When the recent soundings were completed in January, 1879, the South Channel had shoaled so much that the buoys had been removed from it and transferred to a more northerly channel that had meanwhile broken out. The direction across the bar was then about east 10 degrees north, with a low-water depth of about 6 feet. The new channel where it crosses the bar is very near the position occupied by the ship-channels of 1853 and 1857, indicated on a comparative chart published by the United States Coast Survey Office in 1857.

The general direction of nearly all these channels as they appear and disappear from time to time is nearly at right angles to the general range of the coast in that vicinity, and seems to suggest that if the river were left to itself it would have its main outlet over the bar on that line or in proximity to it.

SECOND. CURRENT-OBSERVATIONS.

Current-observations were taken at four stations on the present bar channel, marked A, B, C, and D on the chart accompanying this report.

Three stations were located upon the inner slope of the bar crest and one station upon the outer slope.

For the purpose in view it was deemed sufficient to observe surface and bottom velocities only. For the latter a combination of a small surface cork float with a large submerged keg was used attached to a line passing over a log-reel in a boat. When it was feared that the bottom might touch ground another observation was taken with 1 foot less line. The horizontal velocity curves are shown on sheet E.

At station A, 2,550 feet inside of the crest of the bar, in 14 feet depth at mean low-water, the maximum velocities found were 2.6 statute miles per hour at the surface, nearly 2.3 miles 1 foot from bottom, and about 2 miles at bottom.

At station B, 1,350 feet inside of the crest in 7½ feet mean low-water, a little out of the channel the maximum velocities were found to be nearly 3.1 miles at surface, and 2.8 miles at bottom. The range of tide for these two stations was 5.4 feet.

At station C, 550 feet inside the crest in 11 feet low-water soundings, the maximum velocity was about 2.47 miles at surface, 2.15 miles 1 foot from the bottom, and about 1.9 miles at bottom.

These observations were made when the influence of the wind was not considered to be material. For station B the boat had been anchored by mistake near the side of the channel instead of in the center.

The ratio of bottom velocities ($\sqrt{b}$) to surface velocities ($\sqrt{s}$) was, therefore,

$$\text{At station A } \frac{\sqrt{b}}{\sqrt{s}} = 0.769$$

$$\text{At station B } \frac{\sqrt{b}}{\sqrt{s}} = 0.903$$

$$\text{At station C } \frac{\sqrt{b}}{\sqrt{s}} = 0.769$$

$$\text{At station D } \frac{\sqrt{b}}{\sqrt{s}} = 0.714$$

Discarding station B as not being in the channel-way, and from its relative proximity to the shoals possibly subject to disturbing influences, we find the average ratio for the three other stations combined to be

$$\frac{\sqrt{b}}{\sqrt{s}} = 0.757$$

THIRD. THE BORINGS.

In consequence of the roughness of the sea on the bar, producing heavy breakers during a great part of the time that could be devoted to making the borings, the latter were reduced to three in number, one of which was made on the beach of Fort George Island, another in the Old North Channel, near the wreck of a steamboat called the Lizzie Baker, and the third one in the channel existing at the time near the bar.

The borings show that the materials of which the bar is composed, so far as can be judged from the few points selected for testing, are entirely capable of supporting the weight of any structure suitable for securing the object in view.

The results are tabulated on the chart accompanying this report.

FOURTH. GAUGING THE STREAM.

Among the difficulties attending the gauging of a tidal stream there may be named the constantly varying depth and volume of discharge, the change of rise and fall, and of duration of currents from day to day, the necessity of observing several, or rather all, compartments of a profile simultaneously, and of constantly watching for undercurrents in contrary direction. Observations carried on through an entire lunation would not suffice to determine the average discharge, because generally there will be several days lost by bad weather, and in fair weather the time of the tides may not serve. Moreover, if but a single lunation be used for observations, the river, especially if it drains a large area of country, may not be at its normal height. It is quite as likely to be above or below that stage. To obtain something like a true average it appears necessary to carry on the operations during a period of at least 6 or 8 months. Such suitable days as occurred in the months of November and December comprised all the time that could be devoted to gauging the Saint John's River.

