30th Congress, 2d Session. [SENATE.] Executive, No. 1.

REPORT

OF THE

SECRETARY OF THE TREASURY,

COMMUNICATING

A report of the superintendent of the coast survey, showing the progress of that work during the year ending November, 1848.

DECEMBER 12, 1848.

Read, and ordered to be printed; and that 2,000 additional copies be printed, 250 of which are for the superintendent of the coast survey.

Letter from the Secretary of the Treasury, communicating the report of the superintendent of the coast survey, showing the progress of that work.

TREASURY DEPARTMENT, *December* 11, 1848.

SIR: I have the honor to submit, for the information of the House of Representatives, the accompanying report, made to the department by Professor A. D. Bache, superintendent of the coast survey, showing the progress of said work during the year ending November, 1848. All of which is respectfully submitted.

R. J. WALKER,
Secretary of the Treasury.

Hon. GEORGE M. DALLAS,
Vice President of the United States and President of the Senate.

Report of the superintendent of the coast survey, showing the progress of the work for the year ending November 13, 1848.

BODIES' ISLAND, NORTH CAROLINA,
November 14, 1848.

SIR: I have the honor to submit to you my report of the progress of the survey of the coast of the United States during the past year, to be laid before the President and Congress. In conformity with your instructions, a brief notice is given of the pro-

National Oceanic and Atmospheric Administration

Report from the Secretary of the Treasury communicating the report of the Superintendent of the Coast Survey

gress of the work for four years and a half, including the surveying season of 1844. The estimates for the next fiscal year are submitted at the close of the report.

The reports made to me by the assistants bring the progress of their work, generally, up to the first of November, and in some cases to the close of the surveying season in the different localities where they have been employed.

During the past year the work has been carried into every State, with one exception, on the Atlantic and gulf of Mexico, and parties are on the way and under orders for the Pacific coast. The operations have been in progress on the full scale in four sections of the coast, including the reduction of the results; work of verification and filling up, and the engraving of charts from the back work, has been continued in a fifth section; the second stage of progress has been reached in a sixth and seventh section, and preliminary reconnaissance has been made in an eighth. The work has been equivalent, at least, to full activity in six sections. The estimates for the next fiscal year will furnish work equivalent to the full scale of operations in seven sections. A base line has been measured in one section, and two preliminary measurements of others made. Six sheets of charts have been published, and ten others are in the hands of the engravers. Thirteen sheets of maps and charts have been drawn in whole or in part within the year, exclusive of assemblage maps, sketches, &c.

Six new shoals have been discovered within the season off Nantucket, and one in the Chesapeake bay.

I have often introduced in my reports the subject of the relative economy of the work, and have endeavored to show, by comparisons from year to year, that increased economy is secured as the operations are extended in the progress of the survey. It is, however, frequently assumed that a work of this kind, conducted upon the highest scientific principles, must be expensive, no matter what may be its gain in economy in successive years. It is generally conceded that the survey of an extended coast, like that of the United States, cannot be satisfactorily made except by the employment of the most refined methods of modern mathematics and physics; and these methods, it is usually supposed, must be costly in their application. When a work of this kind is conducted on a sufficiently large scale to effect a proper division of labor, it is by no means expensive as is generally assumed, notwithstanding its elaborate character; and it will even bear comparison, in regard to cost, with works of far lower claims in reference to scientific methods or results.

The operations of the coast survey are well understood to be the following: 1st. A reconnaissance determines the plan of the work, then astronomical observations fix geographically the positions of places, and magnetic observations are made in connexion with them. A base line is measured with the best means which the science of the day presents; on which a triangulation rests, with gradually increasing sides; the primary triangulation checks the results of the secondary work, less elaborately executed. The distances between places are thus determined, the direction of the lines with the meri-

dian, and the latitudes and longitudes of the several station points. The topographical survey which follows represents the outline of the shores, and the roads to the nearest communication by land, landmarks, all objects, natural or artificial, within the space surveyed, showing, upon an accurately projected map, absolute positions and directions on the earth's surface, as well as relative positions and distances. Topographical signs define the character of the surface, and indicate its slope. The land work extends thus far, and the hydrographic parties, using the shore line defined by the topography, and the points of triangulation previously determined, make their soundings, which are platted with an accuracy corresponding to the other parts of the work.

The topographical survey referred to furnishes what is usually derived from a local survey, namely, a map of a portion of the surface; it gives all the details, natural and artificial, of the country, which is more than an ordinary land survey presents, and more than is attempted in the surveys of the public lands. It is admitted to be desirable, if not too costly. The cost of one cent and ninety-four hundredths per acre, ($12 41 per square mile,) stated by the Commissioner of the General Land Office in 1845, from careful averages, to be that of the land surveys to that time, is certainly less than has been paid by other governments for similar work. The estimated cost of six dollars and thirteen cents per lineal mile ($6 13) for 1846 is quite low, and even the maximum cost, in some of the land districts, of ten dollars and forty-nine cents, ($10 49,) is, beyond a doubt, reasonable. The cost of the topography of the coast survey in 1847, the year now reported upon, was, exclusive of drawings, *one cent and forty-five hundredths per acre*, (less than the average cost above stated,) including the drawings, two cents and fifteen hundredths per acre, or two mills per acre greater than the cost above stated. Converting the lineal surveys of the coast survey into area by the average proportion deduced from four years, 1844 to 1848, the cost per lineal mile, without drawings, was three dollars and forty cents, ($3 40;) with drawings, five dollars and ten cents, ($5 10;) both less than either the actual cost of the land surveys up to 1845, or the estimated cost for 1846.

As the other operations of the survey are beyond those of ordinary land surveys, they might be expected to add greatly to its cost; and as it is admitted that the work, topography inclusive, derives its highest importance from these other results, the question might be turned upon their actual value and not their expense. The geographical determinations of the points and bearings are indispensable to an accurate map even of a moderate extent of surface. If a map or chart is desirable, it should certainly be constructed on correct mathematical and physical principles. What these results cost, however, is a matter of simple computation; and taking the fiscal year just passed, which is unfavorable, as during that period a base was measured, and reconnaissance and triangulations made, without topographical work; all of which, with the astronomical and magnetic observations, are included in the estimates, the whole cost per acre, including the topography, is three cents and fifty-

two hundredths without drawings, or four cents and thirty-three hundredths with. Per lineal mile, (taking the area as if divided into squares,) the cost of the whole geodetic survey is, with the topographical drawings, eleven dollars and twenty-five cents, ($11 25,) and without them ten dollars and six cents ($10 06) less than the maximum paid for the survey of the public lands. The work thus proves to have a character in reference to expense the very reverse of what is sometimes attributed to it. It not only furnishes accurate scientific details and practical results, but it affords them at a very moderate cost. The relief to the coast survey appropriation by the detail of officers of the army, does not sensibly vary the above result in the year referred to, as the war had taken all the line officers from service on the work. The officers of the navy are employed in the hydrography, and not in the land work which is above referred to.

The estimates for that part of the expenditure of the hydrography which is derived from the coast survey appropriation, pass through the same routine as those for the civil and military parties The pay of the officers, and the pay and subsistence of the officers and men, are furnished by the Navy Department. The number of officers and petty officers and men are regulated by the same department, on application from the officers of the navy commanding the hydrographic parties. These are transmitted through the superintendent and Secretary of the Treasury, as a matter of form; but the judgment of the officers is conclusive with me, and the requisitions are complied with or denied, at the pleasure of the Secretary of the Navy. The law requires that as many officers of the army and navy as practicable be employed on the work; and, independently of the desire to husband the direct appropriation, which, I confess, is a strong motive with me, and of the respect which I feel for the officers of both branches of the service, and of the gratification which official or private intercourse with them always gives, I am bound by the spirit and even by the letter of the law to apply for additional officers whenever they can be usefully employed on the work. Besides the regular requisitions for the hydrographic parties, the Secretary of the Navy has it in his power, under the same law, to furnish repairs to the coast survey vessels. The liberality of the present Secretary, and of his immediate predecessor, has frequently been shown in this way to the work. This very liberality has induced me to abstain from formal applications for such a purpose, which might seem like a direct solicitation from the Treasury Department, through which my communications take place. I must be excused from referring here to the very important aid derived from the Treasury Department, in the transfer, by your direction, to the coast survey of a part of the steam vessels of the revenue marine, when the use of steam had been abandoned in that service. The moderate speed of these vessels is no objection to their use for surveying purposes.

Under the law, the organization of the coast survey contemplates the employment of civilians and officers of the army and navy. This triple organization brings the scientific and practical

training of civilians and of officers of the army and navy to its aid, a more permanent nucleus is supplied from civil life than the wants of either the military or naval service could yield, while entire concert of action is secured under a central authority, the department in which matters pertaining to the trade, commerce and navigation of the country centre, in the name and by the authority of which the superintendent acts. The scientific details, which careful study and the action of many minds viewing them from different points have matured, are made uniform throughout the work, and the whole proceeds according to a regular plan carefully arranged, and having in view a definite result. The temporary character of the work is recognized as a cardinal principle, no permanent corps being organized to conduct it, a feature which has proved important in other works, and which I doubt not has its influence in this. Free scope is afforded for selection from the science of the country at large, or from either branch of the military or naval service, under the heads of their respective departments, of those whom ability, knowledge, and opportunity unite in recommending for the service.

As soon as the arrangements of the army in its new positions permit, I hope again to have the services upon the work of such of the staff and line officers as can be suitably employed, and can be spared from their regular duties.

I annex a table showing the operations of the several parties, the names of the chiefs and of their aids, with a note of the localities where they have been engaged during the past season. Each party receives its instructions from me before taking the field, and communicates monthly reports of progress of the operations directed, so that the whole may proceed according to a general plan and with harmony in the different parts. The duty of superintendence, which in 1844 occupied but a small portion of each day while I was engaged in field work, has now increased so as to engage a large part of my time. Although every thing must be done by correspondence, the retirement of camp life is so favorable to the regular occupation of time, and so completely excludes all interruption, that I find it practicable to devote a considerable portion of the year to field work. My own field duties are presented with those of the assistants in the table just referred to. The work is classed under the following geographical divisions, termed sections:

SECTION I. From Passamaquoddy bay to Point Judith.
SECTION II. From Point Judith to Cape Henlopen.
SECTION III. From Cape Henlopen to Cape Henry.
SECTION IV. From Cape Henry to Cape Fear.
SECTION V. From Cape Fear to the St. Mary's river.
SECTION VI. From the St. Mary's to St. Joseph's bay.
SECTION VII. From St. Joseph's bay to Mobile bay.
SECTION VIII. From Mobile bay to Vermillion bay.
SECTION IX. From Vermillion bay to the boundary.
SECTION X. Western coast of the United States.

The preliminary arrangements for the party for the western coast were made by direction of the Secretary of the Treasury in the summer and autumn, and their instructions issued in time to avail themselves of the facilities recently afforded for the transportation of persons and instruments to Oregon. Assistant James S. Williams and Sub-assistant Joseph S. Ruth have been selected as the pioneers of the coast survey in that distant section. A hydrographic party, under Lieutenant Commanding W. P. McArthur, has also been organized for this service, and will probably have sailed before this report is received. I take this opportunity to acknowledge the facilities afforded by the departments of the quartermaster general and commissary general of the army, with the approval of the Hon. Secretary of War, and by Messrs. Howland and Aspinwall of New York.

The seasons during which the survey of the coast can be prosecuted to best advantage are only well marked in their extremes, and are matters of experience, the data of which must be collected under the actual circumstances of each party. The requirements of the different operations are so various that the experience of one party does not apply to the case of another; and the experience of ordinary life fails entirely to enlighten us, except in strongly marked cases. A condition of the atmosphere which will answer very well for the near sights of topography or tertiary triangulation, is not good enough for the longer sights of the primary work. The clear nights required for astronomy accompany very frequently days which are too hazy for main triangulation. Extremes of cold and heat, which cause the weather to be commonly pronounced disagreeable, can be very well borne, if they do not affect the air by producing lateral refraction, haziness or motion. The exposure of the parties to illness results, if we pass over the suffering unregarded, at least in a great loss of time to the work. The monthly reports of the persons engaged in the different sections show the number of days which they are able to employ in different parts of the year, and furnish a valuable body of statistics on this point, as they accumulate. Frequent correspondence with those engaged also determines speedily some general rules within which individual judgment is the guide. Taking the eastern section (No. I.) and one of the southwestern sections, (No. VIII. or No. IX.,) the surveying seasons scarcely overlap, and parties can be transferred from one of these sections to the other, when the office work resulting from the field season does not give full occupation to their time. Sometimes the office work of the party thus accumulates, and the transfer from section to section is impracticable. In some of the new sections we are not yet thoroughly acquainted with the best working seasons, and in others, these vary from year to year, as the winter sets in earlier or later, and is more or less stormy. I endeavor, in concert with the chiefs of parties, to select the most profitable parts of the year for the field, and to keep the party in the same section or to change it, as circumstances require.

The following is a summary of the progress of the field and office work of the survey in its different sections since November, 1847,

of which a more extended description is given under the head of each geographical section. The progress of the work in each section is shown upon a sketch accompanying the report, that of the past year being designated by a date placed near a station occupied, or upon a plane table or hydrographic sheet finished.

SECTION I. An additional station of the *primary triangulation* in New Hampshire has been occupied, at which *astronomical* and *magnetic* observations have been made. The difference of longitude between New York and Cambridge has been ascertained by combined *telegraphic* and *astronomical* observations. The chronometer comparisons between Cambridge and Liverpool (England) have been continued. Observations for latitude and longitude at Cambridge and Nantucket have been reported for the use of the survey. The *reconnaissance* for the *primary triangulation* has been extended in Maine. The *secondary triangulation* of the western shore of Massachusetts bay has been continued to join the Boston harbor work on the north, and the Cape Cod and Buzzard's bay triangulation on the south, and is nearly completed. The *secondary triangulation*, east of Boston, has been extended over Marblehead and Salem harbors to Cape Ann. The *topography* of the peninsula of Cape Cod has been nearly completed, and that of the south shore has been continued. The *hydrography* of the shoals near Nantucket has advanced towards completion; the sounding of Muskeget channel has been completed; the *tidal* and *current* observations in Boston harbor have been completed. A steam vessel was used in the work near Nantucket. *Six shoals* in the vicinity of Nantucket have been discovered and announced. An examination has been made of Sankaty head, as a site for a light-house.

The *computations* of the work of the previous year have been made. The two *manuscript charts* of Boston harbor have been reduced, and the *drawing* is nearly completed. The *drawing* of the same chart, on a smaller scale for engraving, has been commenced. The *drawing* of the chart of Nantucket harbor has been completed, and that of Hyannis harbor has been made. The *engraving* of the chart of Nantucket harbor has been completed. The *engraving* of the chart of Hyannis harbor has been commenced. The *engraving* of the *eastern series* No. I. has been commenced.

The chart of *Edgartown* harbor (Martha's Vineyard) has been published. A sketch of the Nantucket shoals has been engraved and published, for distribution.

SECTION II. *Astronomical* observations have been made at West Point, for the general purposes of the survey. *Magnetic* observations have been made at Fire island, and near New Haven. *Triangulation*, to determine points for supplementary hydrography, on the coast of Long island has been made. *Topographical* work near Hell Gate and Sandy Hook has been executed. *Tidal* and *current* observations have been made at the eastern entrance to Long Island sound, and off Montauk Point; *soundings* have been taken in Narragansett bay, Newport harbor, and off shore, between Block island and Cuttyhunk. Supplementary *soundings* have been made off the south side of Long Island, off shore, between the capes

of the Delaware and Martha's vineyard, and for comparison with those of former years, at the entrance to New York harbor; in Buttermilk channel, in the same habor, and in Hell Gate and its approaches. A steam vessel has been used in the off-shore work of this section.

The *re-drawing* of the middle and western sheets of Long Island sound has been made in part, and additions have been made to the harbor map of Black Rock and Bridgeport. The *drawing* of the western sheet of the south shore of Long Island sound has been nearly completed. The topography for the chart of the anchorages of Captain's island, east and west, and of the mouth of the Connecticut river, has been drawn.

The *engraving* of the eastern sheet of Long Island sound has been completed, that of the middle sheet has made tolerable progress, and the western sheet has been in hands. The *engraving* of the chart of Huntingdon bay has been completed. The chart of the anchorage of Cawkin's and Sheffield islands is nearly *engraved*, and Captain's island, east and west, has been commenced. The *engraving* of the entrance sheet of Delaware bay has been completed. The off-shore chart, from Cape Henlopen to Point Judith, has made considerable progress towards completion.

The eastern sheet of Long Island sound, the three sheets of Delaware bay, the chart of New London, Oyster bay, and of Black Rock and Bridgeport harbors, have been published, and Huntingdon bay is ready for printing.

Section III. Verification of *primary triangulation*, extension of *primary* and *secondary triangulation* south of the Potomac and across to Washington, and *reconnaissance* connected with the latter work, have been executed. The *secondary triangulation* of the outer shore of the peninsula has been continued southward into the limits of Virginia. The *topography* of the shores of the Great and Little Choptank, and of the adjacent shores of the Chesapeake, of the Patuxent, from its mouth as far as the triangulation extends, of the bay in the vicinity, of the islands south of Kent island, and of Chester river, has been completed. *Verification* work on the Patapsco is in progress. The *topography* of the ocean shore from Indian river to Sinepuxent bay has been completed. The in-shore *hydrography* outside of the peninsula has been carried from Indian river inlet, south of Isle of Wight shoal; of the Chesapeake, south to the line from Point no Point to Bloodsworth station. A steam vessel, loaned by the Navy Department, was used during part of the season in the work outside. Examinations in relation to light-houses have been made at Sand island inlet and at Blakiston's island. The *hydrography* of the Great and Little Choptank rivers, and of the Chesapeake bay, near their mouths, has been completed. A *shoal* has been discovered in the bay at the mouth of the Great and Little Choptank, and the limits of a dangerous shoal near Sharp's island have been, for the first time, well defined.

The *drawing* of the chart of the entrance to Chester river (harbor of refuge) has been made. The *drawing* of the upper sheet of Chesapeake bay has also been in progress, and has been sufficiently advanced to pass into the hands of the engraver. The *engraving*

of the chart of Chester river harbor, and of the upper sheet of Chesapeake bay has been commenced. That of the chart of Patapsco river and Baltimore harbor (in two sheets) is nearly completed.

SECTION IV. The *measurement* of a base line in North Carolina is in progress. The *triangulation* of Albemarle sound has been completed from Edenton to its entrance. *Astronomical* observations for azimuth and for difference of longitude from Washington by chronometers have been made at Stevenson's point. The *triangulation* of Alligator river has been completed. The *topography* of the southern shore of Albemarle sound has been finished from Durant's island nearly to the head of the sound; that of the shores of the Perquimon's and Little rivers, and of part of the northern shore of the sound from the Pasquotank westward, has also been executed. The *hydrography* of the Pasquotank river has been completed, and that of Albemarle sound has made considerable progress. *Observations* for the rise and fall of the water have been regularly kept up at two stations.

The observations of the section have been *computed*, and a *reduction* of the chart of the Pasquotank river has been made for engraving. The materials are collected for one sheet of a proposed chart of Albemarle sound and its rivers.

The work has been, during the past season, in full activity in this section, and the estimates for the next season contemplate also the full scale of operation.

SECTIONS III. AND IV. The *exploration* of the gulf stream has been continued in these two sections; soundings for temperature having been taken on two lines, one southeast from Cape Charles, and the other southeast from Cape Hatteras. A steam vessel was used in the work.

SECTION V. The preliminary *reconnaissance* of the coast of South Carolina and Georgia has been completed, and the minute *reconnaissance* made from the base line on Edisto Island to Christ Church parish, north of Charleston. A preliminary measurement of the base has been made, and the triangulation has been commenced. *Astronomical* observations have been made at Charleston, and a field party for *astronomical* and *magnetic* observations is under orders to this section. The estimate for the next year provides for *topographical* and *hydrographic* work in this section, and from November a *reconnaissance* towards Savannah. The first work will be directed towards Charleston.

SECTION VII. The preliminary *reconnaissance* has been in progress during part of the season for the extension of the triangulation from Dauphin island base, in section VIII., eastward into this section.

At the close of October, I was requested by the Commissioner of the General Land Office to undertake the survey of the Florida keys, and have taken preliminary steps for commencing the work immediately. A reconnaissance will be made and reported forthwith.

SECTION VIII. The *primary triangulation* of Mississippi sound has been carried to the entrance of Lake Borgne and the Chan-

delcur islands, the limits also of the *secondary triangulation*. The *secondary triangulation* of Mobile bay has made considerable progress. *Astronomical* observations to connect section IX. with this section have been made at East Pascagoula. The *topography* of the islands which enclose Mississippi sound has been completed, and that of the north shore of the sound has been carried as far west as Pascagoula. The *hydrography* of the entrance to Mobile bay and of Ship and Cat island harbors, and of their approaches, has been finished. A steam vessel was used during part of the season in this work. The *computations* of the section have been revised. The hydrographic *reduction* of a chart of the entrance to Mobile bay is in progress; one of Ship and Cat island harbors and their approaches has been commenced. These charts will be drawn and put into the hands of the engraver as early as practicable. Another season will, it is expected, furnish materials for No. 1 of the General Coast Map, which is also, in part, the lower sheet of the map of Mobile bay.

The work has been continued in full activity in this section during the past season.

SECTION IX. A minute *reconnaissance* of Galveston bay and its vicinity has been made, a preliminary *measurement* of a base line made, and the *triangulation* of Galveston lower bay commenced. Observations for *latitude*, *azimuth*, and difference of *longitude*, have been made at one of the stations. The parties for this section are under instruction to proceed there as soon as the season permits; and the estimates for next year contemplate the gradual development of the survey from the preliminary steps already taken.

SECTION X. The continuation of the operations of the land and hydrographical parties despatched to the western coast is provided for by the estimates.

The field or office work of the survey has thus been carried into every State on the Atlantic and Gulf of Mexico, except one.

The entire ignorance of the dangerous part of our coast near the island of Nantucket, so important as being in the track of vessels trading to Europe from New York, and coastwise between New York and New England, is remarkably illustrated by the *discovery* of six new shoals there during the past season, by the hydrographic party under command of Lieutenant Charles H. Davis, United States navy; an illustration unfortunately strengthened by the condition of the packet ship Louis Philippe, which was driven into this dangerous region in December last. I refer to the letter of William Mitchell, of Nantucket, (appendix No. 2,) to show how completely the position of the vessel was unknown. The vessel touched upon shoal after shoal, without the formation of a useful conjecture as to where the last spot upon which she struck was, or where the next might be. The lives of those on board and the vessel were happily (providentially) saved, the vessel being seen by the people of Nantucket, when the storm subsided, in a perilous condition, and aid being promptly rendered. If it were permitted to mention such a fact when life was at stake, I might state that the duties on the cargo of this vessel would have furnished an accu-

rate chart of the whole of this region. These duties would have been *lost to the government*, the chief cargo having been Christmas goods, the orders for which, of course, could not have been renewed.

The following is a brief statement of the progress made in the coast survey, the surveying season of 1844, and that just past, both inclusive, a period of about four years and a half, and five seasons for the northern sections. The triangulation now extends from Maine to Virginia, in a connected series, and has been commenced in North and South Carolina, Alabama, Mississippi, Louisiana, and Texas. The description will be better understood by referring to the sketches accompanying the report, which show the progress for the whole period, that for the past year being specifically marked upon them.

During the period referred to above, the primary reconnaissance and triangulation have been carried from the southwest part of Rhode Island into Maine, (see sketch A.) Astronomical observations have been made at 13 stations, and magnetic at 18. A base line of verification, of eleven miles in length, has been measured. The difference of longitude of New York city hall and Cambridge observatory has been determined by telegraph. The secondary triangulation has advanced from the eastern entrance of Narragansett bay to Cape Ann, with an interval which another season's work will fill up. The topography has been carried from Point Judith to Cape Cod, and has included the shores of Boston harbor and its approaches. The hydrography has been extended from Point Judith east of Nantucket, including part of Narragansett bay, the whole of Buzzard's bay, the Vineyard sound, the dangerous shoals off Nantucket, Muskeget channel, Hyannis harbor, and Boston harbor and its approaches. Charts of four harbors in the section have been drawn, engraved, and published; a fifth has been drawn and engraved, and is ready for publication; a sixth, and one of the sheets of the general coast chart, are in the hands of the engravers. Two manuscript maps of Boston harbor are nearly completed for the commissioners of the State of Massachusetts.

Much work of verification and filling up has been done in the second section, (sketch B,) between Cape May and Point Judith. Seven astronomical and 46 magnetic stations have been occupied. The difference of longitude between New York and Philadelphia has been determined. The hydrography of the approaches to the Delaware has been executed. The map of New York bay and harbor, and the environs, in six sheets, and the smaller map in one sheet, have been published. Five charts of harbors of refuge, &c., in Long Island sound, have been published, two others are engraved and nearly ready for publication, and one other has made considerable progress. The engraving, of course, supposes the previous reduction and drawing of all the maps. One large sheet of the chart of Long Island sound has been published, and another is well advanced towards completion. The complete chart of Delaware bay and river, in three sheets, has been drawn, engraved, printed, and published. A chart of Little Egg harbor, in New Jersey, (har-

bor of refuge,) has been drawn, engraved, and published. The off-shore chart, from Cape May to Point Judith, is nearly completed. One sheet of the south side of Long Island, delayed for work of verification, is nearly completed.

The primary triangulation has been extended across from the Delaware to the Chesapeake, and down the bay to the Virginia line, (sketch C;) and it is estimated that two, or at most three seasons more, will complete this work to the capes of the Chesapeake. A base of verification on Kent island has been measured. Astronomical observations have been made at six stations, and magnetic observations at twenty. The difference of longitude of the observatories at Washington and at Philadelphia has been ascertained by telegraph. The triangulation across from the Chesapeake to the capitol and observatory has been nearly completed. The secondary triangulation on the outer coast has been carried south of the Virginia line.

The triangulation of all the rivers emptying into the Chesapeake north of the Patuxent, and part of the Patuxent, has been made. The topography of this section, on the bay and tributaries, commenced in 1844, is nearly half completed, and, on the outside, has reached Sinepuxent bay. The hydrography of the bay extends south to the line Point no Point and Hilly Hammock station, (see sketch C,) and the in-shore work on the outer coast, south of the Isle of Wight shoal. One harbor chart has been published, three others are nearly engraved, and the engraving of the northern sheet of the Chesapeake has been commenced.

In section IV., (sketch D,) the triangulation has extended over Albemarle, Croatan, and Roanoke sounds. A base line is measuring on Bodies' island. Astronomical and magnetic observations have been made at three stations. Chronometer differences of longitude from Washington have been obtained. The triangulation of the rivers emptying into the north and south sides of Albemarle sound has been made, and the topography of the shores, (with one exception,) and of the sound, has been completed. The hydrography of Albemarle sound is nearly one-half done. The computations and reductions of the proposed chart of the sound have kept pace with the work. A chart of the Pasquotank (the outlet of the Dismal Swamp canal) has been reduced, and will be at once engraved.

The gulf stream has been crossed in various sections from Sandy Hook to Hatteras, extending southeast, the most southwardly and eastwardly point reaching latitude 30° 34′ north, and longitude 69° 36′ west; on these sections, at various depths, to five and six hundred fathoms, and, in a few cases, to greater depths, the temperatures have been ascertained, so as to obtain the law of decrease with the depth and the distribution at and below the surface at any given depth.

A general reconnaissance has been made of the coast of South Carolina and Georgia, (section V.,) and a minute reconnaissance from the base line on Edisto island to north of Charleston, (sketch E.) A preliminary measurement of the base has been made. One

astronomical station has been established. In another year this section will have passed through all the preliminary steps to the full development of the survey in it.

A general reconnaissance has been made of part of the coast of Florida, (section VII.,) and one is now making of the Florida keys and islands, (section VI.)

A complete reconnaissance has been made of part of section VIII., (sketch F,) including the coast of Alabama, Mississippi, and part of Louisiana. A base line has been measured on Dauphin island. The triangulation from Mobile bay to Lake Borgne is nearly complete, and it is estimated that another season will nearly if not quite complete the connexion between Mobile and New Orleans. Two astronomical and magnetic stations have been occupied in this section. The topography of the shores of Mississippi sound, as far west as Pascagoula, is complete, and of Dauphin, Petit Bois, Round, Ship, and Cat islands. The hydrography of the entrance to Mobile bay, and of Cat and Ship island harbors, and their approaches, and of part of Mississippi sound, is complete. The computations and reductions have been kept up, and charts of the entrance to Mobile bay, and of Cat and Ship island harbors, are in preparation.

A reconnaissance has been made of part of section IX., and the triangulation of Galveston bay, (sketch G,) resting upon a preliminary base, has been commenced. Astronomical and magnetic observations have been made at one station, and chronometer differences of longitude obtained between a station in Galveston bay and Pascagoula.

In the instrument with which two of the base lines have been measured, I have combined new principles and details. The apparatus was made in the office of the coast survey, and has fully realized the expectations formed in regard to its performance. New geodetic instruments, adapted to the character of the southern work, have been provided; new and improved astronomical and magnetic instruments have entirely replaced the older ones; new hydrographic methods and instruments have, in many cases, been introduced. The organization of the office, and of all the details of computing, drawing, engraving, printing and publishing, has, as the work has enlarged, been made more complete by the divisions of labor and of responsibility. The principles of modern geodesy are gradually extending to all the computations of this work.

During the period just referred to, an area of 17,555 square miles has been triangulated; the topographical surveys, with the plane table, have covered 2,318 square miles, and embraced an extent of shore line, roads, &c., of 7,179 miles. The hydrography has covered an area of 20,086 square miles, of which 16,824 were principally off shore or deep-sea work. Four thousand four hundred and four copies of maps and charts have been distributed to literary and scientific institutions in our country, and to departments of our own and foreign governments.

The plan of the work has been extended, so as to be more in proportion with the extent of the coast; and, as additions have

taken place, provision has also been made to survey at once the more important portions of the coast added. It is thus certain that any fixed and definite extent of shore line may be surveyed within a reasonable time, the more important parts being put under immediate survey, and the results of the work published.

In this extension of the work, the fostering care of the Treasury Department and of Congress has been especially felt. The increased appropriations necessary have been granted, and every incidental facility which, under the law, the Treasury Department has been able to extend, has been given freely. The War and Navy Departments have also liberally co-operated in aiding the survey.

In the estimates for the next fiscal year, work equivalent to full activity in seven sections is provided for, with a general item for office expenditures, and the cost of using four steam vessels. The total sum asked, is $186,000, which is less than I had assumed, in my report of 1846, as the cost of seven sections and the general item for instruments and materials, without the use of steam vessels. It is, certainly, the least sum for which the work proposed can be done, and may, possibly, owing to unforeseen expenses in the new sections, fall below what is necessary.

The estimates show, with some detail, the work proposed for the next fiscal year. The following is a brief outline, referring only in general terms to the operations.

Full activity is proposed for the work in section I., (coast of Massachusetts, New Hampshire, and Maine,) with the resources which this large section, with its indented coast, requires. The office work will keep up, in general, with the field work. The number of harbor charts furnished by this section has rendered it difficult to keep up in the engraving. It is hoped to finish the hydrography of Nantucket shoals in another season, when the in-shore work will advance rapidly. This important region, however, will receive all the time which it may require.

The field work in section II., (Connecticut, New York, New Jersey, Pennsylvania, and Delaware,) is chiefly of filling up, and the principal items of expense are for the engraving of the back work.

Section III., (coast of Maryland and Virginia,) will be in full activity, the same provision, at least, being made for field work as in the last fiscal year, while the office work will considerably increase, especially in the items of drawing and engraving. The hydrography outside of the peninsula will be pushed forward.

The work will be also in full activity in section IV., (coast of North Carolina,) the necessary astronomical, triangulation, topographical, and hydrographical parties being furnished. The computations, reductions, and drawings, will keep pace with the field work.

The basis laid by the present season will enable the work in section V. (coast of South Carolina) to be fully developed in the course of the next year. This season the triangulation and astronomical parties will prepare for the topography and hydrography of the following year. The minute reconnaissance will be extended

over St. Helena sound into Georgia, after completing Charleston harbor.

The exploration of the gulf stream will be continued.

The reconnaissance in section VII. will be completed, and the work on the Florida keys and islands for the Commissioner of the General Land Office be followed up, (section VI.)

In section VIII. the work will be in full activity, and additional resources are required for drawing and the engraving of maps and charts.

In section IX. the work will reach its full scale by the progress of the present season.

The estimates for the western coast, section X., have not, of course, the precision of the others, but may meet the expenses of the parties already sent there.

I proceed to give a more particular account of the progress of the survey during the past year, under the head of the several geographical sections, and the operations in each section.

SECTION No. I.

From Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.

Three triangulation parties, one including an astronomical party in its organization, two topographical parties, and a hydrographical party, have been at work in this section during the past season. One of the plane table parties included two assistants, each carrying on a part of the work, and one of the hydrographical parties had two surveying vessels. The effective force, therefore, may be reckoned at three plane table, and two hydrographic parties. Besides this, during part of the season, one additional hydrographic party was at work in the western part of the section. One station of the primary triangulation, which is also an astronomical and magnetic station, has been occupied. The difference of longitude between New York and Cambridge has been obtained by telegraph. The secondary triangulation of Boston harbor has been connected with that of Cape Cod by the triangulation of the western side of Massachusetts bay, and has been extended eastward, to include Marblehead and Salem harbors, as far as Manchester, on Cape Ann, requiring but a part of a season to complete the secondary work from Cape Cod to Cape Ann. The topography of Cape Cod has made good progress. The regular progress along the coast, which had been interrupted in order to make the survey of Boston harbor, has thus been resumed.

The hydrography of Nantucket south shoals has made excellent progress, and has realized, in new discoveries, the fruits of the zeal and perseverance of those engaged in it. Muskeget channel, an important avenue to and from the Vineyard sound, and one which was very imperfectly understood, has been sounded out.

The attempt to reduce the expense of the topographical work, by uniting two parties, and thereby dispensing with some of the

persons necessary in a separate organization, which was successful under the direction of Mr. Cutts in section III., has been tried this season in Mr. Whiting's party. The expenditures of the season having been yet returned only in part, I cannot give the result in figures; but Mr. Whiting reports a considerable increase of work in proportion to the addition of expenditure.

An early announcement was made of the discoveries, by Lieutenant Commanding C. H. Davis, off Nantucket, (see appendix No. 3,) in the former part of the season. The work increases in interest as it advances, and as the connexion between the detached parts becomes apparent. The two shoal spots discovered last year, and the ridges discovered in 1846, are now traced as parts of extended shoals. A description of the dangerous locality of the Nantucket shoals, as developed up to the close of the season, will be given in the appendix to this report, (No. 3, bis,) and a sketch showing this part of our coast as now known will accompany it, and also be printed separately for distribution. The steam vessel, sailing vessel, and extra vessels employed this year, will be required for another season, at least, to complete this part of the survey. *Six new shoals* have been discovered during this one season, the number showing how truly this important part of our coast might have been classed with regions unknown.

I mentioned in the report of last year that comparative trials had been made of the zenith telescope, zenith sector, and prime vertical transit, as means of determining latitudes on the coast survey. The results were very favorable to the two instruments first named, and unfavorable to the method by transits over the prime vertical for field work. The eastern and western transits of but few stars could be observed on the same evening, and the intervals were frequently lost, even when the observations were extended through the whole night. The results by the same star upon every wire were good, the probable error of the latitude from a single observation on a single wire being but 0″.85, (about the same in amount as the single observation with the zenith sector;) the probable error of latitude, as observed by a single star, derived from a mean of four observed, being 2″.07, and of the mean of the four 1″.04. It is very probable that these difficulties may be remedied, at least in a degree, by another method of observing or by comparisons at different places for differences of latitude, but the few results which can be procured in a given time, when the weather is particularly favorable, will always tell against it for field purposes. Mr. Davidson, who remained at Agamenticus to add to the number of stars which had been observed on the prime vertical, labored assiduously for twenty-seven nights, watching the whole night when there was any prospect of success, without procuring a single interval between an eastern and western transit of the same star.

With the zenith sector, in sixteen evenings in October and November, before midnight, 106 observations were made on 37 stars, the probable error of a single observation being 0″.88, and the probable error of the place of any one star as given by the catalogue being 0″.47. The error of the mean result for latitude is

thus very small, being probably chiefly that of the part of the catalogue employed. Four observations with the zenith sector thus appear to give a result equivalent in value to the normal place of the star given by the catalogue. By the zenith telescope in 10 nights, to about midnight, 125 observations were made on 25 stars, the probable error of an observation being ± 0".87, of a single pair (catalogue error) being ± 1".43, and the mean latitude being 43° 13' 25".1. There is yet room for doubt whether the zenith sector will maintain its superior accuracy when compared with the more recent forms of the zenith and equal altitude instrument, and with more accurate determinations of the places of the stars. The portability of this latter instrument, and the facility of its use by a single observer, makes it deservedly a favorite. The trial at Agamenticus was favorable to one determination of latitude by the zenith sector, as compared with one determination of latitude by the zenith telescope. The results for the latitude of the station, derived from the three instruments, were for the zenith sector 43° 13' 25".00; zenith telescope 43° 15' 25".1; transits over the prime vertical 43° 13' 25".81 N.

1. *Reconnaissance.*—The reconnaissance for the extension of the primary triangulation eastward from the stations, in New Hampshire and Maine, shown upon the sketch of the work of last year, has been continued under my immediate direction, by assistant C. O. Boutelle, who was occupied in it from the 21st of June to the 5th of August. The work proved much more difficult than Mr. Boutelle's previous knowledge of that part of the country had led him to suppose; the points which are intervisable and which form, by their connexion, triangles of the proper shape, not giving the length of sides which had been anticipated. After a general examination of the country, for the next range of triangles, Mr. Boutelle made a triangulation with a reconnoitring telescope with a divided circle, so as to fix approximately the relative positions of prominent points. A report, made with his usual ability, shows the conditions which limit the selection of the triangle points in particular directions, and presents a scheme for the extension of the primary triangles.

2. *Primary triangulation.*—As stated in my report of last year, the progress of this triangulation, in advance of the secondary, admits of the devotion of part of my time to work in other sections. Closing the work of verification in section III. in the latter part of August, I occupied Unkonoonuc station in New Hampshire, between the 28th of August and 7th of October. This was not originally intended as an astronomical station, but the Secretary of the Treasury having directed the beginning of the survey of the coast of section X., the western coast, I deemed it expedient that the assistant, who was to be in charge of that work, should have an opportunity of going through all the different classes of observations made in the survey, and determined to use this station, both for astronomical and magnetic observations. When the observa-

tions at Unkonoonuc were completed, I transferred my party to North Carolina for the measurement of a base line on Bodies' island.

The points observed upon from Unkonoonuc, seven in number, are marked in sketch A, and extend from Gunstock mountain on the north, to Blue hill, near Boston, on the south. It has an extended view of the immediate coast, including Blue hill, Thompson's at Cape Ann, and Agamenticus in Maine, about seventy-five miles. The shortest side of the triangulation centring at this mountain is twenty-two miles in length, and the longest fifty-five miles.

The horizontal angles were measured by 316 observations with the thirty-inch Troughton and Simms's theodolite of the coast survey. The area of the polygon, formed by joining the stations observed upon, and reckoned in the usual way, is 1,629 square miles.

