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NORTH VANCOUVER, B.C.

MARINE MONITORING OF STUART CHANNEL NEAR THE CROFTON PULPMILL CROFTON, B.C. 1989

EP REGIONAL DATA REPORT: DR 92-01

By

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REVIEW NOTICE

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ABSTRACT

Environmental Protection has monitored marine waters around coastal pulpmills since 1976. Stuart Channel has been part of this annual routine marine monitoring programme. Water quality records were kept of temperature, salinity, dissolved oxygen and colour relative to water depth. Marine sediment was collected for trace metal, volatile residue, particle size and chlorophenol analysis. Trawls of fish and crustaceans were collected, identified and analyzed for trace metals.

This data report summarizes the sampling done in Stuart Channel by Environmental Protection in April 1989 around Crofton, B.C. Methods used for collection and analysis are described and results are presented without analysis or interpretation. The sole intent of this report is to provide historical data for Crofton pulpmill.

RESUME

La Protection de l'Environnement a échantillonné les eaux marines réceptrices aux environs des usines de pâte côtières depuis 1976. Stuart Channel a fait partie d'un programme d'échantillonnage marin de routine annuel. Les données de qualité de l'eau sont concentrées sur la température, salinité, oxygène dissous, et couleur en relation à la profondeur d'eau. Des échantillons instantanés de sédiment furent recueillis pour des analyses de métal à l'état de trace, de résidu volatil, grosseur de particules, et des analyses de chlorophenoIs. Des poissons et crustacés attrapés au chalut furent recueillis,identifé et analysés pour métaux à l'état de trace.

Ce rapport de donnée résume l'échantillonnage fait dans le Stuart Channel par la Protection de l'Environnement en Avril 1989 près de Crofton C.-B. Les rapports de données résument les méthodes utilisées pour l'échantillonnage et l'analyse. Les résultats sont présentés en tables ou graphiques sans analyse ni interprétation. La seule intention de ces rapports est de fournir des données historiques.

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1.0 INTRODUCTION

Crofton pulpmill has been in operation at Crofton, B.C., on the southeast corner of Vancouver Island, since 1957 (Figure 1). Originally under the ownership of B.C. Forest Products, it is now operated by Fletcher Challenge. It began as a kraft mill and has expanded into a combination kraft, CTMP (Chemical Thermal Mechanical Pulp), and newsprint operation. With an average annual production of 1173 ADTD (air-dried tonnes per day), it ranks second in production of British Columbia mills.

There are two submarine outfalls with diffusers located at depths of 18 and 28 m for effluent discharge at Crofton. Average discharge is about 147,000 cubic metres per day. Effluent passes through a primary clarifier and CTMP effluent receives secondary biological treatment in an aeration basin. With the installation of secondary treatment, mill effluent will be non-acutely toxic by 1992.

One of the major effects of mill effluent on Stuart Channel (Figure 2) has been the development of an extensive fibre mat of wood fibres and solids on the surrounding seabed. This was first reported by Ellis (1970) and covers roughly a distance 1.8 km both northwest and southeast of the outfall to a depth of 5 cm. The mill has carried out routine assessments to determine the trends in fibre content, depth and size of the fibre bed (Severn and Sutherland, 1986). Observations of the bed have been made by Environment Canada on the PISCES IV submarine (Nelson, 1979). Colodey and Tyers (1987) analyzed fibre depth and volatile fraction data from several years and found considerable fluctuation in the data.

Environmental Protection Service (EP) has conducted surveillance and compliance monitoring programs at coastal pulpmills since 1976. This report continues a series of data reports of marine environmental surveillance by EP of Stuart Channel near the discharge of the Fletcher Challenge, Crofton B.C. pulpmill. Water, sediment and biota quality records from the April 27, 1989 cruise are presented.

1.1 Oceanography

Crofton pulpmill is situated on Stuart Channel on the sheltered east coast of southern Vancouver Island. It is in a protected bay which is subject primarily to prevailing southeasterly or southwesterly winds. The bay itself is a typical stratified 'inside water' estuary. Tidal streams are weak at Crofton because the Gulf Islands protect it from the main effects of the Strait of Georgia. It is generally observed that the overall surface water flow is southeastward. This is due in part to a stronger ebb than flow current (Thomson, 1981).

Waldichuk (1964) studied the oceanography of Stuart Channel to help ascertain the factors affecting effluent dispersal from the Crofton mill. His principal finding was that as the primarily freshwater effluent rose, it entrained seawater resulting in an effluent-seawater mixture that was denser than seawater. This mixture would spread in a thin layer at depths between 3 and 10 metres.

In the winter, lower surface water temperatures combined with wind mixing tend to vertically homogenize the waters in the vicinity of the Crofton mill. This reduces the effect of the seawater-effluent since the effluent plume follows the density gradient of salinity and/or temperature. In the summer months, the gradient is most pronounced, and it is during this period that the location of the lower dissolved oxygen layer is critical.

