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RESOURCE DEVELOPMENT BRANCH

MANUSCRIPT REPORT

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Pollution Survey of the Saint John Industrial Complex and its Effect on the Water Quality of the Saint John Harbour

by

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POLLUTION SURVEY

of the

SAINT JOHN INDUSTRIAL COMPLEX

and its

EFFECT ON THE WATER QUALITY

of the

SAINT JOHN HARBOUR

by

Richard Row

November, 1970

ACKNOWLEDGMENTS

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Section "A"

Pollution Survey

of the

Saint John Industrial Complex

Saint John, with a population of 90,000, is the largest city in the Province of New Brunswick and is also New Brunswick's main industrial centre. Pulp and paper mills, breweries, oil and sugar refineries, meat packing and many small secondary industries are all located in the city with most discharging their waste directly, without treatment, into the Saint John River. This gross load of pollution dumped into the mouth of what used to be an outstanding sports fishing and recreational river is taking its toll, for no longer are citizens able to swim in the vicinity of Saint John. Evidence is also being accumulated which suggests that during the summer months, particularly during periods of low flow, a chemical blockage is being developed which prevents or delays the upriver migration of Atlantic salmon.

Even the Reversing Falls, one of Canada's natural wonders, has not escaped, as evidenced by the large amounts of foam and coloured material which mask its beauty during certain phases of the tidal cycle.

During the months of June, July, August and September, 1970, the Resource Development Branch of the Federal Department of Fisheries and Forestry carried out a pollution survey in the City of Saint John to determine the pollutional load which industry is placing in the river and to discover the effect of this pollution on the water quality.

Composite samples were collected from each large industry in the area over a two- or three-week period and daily analyses were performed on these samples to determine the various parameters shown for each industry.

Samples were also collected from the Saint John Harbour at the locations shown on Figure 6, Section "B". At each site, samples were collected from three depths and, in addition, a temperature and dissolved oxygen profile was determined. Each sampling station was visited during all phases of the tidal cycle to determine its effect on the distribution of pollutants.

ATLANTIC SUGAR

TYPE OF INDUSTRY

Sugar Refinery

TYPE OF PRODUCT

Refined Sugar

PRODUCTION

600×10^6 lbs of sugar/year = 2.4×10^6 lbs of sugar/day

WORK CYCLE

5 days/week, 50 weeks/year, 250 days/year

WATER CONSUMPTION

248,627,000 gallons of fresh water were purchased from the city in 1969; and 288,151,000 in 1968. The average for the two years was 268.4×10^6 gallons/year. The daily water consumption is 1.07×10^6 gallons/operating day.

SEWER SYSTEM

Two sewers discharge directly into Courtney Bay. The first, referred to as the "North Sewer," carries saltwater used for condensing purposes in the process. The second or "South Sewer" carries the high strength wastes from the actual process.

WASTE TREATMENT FACILITIES

At the time of the survey, this industry had no form of waste treatment and had no plans for future installation.

Table 1. North Sewer Waste Characteristics

Flow, 7.8 MGD; Temperature, 33°C

Date	BOD mg/l	COD mg/l	S.S. mg/l	
23 June 70	30	32	100	
23 June 70	17	-	-	(This value obtained from Atlantic Sugar)
24 June 70	21	740	172	
25 June 70	5	500	76	
30 July 70	100	3980	30	
31 July 70	108	3920	55	
AVERAGE:	104	3950	43	

NOTE: Atlantic Sugar was preparing for a two-week shutdown during the first part of the survey (during June) so only the July values were used to calculate average representative figures for BOD, COD and suspended solids. The July samples were composited over an eight-hour period.

Table 2. South Sewer Waste Characteristics

Flow, 1.07 MGD; Temperature, 38°C

Date	BOD mg/l	COD mg/l	S.S. mg/l	
23 June 70	74	203	70	
23 June 70	38	-	-	(Value obtained from Atlantic Sugar)
24 June 70	253	630	72	
25 June 70	2000	31900	188	
30 July 70	392	1000	87	
31 July 70	210	1690	11	
AVERAGE:	300	1345	50	

NOTE: As with the "North Sewer," results from June have not been used when calculating averages due to the effect of the two-week annual shutdown. The July samples were composited over eight hours.

Table 3. Total Waste Loading

lbs/day			lbs/ton of Sugar		
BOD	COD	S.S.	BOD	COD	S.S.
11392	322490	3885	9.5	269	3.2

Receiving water temperature at the time of the survey was 14°C

Atlantic Sugar is an old plant with all the problems of old age, such as high leakage rates and unknown waste volumes and loads. It is, therefore, to be expected that at times the amount of waste which is discharged to Courtney Bay in terms of pounds of BOD and suspended solids per day would be much higher than measured during this survey.

The waste from this industry is quite amenable to treatment and no problems would be expected in treating the approximately 1 MGD from the "South Sewer," aside from a phenomenon known as sludge bulking. There are methods of controlling this so that adequate waste treatment is produced.

CANADA PACKERS

TYPE OF INDUSTRY

Packing house

PRODUCT

Kills, dresses, renders and produces consumer items

ANNUAL KILL

Beef: 520 head
Veal: 1,040 head
Lamb: 900 head
Hogs: 9,800 head

ANNUAL PRODUCTION

Out of a total production of 11,612,000 lbs, there is 7,612,000 lbs of meat and 4,000,000 lbs of inedible rendering consisting of 2,500,000 lbs of fat and bones and 1,500,000 lbs of eviscera.

Only 3,372,000 lbs is killed at the plant, the rest is shipped dressed.

WORK CYCLE

5 days a week, 52 weeks a year (260 days/year)

WATER CONSUMPTION

(Average = 0.177×10^6 IMP gallons/day)

As of August 1, 1970, consumption was 23,480,300 gallons or 0.159×10^6 IMP gallons/day.

SEWER SYSTEM

A. Sanitary Sewer

As well as handling the sanitary sewage, this sewer also

SEWER SYSTEM

A. Sanitary Sewer (cont'd)

includes two parts of the process: rendering and rolling.

B. Main Process Sewer

This sewer carries all of the process flow except as mentioned above. The sanitary sewer runs into the main process sewer and then the total flow runs into the city sanitary system.

WASTE TREATMENT

At the present time, no treatment is given to the wastes from Canada Packers; but it is expected that in 1971 the effluent will be discharged to a city treatment plant for solids and BOD removal.

SAMPLING PROGRAM

Each of the sewers was sampled by hand through a manhole and the individual samples were then composited for each sewer. The samples collected were analysed for the parameters shown in Table 1.