Two hundred and two observations were made for differences of height with the micrometer of the thirty-inch theodolite. Seventy-eight observations for the height of the barometer, 78 for temperature, and 78 for evaporating point, besides other miscellaneous meteorological observations, were also made. The comparison of the barometer observations with those at the Cambridge observatory will serve to determine the height of the mountain, which appears not yet to have been ascertained.

I was aided in the observations and in the miscellaneous work of the party by Mr. J. Hewston, jr., and Mr. B. H. Duncan.

3. *Astronomical* and *magnetic* observations.—The astronomical observations were of latitude and azimuth, and for local time; the magnetic, of declination, dip and intensity. These were made by me personally, or by Sub-assistant Joseph S. Ruth, under my immediate direction. Assistant James S. Williams also took part in the astronomical observations.

A new zenith telescope, by Simms, (No. 2, of the coast survey,) with such improvements as the experience in its use by former observers has suggested, was used for determining the latitude by Captain Talcott's method. This instrument is arranged so as to reach the zenith stars without difficulty. It has a telescope of 3½ inches aperture, and 40 inches in length, a single micrometer, a brass arc for steadying its vertical motion, and is well arranged in its minor details. A re-computation of the results is necessary before we can compare its performance with those of the other instruments of the same kind used in the coast survey. 118 observations were made for latitude with this instrument on 30 pairs of stars. 124 observations were made on Polaris at culmination for the value of the micrometer, and 25 at elongation for the value of the level divisions.

Eighty transits of stars were observed for local time, in connexion with the observations of latitude and azimuth with the forty-five inch transit instrument of Simms, (No. 1.)

Fifty-three observations for azimuth were made with the thirty-inch Troughton theodolite on Polaris, gamma and zeta ursæ minoris at elongation, and on Polaris near its elongations. The results are nearly independent of the latitude of the place and the position of

Polaris, by observing near both eastern and western elongations. Five positions of the instrument were used in the measurement of terrestrial horizontal angles. 35 observations were made for connecting the observed positions of the star and the elongation mark. The heliotrope, or pole at Holt's station near Andover, (see sketch A,) was the mark of reference in the morning elongations, and a lamp, such as is used in the smaller light-houses on the coast, with a single reflector, kindly loaned to the coast survey by the Fifth Auditor, was the night mark at Holt's. When the atmosphere was moderately clear, the light was readily observed with the wires fully illuminated; the distance to Holt's is about 34 miles.

Ninety-three readings for magnetic variation were made on three days; six sets of observations for horizontal intensity on four days, and three sets for dip on two days. Four sets of experiments for the moment of inertia, and magnetic moment of the magnet were made on two days. A declinometer and magnetometer, described by Riddell in the magnetic instructions of the British Association, and made for the coast survey by Jones, (No. 2,) was used in these observations; also, a dip circle, by Barrow of London, (No. 1.)

The observations at Nantucket have been continued during the past year by William Mitchell, esq., who reports one hundred and thirty-two observations of the moon and moon culminating stars, and four occultations for longitudes, thirty-two prime vertical transits, (sixteen intervals,) and thirty-five series of observations with the West Point repeating circle for latitude.

The chronometer comparisons for differences of longitude of Cambridge and Liverpool have been continued by Professor W. C. Bond, director of the Cambridge observatory, and seventy determinations made during the past year. Mr. Bond also reports, for the use of the coast survey, twenty-nine moon culminations, (reduced,) ten occultations of stars by the moon, and seventy-two results for latitude by transits over the prime vertical. Observations for local time were made, also, by Mr. Bond; and Mr. George P. Bond, in connexion with the telegraphic operations, for difference of longitude of New York and Cambridge, on nineteen days in July, and fifteen in August, besides others for personal equations.

4. *Difference of longitude by telegraph.*—This method, which may be considered to have passed into one of the regular methods of geodesy, was employed to determine the difference of longitude between a station in the Stuyvesant garden, New York, kindly provided by Mr. Rutherford, and the observatory at Cambridge. The president of the New York and Boston telegraphic company, Hon. Francis O. J. Smith, facilitated in every way our operations, and put up, with economy and despatch, a small extra line which was necessary to connect the Cambridge observatory with the main telegraphic line near the depot at Brighton. This line was suggested by W. C. Bond, esq., and the reconnaissance for it was made by Assistant C. O. Boutelle. The arrangements at the New York end of the line were made, under my direction by Professor Elias Loomis; those at the Cambridge end were made by Mr.

Bond. The details of the operations were, as heretofore, placed in the charge of Assistant S. C. Walker.

At New York, a new forty-five inch transit instrument of the coast survey, by Simms of London, (No. 2,) was used for local time, and a sidereal clock, belonging to Messrs. E. and G. W. Blunt, with chronometers for comparisons. The performance of the new transit is reported by the observers to be entirely satisfactory. At Cambridge, a similar transit, of the Messrs. Bond was used, with numerous chronometers carefully compared. The comparisons at the ends of the line were made by the method of coincidences.

The mode of using the telegraph has been explained in my last report, and the conditions necessary to accuracy, as also the method of deducing results from the observations. The receiving magnets used last year were laid aside, to give place to others of greater power.

Signals were exchanged on seven nights in July and August between the two stations, the whole number amounting to 12,000. These were generally coincident with the beats of the clock or chronometers; but, in some cases, the transit of the same stars over the different wires of the instruments were also telegraphed.

The personal equations for the clock corrections of different observers were obtained by a very extensive series of comparisons, 894 in number, the transit of the same equatoreal star over alternate wires being noted by different observers. The other observers repaired to Cambridge for comparisons with the Messrs. Bond. The observations for clock corrections were made by the most approved method. The small list of zenith stars was used for observations of clock corrections at New York and Cambridge, eliminating, nearly, the errors in the right ascensions as derived from the catalogue of the British Association. Mr. Walker proposes to reduce these right ascensions to an average value for all the observations of the season, (575 observed transits,) making the corrections which the observed differences may indicate.

In reference to the corrections of the telegraphic part of the operations identical results were obtained with those stated in my report of last year, leading to the same conclusions that, when due precautions are taken, the "telegraph itself commits no error which the most delicate ear can detect."

Very great attention has been given by Mr. Walker to the determination of personal equations, upon the success of which these operations finally hinge. The views of Mr. Walker are thus presented in his annual report:

"The importance of the careful determination of this element was explained in my last year's report. It is the most difficult and most variable element in the whole work; while all the others, by repetitions of the same process on several nights, converge towards a final result apparently free from *constant*, and, indeed, from all sensible *accidental* error, this element retains its constant error until it is removed by alternations of the four principal observers, or mediate comparisons. An important question arises

on this subject, viz: whether there is any constant relation between two individuals for a term of several weeks, or whether the element is not subject to fluctuations with the relative state of the health and temperament of the observers. I think the experience of fixed observatories warrants the conclusion, that two observers of the regular corps, retaining the same instruments at the same locality, have, for several months, and even for several years, the same relation to each other. Such was not the experience of the last year's work among the travelling corps of observers of the United States coast survey; change of place and instruments have seemed to produce changes in the value of this element. Since the liability to error from this source exceeds that from all others, too much stress cannot be laid on the importance of studying the philosophy of it."

"I beg to suggest the following hypothesis: There exists between the absolute time of the sensation of sight of a phenomenon, and of reference of that sensation in point of time to that of the hearing of a sound in every individual, a very small interval, which, though slightly variable with his temperament in other respects under similar circumstances, may remain constant for months, and perhaps for years. It is the difference in this quantity of time that constitutes the personal equation of two observers. In order to arrive at it, the two persons must eliminate their relative *accidental error of seeing* and also of *hearing*. The outstanding difference after this elimination constitutes the personal equation."

"In order to converge with rapidity to this ultimate relation between two persons, the clock beat used by both should be clear and distinct. The optical capacity and definition of the transit instrument should be the best possible. The solar focus and the ocular focus of the transit wires should coincide in space for each observer. This can only be secured if the vision of one is shorter than that of the other, by one or both of them wearing those spectacles which every day's practice has shown to be needful. After taking these precautions, I have reason to believe that the trial of 100 wires at a single comparison gives a result nearly freed from accidental error, when both parties are in good health and free from fatigue. If these conditions are not complied with, if the definition of the telescope is imperfect, or if the ocular focus is not good for both parties, several such comparisons are needed in order to obtain the requisite precision of the result. If the solar or ocular focus is bad, the eye endeavors to overcome this imperfection by its own adaptability. This power of overcoming such a difficulty varies with the state of the nervous system or temperament, and in such a case different states of temperament produce different degrees of perfection of vision, and different degrees of convergency towards the true result from a given number of wires."

"It often happens that two persons after a state of rest or resumption of work, converge rapidly towards their normal relation. If afterwards one of them rests, and the other labors so as to be much chilled or fatigued, the two on recommencement of their

trials, find a very different result from the preceding. From the experience of this year, it seems proper to conclude that observations for personal equations, when all the above mentioned requisites are not complied with, are of very little use, and that the incorporation of them in the mean or general result leaves it less accurate than that of a smaller number of trials under circumstances favorable throughout. Observations by daylight are preferable. The eyes of different focus adapt themselves to the same eye-piece better than by night."

The collection of personal equations appended to Mr. Walker's report of this and of last year is, I believe, the most extended on record, embracing forty-seven different pairs of observers. The personal equations beween the four principal observers of the season are determined within a probable error of one-hundredth of a second of time. As these results will be of considerable interest to practical astronomy generally, and the necessity of recurring to similar observations in the coast survey will be constant, so as to render the results valuable for reference to the work, I have placed the general abstract in the appendix No. 4.

The formation and discussion of the conditional equations for the difference of longitude will complete this report of Mr. Walker. His other labors in computing will be found noted under their appropriate head of office work.

We have now obtained the difference of longitude between Washington and Cambridge by the telegraph, using two intermediate stations at Jersey City and New York, which may be connected with certainty by the geodetic operations of the survey. The difference of longitude between Philadelphia and Washington and Jersey City was obtained in the course of the first series of observations.

5. *Secondary triangulation.*—The secondary triangulation of the western shore of Massachusetts bay has been in part completed by Captain T. J. Cram, United States Topographical Engineers, assistant in the coast survey. This was necessarily preceded by a reconnaissance which resulted in the scheme shown in sketch A, extending from the line Falmouth, Hyannis on the Vineyard sound to the line Blue hill, Prospect hill, (Hingham,) near Boston harbor, where a junction is made with the secondary triangulation of Boston harbor of Assistant C. O. Boutelle. This work furnishes points for the plane table survey of the western side of Massachusetts bay. The party of Captain Cram took the field in July, and by the middle of August the reconnaissance was finished, and the additional signals (twelve in number) erected. Up to the 27th of September, the following work had been completed. Seven stations had been occupied, and an area embraced of 453 square miles. Observations had been made on twenty-one stations and eight other objects, including steeples, light-houses, &c. The number of angles measured, was 418 by 4,189 observations. The instrument used is a twelve-inch repeating theodolite (with a repeating stand) made by Simms, of London, for the coast survey. Captain Cram reports favorably of its performance.

A supplementary report by Captain Cram, stating the progress of his work to November 1, at which date he had been directed to close it for the season, shows 12 additional stations occupied, 32 objects observed upon, and 4,044 observations made.

Sketch A indicates the progress of the triangulation by the connexion of stations, both of which have been occupied by the darker full lines, and those of which one has been occupied by the lighter full lines.

The work executed by Captain Cram on Cape Cod, after the date of his annual report last year, that is from October 1 to November 9, and not included, therefore, in my last report, was as follows: Three stations were occupied, and the positions of thirty-three objects fixed by 726 observations. The area embraced was 185 square miles. Ten stations were occupied or visited with instruments, and the height of them above the ocean determined. The whole working season of 1847 of this party was five and a half months. During the winter Captain Cram has reduced his observations, and put them in form, and made the prescribed computations.

6. The secondary triangulation of the vicinity of Boston harbor to its connexion with the work of Captain Cram, just stated, has been completed by Assistant C. O. Boutelle, who has also extended his triangulation north and east of Boston harbor, to include Marblehead and Salem harbors, and part of Cape Ann as far east as Manchester, (see sketch A.) At the main stations, Mr. Boutelle used the two-feet Troughton theodolite of the coast survey, and at the minor stations, the six-inch repeating theodolite by Gambey, (No. 1.) Between the 30th of August and 26th of September five main stations were occupied, at which 129 angles upon 126 objects were measured by 990 observations, and seven subsidiary stations, at which 99 angles were measured upon 93 objects, by 600 observations.

Mr. Boutelle closed his work in the latter part of September to proceed to section IV., North Carolina, to make the preliminary arrangements necessary to measuring the base line on Bodies' island, and to assist in the measurement.

Between the 1st of November and the 11th of December, 1847, the following work was done by this party in the survey of Boston harbor, not included in my report of last year, viz: six stations occupied, 152 angles measured upon 142 objects, by 1,310 observations with the two-feet Troughton theodolite.

Mr. Boutelle was engaged last winter in astronomical observations in North Carolina, which are noted under the head of section IV., and on their completion was occupied in computations of that work, and in the re-computation of portions of the observations of former years until he took the field in June. He was aided by Mr. G. W. Dean, attached to his party.

7. *Topography.*—The topography of Cape Cod has employed two parties, and has embraced sheets Nos. 28, 31, 32, 33 of sketch A. The first party was under the general charge of Assistant H. L. Whiting, and the work was executed by him and by Sub-assistant

S. A. Gilbert, the number of hands of the party being doubled. Up to the close of September, sheets Nos. 31, 32, 33 had been completed by this party, an area had been surveyed of 73½ square miles, an extent of shore line of 103 miles, shore lines of creeks and ponds 38½ miles, and roads 210½ miles. The topography of the shores of Wellfleet harbor, of South Wellfleet or Blackfish creek, and of Parmet river harbor in Truro are included in No. 31. This sheet alone contains 184 miles of roads, and the character of the natural features of the country included in it is very complex. Mr. Whiting remarks: "The hills in Truro will average from 100 to 140 feet high, and in Wellfleet and Eastham from 120 to 80 and 60. These are all of the most abrupt and irregular character, with alternate hollows and peaks." "In six *consecutive* square miles there are not less than 300 separate peaks of hills, and some 510 holes or hollows, all requiring and having separate and distinct curves of contour and elevation."

Mr. Whiting took the field in June, and, after preliminary reconnaissance, commenced his plane table operations on the 8th of July. He was joined by Mr. Gilbert on the 20th of July, since which time two instruments have been employed. The party expected to finish this part of Cape Cod during the present season; but I have been obliged to direct the closing of the work in October, for important verifications in section II. of the survey, and a re-survey of Sandy Hook, to ascertain its increase. The topography in this section is sufficiently in advance of the hydrography to permit a short season's work without detriment to the general progress of the section.

During the last winter, Mr. Whiting was engaged at Boston in transferring the survey of the city, by the water commissioners, to his topographical sheets of the shores of Boston harbor. In effecting this, it was necessary to run additional lines and occupy many stations. This work employed him until the 20th of March, when he repaired to the office and put in ink the topographical details of his plane table sheets, as far as the time permitted, until it was necessary again to take the field. Mr. Gilbert was engaged in putting in ink the topography surveyed during the previous season, and also in reducing in pencil, for the commissioners of Boston harbor, a part of the plane table sheets of the harbor shores.

8. The second topographical party was under the charge of assistant J. B. Glück. Sheet No. 28, on the south side of Cape Cod, was commenced by Mr. Glück early in June. His work upon it was interrupted from the close of July until the beginning of September; and up to the 25th September an area of 26 square miles, 36¾ miles of shore line, and 67½ miles of roads, had been surveyed. The part completed includes no less than seven villages.

Additional topographical surveys, indispensably required for the map of the eastern series, No. 1, in the course of engraving, occupied Mr. Glück during the month of August. These are shown in sketch A, Nos. 1½, 3, and 4, one being in the vicinity of Dutch island and the ferries across the western arm of Naragansett bay, the other on the eastern passage, or Saughkonnet river, and near

Pamanet or Slocum river. The extent included in these surveys is about 9½ square miles, but does not fairly represent the amount of work done, as it is in detached parts, which are at considerable distances from each other. The distance gone over, in moving from place to place in executing the work, is estimated at three hundred miles.

Mr. Glück mentions with thanks the prompt assistance received from Captain Walden, of the revenue cutter Jackson, who was directed to afford him transportation in the surveys in Naragansett and Buzzard's bays.

In October this party was directed to take up the verification of the shores of the Patapsco. During the last winter Mr. Glück was occupied in the office in putting in ink his surveys for the chart of Boston harbor, and in transferring the topographical details to the map for the commissioners of Boston harbor.

9. *Verification of topography.*—Verifications of part of the topography of the shores of Boston harbor and the vicinity were made in September, by Captain A. A. Humphreys, United States Topographical Engineers, assistant in the coast survey. The results are highly satisfactory both as to accuracy and uniformity of representation by Assistants Whiting, Glück, and Williams, and Subassistant Gilbert.

10. *Hydrography.*—The hydrography of the Nantucket shoals, and of the vicinity of Nantucket island, has been continued by the party under the command of Lieutenant Charles H. Davis, United States navy, assistant in the coast survey. The vessels employed have consisted of the steamer Bibb, the schooner Gallatin, and a hired tender of ninety-five tons burthen. The Gallatin was under the command of Lieutenant J. N. Maffit, United States navy. In his report at the end of the season, Lieutenant Commanding Davis remarks:—"The progress made in the first month of the season (July) was so very satisfactory that there was but little doubt of completing before the end of the season the survey beyond the new south shoal on the south, and on the meridian of Great Rip on the east.

"A chart having these limits, and embracing the anchorage under Great Point on the north, would be of the highest value to the foreign and coasting trade. It would be in demand abroad as well as at home, and would be relied upon by all those merchant vessels of Great Britain, and the north of Europe, which are engaged in commerce with this country. But the very dangerous character of the ground requires that every possible care should be used to ensure accuracy, and in accordance with this view, the South shoal charts already issued have been called "Preliminary Sketches," leaving an opening for future corrections, if upon a comparison of the work of separate seasons, any should be found necessary. The necessity for accuracy, arising from the dangerous nature of the ground, is increased by the imperfections of the existing charts, and it is the reiterated proof of this imperfection, and the constant discovery of new shoals, which, more than anything else, has com-

pelled me most unwillingly to report to you the necessity for giving another season to the outer Nantucket shoals.

"Five new shoals, discovered during the present year, have already been reported to the public, and another shoal or bank has since been discovered, eighteen miles from Nantucket, of equal importance to any of the preceding. But the weather during the month of August has also been a cause of our not completing the proposed chart this season. It proved a greater drawback than usual. The fog was so continuous and dense, that the vessels have more than once laid at anchor on the shoals without seeing each other for forty-eight hours, though only a few miles apart."

In the appendix (No. 3, bis) will be found a notice of the dangers in this vicinity as they were known at the close of the surveying season. The preliminary sketch which accompanies this report gives the hydrography of this region as far as completed.

In conformity with the request of a committee of the citizens of Nantucket, a very careful examination has been made of the bay inside of Great Point, with a view to ascertain what changes, if any, have occurred since former surveys. The channel between the island of Muskeget and Martha's Vineyard has also been carefully sounded; and Lieutenant Commanding Davis recommends that a chart be prepared, embracing this channel and the harbors of Edgartown and Holmes's Hole—a recommendation which meets my entire concurrence. He is of opinion that this channel may be useful, if properly buoyed, as vessels passing through Nantucket sound would have the choice of passing out by this channel or by the Vineyard sound, and "at certain times of the tide the current is unfavorable in one place, while it is favorable in the other; and, owing to the different directions of the two channels, the same wind may be fair in one that is ahead in the other. After passing the outer bar, about eight miles distant from the southeast point of Chappaquiddock, over which there is good beating space of three fathoms, vessels are clear of danger. Muskeget channel, however, promises to be principally useful as a means of entrance to the sound in threatening weather, when the object will be to reach a harbor of refuge."

The recommendations of a light on Sankaty head and of a beacon on the new South shoal, are again renewed by Lieutenant Commanding Davis in his report of this year, in the following terms:

"It will be highly gratifying to you, however, to know that our labors in this field have already proved useful to the coasting trade, in pointing out the safe and expeditious route clear of the shoals to the southward of Nantucket; this has been made known chiefly through the pilots and others employed in this branch of the coast survey. I have never seen so many vessels in this track as during the past season. But the valuable knowledge collected by the coast survey in this region will become much more conspicuous and generally useful when the light is established on Sankaty head. If this light is, as it undoubtedly should be, one of great power, distinctly visible in clear weather at a distance of thirty miles, not only will the domestic commerce derive great ad-

vantages from it, but we shall hear less frequently of accidents to our foreign merchant ships on the shoals.

"To navigate safely among them reqires a local knowledge which pilots only attain, and which few pilots ever possess. Navigators are easily bewildered on coming from the sea, and finding themselves suddenly in shoal water, and uncertain what course to pursue; this evil will be partially remedied by a good light on Sankaty head. Next in importance to this light, as a security to navigation, is a beacon on the new South shoal, which I consider it again my duty to urge now, and on all proper occasions; the value of which I hope yet to see recognized, and the erection of which is not, I trust, far distant." A detailed report, relating to a light-house on Sankaty head was made to me last December by Lieutenant Commanding Davis, and a copy of it was duly forwarded to the Fifth Auditor; it will be found in the Appendix to this report, No. 5. A report from the same officer in regard to buoys is also appended.—(Appendix No. 6.)

11. It is not usual to refer in my reports to attempts, however useful, which have not succeeded, but I feel disposed to depart from this rule, to render justice to the effort of Passed Midshipman Daniel Ammen, of the United States navy, acting master of the steamer Bibb, who volunteered, under circumstances of no little personal hardship, to attempt to determine the position of Cashe's ledge. My attention was called by the honorable Daniel P. King, of Massachusetts, to a letter received by him from Mr. Samuel Giles, of Rockport, Massachusetts, in which it was stated that this ledge, having "only twenty-seven feet of water" upon it, is erroneously laid down in the charts to the extent of nine miles of latitude. It was further stated that the fishermen from this part of the coast crossed "the White rock" of Cashe's ledge many times in the course of the season. On communicating with Lieutenant Commanding Davis in regard to this matter, he informed me that Acting Master Ammen had volunteered to go in a fishing smack from Rockport, and that he had been furnished with proper instruments to determine the approximate position of the ledge, if found. Mr. Ammen sailed in company with two experienced fishermen from Rockport, as pilots; and, after reaching the deeper parts of the ledge, sounded for two days and a half to find the shoaler parts, without success. The pilots "had not before appreciated the advantage that the vessels at anchor had at other times been to them, affording the means of always keeping in the vicinity of the shoal, and of avoiding sounding over and over again the same ground." As the information collected by Acting Master Ammen may, in the absence of more precise data, be of service to navigators, I have appended his letter to this report—(Appendix No. 7.) I propose to give Mr. Ammen the opportunity which he desires, to complete this work, at a period of the year when the fleet of fishing vessels is anchored on or near the ledge.

Among the disagreeable incidents of the season was the danger run by the schooner Gallatin in her return to Boston harbor, hav-

ing been caught in a violent northeast gale of Scituate rocks. The vessel suffered damage, easily repaired, in her spars and sails, but no further. Her situation at one period of the gale is represented to have been perilous. Two vessels under similar circumstances went ashore on Scituate rocks.

After the season was so far advanced (September) as to render further work on Nantucket shoals impracticable, the schooner Gallatin, was employed in observations of currents in Boston harbor, which, by great industry, were completed before the close of the season. Tidal observations at this important port have been kept up throughout the year.

A report by Lieutenant Commanding Davis, on the necessity for a landmark upon Long Island, Boston harbor, is hereto appended, (Appendix No. 8;) also a notice by the same officer of an invention of Captain Owen, of the British navy, designed to be used at light-houses and light-boats, to give warning to approaching vessels during fogs, (Appendix No. 9.) Lieutenant Commanding Davis acknowledges his obligations to Commodore Parker and to Captain Tatnall, of the Charlestown navy yard.

The office work, of this party during last winter, was quite arduous. The notes of the hydrography of the South shoals, of Boston harbor, and of Hyannis harbor, including soundings, currents, tides, and sailing directions, were all copied, the reductions made, and the work platted. In addition to this, Lieutenant Commanding Davis continued the discussion of the tidal observations at Fort Monroe. He also made an examination of Hell Gate, which will be reported in its place in section II.

12. The *hydrographic party* of Lieutenant Commanding John R. Goldsborough, U. S. N., assistant in the coast survey, has, during part of the season, been employed in this section in soundings to fill up certain parts of the first sheet of the chart of the eastern coast, from Point Judith to Cuttyhunk, between Cuttyhunk and Gay Head, and in the different arms of Narragansett bay; also in soundings in Newport harbor. Local tidal observations have been made in connexion with this work.

13. Professor Baily, of West Point, examined, at my request, the specimens of bottom taken up in the different parts of Boston harbor, with a view to develope facts of practical importance in regard to the sources of the different deposites. The microscope did not point out characteristic differences in the organic remains.

SECTION II.

From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.

The supplementary work in this section, has consisted of re-determinations of points of triangulation on the southern shore of

Long Island; for filling up portions of hydrography; of additional magnetic observations; of the verification of topography near Hell Gate, and of the re-survey of Sandy Hook to ascertain its changes; of tidal and current observations; of additional soundings for the western sheet of Long Island, and for the off-shore chart, and of a re-examination of Buttermilk channel, near New York, and of the hydrography of Hell Gate. This work has been executed from time to time, as parties could readily be disposed of from other sections.

The drawing, engraving, and publishing of charts, which have required the chief expenditure in the section, will be particularly spoken of with the office work, to which they belong.

In employing the zenith telescope by Captain Talcott's method to obtain latitude, it is necessary, frequently, to use stars of which the positions, as given in the catalogue, depend upon a few observations.

The necessity of better determinations, in many cases presented itself to us early, in the use of this instrument. In the series at Fort Morgan, the second made upon the coast survey, the mean catalogue error was greater than the mean probable error of a single observation with the zenith telescope. Many of the pairs employed were beyond the range of the zenith sector, especially with the first instruments used, which did not admit of observations near the zenith. Captain T. J. Lee, who had taken part in these observations, and had seen with regret the impossibility of making use of all the pairs of stars, until better determinations were had, suggested observations with the mural circle of the observatory of the military academy at West Point, to determine the positions of all the stars used, beginning with those which gave decidedly discrepant results. Such work is, perhaps, hardly to be expected from the regular observations of an observatory as usually organized, however important to the coast survey. On application to professor Bartlett, of West Point, he acceded with great cheerfulness to my request to permit the use of the mural, and furnished most liberally to Captain Lee every facility in making the observations, and gave him the benefit of his advice and knowledge in directing the course of observation; insuring thereby the best application of Captain Lee's time and ability as an observer.

The observations for longitude have been continued at Philadelphia by Professor Kendall.

1. The determination of points on the south shore of Long Island, to fill up the hydrography, has been executed in part by Sub-assistant Joseph S. Ruth, and in part by Professor Pendleton, United States navy, both under the immediate direction of Lieutenant Commanding Richard Bache, United States navy, assistant in the coast survey. Hydrographic points were determined by Mr. Ruth from 329 observations from main stations on Long Island, including an area of 192 square miles.

2. *Magnetic observations* were made by Sub-assistant Joseph S.

Ruth at Fire island light-house on Long Island, at the Pavilion, New Haven, and at two points, Fort Wooster and Oyster point, in the vicinity of New Haven. The number of readings for variation was 449 on 13 separate days, for horizontal intensity 10 sets on 8 days, and for magnetic dip 9 on 7 days. The apparatus used was that already referred to in the primary triangulation of section I. Twelve sets of observations were made for the moment of inertia and eleven for magnetic moment of the needle employed at the station. Five sets of observations upon the sun for azimuth were made with the small theodolite attached to the declinometer. The observations required frequent repetitions in consequence of magnetic disturbances, accompanied by auroras, which rendered them of no value for normal results. This work and the former occupied Mr. Ruth from the 28th of June to the 1st of September.

3. *Astronomical observations.*—Between the 15th of June and the 18th of September, observations for the north polar distance of 38 stars had been made with the mural circle at West Point, by Captain T. J. Lee, topographical engineers, assistant in the coast survey. The purpose of the observations has already been stated, and the acknowledgments justly due to Professor Bartlett made. The stars whose positions have been determined were those giving discrepant results for the latitude of Poole's Island in the Chesapeake, Thompson's, (Cape Ann,) and the Isle of Shoals and Agamenticus on the eastern coast.

4. During the past year Professor Kendall has observed at Philadelphia, for the use of the coast survey, fifty-five culminations of the moon, comprising thirty-six transits of the first and twenty-four of the second limb, with the transits of the moon culminating stars. Since January, 1848, fourteen occultations at the dark limb of the moon have been observed.

5. *Hydrography.*—The supplementary observations of tides and currents which I found to be necessary at the entrance of Long Island sound, by the discussion of the observations in the sound, have been made by Lieutenant Commanding John R. Goldsborough, United States navy, assistant in the coast survey. Simultaneous tidal observations for two lunations were made in the months of June and July near Montauk Point, on Little Gull island, at the entrance of the Race, and at Watch Hill, near the eastern entrance of Fisher's Island sound. Current observations were made in connexion with these, at stations No. 41, near Montauk Point, (see sketch B,) No. 36, in the Race, and near Watch Hill, for four consecutive complete phases of the current. These observations were made chiefly when the sea was smooth and the influence of the wind was imperceptible. The simultaneous observations are intended to determine the interval in the time of rise and fall of the tide and ebb and flow of the current at the important positions selected. To trace minutely the connexion of the rise and fall of the tide and direction and force of current, hourly ob-

servations for three days were made near the west end of Fisher's island, outside of the Race, in connexion with those at Little Gull island and current station No. 36, in the Race; also, near the east end of Fisher's island, in connexion with those at Watch hill and the neighboring current station. These observations are in progress of reducing and representing on the diagrams prescribed.

The tidal observations have been kept up at Governor's island, under the direction of Lieutenant Commanding Goldsborough, and angles have been taken for the positions of rocks and buoys in Huntington bay. The work of the party in section I. has already been stated.

This party was occupied during the last winter in reducing and plotting the tidal and current observations of the previous season, and in reducing and protracting the soundings made on the Bulkhead shoal, near Fort Delaware, in the channel east of the Pea Patch island, at the entrance to Dona river, and across the Joe Flogger shoal.

The schooner Nautilus, belonging to the party, was run into by a propeller steamboat in Long Island sound, from carelessness on the part of those in the steamer. The prompt measures taken by Lieutenant Commanding Goldsborough, secured the necessary repairs to the vessel at the expense of the parties doing the damage.

Hydrography of the southern side of Long Island.—The supplementary lines required for the western sheet of the south side of Long Island have been run by Lieutenant Commanding Richard Bache, United States navy, assistant in the coast survey, in the steamer Legaré. Lines from the capes of the Delaware to the New York light-boat, from Sandy Hook to Martha's Vineyard, from Martha's Vineyard to Delaware bay, for filling in the off-shore chart now in progress of completion, have been run, in the course of the season, by the same party. They are now engaged in the re-examination of the entrance to New York harbor, to ascertain if any changes have taken place in Gedney's and the main ship channel, or the shoals bordering them, from the making out of Sandy Hook.

The more accurate defining of the limits of the depression known as the Mud Hole, and the continuation of the soundings on the south side of Long Island, have also been assigned to this party; but the boisterous character of the weather, during this autumn, renders it probable that all may not be accomplished that is desired.

The exploration for temperature of the gulf stream, by Lieutenant Commanding Richard Bache, will be noticed in its proper place.

During last winter, this party was engaged in plotting the work of the previous season. A chart of the over-falls of Cape May was prepared, with a comparison of the three fathom curve resulting from the new and old surveys, showing, contrary to the general opinion, very small changes in this quarter. A comparative chart

of Crow Shoal, surveyed by Major Bache in 1836, and Lieutenant Commanding Davis in 1842–'43, and again during the last season, was also made.

7. In connexion with the soundings near Sandy Hook, I should mention that Sub-assistant S. A. Gilbert is under instructions to resurvey the shore lines of the hook, to ascertain the progress which it has made, if any, since the survey of 1845.

8. *Hydrography of Hell Gate.*—My attention was especially called to the necessity for a more minute chart of this dangerous passage than was in the archives of the coast survey, by a correspondence with Schuyler Livingston, esq., chairman of the committee of the chamber of commerce, of New York.

Lieutenant Commanding Davis, who had made the current and tidal observations in Hell Gate, in 1845, volunteered, at a season of the year when it was certain the work would be anything but pleasant, to make the additions required to the chart to adapt it to the immediate wants of the chamber of commerce. The report presented by Lieutenant Commanding Davis, and the accompanying chart, were forwarded to the chamber of commerce, and their receipt acknowledged, by direction of the chamber, by the secretary, Prosper M. Wetmore, esq., and complimentary resolutions passed. (Appendix, No. 10.) This report was published at the time, but the inquiries for it recently, which I have not been able to answer by furnishing it, and the value of the nautical suggestions which it contains, induce me to append it to the present report. (Appendix, No. 11.)

9. This important work has been resumed by Lieutenant Commanding David D. Porter, United States navy, assistant in the coast survey, who assisted in the survey formerly made, and to whose party the United States schooner Petrel has been assigned.

At the date of September 23, about one-third of the hydrography had been completed, and if the season proves favorable, I expect that he will complete the most essential part of it. The period for working to advantage in this passage is so brief, and the irregularities of the bottom so great, that the area to be sounded gives but little idea of the time required for its completion. 4,000 soundings have been made at the date of Lieutenant Commanding Porter's report, and 614 angles taken with the sextant, to establish hydrographic points. Tidal observations at every half hour of the day and night have been made, in connexion with the soundings.

A report since received from Lieutenant Commanding Porter is inserted in the appendix No. 12, and has been communicated to the chamber of commerce.

10. The party of Assistant H. L. Whiting is under instructions to verify the topography of the shores in this vicinity, and to present a map of them as now existing, improvements and alterations

of late years having very much changed the immediate shore line, as well as the positions in the interior, visible from the water.

11. *Hydography of Buttermilk channel.*—By special instructions from the Secretary of the Treasury, a re-survey was made of this channel to ascertain what changes, if any, had taken place in it within the last few years, to furnish sailing directions for it, and to ascertain the proper place for buoys to facilitate its use. This hydrography was placed in charge of Lieutenant Commanding David D. Porter, United States navy, assistant in the coast survey, who accomplished it between the 28th of August and the 8th September, presenting an interesting report, which I give in the appendix, (No. 13.) In the execution of this work 1,500 soundings have been taken, and 135 angles measured, with the sextant, in establishing the hydrographic points. The least water in the channel is five fathoms. A chart on a large scale will be at once prepared and reported to the Treasury Department.

12. I am indebted to Lieutenant Commanding Porter for an examination of the question of the location of a buoy in the channel west of the Pea Patch island in Delaware river, which was referred to me by the Fifth Auditor. It resulted in the recommendation of replacing a buoy off "Tom's Gut," to mark the channel, and of placing an additional buoy at the lower end of Pea Patch spit. A change in the mode of attaching the buoy to its anchor, by a ring playing freely through an eye instead of a shackle and bolt, was recommended by Lieutenant Commanding Porter, as likely to prevent the chafing which now rapidly takes place, separating the buoy chain from the anchor.

13. Professor Bailey, of West Point, prepared a report on the specimens of the bottom taken up in soundings in this section. I referred to his interesting examination and its results in my last report, and have presented his paper, through Professor Agassiz, to the American Association for the advancement of science, that it may be put in the way of publication. It is accompanied by careful drawings of the organisms described, the character of which is highly praised by Professor Agassiz.

SECTION No. 2.

From Cape Henlopen to Cape Henry, including the coast of Delaware, Maryland, and part of Virginia.

The survey has made its regular progress in this section; two triangulation parties have been employed in it during the whole season, and one during part of the season, two plane table parties, one with two instruments, a force equivalent therefore to two plane table parties; one hydrographic party during the whole, and one during part of the season. The triangulation across to the Capitol has been nearly completed; important work of verification has been

made; the triangulation of the Chesapeake has been extended south of the mouth of the Potomac, covering the bay (which here widens considerably) by a *double series of triangles*; the triangulation of the outer shore has advanced down Sinepuxent bay into Virginia; the topography of the shores of the bay to the limits of the triangulation of last year has been executed; the hydrography of the bay has passed south of the same limits, and on the outer coast has reached them, and the hydrography of the Choptank river has been completed. The hydrography in this section has covered an area of 617 square miles.

The steamer Vixen, loaned temporarily by the Navy Department to the coast survey, was employed in the outside or ocean work for five weeks in August and September.

1. *Primary triangulation* across to Washington, and work of verification.—Two stations were occupied by me before proceeding to section No. 1; one on the Magothy river, near the shores of the Chesapeake, and the other in Anne Arundel county, Webb's hill, (sketch C.) The angles on all the stations visible from the first, seven in number, were measured; the lines which had grown up were re-opened, and the line to Marriott's was opened by Mr. Thomas McDonnell, under my immediate direction. 426 observations were made with the two-feet theodolite of the coast survey, by Troughton and Simms, using seventeen positions of the instrument, and 328 measures were made of eight angles. I also made a reconnaissance before going to this station of the line from Marriott's to Soaper's, and satisfied myself that, without the aid of extraordinary refraction, the two stations were not, as had been supposed, intervisible. Our occupation of the station on the Magothy was prolonged by bad weather to six weeks, during which time the signal at Soaper's was seen but three times. The intermediate station at Webb's was next occupied, and 240 observations made in thirty-four positions of the theodolite on four stations. While there, I requested Assistant James S. Williams to reconnoitre the line from Webb's to Hill's, which, if practicable, would improve the triangulation, and which, from previous reconnaissance, had been supposed impracticable. He reported the line to be practicable, but the obstacles in the way of completely opening it were such as to induce me to postpone to the winter the question of finally opening it. The occupation of but one additional station is required to connect the Chesapeake triangulation with the Capitol and Washington observatory. The area covered by the triangulation was 346 square miles.

2. The *primary triangulation* of Chesapeake bay, and the secondary triangulation connected with it, have been continued southward by Assistant Edmund Blunt, who has also executed work of verification north of the Kent island base. During part of the season Mr. Blunt has been aided by Sub-assistant Charles P. Bolles; and during part of the season by Mr. John Locke, junior.

The triangulation has been extended south of the mouth of the

Potomac, (see sketch C;) a suitable base for the triangulation of that river being furnished, and across Fishing bay, behind the islands which here divide the Chesapeake, to the mouths of the Nanticoke, Wicomico, and Manokin rivers, of the eastern shore. The shortest line of the western branch of the main series is about 11¼ miles, and the longest 17¼ miles. The area included in the season's work, in the lower part of the bay, to December 1, is 417 square miles. Up to October 1, seventeen stations had been occupied, of which six belonged to the western or eastern main series, and one was a station of verification in the upper part of the bay. At the main stations ninety-one angles had been measured by 2,420 observations, with the ten-inch repeating theodolite of the coast survey, (No. 1,) by Simms, of London, and at the secondary stations twenty-eight angles by 186 observations.

Mr. Blunt has had the use of a small vessel for his party during the season. The party has suffered from sickness, Mr. Blunt himself, and two assistants, having been seriously indisposed, as well as a portion of the hands of the party.

