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TIDES AND CURRENTS IN LONG ISLAND AND BLOCK ISLAND SOUNDS

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PREFACE

This volume constitutes the eighth of a series on tides and currents in important waterways of the United States.

The growth of commerce, as well as engineering and scientific work during recent years, has created an urgent and constantly growing demand from navigators, engineers, scientists, and the public generally for complete and up-to-date tide and current information of the important waterways of the United States. To meet this demand and to complete and coordinate various tide and current data now on file in the archives of the Coast and Geodetic Survey, this bureau started in 1922 a series of comprehensive tide and current surveys of important waterways. To date the surveys of several of the more important harbors of the country have been completed and the work is progressing as rapidly as available funds permit.

In order to preserve the results of these surveys, combine and compare them with earlier records, and make the results available to all concerned, and at the same time guard against the possible loss or destruction of valuable information by fire or other causes, a special publication for each area has been printed and distributed as soon after the completion of the survey as possible.

The material presented in this volume is based on observations made at various times in Long Island and Block Island Sounds and their tributaries from 1835 to date. The current data are largely from comprehensive surveys made during the summers of 1929 and 1930 in Long Island and Block Island Sounds, respectively. In addition to the tide observations made by this bureau, observations made by the Corps of Engineers, United States Army, have been included. In this connection the cooperation of the officials in charge of the United States Engineer offices at New York, N. Y., and Providence, R. I., in furnishing valuable tidal data is greatly appreciated by this bureau. Other governmental agencies which have cooperated with this survey in obtaining valuable tide and current data in Long Island Sound are the Bureaus of Fisheries and Lighthouses of the Department of Commerce and the Civil Engineer Corps, United States Navy.

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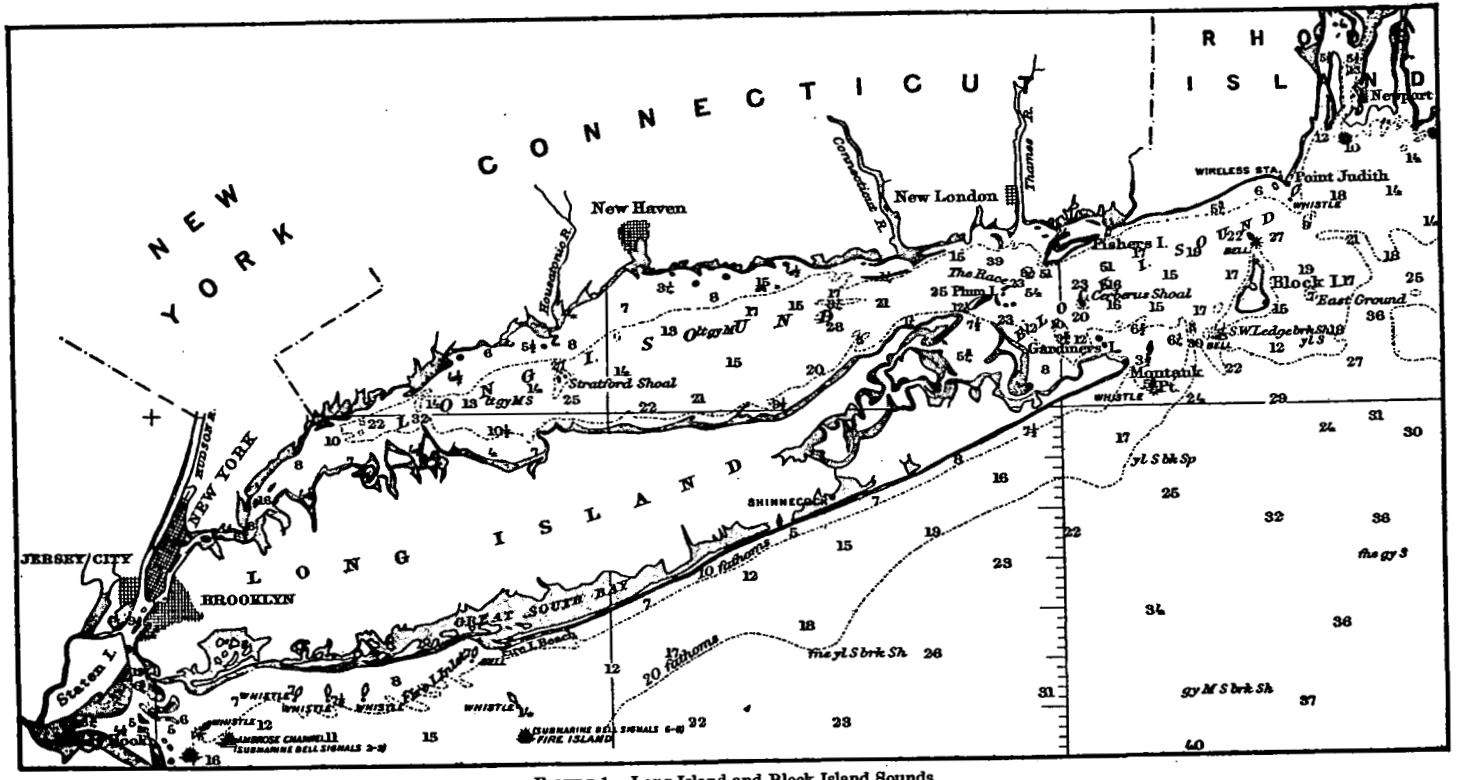

FIGURE 1.—Long Island and Block Island Sounds

TIDES AND CURRENTS IN LONG ISLAND AND BLOCK ISLAND SOUNDS

INTRODUCTION

It is not the purpose of this publication to deal with any involved or mathematical theory of tides or tidal currents, but rather to collect, tabulate, and discuss the data from many years of tide and current observations in Long Island and Block Island Sounds and their tributaries. It is desired to present these results in such form as will be of the most value and interest to scientific and professional organizations as well as the general public. Only such mathematical formulas and discussions will be introduced as are necessary to explain or clarify the tables and diagrams presented.

The earliest tide observations on record in Long Island Sound were made in 1835 and in Block Island Sound in 1839. During the years 1835–1839 tides were observed at a number of stations throughout Long Island Sound and vicinity by field parties directed by G. S. Blake and J. R. Goldsborough. These were short series of observations covering periods of several days to several months in length and were generally obtained in connection with other hydrographic work, especially for use in the reduction of soundings to a uniform datum.

With the exception of a 16-month series of observations made at Fort Trumbull, New London, Conn., from July 31, 1882, to November 20, 1883, and a 17-month series of observations made at Block Island Harbor, Block Island, from July 27, 1882, to December 31, 1883, all series of tide observations made by the Coast and Geodetic Survey in Long Island and Block Island Sounds have generally been for short periods of five months or less. As far as possible the results from these short series have been corrected by comparison with simultaneous observations at some primary tide station.

The principal series of current observations in Long Island Sound and its tributaries were those in charge of the following parties: G. S. Blake, in 1845; J. R. Goldsborough, in 1846, 1847, and 1848; H. Mitchell in 1858 and 1871; W. J. Sears and F. H. Crosby, in 1886; C. P. Perkins, in 1887; E. E. Haskell, in 1890; F. S. Borden, in 1916; P. M. Trueblood, in 1917; and H. E. Finnegan, in 1929.

The principal series of current observations in Block Island Sound and its tributaries were those in charge of the following parties: J. R. Goldsborough, in 1846; F. B. T. Siems, in 1918 and 1919; H. E. Finnegan, in 1929; and J. C. Sammons, in 1930.

Through a cooperative arrangement with the Bureau of Lighthouses, Department of Commerce, hourly current observations were obtained on board three lightships in Long Island and Fishers Island Sounds as follows: Ram Island Reef, in 1913 and 1915; Bartlett Reef, in 1913 and in 1929–30; and Cornfield Point, in 1913, 1922, and in 1929–30. Through a similar cooperative agreement with this bureau slack-water observations at buoy stations in Watch Hill Passage, The Race, and Plum Gut were obtained in 1915 through the efforts of lighthouse keepers in these localities.

Attention is directed to the tide and current tables which are published in advance annually by the Coast and Geodetic Survey. These tables contain data based upon the latest information available at the time of publication. They include the predicted tides and currents for every day in the year at a number of principal ports and also contain summaries of the principal tidal and current elements for several thousand places throughout the world. Included among the ports for which daily predictions for tides are given are New London, Conn., and Willets Point, N. Y., while daily predictions for currents are given for The Race at the eastern entrance to Long Island Sound.

Part I.—LONG ISLAND SOUND

GENERAL CHARACTERISTICS OF LONG ISLAND SOUND AND ITS TRIBUTARIES

Long Island Sound is that deep, navigable waterway situated between the shores of Connecticut and New York and the northern coast of Long Island. As defined in this publication, Long Island Sound also includes Fishers Island Sound which is located between the Connecticut shore and Fishers Island. Geographically, Fishers Island Sound may be considered as the eastern extremity of Long Island Sound. In this publication, therefore, Long Island Sound is defined as that inland waterway extending from Watch Hill Point, R. I., to Throgs Neck, N. Y., or from the eastern entrance to Fishers Island Sound to the eastern entrance to the East River.

Considering the axis of Long Island Sound as a line joining Watch Hill Light, Latimer Reef Light, North Dumpling Light, Bartlett Reef Lightship, Cornfield Point Lightship, Stratford Shoal Light, Execution Rocks Light, and Throgs Neck Light, it will be noted that Long Island Sound has a length of approximately 95 nautical miles. In breadth it varies from a few miles to a maximum of approximately 20 nautical miles off New Haven, Conn.

For purposes of this publication, Long Island Sound is divided into eastern and western portions by means of a line connecting Stratford Point, Conn., Stratford Shoal Light, and Old Field Point, Long Island. Along this line of demarcation, Long Island Sound is approximately 10½ nautical miles in width.

In addition to Fishers Island Sound, the chief tributaries of Eastern Long Island Sound are the Thames, Connecticut, and Housatonic Rivers. Among tributaries of lesser importance there might be included Little Narragansett Bay, Pawcatuck and Mystic Rivers, and Niantic Bay and River. Among the more important harbors are those of New London, Conn., New Haven, Conn., and Port Jefferson, Long Island.

The principal tributaries of Western Long Island Sound include the Poquonock, Saugatuck, and Norwalk Rivers along the Connecticut shore, and Smithtown, Huntington, Northport, Oyster, Hempstead, Manhasset and Little Neck Bays along the northern shore of Long Island. Located between these various bays, each of which extend three or four miles in a northerly and southerly direction, are necks of land which project out into Western Long Island Sound. Obviously, these bays are tidal waterways of considerable commercial importance.

Among the more important harbors of Western Long Island Sound are those of Bridgeport, Norwalk, and Stamford, Conn., Port Chester,

Mamaroneck, and New Rochelle, N. Y., and Port Washington, Oyster Bay, and Northport, Long Island.

Long Island Sound has an eastern entrance from Block Island Sound through The Race and a western entrance from the East River at Throgs Neck. Through these entrances the ocean tide reaches the inland waters of the sound. In addition to The Race, there are secondary eastern entrances to Long Island Sound at Plum Gut, located between Long and Plum Islands, and also in the area between Fishers Island and Watch Hill Point, R. I. The Race is generally considered as that stretch of water between Race Point, Fishers Island, and Little Gull Island. Therefore, the water stretches between Little Gull and Great Gull Islands and between Great Gull and Plum Islands may also be considered as secondary eastern entrances to Long Island Sound.

THE TIDE AT NEW LONDON, CONN.

INTRODUCTORY

Of the tidal observations made by the Coast and Geodetic Survey in Long Island Sound and its tributaries, those at New London, Conn., constitute the principal series. These cover periods of approximately 16 months in 1882–83 at Fort Trumbull Wharf, five months at Lighthouse Wharf in 1917, and shorter periods of observations at various other localities in the vicinity of the city proper.

Through the cooperation of the Corps of Engineers, United States Army, and the Civil Engineer Corps, Navy Department, the Coast and Geodetic Survey has been furnished the results of long-period observations at Shaws Cove and naval station, respectively, the former covering from May, 1913, to August, 1918, and the latter from May, 1899, to June, 1900. The series at naval station is continuous, while that at Shaws Cove is likewise continuous with the exception of a few short interruptions. The results of these observations will be found in Table 52 on page 63, accompanying a discussion of the tide in the Thames River.

The earliest tidal observations on record for New London and vicinity were those obtained in 1839 near New London Harbor Light in connection with a hydrographic survey of the lower portion of the Thames River. Further observations were obtained in 1847, 1869, 1874, 1882–83, 1890, 1899–1900, 1904, 1907, 1917, 1918, 1923, and 1929. Generally, these are short-period observations of a lunar period or less and were obtained in connection with hydrographic surveys of New London Harbor. The results from these observations will also be found in the above-mentioned table on p. 63.

The series of tidal observations at Fort Trumbull Wharf covers the period from July 31, 1882, to November 20, 1883. From the beginning of the series until October 11, 1882, observations were made on a plain staff gage. From that date, however, the observations were obtained by means of a Saxton self-registering tide gage. The tide records furnished by the Corps of Engineers, United States Navy, were obtained at the naval station by means of a Bilgram automatic tide gage.

The series furnished by the Corps of Engineers, United States Army, was obtained from observations made at Shaws Cove by means of a Bristol automatic tide gage. The Bristol gage is actuated by

the compression of a soft rubber box which is placed about four feet below low water and is connected to the recording part by an armored hose. The record is produced on a disc some 12 inches in diameter. The rise of tide compressing the rubber box causes an increase of pressure which moves a pen across the disc. The circumference of the disc is divided into hour spaces which are ruled radially while the scale of feet is marked by small circles which intersect these radii. The height of the tide can be scaled off to the nearest tenth of a foot, the time of high water to the nearest 5 or 10 minutes and of low water to the nearest 15 minutes. The clock is set correct when the record is put on the instrument and the staff reading is noted. The clock correction is noted when the record is removed.

The 1917 series of tidal observations at Lighthouse Wharf was obtained by means of a standard Coast and Geodetic Survey automatic tide gage. This gage traces a curve which represents to appropriate scale the rise and fall of the tide, the abscissae indicating the time and the ordinates the height of the tide. The essential parts of the instrument consist of a clock that moves a roll of paper forward on a drum at a uniform rate and a float that is free to rise and fall in a float well with the rise and fall of the tide on the outside, the float well having an opening of sufficient size for the free access of the water but small enough to dampen somewhat wave action due to wind waves. The float is connected by means of a phosphor-bronze wire and a worm screw to a pencil that moves perpendicularly to the motion of the paper and proportional to the rise and fall of the tide. The combined motion of the paper and the pencil produces a curve or marigram from which the height of the tide for any desired time can be read by means of a scale. The heights on the paper record are connected with a fixed zero by readings made on a fixed staff, these comparative readings being made several times weekly.

TIME RELATIONS

The lunitidal intervals at New London, or the intervals by which high and low water follow the moon's meridian passage, vary somewhat from day to day. This variation is due principally to the variation in the positions of the sun and moon relative to the earth; but changes in wind and weather also cause variations in the lunitidal intervals.

The change in lunitidal intervals from day to day throughout the month of July, 1917, is shown in columns 5 and 6 of Table 1.

TABLE 1.—*Daily high and low waters, New London (lighthouse wharf), Conn., July, 1917*

Date	Moon's transit meridian of Greenwich	Time of— High water	Time of— Low water	Lunitidal interval High water	Lunitidal interval Low water	Duration of— Rise	Duration of— Fall	Height of— High water	Height of— Low water	Range— Rise	Range— Fall
	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*	*Feet*
1	(8.7)	6.5	0.5	10.3	4.3	6.0	7.0	5.8	4.0	1.8	2.9
	21.1	18.5	12.0	(9.8)	(3.3)	6.5	5.5	6.8	4.2	2.6	1.6
2	(9.6)	7.0	1.4	9.9	4.3	5.6	6.9	6.0	3.8	2.2	3.0
	22.1	19.5	13.0	(9.9)	(3.4)	6.5	6.0	7.0	4.3	2.7	1.7
3	(10.6)	8.0	1.8	9.9	3.7	6.2	6.3	6.3	3.7	2.6	3.3
	23.1	20.0	13.9	(9.4)	(3.3)	6.1	5.9	7.1	4.2	2.9	2.1
4	(11.7)	8.5	2.9	9.4	3.8	5.6	6.9	6.4	3.6	2.8	3.5
	-------	21.0	15.0	(9.3)	(3.3)	6.0	6.5	7.2	4.1	3.1	2.3
5	0.2	9.2	3.8	9.0	3.6	5.4	6.8	6.3	3.4	2.9	3.8
	(12.7)	21.7	15.8	(9.0)	(3.1)	5.9	6.6	7.1	3.9	3.2	2.4
6	1.2	10.0	4.5	8.8	3.3	5.5	6.8	6.4	3.3	3.1	3.8
	(13.7)	22.5	16.7	(8.8)	(3.0)	5.8	6.7	7.0	3.7	3.3	2.7
7	2.1	11.0	5.3	8.9	3.2	5.7	6.8	6.6	3.2	3.4	3.8
	(14.6)	23.5	17.6	(8.9)	(3.0)	5.9	6.6	6.9	3.7	3.2	2.9
8	3.0	12.0	6.0	9.0	3.0	6.0	6.5	6.9	3.4	3.5	3.5
	(15.4)	-------	18.6	-------	(3.2)	-------	6.6	-------	4.0	-------	2.9
9	3.9	0.3	7.0	(8.9)	3.1	5.7	6.7	7.0	4.0	3.0	3.0
	(16.3)	13.0	19.8	9.1	(3.5)	6.0	6.8	7.3	4.3	3.3	3.0
10	4.7	1.2	7.8	(8.9)	3.1	5.4	6.6	7.0	4.2	2.7	2.8
	(17.1)	13.9	20.8	9.2	(3.7)	6.1	6.9	7.4	4.5	3.2	2.9
11	5.5	2.2	9.0	(9.1)	3.5	5.4	6.8	6.8	4.4	2.3	2.4
	(17.9)	14.8	21.8	9.3	(3.9)	5.8	7.0	7.6	4.5	3.2	3.1
12	6.4	3.0	9.7	(9.1)	3.3	5.2	6.7	6.5	4.5	2.0	2.0
	(18.8)	15.8	22.8	9.4	(4.0)	6.1	7.0	7.2	4.3	2.7	2.9
13	7.2	4.5	10.8	(9.7)	3.6	5.7	6.3	6.3	4.4	2.0	1.9
	(19.7)	17.0	-------	9.8	-------	6.2	-------	7.0	-------	2.6	-------
14	8.1	5.3	0.0	(9.6)	(4.3)	5.3	7.0	6.0	4.2	1.8	2.8
	(20.5)	18.0	11.9	9.9	3.8	6.1	6.6	6.8	4.4	2.4	1.6
15	9.0	6.5	0.8	(10.0)	(4.3)	5.7	6.8	6.0	3.9	2.1	2.9
	(21.4)	19.0	13.1	10.0	4.1	5.9	6.6	6.8	4.4	2.4	1.6
16	9.9	7.3	1.8	(9.9)	(4.4)	5.5	6.8	6.1	4.0	2.1	2.8
	(22.3)	19.7	13.5	9.8	3.6	6.2	6.2	6.7	4.4	2.3	1.7
17	10.8	8.3	2.1	(10.0)	(3.8)	6.2	6.4	6.2	3.9	2.3	2.8
	(23.2)	20.5	14.0	9.7	3.2	6.5	5.7	6.7	4.3	2.4	1.9
18	11.6	8.7	3.0	(9.5)	(3.8)	5.7	6.5	6.2	3.8	2.4	2.9
	-------	21.2	14.7	9.6	3.1	6.5	6.0	6.6	4.2	2.4	2.0
19	(0.0)	9.4	3.8	(9.4)	(3.8)	5.6	6.6	6.1	3.8	2.3	2.8
	12.4	21.9	15.6	9.5	3.2	6.3	6.2	6.4	4.1	2.3	2.0
20	(0.8)	10.2	4.5	(9.4)	(3.7)	5.7	6.6	6.0	3.7	2.3	2.7
	13.1	22.5	16.5	9.4	3.4	6.0	6.3	6.3	4.2	2.1	1.8
21	(1.5)	11.0	5.0	(9.5)	(3.5)	6.0	6.5	6.1	3.6	2.5	2.7
	13.8	23.1	17.1	9.3	3.3	6.0	6.1	6.3	4.1	2.2	2.0
22	(2.2)	11.5	5.7	(9.3)	(3.5)	5.8	6.6	6.2	3.8	2.4	2.5
	14.5	23.7	18.0	9.2	3.5	5.7	6.5	6.2	4.3	1.9	1.9
23	(2.8)	12.3	6.2	(9.5)	(3.4)	6.1	6.5	6.3	4.0	2.3	2.2
	15.2	-------	18.7	-------	3.5	-------	6.4	-------	4.4	-------	1.9
24	(3.5)	0.4	6.8	9.2	(3.3)	5.7	6.4	6.2	4.3	1.8	1.9
	15.8	13.0	19.7	(9.5)	3.9	6.2	6.7	6.5	4.4	2.2	2.1
25	(4.2)	1.0	7.2	9.2	(3.0)	5.3	6.2	6.0	4.2	1.6	1.8
	16.5	13.8	20.3	(9.6)	3.8	6.6	6.5	6.3	4.2	2.1	2.1
26	(4.9)	2.0	8.0	9.5	(3.1)	5.7	6.0	5.7	4.3	1.5	1.4
	17.3	14.5	21.3	(9.6)	4.0	6.5	6.8	6.4	4.3	2.1	2.1
27	(5.7)	2.5	8.5	9.2	(2.8)	5.2	6.0	5.7	4.4	1.4	1.3
	18.1	15.3	22.2	(9.6)	4.1	6.8	6.9	6.7	4.4	2.3	2.3
28	(6.5)	2.5	9.5	8.4	(3.0)	4.3	7.0	5.8	4.4	1.4	1.4
	18.9	16.0	23.3	(9.5)	4.4	6.5	7.3	6.7	4.2	2.3	2.5
29	(7.4)	5.3	11.0	10.4	(3.6)	6.0	5.7	5.8	4.5	1.6	1.3
	19.8	17.0	-------	(9.6)	-------	6.0	-------	6.8	-------	2.3	-------
30	(8.3)	6.0	0.0	10.2	4.2	6.0	7.0	6.0	4.1	1.9	2.7
	20.8	18.2	11.9	(9.9)	(3.6)	6.3	5.9	7.0	4.5	2.5	1.5
31	(9.3)	7.0	1.0	10.2	4.2	6.0	6.8	6.0	3.9	2.1	3.1
	21.8	19.0	12.5	9.7	(3.2)	6.5	5.5	7.0	4.2	2.8	1.8
Sums				568.6	213.9	354.7	390.8	390.5	245.4	145.1	145.0
Means				9.48	3.56	5.91	6.51	6.51	4.09	2.42	2.42
Correction to intervals				0.03	0.03						
Corrected intervals				9.51	3.59						

For convenience in computation the moon's transits across the meridian of Greenwich expressed in Greenwich time are taken, the necessary correction to refer these intervals to the local meridian being made to the average values determined for the month. When using eastern standard time for making tidal observations, this correction is +0.03 hour for New London. The lower transits of the moon are distinguished from the upper transits by being inclosed in parentheses. The high and low water lunitidal intervals for New London, 9.51 hours and 3.59 hours, respectively, derived from the one month's series of observations at Lighthouse Wharf shown in Table 1 agree very well with the adjusted values for this station given in Table 53 on page 64.

TABLE 2.—*High-water lunitidal interval, New London, Conn.*

Month	Fort Trumbull		Naval Station		Lighthouse wharf	Month	Fort Trumbull		Naval Station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Hours	*Hours*	*Hours*	*Hours*	*Hours*		*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January	------	9.50	------	9.35	------	September	------	9.52	9.42	------	9.42
February	------	9.45	------	9.64	------	October	------	9.48	9.54	------	9.54
March	------	9.40	------	9.34	------	November	9.40	------	9.36	------	------
April	------	9.50	------	9.53	------	December	9.46	------	9.47	------	------
May	------	9.48	------	9.54	------						
June	------	9.60	9.48	------	9.43	Sum	------	113.94	------	113.97	47.25
July	------	9.58	9.78	------	9.45	Mean	------	9.50	------	9.50	9.45
August	------	9.57	9.52	------	9.41						

The monthly variations in the high-water and low-water lunitidal intervals at New London are shown in Tables 2 and 3. The monthly means derived from the series at Fort Trumbull and naval station are for calendar periods, while those at lighthouse wharf are for 29-day lunar periods. The monthly means as given in the tables refer to the moon's transit across the meridian of New London. The differences in latitude and longitude between Fort Trumbull, naval station, and lighthouse wharf are so slight that they do not affect the mean values appreciably. It will be noticed from the data in the tables that there are monthly variations in the high-water and low-water lunitidal intervals. The series, however, are too short to show any periodic variations.

TABLE 3.—*Low-water lunitidal interval, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Hours	*Hours*	*Hours*	*Hours*	*Hours*		*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January	------	3.41	------	3.50	------	September	------	3.49	3.69	------	3.55
February	------	3.49	------	3.79	------	October	------	3.45	3.74	------	3.64
March	------	3.50	------	3.49	------	November	3.46	------	3.50	------	------
April	------	3.47	------	3.73	------	December	3.48	------	3.66	------	------
May	------	3.53	------	3.84	------						
June	------	3.65	3.70	------	3.47	Sum	------	42.22	------	44.42	17.87
July	------	3.66	4.04	------	3.58	Mean	------	3.52	------	3.70	3.57
August	------	3.63	3.74	------	3.63						

The difference between the mean low-water lunitidal interval and the mean high-water lunitidal interval is known as the mean duration of rise of the tide. The values in Table 4, showing the mean duration of rise of tide at New London, are therefore derived by subtracting the values given in Table 3 from those given in Table 2.

TABLE 4.—*Duration of rise of tide, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Hours	*Hours*	*Hours*	*Hours*	*Hours*		*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January	------	6.09	------	5.85	------	September	------	6.03	5.73	------	5.87
February	------	5.96	------	5.85	------	October	------	6.03	5.80	------	5.90
March	------	5.90	------	5.85	------	November	5.94	------	5.86	------	------
April	------	6.03	------	5.80	------	December	5.98	------	5.81	------	------
May	------	5.95	------	5.70	------						
June	------	5.95	5.78	------	5.96	Sum	------	71.72	------	69.55	29.38
July	------	5.92	5.74	------	5.87	Mean	------	5.98	------	5.80	5.88
August	------	5.94	5.78	------	5.78						

Since the length of the tidal cycle is 12.42 hours (half the tidal day of 24.84 hours) the duration of fall may be obtained by subtracting the duration of rise from 12.42 hours. Therefore, if the mean values for duration of rise given in Table 4 be subtracted from 12.42 hours the resultant mean values for duration of fall for the three series at New London become, respectively, 6.44, 6.62, and 6.54 hours. Daily variations in the durations of rise and fall at New London may be seen in columns 7 and 8 of Table 1 on page 5.

TABLE 5.—*Mean rise interval, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Hours	*Hours*	*Hours*	*Hours*	*Hours*		*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January	------	6.46	------	6.42	------	September	------	6.50	6.56	------	6.48
February	------	6.47	------	6.72	------	October	------	6.46	6.64	------	6.59
March	------	6.45	------	6.42	------	November	6.43	------	6.43	------	------
April	------	6.48	------	6.63	------	December	6.47	------	6.56	------	------
May	------	6.50	------	6.69	------						
June	------	6.62	6.59	------	6.45	Sum	------	78.06	------	79.20	32.56
July	------	6.62	6.91	------	6.52	Mean	------	6.51	------	6.60	6.51
August	------	6.60	6.63	------	6.52						

The mean rise interval is the average time between the transit of the moon and the middle of the period of the rise of the tide. It may be computed by adding the half period of rise to the mean low-water interval, rejecting multiples of the semidiurnal tidal period (12.42 hours) when desired. The mean rise interval is convenient for comparing the time of the tides at different stations when it is unnecessary to distinguish between the high and low water differences.

When the high-water interval is larger than the low-water interval, the mean rise interval may be computed by taking one-half the sum of the high-water and low-water lunitidal intervals. The values in Table 5, showing the mean rise interval at New London, Conn., were obtained from the values in Tables 2 and 3 by means of this method.

HEIGHT RELATIONS

The height to which high water rises and low water falls varies from day to day, chiefly in accordance with the varying positions of the moon and sun with respect to that of the earth. At times of new and full moon, when spring tides occur, high water rises higher than usual and low water falls lower than usual. On the contrary, at times when the moon is in its first and third quarters the rise of high water and fall of low water is less than usual.

Similarly, at times when the moon is in perigee, or nearest the earth, high water rises higher than the average and low water falls lower than the average, while at the times of the moon's apogee contrary conditions obtain. Changes in the moon's declination also bring about differences in the heights of high and low waters from day to day.

TABLE 6.—*Mean high water on tide staffs, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Feet	*Feet*	*Feet*	*Feet*	*Feet*		*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	3.90	------	4.59	------	September	------	4.21	5.20	------	6.51
February	------	3.58	------	4.59	------	October	------	4.29	5.09	------	6.60
March	------	3.78	------	4.82	------	November	4.34	------	5.27	------	------
April	------	4.02	------	4.90	------	December	3.84	------	4.95	------	------
May	------	4.16	------	5.14	------						
June	------	4.08	5.05	------	6.52	Sum	------	48.61	------	59.79	32.73
July	------	4.20	5.01	------	6.51	Mean	------	4.05	------	4.98	6.55
August	------	4.21	5.18	------	6.59						

Daily variations in the heights of high and low water on tide staff at New London are given in columns 9 and 10 of Table 1 on page 5. In Tables 6 and 7 the monthly variations of mean high water and mean low water on tide staffs are shown. It will be seen that the tide-staff settings were different at each of the three stations—Fort Trumbull, naval station, and lighthouse wharf. In other words, the zero readings of the tide staffs were set at different elevations, that at naval station being set about 1 foot lower than that at Fort Trumbull, while the zero of the staff at lighthouse wharf was set about 2 feet lower than that at Fort Trumbull.

TABLE 7.—*Mean low water on tide staffs, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Feet	*Feet*	*Feet*	*Feet*	*Feet*		*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	1.34	------	2.19	------	September	------	1.56	2.63	------	3.98
February	------	1.00	------	2.12	------	October	------	1.65	2.49	------	4.07
March	------	1.26	------	2.23	------	November	1.71	------	2.64	------	------
April	------	1.39	------	2.32	------	December	1.25	------	2.35	------	------
May	------	1.51	------	2.63	------						
June	------	1.45	2.48	------	4.07	Sum	------	17.31	------	29.29	20.30
July	------	1.59	2.55	------	4.08	Mean	------	1.44	------	2.44	4.06
August	------	1.60	2.66	------	4.10						

There are various planes of high water and low water but those of mean high water and mean low water are the most easily determined and the most generally used on the Atlantic coast. These planes are, respectively, the average of all the high waters and all the low waters over a considerable period of time.

From a consideration of the data in Tables 6 and 7, it will be noted that the maximum monthly variations in the readings of high and low water on tide staff are approximately 0.75 foot, highest readings occurring in November and lowest readings in February. During the summer months, however, monthly variations in high water and

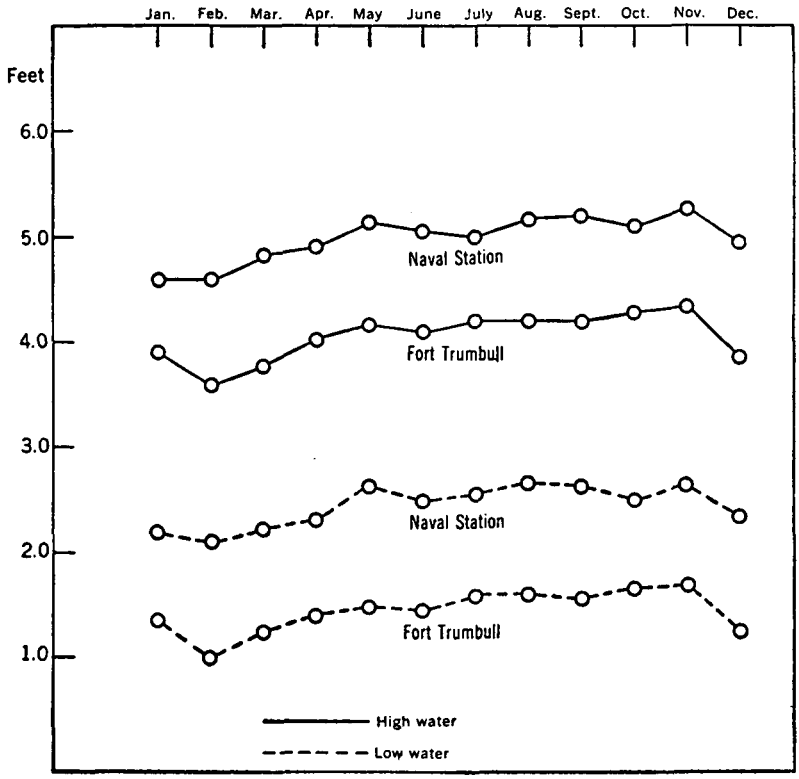

FIGURE 2.—Monthly variation in high water and low water on tide staff, New London, Conn.

low water are slight, approximating about 0.15 foot. Figure 2 shows the monthly variation of high water and low water on tide staff at Fort Trumbull and naval station based on data given in Tables 6 and 7.

It will be noted from the curves in Figure 2 that there are secondary maximum and minimum readings in May and June. In general, the curves in Figure 2 resemble closely those in Figure 3 which show monthly variations in mean sea level, the monthly variations in the heights of high water and low water corresponding approximately to the variations in the plane of mean sea level.

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TABLE 8.—*Monthly mean tide level on tide staffs, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Feet	*Feet*	*Feet*	*Feet*	*Feet*		*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	2.62	------	3.39	--------	September	------	2.88	3.92	------	5.24
February	------	2.29	------	3.36	--------	October	------	2.97	3.79	------	5.34
March	------	2.52	------	3.52	--------	November	3.02	------	3.96	------	------
April	------	2.70	------	3.61	--------	December	2.54	------	3.65	------	------
May	------	2.84	------	3.88	--------						
June	------	2.76	3.76	------	5.30	Sum	------	32.94	------	44.54	26.52
July	------	2.90	3.78	------	5.30	Mean	------	2.74	------	3.71	5.30
August	------	2.90	3.92	------	5.34						

The plane of mean tide level, or, as it is sometimes called, the plane of half-tide level, is a plane halfway between the planes of mean high water and mean low water. From its definition it is obvious that the plane of mean tide level exhibits the annual variation of the planes of mean high water and mean low water. Table 8 shows the monthly variation in mean tide level at Fort Trumbull, naval station, and lighthouse wharf. The values in Table 8 were derived by taking one-half of the sum of the values in Tables 6 and 7.

TABLE 9.—*Monthly mean sea level on tide staffs, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Feet	*Feet*	*Feet*	*Feet*	*Feet*		*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	2.68	------	3.43	--------	September	------	2.93	3.98	------	5.29
February	------	2.32	------	3.37	--------	October	------	3.03	3.83	------	5.38
March	------	2.56	------	3.59	--------	November	3.06	------	4.00	------	------
April	------	2.76	------	3.66	--------	December	2.59	------	3.69	------	------
May	------	2.90	------	3.92	--------						
June	------	2.83	3.83	------	5.33	Sum	------	33.58	------	45.13	26.76
July	------	2.96	3.85	------	5.36	Mean	------	2.80	------	3.76	5.35
August	------	2.96	3.98	------	5.40						

The plane of mean sea level may be defined as the plane about which the tide oscillates or as the surface the sea would assume when undisturbed by the rise and fall of the tide. With reference to a bench mark on the shore, the plane of mean sea level may be determined by averaging over a considerable period of time the hourly heights of the tide as read on a fixed tide staff, the zero of which has been connected with the bench mark by spirit levels. This is also accomplished by reading the hourly heights from the record of an automatic tide gauge whose relation to a fixed staff has been determined by comparative readings.

Because of the disturbing influences of wind and weather an accurate determination of mean sea level must be based on observations extending over a considerable period of time. In general, a series of tidal observations three years in length will, when corrected by comparison with the results from a suitably located primary station, determine mean sea level within 0.02 foot; observations covering a

period of a year will determine it to 0.05 foot, and a month of observations may be considered to determine it within 0.10 foot.

The values for mean sea level in Table 9 were derived by averaging the 24 hourly heights of the tide each day during the monthly period. These heights are recorded in feet and tenths and are referred to the fixed staffs at Fort Trumbull, naval station, and lighthouse wharf, respectively.

From the values given in Table 9 graphs have been constructed showing the monthly variations in mean sea level at New London. (See figure 3.) It will be seen that the plane of mean sea level fluctuates from month to month throughout the year, being lowest in February and highest in November. In general trend the annual variation in sea level at New London appears to approximate that at

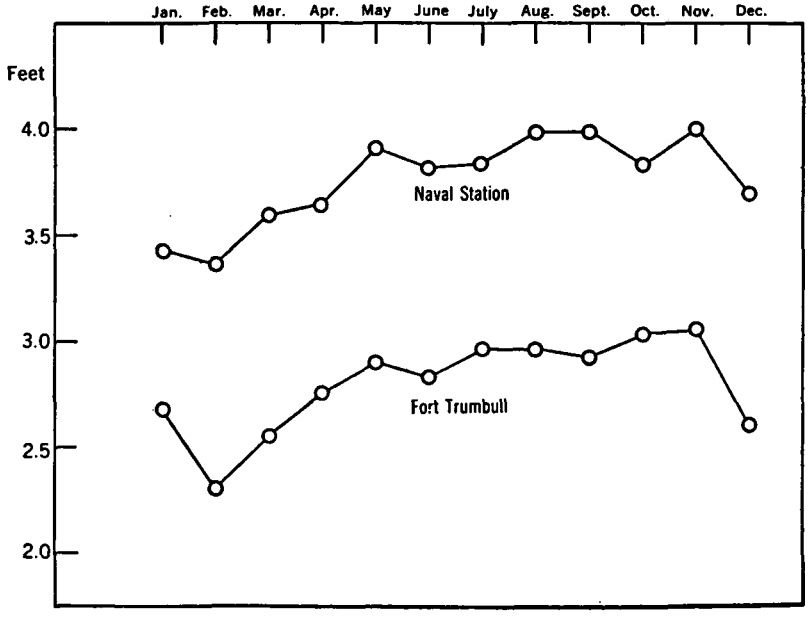

FIGURE 3.—Monthly variation in mean sea level on tide staff, New London, Conn.

Fort Hamilton, N. Y., Atlantic City, N. J., and other Atlantic coast points.

By comparing the annual mean values for mean tide level and mean sea level in Tables 8 and 9, it will be noted that at each of the three localities in New London the plane of mean sea level is about 0.05 foot above that of mean tide level. In passing it might be well to state that on the Atlantic coast the plane of mean sea level is generally higher than that of mean tide level.

THE RANGE OF THE TIDE

The extent of rise and fall of the tide, or the range of the tide, varies from day to day, principally in accordance with the positions of the sun and moon relative to the earth. Spring tides and perigean tides bring relatively large ranges, while neap tides and apogean tides bring relatively small ranges. The daily variation in range of tide

at New London is shown in the last two columns of Table 1. From the data in the table it will be noted that the rise of the tide varies from 1.4 to 3.5 feet and the fall of the tide from 1.3 to 3.8 feet throughout a summer month (July, 1917) when severe meteorological conditions are not generally present. It will further be noted that the range of the tide for the month was 2.42 feet.

TABLE 10.—*Range of tide, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Feet	*Feet*	*Feet*	*Feet*	*Feet*		*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	2.56	------	2.40	------	September	------	2.65	2.57	------	2.53
February	------	2.58	------	2.47	------	October	------	2.64	2.60	------	2.53
March	------	2.52	------	2.59	------	November	2.63	------	2.63	------	------
April	------	2.63	------	2.58	------	December	2.59	------	2.60	------	------
May	------	2.65	------	2.51	------						
June	------	2.63	2.57	------	2.45	Sum	------	31.30	------	30.50	12.43
July	------	2.61	2.46	------	2.43	Mean	------	2.61	------	2.54	2.49
August	------	2.61	2.52	------	2.49						

While there are various tidal ranges just as there are various tidal datum planes, that of mean range is of primary importance. The range of tide showing monthly variations is given in Table 10 for Fort Trumbull, naval station, and lighthouse wharf. The values in the table are the differences between the mean high and low waters for each month as obtained directly from the observations.

The range of tide varies not only from day to day and month to month but also from year to year throughout a period of approximately 19 years. Greater ranges occur when the inclination of the lunar orbit to the plane of the earth's Equator is small, and smaller ranges when the inclination is large. The mean range of tide for each year or each month is obtained by multiplying the range as directly obtained from the tabulations by factors to take account of the variation in the longitude of the moon's node.

TABLE 11.—*Mean range reduced for longitude of moon's node, New London, Conn.*

Month	Fort Trumbull		Naval station		Lighthouse wharf	Month	Fort Trumbull		Naval station		Lighthouse wharf
	1882	1883	1899	1900	1917		1882	1883	1899	1900	1917
	Feet	*Feet*	*Feet*	*Feet*	*Feet*		*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	2.51	------	2.37	------	September	------	2.59	2.57	------	2.56
February	------	2.53	------	2.44	------	October	------	2.58	2.60	------	2.56
March	------	2.47	------	2.56	------	November	2.58	------	2.63	------	------
April	------	2.57	------	2.55	------	December	2.54	------	2.60	------	------
May	------	2.59	------	2.48	------						
June	------	2.57	2.57	------	2.47	Sum	------	30.63	------	30.35	12.55
July	------	2.55	2.46	------	2.45	Mean	------	2.55	------	2.53	2.51
August	------	2.55	2.52	------	2.51						

The reduced values for range in Table 11 were derived from Table 10 by applying factors depending upon the longitude of the moon's node to the values from the tabulations.

Other tidal ranges than mean range are principally the following: Spring, neap, perigean, apogean, great diurnal, small diurnal, great tropic, mean tropic, and small tropic.

EXTREME TIDES

Tables 12 and 13 show, respectively, monthly extreme high waters and low waters observed at Fort Trumbull with respect to the plane of mean sea level, while Tables 14 and 15 show similar data at naval station. These extreme tides are the highest and lowest tides observed during each month of observation. While extreme tides may be due to either astronomical or meteorological conditions alone they generally result from the combined effects of both causes.

TABLE 12.—*Monthly extreme high water above mean sea level, New London (Fort Trumbull), Conn.*

Date	Height	Date	Height
1882:	*Feet*	1883—Continued	*Feet*
Aug. 28	2.2	Apr. 7	2.4
Sept. 28	2.9	May 22	2.3
Oct. 29	2.9	June 30	2.0
Nov. 7, 24	2.6	July 28	2.0
Dec. 23	3.0	Aug. 29	2.5
		Sept. 21	2.3
Highest	3.0	Oct. 2	2.8
Average	2.72		
		Highest	3.2
1883:		Average	2.44
Jan. 10	3.2		
Feb. 7	2.3	Average for series	2.53
Mar. 10	2.6		

TABLE 13.—*Monthly extreme low water below mean sea level, New London (Fort Trumbull), Conn.*

Date	Height	Date	Height
1882:	*Feet*	1883—Continued	*Feet*
Aug. 1, 2, 31	2.1	Apr. 9	2.3
Sept. 1	1.8	May 9	2.2
Oct. 27	2.2	June 3	2.4
Nov. 25	3.5	July 3	2.0
Dec. 8	3.0	Aug. 19	1.8
		Sept. 19	2.0
Lowest	3.5	Oct. 17	2.4
Average	2.52		
		Lowest	3.2
1883:		Average	2.47
Jan. 22	3.2		
Feb. 10	3.2	Average for series	2.49
Mar. 8, 12	3.2		

TABLE 14.—*Monthly extreme high water above mean sea level, New London (naval station), Conn.*

Date	Height	Date	Height
1899:	*Feet*	1900:	*Feet*
June 7	2.2	Jan. 21, 26, 31	1.8
July 23, 24	2.2	Feb. 25	3.2
Aug. 21, 22	2.5	Mar. 31	2.6
Sept. 20	3.0	Apr. 2	2.7
Oct. 18, 31	2.3	May 25	2.5
Nov. 18	2.4		
Dec. 4	3.2	Highest	3.2
		Average	2.56
Highest	3.2		
Average	2.54	Average for series	2.55

TABLE 15.—*Monthly extreme low water below mean sea level, New London (naval station), Conn.*

Date	Height	Date	Height
1899:	*Feet*	1900:	*Feet*
June 25	2.3	Jan. 26, 27	3.6
July 22	1.9	Feb. 2	3.5
Aug. 20, 21, 22, 23	1.7	Mar. 3	3.0
Sept. 22	2.1	Apr. 15	2.4
Oct. 19, 20	2.1	May 1, 30	2.0
Nov. 4	2.3		
Dec. 5, 6	2.7	Lowest	3.6
		Average	2.90
Lowest	2.7		
Average	2.16	Average for series	2.47

On the Atlantic coast the semidiurnal type of tide obtains. There are generally two high waters and two low waters each day, but there is usually a difference in the height of the two high waters and also in the height of the two low waters of the day. The variations of the unequal high water heights and the unequal low water heights from their averages are known as the diurnal high-water inequality and diurnal low-water inequality, respectively.

TABLE 16.—*Diurnal inequalities, New London (naval station), Conn.*

Month	Diurnal high-water inequality				Diurnal low-water inequality			
	1899	1900	Mean from observations	Reduced mean	1899	1900	Mean from observations	Reduced mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		0.51	0.51	0.45		0.19	0.19	0.17
February		0.26	0.26	0.28		0.20	0.20	0.21
March		0.13	0.13	0.16		0.14	0.14	0.17
April		0.20	0.20	0.23		0.15	0.15	0.17
May	0.25	0.29	0.27	0.25	0.29	0.14	0.22	0.21
June	0.36	0.24	0.30	0.26	0.26	0.14	0.20	0.17
July	0.34		0.34	0.30	0.19		0.19	0.17
August	0.09		0.09	0.09	0.22		0.22	0.23
September	0.29		0.29	0.35	0.14		0.14	0.17
October	0.23		0.23	0.26	0.18		0.18	0.20
November	0.28		0.28	0.26	0.23		0.23	0.21
December	0.42		0.42	0.36	0.23		0.23	0.20
Sum			3.32	3.25			2.29	2.28
Mean			0.277	0.271			0.191	0.190

DIURNAL INEQUALITIES

Monthly variation in the diurnal inequalities of the tide at naval station are given in Table 16. The diurnal high-water inequality is derived by subtracting mean high water from mean higher high water. Similarly, the diurnal low-water inequality is obtained by subtracting mean lower low water from mean low water.

The diurnal inequalities exhibit variations from month to month and year to year due to changing astronomical conditions. The reduced values in the table have been obtained by means of factors applied to the observed mean values.

HARMONIC CONSTANTS

Tidal harmonic constants from an harmonic analysis of the hourly ordinates of the tide at Fort Trumbull have been obtained from a series of observations beginning November 1, 1882, and extending through a period of 358 days to 382 days varying with the component tide.

TABLE 17.—*Harmonic constants, New London (Fort Trumbull), Conn.*

[Values in parentheses have been inferred from other constants]

Component	1882-83		Component	1882-83		Component	1882-83	
	Amplitude	Epoch		Amplitude	Epoch		Amplitude	Epoch
	H	κ		H	κ		H	κ
	Feet	*Degrees*		*Feet*	*Degrees*		*Feet*	*Degrees*
J_1	(0.014)	(100)	N_2	0.266	247	S_2	0.214	288
K_1	0.249	112	2N	(0.035)	(220)	T_2	(0.013)	(288)
K_2	0.065	285	O_1	0.181	137	λ_2	(0.008)	(281)
L_2	0.057	339	OO	(0.008)	(87)	μ_2	0.042	191
M_1	0.002	300	P_1	0.074	113	ν_2	0.043	257
M_2	1.136	274	Q_1	0.023	132	ρ_1	(0.007)	(148)
M_4	0.064	62	2Q	(0.005)	(162)			
M_6	0.039	134	R_2	(0.002)	(288)			

Tidal harmonic constants from an harmonic analysis of the hourly ordinates of the tide at naval station have been obtained from a 369-day series of observations beginning May 12, 1899. The harmonic constants from this harmonic analysis are given in Table 18.

TABLE 18.—*Harmonic constants, New London (naval station), Conn.*

[Values in parentheses have been inferred from other constants]

Component	1899-1900		Component	1899-1900		Component	1899-1900	
	Amplitude	Epoch		Amplitude	Epoch		Amplitude	Epoch
	H	κ		H	κ		H	κ
	Feet	*Degrees*		*Feet*	*Degrees*		*Feet*	*Degrees*
J_1	(0.013)	(94)	M_8	0.043	164	2Q	(0.004)	(167)
K_1	0.225	109	N_2	0.243	253	R_2	(0.002)	(290)
K_2	0.072	279	2N	(0.032)	(228)	S_2	0.216	290
L_2	0.028	357	O_1	0.168	138	T_2	(0.013)	(290)
M_1	0.008	169	OO	(0.007)	(80)	λ_2	(0.008)	(284)
M_2	1.157	278	P_1	0.097	121	μ_2	(0.028)	(226)
M_4	0.077	79	Q_1	(0.033)	(152)	ν_2	(0.056)	(295)

SUMMARY OF TIDAL DATA

For convenience the results derived and discussed in this section have been compiled in one table and the data are given in Table 19. While they are specifically for naval station (submarine base) they are applicable approximately to New London and vicinity.

TABLE 19.—*Tidal data, New London (naval station), Conn.*

TIME RELATIONS

	Hours
High-water interval	9. 50
Low-water interval	3. 70
Duration of rise	5. 80
Duration of fall	6. 62
Phase age	12. 0
Parallax age	46. 7
Diurnal age	333. 6

Sequence of tides is HHW to LLW.

RANGES

	Feet
Mean range	2. 53
Great diurnal range	2. 99
Small diurnal range	2. 07
Great tropic range	2. 82
Mean tropic range	2. 28
Small tropic range	1. 74
Spring range	2. 94
Neap range	1. 99
Perigean range	2. 97
Apogean range	2. 08

COMPARISON OF RANGES

	Ratios
Great diurnal range÷mean range	1. 182
Small diurnal range÷mean range	0. 818
Great tropic range÷mean range	1. 115
Mean tropic range÷mean range	0. 901
Small tropic range÷mean range	0. 688
Spring range÷mean range	1. 162
Neap range÷mean range	0. 787
Perigean range÷mean range	1. 174
Apogean range÷mean range	0. 822

HEIGHT RELATIONS

	Feet
Mean high water above mean sea level	1. 22
Mean higher high water above mean sea level	1. 49
Mean lower high water above mean sea level	0. 95
Tropic higher high water above mean sea level	1. 53
Tropic lower high water above mean sea level	0. 74
Spring high water above mean sea level	1. 43
Neap high water above mean sea level	0. 96
Mean low water below mean sea level	1. 32
Mean lower low water below mean sea level	1. 51
Mean higher low water below mean sea level	1. 13
Tropic lower low water below mean sea level	1. 29
Tropic higher low water below mean sea level	1. 01
Spring low water below mean sea level	1. 51
Neap low water below mean sea level	1. 03
Half-tide level below mean sea level	0. 05

THE TIDE AT FORT SCHUYLER, THROGS NECK, N. Y.

INTRODUCTORY

The earliest tidal observations on record for the vicinity of Fort Schuyler, Throgs Neck, N. Y., at the western end of Long Island Sound where the latter joins the East River, were those obtained in 1837 from August 9 to 17 in connection with a hydrographic survey of this area. Ten years later the Coast and Geodetic Survey obtained 63 days of tidal observations at this locality during the period March 20 to May 29, 1847, when another hydrographic survey was made.

From that time until 1929, however, this bureau made no tidal observations in this vicinity with the exception of short series at Willets Point, Long Island, in 1886 and 1890.

Through the cooperation of the Corps of Engineers, United States Army, the Coast and Geodetic Survey has been furnished with the results of long-period tidal observations made at Fort Schuyler, Throgs Neck, N. Y., during the years 1920–1922 and 1926–1930. Monthly values obtained from these records which show variation in time and height of tide at this locality will be found on subsequent pages.

These tidal observations were obtained by means of a Gurley printing gage and the heights of the tide at intervals of 15 minutes were recorded automatically in feet and hundredths of a foot on a continuous strip of paper.

TIME RELATIONS

The lunitidal intervals at Fort Schuyler, N. Y., in hours and hundredths of an hour, are given in Tables 20 and 21. These tables show the monthly variation in the lunitidal intervals at this station, and represent the time intervals by which high water and low water follow the moon's meridian passage.

TABLE 20.—*High-water lunitidal interval, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January	----------	10.43	11.20	----------	11.14	11.36	11.24	11.07
February	----------	11.27	11.23	----------	11.01	11.18	11.30	11.20
March	----------	11.28	11.16	----------	11.06	11.14	11.45	11.22
April	----------	----------	11.33	----------	11.19	11.19	11.17	11.22
May	----------	----------	11.36	----------	11.22	11.36	10.69	11.16
June	----------	----------	11.51	----------	11.40	11.37	11.29	11.39
July	----------	----------	11.25	----------	11.41	11.54	12.08	11.57
August	----------	11.51	11.42	11.27	11.58	11.39	12.21	11.56
September	----------	11.42	11.39	11.16	11.64	11.41	11.53	11.42
October	11.55	11.42	11.37	11.16	11.62	11.22	11.16	11.36
November	11.43	11.28	11.30	11.25	11.53	11.16	----------	11.32
December	11.29	11.27	11.10	11.21	11.37	11.08	----------	11.22
Mean	----------	----------	----------	----------	----------	----------	----------	11.31

It will be noted that the monthly mean values in the last column of Table 20 do not vary considerably from the yearly mean of 11.31 hours. However, individual monthly values over the 7-year period vary from 10.43 hours to 12.21 hours, or by approximately an hour earlier and later, respectively, than the yearly mean value. It will be noted that the high-water interval is diminished in the winter and spring months and is increased in the summer and fall months. This appears to be a seasonal effect.

TABLE 21.—*Low-water lunitidal interval, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January		5.65	5.68		5.48	5.58	5.43	5.56
February		5.61	5.59		5.49	5.53	5.43	5.53
March		5.80	5.54		5.54	5.53	5.47	5.58
April			5.70		5.66	5.45	5.47	5.57
May			5.63		5.58	5.50	5.50	5.55
June			5.69		5.74	5.74	5.88	5.76
July			5.76		5.72	5.76	5.97	5.80
August		5.80	5.78	5.77	5.67	5.76	6.01	5.80
September		5.70	5.82	5.64	5.80	5.63	5.70	5.72
October	5.77	5.75	5.75	5.57	5.83	5.67	5.45	5.68
November	5.73	5.79	5.76	5.66	5.63	5.65		5.70
December	5.67	5.58	5.50	5.55	5.61	5.50		5.57
Mean								5.65

It will also be noted that the monthly mean values for low-water interval in the last column of Table 21 do not vary much from the yearly mean value of 5.65 hours. Over the 7-year period of observations the monthly values vary from 5.43 hours to 6.01 hours, or approximately one-fourth hour earlier to one-half hour later than the yearly mean. This variation is considerably less than that shown above in the high-water lunitidal interval. Nevertheless, the variation in low-water interval also appears to be seasonal, the interval being diminished in the winter and spring months and increased in the summer and fall months.

TABLE 22.—*Duration of rise of tide, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January		4.78	5.52		5.66	5.78	5.81	5.51
February		5.66	5.64		5.52	5.65	5.87	5.67
March		5.49	5.62		5.52	5.61	5.98	5.64
April			5.63		5.52	5.74	5.71	5.65
May			5.73		5.64	5.86	5.20	5.61
June			5.83		5.66	5.63	5.40	5.63
July			5.48		5.69	5.78	6.11	5.76
August		5.71	5.64	5.50	5.91	5.63	6.20	5.76
September		5.72	5.57	5.52	5.83	5.78	5.83	5.71
October	5.78	5.67	5.62	5.58	5.79	5.55	5.71	5.67
November	5.70	5.49	5.54	5.58	5.90	5.51		5.62
December	5.62	5.69	5.61	5.66	5.76	5.58		5.65
Mean								5.66

Table 22 shows the duration of rise of tide at Fort Schuyler, N. Y. The values in this table were obtained by taking the differences between the values for high-water interval in Table 20 and those for low-water interval in Table 21

Since 12.42 hours constitutes one-half a lunar day, and the yearly mean value for duration of rise at Fort Schuyler is 5.66 hours as shown in Table 22, the duration of fall of tide at this station is the difference between these two values, or 6.76 hours.

TABLE 23.—*Mean rise interval, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Hours	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*
January		8.04	8.44		8.31	8.47	8.33	8.32
February		8.44	8.41		8.25	8.36	8.36	8.36
March		8.54	8.35		8.30	8.33	8.46	8.40
April			8.51		8.43	8.32	8.32	8.40
May			8.50		8.30	8.43	8.10	8.33
June			8.60		8.57	8.56	8.59	8.58
July			8.51		8.56	8.66	9.02	8.69
August		8.65	8.60	8.52	8.62	8.58	9.11	8.68
September		8.56	8.60	8.40	8.72	8.52	8.61	8.57
October	8.66	8.59	8.56	8.37	8.72	8.44	8.30	8.52
November	8.58	8.53	8.53	8.46	8.58	8.41		8.52
December	8.48	8.43	8.30	8.38	8.49	8.29		8.40
Mean								8.48

The values in Table 23 which show monthly variations in mean rise interval at Fort Schuyler, N. Y., were obtained from the values in Tables 20 and 21 by taking one-half the sum of the high-water and low-water intervals

HEIGHT RELATIONS

Monthly variations in mean high water on tide staff at Fort Schuyler, N. Y., are given in Table 24. The monthly mean values in the last column of this table are also plotted in the form of a curve in Figure 4 on page 21. It will be noted that over the 7-year period of observations monthly mean high-water readings on tide staff varied from a maximum of 9.24 feet in June, 1928, to a minimum of 7.84 feet in January, 1929, a variation of nearly 1½ feet.

TABLE 24.—*Mean high water on tide staff, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		8.49	8.26		8.29	8.10	7.84	8.20
February		8.90	8.45		8.86	8.38	8.70	8.66
March		8.59	8.63		8.74	8.50	8.47	8.59
April			8.78		8.83	8.53	9.03	8.79
May			8.85		8.92	9.01	8.51	8.82
June			8.95		8.97	9.24	8.96	9.03
July			9.05		8.80	8.92	8.70	8.87
August		9.01	9.09	9.22	9.04	9.03	8.70	9.02
September		9.05	9.05	9.20	8.97	9.06	8.93	9.04
October	9.08	8.83	8.97	9.04	8.94	8.66	8.54	8.87
November	9.00	9.01	8.76	8.70	9.08	8.39		8.82
December	8.86	8.53	8.58	8.76	8.90	8.30		8.66
Mean								8.78

Table 25 shows the monthly variation in mean low-water readings on tide staff at Fort Schuyler, N. Y. The monthly mean values in the last column of this table have also been plotted in the form of a curve in Figure 4. It will be noted that the plane of mean low water like that of mean high water is highest in the summer months and lowest in the winter months. During the observational period monthly mean low-water readings on tide staff varied from a maximum of 2.05 feet in September, 1926, to a minimum of 0.85 foot in January, 1928, a variation of about 1¼ feet.

TABLE 25.—*Mean low water on tide staff, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		1.31	1.21		1.21	0.85	0.98	1.11
February		1.63	1.22		1.68	1.17	1.64	1.47
March		1.32	1.46		1.54	1.40	1.48	1.44
April			1.41		1.52	1.49	1.95	1.59
May			1.46		1.62	1.79	1.31	1.54
June			1.50		1.71	1.95	1.77	1.73
July			1.52		1.60	1.70	1.53	1.59
August		1.54	1.56	1.91	1.90	1.87	1.68	1.74
September		1.61	1.65	2.05	1.82	1.84	1.88	1.81
October	1.73	1.45	1.60	1.92	1.78	1.53	1.63	1.66
November	1.61	1.84	1.56	1.52	1.88	1.34		1.62
December	1.51	1.30	1.49	1.69	1.73	1.29		1.50
Mean								1.57

The values in Table 26, showing mean tide level on staff at Fort Schuyler, N. Y., were obtained from those given in Tables 24 and 25.

TABLE 26.—*Mean tide level on staff, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		4.90	4.74		4.75	4.47	4.41	4.65
February		5.27	4.84		5.27	4.78	5.17	5.07
March		4.96	5.05		5.14	4.95	4.98	5.02
April			5.10		5.18	5.01	5.49	5.20
May			5.16		5.27	5.40	4.91	5.18
June			5.22		5.34	5.59	5.37	5.38
July			5.29		5.20	5.31	5.12	5.23
August		5.27	5.33	5.56	5.47	5.45	5.19	5.38
September		5.33	5.35	5.62	5.39	5.44	5.41	5.42
October	5.41	5.14	5.28	5.28	5.36	5.10	5.08	5.24
November	5.31	5.42	5.16	5.11	5.48	4.87		5.22
December	5.19	4.92	5.04	5.22	5.31	4.80		5.08
Mean								5.17

It will be noted that mean tide level exhibits similar variations to those of mean high water and mean low water. Perhaps this is more clearly shown in Figure 4 where the values in the last column of Table 26 have been plotted in the form of a curve.

The datum used in connection with these tidal observations is a plane 5 feet below that of mean sea level at Sandy Hook, N. J.; that is, the zero of the tide staff was set at an elevation of 5 feet below the plane of mean sea level at Sandy Hook.

The mean sea level datum at Sandy Hook is based on six years of continuous tidal observations made with an automatic tide gauge during the years 1876 to 1881, inclusive. Through precise levels this datum has been carried to Fort Schuyler, N. Y.

For use in connection with the recovery of various tidal datum planes at Fort Schuyler, Throgs Neck, N. Y., reference is made to the description and elevation of bench mark 999 at Fort Schuyler as listed on page 17 in Tidal Bench Marks, State of New York (Special Publication No. 83, Coast and Geodetic Survey), as follows:

Serial No. 95. Throgs Neck: B. M. 999 (B. E. & A.) is a ⅞″ copper bolt in the top of the southeast corner of a large coping stone on top of the sea wall on the southerly side of the military reservation at Fort Schuyler. The bolt is 3 feet south of the southeast corner of the 2-story brick house occupied by Mr. Mayhew,

post engineer, and about 50 feet west of the east dock. The bolt is 5 inches from the face of the sea wall and in the center of a 4-inch square cavity in the coping stone, which is also a part of the foundation of the post engineer's house. Elevation: 11.9 feet above mean low water; 8.26 feet above standard (Sandy Hook) sea level.

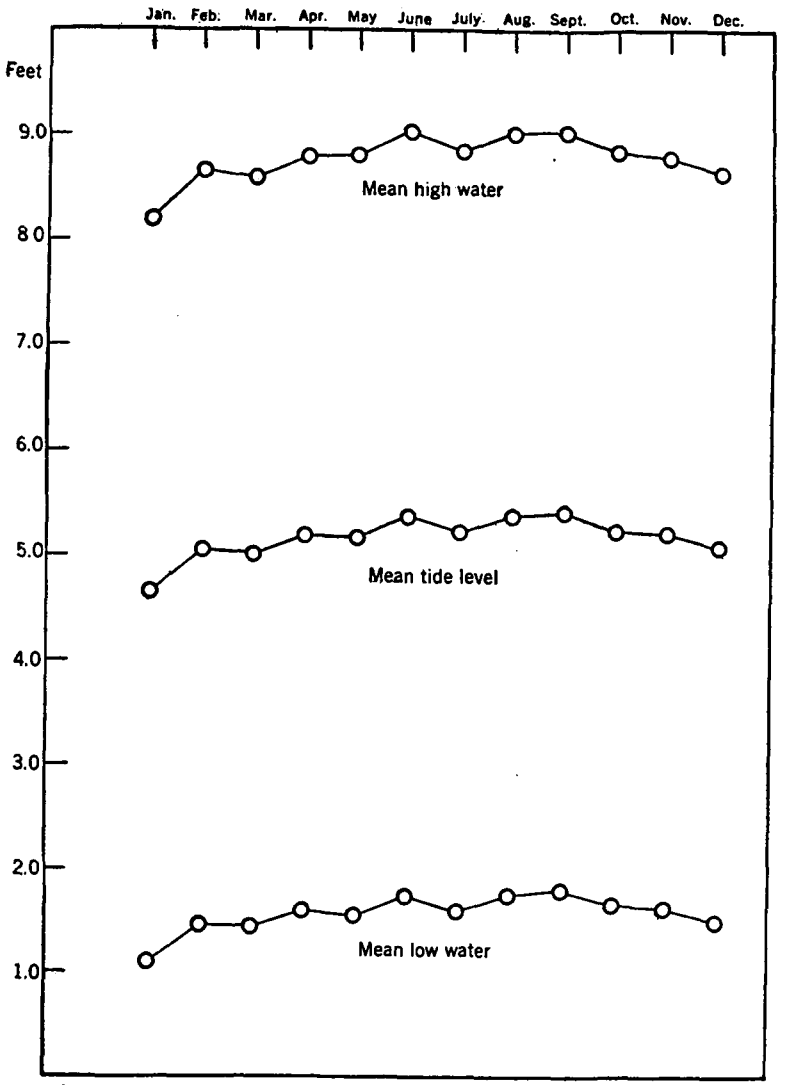

FIGURE 4.—Mean high water, mean low water and mean tide level on tide staff, Fort Schuyler, N. Y.

THE RANGE OF THE TIDE

The values in Table 27, showing the range of the tide at Fort Schuyler, N. Y., were obtained by means of the differences between the mean high and low waters for each month as obtained directly from observations and given in Tables 24 and 25. During the 7-year period of observations the range of tide varied from a maximum of

7.54 feet in August, 1922, to a minimum of 6.86 feet in January, 1929, a variation of only approximately 0.35 foot from the mean value of 7.21 feet.

TABLE 27.—*Range of tide, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		7.19	7.05		7.07	7.25	6.86	7.08
February		7.27	7.22		7.18	7.20	7.06	7.19
March		7.26	7.17		7.20	7.10	6.99	7.14
April			7.37		7.32	7.04	7.08	7.20
May			7.39		7.31	7.22	7.20	7.28
June			7.44		7.26	7.29	7.19	7.30
July			7.53		7.20	7.21	7.17	7.28
August		7.47	7.54	7.31	7.14	7.16	7.02	7.27
September		7.44	7.40	7.15	7.15	7.22	7.04	7.23
October	7.35	7.38	7.38	7.12	7.16	7.13	6.90	7.20
November	7.39	7.17	7.20	7.18	7.20	7.05		7.20
December	7.35	7.22	7.09	7.07	7.16	7.02		7.15
Mean								7.21

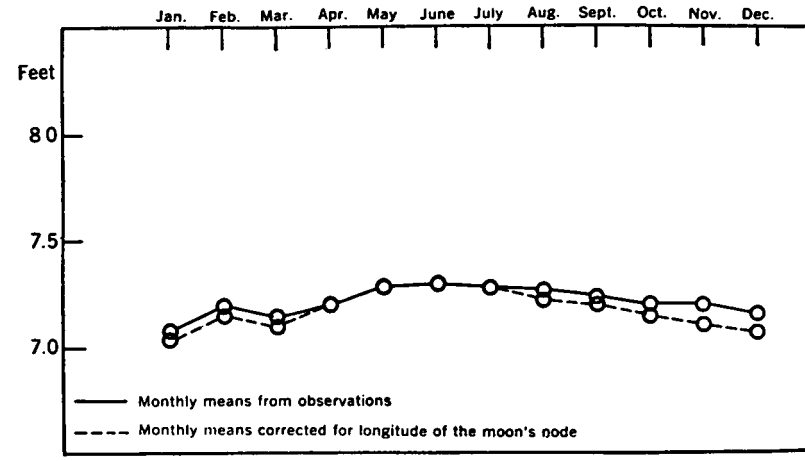

FIGURE 5.—Mean range of tide, Fort Schuyler, N. Y.

TABLE 28.—*Mean range reduced for longitude of moon's node, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		6.99	6.85		7.07	7.32	6.99	7.04
February		7.07	7.01		7.18	7.27	7.20	7.15
March		7.06	6.96		7.20	7.17	7.13	7.10
April			7.16		7.32	7.11	7.22	7.20
May			7.18		7.31	7.29	7.35	7.28
June			7.22		7.26	7.36	7.33	7.29
July			7.31		7.20	7.28	7.31	7.28
August		7.26	7.32	7.23	7.14	7.23	7.16	7.22
September		7.23	7.19	7.08	7.15	7.29	7.19	7.19
October	7.19	7.17	7.17	7.05	7.16	7.20	7.04	7.14
November	7.23	6.97	6.99	7.11	7.20	7.12		7.10
December	7.19	7.02	6.88	7.00	7.16	7.08		7.06
Mean								7.17

By means of factors the values given in Table 27 have been reduced for longitude of the moon's node and the reduced values are presented

in Table 28. It will be noted that the yearly mean value, 7.17 feet, agrees closely with the accepted mean value for range of tide at Willets Point, Long Island, which is 7.18 feet (see p. 28). Willets Point is located just across the East River entrance from Fort Schuyler, Throgs Neck.

The monthly mean values for observed and reduced ranges of tide at Fort Schuyler, N. Y., as given in the last columns of Tables 27 and 28, respectively, have been plotted in the form of curves in Figure 5. It will be noted that there is a seasonal variation in the range of the tide at this station, the range increasing in the late spring and early summer months and decreasing in the winter months.

EXTREME TIDES

The monthly highest and lowest observed tides at Fort Schuyler, N. Y., are given in Tables 29 and 30. These heights are referred to sea-level datum which has been previously discussed on page 20.

For use in connection with the elevations of extreme tides above and below the datum given in Tables 29 and 30, respectively, reference is made to the description and elevation of bench mark 999 at Fort Schuyler as listed on page 20.

While the mean range of tide at Fort Schuyler is 7.17 feet, and the tide normally rises and falls to a plane about 3½ feet above and below mean sea level, it will be noted from the data in these tables that tides have been observed at this station at elevations of nearly 7¾ feet above and 6½ feet below this datum plane.

TABLE 29.—*Monthly extreme high water above sea-level datum, Fort Schuyler, N. Y.*

Year	January		February		March		April		May		June		July	
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*
1921	23	5.4	21	5.6	24	5.1	------	------	------	------	------	------	------	------
1922	11	6.2	15	5.3	11	5.4	1	6.2	11	5.5	11	5.2	24	5.7
1927	4	5.4	20	7.7	3	5.7	2	5.8	5	5.5	1	5.4	2	5.6
1928	28	5.8	23	6.2	18	6.8	24	6.3	30	4.7	20	5.7	16	5.0
1929	25	5.5	7	5.9	16	5.1	16	7.7	9	4.8	7	5.6	6	5.2
Average	------	5.66	------	6.14	------	5.62	------	6.50	------	5.12	------	5.48	------	5.38

Year	August		September		October		November		December		Highest	Average
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Feet*	*Feet*
1920	------	------	------	------	28	5.6	17	7.2	27	7.1	7.2	6.63
1921	3	5.3	5	5.5	3	5.7	27	6.3	2	4.9	6.3	5.48
1922	26	5.2	22	5.8	21	5.4	20	5.7	17	5.9	6.2	5.62
1926	22	5.6	20	5.5	20	6.1	16	5.7	5	5.4	6.1	5.66
1927	15	5.6	14	5.4	18	5.9	28	6.1	4	7.0	7.7	5.92
1928	12	5.1	19	6.9	1	5.7	30	5.3	27	5.4	6.9	5.74
1929	6	4.6	22	5.3	2	7.3	------	------	------	------	7.7	5.70
Average	------	5.23	------	5.73	------	5.96	------	6.05	------	5.95	------	5.75

The highest tide of these observations was 7.7 feet above sea-level datum and occurred on Feb. 20, 1927, and Apr. 16, 1929.

The heights in the above table are referred to the sea-level datum defined on page 20.

TABLE 30.—*Monthly extreme low water below sea-level datum, Fort Schuyler, N. Y.*

Year	January		February		March		April		May		June		July	
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*
1921	24	6.1	19	4.8	22	5.3	------	------	------	------	------	------	------	------
1922	16	6.0	13	6.1	14	4.8	13	4.7	10	5.1	26	4.8	26	4.6
1927	16	6.0	4	3.9	4	4.8	1	4.9	1	4.8	28	4.6	16	4.4
1928	26	6.0	21	6.3	20	5.1	9	4.6	------	------	18	5.2	17	4.8
1929	29	5.0	23	5.1	7	5.4	2	4.8	8	5.5	8	4.8	6	5.0
Average	------	5.82	------	5.24	------	5.08	------	4.75	------	5.13	------	4.85	------	4.70

Year	August		September		October		November		December		Lowest	Average
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Feet*	*Feet*
1920	------	------	------	------	30	5.5	17	5.6	25	5.9	5.9	5.67
1921	4	4.9	2	4.8	1	4.7	15	4.8	18	5.4	6.1	5.10
1922	24	5.1	20	4.5	19	5.6	16	5.1	6	6.2	6.2	5.22
1926	24	4.3	22	4.6	21	4.7	10	5.2	17	5.2	5.2	4.80
1927	16	4.4	13	4.2	11	4.9	7	5.6	10	5.5	6.0	4.83
1928	15	4.4	28	4.9	29	5.3	28	5.7	30	6.0	6.3	5.30
1929	5	5.3	3	4.7	4	4.8	------	------	------	------	5.4	5.04
Average	------	4.73	------	4.62	------	5.07	------	5.33	------	5.70	------	5.10

The lowest tide of these observations was 6.3 feet below sea-level datum and occurred on Feb. 21, 1928. The heights in the above table are referred to the sea-level datum defined on page 20.

DIURNAL INEQUALITIES

The diurnal high-water inequalities and diurnal low-water inequalities in the tide at this locality, based on actual observations, are presented in Tables 31 and 32, respectively, which show monthly variations in such inequalities.

TABLE 31.—*Diurnal high-water inequalities, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January	------	0.41	0.22	------	0.24	0.46	0.38	0.34
February	------	0.35	0.30	------	0.43	0.64	0.33	0.41
March	------	0.24	0.28	------	0.28	0.42	0.41	0.33
April	------	------	0.31	------	0.23	0.52	0.45	0.38
May	------	------	0.36	------	0.70	0.36	0.37	0.45
June	------	------	0.31	------	0.32	0.41	0.33	0.34
July	------	------	0.32	------	0.33	0.40	0.33	0.34
August	------	0.21	0.25	0.29	0.28	0.32	0.34	0.28
September	------	------	0.22	0.34	0.27	0.26	0.29	0.28
October	0.28	0.19	0.33	0.36	0.25	0.19	0.34	0.28
November	0.58	0.23	0.28	0.48	0.37	0.27	------	0.37
December	0.42	0.33	0.34	0.46	0.61	0.28	------	0.41
Mean	------	------	------	------	------	------	------	0.35

TABLE 32.—*Diurnal low-water inequalities, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		0.23	0.37		0.27	0.44	0.23	0.31
February		0.31	0.20		0.10	0.33	0.17	0.22
March		0.26	0.16		0.23	0.33	0.43	0.28
April			0.20		0.17	0.33	0.42	0.28
May			0.17		0.29	0.26	0.26	0.24
June			0.22		0.28	0.31	0.31	0.28
July			0.24		0.26	0.33	0.25	0.27
August		0.10	0.21	0.24	0.30	0.23	0.25	0.22
September			0.19	0.18	0.25	0.15	0.21	0.20
October	0.22	0.23	0.20	0.34	0.24	0.18	0.22	0.23
November	0.36	0.40	0.24	0.37	0.34	0.25		0.33
December	0.37	0.28	0.32	0.43	0.51	0.32		0.37
Mean								0.27

The values in Table 31 are the differences between mean high water and mean higher high water for each month while those in Table 32 are the differences between mean low water and mean lower low water for each month. It will be noted that the inequalities for high water and low water do not vary much from month to month and also that the inequalities for both high water and low water are approximately equal, averaging about 0.3 foot. In a range of 7.2 feet, such as obtains at Fort Schuyler, it will be seen that the inequalities in the tide represent something less than 4 per cent of the range of tide.

The diurnal inequalities exhibit variations from month to month and year to year due to changes in astronomical conditions. The reduced values for diurnal high-water and low-water inequalities at this station are given in Tables 33 and 34. These values have been obtained by applying factors to the values in Tables 31 and 32 depending upon the longitude of the moon's node.

TABLE 33.—*Diurnal high-water inequalities reduced for longitude of moon's node, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		0.41	0.23		0.21	0.39	0.31	0.31
February		0.43	0.38		0.44	0.63	0.31	0.44
March		0.35	0.42		0.33	0.47	0.44	0.40
April			0.43		0.25	0.55	0.45	0.42
May			0.40		0.64	0.32	0.31	0.42
June			0.31		0.27	0.33	0.26	0.29
July			0.39		0.28	0.33	0.26	0.32
August		0.25	0.31	0.31	0.28	0.31	0.32	0.30
September			0.33	0.42	0.31	0.29	0.31	0.33
October	0.36	0.26	0.45	0.41	0.27	0.19	0.34	0.33
November	0.60	0.25	0.30	0.45	0.33	0.23		0.36
December	0.39	0.32	0.34	0.39	0.49	0.22		0.36
Mean								0.36

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TABLE 34.—*Diurnal low-water inequalities reduced for longitude of moon's node, Fort Schuyler, Throgs Neck, N. Y.*

Month	1920	1921	1922	1926	1927	1928	1929	Mean
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
January		0.23	0.38		0.24	0.37	0.19	0.28
February		0.38	0.26		0.10	0.33	0.16	0.25
March		0.38	0.24		0.27	0.37	0.46	0.34
April			0.27		0.19	0.24	0.42	0.28
May			0.18		0.26	0.23	0.22	0.22
June			0.22		0.23	0.25	0.24	0.24
July			0.30		0.22	0.27	0.20	0.25
August		0.13	0.26	0.25	0.30	0.22	0.23	0.23
September			0.29	0.22	0.29	0.17	0.22	0.24
October	0.28	0.30	0.28	0.38	0.26	0.18	0.22	0.27
November	0.37	0.43	0.26	0.34	0.30	0.22		0.32
December	0.35	0.27	0.32	0.37	0.41	0.25		0.33
Mean								0.27

SUMMARY OF TIDAL DATA

For convenience the results derived and discussed in this section have been compiled in one table and the data are given in Table 35. In this summary the great diurnal range was obtained by adding to the mean range the reduced high-water inequality of 0.36 foot and the reduced low-water inequality of 0.27 foot. The small diurnal range was likewise obtained by subtracting from the mean range the sum of the reduced inequalities of the tide.

TABLE 35.—*Tidal data, Fort Schuyler, Throgs Neck, N. Y.*

TIME RELATIONS	
	Hours
High-water interval	11.31
Low-water interval	5.65
Duration of rise	5.66
Duration of fall	6.76
Mean rise interval	8.48
RANGES	
	Feet
Mean range	7.17
Great diurnal range	7.80
Small diurnal range	6.54
COMPARISON OF RANGES	
	Ratios
Great diurnal range÷mean range	1.088
Small diurnal range÷mean range	0.912
HEIGHT RELATIONS	
	Feet
Mean high water above sea-level datum	3.78
Mean higher high water above sea-level datum	4.14
Mean lower high water above sea-level datum	3.42
Mean low water below sea-level datum	3.43
Mean lower low water below sea-level datum	3.70
Mean higher low water below sea-level datum	3.16
Half-tide level above sea-level datum	0.17

THE TIDE AT WILLETS POINT, LONG ISLAND, N. Y.

