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WASHINGTON STATE DEPARTMENT OF ECOLOGY
ENVIRONMENTAL INVESTIGATIONS AND LABORATORY SERVICES

MEMORANDUM

TO: Mike Templeton, SWRO

FROM: Joe Joy, Surface Water Investigations Section

SUBJECT: Dillenbaugh Creek Benthic Invertebrate and Sediment Assessment, July 1987

DATE: December 20, 1988

INTRODUCTION

Dillenbaugh Creek, a Class A stream and tributary to the Chehalis River, flows through agricultural and industrial properties along the south side of Chehalis (Figure 1). The creek has been the subject of several investigations by the Ecology Southwest Regional Office (SWRO) and Ecology's Environmental Investigations and Laboratory Services (EILS) Program. In 1986, Crawford (1987) identified several non-point sources of contamination and questionable point source discharges to the SWRO for further investigation. One source, the John Street storm drain, was identified as a major problem. Elevated oils, pentachlorophenol, and fecal coliform bacteria concentrations were detected in this drain (Crawford, 1987). The American Crossarm and Conduit (ACC) wood-preserving facility was the source of the pentachlorophenol (PCP), and a broken sanitary sewer was the source of the high bacteria levels (Crawford, 1987).

In November 1986, water from Dillenbaugh Creek and the Chehalis River inundated the ACC site. Wood-preserving chemicals stored in underground tanks and an open sump mixed with the floodwaters, and resulted in widespread contamination of residential and business neighborhoods with PCP, dibenzofuran, and chlorinated dioxin compounds (Yake, 1987). Decontamination processes, collection and storage of contaminated furnishings, and isolation of contaminated materials at the ACC site commenced under the direction of the U.S. Environmental Protection Agency (USEPA) as floodwaters subsided.

On behalf of the Ecology Hazardous Waste Cleanup Program, the Toxics Investigations/Ground Water Monitoring Section collected sediment and water samples in December 1986 from the John Street storm drain lagoon, Dillenbaugh Creek, and the Chehalis River (Yake, 1987). Some water samples contained PCP concentrations above USEPA chronic aquatic toxicity criteria, and lagoon sediments contained PCP, polychlorinated dibenzo dioxins, and polynuclear aromatic hydrocarbons (PNA's). Yake (1987) suggested that lower Dillenbaugh Creek be posted against the taking and consumption of fish and crayfish until they are tested.

The SWRO had concerns about the effects of the PCP contamination on biota in Dillenbaugh Creek. The Surface Water Investigations Section (SWIS) of Ecology's EILS Program was requested to assess the biological community in the vicinity of the site. The information was necessary to evaluate the ACC site as a candidate for cleanup funds, and placement on the National Superfund List. The USEPA Region 10 offered an allocation of four sediment samples for priority pollutant analyses to be entered as a part of their Sediment Watch program.

A survey was designed to meet the following objectives:

1. Compare Dillenbaugh Creek benthic macroinvertebrate populations above and below the ACC site using quick qualitative techniques; e.g., 3-rock, kick-net, or hand-turning with net methods.

2. Collect sediment samples for priority pollutant analyses by USEPA, and water samples for conventional analyses by Ecology. Note any important results with respect to the macroinvertebrate data.

Concurrent to the SWRO request, the Hazardous Waste Cleanup Program requested we coordinate our survey with their efforts by collecting fish for tissue analysis. The results of which would evaluate the fish consumption issue. The macroinvertebrate and sediment survey was conducted on July 27-28, and the fish survey was conducted July 29, 1987.

METHODS

Various samples were collected from six sites in the study area. Table 1 describes these sites and lists the type of sample collected at each, and Figure 1 shows the site locations. Stations 1 and 2 were established as control sites, Stations 3, 4, and 5 as affected sites.

Benthic invertebrate samples were collected at four sampling stations in the middle of riffle areas (Figure 1). Specific collection sites were chosen because of similarities in water velocity and depth, and ambient lighting. At each site a rock of four to six inches in diameter was randomly selected from mid-channel, right-channel, and left-channel. The organisms were picked, scraped, and rinsed clean from the three rocks into a No. 30 standard screen bucket, and transferred into jars with a 70 percent alcohol solution. Replicate collections were conducted at two sites. At the office, organisms were enumerated and identified to at least family level using standard texts: Merritt and Cummins (1984), Pennak (1978), and Usinger (1973).

Fish collections were conducted at or near Stations 3, 4, and 5 on Dillenbaugh Creek (Figure 1). Approximately 100 feet of mixed riffle and run area was selected at each site, and covered once using a backpack electroshocking unit. Block nets were not used, but fish moving ahead of the shocking field could be easily seen.

