Saint John River
at Saint John, N.B.
Measurement Program
1977
Revised
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Introduction

The Special Services and Surveys Section of the Applied Hydrology Division, Ottawa was requested by the Atlantic Region of the Inland Waters Directorate to undertake a measurement program on a tidal influenced reach of the Saint John River during the freshet period of 1977. The request by Atlantic Region in conjunction with Maclaren Atlantic Limited, a consulting firm requiring data for a surface water profile simulation model, included the following:

a) Flow measurements during the rising, peak, and falling stages of the river at Saint John, N.B.

b) For each of the three stages, measurements at high and low tidal extremes.

c) River stage record for each measurement on existing or installed gauges.

d) As many measurements as possible should be taken during the tidal cycle.

e) Measurements at Evandale, 30 miles upstream from Saint John, also at rising, peak, and falling stages to confirm the simulation.

As no previous discharge measurements had ever been made at Evandale or Saint John it was necessary to establish a metering section at each site and to employ a measurement technique that would prove sufficiently accurate for the ever changing river conditions.

Measurement Site

Saint John

The measurement site at Saint John was chosen rather quickly due to time limitations as the river was at its peak when the survey party arrived on site and measurements had to be taken as soon as possible.

From nautical charts it was determined that the reach immediately above the Reversing Falls would be too deep for our equipment. Referring to Figure 1, the section of river from the Saint John Harbour limit to the first river bend downstream was investigated as a possible metering site. The minimum river depths were determined at the channel entrance by echo sounder. The river banks were virtually sheer walls rising from below the river surface along this part of the channel and as our measurement technique required a suitable shore location to position the slave Tellurometer the section line required at least one gradually sloping bank. The section line finally chosen and indicated in Figure 1 was based on a number of compromises. The section was as shallow as could be