Table 1. Sanitary Sewer

Date	BOD mg/l	COD mg/l	S.S. gm/l
23 June 70	303	650	0.071
24 June 70	1110	3380	-
29 June 70	900	-	5.029
30 June 70	1200	3060	1.225
2 July 70	1200	-	-
AVERAGE:	945	1418	2.108

FLOW: 1000 gal/day

Table 2. Main Sewer

Date	BOD mg/l	COD mg/l	S.S. gm/l
23 June 70	-	167	.071
24 June 70	384	512	-
25 June 70	140	242	.150
29 June 70	255	-	-
30 June 70	63	184	.220
2 July 70	-	296	-
AVERAGE:	210	280	.147

FLOW: 177,000 gallons/day

Table 3. Total Waste Loading from Main and Sanitary Sewer

	lbs/day	lbs/1000 lbs of Liveweight Kill
BOD	= 382	29
COD	= 510	39
S.S.	= 281	22

FLOW (gallons/1000 lbs of LWK): 13,600

From the "Cost of Clean Water," waste flows and loads as presented for old, today's, and advanced levels of technology in the meat packing industry are as follows:

Table 4. Waste Characteristics per 1000 lbs of Kill

Levels of Technology	BOD (lbs)	Wastewater Flow (IMP gallons)
Old	20.2	1770
Today's	14.4	1070
Advanced	11.3	930

Comparing the measured results of Table 3 with the "typical" results of Table 4, it is clear that Canada Packers is discharging much higher flows and higher amounts of wastes than that which would be discharged from an old plant in the United States. In particular, the waste flows are much higher, indicating cheap water and poor conservation practices.

IRVING PULP

TYPE OF INDUSTRY

Pulp manufacturer

TYPE OF PRODUCT

Bleached kraft and sulphite pulp

CONSUMPTION OF RAW MATERIALS

Approximately 700 tpd wood

PRODUCTION

518 tpd pulp which consists of about one-half kraft and one-half sulphite.

WORK CYCLE

330 days/year

WATER CONSUMPTION

The total water consumption is obtained from the following sources:

1) City of Saint John: 10.7×10^9 gallons in 1969
9.8×10^9 gallons in 1968

2) Private well: 100 gpm which is used in acid plant

3) River water: used in condensers and for about 1/4 of the woodroom requirements.

WATER BALANCE

Screenroom ..... 6.6 MGD
Woodroom ..... 6.0 MGD
Condenser ..... River water

WATER BALANCE (cont'd)

Causticizing-Boiler-Drains	1.4 MGD
Bleachery	6.0 MGD
Auxiliary Company	1.0 MGD
Steam Losses	3.5 MGD
Other	2.5 MGD
T O T A L	27.0 MGD

SEWER SYSTEM

There are seven outfalls from this mill:

1) Woodroom - The woodroom sewer discharges into the bark retention pond. This sewer receives the overflow from the bleachery and the total discharge is 8,400 gpm.

2) Causticizing - This small 6" line discharges 250 gpm into the Saint John River.

3) Bleachery - The bleachery sewer discharges 4,200 gpm to the Saint John and supplies 2,100 gpm to the woodroom.

4) Barometric Condenser - This 18" line discharges 500 gpm to the river.

5) Boiler Plant - The boiler plant wastes consists mainly of blow-off water, amounting to 670 gpm.

6) Screen Room - This line, with a flow of 4,700 gpm, discharges a waste with a high foaming tendency to the river.

7) Floor Drains plus Miscellaneous - This sewer, whose flow does not exceed 100 gpm, picks up the odd sources of waste around the mill.

WASTE TREATMENT FACILITIES

Irving is in the process of expanding the kraft side of his operation by 600 tpd, making the total output of the mill about 1100 tpd, including sulphite. All of his wastes will be removed from the Saint John River and the kraft portion will receive full secondary treatment.

Table 1. Wood Room Sewer
Waste Characteristics

Flow = 10.0 MGD

Date	BOD mg/l	COD mg/l	S.S. mg/l	L. Sulfonates ppm	R. Acid ppm
7 Aug 70	325	1208	466.9	50	-
10 Aug 70	396	1720	188.7	20	-
11 Aug 70	108	1192	277.5	100	3.4
12 Aug 70		"Down"			
13 Aug 70		"Down"			
14 Aug 70	176	1112	1048.0	175	10.0
AVERAGE:	251	1308	495.3	86.25	6.7

Table 2. Screen Room Sewer
Waste Characteristics

Flow = 6.6 MGD

Date	BOD mg/l	COD mg/l	S.S. mg/l	L. Sulfonates ppm
7 Aug 70	2090	10,400	452.	6200
10 Aug 70	2525	10,800	-	6500
11 Aug 70	1820	13,440	-	6360
12 Aug 70	2075	10,160	-	7200
13 Aug 70	1794	9,040	-	5760
14 Aug 70	2010	9,520	-	9000
AVERAGE:	2052	10,560	452.	6837

Table 3. Barometric Condenser Sewer Waste Characteristics

Flow = 0.72 MGD

Date	BOD mg/l	COD mg/l	S.S. mg/l	L. Sulfonates ppm
7 Aug 70	252	800	184.2	120.0
10 Aug 70	204	160	-	43.3
11 Aug 70	84	-	-	-
12 Aug 70	69	-	-	48.0
13 Aug 70	108	640	-	58.0
14 Aug 70	235	480	-	90.6
AVERAGE:	159	416	184.2	69.9

Table 4. Bleachery Sewer Waste Characteristics

Flow = 6.0 MGD

Date	BOD mg/l	COD mg/l	S.S. mg/l
7 Aug 70	147	720	27.0
10 Aug 70	150	968	108.0
11 Aug 70	120	-	-
12 Aug 70	151	1000	-
13 Aug 70	187	-	-
14 Aug 70	157	-	-
AVERAGE:	152	896	67.5

Table 5. Total Waste Loading

	BOD	COD	S.S.	Ligno Sulphonates	Resin Acids
lbs/day	170,464	884,455	83,593	460,128	670
lbs/ton	330	1,709	111	889	1.3

Table 6. Typical Waste Loading
(Cost of Clean Water)

	Older Technology		Today's Technology		New Technology	
	BOD	S.S.	BOD	S.S.	BOD	S.S.
lbs/ton	313	95	183	58	67	21

The comparison of waste loadings from Irving's mill with those of typical mills indicates that this plant falls in the category of older technology.

IRVING REFINERY

TYPE OF INDUSTRY

Crude oil refinery

TYPE OF PRODUCT

Oil, gas, lubricants and other by-products

CONSUMPTION OF RAW MATERIALS

42,000 barrels/day of crude oil (35 IMP gallons/barrel)

PRODUCTION

42,000 barrels/day of petroleum products

WORK CYCLE

365 days/year

WATER CONSUMPTION

855,817,700 gallons in 1969 = 2,340,000 gpd. The water for the refinery is purchased from the City of Saint John and comes directly from the Loch Lomond Lakes.

SEWER SYSTEM

There are two points of waste discharge from the refinery. One is discharged to Courtenay Bay at the end of a breakwater while the other flows to a surge pond on the refinery property and then into Little River. The first waste is referred to as the sour water while the second effluent is called the lower surge effluent.

SOUR WATER

The sour water is mainly from the crude oil washing process, which removes soluble salts. The other major source is from corrosion control techniques in which ammonia is added to water to control the pH of the process stream.

LOWER SURGE EFFLUENT

The waste water constitutes all the sources of pollution except those of the sour water. This waste includes all of the oil which escapes during refining as well as plant runoff and the sanitary sewage. Samples were collected at the outlet of the lower surge pond as the effluent entered Little River.

WASTE TREATMENT FACILITIES

At present, no treatment is given to the sour water before it is discharged to the environment, while the lower surge waste flows to a lagoon where the oil is removed and sent back to the process.