Sediment samples were collected at deposition areas near benthic invertebrate Stations 3 and 4. Sediment was also collected from the John Street drain lagoon and upstream of the lagoon in Dillenbaugh Creek at Station 2 (Figure 1). All sampling equipment was soap-and-water washed, distilled water and acid rinsed, and methylene chloride and acetone rinsed prior to sampling. Sediments were obtained by a stainless steel pipe dredge. Several casts were deposited into a large stainless steel bucket and homogenized with a stainless steel spoon. Subsamples were then placed into specially cleaned glass jars with teflon-lined lids. Samples were stored in the dark, on ice, and immediately sent to the USEPA/Washington Department of Ecology Environmental Laboratory in Manchester. Sediments were analyzed for acid and base neutral organic compounds, percent solids and grain size. Organic compounds were analyzed by the USEPA at Manchester using gas chromatography/mass spectroscopy (Solid Waste Protocols, Method 8270). Grain size and percent solids were measured by Parametrix, Inc. using methods described in Holme and McIntyre (1971).

Water samples were collected at five sites along Dillenbaugh Creek (Figure 1). Field measurements of temperature, pH, specific conductance, and stream discharge were conducted. Samples were taken for dissolved oxygen (D.O.) measurement. The Winkler azide-modified titration was used (APHA, 1985). Additional samples were collected for nutrients, solids, and alkalinity. These were obtained in clean, polyethylene bottles, stored in the dark on ice, transported to the Manchester laboratory, and analyzed using methods described in Huntamer (1986), APHA (1985), and USEPA (1983).

RESULTS AND DISCUSSION

Analytical results of water, sediment, and benthic invertebrate samples are shown in Tables 2, 3, and 4, respectively. The only fish seen during the survey on July 29 were two juvenile coho (Oncorhynchus kisutch), in a small riffle area at Station 4. They were not collected for analysis because they are not resident species and because they would not have provided enough sample material. Crayfish were seen at Stations 1, 2, 3, and 4, but not in sufficient quantity for samples. A brief discussion of water, sediment and invertebrate results follows.

Water Quality

Water quality in the lower portion of Dillenbaugh Creek appears to be highly influenced by its marsh environment during periods of summer low-flow. Only Station 1 was located outside this type of habitat, and its data are quite different from the other four stations (Table 2). The loss of flow in the channel areas of the creek between Stations 1 and 5 is also characteristic of a marsh habitat.

Only Station 1 D.O. concentrations met the Class A criterion of 8 mg/L. D.O. values at Stations 2 through 5 were far below 8 mg/L (Figure 2). D.O. concentrations at Stations 2, 3, and 4 were at the lethal limits for most types of fish and many aquatic macroinvertebrates (USEPA, 1986). These D.O. concentrations were lower than those reported at similar sites along the creek by Crawford (1987).

The pH levels and nutrient concentrations were also characteristic of the reducing marsh environment (Table 2). These data were similar to Crawford's.

Non-point sources of contamination identified earlier by Crawford (1987) may be aggravating water quality problems in lower Dillenbaugh Creek--especially poor livestock management practices and the presence of the John Street storm drain outlet. However, the impact of these sources would be difficult to differentiate from the influence of the marsh environment during low flow conditions. The stagnation of flow, microbial processes, and organic materials flux, yield naturally low D.O. concentrations and pH levels, and seasonally high nutrient concentrations in many marshes (Reed, Middlebrooks, and Crites, 1988).

Sediment

The sediment sample results are reported in Table 3. It is evident that the quality of the data is generally poor: compound recoveries during analysis were poor; detection limits were high; samples were held longer than recommended before processing; and there appeared to be contamination of the laboratory methods blank.

Considering these faults, the following conclusions based on these data are very tentative:

- High concentrations of PNA's, phthalate esters, dichlorobenzenes, and 2-methylnaphthalene were detected in the lagoon sediments.

- Lower concentrations (than in the lagoon sediment) of some PNA's and phthalate esters were detected in creek sediments upstream and downstream of the lagoon outfall.

- 2.1 ppm PCP was detected in sediments approximately 600 feet below the lagoon outlet. Detection limits for the other samples were too high to determine if similar contamination exists at the other sites.

Compounds detected in the sediment appear to have some similarities to samples taken by Yake (1987). Both studies' lagoon sediment samples contained high levels of PNA's and phthalate esters (Table 5). The primary PNA's detected were similar: phenanthrene, anthracene, and fluoranthene. Sediments collected during both surveys just below the lagoon outfall (Station 3-this study, D-2-Yake's study) contained fluoranthene and pyrene. PCP was not detected in the sample collected by Yake (1987), although dibenzofurans and dioxins were detected. Dibenzofurans and dioxins were not analyzed compounds in this survey.

PNA's and PCP readily adsorb to sediments and organic materials (Callahan et al., 1979). Organically enriched clays and silts common to wetlands (Stations 3 and 4 in Table 3) are especially efficient traps for these compounds (USDA, 1980). PCP is also susceptible to microbial decomposition, and it appears that flooded soils can enhance the decomposition process (USDA, 1980). The decomposition products of PCP are less chlorinated phenols and anisoles, and half-lives for all these compounds are difficult to predict.

In summary, it appears some contamination of creek sediments has remained since the November 1986 flood and ACC site cleanup efforts. The geographical extent of that contamination and the variety of chemicals involved were not clarified by this set of survey data. It is also unclear how long the contamination will last, although the marsh habitat may enhance the breakdown processes.