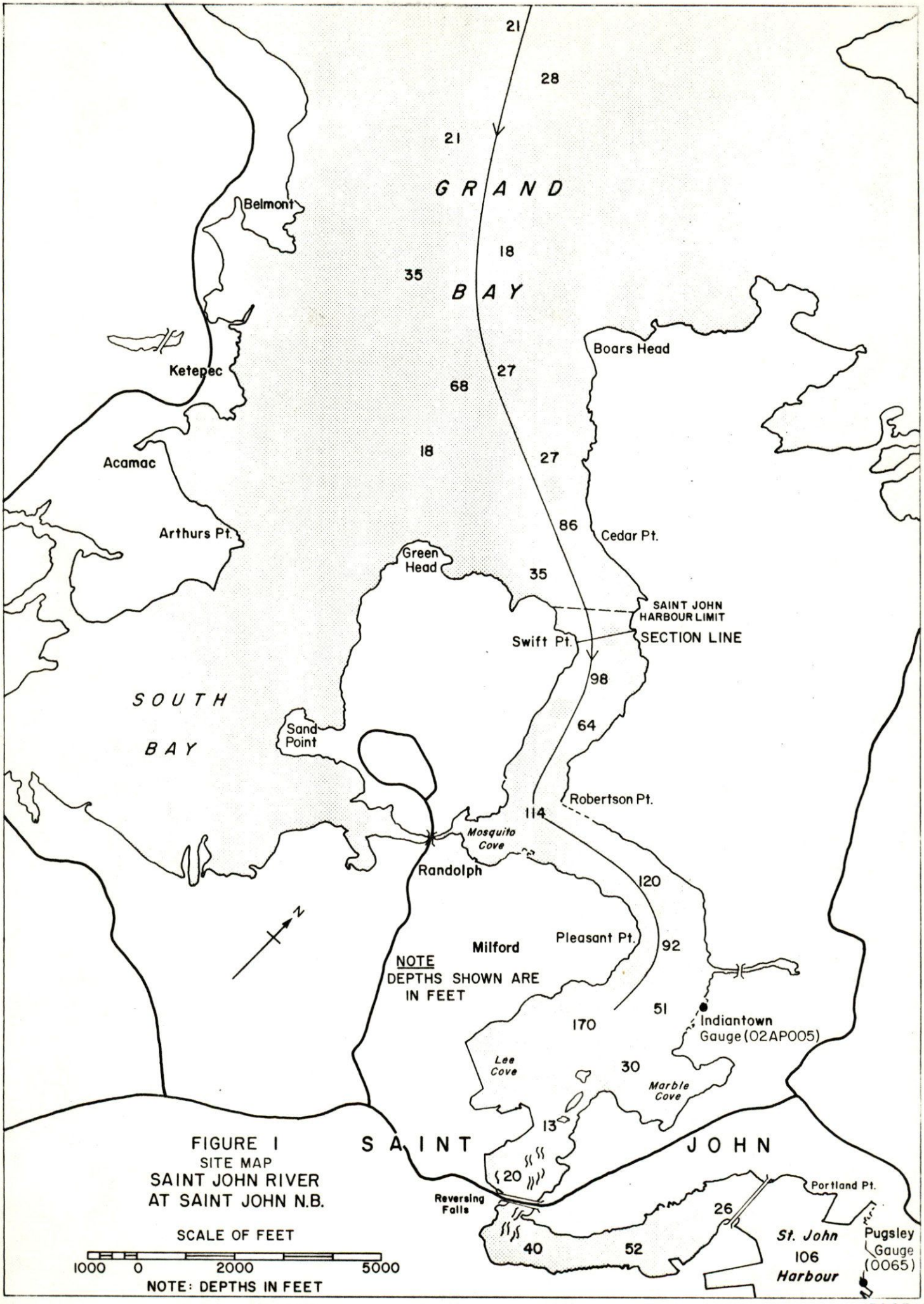

FIGURE 1
SITE MAP
SAINT JOHN RIVER
AT SAINT JOHN N.B.

