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RESOURCE DEVELOPMENT BRANCH

MANUSCRIPT REPORT

No. 70 - 10

An Investigation into A Possible Inadequate Water Supply To Operate the Middle River and Pictou Harbour Fishways

by

H. Jansen

FISHERIES SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY OF CANADA
HALIFAX, N.S.

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HALIFAX, NOVA SCOTIA

MARCH, 1970

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INTRODUCTION

The purpose of this report is to investigate reports of an inadequate water supply to operate the Middle River fishway and possibly the Pictou Harbour fishway which came to light during the operation of a fish counting trap installed in the Middle River and Pictou Harbour fishways in the fall of 1969. In this report the historical background leading up to the construction and operation of the fishways is included. Also for this report inflow and outflow data for the reservoirs has been compiled, and the data will be analyzed to determine if a problem exists and recommendations will be made on how to improve the situation.

BACKGROUND INFORMATION

News releases in January 1965 gave mention of the construction of a multipurpose causeway dam to bring major benefits to the Pictou Harbour area. The Government of Nova Scotia named a committee of five, with Mr. V. M. Knight, Deputy Minister of Trade and Industry, as Chairman, with Montreal Engineering Company Limited as consulting engineers. The dam was to supply water to Scott Paper Company who required 25 MGPD of fresh water by March 1967 with leeway for double this quantity for future expansion. The scheme was also to provide 15 MGPD or more to supply Trenton, New Glasgow, Stellarton and Westville, as well as new industries. The dam for water storage would become a multipurpose causeway by serving as a Trans-Canada Highway link and possibly to accommodate a Canadian National Railways track.

Information on our files appears to be scanty, but sometime between January and April 1965 it was decided to construct two causeway-dams one at Pictou Harbour[1] and one at the Mouth of Middle River[1]. The way things have developed, the Pictou Harbour Dam serves as a Trans-Canada Highway link and the Middle River Dam accommodates a Canadian National Railways track. The Middle River Reservoir is used to provide 25 MGPD of fresh water to Scott Paper Company with no demand on water being placed on the Pictou Harbour Reservoir.

[1] See Figure 2.

The Nova Scotia Power Commission was named to represent the Province as "owners" of the proposed dams, and O. J. McCulloch and Company were hired as Consulting Engineers for the project. There is a great deal of correspondence on file between O. J. McCulloch and Company and the Department of Fisheries beginning in August 1965 with the Department providing functional layouts of fishways. Some of the major points brought forward in the correspondence concerning the fishways are as follows:

1. Initially water levels will be kept near +10.0 in the Middle River Reservoir and +4.0 to +6.0 in the Pictou Harbour Reservoir. It will be many years before the normal maximum water levels of +15.0 for Middle River Reservoir and +12.0 for Pictou Harbour Reservoir come into effect.

2. Considerable correspondence took place on moveable baffles at the fish entrance and on the distance of the fish entrance from the main gate section of the causeway to provide suitable attraction water.

3. The facility was designed to function efficiently at two different stages of reservoir elevation. During the initial stages of operation, the reservoir is expected to be held at a much lower elevation, pending land acquisition and flooding rights, than ultimate operating levels.

4. Approval for construction of the Middle River Fishway was given March 16, 1966 by the Minister of Fisheries, H. J. Robichaud.

5. Approval for construction of the Pictou Harbour

Fishway was given May 27, 1966 by the Minister of Fisheries H. J. Robichaud.

6. Excerpts from a letter to J. P. Parkinson, Chief Resource Development from O. J. McCulloch dated November 21, 1967 read as follows:

> "You will find attached hereto, for your information two prints of Drawing No. 49, entitled 'Operation Schedules for Fishways'. This drawing will serve to provide information for the operators of the Middle River and Pictou Dams in respect to fishways".

Also this letter states:

> "Because of the problem of interference and the possibility of damage occurring, it is our intention to take the moveable baffles at both dams out of the water as ice begins to form".

7. J. P. Parkinson's reply to McCulloch dated December 8, 1967 read as follows:

> "Our engineering staff has checked over the operational schedules for the above-mentioned fish facilities to which approval of same is hereby given".

also,

> "We concur with your suggestion of taking out the moveable baffles at both dams when winter freeze-up begins".

ANALYSIS OF FLOW DATA

The drainage area of the watershed of the Middle River Causeway is 90.96 square miles, and the drainage area of the watershed of the Pictou Harbour Causeway is 119.94 square miles, making a total drainage area of 210.9 square miles for the Pictou Harbour Causeway. The area of the Middle River Reservoir is approximately 1,107 acres and the Pictou Harbour Reservoir is 3,200 acres. The agove areas were obtained from topographic maps of scale 1:50,000.

The nearest gauging station in the Pictou Harbour area is located at Rocklin on the Middle River and is operated by the Department of Energy, Mines and Resources, Inland Waters Branch, Water Survey of Canada and is known as Station No. 01DP004 with a drainage of 35.6 square miles. This station was established in 1966 and at present the records are available for the calendar years 1966, 1967, 1968[1]. Out of these three years the year of lowest flow, 1966, was used to obtain the inflow to Middle River Reservoir from the Middle River[2] and also the inflow to Pictou Harbour Reservoir from the West River[3].