Benthic Macroinvertebrates

Results of the collection of benthic macroinvertebrates are listed in Table 4. The dissimilarity between Station 1 habitat to the other stations in the study area was mentioned in the water quality discussion. Invertebrate assemblages at Station 1 were also very different from the other two stations, but because of habitat and basic water quality differences rather than toxic effects from the ACC spill. Riffle habitat was not available in the marsh area upstream of the ACC site.

Replicate collections were most similar to each other. Invertebrate assemblages at Stations 3 and 5 were somewhat similar. The organisms identified at both downstream stations could generally be classified as tolerant to organic contamination (Hellawell, 1978).

PNA's and PCP, although they were detected in the sediments, appear not to be available to the aquatic organisms in acutely toxic concentrations. Crayfish, coho salmon, and various macroinvertebrates were present at sites below the lagoon outfall. Even the lagoon was not totally devoid of aquatic life--a net dipped into emergent vegetation revealed a concentrated population of Culicidae (mosquito) larvae. If acutely toxic concentrations were present, a sterile condition would most likely exist.

There continues to be a paucity of toxicity data for acute and chronic effects of PCP and PNA's on invertebrates (Table 6). Invertebrates are generally considered to be less sensitive than fish to these compounds (USEPA, 1980; Canadian Council of Resource and Environment Ministries, 1987).

SUMMARY AND RECOMMENDATIONS

The collection of benthic macroinvertebrates to assess the impact of the ACC spill on Dillenbaugh Creek was not successful. Collection methods were not applicable to marshland environments, and the poor basic water quality characteristics eliminated usual comparisons between control and affected sites. Fish and invertebrates were present in the affected area, so acutely toxic concentrations of PCP and PNA's were probably absent.

Sediment sample results were generally of poor analytical quality. However, some of the detected compounds were similar compounds detected in past surveys. Approximately 2.1 ppm pentachlorophenol (PCP) was detected in creek sediment 600 feet below the storm drain outfall.

Fish collection was unsuccessful. Resident fish were not found, and crayfish were of insufficient quantity to meet minimum sample size requirements.

Sediments in the affected area should again be collected and analyzed for PCP and PNA's. The persistence of the compounds in natural marshlands requires checking. Fish or crayfish collection should be attempted if it is evident that the public are still fishing in the area.

JJ:sk

cc: Mike Blum

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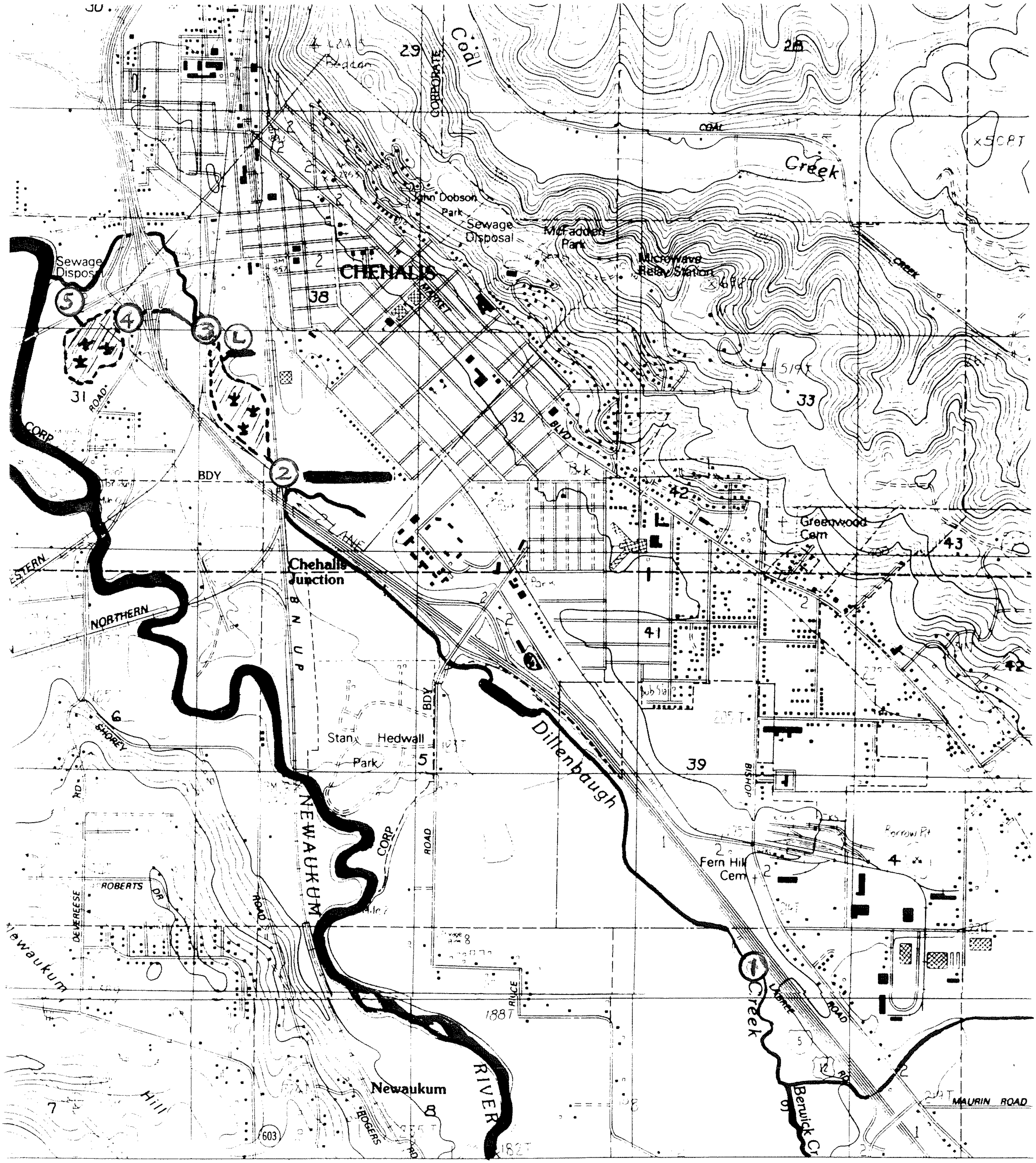