It is thought that the river was rather above its normal state during at least part of the time that gauging operations were carried on. They were begun on the last day of October, 1878. During nearly the whole of the month of October, heavy and continuous rain-falls had prevailed in a large portion of country drained by Saint John's River. The upper sections were flooded. The river is generally quite sluggish, and it is known that ordinary freshets do not raise its surface more than a few feet at most. This is owing partly to its great widths, especially from Pilatka downward, but also in a greater degree to the topographical features of the country. The water furnished by a series of heavy rainstorms is in the first place, to a very large extent, collected in the innumerable depressions of the ground, such as ponds, lakes, and swamps, which form the natural storage reservoirs feeding the river and its tributaries, and from which the surplus or overflow is but gradually withdrawn as the water-level of the trunk becomes lowered by discharge and evaporation. From these causes it will take a longer period for the Saint John's River to return to its average condition after a freshet than for a river with a more rapid descent, and having a water-shed characterized by more marked differences of level.

As a consequence of the heavy rain-falls the river was found for some time to be fresh at both high and low water, that is near the surface, and low-water mark rose nearly to the level of common high-water. On two days it was observed that there were no flood currents at all, the water flowing seaward for 18 or 20 hours consecutively. The velocities were then very high, reaching 5 miles per hour at the surface and little less at the bottom.

The line chosen for gauging the river was below Mayport Mills, where the banks of the river are well enough defined and nearly parallel to each other. Two profiles, 100 feet apart, were measured. They are shown on sheet F, from which it will be seen that there is little difference between them as to depth, width, and area. For purposes of calculation, the mean area is taken of both.

The widths of the cross-section are 1,735 feet at mean low-water, and 1,890 feet at high-water.

The range of tide near Mayport averages 4.3 feet. The ebb current begins about 2 hours after the tide has commenced falling, while the flood currents are not felt until about 3 hours after the water has begun to rise. It results from these conditions that there is no ebb discharge during the period of greatest profile area and depths, and also that the mean water-level of the river through the time of actual *ebb currents* is only 1 foot above its low-water mark. These phenomena may, at the time the examination was made, have been in some degree exceptional.

The profile was divided into 8 compartments or divisions, numbered from 1 to 8 across the stream, beginning on the Mayport side. The division next the shore on either side had a width of 180 feet and 175 feet respectively. The other 6 divisions were each 230 feet wide.

The method adopted was to anchor a boat at a station, remaining through an entire tide, and run off the floats from log-reels. Two stations were generally occupied simultaneously. Observations were taken every 5 minutes, with floats adjusted to mid-depth.

In order to establish, if possible, a ratio between mid-depth and mean velocities, a series of experiments was made at station 3.

Two boats were anchored side by side, and velocities were measured at the surface, and at points 4, 8, 12, and 16 feet below the surface, as well as at a point near the bottom. From one boat, velocities were taken for the surface, and for the 4-feet and 8-feet depths; and from the other boat the velocities at the other specified depths were obtained. As these two sets of observations were separate from each other by little more than the width of one boat, they were all regarded as practically belonging to the same vertical section.

With the greatest dispatch, it required 5 minutes to take a full set of observations. Each float was allowed to run 10 seconds for actual measurement of velocity.

The results of two full series of observations, both for ebb-tide, are graphically given on sheets A, B, C, and D.

On sheets A and C the 10-second velocities are represented by horizontal curves. They are plotted to correspond precisely to the time when each individual observation was taken, and the points thus fixed are connected by curves. From these horizontal curves the vertical curves were constructed, represented on sheets B and D; sheet A being the basis of construction for sheet B, and C for D.

These vertical curves are plotted for every 5 minntes, giving the velocities during 10 seconds for every 4 feet of depth from surface to bottom, and also the actual depth of water for each curve. A short line, drawn at half depth, intersects each vertical curve, thus determining the mid-depth velocity.

An inspection of the horizontal curve, sheets A and C, shows great fluctuations of velocity. Not only at the surface, but also at the various

depths, velocities change from fast to slow and the reverse at very short intervals of time. The vertical curves of sheets B and D show in but a few instances an approach to a parabolic form. As a general rule they are simply irregular, and it would seem to be a hopeless task to attempt to discover any law from these results. The causes for these irregularities are not known. Perhaps the flow of water higher up is impeded momentarily, but frequently by bends, shoals, and other obstructions aggravated by the incessant change of depth, causing a temporary slacking of speed farther below, to be followed by an increase of velocity when the water has overcome the resistance. It is possible that experiments made upon an extensive scale, as already suggested, would throw some much needed light upon this subject.