INTRODUCTORY

With the exception of approximately one lunar period in 1886 and brief periods in 1890 and 1929, the Coast and Geodetic Survey has never obtained tidal observations at Willets Point, Long Island, a locality at the mouth of the East River where that waterway joins western Long Island Sound. Through the cooperation of the Corps of Engineers, United States Army, however, the Coast and Geodetic Survey has been furnished the hourly ordinates of the tide at the United States Army Engineers Wharf, Fort Totten, Willets Point, for two yearly periods from July, 1891 to July, 1892, and from January, 1894 to January, 1895, respectively. These observations were obtained by means of a Stierle or Bilgram automatic tide gage.

HARMONIC CONSTANTS

The above-mentioned series of tidal observations are important in that they furnish the basis for the prediction of tides for that locality. Tidal harmonic constants were obtained from harmonic analyses of the two 369-day series of tidal observations beginning July 1, 1891, and January 1, 1894, respectively. These constants are given in Table 36.

TABLE 36.—*Harmonic constants, Willets Point (United States Army Engineers Wharf), N. Y.*

[Values in parentheses have been inferred from other constants]

Component	1891		1894		Mean of the 2-year series	
	Amplitude	Epoch	Amplitude	Epoch	Amplitude	Epoch
	H	κ	H	κ	H	κ
	Feet	*Degrees*	*Feet*	*Degrees*	*Feet*	*Degrees*
J_1	(0.015)	(108)	(0.016)	(99)	(0.016)	(104)
K_1	0.339	122	0.339	116	0.339	119
K_2	0.160	357	0.131	360	0.146	359
L_2	0.411	1	0.189	4	0.300	3
M_1	0.028	120	0.013	212	0.020	166
M_2	3.597	330	3.701	328	3.649	329
M_4	0.108	214	0.085	207	0.096	211
M_6	0.193	88	0.228	80	0.210	84
N_2	0.749	306	0.738	302	0.744	304
2N	(0.100)	(283)	(0.098)	(277)	(0.099)	(280)
O_1	0.191	148	0.205	151	0.198	150
OO	(0.008)	(95)	(0.009)	(81)	(0.008)	(88)
P_1	0.090	147	0.092	120	0.091	134
Q_1	(0.037)	(161)	(0.040)	(169)	(0.038)	(165)
2Q	(0.005)	(175)	(0.005)	(186)	(0.005)	(180)
R_2	(0.005)	(351)	(0.005)	(354)	(0.005)	(352)
S_2	0.621	351	0.668	354	0.644	352
T_2	(0.037)	(351)	(0.039)	(354)	(0.038)	(352)
λ_2	(0.025)	(340)	(0.026)	(340)	(0.026)	(340)
μ_2	(0.086)	(308)	(0.089)	(302)	(0.088)	(305)
ν_2	1.145	307	0.080	317	0.112	312
ρ_1	(0.007)	(160)	(0.008)	(166)	(0.008)	(163)
Sa	0.116	92	0.190	129	0.153	110
Ssa	0.100	174	0.126	48	0.113	111

SUMMARY OF TIDAL DATA

Based on the harmonic constants given above in the last two columns of Table 36, various nonharmonic quantities have been derived. These values pertaining to ages, sequence, ranges, and height relations of the tide at Willets Point are presented in Table 37. In addition, the best determined values for high-water interval and low-water interval at this station are also given in Table 37 and further discussion regarding these values will be found in a following paragraph.

TABLE 37.—*Tidal data, Willets Point, N. Y.*

TIME RELATIONS	Hours
High-water interval	11. 30
Low-water interval	5. 71
Duration of rise	5. 59
Duration of fall	6. 83
Phase age	23. 4
Parallax age	44. 8
Diurnal age	331. 9

Sequence of tides is HHW to LLW.

RANGES	Feet
Mean range	7. 18
Great diurnal range	7. 70
Small diurnal range	6. 66
Great tropic range	8. 22
Mean tropic range	7. 44
Small tropic range	6. 65
Spring range	8. 55
Neap range	5. 68
Perigean range	8. 23
Apogean range	6. 38

COMPARISON OF RANGES	Ratios
Great diurnal range÷mean range	1. 072
Small diurnal range÷mean range	0. 928
Great tropic range÷mean range	1. 145
Mean tropic range÷mean range	1. 036
Small tropic range÷mean range	0. 926
Spring range÷mean range	1. 191
Neap range÷mean range	0. 791
Perigean range÷mean range	1. 146
Apogean range÷mean range	0. 889

HEIGHT RELATIONS	Feet
Mean high water above mean sea level	3. 59
Mean higher high water above mean sea level	3. 91
Mean lower high water above mean sea level	3. 27
Tropic higher high water above mean sea level	4. 20
Tropic lower high water above mean sea level	3. 23
Spring high water above mean sea level	4. 27
Neap high water above mean sea level	2. 84
Mean low water below mean sea level	3. 59
Mean lower low water below mean sea level	3. 79
Mean higher low water below mean sea level	3. 39
Tropic lower low water below mean sea level	4. 02
Tropic higher low water below mean sea level	3. 42
Spring low water below mean sea level	4. 28
Neap low water below mean sea level	2. 84
Half-tide level below mean sea level	0. 00

Particular attention is called to the values for high-water interval and low-water interval for Willets Point, N. Y., as given in Table 37. The value for high-water interval (11.30 hours) was derived by a first-reduction method and is the mean of the yearly average values for the 1892 and 1894 series of observations, which are, respectively, 11.32 hours and 11.27 hours. The value for low-water interval (5.71 hours) is likewise derived by a first-reduction method and is the mean of the average values for the months of December, 1891; March, 1892; April, 1892; June, 1892; and September, 1892, which are, respectively, 5.75 hours, 5.59 hours, 5.67 hours, 5.90 hours, and 5.62 hours. The values for durations of rise and fall of tide at Willets Point, N. Y., as given in Table 37, were derived from the values for high-water interval and low-water interval given in the same table.

EXTREME TIDES

The monthly highest and lowest observed tides at Willets Point, N. Y., during the latter half of the year 1891 and during the years 1892 and 1894 are given in Tables 38 and 39. These heights are referred to local mean sea level, which datum, based on the summation of hourly ordinates of the tide during the observational period, was 4.144 feet on tide staff, or 15.38 feet below bench mark 734 (Board of Estimate and Apportionment, New York City). This bench mark is described on page 34, Tidal Bench Marks, State of New York (Special Publication No. 83, United States Coast and Geodetic Survey), as follows:

Serial No. 264. Willets Point: B. M. 734 (B. E. & A.) is a small cross, ¾″, cut in the top of the horizontal surface at the east end of the bluestone sill of the east window on the north side of the 2-story red brick casemate storehouse building, just south of the long dock, in the military reservation at Fort Totten. The cross is 3½ inches from the east end of the sill and the figure 19.5205 is scratched below on the vertical face of the sill. Elevation: 19.2 feet above mean low water; 15.60 feet above standard sea level.

It should be noted that standard sea level has reference to the datum of mean sea level at Sandy Hook, N. J., which datum has been carried to Willets Point through precise leveling. The tidal observations at this locality based on a two years' series show that there is a difference of 0.22 foot between standard sea level and local mean sea level. The elevation 19.5205 feet referred to in the above description of bench mark 734 is the elevation of that bench mark above the zero of the tide staff at Willets Point during the years 1891, 1892, and 1894.

TABLE 38.—*Monthly extreme high water above sea level, Willets Point, N. Y.*

Year	January		February		March		April		May		June		July	
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*
1891													23	4.7
1892	30	5.8	11	5.6	2	5.5	29	5.1	26	5.5	24	5.3	23	4.8
1894	21	5.7	13	7.2	23	5.3	11	7.4	21	6.1	4	5.1	5	5.2
Average		5.75		6.40		5.40		6.25		5.80		5.20		4.90

Year	August		September		October		November		December		Highest	Average
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Feet*	*Feet*
1891	19	5.1	20	5.1	12	5.3	7	5.0	15	5.7	5.7	5.15
1892	26	4.7	11	5.0	9	5.3	4	5.4	3	5.4	5.8	5.28
1894	2	5.1	1	5.3	10	7.3	26	5.4	11	5.4	7.4	5.88
Average		4.97		5.13		5.97		5.27		5.50		5.54

The highest tide of these observations was 7.4 feet above sea level and occurred on April 11, 1894.
The heights in the above table are referred to local sea level derived from observations during the period 1891–1894.

TABLE 39.—*Monthly extreme low water below sea level, Willets Point, N. Y.*

Year	January		February		March		April		May		June		July	
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*
1891													23	4.8
1892	26	6.0	1	4.9	14	5.7	26	5.2	25	4.9	23	4.4	22	4.6
1894	12	5.6	16	5.9	20	4.6	9	5.0	8	4.7	6	5.0	2	5.1
Average		5.80		5.40		5.65		5.10		4.80		4.70		4.83

Year	August		September		October		November		December		Lowest	Average
	Date	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Date*	*Feet*	*Feet*	*Feet*
1891	20	4.6	16	5.6	20	4.9	18	5.7	17	6.5	6.5	5.35
1892	10	4.6	7	4.9	6	5.5	5	6.3	4	5.9	6.3	5.24
1894	2	4.7	2	4.2	15	5.2	28	5.8	13	6.3	6.3	5.18
Average		4.63		4.90		5.20		5.93		6.23		5.26

The lowest tide of these observations was 6.5 feet below sea level and occurred on December 17, 1891.
The heights in the above table are referred to local sea level derived from observations during the period 1891–1894.

THE CURRENT AT LIGHTSHIP STATIONS, EASTERN LONG ISLAND SOUND

BARTLETT REEF LIGHTSHIP

If the axis of Eastern Long Island Sound be taken as a line connecting Stratford Shoal Light and Stonington Outer Breakwater Light, it will be found that both Bartlett Reef and Cornfield Point Lightships are located on such axis. Vessels entering Long Island Sound from Fishers Island Sound or from the Thames River generally pass Bartlett Reef Lightship in making their courses westerly toward Cornfield Point Lightship, while those entering from The Race generally pass Bartlett Reef Lightship 1 or 2 miles to the southward. This lightship, therefore, is an important aid to navigation at the eastern end of Long Island Sound.

The tidal current at this station is primarily of the reversing, or rectilinear type; that is, it floods, or sets westerly through Long Island Sound for a period of about six hours and then reverses its direction and ebbs, or sets easterly for another 6-hour period. The results of a long period of observations at this station as given in Table 58 on page 78 show the durations of flood and ebb to be 6.84 hours and 5.58 hours, respectively.

Long-period current observations have been obtained by the Coast and Geodetic Survey at Bartlett Reef Lightship on several occasions through the cooperation of the Bureau of Lighthouses. From September 25 to December 25, 1913, hourly current observations were obtained continuously at this station by means of current pole and current log line. During the same period similar observations were obtained at many lightship stations along the Atlantic coast. This series of current observations at Bartlett Reef Lightship was analyzed harmonically and the harmonic constants which were derived from this analysis are given in Table 40.

TABLE 40.—*Harmonic constants, Bartlett Reef Lightship*

[From an 87-day series, 1913]

Component	North and south element (magnetic)		East and west element (magnetic)	
	Amplitude	Epoch	Amplitude	Epoch
	H	κ	H	κ
	Knots	*Degrees*	*Knots*	*Degrees*
K_1	0.0234	89.35	0.0646	187.07
M_2	0.4089	251.03	1.1016	43.91
M_4	0.1619	259.82	0.0388	65.20
M_6	0.0021	345.98	0.0348	112.51
N_2	0.0965	225.67	0.2201	16.55
O_1	0.0175	87.04	0.0419	197.50
S_2	0.0905	290.83	0.1990	54.41

The longest and most recent series of current observations at Bartlett Reef Lightship was that obtained from August 8, 1929, to March 31, 1930. This series was begun in the summer of 1929 when a comprehensive current and tide survey of Long Island Sound was in progress. The results of this series of observations are given in Table 41.

TABLE 41.—*Current data, station 5 (Bartlett Reef Lightship)*

[Referred to times of current at The Race]

Date of observations	Tidal current							
	Slack before flood	Strength of flood			Slack before ebb	Strength of ebb		
		Time	Velocity	Direction		Time	Velocity	Direction
	Hours	*Hours*	*Knots*	*True*	*Hours*	*Hours*	*Knots*	*True*
Aug. 8-31, 1929	−2.07	−0.84	1.50	253	−1.25	−1.73	1.39	90
Sept. 1-30, 1929	−2.41	−0.84	1.41	258	−0.92	−1.79	1.31	83
Oct. 1-31, 1929	−2.31	−0.83	1.25	256	−1.25	−1.67	1.21	84
Nov. 1-30, 1929	−2.23	−1.01	1.27	259	−1.10	−1.43	1.18	87
Dec. 1-31, 1929	−2.28	−1.04	1.29	252	−1.05	−1.72	1.23	93
Jan. 1-31, 1930	−2.24	−1.18	1.32	252	−0.86	−1.72	1.21	96
Feb. 11-28, 1930	−1.85	−1.18	1.39	257	−0.99	−1.75	1.35	98
Mar. 1-31, 1930	−1.24	−1.01	1.38	252	−1.11	−1.41	1.51	92
Mean	−2.08	−0.99	1.35	255	−1.07	−1.65	1.30	90

Date of observations	Nontidal current		Greatest current observed during month					Mean current hour
	Velocity	Direction	Date	Direction	Velocity	Wind		
						Direction	Velocity	
	Knots	*True*		*True*	*Knots*	*Magnetic*	*Miles*	*Hours*
Aug. 8-31, 1929	0.22	183	Aug. 11	251	2.0	135	10	12.08
			Aug. 10	92	1.9	225	8	
Sept. 1-30, 1929	0.08	207	Sept. 18	255	1.8	360	23	12.06
			Sept. 29	90	1.9	225	23	
Oct. 1-31, 1929	0.09	183	Oct. 15	271	1.9	45	34	12.03
			Oct. 30	98	1.7	135	18	
Nov. 1-30, 1929	0.09	197	Nov. 18	276	1.6	45	34	12.11
			Nov. 17	110	1.9	270	8	
Dec. 1-31, 1929	0.23	179	Dec. 23	290	1.7	135	48	12.03
			Dec. 16	124	1.7	45	23	
Jan. 1-31, 1930	0.27	185	Jan. 18	281	1.8	90	23	12.05
			Jan. 18	132	1.9	315	28	
Feb. 11-28, 1930	0.26	180	Feb. 12	298	1.9	225	18	12.11
			Feb. 16	136	1.6	315	34	
Mar. 1-31, 1930	0.22	151	Mar. 15	246	2.1	45	18	12.36
			Mar. 12	126	2.1	225	23	
Mean	0.18	183	----------	271	1.85	----------	----------	12.10
				114	1.84			

Bartlett Reef Lightship will be found to be current station No. 5 in Figure 19 on page 80. In Table 41, which shows the monthly variation in the tidal current at Bartlett Reef Lightship, the times of slack and strength of current are given in hours and hundredths of an hour and are referred to the times of similar phases of the current at The Race, the current in every case being considerably earlier at the lightship station than at the reference station, as indicated by the minus (−) signs placed before such time values. Slack water has reference to the time when the current has ceased flowing in one direction and begins to flow in an opposite direction. Theoretically it is instantaneous, but practically it varies with the velocity of the current at times of strength. It represents the time when the current can not be appreciably measured by means of current pole and current log line.

It will be noted that the easterly current or ebb does not set directly opposite to the flood. This is most likely due to the location of the station. The velocities of flood and ebb are practically of the same strength, however.

The mean current hour listed in the last column of the table is given in solar hours and is the mean interval between the transit of the moon over the meridian of Greenwich and the time of the strength of the flood current modified by the times of slack water and strength of ebb. In computing the mean current hour an average is obtained of the intervals for the following phases: Flood strength, slack before flood increased by one-fourth semilunar day (3.10 hours), slack after flood decreased by one-fourth semilunar day, and ebb strength increased or decreased by one-half semilunar day (6.21 hours). Before taking the average the four phases are

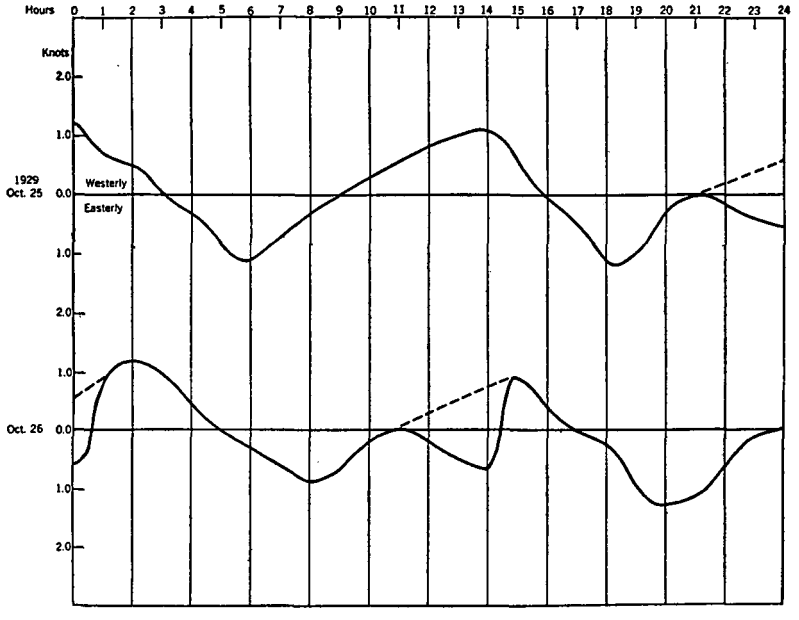

FIGURE 6.—*Current curve, Bartlett Reef Lightship, showing the effect of strong winds upon the tidal current*

made comparable by the addition or rejection of such multiples of the semilunar day (12.42 hours) as may be necessary.

In addition to the results for the tidal current, which is a periodic phenomenon accompanying the tide, there are also given in Table 41 the results for mean monthly nontidal current at this station. Nontidal currents are not periodic in character and are produced principally by winds, fresh water run-off, changes in atmospheric pressures, temperatures, etc. The southerly monthly sets at this station during the observational period from August to March are most likely due to the prevalence of northerly winds and the decreased velocities of the nontidal sets during the fall months are likewise due to decreased wind velocities.

The greatest observed flood and ebb currents during the monthly periods are also given in Table 41. These are comparable to highest

and lowest observed tides and should prove to be of interest and value to navigators. It will be noted that in general the greatest observed currents are about one-half knot stronger in velocity than the mean flood or ebb strengths. For convenience there are also given in the table the directions and velocities of the wind which obtained at the times of greatest observed current.

The tidal current curve at Bartlett Reef Lightship under normal weather conditions is of the semidiurnal or semidaily type; that is, there are two flood periods and two ebb periods each day. The non-tidal current produced by strong winds may have a pronounced effect upon the tidal current. In some cases it may be so great as to actually prevent the occurrence of a flood or ebb period of the tidal current itself, causing the latter to flood or ebb for a period of half a lunar day or longer as the case may be.

The effect of strong westerly winds upon the tidal current at Bartlett Reef Lightship is clearly shown in Figure 6, which illustrates the tidal current curve for this station based on observations covering the period October 25–26, 1929. The velocities of flood are plotted above the slack-water datum and the velocities of ebb below such datum.

Average tidal current conditions should have obtained at this station at this time of the month. Owing to the presence of strong westerly winds, however, flood and ebb were considerably affected by such wind influence.

In Figure 6 the solid line represents the plotting of the current velocities as actually observed at this station. The dotted line represents approximately the tidal current curve which would have obtained as uninfluenced by the strong westerly winds which prevailed at the time the observations were made. On the Atlantic coast winds of 35 to 40 miles per hour in strength will produce currents of 0.5 to 0.6 knot in velocity. In Figure 6 it will be noted that when the tidal current attained sufficient strength to overcome the effect of the wind current it then ceased to ebb and began to flood, or run westerly. Attention is called to the portion of the curve for October 25 (9 p. m. to midnight) and for October 26 (11 a. m. to 3 p. m.). Thus, it will be seen that the tidal-current velocities and directions, like the heights of high and low water, are greatly influenced by the occurrence of strong winds.

CORNFIELD POINT LIGHTSHIP

Cornfield Point Lightship is located about 3 miles from Cornfield Point, Conn., from which locality it derives its name. It might also be stated that it is located about 1 mile south of Long Sand Shoal, a narrow shoal 6 miles in length and extending easterly and westerly in Long Island Sound some 2 miles off the entrance to the Connecticut River. From its location Cornfield Point Lightship is an important aid to navigation for vessels sailing through Long Island Sound and especially for those engaged in the navigation of the Connecticut River.

The tidal current at this station, like that at Bartlett Reef Lightship some 12 miles to the eastward, is primarily reversing in character. The results from observations for the month of September, 1922, as shown by the ellipse in Figure 7, however, indicate that even at inland stations such as Cornfield Point Lightship the current,

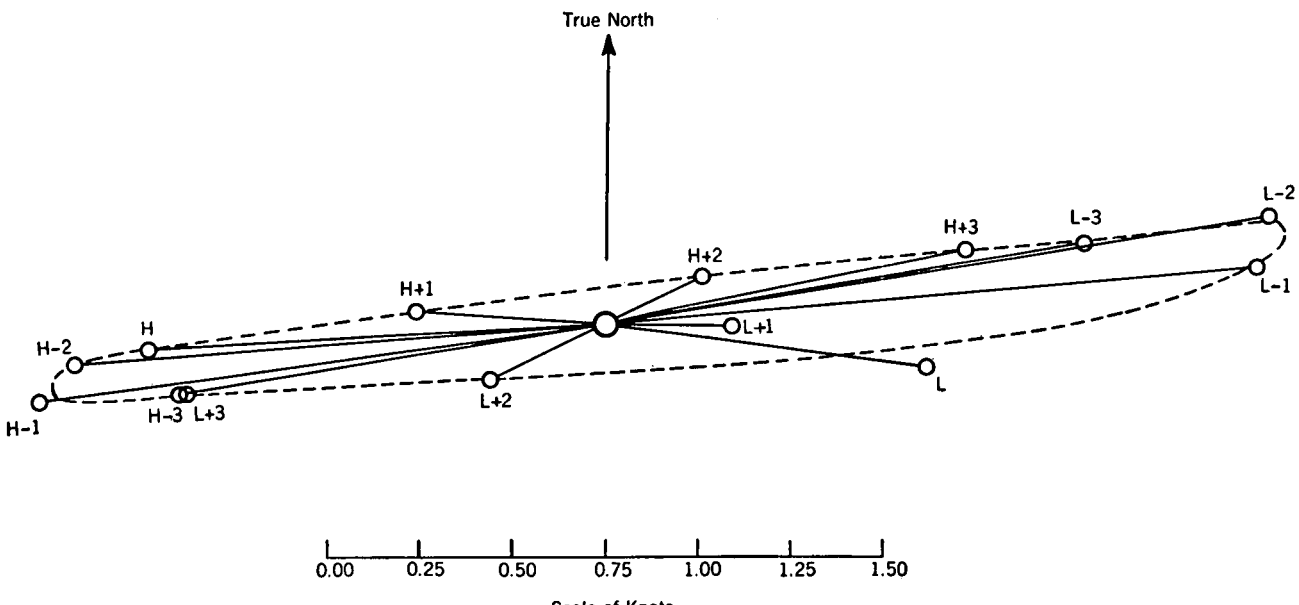

FIGURE 7.—Current ellipse from a nonharmonic tabulation, Cornfield Point Lightship

although primarily of the reversing type, exhibits the characteristics of the rotary type found at offshore points.

In Figure 7 the hourly velocities and directions of the tidal current for a 29-day lunar period have been referred to the times of high water and low water at New London, Conn., the plus (+) sign meaning "later than" and the minus (−) sign meaning "earlier than" the times of high or low water at New London. It will be noted that the current changes considerably in velocity and direction hour by hour and that the reversal of the tidal current from flood to ebb, or vice versa, is clockwise.

Current observations have been obtained at Cornfield Point Lightship from time to time ever since 1890. In the latter year one month's slack water observations were obtained during the month of August. In 1913 an 87-day series was made from September 27 to December 22, simultaneous with that at Bartlett Reef Lightship. In 1922 approximately four months of observations were obtained at this station from August 9 to November 30, in connection with a current and tide survey of New York Harbor which was executed during the summer of that year.

The longest and most recent series of current observations at Cornfield Point Lightship was that obtained from July 11, 1929, to December 31, 1930. The results of this series, together with those derived from the series of 1890, 1913, and 1922, are given in Table 42.

TABLE 42.—*Current data, station 28 (Cornfield Point Lightship)*

[Referred to times of current at The Race]

Date of observations	Tidal current							
	Slack before flood	Strength of flood			Slack before ebb	Strength of ebb		
		Time	Velocity	Direction		Time	Velocity	Direction
	Hours	*Hours*	*Knots*	*True*	*Hours*	*Hours*	*Knots*	*True*
Aug. 1-31, 1890	−0.70				0.12			
Sept. 27-Oct. 25, 1913	−1.10	−0.49	1.85	257	−0.23	0.32	1.67	86
Oct. 26-Nov. 23, 1913	−1.05	−0.47	1.91	258	−0.22	−0.57	1.68	92
Nov. 24-Dec. 22, 1913	−0.97	−0.48	1.70	256	−0.28	−0.50	1.60	94
Aug. 9-31, 1922	−1.22	−0.48	1.90	264	−0.08	−0.50	1.62	82
Sept. 1-30, 1922	−1.15	−0.67	1.82	264	−0.07	−0.28	1.60	82
Oct. 1-31, 1922	−1.00	−0.28	1.78	261	−0.03	−0.37	1.55	88
Nov. 1-30, 1922	−1.01	−0.51	1.83	258	−0.20	−0.43	1.57	92
July 11-31, 1929	−0.92	−0.01	2.00	247	0.27	−0.18	1.75	84
Aug. 1-31, 1929	−1.05	−0.17	2.18	251	0.01	−0.64	1.83	93
Sept. 1-30, 1929	−0.94	−0.40	2.06	254	−0.26	−0.26	1.87	97
Oct. 1-31, 1929	−0.80	−0.48	1.92	252	−0.40	−0.37	1.77	102
Nov. 1-30, 1929	−0.97	−0.60	2.04	253	−0.37	−0.45	1.76	102
Dec. 1-31, 1929	−1.02	−0.62	1.91	255	−0.31	−0.45	1.72	100
Jan. 1-31, 1930	−1.17	−0.51	1.94	254	−0.03	−0.72	1.59	101
Feb. 1-28, 1930	−0.99	−0.58	1.98	255	−0.07	−0.52	1.73	99
Mar. 1-31, 1930	−0.96	−0.60	2.00	251	−0.26	−0.83	1.80	100
Apr. 1-30, 1930	−1.02	−0.50	2.02	252	−0.05	−0.73	1.72	101
May 1-31, 1930	−1.13	−0.41	2.04	258	−0.02	−0.55	1.67	97
June 1-30, 1930	−0.96	−0.21	2.08	258	−0.02	−0.31	1.92	92
July 1-31, 1930	−0.94	−0.15	2.15	254	0.11	−0.37	1.96	90
Aug. 1-31, 1930	−0.95	−0.35	1.99	256	0.12	−0.40	1.86	95
Sept. 1-30, 1930	−0.83	−0.13	1.84	254	0.07	−0.39	1.82	93
Oct. 1-31, 1930	−0.75	−0.46	1.89	251	−0.03	−0.41	1.69	98
Nov. 1-30, 1930	−1.09	−0.41	1.89	253	−0.09	−0.72	1.62	100
Dec. 1-31, 1930	−1.07	−0.31	1.86	252	−0.09	−0.66	1.64	101
Mean	−0.99	−0.41	1.94	255	−0.09	−0.45	1.72	95

TABLE 42.—*Current data, station 28 (Cornfield Point Lightship)*—Continued

Date of observations	Nontidal current		Greatest current observed during month					Mean current hour
	Velocity	Direction	Date	Direction	Velocity	Wind		
						Direction	Velocity	
	Knots	*True*		*True*	*Knots*	*Magnetic*	*Miles*	*Hours*
Aug. 1-31, 1890								0.92
Sept. 27-Oct. 25, 1913	0.18	207	Sept. 30	263	2.7	45	23	0.59
			Oct. 1	101	2.4	90	34	
Oct. 26-Nov. 23, 1913	0.25	205	Oct. 29	265	2.6	135	18	0.55
			Nov. 1	95	2.5	270	40	
Nov. 24-Dec. 22, 1913	0.28	186	Nov. 27	248	2.4	45	28	0.57
			Dec. 14	79	2.6	270	28	
Aug. 9-31, 1922	0.13	256	Aug. 24	261	2.7	225	13	0.56
			Aug. 24	61	2.7	225	18	
Sept. 1-30, 1922	0.31	265	Sept. 21	258	2.6	68	18	0.59
			Sept. 24	89	2.3	225	8	
Oct. 1-31, 1922	0.18	219	Oct. 22	264	2.6		Calm.	0.71
			Oct. 21	94	2.5	270	13	
Nov. 1-30, 1922	0.30	200	Nov. 5	263	2.6	22	8	0.59
			Nov. 18	73	2.3	292	28	
July 11-31, 1929	0.37	186						0.92
Aug. 1-31, 1929	0.51	192						0.67
Sept. 1-30, 1929	0.42	188	Sept. 9	264	2.8	90	18	0.67
			Sept. 3	107	2.5	270	8	
Oct. 1-31, 1929	0.50	184	Oct. 2	264	2.4	22	34	0.62
			Oct. 18	128	2.2	338	28	
Nov. 1-30, 1929	0.52	193	Nov. 17	267	2.6	315	18	0.53
			Nov. 28	170	2.6	292	40	
Dec. 1-31, 1929	0.42	189	Dec. 18	270	2.5	90	13	0.53
			Dec. 2	112	2.4	315	8	
Jan. 1-31, 1930	0.45	200	Jan. 14	270	2.9	90	18	0.52
			Jan. 16	146	2.3	360	13	
Feb. 1-28, 1930	0.41	194	Feb. 11	248	2.8	315	18	0.59
			Feb. 14	124	2.8	315	23	
Mar. 1-31, 1930	0.50	187	Mar. 15	253	2.9	338	18	0.47
			Mar. 19	124	2.4	315	23	
Apr. 1-30, 1930	0.52	193	Apr. 11	254	2.7	135	13	0.55
			Apr. 10	104	2.7	270	18	
May 1-31, 1930	0.37	210	May 28	270	2.7	270	8	0.60
			May 27	98	2.5	292	13	
June 1-30, 1930	0.27	195	June 27	273	2.8	180	8	0.75
			June 24	96	2.7	225	13	
July 1-31, 1930	0.32	189	July 27	258	2.8	90	13	0.79
			July 13	101	2.5	225	13	
Aug. 1-31, 1930	0.33	187	Aug. 25	258	2.8	68	8	0.73
			Aug. 2	81	2.7	248	18	
Sept. 1-30, 1930	0.32	176	Sept. 22	255	2.5	225	13	0.81
			Sept. 22	103	2.5	292	8	
Oct. 1-31, 1930	0.44	188	Oct. 20	247	2.7	338	18	0.72
			Oct. 25	100	2.4	315	34	
Nov. 1-30, 1930	0.44	195	Nov. 19	250	2.6	22	18	0.55
			Nov. 9	95	2.3	248	18	
Dec. 1-31, 1930	0.47	191	Dec. 7	247	2.4	22	18	0.60
			Dec. 9	95	2.4	270	28	
Mean	0.37	199		260 103	2.66 2.49			0.64

Cornfield Point Lightship will be found as current station No. 28 in Figure 19 on page 80. The above-mentioned current observations were all obtained by means of current pole and current log line. They were made continuously at hourly intervals of time. The only additional information which might be added to the data given in Table 42 is that for the durations of flood and ebb at this station. These are, respectively, 6.72 hours and 5.70 hours, and are based on all the above-mentioned series of observations.

Monthly variations in the times and velocities of the current at Cornfield Point Lightship are given in Table 42. It will be noted that the velocities of flood and ebb at this station are greater than

those at Bartlett Reef Lightship by approximately one-half knot. It will also be noted from a comparison of the mean current hours that the time of current at this station is about an hour later than that at Bartlett Reef Lightship.

The 87-day series of current observations obtained in 1913 at Cornfield Point Lightship was analyzed harmonically and the harmonic constants which were derived from this analysis are given in Table 43.

TABLE 43.—*Harmonic constants, Cornfield Point Lightship*

[Values in parentheses have been inferred from other constants]

Component	1913		Component	1913		Component	1913	
	Amplitude	Epoch		Amplitude	Epoch		Amplitude	Epoch
	H	κ		H	κ		H	κ
	Knots	*Degrees*		*Knots*	*Degrees*		*Knots*	*Degrees*
J_1	(0.004)	(30.2)	N_2	0.352	205.1	S_2	0.304	254.7
K_1	0.104	42.2	2N	(0.047)	178.8	S_4	0.014	95.3
K_2	0.111	271.6	O_1	0.052	66.2	T_2	(0.018)	(254.7)
L_2	(0.047)	(257.7)	OO	(0.002)	(18.2)	λ_2	(0.012)	(242.2)
M_1	0.003	349.4	P_1	(0.034)	(42.2)	μ_2	(0.040)	(208.1)
M_2	1.675	231.4	Q_1	(0.010)	(78.2)	ν_2	(0.068)	(208.6)
M_4	0.075	231.6	2Q	(0.001)	(90.2)	ρ_1	(0.002)	(76.5)

THE TIDE AND CURRENT IN THE RACE AND PLUM GUT

For convenience in discussing the results of tide and current observations in Long Island Sound and its tributaries, this waterway has been subdivided into the following component parts: The Race and Plum Gut, Fishers Island Sound, Thames River, Eastern Long Island Sound, Connecticut River, Housatonic River, and Western Long Island Sound.

The first of these component parts comprises the eastern entrance to Long Island Sound from Block Island Sound. The main entrance is through The Race and secondary entrances are to be found in Plum Gut and in the waterway between Plum and Great Gull Islands.

The Race is a deep waterway between Race Point, Fishers Island, and Little Gull Island. It is 4 miles in width, and about midway between Race Point and Little Gull Island it has a least depth of 18 feet at mean low water over a small, rocky shoal known as Valiant Rock. Most vessels pass through The Race between Valiant Rock and Race Rock Light. This portion of The Race is approximately 1½ miles in extent, and depths up to 300 feet obtain.

Plum Gut connects Long Island Sound with Gardiners Bay, the latter being a western extension from Block Island Sound. It is a deep, navigable waterway situated between Plum Island and Orient Point, Long Island. While its width is about 1 mile in extent, the available width for purposes of navigation is only about one-half mile, owing to the presence of Oyster Pond Reef, a rocky reef extending nearly one-half mile eastward from Orient Point, Long Island, to the vicinity of Orient Point Light. Depths of nearly 200 feet obtain in Plum Gut.

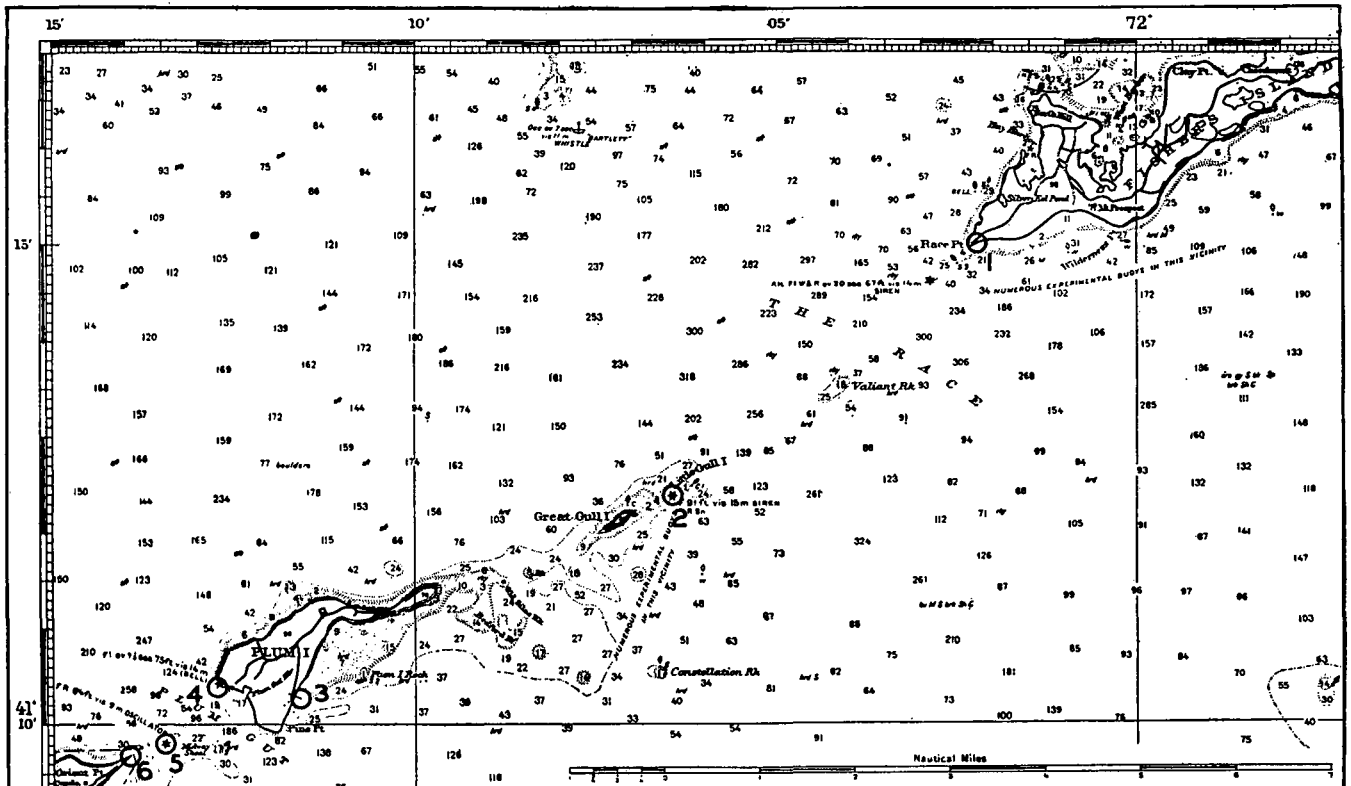

FIGURE 8.—Tide stations, The Race and Plum Gut

TABLE 44.—*Tidal data, The Race and Plum Gut, 1838—1929*

Station No.	Location	Observations		Lunitidal intervals		Duration of rise	Mean range	Compared with—
		Date	Period	HWI	LWI			
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Near Race Point, Fishers Island	July 13-16, 1848	4	9.08	2.41	6.67	2.12	Boston, Mass.
2	Little Gull Island Light	June 24-Aug. 28, 1848	63	9.63	3.62	6.01	2.41	Do.
		July 12-Nov. 2, 1883	65	9.43	3.07	6.36	2.31	New London, Conn.
		June 17-18, 1887	2	10.18	3.13	7.05	2.10	Sandy Hook, N. J.
		July 1-3, 1896	2	9.43	3.15	6.28	2.97	New London, Conn.
		Aug. 27-Nov. 23, 1918	73	9.88	3.47	6.41	2.58	Do.
3	South dock, Plum Island	Nov. 6-10, 1909	2	----------	3.84	----------	----------	Do.
		May 24-June 6, 1910	4	9.82	3.44	6.38	3.18	Do.
4	Plum Island Light, Plum Gut	July 30-Aug. 19, 1874	13	10.11	3.82	6.29	2.69	Boston, Mass.
5	Orient Point Light	July 25-30, 1929	6	9.86	3.96	5.90	2.64	New London, Conn.
6	Orient Point, Long Island	Sept. 3-10, 1838	6	9.33	3.33	6.00	2.75	(1).

[1] Series not compared with that at a standard station; values obtained from first reduction.

Tidal observations have been made by the Coast and Geodetic Survey at six stations in The Race and Plum Gut since 1838, and the locations of these stations are shown in Figure 8. With the exception of the series at Little Gull Island Light, these observations were for brief periods of less than two weeks and were generally made in connection with wire-drag operations or other hydrographic work. At Little Gull Island Light, however, series of two months or more in length were obtained in 1848, 1883, and 1918.

The tidal observations at each of the stations in this area were made by means of a plain staff gage, with the exception of the observations made at Orient Point Light (station 5). Tidal observations at the latter station were obtained by means of a Coast and Geodetic Survey portable automatic tide gage. The results of tidal observations made at stations in The Race and Plum Gut are shown in Table 44.

The lunitidal intervals for high water and low water in Table 44 are given in hours and hundredths of an hour. It might be well to restate that mean high-water lunitidal interval is the average time that elapses between the transit of the moon over the meridian of a place and the following high water. The duration of rise of tide, also given in hours and hundredths of an hour, is obtained by means of differences between the values for high-water interval and those for low-water interval.

In each case, owing to the shortness of the series of observations, the observed times and ranges of the tide were compared with simultaneous observations at long-period standard tide stations. This procedure was not practicable in connection with the series at Orient Point, Long Island, and the values from a first reduction were corrected by means of factors.

The observational values as given in Table 44 were subjected to an adjustment process along with those for Long Island Sound generally and these adjusted values for tide stations in The Race and Plum Gut will be found in Table 57 on page 75. From the data in the latter table, as well as that in Table 44, it will be noted that the time of tide at Race Point, Fishers Island, as compared with that at Little Gull Island Light is about one-half hour earlier at high water and about one hour earlier at low water, the range of tide being somewhat less, however, than that at Little Gull Island Light. Perhaps this relationship in time of tide at these stations at either end of The Race is better shown by reference to the cotidal hours for the two stations. The cotidal hours for Race Point and Little Gull Island Light are I. 90 and II. 44 for high water, respectively, and VII. 19 and VIII. 29 for low water, respectively. The cotidal hour at any place is the time in lunar hours after the moon's transit across the Greenwich meridian at which high water or low water occurs at that place.

The cotidal hour permits differences in absolute time to be readily seen. It is obtained by reducing the high and low water lunitidal intervals to lunar time and then adding the difference in time (if west longitude) in hours and decimals between Greenwich and the place for which the cotidal hour is desired.

The cotidal hours for high water and low water at Orient Point Light, Plum Gut are II. 69 and VIII. 74, respectively. It will be seen, therefore, that the time of tide in Plum Gut, as compared with that at Little Gull Island Light is about one-quarter hour later at

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high water and one-half hour later at low water. The range of tide in Plum Gut is also slightly greater than that at Little Gull Island Light.

Summing up, therefore, the tidal régime in the eastern entrance to Long Island Sound, which extends from Race Point, Fishers Island, to Orient Point, Long Island, is as follows: The time of tide becomes later from east to west through the several entrances to Long Island Sound from Block Island Sound and Gardiners Bay, being much later at low water than at high water. High water in Plum Gut is about three-fourths hour later than high water at Race Point, Fishers Island, while low water is about 1½ hours later at the former locality than at the latter. The durations of rise of tide decrease from east to west from Race Point to Orient Point, while, conversely, the durations of fall of tide increase. The range of tide increases from east to west through these entrances to Long Island Sound, the range in Plum Gut being from one-fourth foot to one-half foot, or about 20 per cent, greater than that at Race Point, Fishers Island.

Since the tide in Long Island Sound and its tributaries is derived from that of the North Atlantic Ocean it is perhaps in order to discuss briefly tidal conditions which obtain along the open coast. The tide occurring along the North Atlantic coast is produced by an oscillating tidal system which has its center of origin, or amphidromic center, southeasterly from Newfoundland at approximately latitude 40° N. and longitude 40° W.

According to Harris [1] —

> Along the greater part of the Atlantic coast, extending from Nova Scotia to Florida, the time of tide is but little delayed on account of the strip of shallow water which borders it. * * * The tidal hour for this stretch of coast (Rhode Island to Florida) is about XII. * * * The tides in Long Island Sound are analogous to the tides in the Gulf of Maine and Bay of Fundy, and so at the western part of the Sound are three hours later than the tides outside and upon which they depend. There is, however, some progression.

According to this authority on tides, this progression is due not to a shoaling at the mouth or entrance to the Sound, such as obtains at the mouth of the Gulf of Maine in the presence of Georges Bank, but rather to a contraction. In addition to this contraction, there are of course, obstacles to the progression of the tide wave such as Fishers Island, Little Gull Island, Great Gull Island, Plum Island, and several rocky shoals and reefs.

In general, the tide of Long Island Sound consists chiefly of a stationary wave whose length has been computed to be approximately 365 nautical miles, based upon a mean tide level depth of 12 fathoms in this waterway. The strong currents which occur at the eastern entrances to Long Island Sound and at the southern entrance to Block Island Sound are due to the fact that a north-and-south line one-fourth of the above-mentioned wave length (365 nautical miles) from the head of Long Island Sound lies about 10 miles east of Little Gull Island Light, or immediately east of Montauk Point, Long Island.

Owing to the presence of a stationary tide wave in Long Island Sound we should expect a large range of tide and a small current

[1] "Manual of Tides," Rollin A. Harris, Part IV B, "Cotidal Lines of the World," pp. 372-373. Appendix No. 5, Report of Superintendent, U. S. Coast and Geodetic Survey for 1904. (Government Printing Office, Washington, 1904.)

velocity at the head of the waterway or western end of the Sound and a small range of tide and considerable current velocities in The Race and Plum Gut at the eastern entrance to the Sound. Such conditions actually obtain, a range of tide of 7¼ feet and current strength of about three-fourths knot occurring off Execution Rocks while in Plum Gut and The Race current velocities of 3½ to 4 knots accompany a tide range of about 2½ feet. Moreover, Plum, Great Gull, and Fishers Islands partially obstruct the passageway to Long Island Sound, thus necessitating increased velocities for maintaining a given rise and fall at the head of the Sound.

The Coast and Geodetic Survey has observed tidal currents in The Race and Plum Gut from time to time since 1845. Special surveys of the current in these passageways were made in 1846 by Goldsborough, in 1915 by lighthouse keepers of the Bureau of Lighthouses, in 1917 by Trueblood, and in 1929 by Finnegan. The results of these observations are given in Table 45 and the locations of the current stations occupied are shown in Figure 9.

For the most part these current observations which are represented in Table 45 were made by means of current pole and current log line method. The current pole used in recent years by the Coast and Geodetic Survey is a standard one, 15 feet in length and weighted at one end with sheet lead so as to float uprightly in the water with 1 foot of its length above the surface of the water. Since this pole submerges to a depth of 14 feet the results of observations may be considered as pertaining to current conditions at an average depth of about 7 feet. The remaining observations were made either with floats at the surface of the water or by observing the action of flood and ebb tidal currents upon anchored buoys. The latter observations were obtained through the cooperation of the Bureau of Lighthouses and were made primarily to determine the times of slack water and durations of flood and ebb currents at such buoy stations.

The times of slack water and of strength of current at stations given in Table 45 are referred to the times of similar phases of the predicted current at The Race. Predictions for The Race of the times of slack water and the times and velocities of flood and ebb strengths for every day in the year are given in the Atlantic Coast Current Tables, published annually, in advance, by the Coast and Geodetic Survey; that is, The Race is a standard port to which subordinate stations in Long Island Sound may be referred in order to predict tidal current conditions at such subordinate stations.

The station in The Race for which predictions are made by the Coast and Geodetic Survey is located approximately three-eighths mile southwest of Valiant Rock, in the neighborhood of station 13 shown in Figure 9. As this is the reference station for the times of the current at all stations in Long Island and Block Island Sounds and their tributaries mentioned in this publication it is considered apropos to give the accepted values for the times of the current at this station. The Greenwich intervals in hours and hundredths of an hour are as follows: Slack before flood, 10.71; strength of flood, 1.16 or 13.58; slack before ebb, 4.12; and strength of ebb, 7.16. The longitude of The Race (standard port) is 72° 04′ W. Allowing for a time correction, therefore, of 4.97 hours for the difference in time between The Race and Greenwich, the local current intervals for The Race in hours and hundredths of an hour are as follows: Slack before flood, 5.74;

TABLE 45.—*Results from current observations near the surface, The Race and Plum Gut*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		The Race		*Days*		*Ft.*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	A. F. Biedermann	Race Point Buoy No. 2	July 4–Sept. 28, 1915	24	Buoy	(1)	−0.60				5.24	−1.19				7.18	0.31
2	P. M. Trueblood	Off Race Rock Light	Aug. 13–15, 1917	2	Pole	7	−0.16	−1.25	291	2.67	5.01	−0.98	−0.26	172	3.66	7.41	0.47
3	H. E. Finnegan	do	July 30–Aug. 1, 1929	1½	do	7	−0.50	−0.50	296	2.15	5.28	−1.05	0.17	159	4.40	7.14	0.66
4	A. F. Biedermann	Special Buoy, south of Race Rock Light	July 10–Sept. 30, 1915.	22	Buoy	(1)	−0.14				5.45	−0.52				6.97	0.88
5	G. S. Blake	Off Race Rock Light	Aug. 9–11, 1845	1½	Pole	9	0.32	−0.25	290	3.57	5.60	0.09	−0.23	171	3.63	6.82	1.11
6	P. M. Trueblood	Northeast of Valiant Rock	Sept. 4–6, 1917	1½	do	7	0.20	−0.07	301	2.59	5.53	−0.10	0.27	115	3.86	6.89	1.21
7	H. E. Finnegan	do	July 30–Aug. 2, 1929	2½	do	7	0.22	0.34	274	2.77	5.73	0.12	0.18	127	3.19	6.69	1.35
8	J. R. Goldsborough	do	Sept. 3–4, 1846; July 15–16, 1848.	2	Float	(1)	0.53	0.64	286	2.88	5.86	0.56	0.59	112	2.81	6.56	1.71
9	H. Mitchell	do	Aug. 22, 1871	½	do	(1)	0.16	0.10	300		5.86	0.19	−0.60			6.56	1.09
10	P. M. Trueblood	do	Aug. 2–4, 1917	1½	Pole	7	−0.03	0.06	303	4.12	6.03	0.17	−0.11	105	4.05	6.39	1.15
11	F. G. Engle	Southwest of Valiant Rock	Aug. 5–7, 1915	2	do	7	−0.18	0.21	295	2.86	6.09	0.08	0.13	121	3.59	6.33	1.19
12	C. P. Perkins	do	June 17–18, 1887	1¼	do	6	0.19	−0.22	306	2.96	5.47	−0.17	−0.11	100	3.36	6.95	1.05
13	H. E. Finnegan	do	July 30–Aug. 1, 1929	1½	do	7	0.07	0.10	319	3.61	5.89	0.13	−0.03	115	4.71	6.53	1.20
14	P. M. Trueblood	do	Sept. 7–8, 1917	1	do	7	−0.13	−0.52	307	3.68	5.83	−0.13	−0.48	118	5.43	6.59	0.81
15	H. E. Finnegan	Off Little Gull Island Reef	July 30–Aug. 1, 1929	1½	do	7	−0.60	−0.20	2	3.27	6.20	−0.23	−0.63	107	3.30	6.22	0.71
16	W. J. Murray	Little Gull Island Reef Buoy No. 1	July 6–Sept. 30, 1915	28	Buoy	(1)	−1.24				6.31	−0.76				6.11	0.20
		Between Great Gull and Plum Islands															
17	H. E. Finnegan	Off Great Gull Island Reef	Aug. 1–2, 1929	1	Pole	7	−0.80	−0.35	281	2.12	5.73	−0.90	−1.85	134	2.72	6.69	0.14
18	J. R. Goldsborough	do	Aug. 16–17, 1846	1	Float	(1)	−0.35	−0.15	307	1.95	6.24	0.06	−0.85	112	2.58	6.18	0.81
19	H. E. Finnegan	Off Old Silas Rock	Aug. 1–2, 1929	1	Pole	7	−1.10	−0.30	323	2.00	6.33	−0.60	−1.15	129	1.72	6.09	0.34
		Plum Gut															
20	C. E. Whitford	Midway Shoal Buoy	July 6–Sept. 30, 1915	21	Buoy	(1)	−1.53				6.25	−1.11				6.17	12 30
21	H. E. Finnegan	North of Midway Shoal	July 29–30, 1929	1	Pole	7	−1.50	−0.95	314	3.46	6.33	−1.00	−1.35	128	4.01	6.09	12.35
22	C. E. Whitford	Special Buoy, Middle Ground Shoal	July 12–Sept. 30, 1915.	20	Buoy	(1)	−1.13				5.74	−1.22				6.68	0.03
23	J. R. Goldsborough	South of Middle Ground Shoal	June 6–7, 1846	1	Float	(1)	0.04	−0.47	270	1.58	4.83	−0.96	−0.35	104	2.08	7.59	0.69
24	P. M. Trueblood	Southwest of Middle Ground Shoal	July 31–Aug. 1, 1917	1	Pole	7	−1.18	−1.42	326	4.02	6.18	−0.83	−1.63	106	3.85	6.24	12.29
25	H. E. Finnegan	Off Oyster Pond Reef	July 26–27, 29–30, 1929.	2	do	7	−1.72	−1.22	351	3.14	6.27	−1.28	−1.50	106	3.74	6.15	12.12

[1] Surface.

strength of flood, 8.61; slack before ebb, 11.57; and strength of ebb, 2.19. However, for strength of flood an adjusted local interval of 8.58 hours (8 hours, 35 minutes), and, consequently, a Greenwich interval of 13.55 hours, or 1.13 hours, is used by the Coast and Geodetic Survey. This latter value is of considerable importance since it is employed in obtaining the mean solar current hour for all current stations listed in this publication.

The accepted intervals for durations of flood and ebb currents at The Race are 5.83 hours and 6.59 hours, respectively. The duration of flood, or time at The Race when the tidal current flows westerly, is the time interval between slack before flood and slack before ebb. Subtracting the value for flood duration, 5.83 hours, from the duration of one-half a lunar day which is 12.42 hours, a value of 6.59 hours is obtained for the duration of ebb at The Race.

A glance at the time relations in Table 45, and especially the data in the last column of this table, will show that the time of current in Plum Gut is considerably earlier, in fact about an hour earlier than the time of current in The Race. This is exactly the opposite with respect to the time of tide in these entrances, where, as it was shown above, the tide in Plum Gut occurs about an hour later than it does at Race Point, Fishers Island.

The observed velocities of the current at stations given in Table 45 have been corrected to a mean range of tide and the corrected velocities, which are representative of average current conditions, are given in the table. Obviously, these velocities would be increased with increased tidal ranges and would be decreased at times of neap or apogean tides. This increase or decrease might be as much as 35 or 40 per cent from the mean velocities, depending upon tidal conditions at a given time.

With respect to The Race, it will be noted that the stronger ebb velocities occur north of Race Rock Light and southwest of Valiant Rock. On the other hand, the stronger flood velocities seem to occur in the immediate vicinity of Valiant Rock.

It is interesting to note that the durations of flood increase from north to south at stations in The Race, while, conversely, durations of ebb decrease. In other words, the ebb current is more noticeable in the northern portion of this entrance and the flood in the southern. This is true not only in regard to durations but also in regard to velocities, as referred to above. Ebb velocities of approximately 5.0 knots were observed in 1929 at current station number 3, located about midway between Race Point Buoy and Race Rock Light.

Similar current conditions to those in The Race obtain in the entrance between Great Gull and Plum Islands. The durations of flood increase from north to south while those of ebb decrease. Likewise, stronger ebb velocities occur nearer Great Gull Island than Plum Island. However, the velocity of the ebb at station 19 may be retarded somewhat owing to the presence of the rocky reef east of Plum Island.

Slack water observations in 1915 over a 20-day period at a special buoy in the vicinity of Middle Ground Shoal and also at Midway Shoal Buoy indicate that the duration of flood in Plum Gut likewise increases from north to south while the converse is true for the ebb duration. Although current velocities in Plum Gut are considerable, averaging from 3½ to 4 knots, they are somewhat less than those which obtain in portions of The Race.

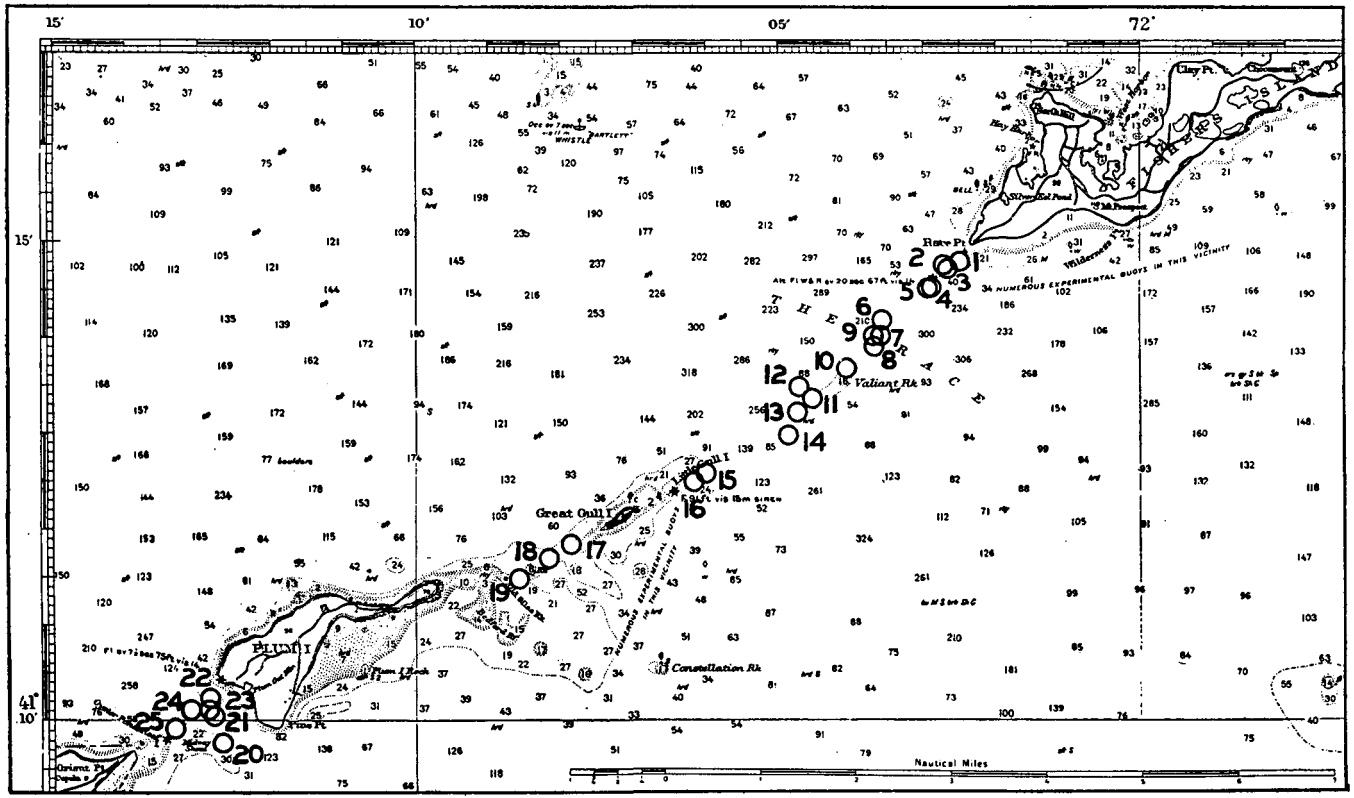

FIGURE 9.—Current stations, The Race and Plum Gut

In addition to surface current observations in The Race and Plum Gut, observations have also been made at various depths in these entrances at stations 2, 3, 6, 7, 9, 13, 14, 15, 17, 19, 21, 24, and 25.

The results from observations at these stations are shown in Table 46.

Generally these observations were made at depths of 0.2, 0.5, and 0.8 of the total depths of water at these stations. Therefore, the results of observations are representative of tidal current conditions at the surface, mid depth, and bottom.

These observations were generally made by means of the Price current meter. The current meter comprises two essential parts: (*a*) A wheel arranged so that when suspended in flowing water the pressure of the water against it causes it to revolve, and (*b*) a device for recording or indicating the number of revolutions of this wheel. The relation between the velocity of the moving water and the revolutions of the wheel is determined by rating each meter.

The Price current meter is equipped with a telephone attachment for counting the number of revolutions. The meter is lowered from the vessel by means of a specially designed triple-strand insulated wire; two of the wires carry the electric current and the third and heavier wire carries the weight of the meter. From the meter the triple-strand wire leads over a registering sheave swinging outboard from the vessel and thence to a small sounding machine upon which is wound a supply of the wire necessary for the depths to be encountered and also enough to allow for waste as the wire becomes unserviceable from wear. A registering sheave serves to show the depths at which the meter is lowered, but once the depth at the station is determined the wire itself is marked by a small piece of tape for the 0.2, 0.5, and 0.8 depths and no further reference made to the registering sheave. The end of the wire which is attached to the sounding machine is led through a hole in the flange of the machine and fitted with a connection for "plugging in" with a small dry-cell battery and telephone receiver.

The meter is rather light in weight and to prevent its being carried downstream by the current it is allowed to slide on a ¼-inch steel cable at the lower end of which is attached a 250-pound concrete block, molded to stream lines. The cable supporting the concrete block is led over a sheave and thence to a small hand winch for lowering and raising the block on arriving at and leaving the station. The block when in use is lowered to within a few feet of the bottom. Torpedo-shaped weights of approximately 10 pounds and 30 pounds each are attached to the meter stem for holding the meter in place while making observations.

At stations 7 in The Race and 21 in Plum Gut current observations were also obtained by means of a Pettersson current meter as indicated in the footnote to Table 46. The results of observations made by means of this meter are comparable with those at approximately the same depth made with the Price meter. In addition, the Pettersson meter records directions of the current as well as velocities.

The Pettersson meter is designed to give a photographic record of both the velocity and direction of the current and will operate automatically for a period of two weeks. A water-tight cylinder contains a tiny camera with a roll of film moved by clockwork, a small electric lamp with batteries, a glass velocity disk with numerals inscribed near the outer edge, and a glass compass disk carrying two magnetic needles and inscribed with numerals to indicate direction.

TABLE 46.—*Results from current observations at various depths, The Race and Plum Gut*

(Referred to times of predicted current at The Race)

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		The Race		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
2	P. M. Trueblood	Off Race Rock Light	Aug. 13-15, 1917	2	Pole	7	−0.16	−1.25	291	2.67	5.01	−0.98	−0.26	172	3.66	7.41	0.47
				2	Meter	6	−0.36	−1.42		2.76	5.11	−1.08	−0.26		3.68	7.31	0.35
				2	do	18	−0.36	−1.37		2.65	5.18	−1.01	−0.48		3.43	7.24	0.33
				1½	do	30	−0.73	−1.10		1.93	5.40	−1.16	−0.41		2.67	7.02	0.28
3	H. E. Finnegan	do	July 30-Aug. 1, 1929	1½	Pole	7	−0.50	−0.50	296	2.15	5.28	−1.05	0.17	159	4.40	7.14	0.66
				1½	Meter	9	−0.57	−0.75		2.21	5.45	−0.95	−0.07		3.93	6.97	0.55
				1½	do	22	−0.50	−0.30		2.24	5.38	−0.95	−0.23		3.54	7.04	0.63
				1½	do	36	−0.55	−0.50		2.00	5.43	−0.95	−0.27		2.87	6.99	0.56
6	P. M. Trueblood	Northeast of Valiant Rock	Sept. 4-6, 1917	1½	Pole	7	0.20	−0.07	301	2.59	5.53	−0.10	0.27	115	3.86	6.89	1.21
				¾	Meter	6	0.37	−0.17		2.74	5.03	−0.43	−0.08		3.94	7.39	1.05
				¾	do	30	0.17	−0.47		2.75	5.33	−0.33	−0.28		3.85	7.09	0.90
				¾	do	60	0.17	−0.37		2.86	5.33	−0.33	−0.38		3.56	7.09	0.90
				¾	do	120	−0.33	−0.47		3.15	5.93	−0.23	−0.38		3.45	6.49	0.78
7	H. E. Finnegan	do	July 30-Aug. 2, 1929	2½	Pole	7	0.22	0.34	274	2.77	5.73	0.12	0.18	127	3.19	6.69	1.35
				2½	Meter	50	−0.02	0.66		2.81	6.10	0.25	0.06		3.21	6.32	1.37
				2	do.[1]	43	−0.10	0.52	297	2.95	6.23	0.30	0.48	122	3.04	6.19	1.43
				2½	do	125	−0.22	0.30		2.94	6.25	0.20	0.08		3.19	6.17	1.22
				2½	do	200	−0.30	0.16		2.90	6.35	0.22	0.22		3.04	6.07	1.21
9	H. Mitchell	do	Aug. 22, 1871	½	Float	(2)	0.16	0.10	300		5.86	0.19	−0.60			6.56	1.09
				½	Log	102	−0.04	0.07			6.27	0.40	−0.34			6.15	1.15
				½	do	216	−0.15	0.27			5.48	−0.50	−0.30			6.94	0.96
13	H. E. Finnegan	Southwest of Valiant Rock	July 30-Aug. 1, 1929	1½	Pole	7	0.07	0.10	319	3.61	5.89	0.13	−0.03	115	4.71	6.53	1.20
				1½	Meter	22	0.03	0.25		3.42	5.97	0.17	−0.30		4.25	6.45	1.17
				1½	do	55	−0.03	0.05		3.56	6.03	0.17	−0.20		3.98	6.39	1.13
				1½	do	87	−0.23	0.15		2.71	6.33	0.27	−0.20		3.59	6.09	1.13
14	P. M. Trueblood	do	Sept. 7-8, 1917	¾	Pole	7	−0.13	−0.52	307	3.68	5.83	−0.13	−0.48	118	5.43	6.59	0.81
				¾	Meter	6	−0.28	−0.57		3.79	5.88	−0.23	−0.98		4.89	6.54	0.61
				¾	do	30	−0.23	−0.47		3.81	5.73	−0.33	−0.98		4.46	6.69	0.63
				¾	do	60	−0.43	−0.52		3.74	5.93	−0.33	−0.88		4.24	6.49	0.59
				½	do	90	−0.83	−0.72		3.33	6.43	−0.23				5.99	0.60
15	H. E. Finnegan	Off Little Gull Island Reef	July 30-Aug. 1, 1929	1½	Pole	7	−0.60	−0.20	2	3.27	6.20	−0.23	−0.63	107	3.30	6.22	0.71
				1½	Meter	14	−0.53	−0.57		3.33	6.09	−0.27	−0.50		2.96	6.33	0.66
				1½	do	35	−0.73	0.13		2.92	6.26	−0.30	−0.03		2.45	6.16	0.90
				1½	do	56	−0.83	0.17		2.49	6.59	−0.07	−0.13		2.09	5.83	0.91
		Between Great Gull and Plum Islands															
17	do	Off Great Gull Island Reef	Aug. 1-2, 1929	1	Pole	7	−0.80	−0.35	281	2.12	5.73	−0.90	−1.85	134	2.72	6.69	0.14
				1	Meter	6	−0.65	0.20		2.58	5.63	−0.85	−1.75		2.78	6.79	0.37
				1	do	10	−0.65	0.00		2.16	5.63	−0.85	−1.25		2.51	6.79	0.44
				1	do	16	−0.85	0.10		1.79	5.83	−0.85	−1.35		1.94	6.59	0.39
19	do	Off Old Silas Rock	do	1	Pole	7	−1.10	−0.30	323	2.00	6.33	−0.60	−1.15	129	1.72	6.09	0.34
				1	Meter	7	−1.05	−0.40		2.07	6.18	−0.70	−1.45		1.77	6.24	0.23
				1	do	10	−1.05	−0.40		1.95	6.23	−0.65	−1.25		1.70	6.19	0.29
				1	do	16	−1.25	−0.55		1.49	6.33	−0.75	−1.30		1.44	6.09	0.17
		Plum Gut															
21	do	North of Midway Shoal	July 29-30, 1929	1	Pole	7	−1.50	−0.95	314	3.46	6.33	−1.00	−1.35	128	4.01	6.09	12.35
				1	Meter	13	−1.35	−1.10		3.15	6.13	−1.05	−1.35		4.00	6.29	12.34
				1	do.[1]	13	−1.25	−1.15	317	3.19	5.78	−1.30	−1.30	130	3.79	6.64	12.30
				1	do	33	−1.40	−1.05		2.97	6.23	−1.00	−1.45		3.57	6.19	12.33
				1	do	52	−1.15	−1.20		2.05	5.93	−1.05	−1.45		2.80	6.49	12.34
24	P. M. Trueblood	Southwest of Middle Ground Shoal.	July 31-Aug. 1, 1917	1	Pole	7	−1.18	−1.42	326	4.02	6.18	−0.83	−1.63	106	3.85	6.24	12.29
				1	Meter	6	−1.43	−1.32		3.60	6.38	−0.88	−1.63		4.05	6.04	12.23
				1	do	18	−1.63	−1.67		3.80	6.53	−0.93	−1.73		4.00	5.89	12.06
				1	do	30	−1.68	−1.72		3.80	6.63	−0.88	−1.78		4.00	5.79	12.03
				1	do	42	−1.73	−1.82		3.80	6.63	−0.93	−1.88		3.95	5.79	11.96
25	H. E. Finnegan	Off Oyster Pond Reef	July 26-27, 29-30, 1929.	2	Pole	7	−1.72	−1.22	351	3.14	6.27	−1.28	−1.50	106	3.74	6.15	12.12
				2	Meter	7	−1.70	−1.10		3.11	6.31	−1.22	−1.47		3.72	6.11	12.18
				2	do	12	−1.65	−1.10		2.93	6.28	−1.20	−1.57		3.61	6.14	12.16
				2	do	20	−1.60	−1.00		2.38	6.13	−1.30	−1.57		3.46	6.29	12.18

[1] Pettersson meter observations.

[2] Surface.

The compass dial is free to move so that the needles may assume a north and south direction. The velocity dial, through a system of reducing gears and parallel magnets rotates with an anemometer wheel which is actuated by the current. At intervals of 30 minutes the electric lamp is automatically flashed and a picture is taken showing certain numerals on the velocity and compass dials. The numeral on the velocity dial indicates the accumulated motion of that dial due to the movement of the current. The difference between two successive readings, as interpreted by a rating table, gives the average velocity of the current for the half-hour period. The numeral on the compass dial indicates the direction of the current at the moment the picture was taken.

It will be noted from the data in Table 46 that the time of the current generally becomes earlier and the velocity of the current less with increased depth.

The harmonic constants used in predicting the times of slack water and times and velocities of strength of current at The Race for every day in the year are given in Table 47. These constants were derived from the tidal constants for Willets Point, N. Y.

TABLE 47.—*Harmonic constants, The Race*

Component	Amplitude H	Epoch κ	Component	Amplitude H	Epoch κ	Component	Amplitude H	Epoch κ
	Knots	*Degrees*		*Knots*	*Degrees*		*Knots*	*Degrees*
K_1	0.154	117.5	N_2	0.677	309.6	S_2	0.586	350.0
K_2	0.133	356.2	2N	0.090	287.9	T_2	0.035	350.2
L_2	0.273	2.5	O_1	0.090	153.8	λ_2	0.024	339.9
M_2	3.321	331.2	P_1	0.041	132.5	μ_2	0.080	312.5
M_4	0.191	91.7	Q_1	0.017	171.8	ν_2	0.102	317.4

THE TIDE AND CURRENT IN FISHERS ISLAND SOUND

Fishers Island Sound is that waterway situated between Fishers Island, N. Y., and the Connecticut shore east of the Thames River entrance. As stated previously, however, it may be considered as the eastern end of Long Island Sound, especially for the discussion of the action of the tide and tidal current.

The physical characteristics of Fishers Island Sound are briefly as follows: The waterway is about 6 miles long from North Dumpling to Napatree Point or about 7½ miles from the former to Watch Hill Point. Its greatest width is approximately 3 miles although in places the width is less than 2 miles in extent. At its eastern entrance from Block Island Sound, some 3 miles in length from Watch Hill Point, R. I., to East Point, Fishers Island, N. Y., several rocky reefs are located. Between these reefs there are fairly deep passages which are buoyed for the use of the navigator. Chief among these passages are Watch Hill Passage between Watch Hill Point and Watch Hill Reef and Wicopesset Passage between Wicopesset and Fishers Islands.

Fishers Island Sound is quite deep, depths of 50 to 70 feet or more prevailing in mid sound. Prominent tributaries of Fishers Island Sound are Little Narragansett Bay and Pawcatuck River at its eastern end and the Mystic River on its northern boundary. Little Narragansett Bay, which has an area of about 1 square mile, is extremely shoal, having a mean low water depth averaging approximately 4 feet.

TABLE 48.—*Tidal data, Fishers Island Sound, 1839–1918*

Station No.	Location	Observations		Lunitidal intervals		Duration of rise	Mean range	Compared with—
		Date	Period	HWI	LWI			
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Watch Hill Light, Watch Hill Point, R. I.	July 26–27, 1839	2	8.95	2.72	6.23	2.50	New London, Conn.
		June 13–Aug. 28, 1848	77	9.09	2.66	6.43	2.69	Boston, Mass.
		Aug. 31–Sept. 9, 1883	4	9.03	3.06	5.97	2.99	Sandy Hook, N. J.
		June 25, 1896	1	8.45	2.52	5.93	3.30	New London, Conn.
2	Watch Hill, Little Narragansett Bay	Aug. 11–12, 1846	2	9.83	4.55	5.28	2.43	Sandy Hook, N. J.
		July 2–Sept. 8, 1883	15	9.80	4.06	5.74	2.05	Do.
3	Westerly, R. I. (Pawcatuck River)	June 22–30, 1917	6	9.26	3.57	5.69	2.50	New London, Conn.
4	Stonington, Conn.	June 11–Sept. 3, 1845	85	9.07	2.82	6.25	2.70	Sandy Hook, N. J.
		Oct. 7–Nov. 11, 1856	36	9.21	2.96	6.25	2.60	Do.
		Aug. 11–12, 1882	2	8.99	3.21	5.78	2.39	New London, Conn.
		June 18–Nov. 19, 1883	101	8.90	2.93	5.97	2.44	Do.
		May 22–June 25, 1888	35	8.89	2.96	5.93	2.52	Sandy Hook, N. J.
		Dec. 4–5, 1906	2	9.14	2.56	6.58	2.62	New London, Conn.
		Aug. 27–29, 1907	3	9.11				Do.
		Nov. 3–10, 1908	3	8.84	3.06	5.78	2.87	Do.
		June 26–27, 1917	2	8.97	2.68	6.29	2.41	Do.
		July 15–Nov. 7, 1918	65	8.91	2.88	6.03	2.67	Do.
5	Noank, Conn. (Mystic River)	Oct. 25–Nov. 24, 1882	13	9.14	3.22	5.92	2.37	Do.
6	West Mystic, Conn. (Mystic River)	June 22–24, 1917	3	9.42	3.23	6.19	2.48	Do.
7	Boat basin, North Dumpling Island	Oct. 31–Nov. 1, 1883	1	9.59	3.21	6.38	2.28	Do.
8	West Harbor, Fishers Island	Oct. 22–Nov. 9, 1883	19	9.31	3.44	5.87	2.28	Do.
9	East Point, Fishers Island	July 19–21, 1848	2	8.23	2.52	5.71	3.10	Boston, Mass.

Tides have been observed by the Coast and Geodetic Survey at a number of stations in Fishers Island Sound and its tributaries since 1839 and the locations of stations at which these observations were made are shown in Figure 10. The results of tidal observations at these stations are given in Table 48.

It will be noted from the data in Table 48 that several tidal series of more than one lunar period in length have been obtained from time

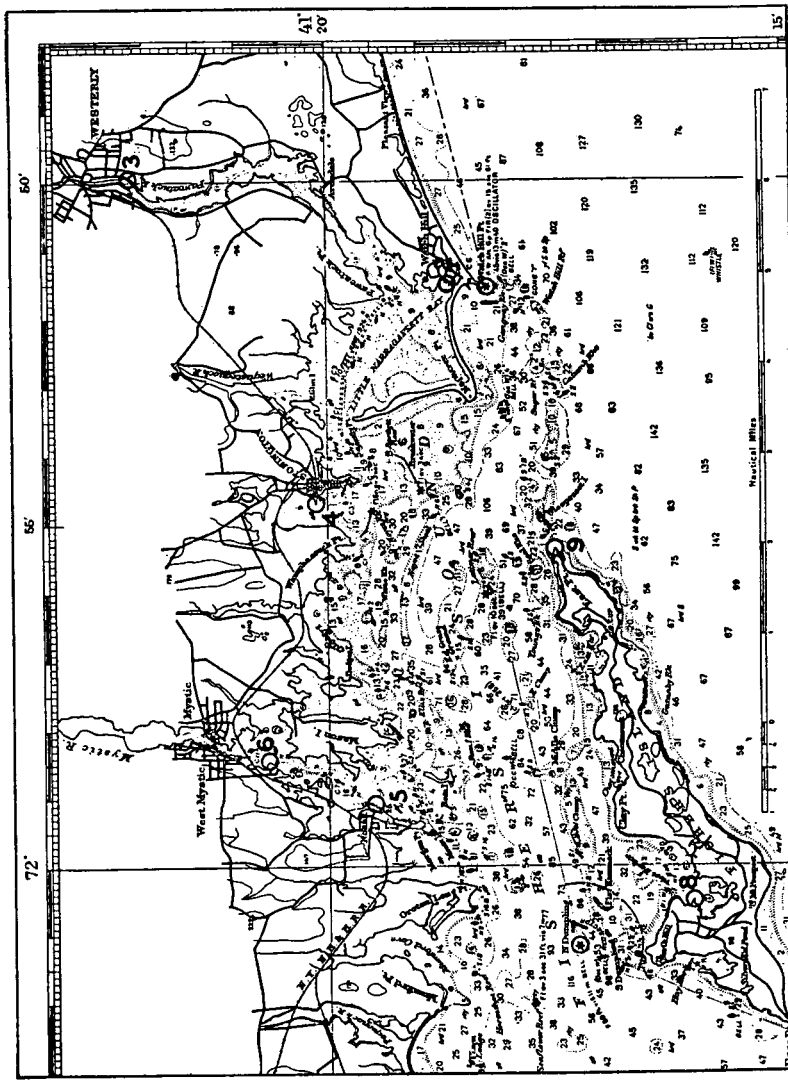

FIGURE 10.—Tide stations, Fishers Island Sound and its tributaries

to time at Stonington, Conn., at the eastern end of Fishers Island Sound. Generally, the results of these several series of observations agree very well in themselves, and the tidal data for this station may be considered to be quite well determined. The results of tidal observations at Watch Hill Light, although obtained generally from earlier series of observations, indicate that the time and range of the

tide at that locality are approximately the same as the time and range of the tide at Stonington. In other words, the time of tide at various localities in the eastern portion of Fishers Island Sound occurs simultaneously, and the mean range of tide over this area is approximately 2.7 feet.

FIGURE 11.—Current stations, Fishers Island Sound and its tributaries

Naturally, the shoal waters of Little Narragansett Bay and its approaches offer considerable opposition to the progression of the tide in that waterway. This accounts for the retarded times of tide and diminished ranges of tide at stations 2 and 3 as compared with the times and ranges of tide at stations 1 and 4.