The demand for water by the two fishways, with the baffles properly adjusted[4], is normally approximately 10 c.f.s.

1 See Table No. 1

2 See Table No. 2

3 See Table No. 3

4 See Table No. 4

each. The fishways are required to operate in the months of April, May, June, September, October and November and the demand for water by the fishways are tabulated in Table No. 2 and Table No. 3.

The evaporation losses for the reservoirs were based on experiments[1] carried out in Truro, Nova Scotia, by the Thornwaite Method and found to be 20 inches/year. It was assumed that 75% of the evaporation occurred in the months of July, August and September, with remaining 25% evenly distributed between April, May, June, October and November[2]. The demand for water by Scott Paper is 25 MGPD[3] on the Middle River Reservoir.

The Pictou Harbour Reservoir has no demand on it at present for domestic water supply or industrial use[4].

The column for spill on Table No. 2 and Table No. 3 is the difference between the inflow to the reservoir and the demand on the reservoir. The Pictou Harbour Reservoir is continually spilling[4] because there is no demand on the water.

1 Maritime Provinces Water Resources Study
P. 2-33, stage 1, Appendix XI Surface Water Resources

2 See Table No. 2 and Table No. 3

3 See Table No. 2

4 See Table No. 3

The Middle River Reservoir must rely totally on reservoir storage in the months of July, August and September; and depending on how the gates are controlled, for the remaining months the Middle River Reservoir could be continually spilling into the Pictou Harbour Reservoir. Assuming that the Reservoir is brought up to normal full elevation in the months of October and November, the regulated spill from Middle River Reservoir into Pictou Harbour Reservoir is tabulated in Table No. 2 and Table No. 3.

From the data tabulated in Table No. 3, it can be seen that there is no problem in water supply to operate the Pictou Harbour Fishway. However, it should be noted that the controlling elevation for this fishway is based on the elevation of the notch of the fixed concrete baffle No. 4 with elevation 2.42[1]. In discussions with the Nova Scotia Water Resources Commission, this reservoir is maintained between elevation 3.0 and 3.5 which provides a flow of 2.7 to 5.1 c.f.s. to the fishway with 0.48 feet to 0.72 feet of head through the notch. The Pictou Harbour Reservoir cannot be maintained at elevations higher than elevation 3.5 because the Nova Scotia Water Resources Commission have not obtained the land surrounding the reservoir, and it appears very doubtful that they will do so because of the excessive costs involved.

[1] See Table No. 4 and Figure No. 4

From the data tabulated in Table No. 2, it can be seen that the Middle River Reservoir can be maintained full in the months of January, February, March, April, May, June, November and December, and the fishway will work effectively with the baffles adjusted properly[1]. However, in the months of July, August and September, the demand on the reservoir must be met by storage, therefore, the reservoir is continuously being drawn down. Based on the figures available, the area of the Middle River Reservoir is approximately 1,107 acres and the total demand on reservoir storage is approximately 6,503 acre-feet in the months of July, August and September causing a drawdown of approximately six (6) feet in the reservoir. This was verified in discussions with the Nova Scotia Water Authority in which they said the minimum water level is elevation 6.0 and the maximum elevation they maintain is 12.0 to 13.0. However, the controlling elevation for the Middle River Fishway is elevation 6.38, which is the elevation of the notch of the controlling fixed concrete baffle[1]. Therefore, it is impossible for the fishway to operate in September if the Middle River Reservoir is permitted to drop to elevation 6.0. It appears that the Middle River Reservoir must be brought up to elevations higher than elevation 13.0 by the end of June in order that the reservoir elevation in September will be higher than elevation

[1] See Table No. 4 and Figure No. 3

6.38 which would enable the fishway to operate.

As the reservoir begins to fill in October and November, the fishway must be regulated[1] to ensure operation of the fishway during the fall run of salmon.

[1] See Table No. 4 and Figure No. 3

CONCLUSIONS

1. It appears that there is an adequate water supply to operate the Middle River Fishway provided that the reservoir is brought up to an elevation between +13.0 and +15.0 by the end of June, in order for the reservoir to be higher than elevation 6.38 in September. This is based on the present demand of 25 MGPD by Scott Paper[1].