Previous Environment Canada reports (Nelson, 1979; Sullivan, 1982; Colodey and Tyers, 1987) described the oceanography of Stuart Channel in the vicinity of the mill. Various water quality and environmental effects studies were conducted by Dobrocky Seatech for the mill in 1986 (Smyth, 1986a, 1986b; Severn and Sutherland, 1986). Oceanographic information prior to mill construction is unavailable.

1.2 Fisheries

Crofton is located within Fisheries Statistical Area 18, one of the most popular and extensively used sport fishing areas in B.C. All five species of Pacific salmon are commercially and recreationally harvested with chinook salmon representing the bulk of the commercial catch. The Crofton mill draws water from the Cowichan River which is viewed as one of the most productive salmon systems on Vancouver Island (Nelson, 1979). This river system is about 16 km south of Crofton. Sediment from the intake water treatment plant is flushed into Bonsall Bay, resulting in sediment accumulation which necessitates localized dredging.

At one time the intertidal zone north and south of Crofton mill contained highly productive commercial oyster (***Crassostrea gigas***) beds. Although preservation of this important resource was considered in the planning of the mill, by 1964 the oyster population had deteriorated from effects of pulpmill effluent to the extent of losing all commercial value (Nelson, 1979). All shellfish in this area remain poor quality for human consumption. One of the main problems was zinc contamination of the shellfish and although the mill has changed its process, there has been no documentation of the change in concentration of zinc in oysters.

Stuart Channel is a small, but well-established shrimp trawling ground. Production peaked in 1957, the year Crofton pulpmill was established (Harbo and Jamieson, 1987). The primary species harvested is the pink shrimp (***Pandalus borealis/P. jordani***) with minor harvesting of the sidestripe shrimp (***Pandalopsis dispar***) and prawn (***Pandalus platyceros***) (Boutillier, pers. comm., DFO - PBS, 1991).

In November 1989, a national dioxin study by Environment Canada and Fisheries and Oceans Canada demonstrated the presence of dioxins and furans in harvested fish and shellfish in the vicinity of several pulpmills. Crofton was on this list and closures resulted for crab and oyster fisheries (Figure 2). Recreational and native harvesting of crab remained open with some hepatopancreas consumption guidelines. Associated with these closures, the mill has conducted extensive annual dioxin and furan monitoring surveys (E.V.S, 1989; Dwernychuk, 1990; Dwernychuk *et al*., 1991).

2.0 MATERIALS AND METHODS

Sampling in Stuart Channel was done from the C.S.S. *Vector* on April 27, 1989 at stations shown in Figure 3. Stations were located using ship's LORAN-C and radar. Station positions are described in Appendix II. Table 1 summarizes water quality, sediment and tissue parameters sampled, and techniques are summarized in Table 2. Lab analyses were done at the EP/DFO West Vancouver laboratory.

2.1 Water Samples

Water samples were collected at discrete depths with polypropylene N.I.O. (National Institute of Oceanography) water bottles using standard oceanographic techniques at stations depicted in Figure 3. Conductivity, temperature and depth (CTD) profiles were taken using a Guildline 8770 CTD/DO sensor.

2.1.1 Analytical Procedures - Water. Oxygen concentrations were determined in the ship's lab using the azide modification of the Winkler method. The equations of Gameson and Robertson (1955) were used in the calculation of percent dissolved oxygen saturation:

$$C=\frac{475-(2.65xS)}{33.5+T}$$

$$\%Saturation=\frac{A}{C}x100$$

where:
C = saturation of oxygen in the sample water
S = salinity of the sample water
T = corrected temperature of the sample water
A = observed dissolved oxygen concentration in the sample

Tri-stimulus colour values of previously frozen samples were determined spectrophotometrically in the lab.

2.2 Sediment Samples

Sediment grabs were taken at the stations depicted in Figure 3 using a stainless steel 0.1 m^2 Smith-MacIntyre grab. The surficial (2 cm) sediment layer was collected using a plastic scoop, avoiding the sediment near the sides of the grab. Samples for trace metal, volatile residue and particle size analysis were placed in paper sediment bags inside plastic bags and immediately frozen. Sediments collected for PCB and resin acid analysis were collected using a heat-treated metal spoon and stored frozen in heat-treated glass jars.

2.2.1 Analytical Procedures - Sediment. Sediment samples were analyzed by the EP/DFO West Vancouver Laboratory for trace metals, volatile residue and particle size according to the procedures described by Swingle and Davidson (1979) with some modification by the lab (Millward and Kluckner, 1989). Trace metal samples were dried at 60°C and passed through a nylon seive (0.15 mm mesh) then digested in a 4:1 nitric:hydrochloric acid solution diluted slightly with 1 ml of distilled water. Samples were digested in a microwave oven for 15 minutes at 720 joules/sec (watts). Trace metals were determined using a Perkin-Elmer Inductively Coupled Argon Plasma (ICAP) Optical Emission Spectrophotometer. A Jarrel Ash 850 Atomic Absorption Spectrophotometer (AAS) with an FLA 100 graphite tube furnace was used to detect low-level cadmium. Electron capture gas liquid chromatography was used for PCB and resin acid determination.