TABLE 49.—*Results from current observations near the surface, Fishers Island Sound and vicinity*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Eastern entrance		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	H. Burkhardt	Gangway Rock Gas Buoy, Watch Hill Passage.	July 6–Sept. 25, 1915	14	Buoy	(1)	−1.60				6.35	−1.08				6.07	12.28
2	G. S. Blake	West of Watch Hill Passage	July 8–10, 1845	2	Pole	9	−1.60	−1.07	278	1.27	6.18	−1.25	−1.29	94	1.26	6.24	12.25
3	H. E. Finnegan	Off Napatree Point	Aug. 8–9, 1929	1	do	7	−1.90	−1.45	310	1.85	6.68	−1.05	−1.80	129	1.18	5.74	12.00
3a	J. C. Sammons	do	Aug. 12–13, 1930	1	do	7	−0.46	−0.98	287	1.62	5.70	−0.59	−0.93	115	2.22	6.72	12.81
			Aug. 27–29, 1930	1½	do	3¼	−0.71	−1.41	315	1.61	5.62	−0.92	−1.63	117	1.98	6.80	12.38
4	H. E. Finnegan	do	Aug. 8–9, 1929	1	do	7	−1.15	−1.35	317	1.41	5.83	−1.15	−1.20	128	2.34	6.59	12.34
5	P. M. Trueblood	do	Aug. 23, 1917	½	do	7	−1.63				6.73	−0.73	−1.58	112	2.62	5.69	12.23
6	do	do	Aug. 30–31, 1917	1	do	7	−0.83	−1.17	295	2.16	6.03	−0.63	−1.23	116	2.31	6.39	12.59
7	H. E. Finnegan	Wicopesset Passage	Aug. 8–9, 1929	1	do	7	−1.65	−1.25	317	2.82	6.33	−1.15	−2.05	122	1.47	6.09	12.03
		Pawcatuck River															
8	H. E. Finnegan	Off Pawcatuck Rock	Aug. 6–7, 1929	1	do	3½	−0.90	−1.50	3	0.50	4.58	−2.15	−1.65	179	0.50	7.84	12.00
9	P. M. Trueblood	Off Graves Neck	July 25–26, 1917	1	do	4	−1.48	−2.02	58	0.47	4.98	−2.33	−3.48	240	0.38	7.44	11.22
		Little Narragansett Bay															
10	H. E. Finnegan	Off Sandy Point	Aug. 6–8, 1929	1½	do	4½	−1.50	−1.83	100	1.08	5.07	−2.26	−1.66	275	1.24	7.35	11.74
11	P. M. Trueblood	do	July 24–25, 1917	1	do	4	−2.33	−2.22	85	1.39	5.98	−2.18	−3.68	260	1.44	6.44	10.95
		Mystic River															
12	H. E. Finnegan	Highway Bridge, Mystic—West Mystic.	Aug. 6–7, 1929	1	do	7	−1.85	−2.80	27	1.02	5.58	−2.10	−3.35	207	0.82	6.84	11.03
13	P. M. Trueblood	Off Murphy Point	July 19–20, 1917	¾	do	4	−1.43	−1.97	321	0.35	4.43	−2.83	0.12	148	0.30	7.99	12.02
14	H. E. Finnegan	Off Sixpenny Island	Aug. 5–6, 1929	1	do	7	−2.15	−2.60	356	0.67	5.58	−2.40	−3.95	165	0.57	6.84	10.77
		Fishers Island Sound															
15	P. M. Trueblood	Off Stonington Point	July 23–24, 1917	1	do	4	−1.38	0.08	79	0.34	5.68	−1.48	−2.88	225	0.59	6.74	12.15
16	do	Off Latimer Reef Light	Aug. 9–11, 1917	1¾	do	7	−0.83	−0.90	256	1.69	5.88	−0.78	−0.73	88	1.91	6.54	12.74
17	G. S. Blake	do	July 5–6, 14–15, 1845	1¾	do	9	−0.73	−0.83	258	1.24	6.17	−0.39	−0.63	77	1.36	6.25	12.91
18	J. Carlson	Off Ram Island Reef (Lightship station—1913).	Sept. 27–Dec. 22, 1913.	87	do	7	−0.93	−0.95	253	1.34	6.01	−0.75	−0.98	86	1.58	6.41	12.65
19	do	Off Ram Island Reef (Lightship station—1915).	July 10–Oct. 4, 1915	87	do	7	−0.95	−0.92	258	1.29	6.03	−0.75	−0.95	90	1.54	6.39	12.66
20	P. M. Trueblood	Off Ram Island Reef	July 27–28, 1917	1	do	7	−1.13	−1.27	262	1.70	5.98	−0.98	−1.58	96	2.06	6.44	12.31
21	do	Off Morgan Point	July 6–7, 1917	½	do	7	−1.33	−0.77	242	0.90	6.73	−0.43	−1.28	58	0.35	5.69	12.60
22	H. E. Finnegan	Off Clay Point	Aug. 5–6, 1929	1	do	7	−1.15	−1.55	259	1.10	5.88	−1.10	−1.90	68	1.15	6.54	12.13
23	do	Off Groton Long Point	Aug. 5–8, 1929	2½	do	7	−0.82	−1.08	247	1.53	5.75	−0.90	−1.40	87	1.34	6.67	12.50
24	G. S. Blake	do	July 15–17, 1845	1½	do	9	−0.78	−0.68	268	1.09	6.17	−0.44	−1.06	122	1.29	6.25	12.81
25	H. E. Finnegan	do	Aug. 5–6, 1929	1	do	7	−0.80	−1.60	252	1.12	5.28	−1.35	−2.15	83	1.47	7.14	12.07
26	G. S. Blake	do	July 19–21, 1845	1½	do	9	−1.21	−0.85	258	0.98	6.53	−0.51	−1.66	88	0.99	5.89	12.49
27	P. M. Trueblood	Off North Dumpling	July 20–21, 1917	1	do	7	−0.68	−0.52	275	1.18	6.08	−0.43	−0.85	87	1.32	6.34	12.93

[1] Surface.

The data in Table 48 indicate that from Stonington westward the time of tide becomes somewhat later, due, most likely, to the propagation of a progressive wave arising from interference to the stationary Atlantic tide wave at the eastern entrance to the sound. It will also be noted that from east to west in Fishers Island Sound there is a diminished range of tide with apparently a somewhat greater range of tide on the northern, or Connecticut, side of the sound and a lesser range along the southern, or Fishers Island, side of the sound. This increased range of tide along the northern side of the sound is most likely due to the operation of Ferrel's Law, which states that due to the rotation of the earth on its axis there is a tendency to deflect all moving bodies to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. It is to be expected, therefore, that on the rising tide the water moving westward, or flooding, in Fishers Island Sound would be deflected to the right, or northern shore, and high water would therefore be higher on this bank. On the falling tide, when the water is moving eastward, or ebbing in Fishers Island Sound, such water would be again deflected to the right, or southern shore, and therefore the low water would be higher along this shore than along the northern shore. It is evident from the above consideration that the tide should rise higher and fall lower on the northern side of Fishers Island Sound than on the southern side, and hence the range of tide would be greater on the northern side. This will be brought out more clearly later in a discussion of the range of tide in Eastern and Western Long Island Sound.

The results of observations for tide stations in Fishers Island Sound have been subjected to an adjustment process in order to derive standard, or adjusted values. These adjusted values are given in Table 57 on page 75, together with similar values for Eastern Long Island Sound, The Race, and Plum Gut.

Tidal currents have been observed by the Coast and Geodetic Survey at 27 stations in Fishers Island Sound and its tributaries, the earliest observations being in 1845. The locations of these current stations are shown in Figure 11 and the results of the observations are given in Table 49.

Most of the current stations shown in Figure 11 were occupied in 1917 and 1929. In 1915 slack-water observations were obtained at Gangway Rock Gas Buoy by the lightkeeper at Watch Hill Point Light through the cooperation of the Bureau of Lighthouses. The latter observations were obtained simultaneously with similar buoy observations in The Race and Plum Gut.

The most important series of current observations in Fishers Island Sound, however, are those which were obtained at Ram Island Reef Lightship in 1913 and 1915. During each of these years an 87-day series of observations was obtained, and the results are given in the data for stations 18 and 19 in Table 49. These stations are treated independently since the lightship in 1915 was located some 300 yards further southerly from Ram Island Reef than it was in 1913. Some time ago, however, this lightship was removed from station and replaced by a gas and bell buoy.

The method of observing currents in this waterway was generally by means of current pole and current log line at an average depth of about 7 feet. In some of the tributaries of Fishers Island Sound, however, it was necessary to use current poles of shorter length than the standard 15-foot pole, owing to the shoal water depths encountered,

It will be noted from the data in Table 49 that the time of slack and strength of current in Fishers Island Sound is much earlier than the same phenomena in The Race, the reference station to which currents at all stations in Long Island Sound are referred. This is indicated by the minus (−) signs before the time intervals in columns 8, 9, 13, and 14 of the table. Perhaps this is better shown by taking into consideration the data in the last column of the table. It will be noted that the mean solar current hour at each station in this waterway is considerably earlier than that for The Race, the mean current hour for the latter station being 1.13, or 13.55. It will also be noted from the data in Table 49 that the time of current is considerably earlier in Little Narragansett Bay and in the Mystic and Pawcatuck Rivers than it is in the sound proper.

The 87 days' series of current observations obtained at Ram Island Reef Lightship in 1913 has been analyzed harmonically, and the harmonic constants derived from this analysis are given in Table 50.

TABLE 50.—*Harmonic constants, Ram I. Reef Lightship*

[Values in parentheses have been inferred from other constants]

Component	1913		Component	1913		Component	1913	
	Amplitude	Epoch		Amplitude	Epoch		Amplitude	Epoch
	H	κ		H	κ		H	κ
	Knots	*Degrees*		*Knots*	*Degrees*		*Knots*	*Degrees*
J_1	(0.002)	(0.7)	2N	(0.039)	(179.7)	S_4	0.006	258.9
K_1	0.068	21.1	O_1	0.028	61.9	T_2	(0.013)	(245.3)
K_2	0.109	258.7	OO	(0.001)	(340.3)	λ_2	(0.010)	(233.6)
L_2	(0.040)	(245.4)	P_1	(0.023)	(21.1)	μ_2	(0.034)	(201.7)
M_1	0.004	147.8	Q_1	(0.005)	(82.3)	ν_2	(0.057)	(204.5)
M_2	1.433	223.5	2Q	(0.001)	(102.7)	ρ_1	(0.001)	(79.4)
M_4	0.062	193.5	R_2	(0.002)	(245.3)			
N_2	0.293	201.6	S_2	0.228	245.3			

In addition to observations near the surface current observations at various depths were also obtained at 18 stations in Fishers Island Sound and vicinity, and the results of these observations are given in Table 51. Most of these observations were made by means of the Price current meter. At stations 4 and 23 the Pettersson current meter was also employed in addition to the Price meter, and the results of observations at the same depth obtained by the two meters agree quite well in themselves. Descriptions of these meters will be found above in connection with the discussion of tidal currents at various depths in The Race and Plum Gut.

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TABLE 51.—*Results from current observations at various depths, Fishers Island Sound and vicinity*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Eastern Entrance		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
3	H. E. Finnegan	Off Napatree Point	Aug. 8-9, 1929	1	Pole	7	−1.90	−1.45	310	1.85	6.68	−1.05	−1.80	129	1.18	5.74	12.00
				1	Meter	7	−1.85	−1.40		1.71	6.73	−0.95	−1.80		1.14	5.69	12.05
				1	do	15	−1.80	−1.45		1.56	6.53	−1.10	−1.80		1.19	5.89	12.01
				1	do	24	−1.70	−1.45		1.46	6.43	−1.10	−1.85		1.06	5.99	12.03
3a	J. C. Sammons	do	Aug. 12-13, 1930	1	Pole	7	−0.46	−0.98	287	1.62	5.70	−0.59	−0.93	115	2.22	6.72	12.81
				1	Meter	12	−0.46	−1.08		1.68	5.60	−0.69	−0.98		2.33	6.82	12.75
				1	do	30	−0.71	−1.08		1.68	5.80	−0.74	−1.08		2.23	6.62	12.65
				1	do	48	−0.96	−1.13		1.50	6.00	−0.79	−0.73		1.80	6.42	12.65
3a	do	do	Aug. 27-29, 1930	1½	Pole	3¼	−0.71	−1.41	315	1.61	5.62	−0.92	−1.63	117	1.98	6.80	12.38
				1½	Meter	14	−0.91	−1.48		1.42	5.85	−0.89	−1.38		1.94	6.57	12.39
				1½	do	35	−0.91	−1.51		1.40	5.82	−0.92	−1.33		1.85	6.60	12.38
				1½	do	56	−0.91	−1.48		1.34	5.75	−0.99	−1.53		1.81	6.67	12.32
4	H. E. Finnegan	do	Aug. 8-9, 1929	1	Pole	7	−1.15	−1.35	317	1.41	5.83	−1.15	−1.20	128	2.34	6.59	12.34
				1	Meter	9	−1.10	−1.20		1.32	5.83	−1.10	−1.25		2.32	6.59	12.39
				1	do	23	−1.25	−1.15		1.28	6.03	−1.05	−1.25		2.06	6.39	12.37
				1	do	36	−1.30	−1.25		1.25	6.03	−1.10	−1.55		1.80	6.39	12.25
				1	do.[1]	36	−1.30	−1.10	334	1.14	6.13	−1.00	−0.70	129	1.64	6.29	12.53
5	P. M. Trueblood	do	Aug. 23, 1917	½	Pole	7	−1.63				6.73	−0.73	−1.58	112	2.62	5.69	12.23
				½	Meter	6	−1.83				6.93	−0.73	−1.68		2.42	5.49	12.14
				½	do	30	−1.93				6.83	−0.93	−1.88		2.23	5.59	11.97
				½	do	60	−2.23				7.13	−0.93	−1.88		1.70	5.29	11.87
6	do	do	Aug. 30-31, 1917	1	Pole	7	−0.83	−1.17	295	2.16	6.03	−0.63	−1.23	116	2.31	6.39	12.59
				1	Meter	6	−0.93	−1.07		2.17	6.08	−0.68	−1.43		2.22	6.34	12.52
				1	do	18	−1.13	−1.47		2.17	5.93	−1.03	−1.33		2.27	6.49	12.31
				1	do	30	−1.33	−1.57		1.99	6.18	−0.98	−1.38		2.19	6.24	12.23
				1	do	60	−1.43	−1.37		2.02	6.23	−1.03	−1.43		1.67	6.19	12.23
7	H. E. Finnegan	Wicopesset Passage	Aug. 8-9, 1929	1	Pole	7	−1.65	−1.25	317	2.82	6.33	−1.15	−2.05	122	1.47	6.09	12.03
				1	Meter	5	−1.70	−1.20		2.76	6.33	−1.20	−2.20		1.66	6.09	11.97
				1	do	12	−1.65	−1.25		2.53	6.28	−1.20	−2.30		1.48	6.14	11.95
				1	do	19	−1.65	−1.40		2.40	6.38	−1.10	−2.45		1.15	6.04	11.90
		Pawcatuck River															
8	H. E. Finnegan	Off Pawcatuck Rock	Aug. 6-7, 1929	1	Pole	3½	−0.90	−1.50	3	0.50	4.58	−2.15	−1.65	179	0.50	7.84	12.00
				1	Meter	7	−0.85	−1.20		0.55	4.73	−1.95	−1.55		0.55	7.69	12.16
				1	do	9	−0.95	−1.30		0.45	4.88	−1.90	−1.80		0.45	7.54	12.06
9	P. M. Trueblood	Off Graves Neck	July 25-26, 1917	1	Pole	4	−1.48	−2.02	58	0.47	4.98	−2.33	−3.48	240	0.38	7.41	11.22
				1	Meter	3	−1.48	−1.77		0.40	5.18	−2.13	−3.08		0.45	7.24	11.43
				1	do	6	−1.98	−2.17		0.49	5.58	−2.23	−3.63		0.52	6.84	11.05
		Little Narragansett Bay															
10	H. E. Finnegan	Off Sandy Point	Aug. 6-8, 1929	1½	Pole	4½	−1.50	−1.83	100	1.08	5.07	−2.26	−1.66	275	1.24	7.35	11.74
				1½	Meter	6	−1.45	−2.17		1.19	5.11	−2.17	−1.80		1.29	7.31	11.65
				1½	do	9	−1.45	−1.93		1.03	5.02	−2.26	−1.50		1.13	7.40	11.77
11	P. M. Trueblood	do	July 24-25, 1917	1	Pole	4	−2.33	−2.22	85	1.39	5.98	−2.18	−3.68	260	1.44	6.44	10.95
				1	Meter	6	−2.73	−2.32		1.36	6.33	−2.23	−3.73		1.26	6.09	10.80
		Mystic River															
12	H. E. Finnegan	Highway Bridge, Mystic—West Mystic.	Aug. 6-7, 1929	1	Pole	7	−1.85	−2.80	27	1.02	5.58	−2.10	−3.35	207	0.82	6.84	11.03
				1	Meter	3	−1.80	−2.90		0.94	5.53	−2.10	−3.50		0.77	6.89	10.97
				1	do	8	−1.80	−2.80		0.91	5.53	−2.10	−3.50		0.83	6.89	11.00
				1	do	13	−1.85	−2.75		0.76	5.58	−2.10	−3.60		0.71	6.84	10.97
14	do	Off Sixpenny Island	Aug. 5-6, 1929	1	Pole	7	−2.15	−2.60	356	0.67	5.58	−2.40	−3.95	165	0.57	6.84	10.77
				1	Meter	7	−2.00	−2.50		0.75	5.58	−2.25	−3.90		0.65	6.84	10.89
				1	do	16	−2.25	−2.50		0.71	5.88	−2.20	−4.00		0.61	6.54	10.81
		Fishers Island Sound															
15	P. M. Trueblood	Off Stonington Point	July 23-24, 1917	1	Pole	4	−1.33	0.08	79	0.34	5.68	−1.48	−2.88	225	0.59	6.74	12.15
				1	Meter	6	−1.88	−0.17		0.37	6.50	−1.23	−3.18		0.32	5.94	11.93
16	do	Off Latimer Reef Light	Aug. 9-11, 1917	1¾	Pole	7	−0.83	−0.90	256	1.69	5.88	−0.78	−0.73	88	1.91	6.54	12.74
				1¾	Meter	6	−1.03	−1.10		1.55	6.16	−0.70	−0.96		1.92	6.26	12.60
				1¾	do	18	−1.10	−1.20		1.64	6.23	−0.70	−1.05		1.79	6.19	12.54
				1¾	do	36	−1.30	−0.90		1.48	6.33	−0.80	−0.83		1.24	6.09	12.59
20	do	Off Ram Island Reef	July 27-28, 1917	1	Pole	7	−1.13	−1.27	262	1.70	5.98	−0.98	−1.58	96	2.06	6.44	12.31
				1	Meter	6	−1.18	−1.37		1.63	6.08	−0.93	−1.73		2.06	6.34	12.25
				1	do	18	−1.18	−1.34		1.56	6.13	−0.88	−1.58		1.89	6.29	12.31
				1	do	42	−1.18	−1.47		1.55	6.13	−0.88	−1.58		1.83	6.29	12.27
				1	do	60	−1.58	−1.37		1.40	6.58	−0.83	−1.38		1.52	5.84	12.26
21	do	Off Morgan Point	July 5-7, 1917	½	Pole	7	−1.33	−0.77	242	0.90	6.73	−0.43	−1.28	58	0.35	5.69	12.60
				1½	Meter	6	−1.26	−0.94		0.97	6.38	−0.71	−1.81		0.37	6.04	12.37
				1½	do	18	−0.90	−1.20		0.91	6.05	−0.68	−1.55		0.42	6.37	12.47

[1] Pettersson meter observations.

TABLE 51.—*Results from current observations at various depths, Fishers Island Sound and vicinity*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Fishers Island Sound—Contd.															
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
22	H. E. Finnegan	Off Clay Point	Aug. 5-6, 1929	1	Pole	7	−1.15	−1.55	259	1.10	5.88	−1.10	−1.90	68	1.15	6.54	12.13
				1	Meter	7	−1.20	−1.40		1.19	5.88	−1.15	−2.00		1.19	6.54	12.11
				1	do	12	−1.15	−1.45		1.17	5.83	−1.15	−2.05		1.14	6.59	12.10
				1	do	24	−1.10	−1.65		1.07	5.73	−1.20	−2.05		1.03	6.69	12.05
23	do	Off Groton Long Point	Aug. 5-8, 1929	2½	Pole	7	−0.82	−1.08	247	1.53	5.75	−0.90	−1.40	87	1.34	6.67	12.50
				2½	Meter	17	−0.80	−1.00		1.58	5.93	−0.70	−1.50		1.40	6.49	12.55
				2½	do	43	−0.80	−0.70		1.46	6.05	−0.58	−1.22		1.26	6.37	12.73
				2	do.[1]	43	−0.68	−0.62	252	1.40	6.31	−0.20	−1.22	83	1.17	6.11	12.87
				2½	do	68	−0.86	−0.72		1.32	6.17	−0.52	−1.10		1.18	6.25	12.75
25	do	do	Aug. 5-6, 1929	1	Pole	7	−0.80	−1.60	252	1.12	5.28	−1.35	−2.15	83	1.47	7.14	12.07
				1	Meter	7	−0.80	−1.15		1.16	5.33	−1.30	−2.20		1.51	7.09	12.19
				1	do	18	−0.85	−1.25		1.14	5.38	−1.30	−2.15		1.29	7.04	12.16
				1	do	28	−0.90	−1.45		1.07	5.43	−1.30	−2.00		0.97	6.99	12.14

[1] Pettersson meter observations.

In general, the times and velocities of the current near the surface as obtained by means of the Price current meter agree very well with the results obtained at approximately the same depth by means of the current-pole and current-log line. In passing, it may be noted that the direction of the current at subsurface depths in narrow passages is approximately the same as that at the surface. This is shown by the Pettersson meter observation results for the direction of the current at depths of 36 feet at station 4 and 43 feet at station 23 as compared with surface current directions obtained by means of current pole at these stations.

It will be noted that the ebb current generally decreases in velocity with increased depth. This is due to the fact that both the denser tidal water below and the lighter fresh-water discharge above are moving in the same direction and, therefore, the vertical velocity distribution is similar to that in water under hydraulic motion. On the flood the fresh water near the surface, tending to move seaward, decreases the velocity of the incoming tidal current near the surface. With increased depth, however, the effect of the fresh water diminishes, and the full velocity of the flood current is generally attained at some distance from the surface.

In consequence of the diminution of the flood strength near the surface by fresh-water discharge, an increase in the duration of the flood period may be expected with increased depth. This is confirmed by the results of observations at most of the stations listed in Table 51.

THE TIDE AND CURRENT IN THE THAMES RIVER

One of the principal tributaries of Long Island Sound is the Thames River, a short, navigable river in eastern Connecticut formed by the confluence of the Yantic and Shetucket Rivers at Norwich. This waterway, a tidal estuary, is approximately 14 nautical miles in length and is navigable from Long Island Sound to Norwich. Along this waterway is located New London, Conn., one of the chief ports of southern New England.

New London Harbor is located on the north shore of Long Island Sound at the mouth of the Thames River and the main harbor comprises the lower 3 miles of its length from the Sound to the bridges across the river from New London to Groton. The harbor, however, extends 2 miles north of New London to the United States Navy submarine base located on the east bank of the river. The harbor is approached from the ocean through Block Island Sound to The Race and thence through the deep and comparatively well-sheltered waters of Eastern Long Island Sound about 5 miles to the mouth of the river. The lower 5 miles of the river has a general width of about 3,000 feet and natural depths of 25 feet or more. A dredged channel 600 feet wide and about 30 feet deep at mean low water extends from the mouth of the river to New London.

At Norwich, the head of navigation, the river receives the waters of the Yantic and the Shetucket Rivers, two fresh-water streams draining, with their tributaries, about 1,465 square miles of eastern Connecticut and southern Massachusetts. Freshets in the tributary streams customarily produce a rise in the river of not over 2 feet at Norwich. The freshets of 1876 and 1886 are reported to have flooded the lower business streets of Norwich. The effect of these

rises rapidly diminishes within a few miles downstream. The Thames Valley is comparatively narrow. The channel locus is well fixed by the training dikes throughout the upper part of the river. Below the dikes, although the natural width of the river increases, the channel remains stable. The average discharge of the river at Norwich approximates 850 second-feet.

Tides have been observed at a number of stations in the Thames River since 1839 and the locations of these stations are shown in Figure 12. The results of these observations at stations 3 (Fort Trumbull), 5 (Lighthouse Wharf), and 10 (Naval Station) were discussed at some length on pages 3 to 16 of this publication. The results of the observations at 13 tide stations in the Thames River are shown in Table 52.

Tidal observations at stations 4 and 12 were made by the Corps of Engineers, United States Army, which organization furnished the Coast and Geodetic Survey with the results of such observations. Considerable additional tidal data for stations 11 and 13 were also obtained by this bureau as a result of the cooperation between these two governmental engineering organizations. In general, it may be stated that the tidal data for the stations enumerated in Table 52 have been quite well determined, being derived from series of a lunar month or more at most of the stations. The data in the table represent mean values and those for short periods of observations were obtained by means of a comparison with simultaneous observations at a standard station, such as New London or Boston. Mean range determinations for the longer series of observations were obtained by reducing the observational values by factors depending upon the longitude of the moon's node.

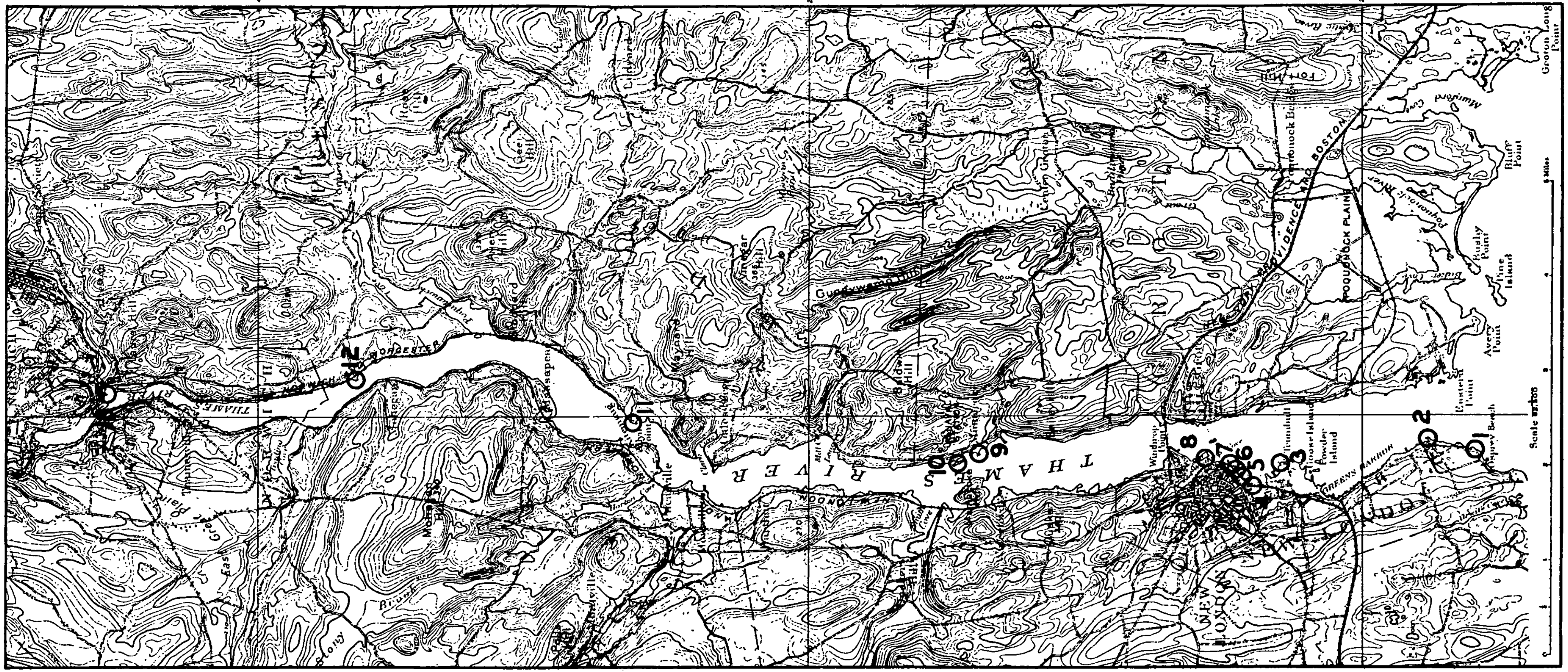

FIGURE 12.—Tide stations, Thames River

TABLE 52.—*Tidal data, Thames River, 1839–1929*

Station No.	Location	Observations		Lunitidal intervals		Duration of rise	Mean range	Compared with—
		Date	Period	HWI	LWI			
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Vicinity of New London Harbor Light	May 5–Sept. 25, 1839	45	9.33	3.10	6.23	2.26	
2	Pequot House wharf, entrance to Thames River	June 25–Sept. 16, 1890	52	9.83	3.91	5.92	2.67	New London, Conn.
		Sept. 7–20, 1900	11	9.52	3.42	6.10	3.12	Do.
		Oct. 26–Nov. 1, 1907	4	9.43	3.83	5.60	2.54	Do.
3	New London, Fort Trumbull wharf	July 31, 1882–Nov. 20, 1883	478	9.47	3.50	5.97	2.57	
4	New London, Shaws Cove	May 6, 1913–Aug. 19, 1918	1,592				2.44	(1)
5	New London, Lighthouse wharf	June 5–Oct. 29, 1917	147	9.45	3.57	5.88	2.51	
		Nov. 15–26, 1917	10	9.15	3.56	5.59	2.85	New London, Conn.
		May 9–24, 1918	10	9.20	3.32	5.88	2.54	Do.
6	Vicinity of New London	June 17–Sept. 17, 1847	93	9.57	3.63	5.94	2.46	
7	New London, New England Navigation Co. wharf.	July 29–Aug. 19, 1929	22	9.67	3.73	5.94	2.54	Do.
8	New London, Central Vermont Railroad dock	Aug. 17–Sept. 15, 1900	4	9.51	3.68	5.83	2.84	Do.
9	New London, Naval Station (Chapmans wharf)	May 30–June 27, 1869	29	9.79	3.70	6.09	2.60	Boston, Mass.
		Aug. 26–Sept. 2, 1874	7	9.31			2.74	Do.[2]
		Aug. 20–Sept. 17, 1900	5	9.53	3.92	5.61	2.72	New London, Conn.
10	New London, Naval Station (Government wharf)	May 12, 1899–June 23, 1900	409	9.50	3.70	5.80	2.53	
		Sept. 10–12, 1904	2	9.48	3.80	5.68	2.81	Do.
11	Allyns Point	Aug. 24–Sept. 4, 1900	2	9.78	3.95	5.83	3.17	Do.
		June 21–23, 1917	3	9.68	3.75	5.93	2.70	Do
		July 6–Dec. 11, 1923	142				2.74	(1)
12	Fort Point, Dawleys wharf	July 6–Oct. 31, 1923	97	10.24	4.46	5.78	2.82	(1)
13	Norwich	Aug. 25–Sept. 10, 1874	14	10.20	4.20	6.00	3.02	Boston, Mass.
		Aug. 24–Sept. 5, 1900	2	10.43	4.00	6.43	3.26	New London, Conn.
		June 18–20, 1917	3	10.40	4.35	6.05	2.91	Do.
		July 6–Dec. 11, 1923	107				2.45	(1)

[1] From tide records furnished by the Corps of Engineers, U. S. Army.
[2] Compared also with New London, Conn.

TABLE 53.—*Adjusted tidal data, Thames River*

Station No.	Locality	Lunitidal intervals		Duration of rise	Range of tide		
		HWI	LWI		Mean	Spring	Neap
		Hours	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*
1	Vicinity of New London Harbor Light	9.95	3.95	6.00	2.5	3.0	2.0
2	Pequot House Wharf	9.75	3.80	5.95	2.5	3.0	2.0
3	New London, Fort Trumbull Wharf	9.45	3.50	5.95	2.5	3.0	2.0
4	New London, Shaws Cove	9.45	3.50	5.95	2.5	3.0	2.0
5	New London, Lighthouse Wharf	9.45	3.50	5.95	2.5	3.0	2.0
6	Vicinity of New London	9.45	3.50	5.95	2.5	3.0	2.0
7	New London, New England Navigation Co. wharf	9.45	3.50	5.95	2.5	3.0	2.0
8	New London, Central Vermont Railroad dock	9.45	3.50	5.95	2.5	3.0	2.0
9	New London, Naval Station (Chapmans Wharf)	9.45	3.65	5.80	2.5	3.0	2.0
10	New London, Naval Station (Government wharf)	9.50	3.70	5.80	2.5	3.0	2.0
11	Allyns Point	9.75	3.85	5.90	2.8	3.3	2.2
12	Fort Point, Dawleys Wharf	10.25	4.45	5.80	2.9	3.4	2.3
13	Norwich	10.30	4.20	6.10	3.0	3.5	2.4

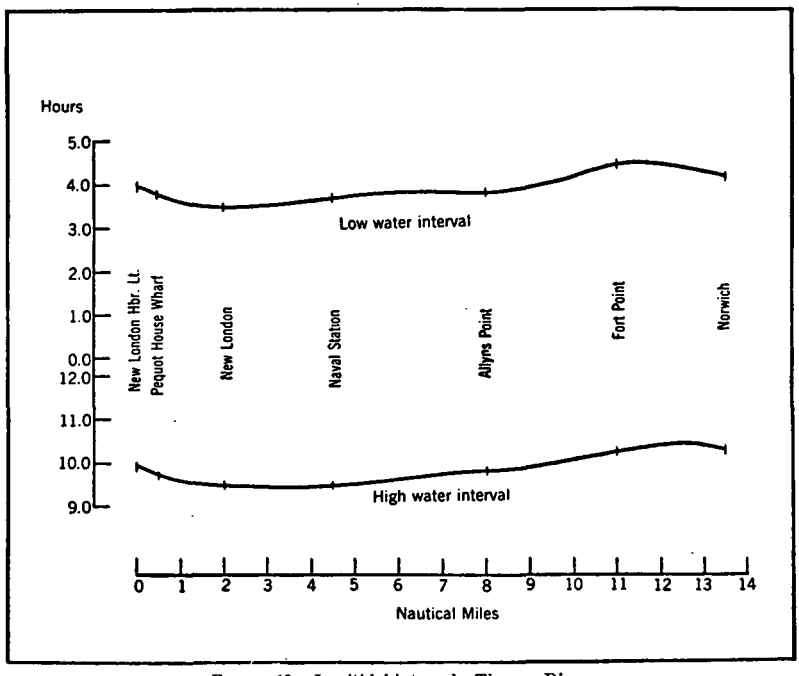

FIGURE 13.—Lunitidal intervals, Thames River

The values in Table 52 have been subjected to a process of adjustment in order to arrive at standard values for each tide station. This adjustment was made because of the fact that some series of observations were much shorter in length than others and other series were obtained many years ago when methods of observation differed from present-day methods.

The results obtained from very short series of observations may be affected by accidental conditions prevailing at the time of the observations which would be largely eliminated in a longer series. Again, the difficulties of maintaining accurate time in the earlier years were undoubtedly much greater than during more recent years.

The adjusted values for high and low water intervals, duration of rise, and mean range for tide stations in the Thames River are given in Table 53.

The adjusted values for time and range of tide at Thames River stations have been plotted in the form of curves in Figures 13 and 14, respectively.

It will be noted from the data in Table 53 and the curves for high and low water intervals in Figure 13 that the time of tide at New London, 3 miles upstream, occurs about half an hour earlier than it does near the entrance to the river in the vicinity of New London Harbor Light and Pequot House Wharf. This is somewhat unusual but it is substantiated by the fact that the time of current at New London is likewise earlier than that at the entrance to the river, as will be discussed a little later. The time of tide at Norwich occurs

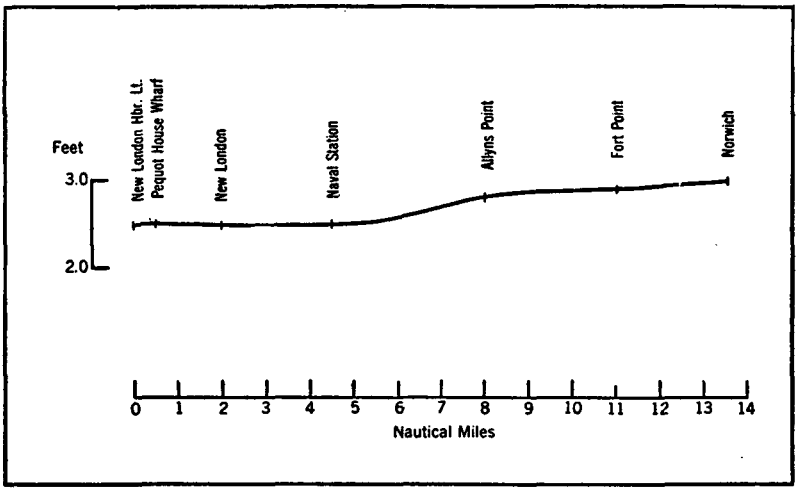

FIGURE 14.—Range of tide, Thames River

about three-fourths hour later than it does at New London, being progressively later and later at points above New London.

The mean range of tide is uniformly 2.5 feet throughout New London Harbor; that is, throughout the lower 5 miles of the Thames River. North of the submarine station, however, it increases steadily until at Norwich it averages 3.0 feet. For convenience, the approximate spring and neap ranges at tide stations in the Thames River are given in Table 53.

Tidal currents have been observed at 13 stations in the Thames River by field parties of the Coast and Geodetic Survey. The locations of these current stations are shown in Figure 15 and the results from observations made near the surface by means of current pole and current log line are given in Table 54.

The times of the current in hours for the various stations in this waterway have been referred to the times of the same phases of the current at The Race. Daily predictions for the latter will be found in the Atlantic Coast Current Tables published by the Coast and Geodetic Survey.

By inspection of the minus (−) signs before the time intervals in columns 8, 9, 13, and 14 it will be seen that the time of the current in the Thames River occurs much earlier than it does at the reference station. This is also shown by the data in the last column of Table 54. Reference to this column will show that the time of flood strength at Norwich occurs more than an hour later than the same phase of the current at the entrance to the river, and more than half an hour earlier than the time of flood strength at The Race, the mean solar current hour for the latter being 13.55.

Considerable fresh-water discharge occurs in the Thames River. This is shown distinctly in the long durations of ebb at each station as compared with the durations of flood. Along the open coast the durations of flood and ebb would be approximately equal, or about 6.12 hours each. It will be noted in Table 54, however, that the ebb durations at Thames River stations in many cases are more than twice as long as the flood durations.

Current velocities in the Thames River are rather small, the flood generally averaging from one-fourth to one-half knot and the ebb from one-half to 1 knot. Somewhat increased velocities obtain south of Allyns Point in the vicinity of Montville and Gales Ferry owing to constrictions in the width of the river. The results from a station in mid-channel off Montville, Conn., verify this conclusion.

In passing, the results in Table 54 for stations 7 and 13 call for detailed explanation. It will be noted that both these stations were occupied during the middle portion of the month of June, 1917. The observations at these stations showed that at the surface the current was ebbing, or flowing southerly, continuously during the entire period of occupation of approximately 25 hours. In other words, there was no flood current at this time, probably because of the effect of excessive fresh-water discharge. Therefore, the velocities given in parentheses for these stations are those for the minimum ebb current. Obviously, no times of slack water occurred since the current was ebbing all the time. At greater depths, not affected by the fresh-water discharge, there is evidence that the current ran flood during a portion of this period.

In passing, it might be stated that the surface tidal current at stations 7 and 13 averaged approximately 0.45 and 0.20 knot, respectively. These weak tidal current velocities, however, were completely masked by the strong nontidal current which obtained at the time the observations were made.

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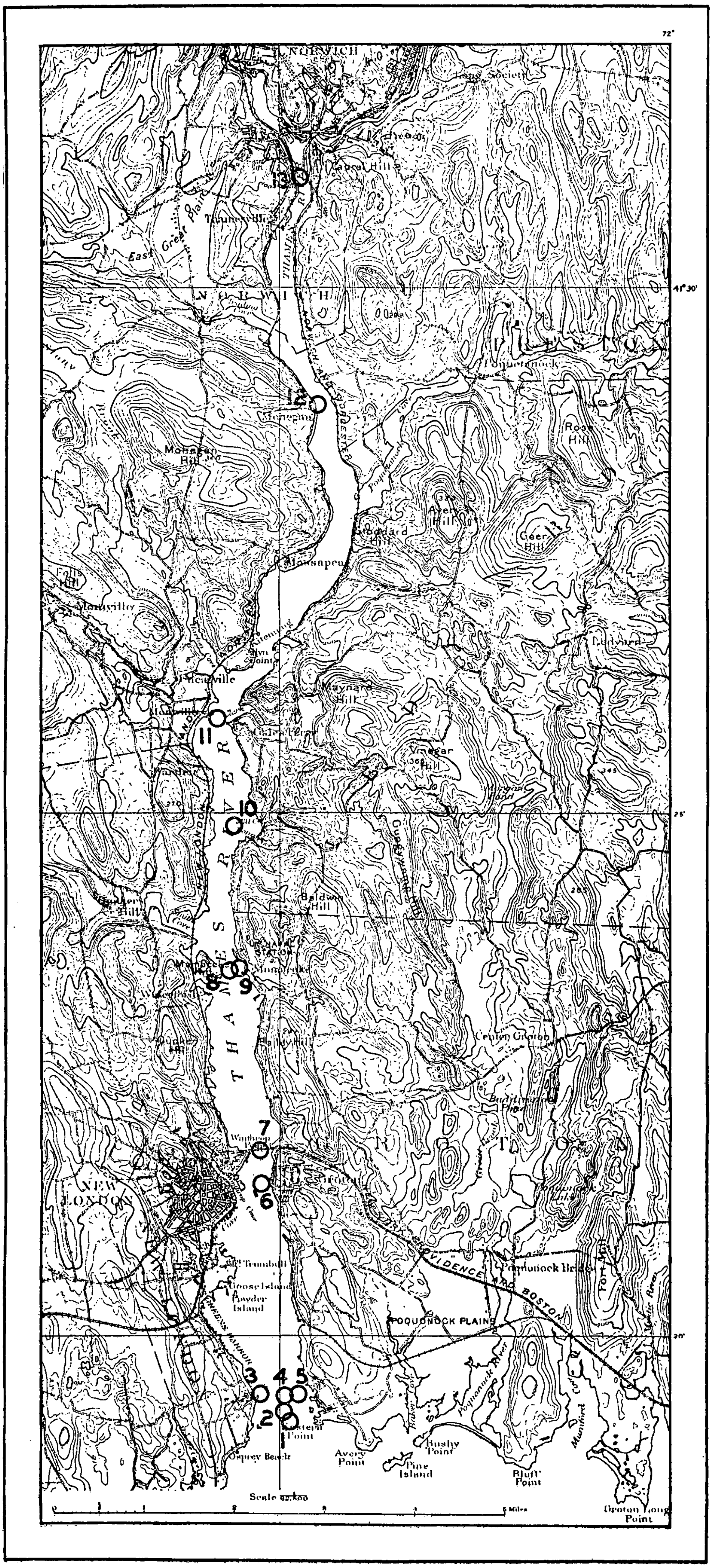

FIGURE 15.—Current stations, Thames River

TABLE 54.—*Results from current observations near the surface, Thames River*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Mid-channel, off Eastern Point	Aug. 21-22, 1917	1	Pole	7	−1.48	−2.12	322	0.46	4.48	−2.83	−2.13	178	0.46	7.94	11.41
2	do	Mid-channel, off Hobs Island	Aug. 7-8, 1917	¾	do	7	−1.63	−2.37	347	0.35	4.38	−3.08	−1.78	154	0.35	8.04	11.33
3	H. E. Finnegan	North of Quinnipeag Rocks	Aug. 12-13, 1929	1	do	7	−0.60	−2.30	302	0.17	3.63	−2.80	−2.25	168	0.37	8.79	11.56
4	do	Mid-channel, off Hobs Island	Aug. 12-15, 1929	3¼	do	7	−0.58	−2.40	314	0.08	4.08	−2.33	−0.95	179	0.30	8.34	11.99
5	do	North of Hobs Island	Aug. 12-13, 1929	1	do	7	−0.60	−2.60	335	0.17	3.33	−3.10	−2.75	158	0.37	9.09	11.29
6	do	Mid-channel, off Groton, Conn.	Aug. 13-14, 1929	1	do	7	−0.60	−2.30	352	0.25	3.63	−2.80	−1.10	176	0.50	8.79	11.85
7	P. M. Trueblood	Mid-channel, N. Y., N. H. & H. R. R. bridge.	June 15-16, 1917	1	Meter	3		−1.92	(1)	(0.06)			−0.08	171	0.96		12.48
8	H. E. Finnegan	Off Mamacock Hill	Aug. 14-15, 1929	1	Pole	7	−0.90	−1.65	326	0.56	5.63	−1.10	−0.95	162	0.76	6.79	12.40
9	do	Off Submarine Base	do	1	do	7	−1.50	−2.30	340	0.55	5.78	−1.55	−2.35	153	0.65	6.64	11.63
10	do	Off Cow Point	Aug. 13-14, 1929	1	do	7	−1.15	−2.40	25	0.56	5.93	−1.05	−1.70	194	0.43	6.49	11.97
11	P. M. Trueblood	Off Montville, Conn.	Aug. 24-25, 1917	1	do	4	−1.73	−1.67	16	0.70	5.23	−2.33	−2.48	200	1.05	7.19	11.50
12	H. E. Finnegan	Mid-channel, off Mohegan, Conn.	Aug. 12-13, 1929	1	do	3½	−1.20	−2.40	331	0.49	4.43	−2.60	−1.90	159	0.62	7.99	11.53
13	P. M. Trueblood	Off Norwich, Conn.	June 18-19, 1917	1	Meter	6		−0.82	(1)	(0.40)			−0.28	196	0.78		12.92

[1] The current was ebbing, or setting southerly, at this station during the whole period of occupation. Therefore, the velocity given in parentheses is that for the minimum ebb.

TABLE 55.—*Results from current observations at various depths, Thames River*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Mid-channel, off Eastern Point.	Aug. 21-22, 1917	1	Pole	7	−1.48	−2.12	322	0.46	4.48	−2.83	−2.13	178	0.46	7.94	11.41
				1	Meter	6	−1.68	−2.27		0.46	4.63	−2.88	−2.68		0.51	7.79	11.17
				1	do	27	−1.98	−2.27		0.34	5.23	−2.58	−2.98		0.34	7.19	11.10
2	do	Mid-channel, off Hobs Island	Aug. 7-8, 1917	¾	Pole	7	−1.63	−2.37	347	0.35	4.38	−3.08	−1.78	154	0.35	8.04	11.33
				½	Meter	6	−1.33	−2.77		0.35	3.43	−3.73	−1.68		0.45	8.99	11.17
				½	do	30	−1.63	−2.37		0.35	4.43	−3.03	−1.58		0.35	7.99	11.40
3	H. E. Finnegan	North of Quinnipeag Rocks	Aug. 12-13, 1929	1	Pole	7	−0.60	−2.30	302	0.17	3.63	−2.80	−2.25	168	0.37	8.79	11.56
				1	Meter	7	−0.60	−1.80		0.23	3.83	−2.60	−2.45		0.40	8.59	11.69
				1	do	14	−1.00	−1.90		0.34	4.58	−2.25	−2.50		0.37	7.84	11.64
				1	do	22	−2.00	−2.60		0.33	5.58	−2.25	−3.00		0.30	6.84	11.09
4	do	Mid-channel, off Hobs Island	Aug. 12-15, 1929	3¼	Pole	7	−0.58	−2.40	314	0.08	4.08	−2.33	−0.95	179	0.30	8.34	11.99
				3¼	Meter	7	−0.45	−2.50		0.16	3.58	−2.70	−3.27		0.37	8.84	11.32
				3¼	do	18	−0.48	−2.38		0.18	3.76	−2.55	−3.58		0.28	8.66	11.30
				3¼	do	29	−0.50	−2.24		0.25	3.85	−2.48	−3.72		0.29	8.57	11.31
5	do	North of Hobs Island	Aug. 12-13, 1929	1	Pole	7	−0.60	−2.60	335	0.17	3.33	−3.10	−2.75	158	0.37	9.09	11.29
				1	Meter	7	−0.55	−2.30		0.34	3.08	−3.30	−2.75		0.39	9.34	11.33
				1	do	10	−1.35	−2.40		0.45	3.78	−3.40	−3.35		0.38	8.64	10.93
				1	do.[1]	10	−1.25	−2.70	353	0.41	3.58	−3.50	−2.85	187	0.34	8.84	11.09
				1	do	16	−1.60	−2.20		0.33	4.43	−3.00	−3.20		0.33	7.99	11.05
6	do	Mid-channel, off Groton, Conn.	Aug. 13-14, 1929	1	Pole	7	−0.60	−2.30	352	0.25	3.63	−2.80	−1.10	176	0.50	8.79	11.85
				1	Meter	14	−1.10	−2.40		0.40	4.58	−2.35	−2.20		0.35	7.84	11.54
				1	do	34	−2.20	−2.20		0.45	6.28	−1.75	−2.70		0.32	6.14	11.34
				1	do	54	−2.40	−2.20		0.45	6.23	−2.00	−3.00		0.32	6.19	11.15
7	P. M. Trueblood	Mid-channel, N. Y., N. H. & H. R. R. bridge.	June 15-16, 1917	1	Meter	3		−1.92	(2)	(0.06)			−0.08	171	0.96		12.48
				1	do	18	−1.93	−2.42	(3)	0.66	5.43	−2.33	−0.98		0.51	6.99	11.63
				1	do	42	−2.08	−2.72	(3)	0.66	5.38	−2.53	−1.08		0.46	7.04	11.45
8	H. E. Finnegan	Off Mamacock Hill	Aug. 14-15, 1929	1	Pole	7	−0.90	−1.65	326	0.56	5.63	−1.10	−0.95	162	0.76	6.79	12.40
				1	Meter	7	−0.95	−2.25		0.57	5.58	−1.20	−1.10		0.82	6.84	12.17
				1	do	16	−1.40	−2.25		0.54	6.23	−1.00	−1.80		0.44	6.19	11.94
9	do	Off Submarine Base	do	1	Pole	7	−1.50	−2.30	340	0.55	5.78	−1.55	−2.35	153	0.65	6.64	11.63
				1	Meter	7	−1.55	−2.30		0.67	5.73	−1.65	−2.10		0.89	6.69	11.65
				1	do	12	−1.65	−2.20		0.82	6.03	−1.45	−2.05		0.57	6.39	11.71
				1	do	20	−2.05	−2.65		0.49	6.38	−1.50	−2.35		0.29	6.04	11.41
10	do	Off Cow Point	Aug. 13-14, 1929	1	Pole	7	−1.15	−2.40	25	0.56	5.93	−1.05	−1.70	194	0.43	6.49	11.97
				1	Meter	7	−1.00	−2.25		0.62	5.68	−1.15	−1.05		0.42	6.74	12.19
				1	do	12	−1.40	−2.55		0.84	6.08	−1.15	−1.55		0.57	6.34	11.89
				1	do	20	−2.05	−3.05		0.76	6.33	−1.55	−2.30		0.29	6.09	11.31
11	P. M. Trueblood	Off Montville, Conn	Aug. 24-25, 1917	1	Pole	4	−1.73	−1.67	16	0.70	5.23	−2.33	−2.48	200	1.05	7.19	11.50
				1	Meter	1	−1.43	−1.72		0.63	4.63	−2.63	−1.38		1.48	7.79	11.76
				1	do	6	−1.78	−1.87		0.63	4.98	−2.63	−2.48		1.07	7.44	11.36
				1	do	12	−2.53	−2.42		0.45	5.43	−2.93	−1.68		0.37	6.99	11.16
12	H. E. Finnegan	Mid-channel, off Mohegan, Conn.	Aug. 12-13, 1929	1	Pole	3½	−1.20	−2.40	331	0.49	4.43	−2.60	−1.90	159	0.62	7.99	11.53
				1	Meter	7	−1.20	−2.60		0.56	3.83	−3.20	−2.90		0.76	8.59	11.07

[1] Pettersson meter observations.
[2] Near the surface at this station the current was ebbing, or setting southerly, during the whole period of occupation. Therefore, the velocity given in parentheses is that for the minimum ebb.
[3] At this depth the current floods or sets northerly.

At 12 of the 13 current stations occupied in the Thames River by field parties of the Coast and Geodetic Survey during the summers of 1917 and 1929 observations were also made by means of Price current meters at various depths in addition to surface current observations made by means of current-pole and current-log line. The results from these subsurface observations are given in Table 55. For comparative purposes, the results from observations near the surface are also given in the table. It will be noted that the results from meter observations at a depth of about 7 feet generally agree quite well with those obtained by means of current-pole and current-log line.

At station 5 Pettersson meter observations were also obtained at a depth of 10 feet. The times and velocities of the current obtained by means of this meter agree quite well with those obtained by means of the Price current meter. The directional observations obtained by means of the Pettersson current meter indicate that the subsurface current at station 5 at the entrance to the river sets more northerly on the flood and more southerly on the ebb than the surface current does; that is, more in the direction of the axis of the dredged channel.

Reference to the values in the last column of Table 55 will show that the time of the current at each station generally occurs earlier and earlier as the depth increases. This is perhaps shown more clearly in columns 8, 9, 13, and 14. It will also be noted from the data in column 12 that the duration of flood generally increases with depth, while that of ebb decreases. As the depth increases, ebb velocities generally decrease while flood velocities increase. These phenomena have been discussed and explained in the above section on the tide and current in Fishers Island Sound.

Further reference is here made to current conditions at station 7, where, as stated above, the tidal current at the surface was ebbing throughout the entire 25-hour period of observations. Velocity observations at this station were made by means of a Price current meter at three depths—3, 18, and 42 feet. Directions of the current were observed at the surface by means of a float and at a 3-foot depth by means of a vane. No directions were observed at depths of 18 and 42 feet, but in the reduction of the current observations it was assumed that the velocity curves at these depths followed those at the 3-foot depth. Furthermore, there were observational notes to the effect that at times the subsurface current was flowing in, or upstream, while the surface current was ebbing. Therefore, the indications strongly point to a flood current at subsurface depths while the current at the surface, most likely due to freshet conditions, was continuing to ebb. Again, the velocities of ebb at depths of 18 and 42 feet were but half as great as that at the surface, while the flood velocities at these depths were about 50 per cent greater than the ebb velocities.

THE TIDE AND CURRENT IN EASTERN LONG ISLAND SOUND

Eastern Long Island Sound, for purposes of discussion in this publication, is that waterway extending from Fishers Island Sound and The Race to a line joining Stratford Point Light, Conn., Stratford Shoal Light, and Old Field Point Light, Long Island. It is approximately 50 nautical miles in length, as measured along an axis joining Stratford

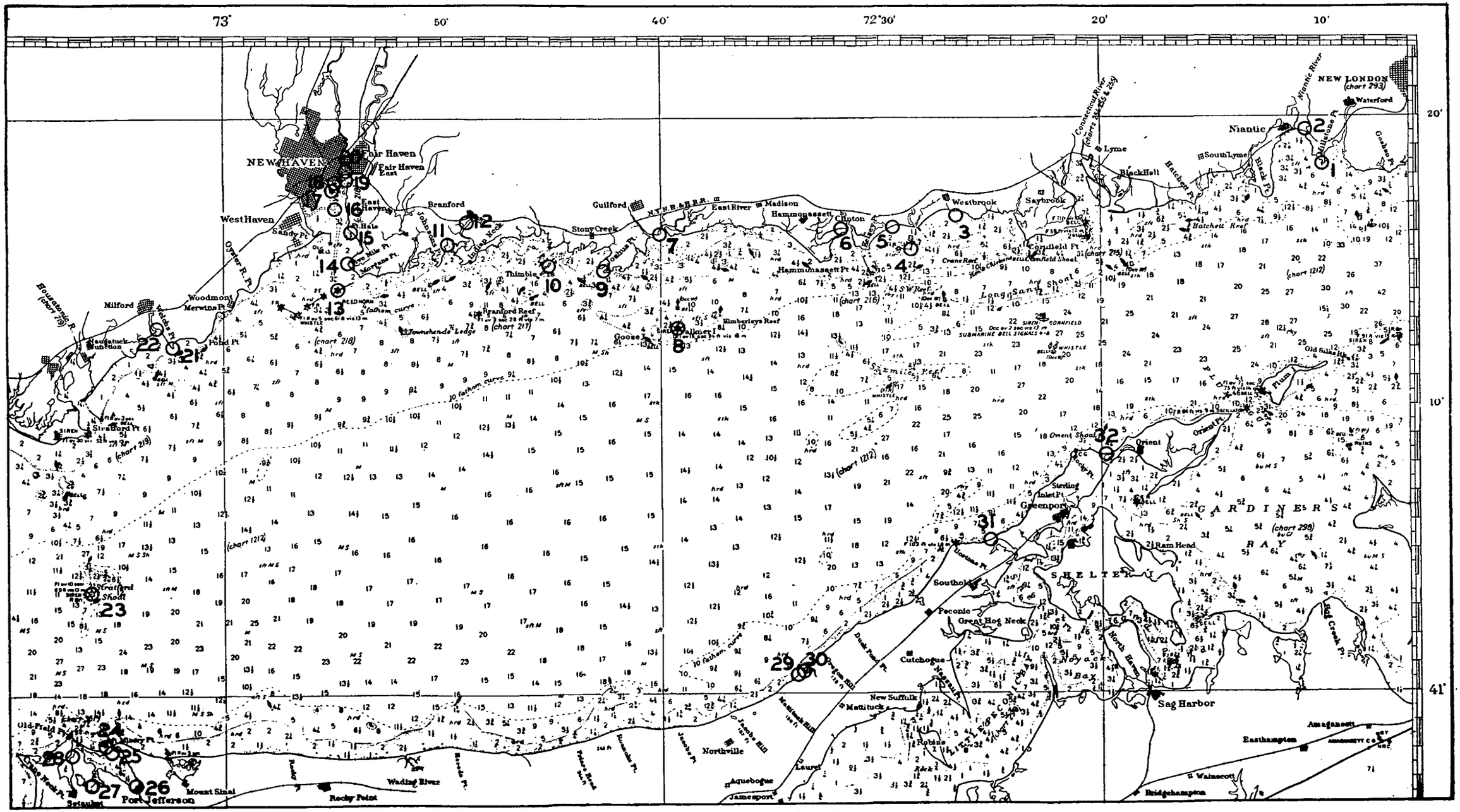

FIGURE 16.—Tide stations, eastern Long Island Sound

Shoal Light, Cornfield Point Lightship, and Bartlett Reef Lightship, and varies in width from about 5 nautical miles at The Race to about 20 nautical miles off New Haven, Conn.

Stratford Shoal Middle Ground, a triangular-shaped shoal about 1 square mile in area, is located nearly in mid sound between Stratford Point, Conn., and Old Field Point, Long Island. Depths of more than 140 feet obtain in the water passages north and south of this shoal area, although the southern passage is generally deeper and considerably wider than the northern. The northern coast of Long Island is very regular in character, the only obstructions to the progression of the tide wave being the presence of sandy shoals extending about 2 miles offshore in the vicinity of Roanoke, Herods, and Rocky Points. The Connecticut shore on the other hand, is very irregular and is characterized by the presence of numerous rocky headlands and shoals. West of the entrance to the Thames River several extensive shoals and reefs offer considerable opposition to the progression of the tide wave, the more important of these being Bartlett Reef, Hatchett Reef, Long Sand Shoal, Sixmile Reef, and Kimberleys Reef.

Another characteristic feature about eastern Long Island Sound is its funnel shape, the width varying from about 7½ miles off Orient Point, Long Island, to approximately 17 nautical miles off Herods Point, Long Island. Average widths and depths at mean low water along four cross sections of eastern Long Island Sound are as follows:

Cross section	Width	Depth
	Nautical miles	*Feet*
Mount Misery Point, Long Island-Stratford Point, Conn.	10¾	58
Roanoke Point, Long Island-Sachem Head, Conn.	16	76
Terry Point, Long Island-Lynde Point, Conn.	7½	84
Orient Point, Long Island-Hatchett Point, Conn.	7½	120

Tides have been observed in eastern Long Island Sound since 1838, when records were obtained at Falkner Island Light, Sachem Head, Branford Harbor, and New Haven Harbor in connection with early hydrographic operations along the Connecticut shore. The locations of 32 tide stations occupied in this waterway are shown in Figure 16 and the results of observations at these stations are given in Table 56.

TABLE 56.—*Tidal data, eastern Long Island Sound, 1838–1929*

Station No.	Location	Observations: Date	Observations: Period	Lunitidal intervals: HWI	Lunitidal intervals: LWI	Duration of rise	Mean range	Compared with—
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Millstone Point, Conn	July 16–Nov. 1, 1883	39	9.65	3.58	6.07	2.62	New London, Conn.
2	Niantic, Conn. (highway bridge)	June 29–Aug. 29, 1917	5	10.24	4.12	6.12	2.44	Do.
3	Salt Island, Westbrook Harbor, Conn	Oct. 2–Nov. 4, 1894	7	10.57	4.50	6.07	4.39	Do.
4	Duck Island Harbor, Conn	Oct. 12–Nov. 3, 1883	4	10.25	4.19	6.06	4.02	Do.
		Oct. 15–Nov. 12, 1895	3	11.20	4.54	6.66	3.97	Do.
		Sept. 10, 1912–May 26, 1915	226				4.18	(1).
5	Pine Orchard Beach, Duck Island Roads	July 5–21, 1877	8	11.22	4.51	6.71	4.08	Sandy Hook, N. J.
6	Clinton, Conn. (Hammonasset River)	Sept. 18–Oct. 5, 1894	5	11.06	4.87	6.19	4.52	New London, Conn.
		Aug. 2, 1895	1	11.60	5.87	5.73	4.50	Do.
		June 15–27, 1911	11	11.08	4.55	6.53	5.28	Do.
		Oct. 2–18, 1913	15	11.11	5.16	5.95	4.74	Do.
		Sept. 1–3, 1917	3	11.12	5.07	6.05	4.04	Do.
7	Guilford, Conn	Sept. 7–9, 1917	3	10.96	5.06	5.90	5.34	Do.
8	Falkner Island Light	Aug. 10–26, 1838	17	11.16	4.69	6.47	5.15	
		July 18–Sept. 9, 1884	54	11.00	4.73	6.27	5.33	Pulpit Harbor, Me.
		Nov. 10–13, 1884	4	10.86	4.66	6.40	5.34	Do.
		June 16–Aug. 19, 1886	36	10.87	4.40	6.47	5.03	Providence, R. I.
		May 26–27; June 9–10, 1887	4	11.09	4.69	6.40	5.09	Sandy Hook, N. J.
		July 25–28, 1893	3	11.37	4.94	6.43	5.53	Fort Hamilton, N. Y.
		Sept. 17–25, 1894	4	10.97	4.69	6.28	5.06	Do.
9	Sachem Head, Conn	Aug. 29–Nov. 1, 1838	65	11.08	4.75	6.33	5.47	
10	Money Island (The Thimbles)	Sept. 7–20, 1884	14	10.85	4.65	6.20	5.64	Pulpit Harbor, Me.
		June 28–July 12, 1886	6	11.11	4.92	6.19	5.53	Providence, R. I.
		July 27–Aug. 3, 1893	5	10.96	4.80	6.16	5.67	Fort Hamilton, N. Y.
		Sept. 12–13, 1894	1	11.26	4.83	6.43	6.09	Do.
11	Branford Harbor, Conn. (Brocketts Point)	July 27–Aug. 24, 1838	29	11.00	4.57	6.43	5.67	
		Nov. 20, 1915–Jan. 22, 1916	66				5.54	(1).
12	Branford River (Malleable Iron Foundry Co. wharf).	Nov. 20, 1915–Jan. 22, 1916	45				5.63	(1).
13	Southwest Ledge Light, New Haven Harbor	July 31–Nov. 14, 1884	107	11.02	4.90	6.12	6.01	
		July 8–13, 1886	4	11.28	4.93	6.35	5.79	Providence, R. I.
		May 4–12, 1887	4	11.20	4.93	6.27	5.77	Sandy Hook, N. J.
14	Five-Mile Point, New Haven Harbor	Mar. 31–Apr. 15, 1871	16	10.98	4.86	6.12	6.02	Boston, Mass.[1]
		May 4–Sept. 7, 1872	75	11.14	4.83	6.31	6.06	
		June 17–Sept. 13, 1890	44	11.21	5.01	6.20	5.98	
15	Fort Hale, New Haven Harbor	Aug. 2–7, 1858	5	11.06	4.92	6.14	6.29	Boston, Mass.
		Mar. 31–Apr. 15, 1871	14	10.98	4.95	6.03	6.09	Do.[1]
16	Off Oyster Point, New Haven Harbor	May 8–July 24, 1838	78	11.08	4.80	6.28	6.05	
17	New Haven, Conn. (Long Wharf)	Mar. 18–Apr. 15, 1871	28	11.11	4.95	6.16	6.15	Boston, Mass.[1]
		Sept. 18–Oct. 9, 1872	13	11.07	5.17	5.90	6.34	Do.
18	New Haven, Conn. (City dock, Hamilton Street)	June 13–Sept. 29, 1917	109	11.15	5.02	6.13	6.28	
19	New Haven, Conn. (Tomlinson Bridge)	Jan. 11, 1910–Dec. 28, 1915	851				5.93	(1).
20	New Haven, Conn. (Chapel Street Bridge)	Mar. 18–Apr. 15, 1871	29	11.17	5.05	6.12	5.95	Boston, Mass.[1]
		Oct. 10–25, 1872	10	11.03	5.21	5.82	5.55	Do.
21	Welchs Point, Conn	July 8–29, 1885	22	11.00	4.78	6.22	6.47	Pulpit Harbor, Me.
22	Entrance to Wepawaug River	Apr. 26–27, 1878	1	11.75	4.62	7.13	5.50	Sandy Hook, N. J.
		Aug. 20–22, 1917	3	11.24	4.85	6.39	6.75	Fort Hamilton, N. Y.
23	Stratford Shoal Light	July 8–Oct. 26, 1886	103	11.12	4.98	6.14	6.49	
24	Entrance to Port Jefferson Harbor, Long Island	Aug. 6–Oct. 3, 1874	22	11.38	5.58	5.80	6.34	Boston, Mass.
		Apr. 30–May 6, 1918	6	11.39	5.11	6.28	6.38	Fort Hamilton, N. Y.
25	Barrel Island, Port Jefferson Harbor	Oct. 7, 1927–Jan. 19, 1928	63	11.51	5.42	6.09	6.44	(1).
26	Port Jefferson, Long Island	July 27–Oct. 4, 1874	68	11.57	5.88	5.69	6.06	
		July 30–Sept. 21, 1886	36	11.68	5.77	5.91	6.41	
		Oct. 11–Nov. 8, 1916	29	11.50	5.41	6.09	6.45	
		Mar. 1, 1928–Sept. 27, 1929	384	11.52	5.45	6.07	6.52	(1).
27	Setauket Harbor	Sept. 11–15, 1874	5	11.78	6.49	5.29	6.41	Boston, Mass.
		Sept. 11, 1886	1	11.67	5.83	5.84	6.50	Port Jefferson, L. I.
28	Conscience Bay	Sept. 11, 1886	1	12.37	7.23	5.14	4.72	Do.
29	300 meters west of Mattituck Inlet, Long Island	Oct. 10–29, 1883	15	11.32	5.22	6.10	4.65	New London, Conn.
30	Mattituck Inlet, Long Island	Sept. 24–Nov. 1, 1883	33	11.47	5.47	6.00	3.63	Do.
		Aug. 7–9, 1917	3	11.27	5.06	6.21	5.53	Fort Hamilton, N. Y.
		Aug. 30–Nov. 6, 1927	19	11.90	5.89	6.01	4.53	Do.[1]
31	Hashamomuck Beach, east of Horton Point, Long Island.	Sept. 24–26, 1884	3	10.84	4.71	6.13	4.30	Pulpit Harbor, Me.
32	Truman Beach, Orient, Long Island	Sept. 7–Nov. 2, 1883	26	10.92	4.60	6.32	3.28	New London, Conn.
		Sept. 27–30, 1884	3	11.11	4.26	6.85	3.76	Pulpit Harbor, Me.

[1] From tide records furnished by the Corps of Engineers, U. S. Army.

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Except as indicated, the values in Table 56 were derived from observations obtained by the Coast and Geodetic Survey. Where it was possible to do so, short series of observations were compared with simultaneous observations at a long-period standard, or primary, tide station in order to reduce the results to mean values. It will be noted from the data in the table that the results from various series at the same station generally agree quite closely, especially if such series of observations are of a fortnight or longer in duration. It should also be borne in mind that it is somewhat difficult to find a reference tide station located outside of Long Island Sound where tidal conditions closely approximate those in the Sound itself. In order to arrive at standard values, therefore, the results from observations as listed in Table 56 were subjected to an adjustment process, giving due weight to the lengths of series at each station, and the adjusted values for each tide station in this waterway are given in Table 57 along with those for Fishers Island Sound, The Race, and Plum Gut.

In Table 57 the high and low water lunitidal intervals and duration of rise of tide at each station are given in hours and hundredths of an hour. The duration of rise of tide is obtained by subtracting the low-water interval from the high-water interval. In addition to the values for mean range at each station there are also given the approximate values for spring and neap ranges. The latter were obtained through the application of factors to the values for mean range as follows: Spring range = mean range × 1.18; neap range = mean range × 0.80. These formulæ were obtained by comparing the relation of harmonic tidal constants at New London, Conn., and Willets Point, N. Y., two primary tide stations at the eastern and western ends of Long Island Sound, respectively. In passing, it might be stated that the approximate great tropic range at each station may be derived by multiplying the value for mean range by the factor 1.14. The great tropic range obtains at the time when the height inequality, or difference between higher high water and lower low water is a maximum.

In order to bring out more clearly the variations in time and range of tide throughout eastern Long Island Sound and its tributaries the data in Table 57 have been plotted in the form of curves in Figures 17 and 18 which show, respectively, the variations in lunitidal intervals and range of tide at stations in this waterway.

A glance at Figure 17 will show that in eastern Long Island Sound west of Orient Point, Long Island, and Saybrook Breakwater Light (Connecticut River entrance) both high-water interval and low-water interval occur earlier along the northern shore of the Sound than along the southern shore. This is indicated by means of the solid-lined curve. In the case of the high-water interval this difference in time of tide along the northern and southern shores of the Sound is rather uniformly about 0.4 hour, or approximately 25 minutes. Except for a few slight variations this same relationship also holds true for the occurrence of low water, the latter occurring earlier along the northern shore than along the southern shore.

TABLE 57.—*Adjusted tidal data, eastern Long Island Sound and Fishers Island Sound*

Station No.	Locality	Lunitidal intervals		Duration of rise	Range of tide		
		HWI	LWI		Mean	Spring	Neap
	Fishers Island Sound	*Hours*	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*
1	Watch Hill Light, Watch Hill Point, R. I.	9.00	2.70	6.30	2.7	3.2	2.2
2	Watch Hill, Little Narragansett Bay	9.80	4.10	5.70	2.2	2.6	1.8
3	Westerly, R. I. (Pawcatuck River)	9.25	3.55	5.70	2.5	3.0	2.0
4	Stonington, Conn.	9.00	2.90	6.10	2.7	3.2	2.2
5	Noank, Conn. (Mystic River)	9.15	3.20	5.95	2.7	3.2	2.2
6	West Mystic, Conn.	9.40	3.30	6.10	2.5	3.0	2.0
7	Boat basin, North Dumpling Island	9.60	3.20	6.40	2.3	2.7	1.8
8	West Harbor, Fishers Island	9.30	3.45	5.85	2.3	2.7	1.8
9	East Point, Fishers Island	8.25	2.50	5.75	2.7	3.2	2.2
	The Race and Plum Gut						
1	Near Race Point, Fishers Island	9.10	2.40	6.70	2.3	2.7	1.8
2	Little Gull Island Light	9.65	3.50	6.15	2.5	3.0	2.0
3	South Dock, Plum Island	9.75	3.80	5.95	2.6	3.1	2.1
4	Plum Island Light, Plum Gut	9.80	3.85	5.95	2.6	3.1	2.1
5	Orient Point Light	9.90	3.95	5.95	2.7	3.2	2.2
6	Orient Point, L. I.	10.20	4.15	6.05	2.8	3.3	2.2
	Eastern Long Island Sound						
1	Millstone Point, Conn.	9.65	3.60	6.05	2.7	3.2	2.2
2	Niantic, Conn. (highway bridge)	10.00	3.90	6.10	2.7	3.2	2.2
3	Salt Island, Westbrook Harbor, Conn.	10.65	4.40	6.25	4.3	5.1	3.4
4	Duck Island Harbor, Conn.	10.70	4.35	6.35	4.3	5.1	3.4
5	Pine Orchard Beach, Duck Island Roads	11.15	4.45	6.70	4.3	5.1	3.4
6	Clinton, Conn. (Hammonasset River)	11.10	5.00	6.10	4.7	5.5	3.8
7	Guilford, Conn.	10.95	5.00	5.95	5.3	6.3	4.2
8	Falkner Island Light	10.90	4.70	6.20	5.3	6.3	4.2
9	Sachem Head, Conn.	11.00	4.75	6.25	5.4	6.4	4.3
10	Money Island (The Thimbles)	11.00	4.75	6.25	5.6	6.6	4.5
11	Branford Harbor, Conn. (Brocketts Point)	11.00	4.60	6.40	5.7	6.7	4.6
12	Branford River (Malleable Iron Foundry Co. wharf)	------	------	------	5.7	6.7	4.6
13	Southwest Ledge Light, New Haven Harbor	11.00	4.90	6.10	6.0	7.1	4.8
14	Five-Mile Point, New Haven Harbor	11.00	4.90	6.10	6.0	7.1	4.8
15	Fort Hale, New Haven Harbor	11.05	4.95	6.10	6.2	7.3	5.0
16	Off Oyster Point, New Haven Harbor	11.05	4.95	6.10	6.1	7.2	4.9
17	New Haven, Conn. (Long Wharf)	11.10	5.00	6.10	6.2	7.3	5.0
18	New Haven, Conn. (city dock, Hamilton Street)	11.15	5.00	6.15	6.3	7.4	5.0
19	New Haven, Conn. (Tomlinson Bridge)	------	------	------	6.0	7.1	4.8
20	New Haven, Conn. (Chapel Street Bridge)	11.15	5.10	6.05	6.0	7.1	4.8
21	Welchs Point, Conn.	11.00	4.80	6.20	6.5	7.7	5.2
22	Entrance to Wepawaug River	11.20	4.85	6.35	6.5	7.7	5.2
23	Stratford Shoal Light	11.10	5.00	6.10	6.5	7.7	5.2
24	Entrance to Port Jefferson Harbor, Long Island	11.40	5.40	6.00	6.3	7.4	5.0
25	Barrel Island, Port Jefferson Harbor	11.50	5.40	6.10	6.5	7.7	5.2
26	Port Jefferson, Long Island	11.55	5.45	6.10	6.5	7.7	5.2
27	Setauket Harbor	11.80	6.00	5.80	6.5	7.7	5.2
28	Conscience Bay	12.35	7.25	5.10	4.7	5.5	3.8
29	300 meters west of Mattituck Inlet, Long Island	11.30	5.20	6.10	4.6	5.4	3.7
30	Mattituck Inlet, Long Island	11.60	5.60	6.00	4.7	5.5	3.8
31	Hashamomuck Beach, east of Horton Point, Long Island	11.00	4.70	6.30	4.0	4.7	3.2
32	Truman Beach, Orient, Long Island	10.90	4.60	6.30	3.4	4.0	2.7

The range of tide is greater along the northern shore of eastern Long Island Sound than along the southern shore, as is clearly shown in Figure 18. In the vicinity of the Connecticut River entrance this difference in range is small, being but approximately 0.2 foot. As the Sound widens out, however, this difference in range becomes somewhat sizeable, the range in the vicinity of Falkner Island Light being about 0.6 foot greater than that near Mattituck Inlet, Long Island. This increase in range along the northern shore of Long

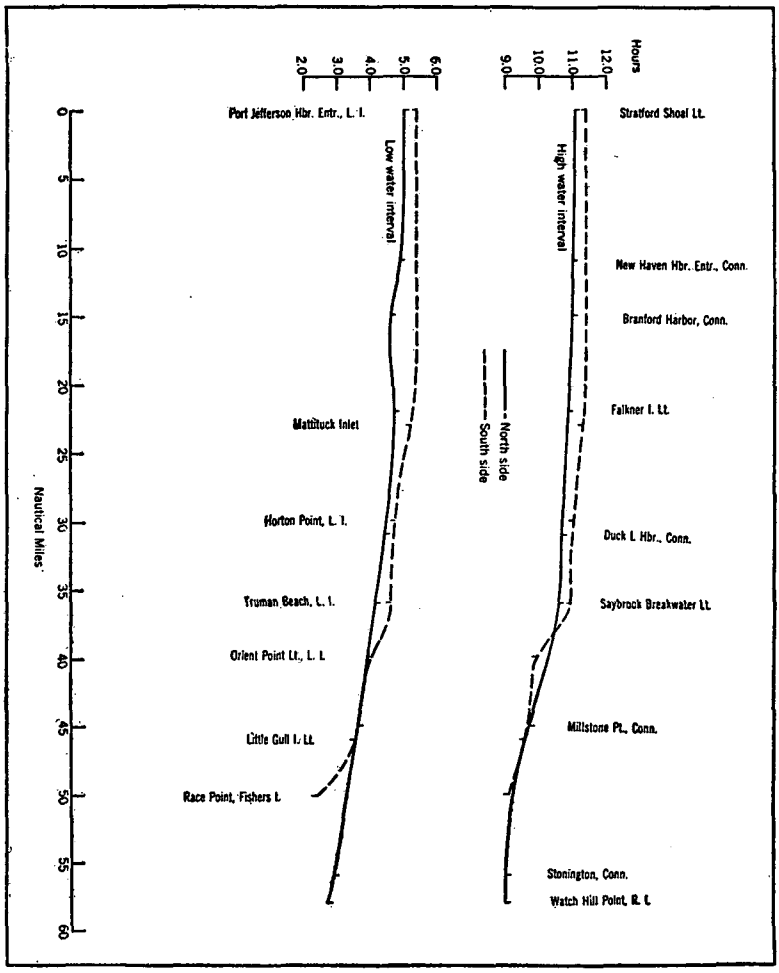

FIGURE 17.—Lunitidal intervals, eastern Long Island and Fishers Island Sounds

Island Sound, or right-hand side of the waterway with respect to the progression of the tide wave, is due to the deflecting force which results from the earth's rotation which was discussed in detail in connection with the tide in Fishers Island Sound.

Tidal currents have been observed by the Coast and Geodetic Survey at 65 stations in eastern Long Island Sound since 1846. The locations of these stations are shown in Figure 19 and the results from current observations near the surface are given in Table 58.

The data for two of these stations, namely, station 5 (Bartlett Reef Lightship) and station 28 (Cornfield Point Lightship) have been obtained from long series of observations and were discussed at length above on pages 30 to 38.