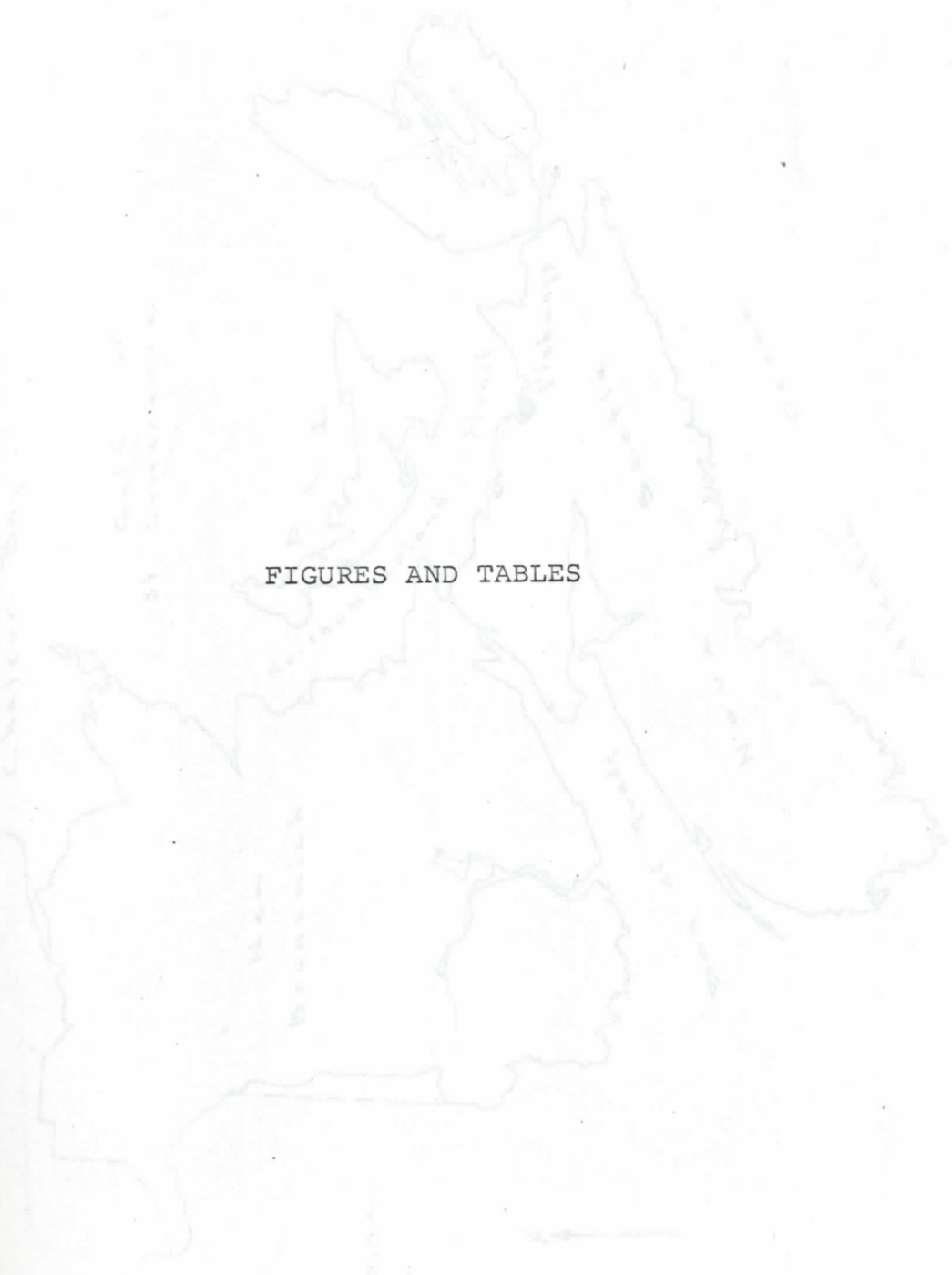
2. As the reservoir begins to fill in October and November the fishway baffles must be regulated according to the operational schedule in Table No. 4 in order to maintain an adequate supply of water to the fishway.

3. There appears to be no major difficulties at the Pictou Harbour Fishway if the Nova Scotia Water Resources Commission maintains the reservoir level between elevations 3.0 and 3.5. This provides a flow of 2.7 to 5.1 c.f.s. through the fishway with 0.48 feet to 0.72 feet of head through the notch. However, it should be noted that if the elevation of the reservoir is to be maintained at elevations greater than 5.0 it will be necessary to install the removeable baffles according to the operational schedule in Table No. 4.

4. Correspondence on file indicates that Scott Paper Company will require an additional 25 MGPD in the future and other industrial development will no doubt put a substantial

[1] See Table No. 4

demand on the reservoirs. If the Middle River Reservoir is to be used for this increased demand, serious difficulties could be encountered in providing water to operate the fishway. At present the drawdown of the reservoir is between 6 and 7 feet, therefore, with double the demand, a drawdown in the vicinity of 14 feet could be expected making the fishway inoperable until some time in November, at which time the run of adult salmon is normally completed.



FIGURES AND TABLES

FIG. 1.

Drawn: B.W.K.	DEPARTMENT OF FISHERIES, CANADA	Date: Apr. 1, 1970
Checked: M.S.	MIDDLE RIVER & PICTOU HARBOUR, N.S.	Scale: None
Approved:	FISHWAY LOCATION PLAN	Dwg. No. M-E-1070