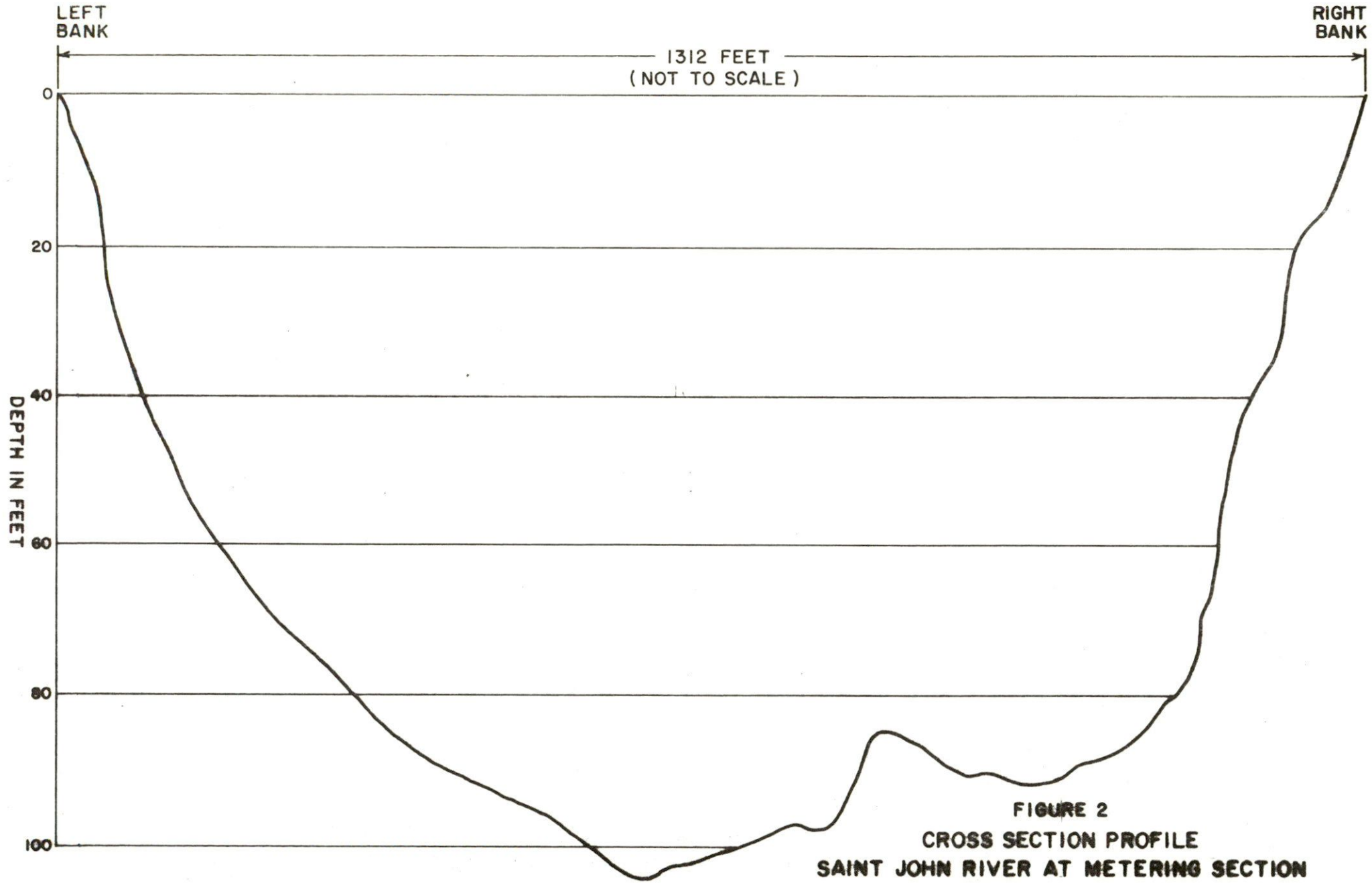

FIGURE 2

CROSS SECTION PROFILE

SAINT JOHN RIVER AT METERING SECTION

NEAR SAINT JOHN N. B.

RIVER ELEVATION 11.98 FEET G.S OF C.

found in the confined channel, had easily accessible banks, and had sufficient velocity at most tidal elevations. The only deficiency was a section of dead water at the left bank and a section of back flow at the right bank. The edge of flow was defined as closely as possible for each measurement.

Referring to Figure 1, it can be seen that flow can occur between South Bay and Mosquito Cove. A discharge measurement was made above a box culvert at high stage by MacLaren Atlantic. The flow was too insignificant to have any effect on the total river discharge.

Description of Station

On the Saint John River at Saint John, Province of New Brunswick.

Located in St. John County

Latitude 45° 17' 00" N

Longitude 66° 07' 00" W

Established April 27, 1977 by D. Anderson and E.J. Fast.

The station is located at Swift Point, approximately 700 feet downstream from the upstream Saint John Harbour limit.

A 0-6 foot staff gauge located on the left bank was used as stage reference for measurements on April 27, 28, and May 1. This staff gauge was subsequently destroyed.

A rock marking point located on the left bank was used as stage reference for measurements on May 19, 20, and 21st. A temporary bench mark was established on the left bank at the section line. TBM 1 is the highest point on rock ledge at the base of the rock face on the left bank approximately 5 feet above the section line marked with orange fluorescent paint. The staff gauge and marking point were both referenced to TBM 1. Elevation TBM 1 15.32 feet, Geodetic Survey of Canada.

Measurements were also referred to Indiantown gauge 01AP005 and Pugsley wharf tidal gauge 0065.

Measurements were made using the Moving Boat or Jet Boat-Tellurometer techniques. Shore ranges using painted plywood and natural features were used for alignment along the section line.

The initial point for soundings was the top centre front of the limestone kiln on the left bank.

The channel above the station curves into the lower end of Grand Bay.