During the years 1844–1848 tides and tidal currents were observed at a number of stations in New York Harbor, Long Island Sound, and Block Island Sound in order to arrive at an understanding of tidal

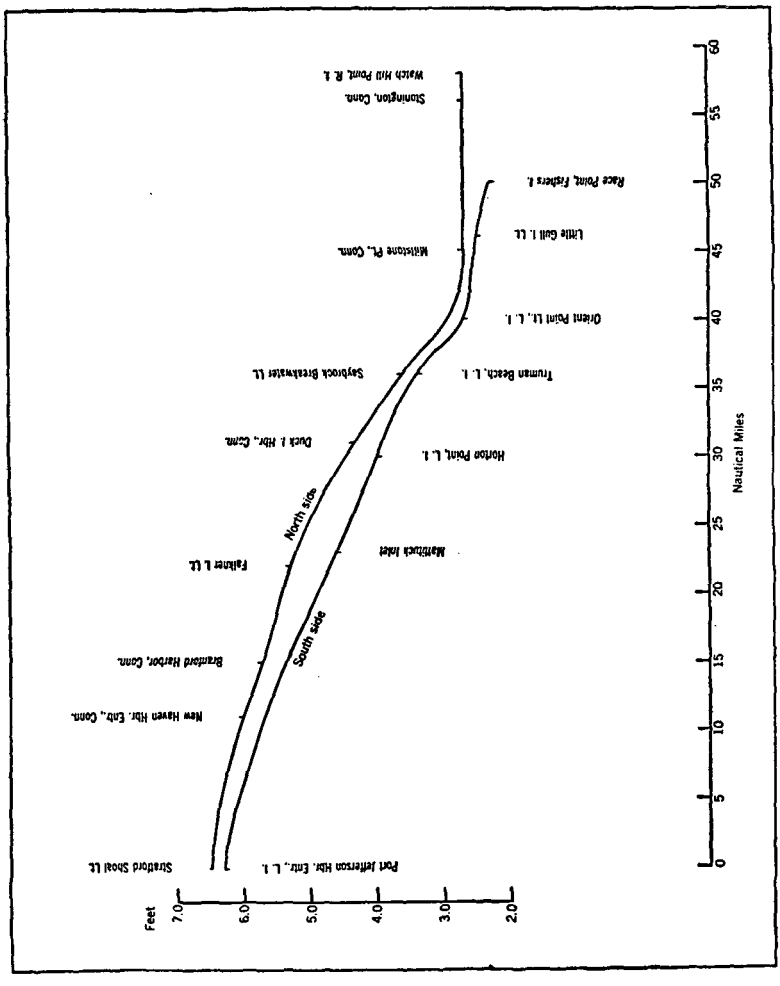

FIGURE 18.—Range of tide, Eastern Long Island and Fishers Island Sounds

and current conditions in these waterways and at the same time furnish data for use in connection with the prediction of tides and currents at stations in these waterways. The current observations made by Goldsborough at 37 stations in Long Island Sound, of which 14 were located in the eastern portion of this waterway, were obtained in connection with this program which is discussed at some length on pages 168–179, Appendix No. 60, Report of the Superintendent of the United States Coast Survey for 1854, in an article by Charles A. Schott, entitled "Report on the Tidal Currents of Long Island Sound and Approaches."

TABLE 58.—*Results from current observations near the surface, eastern Long Island Sound*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations: Date	Observations: Period	Observations: Method	Observations: Depth	Slack	Flood strength: Time	Flood strength: Direction (true)	Flood strength: Velocity	Flood duration	Slack	Ebb strength: Time	Ebb strength: Direction (true)	Ebb strength: Velocity	Ebb duration	Mean current hour
				Days		Feet	Hours after	Hours after	°	Knots	Hours	Hours after	Hours after	°	Knots	Hours	Hours
1	P. M. Trueblood	North of Race Point, Fishers Island.	Aug. 8-9, 1917	1	Pole	7	−2.58	−3.02	30	0.98	7.68	−0.73	−0.63	216	0.45	4.74	11.81
2	J. R. Goldsborough	Off Thames River Entrance	Aug. 14-15, 1846	1	Float	(1)	−2.52	−1.51	268	1.10	6.91	−1.44	−1.77	58	1.13	5.51	11.74
3	P. M. Trueblood	do	July 31-Aug. 1, 1917	1	Pole	7	−4.53	−1.27	260	1.08	8.78	−1.58	−2.58	60	0.62	3.64	11.06
4	J. R. Goldsborough	Off Bartlett Reef	Sept. 3-4, 1846	1	Float	(1)	−1.90	−1.85	277	1.59	6.17	−1.56	−1.65	84	1.66	6.25	11.81
5	Master	Bartlett Reef Lightship	Aug. 8, 1929-Mar. 31, 1930.	226	Pole	7	−2.08	−0.99	255	1.35	6.84	−1.07	−1.65	90	1.30	5.58	12.10
6	P. M. Trueblood	Off Bartlett Reef Lightship	July 16-17, 1917	1	Pole	7	−0.03	−0.77	250	1.66	5.18	−0.68	−0.33	111	1.90	7.24	0.68
7	do	do	July 10-11, 1917	¾	do	7	−0.98	−1.47	272	1.45	6.53	−0.28	−0.28	116	1.50	5.89	0.38
8	H. E. Finnegan	Twotree Island Channel	July 29-30, 1929	1	do	7	−1.20	−0.80	297	1.27	6.13	−0.90	−0.90	110	1.67	6.29	0.18
9	P. M. Trueblood	do	July 12-14, 1917	1¾	do	7	−3.05	−0.84	280	1.33	8.42	−0.46	−1.51	107	1.05	4.00	12.09
10	J. R. Goldsborough	North of Plum Island	June 13-14, 1846	1	Float	(1)	−0.68	−0.70	256	2.12	5.88	−0.63	−0.48	68	2.51	6.54	0.51
11	H. E. Finnegan	Niantic Bay (N. Y., N. H. & H. R. R. bridge).	July 29-30, 1929	1	Pole	4½	−0.70	0.00	(2)	1.31	6.23	−0.30	0.10	(2)	1.31	6.19	0.91
12	P. M. Trueblood	Niantic Bay (highway bridge)	Aug. 27-29, 1917	1½	Meter	6	−0.66	−0.14	(2)	2.30	5.99	−0.50	−0.05	(2)	2.48	6.43	0.79
13	do	Off Black Point	Aug. 29, 1917	½	Pole	7	−1.63	−1.67	254	1.75	5.63	−1.83	−1.08	94	1.75	6.79	12.00
14	do	do	Sept. 13-14, 1917	¾	do	7	−1.53	−0.92	259	1.55	6.08	−1.28	−1.23	94	1.40	6.34	12.31
15	do	Off Hatchett Point	Sept. 14-15, 1917	1	do	7	−2.03	−1.72	268	1.52	7.23	−0.63	−1.68	82	1.35	5.19	12.04
16	C. P. Perkins	North of Orient Point	June 16-17, 1887	1¼	do	6	0.56	0.19	275	1.98	5.02	−0.25	0.43	88	2.53	7.40	1.36
17	P. M. Trueblood	Off Terry Point	Sept. 21-22, 1917	1	do	7	−0.26	−0.07	243	2.75	6.06	−0.03	−1.03	82	3.25	6.36	0.78
18	E. E. Haskell	do	July 19, 21-22, 1890	1¼	Meter	(1)	0.22	−0.05	269	2.68	5.23	−0.38	0.00	58	3.42	7.19	1.08
19	do	East of Cornfield Point Lightship.	July 8, 11-12, 1890	1	do	(1)	0.62	0.38	232	1.50	5.01	−0.20	0.68	50	2.42	7.41	1.50
20	do	do	July 7-8, 1890	1	do	(1)	−1.16	−0.57	288	2.42	7.04	0.05	−0.80	73	1.97	5.38	0.51
21	H. E. Finnegan	Off east end of Long Sand Shoal.	July 24-25, 1929	1	Pole	7	−1.50	−1.20	252	2.13	6.63	−0.70	−1.20	100	1.43	5.79	12.40
22	J. R. Goldsborough	do	June 15-16, 1846	1	Float	(1)	−1.47	−1.39	266	1.44	5.77	−1.53	−1.20	104	1.60	6.65	12.15
23	E. E. Haskell	South of Lyndes Neck	July 5, 10-11, 1890	1¼	Meter	(1)	−1.38	−2.00	299	1.31	5.89	−1.32	−1.67	81	1.75	6.53	11.96
24	P. M. Trueblood	Off Cornfield Point	Sept. 17-18, 1917	½	Pole	7	−1.13	−2.07	268	1.57	5.33	−1.63	−1.78	111	1.97	7.09	11.90
25	do	do	Sept. 19-20, 1917	1	do	7	−1.48	−1.97	268	1.94	5.73	−1.58	−1.98	96	1.99	6.69	11.80
26	J. R. Goldsborough	do	June 14-15, 1846	1	Float	(1)	−1.15	−2.16	275	1.38	5.65	−1.33	−1.97	98	1.25	6.77	11.90
27	P. M. Trueblood	South of Long Sand Shoal	Sept. 19-20, 1917	1	Pole	2	−1.28	−1.67	299	2.40	6.08	−1.03	−1.71	135	2.27	6.34	12.13
28	Master	Cornfield Point Lightship	Aug. 1, 1890-July 31, 1930.	618	do	7	−1.00	−0.43	256	1.96	6.72	−0.11	−0.47	94	1.72	5.70	0.63
29	P. M. Trueblood	Off Cornfield Point Lightship	Sept. 20-22, 1917	1½	do	7	−0.76	0.00	251	2.18	6.56	−0.03	−0.18	65	2.60	5.86	0.89
30	J. R. Goldsborough	do	June 20-21, 1846	1	Float	(1)	0.28	0.28	240	1.20	6.08	0.45	0.90	53	1.73	6.34	1.59
31	C. P. Perkins	Off Sixmile Reef	June 14-15, 1887	1¼	Pole	6	0.05	−0.42	252	2.38	6.10	0.32	−0.01	57	2.42	6.32	1.11
32	C. E. Littlefield	do	Sept. 18-19, 1906	¾	do	7	−0.60	−0.09	238	1.72	6.37	−0.06	−0.75	69	2.20	6.05	0.75
33	J. R. Goldsborough	Off west end of Long Sand Shoal.	June 19-20, 1846	1	Float	(1)	−0.03	−0.36	290	1.09	5.45	−0.41	0.39	96	1.22	6.97	1.03
34	P. M. Trueblood	Off Kelsey Point	Aug. 30-31, 1917	1	Pole	7	−1.48	−0.97	249	1.84	6.38	−0.93	−1.93	118	1.64	6.04	12.22
35	J. R. Goldsborough	East of Falkner Island Light	June 23-24, 1846	1	Float	(1)	−0.60	−0.77	270	1.06	6.00	−0.43	−0.10	111	1.35	6.42	0.65
36	E. E. Haskell	North of Mattituck Inlet	July 29, 1890	½	Meter	(1)	0.92	0.77	300	1.93	5.63	0.72	0.51	38	1.70	6.79	1.86
37	C. P. Perkins	do	June 9-10, 1887	1¼	Pole	6	−0.25	−0.14	250	1.54	6.28	0.20	−0.10	66	1.36	6.14	1.06
38	do	do	May 25-26, 1887	1¼	do	6	0.00	−0.34	260	0.82	5.96	0.13	−0.20	74	0.99	6.46	1.03
39	H. E. Finnegan	North of Roanoke Point Shoal.	July 22-23, 1929	1	do	7	−0.05	0.05	252	0.74	5.88	0.00	0.90	76	0.52	6.54	1.35
40	J. R. Goldsborough	do	Sept. 21-22, 1846	1	Float	(1)	1.34	1.17	276	1.86	4.94	0.45	0.84	104	1.92	7.48	2.08
41	H. E. Finnegan	do	July 22-23, 1929	1	Pole	7	−0.15	−0.70	266	0.70	5.78	−0.20	−0.15	50	0.92	6.64	0.83
42	F. H. Crosby	do	May 11-12, 1887	1	do	6	0.20	−0.15	241	0.80	6.83	1.20	0.28	58	0.80	5.59	1.51
43	E. E. Haskell	do	July 28-29, 1890	½	Meter	(1)	0.94	0.73	230	0.86	5.66	0.77	0.90	63	1.33	6.76	1.97
44	H. E. Finnegan	do	July 19-20, 22-24, 1929	3¼	Pole	7	0.18	0.05	227	0.80	6.02	0.37	0.42	84	1.03	6.40	1.39
45	do	Off Sachem Head	July 23-24, 1929	1	do	7	−0.75	−0.05	278	0.89	5.93	−0.65	−0.75	84	1.09	6.49	0.58
46	J. R. Goldsborough	Off Branford Reef Light	June 25-26, 1846	1	Float	(2)	−0.02	0.17	252	0.55	6.10	0.25	0.19	72	0.68	6.32	1.28
47	C. E. Littlefield	do	Sept. 19-20, 1906	¾	Pole	7	0.40	0.70	260	0.76	5.38	−0.05	0.49	82	1.12	7.04	1.51
48	P. M. Trueblood	Off Townshend Ledge	Sept. 13-14, 1917	1	do	7	−0.18	−0.32	251	0.67	5.78	−0.23	0.12	65	0.82	6.64	0.98
49	do	Entrance to New Haven Harbor.	Aug. 23, 29, 1917	1	do	7	−1.18	−1.77	319	1.49	6.23	−0.78	−1.48	152	0.89	6.19	12.25
50	H. E. Finnegan	do	July 19-20, 1929	1	do	7	−0.15	−2.45	341	0.24	1.53	−4.45	−1.30	177	0.52	10.89	11.46
51	P. M. Trueblood	Tomlinson Bridge, New Haven.	Aug. 13-14, 1917	1	Meter	3	0.57	−0.32	48	1.13	5.43	0.17	0.17	201	1.23	6.99	1.28
52	J. R. Goldsborough	Off entrance to New Haven Harbor.	Sept. 25-26, 1846	1	Float	(1)	−0.63	−0.42	296	1.38	5.80	−0.66	−0.30	76	1.48	6.62	0.63
53	E. E. Haskell	do	Sept. 29-30, 1890	½	Meter	(1)	0.02	0.13	238	0.81	6.28	0.47	0.56	104	0.87	6.14	1.43
54	F. H. Crosby	East of Stratford Shoal Middle Ground.	May 4-5, 1887	1¼	Pole	6	−0.03	−0.05	249	0.90	7.33	1.47	0.56	62	0.70	5.09	1.62
55	E. E. Haskell	do	Aug. 1-2, 1890	½	Meter	(1)	0.99	0.80	331	0.96	5.06	0.22				7.36	1.86
56	P. M. Trueblood	Off Stratford Point	Aug. 9-10, 1917	1	Pole	7	−2.03	−0.28	234	1.16	8.63	0.77	−0.88	80	1.06	3.79	0.53
57	W. J. Sears	Off Stratford Shoal Middle Ground.	Nov. 21-22, 1886	1	do	6	−0.50	−0.54	240	1.30	6.17	−0.16	−0.32	88	1.25	6.25	0.75
58	J. R. Goldsborough	do	Sept. 29, 1846	½	Float	(1)	0.06	0.46	266	1.84	5.77	0.00	0.16	75	2.56	6.65	1.30
59	P. M. Trueblood	do	Sept. 18-19, 1917	1	Pole	7	−0.18	−0.12	270	1.16	5.78	−0.23	−0.18	77	1.08	6.64	0.95
60	J. R. Goldsborough	do	Sept. 23-24, 1846	1	Float	(1)	0.45	0.66	260	1.94	5.88	0.50	1.08	65	2.32	6.54	1.80
61	do	do	Sept. 30-Oct. 1, 1846	1	do	(1)	0.66	0.96	252	2.26	6.10	0.93	1.00	96	2.23	6.32	2.62
62	J. H. Hawley	Off Mount Misery Point	Apr. 26-27, 1918	¾	Pole	5½		−0.64	269	0.83		−0.05	0.12	73	0.73		1.28
63	do	do	Apr. 26-28, 1918	2	do	8	0.10	−0.16	252	0.82	5.65	−0.08	0.22	102	0.88	6.77	1.15
64	F. S. Borden	Entrance to Port Jefferson Harbor.	Oct. 11-13, 1916	2	do	3½	0.09	0.51	146	2.90	6.11	0.37	0.50	336	2.41	6.31	1.50
65	H. E. Finnegan	do	July 19-20, 1929	1	do	4½	0.15	0.70	156	2.41	6.13	0.45	0.10	310	1.46	6.29	1.48

[1] Surface.

[2] Flood sets northerly, ebb sets southerly.

The current observations made by Haskell at 18 stations in Long Island Sound, of which eight were located in the eastern portion of this waterway, were obtained in cooperation with the United States Fish Commission. Two objects were kept in view in obtaining these observations: First, to determine the circulation of the waters of Long Island Sound, and, second, to ascertain the direction of movement of material dumped on the dumping grounds in the waters of the State of Connecticut. In this connection four stations (Nos. 18, 19, 20, and 23, fig. 19) were located on a cross section at the eastern end of the Sound between the mouth of the Connecticut River and the northern shore of Long Island for the purpose of obtaining an approximation to the volume of the flow of flood and ebb. A number of stations were located in the longitudinal axis of the Sound and were occupied to trace the current movement as distinguished from the tide-wave movement. Other stations were located on the dumping grounds of Bridgeport, Norwalk, Stamford, Milford, and New Haven.

In general, the results shown in Table 58 are from current observations obtained by means of a standard 15-foot current pole and current log line. The party of Perkins in 1887 made observations with a pole measuring 12 feet 11 inches in length and which submerged 11 feet 7 inches. The party of Sears in 1886 likewise used a current pole which submerged 12 feet. Haskell's observations were entirely made by means of the Ritchie-Haskell current meter, which will be described later in connection with a discussion of the data in the next table. Owing to the depth of water in Port Jefferson Harbor entrance it was found necessary to use short-length current poles. Observations at stations 62 and 63 were obtained in connection with a wire-drag survey of a submarine trial course off the entrance to Port Jefferson Harbor, Long Island.

The times and durations of the current at each station in Table 58 are given in hours and are referred to similar phases of the current at The Race. The velocities of the current have been corrected to a mean range of tide and represent average current conditions. These velocities of flood and ebb would increase or decrease proportionately as the range of the tide increased or decreased from a mean value.

The minus (−) sign in columns 8, 9, 13, and 14 means "earlier than"—that is, the time of slack or strength of current is earlier than the same phase of the current at The Race. Where no sign precedes the time value, it means that the time of current at the subordinate station occurs later than that at the reference, or standard, station.

The mean solar current hour given in the last column of the table has already been referred to above on page 33. However, further explanation is necessary here to show how the values given in this column are related to one another. The individual values in this column refer to the strength of flood current at each station. In comparing values in this column attention is called to the fact that the semilunar period of 12.42 hours may be added or subtracted as desired as shown by the following illustration: 0.00 hour is the same as 12.42 hours; 11.81 hours is the same as −0.61 hour; and 0.68 hour is the same as 13.10 hours. In this connection it might be restated that the mean solar current hour for strength of flood current at The Race is 1.13, or 13.55.

It will be noted from the values for mean current hour that the time of current throughout eastern Long Island Sound from Falkner Island eastward is earlier than that at The Race with the exception

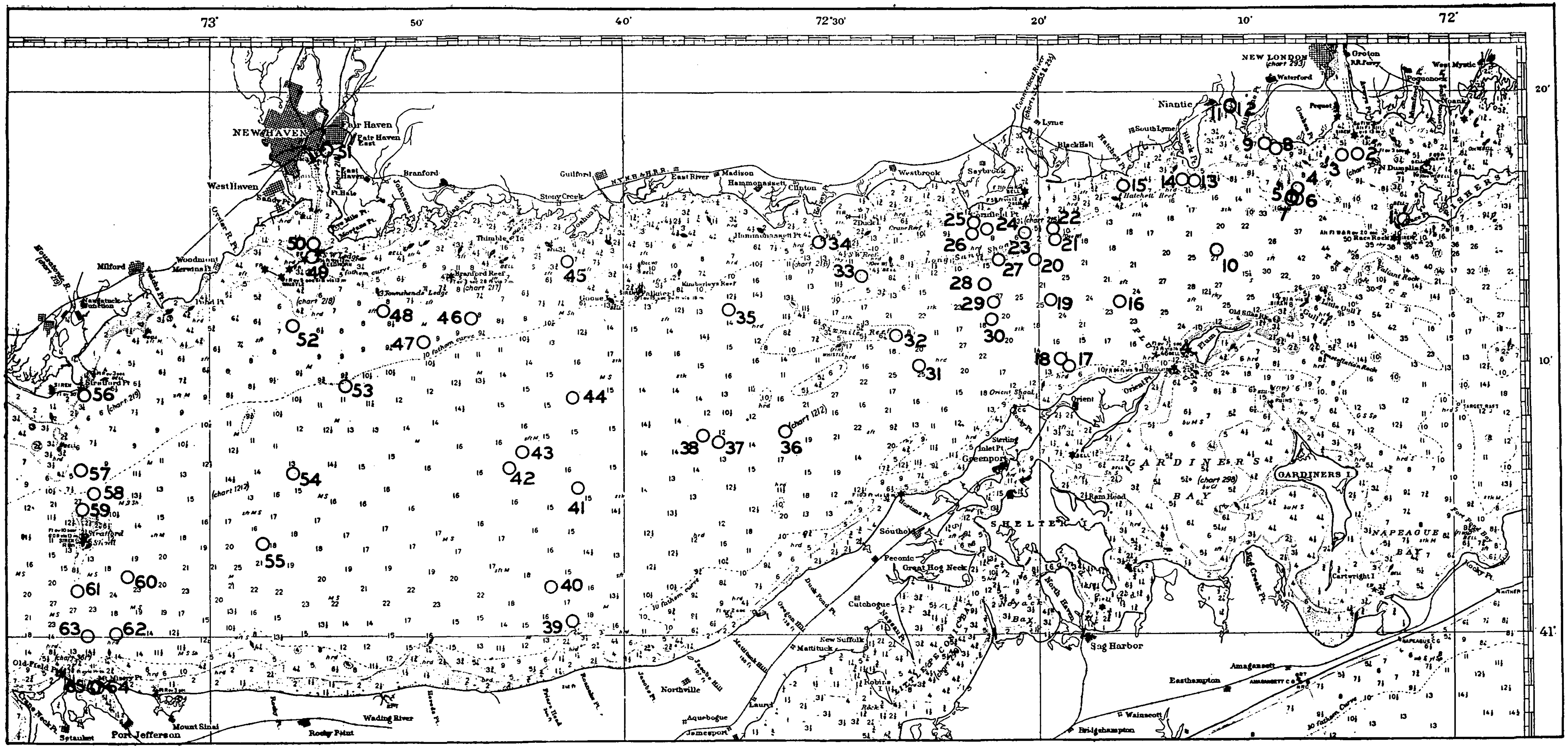

Figure 19.—Current stations, eastern Long Island Sound

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of the main channel way. The data for stations 16, 19, 30, and 36 show that the current along the axis of the channel occurs somewhat later than that at the reference station. Since this channel axis is located nearer the Long Island shore of the Sound, it will be noted that the time of current is considerably earlier along the Connecticut, or northern, shore than along the southern shore. Therefore, an acceleration in the time of current obtains along the northern shore just as there is likewise an acceleration in the time of tide along this shore, as was shown above in the discussion of the tidal data for this waterway. The acceleration in the time of current, however, is due to the fact that the current generally occurs earlier in shoaler waters than in mid-channel, and, as has been pointed out above, the waters along the Connecticut shore are relatively shoal.

A study of cocurrent lines shows that such lines for Long Island Sound are approximately parallel to the axis of the Sound. The current hour for the greater part of the Sound lies between I and I½. Near the northern shore the current hour is less than I. This acceleration is due to the direct action of gravity upon the shore waters when possessing an eastward or westward slope. A similar effect is not equally great near the south shore of the Sound, because the regularity of the shore line there permits the oscillation to extend very near to the land. The cocurrent hour at any place is the time in lunar hours after the moon's transit across the Greenwich meridian at which strength of flood current occurs at that place. A cocurrent line is drawn through places having the same cocurrent hour.

Along the cross section occupied by Haskell in 1890 (stations 18, 19, and 20) strong current velocities obtain, being generally greater than 2.0 knots at strength, the flood being stronger along the northern shore and the ebb along the southern. Average ebb velocities of over 3¼ knots obtain about 1 mile north of Terry Point, Long Island. Likewise, the duration of flood is considerably longer than that of ebb along the northern shore, while the reverse is true along the Long Island shore.

Along the main channel of the Sound average current velocities of 1½ to 2½ knots obtain. At other localities throughout the Sound velocities of 1 knot or more are generally found. Strong velocities of 2 to 3 knots are found at Port Jefferson Harbor entrance owing to the volume of water passing through a relatively narrow entrance.

Current conditions at station 1, off the west end of Fishers Island, need some detailed explanation owing to the location of the station. It will be noted that the flood current sets northeasterly or approximately parallel with the shore line of Fishers Island. At first glance this may seem unusual in view of the fact that the flood current throughout Fishers Island Sound sets westerly and southwesterly.

It takes some time for the current wave to traverse this waterway, however, and the wave entering at The Race reaches this particular locality first and a northerly current direction is produced. Again, when the current is ebbing, or flowing easterly in Fishers Island Sound it begins to ebb, or run southerly at station 1 and continues to set southerly through The Race. The ebb current at this station is weak and is evidently subject to considerable interference with regard to time of slack and strength.

At 38 of the 65 current stations occupied in eastern Long Island Sound observations were made at various depths by means of current meter in addition to surface-current measurements, and the results from these observations are given in Table 59.

TABLE 59.—*Results from current observations at various depths, eastern Long Island Sound*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	North of Race Point, Fishers Island.	Aug. 8-9, 1917	1	Pole	7	−2.58	−3.02	30	0.98	7.68	−0.73	−0.63	216	0.45	4.74	11.81
				1	Meter	6	−2.58	−3.32		1.00	7.48	−0.93	−0.73		0.53	4.94	11.66
				1	do	24	−2.68	−3.72		0.68	7.83	−0.68	−0.83		0.53	4.59	11.57
3	do	Off Thames River Entrance	July 31-Aug. 1, 1917	1	Pole	7	−4.53	−1.27	260	1.08	8.78	−1.58	−2.58	60	0.62	3.64	11.06
				1	Meter	6	−4.28	−1.52		1.17	8.58	−1.53	−2.63		0.75	3.84	11.06
				1	do	18	−3.93	−1.62		1.05	8.43	−1.33	−2.53		0.60	3.99	11.20
				1	do	30	−3.88	−2.07		0.85	8.13	−1.58	−2.33		0.52	4.29	11.09
5	J. C. Sammons	Bartlett Reef Lightship	Dec. 18, 1929	1	Pole	5	−3.03	−2.22		1.37	8.13	−0.73	−1.68		1.17	4.29	11.63
				¼	Meter	10						−1.03					12.41
				¼	do	20						−1.03					12.41
6	P. M. Trueblood	Off Bartlett Reef Lightship	July 16-17, 1917	1	Pole	7	−0.03	−0.77	250	1.66	5.18	−0.68	−0.33	111	1.90	7.24	0.68
				1	Meter	6	−0.03	−1.07		1.79	5.23	−0.63	−0.63		1.99	7.19	0.54
				1	do	30	−0.58	−0.87		1.60	5.53	−0.68	−0.73		1.70	6.89	0.47
				¾	do	60	−0.63	−0.87		1.55	5.75	−0.73	−0.28		1.45	6.67	0.50
				¾	do	90	−0.63	−0.87		1.33	5.78	−0.68	0.02		1.33	6.64	0.59
				¾	do	120	−0.83	−1.07		1.01	6.13	−0.53	−0.08		1.21	6.29	0.50
7	do	do	July 10-11, 1917	¾	Pole	7	−0.98	−1.47	272	1.45	6.53	−0.28	−0.28	116	1.50	5.89	0.38
				¾	Meter	6	−0.78	−1.27		1.45	6.13	−0.48	−0.73		1.80	6.29	0.31
				¾	do	30	−1.03	−0.77		1.45	6.53	−0.33	−0.48		1.50	5.89	0.48
				¾	do	60	−1.13	−0.97		1.46	6.43	−0.53	−0.28		1.41	5.99	0.40
				¾	do	90	−1.03	−0.77		1.26	6.38	−0.48	−0.28		1.16	6.04	0.49
				¾	do	120	−0.88	−0.27		0.87	6.43	−0.28	−0.33		1.12	5.99	0.69
8	H. E. Finnegan	Twotree Island Channel	July 29-30, 1929	1	Pole	7	−1.20	−0.80	297	1.27	6.13	−0.90	−0.90	110	1.67	6.29	0.18
				1	Meter	17	−1.15	−0.90		1.27	6.08	−0.90	−1.05		1.64	6.34	0.13
				1	do	42	−1.50	−0.45		1.27	6.48	−0.85	−1.00		1.70	5.94	0.18
				1	do	67	−1.45	−0.45		1.17	6.33	−0.95	−1.00		1.64	6.09	0.17
9	P. M. Trueblood	do	July 12-14, 1917	1¾	Pole	7	−3.05	−0.84	280	1.33	8.42	−0.46	−1.51	107	1.05	4.00	12.09
				1¾	Meter	6	−3.23	−1.17		1.30	8.53	−0.53	−1.78		1.10	3.89	11.87
				1¾	do	30	−3.23	−0.90		1.12	8.40	−0.66	−1.78		0.96	4.02	11.91
				1¾	do	39	−3.11	−1.04		0.87	8.44	−0.50	−1.55		0.80	3.98	12.00
11	H. E. Finnegan	Niantic Bay (N. Y., N. H. & H. R. R. bridge)	July 29-30, 1929	1	Pole	4½	−0.70	0.00	(1)	1.31	6.23	−0.30	0.10	(1)	1.31	6.19	0.91
				1	Meter	7	−0.70	0.15		2.09	6.43	−0.10	0.00		1.34	5.99	0.97
				1	do	12	−0.65	0.20		2.03	6.38	−0.10	0.15		1.08	6.04	1.03
12	P. M. Trueblood	Niantic Bay (highway bridge)	Aug. 27-29, 1917	1½	Meter	6	−0.66	−0.14	(1)	2.30	5.99	−0.50	−0.05	(1)	2.48	6.43	0.79
				1½	do	12	−0.70	−0.20		2.44	5.97	−0.56	−0.05		2.79	6.45	0.75
13	do	Off Black Point	Aug. 29, 1917	½	Pole	7	−1.63	−1.67	254	1.75	5.63	−1.83	−1.08	94	1.75	6.79	12.00
				½	Meter	6	−1.73	−1.77		1.65	5.93	−1.63				6.49	11.90
				½	do	18	−2.03	−1.87		1.70	6.23	−1.63				6.19	11.77
				½	do	30	−2.23	−1.67		1.45							11.74
14	do	do	Sept. 13-14, 1917	¾	Pole	7	−1.53	−0.92	259	1.55	6.08	−1.28	−1.23	94	1.40	6.34	12.31
				¾	Meter	6	−1.73	−1.07		1.44	6.68	−0.88	−0.88		1.44	5.74	12.41
				¾	do	18	−1.53	−1.07		1.38	6.23	−1.13	−1.08		1.33	6.19	12.35
				¾	do	30	−1.63	−1.17		1.33	6.38	−1.08	−1.18		1.28	6.04	12.29
15	do	Off Hatchett Point	Sept. 14-15, 1917	1	Pole	7	−2.03	−1.72	268	1.52	7.23	−0.63	−1.68	82	1.35	5.19	12.04
				1	Meter	6	−2.08	−1.47		1.50	7.13	−0.78	−1.78		1.35	5.29	12.02
				1	do	18	−1.93	−1.52		1.46	6.98	−0.78	−1.73		1.22	5.44	12.06
				1	do	30	−2.08	−1.57		1.31	6.98	−0.93	−1.58		1.14	5.44	12.01
17	do	Off Terry Point	Sept. 21-22, 1917	1	Pole	7	−0.26	−0.07	243	2.75	6.06	−0.03	−1.03	82	3.25	6.36	0.78
				1	Meter	6	−0.30	−0.12		2.62	6.15	0.02	−0.63		3.07	6.27	0.87
				1	do	18	−0.43	−0.47		2.66	6.13	−0.13	−0.78		2.94	6.29	0.68
				1	do	36	−0.43	−0.52		2.63	6.11	−0.18	−0.78		2.68	6.31	0.65
				1	do	60	−0.70	−0.52		2.44	6.10	−0.43	−0.83		2.44	6.32	0.51
18	E. E. Haskell	do	July 19, 21-22, 1890	1¼	Meter	(2)	0.22	−0.05	269	2.68	5.23	−0.38	0.00	58	3.42	7.19	1.08
				1¼	do	50	−0.23	−0.24	272	2.72	6.23	0.17	0.27	62	2.47	6.19	1.12
				1¼	do	100	−0.70	−0.80	281	2.20	6.53	0.00	−0.33	66	1.83	5.89	0.67
19	do	East of Cornfield Point Lightship.	July 8, 11-12, 1890	1	do	(2)	0.62	0.38	232	1.50	5.01	−0.20	0.68	50	2.42	7.41	1.50
				1	do	81	−0.38	−0.17	283	1.97	6.41	0.20	0.02	46	1.94	6.01	1.05
				1	do	162	−1.28	−1.07	278	1.86	7.03	−0.08	0.22	52	1.47	5.39	0.83
20	do	do	July 7-8, 1890	1	do	(2)	−1.16	−0.57	288	2.42	7.04	0.05	−0.80	73	1.97	5.38	0.51
				1	do	76	−0.68	−0.62	290	2.29	6.68	0.17	−0.33	45	2.29	5.74	0.77
				1	do	151	−0.43	−0.52	274	2.14	6.18	−0.08	−0.23	45	1.43	6.24	0.81
21	H. E. Finnegan	Off east end of Long Sand Shoal.	July 24-25, 1929	1	Pole	7	−1.50	−1.20	252	2.13	6.63	−0.70	−1.20	100	1.43	5.79	12.40
				1	Meter	8	−1.50	−1.05		2.13	6.68	−0.65	−1.30		1.43	5.74	12.43
				1	do	20	−1.35	−0.95		1.93	6.53	−0.65	−1.10		1.23	5.89	12.54
				1	do	32	−1.35	−1.05		1.64	6.53	−0.65	−0.95		1.14	5.89	12.55
23	E. E. Haskell	South of Lynde Neck	July 5, 10-11, 1890	1¼	Meter	(2)	−1.38	−2.00	299	1.31	5.89	−1.32	−1.67	81	1.75	6.53	11.96
				1	do	12	−1.43	−2.12	303	1.20	5.88	−1.38	−1.43	70	1.36	6.54	11.96
				1	do	24	−1.58	−1.97	273	0.79	5.88	−1.53	−1.48	78	1.11	6.54	11.91

[1] Flood sets northerly, ebb sets southerly.

[2] Surface.

TABLE 59.—*Results from current observations at various depths, eastern Long Island Sound*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
25	P. M. Trueblood	Off Cornfield Point	Sept. 19–20, 1917	1	Pole	7	−1.48	−1.97	268	1.94	5.73	−1.58	−1.98	96	1.99	6.69	11.80
				1	Meter	6	−1.63	−1.97		1.73	5.83	−1.63	−2.18		2.08	6.59	11.70
				1	do	12	−1.78	−1.92		1.56	6.08	−1.53	−2.18		1.96	6.34	11.70
				1	do	18	−1.73	−1.87		1.34	5.83	−1.73	−1.98		1.79	6.59	11.72
				1	do	24	−1.63	−1.87		1.17	5.88	−1.58	−1.98		1.67	6.54	11.79
27	do	South of Long Sand Shoal	do	1	Pole	2	−1.28	−1.67	299	2.40	6.08	−1.03	−1.71	135	2.27	6.34	12.13
				1	Meter	6	−1.48	−1.57		2.16	6.38	−0.93	−1.48		1.91	6.04	12.19
28	J. C. Sammons	Cornfield Point Lightship	Dec. 22, 1929	1	Pole	7	−1.03	−0.92	266	2.07	6.33	−0.53	−0.98	121	1.67	6.09	0.27
				½	Meter	10	−0.93	−0.47		1.97	6.03	−0.73	−0.68		1.57	6.39	0.43
				½	do	40	−0.93	−0.37		1.92	6.13	−0.63	0.42		1.57	6.29	0.75
29	P. M. Trueblood	Off Cornfield Point Lightship	Sept. 20–22, 1917	1⅓	Pole	7	−0.76	0.00	251	2.18	6.56	−0.03	−0.18	65	2.60	5.86	0.89
				1⅓	Meter	6	−0.83	−0.20		2.26	6.53	−0.13	−0.18		2.69	5.89	0.79
				1⅓	do	30	−0.93	−0.37		2.24	6.68	−0.08	−0.33		2.49	5.74	0.70
				¾	do	60	−1.23	−0.42		2.15	7.03	−0.03	−0.88		2.35	5.39	0.49
				1⅓	do	87	−1.13	−0.67		2.26	6.83	−0.13	−0.68		2.08	5.59	0.48
34	do	Off Kelsey Point	Aug. 30–31, 1917	1	Pole	7	−1.48	−0.97	249	1.84	6.38	−0.93	−1.93	118	1.64	6.04	12.22
				1	Meter	6	−1.68	−1.27		2.09	6.38	−1.13	−1.98		1.39	6.04	12.03
				1	do	12	−1.63	−1.22		2.02	6.18	−1.28	−2.03		1.35	6.24	12.01
				1	do	18	−1.78	−1.22		1.98	6.18	−1.43	−2.23		1.23	6.24	11.89
				1	do	24	−1.83	−1.57		1.79	6.13	−1.53	−2.18		1.19	6.29	11.77
36	E. E. Haskell	North of Mattituck Inlet	July 29, 1890	½	do	(2)	0.92	0.77	300	1.93	5.63	0.72	0.51	38	1.70	6.79	1.86
				½	do	40	−0.63	0.13	319	1.44	7.13	0.67	0.32	47	1.09	5.29	1.25
				½	do	80	−0.23				6.33	0.27	0.52	120	0.75	6.09	1.31
39	H. E. Finnegan	North of Roanoke Point Shoal	July 22–23, 1929	1	Pole	7	−0.05	0.05	252	0.74	5.88	0.00	0.90	76	0.52	6.54	1.35
				1	Meter	22	−0.10	0.10		0.62	6.08	0.15	0.60		0.67	6.34	1.32
				1	do	55	−0.50	−0.20		0.70	6.48	0.15	0.20		0.72	5.94	1.04
				1	do	80	−0.65	−0.35		0.77	6.63	0.15	−0.20		0.72	5.79	0.87
41	do	do	do	1	Pole	7	−0.15	−0.70	266	0.70	5.78	−0.20	−0.15	50	0.92	6.64	0.83
				1	Meter	18	−0.20	−0.15		0.80	5.93	−0.10	−0.05		1.05	6.49	1.01
				1	do	45	−0.35	0.05		0.95	6.38	0.20	−0.25		0.85	6.04	1.04
				1	do	72	−0.90	−0.60		0.85	6.63	−0.10	−0.65		0.75	5.79	0.57
43	E. E. Haskell	do	July 28–29, 1890	½	do	(2)	0.94	0.73	230	0.86	5.66	0.77	0.90	63	1.33	6.76	1.97
				½	do	46	−0.53	−0.07	286	1.07	6.43	0.07	−0.48	59	0.80	5.99	0.88
				½	do	92	−0.83	−0.27	281	0.86	6.63	−0.03	−1.08	51	0.72	5.79	0.58
44	H. E. Finnegan	do	July 19–20, 22–24, 1929	3¼	Pole	7	0.18	0.05	227	0.80	6.02	0.37	0.42	84	1.03	6.40	1.39
				3¼	Meter	20	0.15	0.48		0.96	6.18	0.50	0.03		0.88	6.24	1.42
				1¾	do.[3]	20	−0.03	0.33	245	0.94	6.39	0.53	0.43	78	0.90	6.03	1.45
				3¼	do	50	0.15	0.15		1.02	5.98	0.30	−0.26		0.94	6.44	1.22
				3¼	do	80	−0.03	−0.27		0.85	6.06	0.20	−0.80		0.74	6.36	0.91
45	do	Off Sachem Head	July 23–24, 1929	1	Pole	7	−0.75	−0.05	278	0.89	5.93	−0.65	−0.75	84	1.09	6.49	0.58
				1	Meter	8	−0.90	−0.15		0.99	6.13	−0.60	−0.80		1.24	6.29	0.52
				1	do	20	−0.90	−0.30		0.99	6.13	−0.60	−0.85		1.04	6.29	0.47
				1	do	32	−1.10	−0.45		0.99	6.23	−0.70	−1.20		0.84	6.19	0.27
48	P. M. Trueblood	Off Townshend Ledge	Sept. 13–14, 1917	1	Pole	7	−0.18	−0.32	251	0.67	5.78	−0.23	0.12	65	0.82	6.64	0.98
				1	Meter	6	0.02	0.13		0.89	5.73	−0.08	−0.23		0.89	6.69	1.09
				1	do	12	−0.13	−0.37		0.88	5.63	−0.33	−0.33		0.83	6.79	0.84
				1	do	24	−0.18	−0.12		0.88	5.73	−0.28	−0.38		0.78	6.69	0.89
				1	do	38	−0.33	−0.27		0.72	5.93	−0.23	−0.43		0.67	6.49	0.81
49	do	Entrance to New Haven Harbor.	Aug. 23, 29, 1917	1	Pole	7	−1.18	−1.77	319	1.49	6.23	−0.78	−1.48	152	0.89	6.19	12.25
				1	Meter	6	−1.23	−1.67		1.41	6.53	−0.53	−1.28		0.94	5.89	12.37
				1	do	12	−1.33	−1.72		1.34	6.43	−0.73	−1.38		0.94	5.99	12.26
				1	do	18	−1.23	−1.62		1.19	6.08	−0.98	−1.23		0.84	6.34	12.29
				½	do	21	−1.63	−1.77		1.19	5.93	−1.53	−1.68		0.84	6.49	11.90
50	H. E. Finnegan	do	July 19–20, 1929	1	Pole	7	−0.15	−2.45	341	0.24	1.53	−4.45	−1.30	177	0.52	10.89	11.46
				1	Meter	7	−0.25	−2.45		0.31	1.58	−4.50	−1.30		0.58	10.84	11.43
				1	do	10	−0.25	−2.45		0.27	1.58	−4.50	−1.40		0.57	10.84	11.40
				1	do	16	−0.45	−2.60		0.43	1.78	−4.50	−1.00		0.48	10.64	11.41
51	P. M. Trueblood	Tomlinson Bridge, New Haven.	Aug. 13–14, 1917	1	do	3	0.57	−0.32	48	1.13	5.43	0.17	0.17	201	1.23	6.99	1.28
				1	do	6	0.27	−0.37		1.18	5.73	0.17	0.02		1.38	6.69	1.15
				1	do	12	−0.18	−0.07		0.99	5.98	−0.03	−0.33		1.14	6.44	0.98
53	E. E. Haskell	Off entrance to New Haven Harbor.	Sept. 29–30, 1890	½	do	(2)	0.02	0.13	238	0.81	6.28	0.47	0.56	104	0.87	6.14	1.43
				½	do	29	0.37	−0.57	240	0.88	5.73	0.27	0.62	107	0.76	6.69	1.30
				½	do	58	−0.03	−0.47	243	0.54	5.83	−0.03	0.02	96	0.60	6.59	1.00
55	do	East of Stratford Shoal Middle Ground.	Aug. 1–2, 1890	½	do	(2)	0.99	0.80	331	0.96	5.06	0.22				7.36	1.86
				½	do	50	−0.23	0.63	312	0.91	7.13	1.07	−0.08	153	0.91	5.29	1.48
				½	do	99	−0.63	−0.17	351	0.72	6.73	0.27	−0.58		0.78	5.69	0.85
56	P. M. Trueblood	Off Stratford Point	Aug. 9–10, 1917	1	Pole	7	−2.03	−0.28	234	1.16	8.63	0.77	−0.88	80	1.06	3.79	0.53
				1	Meter	6	−1.68	−0.22		1.21	7.98	0.47	−0.78		1.11	4.44	0.58
				1	do	18	−1.93	−0.52		0.88	8.23	0.47	−1.13		0.78	4.19	0.35
				1	do	28	−1.73	−0.32		0.72	7.83	0.27	−0.83		0.72	4.59	0.48
59	do	Off Stratford Shoal Middle Ground.	Sept. 18–19, 1917	1	Pole	7	−0.18	−0.12	270	1.16	5.78	−0.23	−0.18	77	1.08	6.64	0.95
				1	Meter	6	−0.28	−0.22		1.24	5.93	−0.18	−0.23		1.29	6.49	0.90
				1	do	18	−0.38	−0.42		1.19	5.88	−0.33	−0.43		1.29	6.54	0.74
				1	do	36	−0.28	−0.27		1.03	5.58	−0.53	−0.28		1.23	6.84	0.79
				1	do	50	−0.43	−0.27		0.87	5.88	−0.38	−0.23		1.02	6.54	0.80
65	H. E. Finnegan	Entrance to Port Jefferson Harbor.	July 19–20, 1929	1	Pole	4½	0.15	0.70	156	2.41	6.13	0.45	0.10	310	1.46	6.29	1.48
				1	Meter	6	0.10	0.35		2.42	6.33	0.60	−0.30		1.72	6.09	1.32
				1	do	10	0.10	0.40		2.33	6.23	0.50	−0.40		1.61	6.19	1.28

[2] Surface.

[3] Pettersson meter observations.

Price current meters were used in connection with the 1917 and 1919 surveys of Long Island Sound. At station 44, a control station during the 1929 survey, located on a cross section off Sachem Head, Conn., the Pettersson current meter was also employed at a depth of 20 feet. The results obtained with this meter agree closely with those from Price meter records obtained at the same depth. At the stations occupied by the party of Haskell aboard the United States Fish Commission steamer *Fish Hawk*, Lieut. Robert Platt, United States Navy, commanding, the Ritchie-Haskell direction-current meter was employed at the surface, middle depth, and bottom.

As the name implies, this meter is an instrument for determining the direction and velocity or the set and drift of a current of running water. It records these electrically on registers before the observer, so that when once in the water it only needs to be shifted from depth to depth at which information is required. There is a direction register and also a velocity register. In observing a current it is suspended in the water from a boat at anchor by means of a single cable, the core of which is made up of the necessary number of insulated wires forming the operating circuits. The armor or covering of the cable furnishes the necessary tensile strength for carrying the weight of the meter and the strain brought about by the friction of the running water on both meter and cable.

The velocity wheel is of the propeller or screw type, conical in front to constitute a self-clearing prow for all débris moving with the current. The central chamber or body of the meter is a compass whose needle is free to assume the magnetic meridian at all times. This chamber is filled with oil, giving stability to and preventing rust of the needle and other mechanism. An expansion bag compensates for changes in temperature and establishes equilibrium of pressure between the inside and outside of the chamber when immersed. By the use of an electric circuit the angle to the nearest degree between the direction of the current and the magnetic needle or meridian is transmitted to the repeater or direction register in the boat. The two observations, or the velocity and direction of the current, can thus be taken simultaneously and repeated at will.

A study of the data in Table 59 will show that the current generally becomes earlier in occurrence as the depth increases. It will also be noted that the direction of the current at subsurface depths as obtained by means of Ritchie-Haskell and Pettersson meters differs considerably from that at the surface. This is most likely a true condition owing to the broad expansion of eastern Long Island Sound which permits no interference to the set of subsurface currents. Observations of currents in rivers, on the other hand, show very little deviation in the direction of the current at subsurface depths from that at the surface. This is, obviously, due to the fact that the comparatively narrow width of rivers offers considerable interference to the direction of the current at various depths.

Haskell's observations along a cross section at stations 18, 19, and 20 off Terry Point, Long Island, show that subsurface currents are deflected to the right on both the flood and ebb at stations 18 and 19, located near Long Island and mid sound, respectively. At station 20, however, off the eastern end of Long Sand Shoal, the subsurface currents are deflected to the left on both flood and ebb, and most

likely this explains the northeast-southwest axis of Hatchett Reef and the eastern portion of Long Sand Shoal.

While on the subject of currents in the vicinity of Long Sand Shoal and the entrance to the Connecticut River it might be stated that surface current observations at station 21, off the east end of Long Sand Shoal, show that in going from flood to ebb (west to east) at this station the current comes to a slack but in changing from ebb to flood (east to west) it does not come to a slack but swings from east to west by way of south, minimum velocities of about one-half knot obtaining at such times. This swing is in accordance with that at Cornfield Point Lightship. (See p. 35.)

Current conditions at station 50 located in mid-channel inside the New Haven Harbor breakwater were peculiar owing to the brief flood period of about 1½ hours and the long ebb duration of nearly 11 hours. Likewise, observed velocities were rather small, although, as might be expected, the velocity of the ebb was approximately twice as great as that of the flood. Meteorological disturbances may have been responsible for these unusual current conditions, strong northeasterly and northerly winds having obtained during most of the observation period. Under normal weather conditions the results from this station should be approximately the same as those for station 49 at the breakwaters.

Strong currents obtain in Port Jefferson Harbor entrance as will be seen in the data for the last station in Table 59 and the strength of the current does not apparently change much with increased depth. The greater flood than ebb velocities at this station are most likely due to the location of the station on the western edge of the dredged channel where the full effect of the flood is encountered and the ebb effect diminished.

THE TIDE AND CURRENT IN THE CONNECTICUT RIVER

The Connecticut River rises in the extreme northern part of New Hampshire, near the Canadian border, and flows southerly between the States of Vermont and New Hampshire and across Massachusetts and Connecticut to Long Island Sound. Its entire watershed is about 11,083 square miles, of which 10,234 square miles are above Hartford, Conn.

The Connecticut River is subject to freshets of considerable height which occur principally in the spring, when the volume is swollen by melting snow, although occasional floods have occurred in every month of the year except July and September. The highest freshets generally take place in the spring. There was one remarkable exception, however, in August, 1856, when the water at Hartford rose to a height of 23 feet 4 inches above low-water mark. This was caused by unusually heavy rains which occurred at that time.[1]

[1] Annual Report of the Chief of Engineers, U. S. Army, for 1878, p. 265. (Government Printing Office, Washington.)

TABLE 60.—*Tidal data, Connecticut River, 1838–1918*

Station No.	Location	Observations		Lunitidal intervals		Duration of rise	Mean range	Compared with—
		Date	Period	HWI	LWI			
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Saybrook Breakwater Light	June 14–17, 1887	4	10.73	4.18	6.55	3.81	Sandy Hook, N. J.
		July 7, 1890	1	10.71				New London, Conn.
		Sept. 29–Dec. 24, 1909	87	10.57	4.06	6.51	3.55	Fort Hamilton, N. Y.[1]
		July 31, 1917–Aug. 6, 1918	342				3.35	([1])
2	Saybrook Beacon	Oct. 1–21, 1838	21	10.08			4.00	
		June 15–20, 1846	5	11.45	4.63	6.82	3.51	Sandy Hook, N. J.
3	Lynde Point	May 16, 1851	1		4.04			Boston, Mass.
		Oct. 19–29, 1851	11	10.58	4.32	6.26	3.30	Do.
4	Saybrook Point	June 2–15, 1849	4	10.87	4.33	6.54	2.98	Do.
		Aug. 24–Nov. 3, 1883	54	10.48	4.18	6.30	3.35	New London, Conn.
5	Lyme Ferry	June 2, 1849	1	10.50	4.54	5.96	2.97	Boston, Mass.
6	Essex	June 6–7, 1849	1	10.95	5.04	5.91	2.55	Do.
		Aug. 22–Sept. 25, 1890	34	11.20	5.32	5.88	2.68	
7	Deep River	Nov. 22–Dec. 20, 1909	29	11.87	5.96	5.91	2.53	Saybrook Breakwater.[1]
8	Chester Creek	Sept. 25–Oct. 6, 1890	9	11.67	5.88	5.79	2.49	New London, Conn.
9	Hadlyme	June 28–30, 1917	2	11.43	6.28	5.15	2.69	Do.[2]
10	Higganum	Oct. 5–Nov. 8, 1890	17	0.21	7.65	4.98	2.20	Do.
		Aug. 20–22, 1891	3	0.68	7.77	5.33	2.13	Do.
		Oct. 26–Nov. 23, 1909	29	0.03	7.29	5.16	2.15	Saybrook Breakwater.[1]
		June 28–30, 1917	2	−0.20	7.25	4.97	2.31	New London, Conn.
11	Middletown	Oct. 30–Nov. 8, 1890	9	1.60	8.88	5.14		
		Aug. 20–22, 1891	3	1.30	8.96	4.76	1.88	Do.
		Sept. 27–Dec. 22, 1909	87	1.25	8.52	5.15	1.89	Saybrook Breakwater.[1]
		July 23–25, 1917	3	1.32	8.86	4.88	2.21	New London, Conn.
12	South Glastonbury (steamboat wharf)	Aug. 10–29, 1891	12	1.88	9.32	4.98	1.90	Do.
13	Two Piers, Roaring Brook entrance	Sept. 28–Oct. 26, 1909	29	2.17	9.99	4.60	1.48	Saybrook Breakwater.[1]
14	Glastonbury	July 25–26, 1917	2	1.89	9.86	4.45	1.54	New London, Conn.
15	Wethersfield	Aug. 28–Sept. 17, 1891	11	2.50	10.25	4.67	1.14	Do.
16	Hartford	Sept. 12–13, 1891	2	2.75	10.51	4.63	1.16	Do.
		Nov. 14–16, 1891	3	3.24	11.46	4.20	1.11	Do.
		Sept. 27–Dec. 18, 1909	83				1.24	Saybrook Breakwater.[1]
		June 25–27, 1917	3	2.85	11.58	3.69	0.38	New London, Conn.

[1] From tide records furnished by the Corps of Engineers, U. S. Army.
[2] Compared also with Higganum, Conn.

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The usual rise at Hartford, due to spring freshets is between 16 and 24 feet above mean low water. The maximum recorded freshet at Hartford (May, 1854) was 27.8 feet above mean low water. Occasional freshets of short duration may occur during the remainder of the year. The drainage area is about 11,000 square miles and the average discharge in second-feet: At Holyoke, Mass., low water, 2,600; high water, 71,000. At Hartford, Conn., low water, 5,000; 20-foot freshet, 101,000.[1]

The Connecticut River is approximately 375 miles in length. The head of commercial navigation is Hartford, Conn., located 51.9 miles by channel from the mouth of the river. The tidal influence extends some distance above Hartford.

Tides have been observed in the Connecticut River by the Coast and Geodetic Survey since 1838. In 1909 the Corps of Engineers, United States Army, made a comprehensive tide and current survey of this waterway from Hartford, Conn., to the mouth of the river. The results from the latter have been furnished the Coast and Geodetic Survey. The locations of 16 tide stations in this portion of the Connecticut River are shown in Figure 20 and the results from observations made at these localities are given in Table 60.

It will be noted from the data in Table 60 that the results for several stations where observations were made for one or more lunar periods have been obtained from records furnished by the Corps of Engineers, United States Army. Owing to the comparatively long series of observations at Saybrook Breakwater, the latter was used as a reference, or primary, tide station in reducing the results from observations by the Corps of Engineers, United States Army, at other Connecticut River localities in 1909. Furthermore, the type of tide at Saybrook Breakwater is more nearly like that at other Connecticut River localities than the tide on the open coast.

In order to arrive at standard values for time intervals and range of tide at each locality the values given in Table 60 were subjected to an adjustment process, giving greater weight to the longer series, and the adjusted tidal values for stations in this waterway are given in Table 61.

TABLE 61.—*Adjusted tidal data, Connecticut River*

Station No.	Locality	Lunitidal intervals		Duration of rise	Range of tide		
		HWI	LWI		Mean	Spring	Neap
		Hours	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*
1	Saybrook Breakwater Light	10.60	4.10	6.50	3.6	4.2	2.9
2	Saybrook Beacon	10.60	4.10	6.50	3.5	4.1	2.8
3	Lynde Point	10.60	4.15	6.45	3.4	4.0	2.7
4	Saybrook Point	10.60	4.20	6.40	3.3	3.9	2.6
5	Lyme Ferry	10.75	4.55	6.20	3.0	3.5	2.4
6	Essex	11.20	5.30	5.90	2.7	3.2	2.2
7	Deep River	11.85	5.95	5.90	2.5	3.0	2.0
8	Chester Creek	11.90	6.05	5.85	2.5	3.0	2.0
9	Hadlyme	11.95	6.15	5.80	2.4	2.8	1.9
10	Higganum	0.10	7.50	5.00	2.2	2.6	1.8
11	Middletown	1.30	8.65	5.05	2.0	2.4	1.6
12	South Glastonbury	2.10	9.90	4.60	1.7	2.0	1.4
13	Two piers, Roaring Brook entrance	2.15	10.00	4.55	1.6	1.9	1.3
14	Glastonbury	2.45	10.45	4.40	1.4	1.7	1.1
15	Wethersfield	2.60	10.70	4.30	1.3	1.5	1.0
16	Hartford	2.95	11.20	4.15	1.2	1.4	1.0

[1] Annual Report of the Chief of Engineers, U. S. Army, for 1927, Part I, pp. 108-109. (Government Printing Office, Washington, 1927.)

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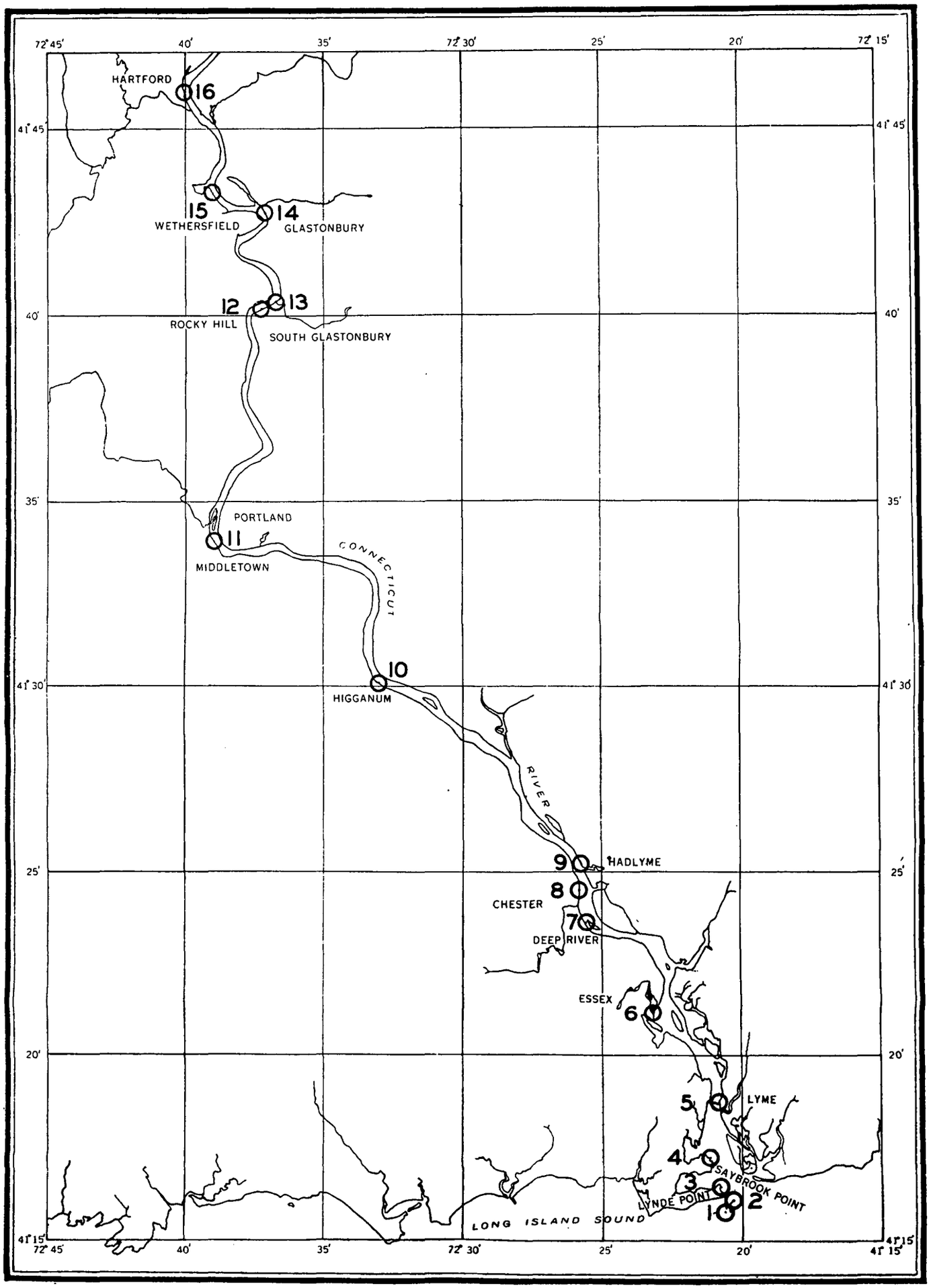

FIGURE 20.—Tide stations, Connecticut River

It will be noted from the data in Table 61 that the tide becomes progressively later from Saybrook Breakwater to Hartford, the time of low water being considerably later than that of high water. Likewise, the duration of rise of tide, which, at the entrance to the river, is actually greater than that of fall, decreases considerably upstream. Conversely, the duration of fall increases from Saybrook to Hartford.

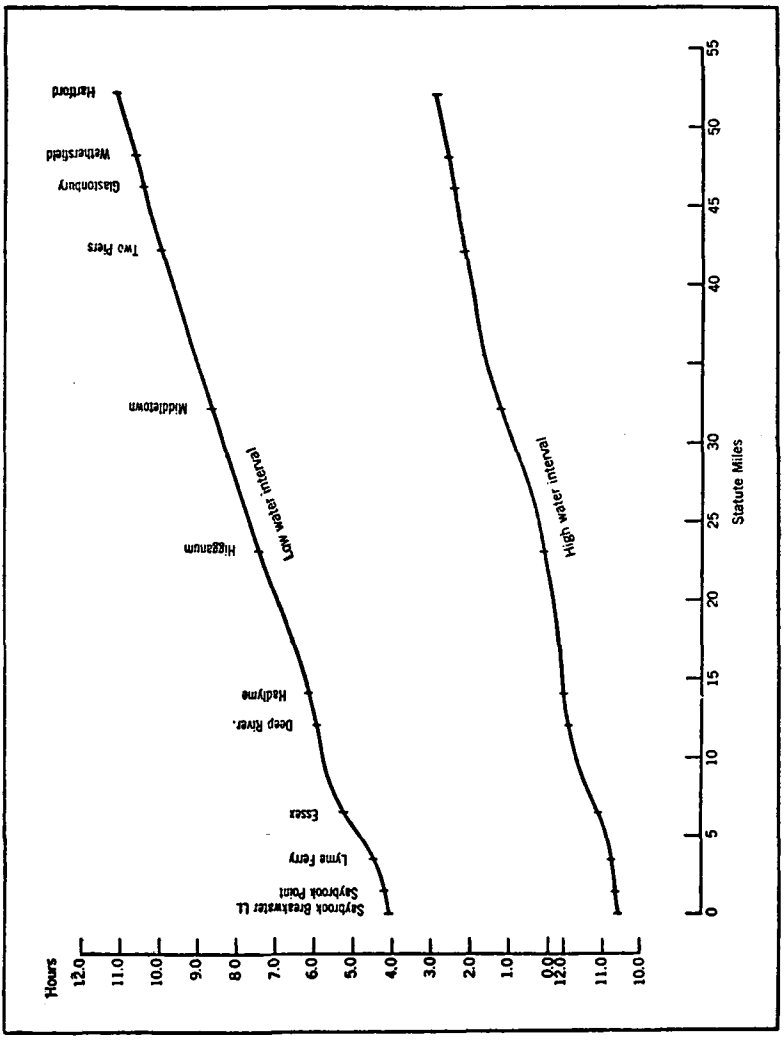

FIGURE 21.—Lunitidal Intervals, Connecticut River

This is typical of the river tide where the permanent current, due to fresh water run-off, opposes the rising tide. In the fall of the tide, the fresh water seeking its way to the ocean adds its strength to that of the ebb current and prolongs the time during which the tide falls.

There are also given in Table 61 the mean, spring, and neap ranges for tide stations in the Connecticut River. The values for mean range are adjusted values based on the data from observations given

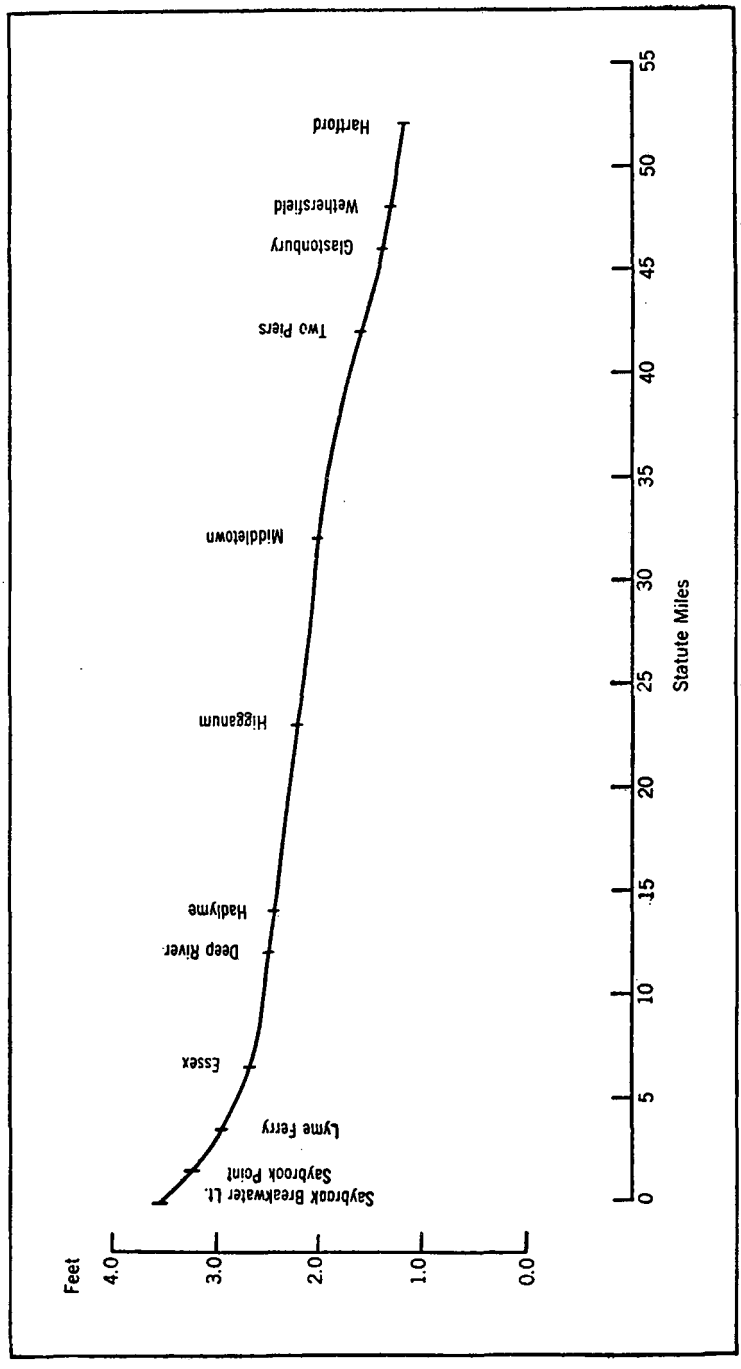

FIGURE 22.—Range of tide, Connecticut River

in Table 60. It will be noted from the data in Table 61 that the range of tide in the Connecticut River decreases steadily from Saybrook Breakwater to Hartford, the range at the latter station, when not affected by freshet conditions, being approximately one-third as great as that at the entrance to the river. The values in Table 61 for spring and neap ranges were obtained by applying the factors 1.18 and 0.80, respectively, to the adjusted values for mean range of tide. These factors are the same as those which were used in obtaining similar data for tide stations in eastern Long Island Sound and the derivation of these factors was discussed above in connection with the tide in eastern Long Island Sound.

In order to bring out more clearly the data given in Table 61, Figures 21 and 22 have been prepared, showing, respectively, the lunitidal intervals and range of tide for stations in the Connecticut River. In plotting these curves due consideration was given to the length of the series of tidal observations at each station. It will be noted from Figure 22 that the range of tide decreases sharply by approximately 1 foot in the 6½-mile stretch from Saybrook Breakwater Light to Essex. From Essex to Hartford the decrease in range is very gradual in character, the curve approximating a straight line. With the exception of slight fluctuations, the curves representing high and low water lunitidal intervals in Figure 21 also approximate straight lines.

The following statements from Special Publication No. 136, entitled "Tidal Bench Marks, State of Connecticut," (United States Coast and Geodetic Survey, Department of Commerce, Government Printing Office, Washington, 1927) are of considerable value regarding tidal conditions in the Connecticut River:

Except for the bench marks along the Housatonic River which are referred to only the mean low water of the United States Army Engineers, the elevations of the bench marks in this publication are referred to five different tidal datums. Those marks which have been connected with the first-order level net are referred to mean sea level, which is the standard datum for that work. All other bench marks are referred to mean tide level. In addition to either mean sea level or mean tide level, as the case may be, the elevations are also referred to mean high water, mean low water, highest tide, and lowest tide.

Mean tide level is determined from the high and low-water readings and is a datum midway between mean high water and mean low water. It should be distinguished from mean sea level, which is determined from the hourly heights of the tide. For most places on the open coast mean tide level does not differ much from mean sea level, and for practical purposes the two planes may be used as if identical. Based on long series of tidal observations at New London and New Haven, Conn., supported by another long series of observations at Willets Point, N. Y., the two datums are found to be practically at the same elevation along the Connecticut shore of Long Island Sound and for the purposes of this publication are assumed to be identical.

Up the Connecticut River, however, there is an increasing difference from Saybrook Breakwater to Hartford, between the mean sea level of Long Island Sound and the mean tide level of the river. This difference is due to the slope of the river bed, together with the fresh water flow, and amounts to approximately 2.2 feet at Hartford. (See fig. 23.)

The mean tide level for the Connecticut River is based on simultaneous tidal observations by the United States Army Engineers at Saybrook Breakwater, Deep River, Higganum, Middletown and Two Piers, and by the United States Weather Bureau at Hartford. The observations were made in the fall of 1909 during a dry season when the river was at about a normal mean summer stage. The zeros of all these gauges were referred to the Hartford datum of the United States Army Engineers through a line of spirit levels run by them on each side of the river in 1909.

The Hartford datum has been connected with the first-order level net at both Hartford and Saybrook, and through these connections the relation of mean tide level of the Connecticut River to the mean sea level of Long Island Sound has been determined.

The elevations of many of the United States Army Engineer bench marks along Long Island Sound were furnished this bureau as referred to their Bridgeport datum. Some of these marks have been connected by this bureau with the first-order level net. Through these connections the relations of the Bridgeport datum to mean sea level for the different points along the coast from Saybrook Junction to Greenwich have been derived.

Mean high water is the mean height of all the high waters and mean low water the mean height of all low waters for the period of the observations. The difference in height between mean high water and mean low water corresponds to the mean range of tide. The relation of mean high water and mean low water to mean tide level at any point is equal to one-half the mean range of tide above and below that datum. The mean range of tide varies considerably from place to place, depending in a large measure on the location, depth of water, and configuration of the coast line. Therefore, mean high water and mean low water are not uniform datums over a large area like mean sea level and mean tide level, but vary in accordance with the differences in the range of tide over that area. Mean low water on the Atlantic coast of the United States is of importance as the hydrographic datum to which all soundings on charts and the predicted heights in tide tables are referred.

The highest and lowest tides represent the probable extreme heights for each locality and, in places where long series of observations are not available, have been estimated to the nearest half foot based on the highest and lowest values observed in that region.

A record of some of the highest and lowest stages of the Connecticut River at Hartford for a number of years to 1923, including the years 1683 and 1692, has been furnished by the United States Weather Bureau as follows:

Year	Highest	Lowest	Year	Highest	Lowest	Year	Highest	Lowest
1683	26.0		1877	22.6	1.2	1913	26.3	0.5
1692	26.2		1903	23.3		1914	21.9	.2
1801	27.5		1904	19.5		1915	20.6	.6
1841	26.3		1905	24.0		1916	20.8	.9
1854	29.8		1906	19.8	.9	1917	18.3	.5
1871	18.5	1.0	1907	20.3	.7	1918	18.8	−.2
1872	19.6	1.6	1908	18.5	−.5	1919	19.8	.7
1873	20.8	.9	1909	24.7	−.2	1920	22.5	.3
1874	23.5	.4	1910	20.2	.4	1921	19.9	.0
1875	18.7	1.2	1911	16.0	.6	1922	24.5	.3
1876	21.8	.7	1912	21.2	.5	1923	22.0	.2

The above heights are referred to the zero of the Hartford gauge, which is 2.02 feet below mean low water.

The Corps of Engineers, United States Army, reports in regard to the highest and lowest stages of the Connecticut River, as follows:

"The principal freshets are caused by the melting snows and springs rains. The highest freshets are generally of short duration, but the period during which the river at Hartford is at a level of 10 feet or more above the zero of that gauge averages nearly two months in the year. Freshets of at least 18 feet above the zero of the Hartford gauge occur practically every year, and the maximum height to which the water ordinarily rises on that gauge appears to be between 23 and 24 feet. It is stated that a freshet of 22 feet at Hartford gives a freshet of about 15 feet at Middletown, and below that point it rapidly decreases.

"The zero of the Hartford gauge is the low water of 1801, which, previous to 1858, was at the lowest water on record. Since then the water has occasionally fallen below this zero, but generally this has been due to closing the gates at Windsor Locks or some such abnormal reason." (From House Document No. 1294, 61st Cong., 3d sess., p. 21.)

When lunitidal intervals are used in determining the difference in the time of tide between two stations, the correction to be applied is 0.07 hour for each degree of difference in longitude. However,

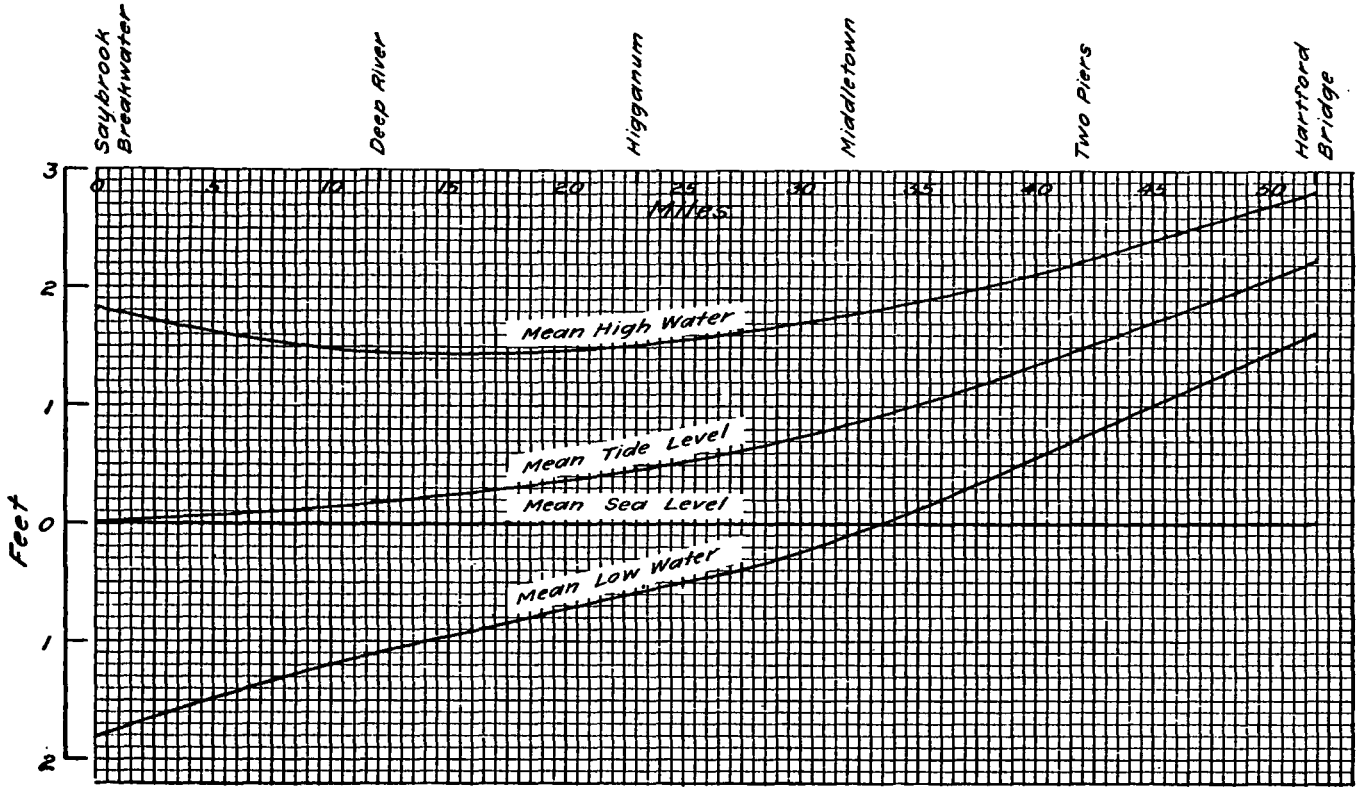

FIGURE 23.—Connecticut River datums referred to mean sea level

since the Connecticut River runs in an approximately north-and-south direction, the difference in longitude between any two stations will be small and the difference in time of tide for stations listed in Table 61 may be derived directly by taking the difference of the lunitidal intervals.

It will be noted from the data in Table 61 that between Saybrook Breakwater Light and Hartford, a distance of 51.9 statute miles, the range decreases from 3.6 to 1.2 feet, while the high-water lunitidal interval increases from 10.60 to 15.37 (2.95) hours. Between these two tide stations, therefore, a range difference of 2.4 feet and a high-water time difference of 4.77 hours obtains.

The distance between Saybrook Breakwater and Hartford is 51.9 statute miles, or 274,032 feet, and the average depth of the Connecticut River reckoned from mean low water has been calculated to be 10.5 feet. Allowing for an average range of about 2.0 feet in this waterway, this would make the average depth of the river from mean tide level approximately 11.5 feet. In the formula for progressive-wave motion, $r=\sqrt{gh}$, in which r = rate of advance of a progressive wave, g = acceleration of gravity or 32.2 feet per second, and h = average depth of water (mean tide level depth). From the above formula, the theoretical time required for the propagation of a progressive wave in the Connecticut River from Saybrook Breakwater to Hartford would be 4 hours. That is, at a rate of advance of 19.2 feet per second derived from the above formula, it would take 14,270 seconds, or 4 hours, for a progressive wave to traverse this stretch of the river. The actual time required, based on observations, is about 4.77 hours, as mentioned above.

This is a fairly close agreement and indicates that the type of tide in the Connecticut River is progressive rather than stationary. In computing the mean low-water depth throughout the river from Saybrook Breakwater to Hartford, equally spaced depths along 21 cross sections of the river were obtained from various hydrographic sheets. These cross sections were spaced approximately 2 miles apart and are for the most part in deeper stretches of water rather than shoal areas. Considering the many shoals in the Connecticut River, the average depth of this portion of the river below mean low water would more likely be less than 10 feet and the theoretical value for the propagation of the progressive tide wave from Saybrook Breakwater to Hartford would more likely be greater than four hours. The many bends in the river, especially below Hartford where the river is of the meandering type, likewise retard the propagation of the tide wave. This is also true of the numerous islands and shoals in the river.

Eight current stations have been occupied in the Connecticut River by field parties of the Coast and Geodetic Survey and the locations of these stations are shown in Figure 24. The results obtained at these stations from observations near the surface are given in Table 62.