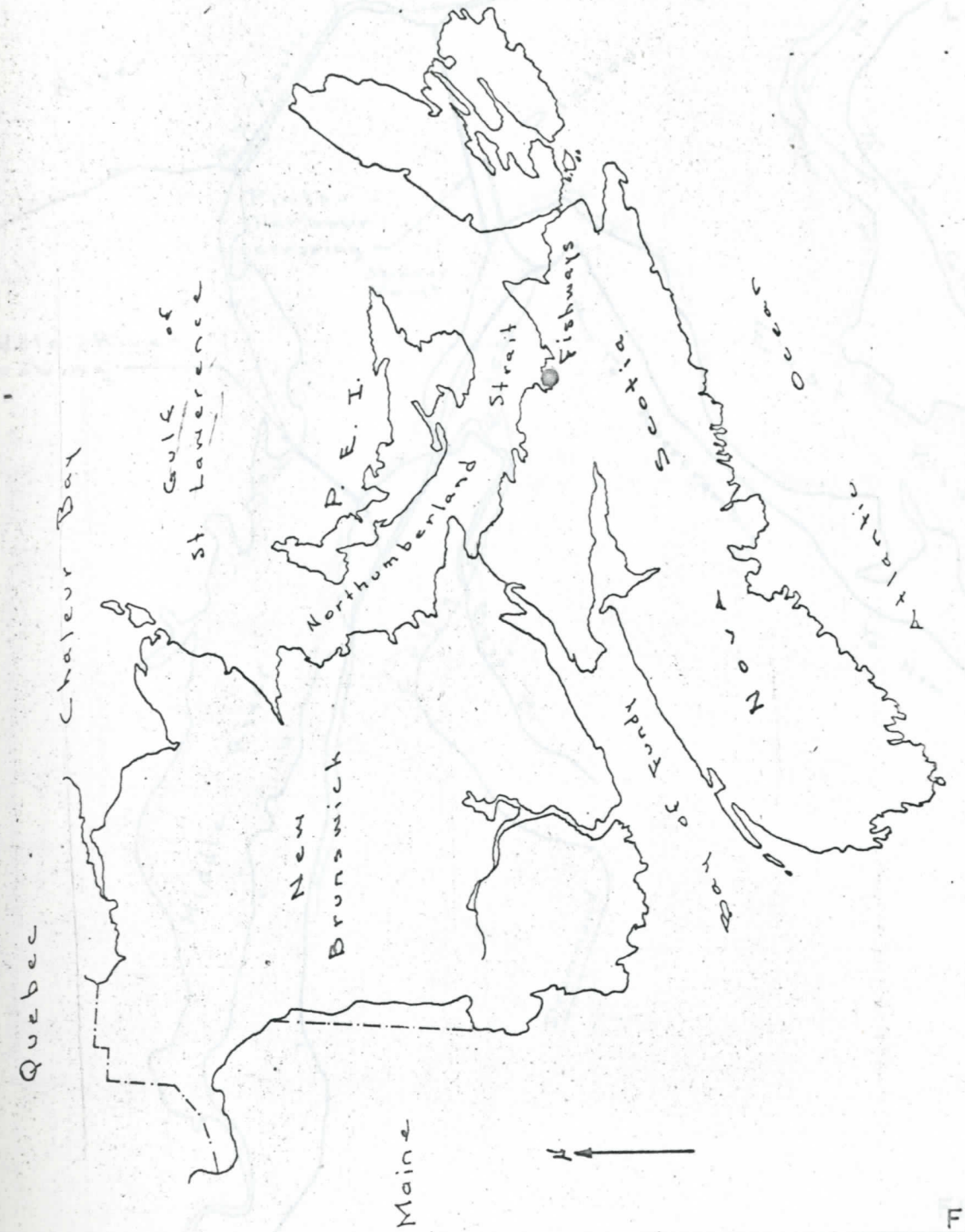


FIG. 1.

DRAWN: B.W.K.	DEPARTMENT OF FISHERIES, CANADA	DATE: Apr. 1, 1970
CHECK: HJ	MIDDLE RIVER & PICTOU HARBOUR, N.S. FISHWAY LOCATION PLAN	SCALE: None
APPROVED:		DWG. NO.: M-E-1070

