0.6u
Di-n-butylphthalate	*	3.4u	*	2.5u	*	*
Di-n-octylphthalate	0.5u	84	1.1u	1.4u	8.8	0.8u
Benzylbutylphthalate	0.6	1.4u	1.3u	1.5u	0.6u	0.7u
Bis(2-ethylhexyl)phthalate	0.8J	1.2u	1.2u	0.8u	380	0.7u

R = Data rejected due to inadequate isotope recovery.
ND = Not detected, detection limit unknown.
u = Not detected at detection limit given.
J = Detected at concentration below quantification limit given.
* = Detected; however also detected in field or laboratory blanks at similar concentrations.
est = Estimated concentration.

Table 3. American Crossarm and Conduit spill; sediment data.

Station Number	SDL-1		D-2	D-3	C-1
Date	12/4		12/4	12/5	12/5
Time	1240		1210	1115	1010
Sample Number	498277	498277R	498279	498281	498283
Total Organic Carbon (%)	8.5	8.6	3.1	1.8	1.2
Solids (%, METRO lab)	33	33	62	61	74
(%, Cal Analytical)	36	36	60		
(%, Laucks)	30.6	29.0	56.5	58.3	71
Grain Size					
% Gravel (>2 mm)	22.74	4.11	0.45	0.02	0.0
% Sand (62 um - 2 mm)	23.45	33.29	11.26	72.81	93.31
% Silt (4 um - 62 um)	48.78	57.05	55.38	22.91	5.97
% Clay (<4 um)	3.15	4.13	33.97	3.55	2.10
Acid Extractables (ug/kg d.w.)					
Pentachlorophenol	7400	8200	140u	92u	110u
Neutral Extractables (ug/kg d.w.)					
Fluorene	4100	3200	77u	51u	52u
Anthracene	1200J	1100J	64u	49u	50u
Phenanthrene	7000	6300	27J	48u	40u
Fluoranthene	5400	5000	39J	49u	46u
Pyrene	6600	5900	64	54u	39u
Chrysene	2700	2700	48u	30u	48u
Benzo(a)anthracene	1600	1500	40u	38u	54u
Di-n-butylphthalate	*	*	110u	99u	85u
Benzylbutylphthalate	1700u	1300J	44u	38u	50u
Bis(2-ethylhexyl)phthalate	230,000	200,000	390	36J	71u
Polychlorinated Dioxins (ug/kg d.w.)					
tetra (2,3,7,8)	0.044u	0.081u	0.022u		
tetra - total	0.044u	0.081u	0.022u		
penta (1,2,3,7,8)	1.8u	1.4**u	0.043u		
penta - total	2.5	1.7	0.043u		
hexa (1,2,3,4,7,8)	3.6	3.2	1.1**u		
hexa (1,2,3,6,7,8)	16.4	18.9	3.2u		
hexa (1,2,3,7,8,9)	7.5	7.5	0.27u		
hexa - total	52.2	52.2	2.3		
hepta (1,2,3,4,6,7,8)	276	294	17.2		
hepta - total	446	475	28.3		
octa - total	1030	1000	71.3		
Polychlorinated Dibenzofurans (ug/kg d.w.)					
tetra (2,3,7,8)	0.083u	0.27u	0.015u		
tetra - total	0.083u	0.27u	0.015u		
penta (1,2,3,7,8)	1.0	0.92	0.085u		
penta (2,3,4,7,8)	0.27u	0.53u	0.11u		
penta - total	4.2	2.7	0.35		
hexa (1,2,3,4,7,8)	2.8	2.9	0.22u		
hexa (1,2,3,6,7,8)	1.2	1.5	0.22u		
hexa (2,3,4,6,7,8)	0.42u	1.1u	0.25u		
hexa (1,2,3,7,8,9)	1.4u	1.4	0.23u		
hexa - total	56.9	57.5	4.8		
hepta (1,2,3,4,6,7,8)	29.7	30.6	1.7		
hepta (1,2,3,4,7,8,9)	1.8	1.8	0.77u		
hepta - total	108	109	6.7		
octa - total	204	155	1.4		

* = Detected; however also detected in field and/or method blank.
J = Detected at level below quantification limit given.
** = Chemical interference.
u = Not detected at concentration given.

where concentrations approach or exceed those in these lagoon samples. Several of the Puget Sound "hotspots" (primarily in urban embayments) meet or exceed these concentrations. Two of the most notable are Eagle Harbor (near Wyckoff) and Budd Inlet (near Cascade Pole). All of these sites are associated with facilities which produced or used coal tar, creosote, or related products.