Table 1. Waste Water

Flow = 200 gpm

Date	BOD mg/l	COD mg/l	S.S. gm/l	Phenols mg/l	Oil mg/l	Sulfides mg/l
15 July 70	431	1900	.0500	6.2	555.7	928
17 July 70	329	1820	.0285	6.1	6253.0	896
21 July 70	1002	3180	.0200	22.4	3390.0	576
23 July 70	750	2300	-	11.0	3675.0	576
27 July 70	1616	2150	.0890	31.0	4083.0	832
AVERAGE:	826	2270	.0469	15.3	3591.4	762

200 gpm = 288,000 gpd

Table 2. Waste Loadings
Sour Water Effluent

	mg/l	lbs/day
BOD	826	2378
COD	2270	5180
S.S.	46.9	135
Phenols	15.3	44
Oils	3591	10340
Sulphides	762	2196

Table 3. Lower Surge Pond

Date	BOD mg/l	COD mg/l	S.S. gm/l	Phenols mg/l	Oil mg/l	Sulfides mg/l
15 July 70	44	45	0.010	0.3	43.0	0.6
17 July 70	26	56	0.3725	0.3	18.7	0
21 July 70	35	112	0.010	0.3	69.0	0.6
23 July 70	71	141	0.272	0.12	79.0	0
27 July 70	114	41.5	0.055	0.9	32.0	0.6
AVERAGE:	58	79.1	0.144	0.4	48.3	0.36

FLOW: The area of water being discharged from the Lower Surge Outfall was (on September 3, 1970, at 10:00 a.m.) = 55 sq. in. The velocity was estimated (floating chip method) to be = 8 ft/sec. This implies 1.6×10^6 (IMP) gpd.

Table 4. Lower Surge Pond

BOD	58	mg/l	912	lbs/day
COD	79.1	mg/l	1267	lbs/day
S.S.	144	mg/l	2310	lbs/day
Phenols	0.4	mg/l	6.4	lbs/day
Oils	48.3	mg/l	773	lbs/day
Sulfides	0.36	mg/l	5.7	lbs/day

Table 5. Total Waste Loading

	lbs/day	lbs/100,000 barrels
BOD	3,290	7,840
COD	6,447	15,300
S.S.	2,445	5,830
Phenols	51	121
Oil	11,113	26,500
Sulphide	2,202	5,250

TOTAL FLOW: 2 mgd = 4 mgd/100,000 barrels

Table 6. Waste Loading from Mills of Different Technologies (Cost of Clean Water)

Level of Technology (Refinery Production 100,000 barrels/day)	Flow mgd	BOD lbs/day	Phenol lbs/day	Sulphide lbs/day
Older	25.0	40,000	3,000	1,000
Today's	10.0	10,000	1,000	300
New	5.0	5,000	500	300

Tables 5 and 6 show that the Irving Refinery is low in BOD and phenol discharge but put out an excessive amount of sulphide. Concentrations of phenols and sulphides in the waste exceed those levels which are toxic to fish, and no efforts are made at the plant to reduce these levels before discharge to the environment.

EXPANSION PLANS

This refinery is expanding its operation so that sometime in 1971 125,000 barrels of crude oil will be processed each day.

KIMBERLY-CLARK

TYPE OF INDUSTRY

Paper manufacturer

TYPE OF PRODUCT

Uncoated paper products such as Kleenex and toilet paper.

CONSUMPTION OF RAW MATERIALS

Kimberly-Clark purchases all of the pulp (about 48 tpd) which they use.

PRODUCTION

48 tpd of uncoated papers

WORK CYCLE

The plant works an average of 29 days/month or 347 days/year.

WATER CONSUMPTION

1.2 MGD

SEWER SYSTEM

The waste from MacMillan-Rothesay enters the Saint John River through one sewer line.

Table 1. Waste Effluent Characteristics

Date	BOD mg/l	COD mg/l	S.S. gm/l
23 June 70	182	32	253
24 June 70	70	630	479
25 June 70	70	960	775
29 June 70	60	960	1370
30 June 70	164	820	1930
7 July 70 (Major washup)	93	2400	
AVERAGE:	106	967	961

FLOW: 1.1 MGD

The figures from 7 July illustrate the effects of a major washup, during which time the plant switched from a dark to a light dye. This is the cause for the high COD and suspended solids data. This has been included in the average since a washup occurs with some degree of regularity and does indeed impose an added waste load on the environment.

Table 2. Total Waste Loading

	lbs/day	lbs/ton of product
BOD	1,170	24
COD	10,600	221
S.S.	10,590	220

Table 3. The "Cost of Clean Water" Waste Loading Values for a Paper Making Process

	Older Technology		Today's Technology		New Technology	
	BOD	S.S.	BOD	S.S.	BOD	S.S.
lbs/ton of product	20	60	12	40	10	30

The above figures indicate that Kimberly-Clark is discharging waste at a higher rate than would be put out by a representative mill with older technology.

WASTE TREATMENT FACILITIES

This plant has no waste treatment facilities, with no plans for any in the immediate future.

EXPANSION PLANS

Kimberly-Clark has no expansion plans at the time of this report.

MacMILLAN-ROTHESAY

TYPE OF INDUSTRY

Pulp and paper

TYPE OF PRODUCT

Newsprint and groundwood pulp

CONSUMPTION OF RAW MATERIALS

Approximately 600 tpd unbarked wood

PRODUCTION

512 tpd of newsprint

400 tpd of pulp is made at the mill from the groundwood process

112 tpd of kraft pulp is purchased

WORK CYCLE

7 days/week, 52 weeks/year

WATER CONSUMPTION

5.0 MGD, which is purchased from the City of Saint John

SEWER SYSTEM

Three sewers from the mill discharge into Little River. The main sewer carries the waste from the pulp and paper making process. The floor drain sewer carries all of the waste from the floor drains plus the sanitary sewage. The woodroom sewer carries the pollutional load from the new woodroom, which went into operation on June 8, 1970.

WASTE TREATMENT FACILITIES

At the time of the survey, MacMillan-Rothesay had no form of waste treatment installed at their mill. Primary treatment has been planned and will be on-line during 1971 to remove 80% plus of the suspended solids from the waste effluent.

Table 1. Main Sewer Waste Characteristics

Flow - 3.52 MGD

Date	BOD mg/l	COD mg/l	S.S. gm/l	R. Acid ppm
16 July 70	258	2280	1.4930	-
20 July 70	315	2280	0.7165	-
22 July 70	155	2540	1.0905	-
24 July 70	214	3600	2.4200	-
28 July 70	187	2230	2.5905	4.6
14 Aug 70	-	-	-	6.2
17 Aug 70	-	-	-	9.2
AVERAGE:	226	2586	1.6621	6.7

Table 2. Floor Drain Waste Characteristics

Flow = 0.1 MGD

Date	BOD mg/l	COD mg/l	S.S. gm/l	R. Acids ppm
16 July 70	114	1560	2.0915	-
20 July 70	171	2790	.9990	-
22 July 70	11	770	.4405	-
28 July 70	27	-	.0750	4.0
14 Aug 70	-	-	-	6.2
AVERAGE:	80	1707	.9015	5.1