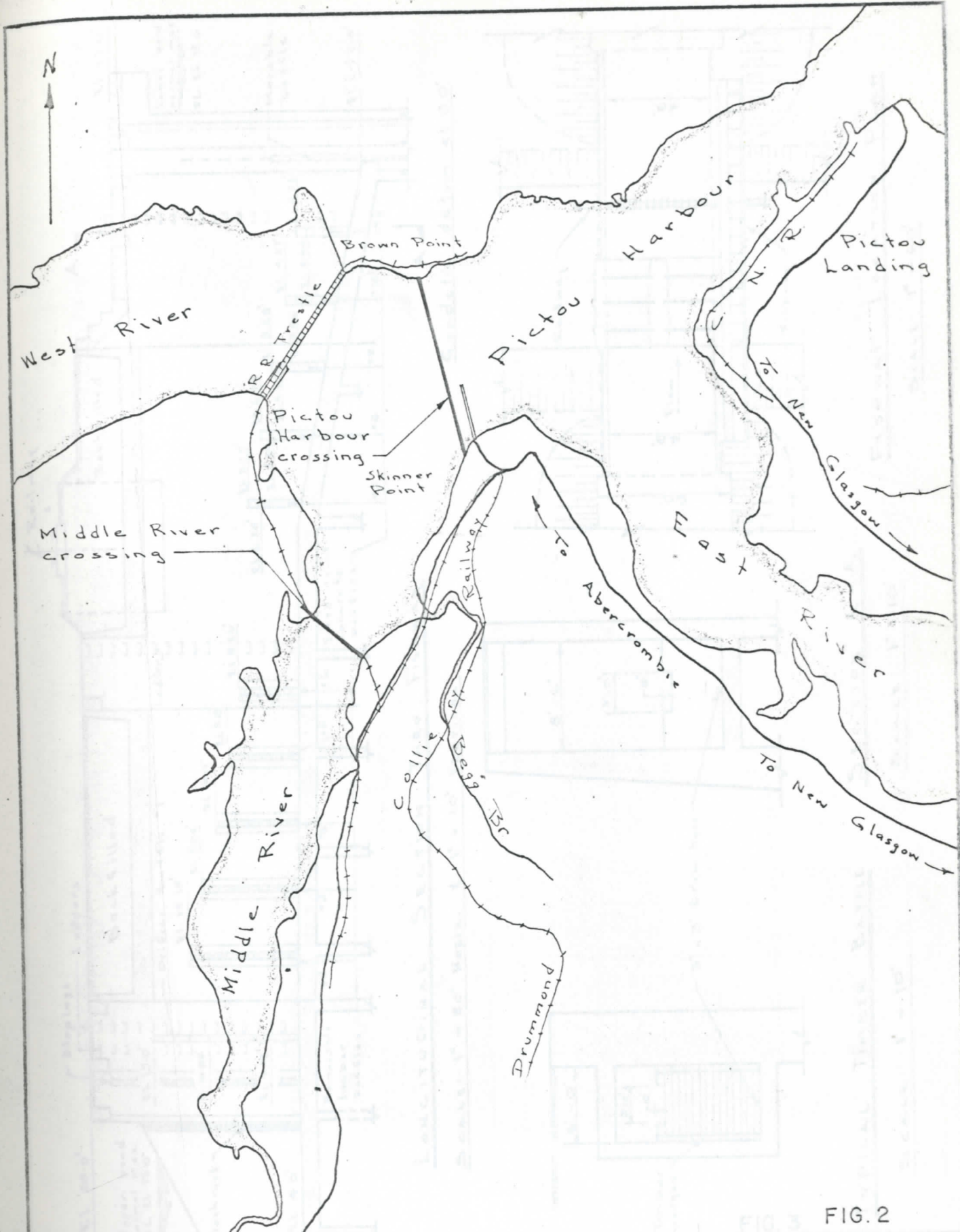
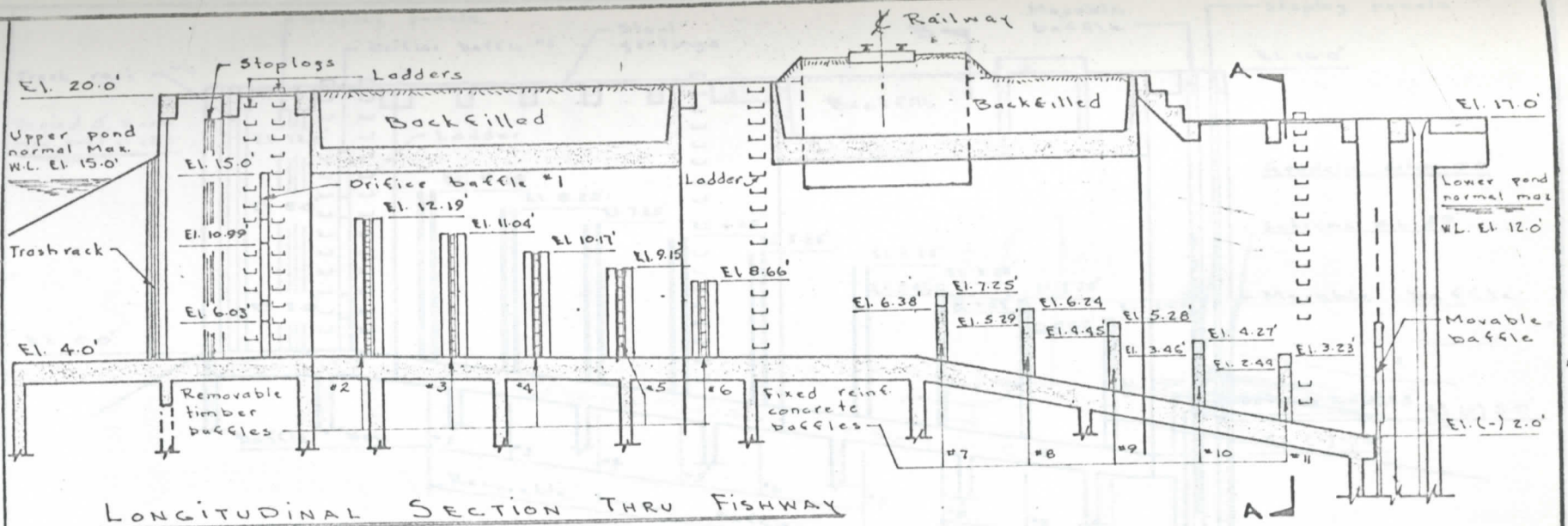


FIG. 2

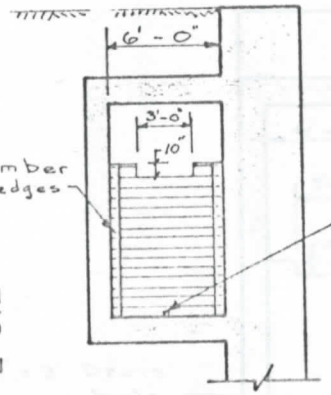
DRAWN: B.W.K.	DEPARTMENT OF FISHERIES. CANADA	DATE: Apr. 1, 1970
CHECK: HJ	MIDDLE RIVER & PICTOU HARBOUR, N.S. FISHWAY SITE PLAN	SCALE: 1: 50,000
APPROVED:		DWG. NO.: M-E-1071