The channel below the station curves several times and empties into the Bay of Fundy.

The bottom of the river was bedrock with no apparent loose material.

The maximum depth was near mid-channel and was 104 feet at high stage (see Figure 2).

The measured width was 1,312 feet between two large painted boulders marking the section line on each shore.

Measurement Site

Evandale

The metering section at Evandale was established approximately ¼ mile above the ferry crossing between Evandale and Kars, N.B. The measured width was 1,910 feet with a maximum depth of 74 feet at mid-channel at high stage (Figure 3). Velocities up to 4 f.p.s. were found at high stage. The first 200 feet from the left shore was sluggish at all stages. The river was measured at high stage by the Moving Boat technique and at medium stage by the Jet Boat-Tellurometer technique. Discharge was related to a staff gauge installed by Maclaren Atlantic at the ferry crossing on the right bank.

The section was marked by wooden pins on each shore which likely have been destroyed. The river reach for at least a mile above and below the metering section was straight and numerous measurement sections can be chosen for future programs.

Measurement Technique

Twenty-nine discharge measurements were taken at the Saint John site and three at Evandale. The Moving Boat technique and a modified conventional technique (Jet Boat-Tellurometer) were used.

The Moving Boat technique was used at Saint John, April 27 and 28 with the results denoted in Table 1. These measurements were