The party was engaged during the last winter in computing the work of the previous season, and in copying the journals, &c.

Secondary triangulation of the peninsula.—This work has been continued, by Assistant John Farley, southward from the point of termination of last year on the Isle of Wight bay, Maryland, along Sinepuxent bay, into Virginia. Operations were commenced in May and discontinued in August and resumed in September, the season closing in November. Up to 29th September fifteen stations had been occupied and 831 complete observations (one telescope direct and one reversed,) made with a six-inch repeating theodolite, (No. 2,) by Gambey, of Paris. The progress of this work is shown on sketch C.

The work of the last season was computed and put in duplicate by Mr. Farley, before taking the field.

Topography.—The topography in this section has been included in sheets Nos. 21, 21½, 25, 26, 27, 28, 30, and 32, of sketch C, covering an area of 200½ square miles, an extent of shore line of 360 miles, and of roads of 151¼ miles.

The survey of sheets Nos. 21, 21½, 26, 27, 28, and 30, has been made by the party under the direction of Assistant Richard D. Cutts, one plane table being used by Mr. Cutts himself, and the other by his assistant, Mr. John Seib. The work was begun on the 14th of May, and closed on the 20th of November. The shore line of the bay sheets was first executed and furnished to the hydrographical party of Lieutenant Commanding S. P. Lee, working in the vicinity; the interior details were then in succession filled up, then the river sheets were taken up and finished.

The survey includes 339 miles of shore line, 146 of roads, and an area of 143 square miles. The country is low and intersected with bays and water courses. The plan of a double party, two plane tables under the direction of one chief, has proved economical and effective as last year, and I am of opinion that it may be ex-

tended with advantage. This party has had the use of the schooner Wave during the whole season.

Mr. Cutts has occupied, in addition, three stations of the triangulation of the Choptank, where the results required verification, using the six-inch Gambey repeating theodolite (No. 2.)

At the date of his last annual report, October, 1847, Mr. Cutts was still in the field, and, before closing his work, had surveyed an additional area of 9½ square miles, an extent of shore line of 21 miles, and of roads of 5½ miles. The plane table sheets of the last season were put in ink during the winter.

The topography of sheet No. 25 of the Chesapeake bay has been completed by Assistant George D. Wise, who has also re-examined a portion of his work on the shores of the Patapsco. He had, also, commenced sheet No. 32 on the outer shore, south of Indian river, and joining the plane table sheet of Mr. J. J. S. Hassler from Cape Henlopen. The party took the field on the 20th of May, and returned to the Patapsco for verification work there on the 14th of October. Mr. Wise has used a small vessel hired by the coast survey for the purpose. The amount of new work executed during the part of the season devoted to it covers an area of 48 square miles.

Hydrography.—Two hydrographic parties have been engaged in this section, one during the whole season under the command of Lieutenant Commanding S. P Lee, U. S. N., assistant in the coast survey, and the other under the command of Lieutenant Commanding W. P. McArthur. The party of Lieutenant Commanding Lee began their work in the bay on the 29th of May, and, by the 13th of July, had nearly sounded out the space between a line drawn from Cove Point light-house (see sketch C.) to Meekin's Neck station, and a line from Point no Point to Bloodsworth station, including an area of 205 square miles. Having made preliminary arrangements for setting up signals on the outer coast south of Indian river, Lieutenant Commanding Lee proceeded in the steamer Vixen, kindly loaned by the Hon. the Secretary of the Navy temporarily for service in the coast survey, on the 27th of July, to commence the outside work, from the line at which it had been discontinued in 1845. On the way northward, Sand Island inlet was examined, according to a request made of me by the Committee of Commerce of the House of Representatives, and a report made, which is placed in the appendix, No. 14.

Between the 5th of August and 12th of September, when the steamer Vixen was required by the Navy Department to be returned, the party of Lieutenant Commanding Lee completed the sounding of 230 square miles, from Indian river south to Beach house signal, (see sketch C,) and off shore to a distance of from 10 to 15 miles, as far as the steamer could be seen by observers stationed on the tripods of the signals. Within this limit lies Fenwick's shoals, bearing east 7½° north from Fenwick's island station, distant 6½ miles, and having 2½ fathoms least water upon them. Lieutenant Commanding Lee recommends that a light-boat be placed within these shoals, and that artificial marks be erected at different convenient points along the coast, so that the coasters who run by the

land only, should be certain of their position, the coast itself affording no natural land marks to serve as adequate guides.

In September, Lieutenant Commanding Lee, in the brig Washington, returned to the Chesapeake, and before the close of the season, November 16th, completed the hydrography of the section as far south as the line (sketch C) Point no Point, Hilly Hammock, the Honga river, and Hooper's straits to Bishop's head signal, on the eastern side, and the Patuxent river to St. Leonard's creek.

This party, after closing the work in the gulf stream, mentioned in my last report, executed a portion of off-shore work south of Cape Henlopen, running 100 miles of soundings, and collecting characteristic specimens of the bottom. Round shoal, on the northern end of the Hen and Chicken shoal, was also sounded. The late period of the season prevented a further extension of this work. During the winter the party was engaged in copying notes in duplicate, copying diagrams of the gulf stream observations, and plotting the soundings of the off and in-shore work, in copying soundings taken in the Gulf of Mexico, and in preparing the sounding sheets of the Chesapeake.

The hydrography of the Choptank rivers, and of an unfinished portion of the bay sheet of last year, has been completed by the party under the command of Lieutenant W. P. McArthur, U. S. N., assistant in the coast survey, in the schooner John Y. Mason. The regular work of this party was in section IV., Albemarle sound; but Lieutenant Commanding McArthur, with characteristic zeal, requested that, on closing his work there, he might be assigned to the completion of the hydrography of the great and little Choptank rivers, near the mouths of which he worked last year.

The great Choptank is nearly sixty miles in length, and, with its tributaries, passes through one of the most fertile portions of Maryland; the river, though deep, is interrupted by shoals. One of these, "lying immediately in the mouth of both Choptanks, with but nine feet of water on it," is claimed as a discovery by Lieutenant Commanding McArthur. The area of this river, as far as sounded out, is 125 square miles, that of the little Choptank 37 square miles.

In his annual report, Lieut. Commanding McArthur remarks: "In order to assist and facilitate navigators in these rivers, ten small spar buoys are required, viz: one on the new shoal in the mouth of the river; one on Tilghman's Point bar, one on Hambrook shoal; one on the extremity of Hambrook bar; and one on the Sugar Loaf shoal off Chancellor's Point; and three on the Jamaica shoals. In the little Choptank, one on the bar running NE. by E. from James's Island signal, and one on Ragged Point bar."

On the bay sheet south of Sharp's Island, a shoal was sounded out, the limits of which were before but imperfectly known; a buoy is recommended to be placed on this shoal, "enabling navigators to avoid the shoal, and have the full benefit of the whole width of the channel in beating up or down." The area sounded out upon this sheet was about twenty square miles.

At the request of the Committee of Commerce of the House of

Representatives, and with the assent of the Fifth Auditor, I instructed Lieut. Commanding McArthur to make an examination into the alleged necessity for a light-house on Blakiston's Island, in the Potomac, above Piney Point. His report (which was at once presented to the committee) will be found in the appendix No. 15.

Before proceeding to Albemarle sound last winter, the hydrography of a chart of the harbor of refuge at the mouth of Chester river was prepared for engraving by this party.

SECTIONS III. AND IV.

Exploration of the gulf stream.

The observations in the gulf stream were continued this year by Lieutenant Commanding Richard Bache, United States navy, assistant in the coast survey, in the steam vessel Legaré, transferred by the Treasury Department from the revenue marine. Two sections, perpendicular to the axis of the stream, were made between the 4th and the 25th of July, temperatures being taken from the surface to 600 fathoms, in thirteen positions on the first section, and from the surface to 500 fathoms, in fourteen positions in the second section. The positions are marked on the chart D bis, where the sections are designated as III. and IV., and the positions are numbered in the order in which they were occupied; the letter R, affixed to the number of the position, serving to distinguish the work of the party of Lieutenant Commanding Richard Bache from that of Lieutenant Commanding George M. Bache, in 1846, and of Lieutenant Commanding S. P. Lee, in 1847.

Observations upon the section southeast from Cape Henry have been made for three consecutive years, to indicate the changes in the distribution of the temperature of the ocean. In consequence of the loss of the most trustworthy instruments, by the parting of the line in drawing it up, after a cast of 3,300 fathoms in depth, off Hatteras, the further prosecution of the soundings for temperature during the season was postponed, and the Legaré was used for important service in another part of the survey.

This is the first year that steam has been applied to this portion of the work. The circumstances were not of the most favorable kind, but some advantage, nevertheless, seems to have been gained. Lieutenant Bache remarks: "Section III. was run by the brig Washington, in 1846, in nine days, eleven positions being occupied, and in 1847, in eighteen days, thirteen positions being occupied. It took us eleven days, occupying thirteen positions, and taking temperatures to 600 fathoms. Although we had head winds, they were generally fresh enough to allow a smart working vessel to reach her station as quickly as we did. On our return (section 4) and on one or two days going out, the weather was so calm as to give us an advantage over sails, and always in being able to keep the vessel directly over the line, and to reel it up by steam. At the same time I do not conceive this a proper vessel for this duty;

her power is small, so small as to make it necessary to beat under steam, and sail against a whole topsail breeze. She is heavily masted, and yet has not sail enough to drive her moderately through the water in good sailing breezes."

"On no single day while running section III. could our sails be used to advantage in moving from one position to another. Returning, the section (No. IV.) was from latitude 30° 34′ north, longitude 69° 36′ west to cape Hatteras, on which we were occupied nine days in making fourteen positions, observing the temperatures to the depth of five hundred fathoms."

Besides the instruments for ascertaining temperatures used last year, there were tried two Six's thermometers, by Bunten of Paris, for which I am indebted to the kindness of Professor Agassiz of Cambridge, two larger thermometers on the same plan by Tagliabue and Negretti of New York, and a metallic thermometer by Mr. Saxton of the office of weights and measures, specially designed for this work. This latter instrument proved decidedly the most convenient, requiring no covering to guard against pressure. It is shown in sketch D bis, diagram No. 4. The thermometer coil is like that of Breguet, only of much stouter material, and of two metals, silver and platinum, soldered together. The plan of registering resembles that adopted by Jurgensen of Copenhagen, and by Montandon of Washington, in their metallic thermometers. The hand attached to the thermometer coil pushes before it, by a projecting pin, a hand which moves with a slight friction on the central axis. In the diagram, A is the hand attached to the coil, and B the hand registering the lowest temperature to which the instrument has been exposed. The brass work of the instrument was gilded so that the sea water might touch every part of it without injury. The Six thermometers were used only at moderate depths.

A general comparison of the results of three consecutive years, as shown by the curve of temperature from a mean of observations from 20 to 120 fathoms, and 120 to 480 fathoms, is made upon sketch D tris, diagram No. 1. The positions are laid off at the top and bottom of the diagram, and the temperatures at the sides. The abscissæ of the curves correspond therefore to the positions, and the ordinates to the temperatures.

The two branches of the gulf stream shown in 1846 reappear in the observations of 1848. From causes beyond the control of the navigator, the new observations do not seem to show whether in this year there was more than this division. The whole temperature of the ocean was higher in July, 1848, than August, 1846 or 1847, especially the lower portions. Although the hottest part of the section was not struck in 1848, the curve from 20 to 120 fathoms rises generally above that of the other two years, and that from 120 to 480 fathoms rises very greatly above the others. In all those curves it is seen that the point of highest temperature passes away from the shore side of the diagram at the greater depths. The highest temperature from the mean of 20 to 120 fathoms was in 1846, about 130 nautical miles from Cape Henry, in 1847 about

135 miles, in 1848 about 125 miles, measuring upon a line perpendicular to the stream, or about southeast from the cape.

The fact of the higher temperatures of the ocean at corresponding depths, in section III. in 1848 than in 1846, is well illustrated by comparing the curves resulting from the mean of the observations in several positions beyond the first branch of the gulf stream. In these curves, representing the law of change of temperature with depth, the temperatures are laid off at the top of the diagram, and the depth at the sides, the temperatures being the abscissæ, and the depths the ordinates. The mean curve derived from observations in positions 1, 2, 3, 4, 5 and 6, showing the law of decrease of temperature from the surface to five hundred fathoms, is contained in diagram No. 2, sketch D, tris. Its remarkable similarity to the corresponding curve on the same diagram, from positions 8, 9, 10, 11, 12 and 13, (corresponding in the observations of 1848 to the positions of 1847, first referred to,) strikes the eye, there being an exact parallelism in the two curves from one hundred fathoms to nearly five hundred fathoms. The whole of the former curve (for 1847) is within the latter, the difference of temperature below one hundred fathoms being about $3\frac{1}{2}°$ at the same depth.

The remarkable consistency with which the law of change of temperature is developed in all these observations, is one of the most satisfactory points relating to them, giving confidence in determinations which otherwise, from the very variable circumstances of the ocean temperatures, might fail to be accorded to them.

The same form of curve for the law of distribution of heat, in the cold current between the shore and the gulf stream (the cold wall) is developed in the observations of the three years, as shown by diagram No. 4, sketch D, tris. The coincidence of these curves with a logarithmic curve (the curve of equilibrium in conduction of heat) has been already the subject of remark in a former report. The development was made from the observations of Lieutenant Commanding C. H. Davis, in 1845.

The diagram just referred to contains also the three curves corresponding to the highest temperatures observed in section III. of the gulf stream in each year, the general similarity of which is very striking. The curves are from observations by different observers, with different instruments, and have been drawn by me from the notes of each one as received year by year, and therefore from discussions independent of each other. The portion of these curves between 300 and 500 or 600 fathoms, and of the mean curves of diagram No. 3, between 150 and 500 and 600 fathoms, may be closely represented by considering the difference of temperature from the highest to the lowest temperature as a geometrical series with decreasing terms from 600 or 500 fathoms. The effect of the introduction of a disturbing cause to the equilibrium of temperature is well shown by the form of these curves, as also the tendency to a common and low temperature in the deep water of the ocean. This is not the place to present in detail the developments

of this subject, so interesting in both a practical and scientific point of view.

The results of 1848 have rendered probable the curious fact that the cold in-shore wall is cut off at Cape Hatteras, the hot water of the gulf extending quite into soundings. The peculiar circumstances of these observations make a confirmation desirable, but such is the result which now appears. In diagram No. 4, (sketch D, tris,) the two inner curves show the temperatures on soundings in section III., while the four outer ones, rising in temperature at the surface to 79½, 80½, and 81, show that the off-shore high temperature is carried quite into the coast. Between this and the hottest part of the gulf stream, no curve resembling the inner ones of diagram No. 3 occurs in a position which is fairly upon the section.

A remarkable uniformity in the temperature at the same depth is shown in positions 1, 2, 3, 4, 5, and 6, of section IV., the distance between 1 and 6 being 228 nautical miles. The mean temperature at the surface and down to 100 fathoms, does not vary more than one-half of a degree of Fahrenheit's thermometer from the two extremes at the corresponding depth; from 100 to 200 fathoms, the variation does not exceed one degree; and at 500 fathoms, where the difference is greatest, it amounts to five degrees on each side of the mean.

The temperatures at the same depths, in the more southern section, in 1848, were lower than those of the more northern section. The same fact was observed in regard to sections II. and III., in 1846, pointing distinctly to the source of the difference in the results obtained in different seasons.

SECTION No. IV.

From Cape Henry to Cape Fear, including part of the coast of Virginia, and the coast of North Carolina.

The survey has been in full activity in this section during the past year; the operations including reconnaissance of different grades, preparations for the measurement of a base, astronomical observations, main, secondary and tertiary triangulation, topography and hydrography. Six parties have been employed during the whole or part of the season, and the work is rather more advanced than I gave reason in my last report to expect that it would be. The triangulation of Albemarle sound, and of the rivers, except the Cushai, Roanoke and Chowan, is completed. The geographical positions of certain points are approximately fixed; the topography of the shores of the sound and rivers is more than two thirds done; the hydrography of the Pasquotank river is completed, and that of the sound has been commenced and made good progress. These and other materials are in the hands of the computers and draughtsmen of the survey, for the preparation of the map of this sound, a project for which has been made.

During the coming season, the final measurement of the base, and

connexion of the triangulation with it, will be made; the main and secondary triangulation of Roanoke and Croatan sounds will be finished, and that of Pamlico sound be in progress; the triangulation of the lower part of the Roanoke and Chowan rivers; of the outer coast on Bodies' island to north of Nag's head, and southward on Chicamicomico, will be executed; the topography of Albemarle sound and its rivers will be completed, and that of the ocean shore be commenced; the hydrography of Albemarle sound will be nearly completed. The hydrography of the outer coast, for which the work on the ocean shore will furnish points, cannot be executed satisfactorily, nor without great peril to those engaged in it, except by the use of a steam vessel. One that shall have power to make a port whenever taken by a northeast gale, in the dangerous regions north of Hatteras, is indispensable for this work.

The operations of the past year in this section have included the following:

1. A reconnaissance for determining the site of a new base on Bodies' island, and its connexion with the main triangulations of the sounds.
2. The measurement of a base line on Bodies' island.
3. Observations for azimuth at Stevenson's point, Albemarle sound, and for difference of longitude by chronometers from Washington.
4. The main triangulation of Albemarle sound, and the secondary connected with it, furnishing bases for the triangulations of the rivers emptying into the sound.
5. The reconnaissance for the triangulation of part of Albemarle sound, and of Alligator river, and the triangulation.
6. The triangulation and three topographical sheets of the north shore of Albemarle sound from the Pasquotank river westward to Bluff Point, and including the shores of Little river, the Perquimons and Yeopim rivers.
7. The topographical survey of the south shore of Albemarle sound from Durant's island to west of Laurel Point.
8. The hydrography of the Pasquotank river and part of Albemarle sound, between the Perquimons and Little rivers, and extending nearly to the south shore of the sound.
9. Observations for the rise and fall of water of Albemarle sound, near the mouth of the Pasquotank, and at Caroon's Point, at the entrance of Croatan sound.
10. In connexion with the reconnaissance mentioned in I, the inlets made through Bodies' island, in 1846, have been examined, and the gradual closing of one and deepening of the other ascertained.

Site of base line.—When it became certain that one of the inlets formed across Bodies' island would not close in time to admit the measurement of the base on the site formerly selected, on consultation with Assistant J. C. Neilson, by whom the reconnaissance of this part of section IV. had been made, I determined on the examination of a site just north of that formerly selected. This

was made by Assistants J. C. Neilson and C. O. Boutelle, and the site of the base has been approximately determined by the latter, who placed signals at the extremities, made a rough measurement with a chain, and took the levels necessary for a profile. A signal was put up by Mr. Boutelle at the Roanake marshes, to replace the light-house, which had fallen in ruins since its use as a station point in 1844, and a line opened across the island to the north end of the base.

In the course of the various examinations in this quarter, facts were ascertained in reference to the communications which were opened in 1846, between the sound and ocean across Bodies' island, which appear now to have greater interest than was at first attached to them, from the continued deepening of the southern inlet. I gave those which were collected up to the time of my last report in the appendix, and recapitulate the principal particulars, and add such new ones as have been collected in the appendix to the present report No. 16. At the last examination in March, this inlet, which I have called in my previous reports, and marked upon the sketch accompanying it, as the inlet of 1846, though presenting six feet of water on the bar upon the seaward side, was closed by a "bulk-head" across the sound entrance, having only three or three and a half feet of water upon it. The greatest care will be taken to watch the progress of an entrance which may become so important to the navigation of Pamlico and Albemarle sounds, or which, as is more probable, from the general laws acting on this extensive region of the coast may close unless artificially kept open. This is the inlet which was entered by the small steamboat Oregon in 1848.

Measurement of base.—The preliminary steps of aligning the base and marking it out, grading, selection of a camp, &c., were satisfactorily taken by Assistant C. O. Boutelle, or under his direction. The measurement was made with the apparatus described in my previous reports, to which such additions have been made as were suggested by its use at Dauphin island. The measurement was commenced on the seventh of November and completed in ten working days. The base is about $6\frac{3}{4}$ miles in length, giving an average of more than two-thirds of a mile for the daily measurement. As this work is, in fact, still in progress while this report is before me, I reserve the particulars of the measurement for my report of next year. I was assisted in this measurement by Assistant C. O. Boutelle, aided by Sub-assistant Joseph S. Ruth, and by Messrs Hewston, Duncan and McDonnell. Mr. Clarke, of the office of weights and measures, attended to keep the apparatus in order, and showed both industry and skill in his work. This base line is marked with a strong line upon sketch D.

The main and secondary triangulations of Albemarle sound have been completed by Assistant W. M. Boyce. The connexion with the main triangulation by Assistant Fergusson is made on the line Caroon's point, Roden, (sketch D,) the work has been extended up the sound, to the mouths of Chowan, Cushai, and Roanoke rivers, and bases have been furnished for the triangulation of the

Chowan and Roanoke at one extremity of the sound, and of the Alligator and North rivers at the other. The connexion of the triangulation of the Pasquotank with this work has been made in part by Assistant Boyce, and in part by Assistant Neilson.

The party of Assistant Boyce took the field on the 16th of November, 1847. The unfavorable character of the season caused the suspension of operations from the 3d of March to the 24th of April, when, having been resumed, they were continued until the 6th of July. The party has had the use of one of the small vessels of the coast survey throughout the season.

During this period 31 stations were occupied for the first or second time, including 20 main and 11 secondary stations, from which 13,133 observations were made upon 219 points. The area inclosed is 360 square miles. The observations were made with a ten-inch repeating theodolite, by Gambey of Paris, and each repetition, telescope direct or telescope reversed, is counted as a single observation. The observations were made from stations elevated from eight to 24 feet above the ground. The closing of the triangles is entirely satisfactory. The theodolite was furnished in the office of the coast survey with a pair of y's, and a telescope of 18 inches in length replacing the eccentrically mounted telescope of small power, with a vertical circle attached, originally belonging to the instrument.

Astronomical observations.—One astronomical station (Stevenson's Point) was occupied by Assistant C. O. Boutelle, and observations for azimuth and for difference of longitude from Washington made. The azimuth determinations were with the two feet theodolite of the coast survey, and consisted of observations of five eastern and five western elongations of Polaris, observed in five positions of the instrument. The total number of observations between the star and mark was 230, and for connecting the elongation mark with the stations of the triangulation 170.

To obtain an approximate difference of longitude to be used in the preliminary chart of Albemarle sound, four chronometers were transported in five successive journeys to the observatory at Washington from Stevenson's Point and four return journeys; a fifth was retained at the station, and a sixth carried in two of the trips (each way) only. The superintendent of the observatory undertook, at my request, to furnish the local time at Washington. That at Stevenson's Point was obtained by Mr. Boutelle, by a forty-five inch transit instrument of Troughton and Simms; 454 observations were made for local time at Stevenson's Point. The comparisons were made by coincidences of the beats of a mean time and sidereal chronometer. The deviation of the transit instruments was ascertained by observations of high and low stars, and the local time was obtained from the transits of zenith stars. The level of the instrument is an excellent one, and the optical power of the telescope adequate.* In general it may be said that the means of observing at Stevenson's Point were good, and were properly used. The limits of uncertainty in the difference of longitude are, how-

ever, greater than is desirable, involving the necessity of new determinations.

A few moon culminations and one occultation were observed by Mr. Boutelle, the weather having proved unfavorable during the period set apart for these observations.

Tertiary triangulations.—The connexion of the triangulation of the Pasquotank with that of Albemarle sound was made chiefly by Assistant J. C. Neilson, who also placed the signals for the work in the upper part of Albemarle sound, west of Bluff Point, and in Alligator river, (see sketch D.)

Upon receiving notice of his intended resignation from Assistant J. C. Neilson, Assistant Longfellow was sent to replace him, and after accompanying Mr. Neilson during the closing part of his work, made, between the first of April and the 24th of June, the triangulation of the Alligator river, shown in sketch D. This river is bounded by cypress swamps, the trees growing in the water, and, with rare exceptions, having no defined limit of firm land to constitute its banks. The difficulties of the work were, therefore, considerable.

This party is under instructions to resume the work in Alligator river, and in the vicinity of Roanoke and Pamlico sounds.

Topography.—The topography of the north shore of Albemarle sound and its rivers has been executed by Assistant J. C. Neilson, and of the south shore by Assistant J. J. S. Hassler. Mr. Neilson was in the field from the latter part of October to the latter part of March, during which time, in addition to the work already stated, he made a plane table survey, extending from the Pasquotank to Bluff Point, (see sketch D,) and including the sheets numbered 2, 5. Tracings of the shore lines were furnished to the hydrographic party in the vicinity. The area surveyed is 77½ square miles, the extent of shore line 117 miles, of roads 109 miles.

The topographical work of Mr. Hassler was upon sheets Nos. 6, 7, 8, of the sketch, and included an area of 113 square miles, and an extent of shore line of 80 miles, and of roads of 142 miles. This party was transferred from the Chesapeake on the 24th of October, and remained in the field until the close of June.

The parties of Mr. Neilson and of Mr. Hassler have been, with brief intervals, in the field in this and the preceding section, during the past year.

Hydrography.—The hydrography of the Pasquotank river was completed by Lieutenant Commanding W. P. McArthur, U. S. N., assistant in the coast survey, in the coast survey schooner, John Y. Mason, between the middle of October and the 29th of November. The area is 50 square miles. The river being one of the connecting links between the Chesapeake bay and Albemarle sound, the Dismal Swamp canal completing the connexion, was very closely sounded.

During the winter the party was employed in the usual office

work, and resumed the hydrography of the section in April, between which time and the month of June, an area of 180 miles in Albemarle sound, between Wade's Bluff and Harvey's mill (sketch D.) on the north, and Pear-tree Point and Mill Point on the south, had been sounded, except a narrow border near the south shore of the sound.

The tidal observations at the light boat near the entrance to the Pasquotank, and at Caroon's Point, conclusively prove that, as far as the tides are concerned, Albemarle sound is a closed sea. The rise and fall of the waters depend upon the winds and the quantity of water brought down by the rivers. The tidal observations already collected show the general laws of the more rapid changes depending upon the direction and force of the wind.

This party is under instructions to resume the work in Albemarle sound early in November.

SECTION No. V.

From Cape Fear to the St. Mary's river, including the coast of the States of South Carolina and Georgia.

The general reconnaissance of this coast was completed at the date of my last report by Assistant James S. Williams, and the minute reconnaissance had been commenced. The site for a base line was selected on Edisto island, a scheme of triangulation planned, and its practicability ascertained from this base nearly to Bull's bay, about fifty miles along the coast; the base was approximately measured and the sides of the first four triangles traced on the ground. This work has prepared for the measurement of the angles of the main series, and for the secondary series of triangles connected with it. The sketch E shows the scheme for the main triangles. The base is marked with a full line, the sides of the triangles which have been marked on the ground designated by large dots, those of which the possibility has been ascertained by small dots.

During the season about to commence, the work just referred to will be in progress, astronomical and magnetic observations will be provided for, and the reconnaissance may be extended southward, or the secondary triangulation of Charleston harbor be made.

The party of Assistant Williams took the field on the 19th of November of last year, and left it on the 31st of May last. Sub-assistant C. P. Bolles has been attached to the party, and has rendered acceptable service. At the close of the season Mr. Williams joined my party in section III., and Mr. Bolles that of Assistant Blunt in the same section, so that both have been in the field during the whole year, with but a brief intermission. The mode in which Mr. Williams has executed this difficult duty calls again for an expression of high commendation.

The following remarks contain a more minute account of the work briefly summed up above:

"The site selected for the base is on the southern side of Edisto island, extending across the fast land of the island from the edge of the marsh on North Edisto river to the bank of a creek communicating with the South Edisto The line runs through cotton and corn fields on dry, firm land, secure from any encroachment of the sea; its profile is favorable, the undulations being slight and gentle; very little grading will serve to prepare it for measurement." The length of the base is 6 6 miles, the mean elevation above high water about 6 feet, the greatest elevation of any point 11.1 feet, the least 3.1 feet, and the greatest rise in any distance of 30 yards is less than 4 feet.

The lines of triangulation have been so directed as to require the least possible cutting of timber; and the triangulation has been confined with the same view to the level cultivated land and marshes, intersected by numerous rivers and creeks, which border the fast land of the coast. This gives sides of about ten miles in length, as shown upon the sketch. The level surface of the country, and the occurrence of heavy timber on some portions of it, has required the tracing of the sides of the triangles throughout their entire extent—tracings which required care and accuracy to make them of any value.

The parties who are to continue and extend this work will take the field as early as the season permits.

A five-feet transit instrument of the coast survey has been mounted, under the charge of Professor Gibbs, of Charleston college, for observations of moon culminations; this will also be used to give local time for occulations and for telegraphic differences of longitude.

SECTION No. VII.

From St. Joseph's bay to Mobile bay.

A preliminary reconnaissance for extending the triangulation of the coast of the Gulf of Mexico from the entrance of Mobile bay eastward, was made in 1845, by Assis ant F. H. Gerdes, as far as the Perdido river. As it is expected when the triangulation of Mobile bay is completed, and the general progress in section VIII. admits of it, to take up this extension of the survey eastward, Assistant Gerdes has been directed to resume his reconnaissance, and has carried it during the month of September westward to Choctawhatchie. The time which has been allowed to Mr. Gerdes, and various circumstances beyond his control, have prevented the reconnaissance from being complete along the whole line of coast examined; but his report so ably presents the points well settled, and those requiring further examination, as to be a real step in the progress of the survey in this quarter.

It has been necessary to detach him from this portion of his work, to examine the Florida keys and islands west of Cape Florida, (section VI.,) preparatory to commencing the survey of them requested by the Commissioner of the General Land Office.

SECTION No. VIII.

From Dauphin island to Vermillion bay, including the coast Alabama, Mississippi, and part of Louisiana.

The primary triangulation in this section has, during the past year, been extended westward, nearly to the limits of the secondary and the entrance to Lake Borgne. Astronomical observations have been made at one station. The triangulation of Mobile bay has been nearly completed. The topography of the islands off the coast of Alabama and Mississippi, and Isle au Pied, off the coast of Louisiana, has been completed. The topography of the main shore has been carried from Fowl river, emptying into Mississippi sound, to Pascagoula river.

The soundings of the entrance to Mobile bay, for a harbor sheet, have been completed, as also the soundings of Cat and Ship island harbors, and of their approaches. Tidal observations have been kept up at Fort Morgan, Round island, and Cat island. Complete observations for the direction and velocity of currents have been made at two stations.

Near the point now reached on this part of the coast by the triangulation, it branches—one branch passing over the shores of Lakes Borgne and Ponchartrain, to New Orleans—the other main branch passing down the coast of Louisiana, by the Chandeleur islands. The one through the lakes, as necessary to complete the connexion between Mobile and New Orleans, will be undertaken first, and can, in great part, be accomplished during the season about to commence. Materials now exist for the land work of nearly two sheets of the coast map projected for this section, and for the hydrography of three harbor sheets, and nearly the whole of one coast sheet. They are in progress of computation and reduction. The first chart will be one of the entrance to Mobile bay, the drawing of which is now commenced.

The authorities of the city of Mobile have continued to manifest that solicitude, in regard to the progress of the survey, to which I had occasion to refer in my last report. A correspondence of Lieutenant Commanding Patterson, the assistant charged with the hydrography of this section, with the mayor of Mobile, with the very complimentary resolutions of the council, are given in the appendix to this report, No. 17.

1. *Primary triangulation* and secondary connected with it.—This triangulation (see sketch F) has been under the charge, as heretofore, of Assistant F. H. Gerdes, who has carried it westward to Ship island, besides making a reconnaissance in section IX., and another in section VII. A dangerous illness, resulting from exposure in the former reconnaissance, had nearly deprived the survey of the services of this valuable assistant. Providence has spared his life to his friends and to the work. With characteristic zeal, he has labored successfully at a season when he ought to have claimed a respite from field work, to make up for this drawback to his progress. The number of primary stations occupied has been

5; of stations observed upon, 22; and of observations made, 726. The area included is 204 square miles. The lines of sight extend to the Chandeleur islands, on the coast of Louisiana.

The computations connected with this triangulation have been made and turned into the office in the course of the season. The triangulation in this section is sufficiently in advance of the hydrography to enable me to use Mr. Gerdes's service in the important reconnaissance of the Florida keys and islands.

2. *Astronomical observations.*—These have been for difference of longitude in connexion with section IX., and will be particularly spoken of under the head of that section. They were under the immediate charge of assistant R. H. Fauntleroy, and made by Sub-assistant George Davidson.

3. *Secondary triangulation.*—The triangulation of Mobile bay has been under the charge of Assistant C. M. Eakin, and has been carried during the season from near the entrance to Choctaw Point; requiring only the connexion with the primary triangulation to furnish points for the plane table and hydrographic surveys of the bay, (see sketch F.) The reconnaissance of the bay, made by Assistant F. H. Gerdes in 1846, was extended by Assistant Eakin up the delta of the Mobile river to about five miles above the city; and signals for the triangulation of the bay were put up between the 16th of December and the 29th of March. On the 21st, the triangulation was commenced; and between that period and the 9th of June, eight stations were occupied, at which 2,106 observations were made with a twelve inch repeating theodolite, by Patten, upon 58 objects, consisting of 38 stations, 13 signals, 3 light-houses, 2 spires and 2 academies. It was necessary, generally, to elevate the instrument above the ground on a tripod. The area embraced is 188 square miles. Mr. Eakin was assisted by Mr. Spencer McCorkle. During part of the season the party had the use of the revenue cutter Wolcott, and, for the greater part, of the United States schooner Phœnix. Mr. Eakin acknowledges the cheerful aid rendered by the officers of the Wolcott.

Instructions have been issued for the resumption of this work as soon as the season will permit.

4. *Topography.*—The topography in this section has been executed by assistant W. E. Greenwell, whose party took the field on the 4th of January, and closed their duties for the season on the 17th of July.

Notwithstanding the delay caused by the illness of Mr. Greenwell during part of March and April, and the want of suitable facilities for transportation in the early part of the season, his work has made satisfactory progress. Sheets Nos. 1, 5. 7, 6 and 4, (sketch F,) have been completed, the topography of Isle au Pied, on the Louisiana coast, having been left incomplete last year. The area surveyed is about 75 square miles; extent of shore line, 186 miles; length of road, 6 miles. The islands are of sand, thrown

up into irregular hills of no great height, with patches of marsh, and, in places, covered with a growth of pine. The main shore is chiefly flat and marshy, and much cut up by bayous; it has been surveyed back to the pine growth on the fast land. Mr. Greenwell has the use of a small schooner belonging to the coast survey.

5. *Hydrography.*—The hydrography of this section has been executed by the party under the command of Lieutenant C. P. Patterson, United States navy, assistant in the coast survey, first in the schooner Forward and then in the steamer R. J. Walker. The steamer was transferred from the revenue marine to the coast survey by the Treasury Department, the use of steam vessels for the revenue service having been abandoned. The party left New York for Mobile on the 20th of November, and returned to New York on the 29th of July; the sounding work was done from January 6 to February 11, in the sailing vessel, and from that date to June 24 in the steam vessel.

The soundings of the entrance to Mobile bay, and of Cat and and Ship island harbors, and of their approaches, have been completed, making, together, an area of 316 square miles, and 2,208 linear miles surveyed. Three permanent tide stations were occupied; at Fort Morgan, entrance to Mobile bay, the tides were observed hourly for fifteen hours of the twenty-four; at the west end of Cat island every hour; and at Round island light, Mississippi sound, every two hours. The number of current stations occupied for observations of currents was seven; at two of which complete results were procured. The sketch F shows the limits of the sounding sheets Nos. 2, 3, and 4, and localities of the tidal and current observations. The results of the average of January and July tides at Mobile Point and Cat island is shown upon sketch F, bis. The normal tide rises and falls once in twenty-four hours nearly; the time of high water being displaced is between 6 and 9 hours from January to July. The subject of these tides is undergoing investigation, the tidal observations being in the hands of computors for reduction.

A direct comparison of the use of sails and steam, under the circumstances of this part of the work, was had by this party. After making all necessary allowances in the comparison, the expense of sounding out a given area by a sailing vessel and a steam vessel was as five to three, presenting an economy of forty per cent. in favor of steam. The absolute cost per day of the steam vessel to the survey was nearly three times that of the sailing vessel; the amount of work done five times. Lieutenant Commanding Patterson remarks: "It must be stated, however, that the most economical use of a steamer is in off-shore or sea work, or where the proportion of boat work is small, as the boat work can certainly be done more cheaply from a sailing vessel than from a steamer, but little work being done in the vessel; in this case, she is merely used as a floating boarding-house, and for transportation from place to place. It is only, then, when the principal part of the work is to be done in the vessel, which is the case in all off-shore or sea work

and about one-half of the in-shore or bay and harbor work, that a steamer can be economically used. In this respect our localities were against the steamer, as fully one-half of the work had to be done in boats." To this should be added the statement that the steamer Walker is larger and more powerful than is necessary for this particular part of the survey.

The account of the changes going on at the entrance to Mobile bay, shows the very great importance of careful examinations from time to time to develope their causes. The depth of 20¾ feet in the channel over the bar was again verified by the soundings of Lieutenant Patterson.

"At the entrance to Mobile bay the islands are still undergoing changes, as is the southwest side of Mobile Point. Sand island, upon which stands the outer light-house, has lost a strip the whole length of the eastern shore, from 66 to 100 yards in width, about 200 yards from its northeast point; and has made out on its north shore, abreast the light-house, about 233 yards during the last year. Mobile Point has made out to the southward and westward during the last few years, so far as entirely to change a range by which the east bank was cleared in going up. *Little* Pelican island, a small sand knoll which, in June, 1847, was three feet above low water, has entirely disappeared, leaving a shoal with two or three feet water upon it. This knoll constantly appears and disappears at intervals of several months, as it may be 'cut off' or 'made up' by strong tides and heavy gales. The north point of *Pelican* island still 'makes out,' while the opposite shore of Dauphin has 'cut out' in the same degree, leaving the distance between them the same and not affecting the depth of the water."

"About Grant's Pass, between Little Dauphin island and Cedar Point, the shoal and oyster beds, bare at low water, are undergoing changes."

"At Cat island, the south end of South Spit has 'made out' in a small degree, as has also the north end of 'North Point.'"

"At Ship island the southwestern shore of the west end is slowly making out in the same manner as that of Mobile Point, and which, from the great similarity in the conditions of the two localities, must follow the same law."

Important hydrographical information in regard to this part of the coast is given in a letter from Lieutenant Commanding Patterson to Captain Scott, royal navy, who had referred to him in reference to anchorages suitable for the British West India mail steamers. It is given in the appendix No. 18.

The thanks of the survey are due to Acting Master Aby, United States navy, for the prompt and intelligent manner in which he has discharged several extra official duties, among these, during the last season, for sailing the coast survey schooner F. H. Gerdes to Galveston, to place the buoys on the coast of Texas, a mission not the less unpleasant that it proved useless from circumstances beyond his control.

SECTION IX.

From Vermillion bay to the boundary, including the coast of part of Louisiana and Texas.