2.3 Biota Samples

Fish and invertebrate tissue were collected for trace metal analysis from trawls taken at Crofton Stations 3 and 9. Samples were placed in plastic bags and frozen prior to analysis. The following species were used for analysis:

English sole	*Parophrys vetulus*
Hake	*Merluccius productus*
Ratfish	*Hydrolagus colliei*
Rockfish	*Sebastes* sp.
Pacific cod	*Gadus macrocephalus*
Rough scale sole	*Lepidopsetta bilineata*
Prawn	*Pandalus platyceros*
Sidestripe shrimp	*Pandalopsis dispar*
Pink shrimp	*Pandalus borealis* OR *Pandalus jordani*
Dungeness crab	*Cancer magister*

2.3.1 **Analytical Procedures - Biota**. At the EP/DFO West Vancouver Lab, samples were thawed, blended, freeze-dried and oxidized in a low temperature asher. The ash (metallic salts) was dissolved in warm concentrated nitric acid, then analyzed on the ICAP Spectrophotometer. Low-level cadmium was analyzed using a Jarrel Ash 850 Atomic Absorption Spectrophotometer (AAS) with a FLA 100 graphite tube furnace.

<u>TABLE 1</u>: WATER, SEDIMENT AND BIOTA SAMPLING STATIONS, CROFTON SAMPLING SUMMARY, APRIL 27, 1989

STATION	WATER			SEDIMENT		BIOTA
	CTD	DO	COLOUR	PS	TM	MUSCLE
C-1	X	X	X	X	X	
C-2				X	X	
C-3				X	X	
C-4				X	X	
C-5				X	X	
C-6				X	X	
C-7	X	X	X	X	X	
C-8	X	X	X	X	X	
C-9			X	X	X	
C-10	X	X	X	X	X	
C-11				X	X	
C-12				X	X	
C-13				X	X	
C-3 TRAWL						X
C-9 TRAWL						X

CTD Conductivity, Temperature, Depth
DO Dissolved Oxygen
PS Particle Size
TM Trace Metal

TABLE 2: SUMMARY OF ENVIRONMENTAL PROTECTION METHODS FOR WATER, SEDIMENT AND TISSUE ANALYSES

SAMPLE TYPE	METHODS	REFERENCE
WATER		
Salinity, temperature, depth	CTD	Goyette & MacLeod, 1984
Dissolved Oxygen	Azide Modification of Winkler	Swingle & Davidson, 1979 Gameson & Robertson, 1955
Colour	Spectrophotometer	Swingle & Davidson, 1979
SEDIMENT		
Particle Size	Freeze drying, Screening	Swingle & Davidson, 1979 Griffiths, 1967
Trace Metals	ICAP Optical Emmission Spectrophotometer	Swingle & Davidson, 1979 Millward & Kluckner, 1989
Volatile Residue	Wt. loss on ignition 550°C for 1 hr.	Swingle & Davidson, 1979
TISSUE		
Trace Metals	ICAP Optical Emission Spectrophotometer	Swingle & Davidson, 1979

3.0 RESULTS

3.1 Water Quality

Salinity, temperature, dissolved oxygen (DO), % oxygen saturation and colour data from Crofton water quality stations C-1,C-7,C-8 and C-10 for April 27, 1989 are listed in Tables 3 to 6. Results of effluent monitoring for the Crofton mill on November 11, 1989 for chloroanisoles, chlorophenols and resin acids are found in Appendix III.

TABLE 3: WATER QUALITY, CROFTON 1, APRIL 27, 1989

DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	DISSOLVED OXYGEN (mg/L)	% OXYGEN SATURATION	COLOUR
0	13.3	26.1	9.9	114.16	9.3
2	10.0	28.8	7.9	86.20	17.8
5	9.9	28.9	6.7	72.98	26.7
10	8.9	29.6	6.0	64.15	9.2
20	8.3	30.0	6.8	71.87	<5.0
30	8.0	30.1	6.2	65.10	<5.0

TABLE 4: WATER QUALITY, CROFTON 7, APRIL 27, 1989

DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	DISSOLVED OXYGEN (mg/L)	% OXYGEN SATURATION	COLOUR
0	12.0	28.6	10.5	119.67	5.3
2	11.0	28.9	10.3	115.04	<5.0
5	10.9	29.0	10.1	112.63	<5.0
10	9.3	29.6	8.5	91.74	<5.0
20	8.3	30.0	6.7	70.81	<5.0
50	7.6	30.3	5.8	60.39	<5.0
100	7.3	30.3	5.8	59.95	<5.0
200	7.0	30.5	5.2	53.43	ND