Table 3. Woodroom Waste Characteristics

Flow = 1.38 MGD

Date	BOD mg/l	COD mg/l	S.S. gm/l	R. Acids ppm
16 July 70	713	1820	4.1440	-
20 July 70	239	1850	-	-
22 July 70	115	2000	0.8050	-
24 July 70	320	1350	0.4150	5.2
28 July 70	266	1810	0.1245	6.5
14 Aug 70	-	-	-	9.2
17 Aug 70	-	-	-	22.4
AVERAGE:	330	1766	1.3721	10.8

Table 4. Total Waste Loading

	BOD	COD	S.S.	Resin Acids
lbs/day	12,605	117,137	78,432	390
lbs/ton of newsprint	25	231	155	0.8
lbs/ton of groundwood pulp	33	293	196	1.0

Table 5. Typical Wastes Losses found in Several Groundwood Mills as given in the "Cost of Clean Water"

	Older Technology		Today's Technology		New Technology	
	BOD	S.S.	BOD	S.S.	BOD	S.S.
lbs/ton of newsprint	63	69	33	46	20	23

It is evident that while the BOD content of MacMillan-Rothesay's waste is compatible with today's level of technology, before waste treatment, the suspended solids level is considerably higher than even the loading from a representative mill with older technology. It must be assumed, therefore, that the process in use at this mill is somewhat wasteful with the forestry resource.

EXPANSION PLANS

This mill is adding another paper machine (it now has one), and is expected to double its waste output. The start-up date for the expanded facility is January 1971.

INDUSTRIAL SURVEY SUMMARY

The industrial community at Saint John contributes a gross amount of polluting materials to the Saint John River and harbour. Over 200,000 lbs of BOD are dumped into the aquatic environment each day by these industries. This is equivalent to the waste which would be discharged by a city of well over one million.

The pulp and paper industry is responsible for the major share of the waste material, contributing over 90% of the BOD and suspended solids load, as well as a large amount of highly toxic resin acid.

The oil refinery also is responsible for a great deal of pollution, for it discharges a large quantity of highly toxic phenol, plus considerable amounts of oil and sulphides.

None of the industries investigated during this investigation can be absolved of blame for the discharge of harmful pollutants, but the Irving Pulp mill, the Irving Oil Refinery and MacMillan Rothesay must shoulder the major share of the responsibility for any environmental damage.

There is hope, however, for both pulp mills plus Canada Packers have made definite steps towards treting their wastes to safeguard both the aquatic environment and the fisheries resource.

The Irving refinery will then be the most serious source of pollution in Saint John. This threat, of course, will be even greater when its expansion project, which will double production, is completed.

Section "B"

Pollution Survey

of the

Saint John Harbour

SAINT JOHN HARBOUR POLLUTION SURVEY

In order to determine the pollutional effects of the industrial complex in the City of Saint John, a water quality survey was carried out concurrent with the industrial waste sampling program. An attempt was made to correlate the effects of particular industries on the aquatic environment by analysing for specific parameters in the receiving waters which were unique to one industry. For example, the Irving Pulp Company alone employs a sulphite pulping process, producing lignosulphonates in its waste, while the Irving Oil Refinery discharges large quantities of phenol and oil.

Samples were collected from three depths at the stations shown on Figure 6. Representative results are presented in graphical form on Figures 1 to 5, and Tables 1 to 5.

"A" level is at the bottom, "B" is mid-depth while "C" level is at the surface.