During the past year the preliminary operation of reconnaissance has been brought to a close, as far as is necessary for commencing the triangulation, the geographical position of a point in Galveston bay, near the city, has been determined, and the point has been approximately connected with a coast survey station in section VIII. at Pascagoula, by chronometer differences of longitude; a base line has been approximately measured; and the triangulation of Galveston bay has been commenced; a reconnaissance for a base line on Galveston island has been made. The survey has thus made due progress, and the estimates of the present year provide for the triangulation of Galveston upper and lower bay, and for part of the topography, and, if the progress of the land work for the season renders it advisable, of a commencement of the hydrography.

The best method of working in this section yet remains to be developed; but the arrangements already made for the coming season will resolve the doubts which are now entertained. The triangulation party is under instructions to proceed to Galveston as soon as the advance of the working season permits.

The most cheering evidences of interest in the commencement of the coast survey in this section have been given by the citizens of Galveston, who have manifested great kindness to the persons composing the parties, and full appreciation of their labors.

1. *Reconnaissance.*—At the date of my last report, Assistant F. H. Gerdes was under instructions to proceed, as early as he judged it safe to do so, from his work in Mississippi, to make a reconnaissance of Galveston bay and of its vicinity, extending it as far south and west as time would permit, before it was necessary to return to his duties in section VIII. This work has been accomplished with his usual skill and intelligence, and his excellent report enabled me to give at once instructions of a definite character to a triangulation party for this section. The zeal which induced Mr. Gerdes to risk his health for the progress of the work has not passed without marks of appreciation by the department having charge of the coast survey.

Mr. Gerdes recommended that the base line previously laid out on Bolivar Point should be adopted only provisionally, and proposed for minute examination a site on Galveston island, presenting equal facilities for measurement, and for communication with Galveston. The scheme of main and secondary triangulation of Galveston lower bay, suggested by Mr. Gerdes, appears, as in part subsequently executed, on sketch G. A more or less minute description of each station, of its vicinity, and of the coast between them, is given in his report, with references to the landmarks for different parts of the bay and ocean shores. Approximate measurements of distances, sufficient to show the figures of the trian-

gles, were made in important cases. The character, position, elevation, and materials of the signals necessary for the triangulation are discussed; the facilities for procuring materials and their cost, an economical mode of procuring materials from section VIII. is proposed. The conclusion in regard to the triangulation is, that the main series, with means for supporting the instrument and signals for observing upon, of a kind already approved, may have sides of from twelve to fifteen miles in length.

Astronomical observations.—The astronomical and magnetic observations, and the triangulation in this section, were under the charge of Assistant R. H. Fauntleroy; to whose party Assistant Julius E. Hilgard and Sub-assistant George Davidson were attached. Mr. Hilgard assisted chiefly in the astronomical observations near Galveston, and Mr. Davidson in the observations for difference of longitudes by chronometers, making the observations for time and chronometer comparisons at Pascagoula. The station selected for astronomical observations was Dollar Point, (see sketch G.) The latitude was observed with a zenith telescope, by Simms of London, made for the coast survey, used as in Captain Talcott's method. One hundred and forty-two determinations were made on fifty-two pairs of stars. The azimuths were obtained by observations of Polaris and δ ursæ minoris at elongation, and of Polaris at various hour-angles, forty-five determinations being made, and fifty-five horizontal angles measured (telescope direct and reversed) to connect the elongation mark with the main stations at Smith's Point and Bolivar Point. The observations were made with the two theodolites referred to in speaking of the triangulation. 1,011 transits were taken with the Hassler transit instrument of the coast survey; thirty of these were moon culminations for longitude; six hundred and twenty were in connexion with observations of moon culminations, occultations, azimuths and latitudes; three hundred and fifty-seven for the chronometer difference of longitude of East Pascagoula station and Dollar Point, and thirty-four for investigation of the instrument itself. Two occultations were observed at Dollar Point; that of Aldebaran on the 10th of March, and of ρ' Sagittarii on the 21st of May.

Magnetic observations were made, in connexion with the foregoing, by Assistant R. H. Fauntleroy with a portable declinometer and magnetometer by Jones, (No. 2, coast survey,) and a new dip circle, (No. 2, coast survey,) by Barrow of London. Four determinations of the declination, (variation,) by observing the maximum and minimum, were made; three of horizontal intensity, and six of dip, the sets of each kind being made on as many different days. Two determinations for moment of inertia, and one for correction of temperature of the magnet, were made.

Triangulation.—Three main stations were occupied, and three hundred and forty-two measurements of angles made with the twelve-inch Troughton theodolite, or the ten-inch coast survey theodolite, of the old collection, ("E pluribus Unum.") At each

of the first and second stations, fifteen points were observed upon, and at the third six points, (see sketch G.) The provisional base line on Bolivèr Point was measured by using a wire 348 metres in length.

A reconnaissance was made for a base line on Galveston island, and a suitable site found for a base of about six miles in length. This site will require less labor in its preparation for the measurement than that at Bolivar Point, and will furnish greater facilities of sure communication with Galveston. It is not exposed, according to the opinion of Mr. Fauntleroy, to inroads from the ocean.

Mr. Fauntleroy was engaged in making magnetic observations in section II. until the close of the autumn. He reached Galveston on the 14th of February, and at once commenced his work, which was brought to a close by the advance of summer, on the 22d of July. The party has had the use of a schooner belonging to the coast survey, sailed by Mr. Andrew J. Hussey, of Alexandria, who has given entire satisfaction in the execution of the contract for sailing the vessel and providing for the crew.

Since the close of the season, Mr. Fauntleroy has been engaged in recomputing observations of previous years, which his constant employment in the field had hitherto prevented. In this he has been aided by Mr. Davidson. The party is under instructions to resume the triangulation in section IX. as early as practicable.

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OFFICE WORK.

The organization of the office has continued during the past year as it was at the period of my last report. The extension of the work has required the employment of additional persons in connexion with it, rendering changes desirable, which the exertions of Captain A. A. Humphreys, United States topographical engineers, the assistant in charge, have prevented from becoming pressing or detrimental. The services of this officer to the government, in this work, have well merited the promotion which he has received from seniority; and I would respectfully call the attention of the head of the Treasury Department to them, and would ask that representations may be made to the proper authority in relation to them. As the detail of officers of the army is made upon the coast survey under the law, I do not doubt that meritorious services are to be noticed in this, as in any other duty required of them.

Besides conducting the general concerns of the office, Captain Humphreys directs, personally, the details of computing and drawing, and inspects every department of the office, including the engraving, printing, and instrument making. As he administers this branch of the work, there is no position of assistant of greater importance to the success of the whole.

The engraving and printing are under the immediate direc-

tion of Assistant W. M. C. Fairfax. The records, instruments, books, and maps are under the charge of Samuel Hein, esq., who also directs the publishing department. By monthly reports and proof sheets of the engravings, all the details of the establishment are laid before the superintendent.

The following progress has been made in the several departments of the office during the past year.

Computations.—Captain T. J. Lee, United States topographical engineers, assistant in the coast survey, has been engaged under my general direction during a portion of the past year, in putting in form the results of the work in its different branches, during the previous year, and in recomputations and comparisons. He has been assisted by Mr. J. H. Lane, whose appointment as assistant examiner in the Patent Office has deprived the coast survey of one of its most promising junior members. The computations made by Captain Lee were of latitude observations at Taylor's and Poole's island, on the Chesapeake, (Sec. III.,) and at the Isle of Shoals and Agamenticus, (Sec I.,) in 1847; of magnetic observations in sections I. and III., of the year 1847, and in section IV. in 1846 and 1847; in computations to form the basis of a discussion by the superintendent of all previous magnetic observations; the recomputation of observations for latitude at Thompson's station, section I., comparisons with duplicate computations, and making the final corrections.

Mr. Lane had commenced, also under my immediate direction, the determinations of the equations of condition, at the stations of the primary triangulation in section I., by the method of least squares, and had completed three important stations before leaving the office.

The computations relating to longitudes, by Assistant S. C. Walker, have been continued with his usual diligence. His labors have contributed to the coast survey archives no less than fifteen reports within the past year; many are, of course, temporary in their character, but some of them so elaborate that they might rather be called scientific memoirs. I subjoin their titles, with a brief statement of their contents:

1. Report on longitudes, by moon culminations up to January 1, 1848, containing an abstract of the result of computations in 1847, for longitudes by moon culminations, including the computations by Lieutenant Gilliss, United States navy, assistant in the coast survey, of the moon culminations, accessible to us, up to January 1, 1848. The observatories at which comparative results were obtained, are Hudson, Ohio; Capitol hill, Washington; Dorchester Massachusetts; and abroad: Edinburgh, Greenwich, Cambridge, Hamburg, Copenhagen, Kremsmunster, Cracow, and Wilna, for each of which Bessel's constants are given. The results are placed in the form of corrections of assumed longitudes, and the weights computed by the usual formula.

2. Report on the longitude of East Pascagoula station, as de-

duced from moon culminations, observed by Assistant R. H. Fauntleroy, in June and July, 1847.

No correction in the assumed longitude, 5*h*, 59*m*., is proposed.

3. On the difference of longitude of Cambridge and Philadelphia observatories, from the results of corresponding observations of eclipses and occultations, and by the transportation of chronometers.

This assigns a difference of longitude of 16*m* 08*s*.95.

4. On the longitude of Cambridge observatory (Harvard) from eclipses and occultations, using Burkhardt's value of the moon's semi-diameter and parallax.

The value assigned is 4*h*. 44*m*. 31*s*.95 west of Greenwich.

5. Report on the longitude of Cambridge observatory, (Harvard,) deduced from the results of chronometer comparisons in Boston and Liverpool, reported for the use of the coast survey, by Professor W. C. Bond, director of the Cambridge observatory.

Mr. Bond's list gives 4*h*. 44*m*. 30*s*.49 W. for the longitude of Cambridge observatory, with a probable error of 0*s*.75. In this report Mr. Walker urges very strongly what has occurred to Mr. Bond, as a great desideratum, and which he has been earnest in endeavors to supply, the procuring from Liverpool the data from the eastern voyages. The difference in the longitudes by astronomical observations and by chronometers becomes of great importance, in connexion with Mr. Walker's other investigations, which will be hereafter referred to.

6. Reduction of the observations of the occultations of Aldebaran, at Galveston, Texas, March 10, 1848, by Assistant R. H. Fauntleroy, United States coast survey.

7. On the corrections of Burkhardt's lunar tables. A recapitulation of the most important results contained in this paper is given, with additional matters bearing upon them, in Mr. Walker's annual report. (Appendix, No. 19.)

8. On the coast survey forms for reducing occultations and moon culminations.

9. On the difference of longitude of Stevenson's Point, North Carolina, and Washington, by chronometers.

10. On a telegraphic clock, proposed by Professor W. C. Bond.

11. Report on the reductions of moon culminations in the coast survey archives to September 12, 1848.

In this report Mr. Walker remarks: "You will notice that their uniform tendency is to place the three principal astronomical stations several seconds eastward of the assumed places, based on previous reductions of solar eclipses and lunar occultations, subject to the moon's parallax and semi-diameter. The discrepancy is too great to be ascribed to the *accidental* error of either group of phenomena. It indicates a constant error in one method or the other."

"In searching for the source of such a constant error, I am unable to detect one of so great an amount in the method of moon culminations. The peculiar excellence of this method consists in its removing the constant errors of the lunar elements and of the

stars' places. It can hardly be ascribed to the residual personal error of the average of three persons in America, and of more than a dozen in Europe, in judging of the time of contact of a limb with a wire. Still less can it be ascribed to that optical imperfection of the groups of telescopes employed, called *irradiation*."

"With regard to the other class of phenomena, the lunar occultations and eclipses, a constant source of error may exist in the mean value of the moon's horizontal equatorial parallax, on which Burkhardt's tables are based." * * * * * *

"I do not hesitate to attribute in a great degree to this source alone, [this residual phenomenon.] Other circumstances tend strongly to confirm this hypothesis. I shall make it the subject of a more full discussion in my annual report, in which I propose to bring together those authorities which may aid in forming an opinion on this subject, which is of paramount importance in the further prosecution of the longitude computations of the United States coast survey."

The results by moon culminations place Cambridge observatory 4*s*.27, and Washington (Capitol hill observatory) 3*s*.92 east of the place by eclipses and occultations. The probable accidental error at each place is 0*s*.17.

12. Preliminary report on telegraphic operations.

13. Report on difference of longitudes of New York and Cambridge, by the telegraphic method.

14. Theory of longitude by chronometers, and proposed form of reductions of observations.

15. Annual report on the results for longitude of points connected with coast survey stations.

The importance of a determination, which should not be shaken by subsequent observations of difference of longitude of a cardinal point in the coast survey and of European observatories, is so great that I have spared no pains in accumulating results by stimulating observers, by collecting observations, and by obtaining the aid of accomplished computers in the reduction or discussion of the results. The questions, as they have arisen, have been met in such a way as to insure progress in the right direction, without being daunted much by the obstacles which a close study of the subject by Mr. Walker and others found in the way. A superficial examination of a subject, or the taking for granted of a prescribed routine, is apt to impress one with notions of the great accuracy of processes and results, in which are concealed constant errors of grave importance. Turning up the surface, developes these concealed errors, and leads to scientific discovery. The action of different minds accelerates the progress of truth, and on this account I have published the report of Assistant S. C. Walker, as of high interest to the astronomer, though the subject yet remains, and must for some time remain, not fully explored. A portion of the recommendations of Mr. Walker are such as have necessarily occurred to me, and in regard to which, indeed, measures have already been taken; the others will not fail to be acted on as means are found for their execution. They present an outline of

work which only a most resolute and zealous computer could venture to trace. The chief suggestions, relating to computations, are as follows:

1. "To employ a greater force of computers, and urge forward, by every possible means, the reduction of the American observations of moon culminations, from 1842 to 1846, using the blank forms of the survey."

2. "To employ additional force in forming the conditional equations for the eclipses and occultations, with corresponding meridian observations in Europe, to the end of 1846; also, according to the coast survey forms."

3. "From the report of Professor Airy, and from any other available sources and subsidiary computations, to find the most plausible theoretical elements for the moon's place on the nights of the American observations."

4. "To apply these values to the conditional equations in articles 3d and 4th, so as to render the residual error of theory the least possible."

5. "To complete the discussion of the value 122″.37 of the coefficient of the parallactic equation, given by Professor Airy. For this purpose it will be necessary to extend the discussion which Professor Airy has limited to the instruments of Greenwich and Cambridge, so as to include all those in which the transits and altitudes of both limbs of the moon have been observed at the same time in any country, so as to decide whether the theoretical coefficient of 122″.37, or a more plausible empirical one, is to be adopted in the longitude computations of the coast survey."

6. "To institute a full discussion of all the observations of occultations of the stars in the group of the Pleiades extant in any country. This discussion is earnestly recommended by Bessel as certain to afford more perfect data than those from any other source for the determination of longitudes, and for the correction of the moon's parallax and semi-diameter."

7. "To resolve, by the method of least squares or otherwise, all the conditional equations so obtained, after applying all the theoretical and empirical corrections to the lunar constants and coefficients, so as to obtain the most plausible value of the correction of the longitude of our own cardinal point from the average of the European meridians."

For the entire report I refer to the Appendix, No. 19.

The comparisons of the observations of moon culminations for *deducing longitudes* has been continued by Lieutenant J. M. Gilliss, U. S. N., assistant in the coast survey, who has completed the comparisons for 1840 and those of 1841, except for the observatory at Edinburgh, and has made considerable progress in transcribing the results of 1842. The total number of comparisons in 1840 for Hudson observatory (Ohio) is 127; for Washington (Capitol hill) 241; for Cambridge (Harvard University) 163. In 1841, for Hudson, 89; Washington 169, and Cambridge 67.

Lieutenant Gilliss, calls my attention to the discrepancy already

noticed in a different point of view, in connexion with Mr. Walker's report, between the results of these computations of moon culminations, and the usually received longitude of Washington.

Eugene Nulty, esq., has computed the observations for the latitude of stations Taylor and Poole's island (section III.) made with the 12-inch Gambey theodolite and with the zenith telescope; for time, latitude and azimuth at Pascagoula, (section VIII.;) for time, latitude and azimuth, at Fort Morgan, (section VIII.;) the observations for latitude at Pascagoula and Fort Morgan were made with the zenith telescope. Some want of agreement in the first and second results called for a third computation of the observations for the latitude at Thompson's, Taylor's, Poole's island, Pascagoula, Fort Morgan, Stevenson's Point, and Shell Bank, and Mr. Nulty has accordingly made a complete re-computation of the observations at these points.

Assistant Theodore W. Werner has revised the horizontal angles to connect the triangulation with the elongation marks at Bodies' Island base and Fort Morgan; made the second computation of the resulting angles of the triangulation of Boston harbor, 1846 and 1847, and of part of the triangle sides; finished the second computation of Lieutenant Lee's magnetic observations in 1844 and 1845, and made some further progress in the second computation of Doctor Locke's magnetic observations in 1846; and Assistant Boutelle's, at Bodies' Island, Stevenson's Point and Shell Bank. Recomputed the triangulation in Chesapeake bay in 1847; revised the resulting angles of the triangulation of Albemarle sound in 1847, and computed the triangle sides and ordinates of the triangulation of Albemarle sound in 1848, and of Croatan and Roanoke sounds in 1845 and 1846. Recomputed the triangulation of Alligator river, North Carolina, in 1848; computed the triangle sides and ordinates of the triangulation of Little and Pasquotank rivers, North Carolina; computed the triangle sides and ordinates of the secondary triangulation of Cape Cod, in 1847; has begun the recomputation of the trianguiation in the gulf of Mexico in 1846 and 1847; computed the triangulation south of Cape Henlopen in 1848; extended the table for projection of maps from latitude 35° to latitude 25°, and from latitude 42° 30′ to latitude 50°, and extended auxiliary tables for the computation of the geodetic latitude, longitude and azimuth, from latitude 45° to latitude 50°. He has, besides, made considerable miscellaneous computations.

The second computation of the azimuth observations at Thompson's, 1846, Agamenticus, 1847, and Stevenson's Point, 1848, have been made by Mr. Hilgard since he joined the office in September. Mr. Downes has, since August 23d, recomputed the latitude and azimuth observations made by Mr. Blunt in 1843, at Congress Hall, Cape Henlopen light-house, and Town Bank; and he has in hand the observations for the latitude at Mitchell's observatory, Nantucket, made by Professor Loomis in 1845, and by Mr. Mitchell in 1845 and 1846. The list of occultations prepared by Mr. John Downes was, by request of the superintendent, extended to Galveston, in Texas, for the use of the astronomical party of Assistant R. H. Fauntleroy.

Drawing.—Assistant W. M. C. Fairfax (who has had besides the immediate charge of the engraving) prepares all the reduced maps for the engravers by plotting and testing sailing lines, courses, and bearings; arranging the titles, notes, tables, and other lettering; and, finally, makes the projections on the copper plates; of these, he has made during the past year the projections for the western sheet of the map of Long Island sound, (No. 1;) for the western sheet of the map from Point Judith to Nantucket, (eastern series, No. 1;) for the map of Sheffield and Cawkin's islands; for the map of the mouth of Chester river; for the map of Captain's island, east and west; for the northern sheet (No. 1) of the map of Chesapeake bay; and for the map of Hyannis harbor. He has also continued the reduction of the north shore of sheet No. 1, Long Island sound, and made re-drawings of parts of the sheets Nos. 2 and 3, Long Island sound. The sketches for the yearly report have been prepared by him, or under his direction, from materials furnished by the field parties, and from the office. He has, besides, had charge of the drawing during the absence of Captain Humphreys from the office, in the month of September.

Assistant M. I. McClery was engaged in the preparation of a sheet for the Boston harbor map, on a scale of $\frac{1}{20000}$, in reducing the topography of it in part, and in drawing the topography of the same map reduced by another assistant. This map, made for the commissioners of the State of Massachusetts, extends from Nahant to Scituate light, and beyond Cohasset rocks. It will probably be finished by the middle of January.

F. Schroeder, esq., has made the reduction and drawing of about two thirds of the topography of the western sheet, (No. 1,) eastern series, scale $\frac{1}{80000}$. He has also made the drawing of the topography not yet finished, of the second map of Boston harbor, scale $\frac{1}{20000}$, prepared for the commissioners of the State of Massachusetts, and of the same extent as the first map. This will be completed by the 1st of April, 1849.

John Robertson, esq., has been employed in the office since the 1st of May, and has been engaged in reducing and transferring the hydrography to the Boston harbor map No. 1, scale $\frac{1}{20000}$; in reducing some parts of the topography of both of the Boston harbor maps, scale $\frac{1}{20000}$; in transferring the reduced topography from No. 1 to No. 2, and from No. 2 to No. 1; and in lettering No. 1, Boston harbor map. He has also reduced a part of the hydrography of Boston harbor map for engraving, scale $\frac{1}{40000}$.

Joseph Welch, esq., has been engaged in the coast survey office since the 10th of November, 1847, in preparing a sheet for the Boston harbor map No. 2, scale $\frac{1}{20000}$, and in reducing the same until the 1st of February; then in inking the outlines and drawing of the topography of Mr. McClery's reduction of part of the Chesapeake bay map, sheet No. 1, and in the further reduction of that map; in the reduction of Boston harbor map, for engraving, $\frac{1}{40000}$, and in making a map of Naushon island, scale $\frac{1}{10000}$.

J. H. Adams, esq., has been engaged in bringing up the diagram and assemblage maps of Chesapeake bay, in preparing a map of Chesapeake bay showing the differences between the coast survey map and the preceding maps; has made a topographical plan, scale $\frac{1}{20000}$, of the vicinity of Hell Gate; begun the reduction of the Boston harbor map, scale $\frac{1}{10000}$; has nearly completed the reduction of the map of Pasquotank river, scale $\frac{1}{10000}$, has assisted in making tracings for the Boston harbor map, and has made tracings for use in the office and in the field.

J. M. Wampler, esq., has made several projections for plane table parties, has reduced additional topography for the map of Black Rock and Bridgeport, has made the projection and plotting of triangle points for a reduction of hydrography of Boston harbor map, scale $\frac{1}{10000}$; transferred and drawn the hydrography of Nantucket map, scale $\frac{1}{10000}$; redrawn portions of the map of the Patapsco river, scale $\frac{1}{40000}$; has nearly completed the reduction of the western sheet of the south shore of Long Island sound, scale $\frac{1}{80000}$; besides miscellaneous drawings and other duties.

W. Luce, esq., has been engaged in preparing a part of the sketches for the yearly report of 1847, and in 1848; has reduced the topography of the map of Captain's island, east and west, scale $\frac{1}{10000}$; has reduced the topography of the map of Hyannis harbor, scale $\frac{1}{20000}$; has reduced the map of the mouth of Connecticut river $\frac{1}{20000}$; has made some projections for plane table parties, besides drawings and tracings and other miscellaneous duties.

Charles Mahon, esq., reported at the office about the 10th of July, and from that time until the 1st of September, prepared sketches for the yearly report, reduced a portion of the map of the mouth of Chester river, scale $\frac{1}{40000}$, and made projections for field parties; since the 1st of September he has been on duty with Lieutenant commanding Patterson upon original hydrographic sheets.

Assistant J. B. Glück was occupied during five months in the reduction of parts of the topography of Boston harbor map, scale $\frac{1}{20000}$; and Sub assistant Samuel A. Gilbert, four months on the reduction of a part of the topography of the second Boston harbor map, scale $\frac{1}{20000}$.

Hydrography.—Lieutenant D. D. Porter, United States navy, assisted by Lieutenant S. C. Barney, has verified (and reduced again when necessary) the hydrography of the western sheet of Long Island sound (No. 1.,) the same of a part of No. 2, Long Island sound, has verified the reduction of the hydrography from point Judith eastward, including Buzzard's bay, scale $\frac{1}{80000}$; has verified the reduction of the hydrography of Patapsco river map, scale $\frac{1}{40000}$; has commenced the reduction of hydrography of Chesapeake bay from Poole's island southward, scale $\frac{1}{80000}$; has reduced the hydrography of the harbors of Sheffield and Cawkin's islands, scale $\frac{1}{20000}$; and the hydrography of the harbors of Captain's island east and Captain's island west, scale $\frac{1}{10000}$; and the hydrography of

Hyannis harbor, scale $\frac{1}{30000}$; and the additional hydrography for the western sheet of south side Long Island, scale $\frac{1}{80000}$; he has prepared the hydrographical part of a map of Hell Gate, scale $\frac{1}{3000}$ revised the sailing directions of a part of the harbors of Long Island sound, besides miscellaneous plottings, reductions, revisions of hydrography, &c., &c.

Lieutenant Woodhull, United States navy, has reduced the tidal observations at Baltimore and at the Bodkin light-house in 1845 and 1846, has revised the tide tables at Delaware breakwater, Cape May landing, Coldspring inlet, and Town bank; has reduced the tidal observations at Governor's island in 1844, 1845, and 1846, and at Sandy Hook in 1844, 1845, and 1846, in part; besides attending to miscellaneous matters connected with the tidal reductions.

Engraving.—Assistant W. M. C. Fairfax has had charge of the engraving, in addition to the duties before enumerated under the head of drawing. The engraving of the harbor map of Edgartown, by Messrs. Dankworth, Lawson, and W. Smith; of New London, by Messrs. Rolle and Knight; of Black Rock and Bridgeport, by Messrs. Pettit and W. Smith; of Nantucket, by Messrs. Dankworth, Young, Lawson, and Smith; and of Huntingdon bay, by G. S. Smith, of Boston, has been completed; that of Cawkin's and Sheffield islands, by Messrs. Pettit and Knight will be finished about the 1st of December; that of the mouth of Chester river, by Messrs. Dankworth and W. Smith, about the 1st of February, 1849; that of the Patapsco river and its approaches, by Messrs Dankworth, Lawson, and Knight, about the 1st of March, 1849; the engraving of Captain's island, east and west, has been begun by Mr. Pettit, and a contract has just been made with Sherman and Smith of New York, for the engraving of Hyannis harbor. It was only after considerable delay and trouble that a contract could be made for the engraving of this map.

The engraving of the eastern sheet of Long Island has been completed by Messrs. Siebert, Rolle, and Knight, and electrotype copies of it taken by Mr. Siebert; that of the entrance sheet of Delaware bay, by Messrs. Dankworth, Lawson, and Knight, has also been completed, and an electrotype copy of the middle sheet, taken by Mr. Siebert. Progress has been made in the middle sheet of Long Island sound, by Messrs. Siebert and Rolle, and it is estimated that it will probably be completed in six months. The engraving of the western sheet of Long Island sound has been begun by Messrs. Siebert and Rolle, and also that of the first sheet of the general map extending from Point Judith to, and including, Nantucket island. The engraving of the upper sheet of the map of Chesapeake bay has been begun by Mr. Dankworth. Considerable progress has been made by Mr. W. Smith in the engraving of the offshore soundings map, (estimated to be completed in seven months.) The additional hydrography for the south side of Long Island will be engraved in November, and the plate will then be ready for printing. Electrotype copies have been made by Mr. Siebert of the plates of New Haven, of New London, of New Bedford, of

Little Egg Harbor, of Long Island sound, (sheets Nos. 2 and 3,) of the relief plate for the middle sheet of Delaware bay, and one large and seven small blank plates have been made for engraving.

The engraving for the next year will be upon the Long Island sound sheets, Nos. 1 and 2, the eastern series, sheet No. 1, the Chesapeake sheet No. 1, the map of Boston harbor, the Patapsco river, Hyannis harbor, the mouth of the Connecticut river, Captain's islands, east and west, the mouth of Chester river, and the Pasquotank river. The map of Albemarle sound, harbor maps of entrance to Mobile bay, Cat Island, and Ship Island, and the chart of Muskeget channel, as connected with the harbors of refuge, of Edgartown and Holmes' Hole, will follow in succession.

Printing.—Since the 1st of November, 1847, there have been printed the following numbers of the maps newly published. Of Delaware bay and river, (complete in three sheets,) 1,967; of Long Island sound No. 3, 25 sheets; of the harbor of New London, 770 sheets; of the harbor of Edgartown, 974 sheets; of Black Rock and Bridgeport harbor, 898. Of maps published in former years there have been printed the following numbers within the present year: of Holmes' Hole and Tarpaulin Cove, (harbors of refuge,) 100; of New Bedford harbor, 315; of Little Egg harbor, (harbor of refuge,) 255; of New York bay and harbor, (scale $\frac{1}{80000}$,) 441; of the large map of New York bay, (scale $\frac{1}{30000}$,) 277 sheets; of Fisher's Island sound, 841; of New Haven harbor, 350; of Annapolis harbor and the Severn, 262; making in all 7,475 sheets. Besides the above there were 1,200 sketches for the yearly report, 200 proofs of maps for the superintendent, 1,100 copies of the sketches of Nantucket new South Shoal, Cat Island harbor, and entrance to Mobile bay, and the usual 25 monthly proof sheets, amounting in the year to 300 sheets

Publishing.—At the date of my last report, sixteen sheets of coast survey maps had been published, since which time five have been added, making a total of twenty-one; besides these, three sheets are engraved and nearly ready for publishing. Since November 1, 1847, 301 copies of each of the maps of New London, Holmes' Hole and Tarpaulin Cove and Oyster Bay, 306 copies of each of the maps of Black Rock and Bridgeport and Edgartown, 161 copies of the small map of New York bay and harbor, and 7 copies of the six sheet map of New York bay and harbor have been distributed to scientific and literary institutions in the United States. These distributions are chiefly made on the nominations of members of the two houses of Congress. Seventy-six copies of each of the maps of New London, Holmes' Hole and Tarpaulin Cove, Oyster Bay, Black Rock, and Bridgeport and Edgartown, have been distributed to foreign governments and to the departments of our own government. By direction of the Treasury Department and for use on the survey, 31 copies, 186 sheets, of the large map of New York, 70 copies of the small map of New York, 34 sheets of the map of Delaware bay, 63 copies of the chart of Fisher's Island sound, 34 copies of the map of Annapolis, 40 copies of the map of Little Egg

harbor, 60 copies of the map of New Haven, 70 copies of the map of Holmes' Hole and Tarpaulin Cove, 47 copies of the map of New Bedford, 67 copies of the map of Oyster Bay, 60 copies of the map of New London, 8 copies of the map of Long Island sound, 43 copies of the map of Black Rock and Bridgeport, and 43 copies of the map of Edgartown have been distributed. The whole number of sheets distributed is 2,923. During December, the maps of Delaware bay and river, (in three sheets,) Nantucket harbor and Huntingdon bay will be distributed; and in January, one sheet of the map of the south side of Long Island, the map of Cawkin's and Sheffield islands, and the mouth of Chester river.

There have been turned over to the disbursing officer of the coast survey, to be placed with agents for sale, 300 sheets of the large map of New York bay and harbor, 212 sheets of the small map, 1,743 sheets of the map of Delaware bay and river, 550 copies of the chart of Fisher's Island sound, 265 copies of the map of Annapolis, 155 copies of the map of New Bedford, 360 copies of the map of New Haven, 155 copies of the map of Little Egg harbor, 400 copies of the map of Holmes' Hole, and Tarpaulin Cove, 220 copies of the map of Oyster Bay, 300 copies of the map of New London, 228 copies of the map of Edgartown, and 128 copies of the map of Black Rock and Bridgeport, making, in all, 5,016 sheets of maps. These are sold at prices which about defray the cost of the paper and printing, namely, fifteen cents for each of the small sheets, and for the large sheets, from twenty-five to forty cents each.

Instrument making and repairs.—The repairs and cleaning required by the instruments of the field and office parties, generally, have been made during the current year, under the direction of Mr. William Wurdemann. Considerable additions to, and alterations in, the base measuring apparatus, two new trestles with iron legs, the substitution of iron for wood, and changes in the slides of two trestles, new truss-frames for the bars, compensating holders, spiral springs for all the slides, and changes in the micro-telescopes have been made; Y's and telescopes have been placed in 12, 10, and 6-inch Gambey theodolites, to fit them for measuring horizontal angles, alterations and repairs have been made to the two field transit instruments; alterations and repairs have been made to the two five-feet transit instruments; the old base apparatus has been repaired, cleaned, and put in order. The compensation of the base apparatus holders, with the fixtures necessary for it, has been made. The comparison of the standard bar with the two compound bars of the base apparatus has been made, requiring, at times, the whole force of the shop; and preparations for the comparison of the duplicate, two metre bars of the old base apparatus, with the standard metres, heliotrope fixtures, chains, beam compasses, dividers, scales, steel rulers and triangles, drawing pens, reducing frames, have been made, besides repairs and work of other kinds not easily enumerated.

Disbursements.—This important part of the work has gone on, with its usual regularity, under Samuel Hein, esq. During the

past year, all the instruments have been marked and the inventories greatly improved.

ESTIMATES.

Estimates for the next fiscal year.—These estimates are founded upon precise data, and the regular extension of the work in those sections in which preliminary operations have been carried on for the last one or two years, with a view, as stated in my reports, to this extension. I have presented, repeatedly, the considerations of economy upon which such an extension was based, and have shown how that economy was produced. It is not always recollected that these appropriations cover the cost of reducing, drawing, engraving, and publishing the work as well as of the field work. The cost of the field work, all computations included, is but about five-sevenths, or seventy-two per cent. of the whole work. With an expenditure during the surveying year, 1847–'48, now reported, of about one hundred and fifty-five thousand dollars, we have kept thirty-seven parties in the field in different sections, not counting those employed occasionally, which would swell the list considerably, while for one hundred thousand dollars, in 1844, but fifteen parties were kept up, exhibiting an increase of field work of two and a half times, for an expenditure of less than one and six-tenths, or an economy of three-eighths made. The work done in connexion with the office has been increased in a somewhat greater ratio, being now between two and a half and three times what it was in 1844, so that the economical result is greater, on the whole, than that just stated.

To this I might add that the extension of the work has been in the southern sections, where the expenses are much greater than in the northern, and most of the parties have required vessels, instruments, and other outfits, which, although they remain the property of the survey, must be paid for from the annual appropriations. These will serve in part as a set-off to the additional relief to the appropriation from the war and navy departments.

If the estimates for the different sections are compared with those of last year, it will be found that the increase is in those which were commenced in that year, or the year before, and in which the operations were only preliminary, as in section V. of the coast of South Carolina and Georgia; of section VII. on the coast of Florida, and of section IX. on the coast of Texas. The expense of transporting the land parties to the western coast, which bears a large proportion to the cost of their maintenance there, has been already incurred.

This plan for developing the work was brought forward in my report of 1846, in which the following statement will be found:—"It is easily seen that, by this plan the survey, of the whole coast may be completed within a very limited period of time, the number of sections under survey at the same time determining the period of completion of the entire work. Each section in which all the operations are in progress upon the present scale will cost about

twenty-five thousand dollars per annum, comprising the cost of field work, of reduction and publication of results. This estimate supposes the same proportional aid heretofore had under the law, from the services of officers of the army and navy."

"Before the close of the fiscal year of 1847–'48, the survey will be in full activity in six sections, and may be carried on successfully in them for one hundred and fifty thousand dollars per annum, with the addition of such sums as may be necessary from time to time to meet the general items of expenditure, such as procuring instruments, the increase in number and improvement in quality of which are absolutely necessary; the hire or purchase of the small vessels needed for the parties in the southern sections; current expenses of vessels; general office expenses, and the like. The use of steam vessels upon the work would increase the expenditure for certain years, but would be economical in regard to the amount of work which they would enable the hydrographic parties to do in a given time."

Experience has confirmed the statement thus made, the results produced for the fiscal year 1847–'48 just passed, and the expenditures having been in strict conformity with them. The appropriation for the next year provides for the continuation of publication of the back work in section II.; for full activity in sections I., III., IV., V., VIII. and IX., such as the progress of the work in these sections calls for, and the continuation of preliminary work in sections VII. and X., besides the general office work. This is equivalent to work in *seven sections*, and introduces the survey into every State on the Atlantic and gulf of Mexico, and extends it to the western coast. Steam has been introduced upon the work, and has been used in four sections during the past year, but the expenditure per section has not been increased beyond the limit then proposed. I have no doubt that eight sections might be put under survey for two hundred thousand dollars, including the preparation and publication of the results as the survey advanced. The relative economy of work done to expenditure would be still somewhat greater than at present.

The regular progress of the field work in the different sections, and of the office work, including computations, drawing, engraving, printing, &c., will admit of the following operations, requiring at least the expenditures assigned to them. They are classed, except the usual general items, under the head of the geographical sections. The estimates suppose the usual aid from the war and navy departments.

GENERAL ITEMS.—Rent, fuel, postage, materials for drawing, engraving, and printing; carpenter's work and materials; instrument maker's work and materials; blank books, stationery, printing, and ruling forms; binding; transportation of instruments, maps and charts, and miscellaneous office expenses; purchase of new instruments, books, maps and charts... $14,500

SECTION I.—*Field work.*—To extend the primary triangulation in *Maine* eastward, and make the reconnaissance, astronomical and magnetic observations connected with it; to extend the secondary triangulation across *Cape Ann* into *New Hampshire*, and to complete that of the western shore of *Massachusetts bay*; to complete the topography of *Cape Cod*, and of part of the western shore of *Massachusetts bay*; to continue the hydrography of the *Nantucket Shoals*, and of the ocean near *Nantucket*, and of part of *Massachusetts bay*, including the cost of repairs to vessel and engine, and the fuel for the steam vessel used in the hydrography, and the hire of a vessel to aid in the soundings. *Office work.*—To make the required calculations and reductions of the work; the reduction and drawing of a chart of *Muskeget channel*, and of the harbors to which it leads; to complete the engraving of a chart of *Hyannis harbor*, and to continue that of the general coast from *Point Judith* to *Cuttyhunk*, will require $30,500

SECTION II.—*Field work.*—To continue the magnetic observations required in this section, and the verification and filling up of parts of the hydrography. *Office work.*—To continue the engraving of the western sheet of the map of *Long Island sound*; to continue the engraving of the series of charts of harbors of refuge, and anchorages of *Long Island sound;* to engrave a chart of *Hell Gate* near *New York*, including the electrotyping of the plates, will require about .. 12,500

SECTION III.—*Field work.*—To continue the triangulation southward, including both primary and secondary triangulation, and the secondary triangulation outside of the peninsula of the *eastern shore*, south of the *Virginia* line; to commence the triangulation of the *Potomac*; to make the necessary astronomical and magnetic observations; to continue the topography of the eastern and western shores of the *Chesapeake* southward; the topography of the ocean shore, along *Sinepuxent bay;* the hydrography of the outer or ocean side, from the limits of the present year, near the *Isle of Wight shoal*, southward, and of the *Chesapeake bay* to the limits of the triangulation of the present year, including the cost of maintaining (only) a steam vessel for the outside work. *Office work.*—To make computations and reductions required to complete the drawing of the second sheet of *Chesapeake bay;* to continue the engraving of the first sheet; to complete the engraving of a chart of the harbor of refuge at the entrance to *Chester river;* will require about..... 32,500

SECTION IV.—*Field work.*—To continue the triangulation of *Pamlico sound*, and of the ocean coast to *Cape Hatteras*, and to complete that of the *rivers of Albemarle sound;* to make the necessary astronomical and magnetic observations; to complete the topography of the shores of the *Roanoke* and *Carrituck sounds;* to continue the exploration of the *gulf stream* off the coast of this section, including the current expenses of a steam vessel for the purpose. *Office work.*—To make the calculations and reductions required to complete the drawing of one sheet of *Albemarle sound* and its *rivers;* to complete the engraving of the chart of the *Pasquotank river*, and to print and publish the chart; to commence the engraving of the sheet of *Albemarle sound;* will require about..... $22,000

SECTION V.—*Office work.*—To complete the primary triangulation between the *Edisto base* and *Charleston*; to make the secondary triangulation connected with it, and of *Charleston harbor;* to extend the minute reconnaissance southward over *St. Helena sound*, and towards *Savannah river;* to continue the astronomical observations; to commence the topography of the *coast*, and the hydrography of the approaches to *Charleston harbor;* to continue the exploration of the *gulf stream* off the coast of this section. *Office work.*—To make the computations and reductions of the field work; will require..... 18,500

SECTION VII.—*Field work.*—To continue the reconnaissance of the coast of *Florida*, and to extend the triangulation from section VIII. into this section, will require, including the cost of a small vessel for the reconnaissance party..... 6,500

SECTION VIII.—*Field work.*—To continue the topography of the shores of Mobile bay, and to complete that of the north shore of *Mississippi sound;* to continue the hydrography of Mobile bay, and probably to complete it, and to continue that of *Mississippi sound*. *Office work.*—To make the calculations and reductions of the work; to commence the reduction and drawing of the first sheet of the coast chart from the entrance of *Mobile bay* to *New Orleans*, along *Mississippi sound;* to engrave the entrance chart of *Mobile bay*, and to print and publish it; to commence the engraving of charts of *Cat* and *Ship Island harbors;* will require about..... 21,500

SECTION IX.—*Field work.*—To complete the triangulation of *Galveston bay*, and to extend the main and secondary triangulation along the coast to the southward and westward; to commence the topography of Galveston bay, and its hydrography, including the cost of a small vessel for the topographical party.