The vertical curves of sheet B are 72 in number and represent as many sets of float observations taken every five minutes. The time was from 11 a. m. to 4.55 p. m. The curves of sheet D represent 54 sets of observations, made from 1 p. m. to 5.25 p. m. In neither case was the whole tide observed, but only that portion of it when the currents were well marked.

In the majority of observations—7 out of every 10—the maximum velocity was found at the surface.

The average mid-depth velocities in each series of observations exceeded the mean velocity. For every curve the mean velocity was determined by adding together the velocities actually observed at different depths, from surface to bottom, and dividing the sum by the number of observations.

To obtain a proportion between mean and mid-depth velocity we find, first, the discharge at mean velocity, taking into account the varying depths. We then find the discharge on the assumption that the water passed through the same areas with the mid-depth velocity. Dividing one amount by the other a ratio is found between mean and mid-depth velocity.

It was thought interesting to find also the relations between the velocities at surface, bottom, and mid-depth, as well as mean velocities. They are given in the following table:

	Proportion of velocities.				Proportion of discharge.	
	Surface.	Bottom.	Half depth.	Mean.	Mean.	Half depth.
From sheets A and B	100	72.4	88.6	86.9	99	100
From sheets C and D	100	60.8	86.6	84.3	97.4	100
Grand average	100	68	87.8	85.9	98.48	100

The currents were always found to be in the same direction from top to bottom. On page 311 of Generals Humphreys' and Abbot's report on the Physics and Hydraulics of the Mississippi River, edition 1876, a table is produced showing, with other data, the proportion $\frac{\sqrt{m}}{\sqrt{\frac{1}{2}D}}$ of mean to mid-depth velocity for certain portions of the Mississippi River, for some canal-feeders, and for the Rhine. It has been found that for the—

Mean of 7 observations on the Mississippi . . . . . . $\frac{\sqrt{m}}{\sqrt{\frac{1}{2}}D} = .9819$

Mean of 3 observations on canals or feeders . . . . . $\frac{\sqrt{m}}{\sqrt{\frac{1}{2}}D} = .9600$

Mean of 5 observations on the Rhine . . . . $\frac{\sqrt{m}}{\sqrt{\frac{1}{2}}D} = .9396$

Mean of all observations (15 in number) . . . . $\frac{\sqrt{m}}{\sqrt{\frac{1}{2}}D} = .9626$

Mean of observations mouth of Saint John's River as above $\frac{\sqrt{m}}{\sqrt{\frac{1}{2}}D} = .9848$

It appears that the results obtained at the mouth of Saint John's River, at the lower end of its tidal compartment, nearly coincide with those found in fresh-water currents, as to the average ratio of mean to mid-depth velocity.

During two hours, from 11.45 a. m. to 1.45 p. m., when the currents were strongest (see sheets A and B), ranging from 3.4 to 4.4 statute miles per hour, the bottom velocity averaged 77.3 per centum, and the mid-depth velocity 86.1 per centum of the surface velocity.

DISCHARGE.

To estimate the volume of discharge of the river at Mayport, the eight stations previously described were occupied in succession. With the means on hand it was not possible to make simultaneous observations at more than two stations at a time. Each station was occupied three times for full ebb tide, and once for flood tide. At every station mid-depth observations only were observed, being taken every 5 minutes.

On sheet G the horizontal curves of velocity at every station are represented for ebb tides, and on sheet H the same for flood tides.

From these sheets the volumes of discharge were computed for 1 square foot of each compartment during the whole period of ebb currents, supposing the water to have been flowing with the velocities observed at mid-depth. These volumes, in cubic feet, for every station or compartment, are given on the sheet of ebb curves, together with other data relating to particulars of the tide and currents.

For convenience in examining these data, they are reproduced in the following table (I). The last column, however, shows the supposed *mean* volumes found by multiplying the mid-depth discharge by 0.9848.