The E&E QA review notes, "the ratios of polycyclic aromatic compounds in [the storm drain lagoon sediment] sample suggests the presence of coal tar and/or creosote."

The sediment sample from Dillenbaugh Creek below the lagoon had PNA concentrations of less than 1 percent of the concentrations seen in lagoon sediments.

The concentrations of chlorinated dioxins and dibenzofurans were also one to two orders of magnitude higher in lagoon sediment than in Dillenbaugh Creek sediment immediately downstream (Table 3). No tetrachlorinated dioxins (the most potent forms) were detected.

USEPA (1986) presents a method for estimating the overall toxicity of mixtures of chlorinated dioxins and dibenzofurans. This method is called the 2378-TCDD toxicity equivalence factors (TEFs) approach and provides relative potency factors for each of the isomers shown in Table 3. Using this approach, Table 4 shows the results for the sediment results in this study.

Table 4. 2,3,7,8-TCDD toxicity equivalents for sediment results.

Sediments	TCDD Equivalents
Storm drain lagoon (SDL-1)	1.63 ppb (ug/kg d.w.)
Dillenbaugh Creek (D-2)	0.021 ppb (ug/kg d.w.)

The primary exposure route of concern is the bioaccumulation of these compounds by fish (and possibly crayfish) followed by subsequent ingestion by people.

Although providing a human health risk analysis was beyond the scope of this project, a preliminary review of some of the pertinent literature raises concerns about consumption of fish and crayfish which remain long in lower Dillenbaugh Creek. This concern is based, in part, on the tendency of dioxins to bioaccumulate (Schaum, 1984, reports the equilibrium ratio of TCDD in fish to TCDD in sediment ranging from 1 to 10); their resistance to degradation; and the substantial toxic, carcinogenic, and reproductive effects of certain isomers (USEPA, 1986). The primary concern is probably with non-anadromous species which may reside in lower Dillenbaugh Creek on a more or less permanent basis. Given the nature of the spill, the

detection of pentachlorophenol in Dillenbaugh Creek and chlorinated dioxin and dibenzofuran isomers in creek sediments, it would appear prudent to consider posting lower Dillenbaugh Creak (perhaps from the railroad trestle at D-1 to the mouth) against the consumption of resident fish and crayfish.

It is unusual to suggest posting an area against fish consumption in the absence of tissue data. It may be advisable to collect and analyze fish and crayfish tissue from this stretch of stream to provide direct evidence of the presence or absence of tissue contamination. In any event, the situation should be reassessed after cleanup at the ACC site, storm drain lagoon, and other associated areas is complete.

The relatively high PNA and chlorinated dioxin/dibenzofuran contamination in the storm drain lagoon sediments, coupled with the potential flux of these contaminated sediments into Dillenbaugh Creek at high flows, suggests focus on the potential cleanup of these sediments. Some additional sampling to determine the degree and extent (especially depth) of contamination would be useful prior to implementing cleanup.

CONCLUSIONS AND RECOMMENDATIONS

1. A November 1986 flood resulted in the spillage of wood-preserving chemicals at American Crossarm and Conduit. Subsequent sampling of water and sediment showed:

    - o Substantial pentachlorophenol contamination of water and sediment in the storm drain lagoon, and concentrations in Dillenbaugh Creek near and above the EPA chronic criterion for protection of aquatic organisms.

    - o Presence of elevated concentrations of 3- and 4-ring polynuclear aromatic hydrocarbons (PNA's) in sediment and water from the storm drain lagoon, suggesting the presence of coal tar/creosote mixtures in the spilled materials.

2. Based on the nature of the spill and the data reported here, it would appear prudent to consider posting lower Dillenbaugh Creek against consumption of resident fish and crayfish. This should be considered an interim measure. Sampling and analysis of fish and crayfish tissue from the affected portion of stream, now and/or after cleanup activities are completed, should be conducted to verify, modify, or nullify the advisory.

3. Steps should be taken to evaluate the efficacy of cleaning up sediments in the storm drain lagoon.

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