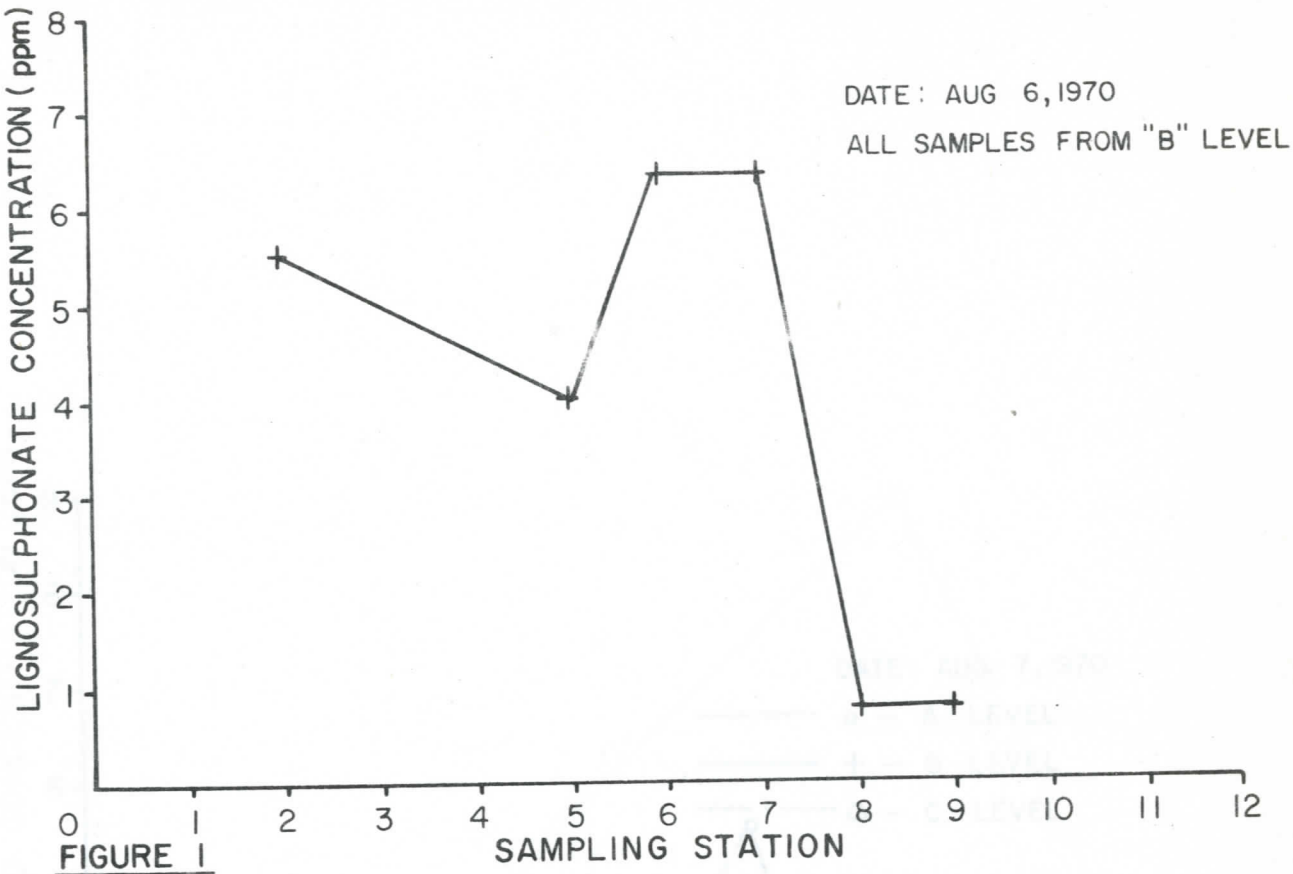


FIGURE 1

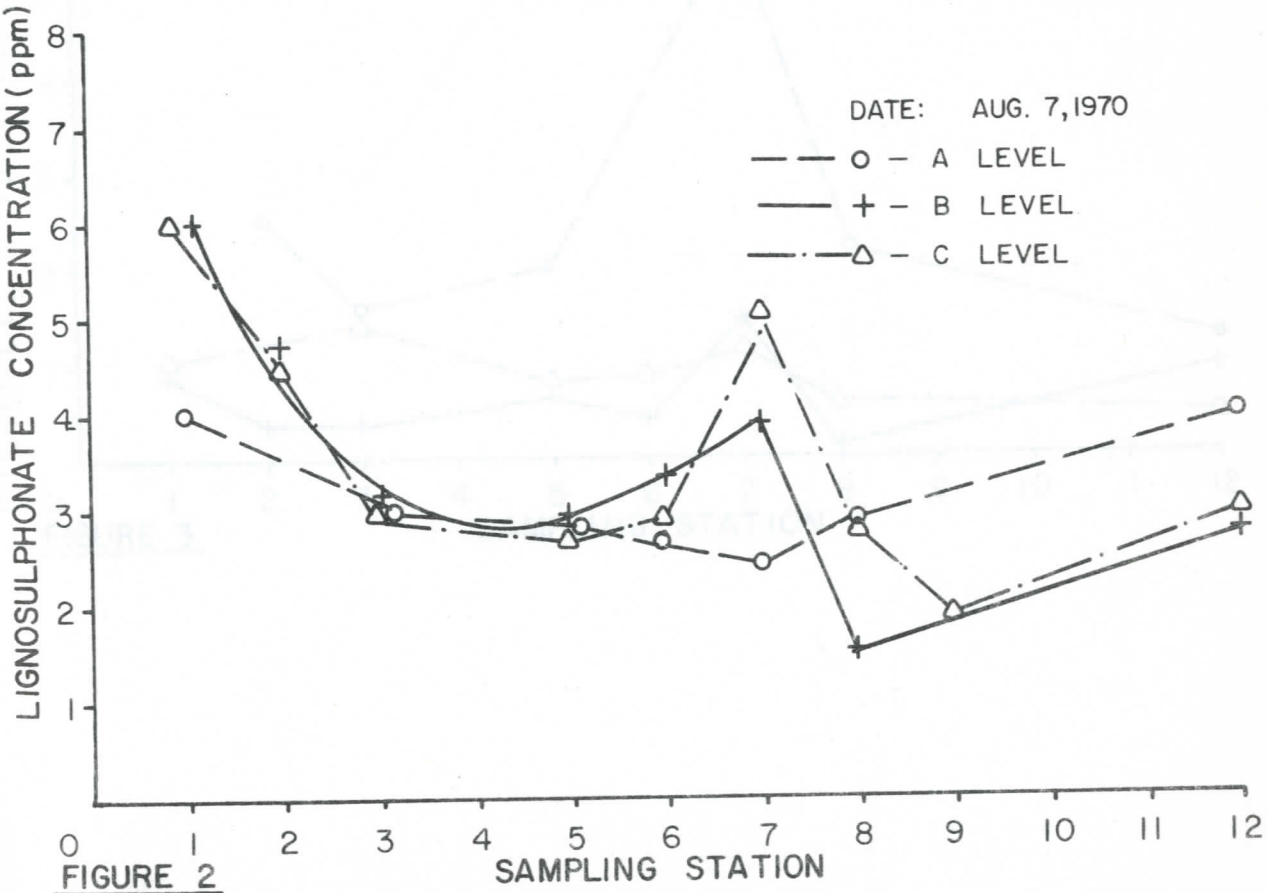
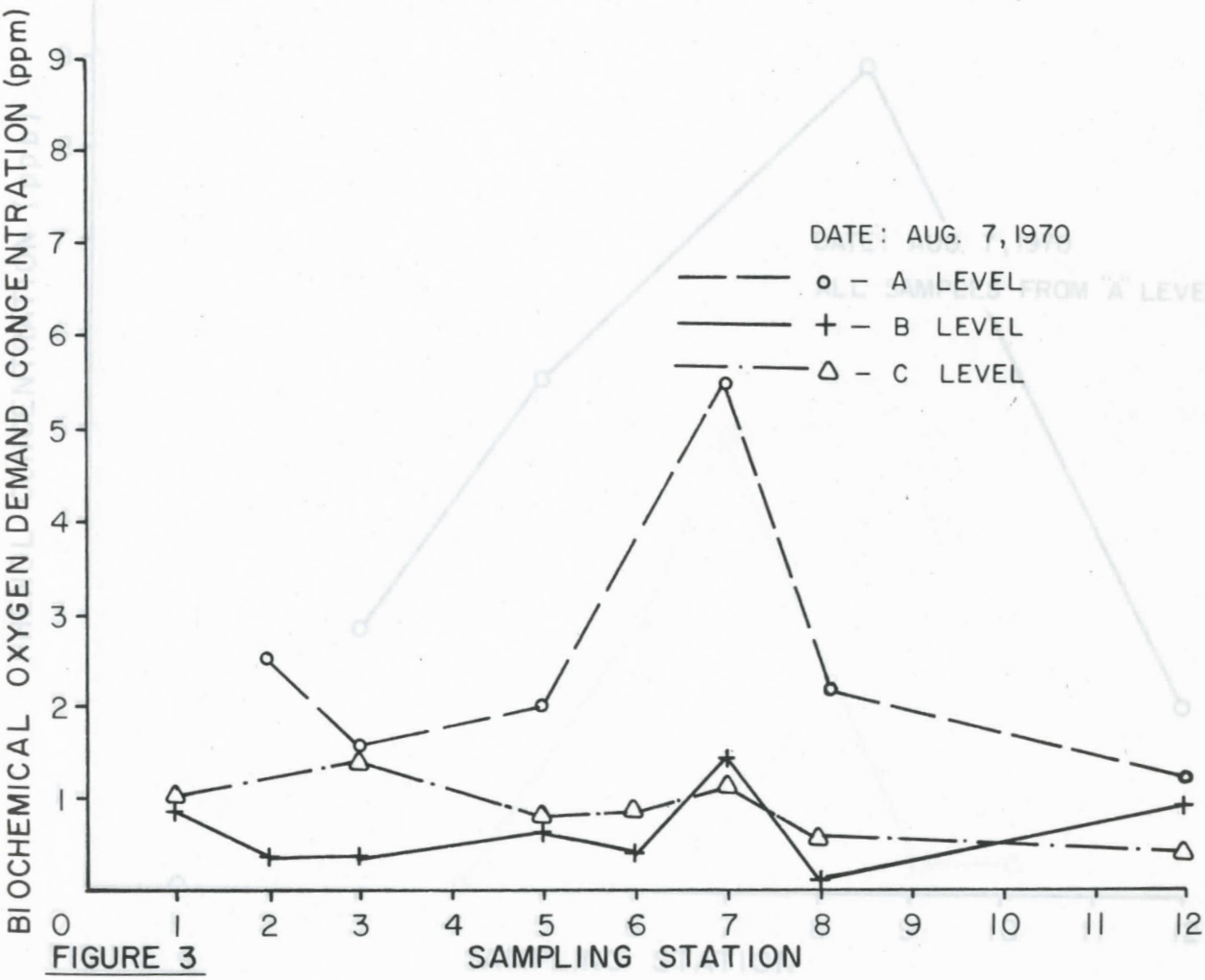