TABLE I.

Table showing mid-depth velocities, discharges, and other data observed at different stations of a cross-section of Saint John's River, near Mayport, Florida.

EBB TIDES.

Station.	Date of observation.	Range of tide.	Tide fell. Before current set down.	Tide fell. After current set down.	Tide rose before current ceased.	Level of high-water referred to mean high-water.	Level of low-water referred to mean low-water.	Duration of ebb current.	Number of cubic feet discharged per square foot of area during tide: At ½-depth velocity.	Number of cubic feet discharged per square foot of area during tide: Mean velocity.
		Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	h. m.		
1	Nov. 8, 1878	5.2	2.0	3.2	2.2	+1.2	+0.3	7 50	60,912	59,986
	Nov. 26, 1878	5.7	1.9	3.8	2.2	+1.0	−0.4	7 15	58,307	57,420
	Dec. 11, 1878	4.8	1.3	3.5	2.3	−0.4	−0.9	7 25	51,237	50,458
2	Nov. 8, 1878	5.2	1.8	3.4	2.4	+1.2	+0.3	8 10	75,705	74,554
	Nov. 26, 1878	5.7	1.9	3.8	2.4	+1.0	−0.4	7 25	75,587	74,438
	Dec. 7, 1878	4.1	1.1	3.0	1.7	−0.6	−0.4	7 30	59,535	58,630
3	Nov. 7, 1878	4.6	1.6	3.0	2.4	+0.9	+0.5	8 20	89,820	88,455
	Nov. 25, 1878	5.9	1.8	4.1	2.5	+1.1	+0.5	7 40	88,402	87,058
	Dec. 7, 1878	4.1	1.2	2.9	1.8	−0.6	−0.4	7 30	69,984	68,920
4	Nov. 7, 1878	4.6	1.6	3.0	2.4	+0.9	+0.5	8 20	79,590	78,380
	Nov. 25, 1878	5.9	1.8	4.1	2.5	+1.1	−0.5	7 40	80,592	79,360
	Dec. 8, 1878	4.5	1.9	2.6	1.7	+0.2	Mean.	6 45	60,556	59,636
5	Nov. 6, 1878	4.6	1.6	3.0	1.9	+1.1	+0.8	7 45	74,716	73,580
	Nov. 24, 1878	6.0	1.8	4.2	2.4	+1.1	−0.6	7 25	70,995	69,916
	Dec. 8, 1878	4.5	1.9	2.6	1.7	+0.2	Mean.	6 45	64,395	63,416
6	Nov. 6, 1878	4.6	1.6	3.0	1.7	+1.1	+0.8	7 30	61,479	60,544
	Nov. 24, 1878	6.0	1.9	4.1	1.7	+1.1	−0.6	6 55	61,428	60,494
	Dec. 11, 1878	4.8	1.5	3.3	2.0	−0.4	−0.9	6 55	49,600	48,846
7	Nov. 5, 1878	4.0	1.4	2.6	1.7	+0.7	+1.0	7 20	52,325	51,530
	Nov. 23, 1878	5.5	1.5	4.0	2.6	+0.4	−0.8	7 40	70,877	69,800
	Dec. 12, 1878	5.0	1.5	3.5	1.6	−0.2	−0.9	6 45	39,195	38,599
8	Nov. 5, 1878	4.0	1.4	2.6	1.3	+0.7	+1.0	6 50	22,140	21,803
	Nov. 23, 1878	5.5	1.5	4.0	2.6	+0.4	−0.8	7 40	63,783	62,813
	Dec. 12, 1878	5.0	1.4	3.6	0.9	−0.2	−0.9	6 15	28,777	28,340

This table plainly shows the impossibility of obtaining accurate information as to the discharge of a tidal stream, when only a limited number of observations at the several compartments of its cross-section can be taken, and when, moreover, those observations are not all simultaneous. The range of tide varies from 4 feet to 6 feet, whereas the mean rise and fall at Mayport is about 4.3 feet, and in but two instances was low-water at its mean level. The highest ranges of tide were by no means found associated generally with a lengthened duration of ebb currents, as shown by the data of stations 1 to 6, inclusive, while at stations 7 and 8 the largest range was accompanied by the longest duration of currents. This shows the obstacles in the way of formulating a mathematical expression for discharge, containing range of tide and duration of currents as members or coefficients. The difficulty is increased by the fact that currents would sometimes cease from 10 to 20 minutes earlier at one station than at another observed simultaneously.