TABLE 5: WATER QUALITY, CROFTON 8, APRIL 27, 1989

DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	DISSOLVED OXYGEN (mg/L)	% OXYGEN SATURATION	COLOUR
0	12.4	28.3	11.1	127.37	<5.0
2	12.1	29.7	11.7	134.63	<5.0
5	10.2	29.4	10.8	118.86	<5.0
10	9.1	29.5	7.4	79.44	<5.0
20	8.1	30.1	6.7	70.52	<5.0
30	7.7	30.2	6.6	68.85	<5.0

TABLE 6: WATER QUALITY, CROFTON 10, APRIL 27, 1989

DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	DISSOLVED OXYGEN (mg/L)	% OXYGEN SATURATION	COLOUR
0	12.9	27.7	11.0	127.09	<5.0
2	11.0	28.0	10.6	117.69	<5.0
5	10.1	29.1	8.6	94.24	<5.0
10	9.2	29.6	8.0	86.14	<5.0
20	8.3	30.0	6.7	70.81	<5.0
50	7.6	30.3	5.4	56.23	<5.0
100	7.3	30.4	5.9	61.03	<5.0

3.2 Sediment Quality

Results of sediment sampling in Stuart Channel are summarized in Table 7. Median particle size and trace metal analysis are recorded for the thirteen stations sampled on April 27, 1989 around the Crofton mill. All stations contained fine sediments classified as either very fine sand, or silt and clay. Results of chlorophenol analysis of the sediments are found in Appendix IV. For most samples, chlorophenols were not detected. However, tetrachlorophenol and pentachlorophenol were detected at all stations except C-2 and C-3.

3.3 Biota Quality

Tables 8 and 9 list the results of trace metal analyses on several different species of marine fish and invertebrates collected in Stuart Channel trawls at Crofton Trawl Stations C-3 and C-9.

TABLE 7: SEDIMENT QUALITY, CROFTON, STUART CHANNEL, APRIL 27, 1989

CROFTON STATION NUMBER	DEPTH (m)	MEDIAN PARTICLE SIZE	Al (%)	As (µg/g)	Cd (µg/g)	Cr (µg/g)	Cu (µg/g)	Fe (%)	Ni (µg/g)	Pb (µg/g)	Zn (µg/g)
C-1	64	v. fine sand	2.0	<8	2.1	54.7	56.0	2.54	29	<8	192
C-2	64	v. fine sand	1.7	<8	2.0	44.2	44.8	2.36	26	<8	161
C-3	119	silt & clay	2.3	24	2.0	54.3	56.3	3.22	34	10	157
C-4	82	v. fine sand	1.9	<8	2.1	54.7	56.0	2.54	29	<8	192
C-5	129	silt & clay	2.3	10	<0.8	52.7	54.5	3.26	34	10	148
C-6	110	silt & clay	2.3	10	1.0	51.9	57.5	3.25	34	<8	146
C-7	217	silt & clay	2.5	<8	<0.8	51.1	44.8	3.23	34	<8	127
C-8	38	silt & clay	1.8	<8	<0.8	36.2	22.9	2.76	23	<8	92.1
C-9	104	silt & clay	2.5	8	<0.8	52.3	56.8	3.25	34	<8	148
C-10	181	silt & clay	2.5	<8	<0.8	52.2	45.0	3.39	35	<8	128
C-11	81	silt & clay	2.1	<8	<0.8	44.8	49.8	2.77	29	<8	102
C-12	107	silt & clay	2.3	10	1.0	55.6	59.9	3.13	33	9	151
C-13	67	v. fine sand	1.9	10	1.0	44.0	46.5	2.47	27	<8	133

TABLE 8: BIOTA QUALITY, CROFTON STATION TRAWL C-3, APRIL 27, 1989

µg/g	HAKE	HAKE	PRAWN	PRAWN	ENGLISH SOLE	ENGLISH SOLE	SHRIMP	SHRIMP	SHRIMP	ROUGH SCALE SOLE	ROCKFISH
	31 cm 195 g	28 cm 127 g	tail	tail	39 cm 480 g	30.3 cm 217 g	tail	tail	tail	35.5 cm 470 g	25 cm 206 g
Cd	0.020	<0.008	<0.008	0.020	<0.008	<0.008	0.040	0.030	0.020	0.009	<0.008
Pb	0.35	0.20	0.13	0.14	0.16	0.19	0.18	0.17	<0.04	0.07	0.12
Hg	0.060	0.050	0.070	0.063	0.056	0.190	0.130	0.081	0.100	0.220	0.786
Al	23	33	52	60	9.1	14	76	80	60	16	39
As	<4	<4	68	25	26	35	43	32	35	17	<4
Ba	0.10	0.30	0.30	0.60	<0.08	0.20	0.80	0.40	0.40	0.09	0.20
Be	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Co	0.5	<0.4	0.6	0.4	<0.4	<0.4	<0.4	<0.4	0.5	<0.4	<0.4
Cr	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Cu	2.0	1.1	10.8	14.8	0.7	0.8	16.6	16.8	14.3	0.6	0.6
Fe	49.0	48.0	60.0	71.0	19.1	23.0	96.6	107	73.3	21.2	48.7
Mg	1460	1550	1520	1450	1060	1160	1480	1480	1440	1230	1350
Mn	1.2	1.7	1.2	1.7	0.3	0.7	1.6	1.7	1.6	0.5	1.1
Ni	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sb	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Sn	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Sr	2.5	6.7	7.6	8.4	4.6	13.9	15.4	9.5	11.9	1.6	9.1
Ti	1.5	2.3	3.5	3.8	1.0	1.0	4.8	5.0	3.9	1.5	2.6
V	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Zn	21.1	17.3	47.7	51.4	27.1	36.8	43.8	43.4	42.2	18.6	14.0
% mois	78.8	79.3	76.9	74.8	84.5	79.5	76.8	76.0	76.3	83.4	81.3