Office work.—To make the calculations and reductions of observations in the section; will require	$18,500
SECTION X.—*Field work.*—To continue the general and minute reconnaissance of the *western coast;* to make the necessary astronomical observations; to continue the triangulation, and to commence the hydrography; will require at least.....	9,000
Total estimate, including the use of steam vessels when considered necessary in the hydrography of the sections specified.....	186,000

In conclusion, I respectfully commend the foregoing statements to the favorable consideration of the Executive and of Congress, whose fostering care has developed this national work into its present extent and usefulness.

Very respectfully submitted, by

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. R. J. WALKER,
Secretary of the Treasury.

APPENDIX No. 1.

Distribution of the parties of the coast survey upon the coast of the United States, during the surveying seasons, in the different parts of the coast, from November, 1847, to November, 1848.

No. of section of survey.	Limits included in several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
I.	Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.	1	Primary triangulation, astronomical, and magnetic observations.	A. D. Bache, superintendent, assisted by Joseph S. Ruth, sub-assistant.	Unkonoonuc Mountain, New Hampshire, (part of season.)
		2	Reconnaissance	C. O. Boutelle, assistant	Reconnaissance, for extension of primary triangulation, continued in Maine, (part of season.)
		3	Telegraphic difference of longitude.	S. C. Walker, assistant.....	Difference of longitude of New York and Cambridge Observatory, determined by electro magnetic telegraph.
		4	Secondary triangulation..	Captain T. J. Cram, United States Topographical Engineers, assistant.	Western shore of Massachusetts bay.
		5	Do	C. O. Boutelle, assistant	From vicinity of Boston harbor to Manchester, Massachusetts, (part of season.)
			Topography.....	Captain A. A. Humphreys, United States Topographical Engineers, assistant.	Inspection and verification of topography of vicinity of Boston harbor.
		6	Do	H. L. Whiting, assistant, S. A. Gilbert, sub-assistant—(double party.)	Topography of peninsula of Cape Cod.
		7	Do	J. B. Glück, assistant	Topography of south shore of Cape Cod. Topography of localities in western passage into Narragansett bay, near Dutch island; and of eastern passage, near entrance.
		8	Hydrography.....	Lieutenant Comd'g Charles H. Davis, United States navy; Lieutenant Commanding J. N. Maffitt, United States navy—(double party.)	Hydrography of Nantucket shoals contin'd. Of Muskeget channel, by Lieut. Comd'g J. N. Maffitt, U. S. navy. Observations of tides and currents in Boston harbor. Report on light-house on Sankaty Head, Nantucket, by Lt. Comd'g C. H. Davis.

II.	Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.	1	Astronomical observations.	Captain T. J. Lee, United States Topographical Engineers, assistant.	Observations of declinations of stars, giving doubtful results for latitude with West Point mural.
		2	Magnetic observations...	Joseph S. Ruth, sub-assistant ..	Fire Island. (Long Island,) and New Haven.
			Auxiliary triangulation..	Joseph S. Ruth, sub-assistant, and Professor A. G. Pendleton, United States navy.	Triangulation, in connexion with verification work, hydrography southern side of Long Island.
		3	Topography.....	H. L. Whiting, assistant	Shore line near Hell Gate, Blackwell's island, retraced.
				S. A. Gilbert, sub-assistant	Shore line of Sandy Hook retraced, to show progress of the Hook, (close of season.)
		4	Hydrography	Lieutenant Commanding J. R. Goldsborough, United States navy, assistant.	Tides and currents observed in Block island sound. Soundings in Narragansett bay and Newport harbor. Off-shore work, between southern coast of Rhode Island, and Massachusetts, and Block island.
		5	Do	Lieutenant Comd'g Richard Bache, United States navy, assistant.	Verification work off south side of Long Island. Off-shore work between Cape May and Martha's Vineyard. Re-examination of Gedney's channel and adjacent shoals.
		6	Do	Lieutenant Commanding D. D. Porter, United States navy. assistant.	Re-examination of Buttermilk channel into New York harbor. Soundings, &c., of Hell Gate.
		7	Do	Lieutenant Comd'g Charles H. Davis, United States navy, assistant.	Examination and report on obstructions of Hell Gate, for Chamber of Commerce, New York.
III.	Cape Henlopen to Cape Henry, including the coast of Delaware, Maryland, and Virginia.	1	Primary triangulation ...	Edmund Blunt, assistant, aided by C. P. Bolles, sub-assistant.	Verification work at Poole's island and Swan Point, Chesapeake bay. Continuation of the triangulation of the Chesapeake, south of the Potomac. *Mr. Bolles assisting, from June to November.*
			Secondary triangulation..		
		2	Primary triangulation...	A. D. Bache, superintendent...	Verification work at Linstid, on Magothy river; continuation of triangulation across from Chesapeake bay to Capitol and Observatory, Washington.
			Reconnaissance.....	James S. Williams, assistant ..	Reconnaissance in Anne Arundel and Prince George's counties, Maryland.
		3	Secondary triangulation..	John Farley, assistant	Continuation of triangulation of outer side of eastern shore peninsula, down Sinepuxent bay, to the Virginia line.
			Topography.....	J. J. S. Hassler, assistant	Shores of Sassafras river completed at close of last season.

APPENDIX No. 1—Continued.

No. of section of survey.	Limits included in several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
		4	Topography.....	R. D. Cutts, assistant, and John Seib, aid—double party.	Topography of Great and Little Choptank, and of bay shores—of Patuxent and of bay shore south of it.
		5	Topography.....	George D. Wise, assistant.....	Examination of Patapsco; topography of islands south of Kent island; of outer shore from Indian river, southward, to head of Sinepuxent bay.
			Topography.....	J. Crawford Neilson, assistant..	Shores of Chester river completed from previous season.
		6	Topography.....	J. B. Glück, assistant.....	Verification work on the shores of the Patapsco river (at close of season only.)
		7	Topography.....	Captain A. A. Humphreys, United States topographical engineers, assistant.	Inspection and verification of topography.
		8	Hydrography.....	Lieutenant Commanding S. P. Lee, United States navy, assistant.	Hydrography of Chesapeake bay from line Cove Point Meekin's Neck to line Point no Point Hilly Hammock station; hydrography of outside coast of peninsula of Eastern shore from Indian river inlet to Beach house signal. Examination of Sand island inlet for site of a light-house.
		9	Hydrography.....	Lieutenant Commanding W. P. McArthur, United States navy, assistant.	Soundings of Great and Little Choptank rivers, and of Chesapeake in vicinity. Report of light-house required on Blakiston's island, in the Potomac.
IV.	Cape Henry to Cape Fear, coast of part of Virginia & N. Carolina.	1	Measurement of base....	A. D. Bache, *superintendent*; C. O. Boutelle, assistant.	Measurement of base on Bodies' island commenced.
		2	Main and secondary triangulation.	W. M. Boyce, assistant	Completion of triangulation of Albemarle sound and entrance to Roanoke and Chowan rivers, North Carolina.
		3	Astronomical observations.	C. O. Boutelle, assistant.....	Observations for azimuths at Stevenson's Point, and for difference of longitude, by chronometers, with Washington.

		4	Tertiary triangulation...	Alexander W. Longfellow, assistant.	Rivers of Albemarle sound. Alligator river triangulated (part of season.)
		5	Topography.....	J. Crawford Neilson, assistant	Topography of Perquimon's and Little rivers completed, and of northern shore of Albemarle sound (part of season.)
		6	Topography.....	J. J. S. Hassler, assistant.....	Southern shore of Albemarle sound, from Durant's island to head of sound.
		7	Hydrography.....	Lieutenant Commanding W. P. McArthur, United States navy, assistant.	Hydrography of Albemarle sound and of Pasquotank river (part of season.)
IV & V.	.....	8	Hydrography.....	Lieutenant Commanding Richard Bache, United States navy, assistant.	Exploration of gulf stream, section No. 3, from Cape Henry, southeast, and No. 4 from Cape Hatteras, southeast. 300 miles.
V.	Cape Fear to the St. Mary's river, coast of South Carolina and Georgia.	1	Main triangulation.....	James S. Williams, assistant; C. P. Bolles, sub-assistant.	Base line laid out on Edisto island, and minute reconnaissance for main triangulation from the base northward and eastward to Bull's bay.
VII.	St. Joseph's river to Mobile bay; western coast of Florida.	1	Reconnaissance.....	F. H. Gerdes, assistant.....	Extension of main triangulation of coast of gulf of Mexico, eastward from Mobile bay. From Perdido bay, east, to Choctawhatchie (part of season.)
VIII.	Dauphin island to Vermillion bay; coast of Alabama, Mississippi, and part of Louisiana.	1	Primary triangulation and secondary connected with it.	F. H. Gerdes, assistant.....	Continuation of main triangulation of the coast of the gulf of Mexico, westward. From Horn island to Cat island and the Chandeleur islands, Louisiana.
		2	Secondary triangulation	C. M. Eakin, assistant.....	Triangulation of Mobile bay, from Cedar Point to Choctaw Point, nearly completed.
		3	Secondary triangulation	Julius E. Hilgard, assistant....	Extension of secondary triangulation of Mississippi sound, westward, to lake Borgne.
		4	Topography.....	W. E. Greenwell, assistant	Topography of islands south of Mississippi sound, and of main shore on north side of sound, from Fowl river, westward, to Pascagoula river.
		5	Hydrography.....	Lieut. Comd'g C. P. Patterson, U. S. navy, assistant.	Hydrography of Cat and Ship island harbors, and of their approaches. Hydrography of entrance to Mobile bay nearly completed.
IX.	Vermillion bay to the boundary; part of Louisiana and Texas.	1	Reconnaissance.....	F. H. Gerdes, assistant..... W. E. Greenwell, assistant....	Minute reconnaissance of Galveston, lower and upper (Anahuac) bays, and of the coast near Galveston to the southward, (part of the season.)
		2	Main triangulation and astronomical and magnetic observations connected with it.	R. H. Fauntleroy, assistant... Julius E. Hilgard, assistant.... George Davidson, sub-assistant.	Observations for lat. and long. of Dollar Point, Galveston bay. Chronometer difference of long. with Pascagoula station, sec. VIII. Preliminary measurement of base and main triangulation of Galveston bay commenced.

APPENDIX No. 2.

Extract of a letter of William Mitchell, of Nantucket, to Lieutenant Commanding Charles H. Davis, relating to the Louis Philippe packet, when off Nantucket in December, 1847.

My dear Henry:

* * * * * After several days of thick weather they made a light, bearing *north*, on the evening of the 16th of December, it blowing a gale at NE. I find by referring to my journal that at 5, p. m., I marked it (5) 6, thou knowest, being the hardest or hurricane gale. She then hauled off SE. by E., and very soon struck, probably, says one, on the Round shoal; another thinks it may have been the "Stone horse." Beating over this, she struck the bottom, with the *Great Point light* bearing west. This was probably the Point Rip, as the light, says the mate, was not far off. Wearing off this, they again struck on what was supposed to be the Bass Rip. Getting off of this, she struck somewhere between the Old Man and Potchic Rip; perhaps on the northern edge of one, or southern edge of the other. Here our people discovered her on the morning of the 17th, and although the wind had fallen to three, or even two, the sea was making a clean breach over her. Swinging off of this, it seemed to be the determination of the captain to put her on shore; but our people (a thousand of them had gathered on the beach,) made signs to them to keep off, when sending a boat to the back of the surf, information was given them that both of our steamboats should be sent to their relief. And this was done at great hazzard. After two or three days they succeeded in getting the ship to the Vineyard. The ship was constantly leaking very badly. Ship and cargo are said to be worth $250,000. It seems to be the general opinion that a light on Sankaty, known as such, would have enabled her to escape. Without reference to this case, or similar ones, it seems to me that a light on that bluff is of the utmost importance to navigation.

* * * * * * *

Thine, most truly,

WILLIAM MITCHELL.

APPENDIX No. 3.

Notice to Mariners.

The following discoveries and determinations, recently made by the hydrographic party of the coast survey, employed on the Nantucket shoals, under the command of Lieutenant C. H. Davis, United States navy, are of sufficient importance to be communicated immediately. They will be transferred, at the close of the season, to the preliminary chart of the Nantucket shoals:

1. A shoal 2½ to 3 miles long, making off from the southern extremity of Great Rip, with which it is connected by a short ridge of 3¼ fathoms. This shoal lies in a N. by W. and S. by E. direction, (mag.) and has only 8 feet on it in several places.

The distance between the eastern end of the south shoal and the new determination is only 6¾ miles, and the southern limit of danger on Great Rip is 15 miles from the shore. Vessels passing to the southward of Great Rip, or to the eastward of the old Nantucket South shoal, should be careful to govern themselves accordingly.

The centre of the shoal bears from Sankaty Head S. E., ¾ E., (mag.) and S. 62° 30′, (true,) 13¾ miles distant.

2. A small shoal, having only 8 feet of water on it in one spot, which bears N. ¼ W. (mag.) and N. 11° W. (true) from eastern end of old South shoal, 4½ miles distant.

3. A small shoal, with 16 feet on it, a little to the northward and eastward of the preceding, bearing N. by E. ½ E. (mag.) and N. 7° 25′ E. (true) from old South shoal, 5¾ miles distant.

4. A small shoal, with 13 feet on it, to the eastward of south end of Bass Rip. The middle of this shoal bears from Sankaty Head S. by E. (mag.) and S. 65° E. (true,) 6 miles distant.

5. A very small shoal spot, having only 10 feet of water on it, north of Bass Rip, and 1 mile distant from the shoal discovered in that vicinity in 1847, and now marked on the latest coast survey "preliminary sketch" of the Nantucket shoals. This spot bears from Great Point light, S. E. ¾ E. (mag.) and S. 62° E. (true,) 6 miles distant.

The ground to the northward, and to the northward and eastward of the old South shoal, is broken, dangerous, and marked by occasional strong tide rips.

Coasters taking the outside way, are advised to follow down the east side of "Bass Rip," and passing over the tail of it in four fathoms, to haul round under the south side of the "Old Man," which (it is always visible) it is best to keep in sight. Here they will have a good beating channel of at least two miles, i. e., from half a mile to two and a half miles from the "Old Man." Vessels taking this course with an ebb (or westerly) tide, will clear the shoals in a few hours. They will also have more room, and be more favored by the prevailing westerly winds than in the sound.

A. D. BACHE,
Superintendent U. S. Coast Survey.

OFFICE OF THE COAST SURVEY,
Washington, August 16, 1848.

APPENDIX No. 8, Bis.

BOSTON, *November* 22, 1848.

DEAR SIR: Yours of the 14th was received to-day, and I send below, as requested, a list of the discoveries of the season:

1. A shoal $2\frac{1}{2}$ (two and a half) miles long, making off from the southern extremity of Great Rip, with which it is connected by a short ridge of $3\frac{1}{4}$ fathoms. This shoal lies in a north by west and south by east direction, magnetic, and has eight feet of water on it in several places.

2. A small shoal having only eight (8) feet of water on it, to the northward of the eastern end of the old South shoal.

3. Another small shoal, with 16 feet on it, a little to the northward of the former.

4. A small shoal spot to the eastward of the south end of Bass Rip.

5. A small spot to the northward of the Bass Rip, with ten (10) feet on it.

6. A long bank to the eastward of the shoal, marked No. 1 on this list, upon which I found four (4) fathoms in two places, four miles apart. The sea was breaking on it whilst I was there, the result of a heavy swell from the southward and eastward.

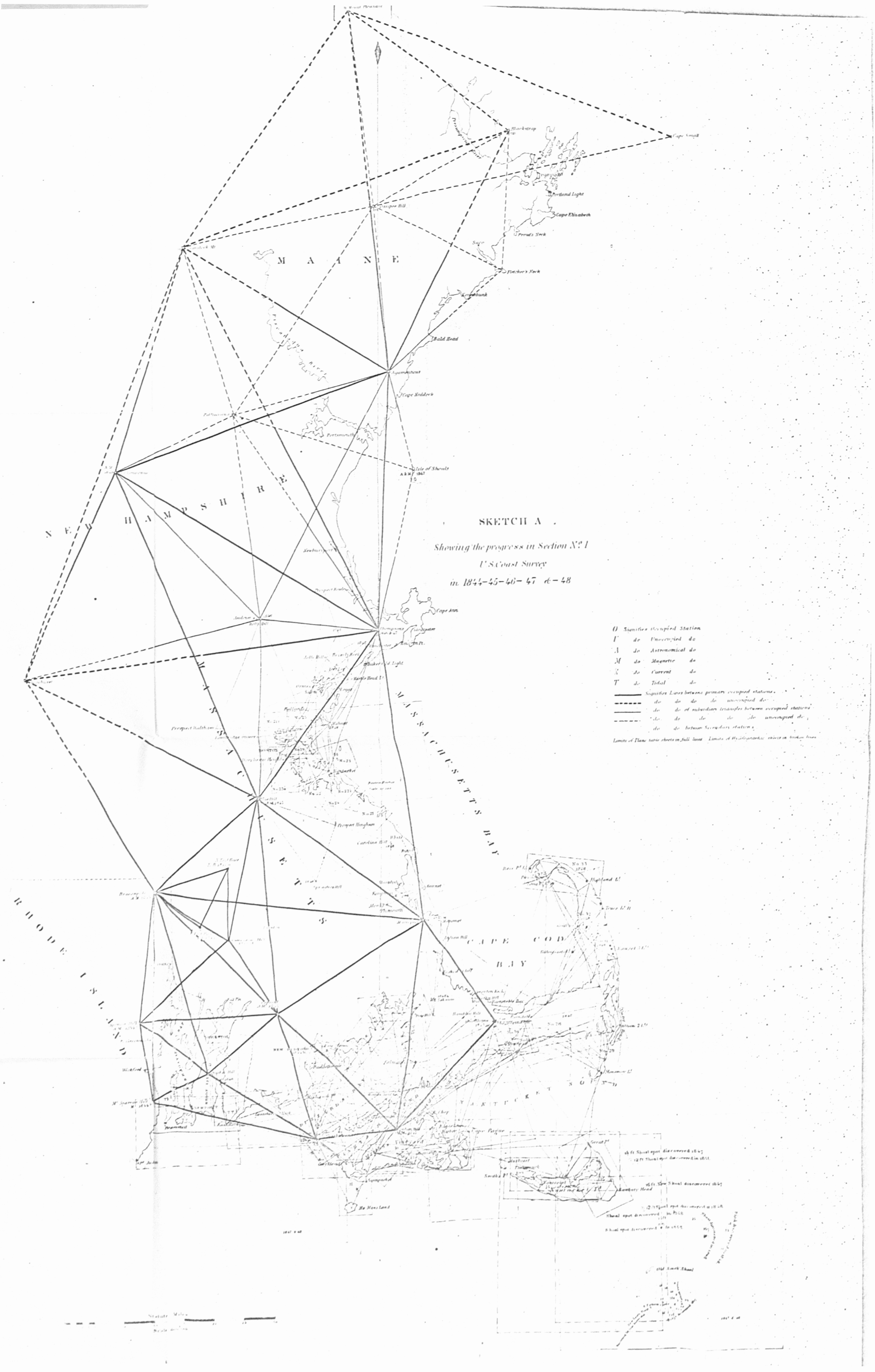
I was unable to determine the extent of this bank, owing to the bad weather and the lateness of the discovery. The further examination of this bank next season will be a point of great interest.

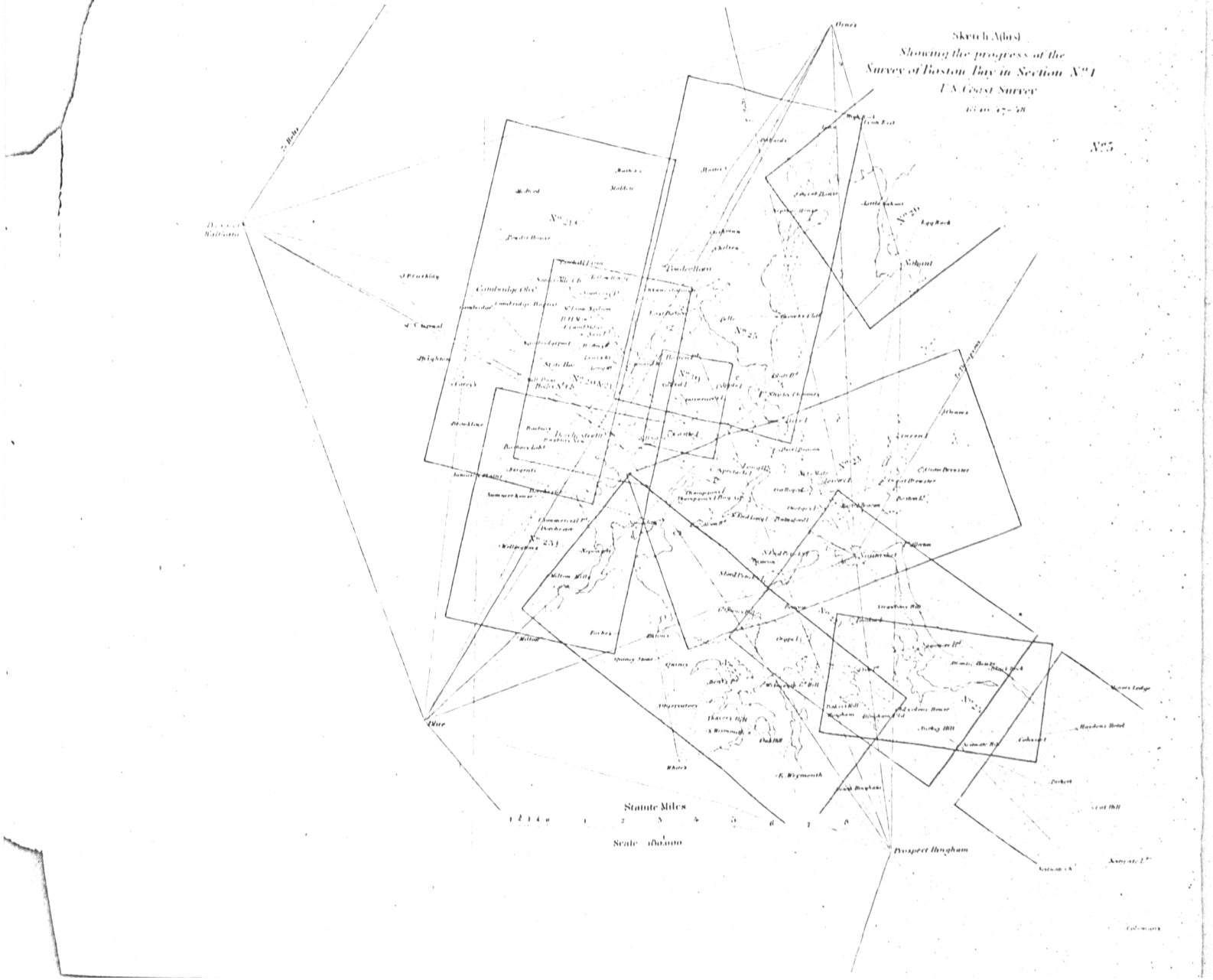
* * * * * * * *

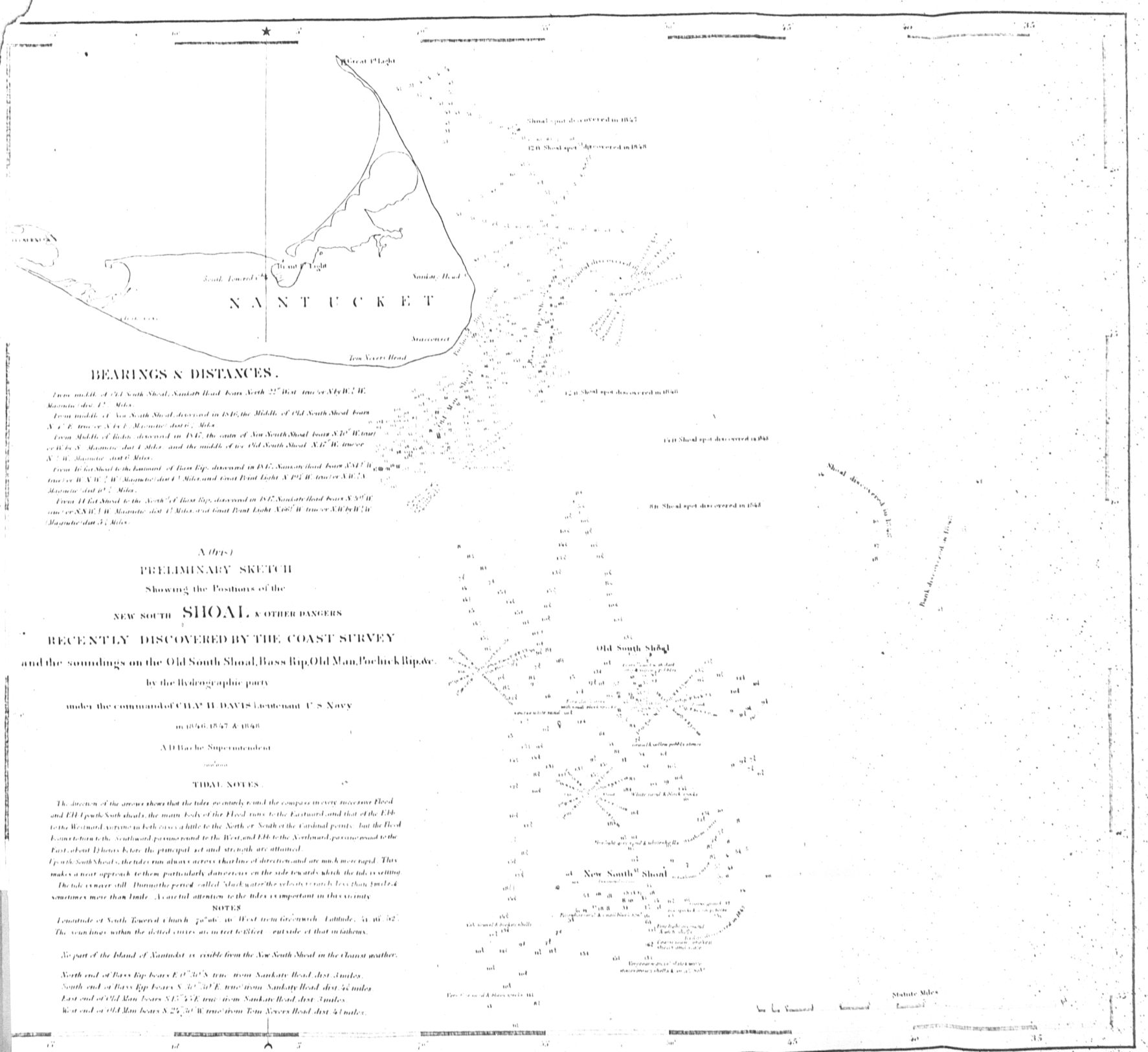
Yours, truly,

C. H. DAVIS.

A. D. BACHE, LL. D.,
Superintendent U. S. Coast Survey,
Bodies' Island, base.


SKETCH A.
Showing the progress in Section No. 1
U.S. Coast Survey
in 1844-45-46-47 & 48
O Signifies Occupied Station
U do Unoccupied do
A do Astronomical do
M do Magnetic do
X do Current do
T do Tidal do
Signifies Lines between primary occupied stations.
do do do do unoccupied do
do do of subsidiary triangles between occupied stations
do do do do do unoccupied do
do do between Secondary stations
Limits of Plane table sheets in full lines
MAINE
NEW HAMPSHIRE
MASSACHUSETTS
MASSACHUSETTS BAY
RHODE ISLAND
CAPE COD BAY
NANTUCKET SOUND
Blackstrap
Cape Small
Portland Light
Cape Elizabeth
Prouts Neck
Fletcher's Neck
Kennebunk
Bald Head
Agamenticus
Cape Neddock
Portsmouth
Isle of Shoals
Cape Ann
Thompson
Newburyport
Baker's Isd Light
Marble Head
Prospect Hingham
Highland Lt
Truro Lt H
Nauset Lt
Monomoy Lt
Cape Pogue
Gay Head
No Mans Land
Rowley Head
Great Pt
Old South Shoal
Smiths Pt
Tuckernuck


Sketch (Map)
Showing the progress of the
Survey of Boston Bay in Section N°1
U.S. Coast Survey
1848 47-48
N°3
N°24
N°23
N°19
N°20
N°21
N°22
N°25
N°26
N°27
Statute Miles
Scale 1/80000
Prospect Hingham



BEARINGS & DISTANCES.

From middle of Old South Shoal, Sankaty Head bears North 22° West true or NbyW½ W Magnetic dist 12 Miles.

From middle of New South Shoal discovered in 1846, the Middle of Old South Shoal bears N 1° E true or NbyE Magnetic dist 6½ Miles.

From Middle of 8 feet discovered in 1847, the centre of New South Shoal bears N 31° W true or WbyN Magnetic dist 4 Miles, and the middle of the Old South Shoal N 47° W true or NW Magnetic dist 6 Miles.

From 12 feet Shoal to the Eastward of Bass Rip discovered in 1847, Sankaty Head bears N 61° E true or ENE Magnetic dist 9 Miles, and Great Point Light N 19° W true or NNW Magnetic dist 6½ Miles.

From 11 feet Shoal to the North end of Bass Rip, discovered in 1847, Sankaty Head bears N 51° W true or NNW Magnetic dist 12 Miles, and Great Point Light N 66° W true or NbyW Magnetic dist 5½ Miles.

(1848)

PRELIMINARY SKETCH

Showing the Positions of the

NEW SOUTH SHOAL & OTHER DANGERS

RECENTLY DISCOVERED BY THE COAST SURVEY

and the soundings on the Old South Shoal, Bass Rip, Old Man, Pochick Rip &c.

by the Hydrographic party

under the command of CHAS H. DAVIS Lieutenant U. S. Navy

in 1846, 1847 & 1848

A.D. Bache Superintendent

TIDAL NOTES.

The direction of the arrows shows that the tides are nearly round the compass in every successive Flood and Ebb. On the South shoals, the main body of the Flood runs to the Eastward, and that of the Ebb to the Westward, sometimes a little to the North or South of the Cardinal points, but the Flood leaves to turn to the Southward, passing round to the West, and Ebb to the Northward, passing round to the East, about 1½ hours before the principal set and strength are attained.

On the South Shoals, the tides run always across that line of direction, and are much more rapid. This makes a great approach to them particularly dangerous on the side towards which the tide is setting.

The tide is never still. During the period called "slack water" the velocity is rarely less than 1 mile, & sometimes more than 3 miles. A careful attention to the tides is important in this vicinity.

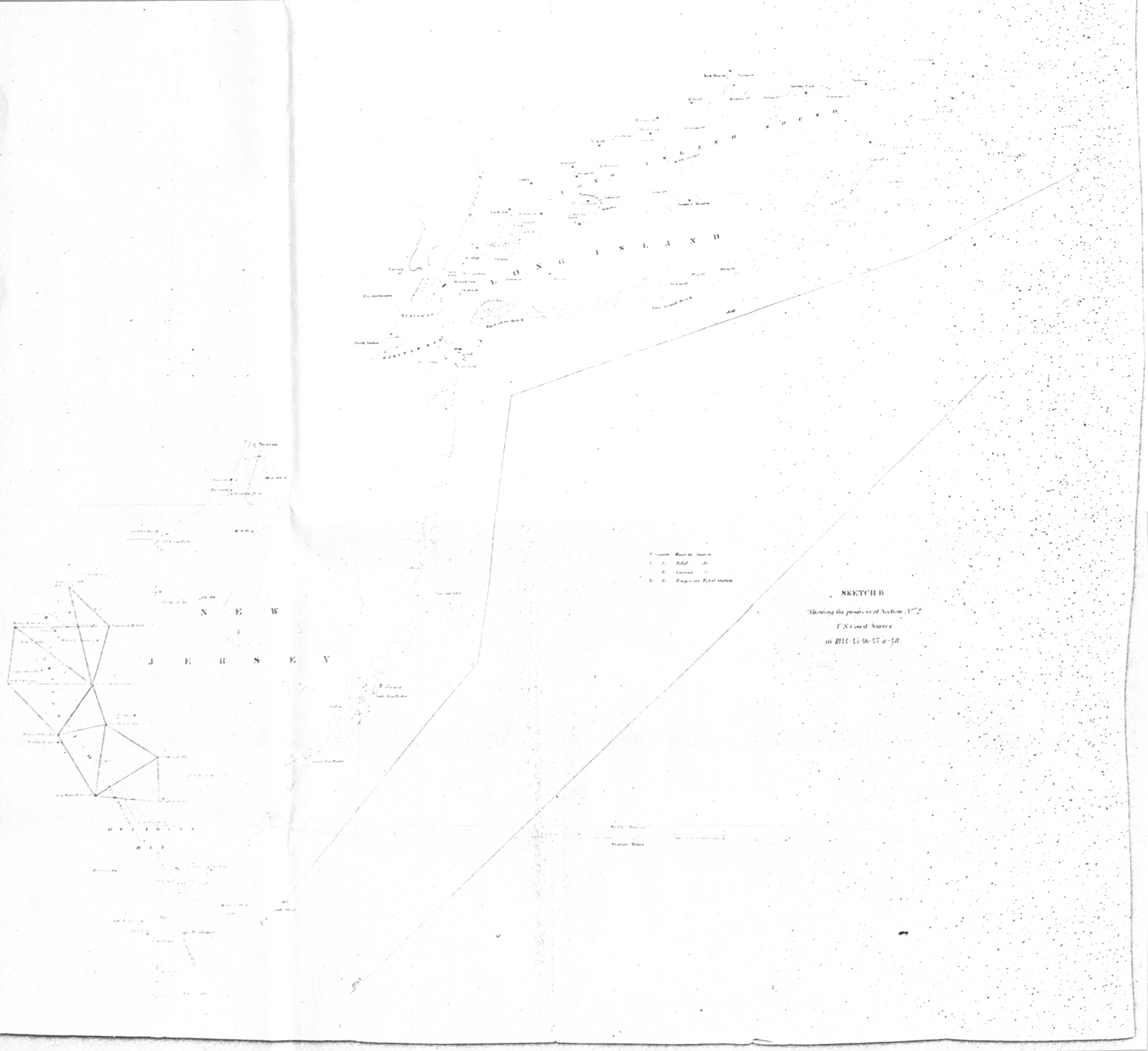
NOTES.

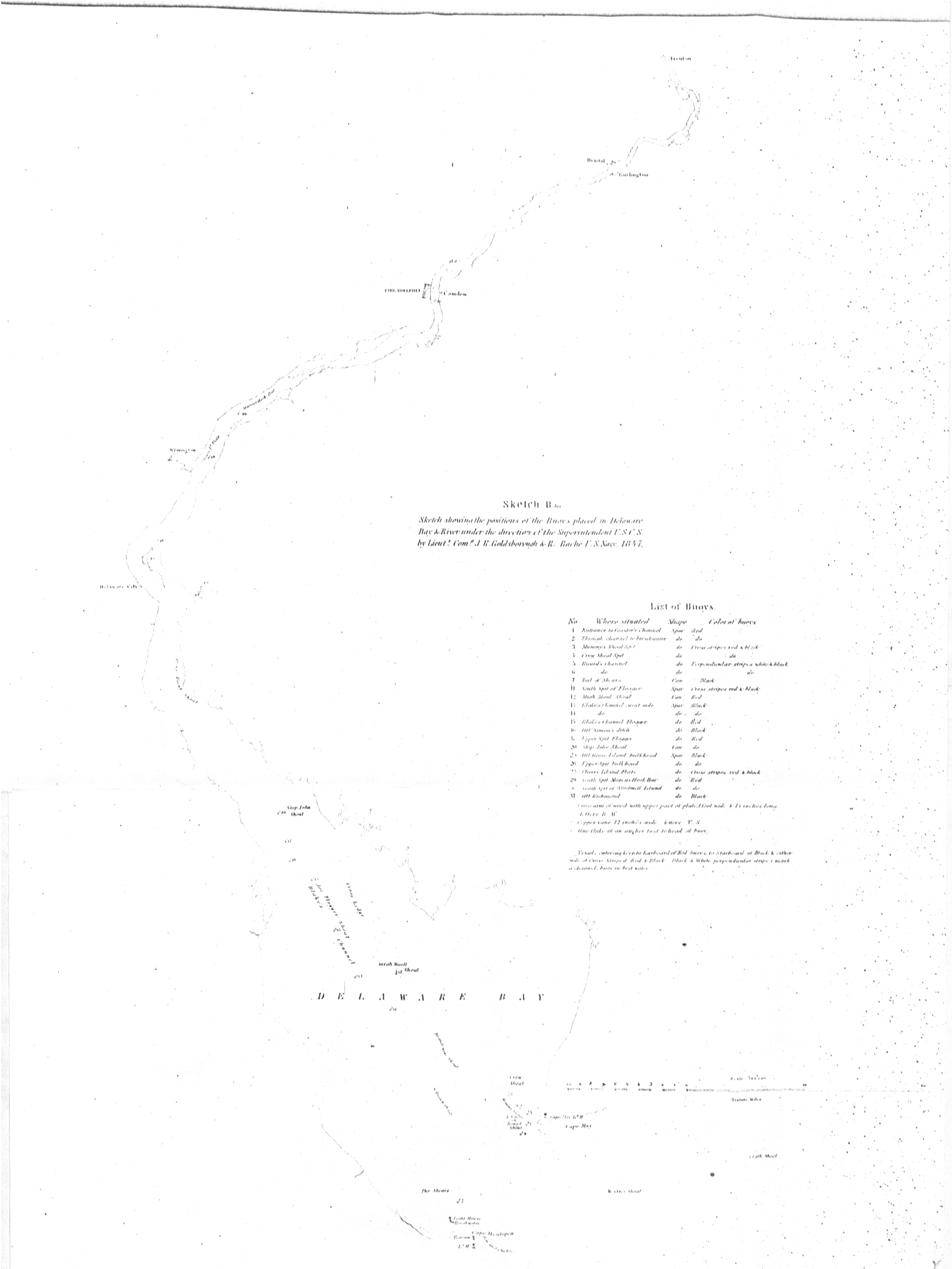
Longitude of South Tower of Church 70° 06' 00" West from Greenwich. Latitude 41° 16' 32".