In a fresh-water stream of normal condition, with a cross-section divided into compartments of equal widths, the greatest volume of discharge will be found in the divisions having the greatest hydraulic radius. When the volumes of discharge are graphically represented for each division in the form of a curve, the figure will much resemble the outline of the river profile itself, the portions of greatest depths of the profile corresponding to the portions of greatest discharge on the curve-diagram. This was not found to be the case at Saint John's River.

Divisions 3 and 7 have each a width of 230 feet, but the mean area of No. 3 is much less than that of No. 7, its hydraulic radius being less than 20 feet, while that of No. 7 is about 27 feet. Yet the table shows that much more water was discharged through the smaller area than through the larger one.

In order to render the data furnished available to determine the discharge of the river, Mr. Daubeney has proposed a method "of taking proportions between stations occupied the same day in one case, and taking proportions between the totals at each station in the other, and applying them to the discharge at such station whose range of tide is nearest the average, and whose high and low waters are nearest the mean."

As a result of treating the question in this manner, he finds that if the volume passing through division 3 is considered as unity, the volume passing through the various compartments are proportioned as follows:

TABLE II.

Compartment No. 1.	56,819 cubic feet per square foot per tide ratio	0.687
No. 2.	70,276 cubic feet per square foot per tide ratio	0.849
No. 3.	82,735 cubic feet per square foot per tide ratio	1.000
No. 4.	73,579 cubic feet per square foot per tide ratio	0.889
No. 5.	70,035 cubic feet per square foot per tide ratio	0.846
No. 6.	57,502 cubic feet per square foot per tide ratio	0.695
No. 7.	54,132 cubic feet per square foot per tide ratio	0.653
No. 8.	38,233 cubic feet per square foot per tide ratio	0.462

The method described below, suggested by Assistant Engineer John L. Suess, was adopted for obtaining an approximate estimate of the total discharge.

From Table I the volume discharged through 1 square foot of each division per minute can be found by dividing the whole mean volume discharged through 1 square foot by the whole number of minutes of actual currents. It is found that at the first compartment, with a rise and fall of 5.2 feet, the discharge per square foot per minute is 127.63 cubic feet; with a range of 5.7 feet the discharge is 132 cubic feet, and with a range of 4.8 feet the discharge is 113.39 cubic feet. One minute's discharge divided by the range of tide in feet will give a certain quotient, and these several quotients may point out some kind of relation between isochronal discharge and range.

TABLE III.

EBB TIDE.

Number of division.	Date of observation.	Range of tide.	Discharge per square foot of area per minute.	Ratio discharge divided by range.	Mean area of division.	Mean hydraulic radius.
		Feet.	*Cubic feet.*		*Sq. feet.*	*Feet.*
1	Nov. 8	5.2	127.63	24.544		
	Nov. 26	5.7	132.00	23.158	2,755	15.0793
	Dec. 11	4.8	113.39	23.623		
2	Nov. 8	5.2	152.15	29.259		
	Nov. 26	5.7	167.28	29.347	4,920	21.0752
	Dec. 7	4.1	130.29	31.778		
3	Nov. 7	4.6	176.91	38.459		
	Nov. 25	5.9	189.25	30.381	4,570	19.5759
	Dec. 7	4.1	153.16	37.356		
4	Nov. 7	4.6	156.76	34.078		
	Nov. 25	5.9	172.52	29.241	4,360	18.6764
	Dec. 8	4.5	147.25	32.722		
5	Nov. 6	4.6	158.24	34.400		
	Nov. 24	6.0	157.11	26.185	4,580	19.6187
	Dec. 8	4.5	156.58	34.796		

TABLE III—Continued.