TABLE 9: BIOTA QUALITY, CROFTON STATION TRAWL C-9, APRIL 27, 1989

μg/g	HAKE	HAKE	ENG SOLE	ENG SOLE	ENG SOLE	PACIFIC COD	PRAWN	SIDESTR SHRIMP	SIDESTR SHRIMP	SIDESTR SHRIMP	DUNGENES S CRAB
	41 cm 438 g	30 cm 194 g	37 cm 409 g	ND	45 cm 470 g	47 cm 1,239 g	tail	tail	tail	tail	hepato
Cd	<0.008	<0.008	<0.008	0.010	<0.008	<0.008	0.030	0.060	0.040	0.030	0.060
Pb	0.12	0.07	0.14	0.18	0.13	0.13	0.63	<0.04	0.36	0.18	0.89
Hg	0.456	0.220	0.220	0.480	0.150	0.250	0.060	0.076	0.099	0.068	0.767
Al	<4	<4	4	4	8	<4	12	35	44	54	187
As	<4	23	40	52	41	10	16	20	27	16	41
Ba	<0.08	<0.08	<0.08	<0.08	0.10	<0.08	0.09	0.20	0.40	0.30	2.10
Be	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Co	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.8
Cr	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	1.4
Cu	0.8	0.8	0.9	1.0	1.2	0.7	15.0	16.3	20.1	19.3	32.7
Fe	7.5	10.3	10.9	11.9	25.1	6.6	15.8	39.1	52.7	61.1	396
Mg	1340	1360	1030	1060	1110	1350	1550	1410	1470	1450	2040
Mn	0.4	0.5	0.5	0.2	0.6	0.5	1.2	1.4	1.3	1.5	4.7
Ni	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	7
Sb	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Sn	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Sr	0.9	3.7	4.3	2.9	10.3	0.5	16.0	11.2	15.8	10.1	133
Ti	0.5	0.5	0.6	0.8	0.9	0.5	0.9	2.1	2.6	3.1	8.9
V	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Zn	17.1	12.1	18.3	23.1	25.5	18.6	56.8	46.1	45.6	46.0	256
%mois	81.6	81.1	76.7	82.9	79.6	77.3	78.1	74.7	75.2	74.8	80.4

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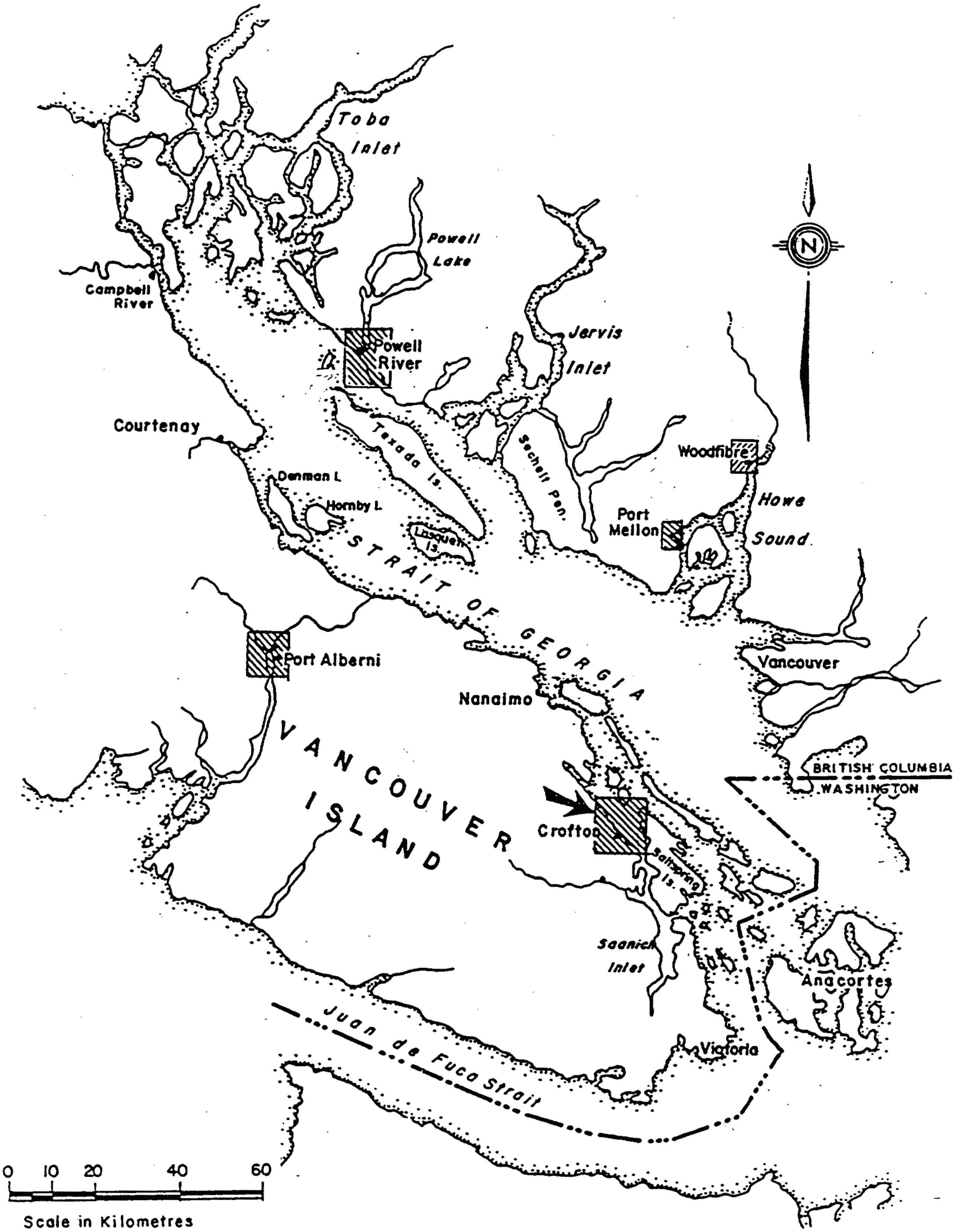