FIGURE 2


BIOCHEMICAL OXYGEN DEMAND CONCENTRATION (ppm)
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3
4
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Δ – C LEVEL
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1
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9
10
11
12
SAMPLING STATION

FIGURE 3

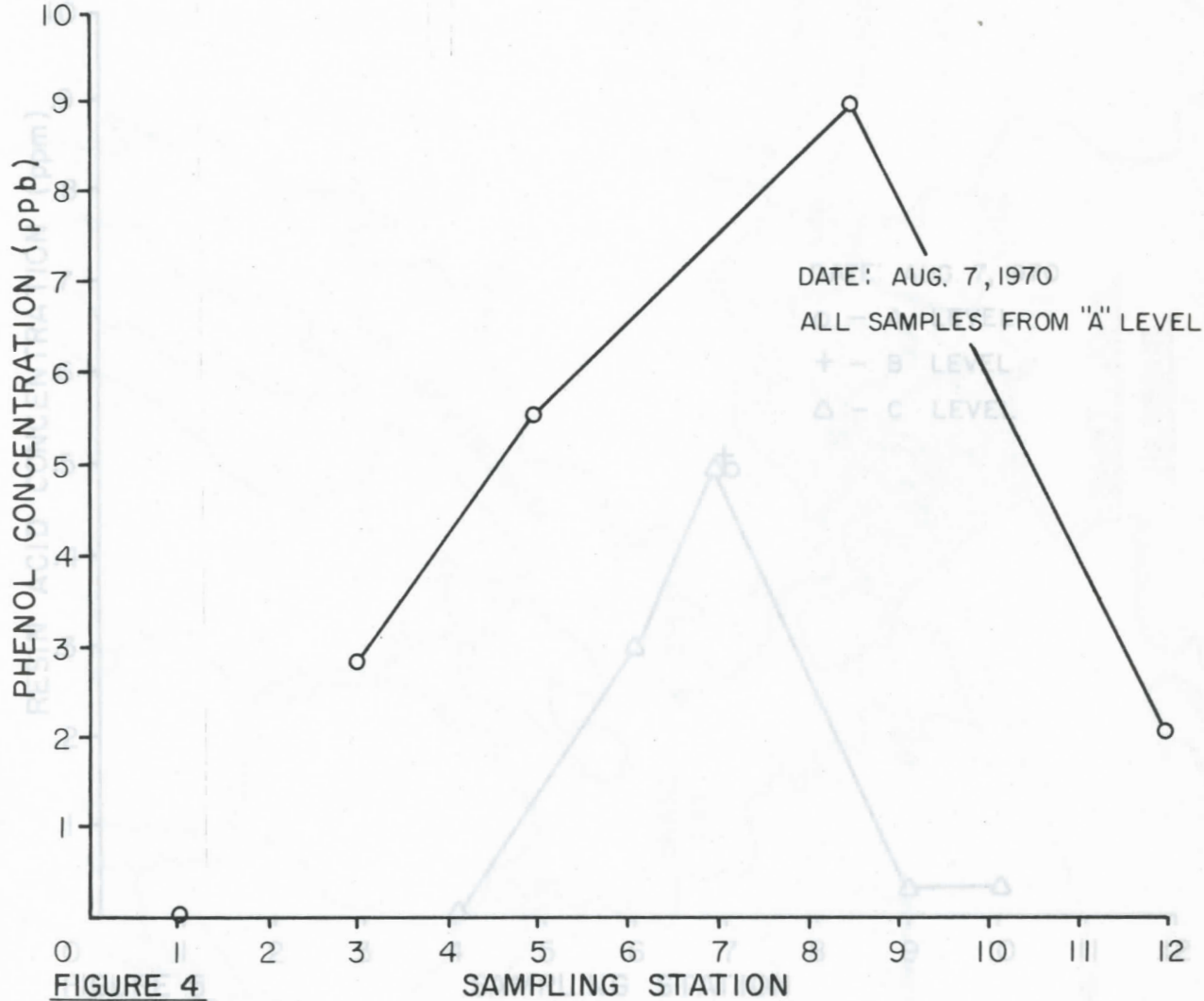

PHENOL CONCENTRATION (ppb)
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
SAMPLING STATION
DATE: AUG. 7, 1970
ALL SAMPLES FROM "A" LEVEL