Number of division.	Date of observation.	Range of tide.	Discharge per square foot of area per minute.	Ratio discharge divided by range.	Mean area of division.	Mean hydraulic radius.
		Feet.	*Cubic feet.*		*Sq. feet.*	
6	Nov. 6	4.6	134.54	29.248		
	Nov. 24	6.0	145.77	24.296	5,180	22.1889
	Dec. 11	4.8	117.70	24.521		
7	Nov. 5	4.0	117.12	29.280		
	Nov. 23	5.5	151.74	27.589	6,280	26,9000
	Dec. 12	5.0	95.31	19.062		
8	Nov. 5	4.0	53.18	13.295		
	Nov. 23	5.5	136.55	24.827	2,290	12.5561
	Dec. 12	5.0	75.57	15.114		

This table discloses several peculiarities.

The ratio of discharge per square foot per minute to the range of tide is generally not much different for the two lowest ranges out of the three at one station, except Nos. 6 and 7.

At the stations from Nos. 1 to 6, both inclusive, the ratio is less with the highest range than with the lower range. At Nos. 7 and 8 the reverse is the case.

The ratio does not appear to be influenced by the mean hydraulic radius, as far as the table shows. At the third division a much larger ratio is found, with a radius of 19.57 feet, than at division No. 7, with a radius of 26.9 feet.

The table shows that in order to find the whole discharge of the river each compartment must be treated according to the data relating to it alone, without reference to any other division.

The first question is to find for each compartment the ratio proper to a mean rise and fall of 4.3 feet, as existing at Mayport.

It was deemed sufficient to find arithmetically for each compartment the ratio to be ascribed to a mean range of 4.3 feet, from the ratios of the two lowest ranges.

The ratios established, the number of cubic feet of water discharged in 1 minute per square foot of area is found by multiplying that ratio with the mean range. The mean duration of ebb-currents during a normal tide has been reported to be 6 hours and 45 minutes, so that the whole volume discharged near Mayport during an average ebb-tide may be found. Table IV gives the results of these computations.

TABLE IV.

Showing volumes of water discharged by Saint John's River, near Mayport Mills, during a normal ebb-current flow of 6 hours 45 minutes, and a mean range of 4.3 feet.

Number of compartment.	Coefficient to be multiplied with 4.3 to find discharge per minute and per foot.	Mean area in square feet.	Discharge in cubic feet.		
			Per square foot and per minute.	Per square foot during period of ebb flow.	Through area during period of ebb-flow.
1	22.886	2,755	98.40	39,852	109,792,250
2	31.320	4,920	134.67	54,541	268,341,740
3	37.797	4,570	162.53	65,825	300,820,280
4	30.010	4,360	129.04	52,261	227,805,470
5	35.588	4,580	153.03	61,977	283,861,260
6	36.388	5,180	156.25	63,281	327,795,600
7	26.216	6,280	112.73	45,656	286,711,970
8	13.841	2,290	59.52	24,106	55,202,750
		34,935	Mean discharge through profile in average ebb tide.		1,860,331,320

FLOOD TIDE.

It has been already stated that each station of the Mayport profile was occupied once for observing mid-depth velocities every 5 minutes from beginning to end of currents. In every case two stations were occupied simultaneously.

It was found as already estimated that on the average more than half of the time from low to high water elapsed before the up-river current commenced; that these currents continued during high-water stand, which lasted from 40 minutes to about 1 hour, and that they only ceased after the water had been falling for $1\frac{1}{4}$ to 2 hours. In consequence the profile was nearly full of water during all the time that the actual flood-currents lasted, the mean height above low-water level being full 88 per centum of the whole range.

The following table exhibits the more important data of observations. The last column gives the estimated number of cubic feet discharged through 1 square foot of each division during flood-tide deduced from the mid-depth discharges.

TABLE V.

Showing mid-depth velocities, discharges, and other data observed at different stations of a cross-section of Saint John's River, near Mayport, Florida.

FLOOD TIDE.