FIGURE 1. Dillenbaugh Creek study area showing station locations for surveys conducted July 27- 29, 1987.

Figure 2. Dissolved Oxygen Profiles along Dillenbaugh Cr. near American Crossarm and Conduit (rm 0.6)-- July 1987.

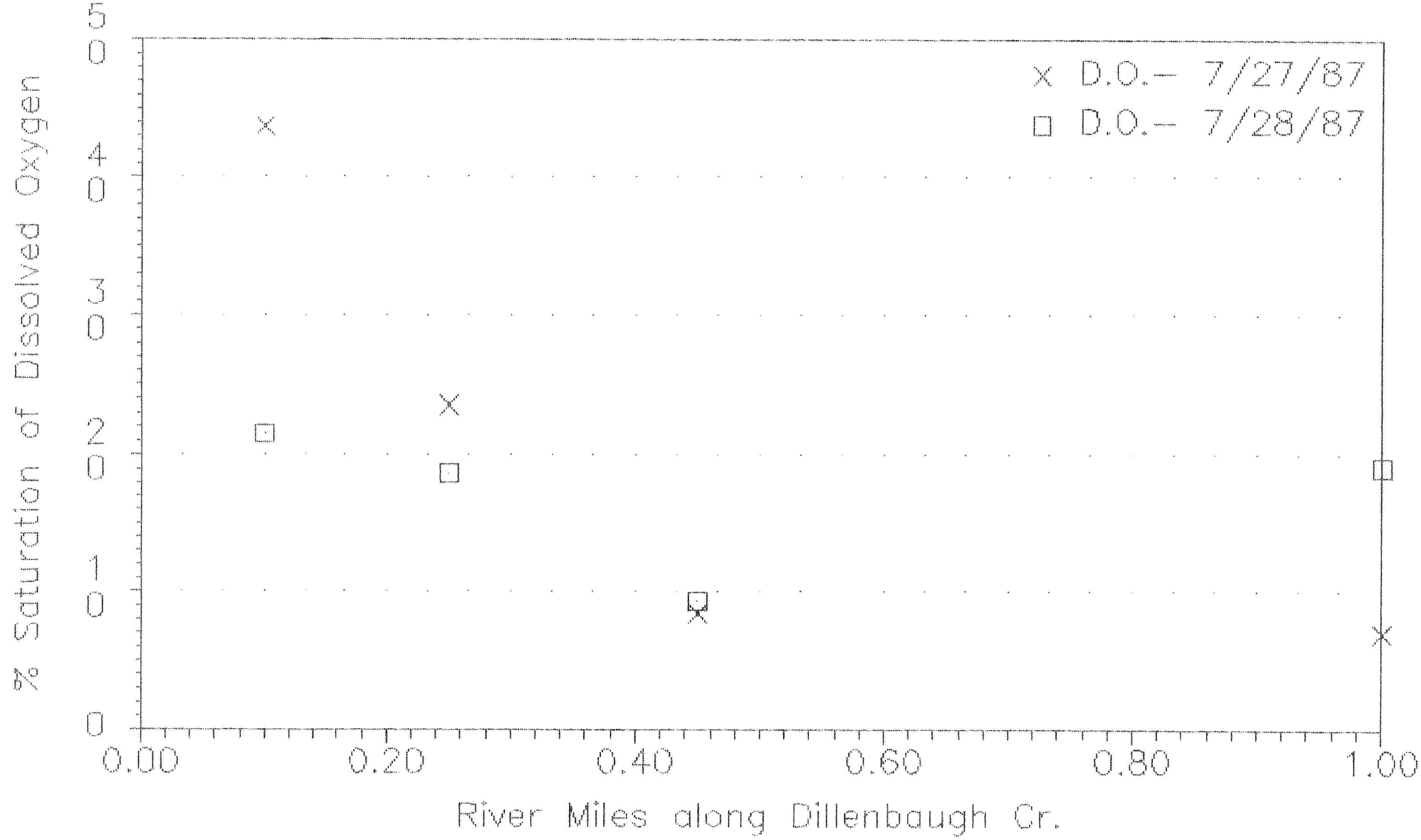

Table 1. Site descriptions of stations on Dillenbaugh Cr.