FIGURE 4

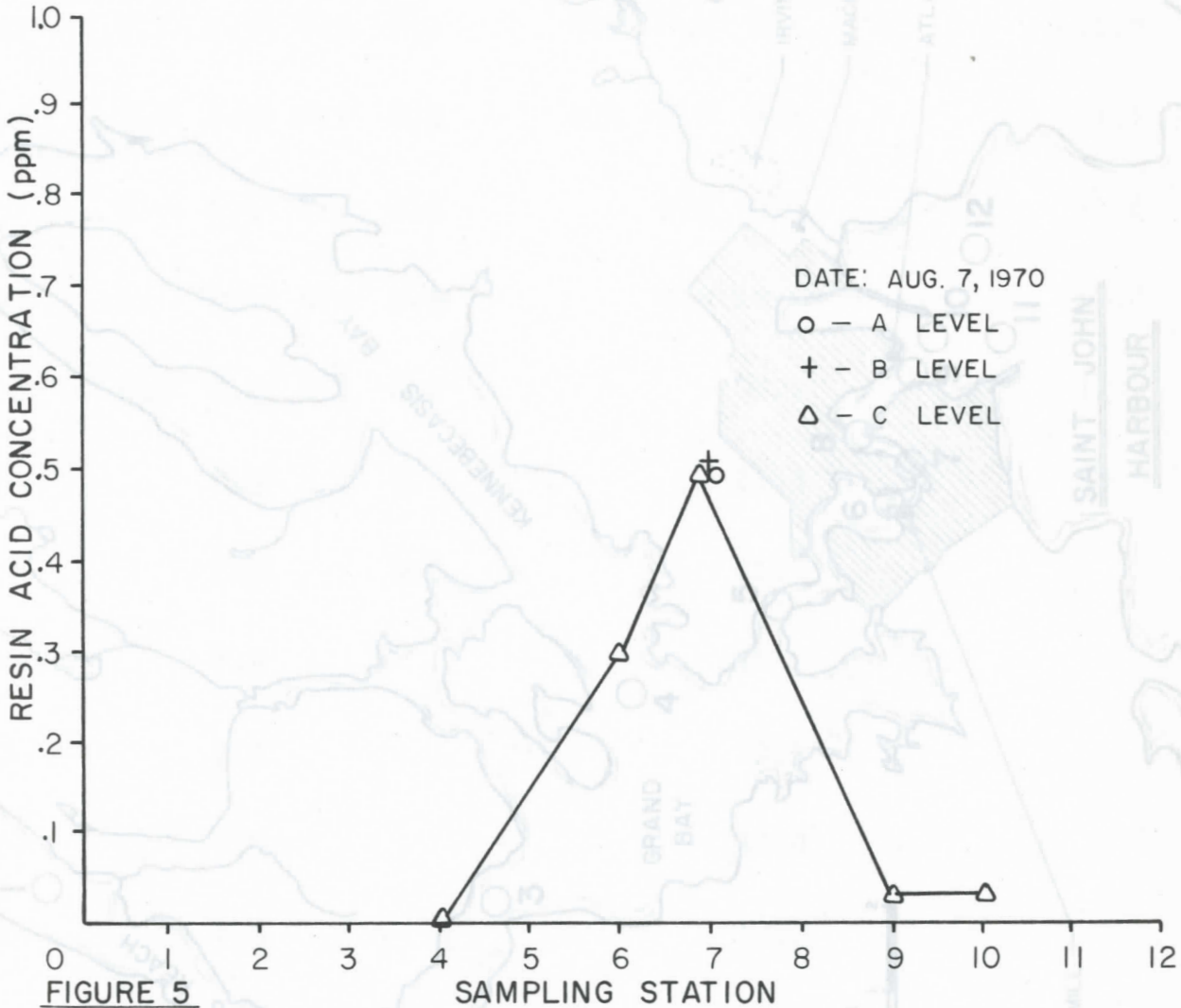
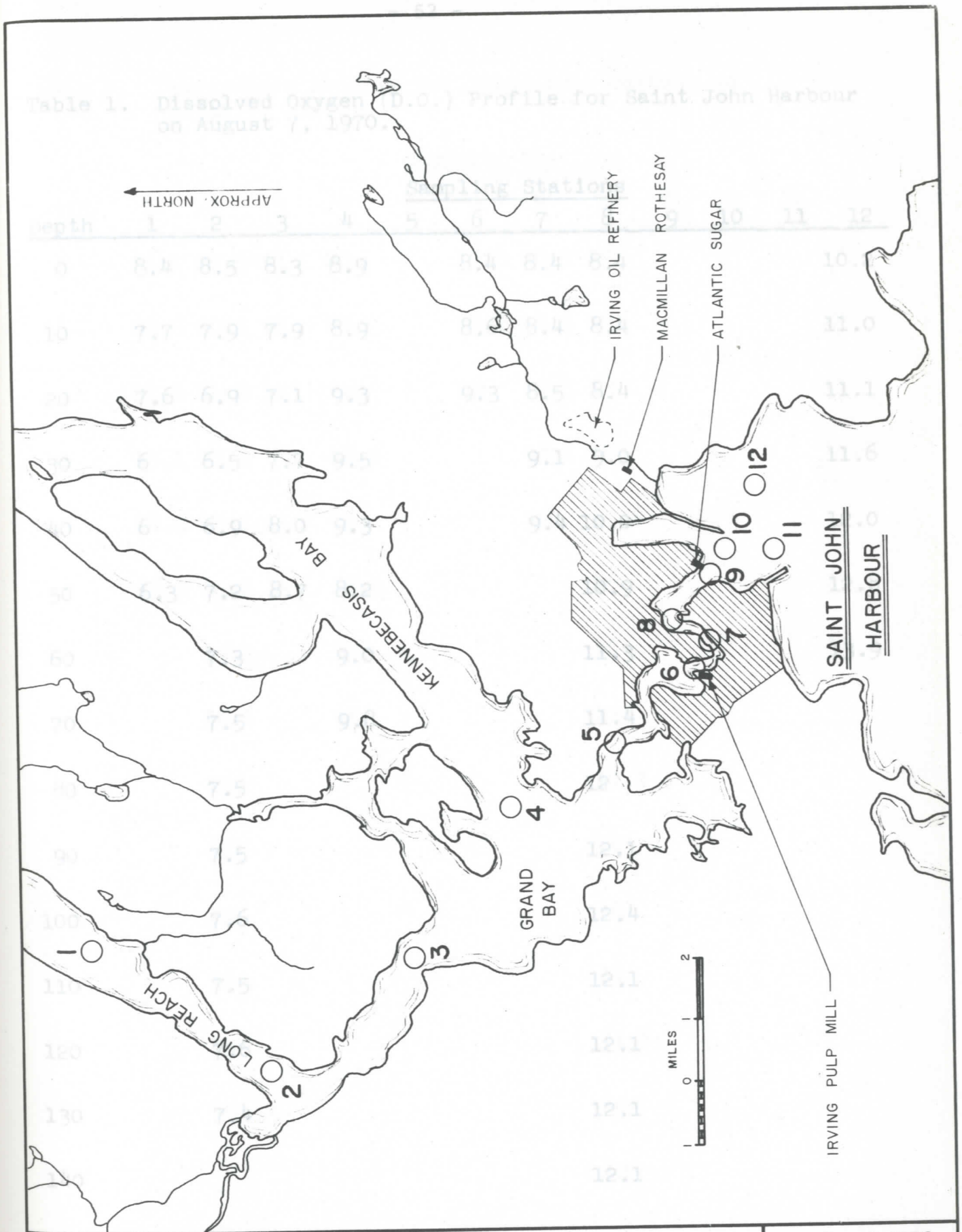


FIGURE 5

DRAWN J.R.C. | DEPARTMENT OF FISHERIES & FORESTRY, CANADA | DATE Dec. 4, 1970
CHECK | SAINT JOHN HARBOUR AREA | SCALE As Shown
APPROVED | DWG. NO. FIGURE No. 6



DRAWN: JRC	DEPARTMENT OF FISHERIES & FORESTRY, CANADA	DATE: Dec. 4, 1970
CHECK:	SAINT JOHN HARBOUR AREA	SCALE: As Shown
APPROVED:		DWG. NO.: FIGURE No. 6

Table 1. Dissolved Oxygen (D.O.) Profile for Saint John Harbour on August 7, 1970.

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	8.4	8.5	8.3	8.9		8.4	8.4	8.4				10.2
10	7.7	7.9	7.9	8.9		8.6	8.4	8.4				11.0
20	7.6	6.9	7.1	9.3		9.3	8.5	8.4				11.1
30	6	6.5	7.7	9.5			9.1	9.0				11.6
40	6	6.9	8.0	9.3			9.4	10.0				12.0
50	6.3	7.2	8.7	8.2				10.9				12.8
60		7.3		9.0				11.3				13.9
70		7.5		9.8				11.4				
80		7.5						12				
90		7.5						12.1				
100		7.6						12.4				
110		7.5						12.1				
120		7.6						12.1				
130		7.4						12.1				
140								12.1				
150												

Table 2. Temperature Profile for Saint John Harbour on August 7, 1970.

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	22.1	22.3	21	20		19.5	18.5	18				17
10	21.6	20.5	20	20		19.2	18.5	18				12
20	21.6	18.9	17	20		19	18.5	18				11
30	15.1	15.3	15	19.5			18.1	18				10.9
40	14.2	15.1	15	19			18	17.6				11
50	14.2	15.2	15	18.5				16				11
60		15.1		17				16				11
70		15.1		15				13				
80		15						12.2				
90		15						12				
100		15						12				
110		15						12				
120		15						11.6				
130		15						12				
140								12				
150												

Table 3. Dissolved Oxygen Profile for Saint John Harbour on August 10, 1970.

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	7.6	7.4	7.4	6.6	8							
10	6.5	6.6	6.6	4.8	7.3							
20	6.3	6.3	5.7	4.6	6.5							
30	3.6	5.7	5.7	4.5	6							
40	4.3	5.4	5.9	3.3	5.8							
50		5.5	6.2	2.4	5.9							
60		5.8	6.4	2.6	6.3							
70		6.2	6.5	2.7	7.4							
80		6.4		3.2	8.4							
90		6.5		3.4	9.3							
100				3.5								
110				3.5								
120												
130												
140												
150												

Table 4. Temperature Profile for Saint John Harbour on August 10, 1970.