Station.	Date of observation.	Range of tide.	Tide rose. Before current set up.	Tide rose. After current set up.	Tide fell before current ceased.	Levels of low-water referred to mean low-water.	Levels of high-water referred to mean high-water.	Duration of flood current.	Number of cubic feet discharged per square foot of area during tide. At $\frac{1}{2}$-depth, velocity.	Number of cubic feet discharged per square foot of area during tide. Mean velocity.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*		
1	Nov. 4, 1878	3.5	2.1	1.4	0.6	+0.7	−0.1	4 25	10,557	10,396
2	Nov. 4, 1878	3.5	2.1	1.4	0.7	+0.7	−0.1	4 30	18,089	17,814
3	Nov. 2, 1878	3.6	2.2	1.4	1.0	+1.0	+0.3	4 45	27,360	26,944
4	Nov. 2, 1878	3.6	2.2	1.4	1.0	+1.0	+0.3	4 45	30,267	29,807
5	Nov. 1, 1878	3.8	1.9	1.9	1.0	+1.1	+0.6	4 55	35,400	34,862
6	Nov. 1, 1878	3.8	1.9	1.9	1.1	+1.1	+0.6	5 00	33,228	32,723
7	Oct. 31, 1878	4.2	2.7	1.5	1.0	+0.7	+0.6	4 30	21,514	21,197
8	Oct. 31, 1878	4.2	2.7	1.5	0.9	+0.7	+0.6	4 10	16,905	16,648

It is seen that while these observations were made, low-water level never fell down to the mean level, but was from .7 to 1.1 foot above it. On one day only the level of high-water was slightly below the average, on the other three days it was higher. No wind prevailed on these days that might have exerted any sensible influence on the flow, and the fact of the observed levels of low-water being above the average level may be naturally ascribed to the increased discharge of fresh water caused by the preceding freshets.

To estimate the mean volume entering the river at Mayport during flood a similar method was adopted as applied for ebb-tide discharge. A certain ratio was found by dividing the discharge (or inflow) at each division per square foot of area during 1 minute by the observed range. The following table gives the data:

TABLE VI.

FLOOD TIDE.

Number of division.	Date of observation.	Range of tide.	Discharge per square foot of area per minute.	Ratio of discharge divided by range.	Mean area of division.	Mean hydraulic radius.
		Feet.	*Cub. feet.*		*Sq. feet.*	*Feet.*
1	Nov. 4	3.5	22.36	6.39	3,446	12.37
2	Nov. 4	3.5	65.98	18.85	5,575	23.92
3	Nov. 2	3.6	94.54	26.26	5,303	22.76
4	Nov. 2	3.6	104.59	29.05	5,093	21.86
5	Nov. 1	3.8	118.18	31.10	5,852	22.97
6	Nov. 1	3.8	109.08	28.70	5,952	25.55
7	Oct. 31	4.2	78.50	18.70	7,082	30.39
8	Oct. 31	4.2	66.60	15.74	3,119	11.38

From these ratios the number of cubic feet of water discharged per minute and per square foot of area during a normal flood-tide is found by multiplying the ratio of each compartment (or division) by 4.3 the mean range. The average duration of flood-currents is believed to be 5 hours.

Table VII gives the results of this mode of computing the total volume of water received during flood-tide.

TABLE VII.

Showing volumes of water entering Saint John's River near Mayport Mills during a flood tide of 5 hours' duration of currents and a mean rise and fall of 4.3 feet.

FLOOD TIDE.

Number of compartment.	Coefficient to be multiplied with 4.3 to find discharge per minute and per square foot.	Mean area in square feet.	Discharge in cubic feet. Per square foot and per minute.	Discharge in cubic feet. Per square foot during period of flood currents.	Discharge in cubic feet. Through area during period of flood currents.
1	6.39	3,435	27.48	8,244	28,318,140
2	18.85	5,564	81.05	24,315	135,288,660
3	26.26	5,214	112.92	33,876	176,629,464
4	29.05	5.004	124.92	37,476	188,529,906
5	31.10	5,224	133.73	40,119	209,581,656
6	28.70	5,824	123.41	37,023	215,621,952
7	18.70	6,924	80.41	24,123	167,027,652
8	15.74	2,965	67.68	20,300	60,201,360
Total					1,181,198,790

The average ebb discharge near Mayport Mills was found to be about 1,860,331,320 cubic feet, while the volume entering the river during flood is estimated at 1,181,198,790 cubic feet. The difference between these amounts, equal to 679,132,530 cubic feet, would represent the quantity of land water carried through the Mayport profile during an average ebb tide.

To find whether such a supply of fresh water is within reasonable