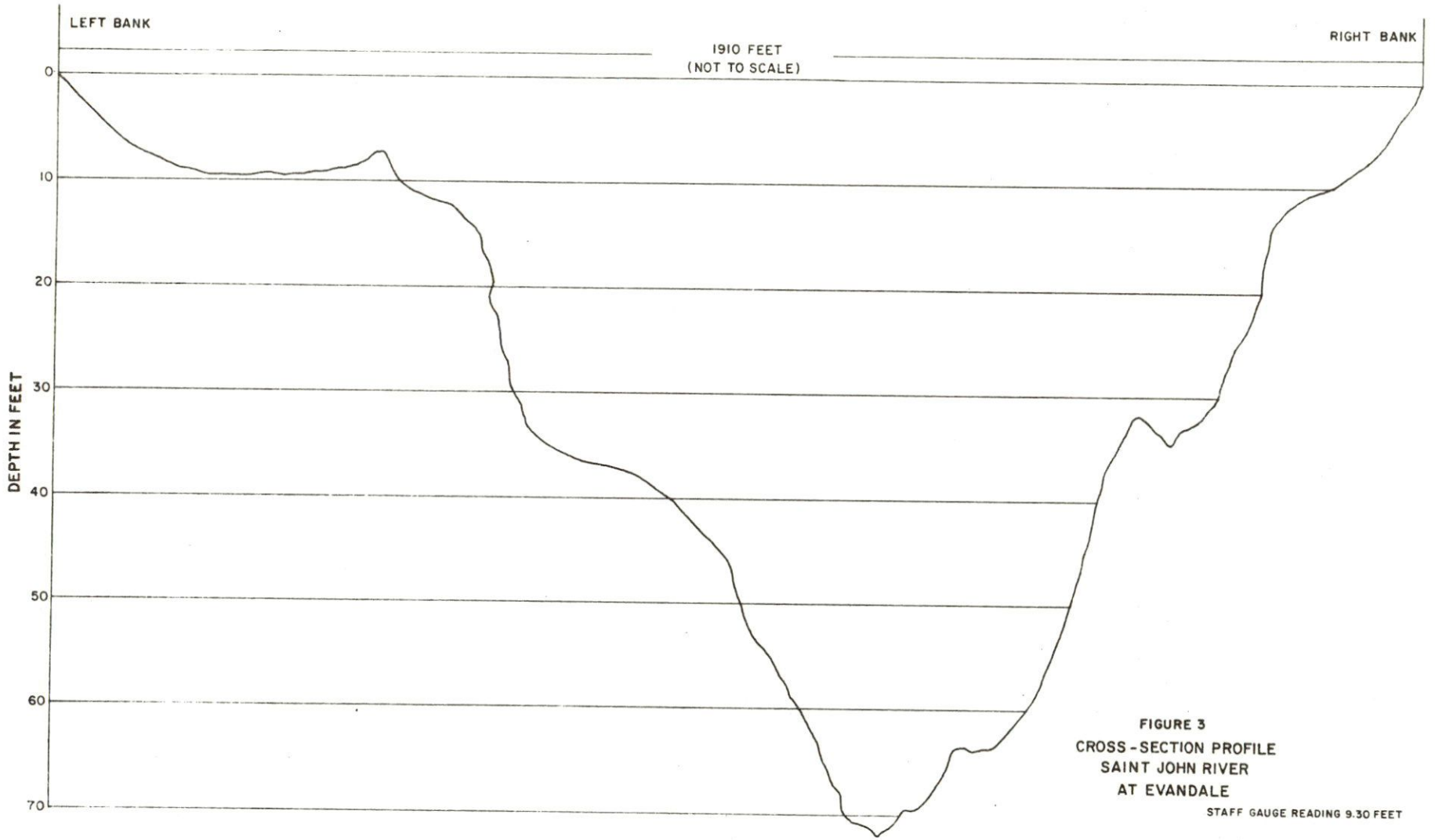

FIGURE 3
CROSS-SECTION PROFILE
SAINT JOHN RIVER
AT EVANDALE
STAFF GAUGE READING 9.30 FEET

taken at the 1977 peak flow of the Saint John River when sufficient velocity was present for this technique to be used. Each measurement was the mean of measurement runs taken from opposite sides of the river with from ½ to one hour delay between measurement pairs to allow a sufficient change in river conditions. The averaging of the opposing runs eliminates errors due to angular flow. Three vertical velocity profiles were taken at 3 different positions along the cross section. Two profiles plotted well but the third bore no resemblance to a normal velocity profile. The third vertical velocity profile was made within 300 feet of the left bank where velocities fluctuated more than in the remainder of the metering section. This was possibly due to channel configuration and upstream influences. To obtain accurate results from this technique on tidal influenced rivers continuous vertical velocity observations are essential. From the two usable profiles a vertical velocity coefficient of 0.93 was calculated.

The Moving Boat technique was discontinued after April 28 due to a number of reasons. The river channel was running swells up to 2 feet during the period of measurement on April 27 and 28. The swells did not diminish with changes in wind direction but increased when the wind blew against the current. Running the boat through the swells made reading the current meter angles very difficult as the angle indicator would fluctuate up to 15 degrees in either direction. Keeping the boat on line during a measurement was

especially difficult with an upstream wind. Measurements had to be terminated on April 28 after one complete run due to high winds.

Manpower was also a problem with this technique. Three men are required to take a Moving Boat measurement and with the high water conditions throughout the area manpower was at a premium. Rather than keep another man tied up with a technique not too well suited to the section it was decided to change to a more conventional method.

Velocity profiles also presented a problem with this technique. Vertical velocity profiles should have been taken continuously to coincide with the ever changing river conditions. Again manpower was a problem as two additional persons and another boat would have to be assigned to this task.

Moving Boat measurements were made at peak river stage at Evandale on April 25 under good weather conditions. Velocities were high enough to obtain good results from the technique. A vertical velocity coefficient of 0.92 was calculated from data obtained by Water Survey of Canada, Fredericton Area Office personnel on April 21 as time did not permit velocity profiles to be taken on the date of measurement.

The three measurements on May 1 were made using the Jet Boat-Tellurometer technique using the MRB 201 tellurometer to position the boat, a Raytheon DE719 echo sounder to develop a set of standard soundings, and a motorized B-reel to obtain velocities at 0.2 and 0.8 depths. Eighteen velocity stations were used for

these measurements which took up to 1½ hours to complete.