M-E-1071



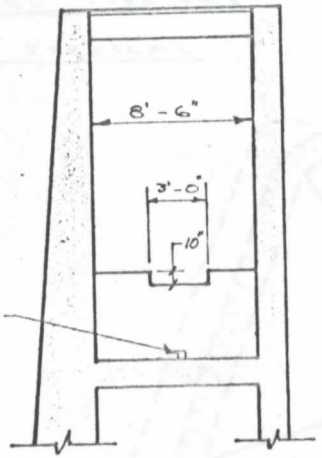
LONGITUDINAL SECTION THRU FISHWAY

SCALE: 1" = 20' Horiz. & 1" = 10' VERTICAL



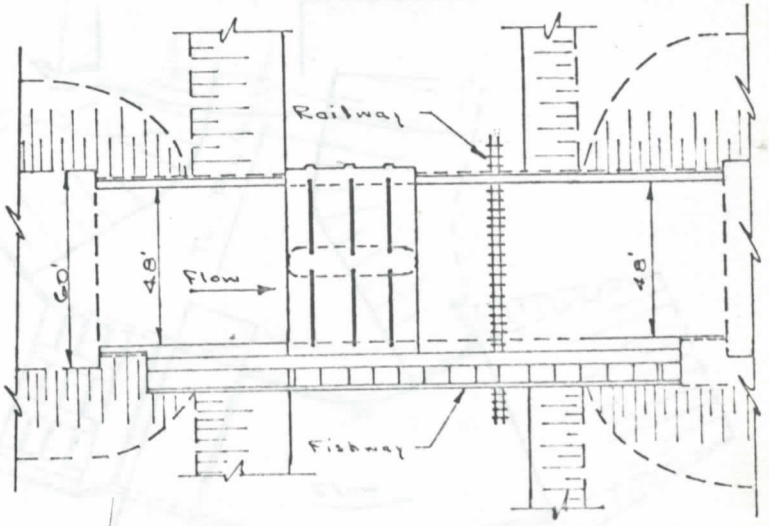
TYPICAL TIMBER BAFFLE

SCALE: 1" = 10'



SECTION A-A

SCALE: 1" = 10'



FISHWAY LOCATION PLAN

SCALE: 1" = 60'

FIG. 3

MIDDLE RIVER FISHWAY, N. S.

DEPARTMENT OF FISHERIES. CANADA

DRAWN: B.W.K.

CHECK:

APPROVED: H.J

DATE: Apr. 1, 1970.