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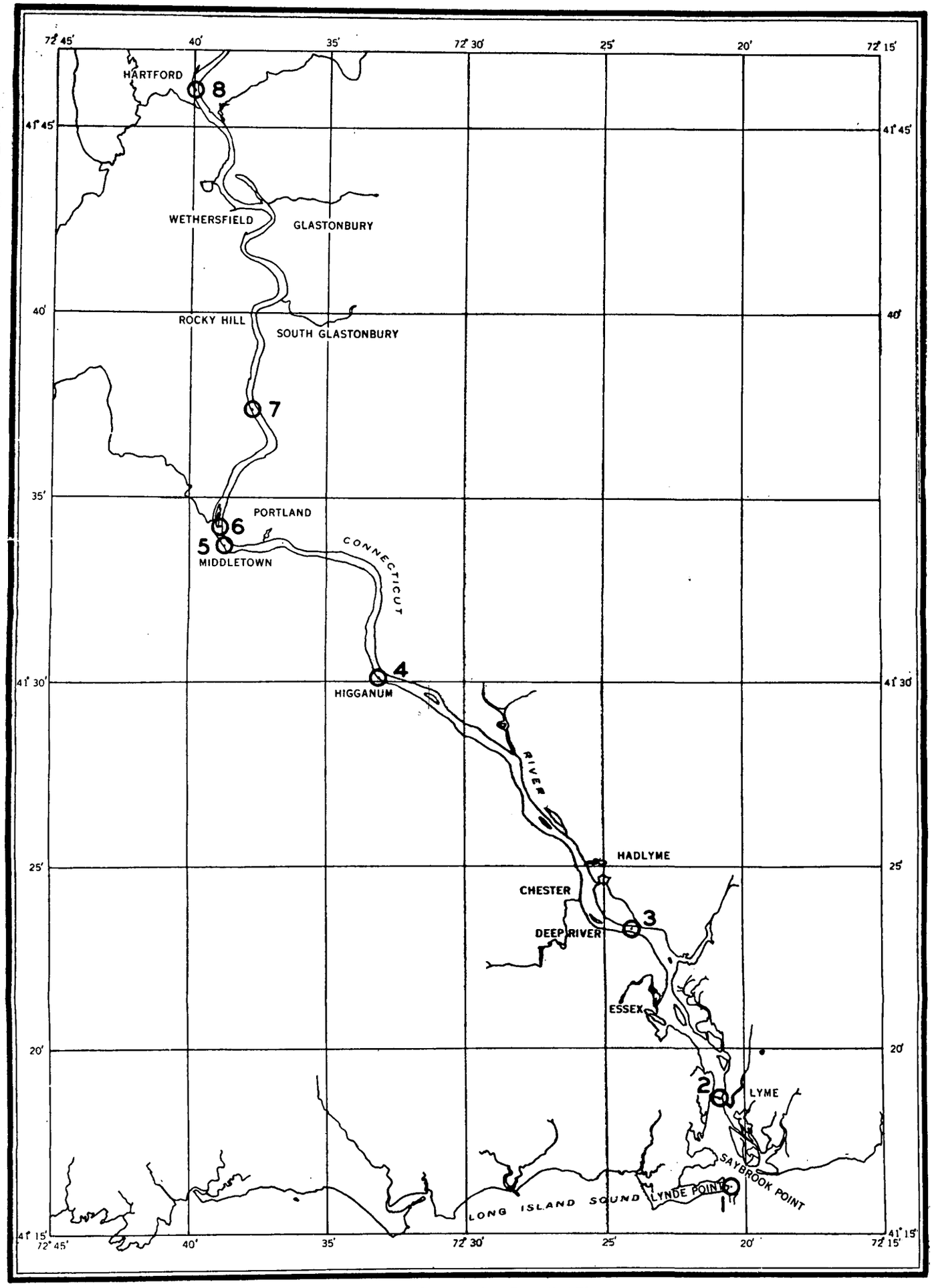

FIGURE 24.—Current stations, Connecticut River

TABLE 62.—*Results from current observations near the surface, Connecticut River*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Entrance, off Lynde Point	Aug. 2-3, 1917	1	Pole	4	0.67	1.18	344	0.86	5.58	0.42	0.42	161	0.56	6.84	1.80
2	do	Midchannel, N. Y., N. H. & H. R. R. drawbridge.	Sept. 7-8, 1917	1	Meter	6	1.22	0.58	(1)	1.62	4.98	0.37	1.22	(1)	2.42	7.44	1.98
	H. E. Finnegan	Midchannel, N. Y., N. H. & H. R. R. drawbridge.	July 24-27, 1929	2½	Pole	7	1.15	0.96	(1)	1.65	5.16	0.48	0.66	(1)	2.06	7.26	1.94
3	do	Midchannel, west of Brockway Landing.	July 25-26, 1929	1	do	7	1.95	2.40	271	0.91	5.08	1.20	1.20	88	1.23	7.34	2.82
4	W. I. Vinal	Off entrance to Mill Creek, Higganum, Conn.	Aug. 20-22, 1891	3	Float	(2)	2.43				5.94	2.54				6.48	3.69
5	do	Off steamboat wharf, Middletown, Conn.	do	3	do	(2)	4.05				4.65	2.87				7.77	4.66
6	P. M. Trueblood	Midchannel, off Portland, Conn.	July 26-27, 1917	1	Pole	7	4.85	3.07	354	0.32	2.34	1.36	3.45	172	0.92	10.08	4.31
7	H. E. Finnegan	Midchannel, north of Gildersleeve Island.	July 24-25, 1929	1	do	7	5.35	4.85	(1)	0.22	3.63	3.15	5.00	(1)	1.00	8.79	5.72
8	P. M. Trueblood	Midchannel, off Hartford, Conn.	July 24-25, 1917	1⅙	do	7		6.52	(3)	(0.29)			7.35	174	0.54		7.99

[1] On the flood the current sets northerly; on the ebb, southerly.
[2] Surface.
[3] The current was ebbing, or setting southerly, at this station during the whole period of occupation. Therefore, the velocity given in parentheses is that for the minimum ebb.

Most of the stations listed in Table 62 were occupied in 1917 and 1929. The station occupied in 1917 at the New York, New Haven & Hartford Railroad drawbridge near Saybrook was reoccupied in 1929 and the results from both series of observations agree quite closely, as will be noted from the data in Table 62 for station 2. At this station no accurate directional observations were made owing to the fact that measurements were taken from the center of the lift span of the bridge, which was a considerable distance above the surface of the water. Likewise, directional observations were not obtained at station 7 because of the fact that, with the exception of the last three hours of occupation of the station, a small skiff was used by the observing party. The float observations made by Vinal in 1891 were made in connection with a hydrographic survey of the Connecticut River and the results give only the times of slack water and durations of flood and ebb off Higganum and Middletown.

The times of slack and strength of current in Table 62 are expressed in hours and are referred to the times of similar phases of the current at The Race. It will be noted from the data in the table that the current at points along the river is progressively later from the entrance to Hartford. In fact, the time of current at the latter locality is about 7 hours later than that at The Race. In other words, therefore, when the current is still flooding, or running northerly at Hartford it is ebbing, or running easterly, at The Race. When the current at Hartford has attained its flood strength the current at the reference station has approximately reached its strength of ebb.

The durations of flood and ebb and mean current hour are also given in hours. It will be noted that the duration of ebb at each station greatly exceeds that of flood. In fact, from Gildersleeve Island to Hartford the duration of ebb is two or three times longer than that of flood. Obviously, this is the effect of fresh-water discharge upon the tidal current. It will, therefore, be seen that the tidal current, like the tide, is subject to considerable interference from nontidal factors such as fresh-water run-off.

It will also be noted that the velocity of ebb at each station is generally greatly in excess of that of flood, due likewise to the effect of fresh-water discharge upon the tidal current. The strong velocities of the current at station 2 are obviously the result of channel constrictions in the form of bridge pier abutments. The results from the 1929 series of observations at this station corroborate the results obtained from observations made in 1917 at the same locality.

Concerning the strong ebb current at station 2, the following note by the observer in the 1917 current record book is of considerable importance:

> On the ebb tide there is a strong current which runs from the Lyme Landing toward the center of the railroad bridge. Tugs with tows steer for the east pier of the draw until right on it before swinging out for the draw.

Likewise, a knowledge of current conditions at the entrance to the river in the vicinity of Saybrook Breakwater is of considerable importance. In this respect the United States Coast Pilot, Atlantic Coast, section B, Cape Cod to Sandy Hook (United States Coast and Geodetic Survey, Department of Commerce, Government Printing Office, Washington) states that—

At the entrance the currents have considerable velocity at times and always require careful attention, as the tidal current of the Sound often sets directly across the direction of the current setting out or in between the jetties.

Current conditions at station 8 off Hartford call for special explanation. The current station was located in mid-channel about 300 yards south of the highway bridge connecting Hartford with East Hartford. At the time observations were made at this station the current was ebbing, or flowing southerly, during the entire period of occupation of the station. This was evidently the effect of fresh-water discharge upon the tidal current owing to the fact that a heavy thunder shower and electrical storm occurred shortly after the station was occupied and continued for about two hours.

The current velocities given in Table 62 have been corrected to a mean range of tide. These velocities, therefore, should be increased by approximately 15 per cent at times of spring tides and decreased by a like amount at times of neap tides. Likewise they should be increased somewhat at times of the moon's maximum north and south declination and decreased somewhat at times during the month when the moon is on the equator. It should be borne in mind, however, that during freshet conditions the tidal current in the Connecticut River may be completely or partially masked by the nontidal current resulting from fresh-water run-off.

It will be noted from the data in Table 62 that the time differences between Saybrook Breakwater and Hartford for strengths of flood and ebb are, respectively, 5.34 and 6.93 hours. These differences compare favorably with the time differences for high water and low water between these localities which were shown above to be 4.77 and 7.10 hours, respectively. In passing, however, it should be noted that both tide and tidal current in the Connecticut River, especially in the section between Middletown and Hartford, are subject to considerable disturbance on account of nontidal factors.

TABLE 63.—*Results from current observations at various depths, Connecticut River*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Entrance, off Lynde Point	Aug. 2-3, 1917	1	Pole	4	0.67	1.18	344	0.86	5.58	0.42	0.42	161	0.56	6.84	1.80
				1	Meter	3	1.12	1.03		0.91	4.78	0.07	0.57		0.86	7.64	1.83
				1	do	6	0.12	−0.17		0.92	5.93	0.22	0.07		0.82	6.49	1.19
				1	do	12	−0.63	−0.42		0.81	6.63	0.17	0.17		0.61	5.79	0.95
2	do	Midchannel, N. Y., N. H. & H. R. R. drawbridge.	Sept. 7-8, 1917	1	Meter	6	1.22	0.58	(1)	1.62	4.98	0.37	1.22	(1)	2.42	7.44	1.98
				1	do	12	0.77	0.23		1.54	5.43	0.37	1.22		2.14	6.99	1.78
				1	do	24	0.82	0.63		1.36	5.53	0.52	1.02		1.26	6.89	1.88
				1	do	36	0.42	0.88		1.23	6.03	0.62	0.27		1.03	6.39	1.68
	H. E. Finnegan	do	July 24-27, 1929	2½	Pole	7	1.15	0.96	(1)	1.65	5.16	0.48	0.66	(1)	2.06	7.26	1.94
				2½	Meter	7	1.05	1.02		1.47	5.28	0.50	0.68		1.82	7.14	1.94
				2½	do	18	0.22	1.46		1.25	6.27	0.66	0.78		1.23	6.15	1.91
				2½	do	29	0.52	1.56		1.24	6.13	0.82	0.08		1.13	6.29	1.87
3	do	Midchannel, west of Brockway Landing.	July 25-26, 1929	1	Pole	7	1.95	2.40	271	0.91	5.08	1.20	1.20	88	1.23	7.34	2.82
				1	Meter	6	2.15	2.25		0.93	4.88	1.20	1.10		1.29	7.54	2.81
				1	do	15	2.15	2.25		0.96	4.98	1.30	1.55		1.23	7.44	2.94
				1	do	24	2.10	2.35		0.91	5.08	1.35	1.75		1.11	7.34	3.02
6	P. M. Trueblood	Midchannel, off Portland, Conn.	July 26-27, 1917	1	Pole	7	4.85	3.07	354	0.32	2.34	1.36	3.45	172	0.92	10.08	4.31
				1	Meter	6	5.05	3.17		0.39	2.04	1.26	4.15		1.04	10.38	4.54
				1	do	12	5.05	3.07		0.39	1.94	1.16	3.85		0.99	10.48	4.41
				1	do	14	5.15	3.12		0.31	1.94	1.26	3.75		0.86	10.48	4.45
7	H. E. Finnegan	Midchannel, north of Gildersleeve Island.	July 24-25, 1929	1	Pole	7	5.35	4.85	(1)	0.22	3.63	3.15	5.00	(1)	1.00	8.79	5.72
				1	Meter	4	5.35	4.80		0.38	3.53	3.05	4.65		0.98	8.89	5.59
				1	do	10	5.35	4.75		0.32	3.48	3.00	4.55		0.88	8.94	5.54
				1	do	16	5.30	4.85		0.30	3.53	3.00	4.60		0.78	8.89	5.57
3	P. M. Trueblood	Midchannel, off Hartford, Conn.	July 24-25, 1917	1⅙	Pole	7		6.52	(2)	(0.29)			7.35	174	0.54		7.99
				1⅙	Meter	6		5.57	(2)	(0.39)			7.25		0.63		7.46
				1⅙	do	12		5.12	(2)	(0.36)			7.35		0.61		7.29

[1] On the flood the current sets northerly; on the ebb, southerly.

[2] The current was ebbing, or setting southerly, at this station during the whole period of occupation. Therefore, the velocities given in parentheses are those for the minimum ebb at each depth.

At each of the current stations occupied in the Connecticut River by field parties of the Coast and Geodetic Survey in 1917 and 1929, observations were made at various depths with Price current meters in addition to observations at the surface by means of current pole and current log line. The results from these observations are given in Table 63.

It will be noted from the data in Table 63 that the time of slack and strength of current at the entrance to the river and also at the railroad drawbridge near Lyme generally occur considerably earlier as the depth increases. At stations further up the river, however, there is apparently little difference in the time of turning of the current at various depths or in the time of strength of current at such subsurface depths. Likewise, there is very little difference in the duration of ebb at each depth at stations located upstream. At the entrance to the river, however, it will be noted that the ebb duration becomes markedly shorter as the depth increases, while, conversely, flood duration at a depth of 12 feet is about an hour longer than at the surface and also about an hour longer than the duration of ebb at the same depth. This shows that at the entrance to the river the current near the bottom is unaffected by fresh-water discharge. It will further be noted at the 12-foot depth at this station that the velocity of flood considerably exceeds that of ebb.

No subsurface current directions have been made at stations in the Connecticut River occupied by the Coast and Geodetic Survey. It may safely be assumed, however, that such current directions would be approximately the same as those which obtain at the surface, especially at times of strength of current. In passing, it might be stated that the unusual current conditions which obtained at station 8, located in mid-channel off Hartford, were explained above in connection with surface current results at this station.

From July to December, 1909, the Corps of Engineers, United States Army, was engaged in an extensive survey of the Connecticut River from Saybrook Breakwater to Hartford, the results of which may be found in United States House of Representatives Docket No. 1294, Sixty-first Congress, third session. The results of tidal observations obtained during this survey have been incorporated in the data given above in Table 60. Some float observations to determine ebb-current conditions were made at various bars in the river from Higganum to Hartford and a few remarks concerning the results of these observations are appropriate.

Floats, consisting of wooden rods 6 feet long, about 1 inch square, and so weighted at one end as to stand vertically in the water with only about 3 inches of the top exposed, were used in making these current observations. Small flags were attached to the tops of these floats in order that transitmen on either shore might sight these floats at regular intervals. The Connecticut River during the summer and fall of 1909 was at low stages. Average velocities of the ebb at nine bars in the river from Higganum to Hartford showed strengths varying from about one-half knot to a little over 1 knot. Of course, these float observations were made only for short periods of about five minutes and may not be representative of the strength of ebb in mid-channel. They indicate, however, that ebb velocities of about a knot may be experienced in the bars of the Connecticut River at

low stages of the river in the stretch from Higganum to Hartford. During freshet conditions these velocities would be considerably increased.

THE TIDE AND CURRENT IN THE HOUSATONIC RIVER

The Housatonic River rises in the Berkshire Hills of western Massachusetts and flows 130 miles southerly through Massachusetts and Connecticut and empties into Long Island Sound. In the vicinity of Derby, Conn., it is joined by the Naugatuck River, which is its principal tributary. From its entrance in the vicinity of Stratford Point the Housatonic River is navigable to a point about 1 mile above Shelton, Conn., where it is closed by a power dam. The head of navigation, however, is practically at the wharves at the towns of Derby and Shelton, a distance of 13½ miles above the entrance.

The drainage area of the Housatonic River is about 1,930 square miles. At Derby the low-water discharge is approximately 600 cubic feet per second. Average freshets reach a height of about 12 feet. They are of short duration and occur mainly in the spring. The highest freshets are caused by ice gorges above the dam at Shelton. The best data available indicate that the highest freshets rise about 18 feet above mean low water at Shelton. The low-water slope per mile from the mouth to Shelton is 0.145 foot.

The stretch of the Housatonic River from its entrance to Shelton is a tidal estuary similar to that of the Thames River. According to the Corps of Engineers, United States Army, an inspection of the tidal data at Bridgeport, Stratford, Pecks Mills, and Shelton shows that the fluctuations in the river follow very closely the fluctuations in Long Island Sound, but, of course, the extent of the fluctuation is very variable. During the summer months the fluctuations in the river due to winds and storms are much less than in Long Island Sound, and the effect of these local conditions becomes less farther upstream. On the other hand, the severe winds and storms of the winter frequently produce a greater effect in the river than in Long Island Sound.

The Coast and Geodetic Survey has been furnished with automatic tide gauge records obtained by the Corps of Engineers, United States Army, at four stations in the Housatonic River. The locations of these tide stations are shown in Figure 25 and the results from observations showing the range of tide at these stations are given in Table 64.

The data given in Table 64 are mean values for several lunar periods at each of the four tide stations in the Housatonic River. It will be noted from columns 4 and 6 of the table, however, that some of the mean values are not for complete lunar periods. Nevertheless, the several lunar period mean values are given equal weight in obtaining the best mean values of high and low-water readings on staff and the range of the tide at each station since such best mean values do not differ materially from the weighted values. It will be noted from the data in the last column of Table 64 that there is considerable monthly variation in the range of tide at stations in this waterway. For example, the range at Shelton fluctuated from 5.8 feet in a late summer month to 2.4 feet in a spring month. As stated above, however, the range of the tide in the estuary of the Housatonic River is subject to considerable disturbance from nontidal factors, primarily freshet conditions and wind effects.

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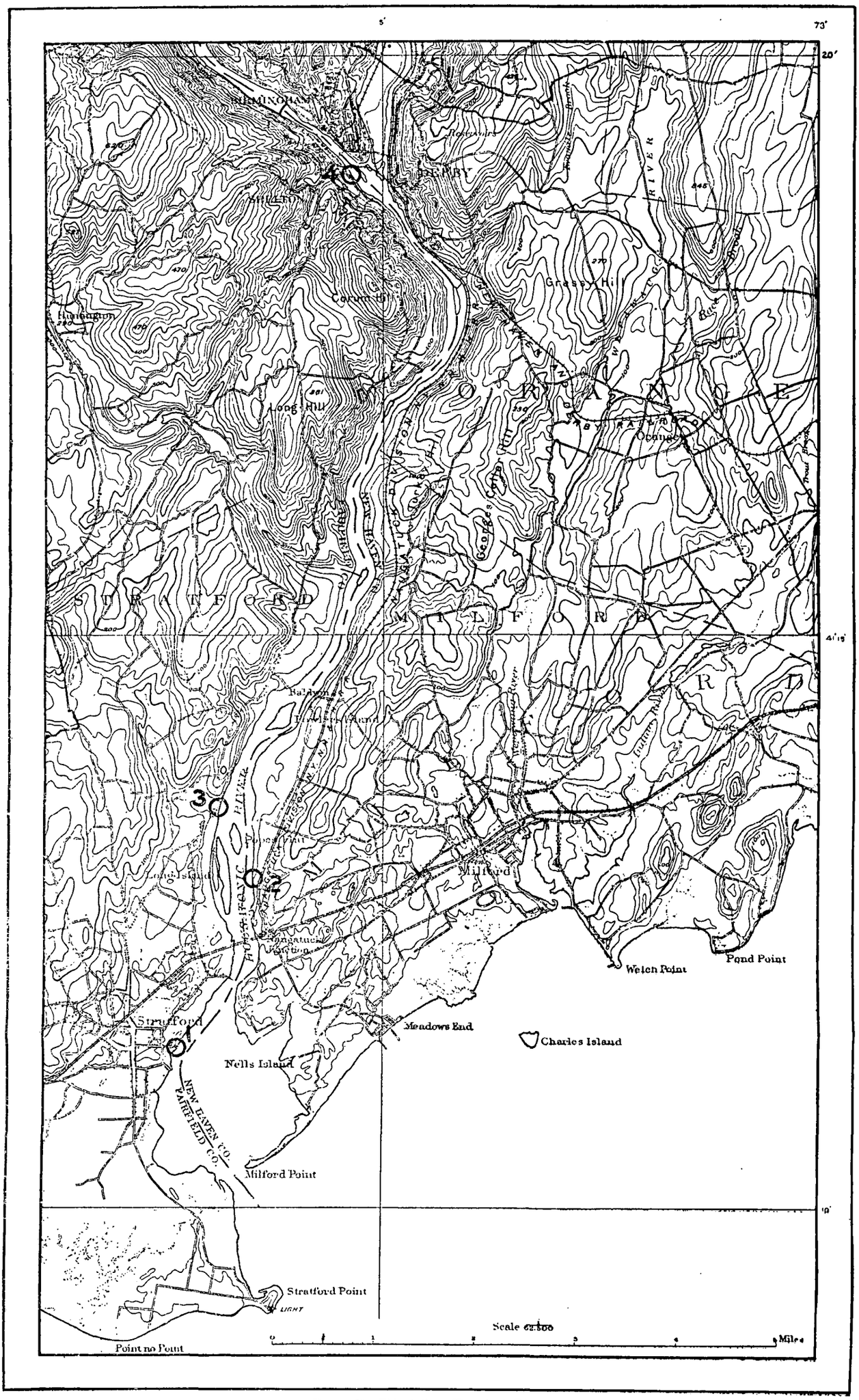

FIGURE 25.—Tide stations, Housatonic River

TABLE 64.—*Range of tide, Housatonic River*

Station No.	Locality	Period of observations	Number of high-water readings	Mean high water on staff	Number of low-water readings	Mean low water on staff	Mean range of tide
				Feet		*Feet*	*Feet*
1	Stratford, Conn.	June 28–July 26, 1913	55	5.39	55	−0.05	5.44
		July 27–Aug. 24, 1913	56	5.47	57	0.01	5.46
		Aug. 25–Sept. 24, 1913	58	5.41	57	0.02	5.39
		Sept. 25–Oct. 22, 1913	54	5.66	55	0.19	5.47
		Oct. 23–Nov. 21, 1913	57	5.45	56	0.35	5.10
		Nov. 22–Dec. 20, 1913	41	5.33	41	−0.24	5.57
		Dec. 21, 1913–Jan. 18, 1914	56	5.56	57	0.24	5.32
		Jan. 19–Feb. 17, 1914	51	4.96	50	0.00	4.96
		Feb. 18–Mar. 18, 1914	22	5.66	21	−0.14	5.80
		Mar. 19–Apr. 17, 1914	55	5.16	55	0.47	4.69
		Apr. 18–May 16, 1914	56	5.60	56	0.38	5.22
		May 17–June 15, 1914	51	5.11	51	−0.33	5.44
		Mean of periods		5.40		0.08	5.32
2	Devon, Conn.	Jan. 19–Feb. 17, 1914	52	4.57	52	0.04	4.53
		Feb. 18–Mar. 18, 1914	56	4.91	56	0.36	4.55
		Mar. 19–Apr. 17, 1914	57	4.71	58	0.50	4.21
		Apr. 18–May 16, 1914	42	5.34	56	0.79	4.55
		May 17–June 15, 1914	29	4.23	28	−0.11	4.34
		Mean of periods		4.75		0.32	4.43
3	Pecks Mills, Conn.	June 28–July 26, 1913	34	5.08	35	−0.26	5.34
		July 27–Aug. 24, 1913	56	5.06	56	−0.38	5.44
		Aug. 25–Sept. 24, 1913	58	5.03	57	−0.31	5.34
		Sept. 25–Oct. 22, 1913	56	5.32	57	−0.02	5.34
		Oct. 23–Nov. 21, 1913	58	5.16	57	0.44	4.72
		Nov. 22–Dec. 20, 1913	56	4.93	56	0.02	4.91
		Dec. 21, 1913–Jan. 18, 1914	15	5.70	16	0.21	5.49
		Mean of periods		5.18		−0.04	5.22
4	Shelton, Conn.	June 28–July 26, 1913	45	4.82	44	−0.79	5.61
		July 27–Aug. 24, 1913	56	5.00	56	−0.80	5.80
		Aug. 25–Sept. 24, 1913	23	4.88	23	−0.89	5.77
		Sept. 25–Oct. 22, 1913	48	5.22	48	−0.27	5.49
		Oct. 23–Nov. 21, 1913	56	5.17	56	1.44	3.73
		Nov. 22–Dec. 20, 1913	56	4.73	55	0.48	4.25
		Dec. 21, 1913–Jan. 18, 1914	56	5.03	56	0.49	4.54
		Jan. 19–Feb. 17, 1914	49	4.62	50	1.00	3.62
		Feb. 18–Mar. 18, 1914	51	5.04	51	1.56	3.48
		Mar. 19–Apr. 17, 1914	55	5.58	54	3.18	2.40
		Apr. 18–May 16, 1914	56	5.49	56	2.36	3.13
		May 17–June 15, 1914	53	4.78	53	−0.29	5.07
		Mean of periods		5.03		0.62	4.41

TABLE 65.—*Time of tide, Housatonic River*

Station No.	Locality	Period of observations	Lunitidal intervals		Duration of rise	Duration of fall
			HWI	LWI		
			Hours	*Hours*	*Hours*	*Hours*
1	Stratford, Conn.	Aug. 19–Sept. 27, 1913	12.01	6.25	5.76	6.66
		Mar. 14–Apr. 18, 1914	11.52	6.22	5.30	7.12
		Mean of periods	11.78	6.23	5.55	6.87
2	Devon, Conn.	Jan. 20–Feb. 26, 1914	12.04	6.42	5.62	6.80
		Mar. 14–Apr. 17, 1914	11.82	6.49	5.33	7.09
		Mean of periods	11.93	6.45	5.48	6.94
3	Pecks Mills, Conn.	July 21–Aug. 26, 1913	12.42	6.45	5.97	6.45
		Nov. 17–Dec. 23, 1913	12.23	6.67	5.56	6.86
		Mean of periods	12.32	6.56	5.76	6.66
4	Shelton, Conn.	July 21–Aug. 26, 1913	12.98	7.82	5.16	7.26
		Dec. 15, 1913–Jan. 19, 1914	12.49	7.75	4.74	7.68
		Mean of periods	12.74	7.78	4.96	7.46

From the lunar periods at each tide station shown in Table 64, two such approximate periods were selected and tabulations were made in order to determine the time of occurrence of the tide at each station. As far as possible these periods were selected for different times of the year at each station in order to show seasonal fluctuations. The results from these tabulations are given in Table 65.

The mean high and low water lunitidal intervals and durations of rise and fall for approximately two lunar periods at each of the four tide stations are given in Table 65. It will be noted from the data in column 5 of the table that there is apparently no considerable fluctuation in the time of low water at each station. The data in column 4, however, especially for the longer-period stations at Stratford and Shelton, indicate that considerable variation occurs in the time of high water at each station. The time differences for high and low water at Shelton as compared with Stratford are 0.96 and 1.55 hours, respectively, as obtained from the data for mean values in columns 4 and 5. It should be noted in this connection that these mean values are weighted values rather than direct mean values.

It will be noted from Table 65 that the durations of fall throughout the river greatly exceed those of rise. Obviously, this is the effect of fresh-water discharge which was discussed in detail above in connection with the tide in the Connecticut River. The duration of fall at Shelton, for instance, is 50 per cent longer than that of rise.

The fact that the range of tide decreases upstream while the time of tide becomes later indicates the presence of the progressive-wave type of tide in this waterway. In order to obtain the average depth of water in the estuary of the Housatonic River for use in the formula for progressive-wave motion, a computation was made in which the mean low-water average cross-sectional depths at 16 points along the Housatonic River below the dam at Shelton, Conn., were obtained. From these average depths an approximate mean low-water depth of 5.8 feet has been derived for this tidal estuary.

Allowing for an average range of tide of about 4.8 feet in this waterway this would make the average depth of the estuary at mean tide level 8.2 feet. The distance between Stratford and Shelton is 9½ nautical miles, or 57,760 feet.

In the formula for progressive-wave motion, $r=\sqrt{gh}$, in which $r=$ rate of advance of a progressive wave, $g=$ acceleration of gravity or 32.2 feet per second, and $h=$ average depth of water (mean tide level depth). From the above formula the theoretical time required for the propagation of a progressive wave in the Housatonic River from Stratford to Shelton would be 1.0 hour. That is, at a rate of advance of 16.2 feet per second derived from the above formula, it would take 3,565 seconds, or 1.0 hour, for a progressive wave to traverse this stretch of the river. The actual time required, based on high water observations and given above, is 0.96 hour. This is a close agreement and indicates that the type of tide in the Housatonic River, like that in the Connecticut River, is progressive rather than stationary.

Tidal current observations were obtained by field parties of the Coast and Geodetic Survey at six stations in the Housatonic River in 1917 and 1929. The locations of these stations are shown in Figure 26 and the results from observations near the surface are given in Table 66.

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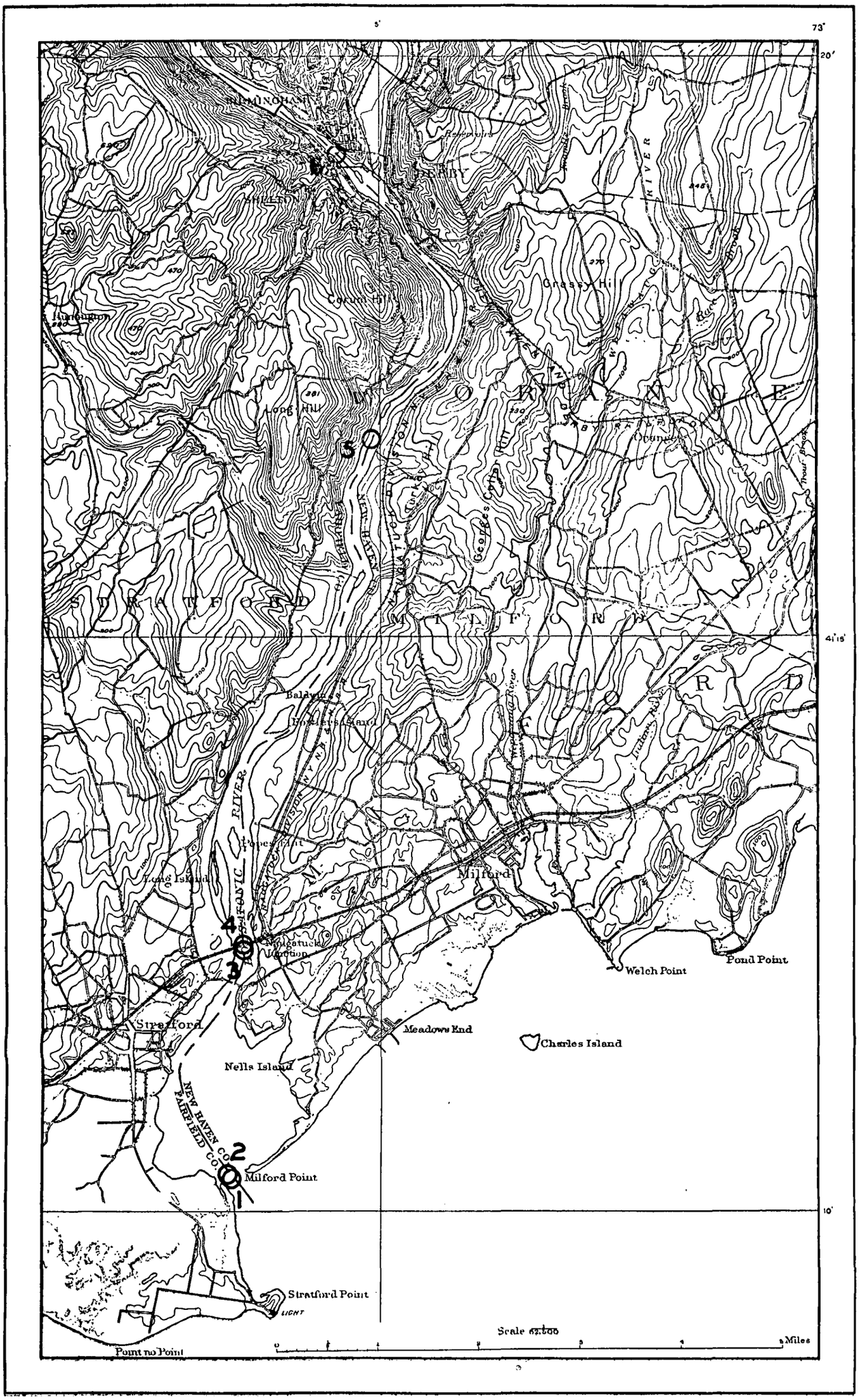

FIGURE 26.—Current stations, Housatonic River

TABLE 66.—*Results from current observations near the surface, Housatonic River*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Mid-channel, off Milford Point.	Aug. 17-18, 1917	1	Pole	4	1.07	1.08	301	2.07	5.38	0.62	0.62	124	2.62	7.04	1.98
2	H. E. Finnegan	do	July 18-19, 1929	1¼	do	3½	0.95	0.57	301	2.51	5.68	0.80	−0.55	136	2.68	6.74	1.57
3	do	Mid-channel, south of N. Y., N. H. & H. R. R. drawbridge.	do	1	do	3½	1.40	1.05	360	0.82	5.38	0.95	0.65	175	1.50	7.04	2.14
4	P. M. Trueblood	Mid-channel at N. Y., N. H. & H. R. R. drawbridge.	Aug. 8-9, 1917	1	Meter	6	0.07	0.08	(1)	1.30	5.58	−0.18	−0.53	(1)	1.65	6.84	0.99
5	H. E. Finnegan	Mid-channel, south of Wooster Island.	July 18-19, 1929	1	Pole	3	2.00	1.65	10	0.85	5.18	1.35	0.65	190	0.95	7.24	2.54
6	P. M. Trueblood	Mid-channel, south of Derby-Shelton bridge.	Aug. 20-21, 1917	1	Meter	3	4.05	2.33	(1)	0.18	2.20	0.42	4.02	(1)	1.43	10.22	3.83

[1] On the flood the current sets northerly; on the ebb, southerly.

Owing to the shallow depths which obtain in the Housatonic River, short current poles of about 7 to 9 feet in length instead of the standard 15-foot pole were used in making current observations. Therefore, the results shown in Table 66 are generally representative of current conditions at an average depth of about 3 or 4 feet.

In Table 66 the times of slack and strength of current in hours are referred to the predicted times of similar phases of the current at The Race, daily predictions for which may be found in the Atlantic Coast Current Tables. Likewise the durations of flood and ebb are given in hours, the sum of the two durations being equal to the duration of one-half a lunar day, or 12.42 hours.

The velocities of flood and ebb strengths at each station represent average velocities of the current as the observed velocities were corrected to a mean range of tide. These velocities should be increased or decreased as the range of tide increases or decreases from a mean. Obviously, freshet conditions in the river would greatly increase the ebb and decrease the flood and might even mask the tidal current completely by causing the current in the estuary to ebb continuously.

It will be noted from Table 66 that the data for stations 1 and 2 agree closely, especially with regard to times of slack water and direction and velocity of the current at times of strength. The strong flood and ebb velocities which obtain at these stations at the mouth of the river are quite comparable with those at the mouth of the Connecticut River which have been discussed above. Although the results for the velocities of the current at stations 3 and 4 agree fairly well the times of the current at the latter station have evidently been greatly disturbed and are most likely due to freshet conditions. This is perhaps partly explained by the peculiar results for station 6 in the vicinity of Shelton, Conn., which show disturbed velocity conditions as well as time relations. It will be noted that the ebb strength velocity at station 6 is 1.43 knots while that of flood strength is but 0.18 knot. Likewise the time relations at this station are disturbed, showing an ebb duration of 10.22 hours as compared with 2.20 hours for that of flood.

The 1929 observations at station 2, off Crimbo Point, and at station 5, south of Wooster Island, show that the time of current at the latter station occurs about an hour later than it does at the entrance to the river. At Shelton, therefore, it would most likely occur about 1½ hours later than it does at the entrance. It was shown previously that the tide at Shelton occurs from 1 to 1½ hours later than it does at Stratford. In general, therefore, the progression of the current in the river closely follows that of the tide, and it may be stated that current and tidal conditions in the Housatonic River are generally similar to those in the Connecticut River.

TABLE 67.—*Results from current observations at various depths, Housatonic River*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Mid-channel, off Milford Point.	Aug. 17–18, 1917	1	Pole	4	1.07	1.08	301	2.07	5.38	0.62	0.62	124	2.62	7.04	1.98
				1	Meter	3	1.12	0.78		2.47	5.13	0.42	0.57		2.77	7.29	1.85
				1	do	6	0.97	0.93		2.32	5.28	0.42	0.42		2.57	7.14	1.81
				1	do	10	0.82	0.63		1.76	5.38	0.37	0.37		2.21	7.04	1.68
2	H. E. Finnegan	do	July 18–19, 1929	1¼	Pole	3½	0.95	0.57	301	2.51	5.68	0.80	−0.55	136	2.68	6.74	1.57
				1¼	Meter	7	0.90	0.57		2.30	5.73	0.80	−0.60		2.30	6.69	1.55
				½	do [1]	7	1.00	0.20	314	2.37	5.53	0.70	−0.50	155	2.62	6.89	1.48
3	do	Mid-channel, south of N. Y., N. H. & H. R. R. drawbridge.	do	1	Pole	3½	1.40	1.05	360	0.82	5.38	0.95	0.65	175	1.50	7.04	2.14
				1	Meter	7	1.40	1.25		1.09	5.53	1.10	0.90		1.49	6.89	2.29
				1	do	12	1.35	1.40		0.98	5.58	1.10	1.65		0.82	6.84	2.51
4	P. M. Trueblood	Mid-channel at N. Y., N. H. & H. R. R. drawbridge.	Aug. 8–9, 1917	1	Meter	6	0.07	0.08	(2)	1.30	5.58	−0.18	−0.53	(2)	1.65	6.84	0.99
				1	do	18	−0.08	0.13		1.36	5.78	−0.13	−0.63		1.36	6.64	0.95
				1	do	25	0.17	0.23		1.44	5.58	−0.08				6.84	1.30
5	H. E. Finnegan	Mid-channel, south of Wooster Island.	July 18–19, 1929	1	Pole	3	2.00	1.65	10	0.85	5.18	1.35	0.65	190	0.95	7.24	2.54
				1	Meter	5½	2.00	1.55		0.90	5.18	1.35	0.70		0.90	7.24	2.53

[1] Pettersson meter observations.
[2] On the flood the current sets northerly; on the ebb, southerly.

At each of the current stations in the Housatonic River observations were made at various depths by means of Price current meters. The results of these observations are given in Table 67 with the exception of the results for station 6, which are given in the preceding table. At station 2 the Pettersson meter was also used for a portion of the time during which the station was occupied. The results obtained with this meter agree very well with those obtained by means of the Price current meter at the same depth. Directional observations obtained with this meter at station 2 indicate that the current near the bottom in mid-channel off Crimbo Point sets about 15° or 20° more northerly on the flood and more southerly on the ebb than it does at the surface. Evidently this is due to the channel banks near the bottom which would deflect the current.

Throughout the waterway it will be noted that the duration of ebb at each depth at each station greatly exceeds that of flood.

THE TIDE AND CURRENT IN WESTERN LONG ISLAND SOUND

Western Long Island Sound is generally considered as that portion of Long Island Sound extending from Stratford Shoal to Throgs Neck, N. Y., where the East River empties into the Sound. It is approximately 35 nautical miles in length and varies in width from about 14 nautical miles off Southport, Conn., to about three-fourths of a nautical mile off Throgs Neck, N. Y. It is generally funnel shaped and its axis has a northeasterly-southwesterly trend. It rapidly narrows from a width of about 6½ nautical miles off Eaton Point, Long Island, to a width of about 3 nautical miles off Execution Rocks. This narrowing of the Sound, together with decreasing depths of water from east to west in this portion of the Sound, accounts in part for the increased range of the tide in the area in the vicinity of Great Captain Island. This will be discussed later, however.

Depths in mid-Sound vary from about 32 fathoms north of Eaton Point to about 6½ fathoms south of Parsonage Point. East of Eaton Point mid-Sound depths average about 22 fathoms and generally are found in close proximity to the forty-first parallel of latitude. From Execution Rocks to Throgs Neck mid-Sound depths vary from about 25 fathoms in the vicinity of the former locality to about 8 fathoms east of Throgs Neck. On a cross section between Throgs Neck and Willets Point, however, mid-channel depths of about 18 fathoms are found. This cross section is located at one mouth of the East River which, by the way, is in reality a strait rather than a river. In the East River west of Fort Schuyler, Throgs Neck, and east of Whitestone Point, Long Island, depths of 8 fathoms or less generally obtain.

While the north coast of Long Island from Orient Point to Mount Misery Point, south of Stratford Shoal, is very regular and devoid of harbors of practical commercial importance, the exact opposite is true west of Stratford Shoal. Extending westward from Mount Misery Point, the north shore of Long Island is indented with a number of small peninsulas or "necks" with bays or harbors situated between them. These bays and harbors are becoming of increasing importance commercially and for a number of years they have been extensively used by vessels of small draft, especially yachts and motor boats.

Smithtown Bay is the largest of these bays, but is perhaps one of the least important commercially. Among the more important of these bays and harbors are Port Jefferson, Huntington, Northport,

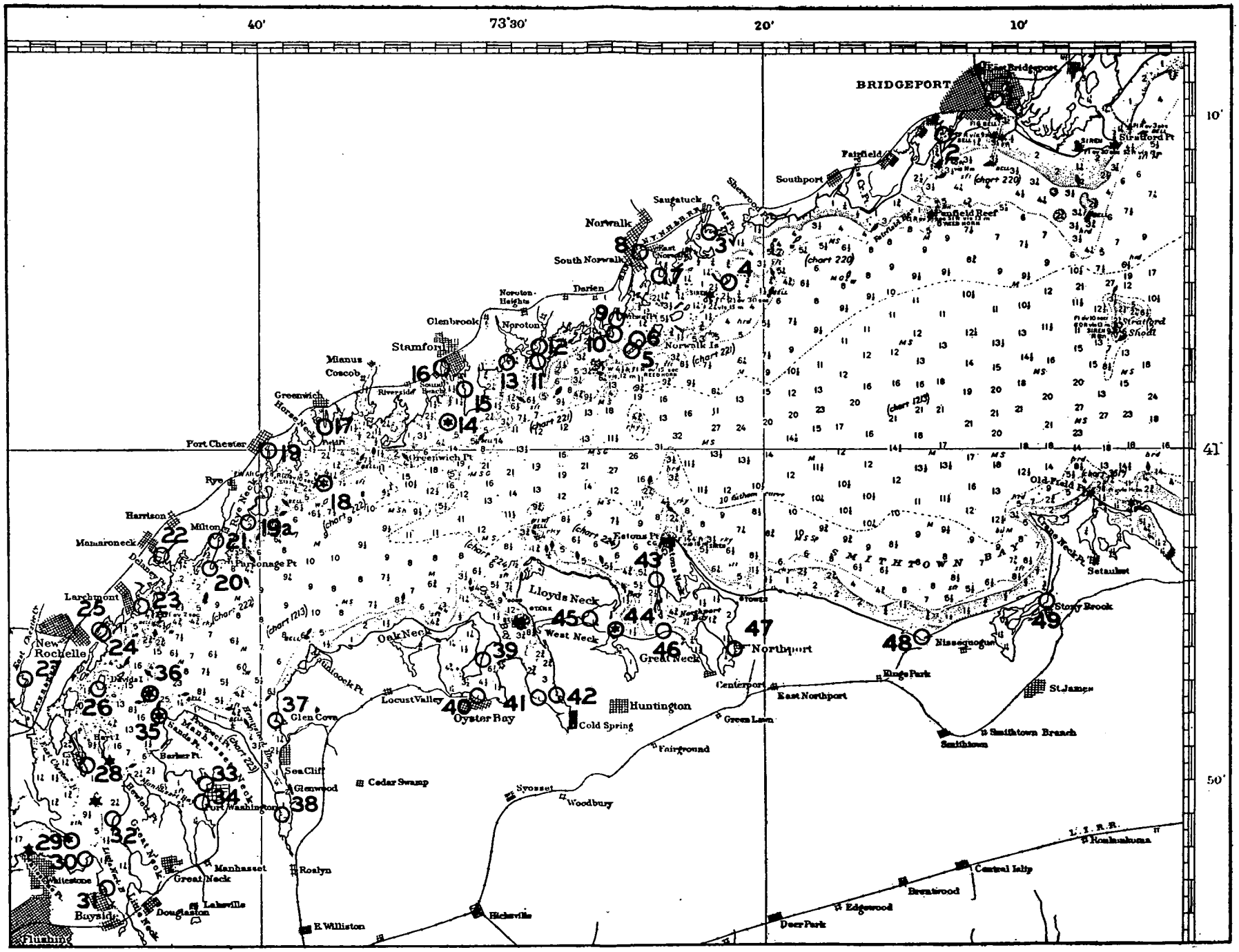

FIGURE 27.—Tide stations, western Long Island Sound

Oyster, Hempstead, and Manhasset. In general, these bays are somewhat funnel shaped, with rather wide mouths at Long Island Sound and narrowing considerably as they extend southerly between the "necks" referred to above. At the same time they rapidly shoal near the head of the bay. Among the more important ports along this shore line are Port Jefferson, Northport, Oyster Bay, and Port Washington.

The shores of Connecticut and New York in western Long Island Sound are extremely irregular. The shore line is indented by many small streams and necks of land. Many small islands and rocky shoals and reefs are in close proximity to the irregular shore line. Prominent among the island groups are the Norwalk Islands off the entrances to the Norwalk and Saugatuck Rivers, the islands in Captain Harbor, and the group of islands along the New York shore line west and southwest of Execution Rocks Light. As stated above, however, very good depths of water obtain in Long Island Sound beyond the numerous reefs and shoals along the shore line. Good harbors and ports of considerable commercial importance are found along this shore line. Among the most important ports are Bridgeport, Norwalk, and Stamford in Connecticut, and Port Chester, Mamaroneck, and New Rochelle in New York.

Tides have been observed by the Coast and Geodetic Survey at many localities in western Long Island Sound. In general, however, these have been for rather short periods of observation. Through the cooperation of the Corps of Engineers, United States Army, however, this bureau has been furnished the results of observations for a number of important localities. Chief among these are the results from observations obtained at Bridgeport, Norwalk River entrance, Stamford, Port Chester, Throgs Neck (Fort Schuyler), Willets Point (Fort Totten), and Roslyn (Hempstead Harbor). The tide at Throgs Neck was discussed at some length on pages 16 to 26 above, and the tide at Willets Point on pages 27 to 30. These two stations may be considered as standard, or primary, tide stations, and daily predictions for Willets Point, N. Y., may be found in the Atlantic Coast Tide Tables, published annually in advance by the Coast and Geodetic Survey.

The locations of stations in western Long Island Sound at which tidal observations have been obtained by the Coast and Geodetic Survey or for which the results from observations obtained by the Corps of Engineers, United States Army, have been furnished this bureau are shown in Figure 27. The results from observations made at these tide stations are given in Table 68.

TABLE 68.—*Tidal data, Western Long Island Sound, 1835–1930*

Station No.	Locality	Observations: Date	Observations: Period	Lunitidal intervals: HWI	Lunitidal intervals: LWI	Duration of rise	Mean range	Compared with—
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Bridgeport Harbor, Conn.	Nov. 16–24, 1835	8	11.09	5.21	5.88	7.03	
		Aug. 15–Nov. 3, 1837	81	11.18	5.10	6.08	6.65	
		Sept. 30–Oct. 6, 1863	7	10.51	4.40	6.11	6.78	Boston, Mass.
		Aug. 5–Nov. 11, 1885	32	11.02	4.95	6.07	6.71	Pulpit Harbor, Me.
		Apr. 20–25, 1887	4	10.85	4.73	6.12	7.03	Do.
		Jan. 13, 1911–May 26, 1915	1,107				6.35	Do.[1]
		Aug. 3–Sept. 22, 1916	40	11.17	5.02	6.15	6.86	Fort Hamilton, N. Y.
		July 18–24, 1929	7	11.07	4.90	6.17	6.86	Whitehall Street, N. Y.
2	Black Rock Harbor, Conn.	Aug. 20–Sept. 11, 1835	20	11.35	5.14	6.21	6.95	
		Oct. 6–12, 1883	7	10.88	4.80	6.08	6.73	New London, Conn.
		Aug. 25–Sept. 4, 1885	11	10.83	4.65	6.18	6.35	Willets Point, N. Y.
3	Saugatuck River (east of Hendricks Point)	Sept. 8–Oct. 26, 1885	46	11.10	5.05	6.05	7.17	Pulpit Harbor, Me.
		July 23–24, 1929	1	11.23	5.33	5.90	6.73	Whitehall Street, N. Y.
4	Cockenoe Island, Norwalk Islands	Sept. 25–Nov. 5, 1835	40	11.06	5.05	6.01	7.53	
5	Sheffield Island (former lighthouse location)	May 9–June 27, 1836	50	11.28	5.08	6.20	6.70	
		June 25–Aug. 5, 1847	41	10.97	4.78	6.19	7.14	
6	Dolphin, north of Sheffield Island	July 17–19, 1929	3	11.76	5.43	6.33	7.23	Do.
7	Gregory Point, Conn. (Norwalk River)	Oct. 23, 1913–May 26, 1915	484				6.94	(1)
8	South Norwalk, Conn. (yacht club wharf)	Sept. 21–Oct. 8, 1914	15	11.31	4.97	6.34	7.35	Fort Hamilton, N. Y.
		July 19–22, 1929	4	11.26	5.11	6.15	7.26	Whitehall Street, N. Y.
9	Wilson Point, Conn. (Sheffield Island Harbor)	May 13–June 8, 1886	16	11.13	5.13	6.00	7.10	Pulpit Harbor, Me.
		Oct. 21–22, 1886	1	10.54	4.51	6.03	7.15	Do.
		Nov. 16–17, 1886	1	10.84	4.79	6.05	7.18	Do.
		Apr. 7–8, 1887	1	10.74				Do.
		Aug. 11–17, 1893	6	10.85	5.14	5.71	7.33	Fort Hamilton, N. Y.
10	Bell Island, Sheffield Island Harbor	Nov. 16–17, 1886	2	10.84	4.79	6.05	7.18	Pulpit Harbor, Me.
11	Long Neck Point, Conn.	June 10–11, 1886	1		5.08			Do.
		Sept. 6–8, 1894	3	11.02	4.86	6.16	7.16	Boston, Mass.
12	Darien River, Conn.	June 28–July 9, 1836	11	10.77	4.69	6.08	7.92	
13	Cove Harbor, Conn.	June 28–29, 1911	2	11.36	4.98	6.38	6.92	Fort Hamilton, N. Y.
14	Stamford Harbor Light	July 11–Aug. 8, 1836	29	11.13	4.77	6.36	7.40	
		June 15–July 9, 1886	14	11.07	4.93	6.14	7.43	Pulpit Harbor, Me.
		Oct. 21–Nov. 6, 1886	11	11.18	5.09	6.09	7.50	Do.
		Apr. 8–15, 1887	5	10.91	5.10	5.81	7.14	Sandy Hook, N. J.
		Apr. 26–27; May 18–19, 1887	4	11.23	5.23	6.00	7.39	Do.
		Aug. 29–31, 1894	3	11.00	4.74	6.26	7.01	Fort Hamilton, N. Y.
15	Stamford, Conn. (yacht club wharf)	Aug. 7–Dec. 3, 1914	53	11.02	4.85	6.17	7.32	
		July 11–12, 1929	2	10.82	5.27	5.55	7.13	Whitehall Street, N. Y.
16	Stamford, Conn. (Stamford Motor Co. wharf)	May 11, 1911–May 26, 1915	256				6.99	(1)
		Sept. 26–28, 1916	3	11.09	5.04	6.05	7.09	Fort Hamilton, N. Y.
		July 20–27, 1929	7	11.21	5.09	6.12	7.23	Whitehall Street, N. Y.
17	Greenwich Harbor, Conn.	May 18–July 29, 1886	71	11.15	5.03	6.12	7.05	
		July 29–Nov. 11, 1886	23	11.13	5.03	6.10	7.39	Pulpit Harbor, Me.
		Aug. 18–Sept. 2, 1893	7	10.93	4.83	6.10	7.32	Willets Point, N. Y.
		Aug. 28–29, 1894	1	10.71	4.99	5.72	7.26	Do.
		June 28–29, 1911	2	11.15	5.17	5.98	7.00	Fort Hamilton, N. Y.
		Sept. 28–30, 1916	3	11.15	4.89	6.26	7.50	Do.
18	Great Captain Island Light	Aug. 13–29, 1836	17	11.05	4.75	6.30	7.06	
19	Port Chester, N. Y. (Byram River)	Aug. 31–Sept. 7, 1893	6	10.73	5.08	5.65	7.32	Willets Point, N. Y.
		Oct. 17–18, 1916	2	10.93	4.72	6.21	7.35	Portland, Me.
		Apr. 15, 1927–Mar. 28, 1928	61	11.30	5.36	5.94	7.14	(1)
19a	Rye Beach, N. Y.	July 1–Oct. 31, 1930	123	11.17	5.26	5.91	7.21	Throgs Neck, N. Y.
20	Milton Harbor, N. Y. (off Rye Point)	July 26–Aug. 20, 1927	15	11.61	5.70	5.91	7.07	Portland, Me.[1]
21	Mill Creek, N. Y.	Sept. 6–Oct. 14, 1836	38	11.18	4.92	6.26	7.49	
22	Mamaroneck Harbor, N. Y.	Oct. 23–24, 1836	2	11.23	4.83	6.40	8.00	
		Aug. 23–Nov. 10, 1886	26	11.09	5.08	6.01	7.52	Pulpit Harbor, Me.
		May 10–June 3, 1887	9	11.10	5.15	5.95	7.12	Do.
		Oct. 3–5, 1916	3	11.29	5.35	5.94	7.24	Portland, Me.
		June 24–30, 1928	7	11.34	5.58	5.76	7.21	Do.[1]
23	Larchmont Harbor, N. Y.	Aug. 18–25, 1894	7	11.03	4.49	6.54	7.46	Fort Hamilton, N. Y.
		Sept. 23–25, 1901	1	11.14	5.06	6.08	8.41	Do.
24	Echo Bay (Beaufort Point)	Sept. 3–4, 1920	2	12.05	5.53	6.52	7.02	Willets Point, N. Y.
25	Echo Bay (New Rochelle, N. Y.)	Oct. 27–Nov. 4, 1836	9	11.37	5.28	6.09	7.04	
		May 20–July 19, 1847	61	11.33	5.48	5.85	7.34	
		Sept. 7–Oct. 5, 1916	29	11.00	5.43	5.57	7.33	
		July 16–17, 1929	2	10.85	4.93	5.92	7.44	Willets Point, N. Y.

[1] From tide records furnished by the corps of Engineers, U. S. Army.

TABLE 68.—*Tidal data, Western Long Island Sound, 1835–1930*—Continued

Station No.	Location	Observations: Date	Observations: Period	Lunitidal intervals: HWI	Lunitidal intervals: LWI	Duration of rise	Mean range	Compared with—
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
26	Davids Island, N. Y. (Fort Slocum)	May 29–Aug. 2, 1837	66	11.42	5.27	6.15	7.11	
		Aug. 6–27, 1894	17	11.13	5.72	5.41	7.52	Fort Hamilton, N. Y.
		July 24–29, 1895	5	11.12	5.42	5.70	6.97	Do.
		Apr. 11–13, 1912	3		5.29			Do.
		June 26–Sept. 2, 1914	62	11.18	5.15	6.03	7.56	
27	East Chester Creek (Westchester Light Co. Dock)	Sept. 6, 1928–Feb. 9, 1929	69	11.61	5.86	5.75	7.14	(1)
28	City Island, N. Y	May 23–26, 1837	4	10.83	5.28	5.55	7.36	
		Nov. 1–30, 1882	30	11.23	5.18	6.05	7.09	
		May 18–June 22, 1883	11	10.78	4.76	6.02	7.76	Pulpit Harbor, Me.
		Oct. 15–Nov. 7, 1883	9	10.70	4.68	6.02	6.67	Do.
		Feb. 5, 1889	1	10.90	5.07	5.83	6.91	Sandy Hook, N. J.
		July 23–Aug. 8, 1894	14	11.01	4.93	6.08	7.09	Portland, Me.
		Oct. 13–14, 1903	1	10.91	5.30	5.61	7.34	Do.
		Sept. 19–22, 1904	4	11.16	5.06	6.10	7.97	Fort Hamilton, N. Y.[2]
		Nov. 8–13, 1907	5	11.31	5.33	5.98	7.38	Portland, Me.
		July 5–8, 1929	4	11.34	5.70	5.64	7.67	Willets Point, N. Y.
29	Throgs Neck, N. Y. (Fort Schuyler)	Aug. 9–17, 1837	9	11.21	5.45	5.76	7.50	
		Mar. 20–May 29, 1847	63	10.50	5.22	5.28	6.96	Governors Island, N. Y.
		Oct. 1, 1920–Oct. 31, 1929	1,887	11.31	5.65	5.66	7.19	(1)
		June 28–July 5, 1929	8	11.37	5.55	5.82	7.25	Throgs Neck, N. Y.
		Oct. 1–31, 1930	31	11.22	5.60	5.62	6.94	Newport, R. I.
30	Willets Point, Long Island (Fort Totten)	Aug. 9, 1886	1		5.36			Pulpit Harbor, Me.
		Oct. 4–30, 1886	27	11.40	5.75	5.65	7.10	
		Sept. 3, 1890	1		5.80			Portland, Me.
		July 1, 1891–Jan. 4, 1895	738	11.30	5.71	5.59	7.18	(1)
		June 29–July 5, 1929	7	11.37	5.66	5.71	7.23	Throgs Neck, N. Y.
31	Bayside, Long Island (Little Neck Bay)	July 12–13, 1929	2	10.66	4.63	6.03	7.29	Do.
32	Elm Point, Great Neck, Long Island	Sept. 3–7, 1920	3	11.36	5.26	6.10	6.74	Fort Hamilton, N. Y.
33	Port Washington, Long Island. Manhasset Bay, (town wharf).	Nov. 16–23, 1927	7	11.33	5.67	5.66	7.30	Portland, Me.[1]
34	Port Washington, Long Island. Manhasset Bay, (Bayside Yacht Club Wharf).	July 9–14, 1929	6	11.11	4.83	6.28	7.73	Willets Point, N. Y.
35	Sands Point, Long Island	June 11–Aug. 4, 1847	55	11.19	5.34	5.85	7.56	
		Dec. 15–28, 1886	3	10.51				Pulpit Harbor, Me.
36	Execution Rocks Light	Nov. 10–12, 1886	3	11.25	5.37	5.88	7.73	Do.
		Sept. 3–11, 1920	7	11.33	5.36	5.97	7.37	Fort Hamilton, N. Y.
37	Glen Cove, Long Island (Hempstead Harbor)	June 16–July 5, 1837	20	10.72	4.82	5.90	7.19	
		Aug. 18–Sept. 26, 1859	31	11.13	5.05	6.08	7.28	Boston, Mass.
		Sept. 30–Dec. 28, 1886	18	10.85	4.97	5.88	7.09	Pulpit Harbor, Me.
		Sept. 7–9, 1916	3	11.43	5.48	5.95	7.58	Portland, Me.
		July 15–17, 1929	3	10.51	5.12	5.39	7.35	Willets Point, N. Y.
38	Roslyn, Long Island (Hempstead Harbor)	Mar. 1–Nov. 10, 1928	49	11.61	5.86	5.75	7.54	Portland, Me.[1]
		July 15–16, 1929	2	11.61	5.51	6.10	7.55	Whitehall Street, N. Y.
39	Center Island (Oyster Bay Harbor)	Oct. 8–28, 1836	19	11.39	5.62	5.77	7.51	
		May 4–21, 1837	18	11.26	4.91	6.35	7.61	
40	Oyster Bay, Long Island (Oyster Bay Harbor)	Jan. 29–Mar. 31, 1847	62	11.10	5.07	6.03	7.04	
		July 19–Aug. 28, 1886	41	11.10	4.98	6.12	7.46	Pulpit Harbor, Me.
		Apr. 29–May 5, 1887	4	10.98	5.20	5.78	7.34	Do.
		Oct. 19–Nov. 30, 1914	22	11.04	5.19	5.85	7.30	Portland, Me.
		Aug. 11–Oct. 29, 1916	80	11.27	5.32	5.95	7.34	
41	Laurelton, Long Island (Cold Spring Harbor)	Aug. 4–Sept. 4, 1886	26	10.97	5.03	5.94	7.51	Pulpit Harbor, Me.
42	Cold Spring Harbor, Long Island	Sept. 11–13, 1916	3	11.11	5.20	5.91	7.13	Portland, Me.
43	Huntington Bay, Long Island	June 27–Aug. 27, 1847	61	10.85	4.60	6.25	7.40	
44	Huntington Bay, Long Island (Lloyd Harbor Light).	Sept. 13–15, 1916	3	11.13	5.02	6.11	7.16	Do.
		Oct. 25–Nov. 22, 1916	24	10.97	5.25	5.72	7.34	Do.
		July 10–12, 1929	3	10.96	5.34	5.62	6.81	Do.
45	Lloyd Harbor, Long Island	Aug. 13–Sept. 4, 1836	23	11.26	5.13	6.13	7.49	
46	Northport Bay, Long Island	Aug. 5–8, 1837	3	10.93	4.83	6.10	6.68	
47	Northport, Long Island	Sept. 1–Nov. 17, 1886	66	11.05	4.85	6.20	7.12	
		Sept. 21–23, 1916	3	11.19	4.98	6.21	7.51	Do.
		July 12–16, 1929	5	11.29	5.39	5.90	7.17	Do.
48	Off entrance to Nissequogue River, Smithtown Bay.	Nov. 2–3, 1886	2	10.75	4.70	6.05	6.79	Pulpit Harbor, Me.
49	Stony Brook, Smithtown Bay	Sept. 30–Oct. 15, 1886	4	11.18	5.41	5.77	6.04	Do.
		Oct. 25–Nov. 10, 1886	17	11.58	5.97	5.61	6.11	Do.

[1] From tide records furnished by the Corps of Engineers, U. S. Army.

[2] Also compared with Portland, Me.

Tidal observations in western Long Island Sound date from 1835 when early hydrographic operations were carried out along the Connecticut shore. In the two following years these operations were extended along the shores of Long Island and New York proper.

Most of the longer series of tidal observations in this waterway, however, have been obtained since 1880. The earlier observations were generally obtained by means of readings on tide staffs. Later automatic tide gages were used in obtaining tidal observations.

The tide stations in Table 68 are arranged geographically and are numbered consecutively from east to west along the Connecticut and New York shores from Bridgeport to Throgs Neck, and from west to east along the Long Island shore from Willets Point to Smithtown Bay. The various series of tidal observations at each station are arranged chronologically. The values for time and mean range of tide for each series are reduced values; that is, the values obtained from a tabulation of the observations have been reduced by means of factors.

The data in columns 5 and 6 of Table 68 show the reduced high and low water lunitidal intervals. Subtracting the values in column 6 from those in column 5, the values in column 7 for duration of rise of tide are obtained. The duration of fall of tide may be derived by subtracting the values in column 7 from 12.42 hours, the latter representing the duration of one-half a lunar day.

The mean range of tide given in column 8, as stated above, is a reduced value. In cases where it was possible to do so, the observed ranges for short-period stations were reduced by means of comparison with simultaneous observations at some long-period standard, or primary, tide station. In the last column of Table 68 the standard tide station used for comparing and reducing the observed range of tide at the subordinate station is listed. In this connection it should be stated that for some of the earlier short series of tidal observations it was impossible to reduce the observed values by comparison owing to the fact that standard tide stations were not in operation at such times. In such cases, however, the observed values for range of tide were reduced by factors to give approximate mean values.

The intervals for time of tide in columns 5 and 6 have also been reduced where it was possible to do so, by comparison with simultaneous observations at a standard station.

In order to arrive at standard, or best values, for each station, the values given in Table 68 have been subjected to a process of adjustment and the adjusted values for tide stations in western Long Island Sound are given in Table 69.

TABLE 69.—*Adjusted tidal data, Western Long Island Sound*

Station No.	Locality	Lunitidal intervals		Duration of rise	Range of tide		
		HWI	LWI		Mean	Spring	Neap
		Hours	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*
1	Bridgeport Harbor, Conn.	11.10	5.00	6.10	6.8	8.0	5.4
2	Black Rock Harbor, Conn.	11.10	5.00	6.10	6.9	8.1	5.5
3	Saugatuck River (east of Hendricks Point)	11.10	5.05	6.05	7.1	8.4	5.7
4	Cockenoe Island, Norwalk Islands	11.05	5.05	6.00	7.1	8.4	5.7
5	Sheffield Island (former lighthouse location)	11.10	5.05	6.05	7.1	8.4	5.7
6	Dolphin, north of Sheffield Island	11.15	5.10	6.05	7.1	8.4	5.7
7	Gregory Point, Conn. (Norwalk River)				7.1	8.4	5.7
8	South Norwalk, Conn. (Yacht club wharf)	11.25	5.05	6.20	7.2	8.5	5.8
9	Wilson Point, Conn. (Sheffield Island Harbor)	11.15	5.10	6.05	7.2	8.5	5.8
10	Bell Island, Sheffield Island Harbor	11.10	5.05	6.05	7.2	8.5	5.8
11	Long Neck Point, Conn.	11.10	5.05	6.05	7.2	8.5	5.8
13	Cove Harbor, Conn.	11.10	5.05	6.05	7.2	8.5	5.8
14	Stamford Harbor Light	11.15	5.10	6.05	7.3	8.6	5.8
15	Stamford, Conn. (yacht club wharf)	11.15	5.10	6.05	7.3	8.6	5.8
16	Stamford, Conn. (Stamford Motor Co. wharf)	11.15	5.10	6.05	7.3	8.6	5.8
17	Greenwich Harbor, Conn.	11.15	5.10	6.05	7.4	8.7	5.9
18	Great Captain Island Light	11.15	5.10	6.05	7.3	8.6	5.8
19	Port Chester, N. Y. (Byram River)	11.30	5.35	5.95	7.3	8.6	5.8
19a	Rye Beach, N. Y.	11.20	5.30	5.90	7.3	8.6	5.8
20	Milton Harbor, N. Y. (off Rye Point)	11.20	5.30	5.90	7.3	8.6	5.8
22	Mamaroneck Harbor, N. Y.	11.20	5.30	5.90	7.3	8.6	5.8
23	Larchmont Harbor, N. Y.	11.20	5.40	5.80	7.3	8.6	5.8
24	Echo Bay (Beaufort Point)	11.20	5.45	5.75	7.3	8.6	5.8
25	Echo Bay (New Rochelle, N. Y.)	11.20	5.45	5.75	7.3	8.6	5.8
26	Davids Island, N. Y. (Fort Slocum)	11.20	5.35	5.85	7.3	8.6	5.8
27	East Chester Creek (Westchester Light Co. dock)	11.60	5.85	5.75	7.3	8.6	5.8
28	City Island, N. Y.	11.25	5.50	5.75	7.2	8.5	5.8
29	Throgs Neck, N. Y. (Fort Schuyler)	11.30	5.65	5.65	7.2	8.5	5.8
30	Willets Point, Long Island (Fort Totten)	11.30	5.70	5.60	7.2	8.5	5.8
31	Bayside, Long Island (Little Neck Bay)	11.15	5.30	5.85	7.2	8.5	5.8
32	Elm Point, Great Neck, Long Island	11.15	5.25	5.90	7.2	8.5	5.8
33	Port Washington, Long Island. Manhasset Bay (town wharf)	11.20	5.30	5.90	7.3	8.6	5.8
34	Port Washington, Long Island. Manhasset Bay (Bayside Yacht Club)	11.20	5.30	5.90	7.3	8.6	5.8
35	Sands Point, Long Island	11.15	5.35	5.80	7.3	8.6	5.8
36	Execution Rocks Light	11.15	5.35	5.80	7.3	8.6	5.8
37	Glen Cove, Long Island (Hempstead Harbor)	11.15	5.10	6.05	7.3	8.6	5.8
38	Roslyn, Long Island (Hempstead Harbor)	11.60	5.75	5.85	7.5	8.8	6.0
40	Oyster Bay, Long Island	11.15	5.20	5.95	7.3	8.6	5.8
41	Laurelton, Long Island (Cold Spring Harbor)	11.10	5.10	6.00	7.3	8.6	5.8
42	Cold Spring Harbor, Long Island	11.15	5.20	5.95	7.3	8.6	5.8
44	Huntington Bay, Long Island (Lloyd Harbor Light)	11.05	5.10	5.95	7.3	8.6	5.8
47	Northport, Long Island	11.10	5.10	6.00	7.2	8.5	5.8
48	Off entrance to Nissequogue River, Smithtown Bay	11.10	5.10	6.00	6.8	8.0	5.4
49	Stony Brook, Smithtown Bay	11.40	5.75	5.65	6.1	7.2	4.9

In the derivation of the values given in Table 69 considerable weight was given to the mean values for the long-period stations. Such mean values for high and low water lunitidal intervals and for range of tide are also shown in graphic form in Figures 28 and 29, respectively. As stated above, the values for spring and neap range of tide given in columns 7 and 8 of Table 69 were derived by applying the factors 1.18 and 0.80, respectively, to the adjusted mean range values given in column 6 of the table. These factors were obtained by comparing the relation of constants at New London, Conn., with those at Willets Point, N. Y. In a similar manner the approximate great tropic range at each station may be derived by applying the factor 1.14 to the mean range values given in column 6.

In passing, attention is called to the fact that locations given in Figure 27 for tide stations 12, 21, 39, 43, and 45 are approximate.

It will be noted from Figure 28 that over the 15-mile stretch from Stratford Shoal Light to the vicinity of Eaton Point, Long Island, and the Norwalk Islands off the Connecticut shore, there is a difference in the time of occurrence of high water and low water on either side of Long Island Sound. Both high water and low water occur

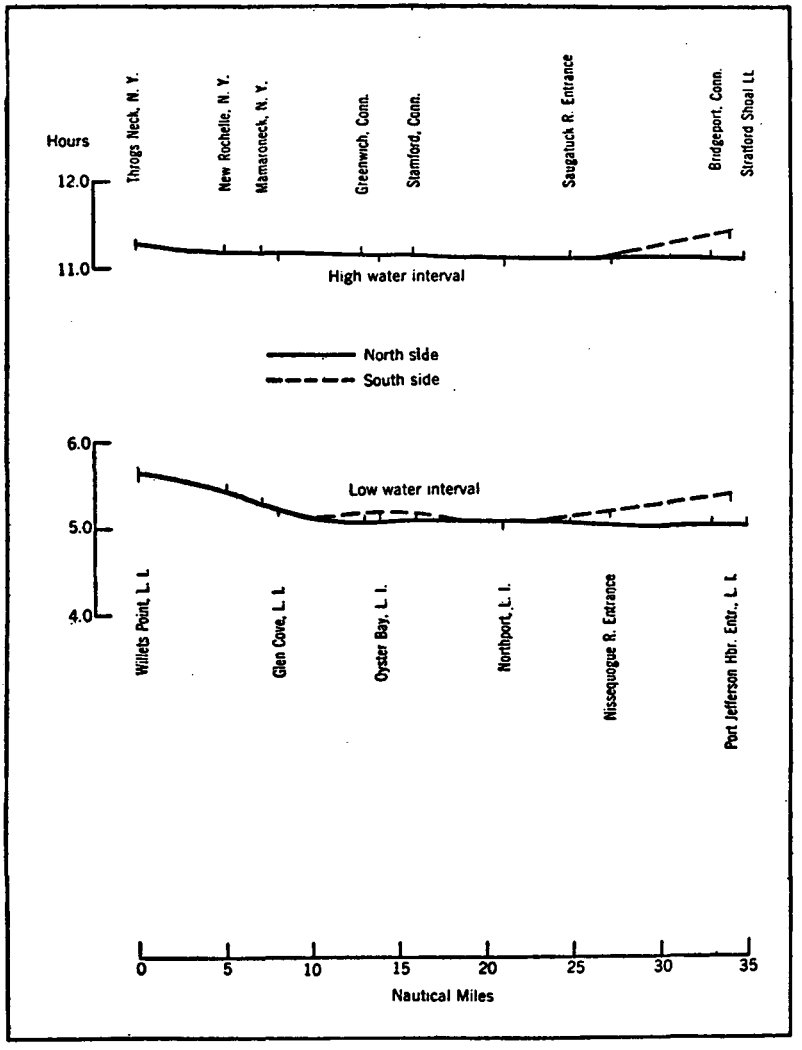

FIGURE 28.—Lunitidal intervals, Western Long Island Sound

earlier along the north side of the Sound. This was also shown to be the case for Eastern Long Island Sound from Orient Point, Long Island, to Stratford Shoal Light, as will be seen from Figure 17 above. West of Stratford Shoal Light and north of Smithtown Bay the high water along the north side of the Sound is about 0.3 hour earlier than on the south side, while the low water is approximately 0.4 hour earlier.

West of Eaton Point, Long Island, and, in fact, all the way to Throgs Neck there is practically no difference in time of high or low water along either side of western Long Island Sound, as will be seen from Figure 28.

It will be noted from Figure 29 that the range of tide along the north side of western Long Island Sound from Stratford Shoal Light to the vicinity of Eaton Point, Long Island, is greater than that along the south side of the Sound. This was likewise true of eastern Long Island Sound, as will be seen by referring back to Figure 18, and was

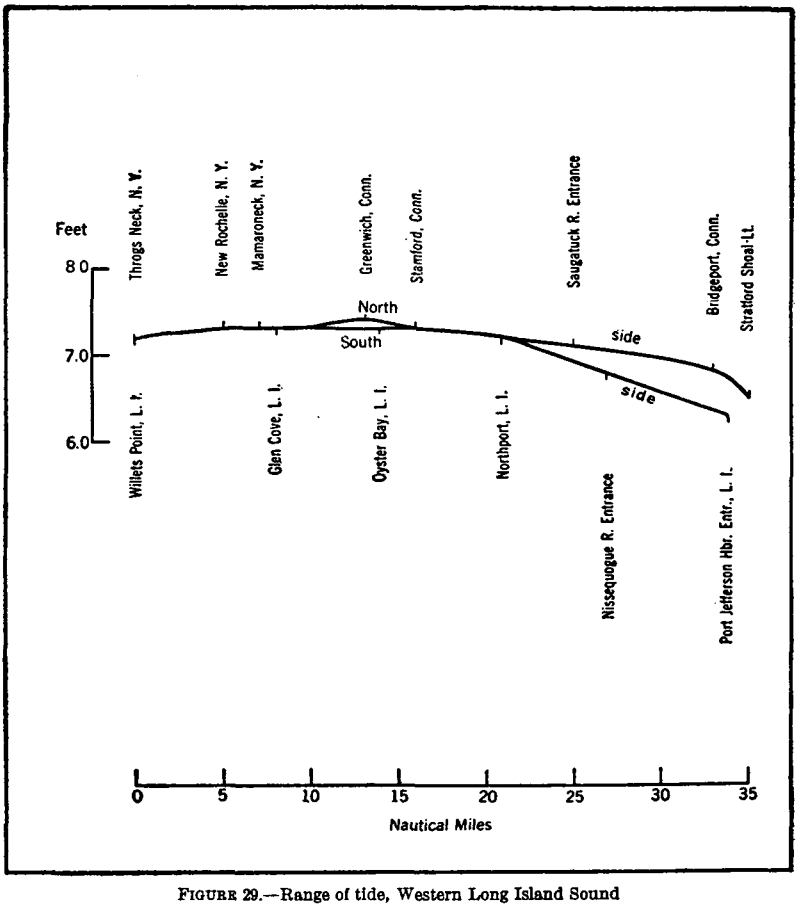

FIGURE 29.—Range of tide, Western Long Island Sound

fully discussed above in connection with the section concerning the tide and current in eastern Long Island Sound.

From Eaton Point, Long Island, to Throgs Neck there is practically no difference in the range of tide along either side of western Long Island Sound. Short series of tidal observations indicate ranges a tenth or two of a foot greater at points near the heads of bays and harbors in the vicinity of Captain Harbor, Conn., and Matinicock Point, Long Island, than those which obtain at points along the Sound proper.

Between Little Gull Island Light and Fort Schuyler, Throgs Neck, located approximately 82 nautical miles apart at the two extremities of Long Island Sound, the range increases from 2.5 feet at the former locality to 7.2 feet at the latter. There is also an increase in the times of high and low water between these points, the Greenwich lunitidal intervals for high and low water at Little Gull Island Light being 2.20 hours and 8.48 hours, respectively, and those for Fort Schuyler being 3.97 hours and 10.74 hours, respectively. From these lunitidal intervals differences of 1.77 hours and 2.26 hours are derived for the times of occurrence of high water and low water, respectively, at Fort Schuyler, after the occurrence of such phenomena at Little Gull Island Light.

It is seen, therefore, that there is a difference in time of tide as well as range of tide at both extremities of Long Island Sound. If only the time of tide changed while the range remained rather constant throughout the waterway, a progressive type of wave might be expected. On the other hand, if the time of tide differed but little while the range increased considerably, a stationary type of wave might be expected. However, from the tidal data it is evident that both time and range of tide differ throughout the waterway from one extremity to the other. Therefore, it is obvious that a combination of the progressive and stationary types of tide wave obtains.

For a body of water to support a stationary tide wave its period of oscillation should be nearly the same as that of the tide, or approximately 12 hours. If the period of oscillation for Long Island Sound be derived from the stationary-wave formula, $T=\frac{4\,L}{\sqrt{gh}}$, in which L=length of body of water or approximately 82 nautical miles (498,560 feet), g=acceleration of gravity or 32.2 feet per second, and h=average (mean tide level) depth of water or 71 feet, a value of 41,720 seconds, or 11.6 hours, is obtained. This approximates to the period of oscillation of the tide, and the body of water will, therefore, support a stationary wave.

From the formula for a progressive tide wave, $r=\sqrt{gh}$, in which r=rate of tide progression, g=acceleration of gravity or 32.2 feet per second, and h=average (mean tide level) depth of water or 71 feet, a value of 47.8 feet per second is obtained for the rate of progression of the tide wave. As the distance between the two extremities of the waterway is approximately 82 nautical miles, or 498,560 feet, the time that it should take for the tide wave to be propagated from Little Gull Island Light to Fort Schuyler—the two extremities of the waterway—should be approximately 10,430 seconds, or 2.9 hours. As determined from the Greenwich lunitidal intervals given above for these tide stations the actual time of propagation of high water throughout Long Island Sound is 1.77 hours, while that of low water is 2.26 hours.

From the above considerations it will be noted that the tide in Long Island Sound is produced by a combination of the stationary and progressive types of tide wave, the former predominating.