The soundings within the dotted curves are in feet to 18 feet, outside of that in fathoms.

No part of the Island of Nantucket is visible from the New South Shoal in the clearest weather.

North end of Bass Rip bears E 0° 30' S true from Sankaty Head dist 3 miles.
South end of Bass Rip bears S 31° 30' E true from Sankaty Head dist 4½ miles.
East end of Old Man bears S 15° 45' E true from Sankaty Head dist 3 miles.
West end of Old Man bears S 27½° W true from Tom Nevers Head dist 4 miles.


L O N G I S L A N D
N E W
J E R S E Y
SKETCH B
Showing the progressed Section No 2
U.S Coast Survey



Sketch B No.

Sketch showing the positions of the Buoys placed in Delaware Bay & River under the direction of the Superintendent U.S.C.S. by Lieut.t Com.d J. R. Goldsborough & R. Bache U.S. Navy. 1847.

List of Buoys.

No.	Where situated	Shape	Color of buoys
1	Entrance to Coaster's Channel	Spar	Red
2	Through channel to breakwater	do	do
3	Mummy's Shoal Spit	do	Cross stripes red & black
4	Crow Shoal Spit	do	do
5	Round's Channel	do	Perpendicular stripes white & black
6	do	do	do
7	Tail of Shears	Can	Black
11	South Spit of Flogger	Spar	Cross stripes red & black
12	Mioh Maul Shoal	Can	Red
13	Blake's Channel west side	Spar	Black
14	do	do	do
15	Blake's Channel Flogger	do	Red
16	Off Simon's ditch	do	Black
[illegible]	Upper Spit Flogger	do	Red
20	Ship John Shoal	Can	do
[illegible]	Off Goose Island bulkhead	Spar	Black
26	Upper Spit bulkhead	do	do
[illegible]	Cherry Island Flats	do	Cross stripes red & black
29	South Spit Marcus Hook Bar	do	Red
[illegible]	South Spit of Windmill Island	do	do
37	Off Richmond	do	Black

Crossarm of wood with upper part of plate, 1 foot wide & [illegible] inches long. Letters R. W.

Copper vane 12 inches wide. Letters T. S.

One flake of an anchor fast to head of buoy.

Vessels entering keep to Larboard of Red buoys, to Starboard of Black & either side of Cross Striped Red & Black. Black & White perpendicular stripes mark a channel, buoy in best water.

Sketch B

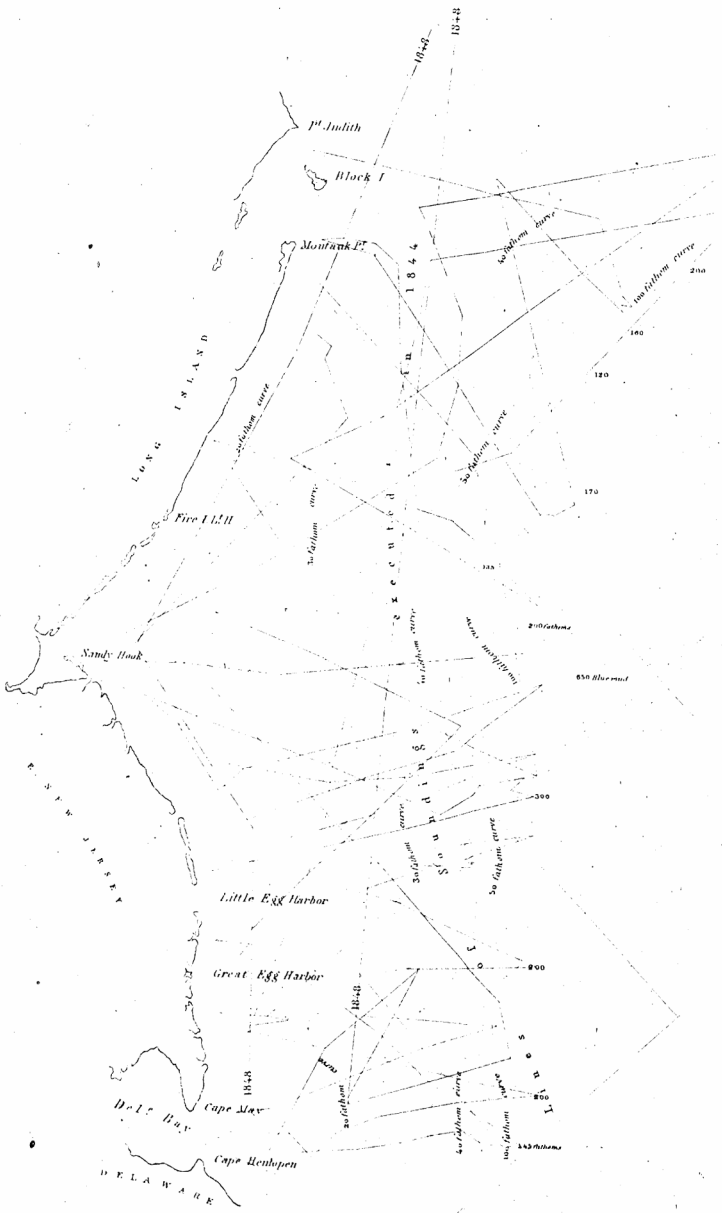
Showing the progress of Off Shore Soundings Section II

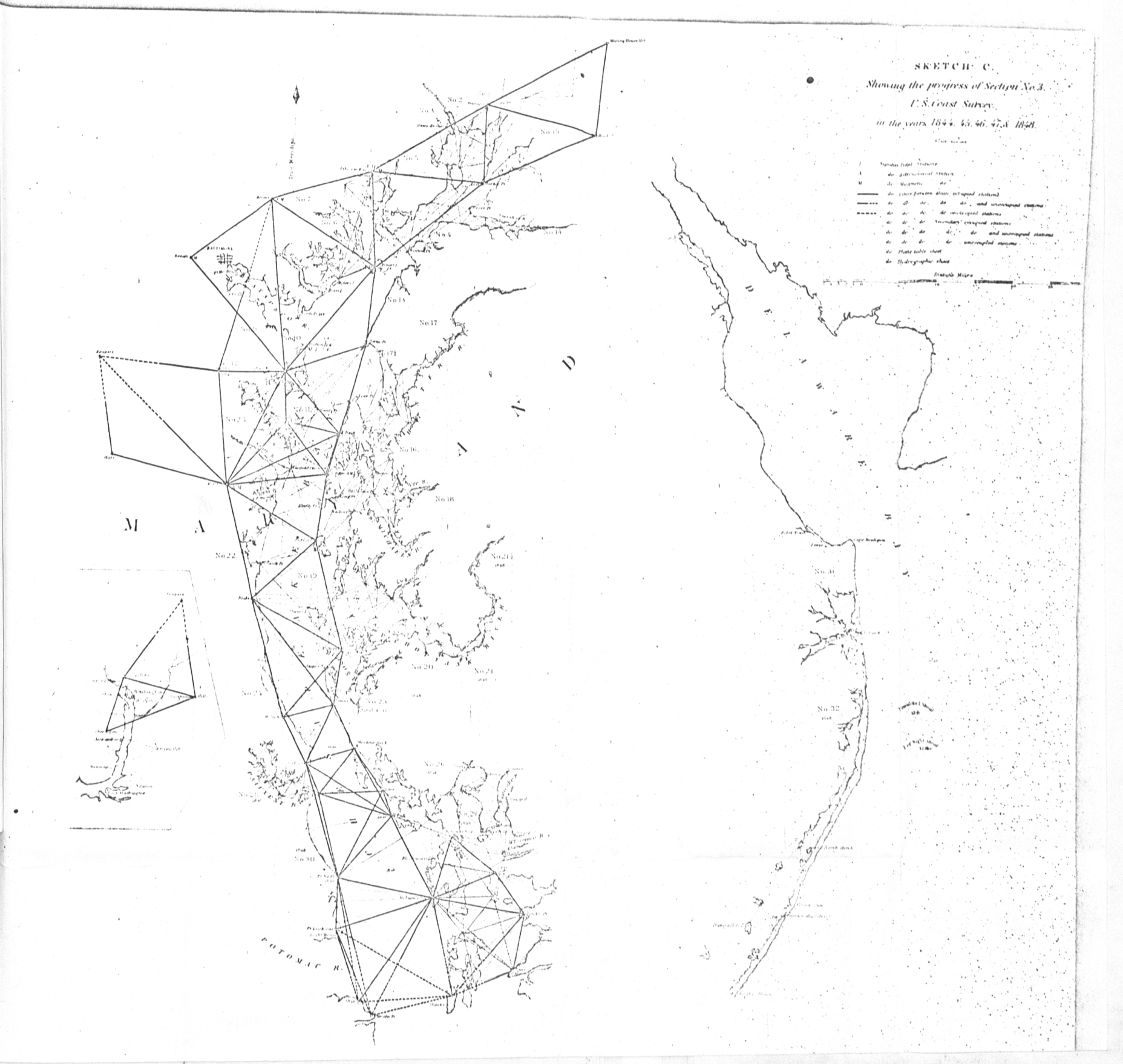
U.S.Coast Survey

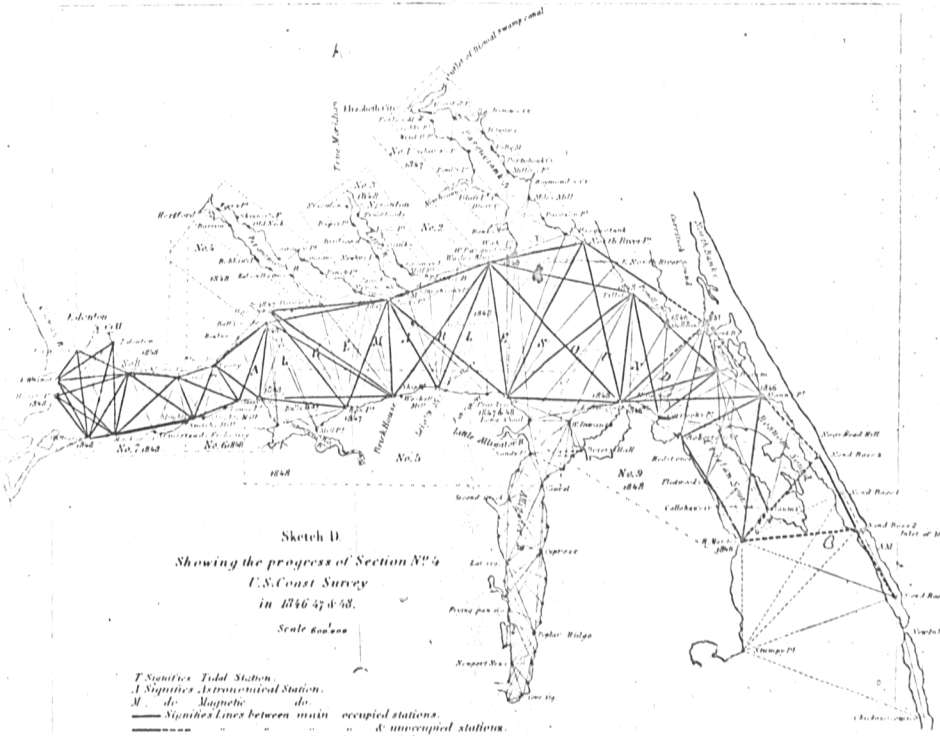
in 1844 & 1848

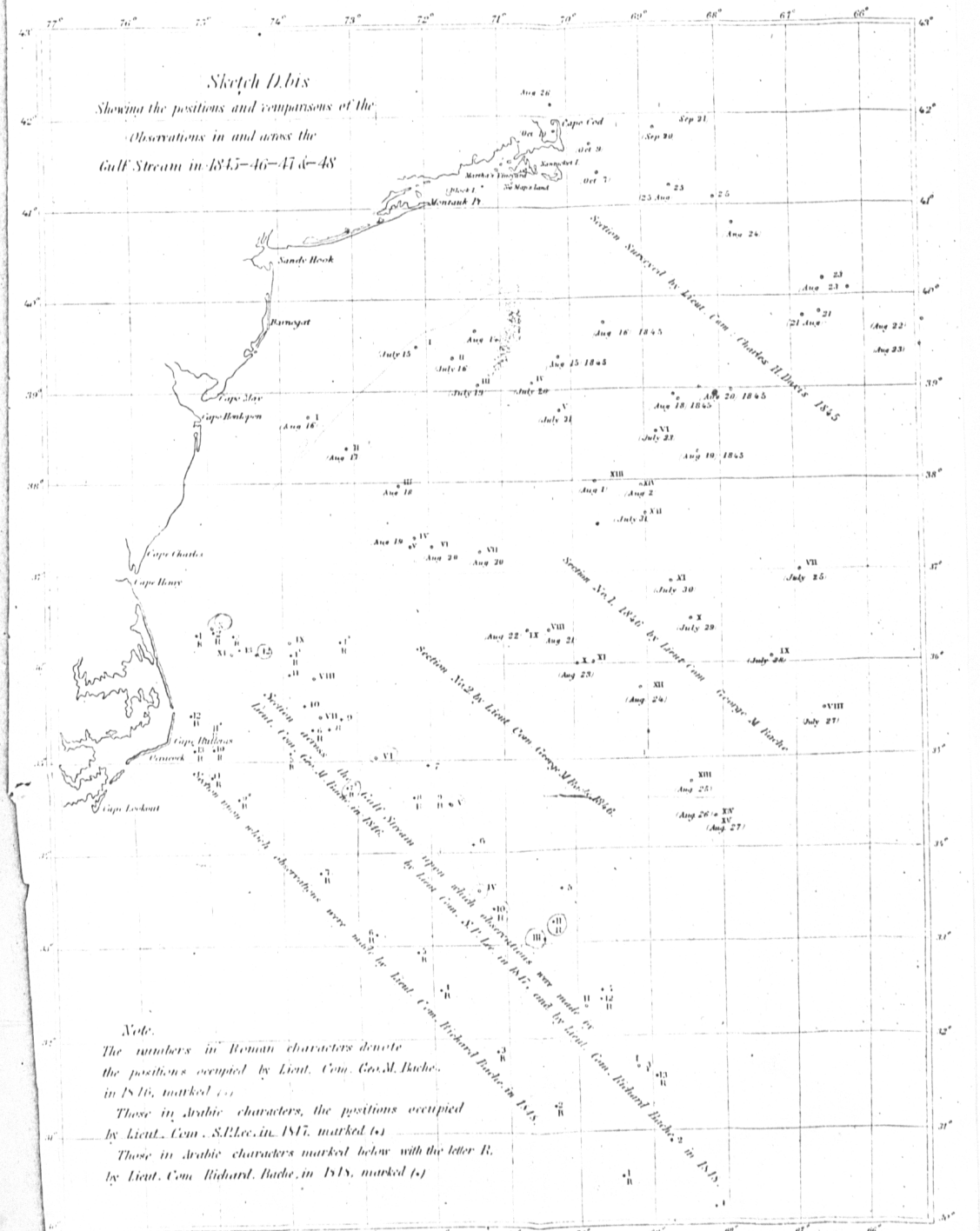
Scale $\frac{1}{200000}$

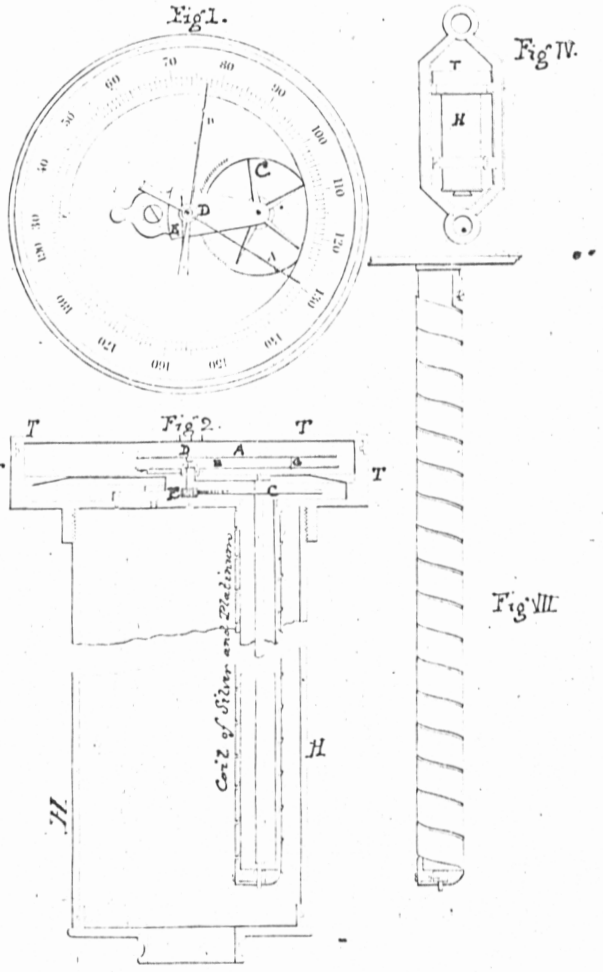
Statute Miles




SKETCH C.
Showing the progress of Section No 3.
U.S. Coast Survey
in the years 1844. 45. 46. 47. & 1848.
Statute Miles
MARYLAND
DELAWARE
POTOMAC R.
No 2
No 3
No 4
No 5
No 7
No 10
No 14
No 15
No 16
No 17
No 18
No 19
No 20
No 21
No 22
No 30
No 31
No 32


Sketch D
Showing the progress of Section N° 4
U.S. Coast Survey
in 1846 47 & 48.
Scale 600,000
T Signifies Tidal Station.
A Signifies Astronomical Station.
M do Magnetic do.
Signifies Lines between main occupied stations.
& unoccupied stations.
Secondary occupied stations.
and unoccupied stations.
unoccupied stations.
Planetable sheet.
Statute Miles.
Signifies Hydrographic sheet.


Sketch D.bis
Showing the positions and comparisons of the
Observations in and across the
Gulf Stream in 1845-46-47 & 48
Cape Cod
Martha's Vineyard
Nantucket I
No Mans Land
Block I
Montauk Pt
Sandy Hook
Barnegat
Cape May
Cape Henlopen
Cape Charles
Cape Henry
Cape Hatteras
Ocracock
Cape Lookout
Section Surveyed by Lieut. Com. Charles H. Davis 1845
Section No 1. 1846. by Lieut. Com. George M. Bache.
Section No 2 by Lieut. Com. George M. Bache 1846.
Section across the Gulf Stream in 1846. Lieut. Com. Geo. M. Bache.
Section across the Gulf Stream upon which observations were made by Lieut. Com. A.D. Lee in 1847. and by Lieut. Com. Richard Bache in 1848.
Section across which observations were made by Lieut. Com. Richard Bache in 1848.
Note.
The numbers in Roman characters denote the positions occupied by Lieut. Com. Geo. M. Bache in 1846. marked (a)
Those in Arabic characters, the positions occupied by Lieut. Com. S.P. Lee in 1847. marked (a)
Those in Arabic characters marked below with the letter B. by Lieut. Com. Richard. Bache in 1848. marked (a)



Sketch D no.

Diagram N.º 4

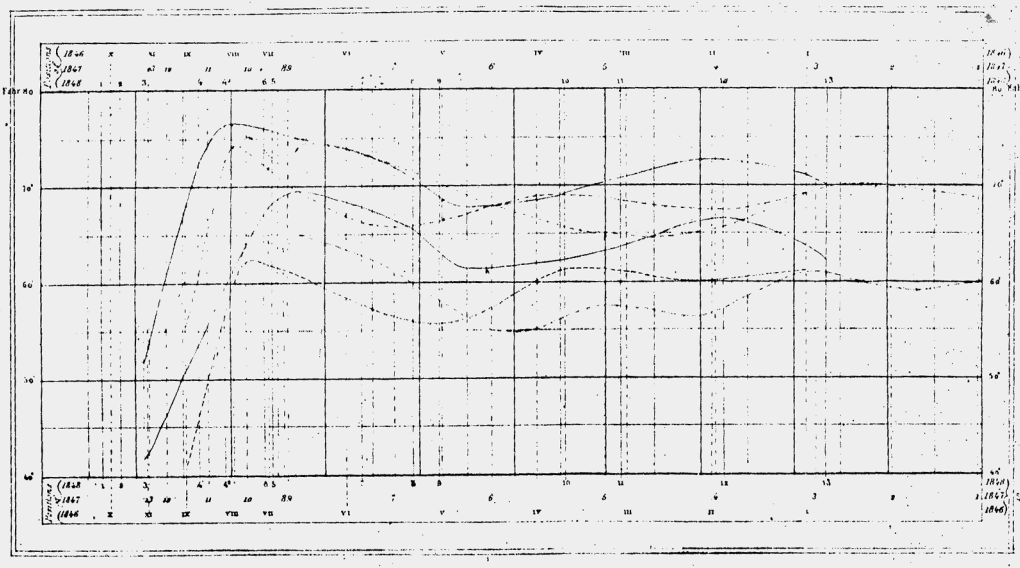
SAXTON'S METALLIC THERMOMETER.

For Deep Sea Temperatures

Sketch Dias

Diagram N°1.

Mean Curves, shewing the temperatures at the same depth in different positions, from observations, from twenty to one hundred & twenty, & from one hundred & twenty to four hundred and eighty fathoms, in Section III. of the Gulf Stream.



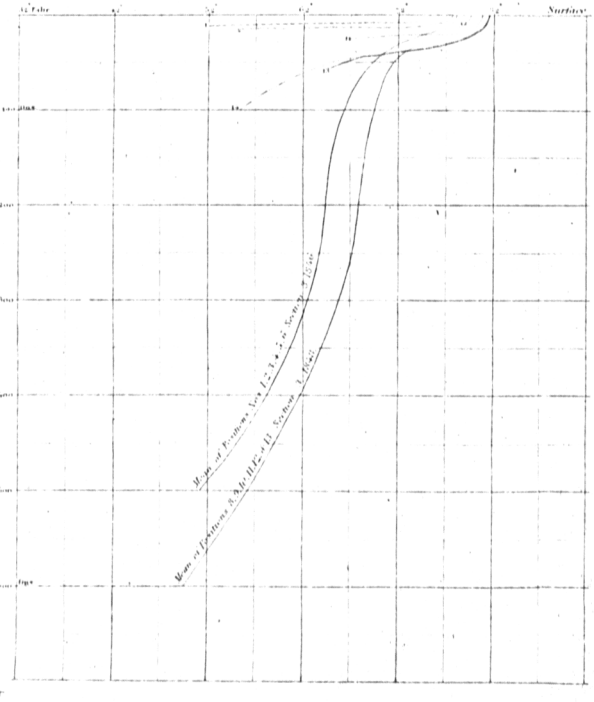
Observations by Lieut. Com. George M. Bache. 1846 ——— —— ———
" " Lieut. Com. S.P. Lee 1847 ——— · ——— · ———
" " Lieut. Com. Richard Bache 1848 ———————

Sketch D'tris

DIAGRAM No. 2

Showing the Mean curves of Temperature at different depths in the Ocean in 1846 and 1848, also the Comparison of the curves on soundings in Sections III and IV of the Gulf-Stream in 1848.

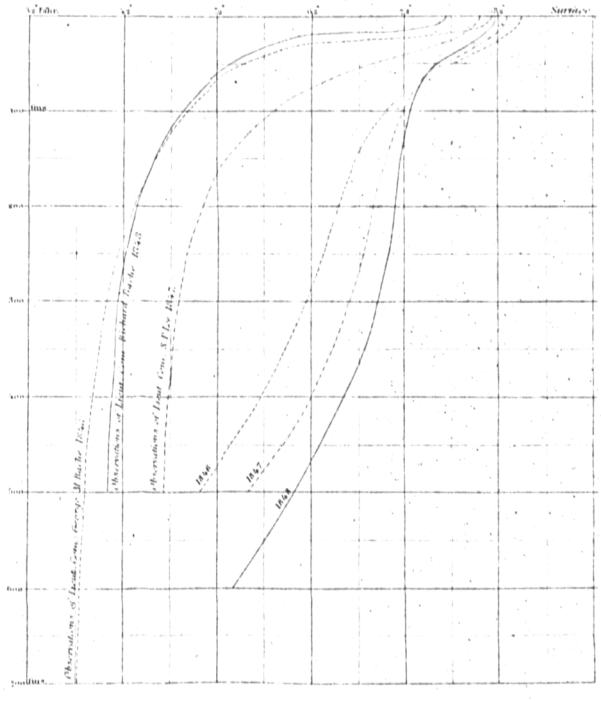
Observations of 1848
Curves of Temperature on Soundings made thus.
Section III. Position 1 ——— *Section IV. Position 11* — — — —
do do 2 ——— *do do 12* — — — —
do do 13 — — — —
do do 14 — — — —



Sketch D'tris

DIAGRAM No 3.

Comparison of the Curves showing the change of Temperature with Depth, in the Cold Water between the Gulf Stream and the shore, and in the Warm Water of the Gulf Stream, in Section III. in the years 1846-47 & 48.



Sketch E

Showing the progress of Section N^o 5

U.S. Coast Survey

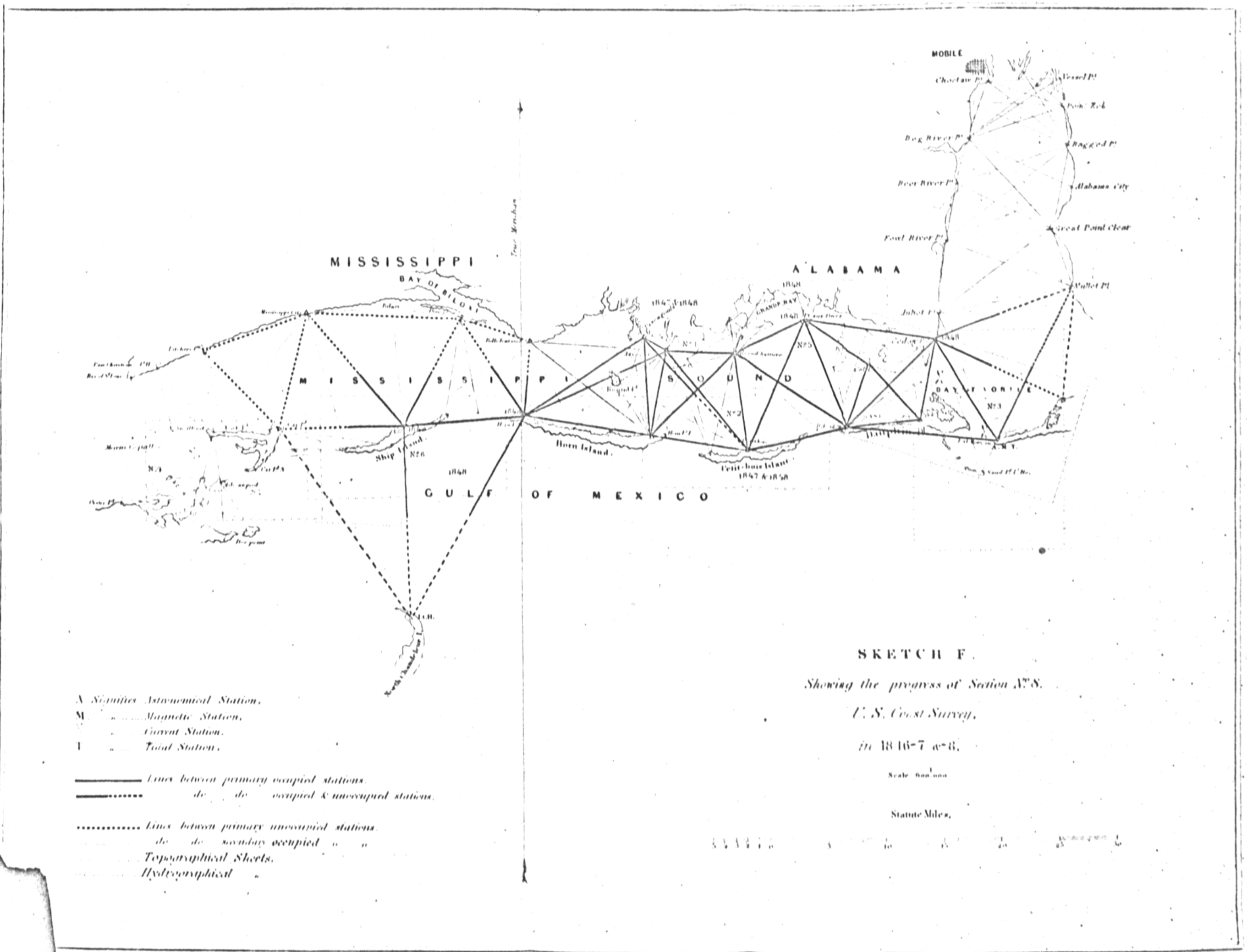
1857-58

Scale 1/80,000

Statute Miles

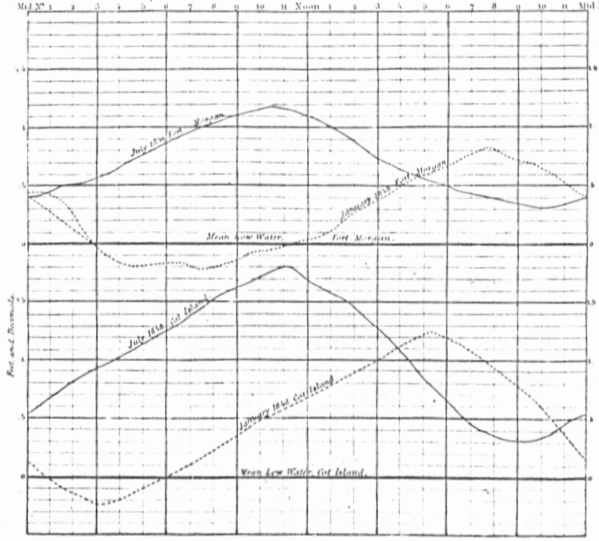
Signifies Lines opened.

do do unopened.


MOBILE
Choctaw Pt.
Dog River Pt.
Deer River Pt.
Fowl River Pt.
Ragged Pt.
Alabama City
Great Point Clear
MISSISSIPPI
BAY OF BILOXI
ALABAMA
GRANDE BAY
MISSISSIPPI SOUND
BAY OF PORTLE
Ship Island
Horn Island
Petit bois Island
1847 & 1848
1848
No.1
No.2
No.3
No.5
No.6
GULF OF MEXICO
SKETCH F.
Showing the progress of Section No. 8.
U. S. Coast Survey,
in 1846-7 & 8.
Statute Miles.
A Signifies Astronomical Station.
M ... Magnetic Station.
Current Station.
T ... Tidal Station.
Lines between primary occupied stations.
do do occupied & unoccupied stations.
Lines between primary unoccupied stations.
do do secondary occupied
Topographical Sheets.
Hydrographical

SKETCH F. bis.

Mean Daily Tidal curves from observations made in July 1851 and January 1852 at Fort Morgan, Mobile Pt. Ala. And in January 1858, and June 1858, at Ost Island, West end of Must Sound.



SKETCH G

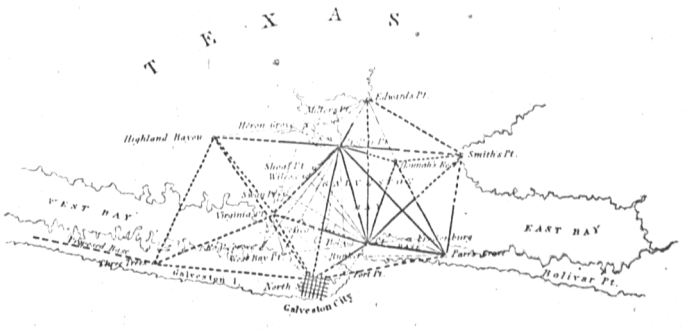
Showing the progress in Section No 9

U.S. Coast Survey

in 1848

Scale of Miles

Statute Miles



A *Signifies Astronomical Station.*

M " *Magnetic do.*

——— *Lines between main occupied Stations.*

——— *do. do. do. do. & unoccupied Stations.*

——— *do. do. secondary occupied Stations.*

- - - - - *do. do. do. do. & unoccupied Stations.*

- - - - - *do between secondary unoccupied do.*

APPENDIX No. 4.

RECAPITULATION OF RESULTS

FOR

PERSONAL EQUATIONS,

1844 to 1848,

IN THE ORDER OF DATES.

APPENDIX No. 4.

Recapitulation of results for personal equations, 1844 to 1848, in the order of dates. Extract of report of S. C. Walker.

No.	Date.	Persons.	Initials.	$d\omega$.	Wires.	Probable errors.			
						By equator intervals of time.	By final results.	For 100 wires interval.	For 1 wire noting.
								s.	s.
1	1844. October 17.....	Hartnup.....J. Bond.....	H—B3.	+0.217	42	.....	±0.065	±0.042	±0.297
2	1846. September 9.....	Keith .....Almy.....	K1—A.	—0.338	63	±0.004	.....	.003	.021
3	1846. October 21.....	Walker.....Keith.....	W—K1.	—0.091	35	.020	.....	.012	.085
4	1846. October 22.....	Almy .....Gilliss	A—G.	+0.271	14	.059	.....	.022	.156
5	1847. July 17.....	Walker.....Kendall.....	W—K.	—0.392	28	.011	.....	.006	.042
6	1847. July 19.....	.....	....do....	—0.423	21	.001	.....	.001	.007
7	1847. August 2.....	Walker.....Reynolds.....	W—R.	—0.188	28	.014	.....	.007	.050
8	1847. August.....	.....	....do....	+0.175	72	.....	.090	.077	.057
9	1847. August 7.....	Walker.....Kendall.....	W—K.	—0.248	56	.017	.....	.013	.091

10	1847. August 9.....	.....do.....Reynolds.....	W—R.	—0.112	42	.036	.....	.023	.163
11	1848. July and August..	Keith .....Beecher.....	K¹—B.	—0.350	140	.....	.017	.020	.141
12	1847. August 10 and 11.	Kendall.....Mason.....	K—M.	+0.170	42	.....	.070	.045	.318
13	1847. July 23 and 28....	Reynolds.....do.....	R—M.	—0.012	56	.....	.060	.045	.318
14	1847. August 10 and 11 .	Walker.....Loomis.....	W—L.	+0.082	35	.....	.062	.037	.261
15	1847. August 11.....	Loomis.....Keith.....	L—K¹,	+0.276	30	.....	.062	.034	.240
16	1847. October 16.....	Kendall .....Reynolds	K—R.	+0.112	77	.001	.....	.001	.007
17	1847. October 25.....	.....	....do....	+0.189	84	.018	.....	.016	.113
18	1847. December 4.....	Walker .....W. C. Bond ..	W—B1.	—0.085	96	.....	.044	.043	.304
19	1847. December 11.....	..do.....Kendall.....	W—K.	+0.018	119	.044	.....	.048	.239
20	1847. December.....	Reith .....Hubbard.....	K¹—H1.	+0.015	28	.032	.....	.017	.120
21	1848.	.....	....do....	—0.156	70	.048	.....	.040	.282
22	1848. January 10.....	Keith .....Fauntleroy	K¹—F.	—0.162	28	.020	.....	.011	.078
23	1848.	..do.....Boutelle	K1—B4	—0.172	28	.034	.....	.018	.127
24	1848.	Boutelle.....Fauntleroy.....	B4—F.	+0.228	42	.159	.....	.038	.268
25	1848. March 27.....	..do.....Major.....	B4—M1.	—0.365	42	.....	.055	.036	.254
26	1848. June 13.....	Walker.....Kendall.....	W—K.	—0.281	112	.021	.....	.022	.155
27	1848. June 30	..do.....W. C. Bond...	W—B1.	+0.021	56	.026	.....	015	.105
28	1848. July 3.....	.....	....do....	+0.092	28	.079	.....	.042	.296
29	1848.	W. C. Bond..Boutelle.....	B1—B4.	—0.007	28	.048	.....	.025	.176
30	1848.	G. P. Bond...W. C. Bond...	B_2—B_1.	—0.429	28	.033	.....	.017	.120

APPENDIX No. 4—Continued.

No.	Date.	Persons.	Initials.	$d\omega$.	Wires.	Probable errors.			
						By equator intervals of time.	By final results.	For 100 wires interval.	For 1 wire noting.
								s.	s.
31	1848.	Walker.....W. C. Bond...	W—B1.	+0.145	28	±0.018	.....	±0.010	±0.071
32	1848. July 24.....	..do.....do.....	W—B1.	—0.153	56	.083	.....	.002	.014
33	1848. July 26.....	..do.....G. P. Bond....	W—B2.	+0.129	112	.....	±0.019	.020	.127
34	1848. August 3.....	..do.....Loomis.....	W—L.	—0.064	18	.....	.060	.025	.176
35	1848. August 5.....	..do.....do.....	....do....	—0.090	49	.046	.....	.032	.226
36	1848. August 7.....	..do.....do.....	....do....	—0.083	84	.026	.....	.024	.169
37	1848. August 8.....	..do.....do.....	....do....	+0.045	46	.009	.....	.006	.042
38	1848. August 11.....	..do.....W. C. Bond...	W—B1.	—0.105	112	.007	.....	.008	.057
39	1848. August 16.....	W. C. Bond..Loomis.....	B1—L.	+0.060	80	.....	.035	.031	.219
40	1848.	..do.....do.....	....do....	+0.015	80	.....	.028	.025	.176
41	1848.	G. P. Bond.....do.....	B2—L.	—0.307	76	.....	.022	.020	.141

42	1848.	W. C. Bond....do.....	B_1—L.	—0.145	80	.....	.071	.064	.452
43	1848. August 17.....	.....do.....	....do....	+0.030	80	.....	.027	.024	.169
44	1848.	G P. Bond.....do.....	B_2—L.	—0.285	80	.....	.024	.021	.148
45	1848.	..do.....W. C. Bond...	B_2—B_1.	—0.240	80	.....	.036	.032	.226
46	1848. August 22.....	.....do.....	....do....	—0.325	80	.....	.025	.022	.155
47	1848.	..do.....do.....	....do....	—0.315	80	.....	.030	.027	.190
				47)8.243	2,801	27).621	20).902	47)1.169	47)7.649
		Mean of results.....	.....	±0.1753	.....	0.0231	0.0451	0.0249	0.1628

APPENDIX No. 4.—Continued.

Recapitulation of results for personal equations, 1844 to 1848, in the order of persons.