SCALE: As Shown

DWG. NO. M-E-1072

M-E-1072

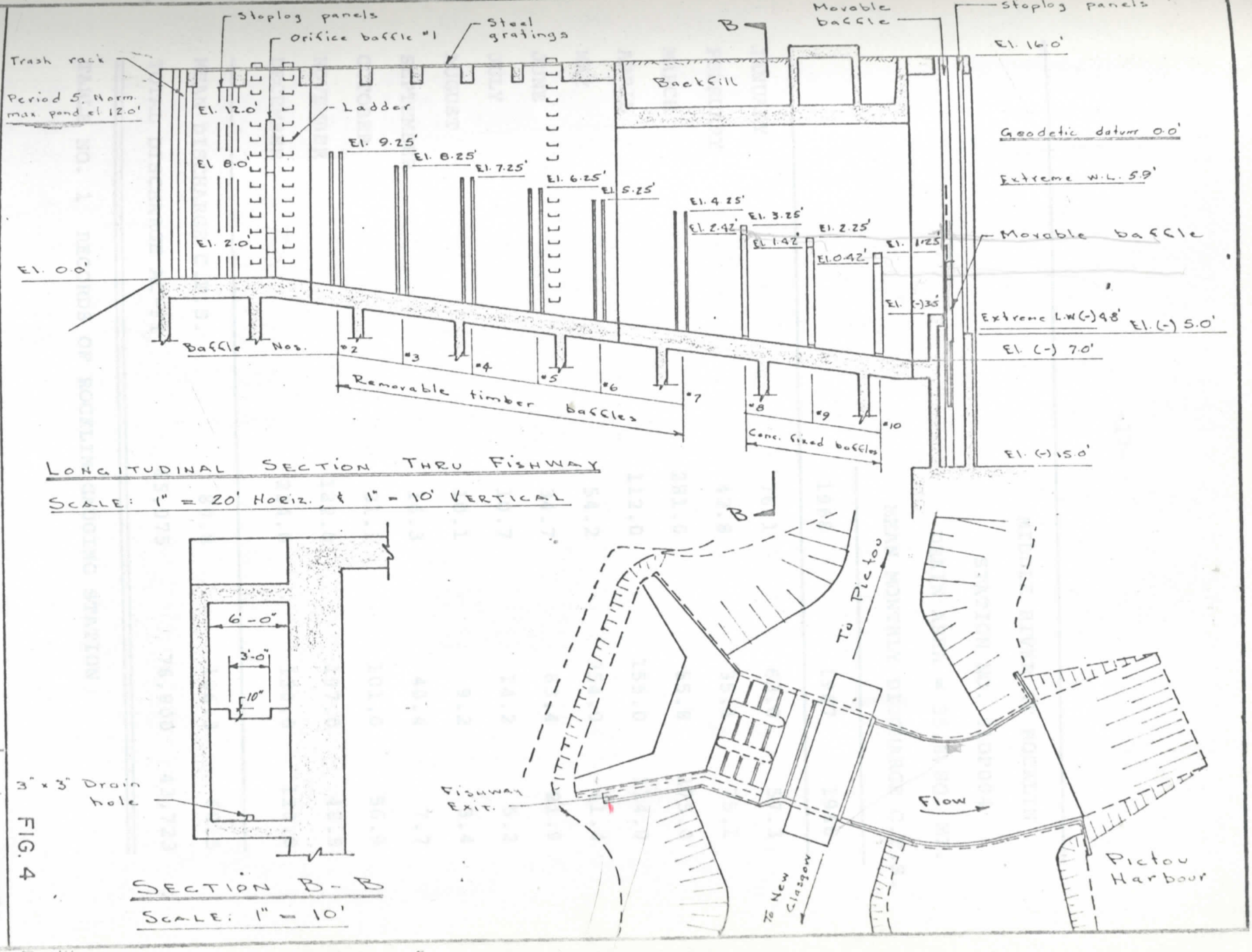


FIG. 4

DRAWN: B.W.K.
CHECK: H.S
APPROVED:

DEPARTMENT OF FISHERIES, CANADA

PICTOU HARBOUR FISHWAY, N. S.

DATE: Apr. 1, 1970.
SCALE: As Shown
DWG. NO.: M-E-1073

M-E-1073

MIDDLE RIVER AT ROCKLIN

STATION NO. 01DP004

DRAIN AREA = 35.6 SQ. MI.

MEAN MONTHLY DISCHARGE C.F.S.

	1968	1967	1966
JANUARY	76.1	63.0	57.3
FEBRUARY	42.8	35.1	75.1
MARCH	281.0	55.8	175.0
APRIL	112.0	155.0	114.0
MAY	54.2	354.0	41.4
JUNE	34.7	63.4	21.9
JULY	10.7	14.2	5.2
AUGUST	10.1	9.2	3.4
SEPTEMBER	16.3	40.4	7.7
OCTOBER	31.1	101.0	56.9
NOVEMBER	182.0	197.0	48.5
DECEMBER	224.0	130.0	120.0
MEAN DISCHARGE C.F.S.	89.8	106.3	60.5
TOTAL DISCHARGE AC-FT	65,075	76,800	43,723

TABLE NO. 1 RECORDS OF ROCKLIN GAUGING STATION

	(1) INFLOW TO MIDDLE RIVER RESERVOIR FROM MIDDLE RIVER 1966	(2) DEMAND BY FISHWAY IN MIDDLE RIVER DAM 10 C.F.S.	(3) EVAPORATION FROM MIDDLE RIVER RESERVOIR	(4) DEMAND BY SCOTT PAPER	(5) TOTAL DEMAND ON RESERVOIR (2)+(3)+(4)	(6) SPILL (5)-(1)	(7) REGULATED SPILL INTO PICTOU HARBOUR RESERVOIR
JANUARY	8,980	0	0	2,375	2,375	6,605	6,605
FEBRUARY	10,639	0	0	2,140	2,140	8,499	8,499
MARCH	27,443	0	0	2,375	2,375	25,068	25,068
APRIL	17,303	594	92	2,300	2,986	14,317	14,317
MAY	6,494	614	92	2,375	3,081	3,413	3,413
JUNE	3,326	594	92	2,300	2,986	340	340
JULY	817	0	460	2,375	2,835	- 2,018	0
AUGUST	534	0	460	2,375	2,835	- 2,301	0
SEPTEMBER	1,170	594	460	2,300	3,354	- 2,184	0
OCTOBER	8,928	614	92	2,375	3,081	5,847	0
NOVEMBER	7,360	594	92	2,300	2,986	4,374	3,718
DECEMBER	18,819	0	0	2,375	2,375	16,444	16,444
	111,813	3,604	1,840	27,965	33,409	78,404	78,404

TABLE 2. FLOW ANALYSIS OF MIDDLE RIVER RESERVOIR

1. All figures are in acre-feet
2. Inflows based on most critical year (1966) on 3 years records
3. Demands on this reservoir are present demands.