Station Number	Description	Samples Collected Water	Sediment	Invertebrates	Fish
1	Approx. 2.5 mi. of John St. ACC site, creek near to La Bree Rd. Riffle area with small pool below Obvious channel erosion in area. Indications of livestock access.	YES	NO	YES	NO
2	Approx. 0.4 mi. upstream of ACC site where creek crosses under railroad trestle, east of Interstate 5. Area is marshy and current is slow. Several livestock access points upstream.	YES	YES	NO	NO
L	John Street drain lagoon adjacent to ACC site, north shore access near outlet to Dillenbaugh Cr.	NO	YES	NO	NO
3	Downstream of lagoon outlet and ACC site at railroad spur crossing approx. 600 ft. below the John St. lagoon outlet. Marshy but definite stream channel present through wood and debris. Benthic invertebrate site another 500' downstream in riffle of basalt cobble.	YES	YES	YES	YES
4	Under Riverside Road bridge, west of Interstate 5 and approximately 0.4 mi. below John St. lagoon outlet. Channel distinct with pools and small runs but primarily gravel and fines.	YES	YES	NO	YES
5	North of Highway 6 bridge, where gravel road ends approx. 0.5 mi. below John St. lagoon outlet and 0.1 mi. above Chehalis R. confluence. Creek exits from marsh via short riffle to long pool/run.	YES	NO	YES	YES

Table 2. Dillenbaugh Cr. water quality data collected in the vicinity of the ACC site, 7/27-28/87.

Parameter	STA. 1	STA. 2	STA. 3	STA. 4	STA. 5
Time	1540 (1510)	1435 (1140)	1510 (1315)	1414 (1045)	1353 (900)
Discharge (cfs)	-- (2.0)	-- (0.96)	-- (0.7)	-- (0.75)	-- (0.6)
Temp.(deg. C)	18.9 (19.8)	19.0 (18.7)	18.2 (17.7)	17.9 (17.3)	19.5 (16.9)
Dissolved Oxygen	10.2 (10.3)	0.65 (1.8)	0.8 (0.9)	2.25 (1.8)	4.05 (2.1)
% D.O. saturation	108.9 (111.8)	7.0 (19.1)	8.4 (9.3)	23.5 (18.6)	43.7 (21.5)
pH (s.u.)	7.95	6.7	6.7	6.8	6.8
Cond. (umhos/cm)	108	130	136	141	131
Alkalinity	47	58	63	60	61
NO3+NO2	0.64	0.02	0.02	0.03	0.05
NH3	0.03	0.02	0.11	0.10	0.03
Unionized NH3	< 0.01	< 0.01	< 0.01	< 0.01	
Total Inorg. N	0.67	0.04	0.13	0.13	0.08
Total P	0.14	0.08	0.17	0.13	0.10
Total Solids	130	210	210	140	220
TNVS	75	72	68	70	69
TSS	15	17	13	6	2
TNVSS	10	8	6	2	<1
Lab Cond.(umhos/cm)	104	128	141	136	135

( ) values taken 7/28/87

< means less than

All value mg/L unless otherwise specified.

Table 3. Base-neutral and acid extractable results for sediment samples collected at Dillenbaugh Cr. in Chehalis near the American Crossarm and Conduit Co. (ACC) site, on two occasions: December 1986 (Yake, 1987); and July 1987 (this report). All values are ug/kg, dry weight, unless otherwise specified.