The next series of measurements at Saint John were taken in mid-May at receding water levels. The section line water elevation was approximately 4 feet lower from the period of peak discharge. Seventeen discharge measurements were taken May 19, 20, and 21, under relatively calm wind conditions. These measurements were all taken using the Jet Boat-Tellurometer technique using two current meters to simultaneously record the 0.2 and 0.8 velocities. The number of velocity stations was reduced to 16, which in conjunction with the second current meter reduced the time of measurement to ½ hour.

A discharge measurement was taken at Evandale on May 18, also using the Jet Boat-Tellurometer technique.

Analysis of Data

The measurements on April 27 and 28 using the Moving Boat technique are of acceptable accuracy. The discharge measurements fluctuate correctly according to changes in the tide. It is difficult to establish the degree of accuracy without comparative data. The accuracy of Moving Boat measurements can be improved with continuous vertical velocity measurements and relatively calm water conditions during the time of measurement.

The measurements taken on May 1 are as accurate as the measurements taken earlier by the Moving Boat technique. The

discharge data improved due to samples being taken at the 0.2 and 0.8 depths but some accuracy was lost in the 1½ hour period required to obtain one measurement.

The measurements taken May 19-21 at Saint John were the best of the whole series. The reduction in time of measurement and the relatively calm water conditions should bring the discharge data to usual Water Survey of Canada standards.

The measurements at Evandale listed in Table 3, two taken by Moving Boat and one by Jet Boat-Tellurometer, are of acceptable accuracy. Weather conditions were good on both days and the river section was suitable for both measurement techniques.

The data listed in Tables 1, 2 and 3 was computed and checked to Water Survey of Canada standards. Date, time of measurement, mean velocity, section line water elevation, and discharge are listed. The data in the last two columns of Tables 1 and 2 for Indiantown gauge and Pugsley wharf gauge was provided by the Halifax District Office of Water Survey of Canada. Indiantown water elevations are not available for May 19-21 as the gauge was inoperative during this period. A water level correlation must be made with the section line gauge to obtain Indiantown elevations for the missing period.

TABLE 1

Discharge Measurements

Saint John River at Saint John, N.B.

1977

Date	Time A.S.T.	Mean Velocity fps	Section Line Gauge ft	Discharge cfs	Indiantown Gauge ft*	Pugsley Wharf Gauge ft**
April 27	11:20	2.47	12.08	233,000†	12.37	6.55
April 27	12:15	2.60	12.03	245,000†	12.32	4.80
April 27	12:55	2.59	12.01	242,000†	12.27	6.70
April 27	14:10	2.51	11.98	241,000†	12.24	10.30
April 27	15:00	2.53	12.03	242,000†	12.28	13.60
April 27	15:45	2.42	12.03	227,000†	12.40	16.80
April 27	16:45	1.84	12.18	174,000†	12.57	20.43
April 27	17:40	1.70	12.36	159,000†	12.71	22.80
April 28	10:40	2.16	12.40	202,000†	12.55	10.95
May 1	08:20	1.20	12.73	109,000	12.93	23.20
May 1	12:35	2.49	12.63	226,000	12.94	16.00
May 1	15:30	2.81	12.28	250,000	12.50	2.50

* Geodetic Survey of Canada Datum

** Chart Datum

† Moving Boat Measurements

TABLE 2

Discharge Measurements

Saint John River at Saint John, N.B.