FIGURE 1: LOCATION MAP - CROFTON

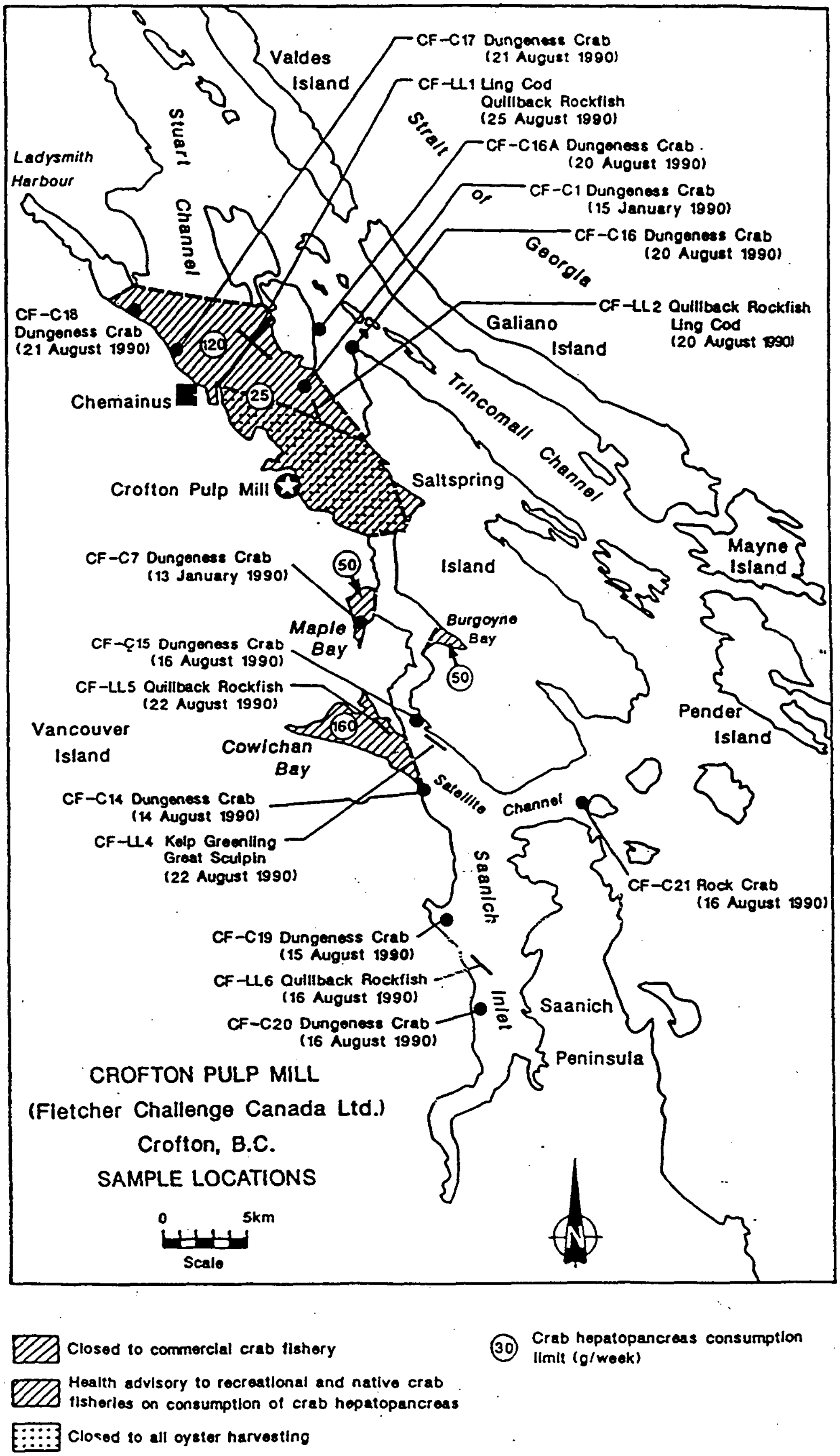

FIGURE 2: CROFTON FISHERIES CLOSURES, 1991

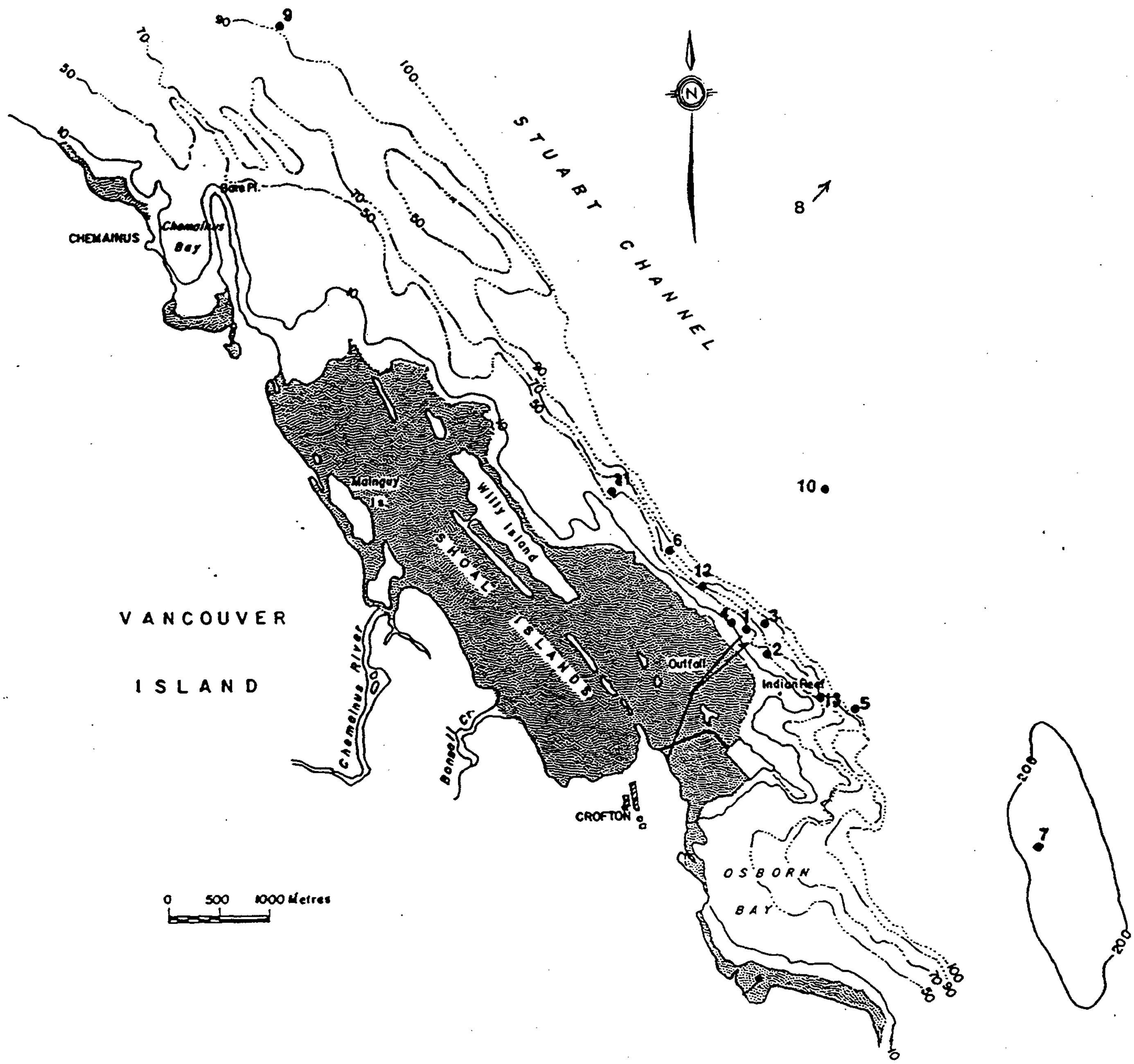

FIGURE 3: SAMPLING LOCATIONS NEAR FLETCHER CHALLENGE, CROFTON

APPENDICES

APPENDIX I: PACIFIC REGION PULP AND PAPER INDUSTRY EFFLUENT SUMMARY

Company: British Columbia Forest Products Ltd.
Mill: Crofton
Location: Crofton

Year: 1987

	===FLOW===		=PRODUCTION=		===TSS (FED)===			==TSS (PROV)==		===BOD5 (FED)===			==BOD5 (PROV)==		==TOXICITY (PROV)==	
	Aver. (m3/d)	# of days	Av. (ADt/d)	# of days	Av. (kg/ADt)	# of Tests	% Comp.	Av. (tonne/d)	# of Tests	Av. (kg/ADt)	# of Tests	% Comp.	Av. (tonne/d)	# of Tests	# of Tests	% Comp.
Yearly Values	179,382	185	1,912	360	10.13	345	47%	19.35	345	23.53	53	89%	44.06	53	9	33%

EFFLUENT QUALITY REQUIREMENTS

	FLOW (m3/d)	TSS	BOD5	TOXICITY (%v/v)
Federal (kg/ADt)	---	8.30	30.80	96LC20 = 65
Provincial (tonne/d)	230,000	27.50	48.00	96LC50 = 30

APPENDIX II: CROFTON SAMPLING STATION LOCATIONS, STUART CHANNEL, 1989

HYDROCASTS & CTD			
STATION	DEPTH (m)	LATITUDE	LONGITUDE
C-1	50	48°53.54′	123°38.04′