COMPOUND	STA. D-2 1987	STA. D-2 1986	STA. 4 1987	D-3 1986	John Street Lagoon 1987	SDL-1 1986	SDL-1Rep. 1986
Phenol	260 u		780 u		5100 u		
2-chlorophenol	260 u		780 u		5100 u		
2-nitrophenol	260 u		780 u		5100 u		
2,4-dimethylphenol	260 u		780 u		5100 u		
2,4-dichlorophenol	260 u		780 u		5100 u		
4-chloro-3-methylphenol	260 u		780 u		5100 u		
2,4,6-trichlorophenol	260 u		780 u		5100 u		
2,4,5-trichlorophenol	1300 u		3800 u		25000 u		
2,4-dinitrophenol	1300 u		3800 u		25000 u		
4-nitrophenol	1300 u		3800 u		25000 u		
4,6-dinitro-o-cresol	1300 u		3800 u		25000 u		
Pentachlorophenol	2100	140 u	3800 u	92 u	25000 u	7400	8200
bis(2-chloroethyl)ether	260 u		780 u		5100 u		
bis(2-chloroisopropyl)ether	260 u		780 u		5100 u		
bis(2-chloroethoxy)methane	260 u		780 u		5100 u		
4-chlorophenyl phenyl ether	260 u		780 u		5100 u		
1,3-dichlorobenzene	260 u		780 u		2100 j		
1,4-dichlorobenzene	260 u		780 u		2000 j		
1,2-dichlorobenzene	260 u		780 u		1200 j		
1,2,4-trichlorobenzene	260 u		780 u		5100 u		
Hexachloroethane	260 u		780 u		5100 u		
Nitrobenzene	260 u		780 u		5100 u		
Hexachlorobenzene	260 u		780 u		5100 u		
2,6-dinitrotoluene	260 u		780 u		5100 u		
2,4-dinitrotoluene	260 u		780 u		5100 u		
Isophorone	9 j		780 u		5100 u		
Nitrosodiphenylamine	260 u		780 u		5100 u		
Hexachlorobutadiene	260 u		780 u		5100 u		
Hexachlorocyclopentadiene	260 u		780 u		5100 u		
2-chloronaphthalene	260 u		780 u		5100 u		
Acenapthene	260 u		780 u		5100 u		
Acenaphthylene	260 u		780 u		5100 u		
Fluorene	260 u	77 u	780 u	51 u	5100 u	4100	3200
Naphthalene	260 u		780 u		1700 j		
Phenanthrene	260 u	27 j	20 j	48 u	5500	7000	6300
Anthracene	260 u	64 u	780 u	49 u	6800	1200 j	1100 j
Fluoranthene	63 bj	39 j	35 bj	49 u	2700 bj	5400	5000
Pyrene	100 j	64	780 u	54 u	5100 u	6600	5900
Benzo(a)anthracene	530 bu	40 u	780 bu	38 u	2100 b	1600	1500
Chrysene	260 bu	48 u	780 bu	30 u	1700 b	2700	2700
Benzo(b)fluoranthene	260 bu		780 bu		2200 b		
Benzo(k)fluoranthene	260 bu		54 bj		2500 b		
Benzo(a)pyrene	260 u		780 u		5100 u		
Dibenzo(a,h)anthracene	260 u		780 u		5100 u		
Indeno-1,2,3-c,d-pyrene	260 u		780 u		5100 u		
Benzo(g,h,i)perylene	260 u		780 u		5100 u		
Diethylphthalate	260 bu		780 bu		5100 bu		
Di-n-butylphthalate	*260 bu*	*110 u*	*780 bu*	*99 u*	*5100 bu*		
Benzyl butylphthalate	260 u	44 u	780 bu	38 u	3200 bj	1700 u	1300 j
bis(2-ethylhexyl)phthalate	920 b	390	470 bj	36 j	130000 b	230000	200000
Di-n-octyl phthlate	260 bu		72 bj		2100 b		
Dimethylphthalate	260 u		780 u		5100 u		
Total Polychlorinated Dioxins*		102				1530	1528
T. Polychlor. Dibenzofurans*		13				373	324
Benzoic acid	1300 u		3800 u		25000 u		
2-nitroaniline	1300 u		3800 u		25000 u		
3-nitroaniline	1300 u		3800 u		25000 u		
4-nitroaniline	1300 u		3800 u		25000 u		
4-chloroaniline	260 u		780 u		25000 u		
2-methylnaphthalene	20 j		780 u		5000 j		
3,3-dichlorobenzidine	530 u		1600 u		10000 u		
2-methylphenol	260 u		780 u		5100 u		
4-methylphenol	260 u		780 u		5100 u		
Dibenzofuran	260 u		780 u		5100 u		
n-nitroso-di-n-propylamine	260 u		780 u		5100 u		
4-bromophenyl phenyl ether	260 u		780 u		5100 u		
Benzyl alcohol	260 u		780 u		5100 u		
Percent solids (%)	19.72	60.00	17.75	60.00	31.54	33.00	33.00
Gravel (>2mm) (%)	0.24	0.45	1.91	0.02	0.00	22.74	4.11
Sand (2mm-62um) (%)	5.60	11.26	15.81	72.81	12.94	23.45	33.29
Silt (62um-4um) (%)	55.78	55.38	56.52	22.91	75.12	48.78	57.05
Clay (<4um) (%)	36.85	33.97	24.44	3.55	9.30	7.15	4.13

bj = Compound detected in methods blank, estimated value.
j = Estimated value, samples exceeded recommended holding time.
u = Compound not detected above stated value.
* = Simple sum of tetra-, penta-, hexa-, hepta-, and octa- compounds listed in Table 3 of Yake (1987).

Table 4. Aquatic organisms identified at three riffle sites along Dillenbaugh Cr. in the vicinity of the American Crossarm and Conduit (ACC) site, July 28, 1987.

ORGANISM	STA.1	STA.3 A	STA.3 B	STA. 5 A	STA.5 B
ANNELIDA					
Hirundinea					
Helobdella sp.		COMMON	PRESENT	COMMON	COMMON
Glossiphonia sp.			PRESENT		
Oligochaeta				COMMON	
ISOPODA				PRESENT	
AMPHIPODA					
Gammaridae		COMMON	PRESENT	ABUNDANT	ABUNDANT
DECAPODA					
Crayfish	PRESENT	PRESENT			
INSECTA					
Ephemeroptera					
Potamanthidae	COMMON				
Baetidae	PRESENT				
Coleoptera					
Elmidae	COMMON				
Trichoptera					
Hydropsycidae	PRESENT				
Diptera					
Tipulidae	PRESENT				
Chironomidae	COMMON	ABUNDANT	ABUNDANT	ABUNDANT	COMMON
Simulidae				ABUNDANT	ABUNDANT
GASTROPODA					
Ancylidae	ABUNDANT				
Lymnaeidae				PRESENT	PRESENT
PELECYPODA					
Sphaeriidae		PRESENT	COMMON	COMMON	COMMON

PRESENT = 1 TO 5 ORGANISMS
COMMON = 6 TO 15 ORGANISMS
ABUNDANT= 16 OR MORE

Table 5. Reported toxicity data for chlorinated phenols and polynuclear aromatic hydrocarbons effecting aquatic organisms. All value ug/L.