The value of 71 feet as the average, or mean tide level, depth of Long Island Sound in the application of the above formulas was obtained by adding 3.0 feet, the approximate half range of the tide over the stretch from Little Gull Island Light to Fort Schuyler, to 68 feet,

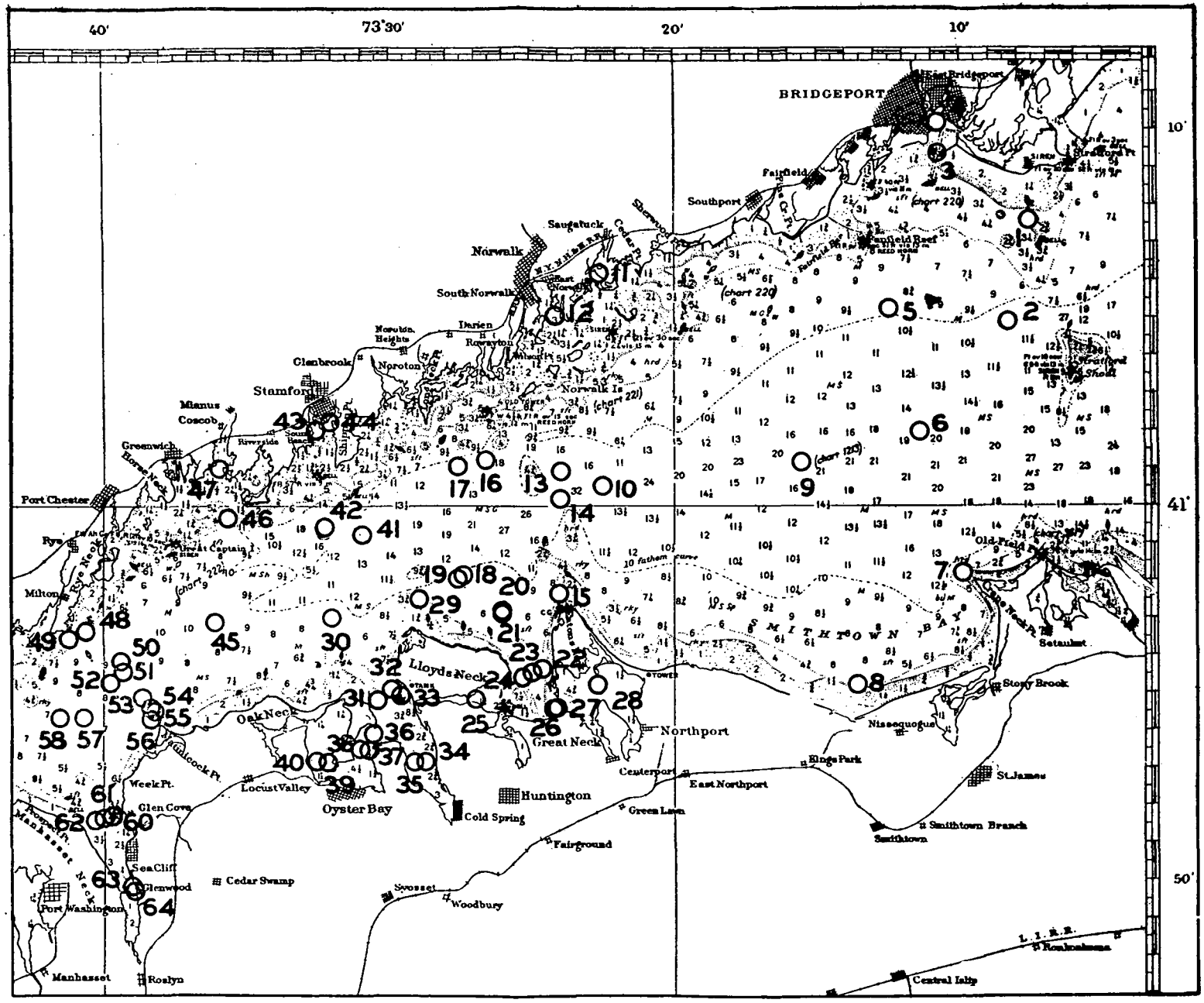

FIGURE 30.—Current stations, western Long Island Sound, Stratford Shoal to Manhasset Neck.

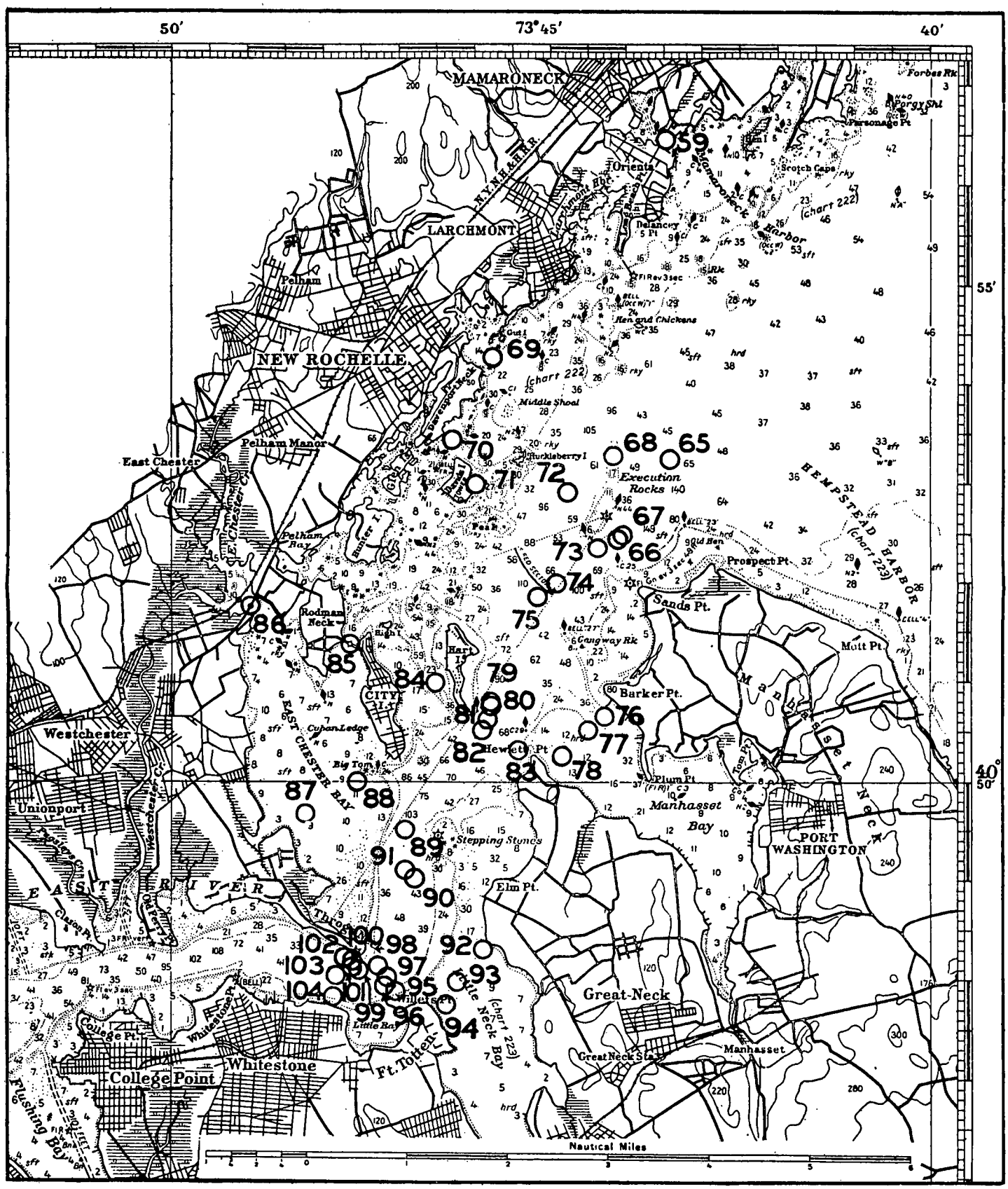

FIGURE 31.—Current stations, western Long Island Sound, Manhasset Neck to Throgs Neck

which is approximately the mean low water depth of Long Island Sound. The latter value was derived by taking the average of 17 cross-sectional mean low-water depths at various points spaced about 5 miles apart throughout the waterway.

Due to the rotation of the earth on its axis there is a tendency to deflect all moving bodies to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. Since the water in Long Island Sound moves westward on the flood it is to be expected that under such conditions the water would be deflected to the right, or northern, shore and the high water would, therefore, be higher on this shore. On the ebb, when the water is moving eastward, the deflection of the water would also be toward the right, therefore low water would be higher along the southern shore of the sound than along the northern shore. It is evident from the above considerations that the tide should rise higher and fall lower on the northern shore of Long Island Sound, and hence the range of tide should be greater along this shore.

Comparing the observed tidal ranges on the two shores of Long Island Sound relative to the axis of the waterway it is found that the range along the Connecticut shore is somewhat greater than that along the Long Island shore from the entrance at The Race to the vicinity of Eaton Point, Long Island. Westward of the latter locality there is practically no difference in range of tide along either shore of Long Island Sound.

The theoretical amount, in feet, by which the ranges on the two banks of a tidal stream differ is represented by the formula $\frac{3\,v\,d\,\sin\phi}{g}$, approximately, in which v = velocity of the water in knots, d = width of waterway in nautical miles, ϕ = the latitude, and g = acceleration of gravity or 32.2 feet per second. For three localities in Long Island Sound the values used in the above formula are as follows:

Locality (cross section)	v	d	ϕ	$\sin\phi$
	Knots	*Nautical miles*	*North latitude* ° ′	
1. Rocky Point, Long Island—Lynde Point, Conn.	0.65	7½	41 12	0.66
2. Roanoke Point, Long Island—Sachem Head, Conn.	0.65	16	41 07	0.66
3. Matinicock Point, Long Island—Parsonage Point, N. Y.	0.45	3½	40 55	0.65

Applying these values in the above formula the theoretical differences in range of tide on either shore of Long Island Sound at the three cross sections shown above are, respectively, 0.3, 0.65, and 0.1 foot. These values agree very well with the observed differences in range of tide at these cross sections, which are, respectively, 0.2, 0.6, and 0.1 foot.

Tidal currents have been observed at a number of stations in Western Long Island Sound by field parties of the Coast and Geodetic Survey. The locations of these stations are shown in Figures 30 and 31 and the results from observations near the surface at these stations are given in Table 70. Figure 30 shows the location of current stations numbers 1 to 64, inclusive, with the exception of station 59, in the stretch from Stratford Shoal to Manhasset Neck, Long Island. Figure 31 shows the location of current station 59 in Mamaroneck Harbor, N. Y., and also current stations numbers 65 to 104, inclusive, in the stretch from Manhasset Neck to Throgs Neck, N. Y.

TABLE 70.—*Results from current observations near the surface, Western Long Island Sound*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Off Point No Point	Aug. 15-16, 1917	1	Pole	7	−0.63	−0.72	256	1.37	6.73	0.27	−0.03	95	1.27	5.69	0.85
2	J.R.Goldsborough	West of Stratford Shoal Middle Ground.	Sept. 27-28, 1846	1	Float	(1)	0.37	1.04	261	1.75	6.27	0.81	0.72	78	2.07	6.15	1.87
3	F. S. Borden	Entrance to Bridgeport Harbor.	Oct. 24-25, 1916	1	Pole	3½	−0.23	−0.52	340	0.66	6.08	0.02	−0.18	176	0.65	6.34	0.90
4	H. E. Finnegan	North of Tongue Point, Bridgeport Harbor.	July 17-19, 1929	1½	do	7	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
5	E. E. Haskell	Off Penfield Reef	Sept. 5-6, 1890	½	Meter	(1)	0.05	−0.27	261	0.68	7.47	1.69	1.33	29	0.74	4.95	1.85
6	do	North of Smithtown Bay	Aug. 5, 22, 1890	½	do	(1)	0.77	0.73	293	0.79	4.81	−0.25				7.61	1.40
7	H. E. Finnegan	Off Crane Neck Point	July 16-17, 1929	1	Pole	7	−0.85	−1.60	256	1.30	4.98	−1.70	−1.65	16	1.44	7.44	12.10
8	do	Smithtown Bay	do	1	do	7	0.10	0.65	256	0.26	6.78	1.05	0.15	62	0.29	5.64	1.62
9	W. J. Sears	North of Smithtown Bay	Nov. 16-17, 1886	1	do	6	−0.82	−0.71	267	0.81	6.27	−0.38	−0.37	83	0.66	6.15	0.56
10	J.R.Goldsborough	North of Eaton Point	Aug. 4-5, 1847	1	Float	(1)	1.55	1.94	243	1.14	6.18	1.20	1.43	72	1.24	6.24	2.66
11	H. E. Finnegan	Mid-channel, Saugatuck River.	July 12-13, 1929	1	Pole	3½	0.05	−1.15	313	0.22	4.58	−1.20	1.05	139	0.27	7.84	0.82
12	do	Off Gregory Point, Norwalk River.	do	1⅙	do	7	−0.43	−0.50	322	0.66	6.21	−0.05	−0.40	146	0.64	6.21	0.79
13	E. E. Haskell	North of Eaton Point	Aug. 19, 1890	½	Meter	(1)	0.44	−0.10	286	1.81	5.59	0.20	0.08	34	1.57	6.83	1.29
14	F. H. Crosby	do	Nov. 16-17, 1886	1¼	Pole	6	0.39	0.27	258	1.20	6.01	0.57	0.25	70	0.80	6.41	1.50
15	F. S. Borden	do	Aug. 24-26, 1916	2	do	7	−0.15	−0.62	312	0.62	3.70	−2.28	−0.62	69	1.41	8.72	0.21
16	E. E. Haskell	South of Greens Ledge Light	Sept. 8, 1890	½	Meter	(1)	0.70	0.67	274	0.63	5.50	0.37	−0.34	11	0.51	6.92	1.48
17	C. E. Littlefield	do	Sept. 20-21, 1906	½	Pole	7	0.19	0.48	260	0.71	5.18	−0.46	0.39	69	1.12	7.24	1.28
18	J.R.Goldsborough	North of Lloyd Neck	June 28-29, 1847	1	Float	(1)	1.00	1.51	213	1.19	5.96	1.13	2.27	58	1.29	6.46	2.61
19	C. P. Perkins	do	May 18-19, 1887	1¾	Pole	6	−1.60	0.35	215	0.70	4.22	−0.01	1.61	90	1.10	8.20	1.22
20	H. E. Finnegan	Entrance to Huntington Bay	Aug. 13-16, 1929	2⅕	do	7	−1.40	−1.46	221	0.54	6.25	−0.98	−0.48	71	0.65	6.17	0.05
21	F. S. Borden	do	Sept. 13-15, 1916	2	do	7	−0.82	−0.08	177	0.48	7.20	0.55	−0.41	65	0.45	5.22	0.94
22	H. E. Finnegan	Huntington Bay (east side)	July 8-9, 1929	1	do	7	−0.65	0.20	179	0.54	5.98	−0.50	−0.90	10	0.52	6.44	0.67
23	do	Huntington Bay (mid-channel)	July 8-11, 1929	2¾	do	7	0.92	0.38	178	0.39	4.87	−0.04	0.62	20	0.58	7.55	1.60
24	do	Huntington Bay (west side)	July 8-9, 1929	1	do	7	0.15	0.00	180	0.52	5.53	−0.15	−0.15	358	0.57	6.89	1.09
25	do	Lloyd Harbor	July 9-10, 1929	1	do	5	−0.20	−0.15	267	0.25	5.13	−0.90	0.05	81	0.37	7.29	0.83
26	F. S. Borden	Entrance to Northport Bay	Sept. 21-23, 1916	2	do	7	−0.32	−0.09	76	0.92	6.20	0.05	0.79	252	1.55	6.22	1.24
27	H. E. Finnegan	do	July 9-11, 1929	1½	do	7	−0.13	−0.50	82	1.20	5.71	−0.25	0.25	250	1.95	6.71	0.97
28	do	South of Duck Island Bluff, Northport Bay.	July 9-10, 1929	1	do	7	0.15	0.65	37	0.39	5.78	0.10	−0.55	286	0.29	6.64	1.22
29	F. S. Borden	North of Lloyd Point	Aug. 21-23, 1916	2	do	7	0.09	−0.15	279	1.32	5.13	−0.61	−0.68	64	1.44	7.29	0.79
30	J.R.Goldsborough	Entrance to Oyster Bay	July 9-10, 1847	1	Float	(1)	−0.58	0.34	245	0.89	7.63	1.22	0.39	64	0.71	4.79	1.47
31	H. E. Finnegan	Oyster Bay (off Center Island)	July 2-3, 1929	1	Pole	4½	−0.35	0.00	146	0.76	6.48	0.30	0.25	348	0.66	5.94	1.18
32	do	Oyster Bay (off Whitewood Point).	July 2-5, 1929	3⅙	do	7	0.22	0.07	114	0.52	5.65	0.04	0.42	318	0.64	6.77	1.32
33	F. S. Borden	Oyster Bay (off West Fort)	Sept. 11-13, 1916	2	do	7	−0.32	−0.73	128	0.52	6.00	−0.15	−0.02	326	0.55	6.42	0.83
34	H. E. Finnegan	Cold Spring Harbor (east side)	July 4-5, 1929	1	do	4½	−1.25	−0.70	(2)	(2)	6.68	−0.40	−1.35	26	0.30	5.74	0.21
35	do	Cold Spring Harbor (west side)	July 3-4, 1929	1	do	4½	−0.85	−0.55	165	0.28	5.48	−1.20	−0.95	10	0.20	6.94	0.24
36	F. S. Borden	Oyster Bay Harbor (south of Plum Point).	Aug. 17-19, 1916	2	Pole	7	−0.14	−0.03	244	0.72	5.97	0.00	−0.07	54	0.66	6.45	1.07
37	H. E. Finnegan	Oyster Bay Harbor (west of Cove Point).	July 3-4, 1929	1	do	7	0.85	−0.45	134	0.33	2.58	−2.40	0.80	14	0.60	9.84	0.83
38	do	do	July 2-3, 1929	1	do	7	0.35	1.10	188	0.65	6.73	1.25	0.90	6	0.35	5.69	2.03
39	do	Oyster Bay Harbor (west of Soper Point).	July 3-4, 1929	1	do	7	−0.10	−0.55	326	0.56	4.18	−1.75	−0.10	146	0.64	8.24	0.51
40	do	do	July 4-5, 1929	1	do	7	0.85	1.25	341	0.40	6.58	1.60	0.80	134	0.23	5.84	2.25
41	C. P. Perkins	South of Shippan Point	Apr. 26-27, 1887	1¼	do	6	1.20	1.00	248	0.56	5.50	0.87	0.82	59	0.58	6.92	2.10
42	E. E. Haskell	do	Sept. 8-9, 1890	½	Meter	(1)	0.12	0.00	263	0.85	5.45	−0.26	−0.67	15	0.61	6.97	0.93
43	H. E. Finnegan	Stamford Harbor (off Cook Point).	July 11-12, 1929	1	Pole	4	−0.15	−0.70	334	0.16	6.78	0.80	0.25	173	0.19	5.64	1.18
44	do	Stamford Harbor (East Branch Ship Canal).	do	1	do	4½	−0.05	0.50	19	0.26	6.08	0.20	−0.70	211	0.13	6.34	1.12
45	J.R.Goldsborough	South of Captain Harbor	July 8-9, 1847	1	Float	(1)	0.14	0.01	258	0.99	6.32	0.63	0.30	74	1.03	6.10	1.40
46	H. E. Finnegan	Entrance to Captain Harbor	July 11-12, 1929	1	Pole	7	0.25	−0.50	304	0.75	5.28	−0.30	−0.95	106	0.78	7.14	0.75
47	do	Off Goose Island, Coscob Harbor.	do	1	do	3½	0.05	−0.35	13	0.41	5.68	−0.10	−0.50	188	0.39	6.74	0.91
48	F. S. Borden	Off Porgy Shoal	Sept. 19-20, Oct. 2-3, 1916.	2¼	do	7	0.29	0.25	221	0.45	5.91	0.37	0.37	42	0.51	6.51	1.45
49	H. E. Finnegan	Off Parsonage Point	June 25-27, 1929	1½	do	7	0.47	0.00	195	0.48	6.13	0.77	0.40	54	0.50	6.29	1.54
50	E. E. Haskell	Off Matinicock Point	Aug. 14-15, 1890	1	Meter	(1)	1.47	0.90	293	0.53	5.30	0.94	1.06	39	0.65	7.12	2.22
51	F. S. Borden	do	Oct. 5-6, 18, 1916	1	Pole	7	0.80	0.13	230	0.41	4.30	−0.73	0.12	46	0.66	8.12	1.45
52	H. E. Finnegan	do	June 25-29, July 15-16, 1929.	5	do	7	1.44	1.10	236	0.51	5.05	0.66	0.50	58	0.73	7.37	2.05
53	E. E. Haskell	do	Aug. 7-8, 13-14, 1890	1½	Meter	(1)	0.55	0.13	272	0.77	6.55	1.27	1.46	30	0.61	5.87	1.98
54	H. E. Finnegan	do	June 26-27, 1929	1	Pole	7	0.90	0.90	262	0.52	5.48	0.55	0.10	60	0.79	6.94	1.74
55	F. S. Borden	do	Aug. 31-Sept. 1, Oct. 3-4, 1916.	2	do	7	0.27	−0.25	254	0.89	4.93	−0.63	−0.60	50	1.03	7.49	0.83

See footnotes at end of table.

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TABLE 70.—*Results from current observations near the surface, Western Long Island Sound*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
56	H. E. Finnegan	Off Matinicock Point	June 25-26, July 15-16, 1929.	1½	Pole	7	0.37	0.07	272	0.97	6.13	0.67	−1.20	46	1.14	6.29	1.11
57	J.R.Goldsborough	South of Rye Neck	June 30-July 1, 1847	1	Float	(1)	0.01	−0.71	234	1.10	6.77	0.95	0.76	77	0.90	5.65	1.38
58	F. H. Crosby	do	Nov. 11-12, 1886	1	Pole	6	1.20	0.60	232	0.60	5.84	1.21	0.92	61	0.50	6.58	2.11
59	H. E. Finnegan	Off Shootfly Island, Mamaroneck Harbor.	June 27-28, 1929	1	do	4½	−0.45	0.90	290	0.12	5.93	−0.35	−0.10	110	0.30	6.49	1.13
60	do	Hempstead Harbor (off Mott Point).	do	1	do	7	0.90	1.10	206	0.34	3.83	−1.10	−0.50	305	0.34	8.59	1.23
61	F. S. Borden	do	Sept. 7-8, 1916	1	do	7	0.25	−0.41	174	0.33	4.95	−0.67	0.54	337	0.21	7.47	1.05
62	H. E. Finnegan	do	June 28-29, 1929	1	do	7	−0.25	1.30	124	0.34	7.23	1.15	0.80	359	0.24	5.19	1.88
63	do	Hempstead Harbor (off Karatsonyis Dock).	do	¾	do	4½	0.80	0.90	(4)	0.30	4.83	−0.20	0.50	346	0.40	7.59	1.63
64	do	Hempstead Harbor (mid-channel, east of Bar Beach.)	June 28, July 15-16, 1929.	1½	do	4½	−0.10	−0.50	------	1.35	5.83	−0.10	−0.10	------	1.75	6.59	0.93
65	J.R.Goldsborough	Off Execution Rocks Light	July 3-4, 1847	1	Float	(1)	0.47	0.51	214	0.42	5.74	0.38	0.97	35	0.46	6.68	1.71
66	do	do	May 27-28, 1847	1	do	(1)	0.34	0.13	239	0.64	6.26	0.77	0.78	32	0.64	6.16	1.63
67	R. J. Auld	do	Sept. 3-4, 1920	1	Pole	7	1.17	−0.10	226	0.39	6.09	1.43	1.89	23	0.67	6.33	2.23
68	F. S. Borden	do	Aug. 29-31, 1916	2	do	7	1.82	0.38	256	0.51	4.96	0.95	1.07	62	0.49	7.46	2.19
69	H. E. Finnegan	Echo Bay	July 1-2, 1929	1	do	3½	0.70	1.85	266	0.11	5.38	0.25	0.20	110	0.17	7.04	1.88
70	do	Mid-channel, north of Davids Island.	do	1	do	7	0.90	0.75	232	0.41	6.13	1.20	0.15	50	0.51	6.29	1.88
71	do	East of Davids Island	do	1	do	7	0.90	1.40	208	0.17	5.93	1.00	−0.40	28	0.47	6.49	1.85
72	J.R.Goldsborough	Off Execution Rocks Light	May 29-30, 1847	1	Float	(1)	0.17	0.60	205	0.60	5.65	−0.01	−0.39	34	0.78	6.77	1.22
73	H. Mitchell	do	July 16-18, 1858	2	Pole	5	0.80	0.33	240	0.69	4.78	−0.25	0.65	65	1.00	7.64	1.51
74	F. H. Crosby	Off Sands Point Light	Nov. 10-11, 1886	1	do	6	2.31	1.99	------	0.56	5.70	2.18	2.86	------	0.31	6.72	3.47
75	J.R.Goldsborough	do	July 15-16, 1847	1	Float	(1)	2.00	2.23	205	0.48	4.80	0.97	2.55	16	0.87	7.62	3.07
76	H. E. Finnegan	Manhassett Bay	June 18-19, 1929	1	Pole	4½	−1.00	−0.65	141	0.67	7.73	0.90	−0.80	342	0.32	4.69	0.74
77	R. J. Auld	do	Sept. 7-8, 1920	1	do	7	−0.08	−0.20	139	0.45	5.19	−0.72	0.09	335	0.40	7.23	0.90
78	H. E. Finnegan	do	June 18-19, 1929	1	do	4½	0.95	−0.50	195	0.21	3.13	−1.75	−1.30	337	0.41	9.29	0.48
79	H. Mitchell	Off Hart Island	July 17, 1858	½	do	5	2.35	1.48	197	0.46	5.30	1.82	3.49	48	0.80	7.12	3.41
80	J.R.Goldsborough	do	July 4-5, 1847	1	Float	(1)	1.67	1.68	199	0.48	5.59	1.43	2.34	46	0.84	6.83	2.91
81	H. E. Finnegan	do	June 19-20, 1929	1	Pole	7	2.70	2.70	201	0.39	5.28	2.15	3.80	22	0.81	7.14	3.97
82	H. Mitchell	do	July 23, 1858	½	do	5	3.50	3.86	184	0.49	4.82	2.49	3.37	53	0.89	7.60	4.43
83	H. E. Finnegan	Off Hewlett Point	June 20-21, 1929	2	do	3½	1.85	2.60	227	0.54	6.43	2.45	1.12	33	0.63	5.99	3.13
84	do	Between Hart and City Islands.	do	1	do	7	2.90	2.75	181	0.46	6.48	3.55	3.25	355	0.76	5.94	4.24
85	do	Rodman Neck-City Island Bridge.	June 17-18, 1929	1	do	4½	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
86	do	East Chester Creek (Pelham Highway Bridge).	June 18-19, 1929	1	do	4½	−0.65	−0.80	(6)	1.75	6.08	−0.40	−1.05	(6)	1.05	6.34	0.41
87	do	East Chester Bay	June 13-14, 1929	1	do	4½	−0.50	0.90	268	0.22	7.23	0.90	−0.30	128	0.17	5.19	1.38
88	do	do	do	1	do	4½	0.40	−0.25	306	0.57	5.73	0.30	−0.20	118	0.45	6.69	1.19
89	H. Mitchell	Off Stepping Stones Light	July 21-24, 1858	2½	do	5	4.39	3.55	197	0.41	3.38	1.94	3.82	14	0.80	9.04	10.76
90	J.R.Goldsborough	do	Aug. 2-3, 1847	1	Float	(1)	3.43	3.80	206	0.51	5.87	2.71	3.39	33	0.85	6.55	10.67
91	E. E. Haskell	do	Sept. 3, 1890	½	Meter	(1)	2.54	2.93	251	0.62	6.06	2.77	4.31	8	0.80	6.36	10.48
92	H. E. Finnegan	Little Neck Bay	June 12-13, 1929	1	Pole	4½	1.65	−0.40	122	0.38	4.58	0.40	−0.25	320	0.73	7.84	1.48
93	R. J. Auld	do	Sept. 8-9, 1920	¾	do	7	−0.73	1.35	135	0.16	7.29	0.73	−0.71	335	0.28	5.13	1.29
94	H. E. Finnegan	do	June 12-13, 1929	1	do	4½	−1.55	0.00	148	0.37	6.73	−0.65	−1.20	336	0.37	5.69	0.28
95	H. C. Denson	Off Throgs Neck	July 30-31, 1922	1	do	7	3.82	3.44	249	0.38	4.39	2.38	4.22	78	1.03	8.03	10.80
96	R. J. Auld	do	Sept. 10-11, 1920	1	do	7	3.47	3.19	260	0.68	5.69	3.33	4.27	93	1.24	6.73	10.90
97	H. C. Denson	do	July 26-Aug. 7, 1922	11½	do	7	3.55	3.07	248	0.53	5.21	2.93	4.19	92	1.20	7.21	10.78
98	do	do	July 30-31, 1922	1	do	7	1.77	3.59	263	0.58	6.49	2.43	2.72	53	0.93	5.93	9.97
99	H. Mitchell	do	July 18-24, 1858	6	do	5	3.89	3.61	265	0.78	4.81	2.87	4.62	90	0.96	7.61	11.09
100	do	do	July 12-13, 1858	¾	do	5	2.39	2.95	316	0.55	6.58	3.14	3.94	92	1.23	5.84	10.44
101	do	do	July 18, 1858	½	do	5	4.19	2.70	276	1.19	4.63	2.99	4.84	108	1.44	7.79	11.02
102	H. E. Finnegan	do	June 24-25, 1929	1	do	7	4.65	4.00	310	0.89	3.75	2.57	4.00	130	1.99	8.67	11.14
103	do	do	do	1	do	7	4.70	3.45	286	1.49	5.38	4.25	3.80	111	1.77	7.04	11.39
104	do	do	do	1	do	7	2.15	3.35	292	1.01	7.53	3.85	2.60	106	1.01	4.89	10.33

[1] Surface.
[2] Current weak and irregular.
[3] See discussion in text on pages 128-9 regarding direction of flood at this station.
[4] Current southerly.
[5] Currents irregular at this station. See curves and text, p. 131.
[6] Flood sets northerly, ebb sets southerly.

The Coast and Geodetic Survey has observed tidal currents in western Long Island Sound from time to time since 1846. For the most part these current observations were made by means of current pole and current log line method. The current pole used in recent years by the Coast and Geodetic Survey has been a standard one, 15 feet in length and weighted at one end with sheet lead so as to float uprightly in the water with 1 foot of its length above the surface of the water. Since this pole submerges to a depth of 14 feet the results of observations may be considered as pertaining to current conditions at an average depth of about 7 feet. The remaining observations were made either with floats or common log chips at the surface of the water, or, in the case of the 1890 observations, by means of current meter near the surface. Perkins, in 1887 used a 13-foot pole which submerged about 11½ feet, while Sears and Crosby in 1886 used a pole which submerged 12 feet. Mitchell, in 1858, used a tin tube which he refers to as a "tube meter." It was a pipe 12 feet long, made of tin and so constructed as to float uprightly in the water with about 10 feet of its length submerged.

The times of slack water and of strength of flood and ebb currents at stations given in Table 70 are referred to the times of similar phases of the predicted current at The Race. Predictions for The Race are given for the times of slack water and the times and velocities of flood and ebb strengths for every day in the year in the Atlantic Coast Current Tables, published annually in advance by the Coast and Geodetic Survey. That is, The Race is a standard port to which, by means of the time differences in columns 8, 9, 13, and 14 of Table 70, subordinate stations in Long Island Sound may be referred in order to predict tidal-current conditions at such subordinate stations. In the columns of Table 70, mentioned above, the minus (−) sign means that that phase of the current at the subordinate station occurs earlier than the corresponding phase of the current at The Race. Otherwise, the current phase occurs later than that at the reference station.

Particular attention is called to the direction of flood and ebb currents in western Long Island Sound as given in the data in Table 70. For purposes of this publication only, and also for convenience in referring the times of the current at each of the 104 stations to a single standard station, namely The Race, the westerly going tidal current is considered as the flood and the easterly going tidal current as the ebb throughout Long Island Sound. Near the western end of the sound, however, these terms might properly be reversed as the westerly going current reaches its maximum strength on a falling tide, while the easterly going current reaches its maximum strength on a rising tide.

The times of the current, as well as the durations of flood and ebb at each station in Table 70, are given in hours. The durations of flood and ebb at each station have been derived from the durations of flood and ebb at the reference station by means of applying to the latter the time differences given in colums 8, 9, 13, and 14. The mean current hour in solar time in the last column of the table has been derived by application of the time differences for slack and strength of current at each station to those for similar current phases at the reference station. It shows the time of strength of flood current at each station as compared with that at The Race, the value for the latter

being 1.13 hours, or 13.55 hours. In other words, the times of strength of flood current at the various stations in the table are now made comparable one with another. For a discussion regarding the mean current hour and its derivation see page 33.

The observed velocities of the current at stations given in Table 70 have been corrected to a mean range of tide and the corrected velocities which are representative of average current conditions, are given in the table. Obviously, these velocities would be increased with increased tidal ranges and would be decreased at times of neap or apogean tides. This increase or decrease might be as much as 35 or 40 per cent from the mean velocities depending upon tidal conditions at a given time.

An inspection of the mean current hour for mid-sound stations 6, 14, 41, 52, 58, 67, and 81 in Table 70 will show that the time of current is progressively later and later from Stratford Shoal westward to Hart Island Light. This progression is slow, however, the current in the vicinity of Execution Rocks occurring about an hour later than that off Old Field Point, Long Island, and Stratford Shoal Light, the distance being about 30 nautical miles. Over the 2½-mile stretch from Execution Rocks to Hart Island Light the difference in time of current is nearly two hours.

In passing, therefore, the progression of the current through the middle of Long Island Sound may be summarized as follows: Over the stretch of eastern Long Island Sound from The Race to Stratford Shoal Light, a distance of 48 nautical miles, the current is almost simultaneous, owing to the wide expanse and good depths of the waterway. In western Long Island Sound, over the stretch from Stratford Shoal Light to Execution Rocks, a distance of 30 nautical miles, the difference in the time of current is about one hour. In this stretch of the waterway the time of current is retarded considerably by the funnel shape of the waterway which narrows rapidly from a width of about 12 nautical miles, off Bridgeport, Conn., to about 2½ nautical miles off Execution Rocks. At the same time the waterway rapidly shoals from depths of about 20 fathoms off Stratford Shoal Light, to about 7 fathoms northeast of Execution Rocks. The extremely slow progression of the current southwestward of Execution Rocks is due to considerable tidal interference in this vicinity.

It will be noted from the time differences in columns 8, 9, 13, and 14 of Table 70 and also from the data for mean current hour in the last column of the table that the current occurs much earlier in the bays and harbors along the shores of Long Island Sound than it does in mid-Sound. In some cases it will be observed that the current in these tributaries even occurs earlier than it does at The Race at the entrance to Long Island Sound. This is attributed to the fact that the various bays and harbors along the shores of the Sound must be filling most rapidly three hours before high water.

In order to test out this theory let us consider the relation of strength of flood current to local high water at the entrances to a few bays and harbors along either shore of western Long Island Sound. At random we may select station 23 in Huntington Bay, Long Island, stations 32 and 33 in Oyster Bay, Long Island, stations 60 and 61 in Hempstead Bay, Long Island, station 59 in Mamaroneck Harbor, N. Y., and station 47 in Coscob Harbor, Conn. The results from current observations at these stations show that the strength of flood current occurs earlier than local high water at each station approxi-

mately as follows: Station 23, 2.3 hours; station 32, 2.8 hours; station 33, 3.6 hours; station 60, 2.9 hours; station 61, 2.8 hours; station 59, 1.8 hours; and station 47, 3.1 hours. From these values we may conclude that the strength of flood current in these bays and harbors occurs about three hours earlier than local high water, or approximately at the time of local mean tide level. This relationship also holds true for the Thames River, off New London, Conn., as was shown above on page 65 in connection with a discussion concerning the relation of current to tide in that waterway.

It may be definitely stated that at virtually no locality in Long Island Sound does the strength of current occur simultaneously with either high or low water. This is clearly seen from a study of cotidal and cocurrent lines for this waterway. Therefore, the distinction between high water and strength of flood current should be clearly drawn, as should, likewise, that between low water and strength of ebb. The fact that the strength of flood current throughout a large area in Long Island Sound from Orient Point, Long Island, to Eaton Point, Long Island, occurs from about 1½ to 2½ hours earlier than local high water, or approximately near the time of mean tide level, is due to the character of the tide wave in Long Island Sound which is predominantly of the stationary type.

It may now be well to consider in some detail peculiar current conditions which occurred at several of the stations in 1929 when the most comprehensive current survey of this waterway was executed. In this group there may be included the following stations: 4, 20, 28, 34, 35, 36, 60, and 85.

Current station 4 was located in mid-channel, off Tongue Point, in Bridgeport Harbor. The results from continuous observations over a period of 25 hours at this station by means of current pole and current log line, as well as by current meter show that the current in this locality was very weak and irregular during the observational period. Slack water obtained for several hours before flood and ebb and maximum velocities of only 0.3 knot were observed at times of flood and ebb.

Current station 20 was located just north of a line joining Lloyd and Eaton Points, Long Island, but much nearer the latter, however, at the entrance to Huntington Bay. The current at this station has been treated as a reversing current in obtaining the data given in Table 70 for this station. However, the current at this station may be treated as a rotary type of current and the resultant curve showing the hourly directions and velocities of the current at this station as observed for a period of 2⅓ days in 1929 by means of current pole and current log line near the surface is plotted in Figure 32.

Figure 32 is a diagrammatic representation of the tidal current at station 20, entrance to Huntington Bay, Long Island Sound, from observations made near the surface. The time of current has been referred to the times of high and low water at New London, Conn. Strength of flood current occurs about 2¼ hours earlier than the time of high water at New London and sets about S. 55° W. (true) with a velocity of about 0.40 knot. Minimum velocities before ebb and flood occur, respectively, about one hour after the times of high and low water at New London with velocities of about 0.10 knot. At times of minimum velocity before ebb and flood at this station the current sets northwesterly and southeasterly, respectively. It should be noted in this connection that the current is somewhat rotary in character at

every current station, but it is particularly so at offshore stations. It is unusual, however, to find it in inland waterways to so marked a degree as it is found at this station, where the minimum velocity of the current is approximately one-fourth as great as the maximum. Reference to Figure 7, showing the rotary type of current at Cornfield Point Lightship in eastern Long Island Sound, will show that the ratio of minimum to maximum current at this lightship station is about 1:13½. In other words, the current at Cornfield Point Lightship is considerably more of the reversing type than that at station 20, at Huntington Bay entrance.

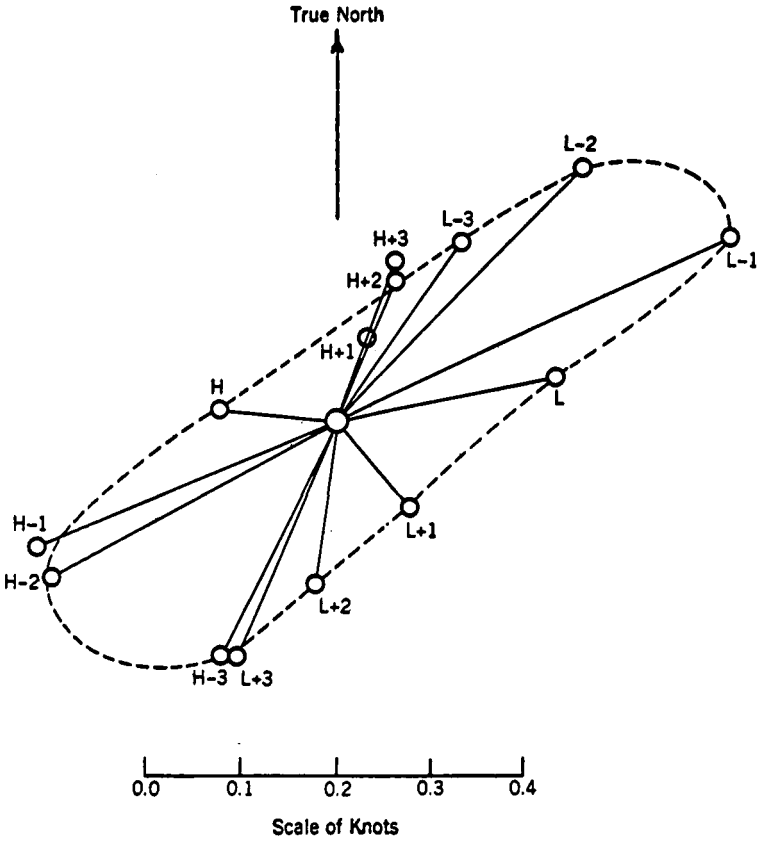

FIGURE 32.—Current ellipse from nonharmonic tabulation showing results from observations by means of current pole and current log line at a depth of 7 feet, station 20, entrance to Huntington, Bay, Long Island

Pettersson current-meter observations were also made at station 20 at a depth of 18 feet. The results from observations with this meter show a rotary subsurface current and such results have been shown diagrammatically in Figure 33.

In Figure 33 the time of current is referred to the time of tide at New London, Conn., as was the case with Figure 32. In both of these figures the true directions and observed velocities of the current are shown with reference to the hourly stages of the tide at New

London, "H" meaning high water, "L" meaning low water, the plus (+) sign meaning "later than," and the minus (−) sign meaning "earlier than" the time of high or low water at the reference station. For instance, as shown in Figures 32 and 33, the current at station 20 is running southerly two hours after the time of low water at New London, Conn., with a velocity of about 0.15 knot. One hour before low water at the reference station it is running northeasterly with a velocity of about 0.45 knot.

A comparison of Figures 32 and 33 is interesting in that it shows a lag in the change of the subsurface current direction at the middle depth at this station as compared with that near the surface. This appears to be characteristic of subsurface tidal current directions and is most likely due to the effects of increased friction upon moving particles of water in layers nearer the bottom. From Figure 33 it is

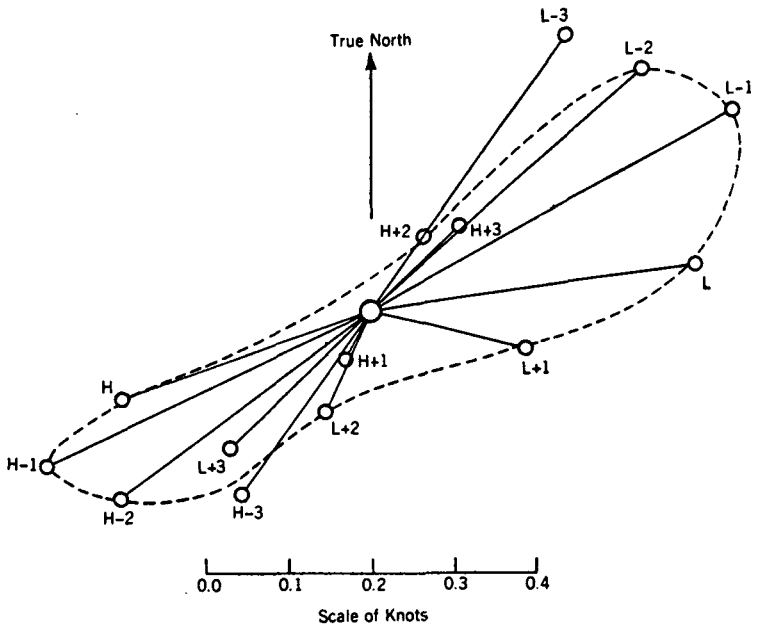

FIGURE 33.—Current ellipse from nonharmonic tabulation showing results from observations by means of Pettersson current meter at a depth of 18 feet, station 20, entrance to Huntington Bay, Long Island

found that the strength of flood current occurs about 1½ hours earlier than the time of high water at New London and sets about S. 55° W. (true) with a velocity of about 0.45 knot.

Nontidal sets at this station, obviously due to effect of northwesterly and westerly winds were observed as follows: 7-foot depth, 0.1 knot, S. 50° E. (true); 18-foot depth, 0.2 knot, S. 20° E. (true). The former was obtained from observations made by means of current pole and current log line, while the latter was derived from Pettersson meter observations.

Current station 28 was located in mid-channel in Northport Bay, about one-fourth mile south of Duck Island Bluff. The unusual feature connected with current conditions at this station concerns itself with the direction of the flood tidal current. It will be noted

from the data in Table 70 that the flood direction listed is N. 7° E. (true). This value is the average of two observed directions of the current at times of flood strength over the 25-hour period of observations at this station and needs further explanation.

It will be noted from the data for station 28 in Table 70 that the duration of flood at this station is about 5¾ hours. The average of the half-hourly flood current directions observed at this station show that for the first 2 to 2½ hours of the flood the current sets N. 66° E. (true) or toward the southern end of Asharoken Beach. For the balance of the flood duration, the observed half-hourly directions very from N. 30° W. (true) to N. 17° E. (true) and the average set of the current during the latter part of the flood is about N. 8° W. (true), or toward the entrance to Duck Island Harbor.

The conclusion from the results obtained from observations at station 28 is that the flood current in this vicinity first fills up the eastern portion of Northport Bay from Asharoken Beach to Northport. On the last half of the flood, after Northport Bay has been filled with water and the level of the water has been raised in the bay proper, the current sets toward Duck Island Harbor. The average direction of ebb at this station is about N. 75° W. (true) and none of the half-hourly observed current directions on the ebb vary more than 30° from this mean value. There is, therefore, no unusual feature regarding the direction of ebb at this station. It is very likely that the discharge of water on the ebb from Duck Island Harbor would not be experienced at current station 28.

Current stations 34 and 35 were located in Cold Spring Harbor, a tributary of Oyster Bay. At both stations strong southerly winds greatly interfered with the velocity and direction of the flood during the 25-hour period of observations, resulting in virtually slack-water periods of six hours' duration when flood would have occurred under normal weather conditions. The flood current at these stations, setting southerly, was often completely masked by being counterbalanced by the nontidal northerly set produced by wind effect.

Cold Spring Harbor is a small tidal basin, and, in a case where such condition obtains that the basin is not so extensive as to show considerable differences in the time of tide in different parts of the basin, a simple formula for the strength of tidal current through the entrance to the basin can be easily derived from the area of the basin and the range of the tide. When the area of the tidal basin is practically the same at high water as at low water and the width at the entrance does not change materially, the formula for strength of surface current through the center of the channel may be expressed as follows:

$$V=\frac{0.000187\ A\ r}{a(2c+r)}$$

In the application of this formula to derive the velocity of the tidal current at the entrance to a tidal basin, numerical values may be substituted for the terms in the formula, as follows: A=area of the basin, or 37,000,000 square feet; r=mean range of tide in the basin, or 7.4 feet; a=width of entrance to the basin, or 4,680 feet; and c=mean depth of entrance from low water, or 14.55 feet. Substituting these values in the above formula, a velocity of 0.30 foot per second,

or 0.18 knot is derived for the average velocity of the tidal current at the entrance to Cold Spring Harbor. Since there is not much change in width or depth at current stations 34 and 35 from that which obtains at the entrance to the harbor it is reasonable to expect that average velocities at the above-mentioned current stations should approximate 0.2 knot. The results in Table 70 for these current stations evidently bear out this conclusion.

In this connection it should be borne in mind that a 10-mile-per-hour wind produces a nontidal current of about 0.2 knot which sets about 20° to the right of the direction in which the wind is blowing, while a 20-mile-per-hour wind produces a nontidal current of about 0.3 knot. The record of current observations at station 34 shows that a continuous south-southwest wind varying in strength from 2 to 30 miles per hour and averaging about 17 miles per hour obtained throughout the first 22 hours of the 25-hour observational period. This condition would produce a northerly nontidal set of about 0.25 knot and completely mask the flood. Therefore flood would not occur and the ebb tidal current would be increased above that which would obtain normally. The results for station 34 are therefore explained when the effect of the wind upon the tidal current is taken into consideration. Actually, instead of flood occurring at this station slack-water periods of several hours' duration were observed.

Station 36 was located in the channel about 350 yards southeasterly from Plum Point at the entrance to Oyster Bay Harbor. There is nothing unusual in the observations at this station itself, but the following note by the officer in charge of the observing party regarding general current conditions in this vicinity is of value to local navigators. He states that—

> Each time the launch swung, when the current changed from ebb to flood, and vice versa, it swung around through the north, and there was a slight current setting to the northward. People living in this locality report that the current continues to flood close to the shore line south of Plum Point after the current has started to ebb in the channel, and that, on the other hand, it continues to ebb on the Cove Point side after slack water in the channel. Pulling boats take advantage of this. There is a very noticeable eddy in the bight just west of Plum Point.

The results from observations at current stations 37 and 38 appear to bear out the above deductions, for an unusually long ebb duration of 9.84 hours obtained at station 37 as compared with a flood duration of but 2.58 hours, with the ebb strength about twice as great as that of flood strength. On the other hand, at station 38 (see fig. 30) a flood duration of 6.73 hours obtained as compared with an ebb duration of 5.69 hours, and the observed flood strength was about twice as great as that of ebb strength. Attention is also called to the unusually long ebb and flood durations in Table 70 for stations 39 and 40, respectively, located in Oyster Bay Harbor west of Soper Point, Center Island.

Current station 60 was located about 125 yards off Glen Cove Breakwater Light at the entrance to Hempstead Harbor. The unusually long ebb duration of 8.59 hours observed near the surface at this station was most likely due to the effect of a continued southerly wind, averaging about 10 miles per hour, which obtained during the observational period of 25 hours. The data for this station derived from observations at various depths, as given in the follow-

ing table, will show that from the mid depth to the bottom the duration of flood greatly exceeds that of ebb, while near the bottom the velocity of flood is considerably greater than that of ebb. This shows rather conclusively the effect of the southerly wind upon the surface current at this station.

Current station 85 in western Long Island Sound was located at City Island Bridge connecting City Island with Rodman Neck. Observations were made in the channel east of the draw span. The current at this station is exceedingly irregular and does not lend itself to tabulation in the usual manner of treating reversing, or rectilinear, tidal currents. Therefore, the current curves derived by plotting the

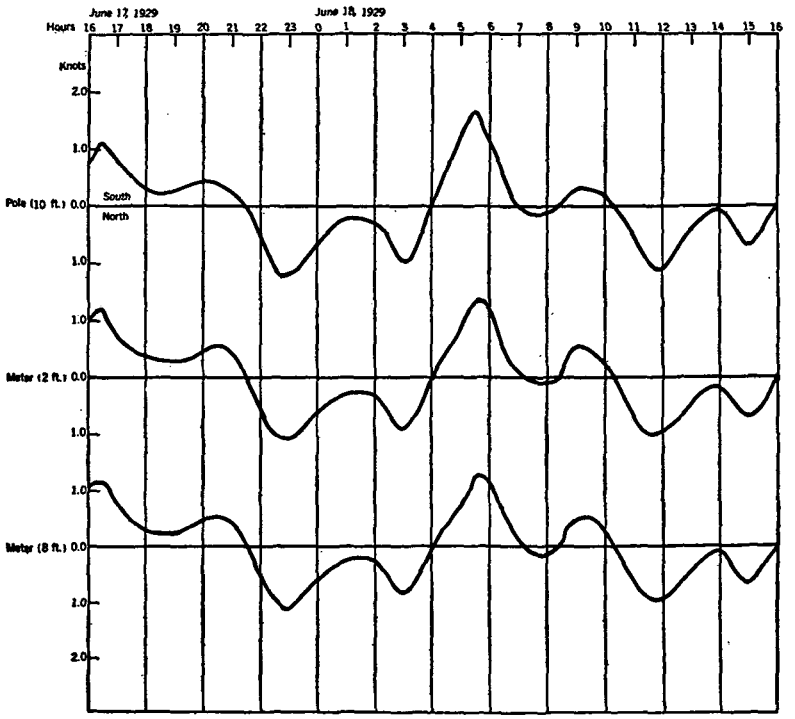

FIGURE 34.—Current curves, station 85, City Island Bridge

observed velocities obtained by current pole and current log line near the surface and also by means of current meter at depths of 2 feet and 8 feet are shown in Figure 34.

It will be noted from the curves in Figure 34 that maximum, minimum, and secondary maximum velocities occurred during the 25-hour observational period, June 17–18, 1929, on both flood and ebb, the inequalities in maximum and minimum flood strengths being somewhat greater than those in the maximum and minimum ebb strengths. There is no doubt, however, that current conditions at this station vary considerably from day to day, and that the current velocities, directions, and times of occurrence depend upon changes in the level of the waters in the areas surrounding City Island.

TABLE 71.—*Results from current observations at various depths, Western Long Island Sound*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	P. M. Trueblood	Off Point No Point	Aug. 15-16, 1917	1	Pole	7	−0.63	−0.72	256	1.37	6.73	0.27	−0.03	95	1.27	5.69	0.85
				1	Meter	6	−0.47	−0.87		1.38	6.52	0.22	−0.13		1.43	5.90	0.82
				1	do	12	−0.43	−0.92		1.11	5.88	−0.38	−0.33		1.31	6.54	0.61
				1	do	18	−0.37	−0.72		0.99	5.77	−0.43	0.07		0.94	6.65	0.77
4	H. E. Finnegan	North of Tongue Point, Bridgeport Harbor.	July 17-19, 1929	1½	Pole	7	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
				1½	Meter	7											
				1½	do	10											
				1½	do	16											
5	E. E. Haskell	Off Penfield Reef	Sept. 5-6, 1890	½	do	(2)	0.05	−0.27	261	0.68	7.47	1.69	1.33	29	0.74	4.95	1.85
				½	do	31	0.27	−0.47	266	0.72	5.63	0.07	−0.38	49	0.81	6.79	1.00
				½	do	62	−1.13	−0.37	280	0.59	6.13	−0.83	0.12	34	0.74	6.29	0.58
6	do	North of Smithtown Bay	Aug. 5, 22, 1890	½	do	(2)	0.77	0.73	293	0.79	4.81	−0.25				7.61	1.40
				½	do	48	0.72	0.38	267	1.02	4.98	−0.13				7.44	1.51
				½	do	96	−0.63	−0.32	272	1.03	6.18	−0.28				6.24	0.78
7	H. E. Finnegan	Off Crane Neck Point	July 16-17, 1929	1	Pole	7	−0.85	−1.60	256	1.30	4.98	−1.70	−1.65	16	1.44	7.44	12.10
				1	Meter	7	−0.80	−1.60		1.23	4.88	−1.75	−1.60		1.43	7.54	12.11
				1	do	12	−0.80	−1.45		1.24	4.98	−1.65	−1.85		1.50	7.44	12.11
				1	do	20	−0.90	−1.35		1.03	5.03	−1.70	−1.45		1.20	7.39	12.20
8	do	Smithtown Bay	do	1	Pole	7	0.10	0.65	256	0.26	6.78	1.05	0.15	62	0.29	5.64	1.62
				1	Meter	7	0.00	0.55		0.26	6.93	1.10	0.35		0.26	5.49	1.63
				1	do.[3]	12	−0.45	−0.30	263	0.25	7.63	1.35	−0.05	69	0.15	4.79	1.27
				1	do	13	0.10	0.55		0.26	7.13	1.40	0.45		0.24	5.29	1.75
				1	do	21	−0.25	−0.25		0.21	7.28	1.20	−0.45		0.21	5.14	1.19
11	do	Midchannel, Saugatuck River	July 12-13, 1929	1	Pole	3½	0.05	−1.15	313	0.22	4.58	−1.20	1.05	139	0.27	7.84	0.82
				1	Meter	7	−0.05	−1.10		0.33	4.78	−1.10	1.00		0.28	7.64	0.82
				1	do	12	−0.15	−1.10		0.27	4.78	−1.20	0.35		0.22	7.64	0.61
12	do	Off Gregory Point, Norwalk River.	do	1⅙	Pole	7	−0.43	−0.50	322	0.66	6.21	−0.05	−0.40	146	0.64	6.21	0.79
				1⅙	Meter	7	−0.40	−0.40		0.66	6.33	0.10	−0.40		0.61	6.09	0.85
				1⅙	do	12	−0.40	−0.40		0.63	6.28	0.05	−0.70		0.57	6.14	0.77
13	E. E. Haskell	North of Eaton Point	Aug. 19, 1890	½	do	(2)	0.44	−0.10	286	1.81	5.59	0.20	0.08	34	1.57	6.83	1.29
				½	do	32	0.97	0.43	273	1.79	6.03	1.17	0.92	17	1.37	6.39	2.00
				½	do	64	0.97	0.33	269	1.59	5.73	0.87	0.62	15	1.35	6.69	1.83
16	do	South of Greens Ledge Light	Sept. 8, 1890	½	Meter	(2)	0.70	0.67	274	0.63	5.50	0.37	−0.34	11	0.51	6.92	1.48
				½	do	45	0.17	0.03	264	0.70	6.33	0.67	0.92	8	0.56	6.09	1.58
				½	do	90	0.87	0.13	255	0.60	5.43	0.47	0.92	331	0.52	6.99	1.73
20	H. E. Finnegan	Entrance to Huntington Bay	Aug. 13-16, 1929	2½	Pole	7	−1.40	−1.46	221	0.54	6.25	−0.98	−0.48	71	0.65	6.17	0.06
				2½	Meter	7	−1.40	−1.98		0.57	6.03	−1.20	−0.95		0.72	6.39	−0.25
				2½	do	18	−0.82	−1.04		0.57	5.65	−1.00	−0.57		0.66	6.77	0.27
				2½	do.[3]	18	−0.85	−1.16	212	0.71	6.83	0.15	−0.40	81	0.72	5.59	0.57
				2½	do	28	−1.08	−0.90		0.52	6.03	−0.88	−0.75		0.56	6.39	0.23
22	do	Huntington Bay (east side)	July 8-9, 1929	1	Pole	7	−0.65	0.20	179	0.54	5.98	−0.50	−0.90	10	0.52	6.44	0.67
				1	Meter	7	−0.45	0.40		0.42	5.78	−0.50	−1.10		0.57	6.64	0.72
				1	do	12	−0.40	0.30		0.45	5.88	−0.35	−0.90		0.53	6.54	0.79
				1	do	20	−0.45	0.55		0.43	5.88	−0.40	−0.80		0.30	6.54	0.85
23	do	Huntington Bay (mid-channel)	July 8-11, 1929	2¾	Pole	7	0.92	0.38	178	0.39	4.87	−0.04	0.62	20	0.58	7.55	1.60
				2¾	Meter	7	0.98	0.20		0.44	4.75	−0.10	0.70		0.64	7.67	1.57
				2¾	do	17	0.88	0.22		0.54	4.95	0.00	0.82		0.51	7.47	1.61
				2¾	do	27	0.82	−0.12		0.51	5.03	0.02	0.88		0.36	7.39	1.53
24	do	Huntington Bay (west side)	July 8-9, 1929	1	Pole	7	0.15	0.00	180	0.52	5.53	−0.15	−0.15	358	0.57	6.89	1.09
				1	Meter	7	0.30	0.00		0.53	5.48	−0.05	0.00		0.66	6.94	1.19
				1	do	12	0.10	−0.10		0.54	5.78	0.05	−0.50		0.57	6.64	1.02
				1	do	20	0.00	−0.10		0.45	5.98	0.15	−0.80		0.45	6.44	0.94
25	do	Lloyd Harbor	July 9-10, 1929	1	Pole	5	−0.20	−0.15	267	0.25	5.13	−0.90	0.05	81	0.37	7.29	0.83
				1	Meter	7	−0.25	−0.20		0.36	5.33	−0.75	−0.25		0.46	7.09	0.77
				1	do	11	−0.30	−0.25		0.35	5.43	−0.70	−0.35		0.32	6.99	0.73
27	do	Entrance to Northport Bay	July 9-11, 1929	1½	Pole	7	−0.13	−0.50	82	1.20	5.71	−0.25	0.25	250	1.95	6.71	0.97
				1½	Meter	7	−0.10	−0.50		1.18	5.60	−0.33	0.35		1.88	6.82	0.99
				1½	do	15	−0.03	−0.37		1.17	5.53	−0.33	0.30		1.98	6.89	1.02
				1½	do.[3]	15	−0.13	−0.47	140	1.15	5.79	−0.17	0.30	266	1.85	6.63	1.01
				1½	do	24	−0.03	−0.60		1.12	5.49	−0.37	0.25		1.72	6.93	0.94
28	do	South of Duck Island Bluff, Northport Bay.	July 9-10, 1929	1	Pole	7	0.15	0.65	47	0.39	5.78	0.10	−0.55	286	0.29	6.64	1.22
				1	Meter	7	0.55	0.70		0.38	5.28	0.00	−0.35		0.36	7.14	1.35
				1	do	12	0.65	0.90		0.39	5.48	0.30	0.25		0.32	6.94	1.65
				1	do	20	0.65	0.80		0.32	5.53	0.35	0.85		0.25	6.89	1.79
31	do	Oyster Bay (off Center Island)	July 2-3, 1929	1	Pole	4½	−0.35	0.00	146	0.76	6.48	0.30	0.25	348	0.66	5.94	1.18
				1	Meter	5	−0.40	0.00		0.79	6.28	0.05	−0.05		0.76	6.14	1.03
				1	do	8	−0.50	0.05		0.71	6.58	0.25	0.00		0.71	5.84	1.08

See footnotes at end of table.

TABLE 71.—*Results from current observations at various depths, Western Long Island Sound*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
32	H. E. Finnegan	Oyster Bay (off Whitewood Point).	July 2-5, 1929	3⅙	Pole	7	0.22	0.07	114	0.52	5.65	0.04	0.42	318	0.64	6.77	1.32
				3⅙	Meter	14	0.30	0.23		0.51	5.61	0.08	0.50		0.64	6.81	1.41
				3⅙	do	35	0.23	0.25		0.45	5.73	0.13	0.43		0.66	6.69	1.39
				3⅙	do	56	0.08	0.38		0.39	5.87	0.12	0.36		0.53	6.55	1.37
34	do	Cold Spring Harbor (east side).	July 4-5, 1929	1	Pole	4½	−1.25	−0.70	(4)	(4)	6.68	−0.40	−1.35	26	0.30	5.74	0.21
				1	Meter	7	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
				1	do	12											
35	do	Cold Spring Harbor (west side).	July 3-4, 1929	1	Pole	4½	−0.85	−0.55	165	0.28	5.48	−1.20	−0.95	10	0.20	6.94	0.24
				1	Meter	7	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
				1	do	12											
37	do	Oyster Bay Harbor (west of Cove Point).	do	1	Pole	7	0.85	−0.45	134	0.33	2.58	−2.40	0.80	14	0.60	9.84	0.83
				1	Meter	8	0.90	−0.30		0.37	2.43	−2.50	0.40		0.75	9.99	0.75
				1	do	20	0.70	−0.30		0.35	2.83	−2.30	0.10		0.70	9.59	0.68
				1	do	32	0.50	−0.65		0.40	2.93	−2.40	0.95		0.67	9.49	0.73
38	do	do	July 2-3, 1929	1	Pole	7	0.35	1.10	188	0.65	6.73	1.25	0.90	6	0.35	5.69	2.03
				1	Meter	7	0.55	1.10		0.66	6.48	1.20	0.70		0.46	5.94	2.02
				1	do	18	−0.30	0.90		0.65	7.18	1.05	−0.15		0.40	5.24	1.51
				1	do	28	−0.70	0.90		0.65	7.33	0.80	−0.35		0.32	5.09	1.29
39	do	Oyster Bay Harbor (west of Soper Point).	July 3-4, 1929	1	Pole	7	−0.10	−0.55	326	0.56	4.18	−1.75	−0.10	146	0.64	8.24	0.51
				1	Meter	7	0.10	−0.80		0.79	4.03	−1.70	−0.20		0.49	8.39	0.48
				1	do	13	0.10	−0.70		0.76	3.93	−1.80	−0.20		0.49	8.49	0.48
40	do	do	July 4-5, 1929	1	Pole	7	0.85	1.25	341	0.40	6.58	1.60	0.80	134	0.23	5.84	2.25
				1	Meter	7	0.60	1.40		0.46	6.88	1.65	0.70		0.34	5.54	2.22
				1	do	15	0.65	1.30		0.44	6.98	1.80	0.75		0.32	5.44	2.25
				1	do	24	0.50	1.20		0.40	7.13	1.80	0.75		0.25	5.29	2.19
42	E. E. Haskell	South of Shippan Point	Sept. 8-9, 1890	½	do	(3)	0.12	0.00	263	0.85	5.45	−0.26	−0.67	15	0.61	6.97	0.93
				½	do	46	−0.03	−0.07	273	0.77	6.03	0.17				6.39	1.21
				½	do	68	−0.03	−0.27	266	0.77	5.73	−0.13				6.69	1.05
43	H. E. Finnegan	Stamford Harbor (off Cook Point).	July 11-12, 1929	1	Pole	4	−0.15	−0.70	334	0.16	6.78	0.80	0.25	173	0.19	5.64	1.18
				1	Meter	7	−0.15	−0.55		0.19	7.13	1.15	0.45		0.13	5.29	1.35
44	do	Stamford Harbor (East Branch Ship Canal).	do	1	Pole	4½	−0.05	0.50	19	0.26	6.08	0.20	−0.70	211	0.13	6.34	1.12
				1	Meter	6	−0.40	−0.40		0.42	6.78	0.55	−0.35		0.24	5.64	0.98
				1	do	10	−1.05	−0.35		0.37	7.13	0.25	−0.30		0.27	5.29	0.77
46	do	Entrance to Captain Harbor	do	1	Pole	7	0.25	−0.50	304	0.75	5.28	−0.30	−0.95	106	0.78	7.14	0.75
				1	Meter	8	0.25	−0.60		0.72	5.43	−0.15	−0.95		0.85	6.99	0.77
				1	do	20	0.25	−0.60		0.70	5.28	−0.30	−0.75		0.75	7.14	0.78
				1	do [8]	20	−0.20	−0.65		0.72	4.93	−1.10	−0.80		0.82	7.49	0.44
				1	do	32	−0.05	−0.85		0.65	5.33	−0.55	−0.60		0.68	7.09	0.62
47	do	Off Goose Island, Coscob Harbor.	do	1	Pole	3½	0.05	−0.35	13	0.41	5.68	−0.10	−0.50	188	0.39	6.74	0.91
				1	Meter	7	0.25	−0.20		0.53	5.68	0.10	−1.10		0.39	6.74	0.89
				1	do	10	0.30	0.00		0.51	5.73	0.20	−1.15		0.41	6.69	0.97
49	do	Off Parsonage Point	June 25-27, 1929	1½	Pole	7	0.47	0.00	195	0.48	6.13	0.77	0.40	54	0.50	6.29	1.54
				1½	Meter	8	0.57	0.03		0.61	6.06	0.80	0.20		0.51	6.36	1.53
				1½	do	20	0.63	−0.07		0.59	5.97	0.77	−0.20		0.58	6.45	1.41
				1½	do	32	0.63	0.13		0.54	5.90	0.70	−0.25		0.54	6.52	1.43
50	E. E. Haskell	Off Matinicock Point	Aug. 14-15, 1890	1	do	(3)	1.47	0.90	293	0.53	5.30	0.94	1.06	39	0.65	7.12	2.22
				1	do	29	0.95	0.73	303	1.31	6.44	1.56	1.32	11	1.31	5.98	2.27
				1	do	58	0.40	0.23	304	1.23	6.54	1.11	0.82	2	0.89	5.88	1.77
52	H. E. Finnegan	do	June 25-29, July 15-16, 1929.	5	Pole	7	1.44	1.10	236	0.51	5.05	0.66	0.50	58	0.73	7.37	2.05
				5	Meter	12	1.49	1.05		0.49	5.10	0.76	0.66		0.66	7.32	2.12
				5	do	30	1.21	0.53		0.66	5.48	0.86	0.12		0.43	6.94	1.81
				5	do	48	1.18	0.57		0.50	5.43	0.78	0.04		0.40	6.99	1.77
53	E. E. Haskell	do	Aug. 7-8, 13-14, 1890	1½	do	(3)	0.55	0.13	272	0.77	6.55	1.27	1.46	30	0.61	5.87	1.98
				1½	do	28	1.27	0.63	299	0.72	5.64	1.08	0.29		0.70	6.78	1.95
				1½	do	56	0.83	0.23	300	0.73	5.68	0.68	0.02		0.60	6.74	1.57
54	H. E. Finnegan	do	June 26-27, 1929	1	Pole	7	0.90	0.90	262	0.52	5.48	0.55	0.10	60	0.79	6.94	1.74
				1	Meter	8	0.93	0.80		0.60	5.40	0.50	0.00		0.96	7.02	1.69
				1	do	20	0.33	0.00		0.84	5.40	−0.10	−0.15		0.81	7.02	1.15
				1	do	32	−0.07	0.20		0.78	5.50	−0.40	−0.65		0.76	6.92	0.90
56	do	do	June 25-26, July 15-16, 1929.	1½	Pole	7	0.37	0.07	272	0.97	6.13	0.67	−1.20	46	1.14	6.29	1.11
				1½	Meter	8	0.47	0.10		1.01	5.99	0.63	−1.25		1.20	6.43	1.12
				1½	do	20	0.43	0.03		0.90	5.80	0.40	−1.20		1.08	6.62	1.05
				1½	do	32	0.20	−0.07		0.81	5.96	0.33	−1.25		0.74	6.46	0.93
59	do	Off Shootfly Island, Mamaroneck Harbor.	June 27-28, 1929	1	Pole	4½	−0.45	0.90	290	0.12	5.93	−0.35	−0.10	110	0.30	6.49	1.13
				1	Meter	5	−0.45	1.05		0.39	6.03	−0.25	−0.15		0.36	6.39	1.18
				1	do	8	−0.45	1.05		0.33	6.03	−0.25	−0.15		0.31	6.39	1.18

See footnotes at end of table.

TABLE 71.—*Results from current observations at various depths, Western Long Island Sound*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
60	H. E. Finnegan	Hempstead Harbor (off Mott Point).	June 27-28, 1929	1	Pole	7	0.90	1.10	206	0.34	3.83	−1.10	−0.50	305	0.34	8.59	1.23
				1	Meter	6	0.90	1.10		0.35	3.88	−1.05	−0.40		0.55	8.54	1.27
				1	do	15	−1.80	−0.80		0.50	6.93	−0.70	−0.85		0.40	5.49	0.09
				1	do	24	−2.25	−0.95		0.45	7.68	−0.40	−1.00		0.35	4.74	−0.02
62	do	do	June 28-29, 1929	1	Pole	7	−0.25	1.30	124	0.34	7.23	1.15	0.80	359	0.24	5.19	1.88
				1	Meter	6	−0.50	1.30		0.34	7.28	0.95	0.80		0.34	5.14	1.77
				1	do	15	−0.65	1.30		0.34	7.38	0.90	0.75		0.34	5.04	1.71
				1	do	24	−0.60	1.30		0.13	7.28	0.85	0.75		0.33	5.14	1.71
63	do	Hempstead Harbor (off Karatsonyis Dock).	do	¾	Pole	4½	0.80	0.90	(3)	0.30	4.83	−0.20	0.50	346	0.40	7.59	1.63
				¾	Meter	6	0.80	0.90		0.45	4.53	−0.50	0.90		0.85	7.89	1.65
				¾	do	10	0.80	1.10		0.44	4.53	−0.50	0.90		0.77	7.89	1.71
64	do	Hempstead Harbor (mid-channel, east of Bar Beach).	June 28, July 15-16, 1929.	1½	Pole	4½	−0.10	−0.50		1.35	5.83	−0.10	−0.10		1.75	6.59	0.93
				1½	Meter	6	−0.15	−0.40		1.59	5.98	0.00	−0.25		2.07	6.44	0.93
				1½	do	10	−0.10	−0.45		1.37	5.98	0.05	−0.25		1.99	6.44	0.94
67	R. J. Auld	Off Execution Rocks Light	Sept. 3-4, 1920	1	Pole	7	1.17	−0.10	226	0.39	6.09	1.43	1.89	23	0.67	6.33	2.23
				1	Meter	15	1.10	0.27		0.66	6.23	1.50	1.16		0.81	6.19	2.14
				1	do	38	0.50	−0.03		0.66	6.34	1.01	1.02		0.76	6.08	1.75
				1	do	60	0.87	−0.20		0.66	5.69	0.73	0.79		0.66	6.73	1.68
69	H. E. Finnegan	Echo Bay	July 1-2, 1929	1	Pole	3½	0.70	1.85	266	0.11	5.38	0.25	0.20	110	0.17	7.04	1.88
				1	Meter	6	0.70	1.45		0.21	5.48	0.35	0.20		0.26	6.94	1.81
				1	do	10	0.40	1.30		0.16	5.78	0.35	0.00		0.19	6.64	1.64
				1	do	16	0.10	1.10		0.19	5.83	0.10	−0.30		0.23	6.59	1.38
70	do	Mid-channel, north of Davids Island.	do	1	Pole	7	0.90	0.75	232	0.41	6.13	1.20	0.15	50	0.51	6.29	1.88
				1	Meter	7	0.95	0.80		0.45	5.98	1.10	0.35		0.61	6.44	1.93
				1	do	18	0.60	0.70		0.45	6.28	1.05	0.10		0.55	6.14	1.74
				1	do	29	0.50	0.65		0.45	6.38	1.05	0.15		0.51	6.04	1.72
71	do	East of Davids Island	do	1	Pole	7	0.90	1.40	208	0.17	5.93	1.00	−0.40	28	0.47	6.49	1.85
				1	Meter	7	0.90	1.40		0.27	6.03	1.10	−0.35		0.40	6.39	1.89
				1	do	16	0.80	1.35		0.27	6.08	1.05	−0.45		0.37	6.34	1.82
76	do	Manhasset Bay	June 18-19, 1929	1	Pole	4½	−1.00	−0.65	141	0.67	7.73	0.90	−0.80	342	0.32	4.69	0.74
				1	Meter	4	−1.20	−0.65		0.77	8.08	1.05	−0.70		0.37	4.34	0.75
				1	do	11	−1.05	−0.60		0.62	7.73	0.85	−0.65		0.44	4.69	0.77
				1	do	17	−1.20	−0.80		0.41	8.13	1.10	−1.00		0.31	4.29	0.65
77	R. J. Auld	do	Sept. 7-8, 1920	1	Pole	7	−0.08	−0.20	139	0.45	5.19	−0.72	0.09	335	0.40	7.23	0.90
				1	Meter	4	−0.21	−0.13		0.60	5.29	−0.75	−0.79		0.40	7.13	0.66
				1	do	10	−0.40	−0.27		0.55	5.29	−0.94	−0.83		0.35	7.13	0.52
				1	do	16	−0.48	−0.20		0.50	5.39	−0.92	−1.16		0.35	7.03	0.44
78	H. E. Finnegan	do	June 18-19, 1929	1	Pole	4½	0.95	−0.50	195	0.21	3.13	−1.75	−1.30	337	0.41	9.29	0.48
				1	Meter	3	0.75	−0.40		0.21	3.48	−1.60	−1.25		0.31	8.94	0.51
				1	do	10	0.60	−0.60		0.21	3.58	−1.65	−1.55		0.26	8.84	0.33
81	do	Off Hart Island	June 19-20, 1929	1	Pole	7	2.70	2.70	201	0.39	5.28	2.15	3.80	22	0.81	7.14	3.97
				1	Meter	22	2.60	2.30		0.51	5.38	2.15	3.50		0.81	7.04	3.77
				1	do	55	2.30	2.40		0.61	5.43	1.90	3.50		0.61	6.99	3.65
				1	do	80	2.30	1.80		0.71	5.18	1.65	3.80		0.51	7.24	3.52
83	do	Off Hewlett Point	June 20-21, 1929	2	Pole	3½	1.85	2.60	227	0.54	6.43	2.45	1.12	33	0.63	5.99	3.13
				2	Meter	9	2.10	2.77		0.53	6.33	2.60	1.88		0.63	6.09	3.47
				2	do	22	1.98	2.67		0.48	6.55	2.70	2.02		0.61	5.87	3.47
				2	do	36	1.90	1.80		0.33	6.43	2.50	1.60		0.57	5.99	3.08
84	do	Between Hart and City Islands.	do	1	Pole	7	2.90	2.75	181	0.46	6.48	3.55	3.25	355	0.76	5.94	4.24
				1	Meter	5	2.95	2.80		0.61	6.38	3.50	3.25		0.71	6.04	4.26
				1	do	12	2.55	2.65		0.51	6.48	3.20	3.45		0.56	5.94	4.09
				1	do	19	2.50	2.85		0.50	6.53	3.20	3.50		0.50	5.89	4.14
85	do	Rodman Neck-City Island Bridge.	June 17-18, 1929	1	Pole	4½	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
				1	Meter	2											
				1	do	8											
86	do	East Chester Creek (Pelham Highway Bridge).	June 18-19, 1929	1	Pole	4½	−0.65	−0.80	(7)	1.75	6.08	−0.40	−1.05	(7)	1.05	6.34	0.41
				1	Meter	3	−0.70	−0.90		1.60	6.08	−0.45	−1.15		1.10	6.34	0.33
				1	do	11	−0.85	−0.55		1.29	6.23	−0.45	−1.25		0.94	6.19	0.35
87	do	East Chester Bay	June 13-14, 1929	1	Pole	4½	−0.50	0.90	268	0.22	7.23	0.90	−0.30	128	0.17	5.19	1.38
				1	Meter	2	−0.30	1.00		0.33	7.13	1.00	−0.45		0.28	5.29	1.44
				1	do	8	−0.40	1.00		0.33	7.03	0.80	−0.50		0.28	5.39	1.35
88	do	do	do	1	Pole	4½	0.40	−0.25	300	0.57	5.73	0.30	−0.20	118	0.45	6.69	1.19
				1	Meter	5	0.50	−0.40		0.60	5.83	0.50	−0.30		0.45	6.59	1.21
				1	do	10	0.45	−0.40		0.50	5.63	0.25	−0.55		0.45	6.79	1.07
91	E. E. Haskell	Off Stepping Stones Light	Sept. 3, 1890	½	do	(5)	2.54	2.93	251	0.62	6.06	2.77	4.31	8	0.80	6.36	10.48
				½	do	25	2.20	1.83	267	0.74	6.23	2.56	4.32	357	0.74	6.19	10.07
				½	do	50	2.10	1.63	253	0.55	6.03	2.66	4.72	320	0.55	6.39	10.12

See footnotes at end of table.

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TABLE 71.—*Results from current observations at various depths, western Long Island Sound*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
92	H. E. Finnegan	Little Neck Bay	June 12-13, 1929	1	Pole	4½	1.65	−0.40	122	0.38	4.58	0.40	−0.25	320	0.73	7.84	1.48
				1	Meter	6	1.50	−0.35		0.43	4.63	0.30	0.05		0.58	7.79	1.51
				1	do	10	1.55	−0.25		0.48	4.58	0.30	−0.15		0.53	7.84	1.49
93	R. J. Auld	do	Sept. 8-9, 1920	¾	Pole	7	−0.73	1.35	135	0.16	7.29	0.73	−0.71	335	0.28	5.13	1.29
				1	Meter	4	−0.88	−0.55		0.42	6.24	−0.47	0.34		0.42	6.18	0.74
				1	do	10	−1.06	−0.68		0.42	6.62	−0.27	−0.34		0.27	5.80	0.54
94	H. E. Finnegan	do	June 12-13, 1929	1	Pole	4½	−1.55	0.00	148	0.37	6.73	−0.65	−1.20	336	0.37	5.69	0.28
				1	Meter	3	−1.35	−0.35		0.42	6.18	−1.00	−1.35		0.42	6.24	0.12
				1	do	6	−1.30	−0.55		0.48	6.28	−0.85	−1.05		0.43	6.14	0.19
				1	do	10	−1.45	−0.50		0.42	6.38	−0.90	−1.25		0.37	6.04	0.11
95	H. C. Denson	Off Throgs Neck	July 30-31, 1922	1	Pole	7	3.82	3.44	249	0.38	4.39	2.38	4.22	78	1.03	8.03	10.80
				1	Meter	8	4.07	3.14		0.38	4.54	2.78	4.02		1.18	7.88	10.84
				1	do	20	3.92	3.89		0.48	4.79	2.88	4.12		0.98	7.63	11.04
				1	do	30	3.77	3.84		0.53	4.84	2.78	4.07		0.93	7.58	10.96
96	R. J. Auld	do	Sept. 10-11, 1920	1	Pole	7	3.47	3.19	260	0.68	5.69	3.33	4.27	93	1.24	6.73	10.90
				¾	Meter	4	3.50	2.87		0.50	5.49	3.16	4.05		1.50	6.93	10.74
				1	do	20	3.47	2.99		0.67	5.49	3.13	4.07		1.02	6.93	10.76
				1	do	50	3.29	3.16		0.74	5.74	3.20	3.89		0.79	6.68	10.72
				1	do	80	3.15	2.82		0.70	5.94	3.26	3.95		0.70	6.48	10.64
97	H. C. Denson	do	July 26-Aug. 7, 1922	11½	Pole	7	3.55	3.07	248	0.53	5.21	2.93	4.19	92	1.20	7.21	10.78
				11½	Meter	22	3.62	3.32		0.63	5.37	3.16	4.42		1.19	7.05	10.97
				11½	do	55	3.54	3.47		0.76	5.40	3.11	4.32		0.91	7.02	10.95
				11½	do	88	3.32	3.32		0.73	5.74	3.23	4.14		0.82	6.68	10.84
98	do	do	July 30-31 1922	1	Pole	7	1.77	3.59	263	0.58	6.49	2.43	2.72	53	0.93	5.93	9.97
				1	Meter	14	2.17	2.99		0.73	6.24	2.58	2.42		0.93	6.18	9.88
				1	do	35	1.57	2.94		0.68	7.04	2.78	2.87		0.78	5.38	9.88
				1	do	58	1.52	2.84		1.07	7.24	2.93	3.57		0.72	5.18	10.06
102	H. E. Finnegan	do	June 24-25, 1929	1	Pole	7	4.65	4.00	310	0.89	3.75	2.57	4.00	130	1.99	8.67	11.14
				1	Meter	10	4.75	3.70		0.96	3.81	2.73	3.95		1.79	8.61	11.12
				1	do	24	4.55	3.40		0.82	4.01	2.73	3.75		1.52	8.41	10.95
				1	do	38	4.40	3.15		0.70	4.16	2.73	3.65		1.38	8.26	10.82
103	do	do	do	1	Pole	7	4.70	3.45	286	1.49	5.38	4.25	3.80	111	1.77	7.04	11.39
				1	Meter	12	4.60	3.65		1.27	5.43	4.20	3.65		1.42	6.99	11.36
				1	do	30	4.30	3.40		1.19	5.63	4.10	3.40		1.15	6.79	11.14
				1	do	48	4.15	3.70		0.95	5.68	4.00	3.15		0.90	6.74	11.09
104	do	do	do	1	Pole	7	2.15	3.35	292	1.01	7.53	3.85	2.60	106	1.01	4.89	10.33
				1	Meter	12	2.20	3.40		0.91	7.43	3.80	2.60		1.06	4.99	10.34
				1	do	30	1.70	3.40		1.06	7.88	3.75	2.50		0.96	4.54	10.18
				1	do	48	1.40	3.45		0.99	7.94	3.55	2.70		0.54	4.44	10.12

[1] Current weak and irregular.
[2] Surface
[3] Pettersson meter observations.
[4] See discussion in text on pages 128-9 regarding direction of flood at this station.
[5] Current southerly.
[6] Currents irregular at this station. See curves and text, p. 131.
[7] Flood sets northerly, ebb sets southerly.