No.	Date.	Persons.	$d\omega$.	Wires.
			s.	
1	1844. October 17.....	Hartnup .....J Bond.....	+ 0.217	42
2	1846. September 9.....	Keith.....Almy	— 0.356	63
3	1846. October 21.....	Walker.....Keith.....	— 0.091	35
4	1846. October 22.....	Almy.....Gilliss	+ 0.271	14
5	1847. July 17	Walker.....Kendall	— 0.392	23
6	1847. July 19	..do.....do.....	— 0.423	21
9	1847. August 7	..do.....do.....	— 0.248	56
19	1847. December 11.....	..do.....do.....	+ 0.018	119
	1847.....	Mean result	— 0.141	224
26	1848. June 13.....	Walker.....Kendall.....	— 0.281	112
7	1847. August 2	..do.....Reynolds.....	— 0.188	28
8	1847.....	..do.....do.....	+ 0.175	72
10	1847. August 9	..do.....do.....	— 0.112	42
	1847.....	Mean result	+ 0.019	142
11	1847. July and August..	Keith .....Beecher.	— 0.350	140
12	1847. August 10 and 11.	Kendall .....Mason	+ 0.170	42
13	1847. July 23 and 28....	Reynolds .....do.....	— 0.042	56
14	1847. August 10 and 11.	Walker.....Loomis.....	+ 0.082	35
34	1848. August 3	..do.....do.....	— 0.064	18
35	1848. August 5	..do.....do.....	— 0.090	49
36	1848. August 7	..do.....do.....	— 0.083	84
37	1848. August 8	..do.....do.....	+ 0.015	46
	1848.....	Mean result	— 0.053	197
15	1847. August 11	Loomis .....Keith	+ 0.276	30
16	1847. October 16.....	Kendall .....Reynolds.....	+ 0.112	77
17	1847. October 25.....	..do.....do.....	+ 0.189	84
	1847.....	Mean result.....	+ 0.152	161
18	1847. December 4.....	Walker.....W. C. Bond....	— 0.085	96
27	1848. June 30.....	..do.....do.....	+ 0.021	56
28	1848. July 3.....	..do.....do.....	+ 0.092	28
32	1848. July 24.....	..do.....do.....	— 0.153	56
38	1848. August 11.....	..do.....do.....	— 0.115	112
	1848.....	Mean result.....	— 0.053	252
20	1847. December	Keith .....Hubbard.....	+ 0.015	28
21	1847. December	..do.....do.....	— 0.056	70
	1847.....	Mean result.....	— 0.116	98

APENDIX No. 4.—*Recapitulation*, &c.—Continued.

No.	Date.	Persons.		$d\omega$.	Wires.
				s.	
22	1848. January 10.....	Keith.....	Fauntleroy	+ 0.062	28
23	1848. January 10.....	..do.....	Boutelle.....	— 0.172	28
24	1848. January 10.....	Boutelle.....	Fauntleroy	+ 0.228	42
25	1848. March 27	..do.....	Major	— 0.365	42
29	1848. July 3.....	W. C. Bond.....	Boutelle	— 0.007	28
30	1848. July 3.....	G. P. Bond.....	W. C. Bond....	— 0.429	28
45	1848. August 17	....do.....	....do.....	— 0.240	80
46	1848. August 22	....do.....	....do.....	— 0.325	80
47	1848. August	....do.....	....do.....	— 0.315	80
	1848.....	Mean result.....		— 0.308	268
31	1848. July 3	Walker.....	G. P. Bond	+ 0.145	28
33	1848. July 26.....	..do.....	....do.....	+ 0.129	112
	1848.....	Mean result.....		+ 0.132	140

APPENDIX No. 5.

Report of Lieutenant commanding Charles H. Davis, U. S. N., assistant in the coast survey, on the expediency of a light on Sankaty head, Nantucket.

OFFICE OF THE COAST SURVEY,
Washington, December 21, 1847.

SIR: My frequent navigation among the South Shoals of Nantucket, on the survey of which I have been employed during a part of the two last seasons, has enabled me to perceive that a light of suitable dimensions and power upon Sankaty head, near the point of triangulation of the coast survey, would be generally as well as locally useful.

The labors of the survey in this region have already resulted in the discovery of several unsuspected dangers, too important to be hereafter neglected. Other dangers probably remain to be found out.

But the coast survey is about to confer another advantage equally as great, by the publication of its chart of the Nantucket shoals. Channels, known only to fishermen and local pilots, are to be rendered practicable to all navigators. Full and distinct information concerning the force and direction of the tides, (without which, it is felt, that there is no security,) is to be communicated. Instructions for the government of vessels unintentionally involved among the shoals are to be given, and sailing directions are to be prepared for the principal passages, by means of which the present routes will be shortened, and this unknown part of our shores, that has hitherto been regarded with dread, will be habitually traversed with safety and advantage, especially by the southern and New England coasters and the West India traders.

In short, the benefit conferred by the coast survey chart of the Nantucket shoals, when completed, will be such as is desired from all its publications, that of making the unknown known, and the known familiar in those places which it examines. It is my opinion, however, that the benefit cannot be fully reaped in this instance, unless a light-house, of the first class in size and in apparatus, be erected on some part of the south coast of the island of Nantucket, and here I give the preference to the southeast bluff, known as Sankaty head.

The most important channel, by which to pass from the northward of the old South shoal into the deep water, along the eastward of Nantucket, is bounded by the eastern extremity of the shoal called the "Old Man" on one side, and by the southwestern point of the "Bass Rip" on the other side. A line north by west and south by east, (magnetic,) from Sankaty head, lies over the deep water of the channel, in which the tides run at times with great violence. The bearing of Sankaty head is therefore the true (and I will add the only) guide, and the land is, at a proper distance to make a divergence from that bearing, caused by the currents, sufficiently sensible by the compass. This channel can now be resorted to when

Sankaty head is visible, that is, in the day time; a light on that point would make it practicable at night.

It is probable that coasting vessels bound from New England ports to those farther south, will profit by the coast survey chart to make more frequent use of the excellent channel around Siasconsett, and by the south side of the island between the shore and the "Old Man," which cuts off a considerable distance, keeps a vessel a shorter time in the violent eddies and tide rips of the shoals, and offers the great convenience of a smooth sea under a weather shore in the stormy season, of a snug anchorage under Nantucket or Squipnocket, and of a chance to enter the sound either by the Muskeget channel, (to be hereafter surveyed,) or by the way of Gay head, whilst the route to the southward of the shoals carries a vessel directly to sea, and exposes her to the delay caused by getting into the influence of the Gulf stream.

To the use of this channel in coming from the north there is opposed the hazard of passing a shoal of limited extent, but badly situated, off the town of Siasconsett, called "Pochic Rip." A light on Sankaty head would remove this hazard. In coming from the westward, the only difficulty consists in doubling the western extremity of the "Old Man."

The bearing of the same light will show when it is prudent to steer an east course.

The preceding considerations regard the *local* utility of this light chiefly; that is, its utility for those channels near the island. They might be extended; but, as the further enumeration of such details would be neither interesting nor necessary, I will pass to the notice of some of the general purposes of navigation, which the erection of the Sankaty light would serve, and which requires, as a condition of its usefulness, that it be a light of a superior order. Sea going vessels coming north from the Atlantic, and bound into Nantucket sound or Boston bay, and farther north, depend solely upon their determination of the longitude (so far as the reckoning is concerned) for striking fairly into either of the great channels which form the highways of this commerce. The approach to those channels (which are themselves interrupted by shoals as dangerous as any *single* shoal on our coast) is restricted on the west side by the south shoals and ridges of Nantucket.

The range, after the channels are entered, and when passing out of them, is limited, first, by the ten fathoms bank, 60 miles to the eastward of Nantucket, discovered by the coast survey brig Washington, in 1845, and afterwards by Clark's bank, verified by the same vessel, and by George's bank, both of which are regarded as unapproachable in bad weather.

But the determination of the longitude, on which the safe navigation depends here, is, under favorable circumstances, subject to considerable error; and it is, under ordinary circumstances, an anxious and insecure reliance.

The proposed light-house on Sankaty head will supply the certainty that is needed. It would be seen a sufficient distance to point the way into the channel to the eastward of "Bass Rip."

A vessel doubtful of her position would run for it, and, being guided by its bearing, would keep it in sight until another light was discovered, or a safe departure taken for a distant port; and thus the Sankaty light, seen in every direction from northeast to southwest, 30 or 40, or even 50 miles in advance of any other port on that part (the most dangerous, and, in some respects, hitherto the least known) of our coast, would, with the help of the hydrographical details contained in the coast survey charts, prevent many of those alarming accidents continually occurring, one of which (that of the packet ship Louis Philippe) is recorded in the public prints at the moment of my writing this report.

I must mention a single fact in confirmation of the preceding remarks, and that is, that it is no uncommon thing for the West India traders to run for the old South shoal on their return home, in order to take a fresh departure for the north. This shows the great want of a light on Nantucket. But the recent discovery of the new South shoal, and the neighboring ridges, by the coast survey, also shows that this practice of the West India traders has been attended with imminent peril. Many of those that have never been heard from have, no doubt, met their fate on these unknown shoals.

But this light is also to provide an additional security to the great fleet of European traders and packet ships, whose course, both going and returning, carries them near these outer shoals. Such a light as I propose will be visible in clear nights beyond the new south shoal.

Vessels in this line of commerce are obliged to sail as near the shoals as possible to save distance. The consequence is, that they are liable to be involved among them by the unforeseen effects of currents, and by slight and unavoidable errors in reckoning.

The cases are, to my own knowledge, numerous; but it is only where there is actual loss, or such alarm that a demand is made for a Nantucket pilot, that they attract public attention. The depths are so variable on this ground, that no degree of minuteness in the chart would render the lead alone a sufficient monitor. Fixed objects are required; one of these—and it will prove a useful one, though not always decided—is the character of the bottom; the other is the Sankaty light.

The last benefit to be conferred by this light, to which I will call your attention, is the great convenience it will afford to navigators outward-bound, by supplying them with a very late departure, and a means of correcting their reckoning after an interval of one or two days from port. I should not insist on this as a matter of great moment, if it were not that the interval will be spent among strong currents and tide-rips, such as disturb the most accurate calculations. The new departure will be taken not long before escaping from their influences altogether, and will, I think, prove an incidental advantage entitled to some weight.

Finally, I will observe, that though the especial uses of a light-house constitute the only satisfactory argument for an appropria-

tion, yet there are always occasional and incidental uses, not easily taken into account, that appear after it is erected. This is well known and deeply felt by the anxious mariner. It could not be made intelligible to others.

But one hour of apprehension in this region of violent currents, of noisy shoals, of fickle and boisterous weather, and of swelling seas, with the knowledge that something in sight upon the land that is not far distant but too low for vision, would convert that apprehension into security, would be an argument which none who experienced it would be disposed to contest in favor of the proposed light-house.

Very respectfully, your obedient servant,

CHARLES HENRY DAVIS,
Lieutenant Commanding, U. S. Navy,
Assistant Coast Survey.

A. D. BACHE, LL. D.,
Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 6.

Report of Lieutenant Commanding Charles H. Davis, United States navy, assistant in the coast survey, to the superintendent, on buoys, beacons, landmarks, &c.

OFFICE OF THE COAST SURVEY,
Washington, December 21, 1847.

SIR: I have received your circular of the 16th instant, in relation to buoys, beacons, or other marks or lights required on that portion of the coast embraced in the last season's work of the party under my command, and I have to report—

1. That I send you herewith a separate statement, showing the importance of erecting a Fresnel light, of the first class, upon Sankaty head, Nantucket, near the point of triangulation of the coast survey.

2. No buoys are recommended in this vicinity, on account of the extreme violence of the tides, and the exposure to the ocean storms and sea. They would be very useful on several points of dangerous shoals, if they could be kept in their places; but, for the reasons mentioned above, this is doubtful, and at any rate would be attended with considerable expense. The money would be more judiciously appropriated to the light on Sankaty head.

3. But I must improve this and every other opportunity to represent the very great benefit to life and property which would result from placing a screw-pile beacon upon the outer or new South shoal, and must commend this subject, as one of high value, to your consideration and to the investigation of engineers.

Concerning Boston harbor, I have to report—

1. That I send you a letter herewith, in which I recommend that a more permanent (though not expensive) mark be put up on Long Island in the place of a temporary scaffold now standing there and serving as part of a range, leading safe through one of the most difficult reaches of the main ship channel.

I am inclined to believe that this subject would receive the attention of the chamber of commerce at Boston, if presented to them. I mentioned it, before leaving the city, to their late president, Mr. R. B. Forbes.

But if you think it had better be submitted to the bureau to which such matters officially pertain, it will be safe to say that such a beacon as will answer the purpose and will stand for fifty years, with occasional repairs of paint, &c., can be constructed for about $600.

2. Buoys, in addition to those already down, are recommended for the following places in Boston harbor, (2:) On two rocks in Nantasket roads, one of which is the extremity of the ledge projecting from the southern and eastern point of Rainsford island. This rock is only exposed in the lowest course of tides, and a channel way leads around it. The other of these rocks is near the Rainsford island shoal, and the more dangerous on this very account. The buoy *on* the shoal marks a wrong limit of danger, and is the cause why this rock is sometimes struck.

3. There is a rock similarly situated with regard to the Lower Middle, in the channel, on which vessels occasionally strike, which should be buoyed.

4. A buoy is needed on the ledge at the entrance of the Blackrock channel. There is a passage on each side. Vessels are constantly carried on this ledge by tide. A buoy on it would give sufficient warning to prevent this, either by dropping anchor, or by choosing one or the other of the passages.

5. A buoy should be placed on a rock to the southward and eastward of George's island, at the entrance to Nantasket roads. The situation of this rock is in the fair channel way. It has between eleven and thirteen feet of water on it at low water. A little rise of tide, therefore, covers it sufficiently for the safe passage of vessels of ordinary draught; but as on this account it attracts but little attention, it is the more dangerous for vessels of large draught.

3. These buoys are all that I have to recommend at present in Boston harbor, but I shall call your particular attention hereafter to the utility of some additional buoys or other marks in Broad Sound channel necessary to render this very important passage available at all times. It will be best to defer this part of my report until the hydrographic sheet is completed.

Concerning Hyannis harbor, I have to report that two buoys are wanted there—one on a small ledge near Collins's ledge; the other on a rock a short distance south by east from Point Gammon. Neither of these rocks are generally known, and both require to be *named* as well as marked. There is a passage for coasters

inside the rock near Point Gammon, and the ledge is in the channel of approach to the harbor.

Yours, respecfully,

CHARLES HENRY DAVIS.

A. D. BACHE, LL. D.,
Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 7.

Extracts from a report to Lieutenant Commanding Charles H. Davis, U. S. N., assistant U. S. coast survey, by Daniel Ammen, acting master of the surveying steamer Bibb, forwarded to the superintendent of the coast survey.

ROCKPORT, MASS., *August* 18, 1848.

The following information is mostly from the fishermen with whom I have conversed. The character of the bottom on "Cashe's ledge," is from actual observed soundings by me. We were not able to assign the bottom very well to any particular part of the ledge, but found sand, white and black gravel, and dark pebbles, generally in depths of 50 to 60 fathoms; mud, in deeper water, and rocks, either rugged or smooth, generally in shoaler water. The shoalest sounding taken by us was 27 fathoms, rough rocks.

"Cashe's ledge" is said to extend about ten leagues, nearly north and south, by compass; the ends for five or six miles are represented as deep and broken ground. Throughout its whole length its soundings are irregular, and the bottom varies, being in the "gullies" or "sloughs," between the ledges, blackish mud, and at other places sand, black and white gravel, dark pebbles, and rough and smooth rocks.

The shoalest water on the northern part is 23 fathoms, very uneven rocks, with 60 fathoms close around it. The soundings between this and the middle ground are from 70 to 40 fathoms, for about six miles, where there is said to be 18, and a very small spot of eleven fathoms, very rocky. The soundings to about three miles southerly of this vary from 40 to 50 fathoms, with the same variety of bottom to the vicinity of the main shoal, which is believed to be about in the middle of the ledge, north and south, and on its eastern edge. This main shoal is *nine* miles from the first shoal ground mentioned, and *three* from the one of 11 fathoms.

The main shoal is small; approaching it from WNW. nine fathoms is found at half a mile; then 12 or 13, and then decreasing to four fathoms.

It is said that, to the north, there are 17 fathoms within one hundred feet of the main shoal; that towards the east, from the shoal, the soundings increase gradually, and at about a mile are forty fathoms; that two miles to the southeast there is 90 fathoms; that towards the south they deepen gradually, with 40 fathoms at a dis-

tance of about three miles, and that at about two miles to the southwest there are soundings of 70 or 75 fathoms, black mud.

The shoal part, under ten fathoms, is thought to have an area of near an acre, which is covered with kelp. The soundings on top of the shoal are reported to be irregular, varying from eight to four fathoms; and a reliable person said he had put a boat-hook on a rock in 19½ feet water. All this part is believed to be rocky. To the southward of the main shoal the soundings are as variable as to the north, with the same character of bottom. The ledge extends about 15 miles to the southward of the main shoal, having one spot on it of less than 30 fathoms. It is said to end in hard broken ground, varying from 70 to 90 fathoms. The average width of the ledge is represented to be about two miles. There being deep "sloughs" or "gullies" cutting it, having about the same depths and character of the bottom as around the ledge, makes it difficult, and sometimes impossible, to tell whether a vessel is over a "slough" or east or west of the ledge. When nearly calm, and drifting with the tide, hauling up a lead-line with us and heaving it at once, changed the soundings from 27 to 34 fathoms.

Jeffrey's ledge my informants did not appear to be very well acquainted with. They said it had a common depth of 30 fathoms, generally sand and shelly bottom, with a lump of rocks of small extent on the southern part, having 16 fathoms water on it.

Tippany's bank.—The middle of this bank lies in a line between Cape Ann and the shoalest part of "Cashe's," or about east by compass. It is about 15 miles inside of "Cashe's," trends northwest and southeast by compass, and is about 5 or 6 miles in length and about 4 miles broad. The southern part is clay and rocks, and tolerably regular, at 40 fathoms, but having two shoal spots of rock, one having 15 and the other 18 fathoms on it. The more northern part is less regular, and has soundings of gravel, sand and shells. This shoal lies in water not varying much from 100 fathoms.

DANL. AMMEN,
Acting master, "Bibb."

APPENDIX No. 8.

Report of Lieutenant Commanding C. H. Davis, United States navy, assistant in the coast survey, to the superintendent, relating to the necessity for a land mark on Long island, Boston harbor.

OFFICE OF THE COAST SURVEY,
Washington, December 21, 1847.

SIR: There is a scaffold, a temporary and insecure structure, standing on Long island, Boston harbor, which makes a range with the northeast part of Spectacle island, such, that a vessel observing it strictly in sailing from President roads to abreast of Bird island buoy, is carried safely by the lower middle, Castle island

rocks, Governor's island point, the upper middle, and in the best water over the shoal ground above the upper middle; and this reach is regarded as one of the difficult parts of the main ship channel. The scaffold was erected by the pilots in the place of a barn which had answered the same purpose before being burned, and this proves the value of the range.

The object of this letter is to represent the importance of putting up in the place of the scaffold, liable at any moment to be overthrown, a suitable mark of wood, painted black, that will be secure against the violence of storms.

This can be done at a small expense. I have no doubt that in order to preserve this valuable range, some kind of beacon will always be kept there; but you will perceive the advantage of having one that is permanent, and easily described in the sailing directions, established before the chart of Boston harbor, now far advanced, is published.

This is a matter worthy of some serious consideration by the people of Boston.

The grounding of the British packet steamers, which has occurred twice, has brought a reproach on the harbor, that is readily taken up and repeated by the friends of a rival city. * * * * I am informed by my excellent and intelligent pilot, that on neither occasion would this accident have occurred if the barn, on which the range formerly depended, had been standing.

Commending this subject again to your earliest possible attention, I am, yours respectfully,

CHARLES HENRY DAVIS,
Lieut. Com'g. U. S. N., assist. coast survey.

A. D. BACHE, LL. D.,
Supt. U. S. coast survey, Washington.

APPENDIX No. 9.

Letter of Lieutenant Commanding Charles H. Davis, United States navy, assistant in the coast survey, to Professor A. D. Bache, superintendent, relating to an invention by Captain Owen, of the British navy, to be used on board of light-boats and at light-house stations during fogs, to give notice to approaching vessels.

WASHINGTON, *December* 21, 1847.

SIR: I desire to recommend to the notice and use of the government, through you, an invention of the honorable Captain Owen, designed to be employed on board of light-boats and at light-house stations, in the night and during fogs, to give warning to approaching vessels.

It consists of a brass trumpet-shaped tube, five or six feet long, having a bell mouth, two or three feet in diameter, the inner end of which is fitted to the muzzle of a musket, or carbine, loading

at the breach. The discharge of the musket produces the sound of a cannon.

On the northeastern parts of our coast, where, at certain seasons, fogs are frequent, dense, and of long continuance, this invention promises to be of great utility; much more effectual than the ringing of bells, the mode of warning practised in foggy weather, on board of light-boats.

If it were employed on certain light-house stations, it would prevent great losses of life and property every year.

At Boston, the want of a similar means of direction has been so often proved by the terrible loss of valuable vessels within a few hundred yards of their destined port, that the inconvenience and expense of firing a cannon has been sometimes incurred by the underwriters.

By the invention of Captain Owen, the noise of the cannon is produced with a small waste of powder, and the little trouble of loading a piece of small arms; whilst the facility of the method better insures the attention of the station keeper to his duty.

The trumpet could also be employed with convenience and advantage at sea.

Very respectfully, yours,

CHARLES HENRY DAVIS.

A. D. BACHE, LL. D.,
Supt. U. S. coast survey, Washington.

APPENDIX No. 10.

Letter of Prosper M. Wetmore, esq., secretary of the chamber of commerce of New York, to Professor A. D. Bache, superintendent of the coast survey, relating to the report of Lieutenant Commanding Charles H. Davis, U. S. N., assistant in the coast survey, on Hell Gate and the accompanying chart.

CHAMBER OF COMMERCE,
New York, March 9, 1848.

SIR: I am directed to tender to you the thanks of this chamber, for your kindness in transmitting to the select committee, appointed to report upon the expediency of improving the navigation of the East river, a chart of Hell Gate and its vicinity.

The thanks of the chamber are also tendered to Lieutenant Davis, for the able suggestions upon the subject before the committee, contained in his letter, transmitted through you.

I am, sir, very respectfully, your obedient servant,

PROSPER M. WETMORE,
Secretary.

Professor A. D. BACHE,
Superintendent U. S. coast survey, Washington.

Report of a committee of the chamber of commerce of New York, and resolutions adopted by the chamber in regard to the information derived from the coast survey chart of Hell Gate.

The committee appointed on the subject of applying to Congress for an appropriation to remove the obstructions to navigation at Hell Gate, in the East river, report: That, as they wanted all the facts before them, before reporting to the chamber, they applied to the superintendent of the U. S. coast survey, for a plan of the Gate and vicinity, who promptly directed an officer to re-examine the ground and furnish a plan, which has been done and is now before the chamber, with a report for its adoption.

The committee recommend the adoption of the following resolutions:

Resolved, That the plan of improvement of Hell Gate, as recommended by Lieutenant Charles H. Davis, of the U. S. coast survey, in the accompanying letter, is not only full and minute, but in the opinion of the chamber will materially diminish the dangers of the navigation of Hell Gate, and that it is due to the immense commerce on this route that immediate action should be taken to carry out this purpose.

Resolved, That this report be sent to the Committee of Naval Affairs of the House of Representatives, asking that the subject may be early acted on by the present Congress.

Resolved, That the thanks of the chamber be presented to Professor Bache, superintendent, and Lieutenant C. H. Davis, U. S. N., assistant U. S. coast survey, for the promptitude and intelligence with which they have carried out the wishes of this chamber.

APPENDIX No. 11.

Report of Lieutenant Commanding Charles H. Davis, United States navy, assistant in the coast survey, to the superintendent, on his examination of Hell Gate, near New York.

OFFICE OF THE COAST SURVEY,
Washington, February 15, 1848.

DEAR SIR: In compliance with your instructions, I have made an examination of the Hell Gate passage, for the purpose of verifying, as far as the season and short time will allow, the records of the office, and of inquiring into the best means of improving this important channel.

That it is very desirable to make such improvements as will lessen, or altogether remove, the hazard attending the ordinary navigation of Hell Gate, will not be disputed, when it is remembered that a very large proportion of the vast fleet of coasting vessels that go to New York and up the North river pass by this route; and that it is the hourly resort of steamboats crowded with passengers, and carrying the most precious freight.

Of the sailing vessels that enter the Hell Gate passage, it is es-

timated that one in fifty sustains more or less injury by being forced by the violence of the currents on the rocks or shoals; and the accident to the Oregon, which nearly proved fatal to her passengers, shows that even steamboats, with a motive power that keeps them under perfect control, and guided by most experienced pilots, are not secure from peril.

Such an improvement in the channels of Hell Gate as would render them navigable to vessels of all classes under common circumstances would supply to the commerce of New York a new outlet to the sea; one in a different direction from the harbor channels, and available when those were temporarily closed by adverse winds, or other causes; and would, therefore, be a permanent and valuable resource both for vessels outward bound and for those returning home.

But a still more serious consideration is that of the increased facilities for naval defence, which this improvement would afford. In the event of a rupture with a naval power, there can be no doubt that the attempt of the last war to ravage the shores of Long Island will be repeated. The means of resisting or preventing such hostilities must be drawn chiefly from New York; and if the Hell Gate passage be made secure, not only our largest men-of-war, but our steamboats of a superior class, which, on such an occasion, would be armed for the purpose of defence, would be at once enabled to hasten to the scene of danger.

The steamboats are now constantly passing through Hell Gate, but the difficulties of the passage to them would be seriously increased, if they were pressed down by a naval armament and equipped for action.

During the war with Great Britain, our frigates were blockaded in the harbor of New York, which could not have been the case if the Hell Gate passage had been open. Commodore Decatur ventured to carry his squadron through, but with such risk that the attempt with a frigate was only made once afterwards, notwithstanding the constantly recurring necessity. The removal, therefore, of the obstructions to the safe navigation of Hell Gate, is recommended by a regard to the future naval defence of the country.

The dangers in this channel arise from the great strength of the currents and the number and positions of the rocks and reefs. The strength of the current is such that sailing vessels can only stem its force or escape from it by a commanding breeze; but as the main course of the *flood* tide keeps the middle of the eastern channel, it is most secure for vessels which are coming from the westward with the tide, to place themselves in the middle of the stream and follow its direction. They are thus carried through safely. This plan, however, is inadmissible for any but small vessels on account of two rocks, the Pot and the Frying Pan, which lie in or very near the mid-channel, are in the way both going to the eastward and westward, and have but little water on them at low tide. There is also a reef called Way's reef, which lies in the course followed by the steamboats principally, when coming from the eastward against a strong flood. It is their custom to keep close round

Pot Cove and run up under Hallet's Point, by which they avoid the strength of the flood. In this part they find an eddy current in their favor.

But on the ebb the greatest danger arises from the divergence of the current at a point marked A. on the sketch, where the ebb tide branches off into three directions, to take the course of the three channels; the main south channel, the middle channel and the eastern channel.

The safe navigation depends here upon deciding sufficiently soon, at the point of separation, which channel shall be taken, and the neglect to do this, or a loss of control over the vessel for any reason, frequently results in being carried on the Gridiron.

When a vessel that has attempted the eastern channel finds herself carried toward the Gridiron, her only chance for safety is to run for the middle channel, which is narrow and made precarious by the middle reef, the outer rock of which is the Negro Head.

The Gridiron is, owing to the strong set of the tide on it, the most dangerous reef in the passage.

The reef known as the Bread and Cheese, on the eastern end of Blackwell's Island, is also very dangerous. Vessels are liable to go on it in the flood when it is covered, by getting into the eddy near it with a light wind. The chief danger is on the ebb, and from the same cause as that which makes the Gridiron dangerous: i. e., the strong set of the tide in that direction.

These, then, are the principal dangers, and I recommend the following measures be adopted for their removal and correction:

1. That Pot rock, the Frying pan, and Way's reef be blasted and scattered. The two former are single rocks of a pointed shape, the latter is long and has the character of a ledge, (the rocks having deep water round them could easily be removed,) and also that the middle reef be blasted so as to make a clear channel, of sufficient depth for common vessels and steamboats, between Flood and Little Mill rocks.

2. That piers be built upon the "Hog's back," "Gridiron," and the "Bread and Cheese," of stone, sufficiently high to show above the surface of the water at high tide at least four feet. That these piers be faced with wood, and be provided with the spring fenders used at the steamboat ferries, and that their forms should correspond to the natural shape of the reef, by which means vessels coming in contact with them would be guided into the channel ways.

To blow up and scatter the large mass of rock comprising the Gridiron, without destroying the middle channel, which has only twenty-two feet of water in it at that point, would hardly be possible. But if the Gridiron were removed, the rock out of water, that is Flood rock, would be equally or nearly as dangerous. The tide would set on that with the same violence and certainty.

The same objection will apply to an attempt to remove the "Bread and Cheese," and, with regard to this and the "Hog's back," the shoal water around them would make it necessary to repeat the blasting an indefinite number of times.

Something has been said of removing and scattering all the rocks in Hell Gate, those out of water as well as those under water. But it appears to me that this proposition is best answered by asking where the materials are to go? Unless carried off, they must obstruct the neighbouring channels, and the process of blasting would never be completed.

By the piers which I propose, the directions of the currents would be made more certain and confined, and where they pass over deep water, they may be safely trusted. Tides would rebound from the piers, and, in most instances, prevent vessels from striking against them. And, again, if vessels were carried on, they would be prevented from receiving any injury, by the spring-fenders, and would have an opportunity, by throwing a line around a pile, either to swing the vessel or to lay by, as might be most convenient.

There are several single rocks less important, and near the shore, which might be easily removed—one, for instance, off Negro Point, and one near the South ferry.

Until this passage is improved by the removal of the present serious impediments to its safe navigation, I recommend that the following buoys be placed:

One on "Way's reef." I have already mentioned that steamboats coming from the eastward on the flood, pass inside of Way's reef, where an eddy tide is found setting towards Hallet's Point. This eddy, produced by the whirls of the "pot," returns from the shore, and sets on to "Way's reef," where it is met by one of the *direct* whirls of the "pot." By this conflict of tides, two straight currents are produced, that run side by side over the reef, the outer one southerly, or flood; the inner one northerly, or counter to the direction of the main body of the tide.

One on "Hog's back." Vessels intending to take the main ship channel on the ebb, (which is the best way,) are in danger, if they give "Hog's back" too wide a berth, of going on Mill reef, or of being forced to run the middle channel, which is only safe to those who are very well acquainted with the ground. A buoy will enable a vessel to keep near "Hog's back," and avoid this danger.

One on "Rylander's reef." This reef is dangerously situated, on account of the deep water around it, and is not well known.

I will also recommend a small light on Great Mill rock, which would enable vessels to pass through Hell Gate at night. It would be the proper guide for hauling round Negro Point, coming from the eastward, and for hauling to the southward, coming from the westward, after passing Hallet's point.

* * * The character of the rocks in Hell Gate is such that they could easily be removed by blasting.

I have the honor to be, very respectfully, your obedient servant,

CHARLES HENRY DAVIS,

Lieut. Comd'g. U. S. Navy, Assistant Coast Survey.

A. D. Bache, LL. D.,

Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 12.

Report of Lieutenant Commanding David D. Porter, of the United States navy, assistant in the coast survey, on the dangers in Hell Gate, and the improvement of the passage.

U. S. SCHOONER PETREL,
New York, October 30, 1848.

SIR: * * * * * * * The chamber of commerce meets in a short time in this city for the purpose of taking measures relative to clearing away the obstructions of Hell Gate; and, at the request of the gentlemen who seem interested in the matter, I lay before you the information I have collected while sounding out the place.

It was my intention to have made you a full report on the subject, but a copy of the report of Lieutenant Charles H. Davis, of the United States navy, assistant in the coast survey, on Hell Gate, was sent to me, and I find it so full and correct in all its details that I could say but little more, without incurring the charge of plagiarism; in fact the opinions expressed by Lieutenant Davis coincide with those I had formed previous to reading his report, and it only remains for me to point out the dangers I have noticed while surveying here, and which have escaped his attention. I have also had a better opportunity of measuring the size and shape of the rocks than he had, and herewith give a description of them.

The first in order, and the principal obstruction to Hell Gate, is Pot rock, on which I found eight feet of water at the lowest tides; the average depth is, however, about ten feet; the lowest depth is only to be found in one place about six feet by six. It deepens to fourteen feet on the east and west sides, and suddenly to four fathoms on the north and south. The strata of this rock are vertical, running north and south—which is the case with every rock in the Gate—and this would render the task of blowing them up much easier than if horizontal. At half tides the depth of water does not increase on Pot rock, as there is a fall of four feet; and a vessel drawing over eight feet must strike upon it. A full rigged brig struck it three days since, and went down, with a valuable cargo on board. This obstruction once removed, Hell Gate would be less dangerous by one-half, and the eddies, which are now the cause of half the difficulties, would in a measure disappear.

Way's reef, to the southward of Pot rock, is divided into two parts, one a conical rock with five feet of water on it, and the other a flat bed of rocks, about ten feet by ten, with fourteen feet of water on it, and twenty yards to the north of the former. The five-feet rock lies on the edge of the eddy, and I found by experiment that a buoy let go in mid channel, at the depth of eight feet and above the north entrance, drifted directly over Way's reef; this was with a light breeze from the northwest. I kept a buoy on this place while sounding; it watched generally and almost always

with the flood tide. Since I removed it, one vessel has struck on the reef. I would recommend that a buoy, made in the shape of a boat be placed upon it until it be removed.

There is a dangerous rock, called "Bald-headed Billy," fifteen yards from Hatter's dock, which is dry at low water, and "brings up" a number of vessels at high water. Three vessels struck upon this rock while I was at Hell Gate; one we got off with some difficulty, another lost bowsprit, anchors and chains. It is a single rock, about six feet by six, and could be blown into deep water without much difficulty.

Opposite Gibbs' Point, and within fifty yards of Blackwell's island, is a large rock which I have called "Blackwell's rock;" the current sets directly upon it with the flood tide, and it is a most dangerous obstruction. It is six feet out of water at low tide, and could be removed at small expense.

The "Frying Pan rock" is a ledge fifteen feet long and only six inches wide at the top. It runs north and south, and is a part of a chain of rocks which runs from "Hog's Back" to Hallet's Point. A buoy, let go in mid-channel at half ebb, drifted directly over the "Frying Pan," with a light northwest wind. It is at this point where the currents divide, taking the directions of the main and middle channels. This rock removed, vessels would always drift through the main ship channel. The difficulty of removing it would be much greater than any other rock in the Gate, as it is so difficult to hit upon.

There is a small rock, though a very dangerous one, to the southward of Wolsey's bath-house. It extends about fifty yards into the channel, and is connected with the shore line at low water. There is three feet of water on it at high tides. On the first of the flood, a buoy let go opposite Gibbs' point, (the southern approach to Hell Gate,) drifted around Hallett's point, between Pot rock and Way's reef, along the edge of the eddies, and on the above mentioned rock into Pot cove. This happens to a great many vessels, and but for this dangerous obstruction they would drift into a safe harbor. This rock could be removed in one or two tides.

I find that "Rylander's reef" extends much further into the channel than is shown by former charts. I found six feet of water on the outer point of it. Nothing can be done with this large bed of rocks, save to erect a stone beacon on the shoalest part; this will save many a vessel.

Hallet's point, I should recommend, by all means, to be removed; it is the most accessible obstruction in the gate, and could be worked at for four or five hours each day. At flood tide, it causes the eddies in Pot cove; and, on the ebb tide, the eddies in east channel. Vessels standing too close to this point in ebb tide, are apt to be caught in these eddies, and thrown on shore opposite Stevens' fort; and vessels passing at high water, when the point is entirely hid, are apt to strike upon it. It extends forty yards into the channel, and has eighteen feet of water at its uttermost point.

If any attempt is made to carry out the recommendations that have been frequently offered, relative to clearing away obstructions in Hell Gate, I would suggest a close examination of the shore line at low water. Many rocks will be found to exist of a dangerous character, and they have, at different times, done much damage to vessels of lighter draft. One point I would recommend for removal is Scaly rock, and close to it is Shell rock; both dangerous at high water, from the fact that they extend far out into the channel.

Two vessels have gone on shore while I have been at work here, on a point called Ravensworth reef, to the southward of Gibbs' point; both vessels bilged, and were nearly ruined. I would recommend a buoy to be placed upon it, as it would be difficult to be removed.

The suggestions made by Lieutenant Davis, about building docks above some of the reefs, I approve of in their fullest extent. I do not think, however, it will be found easy to make a channel by blasting through the middle reef, and would suggest that it be entirely filled in with docks and spring fenders.

"Bread and Cheese," as it now stands, is one of the most troublesome points to avoid in Hell Gate. Heretofore, it has had nothing on it to indicate the danger at high water; at low water, it shows its entire shape and size. I placed a large pole on the outer point. It is so firmly fixed, that it will remain until cut away by the ice. I have been assured that the pole has, no doubt, prevented many vessels from running on the point; and I would recommend, strongly, that an iron spindle be placed firmly upon the same spot, until measures are taken to dock it in; moreover, I think it advisable to close up a small eight feet channel between Bread and Cheese and Blackwell's point, as it is this which causes the most dangerous eddies. After this is done, a beacon, to be lighted up at night, should be placed upon the outer point, and would, in connexion with a light on Mill rock, be of great advantage to commerce. At present, there is not a single light between New York and Throg's Point, when there should be at least six.

In a place where the interests of so many are at stake, the want of attention to the navigation of Hell Gate appears like culpable neglect. No one can form an idea of the number of vessels that go on shore during the course of a month. Fifty went on shore during the period I was occupied there, (two months,) and many of them were much injured. I am convinced that if proper measures were taken to protect the commercial interests of this great city, by blasting the rocks mentioned above, and docking in, as proposed by Lieutenant Davis, not one vessel would be lost in five years.

I believe I have mentioned all the prominent dangers; the minor ones will be apparent to those who make any examination of Hell Gate previous to undertaking the work. I have purposely

omitted those points touched upon by Lieutenant Davis, as he has said all that is required.

I remain, very respectfully, your obedient servant,

DAVID D. PORTER,
Lieutenant commanding

A. D. BACHE, Esq.,
Supt. of coast survey, Washington city.

APPENDIX No. 13.

Extracts from the report of Lieutenant David D. Porter, United States Navy, Assistant in the Coast Survey, on the examination of Buttermilk Channel into the inner harbor of New York.

UNITED STATES SCHOONER PETREL,
Astoria, Long Island, N. Y., September 23, 1848.

SIR: In obedience to your instructions, I took command of the United States schooner "Petrel" on the 24th of August, and on the 28th commenced a re-examination of Buttermilk channel, in the harbor of New York, to ascertain whether any changes had taken place in that important channel. It had been represented to the honorable the Secretary of the Treasury that it was not practicable to use Buttermilk channel, owing to its being so narrow; and as the government was desirous to make use of the Atlantic dock as a depot for the sea steamers now under contract with the Navy Department, it was a matter of some importance that the value of the channel should be established without doubt. I was delayed in the execution of this work, owing to the difficulty of finding proper stations, and did not get to work sounding until the 1st of September. The result of the survey has been most satisfactory, and has established, without fear of future cavil, the practicability of the channel, and I see no difficulty whatever in the department being able to carry out their plans. I enclosed you a sketch of the work with the lines run; but owing to press of time, I was not able to prepare a complete chart for your inspection. I took over one thousand five hundred soundings during the examination, and established the positions by one hundred and thirty-five angles. I do not think we missed any shoal water during the operation. The importance of this entrance seems to be so great, that it is a matter of astonishment to me that the pilots of New York have not heretofore taken advantage of it. It is the deepest, most direct, and the clearest channel into the East river, and when buoyed out properly, will no doubt be generally used.