COMPOUND : ORGANISM	Test Type	Duration	Concentration(s)	Reference
PENTACHLOROPHENOL				
Daphnia magna	static	48 hr.	320	Mayer & Ellersick, 1986
Cutthroat trout	static	96 hr.	10-100	Mayer & Ellersick, 1986
Chinook salmon	flowthrough	24 & 96 hr	225, 170	Mayer & Ellersick, 1986
Chinook salmon	flowthrough	24 & 96 hr	>250, 165	Mayer & Ellersick, 1986
Chinook salmon (fingerling)	static	24 & 96 hr	68, 68	Mayer & Ellersick, 1986
Chinook (swim-up fry)	static	24 hr	73	Mayer & Ellersick, 1986
Chinook (swim-up fry)	flowthrough	24 & 96 hr	>250, >250	Mayer & Ellersick, 1986
Chinook (yolk sac fry)	static	24 & 96 hr	>100, 30.5	Mayer & Ellersick, 1986
Rainbow trout	static	24 & 96 hr	62, 58	Mayer & Ellersick, 1986
Rainbow trout	static	24 & 96 hr	55, 55	Mayer & Ellersick, 1986
Rainbow trout	flowthrough	24 & 96 hr	173, 128	Mayer & Ellersick, 1986
Rainbow trout (eyed egg)	flowthrough	24 & 96 hr	>300, >300	Mayer & Ellersick, 1986
Rainbow trout (swim-up fry)	flowthrough	24 & 96 hr	310, 165	Mayer & Ellersick, 1986
Rainbow trout (yolk sac fry)	flowthrough	24 & 96 hr	280, 160	Mayer & Ellersick, 1986
Fathead minnow	flowthrough	24 & 96 hr	370, 270	Mayer & Ellersick, 1986
Channel catfish	static	24 & 96 hr	77, 77	Mayer & Ellersick, 1986
Channel catfish (yolk sac fry)	flowthrough	24 & 96 hr	249, 200	Mayer & Ellersick, 1986
Bluegill	static	24 & 96 hr	70, 44	Mayer & Ellersick, 1986
Bluegill	flowthrough	24 & 96 hr	540, 390	Mayer & Ellersick, 1986
Coho salmon	?	96 hr	32 - 84	Canadian Ministries, 1987
Rainbow trout	?	96 hr	44 - 220	Canadian Ministries, 1987
Bluegill	?	96 hr	20 - 305	Canadian Ministries, 1987
Fathead minnow	?	96 hr	180 - 600	Canadian Ministries, 1987
Daphnia species	?	96 hr	240	Canadian Ministries, 1987
Lymnaea (snail)	?	96 hr	160	Canadian Ministries, 1987
Oligochaeta	?	96 hr	105 - 980	Canadian Ministries, 1987
Daphnia magna	Chronic test	?	240	Canadian Ministries, 1987
Fathead minnow	Chronic test	?	47 - 73	Canadian Ministries, 1987
Rainbow trout	Early life(Reduction of biomass)		10 - 20	Canadian Ministries, 1987
Sockeye salmon	Early life stage (no effect conc.)		1.84	Canadian Ministries, 1987
FLUORANTHENE				
Bluegill		96 hr	3,980	Canadian Ministries, 1987
Daphnia magna		48 hr	325,000	Canadian Ministries, 1987
PHENANTHRENE				
Rainbow trout (embryo-larvae)	Early life stage		40 - 180	Canadian Ministries, 1987
ANTHRACENE				
Fish in sunlight	?	?	12	Canadian Ministries, 1987
BENZO (a) PYRENE				
Rainbow trout	Full life stage (Abnormalities)		0.08	Canadian Ministries, 1987

Table 6. Base-neutral and acid extractable results for sediment samples collected at Dillenbaugh Cr. in Chehalis near the American Crossarm and Conduit Co. (ACC) site, on two occasions: December 1986 (Yake, 1987); and July 1987 (this report). All values are ug/kg, dry weight, unless otherwise specified.