At 66 of the 104 current stations occupied by the Coast and Geodetic Survey in Western Long Island Sound observations were made by means of current meter at various depths at each station. The results from these observations are given in Table 71. The 1890 observations were made by means of the Ritchie-Haskell direction-current meter, which measures both the velocity and direction of the current, while the 1929 observations were made by means of the Price current meter, which measures velocities of the current only. In 1920 and 1922 Price current-meter observations were obtained at several stations in that portion of Long Island Sound from Execution Rocks to the entrance to the East River. At stations 8, 20, 27, and 46 (see fig. 30) observations were also made by means of the Pettersson current meter. This meter records both velocity and direction of the current.

In general, the results obtained by means of observations with this type of meter agree very well with those obtained by means of the Price meter at corresponding depths. The current curve obtained from observations made by means of the Pettersson current meter at a depth of 18 feet at station 20, entrance to Huntington Bay, Long Island, is shown in Figure 33 accompanying a discussion on currents in that vicinity. This curve shows the hourly velocity and direction of the subsurface current at station 20 with reference to the times of high and low water at New London, Conn. Figure 32 shows similar conditions for the surface current at this station.

The 1890 meter observations were made at the surface, mid depth, and bottom, while the Price meter observations in 1917, 1920, 1922, and 1929 were generally made at 0.2, 0.5, and 0.8 of the depth at the station.

The data for mean current hour in the last column of Table 71 show that at most stations the time of current occurs earlier with increased depth. For unusual current conditions which obtained at some of the stations for which data are given in Table 71 reference should be made to the text above in connection with surface-current conditions at these stations. It will be noted from the data in Table 71 that for most stations the observations show that the flood duration generally increases with increased depth, while the duration of ebb generally decreases. Likewise, there is an increase relatively in subsurface flood velocities as compared with subsurface ebb velocities at the same depth. Obviously, such conditions should generally obtain, and explanations for these phenomena have been given above in connection with a discussion of the effect of fresh-water discharge upon the duration and velocity of flood and ebb tidal currents in other portions of Long Island Sound and its tributaries.

TEMPERATURE, DENSITY, AND SALINITY OBSERVATIONS IN LONG ISLAND SOUND AND ITS TRIBUTARIES, 1929–30

Temperature and density observations were obtained at 71 of the 99 current stations in Long Island Sound and vicinity which were occupied during the summer of 1929. The results from these observations are given in Table 72.

For purposes of identification, the numbers of the current stations at which temperature and density observations were made are given in the first column of the table. These station numbers are identical

with those in Figures 9, 11, 15, 19, 24, 26, 30, and 31, which show, respectively, current station locations in The Race and Plum Gut, Fishers Island Sound and its tributaries, Thames River, Eastern Long Island Sound, Connecticut River, Housatonic River, and Western Long Island Sound. The data for current station 3a, located at the eastern entrance to Fishers Island Sound (see fig. 11) were obtained during the summer of 1930.

Temperatures and densities were observed at three different depths at nearly all of the stations occupied. Exceptions to this general procedure were made at locations where shallow depths obtained. The observed densities were reduced to temperature 15° C. and the corrected densities are given in columns 8, 9, and 10. The salinities given in columns 11, 12, and 13 of Table 72 were obtained from the corresponding density values in the preceding columns.

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
	The Race and Plum Gut											
	1929			*50 ft.*	*125 ft.*	*200 ft.*	*50 ft.*	*125 ft.*	*200 ft.*	*50 ft.*	*125 ft.*	*200 ft.*
7	July 31	6:40–7:10	19.7	17.8	18.0	17.6	1.0230	1.0232	1.0235	31.1	31.4	31.8
	Aug. 1	1:38–1:50	20.7	19.5	18.0	17.5	1.0222	1.0232	1.0236	30.0	31.4	31.9
	Do	6:40–7:20	21.3	19.2	18.5	18.0	1.0232	1.0235	1.0236	31.4	31.8	31.9
		Mean					1.0228	1.0233	1.0236	30.8	31.5	31.9
				20 ft.	*46 ft.*	*76 ft.*	*20 ft.*	*46 ft.*	*76 ft.*	*20 ft.*	*46 ft.*	*76 ft.*
13	July 30	22:30	21.0	20.0			1.0222			30.0		
	July 31	6:45–6:53	20.5	18.0	18.0	18.0	1.0228	1.0227	1.0229	30.8	30.7	31.0
	Do	7:10–7:20	21.9	19.4	19.4	19.4	1.0227	1.0226	1.0226	30.7	30.6	30.6
		Mean					1.0226	1.0227	1.0228	30.5	30.6	30.8
				13 ft.	*33 ft.*	*52 ft.*	*13 ft.*	*33 ft.*	*52 ft.*	*13 ft.*	*33 ft.*	*52 ft.*
21	July 29	22:39–22:52	22.8	20.2	19.2	19.0	1.0222	1.0227	1.0225	30.0	30.7	30.4
	July 30	4:40–4:49	20.7	19.6	19.4	19.8	1.0217	1.0218	1.0222	29.4	29.5	30.0
	Do	15:40	25.9	19.7			1.0224			30.3		
		Mean					1.0221	1.0222	1.0224	29.9	30.1	30.2
				7 ft.	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*
25	July 26	14:10–14:20	21.7	19.2	19.2		1.0222	1.0218	1.0220	30.0	29.5	29.8
	Do	18:10–18:20		17.9	18.7	18.8	1.0221	1.0222	1.0220	29.9	30.0	29.8
	July 29	22:10–22:30	20.9	18.6	18.1	18.0	1.0221	1.0221	1.0218	29.9	29.9	29.5
	July 30	14:40–14:50	26.3	23.0	22.2	22.0	1.0222	1.0209	1.0213	30.0	28.4	28.9
		Mean					1.0221	1.0218	1.0218	30.0	29.4	29.5
	Fishers Island Sound											
				7 ft.	*15 ft.*	*24 ft.*	*7 ft.*	*15 ft.*	*24 ft.*	*7 ft.*	*15 ft.*	*24 ft.*
3	Aug. 8	14:10–14:20	19.0	17.3	16.8	16.7	1.0236			31.9		
	Do	22:10–22:20	15.4	17.0	16.9	16.5						
	Aug. 9	6:10– 6:20	15.4	17.5	17.3	17.2						
		Mean					1.0236			31.9		
	1930			*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*
3a	Aug. 12	13:40–13:49	21.1				1.0240	1.0238	1.0238	32.4	32.1	32.1
	Do	22:10–22:20	16.1				1.0236	1.0238	1.0236	31.9	32.1	31.9
	Aug. 13	6:17– 6:22	13.8				1.0233	1.0233	1.0236	31.5	31.5	31.9
		Mean					1.0236	1.0236	1.0237	31.9	31.9	32.0

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
Fishers Island Sound—Continued												
	1930			*14 ft.*	*35 ft.*	*56 ft.*	*14 ft.*	*35 ft.*	*56 ft.*	*14 ft.*	*35 ft.*	*56 ft.*
3a	Aug. 27	22:10–22:20	20.8	------	------	------	1.0236	1.0238	1.0238	31.9	32.1	32.1
	Aug. 28	6:15– 6:20	21.3	------	------	------	1.0233	1.0232	1.0231	31.5	31.4	31.2
	Do	14:15–14:22	28.0	------	------	------	1.0237	1.0238	1.0238	32.0	32.1	32.1
	Do	22:10–22:20	19.8	------	------	------	1.0236	1.0236	1.0238	31.9	31.9	32.1
		Mean	------	------	------	------	1.0235	1.0236	1.0236	31.8	31.9	31.9
	1929			*9 ft.*	*23 ft.*	*36 ft.*	*9 ft.*	*23 ft.*	*36 ft.*	*9 ft.*	*23 ft.*	*36 ft.*
4	Aug. 8	13:45–13:52	22.0	16.4	17.0	16.4	1.0231	1.0233	1.0234	31.2	31.5	31.6
	Do	22:10–22:24	17.2	17.3	16.2	15.5	1.0237	1.0234	1.0231	32.0	31.6	31.2
	Aug. 9	7:08– 7:16	18.2	17.5	17.3	17.1	1.0234	1.0233	1.0233	31.6	31.5	31.5
		Mean	------	------	------	------	1.0234	1.0233	1.0233	31.6	31.5	31.4
				5 ft.	*12 ft.*	*19 ft.*	*5 ft.*	*12 ft.*	*19 ft.*	*5 ft.*	*12 ft.*	*19 ft.*
7	Aug. 8	15:00–15:10	22.8	17.4	16.7	16.4	1.0245	1.0242	1.0240	33.0	32.7	32.4
	Do	22:10–22:20	17.8	16.5	16.0	16.0	1.0245	1.0242	1.0242	33.0	32.7	32.7
	Aug. 9	6:20– 6:30	17.7	17.4	17.4	17.3	1.0241	1.0239	1.0236	32.5	32.3	31.9
		Mean	------	------	------	------	1.0244	1.0241	1.0239	32.8	32.6	32.3
				8 ft.			*8 ft.*			*8 ft.*		
8	Aug. 6	10:10	15.4	20.0	------	------	1.0114	------	------	16.0	------	------
	Aug. 7	6:20	14.0	20.3	------	------	------	------	------	------	------	------
	Do	14:10	------	21.2	------	------	------	------	------	------	------	------
		Mean	------	------	------	------	1.0114	------	------	16.0	------	------
				3 ft.	*7 ft.*		*3 ft.*	*7 ft.*		*3 ft.*	*7 ft.*	
10	Aug. 6	22:20–22:25	21.5	21.0	21.0	------	1.0246	1.0246	------	33.2	33.2	------
	Aug. 7	6:23– 6:45	16.8	19.4	19.2	------	1.0211	1.0211	------	28.6	28.6	------
	Do	13:40–13:50	20.5	20.7	20.5	------	1.0211	1.0209	------	28.6	28.4	------
	Do	22:10–22:15	18.0	19.7	19.7	------	1.0232	1.0235	------	31.4	31.8	------
		Mean	------	------	------	------	1.0225	1.0225	------	30.4	30.5	------
				8 ft.	*13 ft.*		*8 ft.*	*13 ft.*		*8 ft.*	*13 ft.*	
12	Aug. 6	23:00	17.5	20.0	19.8	------	1.0223	1.0224	------	30.2	30.3	------
	Aug. 7	6:05– 6:10	14.5	20.0	19.9	------	1.0223	1.0223	------	30.2	30.2	------
	Do	16:10–16:15	23.0	21.0	21.0	------	1.0219	1.0219	------	29.7	29.7	------
		Mean	------	------	------	------	1.0222	1.0222	------	30.0	30.1	------
				7 ft.	*14 ft.*		*7 ft.*	*14 ft.*		*7 ft.*	*14 ft.*	
14	Aug. 5	22:00–22:10	18.0	19.1	19.0	------	1.0233	1.0233	------	31.5	31.5	------
	Aug. 6	6:05– 6:10	16.1	18.2	18.2	------	1.0222	1.0226	------	30.0	30.6	------
	Do	14:15–14:20	23.0	20.9	21.0	------	1.0226	1.0228	------	30.6	30.8	------
		Mean	------	------	------	------	1.0227	1.0229	------	30.7	31.0	------
				7 ft.	*12 ft.*	*24 ft.*	*7 ft.*	*12 ft.*	*24 ft.*	*7 ft.*	*12 ft.*	*24 ft.*
22	Aug. 5	22:10–22:20	17.5	17.5	17.3	17.2	1.0228	1.0229	1.0231	30.8	31.0	31.2
	Aug. 6	6:10– 6:20	17.0	18.2	18.0	17.7	1.0230	1.0231	1.0233	31.1	31.2	31.5
	Do	13:10–13:20	19.9	18.0	17.8	17.8	1.0230	1.0230	1.0232	31.1	31.1	31.4
		Mean	------	------	------	------	1.0229	1.0230	1.0232	31.0	31.1	31.4
				17 ft.	*43 ft.*	*68 ft.*	*17 ft.*	*43 ft.*	*68 ft.*	*17 ft.*	*43 ft.*	*68 ft.*
23	Aug. 5	22:12–22:24	17.2	18.4	18.2	17.5	1.0228	1.0230	1.0226	30.8	31.1	30.6
	Aug. 6	6:12– 6:20	18.4	17.7	17.4	17.5	1.0228	1.0229	1.0228	30.8	31.0	30.8
	Do	13:37–13:49	25.0	18.3	18.2	18.8	1.0227	1.0227	1.0227	30.7	30.7	30.7
	Aug. 7	6:11– 6:20	16.6	17.4	17.6	17.6	1.0227	1.0228	1.0228	30.7	30.8	30.8
	Do	14:10–14:22	25.0	18.3	17.7	18.5	1.0227	1.0228	1.0230	30.7	30.8	31.1
	Do	22:15–22:25	20.0	17.8	17.6	17.5	1.0230	1.0230	1.0231	31.1	31.1	31.2
		Mean	------	------	------	------	1.0228	1.0229	1.0228	30.8	30.9	30.9
				7 ft.	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*
25	Aug. 5	18:19–18:47	17.7	17.7	17.7	17.7	1.0237	1.0234	1.0232	32.0	31.6	31.4
	Aug. 6	14:10–14:20	18.5	18.0	17.6	17.3	1.0231	1.0231	1.0227	31.2	31.2	30.7
		Mean	------	------	------	------	1.0234	1.0232	1.0230	31.6	31.4	31.0

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C. Air	Temperature, °C. Water			Density			Salinity		
	Thames River											
	1929			*7 ft.*	*14 ft.*	*22 ft.*	*7 ft.*	*14 ft.*	*22 ft.*	*7 ft.*	*14 ft.*	*22 ft.*
3	Aug. 12	23:40–23:45	20.0	20.0	19.4	18.9	1.0214	1.0217	1.0223	29.0	29.4	30.2
				7 ft.	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*
4	Aug. 12	14:10–14:20	22.5	21.8	21.5	21.5	1.0232	1.0227	1.0227	31.4	30.7	30.7
	Do	22:20–23:09	19.8	19.5	18.5	19.0	1.0203	1.0227	1.0234	27.6	30.7	31.6
	Aug. 13	5:38– 5:48	21.7	21.1	20.7	20.6	1.0189	1.0186	1.0185	25.8	25.4	25.2
	Do	14:10–14:20	23.5	19.5	19.2	18.7	1.0231	1.0240	1.0240	31.2	32.4	32.4
	Do	22:46–23:19	20.5	19.4	18.7	18.1	1.0212	1.0219	1.0231	28.8	29.7	31.2
	Aug. 14	5:40– 5:50	22.0	19.2	19.0	19.0	1.0181	1.0180	1.0180	24.7	24.6	24.6
	Do	14:40–14:50	20.7	19.8	19.5	19.2	1.0234	1.0238	1.0241	31.6	32.1	32.5
	Do	22:18–22:50	20.0	19.6	20.2	19.7	1.0204	1.0222	1.0231	27.7	30.0	31.2
	Aug. 15	5:40– 5:50	21.8	20.4	20.2	20.2	1.0196	1.0190	1.0189	26.7	25.9	25.8
	Do	14:10–14:20	21.3	20.0	19.7	19.3	1.0215	1.0221	1.0229	29.1	29.9	31.0
		Mean					1.0210	1.0215	1.0219	28.5	29.1	29.6
				7 ft.	*10 ft.*	*16 ft.*	*7 ft.*	*10 ft.*	*16 ft.*	*7 ft.*	*10 ft.*	*16 ft.*
5	Aug. 12	14:15–14:22	23.8	19.3	18.7	18.5	1.0214	1.0219	1.0222	29.0	29.7	30.0
	Do	21:40–21:49	20.0	20.0	19.9	19.7	1.0210	1.0212	1.0212	28.5	28.8	28.8
	Aug. 13	6:08– 6:22	20.5	18.5	18.5	18.2	1.0212	1.0212	1.0221	28.8	28.8	29.9
		Mean					1.0212	1.0214	1.0218	28.8	29.1	29.6
	Eastern Long Island Sound											
				17 ft.	*42 ft.*	*67 ft.*	*17 ft.*	*42 ft.*	*67 ft.*	*17 ft.*	*42 ft.*	*67 ft.*
8	July 29	22:00–22:30	21.0	18.6	18.5	18.5	1.0228	1.0206	1.0205	30.8	28.0	27.8
	July 30	8:30– 8:50	21.5	18.7	18.8	18.6	1.0227	1.0227	1.0228	30.7	30.7	30.8
	Do	14:14–14:34	23.5	18.9	18.3	18.1	1.0228	1.0229	1.0229	30.8	31.0	31.0
		Mean					1.0228	1.0221	1.0221	30.8	29.9	29.9
				8 ft.	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
21	July 24	22:10–22:20	21.4	16.7	16.8	16.2	1.0227	1.0229	1.0228	30.7	31.0	30.8
	July 25	6:10– 6:20	17.4	18.1	17.0	17.1	1.0186	1.0210	1.0216	25.4	28.5	29.3
	Do	14:10–14:20	21.0	20.8	18.3	18.4	1.0226	1.0226	1.0226	30.6	30.6	30.6
		Mean					1.0220	1.0222	1.0223	28.9	30.0	30.2
				22 ft.	*55 ft.*	*80 ft.*	*22 ft.*	*55 ft.*	*80 ft.*	*22 ft.*	*55 ft.*	*80 ft.*
39	July 22	14:10–14:20	21.0	19.5	19.3	19.0	1.0212	1.0211	1.0214	28.8	28.6	29.0
				18 ft.	*45 ft.*	*72 ft.*	*18 ft.*	*45 ft.*	*72 ft.*	*18 ft.*	*45 ft.*	*72 ft.*
41	July 22	22:10–22:20	18.5	18.6	17.4	17.2	1.0206	1.0203	1.0201	28.0	27.6	27.3
	July 23	6:10– 6:20	18.4	18.7	17.6	17.3	1.0203	1.0202	1.0202	27.6	27.4	27.4
			27.1	20.0	19.2	19.8	1.0207	1.0204	1.0201	28.1	27.7	27.3
		Mean					1.0205	1.0203	1.0201	27.9	27.6	27.3
				20 ft.	*50 ft.*	*80 ft.*	*20 ft.*	*50 ft.*	*80 ft.*	*20 ft.*	*50 ft.*	*80 ft.*
44	July 19	13:40–14:17	20.8	20.1	20.4	18.0	1.0205	1.0207	1.0220	27.8	28.1	29.8
	Do	22:10–22:21	19.7	19.2	18.6	18.0	1.0219	1.0214	1.0219	29.7	29.0	29.7
	July 22	14:15–14:23	20.5	19.3	18.7	18.2	1.0213	1.0218	1.0219	28.9	29.5	29.7
	Do	21:40–22:19	21.0	19.3	18.5	19.1	1.0210	1.0216	1.0214	28.5	29.3	29.0
	July 23	6:15– 6:25	20.2	19.1	18.7	18.4	1.0210	1.0209	1.0211	28.5	28.4	28.6
	Do	14:13–14:20	24.2	19.8	18.5	18.5	1.0212	1.0212	1.0216	28.8	28.8	29.3
	July 24	6:10– 6:20	------	19.5	18.3	18.0	1.0210	1.0207	1.0210	28.5	28.1	28.5
	Do	14:12–14:20	25.8	20.0	18.2	17.9	1.0213	1.0214	1.0214	28.9	29.0	29.0
		Mean					1.0212	1.0212	1.0215	28.7	28.8	29.2
				7 ft.	*10 ft.*	*16 ft.*	*7 ft.*	*10 ft.*	*16 ft.*	*7 ft.*	*10 ft.*	*16 ft.*
50	July 19	14:10–14:20	18.0	19.3	19.2	19.0	1.0196	1.0194	1.0194	26.7	26.4	26.4
	Do	21:50–22:15	17.8	19.6	19.4	18.7	1.0204	1.0208	1.0207	27.7	28.2	28.1
	July 20	6:10– 6:20	14.5	19.3	19.2	18.6	1.0205	1.0200	1.0198	27.8	27.2	26.9
		Mean					1.0202	1.0200	1.0200	27.4	27.3	27.1
				7 ft.			*7 ft.*			*7 ft.*		
55	July 19	14:05	21.8	19.8			1.0204			27.7		
	Do	22:15	19.8	19.2			1.0229			31.0		
	July 20	6:15	19.4	18.7			1.0212			28.8		
		Mean					1.0215			29.2		

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
	Connecticut River											
	1929			*6 ft.*	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*
3	July 26	6:15– 6:23	19.8	21.5	21.0	21.0	1.0011	1.0010	1.0010	2.5	2.4	2.4
	Do	14:10–14:20		24.3			0.9997			0.7		
	Do	22:20–22:56	19.8	27.2	27.2	26.7	1.0012	1.0004	1.0000	2.6	1.6	1.1
	Mean						1.0007	1.0007	1.0005	1.9	2.0	1.8
	Housatonic River											
				7 ft.			*7 ft.*			*7 ft.*		
2	July 18	14:45	22.8	22.4			1.0120			16.7		
	Do	22:10	21.2	20.0			1.0209			28.4		
	July 19	6:08	19.3	20.2			1.0127			17.6		
	Mean						1.0152			20.9		
				7 ft.	*12 ft.*		*7 ft.*	*12 ft.*		*7 ft.*	*12 ft.*	
3	July 18	22:10–22:15	22.4	19.7	19.6		1.0202	1.0203		27.4	27.6	
				5 ft.			*5 ft.*			*5 ft.*		
5	July 18	14:05	25.4	25.0			1.0002			1.3		
	Do	22:05	24.5	25.8			1.0008			2.1		
	July 19	6:20	19.8	24.0			0.9999			0.9		
	Mean						1.0003			1.4		
	Western Long Island Sound											
				7 ft.	*10 ft.*	*16 ft.*	*7 ft.*	*10 ft.*	*16 ft.*	*7 ft.*	*10 ft.*	*16 ft.*
4	July 17	22:30–22:34	20.0	22.5	22.4	22.0	1.0200	1.0200	1.0200	27.2	27.2	27.2
	July 18	6:10– 6:20	25.0	22.2	22.3	22.2	1.0197	1.0196	1.0197	26.8	26.7	26.8
	Do	14:40–14:50	25.0	22.5	22.5	22.6	1.0198	1.0199	1.0201	26.9	27.1	27.3
	Mean						1.0198	1.0198	1.0199	27.0	27.0	27.1
				7 ft.	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*	*7 ft*	*12 ft.*	*20 ft.*
7	July 16	21:50–22:15	18.0	19.4	19.5	19.3	1.0205	1.0203	1.0203	27.8	27.6	27.6
	July 17	6:10– 6:20	17.4	19.5	19.7	19.8	1.0207	1.0202	1.0209	28.1	27.4	28.4
	Do	14:10–14:20	24.5	22.0	21.8	21.8	1.0210	1.0207	1.0206	28.5	28.1	28.0
	Mean						1.0207	1.0204	1.0206	28.1	27.7	28.0
				7 ft.	*13 ft.*	*21 ft.*	*7 ft.*	*13 ft.*	*21 ft.*	*7 ft.*	*13 ft.*	*21 ft.*
8	July 16	22:10–22:20	15.0	19.3	19.2	19.2	1.0200	1.0205	1.0205	27.2	27.8	27.8
	July 17	6:09– 6:19	15.5	19.3	19.4	18.4	1.0201	1.0199	1.0200	27.3	27.1	27.2
	Do	14:35–14:44		20.0	19.8	19.0	1.0202	1.0204	1.0206	27.4	27.7	28.0
	Mean						1.0201	1.0203	1.0204	27.3	27.5	27.7
				7 ft.	*12 ft.*		*7 ft.*	*12 ft.*		*7 ft.*	*12 ft.*	
11	July 12	14:10–14:15	25.7	21.6	21.5		1.0198	1.0203		26.9	27.6	
	Do	22:10–22:15	17.9	21.0	20.8		1.0195	1.0198		26.5	26.9	
	July 13	6:10– 6:15	26.0	21.1	21.0		1.0203	1.0201		27.6	27.3	
	Mean						1.0199	1.0201		27.0	27.3	
				7 ft.	*12 ft.*		*7 ft.*	*12 ft.*		*7 ft.*	*12 ft.*	
12	July 12	14:10–14:20	26.2	22.6			1.0197	1.0196		26.8	26.7	
	Do	22:15–22:20	19.0	22.5	22.4		1.0192	1.0194		26.1	26.4	
	July 13	5:40– 5:47	22.0	21.1	21.0		1.0198	1.0197		26.9	26.8	
	Mean						1.0196	1.0196		26.6	26.6	
				7 ft.	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*
20	Aug. 14	6:10– 6:22	21.9	20.6	19.8	20.0	1.0213	1.0209	1.0212	28.9	28.4	28.8
	Do	14:14–14:22	25.8	21.0	20.6	20.2	1.0214	1.0211	1.0210	29.0	28.6	28.5
	Do	21:40–21:49	23.5	20.8	20.6	20.3	1.0211	1.0210	1.0214	28.6	28.5	29.0
	Aug. 15	6:17– 6:24	21.2	20.7	20.6	20.0	1.0211	1.0208	1.0209	28.6	28.2	28.4
	Do	14:14–14:23	27.4	21.7	20.8	20.8	1.0211	1.0212	1.0214	28.6	28.8	29.0
	Do	21:37–21:49	20.8	21.0	21.0	20.5	1.0211	1.0210	1.0212	28.6	28.5	28.8
	Aug. 16	6:10– 6:22	20.5	19.7	21.5	20.9	1.0215	1.0209	1.0211	29.1	28.4	28.6
	Mean						1.0212	1.0210	1.0212	28.8	28.5	28.7

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C. Air	Temperature, °C. Water			Density			Salinity		
Western Long Island Sound—Con.												
	1929			*7 ft.*	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*
22	July 8	22:12–22:20	25.2	------	------	------	1.0199	1.0199	1.0200	27.1	27.1	27.2
	July 9	5:37– 5:50	21.6	------	------	------	1.0195	1.0197	1.0198	26.5	26.8	26.9
	Do	14:12–14:20	21.0	17.9	18.8	18.5	1.0194	1.0196	1.0196	26.4	26.7	26.7
		Mean	------	------	------	------	1.0196	1.0197	1.0198	26.7	26.9	26.9
				7 ft.	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*
24	July 8	22:10–22:20	23.1	19.5	19.2	19.2	1.0198	1.0196	1.0196	26.9	26.7	26.7
	July 9	6:10– 6:20	21.5	19.8	19.5	19.7	1.0198	1.0195	1.0196	26.9	26.5	26.7
	Do	14:10–14:20	26.1	20.3	20.1	19.8	1.0198	1.0195	1.0195	26.9	26.5	26.5
		Mean	------	------	------	------	1.0198	1.0195	1.0196	26.9	26.6	26.6
				7 ft.	*11 ft.*		*7 ft.*	*11 ft.*		*7 ft.*	*11 ft.*	
25	July 9	22:15–22:25	25.0	21.2	21.0	------	1.0196	1.0200	------	26.7	27.2	------
	July 10	6:10– 6:15	26.0	20.9	21.0	------	1.0197	1.0195	------	26.8	26.5	------
	Do	15:45–15:50	21.0	20.4	20.9	------	------	------	------	------	------	------
		Mean	------	------	------	------	1.0196	1.0198	------	26.8	26.8	------
				7 ft.	*15 ft.*	*24 ft.*	*7 ft.*	*15 ft.*	*24 ft.*	*7 ft.*	*15 ft.*	*24 ft.*
27	July 9	22:11–22:20	25.0	20.4	20.0	19.5	1.0196	1.0196	1.0195	26.7	26.7	26.5
	July 10	5:35– 5:50	22.8	19.8	20.0	22.3	1.0194	1.0195	1.0193	26.4	26.5	26.3
	Do	22:09–22:16	22.2	20.6	20.0	20.0	1.0197	1.0197	1.0197	26.8	26.8	26.8
		Mean	------	------	------	------	1.0196	1.0196	1.0195	26.6	26.7	26.5
				7 ft.	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*	*7 ft.*	*12 ft.*	*20 ft.*
28	July 9	22:10–22:20	23.6	20.1	19.8	19.6	1.0197	1.0192	1.0191	26.8	26.1	26.0
	July 10	6:10– 6:20	22.8	21.2	20.8	20.7	1.0198	1.0195	1.0194	26.9	26.5	26.4
	Do	14:10–14:20	26.0	21.5	20.3	20.5	1.0201	1.0198	1.0197	27.3	26.9	26.8
		Mean	------	------	------	------	1.0199	1.0195	1.0194	27.0	26.5	26.4
				14 ft.	*35 ft.*	*56 ft.*	*14 ft.*	*35 ft.*	*56 ft.*	*14 ft.*	*35 ft.*	*56 ft.*
32	July 2	21:40–21:50	18.0	16.4	18.0	18.3	1.0190	1.0189	1.0191	25.9	25.8	26.0
	July 3	6:15– 6:25	17.5	15.0	13.8	14.4	1.0190	1.0189	1.0189	25.9	25.8	25.8
	Do	14:14–14:22	20.0	18.7	18.6	16.7	1.0193	1.0192	1.0197	26.3	26.1	26.8
	Do	21:40–21:52	18.5	18.0	18.0	17.5	1.0189	1.0190	1.0187	25.8	25.9	25.5
	July 4	6:10– 6:20	17.0	17.8	17.9	17.5	1.0189	1.0190	1.0188	25.8	25.9	25.6
	Do	14:12–14.20	24.2	18.8	18.4	16.5	1.0196	1.0190	1.0196	26.7	25.9	26.7
	Do	21:45–22:20	20.0	17.4	17.3	16.8	1.0194	1.0191	1.0194	26.4	26.0	26.4
	July 5	6:10– 6:20	20.0	18.5	17.2	15.2	1.0193	1.0193	1.0194	26.3	26.3	26.4
	Do	14:13–14:22	24.8	18.6	18.1	17.6	1.0194	1.0193	1.0192	26.4	26.3	26.1
		Mean	------	------	------	------	1.0192	1.0191	1.0192	26.2	26.0	26.1
				8 ft.	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
37	July 3	22:10–22:20	18.2	19.2	18.9	18.6	1.0193	1.0190	1.0193	26.3	25.9	26.3
	July 4	6:10– 6:20	16.4	19.0	18.6	18.7	1.0194	1.0191	1.0191	26.4	26.0	26.0
	Do	13:50–14:15	24.0	20.2	19.7	19.6	1.0192	1.0190	1.0192	26.1	25.9	26.1
		Mean	------	------	------	------	1.0193	1.0190	1.0192	26.3	25.9	26.1
				7 ft.	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*	*7 ft.*	*18 ft.*	*28 ft.*
38	July 2	22:10–22:20	16.5	18.1	17.9	18.0	1.0190	1.0190	1.0188	25.9	25.9	25.6
	July 3	6:10– 6:20	14.4	18.2	18.0	17.7	1.0192	1.0189	1.0188	26.1	25.8	25.6
	Do	13:50–14:15	27.0	18.7	19.6	19.3	1.0193	1.0190	1.0192	26.3	25.9	26.1
		Mean	------	------	------	------	1.0192	1.0190	1.0189	26.1	25.9	25.8
				7 ft.	*13 ft.*		*7 ft.*	*13 ft.*		*7 ft.*	*13 ft.*	
39	July 3	14:20–14:25	18.2	19.5	19.5	------	1.0198	1.0197	------	26.9	26.8	------
	Do	22:00–22:05	17.0	19.5	19.5	------	------	------	------	------	------	------
	July 4	6:00– 6:05	15.6	18.2	18.2	------	1.0193	1.0198	------	26.3	26.9	------
		Mean	------	------	------	------	1.0196	1.0198	------	26.6	26.8	------
				7 ft.	*15 ft.*	*24 ft.*	*7 ft.*	*15 ft.*	*24 ft.*	*7 ft.*	*15 ft.*	*24 ft.*
40	July 4	22:10–22:20	20.0	19.5	19.3	18.8	1.0193	1.0196	1.0191	26.3	26.7	26.0
	July 5	6:10– 6:20	19.8	19.6	19.2	19.0	1.0196	1.0192	1.0191	26.7	26.1	26.0
	Do	13:55–14:05	28.2	20.8	20.2	19.8	1.0191	1.0191	1.0190	26.0	26.0	25.9
		Mean	------	------	------	------	1.0193	1.0193	1.0191	26.3	26.3	26.0

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C. Air	Temperature, °C. Water			Density			Salinity		
Western Long Island Sound—Con.												
	1929			*6 ft.*			*6 ft.*			*6 ft.*		
44	July 11	14:25	22.5	20.8	------	------	1.0122	------	------	17.0	------	------
	Do	22:20	21.8	20.3	------	------	1.0116	------	------	16.3	------	------
	July 12	6:30	19.0	19.8	------	------	1.0117	------	------	16.3	------	------
		Mean	------	------	------	------	1.0118	------	------	16.5	------	------
				8 ft.	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
46	July 11	14:10–14:20	25.0	19.5	18.5	16.8	1.0198	1.0199	1.0201	26.9	27.1	27.3
	Do	22:09–22:16	21.5	19.8	18.7	17.0	1.0200	1.0199	1.0199	27.2	27.1	27.1
	July 12	5:36– 5:50	18.0	18.0	18.4	18.0	1.0197	1.0197	1.0196	26.8	26.8	26.7
		Mean	------	------	------	------	1.0198	1.0198	1.0199	27.0	27.0	27.0
				7 ft.	*10 ft.*		*7 ft.*	*10 ft.*		*7 ft.*	*10 ft.*	
47	July 12	6:10– 6:15	17.0	19.5	19.6	------	1.0206	1.0199	------	28.0	27.1	------
				8 ft.	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
49	June 25	22:36–22:48	24.2	20.8	20.4	20.0	------	------	------	------	------	------
	June 26	6:10– 6:20	20.5	16.0	15.5	15.5	------	------	------	------	------	------
	Do	14:10–14:20	25.0	21.0	20.5	19.0	------	------	------	------	------	------
	Do	22:36–22:48	19.2	19.4	18.9	18.7	1.0192	1.0193	1.0193	26.1	26.3	26.3
		Mean	------	------	------	------	1.0192	1.0193	1.0193	26.1	26.3	26.3
				12 ft.	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*
52	June 25	22:10–22:20	20.5	21.3	17.8	15.5	1.0186	1.0187	1.0198	25.4	25.5	26.9
	June 26	6:15– 6:22	20.0	19.8	14.3	13.0	1.0190	1.0192	1.0192	25.9	26.1	26.1
	Do	13:45–14:20	26.0	20.6	17.5	17.2	1.0193	1.0193	1.0193	26.3	26.3	26.3
	Do	20:15–20:25	21.0	18.0	16.8	14.3	1.0190	1.0190	1.0196	25.9	25.9	26.7
	June 27	6:18– 6:38	17.0	18.4	15.8	13.4	1.0192	1.0190	1.0192	26.1	25.9	26.1
	Do	13:45–14:20	25.0	20.7	17.5	13.9	1.0189	1.0192	1.0197	25.8	26.1	26.8
	Do	20:15–20:25	23.5	19.8	17.0	14.2	1.0192	1.0192	1.0192	26.1	26.1	26.1
	June 28	6:10– 6:20	19.4	19.2	14.5	14.5	1.0192	1.0192	1.0196	26.1	26.1	26.7
	Do	20:15–20:25	20.0	17.2	15.5	14.3	1.0190	1.0191	1.0195	25.9	26.0	26.5
	June 29	6:15– 6:22	16.6	17.0	13.7	13.4	1.0188	1.0192	1.0194	25.6	26.1	26.4
	July 15	14:15–14:35	22.5	20.3	20.2	19.4	1.0198	1.0199	1.0198	26.9	27.1	26.9
	Do	20:10–20:25	22.0	20.5	19.8	19.2	1.0202	1.0199	1.0198	27.4	27.1	26.9
	July 16	6:09– 6:16	17.0	19.8	18.0	15.8	1.0199	1.0201	1.0200	27.1	27.3	27.2
	Do	13:35–13:47	26.8	20.5	19.0	17.4	1.0200	1.0199	1.0204	27.2	27.1	27.7
		Mean	------	------	------	------	1.0193	1.0194	1.0196	26.3	26.3	26.7
				8 ft.	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
54	June 26	14:10–14:20	23.5	21.0	20.5	18.5	1.0184	1.0187	1.0187	25.1	25.5	25.5
	Do	22:10–22:20	20.2	20.0	19.5	19.6	1.0193	1.0200	1.0204	26.3	27.2	27.7
	June 27	6:10– 6:20	17.2	19.8	20.0	19.9	1.0185	1.0183	1.0185	25.2	25.0	25.2
		Mean	------	------	------	------	1.0187	1.0190	1.0192	25.5	25.9	26.1
				8 ft.	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
56	July 15	14:10–14:50	22.5	20.8	20.1	20.0	1.0202	1.0199	1.0197	27.4	27.1	26.8
	Do	21:05–21:15	17.2	19.3	18.3	18.5	1.0198	1.0202	1.0199	26.9	27.4	27.1
	July 16	6:10– 6:20	28.0	19.1	18.9	18.8	1.0204	1.0203	1.0206	27.7	27.6	28.0
		Mean	------	------	------	------	1.0201	1.0201	1.0201	27.3	27.4	27.0
				5 ft.	*8 ft.*		*5 ft.*	*8 ft.*		*5 ft.*	*8 ft.*	
59	June 27	6:15– 6:20	18.5	16.0	16.0	------	1.0191	1.0193	------	26.0	26.3	------
	Do	22:10–22:20	19.0	16.4	16.4	------	1.0194	1.0193	------	26.4	26.3	------
		Mean	------	------	------	------	1.0192	1.0193	------	26.2	26.3	------
				6 ft.	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*
60	June 27	14:10–14:20	------	20.6	18.9	18.6	1.0194	1.0194	1.0192	26.4	26.4	26.1
	Do	20:50–21:20	18.5	20.0	18.1	18.5	1.0197	1.0190	1.0193	26.8	25.9	26.3
	June 28	6:40– 6:50	20.9	19.6	18.6	18.0	1.0192	1.0183	1.0184	26.1	25.0	25.1
		Mean	------	------	------	------	1.0194	1.0189	1.0190	26.4	25.8	25.8

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
Western Long Island Sound—Con.												
	1929			*6 ft.*	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*
62	June 28	14:10–14:20	20.3	20.1	19.4	18.1	1.0189	1.0185	1.0183	25.8	25.2	25.0
	Do	21:50–22:20	19.9	16.0	15.4	15.4	1.0198	1.0196	1.0192	26.9	26.7	26.1
	June 29	6:40– 6:50	19.0	17.4	17.1	16.7	1.0193	1.0187	1.0184	26.3	25.5	25.1
		Mean	------	------	------	------	1.0193	1.0189	1.0186	26.3	25.8	25.4
				6 ft.	*10 ft.*		*6 ft.*	*10 ft.*		*6 ft.*	*10 ft.*	
64	June 28	22:10–22:20	21.0	19.8	19.6	------	1.0182	1.0183	--------	24.8	25.0	------
	June 29	6:10– 6:15	19.5	17.5	17.5	------	1.0184	1.0186	--------	25.1	25.4	------
		Mean	------	------	------	------	1.0183	1.0184	--------	25.0	25.2	------
				6 ft.	*10 ft.*	*16 ft.*	*6 ft.*	*10 ft.*	*16 ft.*	*6 ft.*	*10 ft.*	*16 ft.*
69	July 1	14:15–14:20	18.5	21.0	21.8	17.8	1.0199	1.0192	1.0194	27.1	26.1	26.4
	Do	22:10–22:20	20.0	18.9	18.7	17.0	1.0199	1.0200	1.0196	27.1	27.2	26.7
	July 2	6:10– 6:20	19.9	19.0	18.6	17.3	1.0200	1.0198	1.0195	27.2	26.9	26.5
	Do	13:50–14:20	29.0	17.4	16.5	15.4	1.0194	1.0186	1.0186	26.4	25.4	25.4
		Mean	------	------	------	------	1.0198	1.0194	1.0193	27.0	26.4	26.2
				7 ft.			*7 ft.*			*7 ft.*		
70	July 1	14:35	22.5	22.5	------	------	1.0135	--------	--------	18.7	------	------
				7 ft.	*16 ft.*		*7 ft.*	*16 ft.*		*7 ft.*	*16 ft.*	
71	July 1	14:45–14:50	23.0	17.0	16.5	------	1.0191	1.0192	--------	26.0	26.1	------
	Do	21:45–21:50	20.0	16.7	15.8	------	1.0190	1.0192	--------	25.9	26.1	------
	July 2	6:10– 6:15	22.5	15.8	15.2	------	1.0196	1.0192	--------	26.7	26.1	------
	Do	14:13–14:17	19.0	16.3	15.2	------	1.0195	1.0197	--------	26.5	26.8	------
		Mean	------	------	------	------	1.0193	1.0193	--------	26.3	26.3	------
				5 ft.	*11 ft.*	*17 ft.*	*5 ft.*	*11 ft.*	*17 ft.*	*5 ft.*	*11 ft.*	*17 ft.*
76	June 18	22:20–22:48	20.5	17.8	16.6	15.5	1.0185	1.0187	1.0188	25.2	25.5	25.6
	June 19	14:10–14:23	27.0	18.0	------	16.3	1.0192	--------	1.0188	26.1	------	25.6
		Mean	------	------	------	------	1.0188	1.0187	1.0188	25.6	25.5	25.6
				3 ft.	*10 ft.*		*3 ft.*	*10 ft.*		*3 ft.*	*10 ft.*	
78	June 11	21:55–22:05	24.3	17.5	16.0	------	1.0195	1.0194	--------	26.5	26.4	------
	June 12	6:10– 6:15	24.3	15.5	14.5	------	1.0187	1.0189	--------	25.5	25.8	------
	Do	13:40–13:50	30.2	20.0	16.0	------	1.0190	1.0182	--------	25.9	24.8	------
		Mean	------	------	------	------	1.0191	1.0188	--------	26.0	25.7	------
				22 ft.	*55 ft.*	*80 ft.*	*22 ft.*	*55 ft.*	*80 ft.*	*22 ft.*	*55 ft.*	*80 ft.*
81	June 19	21:55–22:05	23.0	16.5	16.0	15.7	1.0194	1.0190	1.0192	26.4	25.9	26.1
	June 20	6:10– 6:20	21.0	17.8	17.3	16.0	1.0197	1.0196	1.0191	26.8	26.7	26.0
	Do	15:40–16:00	23.6	16.8	16.5	16.5	1.0192	1.0192	1.0191	26.1	26.1	26.0
		Mean	------	------	------	------	1.0194	1.0193	1.0191	26.4	26.2	26.0
				9 ft.	*22 ft.*	*36 ft.*	*9 ft.*	*22 ft.*	*36 ft.*	*9 ft.*	*22 ft.*	*36 ft.*
83	June 19	22:10–22:22	21.5	15.5	15.2	15.2	1.0187	1.0189	1.0188	25.5	25.8	25.6
	June 20	5:50– 6:18	21.0	17.3	17.1	17.1	1.0183	1.0185	1.0187	25.0	25.2	25.5
	Do	14:05–14:20	26.2	18.5	17.0	15.5	1.0187	1.0186	1.0186	25.5	25.4	25.4
	Do	22:12–22:23	17.8	16.3	16.3	16.1	1.0188	1.0187	1.0186	25.6	25.5	25.4
	June 21	5:35– 5:49	18.5	16.8	16.8	16.7	1.0183	1.0184	1.0186	25.0	25.1	25.4
	Do	14:10–14:25	22.0	17.6	15.0	15.2	1.0184	1.0190	1.0188	25.1	25.9	25.6
	Do	22:10–22:21	19.6	17.0	15.0	14.7	1.0187	1.0186	1.0191	25.5	25.4	26.0
		Mean	------	------	------	------	1.0186	1.0187	1.0187	25.3	25.5	25.6
				5 ft.	*12 ft.*	*19 ft.*	*5 ft.*	*12 ft.*	*19 ft.*	*5 ft.*	*12 ft.*	*19 ft.*
84	June 20	22:00–22:10	18.3	16.2	16.0	15.7	1.0193	1.0191	1.0194	26.3	26.0	26.4
	June 21	6:10– 6:20	20.0	16.0	16.0	15.8	1.0195	1.0195	1.0196	26.5	26.5	26.7
	Do	14:10–14:23	24.0	17.4	17.3	17.1	1.0198	1.0195	1.0194	26.9	26.5	26.4
		Mean	------	------	------	------	1.0195	1.0194	1.0195	26.6	26.3	26.5

TABLE 72.—*Temperature, density, and salinity of water, Long Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
Western Long Island Sound—Con.												
	1929			*7 ft.*	*11 ft.*		*7 ft.*	*11 ft.*		*7 ft.*	*11 ft.*	
86	June 17	22:15	24.0	20.0	------	------	1.0184	--------	--------	25.1	------	------
	June 18	7:00	23.0	23.0	------	------	1.0182	--------	--------	24.8	------	------
	Do	16:00	25.0	------	24.5	------	--------	1.0193	--------	------	26.3	------
		Mean	------	------	------	------	1.0183	1.0193	--------	25.0	26.3	------
				2 ft.	*8 ft.*		*2 ft.*	*8 ft.*		*2 ft.*	*8 ft.*	
87	June 13	22:00–22:10	22.0	17.0	17.0	------	1.0186	1.0186	--------	25.4	25.4	------
	June 14	5:40– 5:50	20.0	17.0	16.3	------	1.0194	1.0188	--------	26.4	25.6	------
	Do	14:10–14:15	27.5	17.5	16.8	------	1.0185	1.0192	--------	25.2	26.1	------
		Mean	------	------	------	------	1.0188	1.0189	--------	25.7	25.7	------
				6 ft.	*10 ft.*	*16 ft.*	*6 ft.*	*10 ft.*	*16 ft.*	*6 ft.*	*10 ft.*	*16 ft.*
88	June 13	22:00	23.0	17.0	------	------	1.0184	--------	--------	25.1	------	------
	June 14	5:53	23.0	------	------	20.0	--------	--------	1.0190	------	------	25.9
	Do	14:13–14:22	24.5	15.8	15.7	------	1.0188	1.0189	--------	25.6	25.8	------
		Mean	------	------	------	------	1.0186	1.0189	1.0190	25.4	25.8	25.9
				6 ft.	*10 ft.*	*16 ft.*	*6 ft.*	*10 ft.*	*16 ft.*	*6 ft.*	*10 ft.*	*16 ft.*
92	June 12	19:00	22.0	17.8	------	------	1.0184	--------	--------	25.1	------	------
	Do	22:00	19.0	16.7	------	------	1.0181	--------	--------	24.7	------	------
	June 13	2:18– 2:40	------	15.5	------	15.5	1.0185	--------	1.0182	25.2	------	24.8
	Do	6:10– 6:15	------	18.0	------	18.0	1.0186	--------	1.0187	25.4	------	25.5
	Do	9:45	------	17.0	------	------	1.0178	--------	--------	24.3	------	------
	Do	14:17–14:23	24.8	17.9	------	17.3	1.0184	--------	1.0182	25.1	------	24.8
	Do	17:53	------	------	20.0	------	--------	1.0190	--------	------	25.8	------
		Mean	------	------	------	------	1.0183	1.0190	1.0184	25.0	25.8	25.0
				3 ft.	*10 ft.*		*3 ft.*	*10 ft.*		*3 ft.*	*10 ft.*	
94	June 12	21:50–22:10	17.2	16.0	14.8	------	1.0184	1.0182	--------	25.1	24.8	------
	June 13	5:40– 5:50	16.5	15.5	14.7	------	1.0183	1.0181	--------	25.0	24.7	------
	Do	14:10–14:15	26.6	18.0	17.8	------	1.0186	1.0198	--------	25.4	26.9	------
		Mean	------	------	------	------	1.0184	1.0187	--------	25.2	25.5	------
				10 ft.	*24 ft.*	*38 ft.*	*10 ft.*	*24 ft.*	*38 ft.*	*10 ft.*	*24 ft.*	*38 ft.*
102	June 24	22:10–22:20	23.6	18.9	18.5	18.0	1.0186	1.0187	1.0187	25.4	25.5	25.5
	June 25	6:10– 6:20	22.0	16.5	16.0	16.0	1.0192	1.0191	1.0193	26.1	26.0	26.3
	Do	14:10–14:20	28.0	17.0	19.0	16.0	1.0192	1.0194	1.0196	26.1	26.4	26.7
		Mean	------	------	------	------	1.0190	1.0191	1.0192	25.9	26.0	26.2
				12 ft.	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*
103	June 24	22:10–22:20	21.2	18.3	17.4	15.0	1.0181	1.0184	1.0185	24.7	25.1	25.2
	June 25	6:15– 6:24	22.0	17.4	16.7	15.7	1.0185	1.0186	1.0188	25.2	25.4	25.6
	Do	13:45–14:15	27.0	------	------	------	1.0186	1.0187	1.0186	25.4	25.5	25.4
		Mean	------	------	------	------	1.0184	1.0186	1.0186	25.1	25.3	25.4
				12 ft.	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*
104	June 24	17:05–17:15	26.8	17.5	17.0	16.2	1.0186	1.0188	1.0189	25.4	25.6	25.8
	Do	22:10–22:22	21.8	18.1	16.2	16.0	1.0189	1.0189	1.0185	25.8	25.8	25.2
	June 25	6:10– 6:20	23.5	18.5	18.2	17.8	1.0189	1.0188	1.0190	25.8	25.6	25.9
	Do	14:10–14:20	27.0	19.0	18.6	18.0	1.0188	1.0186	1.0183	25.6	25.4	25.0
		Mean	------	------	------	------	1.0188	1.0188	1.0187	25.6	25.6	25.5

Part II.—BLOCK ISLAND SOUND

GENERAL CHARACTERISTICS OF BLOCK ISLAND SOUND AND ITS TRIBUTARIES

Block Island Sound is a deep, navigable waterway which forms the eastern approach to Long Island Sound, Fishers Island Sound, and Gardiners Bay from the Atlantic Ocean. It has two entrances from the Atlantic Ocean, an eastern entrance between Block Island and Point Judith, R. I., and a southern entrance between Block Island and Montauk Point, Long Island. It is separated from Long Island Sound by the passage known as The Race and by the passages between the Gull Islands and also between Great Gull and Plum Islands. These passages have been described above in connection with the eastern entrances to Long Island Sound. Block Island Sound is separated from Fishers Island Sound by the several passages located between rocky reefs along the stretch from Watch Hill Point, R. I., to East Point, Fishers Island.

As outlined for discussion in this publication the limits of Block Island Sound proper are defined as follows: Its northern boundary comprises the coast of Rhode Island from Point Judith to Watch Hill Point and the chain of islands between the latter and Orient Point, Long Island, including Fishers, Little Gull, Great Gull, and Plum Islands; its western limit comprises the eastern shore of Gardiners Island, N. Y., and the passages north and south of the latter forming the approaches to Gardiners Bay; its southern limit comprises the coast of Long Island from Goff Point, Napeague Bay, to Montauk Point and the southern entrance to the sound between the latter and Southwest Point, Block Island; and its eastern limit comprises the western shore of Block Island from Southwest Point to Sandy Point and the eastern entrance to the sound between the latter and Point Judith, R. I.

As defined in this publication, Block Island Sound also includes Gardiners Bay, Shelter Island Sound, and the Peconic Bays, these waterways geographically comprising the western extremity of Block Island Sound just as Fishers Island Sound may be considered as the eastern extremity of Long Island Sound.

The axis of Block Island Sound, like that of Long Island Sound, extends in a northeasterly-southwesterly direction. Measured along its axis from a point off Point Judith, R. I., to Gardiners Island, N. Y., Block Island Sound proper is approximately 32 nautical miles in length. Its maximum width from its southern entrance to Watch Hill Point, R. I., is approximately 13 nautical miles. Depths of 15 fathoms or more are found along its axis with the exception of Cerberus Shoal, a small, rocky shoal, located midway between Wilderness Point, Fishers Island, and Shagwong Point, Long Island, and over which but 2¼ fathoms obtain.

The eastern entrance to Block Island Sound is about 9 nautical miles in extent with depths greater than 10 fathoms obtaining over

a stretch of more than 5 miles. Maximum depths of 25 fathoms are found along this entrance about 2½ miles northeast of Sandy Point, Block Island. Block Island, located about 8 miles offshore, is about 5 miles in length and varies from about 1 to 3 miles in width. In the central portion of this island is Great Salt Pond, about 1 square mile in area, which is connected with Block Island Sound by means of a narrow entrance on the western shore of the island.

The southern entrance to Block Island Sound is approximately 12½ nautical miles in extent with depths greater than 10 fathoms obtaining over a stretch of but 2½ miles in an area located somewhat nearer Block Island than Long Island. A maximum depth of about 25 fathoms is found along this entrance. Bowlders, rocks, and rocky ledges and shoals extend offshore approximately 3 miles from Southwest Point, Block Island, and Montauk Point, Long Island. Rocky shoals and reefs are also found in Block Island Sound some 2 miles from Shagwong Point, Long Island, to the northwestward of Montauk Point.

Gardiners Bay, a large bay some 35 or 36 square miles in area, is located at the eastern end of Long Island and is that waterway bounded by Gardiners, Plum, Shelter, and Long Islands. Average depths of about 6 fathoms are found in this waterway. Along its northern entrance from Block Island Sound good depths upward of 6 fathoms obtain in the 3-mile stretch from Gardiners Point to Plum Island. In the middle portion of this entrance depths of over 20 fathoms are found.

The southern entrance from Block Island Sound to Gardiners Bay, or, strictly speaking, from Napeague Bay to Gardiners Bay is about 2½ miles in extent from Cartwright Island, a small island south of Gardiners Island to Goff Point, Long Island. This entrance is marked by shoals which extend westward over a considerable area of approximately 6 square miles. These shoal areas are separated by several channels in which the tidal currents have considerable velocity.

Shelter Island Sound and the Peconic Bays extend westward from Gardiners Bay about 22 miles to Riverhead, the head of navigation on the Peconic River. Shelter Island Sound is that waterway which surrounds Shelter Island and separates it from Long Island. It may be considered as having two parts—a northern and a southern—each of approximately 8 nautical miles in length. From Gardiners Bay the northern part may be considered to extend from the vicinity of Ram Head, Shelter Island, around Hay Beach Point, Shelter Island, to the vicinity of the entrance to Noyack Bay. The southern part extends from a buoyed channel northeast of Cedar Point, Long Island, around the southern shore of Shelter Island to the vicinity of Noyack Bay. Harbors of considerable local importance are Greenport and Orient on the northern part of this sound and Sag Harbor on the southern.

The Peconic Bays are located to the westward of Shelter Island Sound and Noyack Bay and are divided into Little Peconic Bay and Great Peconic Bay by Robins Island, a small island 1½ miles in length and situated about one-half mile south from Suffolk, Long Island. From the southern end of Robins Island to Cow Neck, Long Island, there is a stretch of water about three-fourths mile in width which includes a narrow, buoyed channel of 16-foot depth which is used by most vessels passing between the Peconic Bays.

Little Peconic Bay is about 5 miles long and 4 miles wide and has mid-channel depths of over 5 fathoms. It lies immediately west of Shelter Island Sound and serves as the approach to Great Peconic Bay. The latter is approximately circular in form and is about 5 miles in diameter. It is used primarily by small craft, chiefly motor boats and serves as the approach to Shinnecock Canal. The latter, about three-fourths mile in length, connects Great Peconic Bay with Shinnecock Bay and serves as one of the connecting links between the bays on the south side of Long Island and Eastern Long Island and Block Island Sounds.

THE TIDE AND CURRENT IN BLOCK ISLAND SOUND

Tides have been observed at several stations in Block Island Sound and vicinity since 1839 when a short series was obtained at Watch Hill Light, R. I., in connection with an early hydrographic survey. The locations of seven tide stations occupied in this waterway are shown in Figure 35 and the results of observations at these stations are given in Table 73.

An explanation is necessary concerning some of the station locations shown in Figure 35. The location of station 1 is an approximate location at which the several series of tidal observations were obtained from time to time in the vicinity of Point Judith, R. I. For instance, the 1884 series was obtained at a point about one-fourth mile north of Point Judith Light; the series of 1844 and 1845 were obtained in the vicinity of Point Judith Light; the series of 1896, 1903–1904 (Corps of Engineers, U. S. Army), 1913, and 1919 were obtained inside the inner breakwater near the shore end of same and about one-fourth mile west of Point Judith Light; while the 1904 series (Aug. 27–Sept. 2) was obtained at a point near the southern end of the outer breakwater, about 1¼ miles west of Point Judith Light.

Station 3, located at Block Island Harbor, Block Island, is not in Block Island Sound but is included for sake of completeness. Several series of tidal observations, including a 17-month series in 1882–1883, have been obtained at this station and will be discussed at length in later paragraphs.

Stations 4 and 5 are located at the entrance to Great Salt Pond, Block Island, and the south end of Great Salt Pond, respectively. The various series of tidal observations at station 6 were obtained in the vicinity of Fishermans Cove, about one-half mile west of Montauk Point Light.

In addition to the seven stations shown in Figure 35, tides have been observed at four other localities which might be included in Block Island Sound, namely, Watch Hill Point (R. I.), East Point (Fishers Island), Race Point (Fishers Island), and Little Gull Island Light. The locations of the first two of these four stations are shown above in Figure 10 and the results from observations at these stations are given in Table 48, on page 51, in connection with a discussion of the tide in Fishers Island Sound, while the locations of the latter two are shown above in Figure 8 and the results from observations at these stations are given in Table 44, on page 40, in connection with a discussion of the tide in The Race and Plum Gut.

The results from the earlier series at tide stations in Block Island Sound are generally obtained from observations made by means of staff readings. The 1903–04 and 1919 series at Point Judith, R. I.,

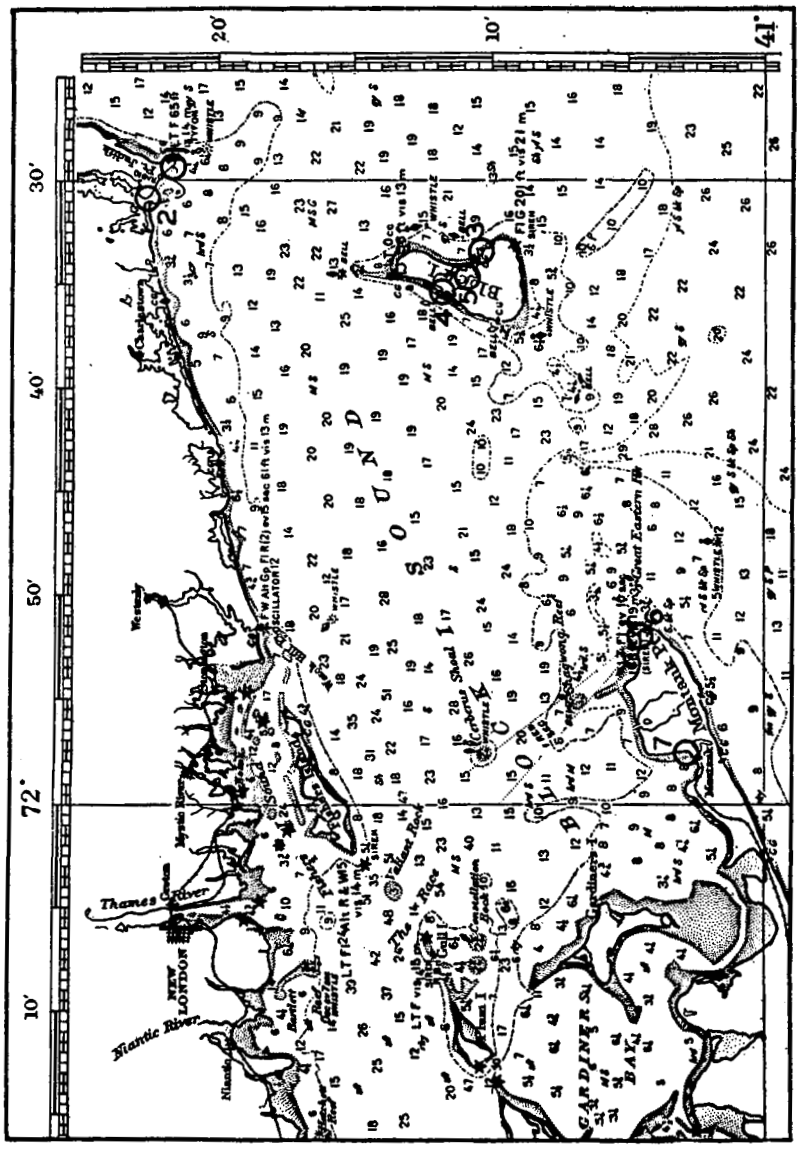

FIGURE 35.—Tide stations, Block Island Sound and vicinity

the 1882–83 series at Block Island Harbor, Block Island, and the 1930 series at stations 2, 3, 4, 5, and 6 were obtained by means of automatic tide gages.

TABLE 73.—*Tidal data, Block Island Sound and vicinity, 1844–1930*

Station No.	Location	Observations: Date	Observations: Period	Lunitidal intervals: HWI	Lunitidal intervals: LWI	Duration of rise	Mean range	Compared with—
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Point Judith, R. I.	June 20–Aug. 31, 1844	68	7.57	1.32	6.25	3.36	
		June 3–Oct. 22, 1845	133	7.52	1.33	6.19	3.07	
		Nov. 12–13, 1884	2	7.87	1.27	6.60	3.13	Pulpit Harbor, Me.
		June 22–23, 1896	2	7.72	1.57	6.15	3.11	Block I. Harbor.
		Nov. 20, 1903–June 30, 1904	91				3.34	(1).
		Aug. 27–Sept. 2, 1904	5	7.44	1.28	6.16	3.26	Fort Hamilton, N. Y.
		June 9–17, 1913	6	7.69	0.97	6.72	3.00	Sandy Hook, N. J.
		June 18–Aug. 31, 1919	75	7.80	1.61	6.19	3.00	Fort Hamilton, N. Y.
2	Creek, entrance to Point Judith Pond	Aug. 16–21, 1930	6	8.45	1.43	7.02	2.80	Newport, R. I.
3	Block Island Harbor, Block Island	Aug. 8–Oct. 14, 1855	67	7.60	1.22	6.38	2.89	
		Aug. 20–Nov. 9, 1878	82	7.23	0.92	6.31	2.88	
		July 27, 1882–Dec. 31, 1883	533	7.55	1.15	6.40	2.96	
		Jan. 1–18, 1884	18				3.02	Pulpit Harbor, Me.
		Oct. 2–31, 1895	8	7.34	1.11	6.23	3.33	Fort Hamilton, N. Y.
		May 29–June 23, 1896	4	7.57	0.53	7.04	3.17	Do.
		Aug. 21–27, 1930	6	7.67	0.44	7.23	2.90	Newport, R. I.
4	Entrance to Great Salt Pond, Block Island	July 16–Sept. 6, 1912	11	7.64	1.08	6.56	2.92	Sandy Hook, N. J.
		Aug. 11, 1915	1		1.22			Do.
		May 15–July 5, 1918	30	7.78	1.38	6.40	2.59	Fort Hamilton, N. Y.
		July 16–Oct. 10, 1918	40	7.72	1.56	6.16	2.83	Do.
		Aug. 29–30, 1930	2	7.91	1.61	6.30	3.04	Newport, R. I.
5	South end of Great Salt Pond, Block Island	June 21–Sept. 25, 1912	80	7.85	1.24	6.61	2.81	Sandy Hook, N. J.
		Aug. 12–31, 1915	11	7.88	1.16	6.72	2.75	Do.
		July 28–Nov. 7, 1919	43	7.49	1.62	5.87	2.80	Fort Hamilton, N. Y.
		Aug. 21–23, 1930	3	7.93	1.69	6.24	3.01	Newport, R. I.
6	Montauk Point, Long Island	June 23–Sept. 4, 1848	61	8.25	2.03	6.22	1.96	
		Oct. 27–Nov. 27, 1855	32	8.48	2.00	6.48	1.98	
		Nov. 5, 1895	1	8.62	2.29	6.33	2.30	Fort Hamilton, N. Y.
		May 25–Sept. 1, 1896	35	8.55	1.88	6.67	2.11	Do.
		Aug. 25–Sept. 30, 1897	20	8.70	2.10	6.60	2.19	Do.
		Aug. 23–Sept. 21, 1916	11	8.25	1.68	6.57	1.86	Sandy Hook, N. J.
		Aug. 15–20, 1930	6	8.66	1.27	7.39	2.03	Newport, R. I.
7	Fort Pond Bay, Long Island	Sept. 9–Oct. 19, 1882	12	9.02	3.17	5.85	2.18	New London, Conn.
		Aug. 20–Nov. 5, 1895	32	8.98	3.05	5.93	2.30	Fort Hamilton, N. Y.
		Sept. 6–Oct. 7, 1916	15	8.57	2.97	5.60	2.34	Do.

[1] From tide records furnished by the Corps of Engineers, U. S. Army.

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Except as indicated, the values in Table 73 were derived from observations obtained by the Coast and Geodetic Survey. Where it was possible to do so, short series of observations were compared with simultaneous observations at a long-period standard, or primary, tide station in order to reduce the results to mean values. It will be noted from the data in the table that the results from various series at the same station generally agree quite closely, especially if such series of observations are of a fortnight or longer in duration.

The relatively long series of observations obtained at Block Island Harbor, Block Island (station 3), from July 27, 1882, to December 31, 1883, was simultaneous with that obtained at Fort Trumbull, New London, Conn. The results from the latter were discussed at length in connection with the tide at New London, Conn.

In addition to the values for high-water interval, low-water interval, duration of rise, and mean range of tide for the 1882–83 series of observations at Block Island Harbor, as given in Table 73, other data have been derived from such series of observations at this station which may be of considerable value, as follows:

Great tropic range	feet	3.39
Mean tropic range	do	2.94
Small tropic range	do	2.49
Tropic high-water inequality	do	0.59
Tropic low-water inequality	do	0.31
Tropic higher high water interval	hours	7.45
Tropic lower low water, interval	do	0.54
Mean tide level on staff	feet	2.80
Mean sea level on staff	do	2.78
Mean tide level above mean sea level	do	0.02

In deriving the above values, the tropic ranges, inequalities, and intervals were obtained from tabulations of tides at times of maximum declination of the moon during the period August, 1882–July, 1883, inclusive. The values for mean tide level and mean sea level are the yearly means of 12 monthly mean values for the period August, 1882–July, 1883, inclusive. These monthly mean values are derived from a tabulation of all tides observed during the month.

Owing to the fact that the results from the various series of observations at each tide station in Block Island Sound give somewhat different values, depending upon length of series, method of observation, effect of weather conditions, etc., the results from observations as given in Table 73 were subjected to an adjustment process in order to arrive at standard values, giving due weight to the lengths of series at each station. The adjusted values for each tide station in this waterway are given in Table 74.

TABLE 74.—*Adjusted tidal data, Block Island Sound and vicinity*

Station No.	Locality	Lunitidal intervals		Duration of rise	Range of tide		
		HWI	LWI		Mean	Spring	Neap
		Hours	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*
1	Point Judith, R. I.	7.75	1.50	6.25	3.1	3.8	2.4
2	Creek, entrance to Point Judith Pond	8.45	1.45	7.00	2.8	3.4	2.1
3	Block Island Harbor, Block Island	7.55	1.15	6.40	3.0	3.6	2.3
4	Entrance to Great Salt Pond, Block Island	7.75	1.45	6.30	2.8	3.4	2.1
5	South end of Great Salt Pond, Block Island	7.80	1.50	6.30	2.8	3.4	2.1
6	Montauk Point, Long Island	8.45	1.90	6.55	2.0	2.4	1.5
7	Fort Pond Bay, Long Island	8.90	3.05	5.85	2.2	2.7	1.7

In Table 74 the high and low water lunitidal intervals and duration of rise of tide at each station are given in hours. The duration of rise of tide is obtained by subtracting the low-water interval from the high-water interval.

In addition to the values for mean range of tide for each station, there are also given the approximate values for spring and neap ranges. The latter were obtained through the application of factors to the values for mean range as follows: Spring range = mean range × 1.21; neap range = mean range × 0.76. These formulæ were obtained by comparing the relation of harmonic tidal constants at Newport, R. I., and Bristol, R. I., with those at New London, Conn.

It will be noted from the data in Table 74 that there is a decrease in range of tide from Point Judith, R. I., to Montauk Point, Long Island, of about 1 foot. Reference to the data in Table 57 on page 75 will likewise show a decrease of about one-half foot in range along the north shore of Block Island Sound from Point Judith, R. I., to Little Gull Island Light. From Montauk Point westward the range of tide increases. A similar condition obtains along the northern limit of Block Island Sound westward of Little Gull Island Light.

While the time of tide at the entrance to Great Salt Pond, Block Island, occurs approximately at the same time as that at Point Judith, R. I., on the mainland, it will be noted from the data in Table 74 that the time of tide at Montauk Point, Long Island, occurs about one-half to three-fourths of an hour later than it does at Point Judith. The progression of the tide wave from Montauk Point to Fort Pond Bay, over a stretch of about 7 miles, is greatly retarded by the shoals and reefs north of Shagwong Point. The observations show that high water and low water at Fort Pond Bay occur about half an hour and one hour later, respectively, than they do at Montauk Point. Likewise, as should be expected, there is a retardation in the time of occurrence of the tide along the northern limit of Block Island Sound, as will be observed from the lunitidal intervals for Watch Hill Point and Little Gull Island Light in Table 57 as compared with those for Point Judith, both high and low water at Little Gull Island Light occurring about two hours later than the occurrence of such phenomena at Point Judith.

Tidal currents have been observed by the Coast and Geodetic Survey at 59 stations in Block Island Sound. The locations of the current stations in Block Island Sound are shown in Figure 36 and the results from observations near the surface at these stations are given in Table 75. Stations 15 to 30, inclusive, in the vicinity of Block Island, have been also plotted on a larger scale in Figure 37 on page 161. This was thought to be advisable on account of the fact that several of the current stations in the vicinity of Block Island were located near one another.

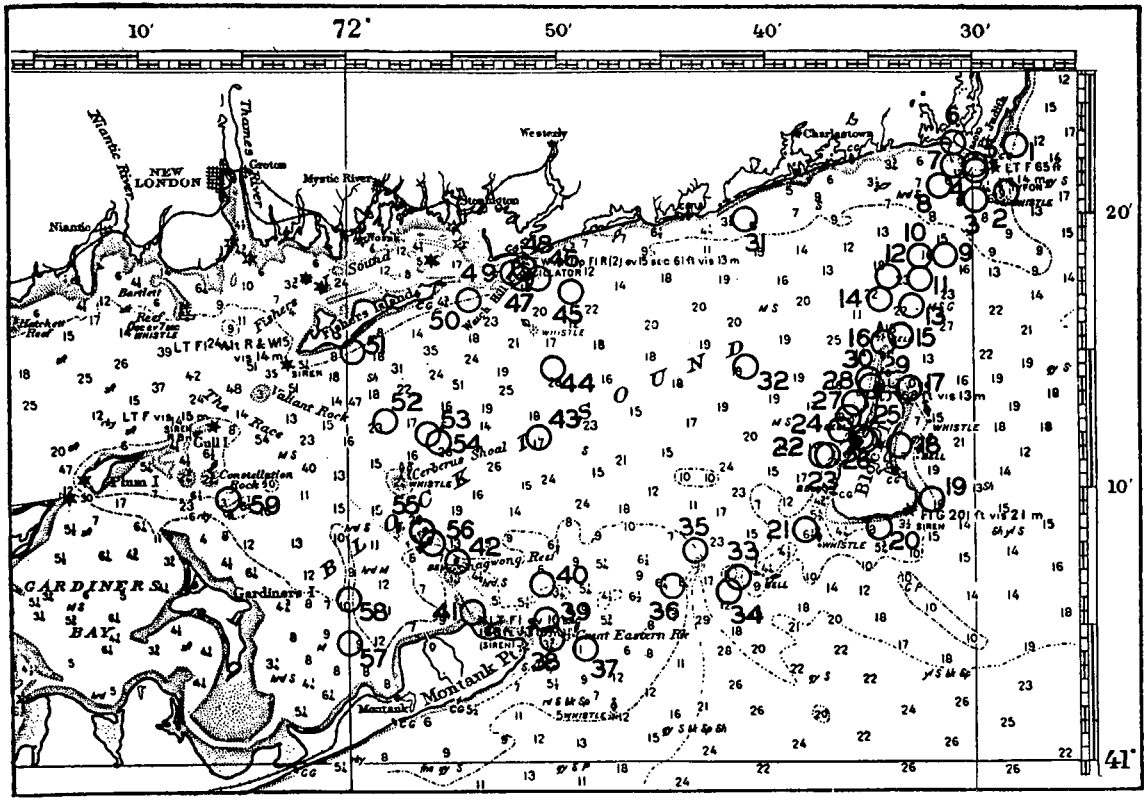

FIGURE 36.—Current stations, Block Island Sound and vicinity

TABLE 75.—*Results from current observations near the surface, Block Island Sound and vicinity*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Vicinity of Point Judith, R. I.		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	J. C. Sammons	Off Peaked Rock	Aug. 29-30, 1930	1	Pole	3¼	(1)	0.02	194	0.35	------	(1)	−1.08	48	0.35	------	0.52
2	F. B. T. Siems	South of Point Judith Light	June 30-July 1, 1919	1	do	7	−1.03	−0.50	261	0.88	6.41	−0.45	−0.74	63	0.76	6.01	0.45
3	J. C. Sammons	do	Aug. 18-19, 1930	1	do	3¼	−1.38	−0.93	273	1.25	7.32	0.11	−0.23	105	0.90	5.10	0.52
4	do	South entrance, Harbor of Refuge.	Aug. 19-20, 1930	1	do	3¼	−2.96	−4.18	334	0.74	6.05	−2.74	−2.08	164	0.94	6.37	10.56
5	F. B. T. Siems	do	June 23-25, 1919	2⅓	do	7	−1.96	−2.35	346	0.76	5.24	−2.55	−1.66	155	1.05	7.18	11.42
6	J. C. Sammons	Mouth of creek, entrance to Point Judith Pond.	Aug. 19-20, 1930	1	do	3½	−3.11	−1.58	(2)	2.97	6.45	−2.49	−3.08	(2)	2.67	5.97	10.99
7	do	West entrance, Harbor of Refuge.	do	1	do	7	−1.96	−3.78	265	0.38	4.05	−3.74	−2.18	144	0.58	8.37	10.63
8	do	Off Harbor of Refuge	do	1	do	7	−1.71	−1.08	309	0.82	7.10	−0.44	−0.53	138	0.57	5.32	0.19
		Between Point Judith and Block Island															
9	J. C. Sammons	Mid sound	Aug. 18-19, 1930	1	Pole	7	−1.61	−0.43	294	0.96	8.55	1.11	0.57	89	0.81	3.87	1.04
10	F. B. T. Siems	do	June 30-July 1, 1919	1	do	7	0.62	0.45	286	0.76	5.11	−0.10	0.51	80	0.81	7.31	1.50
11	J. C. Sammons	do	Aug. 18-19, 1930	1	do	7	−0.71	−0.33	275	0.69	7.05	0.51	−0.43	59	0.89	5.37	0.89
12	W. S. Benson	do	June 22, 1896	¼	do	7	0.82	------	(3) 290	------	------	------	------	(3) 110	------	------	2.21
13	J. R. Goldsborough	do	Aug. 7-8, 1846	1	Float	(4)	−0.29	−0.82	343	1.36	5.92	−0.20	−0.32	68	2.40	6.50	0.72
14	W. S. Benson	do	June 23, 1896	½	Pole	7	−0.58	------	(3) 300	------	7.21	0.80	------	(3) 90	------	5.21	1.31
		Vicinity of Block Island															
15	F. G. Engle	North of Sandy Point	Aug. 11, 20, 1915	⅚	Pole	7	−0.58	−0.53	310	2.00	5.71	−0.70	−0.57	79	2.40	6.71	0.53
16	F. B. T. Siems	do	June 18-20, 1919	2⅙	do	7	−0.28	−0.77	319	1.78	4.56	−1.55	−1.36	47	1.90	7.86	0.14
17	J. C. Sammons	Off Grove Point	Aug. 25-26, 1930	1	do	7	−4.36	−3.18	323	1.50	9.10	−1.09	−2.18	136	0.30	3.32	10.85
18	do	North of Block Island Harbor	do	1	do	7	−3.16	−2.43	7	0.27	9.45	0.46	−0.88	200	0.07	2.97	12.05
19	do	Off Old Harbor Point	do	1	do	3½	−0.16	−0.68	336	0.21	5.30	−0.69	−0.03	175	0.61	7.12	0.74
20	do	Off southern coast of Block Island.	do	1	do	3¼	−3.96	−3.58	276	0.26	7.83	−1.96	−2.33	61	0.16	4.59	10.59

See footnotes at end of table.