	(1) INFLOW TO PICTOU HARBOUR RESERVOIR FROM WEST RIVER	(2) INFLOW TO PICTOU HARBOUR RESERVOIR FROM MIDDLE RIVER FISHWAY	(3) REGULATED SPILL FROM MIDDLE RIVER RESERVOIR	(4) TOTAL INFLOW TO PICTOU HARBOUR RESERVOIR (1)+(2)+(3)	(5) EVAPORATION FROM PICTOU HARBOUR RESERVOIR	(6) DEMAND BY FISHWAY IN PICTOU HARBOUR DAM 10 C.F.S.	(7) SPILL INTO PICTOU HARBOUR (4)-(5)-(6)
JANUARY	11,846	0	6,605	18,451	0		18,451
FEBRUARY	14,026	0	8,499	22,525	0		22,525
MARCH	36,190	0	25,068	61,258	0		61,258
APRIL	22,810	594	14,317	37,721	267	594	36,860
MAY	8,563	614	3,413	12,590	267	614	11,709
JUNE	4,384	594	340	5,318	267	594	4,457
JULY	1,074	0	0	1,074	1,335	0	- 261
AUGUST	706	0	0	706	1,335	0	- 629
SEPTEMBER	1,539	594	0	2,133	1,335	594	204
OCTOBER	11,767	614	0	12,381	267	614	11,500
NOVEMBER	9,706	594	3,718	14,018	267	594	13,157
DECEMBER	24,816	0	16,440	41,256	0	0	41,256
	147,427	3,604	78,400	229,431	5,340	3,604	220,487

TABLE NO. 3 FLOW ANALYSIS OF PICTOU HARBOUR RESERVOIR

1. All figures in acre-feet.
2. Inflows based on most critical year (1966) on 3 years records.
3. Demands are present demands on Pictou Harbour Reservoir.

PICTOU DAM FISHWAY

RESERVOIR W.L.	ORIFICE BAFFLE No.1			CONTROLLING BAFFLE (C)				DISCHARGE IN C.F.S.
	ORIFICE IN USE (A)	HEAD Ho	D/S W.L.	NUMBER (B)	ELEV. OF NOTCH	HEAD ON NOTCH HN	TOTAL HEAD Ht ON NOTCH	
12	UPPER	2.40	9.60	2	8.42	1.18	3.58	13.3
11	"	1.50	9.50	2	8.42	1.08	2.58	10.5
10	"	.70	9.30	2	8.42	0.88	1.58	7.2
10	LOWER	1.50	8.50	3	7.42	1.08	2.58	10.5
9	"	.70	8.30	3	7.42	0.88	1.58	7.2
9	"	1.50	7.50	4	6.42	1.08	2.58	10.5
8	"	.70	7.30	4	6.42	0.88	1.58	7.2
8	"	1.50	6.50	5	5.42	1.08	2.58	10.5
7	"	.70	6.30	5	5.42	0.88	1.58	7.2
7	"	1.50	5.50	6	4.42	1.08	2.58	10.5
6	"	.70	5.30	6	4.42	0.88	1.58	7.2
6	"	1.50	4.50	7	3.42	1.08	2.58	10.5
5	"	.70	4.30	7	3.42	0.88	1.58	7.2
5	"	1.50	3.50	8	2.42	1.08	2.58	10.5
4	"	.70	3.30	8	2.42	0.88	1.58	7.2
3.5	"	.36	3.14	8	2.42	0.72	1.08	5.1
3	"	.10	2.90	8	2.42	0.48	0.58	2.7
2.42	"	NIL	2.42	8	2.42	NIL	NIL	NIL

MIDDLE RIVER DAM FISHWAY

RESERVOIR W. L.	ORIFICE BAFFLE No.1			CONTROLLING BAFFLE (C)				DISCHARGE IN C.F.S.
	ORIFICE IN USE (A)	HEAD Ho	D/S W.L.	NUMBER (B)	ELEV. OF NOTCH	HEAD ON NOTCH HN	TOTAL HEAD Ht ON NOTCH	
15	UPPER	2.40	12.60	2	11.42	1.18	3.58	13.3
14	"	1.50	12.50	2	11.42	1.08	2.58	10.5
13	"	0.70	12.30	2	11.42	.88	1.58	7.2
13	LOWER	1.50	11.50	3	10.42	1.08	2.58	10.5
12	"	.70	11.30	3	10.42	.88	1.58	7.2
12	"	1.50	10.50	4	9.42	1.08	2.58	10.5
11	"	.70	10.30	4	9.42	.88	1.58	7.2
11	"	1.50	9.50	5	8.42	1.08	2.58	10.5
10	"	.70	9.30	5	8.42	.88	1.58	7.2
10	"	1.35	8.65	6	7.62	1.03	2.38	10.0
9	"	.55	8.45	6	7.62	.83	1.38	5.8
9	"	1.55	7.45	7	6.38	1.07	2.62	10.7
8	"	0.74	7.26	7	6.38	.88	1.62	7.4
7	"	.12	6.88	7	6.38	.51	.63	2.6
6.38	"	NIL	6.38	7	6.38	NIL	NIL	NIL

(A) USE ONLY ONE ORIFICE AT A TIME. BLOCK OTHER ONE.

(B) REMOVE TOP MEMBERS OF TIMBER BAFFLES UPSTREAM OF THE CONTROLLING BAFFLE TO AT LEAST 0.5 FOOT LOWER THAN NOTCH OF THE CONTROLLING BAFFLE.

(C) ALL TIMBER BAFFLES DOWNSTREAM FROM CONTROLLING BAFFLE MUST BE INSTALLED FOR FISHWAY TO FUNCTION PROPERLY.

* TABLE 4. OPERATIONAL SCHEDULES FOR VARIOUS RESERVOIR LEVELS

* Photocopy of table on McCulloch Drawing No. 49