COMPOUND	STA. D-2 1987	STA. D-2 1986	STA. 4 D-3 1987	STA. 4 D-3 1986	John Street Lagoon 1987	SDL-1 1986	SDL-1Rep. 1986
Phenol	260 u		780 u		5100 u		
2-chlorophenol	260 u		780 u		5100 u		
2-nitrophenol	260 u		780 u		5100 u		
2,4-dimethylphenol	260 u		780 u		5100 u		
2,4-dichlorophenol	260 u		780 u		5100 u		
4-chloro-3-methylphenol	260 u		780 u		5100 u		
2,4,6-trichlorophenol	260 u		780 u		5100 u		
2,4,5-trichlorophenol	1300 u		3800 u		25000 u		
2,4-dinitrophenol	1300 u		3800 u		25000 u		
4-nitrophenol	1300 u		3800 u		25000 u		
4,6-dinitro-o-cresol	1300 u		3800 u		25000 u		
Pentachlorophenol	2100	140 u	3800 u	92 u	25000 u	7400	8200
bis(2-chloroethyl)ether	260 u		780 u		5100 u		
bis(2-chloroisopropyl)ether	260 u		780 u		5100 u		
bis(2-chloroethoxy)methane	260 u		780 u		5100 u		
4-chlorophenyl phenyl ether	260 u		780 u		5100 u		
1,3-dichlorobenzene	260 u		780 u		2400 j		
1,4-dichlorobenzene	260 u		780 u		2000 j		
1,2-dichlorobenzene	260 u		780 u		1200 j		
1,2,4-trichlorobenzene	260 u		780 u		5100 u		
Hexachloroethane	260 u		780 u		5100 u		
Nitrobenzene	260 u		780 u		5100 u		
Hexachlorobenzene	260 u		780 u		5100 u		
2,6-dinitrotoluene	260 u		780 u		5100 u		
2,4-dinitrotoluene	260 u		780 u		5100 u		
Isophorone	9 j		780 u		5100 u		
Nitrosodiphenylamine	260 u		780 u		5100 u		
Hexachlorobutadiene	260 u		780 u		5100 u		
Hexachlorocyclopentadiene	260 u		780 u		5100 u		
2-chloronaphthalene	260 u		780 u		5100 u		
Acenapthene	260 u		780 u		5100 u		
Acenaphthylene	260 u		780 u		5100 u		
Fluorene	260 u	77 u	780 u	51 u	5100 u	4100	3200
Naphthalene	260 u		780 u		1700 j		
Phenanthrene	260 u	27 j	20 j	48 u	5500	7000	6300
Anthracene	260 u	64 u	780 u	49 u	6800	1200 j	1100 j
Fluoranthene	63 bj	39 j	35 bj	49 u	2700 bj	5400	5000
Pyrene	100 j	64	780 u	54 u	5100 u	6600	5900
Benzo(a)anthracene	530 bu	40 u	780 bu	38 u	2100 b	1600	1500
Chrysene	260 bu	48 u	780 bu	30 u	1700 b	2700	2700
Benzo(b)fluoranthene	260 bu		780 bu		2200 b		
Benzo(k)fluoranthene	260 bu		54 bj		2500 b		
Benzo(a)pyrene	260 u		780 u		5100 u		
Dibenzo(a,h)anthracene	260 u		780 u		5100 u		
Indeno-1,2,3-c,d-pyrene	260 u		780 u		5100 u		
Benzo(g,h,i)perylene	260 u		780 u		5100 u		
Diethylphthalate	260 bu		780 bu		5100 bu		
Di-n-butylphthalate	260 bu	110 u	780 bu	99 u	5100 bu		
Benzyl butylphthalate	260 u	44 u	780 bu	38 u	3200 bj	1700 u	1300 j
bis(2-ethylhexyl)phthalate	920 b	390	470 bj	36 j	130000 b	230000	200000
Di-n-octyl phthlate	260 bu		72 bj		2100 b		
Dimethylphthalate	260 u		780 u		5100 u		
Total Polychlorinated Dioxins*		102				1530	1528
T. Polychlor. Dibenzofurans*		13				373	324
Benzoic acid	1300 u		3800 u		25000 u		
2-nitroaniline	1300 u		3800 u		25000 u		
3-nitroaniline	1300 u		3800 u		25000 u		
4-nitroaniline	1300 u		3800 u		25000 u		
4-chloroaniline	260 u		780 u		25000 u		
2-methylnaphthalene	20 j		780 u		5000 j		
3,3-dichlorobenzidine	530 u		1600 u		10000 u		
2-methylphenol	260 u		780 u		5100 u		
4-methylphenol	260 u		780 u		5100 u		
Dibenzofuran	260 u		780 u		[illegible]		
n-nitroso-di-n-propylamine	260 u		780 u		5100 u		
4-bromophenyl phenyl ether	260 u		780 u		5100 u		
Benzyl alcohol	260 u		780 u		5100 u		
Percent solids (%)	[illegible]	66.00	17.75	[illegible]	71.54	33.00	33.00
Gravel (>2mm) (%)	0.24	0.45	1.91	0.32	0.00	22.74	4.11
Sand (2mm-62um) (%)	5.60	11.26	15.81	72.81	12.94	23.45	33.29
Silt (62um-4um) (%)	55.78	55.38	56.52	22.91	75.12	48.78	57.05
Clay (<4um) (%)	36.85	33.97	24.44	3.55	9.30	3.15	4.13

bj = Compound detected in methods blank, estimated value.
j = Estimated value, samples exceeded recommended holding time.
u = Compound not detected above stated value.
* = Simple sum of tetra-, penta-, hexa-, hepta-, and octa- compounds listed in Table 3 of Yake (1987).