TABLE 75.—*Results from current observations near the surface, Block Island Sound and vicinity*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
				Days		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
21	J. C. Sammons	Off Southwest Point	Aug. 26–27, 1930	1	Pole	3¼	−1.56	−1.38	318	1.53	6.66	−0.73	−1.18	170	1.73	5.76	12.34
22	F. B. T. Siems	Off Graces Point	May 22, 1918	¼	do	7							0.47	220	0.40		10.80
23	do	do	July 1–2, 1918	1⅓	do	7	−3.16	−2.45	25	0.36	5.79	−3.20	−3.07	160	0.21	6.63	10.58
24	do	Off entrance to Great Salt Pond.	July 1–3, 1918	2	do	7	−0.39	−0.28	157	0.36	5.21	−1.03	−0.24	60	0.31	7.21	0.65
25	J. C. Sammons	Entrance to Great Salt Pond	Aug. 29–30, 1930	1	do	7	−3.96	−3.28	145	0.58	6.00	−3.79	−4.28	332	0.53	6.42	9.72
26	F. G. Engle	do	Aug. 24, 31, 1915	½	do	7	−4.79	−4.70	144	0.40	6.96	−3.66	−4.24	313	0.40	5.46	9.20
27	F. B. T. Siems	North of entrance to Great Salt Pond.	May 20–22, 1918	2	do	7	−1.50	−1.95	160	0.41	4.55	−2.78	−1.07	10	0.44	7.87	11.73
28	do	do	July 1–3, 1918	2	do	7	0.00	−0.45	150	0.31	4.71	−1.12	−0.82	20	0.44	7.71	0.53
29	do	Off Sandy Point	July 2–4, 1918	1½	do	7	−0.41	−1.62	157	0.40	4.54	−1.70	−0.91	10	0.60	7.88	12.39
30	do	do	May 21, 1918	¼	do	7							−1.32	5	0.80		12.05
		Block Island Sound															
31	J. C. Sammons	Off Charlestown Pond, about 1 mile.	Aug. 14–16, 1930	1½	Pole	7	−0.31	0.45	251	0.93	6.48	0.34	−0.18	57	0.79	5.94	1.21
32	do	Off Charlestown Pond, mid sound.	do	1½	do	3¼	0.46	0.99	296	0.76	5.98	0.61	1.07	75	0.91	6.44	1.91
		Between Block Island and Montauk Point, Long Island															
33	J. C. Sammons	Off Southwest Ledge	Aug. 26–27, 1930	1	Pole	7	−0.46	−0.83	325	1.36	6.25	−0.04	0.07	150	2.31	6.17	0.81
34	W. S. Benson	do	June 19, 1896	⅓	do	7	−0.33	−0.41	340	2.00			−0.03	145	2.50		0.91
35	J. R. Goldsborough	do	Aug. 23–24, 1846	1	Float	(4)	−0.43	0.25	306	1.32	6.02	−0.24	0.00	132	2.46	6.40	1.03
36	J. C. Sammons	do	Aug. 26–27, 1930	1	Pole	7	−0.91	−0.98	333	1.66	6.30	−0.44	−0.78	142	1.76	6.12	0.35
		Vicinity of Montauk Point, Long Island															
37	J. R. Goldsborough	Off Great Eastern Rock	Aug. 30–31, 1846	1	Float	(4)	−0.98	−0.24	349	1.75	6.51	−0.30	−0.50	157	2.01	5.91	0.63
38	J. C. Sammons	Off Montauk Point	Aug. 26–27, 1930	1	Pole	3½	−2.36	−1.68	4	2.60	6.95	−1.24	−1.88	153	1.65	5.47	11.76
39	J. R. Goldsborough	do	Sept. 3–4, 1848	1	Float	(4)	−1.52	−0.97	348	2.06	6.27	−1.08	−1.69	138	2.48	6.15	12.23
40	do	North of Montauk Point	Aug. 29–30, 1846	1	do	(4)	−1.72	−2.17	310	1.85	5.89	−1.66	−1.97	130	1.73	6.53	11.67
41	J. C. Sammons	Off Shagwong Point	Aug. 27–28, 1930	1	Pole	3½	−1.91	−2.63	266	0.95	4.85	−2.89	−1.63	88	1.35	7.57	11.29
42	J. H. Hawley	Off Shagwong Reef	Sept. 7, 1916	¼	do	7	−1.50	−1.45	274	1.50							12.22
		Block Island Sound															
43	J. C. Sammons	Mid sound, south of Watch Hill Point, R. I.	Aug. 14–16, 1930	1½	Pole	7	1.29	0.79	257	0.94	4.58	0.04	0.72	97	1.64	7.84	1.54
44	W. S. Benson	do	June 25, 1896	½	do	7	1.00	0.09	268	1.00	4.88	0.05	1.14	77	1.14	7.54	1.70
		Vicinity of Watch Hill Point, R. I.															
45	J. R. Goldsborough	Southeast of Watch Hill Point, about 2 miles.	Aug. 11–12, 1846	1	Float	(4)	−0.88	−0.84	274	0.93	6.37	−0.34	−0.45	119	0.82	6.05	0.50
46	do	Southeast of Watch Hill Point, about 1 mile.	July 20–21, 1848	1	do	(4)	−1.98	−0.64	277	1.14	7.18	−0.63	−0.37	58	1.45	5.24	0.23
47	J. C. Sammons	South of Watch Hill Point, about ½ mile.	Aug. 12–13, 1930	1	Pole	7	−1.01	−1.03	265	1.83	6.40	−0.44	−0.78	106	2.13	6.02	0.31
48	H. Burkhardt	Gangway Rock Gas Buoy, Watch Hill Passage.	July 6–Sept. 25, 1915	14	Buoy	(4)	−1.60				6.35	−1.08				6.07	12.28
49	G. S. Blake	West of Watch Hill Passage	July 8–10, 1845	2	Pole	9	−1.60	−1.07	278	1.27	6.18	−1.25	−1.29	94	1.26	6.24	12.25
50	J. C. Sammons	Southwest of Watch Hill Point, about 2½ miles.	Aug. 27–28, 1930	1	do	7	−1.26	−0.58	263	1.14	7.45	0.36	−0.38	83	1.19	4.97	0.67
		Vicinity of Fishers Island															
51	J. C. Sammons	Off Wilderness Point	Aug. 12–14, 1930	1	Pole	7	−0.66	−0.53	258	2.26	6.10	−0.39	−1.03	69	1.91	6.32	0.48
		Vicinity of Cerberus Shoal															
52	J. C. Sammons	Cerberus Shoal, about 2¼ miles north-northwest of.	Aug. 13–14, 1930	1	Pole	7	0.64	0.27	261	0.89	4.50	−0.69	−0.23	94	1.94	7.92	1.13
			Aug. 27–28, 1930	1	do	7	−1.01	−0.23	264	1.51	6.95	0.11	−0.23	96	1.11	5.47	0.79
53	P. M. Trueblood	Cerberus Shoal, about 2 miles north-northeast of.	Sept. 26, 1917	¼	do	7	−0.07	−0.03	248	1.38							1.32
54	J. R. Goldsborough	Cerberus Shoal, about 1¾ miles northeast of.	Aug. 12–13, 1846	1	Float	(4)	−0.21	0.42	274	1.15	6.78	0.74	0.90	84	1.60	5.64	1.59
55	P. M. Trueblood	Cerberus Shoal, about 2 miles south-southeast of.	Sept. 26, 1917	¼	Pole	7	−0.53	−0.67	261	1.48							0.68
56	J. C. Sammons	Cerberus Shoal, about 2½ miles south-southeast of.	Aug. 13–14, 1930	1	do	3¼	−0.11	−0.73	281	1.78	5.00	−0.94	−0.33	73	1.88	7.42	0.60
		Vicinity of Fort Pond Bay															
57	J. C. Sammons	Culloden Point, about 1¾ miles west by south of.	Aug. 12–13, 1930	1	Pole	3¼	−0.96	−2.03	214	0.49	3.50	−2.44	−0.88	64	0.44	8.92	11.97
58	J. R. Goldsborough	Culloden Point, about 2¼ miles northwest by west of.	Aug. 24–25, 1846	1	Float	(4)	−2.41	−2.38	262	0.83	6.55	−1.69	−1.66	76	0.93	5.87	11.51
		Approaches to Gardiners Bay															
59	J. R. Goldsborough	Little Gull Island Light, about 2¾ miles south by east of.	Aug. 31–Sept. 1, 1846	¾	Float	(4)	−0.65	−0.57	298	1.33	5.97	−0.51	−0.60	93	1.78	6.45	0.55

[1] Current weak, and times of slack water are indefinite. [2] Flood sets northerly, ebb southerly. [3] Approximate values. [4] Surface.

It will be noted that the majority of current stations occupied in Block Island Sound are located chiefly in the vicinity of Point Judith, Watch Hill Point, Montauk Point, and Block Island, and also along the following cross sections: Point Judith-Block Island, Block Island-Montauk Point, and Montauk Point-Fishers Island and Watch Hill Point. In general, the results shown in Table 75 are from observations obtained by means of a standard 15-foot current-pole and current-log line.

The times and durations of the current at each station in Table 75 are given in hours and are referred to the times of similar phases of the current at The Race. The velocities of the current have been corrected to a mean range of tide and represent average current conditions. These velocities of flood and ebb would increase or decrease proportionately as the range of the tide increased or decreased from a mean value.

The minus (−) sign in columns 8, 9, 13, and 14 means "earlier than." That is, the time of slack or strength of current is earlier than the same phase of the current at The Race. Where no sign precedes the time value it means that the time of current at the subordinate station occurs later than that at the reference, or standard, station.

The mean solar-current hour given in the last column of Table 75 has been referred to previously on page 33. It will be noted from the values for mean current hour that the time of current throughout Block Island Sound as a whole is generally earlier than that at the reference station, namely, The Race. However, along the axis of the sound from a point north of Block Island to the vicinity of The Race, the data for stations 10, 12, 14, 32, 43, 44, 53, and 54 show that the current along such axis occurs somewhat later than it does at the reference station. There is an acceleration in the time of current near the shore where the waters are much shoaler than in mid-channel. This acceleration is marked in the case of stations located in the vicinity of Point Judith, in the entrance to Great Salt Pond (Block Island), and in the shoal area north and west of Montauk Point.

The results given in Table 75 show that average velocities of the current in mid sound from a point north of Block Island to a point north of Cerberus Shoal vary from about 1.0 knot at the former locality to about 1.5 knots at the latter. Strong velocities averaging 2.0 knots or more occur at the eastern entrance to Block Island Sound in the vicinity of the gas and bell buoy north of the shoal extending from Sandy Point, Block Island. Likewise, strong velocities averaging 2 to 2½ knots or more occur at the southern entrance to Block Island Sound in the stretch between Montauk Point, Long Island, and Southwest Ledge, off Block Island.

Average current strengths of three-fourths knot on the flood and 1 knot on the ebb, respectively, are found at the south entrance to Point Judith Harbor of Refuge, according to the results from observations at stations 4 and 5, the time of current at this entrance occurring about two and one-half hours earlier than that at the reference station, namely, The Race. The results from observations at station 7 at the west entrance to Point Judith Harbor of Refuge show current strengths of about one-half knot, the time of current occurring about three hours earlier than that at The Race. The strong average current velocities of 2½ to 3 knots at station 6, located at the entrance to Point Judith Pond are accounted for by the narrow, 100-yard entrance itself and

the volume of water flowing in and out of Point Judith Pond on the flood and ebb, the area of the pond being approximately 3 square miles.

The results given in Table 75 show that along the eastern entrance to Block Island Sound from Point Judith to Block Island the duration of flood, in mid sound and along the coast of Rhode Island greatly

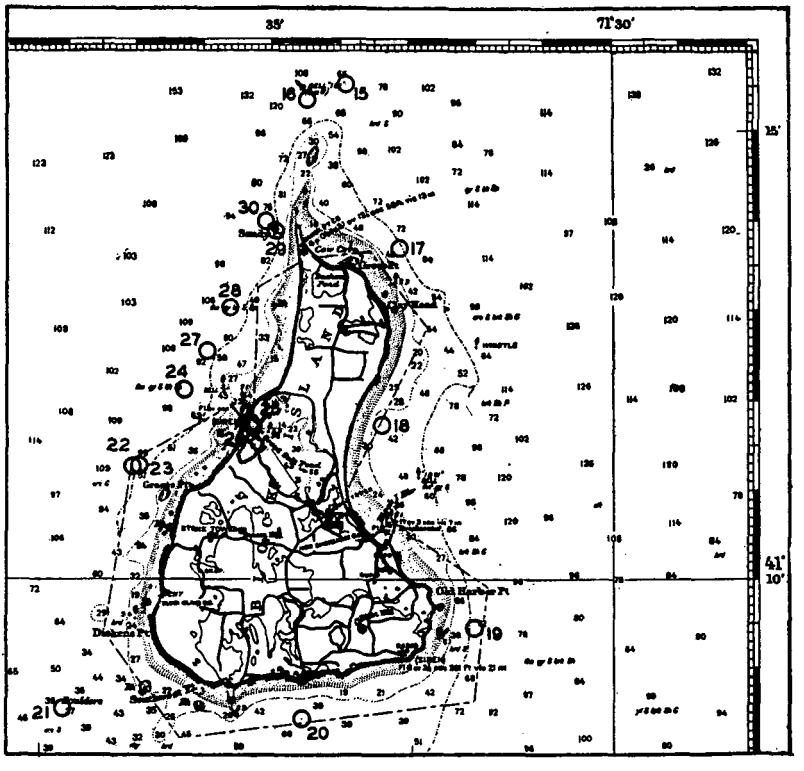

FIGURE 37.—Current stations, vicinity of Block Island

exceeds that of ebb, while along the northern end of Block Island the duration of ebb greatly exceeds that of flood.

At 29 of the 59 current stations occupied in Block Island Sound and vicinity, observations were made at various depths by means of current meter in addition to surface current measurements and the results from these observations are given in Table 76.

TABLE 76.—*Results from current observations at various depths, Block Island Sound and vicinity*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Vicinity of Point Judith, R. I.		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	J. C. Sammons	Off Peaked Rock	Aug. 29-30, 1930	1	Pole	3¼	(1)	0.02	194	0.35		(1)	−1.08	48	0.35		0.52
				1	Meter	13	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
				1	do	32											
				1	do	50											
3	do	South of Point Judith Light	Aug. 18-19, 1930	1	Pole	3¼	−1.38	−0.93	273	1.25	7.32	0.11	−0.23	105	0.90	5.10	0.52
				1	Meter	8	−1.58	−0.68		1.27	7.72	0.31	−0.33		1.02	4.70	0.56
				1	do	21	−1.48	−0.88		1.09	7.57	0.26	−0.43		0.94	4.85	0.50
				1	do	34	−1.51	−0.93		1.01	7.65	0.31	−0.23		0.76	4.77	0.54
4	do	South entrance, Harbor of Refuge.	Aug. 19-20, 1930	1	Pole	3¼	−2.96	−4.18	334	0.74	6.05	−2.74	−2.08	164	0.94	6.37	10.56
				1	Meter	7	−2.71	−3.58		0.64	6.15	−2.39	−1.83		0.99	6.27	10.92
				1	do	18	−2.71	−3.58		0.74	6.20	−2.34	−1.98		0.94	6.22	10.90
				1	do	29	−2.66	−3.58		0.62	6.05	−2.44	−1.93		0.82	6.37	10.90
6	do	Mouth of creek, entrance to Point Judith Pond.	do	1	Pole	3½	−3.11	−1.58	(3)	2.97	6.45	−2.49	−3.08	(3)	2.67	5.97	10.99
				1	Meter	6	−2.96	−2.43		2.81	6.45	−2.34	−2.98		2.66	5.97	10.87
				1	do	10	−2.96	−2.28		2.89	6.40	−2.39	−2.98		2.34	6.02	10.90
7	do	West entrance, Harbor of Refuge.	do	1	Pole	7	−1.96	−3.78	265	0.38	4.05	−3.74	−2.18	144	0.58	8.37	10.63
				1	Meter	5	−1.96	−3.78		0.48	3.95	−3.84	−2.08		0.53	8.47	10.63
				1	do	12	−1.96	−3.78		0.49	4.05	−3.74	−1.93		0.59	8.37	10.70
				1	do	18	−2.01	−3.88		0.36	4.00	−3.84	−2.03		0.41	8.42	10.61
8	do	Off Harbor of Refuge	do	1	Pole	7	−1.71	−1.08	309	0.82	7.10	−0.44	−0.53	138	0.57	5.32	0.19
				1	Meter	10	−2.16	−1.38		0.88	7.65	−0.34	−0.48		0.68	4.77	0.04
				1	do	24	−2.16	−0.93		0.71	7.55	−0.44	−0.48		0.61	4.87	0.13
				1	do	38	−2.21	−0.83		0.60	7.65	−0.39	−0.68		0.60	4.77	0.10
		Between Point Judith and Block Island															
9	do	Mid-sound	Aug. 18-19, 1930	1	Pole	7	−1.61	−0.43	294	0.96	8.55	1.11	0.57	89	0.81	3.87	1.04
				1	Meter	19	−1.71	−0.28		0.90	9.05	1.51	0.07		0.80	3.37	1.03
				1	do	48	−1.61	−0.08		0.79	8.90	1.46	−0.23		0.79	3.52	1.01
				1	do	77	−1.71	−0.72		0.73	9.30	1.76	−0.33		0.78	3.12	0.88
11	do	do	do	1	Pole	7	−0.71	−0.33	275	0.69	7.05	0.51	−0.43	59	0.89	5.37	0.89
				1	Meter	28	−0.71	−0.38		1.02	7.15	0.61	−0.43		0.82	5.27	0.90
				1	do	70	−0.66	−0.13		0.83	7.65	1.16	−0.33		0.68	4.77	1.14
				1	do	112	−0.81	−0.23		0.82	7.70	1.06	−0.43		0.62	4.72	1.03
		Vicinity of Block Island															
17	do	Off Grove Point	Aug. 25-26, 1930	1	Pole	7	−4.36	−3.18	323	1.50	9.10	−1.09	−2.18	136	0.30	3.32	10.85
				1	Meter	13	−4.31	−3.08		1.33	9.05	−1.09	−2.18		0.33	3.37	10.89
				1	do	32	−4.51	−3.03		1.22	9.40	−0.94	−2.33		0.22	3.02	10.85
				1	do	50	−4.61	−2.98		1.07	9.30	−1.14	−2.33		0.17	3.12	10.79
18	do	North of Block Island Harbor	do	1	Pole	7	−3.16	−2.43	7	0.27	9.45	0.46	−0.88	200	0.07	2.97	12.05
				1	Meter	8	−3.36	−2.03		0.28	9.50	0.31	−1.08		0.23	2.92	12.01
				1	do	21	−3.46	−1.68		0.28	9.70	0.41	−1.08		0.23	2.72	12.10
				1	do	34	−3.46	−1.58		0.28	9.85	0.56	−1.03		0.23	2.57	12.17
19	do	Off Old Harbor Point	do	1	Pole	3½	−0.16	−0.68	336	0.21	5.30	−0.69	−0.03	175	0.61	7.12	0.74
				1	Meter	12	−0.31	−0.58		0.28	5.55	−0.59	0.07		0.68	6.87	0.78
				1	do	29	−0.41	−0.58		0.31	5.75	−0.49	0.17		0.56	6.67	0.80
				1	do	46	−0.31	−0.58		0.33	5.65	−0.49	0.17		0.43	6.77	0.83
20	do	Off southern coast of Block Island.	do	1	Pole	3¼	−3.96	−3.58	276	0.26	7.83	−1.96	−2.33	61	0.16	4.59	10.59
				1	Meter	11	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
				1	do	27											
				1	do	43											
21	do	Off Southwest Point	Aug. 26-27, 1930	1	Pole	3¼	−1.56	−1.38	318	1.53	6.66	−0.73	−1.18	170	1.73	5.76	12.34
				1	Meter	9	−1.61	−1.43		1.37	6.58	−0.86	−0.98		1.62	5.84	12.33
				1	do	22	−1.56	−1.38		1.26	6.60	−0.79	−1.03		1.51	5.82	12.36
				1	do	36	−1.56	−1.23		1.22	6.60	−0.79	−1.13		1.22	5.82	12.37
25	do	Entrance to Great Salt Pond	Aug. 29-30, 1930	1	Pole	7	−3.96	−3.28	145	0.58	6.00	−3.79	−4.28	332	0.53	6.42	9.72
				1	Meter	5	−3.66	−3.28		0.46	5.80	−3.69	−4.28		0.46	6.62	9.82
				1	do	14	−3.76	−3.38		0.68	5.85	−3.74	−4.33		0.53	6.57	9.75
				1	do	22	−3.91	−3.48		0.57	6.05	−3.69	−3.98		0.47	6.37	9.79
		Block Island Sound															
31	do	Off Charlestown Pond, about 1 mile.	Aug. 14-16, 1930	1½	Pole	7	−0.31	0.45	251	0.93	6.48	0.34	−0.18	57	0.79	5.94	1.21
				1½	Meter	7	−0.48	0.39		1.12	6.95	0.64	−0.08		0.89	5.47	1.25
				1½	do	17	−0.48	0.39		1.05	6.89	0.58	−0.18		0.88	5.53	1.21
				1½	do	27	−0.41	0.35		0.92	6.88	0.64	−0.18		0.72	5.54	1.23
32	do	Off Charlestown Pond, mid-sound.	do	1½	Pole	3¼	0.46	0.99	296	0.76	5.98	0.61	1.07	75	0.91	6.44	1.91
				1½	Meter	22	0.16	0.22		1.07	5.85	0.18	0.77		0.72	6.57	1.46
				1½	do	56	−0.31	0.02		0.99	6.32	0.18	0.62		0.71	6.10	1.26
				1½	do	89	−0.45	−0.28		1.10	6.46	0.18	0.52		0.67	5.96	1.12

See footnotes at end of table.

TABLE 76.—*Results from current observations at various depths, Block Island Sound and vicinity*—Continued

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Between Block Island and Montauk Point, Long Island		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
33	J. C Sammons	Off Southwest Ledge	Aug. 26-27, 1930	1	Pole	7	−0.46	−0.83	325	1.36	6.25	−0.04	0.07	150	2.31	6.17	0.81
				1	Meter	13	−0.46	−0.78		1.35	6.30	0.01	0.07		2.35	6.12	0.84
				1	do	32	−0.56	−0.98		1.35	6.10	−0.29	−0.03		2.05	6.32	0.67
				1	do	50	−0.56	−1.03		1.17	6.00	−0.39	−0.03		1.87	6.42	0.63
36	do	do	do	1	Pole	7	−0.91	−0.98	333	1.66	6.30	−0.44	−0.78	142	1.76	6.12	0.35
				1	Meter	12	−0.86	−1.18		1.56	6.20	−0.49	−0.73		1.81	6.22	0.31
				1	do	30	−0.91	−1.13		1.47	6.15	−0.59	−0.68		1.57	6.27	0.30
				1	do	48	−1.01	−1.28		1.18	6.20	−0.64	−0.58		1.48	6.22	0.25
		Vicinity of Montauk Point, Long Island															
38	do	Off Montauk Point	do	1	Pole	3½	−2.36	−1.68	4	2.60	6.95	−1.24	−1.88	153	1.66	5.47	11.76
				1	Meter	6	−2.41	−2.23		2.70	6.85	−1.39	−1.88		1.55	5.57	11.57
				1	do	15	−2.41	−1.98		2.50	6.85	−1.39	−1.78		1.45	5.57	11.66
				1	do	24	−2.31	−1.93		2.38	6.75	−1.39	−2.03		1.13	5.67	11.63
41	do	Off Shagwong Point	Aug. 27-28, 1930	1	Pole	3½	−1.91	−2.63	266	0.95	4.85	−2.89	−1.63	88	1.35	7.57	11.29
				1	Meter	6	−1.96	−2.93		1.03	4.95	−2.84	−1.73		1.43	7.47	11.19
				1	do	12	−1.76	−2.73		1.00	4.65	−2.94	−1.63		1.25	7.77	11.29
				1	do	19	−1.96	−2.63		0.74	4.90	−2.89	−1.23		1.14	7.82	11.37
		Block Island Sound															
43	do	Mid-sound, south of Watch Hill Point, R. I.	Aug. 14-16, 1930	1½	Pole	7	1.29	0.79	257	0.94	4.58	0.04	0.72	97	1.64	7.84	1.84
				1½	Meter	21	1.36	0.89		1.02	4.48	0.01	0.57		1.65	7.94	1.84
				1½	do	53	1.02	0.85		1.07	4.89	0.08	−0.03		1.49	7.53	1.61
				1½	do	84	−0.41	−0.28		1.03	5.92	−0.32	−1.03		1.15	6.50	0.62
		Vicinity of Watch Hill Point, R. I.															
47	do	South of Watch Hill Point, about ½ mile.	Aug. 12-13, 1930	1	Pole	7	−1.01	−1.03	265	1.83	6.40	−0.44	−0.78	106	2.13	6.02	0.31
				1	Meter	7	−1.01	−0.98		1.98	6.50	−0.34	−1.03		2.03	5.92	0.29
				1	do	17	−1.06	−0.88		1.72	6.55	−0.34	−0.88		2.02	5.87	0.34
				1	do	27	−1.16	−1.13		1.59	6.55	−0.44	−1.03		1.54	5.87	0.19
50	do	Southwest of Watch Hill Point, about 2½ miles.	Aug. 27-28, 1930	1	Pole	7	−1.26	−0.58	263	1.14	7.45	0.36	−0.38	83	1.19	4.97	0.67
				1	Meter	16	−1.31	−0.58		1.19	7.45	0.31	−0.38		1.14	4.97	0.64
				1	do	39	−1.21	−0.58		0.93	7.15	0.11	−0.53		0.98	5.27	0.58
				1	do	62	−1.21	−0.63		0.82	7.05	0.01	−0.38		0.77	5.37	0.58
		Vicinity of Fishers Island															
51	do	Off Wilderness Point	Aug. 13-14, 1930	1	Pole	7	−0.66	−0.53	258	2.26	6.10	−0.39	−1.03	69	1.91	6.32	0.48
				1	Meter	15	−0.86	−0.48		2.14	6.20	−0.49	−0.73		1.69	6.22	0.49
				1	do	38	−1.06	−0.78		2.03	6.50	−0.39	−0.83		1.58	5.92	0.37
				1	do	60	−1.26	−0.68		1.85	6.60	−0.49	−0.93		1.25	5.82	0.29
		Vicinity of Cerberus Shoal															
52	do	Cerberus Shoal, about 2¼ miles north-northwest of.	Aug. 13-14, 1930	1	Pole	7	0.64	0.27	261	0.89	4.50	−0.69	−0.23	94	1.94	7.92	1.13
				1	Meter	27	0.39	0.22		1.26	5.00	−0.44	−0.28		2.06	7.42	1.10
				1	do	67	0.14	−0.03		1.25	5.00	−0.69	−0.23		1.80	7.42	0.93
				1	do	107	−0.56	−0.53		1.29	5.55	−0.84	−0.48		1.54	6.87	0.53
52	do	do	Aug. 27-28, 1930	1	Pole	7	−1.01	−0.23	264	1.51	6.95	0.11	−0.23	96	1.11	5.47	0.79
				1	Meter	20	−0.91	−0.28		1.38	6.85	0.11	−0.23		1.13	5.57	0.80
				1	do	50	−1.06	−0.53		1.43	6.85	−0.04	−0.43		1.08	5.57	0.61
				1	do	80	−1.11	−0.78		1.34	6.80	−0.14	−0.73		1.04	5.62	0.44
53	P. M. Trueblood	Cerberus Shoal, about 2 miles north-northeast of.	Sept. 26, 1917	¼	Pole	7	−0.07	−0.03	248	1.38							1.32
				¼	Meter	6	0.37	−0.03		1.43							1.48
				¼	do	18	0.27	−0.03		1.43							1.42
				¼	do	39	0.17	−0.37		1.43							1.18
				¼	do	60	−0.23	−1.17		1.38							0.58
				¼	do	90	−0.63	−0.97		1.06							0.48
55	do	Cerberus Shoal, about 2 miles south-southeast of.	do	¼	Pole	7	−0.53	−0.67	261	1.48							0.68
				¼	Meter	6	−0.63	−0.57		1.48							0.68
				¼	do	30	−0.53	−0.87		1.48							0.58
				¼	do	60	−0.73	−0.97		1.27							0.42
				¼	do	78	−0.93	−1.37		1.17							0.12
56	J. C. Sammons	Cerberus Shoal, about 2½ miles south-southeast of.	Aug. 13-14, 1930	1	Pole	3¼	−0.11	−0.73	281	1.78	5.00	−0.94	−0.33	73	1.88	7.42	0.60
				1	Meter	13	−0.36	−0.68		1.66	5.45	−0.74	−0.53		1.56	6.97	0.55
				1	do	32	−0.71	−0.58		1.49	5.85	−0.69	−0.63		1.34	6.57	0.48
				1	do	50	−0.81	−0.68		1.16	5.95	−0.69	−0.53		1.06	6.47	0.45
		Vicinity of Fort Pond Bay															
57	do	Culloden Point, about 1¾ miles west by south of.	Aug. 12-13, 1930	1	Pole	3¼	−0.96	−2.03	214	0.49	3.50	−2.44	−0.88	64	0.44	8.92	11.97
				1	Meter	11	−0.81	−2.28		0.35	4.98	−1.66	−0.53		0.65	7.44	12.23
				1	do	28	−1.01	−2.03		0.34	5.00	−1.84	−1.13		0.54	7.42	12.05
				1	do	46	−0.96	−2.48		0.34	4.70	−2.09	−1.23		0.49	7.72	11.86

[1] Current weak, and times of slack water are indefinite. [2] Current weak and irregular. [3] Flood sets northerly, ebb southerly. [4] Current weak.

Price current meters were used in making the observations referred to above. For purposes of comparison the results near the surface at each station as obtained by means of current-pole and current-log line are also given in Table 76.

With the exception of stations 53 and 55, at which flood observations only were obtained in 1917, the subsurface observations at stations listed in Table 76 were all obtained during the summer of 1930. It was found advisable to reoccupy station 52 located north of Cerberus Shoal because of unfavorable weather conditions which occurred during the first occupation of the station. This probably accounts for the fact that the results from observations at this station for the period August 13–14, 1930, do not agree very well with those derived from observations made during the period August 27–28, 1930. It is very probable that the values obtained for the latter series are the more reliable as they agree more closely with those for other stations in the vicinity and more ideal weather conditions obtained during the observational period.

A study of the data in Table 76 will show that the current generally becomes earlier in occurrence as the depth increases. This is clearly shown by the data for station 43 located in mid-sound south of Watch Hill Point and midway between Block Island and Little Gull Island Light, and in a depth of over 100 feet. At this station the current near the bottom turns more than an hour earlier than it does near the surface. However, at many of the stations the earliness of the current near the bottom as compared with that near the surface is but a matter of a few minutes or so.

THE TIDE AND CURRENT IN GARDINERS AND PECONIC BAYS

The characteristic features of Gardiners Bay, Shelter Island Sound, Little Peconic Bay, and Great Peconic Bay have been described above. Tides have been observed in these waterways since 1838 when short series were obtained at Greenport, Southhold Landing, South Jamesport, and Fireplace Point in connection with an early hydrographic survey. The following year short series were obtained at Greenport, Sag Harbor, and Orient. The locations of 17 tide stations occupied in these waterways are shown in Figure 38 and the results of observations at these stations are given in Table 77.

At a majority of these stations only a single series of tidal observations has been obtained and generally for a period of a lunar month or less. The Corps of Engineers, United States Army, has cooperated with this bureau in furnishing the results of observations at stations 6 and 9, Threemile Harbor and Shinnecock Canal entrance, respectively. The Coast and Geodetic Survey is also indebted to the officials of the department of astronomy, Columbia University, New York City, for their cooperation in obtaining tidal observations at station 14, located at Deering Harbor, Shelter Island.

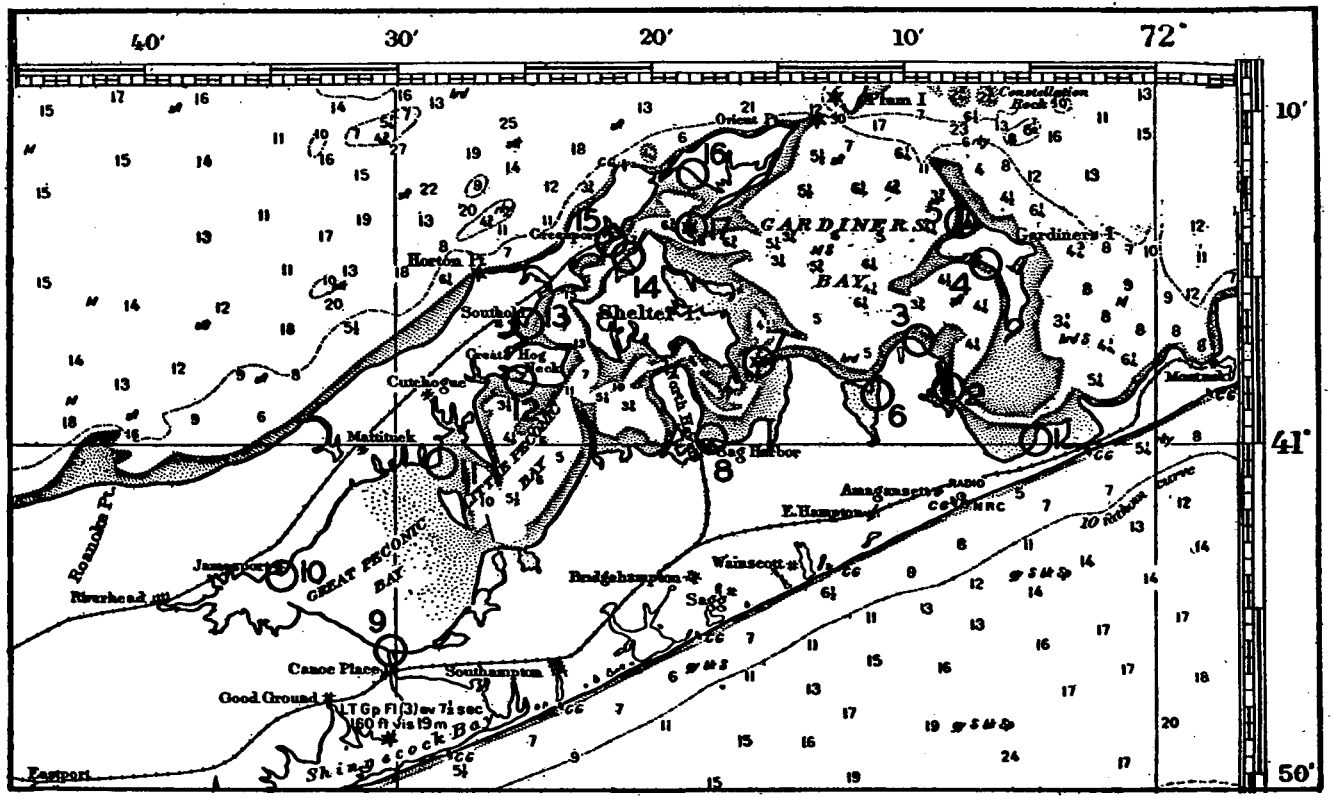

FIGURE 38.—Tide stations, Gardiners Bay and vicinity

TABLE 77.—*Tidal data, Gardiners Bay and vicinity, 1838–1928*

Station No.	Location	Observations		Lunitidal intervals		Duration of rise	Mean range	Compared with—
		Date	Period	HWI	LWI			
			Days	*Hours*	*Hours*	*Hours*	*Feet*	
1	Promised Land, Long Island	Oct. 23–Nov. 19, 1928	27	9.30	3.42	5.88	2.32	Fort Hamilton, N. Y.
2	Off Acabonack Harbor entrance, Long Island	Oct. 4–28, 1882	17	9.40	3.58	5.82	2.37	New London, Conn.
3	Fireplace Point, Long Island	Sept. 22–Oct. 6, 1838	10	9.06	3.42	5.64	2.63	
4	Gardiners Island (southwest side)	Oct. 2–6, 1882	5	9.65	3.82	5.83	2.44	Do.
5	Gardiners Island (Bostwick Bay)	Aug. 25–Oct. 2, 1882	9	9.61	3.48	6.13	2.64	Do.
6	Threemile Harbor (Gardiners Dock), Long Island	Oct. 19–27, 1927	9	12.07	5.70	6.37	[1] 1.62	Fort Hamilton, N. Y.[1]
7	Cedar Island Light	Sept. 6–26, 1882	15	10.12	4.00	6.12	2.82	New London, Conn.
8	Sag Harbor, Long Island	July 9–30, 1839	15	10.13	3.88	6.25	2.32	
		June 5–28, 1891	24	10.28	4.13	6.15	2.41	Sandy Hook, N. J.
9	Shinnecock Canal entrance (Great Peconic Bay)	July 23–Aug. 20, 1909	29				[1] 2.54	
10	South Jamesport, Long Island	July 16–21, 1838	6	12.13	5.82	6.31	2.38	
		Sept. 24–Oct. 6, 1891	13	12.23	6.22	6.01	2.64	Do.
11	New Suffolk, Long Island	May 12–June 12, 1913	32	11.75	5.67	6.08	2.66	
		Oct. 9–31, 1917	22	11.88	5.86	6.02	2.62	Fort Hamilton, N. Y.
12	Great Hog Neck (east of Corey Creek), Long Island.	June 24–Oct. 3, 1891	112	11.58	5.18	6.40	2.48	
13	Southold Landing, Long Island	Sept. 18–Oct. 30, 1838	35	11.10	4.65	6.45	2.61	
		Oct. 25–27, 1917	3	10.93	4.83	6.10	2.32	New London, Conn.
14	Manhanset Manor, Deering Harbor, Shelter Island.	July 10–Sept. 30, 1906	79	10.52	4.30	6.22	2.34	
15	Greenport, Long Island	July 31–Aug. 31, 1838	18	10.32	3.92	6.40	2.37	
		May 16–27, 1839	12	11.05	4.52	6.53	2.42	
		July 31–Nov. 9, 1882	45	10.08	4.02	6.06	2.44	Do.
		July 25–Oct. 8, 1883	17	10.42	4.30	6.12	2.36	Do.
		June 7–Aug. 19, 1891	24	10.32	4.13	6.19	2.33	Sandy Hook, N. J.
		Oct. 22–24, 1917	3	10.31	4.28	6.03	2.47	New London, Conn.
16	Orient, Orient Harbor, Long Island	May 31–July 2, 1839	7	9.25	3.38	5.87	2.56	
17	Long Beach Bar Light, Gardiners Bay	Aug. 10–Sept. 5, 1882	13	9.68	3.52	6.16	2.50	Do.
		Oct. 11–Nov. 11, 1916	27	9.58	3.98	5.60	2.90	Sandy Hook, N. J.

[1] From tide records furnished by the Corps of Engineers, U. S. Army.

Where it was possible to do so, short series of observations were compared with simultaneous observations at a long-period standard, or primary, tide station in order to reduce to mean values. It will be noted from the data in Table 77 that the results from various series at the same station generally agree quite closely, especially if such series of observations are of a fortnight or longer in duration.

Owing to the fact that the results from the various series of observations at each tide station in Gardiners and the Peconic Bays give somewhat different values, depending upon lengths of series, method of observation, effect of weather conditions, etc., the results from observations as given in Table 77 were subjected to an adjustment process in order to arrive at standard values, giving due weight to the lengths of series at each station. The adjusted values for each tide station in these waterways are given in Table 78.

TABLE 78.—*Adjusted tidal data, Gardiners Bay and vicinity*

Station No.	Locality	Lunitidal intervals		Duration of rise	Range of tide		
		HWI	LWI		Mean	Spring	Neap
		Hours	*Hours*	*Hours*	*Feet*	*Feet*	*Feet*
1	Promised Land, Long Island	9.30	3.40	5.90	2.3	2.8	1.7
2	Off Acabonack Harbor entrance, Long Island	9.40	3.60	5.80	2.5	3.0	1.9
3	Fireplace Point, Long Island	9.40	3.60	5.80	2.5	3.0	1.9
4	Gardiners Island (southwest side)	9.65	3.80	5.85	2.5	3.0	1.9
5	Gardiners Island (Bostwick Bay)	9.60	3.50	6.10	2.5	3.0	1.9
6	Threemile Harbor (Gardiners Dock), Long Island	12.05	5.70	6.35	1.6	1.9	1.2
7	Cedar Island Light	10.10	4.00	6.10	2.8	3.4	2.1
8	Sag Harbor, Long Island	10.20	4.05	6.15	2.4	2.9	1.8
9	Shinnecock Canal entrance (Great Peconic Bay)				2.5	3.0	1.9
10	South Jamesport, Long Island	12.20	6.15	6.05	2.5	3.0	1.9
11	New Suffolk, Long Island	11.80	5.75	6.05	2.6	3.1	2.0
12	Great Hog Neck (east of Corey Creek), Long Island	11.60	5.20	6.40	2.5	3.0	1.9
13	Southold Landing, Long Island	11.00	4.75	6.25	2.4	2.9	1.8
14	Manhanset Manor, Shelter Island	10.50	4.30	6.20	2.4	2.9	1.8
15	Greenport, Long Island	10.30	4.30	6.00	2.4	2.9	1.8
16	Orient, Orient Harbor, Long Island	9.65	3.90	5.75	2.5	3.0	1.9
17	Long Beach Bar Light, Gardiners Bay	9.60	3.85	5.75	2.8	3.4	2.1

In Table 78 the high and low water lunitidal intervals and duration of rise of tide at each station are given in hours and hundredths of an hour to the nearest five-hundredths of an hour.

In addition to the values for mean range of tide for each station there are also given the approximate values for spring and neap ranges. The latter were obtained through the application of factors to the values for mean range of tide and the method employed was described above in the preceding section in connection with a discussion of the tide in Block Island Sound.

It will be noted from the data in Table 78 that there is very little difference in range of tide throughout these waterways. From east to west in Gardiners Bay there appears to be an increase in range of about 0.3 foot from Gardiners Island to the vicinities of Cedar Island and Long Beach Bar Lights. From the latter localities westward throughout Shelter Island Sound the range of tide apparently decreases approximately 0.4 foot. From Shelter Island Sound westward the range of tide appears to increase slightly to an approximate mean range of 2.5 feet.

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The range at station 6, however, is apparently about 1 foot less than that in Gardiners Bay. This is most likely due to the fact that the station was located about one-half mile inside Threemile Harbor. The latter is about 1½ square miles in area and is reached from Gardiners Bay by means of a dredged channel about 100 yards in width and having a mean low-water depth of about 5 feet. Threemile Harbor is very shoal, having a maximum mean low-water depth of but 13 feet. Accompanying this decrease in range of tide in Threemile Harbor there is a lateness in the time of tide, the tide in this harbor occurring about two hours later than that outside in Gardiners Bay.

While there is very little difference in range of tide throughout Gardiners Bay, Shelter Island Sound, and the Peconic Bays, there is considerable difference in time of tide throughout these waterways. The data for lunitidal intervals in Table 78 show that there is a difference of nearly three hours in the time of tide, the tide at South Jamesport, Long Island, occurring approximately three hours later than that at Promised Land, Long Island, or Long Beach Bar Light.

In Gardiners Bay there is very little difference in time or range of tide at one locality as compared with the same phenomena at another locality. In Shelter Island Sound, however, there is considerable difference in time and range of tide at various localities. The mean range of tide decreases from about 2.8 feet in the vicinity of Long Beach Bar Light to 2.4 feet in the vicinity of Greenport, Long Island, and Southold, Long Island. Likewise, it decreases from about 2.8 feet in the vicinity of Cedar Island Light to 2.4 feet in the vicinity of Sag Harbor, Long Island. The time of tide throughout the northern and southern portions of Shelter Island Sound is retarded from east to west, high and low water in the vicinity of Cedar Beach Point, Great Hog Neck, Long Island, occurring about an hour later than the same phenomena at Long Beach Bar and Cedar Island Lights.

Tidal currents have been observed by field parties of this bureau at 9 stations in Gardiners Bay, Shelter Island Sound, and the Peconic Bays for brief periods of 26 hours at each station. The locations of these current stations are shown in Figure 39. With the exception of station 5, these stations were occupied during the summer of 1929. The results from observations near the surface at these stations are given in Table 79.

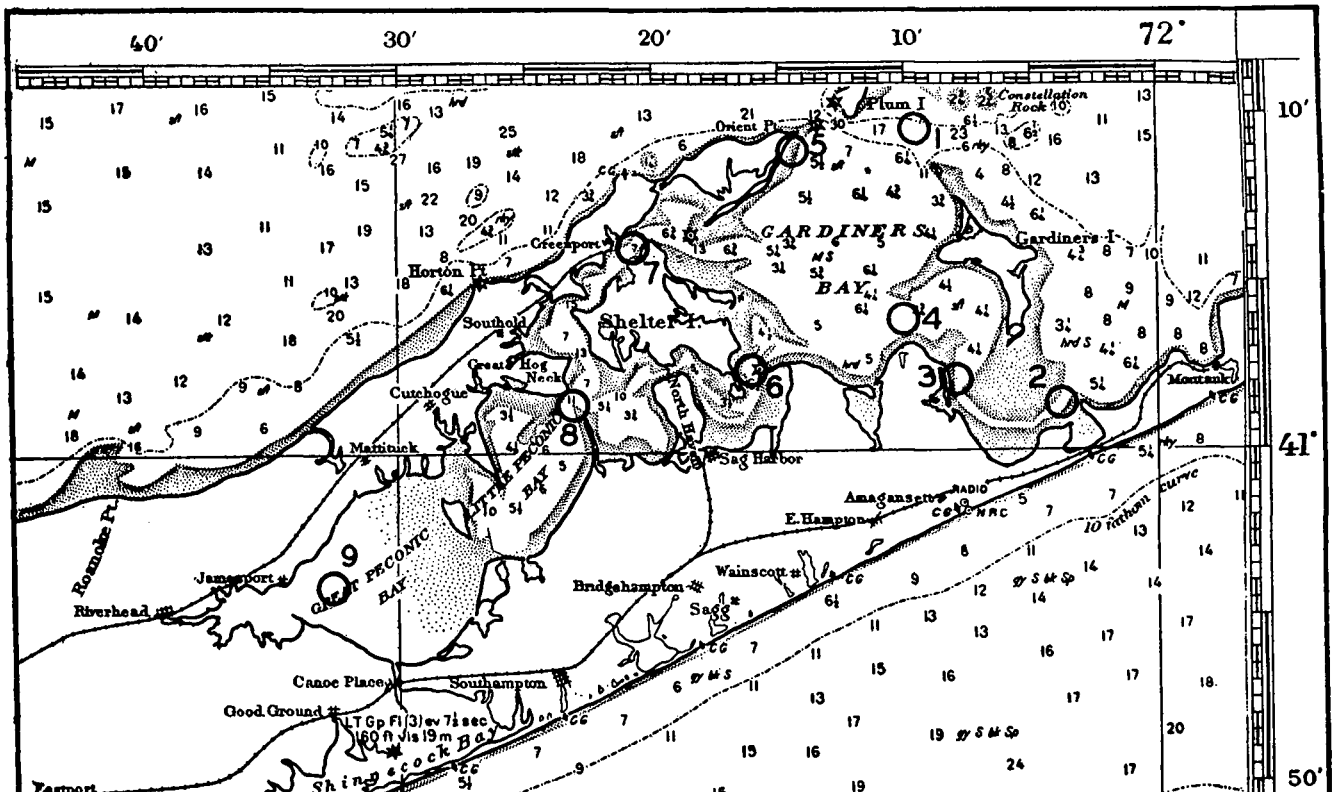

FIGURE 39.—Current stations, Gardiners Bay and vicinity

TABLE 79.—*Results from current observations near the surface, Gardiners Bay and vicinity*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction (true)	Velocity		
		Approaches to Gardiners Bay		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	H. E. Finnegan	Off Gardiners Point	Aug. 2-3, 1929	1	Pole	7	−0.60	0.05	267	1.38	5.98	−0.45	−0.30	78	0.88	6.44	0.81
2	do	Off Goff Point	do	1	do	7	−1.85	−2.05	210	1.21	6.23	−1.45	−2.45	40	1.56	6.19	11.60
3	do	Off Acabonack Harbor	do	1	do	3½	−1.75	−1.25	6	1.30	6.38	−1.20	−2.60	176	1.05	6.04	11.85
		Gardiners Bay															
4	do	Off Hog Creek Point	do	1	do	7	−1.00	−0.75	281	0.25	5.33	−1.50	−1.95	67	0.35	7.09	12.25
5	P. M. Trueblood	Off Orient Point	July 30-31, 1917	1	do	7			(1)					55	0.43		
		Shelter Island Sound															
6	H. E. Finnegan	Off Cedar Island Light	Aug. 9-10, 1929	1	do	7	−0.20	−0.50	192	1.48	6.03	0.00	−1.10	0	1.38	6.39	0.68
7	do	Off Greenport	do	1	do	7	0.40	0.15	215	1.53	5.78	0.35	−0.05	36	1.73	6.64	1.34
		Little Peconic Bay															
8	do	Off Cedar Beach Point	do	1	do	7	0.30	−0.40	220	1.88	5.88	0.35	0.20	46	1.43	6.54	1.24
		Great Peconic Bay															
9	do	Off Southport	do	1	do	7	1.10	0.95	277	0.25	5.78	1.05	0.90	99	0.10	6.64	2.13

[1] See text, p. 173 for current conditions at this station.

In general, the results shown in Table 79 are from observations obtained by means of a standard 15-foot current-pole and current-log line. The times and durations of the current at each station are given in hours and are referred to the times of similar phases of the current at The Race. The velocities of the current have been corrected to a mean range of tide and represent average current conditions. These velocities of flood and ebb would increase or decrease proportionately as the range of the tide increased or decreased from a mean value.

It will be noted from the values for mean current hour in Table 79 that the current at stations in Gardiners Bay, especially in the channels in the shoal area near the southern entrance to the bay from Block Island Sound occurs from about one-half to two hours earlier than at the reference station. Off Greenport and Cedar Beach Point in Shelter Island Sound it occurs a few minutes later than at the reference station, while at station 9, off Southport, in Great Peconic Bay, it occurs about an hour later than it does at The Race.

An explanation is necessary concerning the results obtained from observations at station 5, which was occupied in 1917 for a period of 25 hours. Throughout the observational period a northeasterly current set was noted at this station with a maximum surface velocity of about 0.45 knot, as measured by a 15-foot current-pole and current-log line, and about 0.55 knot at depths of 6, 12, and 17 feet, as measured by a Price current meter. Two slack-water periods of approximately four hours' duration each were observed near the surface by means of current-pole and current-log line. During such times minimum velocities of one-fourth knot or less were observed by means of current meter at subsurface depths.

It is possible that station 5 was located in an eddy where the current continually ebbs, or sets northeasterly. However, the two, long, slack-water periods rather indicate that at this locality the flood, or southwesterly stream, is very weak and may become completely masked by meteorological or other nonastronomical conditions. Throughout the observational period of 25 hours westerly winds, averaging 12 miles per hour, prevailed. This condition would produce a nontidal current, setting easterly, with a velocity of about 0.25 knot. Station 5 was located in shoal water about one-fourth mile from shore in Gardiners Bay and about three-fourths of a mile southwest of Orient Point, Long Island.

Fairly strong average current velocities of 1½ to 2 knots are experienced at stations 6, 7, and 8, off Cedar Island Light, Greenport, and Cedar Beach Point, respectively, owing to the narrow channels in these localities, while the weak currents at stations 4 and 9, off Hog Creek Point and Southport, respectively, are obviously due to the expanse of the waterways in these localities. It will be noted that the duration of ebb is considerably greater than that of flood at all the current stations with the exception of stations 2 and 3. This is obviously the result of fresh-water run-off and the conclusion is that such run-off from streams entering the Peconic Bays and Shelter Island Sound reaches Block Island Sound by way of the northern entrance to Gardiners Bay.

TABLE 80.—*Results from current observations at various depths, Gardiners Bay and vicinity*

[Referred to times of predicted current at The Race]

Station No.	Party of—	Location	Observations				Slack	Flood strength			Flood duration	Slack	Ebb strength			Ebb duration	Mean current hour
			Date	Period	Method	Depth		Time	Direction (true)	Velocity			Time	Direction	Velocity		
		Approaches to Gardiners Bay		*Days*		*Feet*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours after*	*Hours after*	°	*Knots*	*Hours*	*Hours*
1	H. E. Finnegan	Off Gardiners Point	Aug. 2-3, 1929	1	Pole	7	−0.60	0.05	267	1.38	5.98	−0.45	−0.30	78	0.88	6.44	0.81
				1	Meter	18	−0.60	−0.15		1.42	5.98	−0.45	−0.35		1.07	6.44	0.74
				1	do	45	−0.75	−0.25		1.38	6.18	−0.40	−0.35		0.78	6.24	0.69
				1	do	72	−0.95	−0.15		1.20	6.43	−0.35	−0.35		0.45	5.99	0.68
2	do	Off Goff Point	do	1	Pole	7	−1.85	−2.05	210	1.21	6.23	−1.45	−2.45	40	1.56	6.19	11.60
				1	Meter	8	−1.80	−2.20		1.35	6.13	−1.50	−2.55		1.55	6.29	11.54
				1	do	20	−1.75	−2.00		1.21	6.13	−1.45	−2.40		1.46	6.29	11.65
				1	do	32	−1.90	−2.20		1.12	6.28	−1.45	−2.30		1.42	6.14	11.59
3	do	Off Acabonack Harbor	do	1	Pole	3½	−1.75	−1.25	6	1.30	6.38	−1.20	−2.60	176	1.05	6.04	11.85
				1	Meter	7	−1.85	−1.30		1.20	6.33	−1.35	−2.65		1.05	6.09	11.76
				1	do	15	−2.00	−1.40		1.20	6.68	−1.15	−2.65		1.05	5.74	11.75
				1	do	25	−2.10	−1.35	[1] 2	1.00	6.78	−1.15	−2.65	[1] 197	0.80	5.64	11.74
		Gardiners Bay															
4	do	Off Hog Creek Point	do	1	Pole	7	−1.00	−0.75	281	0.25	5.33	−1.50	−1.95	67	0.35	7.09	12.25
				1	Meter	7	−0.95	−0.95		0.22	5.38	−1.40	−1.90		0.35	7.04	12.25
				1	do	12	−0.95	−1.05		0.30	5.63	−1.15	−2.00		0.28	6.79	12.26
				1	do	20	−0.80	−0.60		0.25	6.03	−0.60	−1.55		0.15	6.39	12.66
		Shelter I. Sound															
6	do	Off Cedar Island Light	Aug. 9-10, 1929	1	Pole	7	−0.20	−0.50	192	1.48	6.03	0.00	−1.10	0	1.38	6.39	0.68
				1	Meter	7	−0.15	−0.50		1.43	5.93	−0.05	−1.05		1.43	6.49	0.69
				1	do	15	−0.20	−0.40		1.32	6.13	0.10	−0.80		1.22	6.29	0.81
				1	do	24	−0.40	−0.35		1.17	6.43	0.20	−0.65		0.87	5.99	0.83
7	do	Off Greenport Harbor	do	1	Pole	7	0.40	0.15	215	1.53	5.78	0.35	−0.05	36	1.73	6.64	1.34
				1	Meter	12	0.40	0.10		1.68	5.83	0.40	0.15		1.73	6.59	1.39
				1	do	30	0.25	−0.05		1.58	6.03	0.45	0.00		1.58	6.39	1.29
				1	do	48	0.30	0.10		1.38	6.13	0.60	−0.10		1.33	6.29	1.35
		Little Peconic Bay															
8	do	Off Cedar Beach Point	do	1	Pole	7	0.30	−0.40	220	1.88	5.88	0.35	0.20	46	1.43	6.54	1.24
				1	Meter	10	0.25	−0.25		1.93	6.13	0.55	0.20		1.43	6.29	1.32
				1	do	25	0.25	−0.20		1.93	6.18	0.60	0.15		1.43	6.24	1.33
				1	do [2]	25	0.40	−0.25	237	1.93	6.08	0.65	0.00	37	1.58	6.34	1.33
				1	do	40	0.30	−0.25		1.78	6.23	0.70	−0.15		1.28	6.19	1.28
		Great Peconic Bay															
9	do	Off Southport	do	1	Pole	7	1.10	0.95	277	0.25	5.78	1.05	0.90	99	0.10	6.64	2.13
				1	Meter	7	1.15	1.00		0.51	5.98	1.30			0.29	6.44	2.34
				1	do	10	1.05	0.95		0.53	5.98	1.20			0.26	6.44	2.26
				1	do	17	0.85	0.95		0.56	5.78	0.80			0.23	6.64	2.06

[1] Directions of subsurface current obtained from Pettersson meter observations; times of occurrence and velocities of current at this depth (25 feet) obtained from Price meter observations.
[2] Pettersson meter observations.

At each of the 9 current stations shown in Figure 39 observations were made at three subsurface depths by means of current meter in addition to surface current measurements and the results from these observations are given in Table 80.

The current meters used in making these observations were generally Price meters. At stations 3 and 8 the Pettersson meter was also employed. At the former station it was used in obtaining subsurface current directions only, while at the latter it was used in obtaining the direction and velocity of the current at a depth of 25 feet. Subsurface currents were observed at three depths, representing 0.2, 0.5, and 0.8 of the depth at each station.

For purposes of comparison the results near the surface at each station as obtained by means of current pole and current log line are also given in Table 80. It will further be noted that stations 1, 2, 3, and 4, all located in Gardiners Bay and vicinity, were occupied simultaneously, while stations 6, 7, 8, and 9 located in Shelter Island Sound and the Peconic Bays were likewise occupied simultaneously.

The Pettersson meter results from observations at a depth of 25 feet, or mid depth, at station 8, located at the entrance to Little Peconic Bay, agree remarkably well with those obtained by means of the Price meter at the same depth, regarding the time, velocity, and duration of the tidal current. In addition, the Pettersson meter results show that there is a considerable difference in the direction of the current at strength of flood and ebb at the mid depth as compared with that at the surface.

A study of the data in Table 80 will show that at most of the stations in these waterways the current generally becomes earlier in occurrence as the depth increases. At stations 4 and 6, however, the opposite is apparently the case, while at both of these stations the duration of flood increases considerably with increased depth. Another conclusion is that most of the fresh-water run-off from the streams entering the Peconic Bays is discharged through the northern arm of Shelter Island Sound rather than the southern. This is shown by the data for stations 7 and 6, located off Greenport and Cedar Island, respectively. It will be noted that at station 7 the duration of ebb exceeds that of flood at all depths while at station 6 the duration of flood at the bottom depth actually exceeds that of ebb by nearly half an hour.

It should again be emphasized that these two stations, together with stations 8 and 9 in the Peconic Bays, were occupied simultaneously under the same weather conditions.

The increased ebb duration over that of flood at station 4 and the opposite condition at station 3 are, no doubt, due to the locations of these stations with respect to Hog Creek Point, Long Island, and the western shore of Gardiners Island, together with Cartwright Island and the extensive shoal areas south of these islands. The hydrographic features of this vicinity indicate that the ebb from the southern arm of Shelter Island Sound and also from the southern portion of Gardiners Bay is deflected northeasterly between Hog Creek Point and Crow Shoal, the full effect of such ebb being experienced at station 4. At this station the velocity of ebb, though apparently less than half a knot, is greater than that of flood, while the duration of ebb from the surface to mid depth is from 1 to 1½ hours longer than that of flood.

The ebb then sweeps easterly and is deflected southerly and southwesterly by Gardiners Island. The effect of the ebb, therefore, is somewhat diminished at station 3, located in mid-channel north of the entrance to Acabonack Harbor, Long Island. The velocity and duration of flood at the latter station are naturally greater and longer respectively, than those of ebb, since the flood tidal current accompanying the rising tide entering Gardiners Bay from Block Island Sound follows primarily the natural channel from Goff Point across the extensive shoal area south of Cartwright Island to the vicinity of station 3. The Pettersson meter directional observations at a depth of 25 feet at station 3 show that flood sets more easterly and ebb more westerly near the bottom than near the surface.

It will be noted from the data in Table 80 that the velocity of the current generally decreases with increased depth and the explanation for this condition has been described above at considerable length. However, this condition does not apparently prevail at station 9, located in Great Peconic Bay, as shown by the results in Table 80 from observations at this station. This is most likely due to the location of the station near the head of a land-locked bay of considerable width and fairly shoal.

TEMPERATURE, DENSITY, AND SALINITY OBSERVATIONS IN BLOCK ISLAND SOUND AND ITS TRIBUTARIES, 1929–30

Temperature and density observations were obtained at most of the current stations in Block Island Sound and vicinity which were occupied by the field party during the summer of 1930. Similar observations were obtained at five current stations in Gardiners and the Peconic Bays during the summer of 1929. The results of these observations are given in Table 81.

For purposes of identification the numbers of the current stations at which temperature and density observations were made are given in the first column of the table. These station numbers are identical with those in Figures 36 and 39, which show, respectively, current station locations in Block Island Sound and vicinity and Gardiners Bay and vicinity.

At the Block Island Sound current stations occupied in 1930 water samples were generally obtained at the three depths at which currents were observed by means of meter. These water samples were obtained by means of Sigsbee water-specimen cups. At the current stations occupied in Gardiners and the Peconic Bays in 1929 the temperatures of the water at each meter observational depth were also obtained as well as water samples. Exceptions to the general procedure of observing temperatures and densities at three depths at each current station were made at locations where shallow depths obtained.

The observed densities were reduced to temperature 15° C. and the corrected densities are given in columns 8, 9, and 10. The salinities given in columns 11, 12, and 13 of Table 81 were obtained from the corresponding density values in the preceding columns.

TABLE 81.—*Temperature, density, and salinity of water, Block Island Sound and its tributaries, 1929–30*

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
Block Island Sound and vicinity												
	1930			*13 ft.*	*32 ft.*	*50 ft.*	*13 ft.*	*32 ft.*	*50 ft.*	*13 ft.*	*32 ft.*	*50 ft.*
1	Aug. 29	14:10–14:20	23.2	------	------	------	1.0239	1.0239	1.0239	32.3	32.8	32.3
	Do	22:10–22:20	20.8	------	------	------	1.0241	1.0238	1.0238	32.5	32.1	32.1
	Aug. 30	6:10– 6:20	20.9	------	------	------	1.0235	1.0234	1.0234	31.8	31.6	31.6
		Mean	------	------	------	------	1.0238	1.0237	1.0237	32.2	32.0	32.0
				8 ft.	*21 ft.*	*34 ft.*	*8 ft.*	*21 ft.*	*34 ft.*	*8 ft.*	*21 ft.*	*34 ft.*
3	Aug. 18	14:10–14:20	22.0	------	------	------	1.0241	1.0243	1.0243	32.5	32.8	32.8
	Do	22:10–22:20	19.5	------	------	------	1.0237	1.0240	1.0240	32.0	32.4	32.4
	Aug. 19	6:10– 6:20	19.0	------	------	------	1.0236	1.0238	1.0236	31.9	32.1	31.9
		Mean	------	------	------	------	1.0238	1.0240	1.0240	32.1	32.4	32.4
				7 ft.	*18 ft.*	*29 ft.*	*7 ft.*	*18 ft.*	*29 ft.*	*7 ft.*	*18 ft.*	*29 ft.*
4	Aug. 19	14:10–14:20	25.8	------	------	------	1.0244	1.0238	1.0239	32.9	32.1	32.3
	Do	22:10–22:20	20.2	------	------	------	1.0237	1.0241	1.0241	32.0	32.5	32.5
	Aug. 20	6:10– 6:20	18.2	------	------	------	1.0238	1.0238	1.0238	32.1	32.1	32.1
	Do	14:10–14:20	23.1	------	------	------	1.0239	1.0239	1.0239	32.3	32.3	32.1
		Mean	------	------	------	------	1.0240	1.0239	1.0239	32.3	32.2	32.2
				6 ft.	*10 ft.*		*6 ft.*	*10 ft.*		*6 ft.*	*10 ft.*	
6	Aug. 19	13:52–13:54	22.7	------	------	------	1.0238	1.0239	------	32.1	32.3	------
	Do	21:50–21:53	19.5	------	------	------	------	------	------	------	------	------
	Aug. 20	6:10– 6:13	17.2	------	------	------	1.0237	1.0239	------	32.0	32.3	------
		Mean	------	------	------	------	1.0238	1.0239	------	32.0	32.3	------
				5 ft.	*12 ft.*	*18 ft.*	*5 ft.*	*12 ft.*	*18 ft.*	*5 ft.*	*12 ft.*	*18 ft.*
7	Aug. 19	14:15–14:25	24.5	------	------	------	1.0241	1.0241	1.0240	32.5	32.5	32.4
	Do	22:10–22:20	19.5	------	------	------	1.0238	1.0238	1.0238	32.1	32.1	32.1
	Aug. 20	6:15– 6:22	17.9	------	------	------	1.0241	1.0241	1.0239	32.5	32.5	32.3
		Mean	------	------	------	------	1.0240	1.0240	1.0239	32.4	32.4	32.3
				10 ft.	*24 ft.*	*38 ft.*	*10 ft.*	*24 ft.*	*38 ft.*	*10 ft.*	*24 ft.*	*38 ft.*
8	Aug. 19	14:10–14:20	20.5	------	------	------	1.0242	1.0238	1.0235	32.7	32.1	31.8
	Do	22:10–22:18	19.7	------	------	------	1.0240	1.0238	1.0237	32.4	32.1	32.0
	Aug. 20	5:45– 5:54	17.2	------	------	------	1.0239	1.0241	1.0241	32.3	32.5	32.5
		Mean	------	------	------	------	1.0240	1.0239	1.0238	32.5	32.2	32.1
				19 ft.	*48 ft.*	*77 ft.*	*19 ft.*	*48 ft.*	*77 ft.*	*19 ft.*	*48 ft.*	*77 ft.*
9	Aug. 18	14:14–14:26	26.0	------	------	------	1.0237	1.0238	1.0241	32.0	32.1	32.5
	Do	22:16–22:22	18.3	------	------	------	1.0238	1.0237	1.0237	32.1	32.0	32.0
	Aug. 19	6:17– 6:24	18.0	------	------	------	------	------	------	------	------	------
		Mean	------	------	------	------	1.0238	1.0238	1.0239	32.0	32.0	32.2
				28 ft.	*70 ft.*	*112 ft.*	*28 ft.*	*70 ft.*	*112 ft.*	*28 ft.*	*70 ft.*	*112 ft.*
11	Aug. 18	14:45–15:20	21.0	------	------	------	1.0240	1.0237	1.0235	32.4	32.0	31.8
	Do	22:12–22:23	17.9	------	------	------	1.0240	1.0243	1.0243	32.4	32.8	32.8
	Aug. 19	5:40– 5:55	20.0	------	------	------	1.0242	1.0244	1.0246	32.7	32.9	33.2
		Mean	------	------	------	------	1.0241	1.0241	1.0241	32.5	32.6	32.6
				13 ft.	*32 ft.*	*50 ft.*	*13 ft.*	*32 ft.*	*50 ft.*	*13 ft.*	*32 ft.*	*50 ft.*
17	Aug. 25	14:15–14:20	24.5	------	------	------	1.0238	1.0236	------	32.1	31.9	------
	Do	22:10–22:20	18.3	------	------	------	1.0236	1.0235	1.0237	31.9	31.8	32.0
	Aug. 26	6:10– 6:20	18.2	------	------	------	1.0239	1.0238	1.0237	32.3	32.1	32.0
		Mean	------	------	------	------	1.0238	1.0236	1.0237	32.1	31.9	32.0
				8 ft.	*21 ft.*	*34 ft.*	*8 ft.*	*21 ft.*	*34 ft.*	*8 ft.*	*21 ft.*	*34 ft.*
18	Aug. 25	14:43–14:50	23.8	------	------	------	1.0242	1.0241	1.0241	32.7	32.5	32.5
	Do	22:15–22:22	18.8	------	------	------	1.0239	1.0239	1.0239	32.3	32.3	32.3
	Aug. 26	6:12– 6:22	19.0	------	------	------	1.0240	1.0240	1.0238	32.4	32.4	32.1
		Mean	------	------	------	------	1.0240	1.0240	1.0239	32.5	32.4	32.3
				12 ft.	*29 ft.*	*46 ft.*	*12 ft.*	*29 ft.*	*46 ft.*	*12 ft.*	*29 ft.*	*46 ft.*
19	Aug. 25	13:53–14:47	24.0	------	------	------	1.0237	1.0239	1.0236	32.0	32.3	31.9
	Do	22:10–22:18	18.3	------	------	------	1.0237	1.0239	1.0241	32.0	32.3	32.5
	Aug. 26	5:45– 5:52	19.0	------	------	------	1.0237	1.0237	1.0238	32.0	32.0	32.1
		Mean	------	------	------	------	1.0237	1.0238	1.0238	32.0	32.2	32.2

TABLE 81.—*Temperature, density, and salinity of water, Block Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
Block Island Sound and vicinity—Continued												
	1930			*11 ft.*	*27 ft.*	*43 ft.*	*11 ft.*	*27 ft.*	*43 ft.*	*11 ft.*	*27 ft.*	*43 ft.*
20	Aug. 25	14:10–14:20	23.5				1.0241	1.0239	1.0237	32.5	32.3	32.0
	Do	22:10–22:20	19.5				1.0239	1.0239	1.0246	32.3	32.3	33.2
	Aug. 26	6:10– 6:17	19.1				1.0238	1.0238	1.0236	32.1	32.1	31.9
		Mean					1.0239	1.0239	1.0240	32.3	32.2	32.4
				9 ft.	*22 ft.*	*36 ft.*	*9 ft.*	*22 ft.*	*36 ft.*	*9 ft.*	*22 ft.*	*36 ft.*
21	Aug. 26	14:15–14:23	22.5				1.0237	1.0237	1.0237	32.0	32.0	32.0
	Do	22:10–22:20	18.6				1.0236	1.0235	1.0240	31.9	31.8	32.4
	Aug. 27	6:10– 6:15	20.0				1.0236	1.0235	1.0236	31.9	31.8	31.9
		Mean					1.0236	1.0236	1.0238	31.9	31.9	32.1
				7 ft.	*17 ft.*	*27 ft.*	*7 ft.*	*17 ft.*	*27 ft.*	*7 ft.*	*17 ft.*	*27 ft.*
31	Aug. 15	14:30–14:52	19.5				1.0239	1.0239	1.0242	32.3	32.3	32.7
	Do	21:45–21:52	18.0				1.0238	1.0237	1.0238	32.1	32.0	32.1
	Aug. 16	6:12– 6:20	21.1				1.0236	1.0237	1.0236	31.9	32.0	31.9
		Mean					1.0238	1.0238	1.0239	32.1	32.1	32.2
				22 ft.	*56 ft.*	*89 ft.*	*22 ft.*	*56 ft.*	*89 ft.*	*22 ft.*	*56 ft.*	*89 ft.*
32	Aug. 14	22:10–22:20	19.5				1.0236	1.0235	1.0236	31.9	31.8	31.9
	Aug. 15	6:10– 6:20	19.0				1.0236	1.0237	1.0239	31.9	32.0	32.3
	Do	14:10–14:20	19.5				1.0239	1.0235	1.0238	32.3	31.8	32.1
	Do	22:10–22:20	19.0				1.0236	1.0235	1.0235	31.9	31.8	31.8
	Aug. 16	6:10– 6:20	18.9				1.0237	1.0239	1.0237	32.0	32.3	32.0
		Mean					1.0237	1.0236	1.0237	32.0	31.9	32.0
				12 ft.	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*
36	Aug. 26	14:12–14:21	22.7				1.0232	1.0241	1.0241	31.4	32.5	32.5
	Do	21:47–22:20	17.9				1.0237	1.0237	1.0239	32.0	32.0	32.3
	Aug. 27	6:10– 6:20	19.8				1.0235	1.0235	1.0233	31.8	31.8	31.5
		Mean					1.0235	1.0238	1.0238	31.7	32.1	32.1
				6 ft.	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*	*6 ft.*	*15 ft.*	*24 ft.*
38	Aug. 26	13:50–14:15	23.0				1.0233	1.0232	1.0233	31.5	31.4	31.5
	Do	22:40–22:52	18.0				1.0236	1.0237	1.0237	31.9	32.0	32.0
	Aug. 27	6:15– 6:19	18.0				1.0237	1.0235	1.0234	32.0	31.8	31.6
		Mean					1.0235	1.0235	1.0235	31.8	31.7	31.7
				6 ft.	*12 ft.*	*19 ft.*	*6 ft.*	*12 ft.*	*19 ft.*	*6 ft.*	*12 ft.*	*19 ft.*
41	Aug. 27	22:12–22:18	19.7				1.0234	1.0234	1.0235	31.6	31.6	31.8
	Aug. 28	5:45– 5:52	20.5				1.0232	1.0232	1.0236	31.4	31.4	31.9
	Do	13:39–13:49	25.0				1.0233	1.0231	1.0230	31.5	31.2	31.1
		Mean					1.0233	1.0232	1.0234	31.5	31.4	31.6
				21 ft.	*53 ft.*	*84 ft.*	*21 ft.*	*53 ft.*	*84 ft.*	*21 ft.*	*53 ft.*	*84 ft.*
43	Aug. 14	22:10–22:25	19.1				1.0232	1.0236	1.0237	31.4	31.9	32.0
	Aug. 15	6:40– 6:47	18.6				1.0231	1.0232	1.0233	31.2	31.4	31.5
	Do	14:10–14:40	17.0				1.0236	1.0234	1.0236	31.9	31.6	31.9
	Do	22:09–22:24	18.9				1.0233	1.0236		31.5	31.9	
		Mean					1.0233	1.0234	1.0235	31.5	31.7	31.8
				7 ft.	*17 ft.*	*27 ft.*	*7 ft.*	*17 ft.*	*27 ft.*	*7 ft.*	*17 ft.*	*27 ft.*
47	Aug. 12	14:12–14:22	18.9				1.0230	1.0240	1.0242	31.1	32.4	32.7
	Aug. 13	6:15– 6:23	13.8				1.0235	1.0236	1.0236	31.8	31.9	31.9
		Mean					1.0232	1.0238	1.0239	31.4	32.2	32.3
				15 ft.	*38 ft.*	*60 ft.*	*15 ft.*	*38 ft.*	*60 ft.*	*15 ft.*	*38 ft.*	*60 ft.*
51	Aug. 13	22:15–22:50	11.8				1.0229	1.0234	1.0235	31.0	31.6	31.8
	Aug. 14	6:10– 6:20	21.2				1.0233	1.0231	1.0230	31.5	31.2	31.1
	Do	14:13–14:23	22.5				1.0235	1.0237	1.0238	31.8	32.0	32.1
		Mean					1.0232	1.0234	1.0234	31.4	31.6	31.7

TABLE 81.—*Temperature, density, and salinity of water, Block Island Sound and its tributaries, 1929–30*—Continued

Current station No.	Date	Time	Temperature, °C.				Density			Salinity		
			Air	Water								
Block Island Sound and vicinity—Continued												
	1930			*27 ft.*	*67 ft.*	*107 ft.*	*27 ft.*	*67 ft.*	*107 ft.*	*27 ft.*	*67 ft.*	*107 ft.*
52	Aug. 13	22:15–22:40	18.0				1.0230	1.0231	1.0232	31.1	31.2	31.4
	Aug. 14	6:17– 6:24	20.4				1.0234	1.0233	1.0233	31.6	31.5	31.5
	Do	13:47–14:14	21.5				1.0236	1.0236	1.0236	31.9	31.9	31.9
		Mean					1.0233	1.0233	1.0234	31.5	31.5	31.6
				20 ft.	*50 ft.*	*80 ft.*	*20 ft.*	*50 ft.*	*80 ft.*	*20 ft.*	*50 ft.*	*80 ft.*
52	Aug. 27	21:45–21:51	19.0				1.0237	1.0237	1.0238	32.0	32.0	32.1
	Aug. 28	6:09– 6:18	18.5				1.0233	1.0233	1.0234	31.5	31.5	31.6
	Do	14:13–14:23	25.9				1.0239	1.0237	1.0237	32.3	32.0	32.0
		Mean					1.0236	1.0236	1.0236	31.9	31.8	31.9
				13 ft.	*32 ft.*	*50 ft.*	*13 ft.*	*32 ft.*	*50 ft.*	*13 ft.*	*32 ft.*	*50 ft.*
56	Aug. 13	22:07–22:15	18.6				1.0230	1.0230	1.0231	31.1	31.1	31.2
	Aug. 14	6:10– 6:20	20.2				1.0232	1.0231	1.0231	31.4	31.2	31.2
	Do	14:10–14:20	23.2				1.0230	1.0232	1.0227	31.1	31.4	30.7
		Mean					1.0231	1.0231	1.0230	31.2	31.2	30.0
				11 ft.	*28 ft.*	*46 ft.*	*11 ft.*	*28 ft.*	*46 ft.*	*11 ft.*	*28 ft.*	*46 ft.*
57	Aug. 12	14:10–14:20	23.5				1.0228	1.0229	1.0227	30.8	31.0	30.7
	Do	22:10–22:20	19.0				1.0230	1.0229	1.0230	31.1	31.0	31.1
	Aug. 13	6:10– 6:20	17.3				1.0230	1.0232	1.0228	31.1	31.4	30.8
		Mean					1.0229	1.0230	1.0228	31.0	31.1	30.9
Gardiners Bay and vicinity												
	1929			*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*	*8 ft.*	*20 ft.*	*32 ft.*
2	Aug. 2	15:05–15:15	23.1	21.1	21.1	21.0	1.0234	1.0234	1.0234	31.6	31.6	31.6
	Do	23:40–23:50	23.4	21.2	21.0	21.1	1.0226	1.0227	1.0226	30.6	30.7	30.6
	Aug. 3	6:10– 6:20	26.0	21.2	21.1	21.0	1.0229	1.0227	1.0226	31.0	30.7	30.6
		Mean					1.0230	1.0229	1.0229	31.1	31.0	30.9
				7 ft.	*15 ft.*	*25 ft.*	*7 ft.*	*15 ft.*	*25 ft.*	*7 ft.*	*15 ft.*	*25 ft.*
3	Aug. 2	14:10–14:22	25.7	22.0	21.9	20.5	1.0228	1.0223	1.0225	30.8	30.2	30.4
	Do	22:12–22:22	18.9	21.4	21.6	20.3	1.0226	1.0224	1.0225	30.6	30.3	30.4
	Aug. 3	5:38– 5:50	19.2	21.2	21.1	20.9	1.0223	1.0214	1.0224	30.2	29.0	30.3
		Mean					1.0226	1.0220	1.0225	30.5	29.8	30.4
				12 ft.	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*	*12 ft.*	*30 ft.*	*48 ft.*
7	Aug. 9	22:40–22:50	21.3	21.5	21.4	21.0	1.0257	1.0255	1.0254	34.6	34.4	34.2
	Aug. 10	6:16– 6:58	22.7	21.3	21.3	21.5	1.0222	1.0220	1.0221	30.0	29.8	29.9
	Do	14:40–14:50	21.7	21.2	21.1	21.0	1.0225	1.0226	1.0225	30.4	30.6	30.4
		Mean					1.0235	1.0234	1.0233	31.7	31.6	31.5
				10 ft.	*25 ft.*	*40 ft.*	*10 ft.*	*25 ft.*	*40 ft.*	*10 ft.*	*25 ft.*	*40 ft.*
8	Aug. 9	22:10–22:24	21.1	22.5	22.3	22.2	1.0217	1.0219	1.0220	29.4	29.7	29.8
	Aug. 10	6:12– 6:20	22.0	21.5	21.7	21.6	1.0217	1.0219	1.0217	29.4	29.7	29.4
		Mean					1.0217	1.0219	1.0218	29.4	29.7	29.6
				7 ft.	*10 ft.*	*17 ft.*	*7 ft.*	*10 ft.*	*17 ft.*	*7 ft.*	*10 ft.*	*17 ft.*
9	Aug. 9	22:15–23:10	22.0	22.0	21.9	21.8	1.0203	1.0205	1.0207	27.6	27.8	28.1
	Aug. 10	6:05– 6:20	21.9	21.9	21.6	21.2	1.0197	1.0205	1.0205	26.8	27.8	27.8
	Do	15:45–15:55	24.1	22.2	22.2	22.5	1.0204	1.0205	1.0201	27.7	27.8	27.3
		Mean					1.0201	1.0205	1.0204	27.4	27.8	27.7

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