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	22.5	23	22	21	22							
10	22	22	20.5	17.5	21.5							
20	21.5	21	16	12.5	21.5							
30	15.5	18	15.5	12.5	20							
40	14.8	16.2	15.5	10.5	18							
50		16	15	9	18							
60		15.7	15	8.9	17.2							
70		15.5	15	9	15.5							
80		15.5		10	15							
90		15.5		10	14.5							
100				10.2								
110				10.5								
120												
130												
140												
150												

Table 5. Dissolved Oxygen Profile for Saint John Harbour on August 11, 1970.

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	5.9	6.9	6.8	8.9	6.7	6.2	7.5	6.3	7	7.4	7.7	7.6
10	6.1	6.5	6.1	7	6.3	6.9	7.6	6.4	7.1	7.8	8	8.1
20	5.5	6.2	5.8	5.3	7.2	7.3	8.1	6.6	7.1	8.2	8.5	8.8
30	3.9	5.2	6.2	5.5	8.1	7.8	8.5	6.8	7.6	8.9		9.8
40	4.6	5.5	8	4.7	8.3	8.3	9.2		8			
50	3.8	5.8		4.2	8.5	8.8			8.4			
60		5.9		3.4	8.7	9.5			9.1			
70		6.2		3.2	9				9.5			
80		6.6		3.2	9.2							
90		6.4		3.2								
100				4.1								
110												
120												
130												
140												
150												

Table 6. Temperature Profile for Saint John Harbour on August 11, 1971

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	23.2	23	22.8	23	20.9	19.2	15	12	18.2	19.2	18.2	20
10	22.2	22.2	21.5	21.2	18.5	16.2	14.9	12	17.2	16	16.5	15.2
20	22	17.2	19.5	19.2	16.2	15.3	13.9	12	16.5	15.2	15.2	15
30	15.8	16	16.2	15.5	15.2	14.9	13.5	11.5	16	14.5		15
40	15.2	16	16	12	15.1	14.6	13.2		16			
50	15.1	16		11.5	15.1	14.6			15.8			
60		16		10.2	15	14.5			15.5			
70		16		9	15				15.5			
80		16		9	14.6							
90		16		9.2								
100				9.8								
110												
120												
130												
140												
150												

Table 7. Dissolved Oxygen Profile for Saint John Harbour on August 12, 1971.

	Sampling Stations											
Depth	1	2	3	4	5	6	7	8	9	10	11	12
0	7.6	7.4	7.8		5	5.9	6.8	6.7	6.7	6.4	6.8	6.8
10	7.6	6.6	7		4.7	5.6	7	7.2	7.2	7.2	7.4	7.4
20	6.4	5.8	6.9		5.4	6	7.5	7.3	7.5	7.8	8	7.6
30	5.3	5.8	6.6		5.4	6.6		7.6	7.8	8.3	8.4	8.2
40		6.1	6.9		5.1	7.5		8.1	8	8.9		8.5
50		6.6			5.7	9		8.2	8.5			9.6
60		6.6			5.7			8.6	8.7			
70		6.8			6.2			8.4				
80		6.8			6.3			8.6				
90												
100												
110												
120												
130												
140												
150												

Table 8. Temperature Profile for Saint John Harbour on August 12, 1970.

Depth	Sampling Stations											
	1	2	3	4	5	6	7	8	9	10	11	12
0	21	23	24		22	20	15.2	18	18	19	17.5	18
10	20	22.5	23.5		21.5	17	14	14	13.5	15	13	13
20	19	19.5	22		18	16.5	14	13	13	13	13	13
30	15.2	17	19.5		17.5	15		13	13	13	13	13
40		17	17.5		17.5	16		13	13	13.5		13
50		17			17	16		13	13			13
60		17			17			13	13			
70		17			16			13				
80		17			16			13				
90												
100												
110												
120												
130												
140												
150												

The water quality of the Saint John Harbour showed that industrial development has created changes of varying magnitude in the aquatic environment.

It appears that the Irving Pulp and Paper Mill is the main contributor to river BOD, lignosulphate, and resin acid, while the Irving Oil Refinery adds the major part of the phenol to the receiving water. At times, the dissolved oxygen is reduced below 6 ppm in the river above the Reversing Falls. In the lower harbour area, the dissolved oxygen levels are usually normal except on the surface (Tables 1-8).

The lignosulphonate levels found in the river are not toxic by themselves, but serve as an indication of a source of pollution resulting from the degradation of wood products (figure 1-2). In this instance the sources were the Irving and the MacMillan Rothesay mills. High levels were also found in the Long Reach area, and could be due to pulp and paper mill activities upriver, which are diluted from the inflow of the Kennebecasis River.

BOD values of 6 ppm were found in the river at the Reversing Falls close to the Irving Pulp Mill (fig. 3). Much higher levels were obtained from "A" level, which was at the bottom. Since these samples were collected on the rising tide, the surface and mid-depth concentration of BOD could have been well diluted, while a relatively stagnant zone occurred near the bottom. The remaining harbour area did not have excessively high BOD levels.

Phenol concentrations of almost 10 ppb were measured where the Saint John River empties into the Bay of Fundy (fig. 4). The rising tide could have pushed this phenol contaminated water further out the harbour, near where the Irving oil sour water line empties. This phenol value is cause for concern since workers (3) have found that levels of 0.079 mg/l have been toxic to minnows. It is thus quite plausible that the levels obtained during the survey are close to the avoidance range, since many compounds have an avoidance level which is 1/10 of the toxic concentration.

Resin acid concentrations found in the river are also very high at 0.5 ppm, since it has been determined that 1 ppm has caused mortality in various species of fish (2). If this high resin acid value had been measured in an area of the river where it would have been confined to one side, then fish could easily swim around the problem, but the turbulence of the Reversing Falls evenly mixes the resin acids over the full river width leading to a possible blockage condition at certain phases of the tidal cycle. (fig. 5).

The high tides of the Bay of Fundy appear to aggravate the problem of waste dispersion, for at certain phases of the tidal cycle, the wastes are not only held in the river at the point of discharge, but are pushed upstream. On the rising tide, the resin acids seemed to be high from the point of discharge at Station 7, to almost Station 4 (fig. 5). The same dispersion characteristics seem to hold for phenols (fig. 4).

CONCLUSION

At the present time, the water quality of the Saint John Harbour indicates that a possible threat exists to the continuous upstream migration of Atlantic Salmon. This is mainly due to a buildup at certain tidal cycles, of chemical compounds such as phenols and resin acids. BOD, which is discharged mainly from the Irving pulp mill, has led to a reduction in dissolved oxygen in the area of the Reversing Falls. This could also be a deterrent to the unrestricted passage of the fisheries resource.

During a low water year with the present waste loading to the river, the aquatic habitat would be even less suitable for a viable fisheries resource. This will be even more so when the expansions are finished at MacMillan-Rothesay, Irving Pulp and Paper and the Irving Oil Refinery.

Although treatment facilities are desirable for all major industrial effluents in the area,as well as for the domestic wastes, the immediate priority would be the installation of efficient pollution abatement equipment at the Irving pulp mill and the Irving refinery.

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