C-7	205	48°52.39′	123°35.71′
C-8	35	48°55.52′	123°36.42′
C-9	93	48°56.46′	123°41.25′
C-10	163	48°54.00′	123°37.22′
TRAWL STATIONS			
C-3 (START)	110	48°54.05′	123°38.28′
(FINISH)		48°53.61′	123°37.86′
C-9 (START)	95	48°56.62′	123°41.52′
(FINISH)		48°56.28′	123°41.00′
SEDIMENT GRABS			
C-1	60	48°53.54′	123°38.04′
C-2	64	48°53.45′	123°37.88′
C-3	110	48°53.61′	123°37.85′
C-4	80	48°53.63′	123°38.12′
C-5	126	48°53.18′	123°37.19′
C-6	110	48°53.98′	123°38.59′
C-7	206	48°52.39′	123°35.71′
C-8	38	48°55.52′	123°36.42′
C-9	104	48°56.46′	123°41.25′
C-10	170	48°54.00′	123°37.22′
C-11	75	48°54.30′	123°39.10′
C-12	102	48°53.78′	123°38.30′
C-13	67	48°53.30′	123°37.52′
CORE C-1	60	48°53.54′	123°38.04′

APPENDIX III: RESULTS FOR CROFTON PULP MILL EFFLUENT MONITORING, NOVEMBER 11, 1990

PARAMETER	NOV.11, 1990
CHLOROANISOLE/2,3,4,5-TETRA	<0.005
/2346+56-TETRA	<0.005
/PENTA	<0.002
CHLOROPHENOL/2,3,4,5-TETRA	<0.005
/2,3,4-TRI	<0.01
/2,3,5-TRI	<0.01
/2,3,6-TRI	<0.01
/2,4,5-TRI	<0.01
/2,4,6-TRI	<0.01
/2346+2356-TETRA	<0.005
/PENTA	<0.002
RESIN ACID/12-CHLORO-DHA	0.09
/14-CHLORO-DHA	0.04