On the 22d of this month, I was requested by the honorable the Secretary of the Treasury to accompany him on board the revenue steamer Jefferson, to meet the pilots of New York and the owners of the sea steamers, to prove to them that the Buttermilk channel had sufficient water in it for the largest size vessel, and could be made available for the purposes I have mentioned above as an en-

trance into Atlantic dock for the sea steamers. The "Jefferson" was started from the points I selected, and run out towards the the Robin's Reef beacon under the charge of Mr. McGinn, one of the most intelligent of the New York pilots, and we carried out on the line (marked down on the sketch I sent you as the sailing line) five, six, seven and eight fathoms; this was satisfactory to the ship owners, as demonstrating the necessary depth of water for their largest sized steamers. I then proposed to run through the channel close to the north dock of Governor's Island, and Mr. McGinn carried the vessel through in five fathoms (the least) water, turned the steamer up the East river, and ran down along the docks inside of the middle ground, carrying six fathoms all the way. After a short excursion down the bay, we returned to New York, and it was proposed to run the steamer through the entrance of Atlantic dock; and as the "Jefferson" is one of the most difficult steamers to turn, except with plenty of room, this seemed a matter of some difficulty. Mr. McGinn, however, took her in handsomely, (notwithstanding he had never been inside the dock,) with a stiff northwest wind blowing, an unfavorable tide, and with the disadvantage of having a sloop lying in the middle of the passage, with her decks loaded with plank and projecting out on each side of her. Though with scarcely room to pass, we went through and anchored inside the dock, everybody, I believe, favorably impressed with the result of the trip.

There are many reasons why it is desirable Buttermilk channel should be well known. The most important are those connected with the interest of the government; and I recommend, to avoid all difficulty, that it should be buoyed out in so perfect a manner that vessels of all classes can know exactly how far they can go.

I remain, very respectfully, your obedient servant,

DAVID D. PORTER,
Lieutenant Commanding.

APPENDIX No. 14.

Report of Lieutenant Commanding S. P. Lee, United States navy, assistant in the coast survey, in reference to the expediency of placing two small lights on Sand island, in the Chesapeake.

UNITED STATES STEAMER VIXEN,
Delaware Breakwater, August 1, 1848.

DEAR SIR: I have examined the inlet, &c., at Sand Shoal island, in compliance with the following extract from your general instructions, (dated April 28, 1848,) for the operations of the present season:

"If the weather should permit, as you come round from New York to the Chesapeake, I wish you to examine Sand Island inlet, and report upon the expediency of the two small lights asked for in the petition of which I send herewith a copy, the value of the

inlet as a harbor of refuge, the depth on its bar, the direction of its channel, the possibility of entering with the lights asked for, the distance from Cape Charles, (Smith's Island light,) and the interference or not of these local lights with that important light, the probable height of structure and kind of light required, with any other information you may obtain. As this information is required at once, I wish you would send the report from the nearest convenient post office. Should it be impracticable to obtain this information at this time, do so when passing from the Chesapeake to the outside."

It was not practicable to obtain this information when the Washington came from New York, without the prospect of occasioning considerable delay; and you had told me before I left for New York that the examination might, in that event, be deferred until the brig's return from the Chesapeake for outside work. Our bay pilot had never seen the place, and he thought the wind too fresh from the eastward, as we passed the coast to the northward of Cape Charles, to justify the examination then. The information obtained at Norfolk, and the use of this steamer, have enabled me to execute your instructions when "passing from the Chesapeake to the outside," and in good time, I hope, for the object in view.

Mr. Nathan F. Cobb resides with his family on Sand Shoal island. They are the only inhabitants. Mr. Cobb's nearest neighbor (Dr. Nottingham, I believe) resides on the main about ten miles off, across the marshes. We crossed the northward bar on Friday the 28th ultimo, (Mr. Cobb piloting, it was first of flood, he said,) drawing seven feet five inches; thumped and dragged heavily over the bar, (which is of hard sand,) forcing our way by press of steam. This is the northern channel. There are two spar buoys (about to be replaced by two can buoys) on it, placed by order of the collecter of Norfolk, and under charge of Mr. Cobb. These buoys are about two hundred yards apart. When we crossed the bar the wind was moderate from the southward, with some swell on. The boiler requiring a patch, which would detain us a day, I made some preparations for a hasty survey of the bar and inlet the next day, (at low water, the most favorable time,) but it was too rough on the bar to allow the boats to work at low water; and at high water the steamer was ready to go out, but it was still too rough on the bar. The same cause detained her the next day, (Monday;) as it was then about the time of spring tides, (the moon changed on the morning of the 30th,) with the wind at the eastward on the 29th and 30th, there was probably more water then on that coast than at usual tides. The rise and fall of tides here, Mr. Cobb says, is, as a general thing, about 5½ feet. We came out, piloted by Mr. Cobb, Monday morning, at high spring tide, without touching, and found nearly twelve feet water on the bar. The wind was then light from the southward and eastward. Mr. Cobb (who also looks out for the buoys at Great Matchapungo or Hog Island inlet, some five or six miles to northward) says that the gale of March 2d, two years since, altered and shoaled the entrance there very much. The same gale, he says,

altered the shoals called Carter's shoals, which are off Sand Shoal island, and changed the passages a little. He further informed me that the shoals, bars, &c., at Matchapungo, are the same kind of hard sand as forms the bars and shoals here. Carter's shoals, off Sand Shoal island, stretch along the coast in a north and south direction, and extend out about five miles from the land. The soundings appear pretty regular until quite up with the shoals. From the anchorage at low water (Saturday) the sea appeared to break from shore to shore over both northern and southern passages. The gale of March, 1846, swept through Mr. Cobb's dwelling-house, and carried away some of his levees. He had reclaimed a part of the island around his house, and now has a small portion, where the levees are up, under pretty cultivation. Mr. Cobb's dwelling-house, and the store-house near it, both of which are white houses, are conspicuous land marks. It is by these that the place is known and the bars passed to go into the inlet. Vessels from the northward bring these houses to bear west southwest, which clears the shoals and leads up to the buoys on the bar. Vessels from the southward bring these houses to bear about northwest. This is the next best passage, but it is not buoyed. Our boat carried nine feet in this way at about high tide, (Friday morning,) and found about four feet coming out at low water. Mr. Cobb came in this boat and took us in by the other passage. We anchored in the inlet in twelve feet water, hard bottom. The tide ran very strong, from three to four knots per hour, (Mr. Cobb says five knots at times,) and there is but little slack water. Sounding here will be a tedious and troublesome operation. There are anchorages connected with the main inlet which may answer for small craft in heavy weather.

I beg leave to conclude with the following replies to the several points upon which you desire me to report.

1. Building and keeping two lights to make a range, by which to run at night, had better only be done where there is room enough on shore to put the lights so far apart as would make the range a sensitive one; where there is a solid and safe foundation, and where the channel is not changeable. With these considerations in view, I cannot recommend two lights on Sand island.

2. None but centre-board vessels, or vessels of very light draft, should attempt to make a refuge in Sand inlet, in blowing weather on shore (from seaward.) In very good weather, coasting vessels would prefer to go on. But there are vessels which would like to come in to trade, or to anchor for the night, or to wait for a fair wind, or to avoid the threatening weather. Small coasters, of light draft, might find this a useful resort.

3. We dragged over the bar, drawing 7½ feet on the first of flood; we found nearly 12 feet at high water spring tide.

4. The northern channel, which is buoyed, runs WSW. and E. NE., and the other channel, which is not buoyed, makes NW. and SE.

With two lights a stranger could not pass the bar and get to a fe an chorage without a pilot. By the day the buoys, and the

breakers with the wind eastward, would help to show the way if there was no pilot; but a pilot would be necessary to one not well acquainted. The inlet is perhaps about ten miles north of Smith's island. Our pilot, whose professional opinions are worthy of consideration, thinks that a light there would conflict with that on Smith's island, and would occasion more wrecks than it would prevent.

I propose for this inlet a lantern on the keeper's dwelling—the house to be on piles. This should be a fixed light, and as that on Smith's island is a revolving, they would be too different to be taken one for the other. Light-houses along the coast are good guides to coasters. Many of these, I am told, go by the land altogether. To such the light-houses by day and the lights by night, must be very useful by marking their position. A light-house would also seem as a warning to vessels off Carter's shoals, on which Mr. Cobb says the sea does not break in westerly winds. Every aid and encouragement should be given to coasters. The exposure is very great under the best arrangements. The more stopping places and guiding marks which the small class of inshore coasters can have, the better it will be for their security.

Respectfully and truly yours,

S. P. LEE,
Lieutenant Commanding.

To Professor A. D. Bache,
Supt. U. S. coast survey, near Washington, D. C.

APPENDIX No. 15.

Report of Lieutenant Commanding W. P. McArthur, United States navy, assistant in the coast survey, to Professor A. D. Bache, superintendent, in regard to the utility of a light on Blakiston's island, in the Potomac river.

U. S. Schooner, John Y. Mason,
Off Blakiston's island, Potomac, April 11, 1848.

Dear Sir: The directions contained in your letter, dated Washington, April 5th, have been complied with, and as far as I considered necessary, I have personally inspected "the utility or otherwise of a light at Blakiston's island, in the Potomac;" and I am convinced that a light-house on this island would afford great facility to vessels navigating the Potomac. The facts which conduce to this opinion, are as follows: Firstly, Blakiston's island is very low land with few marks or trees to distinguish it. Secondly, the lead is not to be trusted to approach this island from the main ship channel, as six fathoms water (soft bottom) can be carried to within two hundred yards of it, and in some parts of the channel even nearer. I ran several lines of soundings to the main ship channel, from different parts of the island and in different directions, and sounding in rapid succession; the soundings on the verge of th

channel were as follows: two fathoms—the next cast three fathoms, then six, then eight fathoms. Sufficiently indicative of its abruptness. This, together with the first fact pointed out, causes vessels to sail along the southern shore in order to avoid the island, thus increasing the distance materially between the light-house, on Piney Point and Cedar Point light boat. Thirdly, neither the light-house on Piney Point, nor the light boat at Cedar Point can be seen from Blakiston's island, (that is to say, from the upper part of the island.) The channel here is about two miles wide.

I am of the opinion, that were there a light-house on Blakiston's island, the distance by the courses now used and those which would then be used, would be diminished more than four miles, in the case of large vessels, and not less than six miles with vessels which can run over the Kettle Bottom shoals, without danger.

Since the Potomac river, any where above Piney Point, may be considered a harbor, I cannot say that a light on Blakiston's island is so necessary to the *safety* of vessels as it is to facilitate navigagation; yet *vessels have been lost* in this vicinity.

The course, when in the main ship channel, abreast Piney Point, to pass clear of Ragged Point, is NW. by N., when above Ragged Point, steer W. by N. until past Blakiston's island—here the difficulty occurs, which is at night to *see Blakiston's*—then steer NW. by W½W. until up to a black buoy, off Bluff Point. (This buoy if twelve miles from Blakiston's island.) The course from the last named buoy to the light boat, off Cedar Point, is N. by W. All these courses are given per compass, and are mentioned to show why I am of the opinion that the distance may be diminished between Piney Point and Cedar Point.

A tower about forty feet high, with a second class light, would, in my opinion, be sufficient. The southwest part of the island would probably be the most suitable site.

I have said nothing of a small channel on the north side of the island, as it is seldom, if ever, used at night.

Trusting that this may contain all the information you desire on the subject,

I am, very truly and respectfully, yours,

WM. P. McARTHUR,

Lieut. U. S. Navy, Ass't. U. S. coast survey.

Professor A. D. BACHE,

Sup't. U. S. coast survey, Washington, D. C.

APPENDIX No. 16.

EXTRACTS FROM LETTERS FROM ASSISTANTS J. CRAWFORD NEILSON AND C. O. BOUTELLE, RELATING TO THE NEW INLETS FORMED ACROSS BODIES' ISLAND, N. C., IN 1846.

1. *Extract from letters from Assistant C. O. Boutelle to the superintendent, dated January 10 and February 9, 1847, relating to the new inlets formed across Bodies' island, in 1846.*

"The southern and principal inlet begins at about seven miles and one-eighth from the south end of the base of 1845. Its width, between high-water marks, measured on the line, is 202 yards; between low-water mark, 107 yards; deepest water on line, December 31, 1846, 6.5 feet below low-water mark. The northern one begins at about seven miles and a half; its width on the line, between high-water marks, is 162 yards; between low-water marks, 36 yards; deepest water, 2.1 feet. These inlets were formed in the gale of September 8, when the water from the sound overflowed the whole beach. A breach in the marsh had been made in the March gale, and a creek was formed across our line, extending nearly to the sea beach."

2. *Extracts from a letter of Assistant C. O. Boutelle, dated April 29, 1847.*

"On the 10th and 12th instants, I made an examination of the inlets across the present Bodies' island base, in company with Mr. Neilson. The northern inlet is filling up, and carts can drive across the bar on the ocean side at low water."

"The southern and principal inlet appears now less likely to close rapidly than it did in December last. While it has filled about a foot and a half at the ocean entrance, it has rapidly deepened upon the sound side; and six feet of water may now be found in the central channel, at the distance of a third of a mile from the marsh. The other two channels remain very much in the same condition as when I surveyed them."

3. *Extract from a letter of Assistant J. C. Neilson, dated November 4, 1847.*

"At the inlets, the sea appears to have encroached on their south shore, cutting away the point of the island—the southern point at the marsh—leaving still the bar. The channel into the sound has, I think, deepened, and in some respects changed, although the loss of the stakes, to which Mr. Boutelle referred his observations, leaves me in some doubt as to the extent of the changes, but certain, however, of having found no filling up."

4. *Extract from a report of Assistant C. O. Boutelle to the superintendent on the location of Bodies' island base, March* 1, 1848.

"Went to the south inlet, which I sounded thoroughly. It has changed in shape since last April, but retains about the same depth on the ocean side. On the sound side the principal slue has filled very much, and I could nowhere find more than 3½ feet water at the distance of half a mile from the inlet. The water deepens again about three quarters of a mile west of the inlet, and the channel inclines southerly, towards the Old House channel.

"It is *possible* that a useful channel will yet be formed there, but at present I can see no signs of it."

APPENDIX No. 17.

Letter from the mayor of Mobile to Lieutenant Commanding Patterson, United States navy, assistant in the coast survey, relating to the coast survey in section VIII., with the reply of Lieutenant Patterson.

MAYOR'S OFFICE,
Mobile, December 17, 1847.

SIR: Your note of the 15th instant, accompanying a roll of the published charts, executed under the superintendence of Professor A. D. Bache, of the United States coast survey, and in his name presented to the city of Mobile, has been duly received.

In the name of the corporate authorities, and of the citizens of Mobile, I offer to you, sir, and through you to Professor Bache, sincere thanks for your valuable present, and the assurance of our deepest gratitude for the exertions of your corps, which have already contributed so much to the stores of scientific knowledge and to the benefit of our country.

We trust, sir, that the labors you are about to bestow upon Mobile bay will fully confirm our present anticipations, and establish, beyond controversy, the fact that our bay and harbor are capable of affording at least equal facilities with any other southern port to shipping of any description.

I have the honor to be, sir, with great respect, your obedient servant,

J. W. L. CHILDERS,
Mayor of Mobile.

To Lieutenant C. P. PATTERSON,
United States navy.

MAYOR'S OFFICE, *December* 17, 1848.

SIR: I have the honor to transmit to you a series of resolutions, adopted by the board of aldermen and common council of this city, upon information of your arrival at this port.

In discharging the very agreeable duty assigned me, permit me once more to assure you of the sincere respect and gratitude of the corporate authorities and citizens of Mobile, and personally to wish you a speedy achievement of the highest honors of your corps.

I have the honor to be, sir, your obedient servant,

J. W. L. CHILDERS,
Mayor of Mobile.

Lieutenant PATTERSON,
United States navy.

Resolved, That the city authorities of Mobile have received with great satisfaction information of the arrival at this place of the party of the coast survey, who are to make a general hydrographic reconnaissance of this harbor, with a view to its improvement, in connexion with the lower bay; that the mayor be requested, on the part of the corporation, to signify to Lieutenant Patterson, commanding the party of the coast survey, the thanks of this community to Professor Alexander D. Bache and the officers under his direction, for their attention to the interests of Mobile; and further, that the corporate authorities officially unite with the citizens in any memorials which may hereafter be adopted on the subjects of the improvement of our bay and harbor, and the construction of the proposed railroad to the Ohio river.

The foregoing resolution was unanimously passed by the board of aldermen and common council, and approved by the mayor of the city of Mobile, 16th December, A. D. 1847.

A true copy:
[Attest.]

SAML. PENNY,
Clerk of the corporation.

UNITED STATES C. S. SCHOONER FORWARD,
Dog River Bar, December 18, 1847.

SIR: I have the honor to acknowledge the receipt of your communication of the 17th instant, transmitting a series of resolutions adopted by the board of aldermen and common council of Mobile, and with great satisfaction will have the pleasure of forwarding them to Professor Bache, superintendent of the coast survey, in whose name and in behalf of all the officers, civil and naval, employed upon this coast, I beg to return our warmest thanks to the city authorities of Mobile, for their cheering appreciation of our duties, which, we cannot but hope, will result in the most favor-

able manner to so important a part of our gulf coast as Mobile bay.

I would beg leave to correct an impression which the following wording of the resolutions, "to Lieutenant Patterson, *commanding the party of the survey*," appear to convey. The hydrographical party is but one of the several parties, among which the labors are divided. Assistant F. H. Gerdes first opened the work upon the coast by a reconnaissance under the direction of Professor Bache. The base line selected by Mr. Gerdes was measured by Professor Bache and himself last spring. From this base are carried on a series of main triangles, upon the correctness of which depend all the other labors of the survey. These triangles have been measured by Mr. Gerdes. The smaller triangles, (called secondary triangulation,) founded upon the first, have been measured by Messrs. Gerdes, Fauntleroy, and Hilgard. The astronomical observations for the determination of latitude, longitude, &c., with the magnetical, have been made by Mr. Fauntleroy. The topography has been executed by Mr. Greenwell; and Assistant C. M. Eakin is at present engaged in bringing the triangulation up Mobile bay from the primary triangulation determined by Mr. Gerdes near the entrance. The several parties act under the immediate direction of Professor Bache. This explanation is due to these officers, as the value of *our* results depends entirely upon the accuracy of *their* observations.

For the very kind manner in which you have been pleased to transmit the resolutions, I return my most sincere and grateful thanks.

I have the honor to be, sir, very respectfully, your obedient servant,

C. P. PATTERSON,
Lieutenant U. S. N., and assistant coast survey.

To his honor J. W. L. CHILDERS,
Mayor of Mobile.

APPENDIX No. 18.

Letter of Lieutenant Commanding C. P. Patterson, U. S. N., assistant in the coast survey, to Captain Scott, R. N., in relation to suitable anchorages on the gulf coast, in Mobile bay, and Lake Borgne, for the British West India mail steamers.

U. S. C. S. SCHOONER FORWARD,
Off Mobile, December 16, 1847.

DEAR SIR: It is with great pleasure I find myself enabled to forward at your service the following mems., concerning the several points, upon which you wish to obtain information, relative to this coast. 1st, Chandeleurs; 2d, Cat island; 3d, Ship island; 4th, Mobile bay.

1st. Chandeleurs.

Under the north point of these islands is a roadstead, protected in all winds from the northeast, around easterly to southwest. To this anchorage there is no bar. The best anchorage is the north point, bearing per compass NNE., distant one mile, 4½ fathoms water, sticky bottom. The only advantage of this harbor is of course as one of refuge, in case of heavy weather from seaward.

2d. Cat island.

Into the harbor south of Cat island, 17 feet can be carried at ordinary low water. To the anchorage, south of the island, the channel is plain, but is exposed to southeast gales. The channel to the anchorage, (four miles above the light-house,) secure from these gales, is narrow and difficult, but well protected.

3d. Ship island.

1. The depth which can be carried over this bar is 19 feet at ordinary low water.

2. The channel is perfectly easy, one course (see tracing) taking you over with but one or two casts on the ridge of shoalest water.

3. Continued strong northerly winds will depress the water at an extreme of two feet below ordinary low water, and continued southeast, and south winds will raise the water from one foot to an excessive extreme of eight feet.

4. In heavy southeast gales the sea is said to break upon the bar. This I have never seen, but judge it must be the case.

5. After crossing the bar, the channel, of from 4 to 6 fathoms, is nearly a mile in width. The distance from the bar to the anchorage is but 1½ miles.

6. The best anchorage for large vessels is in from 4 to 6 fathoms, sticky bottom, with west end of Ship island bearing south by west, per compass, distant from ¼ to ½ mile. The sound inside averaging but 2½ fathoms in depth; no sea of consequence could be raised from the longest reach.

7. Four fathoms can be carried within 200 yards of the shore on the north side of west end of Ship island.

8. The anchorage, with water equal to depth on the bar, is five miles long, averaging three quarters of a mile wide, sticky and soft bottom throughout.

9. The average rise and fall of tide is about 16 inches. The coasters are well acquainted here, and good pilots could easily be procured by previous arrangement.

4. Mobile bay.

(The following extracts are from several reports made to Professor Bache, superintendent United States coast survey.)

1. "The depth of water which can be carried over the bar at the entrance of Mobile bay, at mean low water, is 20¾ feet, mean rise and fall of tide one foot."

2. "The channel is perfectly easy, one course north, 19° west, true, taking you over with but one or two casts upon the ridge of shoalest water.

3. Continued strong northerly winds depress the water at the

extreme 2 feet below mean low water, and continued southeast and south winds will elevate it 2½ feet above, at an extreme 4 feet.

4. In heavy southeast gales the sea is said to break across the bar. This I have not seen, but judge it must be the case.

5. After crossing the bar, the channel varies from half to one mile in breadth, carrying seven fathoms and perfectly clear.

6. The depth of the water immediately at the end of wharf (50 yards long) at Fort Morgan (on Mobile point) is 6½ feet, and 100 yards out there are five fathoms. In mid channel, abreast of the wharf one-third of a mile out, there are 11½ fathoms.

7. The depth of water at the anchorage of the fleet (merchant vessels) in the bay is 3½ fathoms. There is perfectly secure anchorage for large vessels northwest from Fort Morgan, distance one half to one mile in 8 fathoms.

The anchorage is equally secure with the fort bearing south, per compass, in 4 fathoms; muddy and sticky.

The ridge of the bar, upon which is the shoalest water, appears to be very narrow, as we obtained but one cast, deepening gradually on the inner side and with great rapidity upon the outer.

Upon the outer bar, in 1822, the greatest depth which could be taken was 17 feet, in 1841 it was 19, in 1847 it was 20¾; each at mean low water.

In 1822, the distance from the position in which Sand Island light-house now stands to the shoalest water in the channel over the bar was 3,150 yards, in 1841 this distance was 3,228, and in 1847 it was 3,402.

Gales from the seaward affect the bar and island more or less, but these are accidents which appear to be eliminated in long periods of time by a constantly acting cause or causes.

The channel of 20¾ feet over the bar, is about 200 yards wide. That of 19 feet, half a mile.

In approaching the outer bay the lead gives no evidence of it, as in six or eight casts you run from 8 fathoms to 3½. The existence of the two light-houses, however, materially lessens this difficulty. There are regular pilots always cruising off the "outer bar."

The southeast and south winds deepen the water upon all the bars of this coast in a ratio due to their several positions, being very much greater in the angle of the coast at Ship island, and gradually lessening in degree as they are more distant from it. Heavy gales from these quarters are relatively rare, and prevail mostly in winter, but occasionally in summer. They necessarily throw in a heavy sea upon the bars, which, however, is met by the increased depth from the same cause.

Northerly winds give less water, but smooth. They are the prevailing winds during winter, and, being off shore, cause but little annoyance.

In summer the land and sea breezes are quite regular, and thunder-squalls, sometimes of great danger, prevail.

As soon as the survey of lower part of Mobile bay and the harbors of Ship and Cat island are finished, I would be happy to for-

ward copies, previous to publication, to you, or such address as you might wish.

Should the foregoing not contain all the facts you wish, I would be glad to answer, if it is in my power, any further inquiries you might propose.

The superintendent of the coast survey, Professor A. D. Bache, at Washington, would be glad at any time to furnish all facts in possession of the survey. No fear of giving trouble or annoyance need deter an inquiry. If we can answer it we will; if not, we will *not*.

Very respectfully, yours,

C. P. PATTERSON,

Lieutenant U. S. Navy, and Assistant Coast Survey.

CAPTAIN SCOTT,

Royal Navy, Mobile.

APPENDIX No. 19.

Annual report to the superintendent on longitude computations, by S. C. Walker, assistant United States coast survey.

CAMBRIDGE, MASS., *September* 16, 1848.

SIR: Since my last annual report of September 20, 1848, I have presented fifteen reports, numbered from X. to XXV. inclusive, in compliance with special instructions, and in furtherance of the general duty of making computations for astronomical longitudes of stations of the coast survey. The telegraph operations of last year were handed, in February last, to the check computor, Mr. Ruth, for final revision. That labor was temporarily interrupted by his early resumption of field operations, and remains to be completed this autumn.

I enclose sections 1st, 2d, and part of section 3d of my full report on the telegraph operations between Cambridge and New York. This will embrace 41 articles, by number, in the first three sections, and the remainder in section 4. Of these, I send you 29 articles of the work, before furnishing the remaining 12 articles of section 3d, and the whole of section 4th. I send, however, the heads of the 12 articles partially completed for section 3d. With regard to the telegraph operations for 1848, I can only remark that the preliminary computations give an approximate result differing only a small fraction of a second of time from the values already reported in 1846, January 13, (III.,) and March 11, 1848, (XII.,) based on the observations of lunar culminations and the transportations of chronometers.

It becomes my duty again to call your attention to a subject of grave importance in the determination of the longitude of the cardinal point, (New York,) from those of the trigonometrical surveys of other nations alluded to in my special report of the 3d and 8th of May last, (XVI.)

In my first report, of November 16, 1844, in which I stated the most probable longitude of the Philadelphia observatory, viz., 5*h*., 00*m*., 40*s*.52 ± 0*s*.35, I made a reserve in respect to *any constant* errors of the methods. I there remarked, "it is to be hoped that those of the latter kind (constant errors) do not much exceed *a second of time.*"

I have only to add, after an interval of four years, that all the additional light thrown on this subject by referring Washington and Cambridge to Philadelphia by the telegraph operations, and combining the results of reports I., II., IV., and XIV., still confirms the conclusion of my first report in 1844, that the probable *accidental error* of the method of eclipses and occultations, subject to parallax and semi-diameter, was at that time not greater than ± 0*s*.35. None of the subsequent results by the same method have varied the longitude of the Philadelphia observatory from Greenwich by more than ± 0*s*.35 from the value of 5*h*. 0*m*. 40*s*.52, then reported. This resultwas based on the use of Burckhardt's *constant or mean value of the moon's semi-diameter and horizontal equatorial parallax.* Any error in the assumption of the correctness of the *mean semi-diameter of the moon* may be supposed to vanish in the mean result of all these groups of eclipses and occultations. Such is not, however, the case with the error of the assumed value of the *moon's mean horizontal equatorial parallax.* It does not disappear in the aggregate of these groups, but remains *a constant residual error*, in the final result, of nearly the same order in *longitude in seconds of time* as that of the *error itself in seconds of arc.*

This constant source of error was more clearly anticipated in 1845, in my report II., in which I remarked as follows:

"There is, however, a source of *constant* error common to classes IV. to VII., inclusive, viz: the uncertainty concerning the true value of the moon's horizontal parallax. This element is not, like the other lunar elements, susceptible of immediate observation in particular instances, but must be derived theoretically from the tables. The fact that Professor Airy, in the Greenwich observations for 1840, has adopted Mr. Henderson's determination and increased the value of Burckhardt's constant of the moon's horizontal parallax by $\frac{57}{100}$, shows the uncertainty of this element. For the sake of uniformity, I have not yet applied this correction, but have used Burckhardt's elements throughout as the basis for reducing both the occultations and corresponding meridian observations." If I had uniformly employed Mr. Henderson's value instead of Burckhardt's, I should have placed Philadelphia about 2*s*, in time, further east than at present reported. The only instance in which the error from this source has been completely eliminated is in (class IV.) the eclipse of May 14, 1836. Here the full discussion of all the equations of condition, computed by Rümker, gave me for the correction of Burckhardt's constant a value 0″.2 greater than Henderson's. I hope, in the course of another year, to complete the discussion of all the observations of classes VI. and VII., within the limits of the survey, using Burckhardt's elements with equations of condition, by means of which the effect of any correction

of these that may hereafter be indicated on the longitude of Philadelphia may be applied at once."

It is useless to attempt to determine the amount and consequent correction of this error of the moon's mean parallax, by the ordinary process of accumulating results of solar eclipses and of lunar occultations, compared with similar phenomena and with meridian observations in Europe. In all the history of the solar eclipses of the past, the illustrious* Bessel, in 1841, could find none that afforded the necessary data for making this computation.

It is proper to remark, however, that he was probably not aware at that time that the eclipse of May 14 and 15, 1836, had been so extensively observed in America. I beg to call your attention to the report of the committee on that eclipse appointed by the American Philosophical Society,† which contains my computation of the error of Burckhardt's mean value of the moon's horizontal parallax, from the group of conditional equations, computed by Rümker, from the European and American observations.

If we adopt the value of the correction of Burckhardt's mean parallax of the moon, from that eclipse (viz. + 1″.52) and apply it to the series of eclipses and occultations that form the basis of my several reports above mentioned, it will probably be necessary to *diminish the longitude of all the stations of the United States coast survey by about two seconds of time, or half a minute of arc.*

There are other grounds which strengthen the presumption of the existence of this error in Burckhardt's constant value of the moon's parallax.

Olupsen‡ has deduced a similar correction of + 2″.22 from Lacaille's meridian altitudes of the moon, observed in the last century at the Cape of Good Hope, and compared with corresponding European observations. Henderson§ finds from his observations with the Cape Mural circle, as compared with the European, a similar correction of + 1″.3.

Mason, Burg, and Damoiseau, in their lunar tables used a greater constant value of the moon's parallax than Burckhardt's.

Plana's theory of the moon gives a similar correction. In my report of April last, I gave the following proposed supplementary equations to be added to the ordinary result from the tables of Burckhardt's, to wit:

$$\begin{aligned} d\pi'_{\circ} = &+ 0.''9 \times \cos(2\,\mathbb{D} - 3\,\odot + 2\,\text{Perigee}\,\mathbb{D} - 2\,\text{Perigee}\,\odot.) \\ &+ 1.''1 \times \cos(\,\mathbb{D} - 3\,\odot + 2\,\text{Perigee}\,\mathbb{D} - 2\,\text{Perigee}\,\odot.) \\ &- 0.''9 \times \cos(2\,\mathbb{D} - \odot + 2\,\text{Perigee}\,\mathbb{D} - 2\,\text{Perigee}\,\odot.) \\ &- 1.''1 \times \cos(\,\mathbb{D} - \odot + 2\,\text{Perigee}\,\mathbb{D} - 2\,\text{Perigee}\,\odot.) \\ ds' = &+ 0.0022 \times \pi' + 0.27272 \times d\pi'_{\circ}. \end{aligned}$$

I there mentioned that these equations, which rest upon theoretic grounds, would very nearly explain the excess of the moon's

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* Astronomische Untersuchungen.
† Trans. Am. Philos. Soc., new series, vol. iv., page 383.
‡ Astr. Nachr. No. 326.
§ Memoirs of the Royal Astronomical Society.

semi-diameter over Burckhardt's value, as deduced from several hundred observations of both limbs of the moon.

All these concurrent sources of information would have warranted a new computation of the American longitudes with the corrected semi-diameter and parallax of the moon. Such a labor I had proposed to undertake, as soon as leisure could be found. It might be fairly inferred that the result would be a diminution of the difference of longitude between the European and all the American stations of one or more seconds.

It is proper to add that, on consultation with Professor Peirce, by the instruction of the superintendent, about the first of July, it was concluded to recommend the following course, viz: to compute the correction of Burckhardt's semi-diameter by the formula above mentioned, and compare the computed and observed semi-diameter in all cases of direct measurement, and thence deduce the most plausible value for the co-efficient $\frac{s'}{\pi'}$ to be used in the coast survey computations of longitudes.

There was further information in the archives of the coast survey, confirmatory of the propriety of this step.

The longitude of the Cambridge observatory from Greenwich has been determined by Mr. Bond, from the transportation of 116 chronometers in 34 voyages of the Cunard steamers from Liverpool to Boston.

This result is stated in my report, XII., to be 4 *h*. 44 *m*. 30.492 *s*. ± 0.754 *s*. It is to be regretted that the data are yet wanting for computation of the longitude by the return voyages from Boston to Liverpool. The possession of them would greatly increase the value of the chronometric result, by removing the constant source of error in the acceleration or retardation of the sea rates.

In my report XIV., on the longitude of Cambridge from Greenwich, as derived from lunar occultations and solar eclipses, I find for the result, 4 *h*. 44 *m*. 31.95 *s*.

An increase of Burckhardt's parallax of about 1″.5 would reconcile these discordant results. It will appear from my report XXIII on the American longitudes, by moon culminations, derived chiefly from the elaborate and very accurate computations of Lieutenant J. M. Gilliss, assistant U. S. coast survey, that this class of phenomena place the four stations of Washington, Philadelphia, Cambridge, and Hudson, Ohio, *more than two seconds of time* nearer to Europe than the eclipses and occultations with Burckhardt's parallax and semi-diameter of the moon. I deem it my duty therefore to state my belief, from all the information now before me in the archives of the coast survey, *that all the astronomical stations of the U. S. coast survey, including the cardinal point, New York, must be set down one or two seconds of time further east than the places hitherto assigned them by American and European astronomers.*

If my previous report, based on the authority of the lunar ta-

bles, have fallen short of the precision that more correct tables would have furnished, I have the consolation to reflect that other computers have shared a similar fate. I might mention in this connexion the names of Rittenhouse, Bowditch, Paine, and Peirce, among the American astronomers, and of Friesnecker, Zach, Lalande, De Ferrer, and Wurm, among the European; all of whom have more or less confirmed, by their computations, the results of my reports. De Ferrer had, in fact, noticed this constant source of error in the moon's mean parallax, but had not sufficient data to guard against its effect.

Such was the state of our information from the archives of the coast survey up to the first of July last, and such were the conclusions to which I had then arrived. Since that time, however, a new era has occurred in our knowledge of the lunar theory. I allude to the recent publication of the report of the astronomer royal of England, (Professor Airy,) on the reduction of the Greenwich observations of the moon. An abstract of this report has just been received in this country, in the proceedings of the Royal Astronomical Society of London for the 9th of June last. In it I find full confirmation of the view contained in my report (XVI) of 3d and 8th May last. The importance of the subject, and its direct bearing on the longitudes of the U. S. coast survey, will justify the quotation from the article.

"The astronomer royal, after proposing the best hypothesis of error which he can suggest, and bringing the later Cambridge and Greenwich observations to bear on the subject, concludes by saying, that probably Plana's mean value of parallax should be a little increased and the moon's mass be correspondingly diminished. He proposes in the future reductions at Greenwich, to increase Burckhardt's parallax by $\frac{1}{1000}$ part." Again, he remarks, "The corrected co-efficient of the parallactic equation is 122".37, but that is uncertain. An empirical equation would render the observations more accordant, but this has no probable physical foundation. The more likely cause for the observed irregularities is a change in the moon's semi-diameter, depending on changes in the telescope, or in the observer. From the law of the inequality this co-efficient will always be somewhat uncertain."*

I will merely remark, that the increase of Burckhardt's mean value of the moon's parallax of 3", (the $\frac{1}{1000}$ part,) if adopted, will fully confirm the report of April last, and will justify the opinion above stated, that *all our American longitudes from Europe must be diminished* one or more seconds of time. As it is of great importance to obtain definite results before venturing on a change that might have to be retracted, I beg to suggest the propriety of the following course of investigation.

1st. To reduce promptly the telegraph operations so as to refer all the American astronomical observations to the cardinal point, (New York.)

* Vol. VIII., No. 8, p. 186.

2d. To complete the geodetic connexion of the points interrupted in the line of telegraph operations.

3d. To employ a greater force of computers, and urge forward, by every possible means, the reduction of the American observations of moon culminations, from 1842 to 1846, using the blank forms of the coast survey.

4th. To employ additional force in forming the conditional equations for the eclipses and occultations, with corresponding meridian observations in Europe, to the end of 1846; also, according to the coast survey blank forms.

5th. From the report of Professor Airy, and from any other available sources, and subsidiary computations, to find the most plausible theoretical elements for the moon's place on the nights of the American observations.

6th. To apply these values to the conditional equations in articles 3d and 4th, so as to render the residual error of theory the least possible.

7th. To complete the discussion of the value 122″.37 of the coefficient of the parallactic equation, given by Professor Airy. For this purpose it will be necessary to extend the discussion which Professor Airy has limited to the instruments of Greenwich and Cambridge, so as to include all those with which the transits and altitudes of both limits of the moon have been observed at the same time in any country, so as to decide whether the theoretical coefficient of 122″.37, or a more plausible empirical one, is to be adopted in the longitude computations of the coast survey.

8th. To institute a full discussion of all the observations of occultations of the stars in the group of the Pleiades* extant in any country. This discussion is earnestly recommended by Bessel† as certain to afford more perfect data than those from any other source, for the determination of longitudes and for the correction of the moon's parallax and semi-diameter.

9th. To resolve by the method of least squares, or otherwise, conditional equations so obtained, after applying all the theoretical and empirical corrections to the lunar constants and co-efficients, so as to obtain the most plausible value of the correction of the longitude of our cardinal point from the average of the European meridians.

I regret that this outline is so copious that my personal efforts, after making and reducing the telegraph operations, and after making out the numerous special reports, that are needed in the department of longitude computations, are hardly sufficient to make a sensible impression upon the accumulating mass of longitude observations in the coast survey collection.

I cannot, therefore, too strongly urge upon your consideration

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* A similar discussion for all cases, in any country, of coincidence of occultations and meridian observations, is much needed; but I dare not propose it until some of the other difficulties are surmounted.

S. C. W.

† Astronomische Untersuchungen.

the importance of taking proper steps to increase the number of computers in the longitude party, especially in the winter term, whenever the opportunity shall offer.

Yours, truly and respectfully,

SEARS C. WALKER,
Assistant United States Coast Survey.

To Professor A. D. BACHE, LL. D.,
Superintendent United States Coast Survey.

CONTENTS OF APPENDIX.

15. Report of Lieutenant Commanding W. P. McArthur, United States navy, assistant in the coast survey, on the utility of a light at Blakiston's island, on the Potomac.

16. Extracts from letters from Assistant C. O. Boutelle, to the superintendent, dated January 10 and February 9, 1847, relating to the new inlets formed across Bodies' island in 1846.

17. Correspondence of Lieutenant Commanding C. P. Patterson, with the Mayor of Mobile, with the resolutions adopted by the Board of Aldermen and Common Council of Mobile.

18. Letter of Lieutenant Commanding C. P. Patterson, to Captain Scott, R. N., transmitting information in reference to anchorages in Mississippi sound.

19. Annual report of S. C. Walker, assistant in the coast survey, to the superintendent.