1977

Date	Time A.S.T.	Mean Velocity fps	Mean Gauge Height ft	Discharge cfs	Indiantown Gauge ft	Pugsley Wharf Gauge ft*
May 19	09:45	1.98	8.57	174,000		14.10
May 19	10:35	1.85	8.65	162,000		19.00
May 19	11:50	0.66	8.97	58,200		23.25
May 19	15:25	1.95	9.00	172,000		15.75
May 19	16:45	2.33	8.79	205,000		10.05
May 19	17:50	2.37	8.63	208,000		6.33
May 19	18:35	2.47	8.47	217,000		5.10
May 20	08:35	2.35	8.24	205,000	NO RECORDS	6.40
May 20	09:20	2.41	8.19	211,000		9.30
May 20	10:30	1.84	8.19	161,000		15.30
May 20	11:50	1.12	8.49	98,000		21.15
May 20	15:45	1.62	8.77	142,000		17.80
May 20	17:35	2.13	8.47	187,000		9.75
May 20	19:10	2.24	8.27	196,000		5.25
May 21	08:30	2.41	7.99	210,000		4.53
May 21	09:15	2.37	7.94	206,000		6.60
May 21	10:10	2.20	7.89	191,000		10.76

* Chart Datum

TABLE 3

Discharge Measurements

Saint John River at Evandale, N.B.

1977

Date	Time A.S.T.	Mean Velocity fps	Discharge cfs	Ferry Dock Gauge ft	Oak Point Gauge ft*
April 25	17:00	3.20	223,000**	9.40	12.06
April 25	17:20	3.13	216,000**	9.30	12.09
May 18	17:05	1.80	108,000	6.55	7.99

* Geodetic Survey of Canada Datum

** Moving Boat Measurements

Recommendations

A number of recommendations are made which will improve the quality of data and simplify the field work in any future measurement program.

The metering section at Saint John at present is far from adequate. It served the purpose for the initial series of measurements but an improved section must be found for future data collection. It is suggested that a section line survey be made this summer when weather conditions are good and river stages are low. A good section should be available, referring to Figure 1, between Robertson Point on the north bank and Pleasant Point on the south bank. The section will be considerably deeper, but should offer no difficulties using the two current meter Jet Boat-Tellurometer technique. This reach of the river appears to be free of backflows and less susceptible to roughness due to winds.

Permanent section line pins should be established and referenced to physical features.

Vertical control should be established at the section line and tied to Geodetic Survey of Canada elevation.

Measurements should be made using the Jet Boat-Tellurometer technique using two current meters.

Measurements should again be made next year at rising, peak, and falling stages to determine the tidal effect at various river elevations. Periods of flow direction change should be avoided.

The Evandale metering section should be permanently located with steel pins if future measurements are anticipated. Measurements can be made by the Moving Boat technique at high stage and by the Jet Boat-Tellurometer technique at all stages.

As the Saint John area is subject to high winds throughout the year, which often made dishcarge measurements difficult or impossible to obtain, it is suggested that future measurements be made by New Brunswick W.S.C. personnel who can pick and choose suitable days for measurements. This would save considerable time and expense on future programs.

Conclusions

Two of the three original requirements were met in the 1977 measurement program at Saint John and Evandale. Measurements were obtained at the peak and falling stages on the Saint John River, but the survey party arrived too late to obtain data on the rising stage. Measurements were obtained at various tidal elevations and the results corresponded very well with a rise or fall of the tide. No inflow occurred from April 27 to May 1. The river just decreased and increased in velocity according to the tide. Some inflow was evident during the May 19-21 measurement period. The periods of low or reverse flow were avoided as low velocities and mixed flows could not be accurately recorded.

A suitable measurement technique was established that would provide accurate data in a very short sampling period.

The biggest disappointment of the 1977 program was the time lost to weather on the first series of measurements. Only 3 days were suitable for measurements in a 9-day period. Relocation of the metering section may improve this poor record, but time lost due to winds must be accepted as fact in a location such as Saint John.

We are confident in the results obtained from the 1977 survey. It must be remembered that conditions were far from ideal and no previous discharge measurements had ever been made on the Saint John River between Fredericton and Saint John, with which to compare our results. The data recorded in this report is at the moment only valid for the time of each measurement. That a conclusion can be reached, with the minimal data collected, on river slope relationships or calibration of a mathematical model cannot be guaranteed.

Acknowledgement

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