/8(14)ABIETENIC	<0.01
/ABIETIC	2.16
/DEHYDROABIETIC	3.41
/DICHLORO-DHA	<0.01
/DIHYROISOPIMARIC	<0.01
/ISOPIMARIC	1.90
/NEOABIETIC	0.20
/PALUSTRIC	1.32
/PIMARIC	0.85
/SANDARACOPIMARIC	0.84

APPENDIX IV: CROFTON PULP MILL, 1990, CHLOROPHENOLS IN SEDIMENT

PARAMETER	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12	C-13
CHLOROPHENOL/ 2,3,4,5-TETRA (μg/g)	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1	ND^1
CHLOROPHENOL/ 2,3,4-TRI (μg/g)	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2
CHLOROPHENOL/ 2,3,5-TRI (μg/g)	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2
CHLOROPHENOL/ 2,3,6-TRI (μg/g)	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2
CHLOROPHENOL/ 2,4,5-TRI (μg/g)	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2
CHLOROPHENOL/ 2,4,6-TRI (μg/g)	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2	ND^2
CHLOROPHENOL/ 2346+2356-TETRA (μg/g x 10^{-3})	3.0	ND^1	ND^1	10.0	ND^1	5.4	11.3	10.6	15.0	16.0	21.9	15.9	9.6
CHLOROPHENOL/ PENTA (μg/g x 10^{-3})	4.4	ND^3	ND^3	7.4	11.9	3.6	7.9	7.1	14.3	11.0	11.6	15.7	7.2

ND^1 = <.0002 ND^2 = <.0005 ND^3 = <.0001